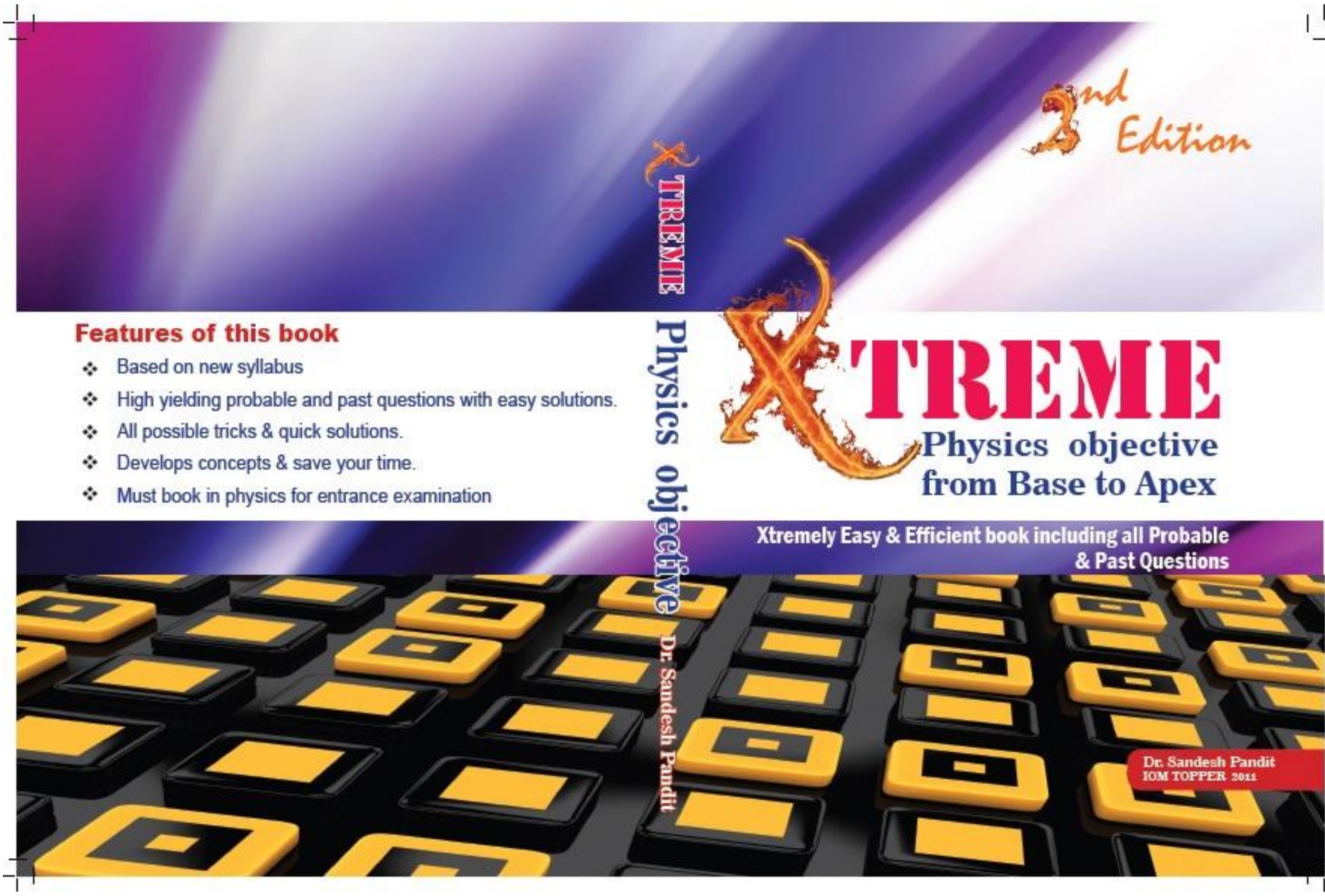
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Chapter: 1

UNITS & DIMENSIONS

1. 'Parsec is the unit of ….

a. Time b. Distance

c. Frequency d. Angular acceleration.

2. Light year is……

a. Light emitted by the sun in one year.

b. Time taken by light to travel from sun to earth.

c. The distance travelled by light in free space in 1 year.

d. Time taken by earth to go once round the sun.

3. 1 x-ray unit is

a. 10^{-10} m b. 10^{-12} m

c. 10^{-13} m d. 10^{-15} m

4. What are the dimensions of angular displacement?

a. [L] b. $[M^0LT^{-1}]$

c. $[L^2]$ d. None

5. A dimensionless quantity

a. is always unitless b. may have a unit

c. must have a unit d. none

6. Which of the following system of unit cannot enter into fundamental units?

a. Length, mass and time

b. velocity, frequency and acceleration

c. Energy, force and gravity

d. volume, time period and moment of inertia.

7. Two quantities A and B have different dimensions. Which mathematical operation given below is physically meaningful?

a. $\frac{A}{B}$ b. A+B

c. A-B d. None

8. Which of the following is not a dimensional constant?

a. Planck's constant

b. Gravitational constant

c. Dielectric constant

d. Gas constant

9. Which of the following is Not dimensionless ?

a. Relative density

b. Relative velocity

c. Relative refractive index

d. Relative permittivity

10. Which of the following is a dimensional constant?

a. refractive index

b. dielectric constant

c. relative density

d. gravitational constant

11. The dimensions of pressure gradient are

a. $ML^{-2}T^{-2}$ b. $ML^{-2}T^{-1}$

c. $ML^{-1}T^{-1}$ d. $ML^{-1}T^{-2}$

12. What is the dimensional formula for $\frac{L}{R^2C}$?

a. $[M^0L^0T^1]$ b. $[M^0L^0T^0]$

c. $[M^0L^0T^2]$ d. $[M^0L^0T^{-2}]$

13. The dimensions of electromotive force in terms of current 'A' are

a. $MT^{-2}A^{-2}$ b. $ML^2T^{-2}A^{-2}$

c. $ML^2T^{-2}A^{-2}$ d. $ML^2T^{-3}A^{-1}$

14. The dimensions of Rydberg's constant are

a. $M^0L^0T^0$ b. MLT^{-1}

c. $M^0L^{-1}T^0$ d. ML^0T^2

15. The dimensions of solar constant are

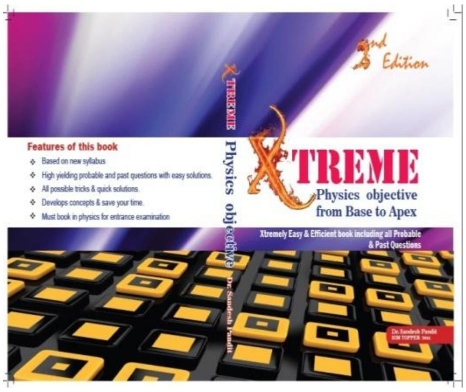
a. $M^0L^0T^0$ b. MLT^{-2}

c. ML^2T^{-2} d. MT^{-3}

16. The dimensions of universal gas constant are

a. $L^2M^1T^{-2}K^{-1}$ b. $L^1M^2T^{-2}K^{-1}$

c. $L^1M^1T^{-2}K^{-1}$ d. $L^2M^2T^{-2}K^{-1}$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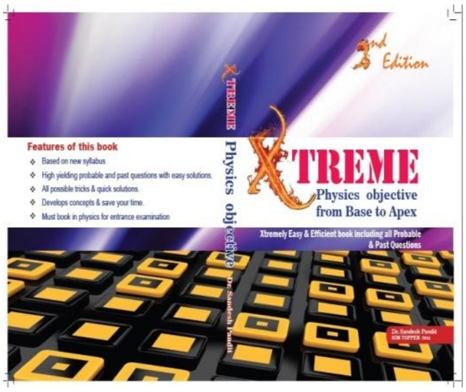
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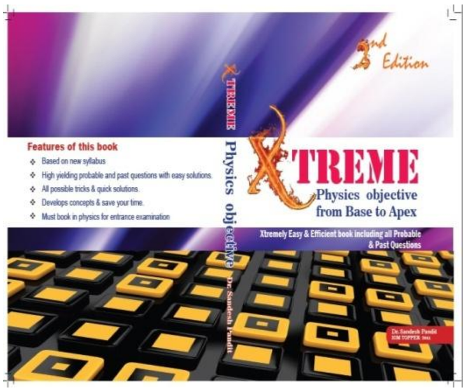
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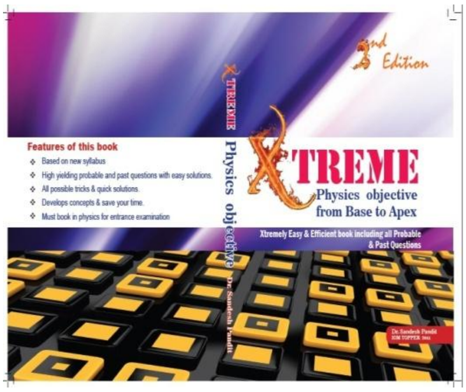
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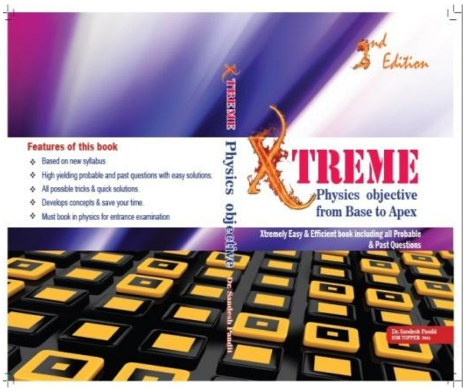
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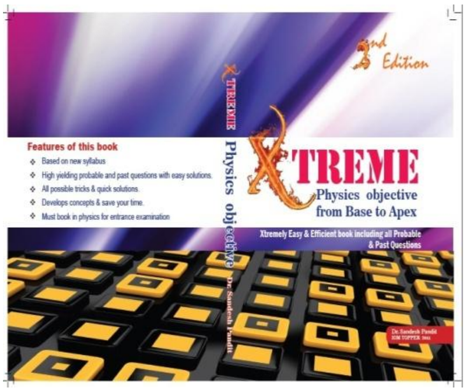
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17. If e is the charge, V the potential difference, T the temperature, the unit of $\frac{eV}{T}$ are same as

a. Planck's constant
b. Stefen's constant
c. Boltzmann constant
d. Gravitational constant

18. The dimensions $\frac{e^2}{\varepsilon_0 hc}$ are

a. $M^{-1}L^{-3}T^4A^2$ b. $ML^3T^{-4}A^{-2}$
c. $M^0L^0T^0A^0$ d. $M^{-1}L^{-3}T^2A$

19. Dimensions of Boltzmann constant are same as that of

a. Pressure density b. Stefan's constant
c. Planck's constant d. entropy

20. The dimensions for $\frac{1}{2}\varepsilon_0E^2$ are (ε_0 = permittivity), (E= Electric field strength.)

a. MLT^{-2} b. ML^0T^{-2}
c. $ML^{-1}T^{-2}$ d. ML^2T^{-2}

21. Which of the following have same dimension

a. Angular momentum and linear momentum.
b. work and power
c. Work and Torque
d. Torque and pressure

22. In vanderwaal's equation $(P+\frac{a}{V^2})(V-b)=RT$, the dimensions of 'a' are

a. $[ML^5T^{-2}]$ b. $[ML^3T^{-1}]$
c. $[M^0L^6T^0]$ d. $[ML^7T^{-2}]$

23. The ratio of dimensions of plank's constant and that of moment of Inertia is the dimension of

a. Velocity
b. Angular momentum
c. Time
d. Frequency

24. If force, length and time are taken as fundamental units, the dimensions of mass are

a. $F^1L^{-1}T^2$ b. $F^0L^0T^2$
c. $F^1L^2T^{-2}$ d. $F^1L^1T^{-2}$

25. The dimension of $\frac{E}{B}$ is same as that of

a. Velocity b. momentum
c. force d. acceleration

Answer Sheet

1. b	*2. c*	*3. c*	*4. d*	*5. b*	*6. b*	*7. a*	*8. c*	*9. b*	*10. d*
11. a	*12. b*	*13. d*	*14. c*	*15. d*	*16. a*	*17. c*	*18. c*	*19. d*	*20. c*
21. c	*22. a*	*23. d*	*24. a*	*25. a*					

SOLUTION

1. Ans. (b)
Par-sec is the unit of length.
1 parsec $=3.08\times10^{16}$m =3.26 light year

2. Ans (c)
1 light year = 9.46×10^{15} m.

3. Ans(c)
1 × ray unit = 10^{-13} m
1 Fermi = 10^{-15} m

4. Ans (d)
Angular displacement = $\frac{l}{r}$ = dimensionless

5. Ans (b)
May have unit eg. Plane angle.

6. Ans (b)
Because mass cannot be measured by these units.

7. Ans (a)

Only like quantities having the same dimensions can be added or subtracted from each other.

8. Ans (c)

Dielectric constant (k) $= \frac{\varepsilon o}{\varepsilon} = [M^o L^o T^o]$

It is constant having no dimensions.

All other are constant and have dimensions.

9. Ans (b)

Relative velocity has dimensions of velocity.

10. Ans. (d)

Gravitational Constant G has constant value and dimensions.

11. Ans (a)

Pressure gradient $= \frac{\text{pressure}}{\text{distance}}$

$= \frac{F}{A \times l} = \frac{MLT^{-2}}{L^3} = ML^{-2}T^{-2}$

12. Ans (b)

$\frac{L}{R^2C} = \frac{L}{R \times RC} = \frac{[T]}{[T]} = [M^0L^0T^0]$

$\boxed{\frac{L}{R} = CR = \sqrt{LC} = [T]}$

13. Ans(d)

Electromotive force = p.d.

$V = \frac{w}{q} = \frac{ML^2T^{-2}}{AT} = MLT^{-3}A^{-1}$

14. Ans(c)

$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

$R = \frac{1}{\lambda} = \frac{1}{L} = [L^{-1}]$

15. Ans (d)

Solar constant = energy/sec/Area

$= [L^0MT^{-3}] = 1400\ w/m^2$

16. Ans (a)

$R = \frac{PV}{T} = \frac{W}{T} = \frac{ML^2T^{-2}}{K} = [ML^2T^{-2}K^{-1}]$

17. Ans (c)

$\frac{eV}{T} = \frac{W}{T} = \frac{PV}{T} = R$

$\frac{R}{N}$ = Boltzmann constant

18. Ans (c)

$F = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2} \Rightarrow, \frac{e^2}{\varepsilon_0} = 4\pi r^2 F$

$\frac{e^2}{\varepsilon_0 hc} = \frac{Fr^2}{hc} = \frac{[MLT^{-2}]L^2}{[ML^2T^{-1}][LT^{-1}]} = [M^0L^0T^0A^0]$

19. Ans (d)

$K = \frac{R}{N} = \frac{PV}{TN} = \frac{Q}{T}$ = entropy

20. Ans (c)

$[ML^{-1}T^{-2}]$

$\frac{1}{2}\varepsilon_0 E^2$ = Energy per unit volume

$= \frac{ML^2T^{-2}}{L^3} = [ML^{-1}T^{-2}]$

21. Ans (c)

Work = F × d = Nm

Torque = F × l = Nm

22. Ans (a)

P and $\frac{a}{V^2}$ are added, they must have same dimensions $P = \frac{a}{V^2}$

a $= [P][V^2] = [ML^{-1}T^{-2}]\,[L^6] = [ML^5T^{-2}]$

b $= [L^3]$

23. Ans (d)

$h = \frac{E}{f} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

Moment of Inertia (I) = ML^2

$\frac{h}{I} = \frac{ML^2T^{-1}}{ML^2} = T^{-1}$ = Frequency

24. Ans (a)

$M = F^aL^bT^c$

$[M] = [MLT^{-2}]^a[L]^bT^c = [M]^a[L]^{a+b}[T]^{-2a+c}$

a=1, (a+b)=0, (–2a+c)=0

$a=1, b=-1, c=2$ $\therefore M = [FL^{-1}T^{-2}]$

25. Ans (a)

$F_e = qE$(in electric field)

$F_m = Bqv$ (in magnetic field)

$qE = Bqv \therefore \frac{E}{B} = V$

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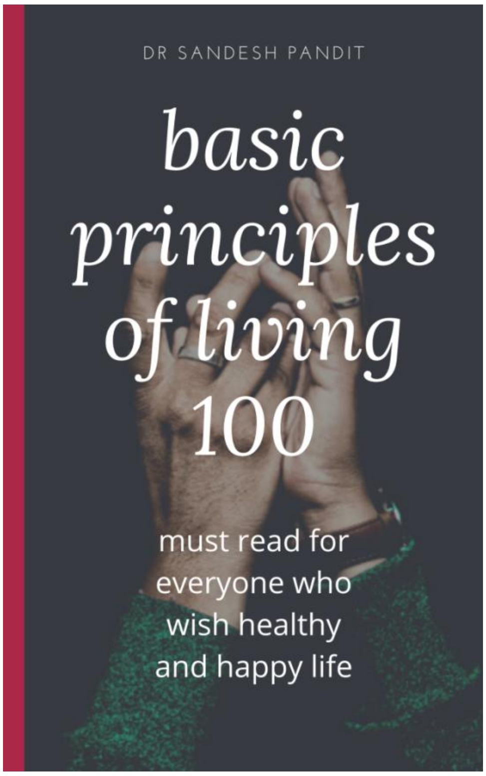

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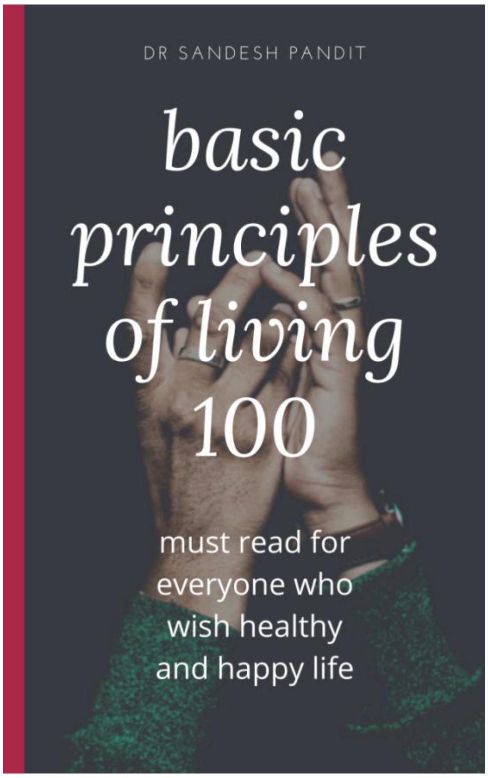
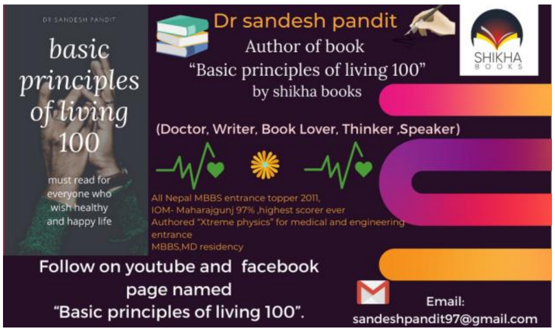
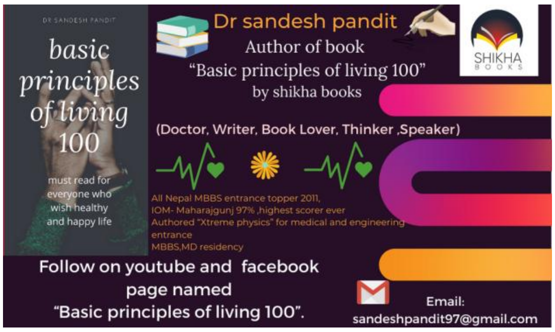
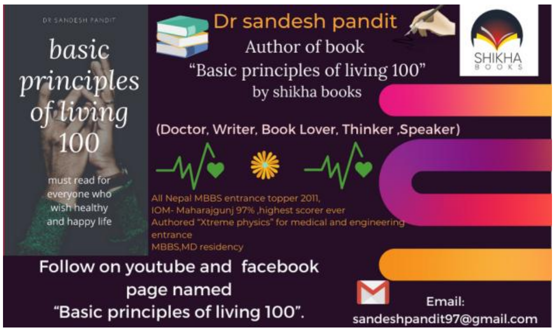
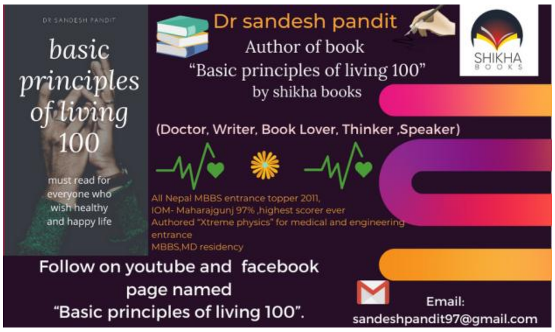
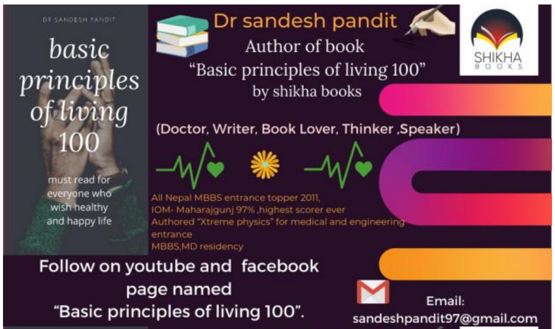


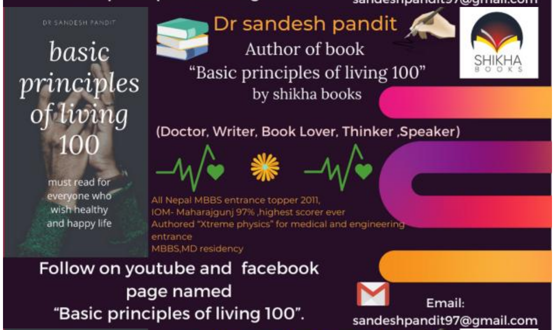


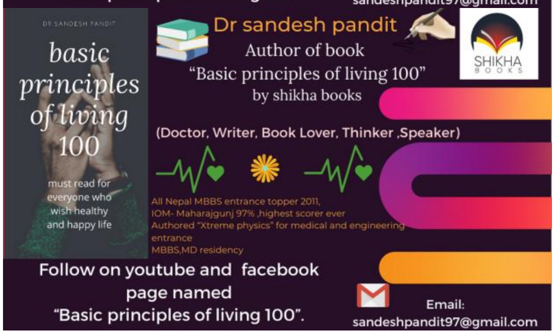












Past Questions

1. Which of the following is the unit of Young's modulus in MKS system. [IOM 2011]

a. N/m b. N/m^2

c. N×m d. $N\times m^2$

2. The star nearest to the earth is 4 light years away. The distance is [IOM 08]

a. 9.46×10^{15}m b. 37.84×10^{12} m

c. 37.84×10^{15} m d. 9.5×10^{12}m

3. Dimension of moment of Inertia of a body is [MOE 068]

a. $M^{+1}L^{-2}T^{1}$ b. $M^{1}L^{2}T^{0}$

c. $M^{2}L^{2}T^{0}$ d. $M^{1}L^{1}T^{1}$

4. The dimension of inductance is [MOE 068]

a. $ML^{2}T^{-2}A^{-2}$ b. $ML^{2}T^{2}A^{-1}$

c. $ML^{2}T^{3}A^{-2}$ d. $MLT^{-1}A^{-1}$

5. I is denoted as current. The dimension of permittivity of vaccum is [MOE 2067]

a. $M^{-1}L^{-3}T^{4}I^{2}$ b. $M^{-1}L^{-3}T^{2}I^{4}$

c. $M^{-1}L^{-2}T^{3}I^{4}$ d. $M^{1}L^{2}T^{3}I^{-4}$

6. Which of the following is a correct unit of gravitational constant? [M0E 09]

a. $m^3\ Kg^{-1}s^{-2}$ b. $m^3kg^{-2}S^{-1}$

c. $m^{-3}kg^{-1}s^{2}$ d. $m^{-3}kg^{2}s^{-1}$

7. NC^{-1} has the same dimension as (KU)

a. Voltmeter b. Faradmeter

c. Farad/meter d. Volt/meter

8. Dimensions of Angstorm (Å), Micron (μ), Fermi (F) and Nanometer (nm) is same. Which of the following represent correct arrangement of the magnitude in decreasing order? [MOE 2009]

a. μ, Å, nm, F b. Å, μ, F , nm

c. F, Å, nm, μ d. μ, nm, Å, F

9. The dimensional formula for stress is the same as that of [MOE 2066]

a. force b. pressure

c. torque d. work

10. SI unit equivalent to magnetic field Telsa(T) may be [MOE 2009]

a. Vsm^{2} b. Vsm^{-2}

c. $Vs^{-1}m^{2}$ d. $V^{-1}sm^{-2}$

11. The dimensional formula for plank's constant is [MOE 2063]

a. $M^{1}L^{2}T^{-1}$ b. $M^{1}L^{2}T^{2}$

c. MLT^{-2} d. $M^{2}L^{2}T^{-1}$

12. The dimensions of angular momentum [MOE]

a. MLT^{-1} b. $ML^{2}T^{-1}$

c. $ML^{-1}T$ d. MLT^{-2}

13. Which of the following have same dimensions [MOE 063]

a. Power and energy

b. Linear momentum and torque

c. Linear momentum and impulse

d. torque and power

14. Which of the following is not a unit of length? [BPKIHS]

a. Parsec b. Light year

c. Debye d. Angstorm

15. The SI unit of electric flux are [IE]

a. $\frac{N}{C^2}$ b. $\frac{N.m}{C}$

c. $\frac{N.m^2}{C}$ d. $\frac{C}{N.m}$

16. The pair NOT having identical dimensions is (BPKIHS)

a. Impulse and Linear momentum

b. Plank's constant and angular momentum

c. moment of inertia and moment of force

d Young's modulus and pressure

17. Astronomical unit (A.U) denotes the distance between (BPKIHS)

a. Sun and earth b. Sun and Mercury

c. Moon and earth d. Two poles of earth

18. If the current in electric bulb drops by 1 % the power decreases by (IOM/ BPKIHS]

a. 10% b. 2%

c. 1% d. 4%

19. If the momentum of a body increases by 100%, what is the percentage change in kinetic energy? [IOM/MOE/ BPKIHS]

a. Increases by 200%

b. Decreases by 100%

c. Increases by 300%

d. Increases by 400%

20. Dimension of torque is [MOE 2069]

a. $M^1L^1T^{-2}$ b. $M^1L^2T^{-2}$

c. $M^1L^1T^{-1}$ d. $M^1L^1T^1$

21. Planck's constant has the dimensions of [MOE 2069]

a. energy b. mass

c. frequency d. Angular momentum

22. Dimension of which are same [BPKIHS-2012]

a. Work & moment of force

b. Torque & force

c. Velocity & velocity gradient

d. All

23. The dimension of Boltzmann's constant is [BPKIHS-2011]

a. $ML^2T^{-2}\theta^{-1}$ b. $ML^2T^{-2}\theta^1$

c. $ML^{-2}T^{-2}\theta^{-1}$ d. $ML^3T^{-2}\theta^{-1}$

24. The dimensional formula for coefficient of viscocity is [BPKIHS -2010]

a. ML^2T^{-2} b. $ML^{-1}T^1$

c. $ML^{-1}T^{-1}$ d. ML^2T^{-1}

25. The dimension of modulus of rigidity is [BPKIHS 2009]

a. $[ML^{-2}T^{-2}]$ b. $[MLT^{-2}]$

c. $[ML^{-1}T^{-1}]$ d. $[ML^{-1}T^{-2}]$

26. Unit of stefan's constant is [IE-2004]

a. watt-m^2 – k^4 b. watt/m^2 – k^4

c. watt/m^2 d. watt – m^2/k^2

Answers

1.b	*2.c*	*3.b*	*4.a*	*5. a*	*6. a*	*7. d*	*8. d*	*9. b*	*10. b*
11. a	*12. b*	*13. c*	*14. c*	*15. c*	*16. c*	*17. a*	*18. b*	*19. c*	*20. b*
21. d	*22. a*	*23. a*	*24. c*	*25. d*	*26. b*				

SOLUTION

1. Ans (b)

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{\frac{F}{A}}{\frac{\Delta L}{L}} = N/m^2$$

Strain = dimensionless

2. Ans (c)
1 light year = 9.46×10^{15} m
4 light year = $4 \times 9.46 \times 10^{15}$m = 37.84×10^{15} m

3. Ans (b)
$I = MR^2 = [ML^2T^0]$

4. Ans (a) $ML^2T^{-2}A^{-2}$
$U = ½ LI^2$
$$L = \frac{\text{Energy}}{\text{Current}^2} = \frac{ML^2T^{-2}}{A^2} = [ML^2T^{-2}A^{-2}]$$

5. Ans (a)
$$\text{Energy stored} = \frac{1}{2}\varepsilon_0 E^2 \times \text{Volume}$$
$$ML^2T^{-2} = \varepsilon_0 \times (\frac{v}{d})^2 \times L^3$$
$$ML^{-1}T^{-1} = \varepsilon_0 \times \frac{(ML^2T^{-2})^2}{(It \times d)^2}$$
$$[W = qv, v = \frac{w}{q} = \frac{W}{It}]$$

OR

Use, $F = \frac{q^2}{4\pi\varepsilon_0 r^2}$ and find ε_0

6. Ans (a)
$$F = \frac{GM^2}{r^2}$$
$$G = \frac{MLT^{-2} \times L^2}{M^2} = M^{-1}L^3T^{-2} = m^3kg^{-1}s^{-2}$$

7. Ans (d)Volt/meter
$$E = \frac{F}{q} \text{ and } E = \frac{V}{d}$$

8. And (d)
$\mu = 10^{-6}$ m
Å = 10^{-10} m
nm = 10^{-9} m
F = 10^{-15} m
μ, nm, Å, F(decreasing order)

9. Ans (b) Pressure
$$\text{Stress} = \text{pressure} = \frac{F}{A}$$

10. Ans (b)
$$v = \frac{E}{B} \qquad ms^{-1} = \frac{V}{m \times T}$$
$T = V\,Sm^{-2}$

11. $E = hf$
$$h = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$$

12. Ans(b)
$L = mvr = ML^2T^{-1}$

13. Ans (c)
$P = mv = [MLT^{-1}]$
Impulse = $F \times \Delta t = [MLT^{-1}]$

14. Ans (c)
Debye = Unit of Dipole momentum
1 Debye = 10^{-18}esu cm = Charge × distance

15. Ans (c)
$$\phi = E.\,A = \frac{N}{C}.m^2 \;(F = qE)$$
$$E = \frac{N}{C} = \frac{V}{d}$$

16. Ans (c)
Moment of inertia = $MR^2 = ML^2$
Moment of force or Torque = $F \times r = [M\,L^2T^{-2}]$

17. Ans (a)
1 AU= 1.5×10^{11} m
= distance between sun and earth.

18. Ans (b) 2%
$P = I^2R$ (If % change is less than 10%) then
$$\frac{\Delta p}{p} = \frac{\Delta I}{I} \times 100\% = 2 \times 1 = 2\%$$

19. Ans (c)
$$E = \frac{p^2}{2m} \Rightarrow E \,\alpha P^2 \;\therefore n = 2 \qquad X = 100\%$$
$$\frac{\Delta E}{E} \times 100\% = [(1 + \frac{x}{100})^n - 1] \times 100\%$$
$= [(1 + 1)^2 - 1] \times 100\% = 300\%$
Use + ve in x if ↑, –ve if ↓.

20 Ans (b)
$$\text{Torque} = \frac{dL}{dt} = \frac{mvr}{dt} = \frac{[MLT^{-1}]\,[L]}{[T]} = [ML^2T^{-2}]$$

21. Ans. (d)

$\boxed{mvr = \frac{nh}{2\pi}}$ OR

$E = \frac{h}{f} \Rightarrow [h] = \frac{[E]}{[f]} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

$L = mvr = [ML^2T^{-1}]$

22. Ans. (a)

Work = energy = $[ML^2T^{-2}]$

Moment of force = $\vec{r} \times \vec{f}$

(Torque) = $[L] \times [MLT^{-2}] = [ML^2T^{-2}]$

23. Ans. (a)

$K = \frac{R}{N} = \frac{Pv}{TN} = \frac{\text{Energy}}{\text{Temperature}} = ML^2T^{-2}\theta^{-1}$

or, $ML^2T^{-2}K^{-1}$

24. Ans. (c)

$F = 6\pi\eta rv$ or $F = \eta A \frac{dv}{dx}$

$[\eta] = \frac{[F]}{[r]\,[v]} = \frac{[MLT^{-2}]}{[L]\,[LT^{-1}]} = [ML^{-1}T^{-1}]$

25. Ans. (d)

Modulus of rigidity

$= \frac{\text{Shearing stress}}{\text{shearing strain}} = \frac{F/A}{\phi} = [ML^{-1}T^{-2}]$

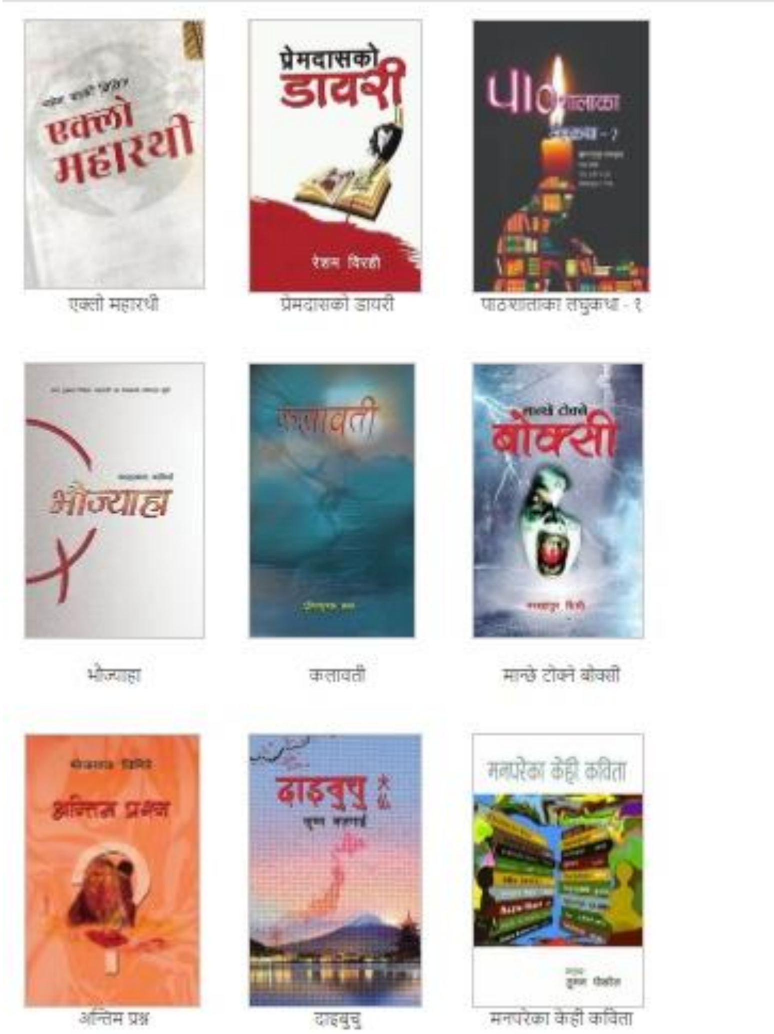
Pressure = Stress = Modulus of elasticity = $[ML^{-1}T^{-2}]$

26. Ans. (b)

$E = \sigma t^4$

$\sigma = \text{watt/m}^2 - k^4$

SHIKHA BOOKS –BOOKS FROM SHIKHA BOOKS



Chapter: 2

VECTORS & SCALARS

1. What is the maximum number of components into which vector can be split?

a. Two b. Three

c. Four d. any no of components.

2. The minimum number of vectors of equal magnitude required to produce zero resultant is

a. 2 b. 3

c. 4 d. more than 4

3. The minimum number of vectors of unequal magnitude required to produce a zero resultant

a. 2 b. 3

c. 4 d. more than 4

4. Which of the following is a scalar quantity ?

a. Electric field b. Electrostatic potential

c. Angular moment d. Torque

5. A vector quantity

a. may have direction

b. must have direction

c. Never have direction

d. Never exists

6. A physical quantity having direction

a. may not be vector b. must be vector

c. never be vector d. never exists

7. Small elementary area is

a. scalar

b. vector

c. neither scalar nor vector

d. sometimes scalar and sometimes vector.

8. Moment of inertia is

a. scalar

b. vector

c. Scalar and vector both

d. Tensor

9. Which of the following can't be resultant of vectors of magnitude 4 and 12 ?

a. 4 b. 10

c. 13 d. 15

10. The magnitudes of set of three vectors of same type are given below. The resultant of which cannot be zero?

a. 10,10,10 b. 10,15,20

c. 10,20,20 d. 10,20,40

11. The angle between $\vec{A}$ and $\vec{B}$ is θ. The value of triple product $\vec{A}.(\vec{B}\times\vec{A})$.

a. Zero b. A^2B

c. $A^2B \sin\theta$ d. $A^2B \cos\theta$

12. Which of the following is not defined in Vectors?

a. addition b. subtraction

c. division d. multiplication

13. At what angle should the two unit vectors be inclined so that their resultant is also a unit vector?

a. 30^0 b. 60^0

c. 120^0 d. 150^0

14. What is the angle between i + j+ k and i?

a. $\sin^{-1}(\frac{1}{3})$ b. $\sin^{-1}(\frac{1}{\sqrt{3}})$

c. $\cos^{-1}(\frac{1}{3})$ d. $\cos^{-1}(\frac{1}{\sqrt{3}})$

15. The unit of vector along $\hat{\imath}+\hat{\jmath}$ is

a. $\vec{k}$ b. $\hat{\imath}+\hat{\jmath}$

c. $\frac{\hat{\imath}+\hat{\jmath}}{\sqrt{2}}$ d. $\frac{\hat{\imath}+\hat{\jmath}}{2}$

16. The sum of two vectors A and B is at right angles to their differences then

a. A = B b. A = 2 B

c. B = 2A d. A = 0

17. Two vectors A and B are inclined at each other at an angle θ. Which of the following is a unit vector perpendicular to both A and B ?

a. $\frac{\vec{A}\times\vec{B}}{\vec{A}.\vec{B}}$ b. $\frac{\hat{A}\times\hat{B}}{Sin\,\theta}$

c. $\frac{\vec{A}\times\vec{B}}{AB\,Sin\,\theta}$ d. $\frac{\vec{A}\times\vec{B}}{AB\,Sin\,\theta}$

18. Two vectors $\vec{A}$ and $\vec{B}$ are such that $|\vec{A}+\vec{B}|$ = $|\vec{A}-\vec{B}|$, then the angles between the vectors A and B is

a. 0^0 b. 60^0

c. 90^0 d. 180^0

19. The angle between $\hat{\imath}+\hat{\jmath}$ and $\hat{\imath}$ is

a. $\frac{\pi}{6}$ b. $\frac{\pi}{4}$

c. $\frac{\pi}{2}$ d. $Cos^{-1}(\frac{1}{\sqrt{3}})$

20. The magnitude of sum of two vectors is equal to difference of their magnitudes. Then angle between those vectors should be.

a. 60^0 b. 90^0

c. 120^0 d. 180^0

21. The sum of two unit vectors is also a unit vector. Then their differences will be

a. 2 b. $\sqrt{2}$

c. $\sqrt{3}$ d. Zero

22. Three vecors $\vec{A}$, $\vec{B}$ and $\vec{C}$ are such that $\vec{A}.\vec{B}$ = 0 and $\vec{A}.\vec{C}$ = 0. Then vector $\vec{A}$ is parallel to

a. $\vec{B}$ b. $\vec{C}$

c. $\vec{A}\times\vec{B}$ d. $\vec{B}\times\vec{C}$

23. The resultant of two vectors $\vec{P}$ and $\vec{Q}$ is perpendicular to $\vec{P}$ and the magnitude of resultant is P. Then the magnitude of $\vec{Q}$ will be

a. $\sqrt{2}$ P b. 2P

c. $\sqrt{3}$ P d. P

24. What is the angle between $\vec{P}\times\vec{Q}$ and $\vec{Q}\times\vec{P}$?

a. 0 b. π

c. $\frac{\pi}{2}$ d. $\frac{\pi}{4}$

25. If $\vec{A}.\vec{B} = |\vec{A}\times\vec{B}|$, then the magnitude of $(\vec{A}+\vec{B})$ is

a. $\sqrt{A^2+B^2}$ b. A + B

c. $\sqrt{A^2+B^2+\sqrt{2AB}}$ d. $\sqrt{A^2+B^2+\frac{AB}{\sqrt{2}}}$

26. If a vector $\vec{2\imath}+\vec{2\jmath}$ is rotated through 90^0. It is changed by

a. 4 $\vec{\imath}$ b. -4$\vec{\imath}$

c. $2\sqrt{2}\,\vec{\imath}$ d. 2 $\vec{\jmath}$

27. A vector $\vec{a}$ is turned through angle θ about its initial position. The magnitude of change in vector $|\Delta\vec{a}|$ is

a. 2a Cos θ b. 2a Sin θ

c. 2a Sin $\frac{\theta}{2}$ d. 2a Cos $\frac{\theta}{2}$

28. The maximum value of magnitude $\vec{A}$-$\vec{B}$ is

a. A-B b. A

c. A +B d. $\sqrt{A^2+B^2}$

29. What is the projection of

$\vec{\imath}+2\vec{\jmath}+3\vec{k}$ on $\vec{\imath}+\vec{\jmath}+\vec{k}$.

a. $3\sqrt{2}$ b. $2\sqrt{3}$

c. $\sqrt{3}$ d. $4\sqrt{2}$

30. If $\vec{A} = \hat{\imath}+2\hat{\jmath}+3\hat{k}$ and $\vec{B} = 3\hat{\imath}-2\hat{\jmath}+\hat{k}$ then the area of parallelogram from these in square unit is

a. $16\sqrt{3}$ b. $8\sqrt{3}$

c. 64 d. zero

Answers

1. d	*2. a*	*3. b*	*4. b*	*5. b*	*6. a*	*7. b*	*8. d*	*9. a*	*10. d*
11. a	*12. c*	*13. c*	*14. d*	*15. c*	*16. a*	*17. b*	*18. c*	*19. b*	*20. d*

21. c	22. d	23. a	24. b	25. c	26. b	27. c	28. c	29. b	30. b

SOLUTION

1. Ans (d)
   A vector can be split into any no of components. 3 rectangular component in space and 2 rectangular component in its own plane.
2. Ans (a)
   Two vectors of equal magnitude & directed in opposite direction.
3. Ans (b)
   Three vectors of unequal magnitude, represented as 3 sides of triangle taken in order.
4. Ans (b)
   All potentials and fluxes $\rightarrow$scalars
   Field, intensities, gradients $\rightarrow$ vectors
5. Ans (b)
   Vector must have direction.
6. Ans (a)
   Current although have direction it is scalar, as it does not obeys laws of vector addition.
7. Ans (b)
   Large area is scalar, small elementary area is vector.
8. Ans (d)
   Tensor

- Its magnitude differs from direction to direction.

9. Ans (a)
   $(a-b) < R \leq (a+b)$
   $8 \leq R \leq 16$
   4 is out of Range.
10. Ans (d)
    The resultant is zero if they can form triangle i.e. sum of two sides > third side.
    10+20 = 30 < 40, so can't form triangle.
11. Ans (a)
    The $(\vec{B}\times\vec{A})$ resultant is $\perp$ to $\vec{A}$.
    Their dot product results zero.
12. Ans (c)
    $\dfrac{\overrightarrow{\text{vector}}}{\overrightarrow{\text{vector}}}$ = Not defined
13. Ans (c)
    $R^2 = A^2 + B^2 + 2AB \cos\theta$
    or, $1 = 2 + 2 \cos \theta$
    or, $\cos \theta = -\frac{1}{2} = 120^0$
14. Ans (c)
    $\vec{a} = \hat{\mathbf{i}}$ $\vec{b} = \hat{\mathbf{i}} + \hat{\mathbf{i}} + \hat{k}$
    $\cos \theta = \frac{\vec{a}.\vec{b}}{ab} = \frac{1}{1.\sqrt{3}}$
    $\theta = \cos^{-1} \frac{1}{\sqrt{3}}$
15. Ans (c)
    $\hat{a} = \frac{\vec{a}}{|\vec{a}|} = \frac{i+j}{\sqrt{1^2+1^2}} = \frac{i+j}{\sqrt{2}}$
16. Ans (a)
    $(\vec{A}+\vec{B}).(\vec{A}-\vec{B}) = 0$
    $A^2 - B^2 = 0$
    $A = B$
17. Ans (b)
    $\vec{A}\times\vec{B} = AB \sin\theta\, \hat{n}$
    $\hat{n} = \frac{\vec{A}\times\vec{B}}{AB \sin\theta} = \frac{\hat{A}\times\hat{B}}{\sin\theta}$
18. Ans (c)
    $|\vec{A}+\vec{B}| = |\vec{A}-\vec{B}|$
    $A^2 + B^2 + 2AB \cos\theta = A^2+B^2-2AB\cos\theta$
    or, $\cos \theta = o$
    $\therefore$ $\theta = 90^0$
19. Ans (b)
    $\vec{a}.\vec{b} = ab\cos\theta;\ \theta \Rightarrow = \cos^{-1}\frac{\vec{a}.\vec{b}}{ab}$
    $\theta = \cos^{-1}\frac{(\hat{i}+\hat{j}).\hat{i}}{.\sqrt{1^2+1^2}.1} = \cos^{-1}(\frac{1}{\sqrt{2}}) = \frac{\pi}{4}$
20. Ans (d)

$|\vec{a}+\vec{b}| = a - b$

$a^2 + b^2 + 2ab\ \text{Cos}\ \theta = (a-b)^2$

$\text{Cos}\ \theta = -1$

$\theta = 180^0$

21. Ans (c) $\sqrt{3}$

$l^2 + l^2 + 2.l^2\ \text{Cos}\ \theta = 1$

$\text{Cos}\ \theta = -\frac{1}{2} \Rightarrow \theta = 120^0$

$|\vec{a}-\vec{b}| = \sqrt{a^2 + b^2 - 2ab\ \text{Cos}\ \theta}$

$= \sqrt{1 + 1 - 2.1.1 \times \frac{-1}{2}} = \sqrt{3}$

22. Ans (d)

$\vec{A}.\vec{B} = 0 \rightarrow \vec{A} \perp \vec{B}$

$\vec{A}.\vec{C} = 0 \rightarrow \vec{A} \perp \vec{C}$

Resultant of $\vec{B}\times\vec{C}$ is $\perp$ to both $\vec{B}$ and $\vec{C}$

$\therefore$ $\vec{A} \parallel \vec{B}\times\vec{C}$

23. Ans (a)

$\text{Tan}\ 90^0 = \frac{Q\ \text{Sin}\ \theta}{P + Q\ \text{Cos}\ \theta} = \frac{1}{0}$

$\text{Cos}\ \theta = \frac{-P}{Q}$

$|\vec{P}+\vec{Q}| = P$

$P^2 + Q^2 + 2\ PQ\ \text{Cos}\ \theta = P^2$

or, $2PQ \times \frac{-P}{Q} = -Q^2 \Rightarrow Q = \sqrt{2}\ P$

24. Ans (b)

$\vec{P}\times\vec{Q} = -(\vec{Q}\times\vec{P})$

25. Ans (c)

$\vec{A}.\vec{B} = |\vec{A}\times\vec{B}|\ \therefore \theta = 45^0$

$(\vec{A}+\vec{B}) = \sqrt{A^2 + 2AB\ \text{Cos}\ 45^0 + B^2}$

$= \sqrt{A^2 + B^2 + \sqrt{2}AB}$

26. Ans (b)

2i + 2j is $\perp$ to new vector. Dot product = 0

New vector = $-2\vec{i}+2\vec{j}$

$\Delta\vec{v} = (-2\vec{i} + 2\vec{j}) - (2\vec{i} + 2\vec{j}) = -4\vec{i}$

27. Ans (c)

$\vec{a}$ becomes $\vec{b}$ after θ.

$|\Delta\vec{a}|^2 = |\vec{a}-\vec{b}|^2 = a^2 + b^2 - 2ab\ \text{Cos}\ \theta$

$= 2\ a^2 - 2a^2\ \text{Cos}\ \theta\ (|\vec{b}| = |\vec{a}|)$

$= 2a^2\ (1 - \text{Cos}\ \theta) = 4\ a^2\ \text{Sin}^2\frac{\theta}{2}$

$\therefore$ $|\Delta\vec{a}| = 2a\ \text{Sin}\ \frac{\theta}{2}$

28. Ans (C)

Max = A + B

Min = A- B

29. Ans (b)

$= \vec{i} + 2\vec{j} + 3\vec{k}.\frac{\vec{i}+\vec{j}+\vec{k}}{|\vec{i}+\vec{j}+\vec{k}|}$

$= \frac{1+2+3}{\sqrt{3}} = 2\sqrt{3}$

30. Ans.(b)

$\vec{A}\times\vec{B} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 1 & 2 & 3 \\ 3 & -2 & 1 \end{vmatrix}$

$= \hat{i}\begin{vmatrix} 2 & 3 \\ -2 & 1 \end{vmatrix} - \hat{j}\begin{vmatrix} 1 & 2 \\ 3 & -2 \end{vmatrix} + \hat{k}\begin{vmatrix} 1 & 2 \\ -3 & 2 \end{vmatrix}$

$= 8\hat{i} - 8\hat{j} - 8\hat{k}$ $|\vec{A}\times\vec{B}| = 8\sqrt{3}$

Past Questions

1. Two forces of magnitude F have a resultant of same magnitude F. The angle between two forces is [IOM 2008]

a. 45^0 b. 120^0

c. 150^0 d. 180^0

2. Three vectors are arranged to form a right angled triangle of sides 5,12,13 units. The sum of the two vectors is equal to third. The angle between those of magnitude 12 and 13 is [IOM 2005]

a. $\text{Sin}^{-1}\left(\frac{12}{13}\right)$ b. $\text{Cos}^{-1}\left(\frac{12}{13}\right)$

c. $\text{Cos}^{-1}\left(\frac{5}{13}\right)$ d. $\text{Tan}^{-1}\left(\frac{5}{13}\right)$

3. The resultant of F_1 and F_2 is F_1 and the resultant is at right angled to the force F_1. Then the Force F_2 is equal to [IOM 2002]

a. $2\,F_1$ b. 0

c. F_1 d. $\sqrt{2}\,F_1$

4. Magnetic moment is [IOM 2001]

a. Scalar quantity

b. Vector quantity

c. Tensor

d. None

5. Three forces of magnitude 1N, 3N and 2 N are acting at angles of 0^0, 90^0 and 120^0 with +ve X-axis. Then resultant will act along [MOE]

a. Positive X-axis b. Positive Y-axis

c. Negative X-axis d. Negative X-axis

6. The condition for $\vec{A} + \vec{B} = \vec{A} - \vec{B}$ is that [BPKIHS 2005]

a. $\vec{\mathbf{B}} = 0$ b. $\vec{\mathbf{B}}$ is unit vector

c. $\vec{\mathbf{A}} = \vec{\mathbf{B}}$ d. $\vec{\mathbf{A}} = 0$

7. A vector remains unchanged [KU 2010]

a. When rotated by an arbitrary angle.

b. When cross multiplied by unit vector

c. Multiplied by scalar

d. When slided paralled to itself.

8. Which of the following is vector? [IOM 2012]

a. Electric charge

b. Electric potential

c. Charge density

d. Electric field intensity

9. If more than 3 forces are acting on a body. Then, the force should be in equilibrium: [BPKIHS 2012]

a. Collinear b. Coplanar

c. should form a closed polygon

d. None

10. Two vectors $\vec{A} = 5\hat{i} + 7\hat{j} - 3\hat{k}$ and $\vec{B} = 2\hat{i} + 2\hat{j} - a\hat{k}$ are perpendicular to each other, then value of is [BPKIHS 2012]

a. 12 b. –12

c. 8 d. –8

11. The radius vector and linear momentum are respectively given by vector $2\hat{i} + \hat{j} + \hat{k}$ and $2\hat{i} - 3\hat{j} + \hat{k}$. Then angular momentum is: [BPKIHS 2008]

a. $2\hat{i} - 4\hat{j}$ b. $4\hat{i} - 8\hat{k}$

c. $2\hat{i} - 4\hat{j} + 2\hat{k}$ d. $4\hat{i} - 8\hat{j}$

Answers Sheet

1. b	*2. b*	*3. d*	*4. b*	*5. b*	*6. a*	*7. d*	*8. d*	*9. c*	*10. c*	*11. b*

SOLUTION

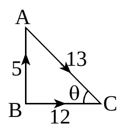
1. Ans (b)

$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$

$F^2 = F^2 + F^2 + 2F^2\cos\theta$

$\cos\theta = -1/2 \Rightarrow \theta = 120^0$

2. Ans (b) $\overrightarrow{\mathbf{AC}} = \overrightarrow{\mathbf{AB}} + \overrightarrow{\mathbf{BC}}$

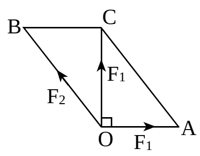


$\cos\theta = \frac{12}{13} = \frac{b}{h}$

$\theta = \cos^{-1}\left(\frac{12}{13}\right)$

3. Ans. (d) $R = F_1$

ΔOCA,



$CA = \left(\sqrt{F_1^2 + F_1^2}\right) = \sqrt{2}\,F_1$

$CA = OB = F_2 = \sqrt{2}\,F_1$

4. Ans (b)

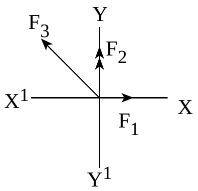
Magnetic moment have both magnitude and direction and follows vector law of addition.

5. Ans (b)

Direction of resultant between F1 and F3

$\text{Tan}\,\alpha = \dfrac{F_3 \text{ Sin } \theta}{F_1 + F_3 \text{ Cos } \theta}$

$= \dfrac{2 \text{ Sin } 120^0}{1 + 2 \text{ Cos } 120^0} = \infty$



$\therefore \quad \alpha = 90^0$

R_{13} is along F_2 so along +ve Y-axis.

6. Ans (a)

$\vec{\mathbf{A}} + \vec{\mathbf{B}} = \vec{\mathbf{A}} - \vec{\mathbf{B}}$

$2\vec{\mathbf{B}} = 0 \;\therefore \vec{\mathbf{B}} = 0$

7. And (d)

Vector remains unchanged when shifted parallel to itself. When rotated change in position vector (2a $\text{Sin}\frac{\theta}{2}$).

8. Ans (d)

Charge, potential and density all are scalar. Electric field intensity is vector.

9. Ans. (c)

If more than 3 forces are acting on a body, then for the force acting to be in equilibrium, they should form a closed polygon.

10. Ans. (c)

$\vec{A} = 5\hat{i} + 7\hat{j} - 3\hat{k}$

$\vec{B} = 2\hat{i} + 2\hat{j} - a\hat{k}$

For perpendicular vector, $\vec{A}.\vec{B} = 0$

So, $10 + 14 - 3a = 0$

or, $3a = 24$

$\therefore \quad a = 8$

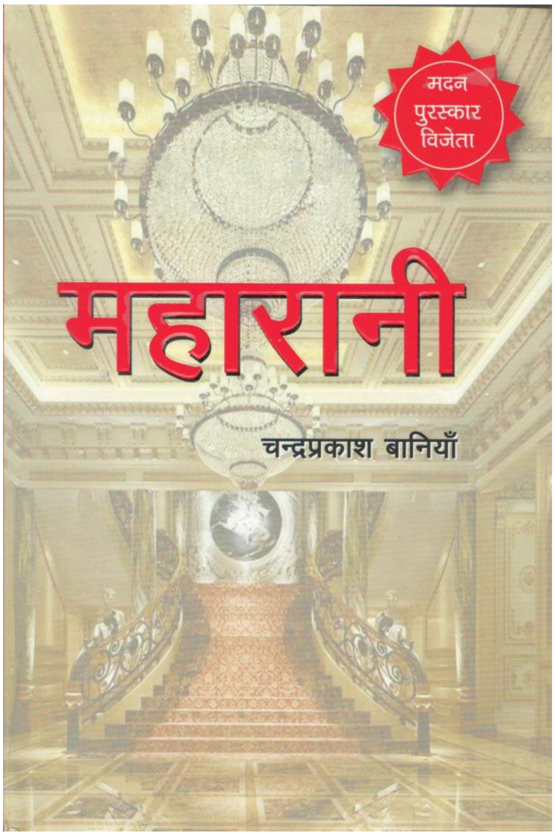
11. Ans. (b)

$\vec{L} = \vec{r} \times \vec{p}$

or, $\vec{L} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 2 & 1 & 1 \\ 2 & -3 & 1 \end{vmatrix}$

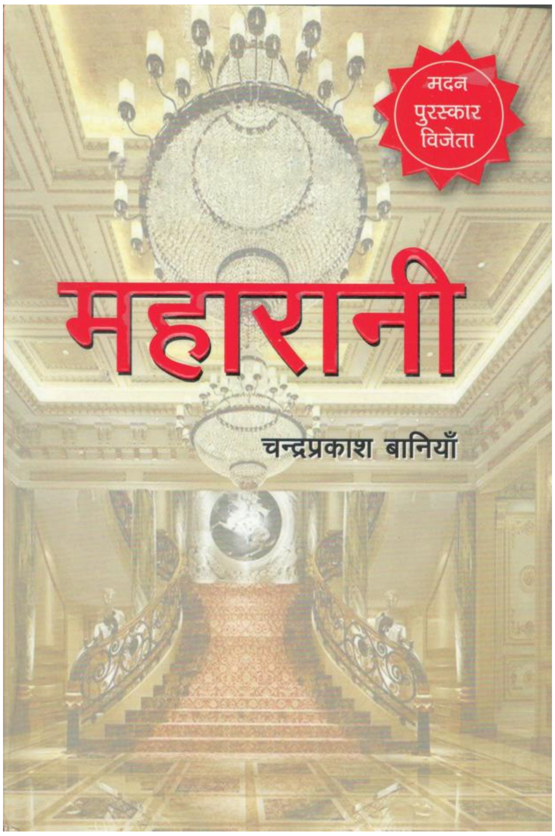
$= \vec{i}(1 + 3) - \vec{j}(2 - 2) + \vec{k}(-6 - 2)$

$= 4\vec{i} - 8\vec{k}$



MADAN PURASKAR WINNER

TOP SELLER FROM SHIKHA BOOKS



Chapter: 3

MOTION IN ONE DIMENSION

1. If the displacement of a body is proportional to square of time, then the body has

a. uniform velocity
b. Uniform acceleration
c. Increasing acceleration
d. decreasing acceleration

2. If the displacement of a body is proportional to cube of time, then body has

a. uniform velocity
b. Uniform acceleration
c. increasing acceleration
d. Decreasing acceleration

3. A body is thrown upward and reaches the maximum height. At maximum height

a. Velocity and acceleration both zero.
b. Velocity is zero and acceleration is maximum.
c. Velocity is max and acceleration is minimum.
d. Velocity is zero and acceleration is equal to 'g'.

4. The distance moved by a uniformly accelerating body from rest in time 't' is proportional to

a. $t^{1/2}$ b. t
c. t^2 d. $t^{3/2}$

5. The displacement 'x' as a function of time 't' is given by x = aSinωt. The acceleration of the particle is

a. $-a \sin \omega t$ b. $a\omega^2 \sin \omega t$
b. $-a\omega^2 \sin \omega t$ d. $a\omega^2 \cos\omega t$

6. For motion on a straight line with constant acceleration, the ratio of the magnitude of displacement to distance covered is

a. =1 b. >1
c. <1 d. ≤1

7. The displacement 's' of a particle along a straight line at time t is given by $s = a + bt + ct^2$. The acceleration of the particle is

a. a b. b
c. 2b d. 2c

8. The displacement of a particle moving in a straight line at any instant time t is given as $x = t^2 + 20$ (meter). What is the average velocity for first four seconds?

a. 4 m/s b. 6 m/s
c. 8 m/s d. 10 m/s

9. A car accelerates at constant rate a_1 for time t_1 and then retards at the constant rate a_2 for time t_2 and comes to rest. t_1/t_2 =

a. $\frac{a_1}{a_2}$ b. $\frac{a_2}{a_1}$
c. $(\frac{a_1}{a_2})^2$ d. $(\frac{a_2}{a_1})^2$

10. A ball is dropped from the top of a tower 100 m high. Simultaneously, another ball is thrown upward with a speed of 50 m/s. At what time do they cross each other?

a. 1 s b. 2 s
c. 3 s d. 4 s

11. A particle under the action of constant force moves from rest upto 20 seconds. If distance covered in first 10 seconds is s_1 and that covered in next 10 seconds is s_2 then

a. $s_1 = s_2$ b. $s_2 = 3s_1$
c. $s_2 = 2s_1$ d. $s_2 = 4s_1$

12. A body falls freely from rest and has velocity v after it fall through a height h. The distance it has to fall down further for its velocity to become double is

a. h b. 2h
c. 3 h d. 4 h

13. If ball A is dropped from top of a building and another ball B is thrown horizontally from same height at the same moment with the same velocity then ball

a. A reaches ground first

b. B reaches ground first

c. A has greater speed, when it reaches ground.

d. B has greater speed, when it reaches ground.

14. Speeds of two identical cars are u and 4u at a specific instant. The ratio of the respective distances in which two cars are stopped form that instant is

a. 1:1 b. 1:4

c. 1:8 d. 1:16

15. A ball A is thrown vertically upward at initial speed u, while another ball B is dropped from a height at the same instant. After time 't', their relative velocity w.r.t one another will be

a. u b. 2gt

c. 2gt – u d. u – 2gt

16. A ball is projected vertically upwards from the ground. It is found at the same elevation at t = 3 and t =7 after projection. Find the projection speed.

a. 30s b. 50 s

c. 40s d. 70 s

17. Two trains, each 50 m long are travelling in opposite directions with velocity with 10m/s and 15m/s. The time of crossing is,

a. 2 s b. 4s

c. $2\sqrt{3}$ s d. $4\sqrt{3}$ s

18. If a ball is thrown vertically upwards with speed u, the distance covered during the last t second of its ascent is

a. ut b. (u + gt)t

c. $\frac{1}{2}gt^2$ d. $ut - \frac{1}{2}gt^2$

19. A body is thrown upwards with velocity 100 m/s and it travels 5 m in last second of its upward journey. If the same body is thrown upwards with velocity 200 m/s. What distance will it travel in the last second of upward journey?

a. 5 m b. 10 m

c. 20 m d. 25 m

20. A stone is dropped from top of tower. If it covers 24.5 m in the last seconds of its motion. The height of the tower is

a. 44.1 m b. 49 m

c. 78.4 m d. 72 m

21. A lion chases a deer 30m ahead of it and gains 3 m in 5 s after the chase started. After 10 s, the distance between them is

a. 16 m b. 17m

c. 18m d. 12 m

22. A balloon is going upwards with velocity 12 m/s. It releases a packet when it is at height of 65 m from ground. How much time will the packet take to reach the ground. ($g = 10\ m/s^2$)

a. 5 s b. 6 s

c. 7 s d. 8 s

23. A body released from a great height falls freely towards earth. Another body is released from same height exactly one second later. The separation between two bodies two seconds after the release of second body is

a. 19.6 m b. 24.5 m

c. 4.9 m d. 9.8 m

24. A train of 150m length is going towards north direction at a speed of 10 m/s. A parrot flies at a speed of 5 m/s towards south direction parallel to railway track. The time taken by parrot to cross the train is

a. 12 s b. 8 s

c. 15 s d. 10 s

25. A bus begins to move with an acceleration of $2 m/s^2$. A boy who is 100 m behind the bus; starts running at 20m/s. After what time will the boy be able to catch the bus?

a. 6 s b. 8s

c. 10s d. The boy can't catch the bus

26. A man in a balloon rising vertically with an acceleration of $4.9 m/s^2$ releases a ball 2s after a balloon is let go from the ground. The max. height above the ground reached by the ball is;

a. 9.8 m b. 14.7 m

c. 19.6 m d. 24.5 m

27. A Particle covers one half of a circle of radius r. Then the distance and displacement of the particle are

a. $2\pi r$, r b. πr, 2r

c. πr, r d. $\frac{\pi r}{2}$, r

28. A balloon is rising upward at constant velocity 15 m/s. At height 50 m above the ground, a stone is released from that balloon. The stone reaches the ground in

a. 3 s b. 5 s

c. 7.5 s d. 10 s

29. The relation between the time 't' and distance 'x' is $t = ax^2 + bx$ where a and b are constants. The retardation is

a. $2av^3$ b. $2bv^3$

c. $2abv^3$ d. $2b^2v^3$

30. A particle is thrown vertically upwards with speed 100m/s. The time taken to reach the body back on earth is

a. 10 s b. 20 s

c. 15 s d. 5 s

31. A particle is projected vertically upwards and it is at a height h after 2 s and again after 8 s. The height 'h' is

a. 50 m b. 40 m

c. 80 m d. 125 m

32. A body starts from rest and falls vertically through a height of 19.6 m. If g = $9.8 m/s^2$, the time taken by the body to fall through the last meter of its fall is.

a. 0.45 s b. 1.95 s

c. 0.05 s d. 2 s

33. Two bodies are thrown vertically upwards with their initial velocities in the ratio 2:3. Then the ratio of max height attained by them is

a. $\sqrt{2}:\sqrt{3}$ b. 2:3

c. 4:9 d. 8:27

34. A ball is dropped from top of a building and its time of fall is 't'. In the last $(t/4)^{th}$ time of its fall it travels 1.4 m. Find out the height of the building?

a. 5.6m b. 7.2 m

c. 3.2 m d. 16m

35. A vehicle moving at constant acceleration along a straight road has velocities u and v at two points A and B on the road. Then its velocity at midway between A and B will be

a. $\frac{2uv}{u+v}$ b. $\sqrt{\frac{u^2+v^2}{2}}$

c. $\frac{1}{2}\sqrt{u^2+v^2}$ d. $\frac{u+v}{2}$

36. A body is projected vertically upward from point A, the top of a tower. It reaches the ground in t_1 secs. If it is projected vertically downwards from A with the same velocity, it reaches the ground in t_2 Secs. If it falls freely from A, it would reach ground in

a. $\frac{t_1 + t_2}{2}$ s b. $\frac{t_1 - t_2}{2}$ s

c. t_1t_2s d. $\sqrt{t_1t_2}$ s

37. The length of a second hand in a watch is 1 cm. The change in velocity in 15s is

a. $\frac{\pi}{30\sqrt{2}}$ cm/s b. $\frac{\pi}{30}$ cm/s

c. 0 d. $\frac{\pi\sqrt{2}}{30}$ cm/s

38. A car runs at constant speed on a circular track of radius 100m, taking 62.8 s on each lap. What is the average velocity and average speed on each lap?

a. 10m/s, 10m/s b. 0, 10m/s
c. 0,0 d. 10m/s,0

39. A bomb is dropped from an airplane when it is at a height h directly about a target. If the airplane is moving horizontally at a speed v, the distance by which bomb will miss target is given by

a. $2v\sqrt{\frac{h}{g}}$ b. $v\sqrt{\frac{h}{g}}$
c. $v\sqrt{\frac{2h}{g}}$ d. $v\sqrt{\frac{h}{2g}}$

40. A body starting from rest moves with constant acceleration. The ratio of the distance covered by body during 5th second to that covered in 5 seconds is

a. $\frac{9}{25}$ b. $\frac{3}{25}$
c. $\frac{25}{9}$ d. $\frac{1}{25}$

41. A car accelerates from rest at constant rate α for some time, after which it decelerates at constant rate β and comes to rest. If the total time elapsed is t the maximum velocity acquired by car will be

a. $\frac{\alpha+\beta}{\alpha\beta}t$ b. $\frac{\alpha\beta}{\alpha+\beta}t$
c. $\frac{\alpha^2-\beta^2}{\alpha\beta}t$ d. $\frac{\alpha^2+\beta^2}{\alpha\beta}t$

42. If a vehicle, starting from rest, moves at constant acceleration 4m/s^2 and then retards to rest at constant deceleration 3 m/s^2 in a straight line. If total displacement is 4.2 km. Then, max. velocity acquired by vehicle is

a. 60 m/s b. 72 m/s
c. 120 m/s d. 144 m/s

43. A smooth inclined plane is inclined at an angle θ with the horizontal. A body starts from rest and slides down the inclined plane, then time taken by the body to reach the bottom is

a. $\sqrt{\frac{2h}{g}}$ b. $\sqrt{\frac{2l}{g}}$
c. Cosec $\theta\sqrt{\frac{2h}{g}}$ d. Sin $\theta\sqrt{\frac{2h}{g}}$

44. A body of mass 2 kg is released at the top of a smooth inclination 30^0. It takes 3s to reach the bottom. If the angle of inclination is doubled, what will be the time taken?

a. 3s b. $\sqrt{3}$ s
c. $\sqrt{3\sqrt{3}}$ s d. 1.5 s

45. Three particles A, B and C are situated at vertices of an equilateral triangle ABC of side l at time t = 0. Each of the particle moves at constant speed v. A always has its velocity along AB, B along BC, C along CA. At what time will these particles meet each other?

a. $\frac{2l}{3v}$ b. $\frac{l}{v}$
c. $\frac{3l}{4v}$ d. never

46. A vehicle moving due north at 20 m/s turns east without changing speed. What is change in velocity?

a. 40 ms^{-1} north east
b. $20\sqrt{2}$ ms^{-1} south east.
c. $20\sqrt{2}$ ms^{-1} south west.
d. $20\sqrt{2}$ ms^{-1} north west.

47. A person who can swim at 12 km/hr in still water wants to cross a river flowing at 6 km/hr along shortest route. Then he has to start swimming at

a. 60^0 with stream
b. 90^0 with stream
c. 120^0 with stream
d. 150^0 with stream

48. A boat which has a speed of 5 kmh^{-1} in still water crosses a river of width 1 km along the shortest possible path in 20 minutes. The velocity of river water is

a. 9kmh^{-1} b. 6 kmh^{-1}

c. 5 kmh^{-1} d. 4 kmh^{-1}

49. A boat takes 2 hrs to travel 8 km and back in still water lake. If the velocity of water is 4 kmh^{-1}. The time taken for going upstream of 8 km and coming back is;

a. 2 hrs b. 2 hrs 40 min

c. 1 hr 30 min d. 4 hrs

50. A river is flowing from west to east at a speed of 5m/min. A man on the south bank of the river capable of swimming at 10m/min in still water wants to cross the river in shortest possible time. In what direction should he swim?

a. due north.

b. at an angle 30^0 west of North.

c. at an angle 30^0 east of North.

d. at 60^0 west of North.

51. If in above question, shortest possible path was given. In what direction should he swim?

a. due North.

b. at an angle 30^0 west of North.

c. at an angle 30^0 east of North.

d. at 60^0 west of North.

52. To a person running with a velocity of 4 km/hr, the rain appears to fall to him with a velocity of 3 km/hr. The actual velocity of rain is

a. 7 km/hr b. 5 km/hr

c. $\frac{4}{3}$ km/hr d. $\frac{3}{4}$ km/hr

53. A person who can swim at 5 km/hr in still water crosses a river 1 km wide flowing at 3km/hr in shortest time. How far he will reach at another bank?

a. 1 km b. 600m

c. 800m d. 1200m

54. A racing car moving along circular track of radius R at constant speed V has described angle θ about centre of the track in certain time. What is average velocity for interval of time?

a. v b. $\frac{v}{\theta}$

c. $\frac{v \text{ Sin } \theta/2}{\theta}$ d. $\frac{2v \sin\theta/2}{\theta}$

55. A body is moved from rest along a straight line by machine, delivering constant power. The distance moved by the body varies with time 't' as

a. $t^{1/2}$ b. t

c. $t^{3/2}$ d. t^2

Answers Sheet

1. b	*2. c*	*3. d*	*4. c*	*5. c*	*6. a*	*7. d*	*8. a*	*9. b*	*10. b*
11. b	*12. c*	*13. d*	*14. d*	*15. a*	*16. b*	*17. b*	*18. c*	*19. a*	*20. a*
21. c	*22. a*	*23. a*	*24. d*	*25. c*	*26. b*	*27. b*	*28. b*	*29. a*	*30. b*
31. c	*32. c*	*33. c*	*34. c*	*35. b*	*36. d*	*37. d*	*38. b*	*39. c*	*40. a*
41. b	*42. c*	*43. c*	*44. c*	*45. a*	*46. b*	*47. c*	*48. d*	*49. b*	*50. a*
51. b	*52. b*	*53. b*	*54. d*	*55. c*					

SOLUTION

1. Ans (b)

$S \alpha\, t^2$

$S = kt^2$

$V = \frac{ds}{dt} = 2kt$

$a = \frac{dv}{dt} = 2K$ (constant)

2. Ans (c)

$S \alpha\, t^3$

$S = kt^3$

$V = \frac{ds}{dt} = 3kt^2$

$a = \frac{dv}{dt} = 6kt.$

∴ ie. $a \,\alpha\, t$

Acceleration increasing with time.

3. Ans (d)

Velocity is zero and is equivalent to dropping a body that falls with acceleration 'g'.

4. Ans (c)

$S = \frac{1}{2} at^2 \,\alpha\, t^2$

5. Ans (c)

$x = a \sin\omega t$

$v = \frac{dx}{dt} = a\omega \text{Cos}\omega t$

$a = \frac{dv}{dt} = -\omega^2 a \text{Sin}\, \omega t$

6. Ans (a)

Distance ≥ displacement

For straight line motion; distance= displacement.

7. Ans (d) 2c

$S = a + bt + ct^2$

$V = \frac{ds}{dt} = b + 2ct$

$a = \frac{dv}{dt} = 2c$

8. Ans (a)

$Vav = \frac{\Delta x}{\Delta t} = \frac{x-x_0}{t-t_0} = \frac{36-20}{4-0} = 4$ m/s

9. Ans (b)

If V is max. velocity

$V = a_1 t_1 = a_2 t_2 \quad \Rightarrow \frac{a_1}{a_2} = \frac{t_1}{t_2}$

10. Ans (b) 2s

If 't' be the time after which the balls cross each other.

$h = h_1 + h_2 \rightarrow 100 = \frac{1}{2} gt^2 + (ut - \frac{1}{2} gt^2)$

$\rightarrow 50\, t = 100 \rightarrow t = 2s$

11. Ans (b)

Distance travelled in successive equal intervals of time is in the ratio of 1:3:5:7.........

12. Ans (c) 3h

Ratio of distance covered in successive n^{th} seconds = 1:3:5:7……..

Velocity in successive n^{th} seconds = 1:2:3:4

13. Ans (d)

The ball A has only vertical velocity while reaching ground. The ball B has vertical velocity as well as horizontal. Therefore, ball B has greater speed when it reaches the ground.

14. Ans (d) 1:16

$S = \frac{v^2 - u^2}{2a}$, when the car stopped, v = 0

$S = \frac{0 - u^2}{2a} = -\frac{u^2}{2a}$

$\frac{s_1}{s_2} = \frac{u_1^2}{u_2^2} = \frac{u^2}{(4u)^2} = 1:16$

15. Ans (a) u

Taking upward motion of ball A for time 't'. $V_A = u - gt$. Taking downward motion of ball B for time 't'. $V_B = gt$

i.e. upward velocity of B = $-v_B = -gt$

$v_{AB} = v_A - v_B = u - gt - (-gt) = u$

16. Ans (b) 50 s

Time of flight = 3s +7s = 10 s

$t = \frac{10}{2}\ s = 5\ s = \frac{v-u}{a} \Rightarrow u = 10 \times 5s = 50\ s$

17. Ans (b)

Total distance = 50 + 50 = 100m

Relative velocity = 10 + 15 = 25 (since, opposite direction)

$t = \frac{100}{25} = 4s$

18. Ans (c)

Last t seconds of upward journey = first t seconds of downward journey.

Initial velocity = zero, $s = \frac{1}{2}gt^2$

19. Ans (a)

Distance travelled in the last second of upward motion = always 5 m regardless of projection speed.

$S = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times 1^2 = 5m$

20. Ans (a)

$S_n = u + \frac{a}{2}(2n-1)$

$24.5 = \frac{9.8}{2}(2t-1) \rightarrow t = 3\ sec$

$h = \frac{1}{2}gt^2 \rightarrow h = 44.1\ m$

21. Ans (c) 18 m

The lion gains a distance of 3 m in 5s w.r.t. to deer. So, relative acceleration of lion w.r.t deer

$S = \frac{1}{2}at^2$

$3 = \frac{1}{2} \times a \times 5^2$

$a = \frac{6}{25}\ m/s^2$

Distance gained in 10s

$= \frac{1}{2}at^2 = \frac{1}{2} \times \frac{6}{25} \times 10^2 = 12\ m$

∴ Separation = (30 – 12) = 18 m

22. Ans (a)

$-65 = 12t + \frac{1}{2}(-10)t^2$

$5t^2 - 12t - 65 = 0$

$t = 5\ s$

23. Ans (a) 24.5 m

A has fallen for 3 s and B for 2 s.

$S_1 - S_2 = \frac{1}{2}gt_1^2 - \frac{1}{2}gt_2^2$

$= \frac{10}{2}(3^2 - 2^2)m = 24.5\ m$

24. Ans (d) 10s

$\text{Time taken} = \frac{\text{Total distance}}{\text{Relative Velocity}}$

$= \frac{150}{10+5} = 10\ s$

25. Ans (c)10s

Displacement of bus relative to boy = -100m

Initial velocity of bus relative to boy = 0 – 20 = –20 m/s

Acceleration of bus relative to boy = $2m/s^2$

$-100 = -20t + \frac{1}{2}2t^2$

$t^2 - 20t - 100 = 0 \rightarrow t = 10s$

26. Ans (b) 14.7 m

Height raised by the ball and balloon in 2 seconds

$h_1 = ut + \frac{1}{2}at^2 = 0 \times 2 + \frac{1}{2} \times 4.9 \times 2^2 = 9.8$ m

Velocity gained by the ball in 2 s is $v_1 = at = 4.9 \times 2 = 9.8$ m/s

Height raised by ball after release

$0^2 = v_1^2 - 2gh \rightarrow 0 = (9.8)^2 - 2 \times 9.8\ h_2$

$h_2 = 4.9$ m

Total height raised = $h_1 + h_2 = 14.7$ m

27. Ans (b) πr, 2r

For circular path displacement $\Delta s = 2r\sin\frac{\theta}{2}$

$= 2r\ \text{Sin}\ \frac{180}{2} = 2r$

Distance = $r\theta = \pi r$

28. Ans (b) 5s

$H = -ut + \frac{1}{2}gt^2$

$50 = -15t + \frac{1}{2} \times 10 \times t^2$

$5t^2 - 3t - 10 = 0$

$(5t + 2)(t - 5) = 0$

$t = \frac{-2}{5}$, $t = 5$

Must be +ve, t = 5s

29. Ans (a)

$t = ax^2 + bx$

Differentiating both sides w.r.t time

$1 = (2ax + b)\frac{dx}{dt}$

$V = \frac{dx}{dt} = \frac{1}{2ax + b}$

Again, differentiating,

$0 = (2a\frac{dx}{dt})(\frac{dx}{dt}) + (2ax + b)(\frac{d^2x}{dt^2})$

$0 = 2av^2 + \frac{1d^2x}{vdt^2}$

$\frac{d^2x}{dt^2} = -2av^3$

30. Ans (b)

$\text{Total time} = \frac{2u}{g} = \frac{2 \times 100}{10} = 20 \text{ s}$

31. Ans (c)

Shortcut,

$h = \frac{1}{2} g\, t_1t_2 = \frac{1}{2} \times 10 \times 2 \times 8 = 80 \text{ m}$

32. Ans (c)

Time to fall through 19.6 m is

$t_1 = \sqrt{\frac{2 \times 19.6}{9.8}} = 2\text{s}$

Time to fall through 18.6 m is

$t_2 = \sqrt{\frac{2 \times 18.6}{9.8}} = 1.95\text{s}$

$t_1 - t_2$= cover last one meter =2–1.95 = 0.05 s

33. Ans (c) 4:9

$v^2 = u^2 - 2gh$

$0 = u^2 - 2gh$

$h \alpha u^2$

$h_1 : h_2 = 4:9$

34. Ans (c)

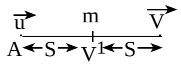
In 1^{st} (t/4)s = x In 2^{nd} (t/4)s= 3x

In 3^{rd} (t/4)s = 5 x In last (t/4)s=7x=1.4 m

x = 0.2 m

Height of the building = x + 3x + 5x + 7x = 16x = 3.2 m

35. Ans (b)



$(v_1)^2 = u^2 + 2as$

$v^2 = (v_1)^2 + 2as$

$v_1^2 - v^2 = v^2 - (v_1)^2$

$v_1 = \sqrt{\frac{u^2+v^2}{2}}$

36. Ans (d)

$h = ut_1 + \frac{1}{2}gt_1^2 \rightarrow \frac{h}{t_1} = u + \frac{gt_1}{2}$ ……(i)

$h = -ut_2 + \frac{1}{2}gt_2^2 \rightarrow \frac{h}{t_2} = -u + \frac{gt_2}{2}$ ……(ii)

$h = \frac{gt_1t_2}{2}$ ……(iii) (from i and (ii))

$h = \frac{1}{2}gt_3^2$…… (iv)

$t_3 = \sqrt{t_1t_2}$ (Comparing iii and (iv))

37. Ans (d)

$v = r\omega = \frac{2\pi}{T} \times 1 = \frac{2\pi}{60}$

In 15 s, the velocity changes by 90^0.

$\Delta v = \sqrt{v^2 + v^2} = \sqrt{2}\, v = \frac{2\sqrt{2}\pi}{60} = \frac{\pi\sqrt{2}}{30}$ cm/s

38. Ans (b)

Average velocity =0

(Total displacement =0)

$\text{Average speed} = \frac{\text{Total distance}}{\text{time}} = \frac{2\pi r}{t}$

$= \frac{2 \times 3.14 \times 100}{62.8} = 10 \text{ m/s}$

39. Ans (c)

$h = 0 \times t + \frac{1}{2} gt^2$

$t = \sqrt{\frac{2h}{g}}$

Horizontal velocity of bomb = aeroplane = v

$d = vt = v\sqrt{\frac{2h}{g}}$

40. Ans (a)

Distance covered in 5^{th} second

$D_5 = 0 + \frac{a}{2}(2\times5-1) = \frac{9a}{2}$

Distance covered in 5 seconds

$S_5 = 0 + \frac{1}{2} \times a \times 5^2 = \frac{25a}{2}$

$D_5 / S_5 = 9/25$

41. Ans (b)

For accelerated motion

Max velocity $v = \alpha t_1 \rightarrow t_1 = \frac{v}{\alpha}$

For retarded motion

$0 = v - \beta t_2 \rightarrow t_2 = \frac{v}{\beta}$

Now $t = t_1 + t_2$

$t = \frac{v}{\alpha} + \frac{v}{\beta} = \frac{\alpha+\beta}{\alpha\beta} v$

$v = \frac{\alpha\beta}{\alpha+\beta} t$

[Net acceleration (a) = $\frac{\alpha\beta}{\alpha+\beta}$]

42. Ans (c)

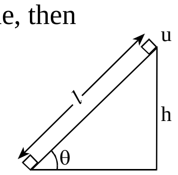
$v = \sqrt{2as} = \sqrt{2 \times \frac{\alpha\beta}{\alpha+\beta} \times S}$

$= \sqrt{2\times\frac{4\times3}{4+3}\times4200} = 120$ m/s

43. Ans (c)

If l be the length of the plane, then

$l = \frac{1}{2}$ (g sinθ) t^2



$t = \sqrt{\frac{2l}{g \sin\theta}}$

$= \sqrt{\frac{2h}{g \sin^2\theta}}$ [$l = \frac{h}{\sin\theta}$]= ($\sqrt{\frac{2h}{g}}$)Cosec θ

44. Ans (c)

$l = \frac{1}{2}$ g (Sin 30) × 3^2 …….. (i)

$l = \frac{1}{2}$ g (Sin 60)× t^2…….. (ii)

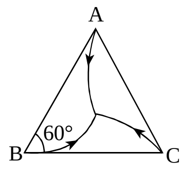
From (i) and (ii)

$1 = \frac{\sin 30 \times 9}{\sin 60 \times t^2}$

$t = \sqrt{3\sqrt{3}}$ s

45. Ans (a)

The component velocity of B along BA = V Cos 60^0= v/2. Thus, separation of particles at A decreases with a speed = v + v/2 = 3v/2. Since, this speed is constant the time taken in reducing the separation in AB from l to zero is t = l/3v/2 = 2l/3v.



46. Ans (b)

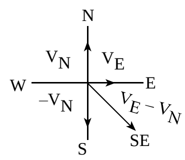
$\overrightarrow{vN}$ = 20 ms^{-1}

$\overrightarrow{vE}$ = 20 ms^{-1}

$|\overrightarrow{vE} - \overrightarrow{vN}| = \sqrt{vE^2+vN^2}$

$= \sqrt{20^2+20^2}$

$=20\sqrt{2}$ south east.



47. Ans (c)

v Sinθ t= ut

Sin θ = $\frac{u}{v} \rightarrow \theta = \sin^{-1}(\frac{u}{v})$

$= 90 + \sin^{-1}(\frac{6}{12})$

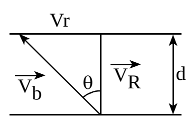
= 120^0 with the stream

48. Ans (d)

$\overrightarrow{vb}$ = 5 kmh^{-1}

$\overrightarrow{vR} = \frac{d}{t}$ = 1/20/60

= 3 kmh^{-1}



Now, $vb^2 = vr^2 + vR^2$

$vr = \sqrt{5^2 - 3^2}$ = 4 km/hr

49. Ans (b)

In still water, $v_b = \frac{8+8}{2} = 8$ km/hr

$v_r = 4$ km/hr

Velocity upstream $= v_b - v_r = 4$

Velocity downstream $= v_b + v_r = 12$

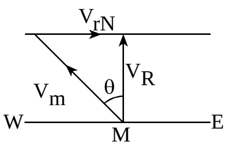
$t = \frac{8}{4} + \frac{8}{12}$ hr = 2 hr 40 mins

50. Ans (a)

Man must swim perpendicular to flowing river to cross the river in shortest possible time. i.e. due North

51 Ans (b)

$\text{Sin } \theta = \frac{v_r}{v_m} = \frac{5}{10}$



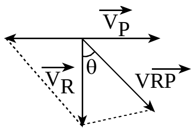
$\theta = 30^0$ west of North. So, that resultant is along shortest path MN.

52. Ans (b)

$VR = \sqrt{V^2{}_P + V^2{}_{RP}}$

$= \sqrt{4^2 + 3^2} = 5$ km/hr

Man can protect himself from rain by tilting umbrella at an angle $\theta = \tan^{-1}(\frac{V_P}{V_R})$



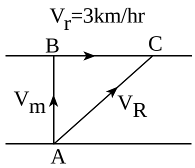
53. Ans (b)

$\frac{AB}{vm} = \frac{BC}{Vr}$

$\frac{1}{5} = \frac{BC}{3}$

BC = 600 m

[least time $\rightarrow\perp$ to stream]



54. Ans (d)

$V_{av} = \frac{\text{displacement}}{\text{time}}$

$= \frac{2R\sin\theta/2}{\frac{R\theta}{V}} = \frac{2v\sin\theta/2}{\theta}$

55. Ans (c) $t^{3/2}$

$Fv = P,\ M\frac{dv}{dt} v = P$

$\int \mathbf{V.\,dv} = \frac{P}{M} \int \mathbf{dt}$

$\frac{v^2}{2} = P\frac{t}{M} \rightarrow v = \sqrt{\frac{2p}{m}}\, t^{1/2}$

$\frac{dx}{dt} = (\sqrt{\frac{2p}{M}})\, t^{1/2}$

$\int \mathbf{dx} = \sqrt{\frac{2p}{M}} \int \mathbf{t}^{1/2}\, dt$

$x = \sqrt{\frac{2p}{M}}\, \frac{2}{3}\, t^{3/2}$

$x \alpha t^{3/2}$

Past Questions

1. A body travels one third of distance with 10 km/hr, another one third with 20 km/hr, remaining one third with 60km/hr then average speed is [IOM09]

a. 12 km/hr   b. 16 km/hr

c. 18 km/hr   d. 32 km/hr

2. Displacement of particle w.r.t time is $x = a_0 + 2a_1t + a_2t^2$. The acceleration is [MOE 067]

a. a_0 b. a_1

c. a_2 d. $2a_2$

3. A vehicle moving along a straight road covers half distance of its journey at 40 km/hr and next half distance 60 km/hr in same direction. The average velocity for entire journey is

[IOM/MOE/BPKIHS]

a. 45 km/hr

b. 48 km/hr

c. 54 km/hr

d. 50 km/hr

4. A vehicle moving along a straight road travels for half time at 40 km/hr and then next half time at 60 km/hr. The average velocity for entire journey [IOM/MOE/BPKIHS]

a. 50 km/hr
b. 48 km/hr
c. 54 km/hr
d. 45 km/hr

5. A car travelling along a circular track of constant speed 20 m/s has completed half revolution on the track. Its average velocity will be [IOM/MOE/KU]

a. 10π m/s
b. $\frac{20}{\pi}$ m/s
c. 20 m/s
d. $\frac{40}{\pi}$ m/s

6. A meter rod pivoted at its one end is rotated through 120^0. Then displacement of its free end will be[IOM]

a. 2m
b. $\frac{2\pi}{3}$ m
c. $\sqrt{2}$ m
d. $\sqrt{3}$ m

7. A person travels certain distance 'x' due east at constant velocity V_1 and then travels distance 'x' due North at constant velocity V_2. What is the average velocity of journey? [IOM/MOE]

a. $\frac{2v_1v_2}{v_1+v_2}$
b. $\sqrt{\frac{v_1^2+v_2^2}{2}}$
c. $\frac{\sqrt{2}v_1v_2}{v_1+v_2}$
d. $\frac{1}{2}\sqrt{v_1+v_2^2}$

8. A person travels for certain time 't' due east at constant velocity V_1 and then he travels for equal time 't' due north at constant velocity V_2. What is his average velocity for entire journey? [IOM]

a. $\frac{2v_1v_2}{v_1+v_2}$
b. $\sqrt{\frac{v_1^2+v_2^2}{2}}$
c. $\frac{v_1+v_2}{2}$
d. $\frac{1}{2}\sqrt{v_1^2+v_2^2}$

9. A car travelling due North at 30 km/hr turns west and travels at same speed, the change in velocity of car is [MOE 066].

a. 30 km/hr North West
b. 60 km/hr South West
c. $30\sqrt{2}$ km/hr South West.
d. $30\sqrt{2}$ km/hr North East.

10. A stone is dropped from top of tower of height 'h'. It reaches the ground in time 't' seconds. The position of the stone after $\frac{t}{3}$ secs will be…from the ground. [IOM 063]

a. $\frac{3}{4}$h
b. $\frac{h}{9}$
c. $\frac{8h}{9}$
d. $\frac{h}{4}$

11. A stone is dropped from top of tower of height 'h'. After 1s, another stone is dropped from balcony 20m below the top. Both reach the bottom simultaneously. What is the value of h? [IOM 05]

a. 3125m
b. 312.5m
c. 31.25m
d. 25.31m

12. A body thrown vertically upwards attains a maximum height H_0 while moving upwards if it covers first $\frac{3H}{4}$ distance from ground in time T. Then time taken to cover remaining $\frac{H}{4}$ will be [IOM/MOE/KU/BPKIHS]

a. T
b. $\frac{T}{2}$
c. $\frac{T}{3}$
d. $\frac{3T}{4}$

13. A person travels 3km towards North then 2Km towards east and finally $2\sqrt{2}$ southwest? What is his displacement? [BPKIHS]

a. $\sqrt{2}$ km North east
b. 1 km North

c. $\sqrt{2}$ km South West.

d. zero

14. A stone is dropped from top of a tower. If it reaches the earth in 6 seconds. The height of the tower is nearly [BPKIHS]

a. 360m b. 180m

c. 100m d. 60m

15. The acceleration of a particle at any instant of time t which starts from origin at initial velocity 2m/s is a = 2t (in m/s^2). What is velocity in 5 seconds ? [Indian Embassy]

a. 52 m/s b. 50 m/s

c. 27 m/s d. 25 m/s

16. A body sliding on a smooth inclined plane requires 4 seconds to reach the bottom starting form rest at the top. How much time does it take to cover one fourth distance starting from rest at top? [KU]

a. 1s b. 2s

c. 4s d. 16s

17. When a ball is thrown upwards with air resistance not neglected, it takes 10s to reach the height. It then returns to ground in time [MOE]

a. 8.2 s b. 6 s

c. 10s d. 12.4 s

18. A body is thrown vertically and attains a velocity of 15m/s at half the maximum height. The maximum height up to which body can reach will be [MOE 2069]

a. 45.8m b. 34.5m

c. 22.9m d. 17.8m

19. Time taken by a train of length 150m and travelling with a uniform velocity of 60km/hr to cross completely a bridge of length 1.5km will be [MOE 2069]

a. 9s b. 9.9s

c. 90s d. 99s

20. If a body travels in straight line and covers $\frac{1}{3}^{rd}$ of its distance with velocity v_1 and remaining $\frac{2}{3}^{rd}$ with velocity v_2 then the average velocity of the entire journey is [IOM 2012]

a. $\frac{3v_1v_2}{2v_1 + v_2}$ b. $\frac{3v_1v_2}{v_1 + 2v_2}$

c. $\frac{3}{v_1 + v_2}$ d. $\frac{2v_1v_2}{v_1 + v_2}$

21. A boy started his journey from home to school which is 6 km far at uniform speed 2.5 km/hr. and while returning he returned with 4km/hr. What is his average speed? [BPKIHS 2012]

a. 3km/hr b. 4km/hr

c. 6km/hr d. 8km/hr

22. If two bodies are projected horizontally from a certain height with velocities 25m/s and 30m/s, then which of the following is true? [BPKIHS 2011]

a. Body with 25m/s reach ground 1st

b. Body with 30m/s reach ground 1st

c. Both reach simultaneously

d. Nothing can be said.

23. A car travels one third of the distance on a straight road with velocity v_1 next one third with v_2 and the last one-third with velocity v_3. What is the average velocity of the car in the whole journey? [BPKIHs 2000]

a. $\frac{v_1 + v_2 + v_3}{3}$ b. $\frac{v_1v_2 + v_2v_3 + v_1v_3}{3}$

c. $\frac{3v_1v_2v_3}{v_1v_2 + v_1v_3 + v_2v_3}$ d. $\frac{v_1 + v_2 + v_3}{3v_1v_2v_3}$

24. A body moves 30m due north, 20m due east and $30\sqrt{2}$ due south west. The total

displacement covered by body from its initial position is [IE 2011]

a. 14m SW b. 28m South

c. 10m west d. 28m South

25. Two bodies of mass '2m' and 'm' are related from height '2H' and 'H' respectively. The ratio of time taken by them to reach the ground is [IE 2011]

a. 1:4 b. 1

c. $\sqrt{2}$ d. 2

26. If a stone is relased from top if tower, the ratio of distance covered by it in 2nd and 3rd second is [IE 2008]

a. 3:5 b. 2:4

c. 1:2 d. 4:3

Answers

1. c	*2. d*	*3. b*	*4. a*	*5. d*	*6. d*	*7. c*	*8. d*	*9. c*	*10. c*
11. c	*12. a*	*13. b*	*14. b*	*15. c*	*16. b*	*17. d*	*18. c*	*19. d*	*20. a*
21. a	*22. c*	*23. c*	*24. c*	*25. c*	*26. a*				

SOLUTION

1. Ans (c)

$$\text{Av. Speed} = \frac{\text{Total distance}}{\text{total time}}$$

$$= \frac{\frac{s}{3}+\frac{s}{3}+\frac{s}{3}}{t_1+t_2+t_3} = \frac{s}{\frac{\frac{s}{3}}{10}+\frac{\frac{s}{3}}{20}+\frac{\frac{s}{3}}{60}}$$

$$= \frac{3}{\frac{1}{10}+\frac{1}{20}+\frac{1}{60}} = \frac{3}{6+3+1} = 18 \text{ km/hr}$$

2. Ans (d)

$S = a_0 + 2a_1t + a_2t^2$

$$V = \frac{ds}{dt} = 2a_1 + 2a_2t$$

$$a = \frac{dv}{dt} = 2a_2$$

3. Ans (b)

$$\text{Average velocity} = \frac{\text{Total displacement}}{\text{Total time}}$$

$$= \frac{2x}{\frac{x}{40}+\frac{x}{60}} = \frac{2x}{\frac{3x+2x}{120}}$$

$$= \frac{2x\times120}{3x} = 48 \text{ km/hr}$$

$$\text{Vav} = \frac{2v_1v_2}{v_1+v_2} \text{ for equal distance.}$$

4. Ans (a)

For equal time,

$$\text{Average velocity} = \frac{v_1+v_2}{2}$$

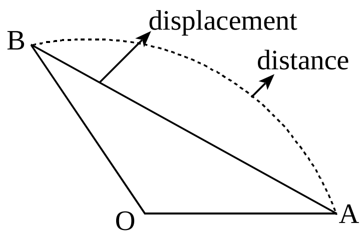
$$= \frac{40+60}{2} = 50 \text{ km/hr.}$$

5. Ans (d)

$$A_{av} = \frac{\text{Total displacement}}{\text{Total time}}$$

$$= \frac{\frac{2r}{\pi r}}{20} = \frac{40}{\pi}$$

6. Ans (d)



Displacement

$= |\vec{\mathbf{AB}}| = |\vec{\mathbf{OB}} - \vec{\mathbf{OA}}|$

$= 2A \sin\frac{\theta}{2}$

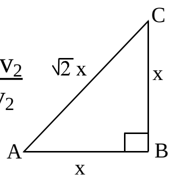
$= 2\times1\times \sin 60 = \sqrt{3}$

Distance = $R\theta$ = $1\times120 = \frac{2\pi}{3}$ m

7. Ans (a)

Total displacement = AC= $\sqrt{2}x$

Total distance = 2 x



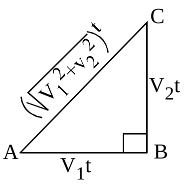
Total time = $\frac{x}{v_1} + \frac{x}{v_2} = x\,\frac{v_1+v_2}{v_1v_2}$

Vav = $\frac{\text{Total displacement}}{\text{Total time}}$

$= \frac{\sqrt{2}x}{\frac{x(v_1+v_2)}{v_1v_2}} = \frac{\sqrt{2}v_1v_2}{v_1+v_2}$

For av. Speed = $\frac{2v_1v_2}{v_1+v_2}$, Ans. (a)

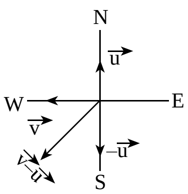
8. Ans (d)



Aav = $\frac{\text{displacement}}{\text{total time}}$

$= \frac{\sqrt{v_1^2+v_2^2}}{2t}\,t = \frac{1}{2}\sqrt{v_1^2+v_2^2}$

9. Ans (c)



$\overrightarrow{\Delta v} = (\vec{v} - \vec{u})$

$= \sqrt{v^2+u^2}$ ($\theta = 90^0$)

$= \sqrt{30^2+30^2} = 30\sqrt{2}$ SW

10. Ans (c)

In time 't' it covers h= $\frac{1}{2}gt^2$

It covers 'x' form top in $\frac{t}{3}$

So, $x=\frac{1}{2}g\left(\frac{t}{3}\right)^2 = \frac{1}{2}gt^2 \times \frac{1}{9} = \frac{h}{9}$

Distance from ground = $h - x = \frac{8h}{9}$

11. Ans (c)

$h = \frac{1}{2}gt^2$

$h - 20 = \frac{1}{2}g(t-1)^2$.......i

Subtracting (ii) from (i)

$20 = \frac{1}{2}gt^2 - \frac{1}{2}g(t^2 - 2t + 1)^2$

$20 = gt - \frac{g}{2} \Rightarrow t = 2.5s$

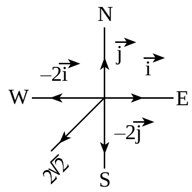
$h = \frac{1}{2}\times 10\times(2.5)^2 = 31.25m$

12. Ans (a)

Ratio of distance covered in successive time interval are in the ratio

= 1:3:5:7 ……..(2n-1)

13. Ans. (b)



$\vec{S} = 3\vec{j} + \overrightarrow{2i}$ ($2\sqrt{2}$ SW $= -\overrightarrow{2j} - \overrightarrow{2i}$)

$= \vec{j}$ = 1km North

14. Ans (b)

$h=\frac{1}{2}gt^2 = \frac{1}{2}\times10\times(6)^2 = 180$ m

15. Ans (c)

$V = \int a\,dt = \int 2t\,dt$

$V = t^2+c$ ……i

When v = 2m/s, t =0

$2 = o^2+c \rightarrow c=2$

eq^n (i) becomes $v = (5)^2+2 = 27$

16. Ans (b)

$l = \frac{1}{2}\times a\times 4^2$

$\frac{l}{4} = \frac{1}{2}\times a\times t^2$

Solving equations (i) and (ii)

T = 2 s

17. Ans(d)

When air resistance is not neglected.

Time of descent > time of ascent.

18. Ans. (c)

Velocity at half maximum height = 15m/s

Velocity at maximum height = O m/s

When body reaches the maximum height from half height

$(O)^2 = (15)^2 - 2 \times g \times h_{1/2}$

$225 = 2 \times 9.8 \times h_{1/2}$

$\therefore \quad h_{1/2} = 11.4m$

Maximum height up to which body can reach $= 2 \times h_{1/2} = 22.9m$

19. Ans. (d)

Distance to cover (d) = 1500 + 150m

= 1650m

Velocity (v) = 60km/hr = 16.67 m/s

time taken $= \frac{d}{v} = \frac{1650}{16.67} = 99s$

20. Ans. (a)

Let total distance = 3s

1st case:

$d = \frac{1}{3} \times 3s = s; v = v_1$

and $t = \frac{S}{v_1}$

2nd case:

$d = \frac{2}{3} \times 3s = 2s$

$v = v_2$ & t_2

$= \frac{2s}{v_2}$

Av. velocity $= \frac{\text{total distance}}{\text{total time}}$

$= \frac{3s}{\frac{s}{v_1} + \frac{2s}{v_2}}$

$= \frac{3v_1v_2}{\sqrt{2} + 2v_1}$

21. Ans. (a)

Av. speed $= \frac{\text{total distance}}{\text{total time}}$

$= \frac{s+s}{t_1+t_2} = \frac{2s}{\frac{s}{v_1} + \frac{s}{v_2}}$

$= \frac{2v_1v_2}{v_1+v_2}$

$= \frac{2 \times 2.5 \times 4}{2.5 + 4} = 3.07$ km/hr

22. Ans. (c)

$T = \sqrt{\frac{2h}{g}}$

- Independent of horizontal velocity
- Both reach the ground simultaneoulsy

23. Ans. (c)

Average velocity $= \frac{\text{Total distance}}{\text{Total time}}$

$= \frac{3S}{\frac{S}{v_1} + \frac{S}{v_2} + \frac{S}{v_3}}$

$= \frac{3}{\frac{1}{v_1} + \frac{1}{v_2} + \frac{1}{v_3}}$

$= \frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$

24. Ans. (c)

$\vec{S_1} = 30\hat{j}$

$\vec{S_2} = 20\hat{i}$

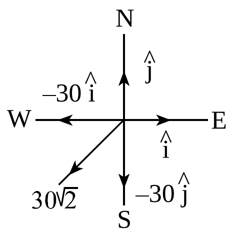
$\vec{S_3} = 30\sqrt{2}$ SW

$= -30\hat{i} - 30\hat{j}$

Resultant displacement (s)

$= 30\hat{j} + 20\hat{i} - 30\hat{i} - 3\hat{j}$

$= -10\hat{i}$ i.e due west



25. Ans. (c)

$T = \sqrt{\frac{2h}{g}} \; \alpha \sqrt{h}$

$\frac{T_1}{T_2} = \sqrt{\frac{h_1}{h_2}} = \sqrt{2}:1$

- Independent of masses.

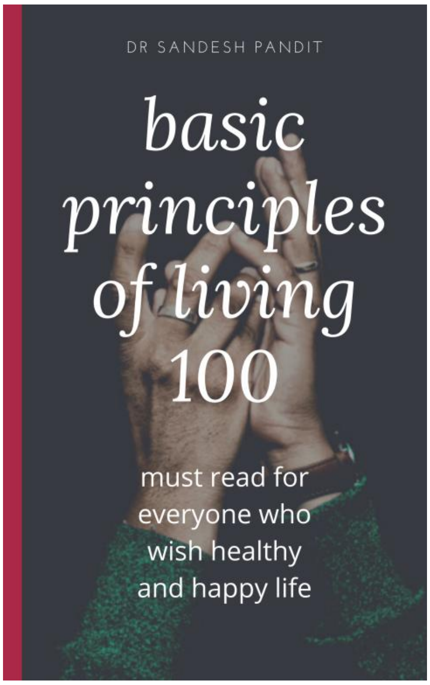
26. Ans. (a)

$St = u + \frac{g}{2}(2t - 1)$

$St \propto (2t - 1)$

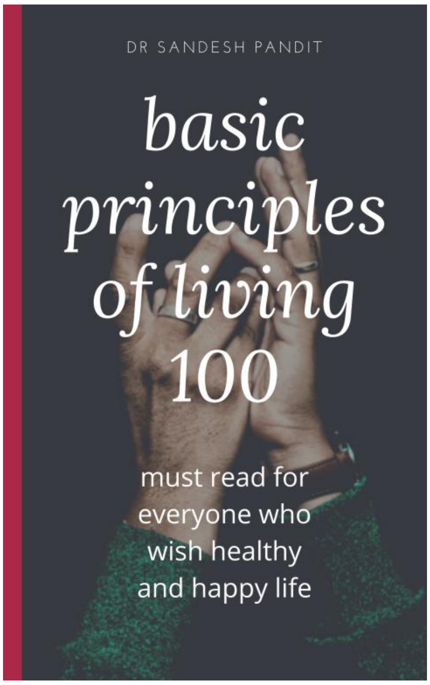
$= 1:3:5:7 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2n - 1)$

$S_2 : S_3 = 3:5$



- As we know so many of our grandparents lived 100 or even more , some never used any medications in their life , but now with so many modern medicine and facilities we are struggling to live even 50 years-60 years. why?
- What mistakes we are doing in the way of our living

- U don't need any medical knowledge and background to understand and perceive the book.
- Every school children's and professor of any field must read this book
- This book is for every human being who wishes healthy and happy life.



Chapter: 4

PROJECTILE

1. A stone is released from a window of a moving train. The stone as observed by a person in the ground is

a. straight line b. circular
c. elliptical d. parabolic

2. A passenger travelling in a train moving with a constant velocity drops a stone from the window. To the passenger the path of projectile will appear to be

a. elliptical b. parabolic
c. arc of a circle d. straight line

3. What determine the nature of the path followed by a particle?

a. velocity b. speed
c. Acceleration d. None

4. The horizontal range of a projectile is $4\sqrt{3}$ times its maximum height, then angle of projection will be

a. 30° b. 40°
c. 60° d. 70°

5. If maximum height and range of projectile is same, what is the angle of projection?

a. 30° b. 76°
c. 45° d. 90°

6. Which of the following is largest when the height attained by the projectile is largest?

a. Range
b. Time of flight
c. Angle of projectile with vertical
d. None

7. A projectile is fired at 30° with momentum P. Neglecting friction, the change in kinetic energy when it returns to the ground will be

a. Zero b. 30%
c. 60% d. 100%

8. In the above question, the change in momentum on returning to the ground will be

a. Zero b. 30%
c. 60% d. 100%

9. When air resistance is taken into account while dealing with the motion of the projectile, which property will increase,

a. range
b. maximum height
c. speed at which it strikes the ground
d. the angle at which projectile strikes the ground

10. From certain height two bodies are projected horizontally with velocities 10m/s and 20m/s. They hit ground in t_1 and t_2 seconds. Then

a. $t_1 = t_2$ b. $t_2 = 2t_1$
c. $t_1 = 2t_2$ d. $t_1 = \sqrt{2t_2}$

11. In case of projectile, what is the angle between the instantaneous velocity and acceleration at highest point?

a. 45° b. 180°
c. 90° d. 0°

12. A body is projected, making an acute angle with horizontal. If angle between velocity $\vec{v}$ and acceleration $\vec{g}$ is θ, then θ is given by

a. $\theta = 90°$ b. $\theta = 0°$
c. $90° < \theta < 0°$ d. $0° < \theta < 180°$

13. Four bodies are projected with the same velocities with angles 30°, 40°, 55° and 65° with the horizontal. The horizontal range will be largest for one projected at an angle

a. 30° b. 40°
c. 55° d. 65°

14. Which of the following does not change when the projected is fixed at an angle with the horizontal?

a. momentum

b. kinetic energy

c. vertical component of velocity

d. horizontal component of velocity

15. A particle moves in a plane with a constant acceleration in a direction different from the initial velocity. The path of the particle is

a. a straight line b. circle

c. parabola d. ellipse

16. For a given angle of projection if the time of flight of projectile is doubled, the horizontal range will increase to

a. twice b. thrice

c. four times d. remains constant

17. A stone is thrown at angle θ to the horizontal reaches a maximum height H. The time of flight of stone will be

a. $\sqrt{\frac{2H}{g}}$ b. $2\sqrt{\frac{2H}{g}}$

c $2\frac{\sqrt{2H\sin\theta}}{g}$ d. $\frac{\sqrt{2H\sin\theta}}{g}$

18. A projectile can have the same range 'R' for two angles of projection. If 't_1' and 't_2' be the times of flights in two cases, then the product of the two time of flights is proportional to

a. R b. $\frac{1}{R}$

c. $\frac{1}{R^2}$ d. R^2

19. A ball is thrown from a point at different angles with same speed u and has same range in both cases. If h_1 and h_2 are the heights attained in the two cases, then (h_1+h_2) will be

a. $\frac{u^2}{g}$ b. $\frac{2u^2}{g}$

c. $\frac{u^2}{2g}$ d. $\frac{u^2}{4g}$

20. A particle of mass m is projected with velocity v making an angle of 45° with horizontal. When the particle lands on the level ground, the magnitude of the change in its momentum will be

a. $mv\sqrt{2}$ b. zero

c. 2mv d. $\frac{mv}{\sqrt{2}}$

21. A particle is projected at 60° to the horizontal with an energy E. The kinetic energy and potential energy at the highest point are

a. $\left(\frac{E}{2},\frac{E}{2}\right)$ b. $\left(\frac{3E}{4},\frac{E}{4}\right)$

c. (E, 0) d. $\left(\frac{E}{4},\frac{3E}{4}\right)$

22. If max height of a projectile is increased by 10% keeping θ same, then the time of flight increased by

a. 5% b. 10%

c. 15% d. 2o%

23. A person sitting in the rear end of the compartment throws a ball a towards the front end. The ball follows a parabolic path. The train is moving with a velocity of 20m/s. A person standing on the ground outside observes the ball. For him (Hm is max height and R is Range).

a. Hm is same but R is different

b. Hm and R both are same

c. Hm is different and R is same

d. Hm & R both are different

24. Kinetic energy and potential energy to be maximum after throw of a projectile, it should cover a distance of respectively

a. R, $\frac{R}{2}$ b. $\frac{R}{2}$, R

c. R, R d. $\frac{R}{2}, \frac{R}{2}$

25. A projectile is thrown with an initial velocity of $a\hat{i}+b\hat{j}$ mls. If the range of the projectile is double the maximum height reached by it, then

a. a = 2b b. b = 4a

c. b = 2a d. b = a

26. A projectile thrown at certain angle θ with horizontal loses 75% of its initial kinetic energy when it reaches at highest point. Then angle of projection θ should be

a. 30° b. 45°
c. 60° d. 75°

27. Two balls are projected at angle θ & (90 – θ) to the horizontal with the same speed. The ratio of their max vertical heights is

a. 1:1 b. tanθ:1
c. 1: tanθ d. $\tan^2\theta:1$

28. A large number of bullets are fired in all directions with speed V. The maximum area on the ground on which these bullets spread is:

a. $\frac{\pi v^2}{g}$ b. $\frac{\pi v^4}{g^2}$
c. $\frac{\pi^2 v^4}{g}$ d. $\frac{\pi^2 v^2}{g}$

29. The range R of a projectile is same when its maximum heights are H_1 and H_2. Then

a. $R = \sqrt{H_1H_2}$ b. $R = 2\sqrt{H_1H_2}$
c. $R = \sqrt{2H_1H_2}$ d. $R = 4\sqrt{H_1H_2}$

30. Two balls are thrown with an angles (θ) & (90 − θ) to horizontal respectively. The ratio of time of flights is

a. 1:1 b. $\tan^2\theta:1$
c. tanθ:1 d. $\cos^2\theta:1$

31. A particle is projected at an angle θ with horizontal with initial speed u. Then its velocity when it is moving at right angle to initial velocity is

a. u tanθ b. u cotθ
c. u secθ d. u cosecθ

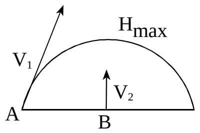
32. The trajectory of a projectile in a vertical plane is $y = \sqrt{3}x - \frac{3}{2}x^2$. The maximum height and angle of projection are

a. 0.5m, 60^o b. 0.5m, 30^o
c. 1m, 60^o d. 1m, 30^o

33. The speed of a projection is 3m/s when it makes 60^o with horizontal. When it makes 30^o with horizontal, its speed is

a. 3m/s b. $\sqrt{3}$ m/s
c. $3\sqrt{3}$ m/s d. 30m/s

34. A body is projected with velocity V_1 from the point A. as shown in fig. At the same time, another body is projected vertically upwards from B with velocity V_2. For figure the bodies to collide $\frac{V_2}{V_1}$ should be:



a. 2 b. 0.5
c. $\sqrt{\frac{3}{2}}$ d. 1

35. A grasshopper can jump a maximum horizontal distance of 20cm. If it spends negligible time on ground, what is its speed of travel along the road?

a. 1m/s b. $\sqrt{2}$m/s
c. $\frac{1}{\sqrt{2}}$ m/s d. None

36. If the time of flight of a bullet over the horizontal Range R is T; The inclination of the direction of projection to the horizontal is

a. $\sin^{-1}\left(\frac{gT^2}{R}\right)$ b. $\tan^{-1}\left(\frac{gT^2}{R}\right)$
c. $\tan^{-1}\left(\frac{gT^2}{2R}\right)$ d. $\cos^{-1}\left(\frac{gT^2}{R}\right)$

37. A ball is thrown vertically upwards at 20 m/s from roof of bus travelling uniformly at 30m/s along straight road. The ball returns to thrower's hand after bus has covered a distance

a. 60m b. 90m
c. 150m d. 120m

38. The maximum range of a gun on horizontal range is 16 km. If 'g' is $10 m/s^2$. The muzzle velocity of shell will be

a. 400mls b. 200mls
c. 800mls d. 256m/s

39. A ball as projected upwards from top of tower with vertical velocity 50m/s making an angle 30^o with horizontal. The height of the tower is 70m. After how many second from the instant of throwing will the ball reach the ground?

a. 2s
b. 5s
c. 7s
d. 9s

40. For hitting a target, one must aim

a. directly at target
b. higher than target
c. lower than target
d. none

41. A boy aims a gun at a bird from a point at horizontal distance of 100m. If the gun can impart velocity of 500m/s to the bullet, what height above the bird must he aim his gun in order to hit it?

a. 20cm
b. 40cm
c. 50cm
d. 100cm

42. A body is given an initial horizontal velocity of 5m/s at angle of 30^o below the horizontal from top of building 25m high. At what distance from the building will the body hit the ground?

a. 5m
b. $5\sqrt{3}$m
c. 10m
d. $10\sqrt{3}$m

43. A projectile is fired with a velocity u making angle θ with the horizontal. What is the angular momentum of the projectile at the highest point about the starting point? [Given m = mass of projectile]

a. $\frac{mu^3\sin^2\theta\cos\theta}{2g}$
b. $\frac{m\cos\theta}{2g}$
c. $\frac{mu^3\cos^2\theta}{2g}$
d. $\frac{mu^3\sin\theta\cos\theta}{2g}$

44. A particle is projected from an ground with initial velocity u at an angle θ with horizontal. The average velocity or a particle for its journey from initial point of projection to highest point of trajectory is

a. $\frac{u}{2}\sqrt{2\cos^2\theta + 1}$
b. $\frac{u}{2}\sqrt{3\cos^2\theta + 1}$
c. $\frac{u}{2}\sqrt{1 + \cos^2\theta}$
d. $u\cos\theta$

45. Two balls A and B are both thrown simultaneously from the top of tower with velocities 20m/s and 80m/s. horizontally in opposite directions. Find the distance between the balls when their velocities are perpendicular to each other

a. 400m
b. 800m
c. 240m
d. 480m

46. In above question, find the time after which their velocities are perpendicular to each other.

a. 2s
b. 4s
c. 8s
d. 10s

47. Find the time after which their position vectors are perpendicular to each other.

a. 2s
b. 4s
c. 8s
d. 10s

Answer Sheet

1. d	*2. d*	*3. a*	*4. a*	*5. b*	*6. b*	*7. a*	*8. d*	*9. d*	*10. a*
11. c	*12. d*	*13. b*	*14. d*	*15. c*	*16. c*	*17. b*	*18. a*	*19. c*	*20. a*
21. d	*22. a*	*23. a*	*24. a*	*25. c*	*26. c*	*27. d*	*28. b*	*29. d*	*30. c*
31. b	*32. a*	*33. b*	*34. b*	*35. a*	*36. c*	*37. d*	*38. a*	*39. c*	*40. b*
41. a	*42. b*	*43. a*	*44. b*	*45. a*	*46. b*	*47. c*			

SOLUTION

1. Ans. (d)

Moving train provides horizontal velocity to the stone so it is similar to horizontal projection from height.

2. Ans. (d)

The horizontal velocity of stone and passenger is the same. Therefore to the passenger the stone dropped will appear to be moving vertically downward.

3. Ans. (a)

It is velocity which determines the nature of path.

4. Ans. (a) 30°

$R = \frac{u^2 \sin 2\theta}{g}$, $H = \frac{u^2 \sin^2\theta}{2g}$

$R = 4H\cot\theta \Rightarrow 4\sqrt{3}\ H = 4\ H\cot\theta$

$\Rightarrow \cot\theta = \sqrt{3}$, $\theta = 30°$

5. Ans. (b)

R= 4H cotθ

$\tan\theta = 4 \Rightarrow \theta = \tan^{-1}(4)$

$\theta \Rightarrow 76°$

6. Ans. (b)

When height is largest 'θ' with horizontal = 90. So, time of flight is largest

7. Ans. (a)

On returning to the ground the speed is same as on firing. So there is no change in kinetic energy.

8. Ans. (d)

$\Delta P = P\sin\theta - (-P\sin\theta) = 2P\sin\theta$

$= 2P\sin 30 = P$

$\frac{\Delta P}{P} \times 100\% = 100\%$

9. Ans. (d)

Due to air, final horizontal component velocity<initial & final vertical component velocity> initial due to which striking angle increases at ground.

10. Ans. (a)

Both the bodies have same vertical acceleration and zero initial vertical velocity. Hence, both will cover the given vertical distance in same time.

11. Ans. (c)

At the highest point, velocity is acting horizontally & acceleration is acting vertically.

12. Ans. (d)

In oblique projection from ground, angle decreases from (90 + θ) to (90 − θ) being 90° at the highest point.

13. Ans. (b)

Horizontal range is max for one projected with least value |45 − θ|

|45 − 40| = 5 (least value)

|45 − 30| = 15

|45 − 55| = 10

14. Ans. (d)

Horizontal component of velocity remains constant throughout motion as 'g' is vertically directed.

15. Ans. (c)

Only in parabolic motion the direction and magnitude of acceleration remains constant.

In circle, direction of acceleration changes continuously.

16. Ans. (c)

$T = \frac{2u\sin\theta}{g} \Rightarrow u \propto t$

$R \propto u^2 \propto t^2$

17. Ans. (b)

$H = \frac{u^2\sin^2\theta}{2g}$, $T = \frac{2u\sin\theta}{g}$

$\frac{T^2}{H} = \left(\frac{2u\sin\theta}{g}\right)^2 \times \frac{2g}{u^2\sin^2\theta} = \frac{8}{g}$

$T = 2\sqrt{\frac{2H}{g}}$

18. Ans. (a)

$t_1 = \frac{2u \sin\theta}{g}$

$t_2 = \frac{2u \sin(90\text{-}\theta)}{g}$

$t_1t_2 = \frac{2u^2 \times 2\sin\theta \cos\theta}{g^2}$

$t_1t_2 = \frac{2u^2\sin2\theta}{g^2}$

$t_1t_2 = \frac{2R}{g} \Rightarrow t_1t_2 \, \alpha R$

19. Ans. (c)

$h_1 = \frac{u^2\sin^2\theta}{2g}$

$h_2 = \frac{u^2\sin^2(90\text{-}\theta)}{2g}$

$h_1 + h_2 = \frac{u^2}{2g}(\sin^2\theta + \cos^2\theta) = \frac{u^2}{2g}$

20. Ans. (a)

Horizontal momentum doesn't change.

The change in vertical momentum

$= \text{mvsin45} - (-\text{mvsin45}) = 2\text{mv}\frac{1}{\sqrt{2}} = \sqrt{2}\text{ mv}$

21. Ans. (d)

At highest point, $V = u\cos60 = \frac{u}{2}$ $(E = \frac{1}{2}mu^2)$

$K.\in = \frac{1}{2}mv^2 = \frac{1}{2}\ m\left(\frac{u}{2}\right)^2$

$= \frac{1}{4}(\frac{1}{2}mu^2) = \frac{E}{4}$

$P.\in = mg \times \frac{u^2\sin^2 60}{2g} = \frac{3}{4}E.$

22. Ans. (a)

$H = \frac{gT^2}{8} = kT^2$

$\frac{\Delta H}{H}\times100\% = 2 \times \frac{\Delta T}{T}\times100\%$

$10 = 2\times\left(\frac{\Delta T}{T}\times100\%\right)$

$\frac{\Delta T}{T}\times100\% = 5\%$

23. Ans. (a)

Horizontal component of velocity affects only range, not height.

24. Ans. (a)

$K\in$ is maximum at ground level R and $P\in$ is maximum at maximum height $\left(\frac{R}{2}\right)$.

25. Ans. (c)

$R = 4H\cot\theta \Rightarrow 2H = 4H\cot\theta$

$\tan\theta = 2\left(\tan\theta = \frac{vy}{vx} = \frac{b}{a}\right)$

or, $\frac{b}{a} = 2$

or, $b = 2a$

26. Ans. (c)

$\frac{\Delta E}{E} = 0.75 \Rightarrow \frac{Eo - Eo\cos^2\theta}{Eo} = \frac{3}{4}$

$\sin^2\theta = \frac{3}{4} \Rightarrow \sin\theta = \frac{\sqrt{3}}{2} \Rightarrow \theta = 60°$

27. Ans. (d)

$h = \frac{u^2\sin^2\theta}{2g} \Rightarrow h \,\alpha\, \sin^2\theta$

$\frac{h_1}{h_2} = \frac{\sin^2\theta}{\sin^2(90-\theta)} = \tan^2\theta{:}1$

28. Ans. (b)

The bullets will spread making a circle whose radius is equal to range (R) of bullet.

$A = \pi R^2 = \pi\left(\frac{v^2}{g}\right)^2 = \frac{\pi V^4}{g^2}$

29. Ans. (d)

$R^2 = \left(\frac{u^2\sin2\theta}{g}\right)^2 = 4^2 \times \frac{u^2\sin^2\theta}{2g} \times \frac{u^2\cos^2\theta}{2g} \Rightarrow R^2 = 4^2\frac{u^2\sin^2\theta}{2g} \times \frac{u^2\sin^2(90-\theta)}{2g}$

$R = 4\sqrt{H_1H_2}$

30. Ans. (c)

$T\alpha \sin\theta\left[T = \frac{2u\sin\theta}{g}\right]$

$\frac{T_1}{T_2} = \frac{\sin\theta}{\sin(90-\theta)} = \frac{\sin\theta}{\cos\theta} = \tan\theta$

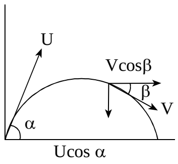
31. Ans. (b)

$V\cos\beta = u\cos\alpha$

$V = u\cos\alpha \sec\beta$

Here, $\alpha = \theta$, $\beta = 90 - \theta$

$V = u\cos\theta \sec(90 - \theta) = u\cot\theta$



32. Ans. (a)

Comparing with

$y = x\tan\theta - \dfrac{gx^2}{2u^2\cos^2\theta}$

$\tan\theta = \sqrt{3} \Rightarrow \theta = 60^o$

$\dfrac{g}{u^2\cos^2\theta} = 3$; $H = \dfrac{u^2\sin^2\theta}{2g} = \dfrac{\sin^2\theta}{2} \times \dfrac{u^2}{g}$

$= \dfrac{\sin^2\theta}{2} \times \dfrac{1}{3\cos^2\theta} = \dfrac{\tan^2 60}{6} = o.5m$

33. Ans. (b)

$u\cos\theta = v\cos\beta$

$V = u\cos\theta \sec\beta = 3\cos60 \sec30 = \sqrt{3}$

34. Ans. (b)

The two bodies will collide at highest point if they both cover same vertical height in same time. So,

$\dfrac{v_1^2\sin^2 30}{2g} = \dfrac{v_2^2}{2g}$

$\dfrac{v_2}{v_1} = \sin30 = 0.5$

35. Ans. (a)

Maximum horizontal range $= \dfrac{u^2}{g} = 20cm = 0.2cm$

$\therefore$ $u^2 = 0.2 \times g = 0.2 \times 10 = 2 \Rightarrow u = \sqrt{2}$

Speed along road $= u_x = u\cos\theta = \sqrt{2} \times \cos45$
$= 1m/s$

36. Ans. (c)

$T = \dfrac{2u\sin\theta}{g}$, $R = u\cos\theta \times T$

$\dfrac{T}{R} = \dfrac{2\tan\theta}{gT} \Rightarrow \tan\theta = \dfrac{gT^2}{2R}$

$\Rightarrow \theta = \tan^{-1}\left(\dfrac{gT^2}{2R}\right)$

37. Ans. (d)

$R = \dfrac{2u_x u_y}{g} = \dfrac{2 \times 30 \times 20}{10} = 120m$

38. Ans. (a)

$R_{max} = \dfrac{u^2}{g} = \sqrt{R_{max} \times g}$

$= \sqrt{16 \times 10^3 \times 10} = 400m/s$

39. Ans. (c)

$V_y = 50 \sin 30 = 25m/s$

$S = -V_y t + \dfrac{1}{2}gt^2$

or, $70 = -25t + 5t^2$

or, $5t^2 - 25t - 70 = 0$

$\therefore$ $t = -25$ or $7s$

$t = 7s$ (+ve value)

40. Ans. (b)

As the bullet suffers a vertically downwards deflection of

$y = \dfrac{1}{2}gt^2$

41. Ans. (a)

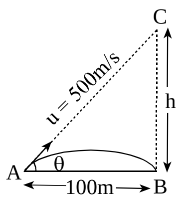
Along horizontal direction $x = ut$

$100 = 500t \therefore t = \dfrac{1}{5}s$

Along vertical direction

$y = \dfrac{1}{2}gt^2$

$= \dfrac{1}{2} \times 10 \times \left(\dfrac{1}{5}\right)^2 = 20$ cm



42. Ans. (d)

$h = ut + \dfrac{1}{2}gt^2$

or, $-25 = -5\sin30t + \dfrac{1}{2}(-10)t^2$

or, $50 = 5t + 10t^2 \Rightarrow t = 2sec$

$\therefore$ $x = u\cos30 \times t = 5 \times \dfrac{\sqrt{3}}{2} \times 2 = 5\sqrt{3}m$

43. Ans. (a)

Angular momentum at highest point = linear momentum x perpendicular distance.

$= mu\cos\theta \times h$

$= mu\cos\theta \times \dfrac{u^2\sin^2\theta}{2g} = \dfrac{mu^3\sin^2\theta\cos\theta}{2g}$

44. Ans. (b)

Avg. $u_x = u\cos\theta$, $u_y = \frac{u\sin\theta + 0}{2}$

Av. Velocity = $\sqrt{u_x^2 + u_y^2}$

$= \sqrt{u^2\cos^2\theta + \frac{u^2\sin^2\theta}{4}}$

$= \frac{u}{2}\sqrt{4\cos^2\theta + \sin^2\theta}$

$= \frac{u}{2}\sqrt{4\cos^2\theta + 1 - \cos^2\theta} = \frac{u}{2}\sqrt{1 + 3\cos^2\theta}$

45. Ans. (a) 4

$S = (u_1 + u_2)\frac{\sqrt{u_1u_2}}{g}$

$= (20 + 80) \times 4 = 400m$

46. Ans. (b)

$t = \frac{\sqrt{u_1u_2}}{g} = \frac{\sqrt{20 \times 80}}{10} = 4s$

47. Ans. (c)

$t = \frac{2\sqrt{u_1u_2}}{g} = 8$

Past Questions

1. A person can throw can throw a stone to maximum horizontal distance d. The maximum vertical distance he can throw is [IOM 2010\BPKIHS]

a. d b. 2d

c. 4d d $\frac{d}{2}$

2. A projectile's time of flight 'T' is related to horizontal range by equation $gT^2 = 2R$. The angle of projection in degrees is [IOM 063]

a. 45^o b. 90^o

c. 30^o d. 60^o

3. A body is thrown vertically upwards and attains a velocity of 15m/s at half the maximum height upto which the body can reach will be [MOE 2068]

a. 45.8m b. 34.5m

c. 22.9m d. 17.8m

4. A body projected at velocity 200m/s at 45^o then max. Height attained[MOE 2068]

a. 1000m b. 200m

c. 400m d. 500m

5. A person has thrown a stone to maximum horizontal distance d. The maximum vertical distance it has reached is [BPKIHS]

a. d b. 2d

c. $\frac{d}{2}$ d. $\frac{d}{4}$

6. A projectile is thrown at an angle θ with vertical with initial kinetic energy E_o. If air resistance is neglected, the KE at highest point will be [MOE]

a. $E_o\cos^2\theta$ b. $E_o\cos\theta$

c. $E_o\sin^2\theta$ d. zero

7. The range of a projection when projected at an angle θ degree is R. If the angle of projection is 2θ degree but the range remains same the angle will be [MOE 2009]

a. 10° b. 20°

c. 30° d. 40°

8. Two bullets A and B are fired horizontally at the same instant of time with velocities Va and Vb from same height. If VA > VB which will reach the ground first? [MOE 065]

a. A

b. B

c. Both A & B simultaneously

d. Depends on their masses

9. A cricket ball is struck with a K.E. of 'K' at an angle of 45° with the horizontal. The K.E. at the maximum height will be [MOE 2062]

a. 0 b. $\frac{k}{2}$

c. k d. 2k

10. R is the horizontal range of projectile for an angle of projection of 15°. For the same range another angle of projection will be [MOE 2000]

a. 30° b. 75°

c. 60° d. 45°

11. For a projectile fixed at equal inclination to horizontal and vertical line with velocity u, the horizontal distance travelled is [MOE]

a. $\frac{u^2}{g}$ b. $\frac{u^2}{2g}$

c. $\frac{u^2\sin\theta}{g}$ d. None

12. If the maximum range or a projectile is four times its maximum height, then the angle of projection is equal to [BPKIHS 2007]

a. 30° b. 45°

c. 60° d. 75°

13. A plane is moving with 300 m/s when it is just above the observer at height of 2km. At what angle with the vertical must he fire the gun with velocity 400m/s directly to hit the aeroplane? [BPKIHS 2002]

a. 30° b. 60°

c. 90° d. 45°

14. If mass and velocity of a body in a projectile motion is doubled then linear momentum becomes [IE 2005]

a. 2 times b. 4 times

c. $\frac{1}{2}$ times d. constant

15. Two projectile A and B are thrown at a same angle with velocity $U_B = 2U_A$, then what is the relation between their range? [IE-2002]

a. $R_A = R_B$ b. $2R_A = R_B$

c. $R_B = 4R_A$ d. $2R_B = R_A$

16. A body is projected of an angle 45° with velocity 200m/s. The maximum height attained by the projectile is [MOE 2069]

a. 200m b. 400m

c. 800m d. 1000m

17. A plane is moving with velocity 200m/s and a observor is just below it. If a shell is fired by observer at 400m/s, what is minimum height for plane so that it would escape? [BPKIHS 2012]

a. 6km b. 12 km

c. 18km d. 3km

Answers

1. d	*2. a*	*3. c*	*4. a*	*5. d*	*6. c*	*7. c*	*8. c*	*9. b*	*10. b*
11. a	*12. b*	*13. a*	*14. b*	*15. c*	*16. d*	*17. a*			

SOLUTION

1. Ans. (d)

$R_{max.} = \frac{u^2}{g}$ $H_{max.} = \frac{u^2}{2g}$

$H_{max.} = \frac{R_{max}}{2}$

2. Ans. (a)

$R = \frac{gT^2}{2\tan\theta}$

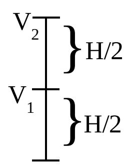
$\tan\theta = \frac{gT^2}{2R} = 1$ $\therefore\ \theta = 45°$

3. Ans. (C)

Taking upper half path,

Taking upper $v_2 = 0$m/s

Half path $v_1 = 15$m/s



$$V_2^2 - V_1^2 = -2g\frac{H}{2}$$

or, $0 - 15^2 = -9.8H$

$\Rightarrow$ H = 22.9m

4. Ans. (a)

$$H = \frac{u^2\sin^2\theta}{2g} = \frac{(200)^2 \times (\sin 45)^2}{2 \times 10} = 1000m$$

5. Ans. (d)

$$R_{max.} = \frac{u^2}{g} \text{ (at } \theta = 45°)$$

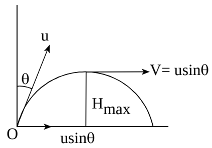
$$H_{max.} = \frac{u^2\sin^2 45}{2g} = \frac{u^2}{4g}$$

$R_{max}: H_{max} = 4:1$

6. Ans. (c)

Here, 'θ' is the angle with vertical.So Horizontal velocity = usinθ

$$k.\varepsilon = \frac{1}{2}mv^2 = \frac{1}{2}mu^2\sin^2\theta = \varepsilon_o\sin^2\theta$$



7. Ans. (C)

$$\frac{u^2\sin 2\theta}{g} = \frac{u^2\sin 4\theta}{g}$$

Solving, θ = 30°

∴ 2θ = 60°

8. Ans. (c)

If bullets are fired horizontally with any velocity, vertical components of velocities are zero in all case. Hence, fall simultaneously.

9. Ans. (b)

K.E at max height

$$= E_o\cos^2\theta = E_o\cos^2 45 = E_o\left(\frac{1}{\sqrt{2}}\right)^2 = \frac{E_o}{2}$$

P.E at max height = $E_o\sin^2\theta$

10. Ans. (b)

For the same horizontal range.

Two angles of projection are θ and 90 – θ

15 and (90 – 15 = 75°)

11. Ans. (a)

θ = 45°

$$R = \frac{u^2\sin 2\theta}{g} = \frac{u^2}{g}$$

12. Ans. (b)

R max = 4H max

$$\frac{u^2\sin 2\theta}{g} = \frac{4 \times u^2\sin^2\theta}{2g}$$

tanθ = 1

∴ θ = 45°

13. Ans. (a)

$$H = \frac{u^2\sin^2\theta}{2g}$$

or, $$2000 = \frac{400^2 \times \sin^2\theta}{2 \times 10}$$

∴ θ = 30°

14. Ans. (b)

$P_1 = mv$

$P_2 = 2m \times 2v$

∴ $P_2 = 4P_1$

15. Ans. (c)

$$R = \frac{u^2\sin 2\theta}{g}$$

$R \alpha u^2$

$$\Rightarrow \frac{R_A}{R_B} = \left(\frac{U_A}{U_B}\right)^2 = \frac{1}{4}$$

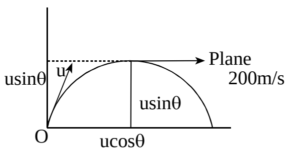
$\Rightarrow R_B = 4R_A$

16. Ans. (d)

$$H = \frac{u^2\sin^2\theta}{2g} \text{ when } \theta = 45°$$

$$H_{max} = \frac{(200)^2 \times (\sin 45)^2}{2 \times 10} = 1000m$$

17. Ans. (a)



ucosθ = 200 ⇒ 400cosθ = 200

$$\therefore \cos\theta = \frac{1}{2} = 60°$$

For max. height $v^2 = u^2 - 2gh$

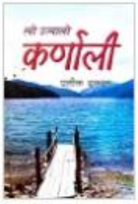
$O = (u\sin\theta)^2 - 2gh$

$h = \dfrac{(400\sin 60)^2}{2g} = 6km$

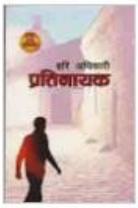
SHIKHA BOOKS


नेपालमा कम्युनिस्ट पार्टीको विकासक्रम, सरकार र नेतृत्व


नेपाली कांग्रेसको इतिहासको प्रारूप



त्यो उज्यालो कर्णाली



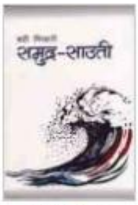
प्रतिनायक

रिकुटे

स्कुल बेन्ने बालक

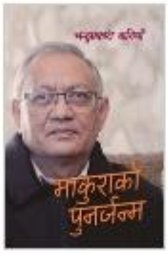
अदभुत तिवारी


छोट्टी



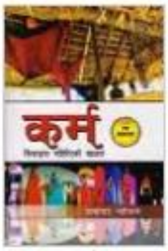
समुन्द्र साउती

गद्य शैलीको रूपविज्ञान



माकुराको पुनर्जन्म

नेपाली कांग्रेसको इतिहासको प्रारूप



कर्म


वीर्य जमिन

सारङ्गी

परदेशका कथा

डिलको डोब

Of Walls And Pigeons

BOOKS FROM SHIKHA BOOKS

Chapter: 5

NEWTON'S LAW OF MOTION

1. In the case of horse pulling a cart the force that causes the horse to move forward is that

a. the horse exerts on the ground.
b. the horse exerts on the cart.
c. the ground exerts on the horse
d. the cart exerts on the ground.

2. A particle is moving with a constant speed along a straight line path. A force is NOT required to

a. increase its speed
b. decrease the momentum
c. change in direction
d. keep it moving with uniform velocity

3. Which of the following relation is NOT applicable to the rocket?

a. $\vec{F} = \frac{d\vec{p}}{dt}$ b. $\vec{F} = m\vec{a}$
c. $\vec{p} = M\vec{v}$ d. $\vec{p} = \int \vec{F} dt$

4. A body of mass 10kg is acted on by a force of 10N for 10sec the change in momentum is

a. 10kg m/s b. 100kg m/s
c. 50kg m/s d. 500kg m/s

5. A uniform rod of mass 6kg and Length L is suspended from a rigid support. The tension at a distance $\frac{L}{4}$ from its free end is

a. 60N b. 15N
c. 45N d. zero

6. n small balls each of mass m impinge elastically each second on a surface with velocity u. The force experience by the surface will be

a. mnu b 2mnu
c. 4mnu d. $\frac{mnu}{2}$

7. A wide hose pipe is held horizontally by a fireman. It delivers water through the nozzle at one litre/sec. One increasing the pressure, this increase to 2litre / sec. The fireman has now to

a. push forward twice as hard
b. push forward four times hard
c. push backward twice as hard
d. push backward four times as hard

8. A ball of mass 0.1kg is thrown against a wall. It strikes the wall normally with velocity of 30m/s rebounds with a velocity of 20m/s. The impulse of the force exerted by the ball on the wall is

a. 0.5Ns b. 50 Ns
c. 1Ns d. 5Ns

9. A man weight 80kg. He stands on a weighing scale in the lift which is moving upwards with a uniform acceleration of 5m/s. What would be the reading on scale?

a. zero b. 400N
c. 800N d. 1200N

10. The heart is pumping blood at x kg per unit time with constant velocity v. The force needed is

a. xv b. $v\frac{dx}{dt}$
c. $x\frac{dv}{dt}$ d. zero

11. A body of mass 'm' collides against a wall with a velocity v and rebounds with same speed. Its change in momentum is

a. –2mv b. mv
c. –mv d. zero

12. A bomb of mass 16kg at rest explodes into two pieces of masses 4kg and 12kg. The velocity of the 12kg mass is 4m/s. The kinetic energy of the other mass is

a. 288J b. 192J
c. 96J d. 144J

13. A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45° with the initial vertical direction is

a. Mg b. $Mg/\sqrt{2}$

c. $Mg\left(\sqrt{2}+1\right)$ d. $Mg\left(\sqrt{2}-1\right)$

14. An ideal string passes over a fixed pulley and carries masses M_1=12kg and M_2=8kg tied at its ends. Calculate the acceleration of masses and tension in the string when released.

a. $2m/s^2$, 96N b. $1m/s^2$, 108N

c. $6m/s^2$, 88N d. $2m/s^2$, 144N

15. A moving body of masses m and velocity 3km/hr collides with a body of mass 2m at rest and sticks to it. Now the combined mass starts to move. What will be the combined mass velocity?

a. 3km/hr b. 2km/hr

c. 1km/hr d. 4km/hr

16. A plump line suspended from the roof of carriage moving with acceleration inclines at an angle θ with the vertical, then

a. $a = g\tan\theta$ b. $a = g\sin\theta$

c. $a = g\cot\theta$ d. $a = g\cos\theta$

17. When a mass of 1kg is suspended by a thread and lifted up and then down with acceleration of $5m/s^2$. The ratio of tension in the thread is

a. 1:1 b. 1:3

c. 3:1 d. 1:2

18. A block of mass 'M' is pulled along a horizontal frictionless surface by a rope of mass m. If a force F is applied at one end of the rope, which the rope exerts on block is

a. $\frac{Fm}{M+m}$ b. $\frac{FM}{M+m}$

c. F d. $\frac{F}{2}$

19. What is the minimum acceleration of a fireman sliding down a fixed vertical rope for which breaking strength is α times its weight.

a. αg b. g/α

c. $(\alpha - 1)g$ d. $(1-\alpha)g$

20. A 20kg crate hangs at the end of a long rope. Find its acceleration when the tension in the rope is 150N

a. $2.7m/s^2$ upward

b. $2.7m/s^2$ downward

c. $2.3m/s^2$ downward

d. $2.3m/s^2$ upward

21. A block of 2kg on a horizontal surface is pulled at 30° with horizontal by a force of 10N. The normal reaction on the block is

a. 10N b. 15N

c. 20N d. 25N

22. A boy of mass 40kg is hanging from the horizontal branch of a tree. The tension in arms is maximum when angle between arms is

a. 0° b. 60°

c. 90° d. 120°

23. A jet of water with area of cross section $2cm^2$ strikes a wall at an angle 60° to normal and rebounds elastically from wall with same speed. If the speed of water in the jet is 10m/s. the force acting on the wall is

a. 10N b. 5N

c. 40N d. 20N

24. When forces F_1, F_2, F_3 are acting on a particle of mass m such that F_2 and F_3 are mutually perpendicular, then the particle remains stationary. If the force F_1 is now removed, then acceleration of particle

a. $\frac{F_1}{m}$ b. $\frac{F_2F_3}{mF_1}$

c. $\frac{F_2 - F_3}{m}$ d. $\frac{F_2}{m}$

25. An open knife edge of mass M is dropped from a height h on a wooden floor. If the blade penetrates distance 's' into the wood, the average resistance offered by the wood to the blade is

a. Mg b. $Mg\left(1+\frac{h}{s}\right)$

c. $Mg\left(1-\frac{h}{s}\right)$ d. $Mg\left(1+\frac{h}{s}\right)^2$

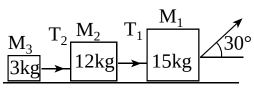
26. A cold drink bottle is kept on a balance. When cap of the bottle is opened, then the reading of the weight on the balance

a. increase b. decrease

c. First increases then decreases

d. remains same

27. The surfaces are frictionless. The ratio of T_1 to T_2 is



a. $\sqrt{3}:2$ b. $1:\sqrt{3}$

c. 1:5 d. 5:1

28. A rocket of initial mass 1500kg ejects gas at constant rate of 10kg/s with a relative speed of 5km/s. What is the acceleration of the rocket 50sec after the blast neglecting gravity?

a. $10m/s^2$ b. $25m/s^2$

c. $50m/s^2$ d. $100m/s^2$

29. A satellite in force free space sweeps stationary dust as the rate of $\frac{dm}{dt} = \alpha v$. The acceleration of the satellite is

a. $\frac{-2\alpha v^2}{M}$ b. $\frac{-\alpha v^2}{M}$

c. $\frac{-\alpha v^2}{2M}$ d. $-\alpha v^2$

30. A body of mass 5kg at rest explodes into 3 segments having masses in the ratio 2:2:1. The fragments with equal masses fly in mutually perpendicular direction with speed 15m/s. What will be the velocity of the lighter segment?

a. 15m/s b. $15\sqrt{2}$m/s

c. 30m/s d. $30\sqrt{2}$m/s

31. A balloon is descending at a constant acceleration a. The mass of the balloon is M. When a mass 'm' is released from the balloon it starts rising with the same acceleration 'a'. Assuming that the value doesn't change when the mass is released, the value of $\frac{m}{M}$

a. $\frac{a}{a+g}$ b. $\frac{2a}{a+g}$

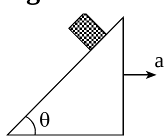
c. $\frac{a+g}{a}$ d. $\frac{a+g}{2a}$

32. A balloon of mass M is rising up with acceleration a, then to double the acceleration, the fraction of weight of balloon to be detached to

a. $\frac{a}{2a+g}$ b. $\frac{2a}{a+g}$

c. $\frac{a}{a+g}$ d. $\frac{a+g}{2a}$

33. A body is lying on a frictionless wedge. The necessary horizontal acceleration 'a' that must be given to the wedge towards right such that the body falls freely is:



a. a = g b. a = g sinθ

c. a = g cosθ d. a = g cotθ

34. In above question, the necessary horizontal acceleration that must be given to the wedge so that the body remains at rest with respect to wedge is

a. a = g b. a = g sinθ

c. a = g tanθ d. a = g cotθ

35. A bird resting on the floor of an air tight box which is carried by a boy, starts flying. The boy feels that now the box

a. is heavier

b. is lighter

c. no change in weight

d. lighter first then heavier

36. If the system is not air tight in above question. The boy feels that now the box

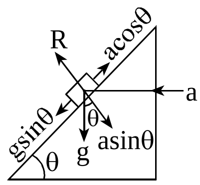
a. is heavier
b. is lighter
c. no change in weight
d. lighter first then heavier

37. A bird flying in the air sits on a stretched telegraph wire. If the weight of birds is w, which of the following is the about additional tension T produced in the wire

a. T = O b. T = W
c. T < W d. T > W

38. The horizontal acceleration that should be given to a smooth inclined plane of angle $\sin^{-1}\left(\frac{1}{l}\right)$ to keep the an object stationary on the plane, relative to inclined plane

a. $\frac{g}{\sqrt{l^2-1}}$
b. $g\sqrt{l^2-1}$
c. $\frac{\sqrt{l^2-1}}{g}$
d. $\frac{g}{\sqrt{l^2+1}}$



39. A fireman wants to slide down a rope. The breaking load for the rope is $\left(\frac{3}{4}\right)$th of the weight of the man with what acceleration should the fireman slide down?

a. $\frac{g}{4}$ b. $\frac{g}{2}$
c. $\frac{3g}{4}$ d. zero

40. A person slides freely down a friction less inclined plane while his ball falls down vertically from same height. The final speed of man (V_M) and bag (V_B) such that

a. $V_M < V_B$ b. $V_M = V_B$
c. $V_M > V_B$ d. depends on masses

41. The minimum force required to move a body of mass m vertically upward is

a. mg. b. $\frac{mg}{2}$
c. more than 2mg d. more than mg

42. Two masses m_1 and m_2 are connected through pulley. The acceleration of m_1 is downward, then tension in the string is:

a. $\left(\frac{m_1m_2}{m_1+m_2}\right)g$ b. $\left(\frac{2m_1m_2}{m_1+m_2}\right)g$
c. $\left(\frac{m_1+m_2}{m_1m_2}\right)g$ d. $\left(\frac{4m_1m_2}{m_1+m_2}\right)g$

Answer Sheet

1. c	2. d	3. b	4. b	5. b	6. b	7. b	8. d	9. d	10. a
11. a	12. a	13. a	14. a	15. a	16. a	17. c	18. b	19. d	20. c
21. b	22. d	23. d	24. a	25. b	26. c	27. d	28. c	29. b	30. d
31. b	32. a	33. d	34. c	35. c	36. b	37. d	38. a	39. a	40. b
41. d	42. b								

SOLUTION

1. Ans. (c)

The horizontal component of the reaction of the ground on the horse makes the cart and horse moves forward.

2. Ans. (d)

According to Newton's first law, No force is required to keep a body in motion with constant velocity.

3. Ans. (b)

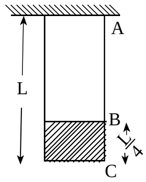
F = ma is applicable when mass remains constant. In rocket mass varies so, $\vec{F} = \vec{V}\dfrac{dm}{dt}$

4. Ans. (b)

$\Delta P = F\int dt = Ft = 10\times 10 = 100 kg/s$

5. Ans. (b)

Tension at B = weight of part BC



$= \left(\dfrac{M}{L} \times \dfrac{L}{4}\right) g = \dfrac{1}{4} \times 6 \times 10 = 15N.$

6. Ans. (b)

$\Delta P = mu - (-mu) = 2mu$

$f = \dfrac{\Delta p}{\Delta t} = \dfrac{2mu}{\dfrac{1}{n}} = 2mnu$

7. Ans. (b)

$F = \dfrac{V^2\delta}{A}$ where V = Volume of water ejecting per sec.

$\Rightarrow$ $F \alpha V^2$

Hence, force becomes 4 times if rate of ejecting water per sec is doubled & it acts forward.

8. (d)

Impulse = change in momentum

= 0.1 (30 – (–20) = 50×0.1 = 5Ns

9. Ans. (d)

Apparent weight = m (g + a) = 80(10 + 5)

= 1200N

10. Ans. (a)

Force = Rate of change of momentum

$= \dfrac{mv}{t} = \left(\dfrac{m}{t}\right) v = xv$

11. Ans. (a)

Change in momentum

= m (v – u) = m (–v – v)= –2mv

12. Ans. (a)

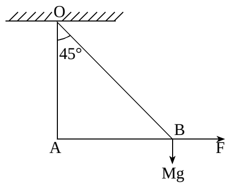
Momentum is conserved

$m_1u_1 = m_2u_2$

$u_1 = \dfrac{12 \times 4}{4} = 12$

$KE = \dfrac{1}{2} m_1u^2{}_1 = \dfrac{1}{2} \times 4 \times 12^2 = 288J$

13. Ans. (a)



$\tan 45° = \dfrac{AB}{OA} = \dfrac{F}{mg}$

$\therefore$ F = mg

14. Ans. (a)

$a = \left(\dfrac{M_1 - M_2}{M_1 + M_2}\right) g = \left(\dfrac{12-8}{12+8}\right) 10 = 2 m/s^2$

$T = \left(\dfrac{2M_1M_2}{M_1 + M_2}\right) g = \left(\dfrac{2 \times 12 \times 8}{12+8}\right) \times 10 = 96N$

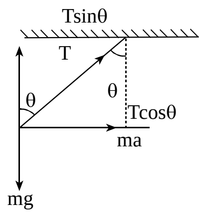
15. Ans. (a)

Conservation of linear momentum

m × 3 + 2m × 0 = (m + 2m)v

$\therefore$ v = 1km/hr

16. Ans. (a)



Tsinθ = ma and Tcosθ = mg

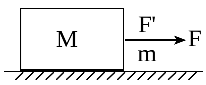
$\therefore$ $\tan\theta = \dfrac{a}{g}$

$\therefore$ a = g tanθ

17. Ans. (c)

$\dfrac{T_1}{T_2} = \dfrac{m(g+a)}{m(g-a)} = \dfrac{10+5}{10-5} = \dfrac{3}{1}$

18. Ans. (b)



$\dfrac{F}{F^1} = \dfrac{M+m}{M}$

$\therefore$ $F^1 = \dfrac{FM}{M+m}$

19. Ans. (d)

For sliding down,

T = mg–ma

αmg = mg–ma

a = (1– α)g

20. Ans. (c)

Tension (=150) < weight

so it accelerates downward

$mg - T = ma$

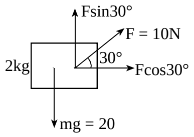
$20\times9.8 - 150 = 20a$

$\therefore \quad a = \frac{46}{20} = 2.3 m/s^2$

21. Ans. (b)

$R = mg - F\sin30°$

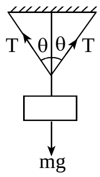
$= 2\times10 - 10\times\frac{1}{2} = 15N$



22. Ans. (d)

$2T\cos\theta = mg$

$\therefore \quad T \propto \frac{1}{\cos\theta}$



θ varies from 0 to 90° T will be more if cosθ is less or max angle

So, here 120° is max angle.

23. Ans. (d) 20N

$F = \frac{dm}{dt}[v\cos\theta - (-v\cos\theta)]$

or, $F = 2Av^2\delta\cos\theta$

or, $F = 2 \times 2 \times 10^{-4} \times 10^2 \times 10^3 \times \cos60 = 20N$

24. Ans. (a)

If particle is stationary under F_1, F_2 & F_3. F_2 & F_3 are mutually perpendicular.

$F_1 + F_2 + F_3 = 0 \Rightarrow F_1 = -(F_2 + F_3)$

If F_1 is removed, Net force = $F_2 + F_3$

$a = \frac{F_2 + F_3}{m} = \frac{F_1}{m}$

25. Ans. (b)

Velocity acquired by knife edge on falling through height 'h' is $v^2 = 2gh$. If a is retardation $v^2 - u^2 = -2as \Rightarrow a = \frac{o^2 - 2gh}{-2s}$

$= \frac{gh}{s}$ (R = Resistance offered by blade)

or, $R - Mg = Ma \Rightarrow R = Mg + ma$

$= Mg \times m\frac{gh}{s} = Mg\left(1 + \frac{h}{s}\right)$

26. Ans. (c)

Weight first increase due to reaction force & then decreases.

27. Ans. (b)

The tension in each string is due to mass tied behind it.

$\frac{T_1}{T_2} = \frac{M_2 + M_3}{M_3} = \frac{12 + 3}{3} = 5:1$

28. Ans. (c)

Force on rocket $F = \vec{V}\frac{dm}{dt}$

$= 5000\times10 = 5\times10^4 N$

Mass after 50s, $M_{50} = 1500 - 50 \times 10$

$= 1000kg$

Acceleration after 50s

$a_{50} = \frac{F}{M_{50}}$

$= \frac{5 \times 10^4}{1000} = 50 m/s^2$

29. Ans. (b)

Thrust on satellite $F = \frac{-vdm}{dt} = -\alpha v^2$

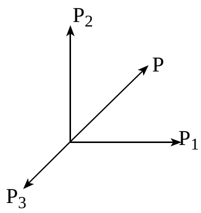
Acceleration, $a = \frac{F}{M} = \frac{-\alpha v^2}{M}$

30. Ans. (d)

Momentum of each masses

$|\vec{P_1}| = |\vec{P_2}|$

$= 2m \times 15 = 30m$



Momentum of Resultant

$|\vec{P}| = \sqrt{P_1^2 + P_1^2}$

$= 30\sqrt{2}m$

Momentum of smaller fragement (P_3)

$P_3 + P = 0$

or, $P_3 = -P \Rightarrow V = -30\sqrt{2}$ m/s

31. Ans. (b)

$R = M(g - a)$ going downwards

$R = (M - m)(g + a)$ going upwards

or, $(M-m)(g + a) = M(g - a)$

$\therefore \quad \frac{m}{M} = \frac{2a}{a + g}$

32. Ans. (a)

$R = M(g + a)$

$R = (M - m)(g + 2a)$

Solving, we get

$\frac{m}{M} = \frac{a}{2a + g}$

33. Ans. (d)

For freefall, Normal reaction, R = o

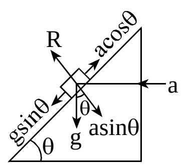
$g \cos\theta - a \sin\theta = o$

$\therefore$ $a = g \cot\theta$

34. Ans. (c)

At rest $g\sin\theta = a\cos\theta$

or, $a = g \tan\theta$



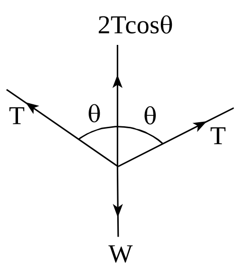
35. Ans. (c)

System is closed, so downward push by the bird & upthrust on the bird balances each other.

36. Ans. (b)

The system is not closed, air pushed down by the bird will go out of the cage and it will not give downward thrust to the cage

37. Ans. (d)



$2T\cos\theta = w$

$T = \frac{w}{2\cos\theta}$

For light mass $\theta \approx 90°$

i.e. $\cos\theta$ is very small

$\Rightarrow$ $T >> w$

38. Ans. (a)

$a \cos\theta = g \sin\theta$

or, $a = g \tan\theta$

$\sin\theta = \frac{1}{l}$ and $\tan\theta = \frac{1}{\sqrt{l^2 - 1}}$

or, $a = g \tan\theta = \frac{g}{\sqrt{l^2 - 1}}$

39. Ans. (a)

let the be acceleration be 'a'.

$mg - R = ma$

$R_{max} = \frac{3}{4}mg$

$mg - \frac{3}{4}mg = ma$

$\therefore$ $a = \frac{g}{4}$

41. Ans. (d)

Let body moves upward with acceleration 'a'

$R = mg + ma$

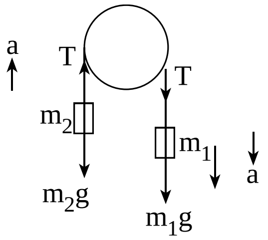
Minimum force $mg + ma > mg$

40. Ans. (b)

The velocity at the bottom = $\sqrt{2gh}$

The velocity depends on height and not on the length of inclined plane.

42. Ans. (b)



$m_1g - T = m_1a$

$T - m_2g = m_2a$

Solving, we get,

$T = \left(\frac{2m_1m_2}{m_1 + m_2}\right) g$ &

$a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$

Past Questions

1. **The forces exerted by a passenger of mass 'M' on the floor of an elevator which is going down with acceleration 'a' is [IOM 2008]**
   a. Mg b. Ma
   c. M (g – a) d. M (g + a)

2. **Rocket works on the principle of conservation of [IOM/MOE/BPKIHS]**
   a. mass
   b. energy
   c. linear momentum
   d. angular momentum

3. **A book on the table lies there till eternity is based on [IOM]**
   a. Newton's first law b. 2nd law
   c. third law d. none

4. **Two bodies of masses 4kg and 5kg are acted upon one after the other by the same force. If the acceleration of heavier body is 2m/s^2 the acceleration of lighter body is [MOE 065]**
   a. 4m/s^2 b. 2.5m/s^2
   c. 2m/s^2 d. 3.5m/s^2

5. **Whatever may be the direction of two forces 6N and 2N acting on a body of mass 2kg, the minimum acceleration of the body cannot be less than [MOE 2058]**
   a. 4m/s^2 b. 2m/s^2
   c. 2.5m/s^2 d. 3m/s^2

6. **Two persons are holding a rope of negligible weight tightly at its end so that it is horizontal. A 15kg weight is attached to rope at its mid-point which now no more remains horizontal. The minimum tension required to completely straighten the rope is [BP 2011]**
   a. 15kg b. 7.5kg
   c. 5kg d. infinite

7. **A body of mass 2kg moving with a certain velocity is acted upon by an opposing force of 4N. It stops in 2s. For the same body to continue motion with same velocity, we should apply [BPKIHS 2001]**
   a. 0N b. 4N
   c. 8N d. 3N

8. **A rope of length L is pulled by a constant force F. What is the tension in the rope at a distance x from the end where force is applied. [BPKIHS]**
   a. $F\left(\frac{L}{x}\right)$ b. $F\frac{L}{L-x}$
   c. $\frac{Fx}{L-x}$ d. $\frac{F(L-x)}{L}$

9. **A ball is dropped onto a floor from height of 10m. It rebounds to a height of 2.5m. If the ball is in contact into a floor for 0.01s. then upward acceleration at the time of contact is [BPKIHS]**
   a. 700m/s^2 b. 1400m/s^2
   c. 2100m/s^2 d. 1800m/s^2

10. **A body having mass of 8kg travels distance of 4, 5 and 6m respectively in successive seconds. The force acting on it is [BPKIHS 05]**
    a. 8N b. 16N
    c. 16 dyne d. 4N

11. **A 60kg man pushes a 40kg man by a force of 60N. The 40kg man has pushed the other man with a force of [BPKIHS- 95]**
    a. 40N b. 0

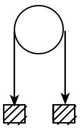
c. 60N d. 20N

12. A force of P magnitude is acting on the free end of a rope of mass m attached with a block of mass M. What is the force on the block? [BPKIHS 2002]

a. $\frac{PM}{M+m}$ b. $\frac{P}{M}$

c. $\frac{Pm}{M+m}$ d. $\frac{PM}{M-m}$

13. What is the total tension acting in above fig? [BPKIHS 2012]



a. 75N b. 37.5N

c. 50N d. 150N

Answer Sheet

1. c	*2. c*	*3. a*	*4. b*	*5. b*	*6. d*	*7. b*	*8. d*	*9. c*	*10. a*
11. c	*12. a*	*13. a*							

SOLUTION

1. Ans. (c)
$Ma = Mg - R$
$R = Mg - Ma$
Here, apparent wt or reaction is asked

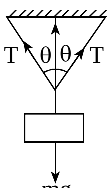
2. Ans. (c) Linear momentum

3. Ans. (a)
First law gives the idea of inertia

4. Ans. (b)
$F = m_1a_1 = m_2a_2$
$a_1 = \left(\frac{m_2}{m_1}\right)a_2 = \left(\frac{5}{4}\right)2 = 2.5\text{m/s}^2$

5. Ans. (b)
The result of 6N and 2N force is
$F_{max} = (6 + 2) = 8N$
$F_{min} = (6 - 2) = 4N$
$a = \frac{F}{m}$; $a_{min} = \frac{Fmin}{m} = \frac{4}{2} = 2\text{m/s}^2$

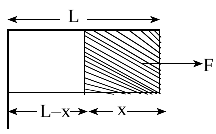
6. Ans. (d)



$2T\cos\theta = mg$
$T = \frac{mg}{2\cos\theta}$
The string will be horizontal if $\theta = 90°$ i.e.
$\cos\theta = 0$
$T = \frac{Mg}{2 \times 0} = \infty$ (infinite)

7. Ans. (b)
Opposing force (F) = 4N
time (t) = 2s, m = 2kg
$a = \frac{F}{m} = 2\text{m/s}^2$
$v = u - at$ (body is retarding) $u = at = 2 \times 2 = 4$
To move with same velocity i.e. u = 4m/s
$F = ma = m \times \frac{u}{t}$
$= 2 \times \frac{4}{2} = 4N$

8. Ans. (d)



Total force
(F) = M × a
$\therefore$ $a = \frac{F}{m}$
T = mass of (L − x) ×a
$= \frac{M}{L}(L - x) \times \frac{F}{M} = \frac{F(L-x)}{L}$

9. Ans. (c)
$u = \sqrt{2gh_1} = \sqrt{2 \times 10 \times 10} = 10\sqrt{2}\text{m/s}^2$
$v = \sqrt{2gh_2} = \sqrt{2 \times 10 \times 2.5} = \sqrt{50}\text{m/s}$
Impulse = F × t = m × a × t = m (v + u)

$$a = \frac{(v + u)m}{mt}$$

$$= \frac{\sqrt{50} + 10\sqrt{2}}{0.01} = 2100 \text{ m/s}^2$$

10. Ans. (a)

$$S_1 = 4 = u + \frac{a}{2}(2 \times 1 - 1) = u + \frac{a}{2}$$

$$S_2 = 5 = u + \frac{a}{2}(2 \times 2 - 1) = u + 3\frac{a}{2}$$

From above, we get

$$a = 1\text{m/s}^2$$

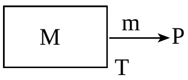
$$F = ma = 8\text{N}$$

11. Ans. (c) 60N

Newton's third law every action equal & opposite reaction.

12. Ans. (a)

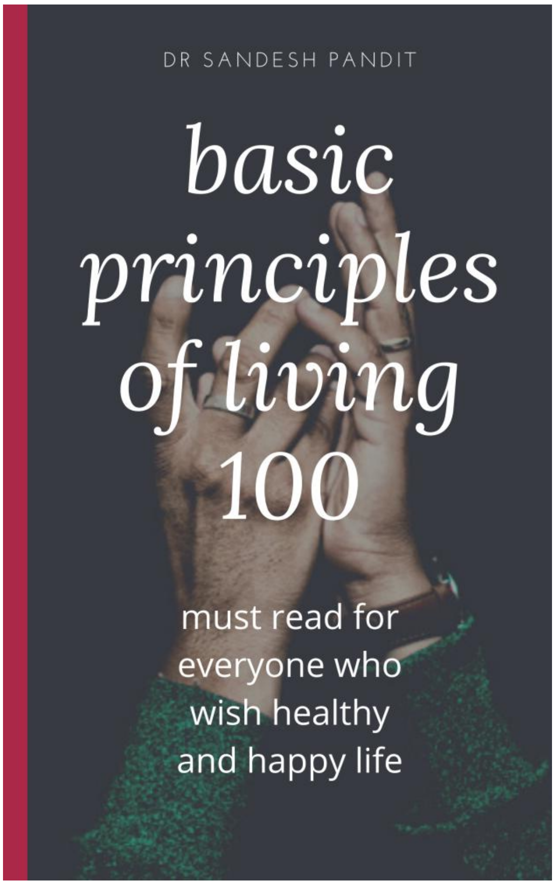
$$T = \frac{M}{M + m} \text{ (Take mass behind it)}$$



$$T = \frac{PM}{M + m}$$

13. Ans. (a)

$$T = \left(\frac{2m_1m_2}{m_1 + m_2}\right)g = \left(\frac{2 \times 6 \times 10}{6 + 10}\right) \times 10 = 75 \text{ N}$$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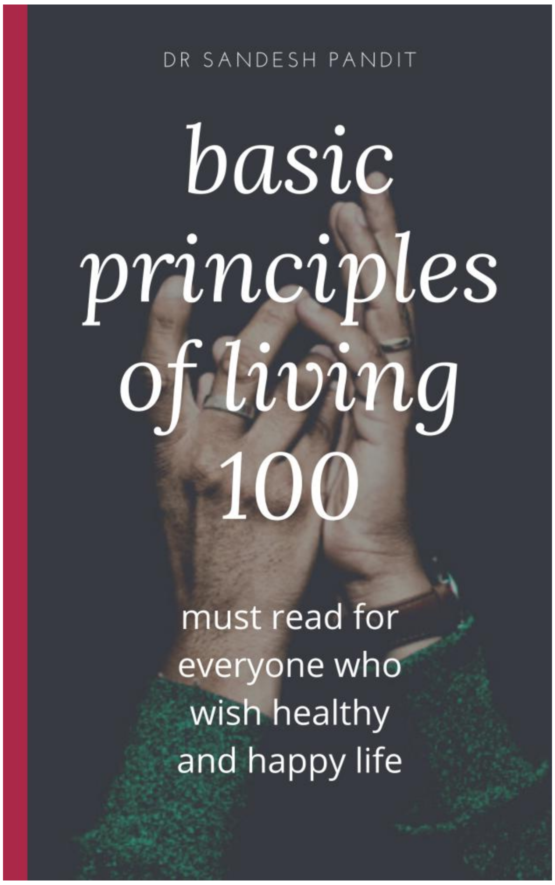
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Chapter: 6

FRICTION

1. The frictional force arises because of

a. interaction force between molecules of two bodies

b. repulsive force between nuclei of two bodies

c. gravitational force between two bodies

d. attraction between two nucleons

2. Which one of the following is self adjusting force?

a. static friction

b. limiting friction

c. kinetic friction

d. rolling friction

3. Which is true for rolling friction (μr) static friction (μs) and kinetic friction (μk)?

a. μs > μk > μr b. μs < μk < μr

c. μs < μk > μr d. μs > μr > μk

4. The angle between the frictional force and instaneous velocity of the body moving on rough surface is

a. zero b. $\frac{\pi}{2}$

c. π d. $\tan^{-1}(\mu)$

5. To avoid slipping while walking on ice, one should take smaller steps because

a. friction of ice is larger

b. larger normal reaction

c. friction of ice is small

d. smaller normal reaction

6. Frictional forces are considered to act in a direction.

a. perpendicular to surface in contact

b. parallel to surface in contact

c. parallel to normal reaction

d. inclined 45^o to normal reaction

7. A box is placed on an included plane has to be pushed down. The angle of inclination of

a. equal to angle of friction

b. more than angle of friction

c. equal to angle of repose

d. less than angle of repose

8. If the normal force is doubled, the coefficient of friction is

a. not changed

b. halved

c. doubled

d. increases four times

9. A particle placed on an inclined plane of slope angle 30^o is just at the verge of sliding. The coefficient of static friction is

a. $\frac{1}{2}$ b. $\frac{1}{\sqrt{3}}$

c. $\sqrt{3}$ d. $\frac{1}{\sqrt{2}}$

10. A block is sliding down a 30^o smooth inclined plane. Then the coefficient of sliding friction.

a. $\frac{1}{\sqrt{3}}$ b. $\frac{\sqrt{3}}{2}$

c. $\frac{1}{2}$ d. zero

11. A car starts from rest to cover a distance S. The coefficient of friction between the road and tyres is μ. The minimum time in which the car can cover the distance is proportional to

a. μ b. $\sqrt{\mu}$

c. $\frac{1}{\sqrt{\mu}}$ d. $\frac{1}{\mu}$

12. A 100N force acts horizontally on a block of 10kg placed on horizontal rough table of coefficient of friction $\mu = 0.5$ 'g' at the table is $10m/s^2$, the acceleration of the block is

a. zero b. $10m/s^2$

c. $5m/s^2$ d. $5.2m/s^2$

13. A lift is moving downwards with acceleration equal to 'g'. A body of mass m kept on the floor of the lift is pulled horizontally. If the coefficient of friction is μ. Then the frictional resistance offered by body is

a. mg b. μmg

c. 2μmg d. zero

14. If in above question, the lift is moving upwards with uniform velocity, then the frictional resistance offered by the body is

a. mg b. μmg

c. 2μmg d. zero

15. A weight w rests on a horizontal plane. What will be the least force to more the body along the plane if angle of friction is θ?

a. w tanθ b. w secθ

c. w cosecθ d. w sinθ

16. A body of mass 2kg is placed on horizontal surface. The coefficient of static friction is 0.4. If a force of 5N is applied on the block parallel to the surface. Then frictional force is

a. 5N b. 2N

c. 8N d. Zero

17. A block of mass 2kg is placed on horizontal surface. The coefficient of static friction is 0.4 and the coefficient of kinetic friction is 0.3. If a force of 12N is applied on the block parallel to the surface, then frictional force and acceleration of the block are

a. 12N, $6m/s^2$ b. 6N, $6m/s^2$

c. 6N, $2m/s^2$ d. 4N, zero

18. A block 2kg on a horizontal surface begins to move when it is pulled at 30^o with horizontal by 10N force. Then coefficient of limiting friction for the block and surface is

a. $\frac{2}{\sqrt{3}}$ b. $\sqrt{3}$

c. 2 d. $\frac{1}{\sqrt{3}}$

19. A block of mass 0.1kg is held against a wall by applying a horizontal force of 5N on the block. If the coefficient of friction between the block and mass is 0.5, the magnitude of frictional force acting on the block is

a. 2.5N b. 0.98N

c. 4.9N d. 0.49N

20. Work done by frictional force is

a. Negative b. Positive

c. zero d. infinity

21. The coefficient of friction between the tyres and the road is μ. A car of mass 'm' is moving with momentum 'p'. What will be the stopping distance due to friction alone?

a. $\frac{P^2}{2\mu g}$ b. $\frac{P^2}{2m\mu g}$

c. $\frac{P^2}{2m^2\mu^2 g}$ d. $\frac{P^2}{2mg}$

22. A body of mass M is placed on the floor of a lift. If lift falls freely and the body is pulled horizontally, then the frictional force offered by the body is (μs = coefficient of static friction, μk = coefficient of kinetic friction).

a. μsMg b. μkMg

c. Mg d. zero

23. A block has been placed on the inclined plane. The slope angle θ of the plane is such that block slides down the plane at a constant speed. The coefficient of kinetic friction is equal to

a. sinθ b. cosθ

c. cotθ d. tanθ

24. A block moving initially with velocity of 10m/s on a rough inclined surface comes to rest a floor covering a distance of 50m. If g = 10mls^2, the coefficient of dynamic friction between the block and surface is

a. 0.1　　b. 0.2

c. 0.5　　d. 1

25. A body of weight W is kept on rough inclined plane having an angle of inclination with horizontal 'θ' & coefficient of friction μ. force required to pull the body downwards is

a. $W(\mu\cos\theta + \sin\theta)$　　b. $W(\mu\cos\theta - \sin\theta)$

c. $W(\sin\theta - \mu\cos\theta)$　　d. $W(\mu\cos\theta + 2\sin\theta)$

26. A block takes n times as much time to slide down a 45^o rough incline as it takes slide down a perfectly smooth 45^o incline. The coefficient of friction between block & incline is given by

a. $1-\frac{1}{n^2}$　　b. $\frac{1}{1-n^2}$

c. $\sqrt{1-\frac{1}{n^2}}$　　d. $\frac{1}{\sqrt{n^2-1}}$

27. Starting from rest a body slides on an 45^o inclined plane through certain distance in twice the time it takes to slides down the same distance in absence of friction. Then coefficient of friction between body and inclined plane is

a. 0.33　　b. 0.25

c. 0.75　　d. 0.8

28. The upper half of an inclined plane of inclination θ is perfectly smooth while the lower half is rough. A block standing from rest at the top of the plane will again come to rest at bottom if the coefficient of friction between then block and the lower half of the plane is given by

a. $\mu = \tan\theta$　　b. $\mu = 2\tan\theta$

c. $\mu = \frac{\tan\theta}{2}$　　d. $\mu = \cot\theta$

29. A block of mass M lying on a rough horizontal plane is acted upon by a horizontal force P and another force Q, inclined at an angle θ to the vertical. The block will remain in equilibrium if coefficient of friction between it and surfaces is

a. $(P + Q\sin\theta)/(mg + Q\cos\theta)$

b. $(P\cos\theta + Q)/(mg - Q\sin\theta)$

c. $(P + Q\cos\theta)/(mg + Q\sin\theta)$

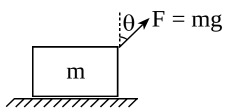
d. $(P\sin\theta - Q)/(mg - Q\cos\theta)$

30. A heavy uniform chain lies on a horizontal table top. If μ = 0.25, then maximum fraction of length of the chain that can hangover the edge of the table is

a. 20%　　b. 25%

c. 35%　　d. 15%

31. A block of mass 'm' rests on a rough horizontal surface as showing in figure coefficient of friction between the block and the surface is μ. A force F = mg acting at an angle θ with vertical side of the block pulls it. In which of the following cases can the block be pulled along the surface?



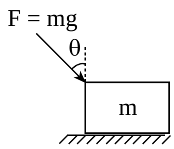
a. $\tan\theta \geq \mu$

b. $\cot\theta \geq \mu$

c. $\tan \geq \mu$

d. $\cot\theta/2 \geq \mu$

32. In the above question, instead of pulling, the force acting on the block pushed it, then the pushing of the block will be possible along the surface it



a. $\tan\theta \geq \mu$

b. $\cot\theta \geq \mu$

c. $\tan\theta/2 \geq \mu$

d. $\cot\theta/2 \geq \mu$

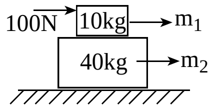
33. A 40kg slab rests on a frictionless floor. The 10kg block rests on top of the slab. The static coefficient of friction between the block & slab is 0.6 while the kinetic coefficient is 0.4. The 10kg block is acted upon by a horizontal force of 100N. What will be the resultant acceleration of the slab?

a. $1 m/s^2$

b. $1.5 m/s^2$

c. $3 m/s^2$

d. $6 m/s^2$



34. Two masses A and B of 10kg and 5kg respectively are connected with a string passing over the frictional less pulley at the corner of the table as shown in fig. The coefficient of friction of A with the table is 0.2. The minimum mass of C that may be placed on A to prevent in from moving is equal to

a. 15kg b. 10kg

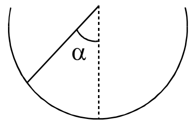
c. 5kg d. zero

35. A gramophone is revolving at angular speed ω with a coin placed on its surface at a distance r from the can be record and coefficient of friction is μ for the coin and the surface. The coin will revolve with record without sliding if

a. $\mu \geq \frac{\omega^2 r}{g}$ b. $\mu = \frac{gr}{\omega^2}$

c. $\mu < \frac{\omega^2}{gr}$ d. $\mu = o$

36. A long horizontal rod has a bead, which can slide along its length and initially placed at a distance L from one end A of the rod. The rod is set in angular acceleration α. If the coefficient of friction between the rod and the bead is μ and gravity is neglected then time after which bead starts slipping is



a. $\sqrt{\frac{\mu}{\alpha}}$ b. $\frac{\mu}{\sqrt{\alpha}}$

c. $\frac{1}{\sqrt{\mu\alpha}}$ d. infinite

37. An insect crawls up a hemispherical surface very slowly. The coefficient of friction between the insect and surface is $\frac{1}{3}$. If the line joining the centre of hemispherical surface to the insect makes an angle α with the vertical, then maximum possible value of α is given by

a. $\alpha = \cot^{-1}(3)$ b. $\alpha = \sec^{-1}(3)$

c. $\alpha = \text{cosec}^{-1}(3)$ d. $\alpha = \tan^{-1}(3)$

38. The work done in moving a body up a rough inclined plane is given by

a. $mg \sin\theta \times s$ b. $mg \cos\theta \times s$

c. $(mg \sin\theta + \mu mg \cos\theta) \times s$

d. $(mg \sin\theta - mg \cos\theta) \times s$

39. The force required to just move a block up the inclined plane is twice the force required to just present the block From sliding down. The coefficient of friction is μ. Then inclination θ of the plane with horizontal is

a. $\tan^{-1}(\mu)$ b. $\tan^{-1}(2\mu)$

c. $\tan^{-1}(3\mu)$ d. $\tan^{-1}(\mu/2)$

Answer Sheet

1. a	2. a	3. a	4. c	5. c	6. c	7. d	8. a	9. b	10. d
11. c	12. c	13. d	14. b	15. a	16. a	17. c	18. d	19. b	20. a
21. c	22. d	23. d	24. a	25. b	26. a	27. c	28. b	29. a	30. a
31. d	32. c	33. a	34. a	35. a	36. a	37. a	38. c	39. c	

SOLUTION

1. Ans. (a)
Frictional force arises due to interlocking of irregularities due to strong atomic or molecular forcse of attraction between two surfaces at point of contact.

2. Ans. (a)
Static frictional force increase correspondingly with applied force until limiting frictional force is attained.

3. Ans. (a)
Limiting friction > kinetic friction > rolling friction.

4. Ans. (c)
Frictional force opposes motion body i.e. $\theta = \pi$

5. Ans. (c)
Due to small friction of ice one cannot obtain larger reaction. So to avoid slipping on ice, we should take smaller steps to produce larger normal reaction.

6. Ans. (c)
$F = \mu R$. This is always parallel to surface in contact. It should be remembered that normal reaction (R) is perpendicular to surface in contact.

7. Ans. (d)
When angle of inclinations is equal to angle of repose the body just slides down the plane. When angle of inclination > angle of repose, the body accelerates down the plane.

8. Ans. (a)
Coefficient of friction is independent of normal reaction.

9. Ans. (b)
The block just slides. So, angle of repose is 30^o (angle of inclination of plane)
$\mu = \tan 30 = \frac{1}{\sqrt{3}}$

10. Ans. (d)
Since the inclined plane is smooth
μ = zero

11. Ans. (c)
$S = ut + \frac{1}{2} at^2$
$S = \frac{1}{2} at^2 = \frac{1}{2} (\mu g)\, t^2$
$t = \sqrt{\frac{2s}{\mu g}}$ $t \alpha \frac{1}{\sqrt{\mu}}$

12. Ans. (c)
$\text{Mass} = \frac{F}{g} = 10\text{kg}$
$a = (F - f_f)\, M = (F - \mu R)M$
$= (100 - 0.5 \times 100)10 = 5\text{m/s}^2$

13. Ans. (d)
Since the observed weight of the body in lift falling down with 'g' is zero. Therefore frictional force offered by the body is zero.

14. Ans. (b)
If the lift is moving upwards with a constant velocity, observed weight is equal to the true weight of body = mg. Then frictional force $F = \mu R = \mu mg$.

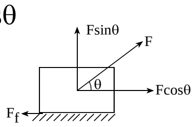
15. Ans. (a)
Least force required to move a weight w on horizontal plane is equal to angle of friction.
$= \mu R = \mu mg = \tan\theta w$ ($\mu = \tan\theta$).

16. Ans. (a)
Limiting frictional force $F_l = \mu mg = 0.4 \times 2 \times 10 = 8N$. As applied force < F_l
$\therefore$ Frictional force = applied force = 5N.

17. Ans. (c)
$F_l = \mu s\, mg = 0.4 \times 2 \times 10 = 8N$.
Applied force, $F = 12N > F_l$
So, block moves.
Frictional force is due to kinetic friction.
$Fk = \mu_k\, mg = 0.3 \times 2 \times 10 = 6N$
Net force for producing acceleration = $12N - 6N = 6N$
$\therefore \quad a = \frac{6}{2} = 3\text{m/s}^2$

18. Ans. (d)

Frictional force $F_f = F\cos\theta$



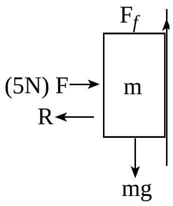
$= F\cos 30° = 10 \times \frac{\sqrt{3}}{2}$

$= 5\sqrt{3}N$

$R = mg - F\sin\theta = 20 - 5 = 15N$

$\mu = \frac{F_f}{R} = \frac{5\sqrt{3}}{15} = \frac{1}{\sqrt{3}}$

19. Ans. (b)



Force tending to slide the block = applied force = weight = mg = 0.1 × 9.8 = 0.98N

Limiting frictional force

$F_f = \mu R = 0.5 \times 5 = 2.5N$

As applied force < limiting frictional force, the body is at rest

∴ Frictional force = Applied force = 0.98N.

20. Ans. (a)

$W = Fs\cos\theta = Fs\cos\pi = -Fs.$

In case of friction force ($\theta = \pi$)

21. Ans. (c)

$v^2 = u^2 - 2as$

$o = u^2 - 2\mu gs$ [$a = \mu g$]

$s = \frac{u^2}{2\mu g} = \frac{P^2}{2m^2\mu g}$ [$p^2 = m^2u^2$]

22. Ans. (d)

When lift falls freely the normal reaction on the the block is zero. The frictional force on the block is also zero.

$F = \mu R = \mu \times o$ = zero.

23. Ans. (d)

The block slides at constant speed. The kinetic frictional force (fk) and component of weight down the plane (mg sinθ are equal & opposite)

$\mu = \frac{Fk}{R} = \frac{mg\sin\theta}{mg\cos\theta} = \tan\theta$

24. Ans. (a)

Retardation while sliding an a rough horizontal surface is μg.

$v^2 = u^2 - 2as$

$O^2 = u^2 - 2 \times \mu g \times s$

$\mu = \frac{u^2}{2gs} = \frac{(10)^2}{2 \times 10 \times 50} = 0.1$

25. Ans. (b)

If force required to pull the body downwards is f then,

$F + mg\sin\theta = \mu R = \mu\, mg\cos\theta$

$F = mg(\cos\theta - \sin\theta)$

$= W(\cos\theta - \sin\theta)$

26. Ans. (a)

For smooth plane

$L = \frac{1}{2} g \sin 45\, t_1^2$

For rough plane

$L = \frac{1}{2} g (\sin 45 - \mu\cos 45)\, t_2^2$

$\left(\frac{t_1}{t_2}\right)^2 = 1 - \mu\tan 45$

$\left(\frac{1}{n}\right)^2 = 1 - \mu$

$\mu = 1 - \frac{1}{n^2}$

27. Ans. (c)

n = 2

using shortcut,

$\mu = \tan\theta\left(1 - \frac{1}{n^2}\right) = \tan\theta\left(1 - \frac{1}{4}\right) = \frac{3}{4} = o.75$

28. Ans. (b)

Downward acceleration in upper half = g sinθ. Retardation in the lower half = − (g sinθ − μg cosθ)

For the block to be at rest at the bottom

$g\sin\theta = -(g\sin\theta - \mu g\cos\theta)$

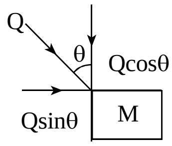
$2g\sin\theta = \mu g\cos\theta$

$\mu = 2\tan\theta.$

29. Ans. (a)

Applied force in horizontal direction = (P + Q sinθ)

Normal reaction (R) = (mg + Q cosθ)



For equilibrium,

P + Q sinθ = μR = (mg + Q cosθ)

$$\mu = \frac{P + Q\sin\theta}{mg + Q\cos\theta}$$

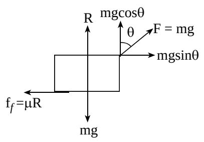
30. Ans. (a)

Length overhung (x) = $\left(\frac{\mu}{\mu + 1}\right)$ L

$$\frac{x}{L} = \frac{\mu}{\mu + 1} \times 100\% = \frac{0.25}{0.25 + 1} \times 100\% = 20\%$$

31. Ans. (d)

From figure



R + m gcosθ = mg

R = mg − m gcosθ

= mg (1−cosθ)

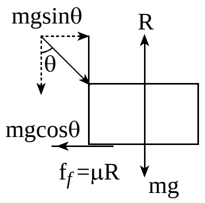
= mg. 2sin²θ/2

The block can be pulled if mg sinθ ≥ f_f

or, mg 2sinθ/2. cosθ/2 ≥ μmg × 2

∴ cotθ ≥ μ

32. Ans. (c)



From figure

R = mg + m g cosθ = mg(1+ cosθ)

= mg. 2cos²θ/2

f_f = μR = μmg2cos²θ/2

The block can be pushed if mg sinθ ≥ f_f

mg. 2sinθ/2 cosθ/2 ≥ μmg 2cos²θ/2

tanθ/2 ≥ μ

33. Ans. (a)

Limiting frictional force of block on the slab = $\mu_l m_1 g$ = 0.6×10×10 = 60N

Applied force (100N) > limiting friction force. So the block will acclerate on the slab due to which, the force acting on the slab will be due to kinetic friction. acceleration of slab = a

$m_2 a = \mu_k m_1 g$

$$a = \frac{0.4 \times 10 \times 10}{40} = 1 m/s^2$$

34. Ans. (a)

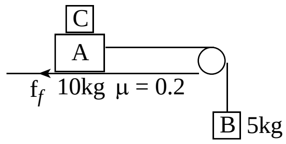
When A doesn't move neither B.

So, Tension in the string T = $M_B g$ = 5g.

Also A doesn't move if the tension is just balanced by frictional force so F_f = T μ(M_A + m)g = 5g

or, 0.2(10 + m) = 5

or, 10 + m = 25 ⇒ m = 15kg



35. Ans. (a)

for the coin revolve without slipping, frictional force ≥ centripetal force

or, $\mu mg \geq \frac{m\omega^2}{r}$

⇒ $\mu \geq \frac{\omega^2 r}{g}$

36. Ans. (a)

Here, tangential force (Ft) = normal reaction (R)

Ft = ma = mα L = R

At an instant, when beads starts sliding,

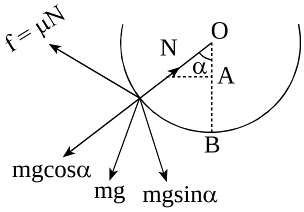
Centripetal force F_C = Friction F_R

$mL\omega^2 = \mu R$

or, $mL\alpha^2 t^2 = \mu m\alpha L$

∴ $t = \sqrt{\frac{\mu}{\alpha}}$

37. Ans. (a)



$\Rightarrow$ $N - mg\cos\alpha = \dfrac{mv^2}{r}$

for slow motion, $V \to O$

$N = mg\cos\alpha$.

insect will crawl up till $mg\sin\alpha = \mu N = mg\cos\alpha \Rightarrow \cot\alpha = \dfrac{1}{\mu} \Rightarrow \alpha = \cot^{-1}(3)$

38. Ans. (c)

The applied force in upward direction

$F = mg\sin\theta + F_f$

$= mg\sin\theta + \mu R$

$= mg\sin\theta + \mu mg\cos\theta$

$w = F.s$

39. Ans. (c)

F up = 2F down

or, $mg(\sin\theta + \mu\cos\theta) = 2mg(\sin\theta - \mu\cos\theta)$

or, $\sin\theta = 3\mu\cos\theta$

or, $\tan\theta = 3\mu$

$\Rightarrow$ $\theta = \tan^{-1}(3\mu)$

Past questions

1. A body of mass m is resting on a horizontal surface. If the angle of friction is θ, the minimum force required to slide the body is [IOM 2007/ BPKIHS]

a. $mg\sin\theta$ b. $mg\cos\theta$
c. $mg\tan\theta$ d. $mg\sec\theta$

2. If a uniform rope of length x lies on a table. If the coefficient of static friction is μ. The maximum length of this part of the rope which can overhang from the edge of the table without sliding down is [IOM 2005]

a. $\dfrac{x}{\mu}$ b. $\dfrac{x}{\mu+1}$
c. $\dfrac{\mu x}{\mu+1}$ d. $\dfrac{\mu x}{\mu-1}$

3. A block mass 'm' remains on the horizontal surface which has coefficient of static friction (μ), then find the minimum force at angle θ with horizontal which can just slide the block on the surface. [IOM 2003 / BPKIHS]

a. μmg b. $\dfrac{mg}{\mu+1}$
c. $\dfrac{\mu mg}{\sqrt{\mu+1}}$ d. $\dfrac{mg}{\mu}$

4. A body weight 30 kg is pushed along the floor at a constant speed by applying a horizontal force. If the coefficient of friction is 0.2, then force applied is

[MOE 2067]

a. 6N b. 12N
c. 60N d. 240N

5. A cart of mass 1000 kg is pulled by horse of 200kg. The coefficient of friction between them and the ground is 0.2. Calculate the force required to produce the accelertion of $2 m/s^2$ in the cart.

[BPKIHS 2011]

a. 1200N b. 2400N
c. 4800N d. 3600N

Answer Sheet

1. a	*2. c*	*3. c*
4. c	*5. c*	

SOLUTION

1. Ans. (a)

The pulling force acting on a block of mass M at an angle α that can move the block on a horizontal surface for which angle of friction θ is

$$F = \frac{Mg\sin\theta}{\cos(\alpha - \theta)} \Rightarrow F\ min = mg\sin\theta$$

[F min when $\cos(\alpha - \theta) = 1$]

2. Ans. (c)

If l part is hanging under equilibrium

Fractional force = weight of hanging part

$$\mu\left(\frac{M}{x} \times (x - l)\right) \times g$$

$$= \frac{M}{x} \times l \times g$$

$$l = \mu(x - l)$$

$$l = \frac{\mu x}{\mu + 1}$$

3. Ans. (c)

F min = mg $\sin\theta$

$$\tan\theta = \frac{\mu}{1} = \frac{p}{b} \quad [h = \sqrt{\mu^2 + 1}\ ]$$

$$\sin\theta = \frac{\mu}{\sqrt{\mu^2 + 1}} = \frac{P}{h}$$

$$F\ min = \left(\frac{\mu mg}{\sqrt{\mu^2 + 1}}\right)$$

4. Ans. (c)

Force applied (F) = μmg

$= 0.2 \times 30 \times 10 = 60N$

5. Ans. (c)

$F_{net} = f_f + f_a$

$= \mu mg + ma = 0.2 \times 1200 \times 10 + 1200 \times 2$

$= 2400 + 2400 = 4800N$


अनुभूतिको अवतरण


उजाले के संग


आवारा बादल


बालउद्यान


नेपाली बालसाहित्यको इतिहास


समाजवाद र बी.पी. कोइराला

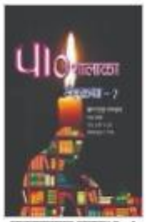

मायामहल


अक्षितपारको धुना


महारानी


एक्लो महारथी


प्रेमदासको डायरी


पाठशालाका लघुकथा - १


भौज्याहा


कलावती


मान्छे टोक्ने बोक्सी


अन्तिम प्रश्न


दाइबुबु


मनपरेका केही कविता

Chapter: 7

CIRCULAR MOTION

1. A particle is moving in a circle of radius r with a uniform speed. Its angular acceleration is

a. $\frac{v}{r}$ directed towards centre

b. $\frac{v^2}{r}$ directed towards centre

c. $\frac{v^2}{r}$ directed a long the axis

d. zero

2. A particle is moving in a circle of radius 'r' with a uniform speed. Its centripetal acceleration is

a. $\frac{v}{r}$ directed towards centre

b. $\frac{v^2}{r}$ directed towards centre

c. $\frac{v^2}{r}$ directed away from centre

d. zero

3. A particle performing uniform circular motion has

a. radial velocity and radial acceleration

b. radial velocity and transverse acceleration

c. transverse velocity & radial acceleration

d. transverse velocity and transverse acceleration

4. A body moves with a constant speed along a circle

a. its velocity remains constant

b. no force acts on it

c. No work is done on it

d. No acceleration is produced in it.

5. Velocity vector and acceleration vector in a uniform circular motion are related as

a. both in same direction

b. perpendicular to each other

c. both in opposite direction

d. not related to each other

6. A body is acted upon by constant force direction towards a fixed point. The magnitude of the force varies inversely as the square of the distance from the fixed point. What is the nature of the path?

a. straight line b. parabola

c. circle d. Hyperbola

7. If a_r and a_t represent radial and tangential acceleration, the motion of the particle will be uniformly circular if

a. $a_r = 0$, at = 0 b. $a_r \neq 0$, at $\neq 0$

c. $a_r \neq 0$, at = 0 d. $a_r = 0$, at $\neq 0$

8. A motorcar is travelling at 20m/s on a circular road of radius 400m. It is increasing speed at the rate of $1m/s^2$. What is acceleration of motorcar?

a. $1m/s^2$ b. $2m/s^2$

c. $\sqrt{2}m/s^2$ d. $\frac{1}{\sqrt{2}}m/s^2$

9. The angular velocity of a fly wheel making 120rev/min is

a. 2π rad/s b. $4\pi^2$ rad/sec

c. π rad/sec d. 4π rad/sec

10. The speed of revolution of a particle going around a circle is doubled and its angular speed is halved. What happens to the centripetal acceleration?

a. becomes 2times

b. becomes 4times

c. Halved

d. Remains unchanged

11. Two particles of masses m_1 and m_2 are moving in concentric horizontal circles of radii r_1 and r_2 respectively such that their periods are same. The ratio of centripetal acceleration is

a. $\frac{r_1}{r_2}$ b. $\frac{r_2}{r_1}$

c. $\left(\frac{r_1}{r_2}\right)^2$ d. $m_1r_1: m_2r_2$

12. Two particles of equal masses are revolving in circular paths of radii r_1 & r_2 respectively with the same speed. The ratio of their centripetal force is

a. $\frac{r_1}{r_2}$ b. $\frac{r_2}{r_1}$

c. $\sqrt{\frac{r_2}{r_1}}$ d. $\left(\frac{r_1}{r_2}\right)^2$

13. Two particle of equal masses are revolving in circular paths of radii r_1 and r_2 respectively. If they experience equal centripetal force, the ratio of their angular velocities is

a. $\frac{r_1}{r_2}$ b. $\sqrt{\frac{r_2}{r_1}}$

c. $\left(\frac{r_1}{r_2}\right)^2$ d. $\left(\frac{r_2}{r_1}\right)^2$

14. The ratio of angular speed of minute hand and hour hand of watch is

a. 1:12 b. 12:1

c. 6:1 d 1:6

15. The angular speed of a second hand of the watch in rad/sec is

a. $\frac{\pi}{6}$ b. $\frac{\pi}{30}$

c. $\frac{\pi}{60}$ d. $\frac{\pi}{180}$

16. The angular speed of earth's rotation about its axis is

a. 7.29×10^{-5} rad/s b. 1.25×10^{-3} rad/s

c. $\frac{\pi}{12}$ rad/s d. 2πrad/s

17. A stone tied to the end of a 20cm long string is whirled in a horizontal circle. If the centripetal acceleration is 9.8 m/s^2, its angular speed is

a. $\frac{20}{7}$ rad/s b. 7rad/s

c. 14rad/s d. 20rad/s

18. A length of second's hand of a clock is 6cm. The change in velocity of its tip in 15 second is

a. $\frac{\pi}{30}$ cm/s b. $\frac{\pi}{5}$ cms^{-1}

c. $\frac{\sqrt{2}\pi}{5}$ cm/s d. $\frac{2\sqrt{2}}{5}\pi$ cm/s

19. A particle P is moving in a circle of radius R with a uniform speed V. C is the centre of the circle and AB is a diameter. Initially the particle is at B. The angular velocity of P about A & C are in the ratio

a. 1:1 b. 1:2

c. 2:1 d. 4:1

20. A man swings a bucket of water in a vertical circle of diameter 2m. The minimum speed with which he must swing the bucket so that water does not spill out of the bucket is

a. 1.56m/s b. 9.8m/s

c. 3.13m/s d. 4.4m/s

21. A particle of mass is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time as $a_c = k^2rt^4$ where k is constant. The power delivered to the particles by the forces acting on it is

a. zero b. $mk^2r^2t^2$

c. $\frac{1}{3}m\,k^2r^2t^2$ d. $2mk^2r^2t^3$

22. A particle initially at rest at the highest point of a smooth vertical circle of Radius R is slight displaced. If will leave the circle at a vertical distance 'h' below the highest point such that

a. h = R b. $h = \frac{R}{3}$

c. $h = \frac{R}{2}$ d. h = 2R

23. A body of mass tied to a string is moved in a vertical circle of radius r. The differences in tension at lowest point and highest point is

a. 2mg b. 4mg

c. 6mg d. 8mg

24. A stone of mass 1kg tied to a light inextensible string of length $\frac{10}{3}$ is whirling in a circular path in a vertical plane. If the ratio of maximum to minimum tension in the string is 4. Find the speed of the stone at the highest point of the circle.

a. $5\sqrt{2}$m/s b. 20m/s

c. 15m/s d. 10m/s

25. A stone tied to a string of length L is whirled in a vertical circle with the other end of string at the centre. At a certain instant of time, the stone is in the lowest position and has speed u. The magnitude of change in velocity as it reaches a point where the string is horizontal is

a. $\sqrt{u^2 - 2gL}$ b. $\sqrt{2gL}$
c. $\sqrt{u^2 - gL}$ d. $\sqrt{2(u^2 - gL)}$

26. What minimum horizontal speed should be imparted to the block at the top smooth hemisphere of Radius R that it slips instantly?

a. $\sqrt{2gR}$ b. $\sqrt{5gR}$
c. zero d. $\sqrt{gR}$

27. A bob of a simple pendulum of length L is at its lowest point. What minimum velocity is imparted to the bob so that the string makes a maximum angle of 60° with vertical?

a. $\sqrt{gL}$ b. $\sqrt{2gL}$
c. $\sqrt{3gL}$ d. $\sqrt{5gL}$

28. An object is tied to a string and rotated in a vertical circle of radius r. Constant speed is maintained along the trajectory. If T max / T min = 2 then $\frac{v^2}{rg}$ is

a. 1 b. 2 c. 3 d. 4

29. A stone tied to one of a string of length $\frac{5}{6}$ m is whirled in a vertical circle so that maximum tension in the string is 4 times the minimum tension in it. The speed of the stone at highest point is

a. 5m/s b. 4m/s c. 6m/s d. 3m/s

30. A body of mass 1kg is rotating in a vertical circle of radius 1m. What will be the difference in its k. ε. at the top and bottom of the circle?

a. 10J b. 20J c. 30J d. 50J

31. A stone tied to one end of string, 5m long is whirled in a horizontal circle at constant speed 5m/s. What is average acceleration of the stone in half revolution?

a. $5\pi m/s^2$ b. $\frac{5}{\pi} m/s^2$
c. $\frac{10}{\pi} m/s^2$ d. zero

32. The angular speed of car increase from 6oo rpm to 1200rpm in 10 sec? What is angular acceleration of the car?

a. 600 rad/s^2 b. 60 rad/s^2
c. 60π rad/s^2 d. 2π rad/s^2

33. A cyclist turns around a curve at 20km/hr. If he turns at the double of this speed, the tendency to overturns is

a. doubled b. quadrupled
c. halved d. unchanged

34. The kinetic energy k of a particle moving along a circle of radius R depends upon the distance S as $K = as^2$. The force acting on the particle is

a. $\frac{2as^2}{R}$ b. $2as\left(1+\frac{s^2}{R^2}\right)^{\frac{1}{2}}$
c. 2as d. 2a

35. A particle of mass M is moving in a horizontal circle of radius r under a centripetal force given by $\left(\frac{-k}{r^2}\right)$ where k is constant. Then;

a. Total energy of the particle is $\frac{-k}{2r}$
b. Kinetic energy of the particle is $\frac{k}{r}$
c. Potential energy of the particle $\frac{k}{2r}$
d. Kinetic energy of the particle $\frac{-k}{r}$

Answer Sheet

1. d	*2. b*	*3. c*	*4. c*	*5. b*	*6. c*	*7. c*	*8. c*	*9. d*	*10. d*	*11. a*	*12. b*
13. b	*14. b*	*15. b*	*16. a*	*17. b*	*18. c*	*19. b*	*20. c*	*21. d*	*22. b*	*23. c*	*24. d*
25. d	*26. d*	*27. a*	*28. c*	*29. a*	*30. b*	*31. c*	*32. d*	*33. b*	*34. b*	*35. a*	

SOLUTION

1. Ans. (d)

Angular acceleration, $\alpha = \frac{d\omega}{dt} = 0$

ω is constant in uniform circular motion.

2. Ans. (b)

Centripetal acceleration $= \frac{v^2}{r}$ & directed towards centre.

3. Ans. (c)

A particle performing a uniform circular motion has a transverse velocity & radial acceleration.

4. Ans. (c)

On circular motion force acts along the radius and displacement at a location is $\perp$ to radius $\theta = 90^o$

$w = \vec{F} \cdot \vec{s} = Fs\cos 90 = 0.$

5. Ans. (b)

Acceleration is centripetal directed radially inwards while velocity is acting tangentially.

6. Ans. (c)

When the force acting a body is directed towards fixed point, then it change only the direction of motion of the body without change its speed. So the particle will describe a circular motion.

7. Ans. (c)

For uniform circular motion at = o

$ar = \frac{v^2}{r} \neq o$

8. Ans. (c)

The motion is variable circular motion so it has radial acceleration

$a_r = \frac{v^2}{r} = \frac{20^2}{400} = 1 m/s^2$

Tangential acceleration (at) $= \frac{dv}{dt} = 1 m/s^2$

$a = \sqrt{a_r^2 + a_t^2} = \sqrt{2} m/s^2$

9. Ans. (d)

$\omega = 2\pi f = 2\pi \times \left(\frac{120}{60}\right) = 4\pi$ rad/s

10. Ans. (d)

$r_1 = \frac{v}{\omega}$, $r_2 = \frac{2v}{\left(\frac{\omega}{2}\right)} = 4r_1$

$a_1 = \frac{v^2}{r_1}$

$a_2 = \frac{(2v)^2}{r_2} = \frac{4v^2}{4r_1} = a_1$

11. Ans. (a)

$a_c = r\omega^2$

If T is same ω is constant $a_c \propto r$.

12. Ans. (b)

$F = \frac{mv^2}{r}$ If speed is same

$F \propto \frac{1}{r}$

13. Ans. (b)

$F_1 = F_2$

$m\omega_1^2 r_1 = m\omega_2^2 r_2 \Rightarrow \frac{\omega_1}{\omega_2} = \sqrt{\frac{r_1}{r_2}}$

14. Ans. (b)

$\frac{\omega_1}{\omega_2} = \frac{T_2}{T_1} = \frac{12h}{1h} = 12:1$

15. Ans. (b)

$\omega = \frac{2\pi}{T} = \frac{2\pi}{60s} = \frac{\pi}{30}$ rad/s

16. Ans. (a)

$\omega = \frac{2\pi}{T} = \frac{2\pi}{24 \times 60 \times 60}$

$= 7.29 \times 10^{-5}$ rad/s

17. Ans. (b)

$a = l\omega^2$

$\omega = \sqrt{\frac{a}{l}} = \sqrt{\frac{9.8}{0.2}}$

$= \sqrt{49} = 7$rad/s

18. Ans. (c)

Linear speed of the tip of second hand is v

$= \omega l = \frac{2\pi}{60} \times 6 = \frac{\pi}{5}$ cm/s

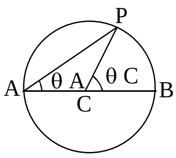
Now, change in velocity in 15S it describes angle 90

$|\Delta \vec{v}| = 2v\sin\frac{\theta}{2} = \frac{2\pi}{5} \sin 45°$

$= \frac{2\pi}{5} \times \frac{1}{\sqrt{2}}$

$= \frac{\sqrt{2}\pi}{5}$ cm/s

19. Ans. (b)



$\frac{\omega_A}{\omega_B} = \frac{\theta_A/t}{\theta_C/t} = \frac{\theta_A}{2\theta_A} = \frac{1}{2}$

20. Ans. (c)

Minimum speed at the highest point

$V = \sqrt{gr} = \sqrt{9.8 \times 1} = 3.13$m/s

21. Ans. (d)

$a_c = k^2rt^4 = \frac{v^2}{r}$

$v = krt^2$

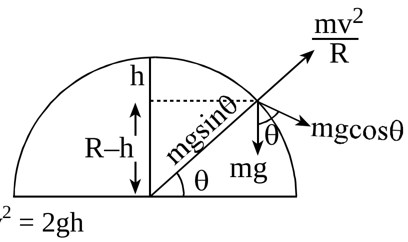
$a_T = \frac{dv}{dt} = 2krt$

$F_T = ma_T = 2m\,krt$

Power delivered to the particle is due to tangential force

$P = F_TV = 2m\,krt \times krt^2 = 2mk^2r^2t^3$

22. Ans. (b)



$v^2 = 2gh$

$mg\sin\theta = \frac{mv^2}{R}$

or, $g \times \frac{R-h}{R} = \frac{2gh}{R}$

$\therefore\ h = \frac{R}{3}$

23. Ans. (c)

T max at lowest point $= \frac{mV_L^2}{r} + mg$

T min at highest point $= \frac{mV_H^2}{r} - mg$

T max !T min $= \frac{m}{r}(V_L^2\ !\ V_H^2) + 2mg$

$\Delta k\varepsilon = \Delta p\varepsilon$

$\frac{1}{2}M(V_L^2\ !\ V_H^2) = mg\ H\ 2R$

$V_L^2 - V_H^2 = 4gR$

T max !T min = 4mg + 2mg = 6mg

24. Ans. (d)

Velocity at highest point = V, lowest point = u

$\frac{T\,max}{T\,min} = 4 = \frac{\frac{mu^2}{r} + mg}{\frac{mv^2}{r} - mg}$

$4v^2 - u^2 = 5gr$!(i)

on going from lowest to highest point

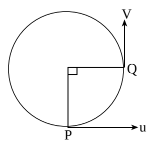
$\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mg\ H\ 2R$

$u^2 - v^2 = 4gr$ .... (ii)

Adding (i) & (ii)

$v = \sqrt{3gr} = \sqrt{3H\ 10\ H\ \frac{10}{3}} = 10$m/s

25. Ans. (d)



At Q $\frac{1}{2}mu^2 = \frac{1}{2}mv^2 + mgL$

or, $\frac{u^2 - v^2}{2} = gL$

or, $v^2 = u^2 - 2gL$

Now, $\vec{v} - \vec{u} = \sqrt{v^2 + u^2}$

$= \sqrt{u^2 - 2gL + u^2} = \sqrt{2(u^2 - gL)}$

26. Ans. (d)

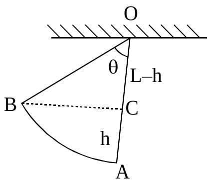
$N = mg - \frac{mv^2}{R}$ For slipping

tangentially N = o

V min $= \sqrt{gR}$

27. Ans. (a)

$h = AC = L - L\cos\theta$



Decreased in k.∈ = increased in p.∈

$\frac{1}{2}mv^2 - 0 = mgh$

$\frac{1}{2}mv^2 = mg(L - L\cos\theta)$

$v = \sqrt{2gL(L - \cos\theta)}$

$v = \sqrt{2gL\,(L - \cos 60°)}$

$v = \sqrt{gL}$

28. Ans. (c)

At highest point,

$\frac{mv^2}{r} = T_H + mg$ ....(i)

At lowest point,

$\frac{mv^2}{r} = T_L - mg$ ....(ii)

$\frac{T_{max}}{T_{min}} = \frac{T_L}{T_H} = 2 \Rightarrow T_L = 2T_H$

$T_H + mg = 2T_H - mg$

$T_H = 2mg \;\Rightarrow \frac{mv^2}{r} = 2mg + mg = 3mg$

$\Rightarrow \frac{v^2}{rg} = 3$

29. Ans. (a)

T max – T min = 6mg

or, 4T min –T min = 6mg

or, T min = 2mg

or, $\frac{mv^2}{l} - mg = 2mg$ (v = velocity at highest point)

or, $v = \sqrt{3gL} = \sqrt{3 \text{ H } 10 \text{ H } \frac{5}{6}} = 5\text{m/s}$

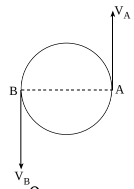
30. Ans. (b)

Difference in k. ε = k.ε at Top – k.ε at bottom

$= \frac{1}{2}m\;[(\sqrt{5gr})^2 - (\sqrt{gr})^2]$

$= 2mgr = 20J$

31. Ans. (c)



at = 0 & $a_r = \frac{v^2}{r}$

$a_r = \frac{5 \times 5}{5} = 5\text{m/s}^2$

$|\vec{a}_{av}| = \frac{|\vec{\Delta v}|}{t} = \frac{|\vec{VB} - \vec{VA}|}{t} = \frac{2v\sin\frac{\theta}{2}}{t}$

$t = \frac{\text{total distance}}{\text{velocity}} = \frac{\pi R}{5}$

$a_{av} = \frac{2 \times 5 \times \sin\frac{180}{2}}{\frac{\pi \times 5}{5}} = \frac{10}{\pi}\text{ m/s}^2$

32. Ans. (d)

$\alpha = \frac{\omega_2 ! \omega_1}{t} = \frac{2\pi f_2 ! 2\pi f_1}{t}$

$= \frac{2\pi\left(\frac{1200}{60} - \frac{600}{60}\right)}{10} = 2\pi \text{ rad/s}^2$

33. Ans. (b)

$F = \frac{mv^2}{r}$ $\qquad F \,\alpha\, v^2$

34. Ans. (b)

$k = \frac{1}{2}mv^2 = as^2$

$mv^2 = 2as^2$!(i)

Differentiating w.r.t time

$2mv\frac{dv}{dt} = 4as\frac{ds}{dt} = 4asv$

$m\frac{dv}{dt} = 2as \Rightarrow ma_T = 2as$

or, $F_T = 2as$, $F_c = \frac{mv^2}{R} = \frac{2as^2}{R}$

∴ $F = \sqrt{F_C^2 + F_T^2} = \sqrt{2as\left(1 + \frac{s^2}{R^2}\right)}$

35. Ans. (a) U = p.∈ $= \int F.\,dr = \int\frac{k}{r^2}.\,dr$

$= k\int r^{-2}\,dr = k\left[\frac{r^{-1}}{-1}\right] = \frac{-k}{r}$

$k.\varepsilon = \frac{1}{2}mv^2 = \frac{1}{2}\frac{k}{r}\left(\frac{mv^2}{r} = \frac{k}{r^2}\right)$

$T.\varepsilon = U + k.\varepsilon = \frac{-k}{r} + \frac{k}{2r} = \frac{-k}{2r}$

Past Questions

1. **If an object of mass 'm' moving in a circular path with uniform velocity v. Which of the following occurs in half circle [IOM 2009]**
   a. kinetic energy changes by $\frac{mv^2}{2}$
   b. kinetic energy changes by $\frac{mv^2}{4}$
   c. momentum changed by 2mv
   d. momentum doesn't change

2. **A body mass 'm' is suspended from a string of length '*l*'. minimum horizontal velocity that should be given to the body in its lowest position so that it may complete full revolution in vertical plane with the point of suspension as the centre of the circle is [IOM 2004]**
   a. $\sqrt{2lg}$ b. $\sqrt{3lg}$
   c. $\sqrt{4lg}$ d. $\sqrt{5lg}$

3. **A body attached to a string must possess a minimum velocity at the top of the vertical circle while moving round without a slack in the string. Minimum velocity will be [MOE curriculum]**
   a. gr b. $\sqrt{gr}$
   c. 4gr d. $\sqrt{4gr}$

4. **A can filled with water is revolved in a vertical circle of radius 4m so that water does not spill down. The maximum period of revolution will be [MOE 2068 Kartik]**
   a. 2s b. 3s
   c. 4s d. 5s

5. **A Cyclist moving with velocity 10m/s in radius 20m, then angle of inclination of cycle is [MOE 2068 Asadh]**
   a. 26.5^o b. 36.5^o
   c. 60^o d. 40^o

6. **The radius of circular path is 1m. The particle makes 10 revolutions in 6s. The linear velocity of the particle is [MOE 2067]**
   a. 6.5 b. 1
   c. 2 d. 4

7. **A particle of mass m is moving along a circular path of radius R with a frequency n and period T. Its centripetal acceleration can be expressed as: [MOE 2010]**
   a. $4\pi^2R^2n$ b. $4\pi^2RT$
   c. $4\pi^2Rn^2$ d. $4\pi^2R^2T^2$

8. **A stone is tied at one end of long string and whirled in a vertical circle. The tension in the string will be maximum at [MOE 2066]**
   a. The highest point of the circle
   b. The lowest point of the circle
   c. At angle 45^o
   d. Remains unchanged throughout the motion

9. **A body of mass 0.1kg tied by a string is rotating round a vertical circle with a speed of 10m/s of radius 1m. What is the tension experienced by the string at the highest point [MOE 2055]**
   a. 8N b. 11N
   c. 10N d. 9N

10. **A body is describing circular motion with constant speed V along circular path of radius r. Then its tangential acceleration will be [MOE]**
   a. $\frac{v^2}{2\pi r}$ b. $\frac{v^2}{\pi r}$

c. $\frac{v^2}{r}$ d. zero

11. A stone is tied to one end of the string is whirled in horizontal circle so that length increases gradually. If T_1 & T_2 are the tension in the string when the length be *l* & 2*l*, then [BPKIHS]

a. $T_1 = 2T_2$ b. $T_1 = 4T_2$
c. $T_1 = 8T_2$ d. $T_1 = \frac{T_2}{2}$

12. A horizontal turn table is rotating steadily at angular speed ω with coin on its surface at distance 4m from centre of the table. If angular speed of the turn table is made 2ω then distance of the win the table in equilibrium condition is [BPKIHS]

a. 1cm b. 2cm
c. 8cm d. 16cm

13. A body slides down a frictionless track, which ends in a circular loop of Diameter D. What should be the minimum height h of the body so that ball is just able to complete the vertical circular motion? [BPKIHS]

a. $\frac{5D}{2}$ b. $\frac{5D}{4}$
c. $\frac{2D}{5}$ d. $\frac{D}{2}$

14. If an object of mass 10kg is whirled around a horizontal circle of radius 4m by revolving string inclined at 30^o to vertical. If the uniform speed of the object is 5mls, the tension in the string (approx) is [IE – 08]

a. 720N b. 960N
c. 114N d. 128N

15. A body of mass 2kg is attached to one end of string of length 1m & rotated in vertical circle such that the velocity at highest point is 4m/s. The tension is [IE]

a. 18N b. 12N
c. 40N d. zero

16. A body of mass 'm' is moving in a vertical circle with constant speed of V. The tension on the mass at the bottom of the circle is [MOE 2069]

a. $mg - mr\omega^2$ b. $mg + mr\omega^2$
c. $mg \times mr\omega^2$ d. $mg/mr\omega^2$

17. An aeroplane is moving in circlar path with velocity of 300km/hr. What is the change in velocity in half turn of revolution? [IOM 2012]

a. zero b. 300 km/hr
c. $300\sqrt{2}$ km/hr d. 600 km/hr

18. A 4 wheeler is moving in a banked track of radius 24m with 10m/s. What is the minimum angle of banking so that it won't overturn? [BPKIHS 2012]

a. 23° b. 24°
c. 25° d. 20°

19. A road of 50m radius is banked at correct angle for a given speed. If the speed is to be doubled, kepping the same banking angle, the radius of the road should be changed to [BPKIHs 2011]

a. 25m b. 100m
c. 150m d. 200m

20. A stone is whirled in a uniform circular motion with the help of a rope. When the rope is set free, then the stone will move. [BPKIHs 2011]

a. Radially outward
d. Radially inward
c. Tangentially outward
d. In circular motion

21. A point 'P' on a wheel rolling on a horizontal road. The radius of the wheel is 'R'. Initially, the point 'P' is in contact with the ground. The wheel rolls through half the revolution, the displacement of the point 'P' is: [BPKIHs 2009]

a. $2\pi R$ b. $R\sqrt{\pi^2 + 1}$
c. πR d. $R\sqrt{\pi^2 + 4}$

Answer Sheet

1. c	*2. d*	*3. b*	*4. c*	*5. a*	*6. a*	*7. c*	*8. b*	*9. d*	*10. d*
11. c	*12. a*	*13. b*	*14. c*	*15. b*	*16. b*	*17. d*	*18. a*	*19. d*	*20. c*

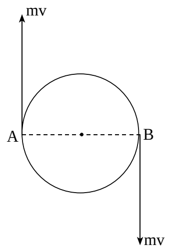
21. d									

SOLUTION

1. Ans. (c)

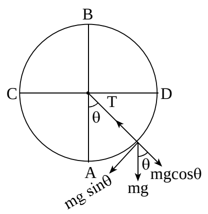
change in momentum

$\Delta P = mv - (-mv) = 2mv$



2. Ans. (d)

If $v < \sqrt{5gl}$, the body will leave the circular path or oscillate about lowest axis, Condition for a body to move in vertical circle



$T_B \geq O$, (T_B) min = O, $T_A \geq 6mg$

T_A (min) = 6mg, $V_B \geq \sqrt{gr}$

$(V_B min)$ = gr, $V_A \geq \sqrt{5gr} \Rightarrow (V_A \text{ min}) = \sqrt{5gr} = \sqrt{5lg}$

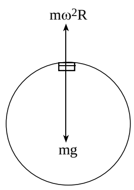
3. Ans. (b)

For vertical circle; velocity at highest point = $\sqrt{rg}$

Velocity at lowest point = $\sqrt{5rg}$

4. Ans. (c)

At top, weight of water = centrifugal force



or, $mg = m\omega^2 R = m\left(\frac{2\pi}{T}\right)^2 R$

$T = 2\pi\sqrt{\frac{R}{r}}$

$= 2\pi\sqrt{\frac{4}{\pi^2}} = 4\text{sec}$

5. Ans. (a)

$\tan\theta = \frac{v^2}{rg} = \frac{100}{20 \times 10}$

$\Rightarrow \theta = \tan^{-1}(0.5) = 26.5°$

6. Ans. (a)

$V = r\omega = 2\pi fr = 2\pi \times \left(\frac{10}{6}\right) \times 1 = 0.5$

7. Ans. (c)

Angular acceleration

$a = \omega^2 R = (2\pi n)^2 R = 4\pi^2 Rn^2$

8. Ans. (b)

Tension is maximum at lowest point and minimum at highest point.

Velocity is maximum at lowest point hence k.ε. momentum are also maximum at lowest point.

9. Ans. (d)

$T \text{ min} = \frac{mv^2}{r} - mg$

$= \frac{0.1 \times (10)^2}{1} - 0.1 \times 10 = 10 - 1 = 9N$

10. Ans. (d)

Tangential acceleration in uniform circular motion is zero.

Radial acceleration is $\frac{v^2}{r}$

11. Ans. (c)

$mv_1 l = mv_2 (2l) \Rightarrow v_2 = \frac{v_1}{2}$

(At constant angular momentum)

$T_1 = \frac{mv_1^2}{l}$; $T_2 = \frac{mv_2^2}{2l} = \frac{m \times v_1^2}{4 \times 2l} = \frac{T_1}{8}$

12. Ans. (a)

$F_f = \mu mg$, $F_C = \frac{mv^2}{r} = m\omega^2 r$

Frictional force provides necessary centripetal force

$F_C = f \Rightarrow \mu mg = m\omega^2 r$

$\omega^2 r = \mu g$ = constant

$\omega_1^2 r_1 = \omega_2^2 r_2$

or, $r_2 = \left(\frac{\omega_1}{\omega_2}\right)^2 \times r_1 = \left(\frac{1}{2}\right)^2 \times 4 = 1\text{cm}$

13. Ans. (b)

When a body falls from a height h, it acquires a velocity $v = \sqrt{2gh}$

From question

$\sqrt{2gh} = \sqrt{5gr}$

$h = \frac{5r}{2} = \frac{5D}{4}$

14. Ans. (c)

Tension of revolving string $= \frac{mv^2}{r} + mg\cos\theta$

$= \frac{10 \times 5^2}{2} + 10 \times 10\cos 30^o$

$= \frac{125}{2} + 50 = 112.5 = 114\text{N}$

15. Ans. (b)

Tension is minimum at highest point

$T\ min = \frac{mv^2}{r} - mg$

$= \frac{2 \times 4^2}{1} - 2 \times 10 = 32 - 20 = 12\text{N}$

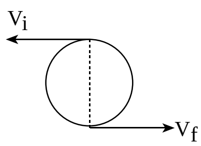
16. Ans. (b)

For motioning vertical circle tension in string $= \frac{mv^2}{r} + mg\cos\theta = m\omega^2 r + mg\cos\theta$ at lowest point $\theta = 0$, $T_{max} = mr\omega^2 + mg$

17. Ans. (d) $\Delta V = V_f - V_i$

$= 300 - (-300)$

$= +600$km/hr



18. Ans. (a)

$\theta = \tan^{-1}\left(\frac{V^2}{rg}\right) = \tan^{-1}\left(\frac{10 \times 10}{24 \times 10}\right) = 23°$

19. Ans. (d)

$\tan\theta = \frac{v^2}{rg}$

$\therefore \frac{v_1^2}{v_1^2} = \frac{r_1}{r_2}$

or, $r = \left(\frac{v_2}{v_1}\right)^2 \times r_1$

$= \left(\frac{2v_1}{v_1}\right)^2 \times 50 = 4 \times 50 = 200\text{m}$

20. Ans. (c)

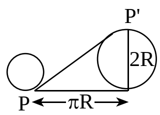
Work done by centripetal force is zero as centripetal force is always normal to the direction of motion.

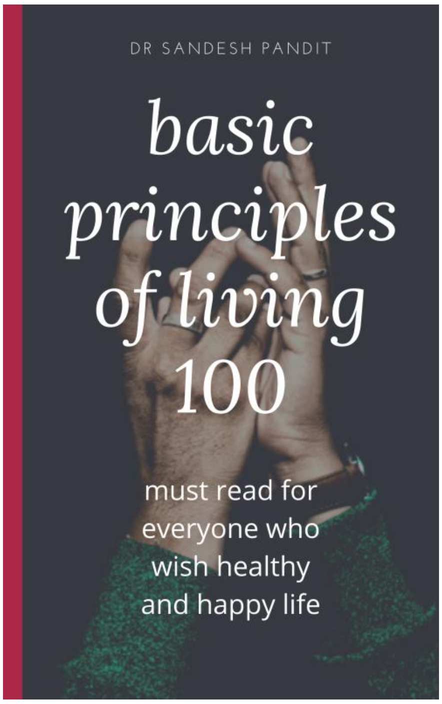
Centrifugal force is a fictious force which acts on a body rotating with uniform velocity in a circle along the radius away from centre.

21. Ans. (d)

Displacement (PP') $= \sqrt{(\pi R)^2 + (2R)^2}$

$= R\sqrt{\pi^2 + 4}$





SHIKHA
BOOKS

Chapter: 8

WORK, ENERGY, POWER, COLLISION

1. **Two balls of different masses have the same kinetic energy. The ball having greater momentum will be**
   a. lighter one
   b. heavier one
   c. both are same
   d. some times lighter and sometimes heavier

2. **Kilowatt hour is the unit of**
   a. Power b. energy
   c. Force d. time

3. **Which of the following unit of energy has minimum value?**
   a. 1 calorie b. 1 kilowatt hour
   c. 1 electron volt d. 1 erg

4. **A car and a lorry are moving with the same kinetic energy. They are brought to rest by applying brakes which provides equal retarding forces. The distances covered by them before coming to rest will be**
   a. equal b. $s \propto m$
   c. $s \propto \frac{1}{m}$ d. $s \propto \frac{1}{m^2}$

5. **A body is moved along a straight line by a machine delivering constant power. The velocity acquired by the body in time't' is proportional to**
   a. $t^{\frac{1}{2}}$ b. $t^{\frac{3}{2}}$
   c. $t^{\frac{3}{4}}$ d. t^2

6. **The kinetic energy acquired by a body of mass m after travelling a fixed distance from rest under the action of constant force is**
   a. $k\in \alpha\, m$ b. $k\in \alpha \sqrt{m}$
   c. $k.\in \alpha \frac{1}{m}$ d. independent of m

7. **A car is moving along a straight horizontal road with velocity v. If the coefficient of friction between types & road is μ. The minimum distance required to stop the car is**
   a. $\frac{v^2}{2\mu g}$ b. $\frac{v}{\mu g}$
   c. $\frac{v^2}{\mu g}$ d. $\frac{v^2}{\mu}$

8. **Tripling the speed of car multiplies the stopping distance for it by**
   a. 3 b. 6
   c. 9 d. 27

9. **A force of 100N acts on a particle and displaces it by 2m at an angle 30°. What is the work done by the force?**
   a. 200J b. 100J
   c. 173J d. zero

10. **A cord is used to lower vertically a block of mass M distance d at constant downward acceleration $\frac{g}{4}$. Then the work done by the cord on the block is:**
    a. $\frac{mgd}{4}$ b. $\frac{-3mgd}{4}$
    c. $\frac{+3mgd}{4}$ d. mgd

11. **From a waterfall water is pouring down at the rate of 100 kg/second on the blades of the turbine. If the height of the fall be 100m, the power delivered to the turbine is**
    a. 1kw b. 10kw
    c. 100kw d. 1000kw

12. **An engine develops 10kw of power. How much time will it take to lift a mass of 200kg to a height of 40m?**
    a. 4s b. 5s
    c. 8s d. 10s

13. Air expands from 100*l* to 300*l* at constant pressure of 1 atmosphere. The work done is

a. 2×10^4J b. 2×10^5J
c. 200J d. 2×10^7J

14. A metallic wire of length L metre extends by L metre when stretched by suspending a weight of Mg to it. Then the mechanical energy stored in the wire is

a. MgL b. $\frac{MgL}{2}$
c. $\frac{MgL}{4}$ d. 2MgL

15. A long string is stretched by 2cm its potential energy is V. If the string is stretched by 10cm, its potential energy stored is

a. $\frac{v}{5}$ b. $\frac{v}{25}$
c. 5v d. 25v

16. A metre stick of mass 800g is pivoted at one end and displaced through an angle of 60°. Then increase in potential energy is

a. 2J b. 4J
c. 20J d. 0.2J

17. A pendulum bob of mass 800 g is suspended from a thread 1metre long. It is displaced through an angle of 60° from vertical. The increased in potential energy of the bob is

a. 2J b. 4J
c. 20J d. 0.2J

18. The potential energy of a certain spring when stretched through a distance x is 10J. The amount of work required to stretched this string through an additional distance x will be

a. 10J b. 20J
c. 30J d. 40J

19. A chain is held on a frictional table with $\frac{1}{n}$ th of its length hanging from its edge. If the chain has length ' L' and mass 'M' how much work is required to pull the hanging part back into table

a. $\frac{mgL}{2n^2}$ b. $\frac{mgL}{n^2}$
c. mgL $(n^2 - 1)$ d. $\frac{mgL}{n}$

20. A chain is placed on a frictionless table with one fourth of its mass hanging over the edge. If the length of the chain is 2m and its mass is 4kg energy spend to pull the hanging part back in to table is

a. 32J b. 16J
c. 10J d. 2.5J

21. A body of mass 3kg is under a force, which causes a displacement given by s = $\frac{t^2}{3}$ (in metre). Then the work done by the force in 2 seconds is

a. 2J b. 2.6J
c. 3.8J d. 5.2J

22. A man of weight 60kg takes a body of mass 15kg at a height of 10m on a building in 3 minutes. The efficiency of the mass is

a. 10% b. 20%
c. 25% d. 40%

23. A pump motor is used to pump water at a certain rate from a given pipe. To increase the rate of water two times from the same pipe, by how much times, the power of the motor should be increased?

a. 2 times b. 4 times
c. 8 times d. 16 times

24. There is 12^{th} storyed building. Each storey is 3m high. A motor pump of power 1kw is fitted at ground. The cross sectional area of the pipe is $5cm^2$. Upto which storey will water reach?

a. 6^{th} b. 7^{th}
c. 10^{th} d. 12^{th}

25. If the kinetic energy of the body increases by 44% the percentage increase its momentum

a. 50% b. 20%
c. 100% d. 25%

26. If the nucleus get ruptured into nuclear fragments having the ratio of 1: 2. The ratio of their speeds is

a. 1: 8 b. 8: 1
c. 4: 9 d. 6: 1

27. A bullet fired into a target loses half of its velocity after penetrating 30cm. How much further will it penetrate before coming to rest?

a. 40cm b. 10cm
c. 60cm d. 80cm

28. A bullet fired normally on an immovable wooden plank loses 25% of its momentum in penetrating o distance of 3.5cm. The total thickness penetrated by the bullet is

a. 8cm b. 10cm
c. 12cm d. 14cm

29. A moving mass of 8kg collides elastically with a stationary mass of 2kg. If E be the initial kinetic energy of the moving mass, then kinetic energy left with it after collision will be

a. 0.8E b. 0.64E
c. 0.36E d. 0.08E

30. A neutron travelling with velocity u and k.ε 'E' collides perfectly elastically head on with nucleus of an atom of mass number A at rest. The fraction of total energy retained by neutron is

a. $\left(\frac{1-A}{A+1}\right)^2$ b. $\left(\frac{1+A}{A-1}\right)^2$
c. $\left(\frac{1-A}{A}\right)^2$ d. $\left(\frac{1+A}{A}\right)^2$

31. If the coefficient of restitution between a ball and floor 0.5. What is percentage loss of energy of each rebounding of a ball dropped from a height?

a. 12.5% b. 25%
c. 50% d. 75%

32. A ball is dropped from a height of 1m. If coefficient of restitution between surface and the balls is 0.6, the ball rebounded to a height of

a. 0.6m b. 0.4m
c. 1m d. 0.36m

33. A rubber ball is dropped from a height of 5m on a planet on bounching it rises to 1.8m. The ball loss its velocity on bounching by factor of

a. $\frac{2}{5}$ b. $\frac{3}{5}$
c. $\frac{9}{5}$ d. $\frac{16}{25}$

34. A rifle bullet losses $\frac{1}{20}$th of its velocity in passing through a plank. The least number of such planks required to just stop the bullet is

a. 5 b. 10
c. 11 d. 20

35. The work done in moving a body of mass 2kg over a smooth inclined plane of 30° and height 3m is w. The work done in moving the same body over another inclined plane of same height but inclination 60° will be

a. w b. $\frac{w}{2}$
c. $\sqrt{3}w$ d. $\frac{w}{\sqrt{3}}$

36. A shell is fired from a canon with a velocity V at angle θ with the horizontal direction at the highest point in its path it explodes into two pieces of equal masses. One of the pieces retraces its path to the canon. The speed the other piece immediately after the explosion is

a. $3v\cos\theta$ b. $2v\cos\theta$
c. $\frac{3v\cos\theta}{2}$ d. $v\cos\theta$

37. A bullet is shot from a rifle as a result the rifle recoils. The k.ε. of the rifle as compared to that of bullet is

a. less b. greater

c. equal d. none

38. The momentum of the body is numerically equal to k.∈. Its velocity is

a. 1m/s b. 2m/s

c. 4m/s d. 8m/s

39. A vehicle is moving on a rough horizontal road with kinetic energy k. If the force of friction on the vehicle be F; then the stopping distance will be given by

a. $\frac{K}{F}$

b. $\frac{\sqrt{K}}{F}$

c. $\frac{K}{\sqrt{F}}$

d. $\sqrt{\frac{K}{F}}$

40. A body falls freely under gravity. Its velocity is V when it has lost potential energy equal to U. What is the mass of the body?

a. $\frac{U^2}{V^2}$ b. $\frac{2U^2}{V^2}$

c. $\frac{2U}{V^2}$ d. $\frac{U}{V^2}$

41. The potential energy between two atoms in a molecule is given by Ux = $\frac{a}{x^{12}}$! $\frac{b}{x^6}$ where a & b are constants and 'x' is the distance between the atoms. The atom is in stable equilibrium, when

a. x = 0 b. $x = \left(\frac{a}{2b}\right)^{\frac{1}{6}}$

c. $x = \left(\frac{2a}{b}\right)^{\frac{1}{6}}$ d. $x = \left(\frac{11a}{5b}\right)^{\frac{1}{6}}$

42. A body of mass 1kg is thrown upwards with a velocity of 20m/s. It momentarily comes to rest after attaining a height of 18m. How much energy is lost due to air friction?

a. 10J b. 20J

c. 30J d. 40J

Answers

1. b	*2. b*	*3. c*	*4. a*	*5. a*	*6. d*	*7. a*	*8. c*	*9. c*	*10. b*
11. c	*12. c*	*13. a*	*14. b*	*15. d*	*16. a*	*17. b*	*18. c*	*19. a*	*20. d*
21. b	*22. b*	*23. c*	*24. b*	*25. b*	*26. b*	*27. b*	*28. a*	*29. c*	*30. a*
31. d	*32. d*	*33. a*	*34. c*	*35. a*	*36. a*				
37. a	*38. b*	*39. a*	*40. c*	*41. c*	*42. b*				

SOLUTION

1. Ans. (b)

$P = \sqrt{2mE} \Rightarrow P \propto \sqrt{m}$

So, momentum is greater for heavier ball.

2. Ans. (b)

$1\text{kwhr} = 3.6\times10^6\text{J}$

3. Ans. (c)

1 kwh > 1cal > 1 erg > 1ev

$3.6 \times 10^6\text{J} > 4.2\text{J} > 10^{-7} > 1.6 \times 10^{-19}\text{J}$

4. Ans. (a)

$W = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$

$F \times S = \frac{1}{2}mv^2 - 0$

KE = F × S

$S = \frac{KE}{F}$ (constant)

5. Ans. (a)

$P = F.\ V = mav$

$P = m.\frac{dv}{dt}.v$

$\int \frac{P}{m} dt = \int dv.V$

$\frac{P}{m}.t = \frac{v^2}{2}$

$V = \sqrt{\left(\frac{2p}{m}\right)t}\ \alpha\ t^{\frac{1}{2}}$

6. Ans. (d)

$K.\in\ = \frac{1}{2}mv^2 = ma\frac{v^2}{(2a)} = F \times S = \text{constant}$

7. Ans. (a)

work energy theorem,

$\frac{1}{2}mv^2 = \mu mg \times s$

$S = \frac{v^2}{2\mu g}$

Frictional force = μmg

8. Ans. (c)

$S = \frac{v^2}{2\mu g} \Rightarrow S\ \alpha\ V^2$

$\Rightarrow S_2 = 9S_1$

9. Ans. (C)

$w = Fs\cos\theta$

$= 100 \times 2 \times \cos 30$

$100\sqrt{3} = 173J$

10. Ans. (b)

Let T be the Tension in the rope then

$Mg - T = ma$

$T = m(g - a) = m\left(g - \frac{g}{4}\right) = \frac{3mg}{4}$

$w = Td\cos 180 = \frac{-3mgd}{4}$

11. Ans. (c) 100kw

Power delivered = Rate of Kε gained

= Rate of decrease of P$\in$ of water

$= \frac{dm}{dt} \times g \times h = 100 \times 10 \times 10 = 100kw$

12. Ans. (c) 8s

$t = \frac{\text{Work done}}{\text{Power}} = \frac{mgh}{\text{Power}}$

$= \frac{200 \times 10 \times 40}{10000} = 8s$

13. Ans. (a)

$W = P\Delta V$

$= 1.01 \times 10^5 \times (300-100) \times 10^{-3}$

$= 2 \times 10^4 J.\ (1L = 10^{-3}m^3)$

14. Ans. (b)

Energy (U) $= \frac{1}{2} \times$ Force $\times$ extension

$U = \frac{1}{2}MgL$

15. Ans. (a)

$U = \frac{1}{2}kx^2 \Rightarrow U\ \alpha\ x^2$

$\frac{V^1}{V} = \left(\frac{10}{2}\right)2 = 25$

$V^1 = 25V$

16. Ans. (a)

ΔU = Increased in Pε

= m $\times$ g $\times$ height raised by C.g.

$= 0.8 \times 10 \times \left(\frac{L}{2} - \frac{L}{2}\cos 60\right) = 8\left(\frac{1}{2} - \frac{1}{4}\right) = 2J$

Use shortcut

$\Delta U = \frac{mgL}{2}(1 - \cos\theta)$

17. Ans. (b)

Increased in P. $\varepsilon = \Delta U$

= mass $\times$ g $\times$ height raised by c.g

$= 0.8 \times 10 \times (1 - l\cos 60°) = 8\left(1 - \frac{1}{2}\right) = 4J$

use short cut $\Delta U = mgl(1 - \cos\theta)$

18. Ans. (c) 30J

Work done = Energy stored

$W = \frac{1}{2}k(x_2^2 - x_1^2)$

$= \frac{1}{2}k(4x^2 - x^2) = \frac{1}{2}(kx^2) \times 3 = 3\times 10 = 30J$

19. Ans. (a)

Worked done = weight of hanging part × height raised from c.g.

$= \frac{mg}{n} \times \frac{L}{2n} = \frac{mgL}{2n^2}$

20. Ans. (d)

Part of chain hanging

$= \left(\frac{1}{4}\right)$ th $= \frac{1}{n}$

∴ n = 4

Work done $= \frac{mgL}{2n^2} = \frac{4 \times 10 \times 2}{2 \times 4^2} = 2.5J$

21. Ans. (b)

$S = \frac{t^2}{3}; V = \frac{ds}{dt} = \frac{2}{3}t$

$a = \frac{dv}{dt} = \frac{2}{3} m/s^2$

At the end of 2s

$S = \frac{t^2}{3} = \frac{4}{3}$

$W = F \times S = ma \times S = \frac{3 \times 2}{3} \times \frac{4}{3}$

$= \frac{8}{3} = 2.6J$

22. Ans. (b) 20%

Total energy supplied = Input work

$W_{in} = (M + m)\, gh = 7500J$

output = energy delivered to 15kg mass = mgh = 1500J

$n = \frac{P_{out}}{P_{in}} = \frac{m}{M + m} = \frac{1}{5} = 20\%$

23. Ans. (c)

$F = \frac{dp}{dt} = \frac{dm}{dt}\; V = (Av\,\rho)\,\rho$

$= Av^2\rho$

$P = F.\,V = Av^3\rho$

$P = \frac{(Av)^3\rho}{A^2} = \frac{V^3\rho}{A^2}$

V = Av = volume of water ejected / sec

P α (volume/second)$^3 \Rightarrow 8$

24. Ans. (b)

Force = Pressure Atm × Area

$= 10^5$ H 5 H $10^{!4}$ = 50N.

If water rises to high 'h'.

Velocity imparted to water

$V = \sqrt{2gh}$ Hence power delivered is F. V = Power

50 H $\sqrt{2gh}$ = 1000

h = 20m

No. of storey $= \frac{20}{3}$ .7

25. Ans. (b) 20%

$P = \sqrt{2mE} = \frac{P - Po}{Po}$ H 100%

$= \left(\sqrt{\frac{E}{E_o}} - 1\right)$ 100% $= (\sqrt{1.44} - 1)$

= 0.2 H 100% = 20%

26. Ans. (b)

Linear momentum conserved

$Mv = \text{constant} \Rightarrow V \times \delta \times v = \text{constant}$

$\frac{4}{3}\pi r^3 \times \delta \times v = \text{constant}$

$\Rightarrow V\alpha \frac{1}{r^3} \Rightarrow v_1 : v_2 = 8:1$

27. Ans. (b)

Work energy theorem

$\frac{\frac{1}{2}mv^2 - o}{\frac{1}{2}mv^2 - \frac{m}{2}\left(\frac{v}{2}\right)}2 = \frac{F \times S}{F \times 30}$

$S = \frac{4}{3}$ H 30 = 40cm (Total distance)

Additional distance = 40 !30 = 10cm

28. Ans. (a)

Loss in velocity $= \frac{25v}{100} = \frac{v}{4}$

∴ n = 4

Use shortcut, Total thickness penetrated

$= \frac{n^2x}{2n!1} = \frac{4^2 H 3.5}{2 H 4 !1} = 8cm$

29. Ans. (c)

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) u_1 + \frac{2m_2 u_2}{m_1 + m_2}$

$v_1 = \left(\frac{8-2}{8+2}\right) u_1 + o = \frac{6}{10} u_1$

$\frac{k.\varepsilon \text{ before collision}}{k.\varepsilon \text{ after collision}} = \frac{\frac{1}{2} \times 8 \times \left(\frac{6u_1}{10}\right)^2}{\frac{1}{2} \times 8 \times (u_1)^2}$

$= \frac{36}{100} = 0.36$

30. Ans. (a)

$v_1 = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) u_1 + \frac{2m_2 u_2}{m_1 + m_2}$

$v_1 = \left(\frac{1 - A}{1 + A}\right) u_1 + o \ (u_2 = o)$

$\frac{v_1}{u_1} = \frac{1 - A}{1 + A}$

Fraction of energy retained

$= \frac{\frac{1}{2} m v_1^2}{\frac{1}{2} m v_2^2} = \frac{v_1^2}{u_1^2} = \left(\frac{1 ! A}{A + 1}\right)2$

31. Ans. (d)

$e = \frac{v_1 - o}{v - o} = \frac{v_1}{v} = 0.5 \Rightarrow v_1 = 0.5v$

% loss of k.∈ is given by

$\frac{\frac{1}{2}mv^2 - \frac{1}{2}mv_1^2}{\frac{1}{2}mv^2} \times 100\%$

$= \frac{v^2 - (0.5v)^2}{v^2} \times 100\% = \frac{3}{4} \times 100\% = 75\%$

32. Ans. (d)

$e = \sqrt{\frac{h}{h_o}} \Rightarrow e^2 = \frac{h}{h_o} = \frac{h}{1}$

$h = 0.6^2 = 0.36m$

33. Ans. (a)

$v_1 = \sqrt{2gh_1} \quad v_2 = \sqrt{2gh_2}$

$\frac{v_2}{v_1} = \sqrt{\frac{h_2}{h_1}} = \sqrt{\frac{1.8}{5}} = o.6$

Loss in velocity $1!\frac{v_2}{v_1} = 1!0.6$

$\frac{V_1!v_2}{v_1} = 0.4 = \frac{2}{5}$

34. Ans. (c)

Using work energy theorem

or, $\frac{\frac{1}{2}m\left[v^2 - \left(\frac{19v}{20}\right)^2\right]}{\frac{1}{2}m(v^2 - 0^2)} = \frac{F \times S}{F \times ns}$

or, $1 - \frac{361}{400} = \frac{1}{n}$ $\qquad n = 10.256$

∴ Not stopped by 10, requires 11.

35. Ans. (a)

W = mgh = same in both the cases as height is given same.

36. Ans. (a)

Law of conservation of linear momentum

$m.u \cos\theta = \frac{m}{2}(-u\cos\theta) + \frac{m}{2} v$

$2u\cos\theta + u\cos\theta = v$

$\Rightarrow v = 3u\cos\theta$

37. Ans. (a)

Rifle & bullet have same momentum

$k.\in = \frac{p^2}{2m} \quad k.\in \ \alpha \ \frac{1}{m}$

$\Rightarrow$ Rifle has less k.∈.

38. Ans. (a)

$P = mv = k \in = \frac{1}{2} mv^2$

$\Rightarrow v = 2m/s$

39. Ans. (a) $S = \frac{v^2}{2\mu g} = \frac{mv^2}{2\mu mg} = \frac{K}{F}$

40. Ans. (c)

$\Delta K\in = \Delta P\in = U$

$\frac{1}{2} mv^2 = U$

$m = \frac{2U}{V^2}$

41. Ans. (c)

For stable equilibrium,

$\frac{du}{dx} = 0$

$\frac{d}{dx}\left(\frac{a}{x^{12}} - \frac{b}{x^6}\right) = 0$

$-12x^{-13} a + 6x^{-7} b = 0$

$\frac{2a}{x^{13}} = \frac{b}{x^7} \Rightarrow x = \left(\frac{2a}{b}\right)^{\frac{1}{6}}$

42. Ans. (b)
Energy lost = K∈ given –P∈ acquired

$= \frac{1}{2} mv^2 - mgh = \frac{1}{2} \times 1 \times (20)^2 - 1 \times 10 \times 18 = 20J$

Past Questions

1. **Two masses m and 4m are moving with equal kinetic energies, the ratio of magnitude of their momentum is [IOM 2011]**
   a. 4:1 b. 1:2
   c. $\sqrt{2} : 1$ d. $\sqrt{6} : 1$
2. **Ball 'A' of mass 0.1 moving with velocity of 6m/s collides with ball B of mass 0.2 kg at rest. If ball A rebounds with a velocity of 2m/s in opposite direction after collision. What will be the velocity of B? [IOM 2063]**
   a. 2m/s b. 4m/s
   c. 6m/s d. 8m/s
3. **If two masses of 4kg and 16kg are moving with equal kinetic energy. What will be the ratio of their momentum? [IOM 98 / MOE 2064]**
   a. 4:1 b. 1:4
   c. 1:2 d. $1:\sqrt{2}$
4. **The power of a water pump is 3 kilowatt. The volume of water it can raise in one minute to a height of 10m, assuming g = $10m/s^2$. [MOE curriculum]**
   a. $2m^3$ b. $2.4m^3$
   c. $4m^3$ d. $1.8m^3$
5. **A machine lifts a block of mass 100kg for the ground to a height of 5m in 50s. The average power in kilowatt of the machine is nearly [MOE 2065]**
   a. 0.5 b. 1
   c. 2 d. 4
6. **Power of water pump is 4kw. Volume of water which can be raised to a height 10m in 1 minute is [MOE 2056]**
   a. $0.4m^3$ b. $1m^3$
   c. $2.4m^3$ d. None
7. **A body B is acted by a force given by F = Cx from distance x = o to x = x_1. What is the work done on the body? [MOE 055]**
   a. Cx_1 b. $\frac{1}{2} Cx_1$
   c. Cx_1^2 d. $\frac{1}{2} Cx_1^2$
8. **A 10kg mass is held 1m above the table for 25 sec. Then work done is [IE 2007]**
   a. 9.8J b. 10J
   c. 250J d. None
9. **A massive ball moving with speed V collides with a tiny ball of negligible mass. The collision is elastic. The second ball will move with a speed equal to [I.E]**
   a. V b. 2V
   c. $\frac{V}{2}$ d. zero
10. **If 'g' is acceleration due to gravity on earth's surface, the gain in potential energy of an objective of mass m raised from surface of earth equal to Radius R of the earth is [BPKIHS 2011]**
    a. $\frac{mgR}{2}$ b. 2mgR
    c. mgR d. $\frac{mgR}{4}$

11. A bullet of mass 'm' moving with velocity 'u' passes through a wooden block of mass M = nm. The block is resting on a smooth horizontal floor. After passing through the block, the velocity of the bullet is V. It's velocity relative to block is [BPKIHS 2009]

a. $\frac{(1+n)v-u}{n}$
b. $\frac{nv-u}{n+1}$
c. $\frac{nu-v}{n+1}$
d. $\frac{(1+n)v-u}{2n+1}$

12. A bob is suspended from a crane of length *l* = 5m. The crane and load are moving at a constant velocity Vo. The crane is stopped by the bumper and the bob on the cable swing out at an angle of 60°. The initial speed Vo [BPKIHS 2009]

a. 10m/s
b. 7m/s
c. 4m/s
d. 2m/s

13. A neutron makes a head on elastic collision on with a stationary deuteron. The fractional energy loss of the neutron in this collision is [BPKIHS 2008]

a. $\frac{16}{81}$
b. $\frac{8}{9}$
c. $\frac{8}{27}$
d. $\frac{2}{3}$

14. A nucleus of mass number A, originally at rest emits an α with speed V. The daughter nucleus recoils with a speed.

a. $\frac{2v}{A+4}$
b. $\frac{4v}{A+4}$
c. $\frac{4v}{A-4}$
d. $\frac{2v}{A-4}$

15. When constant acceleration acts on a body, then power of the body varies

[BPKIHS 2006]

a. $t^{\frac{2}{3}}$
b. $t^{\frac{1}{3}}$
c. t
d. $t^{\frac{3}{2}}$

16. Two springs A and B have force constant K_A and K_B such that $K_A = 2k_B$ are stretched by applying same force. Energy stored in spring A is E and energy stored in B will be.

[BPKIHs 2012]

a. E
b. 2E
c. 4E
d. 8E

Answers

1. b	*2. b*	*3. c*	*4. d*	*5. b*	*6. c*	*7. d*	*8. d*	*9. b*	*10. a*
11. a	*12. b*	*13. b*	*14. c*	*15. c*	*16. b*				

SOLUTION

1. Ans. (b)

$K\,\varepsilon = \frac{1}{2}mv^2 = \frac{p^2}{2m}$

$P = \sqrt{2m\epsilon} \Rightarrow P \propto \sqrt{m}$

$m_1 : m_2 = 1: 4$

$P_1: P_2 = 1: 2$

2. Ans. (b)

From law of conservation of momentum

$M_AV_A + M_BV_B = M_AV_A^1 + M_BV_B^1$

$0.1 \times 6 + 0.2 \times 0 = 0.1 \times (-2) + 0.2 \times V_B^1$

Ball A rebound in opposite direction V_A^1 is taken as –ve.

$0.6 = -v \times 0.2 + 0.2V_B^1$

$V_B^1 = 4m/s$

3. Ans. (c)

$E_K = \frac{p^2}{2m}$

$\frac{p1}{p2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{4}{16}} = \frac{1}{2}$

4. Ans. (d)

$P = \frac{w}{t} = \frac{mgh}{t}$

$3000 = \frac{m \times 10 \times 10}{60}$

m = 1800kg

$V = \frac{m}{\rho} = \frac{1800}{1000} = 1.8m^3$

5. Ans. (b)

$\text{Power} = \frac{\text{work done}}{\text{time}}$

$= \frac{F \times S}{t}$

$= \frac{100 \times 10 \times 5}{5}$

= 1000 watt = 1kw

6. Ans. (c)

Work done = 4kw × 1min

= (4 × 1000 × 60)J

$= 24 \times 10^4 J$

$mgh = 24 \times 10^4 = \rho \times V \times gh$

$V = \frac{24 \times 10^4}{1000 \times 10 \times 10} = 2.4m^3$

7. Ans. (d)

$W = \int_0^{x_1} F.dx$

$= \int_0^{x_1} Cx.dx = \left[\frac{x^2}{2}\right]_0^{x_1} = \frac{1}{2} Cx_1^2$

8. Ans. (d)

Work done = F × displacement. Held stationary, so displacement zero, w = 0.

9. Ans. (b)

$v_1 = \frac{m_1 - m_2}{m_1 + m_2} u_2 + \frac{2m_1 u_1}{m_1 + m_2}$

$u_2 = 0.\ v_2 = \frac{2m_1 u_1}{m_1 + m_2}$

$m_2 <<< m_1,\ v_2 = \frac{2m_1 u_1}{m_1}$

$v_2 = 2u_1\ [m_1 + m_2 \approx m_1]$

10. Ans. (a)

Using shortcut

$\Delta U = \frac{mgRh}{R + h}$

$= \frac{mgR \times R}{R + R} = \frac{mgR}{2}$

11. Ans. (a)

If velocity of block after impact is x, by law of conservation of linear momentum

$mu = mv + nmx \Rightarrow x = \frac{u - v}{n}$

So velocity of bullet relative to block

$= v - x = v - \frac{u - v}{n} = \frac{(1 + n)\, v - u}{n}$

12. Ans. (b)

$V^2 = 2gl\,(1 - \cos\theta)$

$V^2 = 2 \times 10 \times 5\,(1 - \cos 60°)$

$V^2 = 50$

$V = \sqrt{50} \approx 7m/s$

13. Ans. (b)

If mass of neutron = m

deuteron = 2m

$mv = (2m + m)\, v^1 \Rightarrow v^1 = \frac{v}{3}$

$\Delta E = \frac{1}{2} mv^2 - \frac{1}{2} m \left(\frac{v}{3}\right)2 = \frac{8}{9}\left(\frac{1}{2} mv^2\right) = \frac{8E_i}{9}$

$\frac{\Delta E}{E} = \frac{8}{9}$

14. Ans. (c)

Conservation of momentum

$0 = 4.v + (A - 4)\, v^1$

$\Rightarrow v^1 = \frac{4v}{A - 4}$

15. Ans. (c)

$P = FV = ma\,\frac{dv}{dt} \times dt$

$P = ma^2\,dt$

$P \,\alpha\, dt$ (As a is given constant)

16. Ans. (b)

$E = \frac{1}{2}Fx$

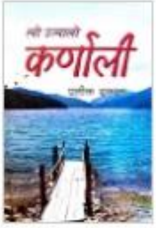
$E = \frac{1}{2}F \,.\, \frac{F}{k}$ [F = Kx]

$E = \frac{F^2}{2K} \,\alpha\, \frac{1}{k}$

$\frac{E_B}{E_A} = \frac{K_B}{K_A} = 2$


नेपालमा कम्युनिस्ट पार्टीको विकासक्रम, सरकार र नेतृत्व


नेपाली कांग्रेसको इतिहासको प्रारूप



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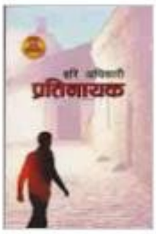


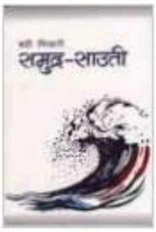
प्रतिनायक

रिकुटे

स्कुल बेच्ने बालक

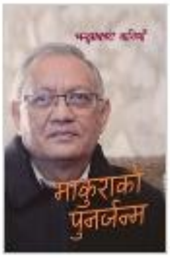
अदभुत तिवारी


छोट्टी



समुन्द्र साउती

गद्य शैलीको रूपविज्ञान



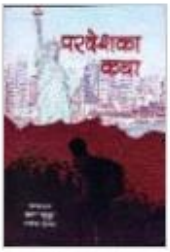
माकुराको पुनर्जन्म

नेपाली कांग्रेसको इतिहासको प्रारूप

कर्म


वीर्य जमिन


सारङ्गी



परदेशका कथा

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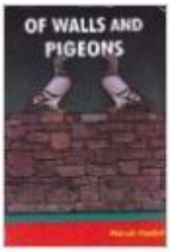


Of Walls And Pigeons

Chapter: 9

GRAVITATION

1. Which of the following fundamental interactions is weakest?

a. nuclear
b. electromagnetic
c. gravitational
d. All above are equally strong.

2. The value of G depends on

a. mass of earth
b. radius of earth
c. both mass & radius
d. constant (independent of mass & radius)

3. The weight of a body at the centre of earth is

a. zero b. infinity
c. slightly less than at poles
d. slightly less than at the equators

4. The mass of a particle at the centre of earth is

a. zero b. infinity
c. slightly more than at poles
d. same as at other places

5. Two spheres of massed 'm' & 'M' are situated in air and the gravitational force between them is F. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force is now

a. F b. $\frac{F}{3}$
c. $\frac{F}{9}$ d. 3F

6. If radius of the earth shrinks by 1%, mass remaining unchanged, the value of 'g'

a. Decreases by 1% b. Increases by 1%
c. Increases by 0.5% d. Increases by 2%

7. The gravitational force between two identical steel balls each of radius R touching their surface is F. Then gravitational force between two identical steel balls each of radius 2R touching their surfaces is

a. 16F b. 2F
c. F d. $\frac{F}{4}$

8. If earth shrinks so that its radius decreases by 50%, then the value of acceleration due to gravity at its surface

a. increases by 300%
b. decreases by 300%
c. increases by 100%
d. decreases by 100%

9. A helium balloon released on a moon would

a. climb with an acceleration $9.8/6ms^2$
b. fall with an acceleration $9.8/6m/s^2$
c. climb with an acceleration $9.8\times6m/s^2$
d. remains stationary wherever left

10. Which of the given is constant?

a. g b. gR
c. gR^2 d. g^2R

11. The acceleration due to gravity in the plant A is 9 times the accelerations due to gravity on earth. A man jumps to a height of 2m on the surface of planet A. What is the height of jump by same person on earth?

a. $\frac{2}{9}$ m b. $\frac{2}{3}$ m
c. 18m d. 6m

12. Fg and Fe represent the gravitational and electrostatic forces respectively between the two electrons situated at distance of 10cm. The ratio of Fg/Fe is of order of

a. 10^{+43} b. 10^{-43}
c. 10^{36} d. 10^{-36}

13. The tidal waves in a sea are due to

a. Sun's attraction
b. Moon's attraction
c. Earth's atmosphere
d. Attraction of Mars

14. Two planets of same materials have radii R and 2R. Then ratio of acceleration due to gravity on their surfaces will be

a. 1:2 b. 4:1
c. 1:4 d. 1:1

15. Two satellites of equal masses have radii R and 2R. Then ratio of acceleration due to gravity on their surface will be

a. 1:2 b. 4:1
c. 1:4 d. 1:1

16. At what height from earth's surface, the value of 'g' will be one fourth of its value at earth surface?

a. R b. $\frac{R}{2}$
c. $\frac{R}{4}$ d. 2R

17. At what depth 'x' from earth's surface the value of g will become one fourth of its value at earth's surface? [MOE]

a. R b. $\frac{R}{2}$
c. $\frac{R}{4}$ d. $\frac{3R}{4}$

18. If 'g' is acceleration due to gravity at earth's surface then the acceleration due to gravity at a planet whose mass and radius are both half of that of earth will be

a. $\frac{g}{4}$ b. $\frac{g}{2}$
c. g d. 2g

19. The value of 'g' will be 1% of its value at its surface of earth at a height (R = 6400 km)

a. 6400 km b. 2560 km
c. 57600 km d. 64000 km

20. Assuming the earth to be a perfect sphere, the differences in the value of 'g' at poles and equator is about

a. 0.017 m/s^2 b. 0.034 m/s^2
c. 0.051 m/s^2 d. 0.98 m/s^2

21. If the earth stops rotating about its axis the value of g at the equator will

a. decrease by ω^2R
b. increase by ω^2R
c. increase by ωR
d. unchanged

22. The radius of earth is 6400 km and g = 10 m/s^2 In order that a body becomes weightlessness at equator, the angular speed will be

a. $\frac{1}{8}$ rad/s b. $\frac{1}{80}$ rad/s
c. $\frac{1}{800}$ rad/s d. $\frac{1}{8000}$ rad/s

23. How much faster than its present speed about its axis should the earth rotate in order that body lying at equator just fly into space?

a. 2 times b. $\sqrt{2}$ times
c. 17 times d. 10 times

24. An astronaut orbiting the earth in a circular orbit 200 km above the surface of the earth gently drops a packet out of spaceship. It will

a. move towards the moon
b. move along with the spaceship
c. Fall vertically down to earth
d. more in a zigzag way & then fall.

25. What remains constant throughout the orbit of planetary motion?

a. angular speed of planet
b. angular momentum
c. linear speed of planet
d. none

26. A satellite revolves around the earth in an elliptical orbit. Its speed

a. is same at all points of the orbit
b. is greatest when it is closest to the earth
c. is greatest when it is farthest to the earth
d. goes on increasing or decreasing depending on mass

27. The radius of the orbit of communication satellite is

a. 36000 km b. 6400 km
c. 3200 km d. 42400 km

28. A satellite of mass 'm' is orbiting the earth in a circular orbit with speed 'v'. The total energy of the satellite is

a. mv^2 b. $\frac{1}{2}mv^2$
c. $\frac{3}{4}mv^2$ d. $\frac{-1}{2}mv^2$

29. An artificial satellite moving in a circular orbit around the earth has total energy Eo. Its potential energy

a. –Eo b. $\frac{3}{2}$ Eo
c. 2 Eo d. Eo

30. The total energy of just escaping body from surface of earth is

a. positive b. negative
c. Zero
d. positive or negative depending on direction

31. A satellite is orbiting close to earth's surface, then its orbital velocity is

a. $\sqrt{2Rg}$ b. $\sqrt{Rg}$
c. $\sqrt{\frac{Rg}{2}}$ d. $(Rg)^2$

32. The relationship between escape velocity and orbital velocity is given by

a. $v_e = \sqrt{2}\, v_o$ b. $v_e = 2v_o$
c. $v_e = \frac{v_o}{\sqrt{2}}$ d. $v_e = \frac{v_o}{2}$

33. The relationship between orbital kinetic energy Eo and escape kinetic energy Ee is given by

a. $Ee = \sqrt{2}\, Eo$ b. $Ee = 2Eo$
c. $Ee = \frac{Eo}{\sqrt{2}}$ d. $Ee = \frac{Eo}{2}$

34. A satellite is revolving in orbit around earth with kinetic energy Eo. The required energy further to escape it leaving the orbit is

a. E b. $\frac{E}{2}$
c. $\sqrt{2}$ E d. 2E

35. A spaceship is launched into a circular orbit close to earth's surface. What additional velocity has now to be imported to the spaceship to over come the gravitational pull. (radius of earth = 6400)

a. 11.2 km/s b. 7.92 km/s
c. 3.28 km/s d. 9.8 km/s

36. A satellite is orbiting close to its earth surface its time period is

a. $\pi\sqrt{\frac{2R}{g}}$ b. $2\pi\sqrt{\frac{R}{g}}$
c. $\pi\sqrt{\frac{R}{g}}$ d. $\frac{\pi}{2}\sqrt{\frac{R}{g}}$

37. A satellite 'A' of mass 'm' is at a distance r from the center of the earth and another satellite B of mass 2m is at distance 2r from the earth's center. Then their time periods are in the ratio

a. 1:2 b. 1:4
c. 1:16 d. $1:2\sqrt{2}$

38. The escape velocity of body on the surface of the earth is 11.2 km/s. If the earth's mass increase to twice its present value and radius of the earth becomes half. The escape velocity would become

a. 5.6 km/s b. 11.2 km/s
c. 22.4 km/s d. 44.8 km/s

39. The escape velocity of a body from earth's surface when projected vertically is 11.2 km/s. The escape velocity of the body when projected at an angle of 60º to the horizontal is

a. 5.6 km/s b. $5.6\sqrt{3}$ km/s

c. 11.2 km/s d. $11.2\sqrt{3}$ km/s

40. The escape speed for a projectile from earth's surface is 11.2 km/s. A body is projected from earth's surface with a speed equal to 4 times the escape speed. The speed of the body at infinite separation from surface of earth.

a. 4×11.2 km/s b. 3×11.2 km/s

c. $11.2\sqrt{15}$ km/s d. zero

41. A body falls on the surface of the earth from infinite height; it will strike the earth with a velocity of

a. infinity b. 0

c. 11.2 km/s d. 8 km/s

42. If 'g' be the acceleration due to gravity at earth's surface and 'R' be the radius of earth, then escape velocity of a particle at a height R will be

a. $\sqrt{2gR}$ b. $\sqrt{gR}$

c. $\frac{\sqrt{gR}}{2}$ d. $2\sqrt{gR}$

43. A satellite is orbiting a planet close to earth surface. If mass of planet is reduced to half & mass of satellite is doubled simultaneously, then

a. fall freely into planet

b. escapes from planet

c. continues to revolve at same speed

d. orbit the planet at lower speed

44. A particle is held inside an isolated solid sphere at distance x from the center of that sphere. The gravitational force on that particle by sphere is

a. directly proportional to x

b. inversely proportional to x^2

c. directly proportional to x^2

d. zero

45. A particle is held inside an isolated hollow sphere at distance 'x' from the center of that sphere. The gravitational force on that particle by the sphere is

a. directly proportional to x

b. inversely proportional to x^2

c. directly proportional to x^2

d. zero

46. The gravitational potential on the surface of an isolated soap bubble is V. Then its potential at its centre is

a. $\frac{3}{2}$ V b. V

c. $\frac{V}{2}$ d. zero

47. The gravitational potential at the surface of an isolated mercury drop is v. Then its potential at its centre is

a. $\frac{3}{2}$ V b. V

c. $\frac{V}{2}$ d. zero

48. A hollow sphere shrinks radially maintaining its shape. The gravitational potential at its centre

a. decreases

b. increases

c. remains unchanged

d. may increase or decrease

49. If a tunnel is dug along the diameter of earth and a mass is released into it from one of the poles. What will be the velocity of mass when it reaches the centre?

a. $\sqrt{gR}$ b. $\sqrt{2gR}$

c. 2gR d. zero

50. Energy required moving a body of mass 'm' from an orbit of radius 2R to 3R is

a. $\frac{GMm}{3R}$ b. $\frac{GMm}{6R}$

c. $\frac{GMm}{R}$ d. $\frac{GMm}{5R}$

51. At what height from the surface of the earth, the total energy of the satellite is equal to potential energy at a height 2R from surface of earth?

a. $\frac{R}{4}$

b. $\frac{R}{2}$

c. 2R

d. 4R

52. Air friction .... Velocity of satellite.

a. increases

b. No effect

c. decreases

d. sometimes decreases, sometimes increase

53. By what percentage should the velocity be increase so that satellite moving close to earth surface escape?

a. 50%

b. 100%

c. 41.4%

d. 25%

54. A satellite going round the earth in a circular orbit loses some energy due to collision. Its speed is 'V' and distance from earth is h. Then

a. h will decrease, V will increase

b. h will increase, V will decrease

c. h will decrease, v will decrease

d. h will increase, v will increase

55. How much velocity should be given for a body if it is to be projected vertically upward from earth's surface to reach the height 10R?

a. $\sqrt{\frac{GM}{R^2}}$

b. $\sqrt{\frac{2GM}{R}}$

c. $\sqrt{\frac{20GM}{11R}}$

d. $\sqrt{\frac{21GM}{12R}}$

56. The ratio of energy required to raise a satellite to a height 'h' above earth's surface to that required to put into the orbit is

a. $\frac{h}{R}$

b. $\frac{R}{h}$

c. $\frac{h}{2R}$

d. $\frac{2h}{R}$

Answer Sheet

1. c	*2. d*	*3. a*	*4. d*	*5. a*	*6. d*	*7. a*	*8. a*	*9. b*	*10. c*
11. c	*12. b*	*13. b*	*14. a*	*15. b*	*16. a*	*17. d*	*18. d*	*19. c*	*20. b*
21. b	*22. c*	*23. c*	*24. b*	*25. b*	*26. b*	*27. d*	*28. d*	*29. c*	*30. c*
31. b	*32. a*	*33. b*	*34. a*	*35. c*	*36. b*	*37. d*	*38. c*	*39. c*	*40. c*
41. c	*42. b*	*43. b*	*44. a*	*45. d*	*46. b*	*47. a*	*48. a*	*49. a*	*50. b*
51. b	*52. a*	*53. c*	*54. a*	*55. c*	*56. d*				

SOLUTION

1. Ans. (c)
Gravitational force is weakest force in nature. It's 10^{38} times weaker than nuclear and10^{36} times weaker than electrostatic force.

2. Ans (d)
G is universal constant & its value remains same in all conditions

3. Ans (a)
Weight, W = mg
At centre of earth
$g^1 = g\left(1-\frac{d}{R}\right) = g\left(1-\frac{R}{R}\right) = 0$

4. Ans (d)

Weight varies but mass remains constant.

5. Ans (a)

$F = \frac{Gm.M}{r^2}$

-depends on masses & distance

-independent of medium around the two bodies.

6. Ans (d)

$g = \frac{GM}{R^2}$

$\frac{\Delta g}{g} = -2\left(\frac{\Delta R}{R}\right)$

$\frac{\Delta g}{g} \times 100\% = -2\left(\frac{\Delta R}{R} \times 100\%\right)$

$= -2(-1) = +2\%$

7. Ans (a)

As they are made of same material, their density is same.

$F = \frac{Gm_1m_2}{R^2}$

$= \frac{Gv^2.\rho^2}{R^2} = \frac{G\rho^2(4/3\pi R^3)^2}{R^2} = F \propto R^4$

$\therefore$ If radius doubled, force 16 times

8. Ans (a)

$R_2 = \frac{R_1}{2}$; $g = \frac{GM}{R^2} \propto \frac{1}{R^2}$

%increase in g = $\frac{g_2 - g_1}{g_1} \times 100$

$= \left(\frac{g_2}{g_1} - 1\right) \times 100\% = \left[\left(\frac{R_1}{R_2}\right)^2 - 1\right] \times 100\%$

$= (4-1) \times 100\% = 300\%$

9. Ans (b)

10. Ans (c) gR^2

$g = \frac{GM}{R^2}$

$GM = gR^2$

= Constant

11. Ans (c)

$mg_eh_e = mg_ph_p$

$h_e = \frac{g_p \times h_p}{g_e} = 9 \times 2 = 18m$

12. Ans (b)

$F_g = \frac{Gmm}{r^2}$ $F_e = \frac{1}{4\pi\varepsilon_o} \frac{e^2}{r^2}$

$\frac{F_g}{F_e} = \frac{Gm^2}{e^2} \times 4\pi\varepsilon_o$

$= \frac{6.67 \times 10^{-11} \times (9.1 \times 10^{-31})^2}{(1.6 \times 10^{-19})^2 \times 9 \times 10^9} = 10^{-43}$

13. Ans. (b)

Gravitational pull of moon on earth causes it.

14 Ans. (a)

$g = \frac{GM}{R^2} = \frac{G\delta 4}{R^2 3}\pi R^3$

$g \propto R$

$g_1 : g_2 = R : 2R = 1:2$

15. Ans (b) 4 : 1

$g = \frac{GM}{R^2} \propto \frac{1}{R^2}$

$g_1 : g_2 = 4 : 1$

16. Ans (a)

Shortcut: For $g^1 = g/n$

$\boxed{h = (\sqrt{n} - 1)R}$

$= (\sqrt{4} - 1)\, R = R$

OR,

$g^1 = \frac{GM}{R^2} = \frac{gR^2}{(R+h)^2}$

$\frac{g^1}{g} = \left(\frac{R}{R+h}\right)^2 = \frac{1}{4}$

$\frac{R}{R+h} = \frac{1}{2}$

$\therefore h = R$

17. Ans (d)

for $g^1 = \frac{g}{n}$

$\boxed{\text{depth} = \left(\frac{n-1}{n}\right) R}$

$= \left(\frac{4-1}{4}\right) R = \frac{3R}{4}$

18. Ans (d)

$g = \frac{GM}{R^2}$

$\frac{g\ planet}{g\ earth} = \frac{M_P}{Me}\left(\frac{Re}{R_P}\right)^2 = \frac{1}{2} \times 2^2 = 2$

g planet = 2g earth

19. Ans (c)

for $g^1 = \frac{g}{n}$ g^1 = 1% of $g = \frac{g}{100}$

$h = \left(\sqrt{n} - 1\right) R$

$= \left(\sqrt{100} - 1\right) R = 9R = 57600$ km

20. Ans (b)

g pole > g eq

shape	due to rotation
$g \ \alpha \ \frac{1}{R^2}$	$g^1 = g - R\omega^2\cos^2\theta$
$gp - ge = 0.018\ m/s^2$	$gp–ge=R\omega^2=0.034 m/s^2$

for perfect sphere, only due to rotation is taken.

21. Ans (b)

$ge = g - R\omega^2$ ($\theta_e = o^o$)

If stops rotating, $\omega = o$

ge = g

so increases by $R\omega^2$.

22. Ans (c)

$ge = g - R\omega^2$

ge = o for weightlessness

$\omega = \sqrt{\frac{g}{R}} = \sqrt{\frac{10}{6.4 \times 10^6}}$

$= \frac{1}{800}$ rad/s $= 1.25 \times 10^{-3}$ rad/s

23. Ans (c)

for body lying at equator to weightlessness

$\omega_1 = 1.25 \times 10^{-3}$ rad/s

present $\omega = \frac{2\pi}{T} = 7.29 \times 10^{-5}$ rad/s

$= \frac{7.29 \times 10^{-5}}{1.25 \times 10^{-3}} = 17$ times

24. Ans (b)

move along with the spaceship with same speed.

25. Ans (b)

Angular momentum is constant

L= mvr = constant

26. Ans (b)

L = mvr = constant

$vr = \frac{L}{m}$ = constant

$v \ \alpha \ \frac{1}{r}$

27. Ans (d)

Height of communication satellite = 36000 km

Radius = (36000 + 6400) = 42400 km

28. Ans (d)

Total energy = – k.E

$= \frac{-1}{2} mv^2$

$\boxed{KE = -TE; PE = 2TE; PE = -2KE}$

29. Ans (c)

$KE = \frac{GMm}{2r}$

$PE = \frac{-GMm}{r}$

$TE = \frac{-GMm}{2r}$

30. Ans (c)

At escape velocity KE = PE

KE is positive while

PE is negative

31. Ans (b)

$v_o = \sqrt{\frac{GM}{R+h}} = \sqrt{\frac{GM}{R}}$

$= \sqrt{\frac{gR^2}{R}} = \sqrt{gR}$

Acc^n to question ($R + h \approx R$)

32. Ans (a)

$v_o = \sqrt{\frac{GM}{R}} = 7.92$ km/s

$v_e = \sqrt{\frac{2GM}{R}} = 11.2$ km/s

33. Ans (b)

$\frac{E_e}{E_o} = \frac{\frac{1}{2}mv_e^2}{\frac{1}{2}mv_o^2} = \left(\frac{v_e}{v_o}\right)^2$

$= \left(\sqrt{2}\right)^2 \Rightarrow 2$

$E_e = 2E_o$

34. Ans (a)

$E = \frac{1}{2}mv_o^2$

To escape, $E^1 = \frac{1}{2}mv_e^2$

$= \frac{1}{2}m\left(\sqrt{2}\,v_o\right)^2$

$= \frac{1}{2}m \times 2v_o^2 = 2E$

Additional energy = $2E - E \Rightarrow E$

35. Ans (c)

$v_o = \sqrt{\frac{GM}{R}} = \sqrt{gR} = 7.92$ Km/s

$v_e = \sqrt{2gR} = 11.2$ km/s

Additional velocity

= (11.2 – 7.92) km/s

= 3.28 km/s

36. Ans (b)

$T = \frac{\text{circumference of orbit}}{\text{orbital velocity}}$

$= \frac{2\pi R}{\sqrt{gR}} = 2\pi\sqrt{\frac{R}{g}}$

37. Ans (d)

$T^2 \alpha\, r^3$

$\left(\frac{T_1}{T_2}\right)^2 = \left(\frac{r_1}{r_2}\right)^3 = \left(\frac{r}{2r}\right)^3 = \frac{1}{8}$

$T_1 : T_2 = 1 : \sqrt{8} = 1 : 2\sqrt{2}$

38. Ans (c)

$ve = \sqrt{\frac{2GM}{R}}$

$\frac{ve^1}{ve} = = \sqrt{\frac{M^1}{M} \times \frac{R}{R^1}} = = \sqrt{2 \times 2} = 2$

$ve^1 = 2ve = 2 \times 11.2 = 22.4$ km/s

39. Ans (c)

Escape velocity is independent of angle of projection

– Also independent of mass to be projected.

40. Ans (c)

shortult $V_i = \left(\sqrt{n^2 - 1}\right)ve$

$= \left(\sqrt{16 - 1}\right) ve = \sqrt{15}\, ve$

Conservation of energy

$\frac{1}{2}mv^2 - \frac{1}{2}mv_1^2 = 0 - \left(\frac{-GMm}{R}\right)$

$\frac{1}{2}mv^2 - \frac{1}{2}mv_1^2 = \frac{1}{2}mv_e^2$

$v_1 = \sqrt{v^2 - ve^2} = \sqrt{(nve)^2 - ve^2} = \left(\sqrt{n^2 - 1}\right) ve$

41. Ans (c)

Conservation of Energy

Energy on earth surface = Energy at $\propto$

$\frac{1}{2}mv^2 - \frac{GMm}{R} = 0$

$v = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2gR^2}{R}} = \sqrt{2gR} = 11.2$ km/s

42. Ans (b)

$ve = \sqrt{\frac{2GM}{R + h}}$ Here, h = R

$ve = \sqrt{\frac{2GM}{2R}} = \frac{\sqrt{GM}}{R} = \sqrt{gR}$

Escape velocity from earth surface= $\sqrt{2gR}$

43. Ans (b)

$v = \sqrt{\frac{GM}{R}}$, only planet mass is considered.

Mass of satellite has no role.

$$ve = \sqrt{\frac{2GM^1}{R}} = \sqrt{\frac{2GM}{2R}} = \sqrt{\frac{GM}{R}} = V$$

So, the satellite escapes.

44. Ans (a)

$$F = mE = m\left(\frac{GM}{R^3}\right) x$$

$F \alpha x$.

45. Ans (d)

$F = mE$

Inside hollow, gravitational field intensity is zero but potential inside the hollow sphere = potential at surface = $\frac{-GM}{R}$

46. Ans (b)

For hollow sphere

$V = \frac{-GM}{R}$ (surface)

$V = \frac{-GM}{R}$ ($r < R$ inside)

47. Ans (a)

For solid sphere

$V \text{ surface} = \frac{-GM}{R}$

$V \text{ centre} = \frac{-3}{2}\frac{GM}{R}$

$\boxed{V \text{ centre} = 1.5 \text{ V surface}}$

48. Ans (a)

On shrinking R↓,V becomes more negative so decreases.

49. Ans (a)

$\in PE = \frac{1}{2} mv^2$

PE (centre) – PE (surface) = 1.5 PE – PE

$0.5 \text{ PE} = \frac{1}{2} mv^2$

$\frac{GMm}{R} = mv^2$

$\therefore V = \sqrt{\frac{GM}{R}} = \sqrt{gR}$

50. Ans (b)

$$\Delta PE = \frac{-GMm}{3R} - \left(\frac{-GMm}{2R}\right)$$

$$= \frac{GMm}{6R}$$

51. Ans (b) $\frac{R}{2}$

Total energy at height h = P.E at 2R

$$\frac{-GMm}{2(R+h)} = \frac{-GMm}{(2R+R)}$$

$\therefore \quad h = \frac{R}{2}$

52. Ans (a)

Increases velocity of satellite.

53. Ans (c)

$$\frac{ve - vo}{vo} \times 100\% = \left(\frac{ve}{vo} - 1\right) \times 100\%$$

$$= \left(\sqrt{2} - 1\right) \times 100 = 41.4\%$$

K.E increases by 100%

54. Ans (a)

$$\text{Total Energy} = \frac{1}{2} mv^2 + \frac{-GMm}{R+h}$$

$$\text{Also, } \frac{mv^2}{R+h} = \frac{GMm}{R+h}$$

$v \, \alpha \, \frac{1}{\sqrt{R+h}}$ T.E ↓, h↓ and v will ↑.

55. Ans (c)

T. E is conserved

$$\frac{1}{2} mv_o^2 - o^2 = \frac{mghR}{R+h}$$

$$vo^2 = \frac{2gR \times 10R}{11R}$$

$$vo = \sqrt{\frac{20GM}{11R}}$$

56. Ans (d)

Energy required to raise to height 'h' from surface

$$E_1 = \frac{-GMm}{R+h} - \left(\frac{-GMm}{R}\right)$$

$$= \frac{GMmh}{R(R+h)}$$

$E_2 = \frac{1}{2}\ mvo^2 = \frac{GMm}{R+h}$

$E_1 : E_2 = \frac{2h}{R}$

Past Questions

1. An earth satellite revolves around a circular orbit at a height 300 km above the earth surface. If the radius of the earth is 6400 km, the velocity of the satellite will be nearly [MOE 068]

a. 7.7 km/s b. 8.1 km/s
c. 3.5 km/s d. 1.2 km/s

2. If the earth were to suddenly contract to half the present radius, what would be the time of rotation of earth? (IOM)

a. 24 hrs b. 12 hrs
c. 6 hrs d. 48 hrs

3. At what height from earth, g becomes $\frac{g}{2}$? (IOM)

a. $\frac{R}{2}$ b. 0.414R
c. 0.7R d. R

4. What would be the time period of satellite moving around the earth if the radius of revolution is increased by 1 and half time?

a. $\left(\frac{2}{3}\right)^{2/3}$ b. $\left(\frac{2}{3}\right)^{1/3}$
c. $\left(\frac{3}{2}\right)^{3/2}$ d. $\left(\frac{3}{2}\right)^{3/2}$

5. If the value of 'g' is same at depth 'd' inside earth and height 'h' above earth, then [IOM]

a. d = h b. d = 2h
c. $d = \frac{h}{2}$ d. d = 3h

6. Two planets of radii r_1, r_2 and densities d_1, d_2 have 'g' in the ratio of [MOE 2010]

a. $r_1d_1 : r_2d_2$
b. $r_1d_2 : r_2d_1$
c. $r_1^2d_1 : r_2^2d_2$
d. $r_1d_1^2 : r_2d_2^2$

7. A missile is launched with a velocity less than the escape velocity from earth. Then sum of its kinetic energy and potential energy is [IOM]

a. positive
b. negative
c. zero
d. positive or negative depending on direction

8. The escape velocity for a projectile at earth's surface is Ve. A body is projected from earth's surface with velocity 2ve. The velocity of the body when at infinite distance from centre of earth [IOM]

a. ve b. 2ve
c. $\sqrt{3}$ ve d. $\sqrt{2}$ ve

9. A rocket launched with the escape velocity follows a [IOM]

a. parabolic path
b. straight path
c. circular path
d. elliptical path

10. The orbital velocity of an artificial satellite in a circular orbit just above the earth's surface is v. For a satellite orbiting at an altitude of half the earth radius the orbital velocity is [MOE 2010]

a. $\frac{3}{2}$ v b. $\sqrt{\frac{3}{2}}$ v
c. $\sqrt{\frac{2}{3}}$ v d. $\frac{2}{3}$ v

11. The escape velocity in the earth is 11 km/s. The escape velocity of the planet with double radius and same mean density is: [IOM 2012]

a. 5.5km/s b. 11 km/s
c. 8 km/s d. 22 km/s

12. The earth satellite is 4 times higher than communication satellite from surface of earth. Then, time period of earth satellite is: [BPKIHS 2012]

a. 186 hrs b. 192 hrs
c. 372 hrs d. 384 hrs

13. The time period of communication satellite is: [BPKIHS 2011]

a. 12 hours b. 24 hours
c. 1 years d. 6 hours

14. "Sun sweep out equal area in equal interval of time". It's the statement of [BPKIHS 2011]

a. Kepler's law b. Kirchoff's law
c. Wein's law d. Einstein's law

15. The acceleration due to gravity on a planet is 1.96 m/s^2. If it is safe to jump from a height of 2m on the surface of the earth. What will be the corresponding safe height on the planet? [BPKIHS]

a. 6m b. 10m
c. 100m d. 1.96m

16. The difference between solar day and sideral day is [BPKIHS 2006]

a. 40 min b. 4 sec
c. 40 sec d. 4 min

17. The escape velocity of the planet is ve. If the mass of the planet is increased four times keeping the radius same. The escape velocity becomes [IE 2011]

a. 4ve b. 2ve
c. $2\sqrt{2}$ve d. $\sqrt{2}$ve

18. Weight of a body at earth's surface is w. If it is taken to a height equal to half the radius of earth, its weight becomes: [IE 2009]

a. $\frac{w}{2}$ b. $\frac{2w}{3}$
c. $\frac{4w}{9}$ d. $\frac{8w}{9}$

19. The satellite of mass M and 9M are orbiting in a circular orbit of radius R. Their time period of revolution will be in the ratio of: [IE 2008]

a. 9:1 b. 3:1
c. 1:1 d. 1:3

Answer Sheet

1. a	*2. c*	*3. b*	*4. c*	*5. b*	*6. a*	*7. b*	*8. c*	*9. a*	*10. c*
11. d	*12. b*	*13. b*	*14. a*	*15. b*	*16. b*	*17. b*	*18. c*	*19. c*	

SOLUTION

1. Ans (a)

$$v = \sqrt{\frac{GM}{R+h}} = \sqrt{\frac{gR^2}{R+h}}$$

$$= \sqrt{\frac{9.8\times10^{-3}\times(6400)^2}{(6400+300)}} = 7.7 \text{ km/s}$$

2. Ans (c)
Angular momentum is conserved
$I_1\omega_1 = I_2\omega_2$

$$\left(\frac{2}{5}mR^2\times\frac{2\pi}{24} = \frac{2}{5}m\left(\frac{R}{2}\right)^2\times\frac{2\pi}{T_1}\right)$$

$$T^1 = \frac{24}{4} = 6 \text{ hrs}$$

3. Ans (b) 0.414R

$h = (\sqrt{n} - 1)\,R$

$= \left(\sqrt{2} - 1\right) R = 0.414R$

4. Ans (c)

$T^2 \alpha r^3 \Rightarrow T \alpha r^{3/2}$

$$\frac{T_2}{T_1} = \left(\frac{\frac{3r}{2}}{r}\right)^{3/2}$$

$$T_2 = \left(\frac{3}{2}\right)^{3/2} T_1$$

5. Ans (b) d = 2h

$$g = \left(1 - \frac{d}{R}\right) = g\left(1 - \frac{2h}{R}\right)$$

d = 2h

6. Ans (a) $r_1d_1 : r_2d_2$

$$g = \frac{GM}{R^2} = \frac{4}{3}\pi RdG$$

g α Rd

7. Ans (b) Negative

PE > KE occurs PE is –ve & KE is +ve & follows circular or elliptical orbit

8. Ans (c) $\sqrt{3}$ ve

If projected with (nve), velocity in free space

$$= \left(\sqrt{n^2 - 1}\right) \text{ve} = \left(\sqrt{4 - 1}\right) \text{ve} = \sqrt{3} \text{ ve.}$$

9. Ans (a) parabolic path

KE = PE occurs

TE = 0

If TE = +ve, follows hyperbolic.

10. Ans (c) $\sqrt{\frac{2}{3}}$ v

$$V = \sqrt{\frac{GM}{R}}$$

$$V^1 = \sqrt{\frac{GM}{R + h}} = \sqrt{\frac{GM}{R + \frac{R}{2}}}$$

$$= \sqrt{\frac{2}{3} \cdot \frac{GM}{R}} = \sqrt{\frac{2}{3}} v$$

11. Ans. (d)

$$V_e = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2G.\rho.\frac{4}{3}\pi R^3}{R}}$$

$$V_e = R\sqrt{\frac{8\pi\rho G}{3}}$$

V_e α R for same δ.

12. Ans. (b)

$T^2 \alpha R^3$

For communication satellite, T = 24hrs

$$\left(\frac{24}{T}\right)^2 = \left(\frac{1}{4}\right)^3 \qquad \therefore T = 192 \text{ hrs.}$$

13. Ans. (b)

Time period of communication satellite = Time of rotation of earth = 24 hrs

14. Ans. (a)

Kepler's 2nd law = law of area, based on conservation of angular momentum

$$\frac{d\vec{A}}{dt} = \frac{\vec{L}}{2m} = \frac{mvr}{2m} = \text{constant}$$

15. Ans. (b

Velocity on reaching the surface of planet & earth should be same.

$$v = \sqrt{2g'h'} = \sqrt{2gh}$$

$$h' = \frac{gh}{g'} = \frac{9.8 \times 2}{1.96} = 10\text{m}$$

16. Ans. (b)

The actual time taken by earth to rotate about its axis is 23 hrs and 56 min but we take 24 hrs. So difference = 4 min

17. Ans. (b)

$$Ve = \sqrt{\frac{2GM}{R}}$$

Ve α $\sqrt{m}$ for 'R' constant

Ve' : Ve = $\sqrt{4}$: 1 = 2:1

18. Ans. (c)

At height 'h'

$$g' = \frac{GM}{(R + h)^2} = \frac{gR^2}{(R + h)^2}$$

$$= \frac{g}{\left(1 + \frac{h}{R}\right)^2}$$

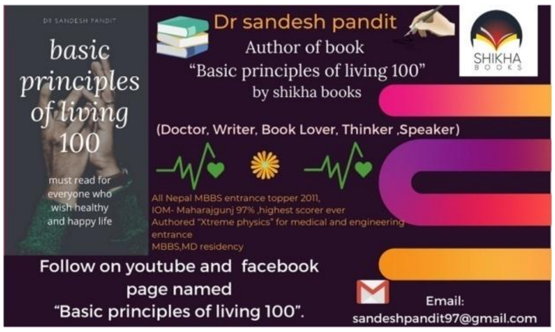
$$= \frac{g}{\left(1 + \frac{1}{2}\right)^2} = \frac{4g}{9}$$

19. Ans (c)

$$T = 2\pi\sqrt{\frac{R^3}{GM}}$$

$$= 2\pi\sqrt{\frac{R^3}{gR^2}} = 2\pi\sqrt{\frac{R}{g}}$$

So, The time period of orbiting satellite is independent of its body of mass but it depends upon mass of planet only.



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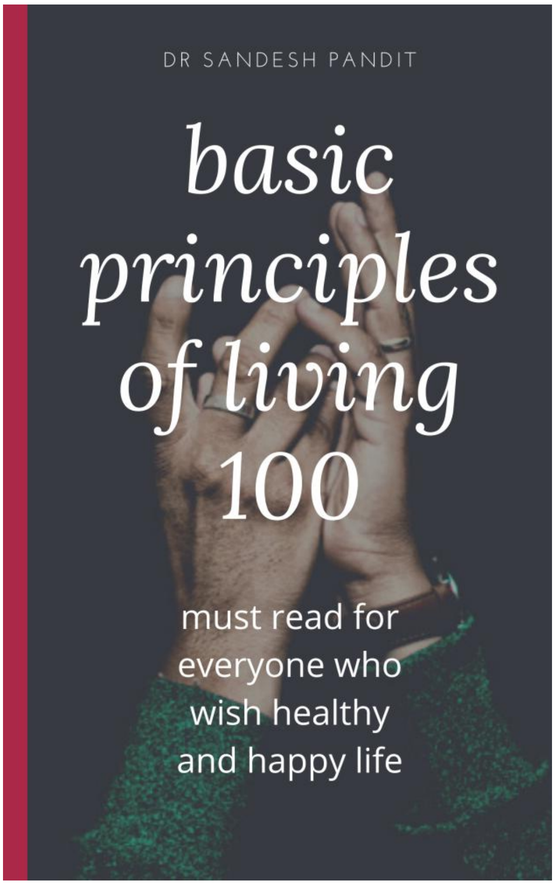


Chapter: 10

SIMPLE HARMONIC MOTION

1. The circular motion of a particle with constant speed is

a. periodic and simple harmonic
b. simple harmonic but not periodic
c. neither periodic nor simple harmonic
d. periodic but not simple harmonic

2. If a simple harmonic motion is represented by $\frac{d^2x}{dt^2} + \alpha x = 0$ its time period is

a. $\frac{2\pi}{\sqrt{\alpha}}$ b. $2\pi\alpha$
c. $2\pi\sqrt{\alpha}$ d. $\frac{2\pi}{\alpha}$

3. The differential equation of SHM is given by $\frac{d^2y}{dt^2} + 100y = 0$
The frequency of motion is

a. 1 b. 0
c. $\frac{10}{2\pi}$ d. $\frac{100}{2\pi}$

4. A simple harmonic motion has an amplitude A and period T. The time taken by it to travel from x= A to x = $\frac{A}{2}$ is

a. $\frac{T}{12}$ b. $\frac{T}{3}$
c. $\frac{T}{4}$ d. $\frac{T}{6}$

5. A particle starts S. H. M from the mean position. Its amplitude is A and Time period is T. At certain time its speed is half that of maximum speed. What is the displacement?

a. $\frac{\sqrt{3}}{2}A$ b. $\frac{\sqrt{2}}{3}A$
c. $\frac{2A}{\sqrt{3}}$ d. $\sqrt{2}A$

6. Time taken from mean position to reach a displacement equal to half the amplitude is

a. $\frac{T}{4}$ b. $\frac{T}{6}$
c. $\frac{T}{12}$ d. $\frac{T}{8}$

7. A particle is vibrating in a SHM with amplitude A. At what distance from equilibrium position is its energy half potential & half kinetic?

a. A b. $\frac{A}{\sqrt{2}}$
c. $\frac{\sqrt{3}A}{2}$ d. $\frac{\sqrt{3}A}{4}$

8. In SHM, y = 0.1 sin $\left(100\pi t + \frac{\pi}{4}\right)$m the maximum velocity is given by:

a. 0.1m/s b. 100πm/s
c. 10πm/s d. 10πm/s

9. What is the length of second's pendulum on earth?

a. 9.93cm b. 99.3cm
c. $\left(\frac{9.93}{6}\right)$ cm d. 993cm

10. For second's pendulum, the numerical value of the ratio of maximum velocity to maximum acceleration is

a. 1 b. less than one
c. greater than one d. zero

11. A S.H.M motion has frequency f. Then frequency of kinetic energy is

a. f b. 2f
c. $\frac{f}{2}$ d. zero

12. A S.H.M has a frequency f, the frequency of total energy is

a. f b. 2f
c. $\frac{f}{2}$ d. zero

13. Two simple harmonic motion are represented by the following equations

$y_1 = 10\sin\frac{\pi}{4}(12t - 1)$

$y_2 = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$

The ratio of their amplitudes is

a. 1: 1 b. 1: 2
c. 2: 1 d. $\sqrt{3}$: 1

14. When amplitude of a particle executing SHM increases, the time period

a. increases
b. decreases
c. remains unchanged
d. sometimes increases, sometimes decreases

15. The time period of simple pendulum is doubled when

a. its length is doubled
b. mass of the bob is doubled
c. the length is made four times
d. the mass of the bob and the length of the pendulum are doubled.

16. A pendulum clock giving correct time at earth is taken to the moon. Then it

a. becomes fast
b. become slow
c. remains unaffected
d. stops

17. A watch based on oscillating spring gives correct time on earth. If it is taken to the moon. it

a. becomes fast
b. becomes slow
c. remains unaffected
d. stops

18. The pendulum suspended from the ceiling of a train has time period T when the train is at rest. Now the train begins to accelerate uniformly, the time period of the pendulum will be

a. T b. more than T
c. less than T d. uncertain

19. In SHM, the acceleration of the particle is zero when its velocity is

a. zero b. maximum
c. $\frac{1}{2}$ maximum d. $\frac{1}{4}$ maximum

20. The time period of a simple pendulum in a stationary lift is T. Now the lift accelerates upward with an acceleration $\frac{g}{2}$, then its time period will be

a. T b. $\sqrt{\frac{2}{3}}$ T
c. $\sqrt{\frac{3}{2}}$ T d. infinite

21. The time period of a simple pendulum in a stationary lift T. When the lift falls freely, then its time period will be

a. T b. 2T
c. infinite d. zero

22. A girl is swimming on a swing in the sitting position. How will the time period be affected if she stands up?

a. period will be longer b. shorter
c. Remains unchanged d. uncertain

23. For a simple pendulum, the graph plotted between length '*l*' & time period 'T' is

a. straight line b. parabola
c. hyperbola d. none

24. The bob of a simple pendulum is in the form of hollow sphere filled with mercury. If a little mercury is drained off, the time period of the pendulum will be

a. will decrease
b. will increase
c. remains unchanged
d. none

25. A simple pendulum has a bob made of solid sphere of steel. If we replaced it with hollow sphere of same mass and material, the time period will.

a. increases b. decreases
c. remains same d. becomes infinite

26. A second's pendulum is placed inside a space laboratory around the earth at height 3R above earth's surface. The time period of the pendulum will be

a. zero b. $2\sqrt{3}$s
c. 4s d. infinite

27. The work done by a the string of simple pendulum during one complete oscillation is equal to

a. Total energy of the pendulum
b. kinetic energy of pendulum
c. potential energy of pendulum
d. zero

28. The value of g decreases by 0.1% on a mountain as compared to sea level. To record proper time by means of simple pendulum its length must be

a. increased by 0.1%
b. decreased by 0.1%
c. increased by 0.2%
d. decreased by 0.2%

29. A simple pendulum of length L has been set up inside a railway wagon sliding down a frictionless inclined plane of slope angle θ with horizontal. What will be the periods of oscillation as recorded by an observer inside the wagon?

a. $2\pi\sqrt{\frac{l}{g}}$ b. $2\pi\sqrt{\frac{l}{g\cos\theta}}$
c. $2\pi\sqrt{\frac{l}{g\sin\theta}}$ d. $2\pi\sqrt{\frac{l\cos\theta}{g}}$

30. A simple pendulum with a solid metal bob has period T. The metal bob is now immersed in a liquid one – tenth that of the bob. The liquid is non–viscous Now the period of same pendulum with its bob remaining all the time in the liquid will be

a. T b. $\frac{9}{10}$T
c. $\sqrt{\frac{10}{9}}$T d. $\sqrt{\frac{9}{10}}$T

31. A simple pendulum is undergoing S.H.M. The velocity of the bob in the mean position is Vo. If now the amplitude is doubled, keeping the length same, the velocity in the mean position will be

a. Vo b. $\frac{Vo}{2}$
c. 2Vo d. 4Vo

32. The time period of a simple pendulum of infinite length is:

a. ∞ b. 84.6min
c. 60min d. uncertain

33. The time period of a simple pendulum of having length equal to radius of earth is

a. ∞ b. 84.6min
c. 60min d. uncertain

34. Two simple pendula of lengths 1m and 1.44m respectively are both given small displacements in the same direction at the same instant. They will again be in same phase after the shorter pendulum has completed 'n' oscillation where n is

a. 3 b. 4
c. 5 d. 6

35. The length of second pendulum on the surface of earth is 1m. The length of same pendulum on the surface of moon where g is $\frac{1th}{6}$ of its value on surface of earth is

a. 36m b. 1m
c. $\frac{1}{6}$ m d. $\frac{1}{36}$ m

36. The temperature of the material of the string of a simple pendulum is increased by 100°c. If $\alpha = 2 \times 10^{-5}\ k^{-1}$ then find the change in its time period per day.

a. losses 86.4 seconds
b. gains 86.4s
c. losses 172.8s
d. losses 172.8s

37. The time period of mass string system having mass 2.5kg and spring of force constant 10N/m is

a. π seconds b. 2π seconds
c. 4π seconds d. 8π seconds

38. M kg weight suspended from a mass less string has a time period T. If 4m kg weight is suspended from same spring, the new time period will be

a. T b. 2T
c. $\frac{T}{2}$ d. 4T

39. A light spiral spring supporting a 1kg weight at its longer end is oscillating. How much weight must be added the lower end to reduce the frequency to half?

a. 1kg b. 2kg
c. 3kg d. 4kg

40. Two identical spring of force constant K each are connected (a) in series and (b) in parallel and supports a mass m. The ratio of the period vertical oscillations of the series arrangement to that of parallel arrangement is:

a. 1: 1 b. 1: 2
c. 1: 4 d. 2: 1

41. A mass M is suspended from a spring has Time period T. Now the spring is divided in to 'n' equal parts. & the same mass is suspended from one part. The new time period will be

a. T b. $\frac{T}{n}$
c. $\frac{T}{\sqrt{n}}$ d. nT

42. A ball of mass 5kg hangs from a spring and oscillates with a time period of 2π seconds. If the ball is removed spring shortens by

a. g metre b. 2π m
c. $\frac{k}{g}$ d. $\frac{g}{k}$

43. A loaded vertical spring executes S.H.M with a period of 4 seconds. The difference between the kinetic energy and potential energy oscillates with a period of

a. 1s b. 2s
c. 4s d. 8s

44. A simple harmonic oscillator has acceleration $2m/s^2$ when its displacement from mean position is 0.02m. The angular frequency of the oscillator is

a. 0.2 rad/s b. 1 rad/s
c. 19 rad/s d. 100 rad/s

45. A block of mass M rests on platform. The platform is allowed to execute S.H.M of amplitude A. What can be the minimum frequency of the platform so that block never leaves the platform?

a. $\sqrt{\frac{g}{A}}$ b. $\frac{1}{2\pi}\sqrt{\frac{g}{A}}$
c. $\frac{1}{2\pi}\frac{g}{A}$ d. $2\pi\sqrt{\frac{A}{g}}$

46. The maximum velocity of a particle executing S.H.M is 16cm/sec and its amplitude is 4cm. Then the maximum acceleration is

a. $16\ cm/s^2$ b. $32\ cm/s^2$
c. $48\ cm/s^2$ d. $64\ cm/s^2$

47. A body executing S.H.M has maximum velocity 1.2m/s and maximum acceleration $9m/s^2$. Then amplitude of the oscillation is

a. 9 cm b. 6 cm
c. 16 cm d. 18 cm

48. The maximum velocity and maximum acceleration of a particle exeulting SHM are 4m/s & $2m/s^2$. Then time period of oscillation will be

a. $\frac{\pi}{2}$ sec b. 2π sec
c. $\frac{2}{\pi}$ sec d. 4π sec

49. A particle executes S.H.M between x = – A and x = +A where A is amplitude. The time taken for it to go from 0 to $\frac{A}{2}$ is T_1 and to from $\frac{A}{2}$ to A is T_2. Then

a. $T_2 = 2T_1$ b. $T_1 > T_2$
c. $T_1 = T_2$ d. $T_1 = 2T_2$

50. A particle is executing S.H.M with time period 10sec. and amplitude 9cm. What would be the velocity of the particle 2.5 sec after it passes through mean position?

a. $\frac{\pi}{10}$ b. $\frac{18}{10\pi}$
c. $\frac{9}{10\pi}$ d. zero

51. When a particle executing SHM is just midway from mean position to extreme position, the ratio of its K∈ to P∈ is

a. 1: 1 b. 2: 1
c. $\sqrt{2} : 1$ d. 3: 1

52. A pendulum is raised to an angle of 4° and released. It

a. undergoes SHM with initial phase 4°
b. undergoes SHM with initial phase 0°
c. undergoes SHM with initial phase 90°
d. does not undergoes SHM

53. A body is dipped into the hole drilled through centre of earth. Then time taken by the body to move from one end of hole through $\frac{R}{2}$ is

a. 7 min b. 12 min
c. 21 min d. 14 min

54. A spring force constant k is into two pieces in the ratio 1: 2. What is the spring constant of the longer piece?

a. k b. $\frac{k}{3}$
c. $\frac{2k}{3}$ d. $\frac{3k}{2}$

55. The time period of two individually oscillating springs are 3 seconds and x second. If they are joined in series the resulting time period is 5 seconds. If they are joined in parallel, the resulting time period is y second find x & y.

a. 4, 2.4 b. 4, 5.6
c. 2, 4.4 d. 6, 8.2

56. A body is executing S.H.M. When its displacement from the mean position are 4cm and 5cm it has velocity 10cm s^{-1} and 8cm s^{-1} respectively. Its time period is

a. πs b. $\frac{3\pi}{2}S$
c. $2\pi S$ d. $\frac{\pi}{2}S$

57. A block of mass M is suspended from a light spring of force constant k. Another mass m moving upward with velocity v hits the mass M and gets embedded in it. What will be amplitude of the combined mass?

a. $\frac{mv}{\sqrt{(M+m)k}}$ b. $\frac{Mv}{\sqrt{(M+m)k}}$
c. $\frac{mv}{\sqrt{(M-m)k}}$ d. $\frac{Mv}{\sqrt{(M-m)k}}$

Answer Sheet

1. d	*2. a*	*3. c*	*4. d*	*5. a*	*6. c*	*7. b*	*8. c*	*9. b*	*10. b*
11. b	*12. d*	*13. a*	*14. c*	*15. c*	*16. b*	*17. c*	*18. c*	*19. b*	*20. b*
21. c	*22. b*	*23. b*	*24. b*	*25. a*	*26. d*	*27. d*	*28. b*	*29. b*	*30. c*
31. c	*32. b*	*33. c*	*34. d*	*35. c*	*36. a*	*37. a*	*38. b*	*39. c*	*40. c*
41. c	*42. a*	*43. b*	*44. c*	*45. b*	*46. d*	*47. c*	*48. d*	*49. a*	*50. d*
51. d	*52. c*	*53. d*	*54. d*	*55. a*	*56. a*	*57. a*			

SOLUTION

1. Ans. (d)

The circular motion of a particle with constant speed is periodic but not simple harmonic motion as it is not to and fro about a fixed point.

2. Ans. (a)

$\frac{d^2x}{dt^2} = \alpha x = -\omega^2 x$

$\Rightarrow \omega = \sqrt{\alpha}$, $T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\alpha}}$

3. Ans. (c)

$\frac{d^2y}{dt^2} + \omega^2 y = 0$ (eq^n of SHM)

$\omega^2 = 100 \Rightarrow \omega = 10$

$\omega = 2\pi f$

$f = \frac{\omega}{2\pi} = \frac{10}{2\pi}$

4. Ans. (d)

y = A cosωt (for displacement from extreme position)

$\frac{A}{2} = A \cos \frac{2\pi}{T} t$

$\cos \frac{2\pi}{T} t = \frac{1}{2} = \cos \frac{\pi}{3}$

$t = \frac{T}{6}$

5. Ans. (a)

$v = \omega \sqrt{A^2 - y^2}$, $V_{max} = A\omega$

$\frac{\omega A}{2} = \omega \sqrt{A^2 - y^2}$

$A^2 - y^2 = \frac{A^2}{4}$

$y^2 = \frac{3A^2}{4} \Rightarrow y = \frac{\sqrt{3}}{2} A$

6. Ans. (c)

y = a sinωt

$\frac{a}{2} = a \sin \frac{2\pi}{T} t$

$\sin \frac{2\pi}{T} t = \frac{1}{2} = \frac{\pi}{6}$ $t = \frac{T}{12}$

7. Ans. (b)

$P\varepsilon = K\varepsilon$ at displacement y

$\frac{1}{2} m\omega^2 y^2 = \frac{1}{2} m\omega^2 (A^2 - y^2)$

$2y^2 = A^2 \Rightarrow y = \frac{A}{\sqrt{2}}$

8. Ans. (c)

Amplitude A = 0.1m, ω = 100π

V max = Aω = 10πm/s.

9. Ans. (b)

Second's pendulum has T = 2s

$T = 2\pi\sqrt{\frac{l}{g}}$ $\Rightarrow 2 = 2\pi\sqrt{\frac{l}{9.8}}$

l = 99.3cm

10. Ans. (b)

$V_{max} = A\omega$, a max $= \omega^2 A$

$\frac{V_{max}}{a_{max}} = \frac{\omega A}{\omega^2 A} = \frac{1}{\omega} = \frac{T}{2\pi}$

For second pendulum, T = 2s

$\frac{V_{max}}{a_{max}} = \frac{2}{2\pi} = \frac{1}{\pi} < 1$

11. Ans. (b)

K.E vary from zero to maximum twice in each vibration.

12. Ans. (d)

Total energy is constant so its frequency is zero.

13. Ans. (a)

For oscillation y_2, $\Delta\phi = \frac{\pi}{2}$

$a_2 = \sqrt{5^2 + (5\sqrt{3})^2} = 10$

$\frac{a_1}{a_2} = \frac{10}{10} = 1 : 1$

14. Ans. (c)

Time period is independent of the amplitude of the particle

15. Ans. (c)

$T = 2\pi\sqrt{\frac{l}{g}}$

$T \alpha \sqrt{l}$ and independent of mass and shape of the bob.

16. Ans. (b)

$T = 2\pi\sqrt{\frac{l}{g}} \alpha \frac{1}{\sqrt{g}}$

$\frac{T\ moon}{T\ earth} = \sqrt{\frac{g\ earth}{g\ moon}} = \sqrt{6}$

T moon = $\sqrt{6}$ T earth (become slow)

17. Ans. (c)

$T = 2\pi\sqrt{\frac{m}{k}}$ independent of g.

18. Ans. (c)

In case of accelerating train

$g_{eff} = \sqrt{g^2 + a^2}$

$T^1 = 2\pi\sqrt{\frac{l}{g^1}} = 2\pi\sqrt{\frac{l}{(a^2 + g^2)^{\frac{1}{2}}}}$

19. Ans. (b)

Acceleration is zero at mean position,

y = 0

$V = \omega\sqrt{A^2 - 0^2} = A\omega$ (max).

20. Ans. (b)

$g_{eff} = g + \frac{g}{2} = \frac{3}{2g}$

$T^1 = 2\pi\sqrt{\frac{l}{3g/2}} = \sqrt{\frac{2}{3}}\,T$

21. Ans. (c)

Effective acceleration

$g^1 = g - g = o$

So, time period will be infinite.

22. Ans. (c)

$T \alpha \sqrt{l}$

When she stands, C.g. is raised, the effective length is decreased & hence time is shorter.

23. Ans. (b)

$T = 2\pi\sqrt{\frac{l}{g}}$

$l = \left(\frac{g}{4\pi^2}\right)T^2;\ y = ax^2$

in the form of parabola.

24. Ans. (b)

On draining off a little mercury, C.g. gets lowered so the effective length increases.

25. Ans. (a)

When a solid sphere is replaced by hollow sphere of same mass, the size of the hollow sphere should be bigger i.e. effective length increases & hence time period.

26. Ans. (d)

Inside space laboratory

$g^1 = o$

T = infinite

27. Ans. (d)

work change = change in energy = zero

28. Ans. (b)

$T = 2\pi\sqrt{\frac{l}{g}}$

g↓ by 0.1% To record

equal time length should be decreased by 0.1% so that $\left(\frac{g}{l}\right)$ = constant

29. Ans. (b)

The component of g perpendicular to inclined plane is g cosθ

So, $T = 2\pi\sqrt{\frac{l}{g'}} = 2\pi\sqrt{\frac{l}{g\cos\theta}}$

30. Ans. (c)

Effective weight in a liquid

$= mg^1 = mg -$ upthrust

$\rho v^1 g = \rho vg - \left(\frac{\rho}{10}\right)vg$

$g^1 = \frac{9}{10}g$

$\frac{T^1}{T} = \sqrt{\frac{g}{g^1}} = \sqrt{\frac{10}{9}}$

31. Ans. (c)

V max = $A\omega \propto A$

So velocity at mean position gets doubled

32. Ans. (b)

$$T = 2\pi\sqrt{\frac{R}{g\left(1+\frac{R}{l}\right)}}$$

$$l \to \infty \ T = 2\pi\sqrt{\frac{R}{g}} = 84.6\text{min} = 1.4\text{hrs.}$$

33. Ans. (c)

For length comparable to Radius above formula is used

$$T = 2\pi\sqrt{\frac{R}{\sqrt{2}g}} = \frac{84}{\sqrt{2}} = 1\text{hr.}$$

34. Ans. (d)

For being same phase the must be minimum difference of 1 oscillation. If shorter pendulum completes n oscillations, longer must complete (n – 1) oscillation.

$$\frac{n}{n-1} = \sqrt{\frac{L^1}{L}} = \sqrt{\frac{1.44}{1}} = 1.2$$

$\Rightarrow$ n = 6

35. Ans. (c)

Time period is constant for second's pendulum i.e. 2s.

$$\frac{l \text{ moon}}{g \text{ moon}} = \frac{l \text{ earth}}{g \text{ earth}}$$

$$l \text{ moon} = \frac{g \text{ moon}}{g \text{ earth}} \times l \text{ earth} = \frac{1}{6} \text{ m}$$

36. Ans. (a)

$$\frac{\Delta T}{T} = \frac{\Delta L}{2L} = \frac{1}{2}(\alpha\, \Delta\, \theta)$$

$$= \frac{1}{2} \times 2 \times 10^{-5} \times 100 = 10^{-3}$$

$$\Delta T = 10^{-3} \times 86400\text{s} = 86.4\text{s}$$

As temperature ↑ length ↑

Hence, time period (T) is increase.

37. Ans. (a)

$$T = 2\pi\sqrt{\frac{m}{k}} = 2\pi\sqrt{\frac{2.5}{10}} = \pi\text{s.}$$

38. Ans. (b)

$T \propto \sqrt{M}$

$$\frac{T^1}{T} = \sqrt{\frac{4M}{M}} = 2$$

$T^1 = 2T$

39. Ans. (c)

$$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \Rightarrow f \propto \frac{1}{\sqrt{m}}$$

$$\frac{m^1}{m} = \left(\frac{f}{f^1}\right)^2 = 4$$

$m^1 = 4\text{kg}$

weight added = 4 – 1 = 3kg

40. Ans. (c)

In series, $Ks = \frac{K \times K}{K + K} = \frac{K}{2}$

In parallel kp = k + k = 2k

$$\frac{Ts}{Tp} = \sqrt{\frac{kp}{ks}} = 2:1$$

41. Ans. (c)

Force constant $K = \frac{F}{e} = \frac{YA}{l}$

$K \propto \frac{1}{l}$, After dividing

$k^1 = nK$

$$T^1 = \sqrt{\frac{k}{k^1}} \times T = \frac{T}{\sqrt{n}}$$

42. Ans. (a) g metre

$$T = 2\pi\sqrt{\frac{m}{k}} \quad \Rightarrow 2\pi = 2\pi\sqrt{\frac{m}{k}}$$

$$\Rightarrow k = m \Rightarrow e = \frac{F}{k} = \frac{mg}{m} = g$$

43. Ans. (b)

Frequency of K.E or P.E is twice the frequency of oscillation.

So time period for K.E or P.E

(their differences) $= \frac{T}{2} = \frac{4}{2} = 2\text{s}$

45. Ans. (c)

$a = \omega^2 y$

$$\omega = \sqrt{\frac{a}{y}} = \sqrt{\frac{2}{0.02}} = 10 \text{ rad/s}$$

46. Ans. (b)

For downward motion of platform

$Mg - R = Ma \Rightarrow R = Mg - Ma$ for avoiding loss of contact, $R \geq 0$

$Mg - Ma \geq 0 \Rightarrow a \leq g$

$a\,max = g \Rightarrow \omega^2 A = g$

$\omega = \sqrt{\frac{g}{A}}$

$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{g}{A}}$

46. Ans. (d)

$a\,max = \omega^2 A = \frac{\omega^2 A^2}{A}$

$= \frac{V\,max^2}{A} = \frac{16^2}{4} = 64\ cm/s^2$

47. Ans. (c)

$A = \frac{V\,max^2}{A\,max} = \frac{1.2^2}{9} = 0.16m = 16cm$

48. Ans. (d)

$a\,max = \omega^2 r$ and $V\,max = \omega r$

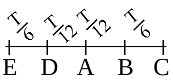
$a\,max = \omega V\,max$

$T = \frac{2\pi}{\omega} = \frac{2\pi\ V\,max}{a\,max} = \frac{2\pi \times 4}{2} = 2\pi sec$

49. Ans. (a)

$T_1 = \frac{T}{12}$, and $T_2 = \frac{T}{6}$

$\Rightarrow T_2 = 2T_1$



$y = -A,\ y = \frac{-A}{2},\ y = 0,\ y = \frac{A}{2},\ y = A$

50. Ans. (d)

$T = 10$ sec $\qquad t = 2.5s = \frac{T}{4}$

51. Ans. (d)

$\frac{K.\in}{P.\in} = \frac{\frac{1}{2}m\omega^2(A^2 - y^2)}{\frac{1}{2}m\omega^2 y^2}$

$= \frac{A^2 - \left(\frac{A}{2}\right)^2}{\left(\frac{A}{2}\right)^2} = \frac{3A^2}{4} : \frac{A^2}{4} = 3: 1$

52. Ans. (c)

When SHM starts from extreme position its initial phase is 90°.

53. Ans. (d)

$T = 2\pi\sqrt{\frac{R}{g}} = 84.6$ min

Time taken to move $\frac{R}{2}$ from extreme position $= \frac{T}{6} = \frac{84.6}{6} = 14.1$ min

54. Ans. (d)

Let K_1 be the spring constant of smaller piece. Then longer piece is combination of two smaller pieces in series

$\frac{1}{k_2} = \frac{1}{k_1} + \frac{1}{k_1} \Rightarrow k_2 = \frac{k_1}{2}$

$\frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_2} = \frac{1}{k_1} + \frac{2}{k_1} = \frac{3}{k_1}$

$k_1 = 3k$

$k_2 = \frac{k_1}{2} = \frac{3k}{2}$

55. Ans. (a)

$Ts^2 = T_1^2 + T_2^2 = 3^2 + x^2$

$5^2 = 3^2 + x^2 \Rightarrow x = 4$

Now, $Ts\,Tp = T_1 T_2 = 3 \times 4$

or, $5 \times y = 3 \times 4$

$\therefore\ y = 2.4$

56. Ans. (a)

$V = \omega\sqrt{r^2 - y^2}$

$10 = \omega\sqrt{r^2 - 4^2}$ – (i) $8 = \omega\sqrt{r^2 - y^2}$ – (ii)

Squaring & subtracting

$100 - 64 = \omega^2(r^2 - 16) - \omega^2(r^2 - 25)$

$36 = 9\omega^2 \quad \Rightarrow \omega = 2 \Rightarrow \frac{2\pi}{T} = 2$

$\Rightarrow T = \pi s$

57. Ans. (a)

$mv + M \times o = (M + m)\,v^1$

$v^1 = \frac{mv}{M + m} = r\omega$

$r\sqrt{\frac{k}{M + m}} = \frac{mv}{M + m}$

$r = \frac{mv}{\sqrt{(M + m)k}}$

Past Questions

1. **The pendulum stops due to [IOM 2011]**
   a. Gravity b. Lack of energy
   c. Air friction d. Its mass

2. **The pendulum of clock made of brass $\alpha = 1.9 \times 10^{-5}$ °C^{-1} keeps correct time at 20°C, how many seconds per day will it lose at 35°C? [IOM 2010]**
   a. 12.3s b. 36.9s
   c. 24.6s d. 49.2s

3. **A simple pendulum with a bob mass m swing with an angular amplitude of 40°. When its angular displacement is 20°. The tension in string is [IOM 2008]**
   a. mg cos20° b. > mg cos40°
   c. < mg cos20° d. mg cos40°

4. **If the displacement of a body in simple harmonic motion is represented y = r sinωt, in as usual motion its maximum acceleration is [MOE curriculum]**
   a. rω b. – rω
   c. $-\omega^2 r$ d. $\omega^2 r$

5. **The kinetic energy & potential energies of a particle executing simple harmonic motion with Amplitude A will be equal when its displacement is [MOE 2010]**
   a. $A\sqrt{2}$ b. $\frac{A}{2}$
   c. $\frac{A}{\sqrt{2}}$ d. $\frac{\sqrt{2}A}{3}$

6. **The kinetic energy of a particle executing simple Harmonic motion is maximum when its displacement is equal to [MOE 066]**
   a. Amplitude b. $\frac{\text{Amplitude}}{4}$
   c. $\frac{\text{Amplitude}}{2}$ d. zero

7. **Two simple harmonic motion are given by x_1 = a sinωt & x_2 = b cosωt. The phase difference between them in radian is [MOE 2009]**
   a. π b. $\frac{\pi}{2}$
   c. $\frac{\pi}{4}$ d. zero

8. **The time period of a simple pendulum inside a satellite orbiting the earth is [MOE 2063]**
   a. infinity b. zero
   c. 1s d. 9.8s

9. **A hole is drilled through the centre of the earth and a stone is dropped into it. When the stone reaches the centre of the earth its [MOE 2062]**
   a. mass will be zero
   b. velocity will be zero
   c. K.∈. will be zero
   d. acceleration will be zero

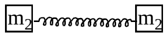
10. **A hole is bored in the earth along its diameter. When a ball is dropped from one end then [MOE 2061]**
    a. it remain stationary
    b. it mores & stops at the centre
    c. it exhibits SHM
    d. it comes out from other end.

11. **Two bodies M and N of equal masses are suspended from two separate massless springs of spring constants k_1 & k_2 respectively. It the two bodies oscillate vertically such that their maximum velocities are equal, the ratio of amplitude of vibration of M to that of N is [BPKIHS]**

a. $\frac{k_1}{k_2}$ b. $\sqrt{\frac{k_1}{k_2}}$

c. $\frac{k_2}{k_1}$ d. $\sqrt{\frac{k_2}{k_1}}$

12. Two blocks of masses m_1 = kg and m_2 = 8kg are connected by a string of force constant k = 1000kg/m. If the blocks are caused to oscillate, the frequency of motion is (g = 10m/s^2). [BPKIHS]



a. $\frac{25\sqrt{2}}{\pi}$ b. $\frac{25}{2\pi}$

c. $\frac{25}{\pi\sqrt{2}}$ d. $\frac{2\pi}{25}$

13. The bob of a simple pendulum of length L is released at time t = o from a position of small angular displacement at time t is given by: [BPKIHS]

a. $X = a \sin 2\pi \sqrt{\frac{L}{g}} \times t$

b. $X = a \cos 2\pi \sqrt{\frac{g}{L}} \times t$

c. $X = a \sin \sqrt{\frac{g}{L}} \times t$

d. $X = a \cos \sqrt{\frac{g}{L}} \times t$

14. Maximum speed of a participate in SHM is Vmax. The average speed of a particle in SHM is equal to [BPKIHS –09]

a. $\frac{V\ max}{2}$ b. $\frac{V\ max}{\pi}$

c. $\frac{\pi V\ max}{2}$ d. $\frac{2\ V\ max}{\pi}$

15. The motion of a particle executing SHM is given by x = 0.1 sin 100 π (t + 0.005) where x is in metre and t in seconds. The time period of the motion in second is [BPKIHS – 96]

a. 0.01 b. 0.02

c. 0.1 d. 0.2

16. A 3kg block loaded on the string execute SHM as x = 2 cosx 50t where x in metre and t in sec. Its spring constant is [IE – 2006]

a. 1N/m b. 2700N/m

c. 7500N/m d. 3400N/m

17. The length of a simple pendulum is increased by 44%. What is the percentage increase in its period? (I.E)

a. 44% b. 20%

c. 10% d. 5%

18. A tunnel is dug through the centre of earth & ball is released in it. The time taken to reach the centre is [IOM]

a. 84 min b. 42 min

c. 21 min d. infinite

19. The graph ploted between acceleration and displacement in SHM will be a [BPKIHS 2011]

a. Straight line b. Hyperbolic

c. Parabolic d. Eclipse

20. The length of simple pendulum is given as 'l', then value of g will be [IE 2012]

a. $\frac{2\pi^2 l}{T^2}$ b. $\frac{4\pi^2 l}{T}$

c. $\frac{2\pi^2 l^2}{T^2}$ d. $4\pi^2 lT$

21. In a body executing stim, in the mean position [IE 2012]

a. No force acts on body

b. velocity becomes maximum

c. Both (a) & (b)

d. None

22. At one end of a non stretehable string of length 'l' is fixed at ceiling and at another end mass 'm' is suspended, when it is disturbed makes 60° with a equilibrium position then its potential. Energy at extreme point is: [IE 2008]

a. mgl b. $\frac{mgl}{2}$

c. $\frac{mgl}{4}$ d. $\frac{mgl}{3}$

23. If a spring of force constant K is cut into 3 parts then force constant of each part is [BPKIHS 2012]

a. k b. 3k

c. $\frac{k}{3}$ d. 9k

Answer Sheet

1. c	*2. a*	*3. b*	*4. d*	*5. c*	*6. d*	*7. b*	*8. a*	*9. d*	*10. c*	*11. d*	*12. b*
13. d	*14. d*	*15. b*	*16. c*	*17. b*	*18. c*	*19. a*	*20. a*	*21. c*	*22. b*	*23. b*	

SOLUTION

1. Ans. (c)
   Pendulum stops due to damping action of friction.
2. Ans. (a)
   $\Delta T = \frac{1}{2} \times \alpha\, \Delta\theta\, T$
   $= \frac{1}{2} \times 1.9 \times 10^{-5} \times 15 \times 86400 = 12.3s$
3. Ans. (b)
   $T - mg\cos\theta = \frac{mv^2}{l}$
   $T = mg\cos\theta + \frac{mv^2}{l}$
   At angular displacement $\theta = 20°$
   $T > mg\cos 20°$ (since $v \neq o$)
4. Ans. (d)
   $y = r\sin\omega t$
   $v = r\omega\cos\omega t$
   $a = -\omega^2 y$
   The negative sign only represents direction, so answer is $\omega^2 r$.
5. Ans. (c) K.E = P.E
   $\frac{1}{2} m\omega^2(A^2 - y^2) = \frac{1}{2} m\omega^2 y^2$
   $A^2 - y^2 = y^2$
   $2y^2 = A^2$
   $\Rightarrow$ $y = \frac{A}{\sqrt{2}}$
6. Ans. (d)
   $K\in = \frac{1}{2} m\omega^2 (r^2 - y^2)$ will be maximum at mean position i.e. at $y = o$ which is $\frac{1}{2} m\omega^2 r^2$
7. Ans. (b)
   $x_1 = a\sin\omega t$ –(i)
   $x_2 = b\cos\omega t$ –(ii)
   $x_2 = b\left(\sin\omega t + \frac{\pi}{2}\right)$ From (i) & (ii)
   Phase difference $(\phi) = \frac{\pi}{2}$
8. Ans. (a)
   Time period $(T) = 2\pi\sqrt{\frac{l}{g}}$
   For a satellite orbiting the earth value of
   $g = o$, $T = \infty$
9. Ans. (d)
   When a hole is drilled through centre of the earth and a stone is dropped into it.
   The stone exhibits SHM.
   Acceleration is max at extreme positions minimum at mean position.
10. Ans. (c)
    It exhibits SHM.
    Velocity is max at the centre and minimum at extreme positions
11. Ans. (d)
    $V\max = A\omega \Rightarrow A_1\omega_1 = A_2\omega_2$
    $\frac{A_1}{A_2} = \frac{\omega_1}{\omega_2} = \frac{\sqrt{k_2/m}}{\sqrt{k_1/m}} = \sqrt{\frac{k_2}{k_1}}$
12. Ans. (b)
    Reduced mass
    $\mu = \frac{m_1 m_2}{m_1 + m_2} = \frac{2 \times 8}{2 + 8} = 1.6kg$
    $f = \frac{1}{2\pi}\sqrt{\frac{\kappa}{\mu}}$
    $= \frac{1}{2\pi}\sqrt{\frac{1000}{1.6}}$
    $= \frac{1}{2\pi} \times \frac{100}{4} = \frac{25}{2\pi}$
13. Ans. (d)

$T = 2\pi\sqrt{\frac{L}{g}}$

$\omega = \frac{2\pi}{T} = \sqrt{\frac{g}{L}}$

X = a cosωt (Given, from small angular displacement)

$= a\cos\sqrt{\frac{g}{L}}\,t$

14. Ans. (d)

V max = aω

$V = \frac{\text{distance travelled in one oscillation}}{\text{Time period}}$

$= \frac{4a}{T} = \frac{4a}{2\pi} \times \omega$

$= \frac{2a\omega}{\pi} = \frac{2V\,max}{\pi}$

15. Ans. (b)

x = 0.01 sin 100 π (t + 0.005) – (i)

y = a sin (ωt + kx) – (ii)

comparing, we get

i.e.$\omega = 100\pi = \frac{2\pi}{T}$

T = 0.02 sec

16. Ans. (c)

$\omega = \sqrt{\frac{K}{m}}$

x = 2 cos 50t – (i)

x = a cosωt – (ii)

ω = 50 rad/s, m = 3

$k = \omega^2 m = 50^3 \times 3 = 7500$N/m

17. Ans. (b)

$T = 2\pi\sqrt{\frac{L}{g}} \Rightarrow T \propto \sqrt{L}$

$\frac{\Delta T}{T} \times 100\%$

$= \left[\left(1 + \frac{44}{100}\right)^{\frac{1}{2}} - 1\right]$

= (1.2 – 1) × 100% = 20%

18. Ans. (c)

The ball executes SHM with

T = 84 min.

Tine taken to reach centre

$= \frac{T}{4} = \frac{84}{4} = 21$min

19. Ans. (a)

$a = -\omega^2 y$ ie. a α –y Acceleration is directly propotional to displacement, hence straight line.

20. Ans. (a)

$T = 2\pi\sqrt{\frac{l}{g}}$

$T^2 = \frac{4\pi^2 l}{g}$

$g = \frac{4\pi^2 l}{T^2}$

21. Ans. (c)

At mean position, y = 0

$v = \omega\sqrt{r^2 - y^2}$

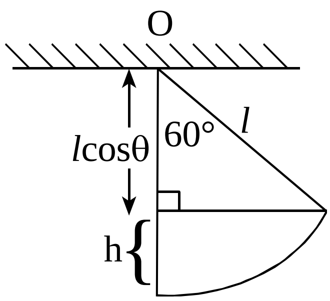
= ωr(max.)

a = 0

F = ma = 0

i.e, No force acts on bob.

22. Ans. (b)



PE = mg$l$(1 – cosθ)

= mg$l$(1 – cos60)

$= mgl(1 - \frac{1}{2})$

$= \frac{mgl}{2}$

Note:

PE = mgh

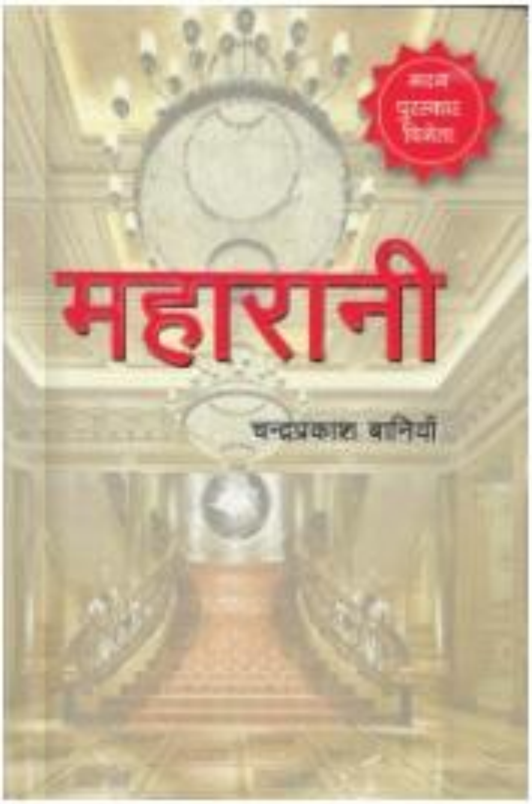
h = $l - l\cos\theta$

$= l(1 - \cos\theta)$

23. Ans. (b)

Force constant (k) $\alpha \frac{1}{\text{length}}$

If a spring of constant 'k' is cut into 'n' equal parts the spring constant of each part will be nk.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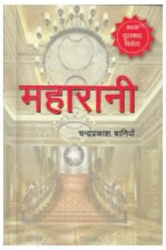
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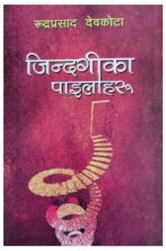
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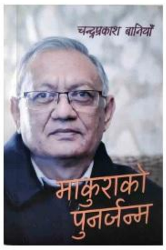
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Chapter: 11

ROTATIONAL MOTION

1. The centre of mass describes:
a. translatory motion
b. rotatory motion
c. vibratory motion
d. all above

2. A couple produces........ motion.
a. No motion
b. Purely linear
c. purely rotational
d. linear as well as rotational

3. Two particles A and B initially at rest move towards each other under a mutual force of attraction. At the instant when velocity of A is v and that of B is 2v. The velocity of centre of mass of the system is;
a. v b. 2v
c. 3v d. zero

4. Ice skaters use the principle of........ for spinning.
a. moment of inertia
b. angular momentum
c. force
d. radius of gyration

5. Two particles of mass 1kg and 3 kg move towards each other under their mutual force of attraction. No other forces acts on them. When the two particles is 2m/s, their centre of mass has a velocity of 0.5m/s. When their relative velocity becomes 3m/s the velocity of the centre of mass is;
a. 0.75 m/s b. 0.5 m/s
c. 2.5 m/s d. 0 m/s

6. Two identical trucks carry equal weights of iron and cotton. Whose tendency of over turning is more?
a. iron truck b. cotton truck
c. equal for both d. uncertain

7. A particle performs uniform circular motion with an angular momentum L. If the frequency of particle's motion is doubled and kinetic energy is halved. Its angular momentum becomes;
a. 2L b. $\frac{L}{2}$
c. $\frac{L}{4}$ d. 4L

8. The moment of inertia of a circular ring of mass M and radius R about its diameter is;
a. MR^2 b. $\frac{MR^2}{2}$
c. $\frac{2}{3}MR^2$ d. $\frac{3}{2}MR^2$

9. Moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an axis perpendicular to its plane and passing through a point on its rim will be;
a. 3I b. 4I
c. 5I d. 6I

10. The moment of inertia of a circular disc about one of its diameter is I. What will be its moment of inertia about a tangent parallel to its diameter?
a. 2I b. 3I
c. 4I d. 5I

11. The moment of inertia of a solid sphere of mass M and radius of R about its tangent is;
a. $\frac{2}{3}MR^2$ b. $\frac{2}{5}MR^2$
c. $\frac{5}{3}MR^2$ d. $\frac{7}{5}MR^2$

12. The moment of inertia of a spherical shell about a tangents;
a. $\frac{2}{3}MR^2$ b. $\frac{2}{5}MR^2$
c. $\frac{5}{3}MR^2$ d. $\frac{7}{5}MR^2$

13. The moment of inertia of thin rod of mass M and length L about an axis passing through one end and perpendicular to length is;

a. $\frac{ML^2}{12}$ b. $\frac{ML^2}{3}$

c. $\frac{ML^2}{4}$ d. ML^2

14. The moment of inertia of solid cylinder of length L, radius R about its geometrical axis is same as about equational axis, then the ratio of R and L will be;

a. $\frac{1}{\sqrt{3}}$ b. $\frac{1}{2}$

c. 3 d. $\sqrt{3}$

15. The moment of inertia of two spheres of equal masses about their respective diameter are the same. If one of them is solid and the other hollow. Then ratio of radii (solid to hollow) is;

a. $\sqrt{5} : \sqrt{3}$ b. $\sqrt{3} : \sqrt{5}$

c. 5 : 3 d. 3 : 5

16. The two circular discs of same mass and thickness are made from metal having densities d_1 & d_2 respectively. The ratio of their moments of inertia about the central axis perpendicular to the plane of the disc will be;

a. $d_1:d_2$ b. $d_2:d_1$

c. $d_1d_2:1$ d. $1:d_1d_2$

17. A particle of mass M and radius of gyration k is rotating with an angular acceleration α. The torque acting on it.

a. $mk^2\alpha$ b. $\frac{mk^2}{\alpha}$

c. $\frac{m\alpha}{k}$ d. $\frac{1}{4}m\alpha^2k^2$

18. If the mass of disc is M and its radius of gyration is R. Then its moment of inertia is;

a. $\frac{MR^2}{2}$ b. MR^2

c. $2MR^2$ d. $\frac{2}{5}MR^2$

19. A uniform metallic disc of moment of inertia I_o about its own axis is melted and uniform ring of equal radius is casted from it. Then M.I. of the ring about its diameter will be;

a. $2\ I_o$ b. I_o

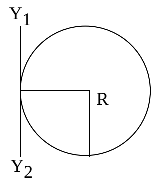
c. $\frac{I_o}{2}$ d. $\frac{I_o}{4}$

20. The moment of inertia of a hoop or ring of mass M & Radius R about axis Y_1Y_2 is:

a. MR^2 b. $\frac{MR^2}{2}$

c. $\frac{3}{2}MR^2$ d. $2MR^2$

21. The moment of inertia of a circular ring about an axis passing its centre and normal to the plane is 50g cm^2. Its moment of inertia about diameter is:



a. 50g cm^2 b. 25g cm^2

c. 100 g cm^2 d. 200 g cm^2

22. A circular disc is rotating with angular velocity ω. A man sitting at the edge walks towards the centre of the disc. The angular velocity ω.

a. decreases b. increases

c. doesn't change d. halved

23. A body is moving in a straight line parallel to X-axis at constant velocity. The angular momentum about origin:

a. increase

b. decrease

c. remains unchanged

d. Always zero

24. If I_1 is M.I. of a uniform thin rod about an axis perpendicular to length and through C.G and I_2 is MI of ring formed by bending the rod about is own axis then $I_1:I_2$

a. 1:1 b. π:4

c. 3:π^2 d. π^2:3

25. Two forces 20N each act tangentially on a wheel of Radius 4 cm at two diametrically opposite points and constitute a couple. The wheel makes 5 revolutions while the torque is kept constant. Work done by the couple is approximately.

a. 30J b. 25J
c. 50J d. 20J

26. A person standing on a rotating plat form with his arms outstretched suddenly lowers his arms. Then his angular speed:

a. increase
b. decrease
c. remains unchanged
d. becomes zero

27. Two bodies of moment of inertia I_1 & I_2 ($I_1 > I_2$) have equal angular momenta. If E_1 & E_2 are their kinetic energies of rotation, the:

a. $E_1 > E_2$ b. $E_1 = E_2$
c. $E_1 < E_2$ d. can't be said

28. The speed of solid sphere after rolling down an inclined plane of vertical height h from rest without sliding is:

a. $\sqrt{\frac{10gh}{7}}$ b. $\sqrt{\frac{4gh}{3}}$
c. $\sqrt{2gh}$ d. $\sqrt{\frac{6gh}{5}}$

29. A solid spherical ball rolls on a table. Ratio of rotational k ε to total k.ε is:

a. $\frac{2}{7}$ b. $\frac{5}{7}$
c. $\frac{1}{2}$ d. $\frac{7}{10}$

30. A body rolls down an inclined plane. If its kε of rotational motion is 40% of its translatory motion the body is:

a. ring b. cylinder
c. spherical shell d. solid sphere

31. A thin uniform circular ring is rolling down a inclined plane of inclination 30° without slipping. The linear acceleration along the inclined plane is:

a. $\frac{g}{2}$ b. $\frac{g}{3}$
c. $\frac{g}{4}$ d. $\frac{2g}{3}$

32. A wheel of mass 10 kg has a moment of inertia 160 kg m^2 about its own axis. The radius of gyration is:

a. 10m b. 4 m
c. 5m d. 6m

33. The radius of gyration of a solid disc of mass 1kg and radius 50cm about its axis through centre of mass and perpendicular to its face is:

a. 25cm b. $25\sqrt{2}$cm
c. 50cm d. $25\sqrt{6}$cm

34. A ring of radius r and mass m rotates about its axis passing through its centre and perpendicular to its plane with angular velocity ω. Its kinetic energy is:

a. $m\omega r^2$ b. $\frac{1}{4}mr^2\omega^2$
c. $mr^2\omega^2$ d. $\frac{1}{2}mr^2\omega^2$

35. A ring of radius r and mass m rolls without slipping on a smooth horizontal surface with velocity of centre of mass being v. Its kinetic energy is:

a. $\frac{1}{2}mv^2$ b. mv^2
c. $\frac{3}{2}mv^2$ d. $2mv^2$

36. A body of mass m slides down a smooth incline and reaches a bottom with a velocity V. If the same mass were in the form of ring which rolls down a rough incline of same inclination from same height, the velocity of ring at the bottom would have been:

a. v b. $\frac{v}{\sqrt{2}}$
c. $\sqrt{2}$v d. $\sqrt{\frac{2}{5}}V$

37. A hoop, a cylinder and a solid sphere are allowed to roll down without slipping on inclined plane from same height simultaneously. Then which of the will reach the bottom first:

a. Hoop

b. cylinder

c. solid sphere

d. All will reach simultaneously

38. A thin hollow cylinder opens at two ends. (i) slides without rotating (ii) rolls without slipping with same speed. The ratio of k.ε in two cases is:

a. 1:1 b. 2:1

c. 4:1 d. 1:2

39. The least coefficient of friction for an inclined plane of inclination a with the horizontal in order that a solid cylinder will roll down without slipping is:

a. $\frac{2}{3}\tan\alpha$ b. $\frac{1}{3}\tan\alpha$

c. $\frac{2}{5}\tan\alpha$ d. $\frac{4}{3}\tan\alpha$

40. A square plate of side L has mass M. What is its moment of inertia about an axis passing through the point of intersection of diagonals and perpendicular to its plane?

a. $\frac{ML^2}{12}$ b. $\frac{ML^2}{24}$

c. $\frac{ML^2}{3}$ d. $\frac{mL^2}{6}$

41. A rod of length *l* is hinged from one end is kept horizontal. It is allowed to fall. The velocity of other end of rod is:

a. $\sqrt{3gl}$ b. $\sqrt{2gl}$

c. $\sqrt{gl}$ d. None

42. A thin circular ring of mass M and Radius R is rotating about its axis with a constant angular speed ω. Two blocks each of mass m are attached gently to opposite ends of the diameter of the ring. The angular speed of the ring will be:

a. $\frac{2M\omega}{M+m}$ b. $\frac{(M-2m)\omega}{M+2m}$

c. $\frac{M\omega}{M+2m}$ d. $\frac{(M+2m)\omega}{M}$

43. A shell is fired from a gun with a muzzle velocity u m/s at angle θ with the horizontal. At the top of the trajectory, the shell explode, into two fragments P and Q of equal mass. If the speed of Fragment P immediately after explosion becomes zero, where does the fragment Q hit the ground from the point of projection?

a. $\frac{3u^2\sin2\theta}{2\ g}$ b. $\frac{u^2\sin2\theta}{g}$

c. $\frac{u^2\sin2\theta}{2g}$ d. $\frac{u^2\sin2\theta}{g}$

Answer Sheet

1. a	*2. c*	*3. d*	*4. b*	*5. b*	*6. b*	*7. c*	*8. b*	*9. d*	*10. d*
11. d	*12. c*	*13. b*	*14. a*	*15. a*	*16. b*	*17. a*	*18. b*	*19. b*	*20. c*
21. b	*22. b*	*23. c*	*24. d*	*25. c*	*26. a*	*27. c*	*28. a*	*29. a*	*30. d*
31. c	*32. b*	*33. b*	*34. d*	*35. b*	*36. b*	*37. c*	*38. d*	*39. b*	*40. d*
41. a	*42. c*	*43. a*							

SOLUTION

1. Ans. (a)

   Location of CM changes in translatory motion but remains unchanged in rotatory motion.

2. Ans. (c)

   Couple produces purely rotational motion.

3. Ans. (d)

   As the motion is due to internal force, the velocity of CM of the system remains constant. In the absence of external force $V_{C.M}$ = Constant.

4. Ans. (b)

5. Ans. (b)

   External force is zero and velocity of centre of mass is 0.5 m/s initially. so velocity of c.m remains 0.5 m/s always.

6. Ans. (b)

   The centre of gravity for cotton truck is higher. So tendency of overturning is more for cotton truck.

7. Ans. (c)

   $L = I\omega,\ I = \dfrac{L}{\omega}$

   $K.\varepsilon = \dfrac{L^2}{2I} = \dfrac{L^2}{2 \times \dfrac{L}{\omega}}$

   $E = \dfrac{1}{2} L\omega = \dfrac{1}{2} L \times 2\pi f = \pi f L$

   $L = \dfrac{E}{\pi f} \Rightarrow \dfrac{L_1}{L} = \dfrac{E_1}{E} \times \dfrac{f}{f_1} = \dfrac{1}{2} \times \dfrac{1}{2}$

   $= \dfrac{1}{4}\ \Psi\ L^1 = \dfrac{L}{4}$

8. Ans. (b)

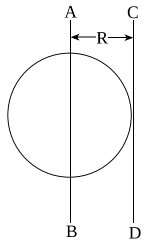
   Applying perpendicular law

   $I_x + I_y = I_z = I_0 = MR^2$

   $Id + Id = MR^2$

   $Id = \dfrac{MR^2}{2}$

9. Ans. (d)

   $IX = Iy + Iz$

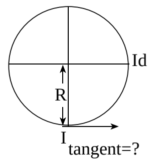
   $I_{AB} = Id + Id$

   $2I = \dfrac{MR^2}{2} \Rightarrow MR^2 = 4I$

   $I_{CD} = I_{AB} + MR^2$

   $= 2I + 4I = 6I$

10. Ans. (d)

    Moment of inertia of a disc about an axis passing through centre & $\perp$ to its plane

    $I_x = \dfrac{MR^2}{2} = I_y + I_z = Id + Id$

    $I_d = \dfrac{MR^2}{4} = I \Rightarrow MR^2 = 4I$

    M.I through tangent

    $= Id + MR^2$

    $= \dfrac{MR^2}{4} + MR^2 = \dfrac{5}{4} MR^2 = \dfrac{5}{4} \times 4I = 5I$

11. Ans. (d)

    Moment of inertia of solid sphere about diameter $Id = \dfrac{2}{5} MR^2$

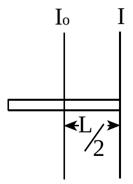
    About Tangent, $It = Id + MR^2 = \dfrac{7}{5} MR^2$

12. Ans. (c)

    M.I of hollow sphere about diameter $Id = \dfrac{2}{3} MR^2$

    $It = \dfrac{2}{3} MR^2 + MR^2 = \dfrac{5}{3} MR^2$

13. Ans. (b)

    $I = Io + Md^2$

    $= \dfrac{ML^2}{12} + M\left(\dfrac{L}{2}\right)^2$

    $= \dfrac{ML^2}{12} + \dfrac{ML^2}{4} = \dfrac{ML^2}{3}$

14. Ans. (a)

MI about geometrical = M.I about equatorial

$\frac{MR^2}{2} = M\left(\frac{R^2}{4} + \frac{L^2}{12}\right)$

$\frac{R^2}{2} = \frac{R^2}{4} + \frac{L^2}{12}$

$\frac{R^2}{4} = \frac{L^2}{12} \Rightarrow \frac{R}{L} = \frac{1}{\sqrt{3}}$

15. Ans. (a)

By question, $\frac{2}{5} MRs^2 = \frac{2}{3} MR_H^2$

$\frac{Rs}{RH} = \sqrt{5} : \sqrt{3}$

16. Ans. (b)

Since masses are equal,

$\pi R_1^2 x d_1 = \pi R_2^2 x d_2$

$\left(\frac{R_1}{R_2}\right)^2 = \frac{d_2}{d_1}$

$\frac{I_1}{I_2} = \left(\frac{R_1}{R_2}\right)^2 = \frac{d_2}{d_1}$

17. Ans. (a)

$\tau = I\alpha = mk^2\alpha.$

18. Ans. (b)

M.I = Mass × (Radius of gyration)^2

$= MK^2 = MR^2$

Don't confuse here between Radius of Gyration & Radius of body.

19. Ans. (b)

For disc, M.I about its own axis through C.G $I_o = \frac{MR^2}{2}$

MI of ring about its diameter $= \frac{MR^2}{2} = I_o$

20. Ans. (c)

M.I of hoop about diameter $= \frac{MR^2}{2}$

M.I about Y_1Y_2

$= \frac{MR^2}{2} + MR^2 = \frac{3}{2}MR^2$

21. Ans. (b)

About own axis $I_o = MR^2 = 50$

About diameter

$I = \frac{MR^2}{2} = \frac{I_o}{2} = 25 \text{ g cm}^2$

22. Ans. (b)

$I\omega$ = constant

$\omega \ \alpha \ \frac{1}{I} \ \alpha \ \frac{1}{r^2}$

As r decrease, ω increases

23. Ans. (c)

L = Mvr . r is constant v is given constant L remains constant

24. Ans. (d)

If L is length of rod and R is the radius of ring formed by bending Rod ($L = 2\pi R$)

$I_1 = \frac{ML^2}{12}$ & $I_2 = MR^2$

$\frac{I_1}{I_2} = \frac{L^2}{12R^2} = \frac{4\pi^2R^2}{12R^2} = \frac{\pi^2}{3}$

25. Ans. (c)

Torque = F×d=20×8cm =20 × 0.08 = 1.6 Nm

$\theta = 2\pi \times 5$ rad

$w = \tau\theta$

$= 1.6 \times 10\pi$

$= 16\pi \approx 50$ Nm

26. Ans. (a)

Moment of inertia (I) decrease in lowering arms.

$I\omega = \text{constant} \Rightarrow \omega \ \alpha \ \frac{1}{I}$

So, ω increases.

27. Ans. (c)

$I_1\omega_1 = I_2\omega_2 \Rightarrow \frac{\omega_1}{\omega_2} = \frac{I_2}{I_1}$

$\frac{E_1}{E_2} = \frac{\frac{1}{2}I_1\omega_1^2}{\frac{1}{2}I_2\omega_2^2} = \frac{I_1}{I_2} \times \left(\frac{I_2}{I_1}\right)^2 = \frac{I_2}{I_1}$

AS $I_1 > I_2$,

$\therefore E_1 < E_2$

28. Ans. (a)

$$v = \sqrt{\frac{2gh}{1+\frac{k^2}{R^2}}} = \sqrt{\frac{2gh}{1+\frac{2}{5}}} = \sqrt{\frac{10gh}{7}}$$

29. Ans. (a)

$$\frac{E_r}{E_T} = \frac{k^2}{k^2+R^2} = \frac{2}{2+5} = \frac{2}{7}$$

30. Ans. (d)

$$\varepsilon_r = \frac{40}{100}\varepsilon_t$$

$$\frac{\varepsilon_r}{\varepsilon_t} = \frac{40}{100} = \frac{40}{10} = \frac{2}{5}$$

$$\frac{k^2}{R^2} = \frac{2}{5}$$

Hence, it must be solid sphere.

31. Ans. (c)

The acceleration of a body rolling down an inclined plane without sliding is

$$a = \frac{g\sin\theta}{1+\frac{k^2}{R^2}} \text{ For ring } \frac{K^2}{R^2} = 1$$

$$a = \frac{g\sin 30°}{1+1} = \frac{g}{4}$$

32. Ans. (b)

$I = MK^2$

$$K = \sqrt{\frac{I}{m}} = \sqrt{\frac{160}{10}} = 4\text{m}$$

33. Ans. (b)

$$Mk^2 = \frac{1}{2}MR^2$$

$$k = \frac{R}{\sqrt{2}} = \frac{50}{\sqrt{2}} = 25\sqrt{2}\text{ cm}$$

34. Ans. (d)

M.I of ring passing through centre $I = mr^2$

$$KE_{rot} = \frac{1}{2}I\omega^2 = \frac{1}{2}mr^2\omega^2$$

35. Ans. (b)

$\varepsilon = \varepsilon_{rot} + \varepsilon_{trans.}$

$$= \frac{1}{2}mv^2\left(\frac{K^2}{R^2}+1\right) = \frac{1}{2}mv^2(1+1) = mv^2$$

36. Ans. (b)

When slides down on smooth inclined plane from height then velocity of the botom of the plane is $\sqrt{2gh} = v$. When rolls down without slipping form same height then,

$$v_o = \sqrt{\frac{2gh}{1+\frac{k^2}{R^2}}} = \sqrt{\frac{2gh}{1+1}} = \frac{v}{\sqrt{2}}$$

37. Ans. (c)

$$t = \sqrt{\frac{2h}{gt}\left(1+\frac{k^2}{R^2}\right)}\text{ cosec }\theta$$

$$t \,\alpha \sqrt{1+\frac{K^2}{R^2}}$$

Hence, solid sphere reaches first because $\frac{k^2}{R^2}$ is least for solid sphere. $\left(\frac{2}{5}\right)$.

38. Ans. (d)

M.I of hollow cylinder = MR^2 sliding K.E $(E_1) = \frac{1}{2}MV^2$. Rolling kinetic energy E_2 = $\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$

$$= \frac{1}{2}mv^2 + \frac{1}{2}MR^2 + \frac{v^2}{R^2} = MV^2 \;\therefore E_1:E_2 = 1:2$$

39. Ans. (b)

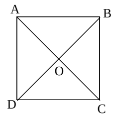
For solid cylinder $\frac{K^2}{R^2} = \frac{1}{2}$

As $\mu \geq \frac{k^2}{k^2+R^2}\tan\alpha$

$$\mu_{Min} = \frac{1}{1+2}\tan\alpha = \frac{1}{3}\tan\alpha$$

40. Ans. (d)

Using theorem of perpendicular axis, we get:



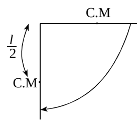
$I_o = I_{AC} + I_{BD}$

$$I_{AC} = I_{BD} = \frac{ML^2}{12}$$

$$I_O = \frac{ML^2}{12} + \frac{ML^2}{12} = \frac{ML^2}{6}$$

41. Ans. (a)

As the mass is concentrated at centre of rod:



$mg \times \frac{l}{2} = \frac{1}{2}I\omega^2 = \frac{1}{2}\left(\frac{ml^2}{3}\right)\omega^2$

$l^2\omega^2 = 3gl$

velocity of other end of rod,

$v = l\omega = \sqrt{3gl}$

42. Ans. (c)

As $L = I\omega$ = constant, therefore

$I_1\omega_1 = I_2\omega_2$

$\omega_2 = \frac{I_1\omega_1}{I_2} = \frac{MK^2\omega}{(M + 2m)k^2} = \frac{M\omega}{M + 2m}$

43. Ans. (a)

As velocity of P is zero, it falls freely at $\frac{R}{2}$ and the centre mass hits the ground at R.

So,

$x_{cm} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$

$R = \frac{m x \frac{R}{2} + m \times x_2}{m + m}$

$= \frac{R}{4} + \frac{x_2}{2}$

$x_2 = \frac{3R}{2} = \frac{3}{2}\frac{u^2 \sin 2\theta}{g}$

Past Questions

1. Two forces of 2N and 4N attached to the ends of 0.5m rod act vertically downwards. A third force will keep the system is equilibrium if applied at a point between the ends of the rod. The magnitude, direction and position of the third force will be: [MOE 2068 Kartik]

a. 6N downwards at 33.33cm from 2N force.

b. 2N downwards at 33.33cm from 2N force.

c. 2N downwards at 16.66cm from 4N force.

d. 6N downwards at 16.66cm from 4N force.

2. A body of mass 2kg of radius 1 m then moment of inertia about diameter.

[2068 Asadh]

a. $0.5kgm^2$ b. $2kgm^2$

c. $4kgm^2$ d. $1\ kgm^2$

3. Moment of inertia doesn't depends upon: [MOE 2067]

a. mass b. distribution of mass

c. radius d. Angular velocity

4. A fly wheel of mass 10kg and radius 50cm is rotating with constant angular speed of ω with its kinetic energy 20 Joule. The angular speed of fly wheel is: [MOE 2066]

a. 4 rad/s b. 2 rad/s

c. 10 rad/s d. 12 rad/s

5. The body applied with constant torque changes the angular momentum I_O to final angular momentum $4I_O$ is 3 sec then find torque: [MOE 2008]

a. $3I_O$ b. I_O

c. $4I_O$ d. $2I_O$

6. Kinetic energy of a body is given by $\frac{1}{2}mv^2$. Which one of the following expression is correct for the kinetic energy of the rigid body where I and ω represent the moment of Inertia and angular velocity of the rigid body?

[MOE 2065]

a. $\frac{1}{2}I\omega^2$ b. $\frac{1}{2}I^2\omega$

c. $\frac{1}{2}(I\omega)^2$ d. $I^2\omega^2$

7. A constant torque acting on a uniform circular wheel changes its angular momentum from Jo to 4Jo in 4 seconds. The magnitude of torque is: [IOM, BPKIHS/MOE/KU]

a. $\frac{3}{4}J_O$ b. $4J_O$

c. J_O d. $12J_O$

8. A circular disc of mass m and radius r is rotating about its axis with uniform speed of V. What's kinetic energy? [IOM 2004]

a. mv^2 b. $\frac{1}{2}mv^2$

c. $\frac{1}{4}mv^2$ d. $\frac{1}{8}mv^2$

9. When the size of the earth is reduced to half with mass remaining same, the time period of earth rotation will be: [IOM 2003]

a. 6 hrs   b. 24 hrs

c. 12 hrs   d. 48 hrs

10. A billiard ball is hit by a cue at a height above the centre. It acquires a linear velocity Vo. mass of the ball is 'm' and radius is r. The angular velocity ω_o acquired by the ball is: [BPKIHS 2009]

a. $\frac{2v_oh}{5r^2}$ b. $\frac{5v_oh}{2r^2}$

c. $\frac{2v_or^2}{5h}$ d. $\frac{5v_or^2}{2h}$

11. The moment of inertia of a disc of mass M and Radius R about an axis which is largest to the circumference of the disc and parallel to its diameter is:
[BPKIHS 2008]

a. $\frac{5}{4}MR^2$ b. $\frac{3}{2}MR^2$

d. $\frac{4}{5}MR^2$ b. $\frac{2}{3}MR^2$

12. The ratio of angular speeds of minute hand and hour hand of a clock is: [BPKIHS 07]

a. 60:1   b. 36:1

c. 24:1   d. 12:1

13. Ratio of the angular velocity of the earth about its axis and the hour hand of a clock is: [BPKIHS 1999]

a. 12:11   b. 11:12

c. 1:2   d. 2:1

14. When an explosive shell travelling in a parabolic path under the effect of gravity explodes. The centre of mass of fragments will move [BPKIHS 97]

a) Vertically upwards and the vertically downwards
b) Horizontally and then follow parabolic path
c) Along the original parabolic path
d) along hyperbolic path

15. Three point masses of mass m are placed at the corners of an equilateral triangle of side *l*. The moment of inertia of system about an axis along one side of the triangle is: [BPKIHS 96]

a. $3ml^2$ b. ml^2

c. $\frac{3}{4}ml^2$ d. $\frac{3}{2}ml^2$

16. Let $I_1$and I_2 be the moment of inertia of two bodies of identical geometrical shape, the first made of aluminium and second of iron: [BPKIHS 95]

a. $I_1 < I_2$ b. $I_1 = I_2$

c. $I_1 > I_2$ d. in sufficient data

17. Radius of Gyration of an uniform rod about an axis through its middle is: [BPKIHS 94]

a. $\frac{L}{\sqrt{3}}$ b. $\frac{L}{\sqrt{8}}$

c. $\frac{L}{\sqrt{12}}$ d. $\frac{L}{\sqrt{2}}$

18. The centre be of gravity of a body: [BPKIHS 94]

a. Lies always outside the body
b. May lie whether outside or on surface of the body

c. Lies inside the body
d. Lies on the surface of the body

19. A shell at rest explodes. The centre of mass of the fragments: [I.E 2008]
a. Moves along the parabolic path
b. Moves along the straight line
c. Moves along an elliptical path
d. Remains at rest

20. If body starts from rest with angular acceleration $\alpha = 6t^2$. What is time taken to complete 10 revolution? [IE 2006]
a. 0 b. 2.14
c. 2.8 d. 3.6

21. When torque acting upon a system is zero. Which of the following will be constant? [IE]
a. Force
b. Linear momentum
c. Angular momentum
d. Linear impulse

22. Two mass of 1kg and 2 kg are 9cm part and make a two body system. Their centre of mass from 1 kg mass will be at: [MOE]
a. 6m b. 4m
c. 3m d. 2m

23. The radii of two steel balls are R and 2R. Then their moment of inertia about their diameter are in the ratio:
a. 1:4 b. 1:8
c. 1:16 d. 1:32

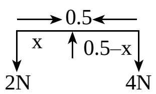
24. The moment of inertia of a cylinder of mass M, length L, radius R about its axis is [IOM 2012]
a. $\frac{MR^2}{2}$ b. MR^2
c. $\frac{ML^2}{3}$ d. $M\left(\frac{L^2}{12} + \frac{R^2}{4}\right)$

Answer Sheet

1. d	*2. a*	*3. d*	*4. a*	*5. b*	*6. a*	*7. a*	*8. c*	*9. a*	*10. b*
11. a	*12. d*	*13. c*	*14. c*	*15. c*	*16. a*	*17. c*	*18. b*	*19. d*	*20. b*
21. c	*22. a*	*23. d*	*24. a*						

SOLUTION

1. Ans. (d)
We can use lever equation.



$2 \times x = 4 \times (0.5 - x)$

$2x = 2 - 4x \Rightarrow x = \frac{1}{3} = 0.33\text{cm}$

0.33m from 2N force.

0.5 – 0.33 = 0.16m from 4N force since Net downward tone is 6N(2 + 4) to balance it net upward force should be 6N.

2. Ans. (a)

$I = \frac{1}{4}MR^2$ (about diameter)

$= \frac{1}{4} \times 2 \times 1^2 = 0.5 \text{ kg m}^2$

3. Ans. (d)

$I = m_1r_1^2 + m_2r_2^2 + ... + m_nr_n^2$

which implies it depends on mass, distribution of mass and radius but not on angular velocity.

4. Ans. (a)

$k.\varepsilon = \frac{1}{2}I\omega^2 = \frac{1}{2}mr^2\omega^2$

$\omega = \sqrt{\frac{2k\varepsilon}{mr^2}} = \sqrt{\frac{40}{10 \times (0.5)^2}} = 4 \text{ rad s}^{-1}$

5. Ans. (b)

Angular momentum (L) = $I\omega$

Torque $(\tau) = \frac{dL}{dt} = \frac{4I_O - I_O}{3} = I_O$

6. Ans. (a)

Analogy between rotational and translational

$K\varepsilon_T = \frac{1}{2}mv^2$ $K\varepsilon_r = \frac{1}{2}I\omega^2$

7. Ans. (a) $\tau = \frac{dL}{dt} = \frac{4J_O - J_O}{4} = \frac{3J_O}{4}$

8. Ans. (c) For a disc $I = \frac{mr^2}{2}$

Rotational k.ε $= \frac{1}{2}I\omega^2 = \frac{1}{2}\frac{mr^2}{2} \times \frac{v^2}{r^2} = \frac{mv^2}{4}$

9. Ans. (a) **Iω = Constant**

$\frac{2}{5}MR^2 \times \frac{2\pi}{T}$ = Constant

$T \alpha \frac{1}{R^2} \Rightarrow T^1 = \frac{T}{4} = \frac{24}{4} = 6$ hrs

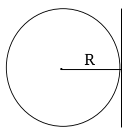
10. Ans. (b)

Angular momentum $= mv_oh = I\omega_o = \frac{2}{5}mr^2\omega_o$

$\omega_o = \frac{5v_oh}{2r^2}$

11. Ans. (a)

I about diameter of disc$= \frac{MR^2}{4}$



From theorem of parallel axis

I tangent = I diameter + MR^2

$= \frac{MR^2}{4} + MR^2 = \frac{5}{4}MR^2$

12. Ans (d)

$\omega = \frac{2\pi}{T}$

$\frac{\omega M}{\omega H} = \frac{2\pi}{Tm} \times \frac{T_H}{2\pi} = \frac{12\times60\times60}{1\times60\times60} = 12$

13. Ans (c)

$\omega_1 = \omega_{earth} = \frac{2\pi}{24 \text{ hrs}}$ & $\omega_2 = \omega_{hour\ hand} = \frac{2\pi}{12}$

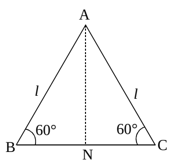
$\frac{\omega_1}{\omega_2} = \frac{12}{24} = 1:2$

14. Ans. (c)

If a shell moving on a parabolic path explodes, the pieces fly in such a way that the centre of mass of all pieces moving on the same parabolic path on which shell was moving.

15. Ans. (c)

$AN = AB \sin 60° = \frac{\sqrt{3}}{2}l$



Moment inertia along one side

$I = m_1r_1^2 + m_2r_2^2 + m_3r_3^2$

$= m \times 0 + m \times 0 + \left(\frac{\sqrt{3}}{2}l\right)^2 = \frac{3}{4}ml^2$

16. Ans. (a)

For same geometrical shape radius of iron body = radius of Aluminium body and mass of iron > mass of Aluminium

I α m $\qquad I_1 < I_2$

17. Ans. (c)

Moment of inertia of uniform rod about its axis through middle $I = \frac{mL^2}{12}$

$I = MK^2$ (K = Radius of Gyration)

$\Rightarrow k^2 = \frac{L^2}{12} \Rightarrow k = \frac{L}{\sqrt{12}}$

18. Ans. (b)

The point due to gravity which helps the body to be in equilibrium position is called centre of gravity of body. It may be inside outside depending on geometry of body.

19. Ans. (d)

Since, the shell is initially at rest, the explosion doesn't alter the c.g. of fragments of shell.

20. Ans. (b)

$\theta = \omega ot + \frac{1}{2}\alpha t^2$ (1 revolution $=2\pi$)

$10 \times 2\pi = \frac{1}{2} \times 6 \times t^2$

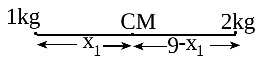
$t^2 = \frac{40\pi}{6}$ $\qquad \therefore$ t = 2.14sec

21. Ans. (c)

$\tau = \frac{dL}{dt}$ = rate of change of angular momentum.

τ = 0, dL = 0, angular momentum = constant.

22. Ans. (a)



$m_1x_1 = m_2x_2$

$1 \times x_1 = 2 \times 9 - x_1$

$x_1 = 6m$

23. Ans. (d)

M.I of solid sphere at diameter $= \frac{2}{5}MR^2$

$= \frac{2}{5} \times \frac{4}{3}\pi R^3\rho \times R^2$

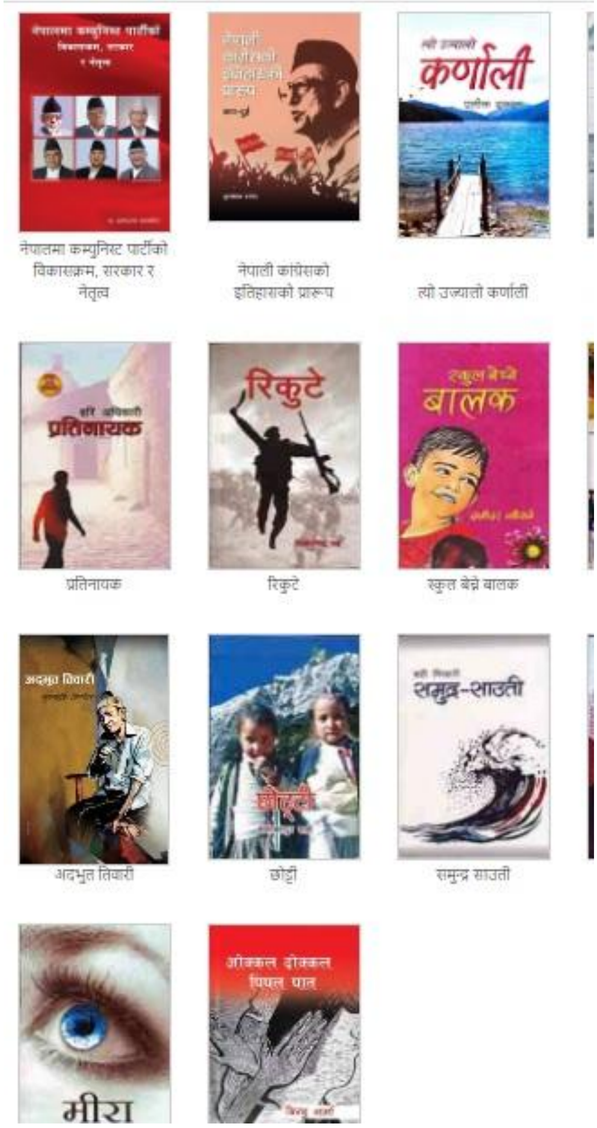
$I \alpha R^5 \Rightarrow$ [ρ same (steel)]

$\frac{I_1}{I_2} = \left(\frac{R}{2R}\right)^5 = 1:32$

24. Ans. (a)

M.I. for solid cylinder about its axis = $\frac{MR^2}{2}$

Through C.G and perpendicular to geometric axis: = $M\left(\frac{L^2}{12}+\frac{R^2}{4}\right)$


नेपालमा कम्युनिस्ट पार्टीको विकासक्रम, सरकार र नेतृत्व
नेपाली कांग्रेसको इतिहासको प्रारूप
कर्णाली
त्यो उज्यालो कर्णाली
प्रतिनायक
रिकुटे
बालक
प्रतिनायक
रिकुटे
स्कुल बेन्ने बालक
अदभुत तिवारी
समुद्र-साउती
अदभुत तिवारी
छोट्टी
समुन्द्र साउती
मीरा
औक्कल दोक्कल पिपल पात

Chapter: 12

ELASTICITY

1. Which of the following affects the elasticity of the substance?

a. hammering and annealing
b. change in temperature
c. impurity in substances
d. all of these

2. According to Hooke's law if stress is increased, the ratio of stress to strain

a. increases b. decreases
c. Remain constant d. None

3. Shearing stress is related in

a. length b. volume
c. shape d. Area

4. A stretched rubber has

a. increases kinetic energy
b. increase potential energy
c. decreased kinetic energy
d. decreases potential energy

5. If the stress – strain relation for volume change is of form $\frac{\Delta V}{V_o} = kP$ where P is applied uniform pressure. then K. stands for

a. Bulk modulus b. Young's modulus
c. compressibility d. shear modulus

6. Four wires of same material are stretched by the same load. The dimensions are given below. Which of them will elongate the most?

a. L = 1m, d = 1mm
b. L = 2m, d = 2mm
c. L = 3m, d = 3mm
d. L = 4m, d = 0.5mm

7. The breaking stress for a wire of radius r of given material is FN/m^2. The breaking stress for the wire of same material of radius 2r is

a. F b. 2F
c. 4F d. $\frac{F}{4}$

8. The breaking force for a wire of radius r of given material is F. The breaking force for the wire of same material of radius 2r is

a. F b. 2F
c. 4F d. $\frac{F}{4}$

9. A metallic bar is heated from 0°c to 100°c but it is so held that can neither expand nor bend, then the force developed is

a. $F \alpha\ l$ b. $F \alpha \frac{1}{l}$
c. $F \alpha\ l^\circ$ d. $F \alpha \frac{1}{A}$

10. A steel wire of length 20cm and uniform cross section 1mm^2 is tied rigidly at both the end. The temperature of the wire is altered from 40°c to 20°c. What the magnitude of force developed in the wire? [α steel = 1.1×10^{-5} °c^{-1}; Y steel = 2×10^{11} N/m^2]

a. 2.2×10^6N b. 16N
c. 8N d. 44N

11. A rubber cord of length L metre density ρkg/m^3, area of cross section A m^2 is suspended vertically. If Y is Young's modulus then extension of cord due to its own weight is

a. $\frac{\rho g L^2}{Y}$ b. $\frac{\rho g L^2}{2Y}$
c. $\frac{\rho g L^2}{4Y}$ d. L

12. A wire of length 'L' and cross sectional Area A is made of a material of Young modulus 'Y'. If the wire is stretched by an amount 'x' work done is

a. $\frac{YAx^2}{2L}$ b. $\frac{YAx^2}{L}$
c. $\frac{YAx}{2L}$ d. YAx^2L

13. With a rise of temperature, the Young's modulus

a. increase

b. decrease

c. remains unchanged

d. increases & sometimes decreases

14. Energy per unit volume of stretched wire is

a. $\frac{1}{2}$ load × extension

b. load × stress

c. stress × stain

d. $\frac{1}{2}$ × stress × stain

15. The stretching of coil is determined by

a. Young's modulus b. Bulk modulus

c. Shear modulus d. None

16. Two identical wires of A and B are takes and equal stretching forces are applied on them along the length. It is observed that A elongates more than B, then

a. B is more elastic than A

b. A is more elastic than B

c. A & B equally elastic

d. A is elastic B is plastic

17. A cable is cut into half of its original length. The maximum load it can support will be now is

a. doubled b. halved

c. quadrupled d. Remains same

18. The breaking stress of a material is F and its density is ρ. The maximum length under gravity, will be

a. $\frac{F}{\rho}$ b. $\frac{F}{\rho g}$

c. $\frac{F\rho}{g}$ d. $\frac{F}{2\rho g}$

19. The ratio of lateral strain to longitudinal strain of a wire is called

a. Young's modulus

b. Bulk modulus

c. Poisson's ratio

d. compressibility

20. Which of the following cannot be the value of Poisson's ratio?

a. – 0.6 b. 0

c. –1 d. 1

21. The longitudinal strain in a stretched cylindrical wire is 10^{-3} and Poisson's ratio is 0.2. Then the percentage change in the volume is

a. 0.02% b. 0.04%

c. 0.06% d. 0.6%

22. The value of Poisson's ratio at which the volume of wire doesn't change when it is subjected to tension is:

a. $\sigma = 0.1$ b. $\sigma = 0.5$

c. $\sigma = 1$ d. $\sigma = 0$

23. For a given material, Young's modulus is 2.4 times that of rigidity modulus. Its poisson's ratio is

a. 2.4 b. 1.2

c. 0.4 d. 0.2

24. Modulus of rigidity is the characteristic of

a. solid b. liquid

c. gas d. All

25. Two rods A and B of same material and length have radii r_1 and r_2 respectively. When they are rigidly fixed at one end and twisted by the same couple applied at the other end. The ratio $\frac{\text{Angle of twist at end A}}{\text{Angle of twisted end B}}$ is

a. $\frac{r_1^2}{r_2^2}$ b. $\frac{r_2^3}{r_1^3}$

c. $\frac{r_2^4}{r_1^4}$ d. $\frac{r_1^4}{r_2^4}$

26. The length of a metallic wire is L_1 when the tension on the wire is T_1 and L_2 when the tension in the wire is T_2. Find the original length of the wire

a. $\frac{L_2T_1 - L_1T_2}{T_1 - T_2}$ b. $\frac{L_2T_1 - L_1T_2}{T_2 - T_1}$

c. $\frac{T_2L_1 - T_1L_2}{T_2 - T_1}$ d. $\frac{L_1T_2 - L_2T_1}{L_1 - L_2}$

27. A beam of metal support at the two end is loaded at is centre. The depression at the centre is proportional to

a. Y^2 b. Y

c. $\frac{1}{Y}$ d. $\frac{1}{Y^2}$

28. A wire on loading by a weight Mg extends in a length by *l*. The work done in this process is

a. $\frac{Mgl}{2}$ b. Mgl

c. $2Mgl$ d. zero

29. A force of 10^6 N/m^2 is required for breaking a material. If the density of the material is 3×10^3 kg/m^3. what should be the length of the wire made of material so that it breaks by its own weight?

a. 30m b. 34m

c. 38m d. 42m

30. The bulk modulus of rubber is 9.8×10^8 N/m^2. To what depth a rubber ball be taken in a lake so that its volume is decreased by 0.1%

a. 1km b. 200m

c. 100m d. 25m

31. A solid sphere of radius R made of material of bulk modulus k is surrounded by a liquid in a cylindrical container. A massless piston of Area A floats on the surface of the liquid. When a mass m is placed on the piston to compress the liquid. The fractional change in the radius of the sphere $\frac{\Delta R}{R}$ is equal to

a. $\frac{mg}{Ak}$ b. $\frac{3mg}{Ak}$

c. $\frac{mg}{A}$ d. $\frac{mg}{3Ak}$

32. Bulk modulus of water is 2×10^9N/m^2. The change in pressure required to increase the density of water by 0.1%

a. 2×10^9N/m^2 b. 2×10^8N/m^2

c. 2×10^6N/m^2 d. 2×10^4N/m^2

33. A steel rod of length '*l*', a area of cross section A, Young's modulus Y and coefficient of linear expansion α is heated through θ°c. The work that can be performed by a rod when heated is

a. $YA\, l\alpha^2\theta^2$ b. $\frac{1}{2} YA\, l\alpha^2\theta^2$

c. $\frac{1}{4} YA\, l\alpha^2\theta^2$ d. $2\, YA\, l\alpha^2\theta^2$

Answer Sheet

1. d	*2. c*	*3. c*	*4. b*	*5. c*	*6. d*	*7. a*	*8. c*	*9. c*	*10. d*
11. b	*12. a*	*13. b*	*14. d*	*15. c*	*16. a*	*17. d*	*18. b*	*19. c*	*20. d*
21. c	*22. b*	*23. d*	*24. a*	*25. c*	*26. c*	*27. c*	*28. a*	*29. b*	*30. c*
31. d	*32. c*	*33. b*							

SOLUTION

1. Ans. (d)

The hammering increase elasticity while annealing. Decrease increase in temp = decrease in elasticity, impurity increase elasticity.

2. Ans. (c)

A/C to Hooke's law

$\frac{\text{stress}}{\text{strain}} = E = \text{constant}$

As stress ↑, strain also ↑accordingly so that ratio remain constant.

3. Ans. (c)
Shearing strain is related to shape.

4. Ans. (b)
When rubber is stretched, some work is done due to elasticity on the rubber. The work is stored in the form of elastic potential energy. As a result P. E. of rubber increases.

5. Ans. (c)

$$\text{Compressibility} = \frac{1}{\text{Bulk modulus}}$$

$$= \frac{\text{volume stress}}{\text{stress}} = \frac{\Delta V/V}{P} = K$$

6. Ans. (d)

$$Y = \frac{FL}{Ae} \Rightarrow e = \frac{FL}{AY} = \frac{FL}{\frac{\pi d^2}{4}Y}$$

$$\therefore e \propto \frac{L}{d^2}$$

The value of $\frac{L}{d^2}$ is max for (d)

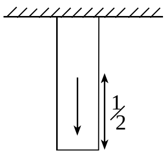
7. Ans. (a)
Breaking stress is independent of area.

8. Ans. (c) Since, breaking force $\propto A \propto r^2$
As r becomes twice F becomes 4times.

9. Ans. (c)
Force developed is given by $F = YA\alpha\Delta\theta$ which is independent of length $F \propto l°$.

10. Ans. (d)
$F = YA\alpha\Delta\theta$
$= 2 \times 10^{11} \times 1 \times 10^{-6} \times 1.1 \times 10^{-5} \times 10$
$= 44N$

11. Ans. (b)
The C. G of the cord lies at the mid point of its total length.



So extension produced is only due to weight below it whose length is $\frac{L}{2}$.

$$\text{Now, } Y = \frac{FL}{Ae} \Rightarrow e = \frac{Mgl}{Ay}$$

$$= \frac{v\rho gl}{AY} = \frac{A \times \frac{L}{2} \times \rho gl}{AY} = \frac{\rho gl^2}{2Y}$$

12. Ans. (a)

$$w = \frac{1}{2}Fx = \frac{1}{2}\frac{YAx}{L}.x\left[Y = \frac{FL}{Ax}\right]$$

$$w = \frac{YAx^2}{2L}$$

13. Ans. (b)

$$Y = \frac{Fl}{A\Delta l} = \frac{F}{A\alpha\Delta\theta}\ [\Delta l = l\alpha\Delta\theta]$$

$Y \propto \frac{1}{\Delta\theta}$ so with rise in temperature, Y decreases.

14. Ans. (d)

$$W = \int F dx = \frac{YA}{L}\int_0^e x\,dx = \frac{YAe^2}{2L} \text{ Then,}$$

$$W = \frac{1}{2}F \times e \Rightarrow \frac{w}{v} = \frac{\left(\frac{1}{2}\right) \times F \times e}{A \times L}$$

$$= \frac{1}{2} \times \text{stress} \times \text{strain}$$

15. Ans. (c)
When coil is stretched, there is neither change in length nor in Volume. Since the change takes place in the shape of coil spring its stretching is determined by its shear modulus.

16. Ans. (a)

$$Y = \frac{FL}{Ae} \Rightarrow Y \propto \frac{l}{e}$$

For elastic body, Y is more and extension is less.
For perfectly elastic body; extension = 0
$\therefore$ Young's modulus = ∞ (infinity)

17. Ans. (d)
Breaking force = Breaking stress × cross sectional Area
– independent of length,

18. Ans. (b)
If maximum length possible is L. Then weight of its own is $w = AL\rho g$

$$\text{Breaking stress } F = \frac{w}{A} = L\rho g$$

$$\text{There fore } L = \frac{F}{\rho g}$$

19. Ans. (c)

$\sigma = \frac{\beta}{\alpha} = \frac{-\Delta R/R}{\Delta L/L}$

20. Ans. (d)

Because the value of Poisson's ratio lies between –1 to 0.5.

21. Ans. (c)

$V = \pi r^2 L \Rightarrow \frac{\Delta v}{v} = \frac{2\Delta r}{r} + \frac{\Delta L}{L}$

$\sigma = \frac{\frac{\Delta r}{r}}{\frac{\Delta L}{L}} \Rightarrow \frac{\Delta r}{r} = \frac{-\Delta L\sigma}{L}$

$\frac{\Delta v}{v} = \frac{\Delta L}{L} - \frac{2\sigma\Delta L}{L}$

$\frac{\Delta v}{v} = (1 - 2\sigma)\frac{\Delta L}{L}$

$= (1 - 2 \times 0.2) \times 10^{-3} \times 100\% = 0.06\%$

22. Ans. (b)

$\frac{\Delta v}{v} = (1 - 2\sigma)\frac{\Delta L}{L}$

$O = 1 - 2\sigma$

$\sigma = \frac{1}{2} = 0.5$

23. Ans. (d)

$Y = 2\eta (1 + \sigma)$

$\frac{2.4}{2} = 1 + \sigma$

$\sigma = 1.2 - 1 = 0.2$

24. Ans. (a)

$\eta = \frac{\text{Tangential stress}}{\text{shearing strain}} = \frac{F/A}{\theta}$

– Characteristic of solid as liquid & gas doesn't have fixed shape.

25. Ans. (c)

$\tau = \frac{\pi\eta r^4\theta}{2l}$

$\theta \propto \frac{1}{r^4}$

$\frac{\theta_1}{\theta_2} = \frac{r_2^4}{r_1^4}$

26. Ans. (c)

Let 'L' be the original length of the wire. Then change in length in the first case = $L_1 - L$ & change in length in the second case = $L_2 - L$

$Y = \frac{T_1}{A} \times \frac{L}{L_1 - L} = \frac{T_2}{A} \times \frac{L}{L_2 - L}$

$T_1L_2 - T_1L = T_2L_1 - T_2L$

$L (T_2 - T_1) = T_2L_1 - T_1L_2$

$L = \frac{T_2L_1 - T_1L_2}{T_2 - T_1}$

27. Ans. (c)

Depression $d = \frac{Mgl^3}{48YI}$ (I = moment of inertia)

28. Ans. (a)

$w = \frac{1}{2} \times \text{load} \times \text{extension}$

$= \frac{1}{2} mgl$

29. Ans. (b)

$\text{Stress} = \frac{\text{weight}}{\text{Area}} = \frac{(AL)\rho g}{A} = L\rho g = 10^6$

$L = \frac{10^6}{3 \times 10^3 \times 10} = 34\text{m}$

30. Ans. (c)

$\text{Pressure required} = \frac{k\Delta v}{v}$

$= 9.8 \times 10^8 \times \frac{0.1}{100} = 9.8 \times 10^5 \text{N/m}^2$

$P = h\rho g \Rightarrow h = \frac{P}{\rho g} = \frac{9.8 \times 10^5}{10^3 \times 9.8} = 100\text{m}$

31. Ans. (d)

$K = \frac{\Delta P}{\frac{\Delta v}{v}}$

$\frac{\Delta v}{v} = \frac{\Delta P}{k} = \frac{F}{Ak} = \frac{mg}{Ak}$

$\frac{3\Delta R}{R} = \frac{mg}{Ak}$

$\frac{\Delta R}{R} = \frac{mg}{3Ak}$

32. Ans. (c)

Volumetric Strain = $\frac{-\Delta V}{V} = \frac{\Delta \rho}{\rho} = \frac{0.1}{100} = 10^{-3}$

Pressure = Bulk modulus × strain

$P = 2 \times 10^9 \times 10^{-3} = 2 \times 10^6$ N/m^2

33. Ans. (b)

$w = \frac{1}{2} \times F \times e$

$= \frac{1}{2}(YA\alpha\theta) \times (l\alpha\theta) = \frac{1}{2}\ YA\, l\alpha^2\theta^2$

Past Questions

1. When an elastic material with Young's modulus Y is subjected to stretching stress S, the elastic energy stored per unit volume of the material is [MOE/IOM 2010] BPKIHS]

a. $\frac{YS}{2}$ b. $\frac{S^2}{2Y}$

c. $\frac{2S^2}{Y}$ d. $\frac{S}{2Y}$

2. The elasticity of highly elastic body is [IOM 2008]

a. 1 b. 0

c. 0.5 d. ∞

3. A stress – strain graph is obtained for cupper and rubber. The slope of rubber and cupper are given as tanθr and tanθc respectively. Then [MOE 2067]

a. tanθc < tanθr b. tanθc ≥ tanθr

c. tanθc = tanθr d. tanθc > tanθr

4. Steel is more elastic than rubber. This means for same applied stress. The strain will be [Bangladesh 09]

a. more for steel b. equal for both

c. less for steel d. None

5. A metal rod of Young's modulus of elasticity 2×10^{11} Nm^2 undergoes an elastic strain of 0.05. The energy stored per unit volume of the rod in Jm^{-3} is [MOE 2065]

a. 2.5×10^8 b. 5×10^9

c. 3.5×10^7 d. 4×10^6

6. A steel wire of length 2.5m and cross sectional area 0.8×10^{-6}m^2 has a Young modulus of 2×10^{11} Pa. The upper end of the wire is fixed and a load of 8N is tied at other end. The extension in mm of wire [MOE 2062]

a. 0.125 b. 0.250

c. 0.5 d. 0.750

7. The mean density of sea water is ρ and Bulk modulus 'B'. The change in density of sea water is going from the surface of water to depth 'h' is [BPKIHS – 09]

a. $\frac{B\rho^2}{gh}$ b. Bρgh

c. $\frac{\rho^2 gh}{2}$ d. $\frac{\rho gh}{B}$

8. Which one of the following substances, possesses the highest elasticity? [BPKIHS 05]

a. rubber b. glass

c. copper d. steel

9. The upper end of a wire 1m long and 4mm radius is clamped. The lower end is twisted by angle of 30°. The angle of shear at surface is [BPKIHS]

a. 12° b. 1.2°

c. 0.12° d. 0.012°

10. The young modulus of a materials is 2×10^{10} N/m^2. If its length is doubled then find the force applied on if it has area 100m^2 [KU 2010]

a. 4×10^{12}N b. 2×10^{-12}N
c. 2×10^{12}N d. 10^{18}N

11. A wire of length 'L' and area of cross section 'A' is made up of Young's modulus Y. It is stretched by an amount x, the work done is [I.E]

a. $\frac{YxA}{2l}$ b. $\frac{Yx^2A}{l}$
c. $\frac{Yx^2A}{2l}$ d. $\frac{2Yx^2A}{l}$

12. P.∈ in a string when stretched by 2cm is U. Its P.∈ when stretched by 10cm is [I.E]

a. $\frac{U}{25}$ b. $\frac{U}{5}$
c. 25U d. 5U

13. The velocity of sound in water is 1400 m/s. The density of water is 1000 kg/m³. Bulk modulus of elasticity of water is [MOE 2069]

a. 5×10^{11} N/m² b. 1.96×10^{9} N/m²
c. 4×10^{9} N/m² d. 1.96×10^{11} N/m²

14. Breaking stress of wire of radius 2mm is F. The breaking stress of same material of radius 4mm will be [MOE 2069]

a. $\frac{F}{4}$ b. $\frac{F}{3}$
c. $\frac{F}{2}$ d. F

Answer Sheet

1. b	*2. d*	*3. d*	*4. b*	*5. a*	*6. a*	*7. c*	*8. d*	*9. c*	*10. c*
11. c	*12. c*	*13. b*	*14. d*						

SOLUTION

1. Ans. (b)

$Y = \frac{\text{stress}}{\text{strain}} \Rightarrow \text{strain} = \frac{\text{stress}}{Y}$

energy density $= \frac{1}{2} \times \text{stress} \times \text{stain}$

$= \frac{1}{2} \times \text{stress} \times \frac{\text{stress}}{Y} = \frac{1}{2} \times \frac{S^2}{Y}$

2. Ans. (d)

Bulk /Young for perfectly rigid body = ∞

Young's modulus for perfectly plastic body = 0.

3. Ans. (d)

Slope of graph $= \frac{\text{stress}}{\text{strain}}$

= tanθ = Young's modulus

Young's modulus of copper > rubber ie

Yc > Yr ⇒ tanθc > tanθr

4. Ans. (b)

$Y = \frac{\text{stress}}{\text{strain}}$ Given, Y steel > Y rubber

Since, stress is same hence strain less than steel.

5. Ans. (a)

Energy stored per unit

Volume $= \frac{1}{2} \times \text{stress} \times \text{strain}$

$= \frac{1}{2} \times Y \times (\text{strain})^2 = \frac{1}{2} \times 10^{11} \times (0.05)^2$

$= 2.5 \times 10^{8}$

6. Ans. (a)

$e = \frac{Fl}{AY} = \frac{8 \times 2.5}{0.8 \times 10^{-6} \times 2 \times 10^{11}}$

$= \frac{20}{1.6 \times 10^{5}} = 12.5 \times 10^{-5}\text{m} = 0.125 \text{ mm}$

7. Ans. (c)

ΔP = ρgh

Bulk modulus $B = \frac{\Delta P}{\frac{\Delta v}{v}}$

For a mixed Δm = o

ρΔv + vΔρ = o

$\frac{\Delta v}{v} = \frac{-\Delta\rho}{\rho}$

$\Delta\rho = \frac{\rho\Delta P}{B} = \frac{\rho(\rho gh)}{B} = \frac{\rho^2 gh}{B}$

8. Ans. (d)

Elasticity $\alpha \frac{1}{\Delta l}$

For a given force, extension produce is the smallest for highly elastic material extension steel is min, so it is more elastic than other.

9. Ans. (c)

$\theta = \frac{r\phi}{l} = \frac{(4 \times 10^{-3})m \times 30}{1m} = 0.12°$

10. Ans. (c)

$Y = \frac{Fl}{A\Delta l}$

$\Delta l = 2l - l = l$

$Y = \frac{F}{A} \Rightarrow F = Y \times A = 2 \times 10^{10} \times 10^2 = 2 \times 10^{12} N.$

11. Ans. (c)

$w = \frac{1}{2} \times \text{stress} \times \text{strain} \times \text{volume}$

$= \frac{1}{2} \times F \times e = \frac{1}{2} \times \frac{YA}{l} = \frac{1}{2} \frac{YAx^2}{l}$

12. Ans. (c)

$P.\in = \frac{1}{2} kx \ \alpha \ x^2$

$\frac{U^1}{U} = \left(\frac{10}{2}\right)2$

$= 5^2 = 25$

$U^1 = 25U$

13. Ans. (b)

$V = \sqrt{\frac{B}{\rho}}$

$\therefore$ $B = V^2\rho = (1400)^2 \times 1000$

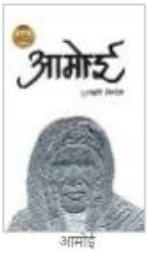
$= 1.96 \times 10^9 \ N/m^2$

14. Ans. (d)

Breaking stress is independent of length and cross sectional area but depends on nature of material (stress α Y)


रमितानानी


संजीवनी


आमोई


नेपाली रैथाने जडिबुटी


कविताको कथा गीतको कथा


विश्रान्त


घामभन्दा पहिले

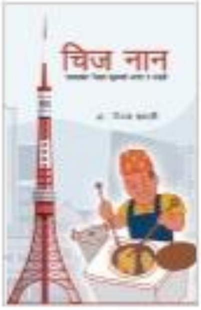

पोल्टाभित्र डिही


अर्को भोर


अन्तत: यन्त्रणा


बिपी कोइरालाको डायरी


बाह्र वर्षपछि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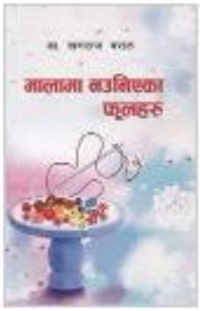
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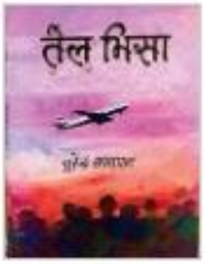
कसले सुधार्छ कांग्रेस ?


तेल भिसा


गुलेली

Chapter: 13

SURFACE TENSION

1. Surface tension of a liquid is due to
a. gravitational force between molecules
b. electrical force between molecules
c. adhesive force between molecules
d. cohesive force between molecules

2. Which molecules of a liquid has higher potential energy?
a. one at centre of gravity of the liquid
b. one at maximum distance from C.g of liquid
c. one in the surface film
d. one at the bottom of the vessel

3. Small liquid drops assume spherical shape because of
a. surface tension b. viscosity
c. gravity d. elasticity

4. With the increase in temperature the angle of contact
a. decrease b. increase
c. remain constant
d. sometimes increases, sometime decrease

5. A capillary tube made of glass is dipped into mercury. Then mercury
a. rises in capillary tube
b. falls
c. rises & falls out of capillary tube
d. Neither rises nor falls.

6. The surface tension of a liquid at critical temperature is
a. zero b. infinity
c. same as that at any other temperature
d. cannot be determined

7. When salt is added to pure water the surface tension
a. increases
b. decreases
c. remains unchanged
d. becomes zero

8. When surf is added to pure water, the surface tension
a. increases b. decreases
c. remains unchanged
d. becomes zero

9. Two water droplets merge with each other to from a large droplet. In this process
a. energy is liberated
b. energy is absorbed
c. energy is neither absorbed nor liberated
d. None

10. The pressure just below the meniscus of mercury is compared to pressure just above is
a. greater b. less
c. same d. Always Atmospheric

11. Water rises in a capillary tube to a height H, when the capillary is vertical. If the same capillary is now inclined to the vertical, the length of water column in it will
a. decrease b. increase
c. will not change
d. may increase or decrease

12. When two tubes of different diameters are dipped vertically the rise of liquid is
a. same in both tubes
b. more in tube of larger diameter
c. more in tube of smaller diameter
d. none

13. Energy needed in breaking a drop of liquid of radius R into n drops of radius r is given by (T = surface tension P = atmospheric pressure).
a. $(4\pi r^2 n - 4\pi R^2)$ T b. $\left(\frac{4}{3}\pi r^3 n - \frac{4}{3}\pi R^3\right)$ T
c. $(4\pi r^2 n - 4\pi R^2)$ P d. $(8\pi r^2 n - 8\pi R^2)$ T

14. A disc of paper of radius R has a hole of radius r. It is floating on a liquid of surface tension T. The force of surface tension on the disc is

a. $2\pi rT$ b. $2\pi (R - r) T$

c. $2\pi (R + r) T$ d. $4\pi (R + r) T$

15. A spherical liquid drop of Radius R is divided into 8 equal droplets. If surface tension is T. then work done in this process will be

a. $2\pi R^2T$ b. $8\pi R^2T$

c. $4\pi R^2T$ d. $16\pi R^2T$

16. A soap bubble of radius r is formed in air. The excess pressure inside the bubble is

a. $\frac{4T}{r}$ b. $\frac{2T}{r}$

c. $Po + \frac{2T}{r}$ d. $Po - \frac{4T}{r}$

17. Two soap bubbles have radii in the ratio 2: 1. The ratio of excess pressure inside these bubbles is

a. 1: 2 b. 2: 1

c. 1: 4 d. 4: 1

18. If the work done in blowing a soap bubble of volume V is w, then work done in blowing a soap bubble of volume 2v is

a. w b. $\sqrt{2}$ w

c. 2w d. $4^{\frac{1}{3}}$ w

19. If the work done in blowing a bubble of radius R is w, then work done in blowing a bubble of radius 2R from the solution is

a. $\frac{w}{2}$ b. 2w

c. 4w d. $2^{\frac{1}{3}}$ w

20. A capillary tube of radius r can support a liquid of weight 6.28×10^{-4} N. If the surface tension of the liquid is 5×10^{-2} N/m. The radius of the capillary must be

a. 2.5×10^{-4}m b. 1.5×10^{-3}m

c. 2×10^{-4}m d. 2×10^{-3}m

21. Two spherical soap bubbles of radii r_1 and r_2 in vacuum coalesce under isothermal condition. The resulting bubble has radius R such that

a. $R = \sqrt{r_1^2 + r_2^2}$ b. $R = \frac{r_1 + r_2}{2}$

c. $R = \frac{r_1 - r_2}{2}$ d. $R = \frac{r_1 r_2}{r_1 + r_2}$

22. Two soap bubble, each of radius r coalesces in vacuum under isothermal condition to form a bigger bubble of radius R. Then R is equal to

a. $2^{\frac{-1}{2}}r$ b. $2^{\frac{1}{3}}r$

c. $2^{\frac{1}{2}}r$ d. 2r

23. A soap bubble of radius r_1 is placed on another soap bubble of radius r_2 ($r_1<r_2$). The radius R of the soapy film, separating the two bubbles is

a. $r_1 + r_2$ b. $\sqrt{r_1^2 + r_2^2}$

c. $(r_1^3 + r_2^3)^{\frac{1}{3}}$ d. $\frac{r_1 r_2}{r_2 - r_1}$

24. A vessel whose bottom has round hole with diameter 0.1mm is filled with water. The maximum height up to which water be filled without leakage is (surface tension = 7.5×10^{-2}N/m & g = 10m/s^2)

a. 100cm b. 75cm

c. 50cm d. 30cm

25. A long capillary tube with both ends open is filled with water and then set in a vertical position in air. What is the length of liquid column remaining in the tube? Surface tension = 7×10^{-2}m & radius of capillary bore is 2mm.

a. 0.75cm b. 1.5cm

c. 3cm d. 4.5cm

26. Force required to separate two glass plates each of area 200cm^2 with a thin film of water 0.05 mm thick is

(S.T of water = 0.072N/M)

a. 28.8N b. 57.6N

c. 14.4N d. 7.2N

27. Force required to pull a circular plate of radius 5cm from water surface of which the surface tension is 75×10^{-3} N/m

a. $30\pi \times 10^{-3}$N b. 60×10^{-3}N
c. $15\pi \times 10^{-3}$N d. $7.5\pi \times 10^{-3}$N

28. Work T is the surface tension of soap solution, the amount of work done in blowing a soap solution from D to diameter 3D is

a. $4\pi D^2T$ b. $\frac{9}{4}\pi D^2T$
c. $16\pi D^2T$ d. $32\pi D^2T$

29. Work done in blowing a soap bubble of Radius R is w. The work done in creating its radius from R to 3R will be

a. 2w b. 4w
c. 8w d. 9w

30. A mercury drop of radius 1cm is broken into 10^6 droplets of equal size. The work done is [T = 35×10^{-2}N/m]

a. 4.35×10^{-2}J b. 4.35×10^{-3}J
c. 4.35×10^{-6}J d. 4.35×10^{-8}J

31. Liquid rises to a height of 2cm in a capillary tube. The angle of contact between solid and liquid is zero. The tube is depressed more now so that the tip of capillary tube is only 1 cm above the liquid, then the apparent angle of contact between solid and liquid is

a. 0° b. 30°
c. 60° d. 90°

32. One thousand Small water drops of equal size combine to form a big drop. The ratio of final surface energy to the total initial surface energy is

a. 10: 1 b. 1: 10
c. 1000: 1 d. 1: 1000

33. Two soap bubbles A and B are formed at the two open ends of a tube. The bubble A is smaller than bubble B. If the valve is opened and air can flow freely between the bubbles, then

a. The size of the bubbles remain same
b. Air flows from B to A until two bubbles of equal size
c. Air flows from A to B and B grows at the expense of A
d. Both will collapse due to excess pressure

34. A number of water droplets each of radius r coalesce to from a droplet of Radius R. The rise temperature $\Delta\theta$ is

a. $\frac{2T}{r}$ b. $\frac{3T}{R\rho}$
c. $\frac{3T}{\rho}\left(\frac{1}{r}+\frac{1}{R}\right)$ d. $\frac{3T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)$

Answer Sheet

1. d	*2. c*	*3. a*	*4. a*	*5. b*	*6. a*	*7. a*	*8. b*	*9. a*	*10. a*
11. b	*12. c*	*13. a*	*14. c*	*15. c*	*16. a*	*17. a*	*18. d*	*19. c*	*20. d*
21. a	*22. c*	*23. d*	*24. d*	*25. b*	*26. b*	*27. d*	*28. c*	*29. c*	*30. a*
31. c	*32. b*	*33. c*	*34. d*						

SOLUTION

1. Ans. (d)

Surface tension of a liquid is due to force of attractive between like molecules of a liquid i.e. cohesive force.

2. Ans. (c)

A molecule in the surface film has maximum potential energy because the molecule when brought in surface flim the work is done against both gravity & surface tension.

3. Ans. (a)
Liquid lends to acquire minimum surface Area due to surface tension.

4. Ans. (a)
With the increase in temperature the surface tension of liquid decrease and angle of constant also decrease.

5. Ans. (b)
Since angle of constant of mercury with glass is obtuse, the mercury level gets depressed.

6. Ans. (a)
At critical temperature the surface tension is zero.

8. Ans. (a)
When highly soluble substance is dissolved in water the surface tension T increase.

8. Ans. (b)
When sparingly soluble substance is added the surface tension decreases.

9. Ans. (a)
On merging surface area decreases. Hence surface energy decrease and energy is liberated.

10. Ans. (a)
Pressure is greater at the concave side of curved liquid surface.

11 Ans. (b)
On inclination, vertical height h of the liquid level always remains same.

$l \cos\alpha = h \Rightarrow l = \frac{h}{cs\alpha}$

$\cos\alpha < 1$

$\therefore$ $l > h$

12. Ans. (c)

$h = \frac{2T\cos\theta}{r\rho g} \Rightarrow h\alpha \frac{l}{r} \alpha \frac{l}{D}$

Hence, liquid rises more in tube of smaller diameter.

13. Ans. (a)
Energy required = surface tension × ΔA

$= T(4\pi r^2 n - 4\pi R^2)$

14. Ans. (c)
Force = surface tension × perimeter

$= T \times (2\pi R + 2\pi r) = 2\pi(R + r)T$

15. Ans. (c)
Radius of small drop

$r = \frac{R}{n^{\frac{1}{3}}} = \frac{R}{8^{\frac{1}{3}}} = \frac{R}{2}$

$w = T\Delta A = T\left(8 \times 4\pi\left(\frac{R}{2}\right)^2 - 4\pi R^2\right)$

$= T(8\pi R^2 - 4\pi R^2) = 4\pi R^2 T$

16. Ans. (a)
Since soap bubble is formed in air

$P = \frac{4T}{r}$

If formed in soap solution

$P = \frac{2T}{r}$

17. Ans. (a)

$P = \frac{4T}{R} \alpha \frac{1}{R}$

$\frac{P_1}{P_2} = \frac{R_2}{R_1} = \frac{1}{2}$

18. Ans. (d)

$V \alpha R^3 \Rightarrow R \alpha v^{\frac{1}{3}}$

$w \alpha R^2 \Rightarrow w \alpha v^{\frac{2}{3}}$

$\frac{w_1}{w_2} = \left(\frac{v_1}{v_2}\right)^{\frac{2}{3}} = \left(\frac{1}{2}\right)^{\frac{2}{3}} = \left(\frac{1}{4}\right)^{\frac{1}{3}}$

$w_2 = (4)^{\frac{1}{3}} w$

19. Ans. (c)

$\frac{w_2}{w_1} = \left(\frac{R_2}{R_1}\right)^2 = \frac{(2R)^2}{R} = 4$

$w_2 = 4w_1 = 4w$

20. Ans. (d)
Force of surface tension acting upward = weight support

$2\pi rT \cos\theta = mg$

$2\pi r \times 5 \times 10^{-2} \times 1 = 6.28 \times 10^{-4}$

$r = 2 \times 10^{-3} m$

21. Ans. (a)

For isothermal condition energy is conserved

$8\pi R^2T = 8\pi r_1^2T + 8\pi r_2^2T$

$R = \sqrt{r_1^2 + r_2^2}$

22. Ans. (c) $R = \sqrt{r^2 + r^2} = 2^{\frac{1}{2}}r$

23. Ans. (d)

Excess pressure of interface = Difference of excess pressure of these bubble

$\frac{4T}{R} = \frac{4T}{r_1} - \frac{4T}{r_2}$

$R = \frac{r_1r_2}{r_2 - r_1}$

24. Ans. (d)

Radius of hole $r = \frac{d}{2} = \frac{0.1 \times 10^{-3}}{2} = 5\times10^{-5}$m

If 'h' is maximum height then

$h\rho g = \frac{2T}{r}$

$h = \frac{2T}{r\rho g} = \frac{2 \times 7.5 \times 10^{-2}}{10^3 \times 5 \times 10^{-5} \times 10}$

$= 30 \times 10^{-2}$m = 30cm

25. Ans. (b)

Since it is open of both ends

$P = \frac{2T}{r} + \frac{2T}{r}$

$h\rho g = \frac{4T}{r}$

$r = \frac{4T}{r\rho g} = \frac{4 \times 7 \times 10^{-2}}{2 \times 10^{-3} \times 10^3 \times 9.8}$

= 1.5cm

26. Ans. (b)

$F = PA = \frac{2T}{d}A = \frac{2 \times 0.072 \times 200 \times 10^{-4}}{0.05 \times 10^{-3}} = 57.6N$

27. Ans. (d)

$F = T \times 2\pi r = 75 \times 10^{-3} \times 2 \times \pi \times 5 \times 10^{-3}$

$= 7.5\pi \times 10^{-3}N$

28. Ans. (c)

$w = T\Delta A$

$= T[2 \times \pi (3D)^2 - 2 \times \pi D^2] = 16\pi D^2T$

29. Ans. (c)

$w = 4\pi R^2T$

$w_1 = T \times 4\pi (9R^2 - R^2)$

$= 8(4\pi R^2T) = 8w.$

30. Ans. (a)

$w = 4\pi R^2T \left(n^{\frac{1}{3}} - 1\right)$

$= 4\pi \times 0.01^2 \times 35 \times 10^{-2} \left(10^{\frac{6}{3}} - 1\right)$

$= 4.35 \times 10^{-2}J$

31. Ans. (c)

$\frac{r}{R} = \cos\theta = \frac{h^1}{h} = \frac{1}{2} = \cos 60°$

$\therefore$ $\theta = 60°$

$[h^1R = hr]$

32. Ans. (b)

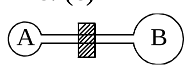
$\frac{4}{3}\pi R^3 = 1000 \times \frac{4}{3}\pi r^3$

$\Rightarrow R = 10r$

$\frac{\text{surface energy of big drop}}{\text{surface energy of 1000 drops}}$

$= \frac{4\pi R^2}{1000 \times 4\pi r^2} = \frac{(10r)^2}{1000 \times r^2} = \frac{1}{10}$

33. Ans. (c)



Excess pressure is given by

$P = \frac{4T}{r} \alpha \frac{1}{r}$

so pressure is more in bubble A. The property of fluids is that it moves from region of high pressure to low pressure i.e. from A to B

34. Ans. (d)

$ms\Delta\theta = T \times \Delta A$

N small drops of radius r = 1 big drop of Radius R

$\left(\frac{4}{3}\pi R^3\rho\right) S \times \Delta\theta = T(N \times 4\pi r^2 - 4\pi R^2)$

$\Delta\theta = \frac{3T(Nr^2 - R^2)}{S\rho R^3} \left(N = \frac{R^3}{r^3}\right)$

$= \frac{3T}{\rho}\left(\frac{R^3}{r^3} \times \frac{r^2}{R^3} - \frac{R^2}{R^3}\right) = \frac{3T}{\rho}\left(\frac{1}{r} - \frac{1}{R}\right)$

Past Questions

1. **'Water proofing' agent changes the angle of contact from [IOM 2011]**
   a. obtuse to acute b. acute to obtuse
   c. obtuse to $\frac{\pi}{2}$ d. acute to $\frac{\pi}{2}$
2. **Water rises in a capillary tube to a height of 3cm. If the tube is inclined to the liquid surface at 30° angle the liquid will rise up to [IOM 2011]**
   a. 6cm b. 3cm
   c. 1.5cm d. 0.5cm
3. **How high does water rise in a capillary tube whose inner diameter is 0.044mm. The surface tension of water is 73 dynes/cm [IOM 2008]**
   a. 6.7cm b. 7.3cm
   c. 5.6cm d. 4.3cm
4. **Pressure inside two soap bubbles is 1.01 and 1.02 atmosphere. Ratio of their volumes is [MOE 2068 kartik]**
   a. 102: 101 b. $(102)^3 : (101)^3$
   c. 8: 1 d. 2: 1
5. **A very narrow capillary tube records a rise of 6cm when dipped in water. When the area of cross section is reduced to one fourth of the former value. Water will rise up to a height of [MOE 2067]**
   a. 3cm b. 6cm
   c. 15cm d. 12cm
6. **Two bubbles of radius r coalesce into one bubble of Radius R. Which of the following is true? [MOE 2062]**
   a. R = 1.8r b. R = 1.6r
   c. R = 1.4r d. R = 1.2r
7. **Oil kept in frying pan spreads more easily when it is hot. Its is due to [BPKIHS 2010]**
   a. Decrease in velocity of oil
   b. Decrease in surface tension of oil
   c. Increase in velocity of oil
   d. Decrease in angle of constant
8. **A capillary tube when immersed vertically in a liquid records a rise of 2cm. If the tube is held immersed at an angle of 60° with the vertical, the length of the liquid column along the tube will be [BPKIHS – 2007]**
   a. 1cm b. 2cm
   c. $\frac{4}{\sqrt{3}}$ cm d. 4cm
9. **A soap bubble having Radius R then. The work done to double the Radius**
[BPKIHS – 2006]
   a. $8\pi R^2T$ b. $32\pi R^2T$
   c. $24\pi R^2T$ d. $16\pi R^2T$
10. **Detergents in hot water enable grease to be removed from plates by [BPKIHS]**
    a. decreasing density of liquid
    b. increasing temperature of liquid
    c. decreasing the contact angle between the gaseous & plate
    d. raising the surface tension of water
11. **If a liquid doesn't wet the solid surface, the angle of contact is [MOE/ BPKIHS]**
    a. acute b. 90°
    c. obtuse d. zero
12. **If the surface tension of soap solution is T, what is the work done in blooming soap bubble of Radius r? [I.E]**
    a. πr^2T b. $2\pi r^2T$
    c. $4\pi r^2T$ d. $8\pi r^2T$
13. **A capillary tube of length 5cm and interior radius 0.1mm open at both ends is lower vertically into water in a vessel. If surface tension of water is 25 dyne/cm, then (Bangladesh 09)**
    a. water rises to a height 2cm upward
    b. water rises to a height 4cm upward
    c. water rises to full length of capillary but do not overflow

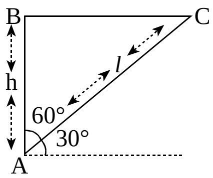
d. water rises to whole length of capillary tube & overflow

Answer Sheet

1. b	*2. a*	*3. a*	*4. c*	*5. d*	*6. d*	*7. b*	*8. d*	*9. c*	*10. c*
11. c	*12. d*	*13. c*							

SOLUTION

1. Ans. (b)
   If angle of contact is acute , the liquid wets the glass surface, liquid spreads & meniscus is concave. If obtuse the liquid doesn't wet.
2. Ans. (a)



$\cos 60° = \frac{h}{l}$

$l = \frac{h}{\cos 60°} = 2h = 6cm$

3. Ans. (a)
   $h = \frac{2T\cos\theta}{r\rho g}$
   For pure water glass interface, $\theta = 0°$
   $h = \frac{2T}{r\rho g} = \frac{2 \times 73}{0.022 \times 1 \times 980} = 6.7cm$
4. Ans. (c)
   P_1, P_2 are excess pressure inside bubbles
   $P_1 = 1.01 - 1 = 0.01atm$, $P_2 = 0.02atm$
   $P = \frac{4T}{r} \propto \frac{1}{r}$
   $r_1: r_2 = 2: 1 \Rightarrow v_1: v_2 = r_1^3: r_2^3$
   $= 8:1$
5. Ans. (d)
   $A \propto r^2$
   A reduced to one fourth means r is halved
   $h = \frac{2T\cos\theta}{r\rho g} \Rightarrow h \propto \frac{1}{r}$
   r is halved so h is doubled $h_1 = 2h = 2 \times 6 = 12cm$
6. Ans. (d) $2 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$
   $R = (2)^{\frac{1}{3}} r = 1.2r$
7. Ans. (b)
   $\uparrow$temperature$\rightarrow\downarrow$ surface tension $\rightarrow\uparrow$ spread
8. Ans. (d)
   $L = \frac{h}{\cos\alpha} = \frac{2}{\cos 60} = 4cm$
   $\alpha \rightarrow$ angle with vertical
9. Ans. (c)
   $w = T \times \Delta A$
   $A_1 = 2 \times 4\pi R^2 = 8\pi R^2$
   $A_2 = 2 \times 4\pi (2R)^2 = 32\pi R^2$
   $w = T \times (A_2 - A_1) = T \times 24\pi R^2 T$
10. Ans. (c)
    If detergents are fairly soluble it increase the surface tension but if detergent in not soluble it decrease surface tension liquid. In hot water, angle of contact is reduced
11. Ans. (c)
    $\theta < 90$, it wets the solid surface
    $\theta > 90$, the liquid doesn't wet the solid surface e.g. mercury & glass capillary.
12. Ans. (d)
    Work done in expanding soap bubble,
    w = TA but soap bubble has two surfaces, so
    $w = 2TA = 2T\, 4\pi r^2 = 8\pi r^2 T$
13. Ans. (c)
    $h = \frac{2T}{r\rho g} = \frac{2 \times 25}{0.01 \times 1 \times 980} = 5.1cm$

Which is greater than height of capillary tube but the water does not flow out its radius changes as: $h_1r_1 = h_2r_2$.

Chapter: 14

FLUID DYNAMICS & VISCOSITY

1. Bernoulli theorem is based on conservation of

a. momentum b. energy
c. mass d. none

2. Machine parts are jammed in winter due to .... of lubricant

a. $\uparrow$ viscosity b. $\downarrow$ viscosity
c. $\uparrow$ surface tension d. $\downarrow$ surface tension

3. A hole is near the bottom of a tank. The volume of liquid emerging from the hole does not depends upon

a. area of hole
b. height of liquid
c. density of liquid
d. acceleration due to gravity

4. The viscous drag on a spherical body of volume V moving with a certain speed is propotional to

a. $V^{\frac{1}{3}}$ b. $V^{\frac{2}{3}}$
c. V d. $\frac{1}{\sqrt{V}}$

5. Water is flowing through a tube of non uniform cross section. If the radius of tube at the entrance and exit is 3: 2 then the ratio of velocity of liquid entering & leaving the tube is

a. 8: 27 b. 4: 9
c. 9: 4 d. 1: 1

6. The angle between the viscous force and motion of flow of liquid is

a. 0° b. $\frac{\pi}{4}$
c. $\frac{\pi}{2}$ d. π

7. Reynolds number is low for

a. low density b. low velocity
c. high viscosity d. All of above

8. What will happen if a stream of air is blown through a tube under one of the pans of a physical balance under equilibrium? The pan will

a. go up b. go down
c. Not affected d. may go up or down

9. with rise of temperature, the viscosity of a liquid

a. increases
b. decreases
c. remains unchanged
d. none

10. with a rise of temperature, the viscosity of a gas

a. increases b. decreases
c. unchanged d. None

11. The level of water in a tank is 5m high. A hole of area 1cm^2 is made at the bottom of the tank. The rate of leakage of water from the hole is (g = 10m/s^2)

a. 10^{-2} m^3/s b. 10^{-3} m^3/s
c. 10^{-4} m^3/s d. 10^3m^3/s

12. A metallic sphere of mass 'm' falls through glycerine with a terminal velocity v. If we drop a ball of mass '8m' of same metal into a column of glycerine, the terminal velocity of the ball will be

a. 2v b. 4v
c. 8v d. 16v

13. A rain drop of radius r has a terminal velocity V m/s in air. The viscosity of air η poise and the viscous force on it is F. If the radius of the drop is 2r and the drop falls with terminal velocity in same air, the viscous force on it will be

a. $\frac{F}{2}$ b. F
c. 4F d. 8F

14. 8 equal drops are falling through air with a steady velocity of 5m/sec. If the drops coalesce, the new terminal velocity will be

a. 5cm/sec b. 10cm/sec

c. 20cm/sec d. 40cm/sec

15. Two hailstones with radii in the ratio of 1: 2 falls from a great height through the atmosphere. Then the ratio of their momenta after they have attained terminal velocity is

a. 1: 32 b. 1: 16

c. 1: 4 d. 1: 1

16. A steel ball falls through a syrup at a small constant speed of 10 cm/s. If the steel ball is pulled upwards with a force to twice its effective weight. How fast will it more upward?

a. 10 cm/s b. 20 cm/s

c. 30 cm/s d. zero

17. A liquid is flowing in a tube under streamline flow. If the radius of the tube is doubled, the rate of flow becomes

a. 4 times b. 16 times

c. 2 times d. $\sqrt{2}$ times

18. The reading of manometer fitted to a closed top is 4×10^5 N/m^2. If the valve is opened, the reading of the manometer falls to 3×10^5 N/m^2. The velocity of water is

a. 1.41m/sec b. 14.1 m/sec

c. 20m/sec d. 2m/s

19. A rectangular vessel full of water takes 10 minutes to be emptied through an orifice in its bottom. How much time will it take to be emptied when the tank is half filled with water?

a. 5 minutes b. 7 minutes

c. 20 minutes d. 24 minutes

20. Water flows in a tube of diameter 2cm so that flow is streamlined. If the Reynold number is 1000 and coefficient viscosity of water be 10^{-3} kgm^{-1}s^{-1}. Then maximum average velocity of water is

a. 0.1m/s b. 1m/s

c. 0.2m/s d. 2m/s

21. A hole is made at the bottom of a tank filled with water. If the total pressure at the bottom of tank is 3 atmosphere and density of water is 1000 kg/m^3, then velocity of efflux

a. 20m/s b. $10\sqrt{2}$ m/s

c. $10\sqrt{6}$ m/s d. $10\sqrt{5}$ m/s

22. There is 1mm thick layer of glycerine in between a plate of 5cm^2 area and another very large plate. The coefficient of viscosity of glycerine is 10 poise. The force required to move a plate with velocity to more a plate with velocity 7cm/sec is

a. 35N b. 3.5N

c. 0.15N d. 0.035N

Answer Sheet

1. b	*2. b*	*3. c*	*4. a*	*5. b*	*6. d*	*7. d*	*8. b*	*9. b*	*10. a*
11. b	*12. b*	*13. d*	*14. c*	*15. a*	*16. a*	*17. b*	*18. b*	*19. b*	*20. a*
21. a	*22. d*								

SOLUTION

1. Ans. (b)

– Bernoulli is based on conservation of energy.

– Applied to streamline flow of ideal liquid.

2. Ans. (b)

Viscosity of liquid is due to cohesive force which ↑ as temperature ↓.

3. Ans. (c)

Volume emerging per sec = Av = $A\sqrt{2gh}$

Velocity of efflux v = $\sqrt{2gh}$

4. Ans. (a)

$F = 6\pi n\, rv \Rightarrow F \alpha\, r \,\alpha\, V^{\frac{1}{3}}$

5. Ans. (b)

Equation of continuity

Av = constant

$\pi R^2 v$ = const

$v \,\alpha\, \frac{1}{R^2}$

$\frac{v_1}{v_2} = \left(\frac{r_2}{r_1}\right)^2 = \left(\frac{2}{3}\right)^2 = 4: 9$

6. Ans. (d)

Viscous force opposes the motion of flow of the liquid.

7. Ans. (d)

Reynold's number

$K = \frac{\rho r v}{\eta}$

8. Ans. (b)

When air is blown, velocity below pan is high and by Bernoullis principle pressure is low.

$P + \frac{1}{2}\rho v^2$ = constant.

9. Ans. (b)

With rise of temperature intermolecular force decreases so viscosity decreases.

10. Ans. (a)

η of gas $\alpha\sqrt{T}$ so it increases

11. Ans. (b)

Velocity of efflux(V) = $\sqrt{2gh}$ volume of liquid flowing out per sec = V × A

$= \sqrt{2 \times 10 \times 5} \times 10^{-4} = 10^{-3} m^3/s$

12. Ans. (b)

$m = \frac{4}{3}\pi r^3 \rho$ & $8m = \frac{4}{3}\pi R^3 \rho$

$R^3 = 8r^3 \Rightarrow R = 2r$

$v \,\alpha\, r^2$

$\frac{v_1}{v_2} = \left(\frac{2r}{r}\right)^2 \Rightarrow v_1 = 4v$

13. Ans. (d)

$F = 6\pi\eta\, rv$ &

$V = \frac{2}{9}\frac{gr^2(\rho - \sigma)}{\eta} \Rightarrow v \,\alpha\, r^2$

$F \,\alpha\, r^3$

As radius becomes twice, F becomes 8 times.

14. Ans. (c)

$V^1 = n^{\frac{2}{3}} v = (8)^{\frac{2}{3}} \times 5 = 4 \times 5 = 20$ cm/sec

15. Ans. (a)

$v \,\alpha\, r^2$ & $m \,\alpha\, r^3$

$p = mv \Rightarrow p \,\alpha\, r^5$

$\frac{p_1}{p_2} = \left(\frac{1}{2}\right)^5 = 1: 32$

16. Ans. (a)

For the motion with terminal velocity, mg = $6\pi\eta\, rv_1$

When upward force 2mg is applied, the viscous force acts downward.

$2mg - mg = 6\pi\eta\, rv_2$ (v_2= upward velocity)

$6\pi\eta\, rv_1 = 6\pi\eta\, rv_2$

$v_1 = v_2 = 10$ cm/s.

17. Ans. (b)

Rate of liquid flow

$\frac{v}{t} = \frac{\pi P r^4}{8\eta l} \Rightarrow \frac{v}{t} \,\alpha\, r^4$, becomes 16 times.

18. Ans. (b)

Loss in P∈ = gain in k∈

$\Delta P = \frac{1}{2}\rho v^2$

$(4 - 3) \times 10^5 = \frac{1}{2} \times 10 \times v^2$

$v = \sqrt{200} = 14.1$m/s

19. Ans. (b)

As $T \,\alpha\, \sqrt{h}$

$\frac{t_1}{t_2} = \sqrt{\frac{h}{\frac{h}{2}}} = \sqrt{2}$

$t_2 = \frac{t_1}{\sqrt{2}} = \frac{10}{\sqrt{2}}$ = 7min

20. Ans. (a) $V_c = \frac{\kappa\eta}{\rho r} = \frac{2000 \times 10^{-3}}{10^3 \times 0.02}$

$V_c = 0.1$m/s

21. Ans. (a) $V = \sqrt{2gh} = \sqrt{\frac{2\rho gh}{\rho}} = \sqrt{\frac{2P}{\rho}}$

Pressure at bottom due to water

$P = (3 - 1)$ atm $= 2 \times 1.01 \times 10^5$N/m

$V = \sqrt{\frac{2P}{\rho}} = \sqrt{\frac{2 \times 2 \times 1.01 \times 10^5}{1000}} = 20$m/s

22. Ans. (d)

$F = \eta A \frac{dv}{dx}$

$= (10 \times 10^{-1}) \times 5 \times 10^{-4} \times \frac{7 \times 10^{-2}}{10^{-3}}$

$= 35 \times 10^{-3}$N

$= 0.035$N

Past Questions

1. Two drops of water having same radius moving in air downwards with constant velocity V. If the drops coalesced, what will be new velocity? [IOM 2010]

a. $2^{\frac{1}{3}}$ V b. $\left(2^{\frac{2}{3}} - 1\right)$ V

c. $(2)^{\frac{2}{3}}$ V d. $\left(2^{\frac{1}{3}} - 1\right)$ V

2. Two parallel square plates of length 10cm and moving with velocity 10cm/sec pass in liquid of viscosity 0.01 poise. If the force between the plates in liquid is 200 dyne then the separation between the plates is [IOM 2009]

a. 5cm b. 0.5cm

c. 0.05cm d. 0.005cm

3. When temperature of gas is increased its viscosity [IOM 2010]

a. Remains constant

b. Decreases

c. Increases

d. First decrease then increases

4. The terminal velocity of an object in a liquid is 100 m/s. What will be the terminal velocity of the object in the vacuum [MOE 2067]

a. < 100m/s b. > 100m/s

c. = 100m/s d. can't be obtained

5. In a wide river, velocity of water at the middle [MOE 2066]

a. increase with depth

b. same everywhere

c. decrease with depth

d. zero

6. The property of liquid by where it O posses its motion is [MOE 2065]

a. surface tension b. viscosity

c. elasticity d. Rigidity

7. One poise equal to [BPKIHS]

a. 10^{-1}N sm^{-2} b. 10N sm^{-2}

c. 100 N sm^{-2} d. 10^{-2} N sm^{-2}

Answer Sheet

1. c	*2. c*	*3. c*	*4. d*	*5. c*	*6. b*	*7. a*

SOLUTION

1. Ans. (c)

$2 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$R = 2^{\frac{1}{3}} r$

Terminal velocity (v) $= \frac{2gr^2(\rho - \sigma)}{9\,\eta}$

$V \propto r^2$ $\quad v^1 = 2^{\frac{2}{3}} V$

2. Ans. (c)

$F = -\eta A \frac{dv}{dx}$ (Newton's formula)

$200 = 0.01 \times 10^2 \times \frac{10}{dx}$

dx = 0.05cm

All are in c.g.s

(SI) 1 poiseuilli = 10 poise (c.g.s)

3. Ans. (c)

Viscosity of gas increases with increase in temperature while viscosity of liquid decrease with increase in temperature.

4. Ans. (d)

In vacuum there is no resisting force so terminal velocity can't be obtained.

5. Ans. (c)

Bernoulli equation $P + \frac{1}{2}\rho v^2$ = constant

At middle, depth ↑, pressure↑ so velocity decrease.

6. Ans. (b)

Viscosity is a fluid friction.

7. Ans. (a)

Poise (C.G.S unit) & decapoise or poiseuilli (S.I unit)

1 Poiseuilli = 10 poise.

Chapter: 15

HYDROSTATICS

A. body is floating in a liquid. The upthrust on the body is

a. equal to wt. of liquid displaced.
b. less than wt. of liquid displaced.
c. weight of body –wt. of liquid displaced
d. zero

2. For a body floating in water. The apparent weight is

a. actual weight of body
b. weight of liquid displaced
c. weight of body–weight of liquid displaced
d. zero

3. A piece of ice is floating in a jar containing water. When ice melts, the temperature of water falls from 25°c to 4°c then level of water

a. rises b. falls
c. remains unchanged d. None

4. A piece of ice is floating in a jar containing water. When ice melts the temperature of water falls from 4°C to 2°C then the level of water

a. rises b. falls
c. remains unchanged d. None

5. A piece of ice is floating in a jar containing water. When the ice melts, the level of water

a. rises b. falls
c. remain unchanged
d. rises or falls depending upon the size of ice piece.

6. A block of ice is floating in a liquid of sp. gr. 1.2 contained in a beaker. When ice melts completely, the level of liquid in a vessel

a. increases b. decreases
c. remains unchanged
d. first increase and then decrease

7. The value of g at a place decreases by 2%. The barometric height of mercury

a. increase by 2% b. decreases by 2%
c. remain unchanged d. unpredictable

8. Two stretched membranes of areas $2m^2$ and $3m^2$ are placed in a liquid at the same depth. The ratio of pressure on them is

a. 1: 1 b. 2: 3
c. $\sqrt{2}:\sqrt{3}$ d. 4: 9

9. What fraction of a wooden raft of density 0.8 g/cc will be outside the sea water of density 1.2g/cc?

a. $\frac{2}{3}$ b. $\frac{1}{2}$
c. $\frac{2}{5}$ d. $\frac{1}{3}$

10. A beaker has oil of relative density 1.2 upto a height of 3cm. on top of the oil is a water column of height 10cm. If the relative density of mercury is 13.6, the pressure at the bottom of the beaker is

a. 1cmof Hg b. 5cm of Hg
c. 13cm of Hg d. 15cm of Hg

11. A block of solid is insoluble in water and a given liquid of specific gravity 1.1. The block weigh 24 g in air and 21g when completely immersed in water. What will be its weight when it is completely immersed in a liquid?

a. 19.9g b. 20.7g
c. 22.1g d. 21.6g

12. A body weighs 160g in air and 130g in water and 136g in oil. The specific of oil is

a. 0.8 b. 1.8
c. 1.3 d. 3.2

13. Which of the following would a hydrogen balloon find easier to lift?

a. 1kg of steel b. 1kg of water
c. 1kg of feather d. all the same

14. A balloon has a volume of $1000m^3$. It is filled with hydrogen of density $0.09kg/m^3$. If the density of air is 1.29 g/m^3. It can lift a total weight of

a. 1800kg b. 1200kg
c. 600 kg d. 300kg

15. A wooden cube floats in water partially immersed. When a 200gm weight is put on the cube, it is further immersed by 2cm. The length of the side of the cube is

a. 10cm b. 20cm
c. 15cm d. 25cm

16. A raft of wood (density $600kg/m^3$) of mass 120kg floats in water. How much weight can be put on the raft to make to just sink?

a. 120kg b. 200kg
c. 40kg d. 80kg

17. A body floats with one third of its volume outside water and three fourth of its volume outside another liquid. The density of another liquid is

a. $\frac{9}{4}$ gm/cc b. 4.9gm/cc
c. $\frac{8}{3}$ gn/cc d. $\frac{3}{8}$ gm/cc

18. A certain piece of metal weighs 5g in air, 3g in water and 3.4g in benzene. The density of the benzene would be

a. 1.8g/cc b. 0.5g/cc
c. 0.88g/cc d. 3.52g/cc

19. An iceberg $2100cm^3$ of density $0.8g/cm^3$ is floating in sea water (density – $1.2g/cm^3$). Then the volume of iceberg immersed in water is

a. $1500cm^3$ b. $1400cm^3$
c. $1600cm^3$ d. $1800cm^3$

20. A large block of ice 10m thick has a vertical hole drilled through it and it is floating in the middle of a lake. Which is minimum length length of a rope required to scoop up a bucket full of water through the hole (density of ice = 0.9gm/cc)

a. 10m b. 9m
c. 1m d. 5m

21. A fisherman hooks an old log of wood of weight 12N and volume $1000cm^3$. He pulls out the log half out of water. The tension in his line at that instant is

a. 12N b. 10N
c. 7N d. 5N

22. When a bubble rises from the bottom of lake to the surface its radius doubles. The atmospheric pressure is equal to column of water of water of Height H. The depth of lake is

a. H b. 2H
c. 7H d. 8H

23. A metallic sphere with an internal cavity has 40g weight air and 20g weight in water. If density of metal is 8g/cc. The volume of cavity is

a. zero b. 15cc
c. 5cc d. 20cc

Answer Sheet

1. a	*2. d*	*3. b*	*4. a*	*5. c*	*6. a*	*7. c*	*8. a*	*9. d*	*10. a*
11. b	*12. a*	*13. c*	*14. b*	*15. a*	*16. d*	*17. c*	*18. c*	*19. b*	*20. c*
21. c	*22. c*	*23. b*							

SOLUTION

1. Ans. (a)
Archimede's principle: Decrease in wt when immersed in liquid = upthrust = wt of liquid displaced.

2. Ans. (d)
Weight and upthrust are equal & opposite so apparent weight is zero.

3. Ans. (b)
Water contracts up to 4°c. so the level falls

4. Ans. (a)
Water expands from 4°C to 2°C so it rises.

5. Ans. (c) When ice melts the volume of water formed by it is equal to volume of water displaced by ice.

6. Ans. (a) As density of liquid is more, ice do not immerse completely so volume of water after melting of ice is more than volume of liquid displacement while floating.
7. Ans. (c) Because barometric height is independent of 'g'.
8. Ans. (a) Hydrostatic pressure is independent of area but depends only on depth of a body inside a liquid [P = hρg]
9. Ans. (d) Fraction immersed $\frac{v^1}{v} = \frac{\rho}{\sigma} = \frac{0.8}{1.2} = \frac{2}{3}$

   Fraction outside = $1 - \frac{2}{3} = \frac{1}{3}$
10. Ans. (a) If pressure at the bottom is equal to height h of Hg, then
    $\rho gh = \rho gh_1 + \rho_2 gh_2$
    $(13.6)h = (1.2) \times 3 + 1 \times 10$
    h = 1cm
    Hence pressure is 1cm of Hg
11. Ans. (b) Specific gravity of block = $\frac{24}{24-21} = 8$

    So, volume of block = $\frac{24}{8} = 3$

    When it is immersed in the given liquid of specific gravity 1.1 then its weight is
    wt in liquid = wt. in air -upthrust
    = 24 – 3 × 1.1 = 24 –3.3g = 20.7g
12. Ans. (a) Specific gravity of liquid
    $= \frac{\text{Loss of wt. of body in liquid}}{\text{Loss of wt. of body in water}}$
    $= \frac{160-136}{160-130} = \frac{24}{30} = 0.8$
13. Ans. (c) Feather has more volume so it experiences more upthrust. As a result, it will be easier to lift it.
14. Ans. (b)
    Lifting force = up thrust – weight of balloon
    F = 1.29 × 1000 × g – 0.09 × 1000 × g
    F = 1200 × g
    mass m = $\frac{F}{g}$ = 1200g
15. Ans. (a) Weight of body = weight of liquid displaced
    mg = vρg
    $\frac{200}{100} = l \times l \times \frac{2}{100} \times 1000$
    l = 0.1m = 10cm
16. Ans. (d)
    Volume of raft of wood = $\frac{m}{\rho} = \frac{120}{600} = 0.2m^3$
    wt. of water displaced = vρg
    = 0.2 × 1000g = 200g i.e. mg = 200g
    m = 200kg
    Mass of water displaced = 200kg
    Additional mass which can be added = 200 – 120 = 80kg
17. Ans. (c) If v_1 is the volume of the body inside water and v_2 is the volume of the body inside another liquid and v be its total volume
    $\frac{v_1}{v} = \frac{\rho}{\rho_w} \qquad \frac{v_2}{v} = \frac{\rho}{\rho_l}$
    $\frac{v_1}{v_2} = \frac{\rho_l}{\rho_w} = \frac{\rho_l}{1} = \rho_l$
    $\rho_l = \frac{v_1}{v_2} = \frac{\frac{2}{3}}{\frac{1}{4}} = \frac{8}{3}$gm/cc
18. Ans. (c) Density in cgs is equal to relative density or specific gravity.
    R.D = $\frac{W - W_L}{W - W_w} = \frac{5-3.24}{5-3}$
    $= \frac{1.76}{2}$ = 0.88g/cc
19. Ans. (b) Volume immersed $v^1 = \left(\frac{\rho}{\sigma}\right) v$
    $v^1 = \left(\frac{0.8}{1.2}\right) \times 2100 = 1400cm^3$
    ρ → density of body & σ → of liquid
20. Ans. (c)
    The density of the ice is 0.9gm/cc. So the ice block is $\frac{9}{10}$ part inside water. Therefore, minimum length of rope = $\frac{1}{10} \times 10$ = 1m
21. Ans. (c)
    Log is half out of water, the volume of water displaced is by its half part (5oocm^3) upthrust = weight of water displaced by 500cm^3
    $= v\rho g = \frac{500}{10^6} \times 1000 \times 10 = 5N$
    Tension = weight – upthrust = 12 – 5 = 7N.

22. Ans. (c)

As r doubles v $\rightarrow$ 8 times P $\alpha \frac{1}{v}$. So,P $\downarrow$ by 8times. 8P $\rightarrow$ pressure bottom, P $\rightarrow$ pressure at surface.

Pressure (bottom) = Atmospheric pressure + hρg

8P = P + hρg

7P = hρg

7Hρg = hρg $\Rightarrow$ h = 7H

23. Ans. (b)

Volume of sphere with cavity

(v^1) = volume of water displaced

$v^1 = \frac{\text{Mass of water displaced}}{\text{Density of water}}$

$= \frac{40 - 20}{1} = 20cm^3$

Volume of sphere without cavity = $\frac{40}{8} = 5cm^3$

Volume of cavity = 20 – 5 = 15.

Past Questions

1. **A piece of ice floats in water. What happen to level of water when ice melts? [IOM 2011]**
   a. Remains unchanged
   b. increases
   c. decreases
   d. may increase or decrease
2. **The specific gravity of sugar is 1.59. Which one is correct density in S.I system? [IOM 2010]**
   a. 1.59 b. 159
   c. 15.9 d. 1590
3. **How much lead of specific gravity 11 should be added to piece of cork sp. gr. 0.2 weighting 10gm so that it may just float in water? [IOM 2009]**
   a. 10g b. 20g
   c. 44g d. 50g
4. **A boat having a length 3m and breadth 2m is floating on a lake. The boat sinks by 1cm when a man gets on it. The mass of the man is [IOM 2004]**
   a. 60kg b. 72kg
   c. 48kg d. 90kg
5. **Metal A having its density 15 and metal B having its density 20 are mixed together by 25% and 75% respectively. Density of new alloy is [IOM 1995]**
   a. 18.75 b. 16.25
   c. 20.75 d. 15.25
6. **Two liquid A and B of density 0.8 kg/m^3 and 1.4kg/m^3 respectively are mixed to prepare a homogenous mixture of density 1 kg/m^3. The ratio of their volumes (v_A /v_B) will be [MOE 2069]**
   a. 1: 2 b. 2: 1
   c. 7: 8 d. 8: 7
7. **What is the resultant density of mixture of two substances A and B having density 8kg/m^3 and 4kg/m^3 respectively if 1kg of both are mixed? [MOE 2068]**
   a. 5.3 b. 5.6
   c. 6.3 d. 4.4
8. **Buoyancy depends on [MOE 2063]**
   a. shape b. depth
   c. mass of object
   d. mass of liquid displaced
9. **A body weights 60g in air and 40 in water. The specific gravity of the body is [IOM]**
   a. 3 b. 1.5
   c. 2 d. 0.5
10. **The condition for the floating body in equilibrium is: [IOM 2012]**
    a. Metacentre concides centre of gravity
    b. Metacentre above c.g.
    c. Metacentre below c.g.
    d. Metacentre coincides centre of buoyancy.
11. **The upthrust on the body floating over a liquid which is freely falling under gravity is: [BPKIHS 2001]**
    a. zero b. eqal to weight of the body

c. greater than weight of body

d. none

Answer Sheet

1. a	2. d	3. c	4. a	5. a	6. b	7. a	8. d	9. a	10. c	11. a

SOLUTION

1. Ans. (a)

When ice melts the volume of water formed by melted ice is equal to volume of water displaced by ice.

2. Ans. (d)

Specific gravity of a substance is the numerical value of its density in g/cm^3.

Density $= 1.59 \times 10^3 kg/m^3$

$= 1590 kg/m^3$

3. Ans. (c)

Total weight = weight of water displaced

$m_1g + m_2g = (v_1 + v_2)\rho_w g$

$m_1 + 10 = \left(\frac{m_1}{11} + \frac{10}{0.2}\right) \times 1$

$m_1 = 44g$

4. Ans. (a)

Weight of the man = weight of the liquid displaced=$v\rho g = mg = 3\times2\times1\times10^{-2}\times 1000g$

$m = 60kg$

5. Ans. (a)

Density $= \frac{m_1 + m_2}{v_1 + v_2}$

$= \frac{\rho_1 v_1 + \rho_2 v_2}{v_1 + v_2}$

$= \frac{15 \times 25 + 50 \times 25}{100} = 18.75$

6. Ans. (b)

Since mass is conserved

$M = m_1 + m_2$

$d \times V \text{ mix} = d_1v_1 + d_2v_2$

$1 \times V \text{ mix} = 0.8v_1 + 1.4v_2$

$v_1 + v_2 = 0.8v_1 + 1.4v_2$

$0.2v_1 = 0.4v_2$

$\frac{v_1}{v_2} = 2 : 1$

7. Ans. (a)

ρ resultant $= \frac{m_1 + m_2}{v_1 + v_2}$

If mass = same

$= \frac{2m}{\frac{m}{\rho_1} + \frac{m}{\rho_2}}$

$= \frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$

$= \frac{2 \times 8 \times 4}{8 + 4}$

$= \frac{64}{12} = 5.3$

8. Ans. (d) Buoyancy or upthrust on a solid kept inside a liquid = $v\rho g$ (ρ = density of liquid

So, it depends on mass of liquid displaced.

9. Ans. (a)

Specific gravity $= \frac{\text{wt in air}}{\text{loss of weight}}$

$= \frac{60}{60 - 40} = 3$

10. Ans. (c)

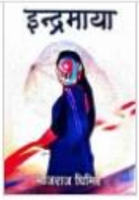
Body is in stable equilibrium if m.c. lies above c.g. and body is in unstable equilibrium if m.c. lies below c.g.

11. Ans. (a)

Gravity is zero during freefall so wt. is zero.

Upthrust = wt. of liquid displaced

In absence of weight is zero gravity hence upthrust is also zero.



इन्द्रमाया

अनुराग

यथार्थवाद र नेपाली कथा परम्परामा आधुनिक कालको प्रणयन


न्यूरोडका झाँकी


कोइकभित्रको हाँसो

छुई

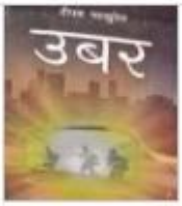
माछो माछो भ्यागुतो

खण्डकाव्य त्र्योदश


प्रजातन्त्रदेखि गणतन्त्रसम्मका उपलब्धिहरू (२००७ देखि २०७७ सम्म)

कन्था

बहत्तर वसन्त



उबर

मा


प्रिय मौनता

साहित्यको अनुसन्धान व्यवस्थापन

यौन शिक्षा

हिमाल, शेर्पा र यती

लालस

Chapter: 16

THERMOMETRY

1. One which of the following scales of temperature, the temperature is never negative

a. Celsius b. Fahrenheit
c. Reumer d. Kelvin

2. At absolute zero

a. all substances exists in solid form
b. molecular motion ceases
c. water becomes ice d. None

3. The equivalence of two systems in thermal equilibrium is represented by the property of

a. heat b. energy
c. temperature d. specific heat

4. Two thermometers are constructed in such a way that one has a spherical bulb and others has elongated bulb. Which one will respond more quickly to temperature changes?

a. with cylindrical bulb
b. with spherical bulb
c. both respond similarly
d. any one may respond quickly depending on value of temperature.

5. Mercury boils at 367°c. However, mercury thermometers are made such that they can measure temperature up to 500°c. This is done by

a. maintaining vacuum above Hg column in the stem of thermometer
b. filling N_2 gas at high pressure above mercury column
c. filling N_2 gas at lower pressure above the mercury
d. filling O_2 gas at high pressure above mercury column

6. The temperature of sun is measured by

a. platinum thermometer
b. gas thermometer
c. pyrometer
d. vapour pressure thermometer

7. Helium sample is at 4k. Which thermometer would you use for measuring this temperatures

a. constant volume gas temperature
b. mercury thermometer
c. Platinum resistance thermometer
d. vapour pressure thermometer

8. A difference of temperature of 25°c is equivalent to a difference of

a. 45°F b. 72°F
c. 32°F d. 25°F

9. A difference of temperature of 25°c is equivalent to a difference of

a. 25k b. (273 + 25) k
c. (273 – 25) k d. 45k

10. Two thermometers one Celsius and other Fahrenheit are put on a hot bath. The reading on Fahrenheit scale is just three times the reading on Celsius thermometer. The reading of the bath is

a. 100°c b. $\left(\frac{80}{3}\right)$ °c
c. 80°c d. 70°c

11. At what temperature will Raumer thermometer show same reading as a Fahrenheit Thermometer?

a. –25.6°F b. –40°F
c. –459°F d. 0°F

12. A centigrade and a Fahrenheit thermometer are dipped in water. The water temperature is lowered until the Fahrenheit thermometer registers 140°F. What is the fall in temperature registered by centigrade thermometer?

a. 30°c b. 40°c
c. 50°c d. 60°c

13. A higher and lower fixed points on a thermometer are separated by 160mm. When length of the mercury thread above the lower temperature is 40mm the temperature reading will be

a. 40°c b. 120°c
c. 32°c d. 25°c

14. A faulty temperature has its fixed point marked 5° and 95°. This thermometer reads the temperature of the body as 59°c. The correct temperature on a Celsius scale is

a. 60°c b. 59°c
b. 48.6°c d. 58°c

15. A faulty thermometer reads melting point of ice as – 10°c. It reads 60°c in place of 50°c. What is the temperature of boiling point of water on this scale?

a. 90°c b. 110°c
c. 125°c d. 130°c

16. The resistance of a resistance thermometer has value 2.71Ω and 3.7Ω at 10°c and 100°c. The temperature at which the resistance is 3.26Ω is:

a. 40°c b. 50°c
c. 60°c d. 70°c

17. The resistance of resistance thermometer has values 6.74Ω and 7.74Ω at 0°c. What is the resistance at 50°c?

a. 7.56Ω b. 7.24Ω
c. 7.64Ω d. 7.52Ω

18. A constant volume gas thermometer shows pressure reading 50cm and 90cm of mercury at 0°c and 100°c respectively. When the pressure reading is 60cm of mercury? The temperature is

a. 12°c b. 12.5°c
c. 25°c d. 40°c

Answer Sheet

1. d	*2. b*	*3. c*	*4. a*	*5. b*	*6. c*	*7. d*	*8. a*	*9. a*	*10. b*
11. a	*12. b*	*13. d*	*14. a*	*15. d*	*16. c*	*17. b*	*18. c*		

SOLUTION

1. Ans. (d)

O°k = –273°c = absolute zero temperature. It is the lowest possible temperature. No matter exists below it.

2. Ans. (b)

If 0° K, all molecular motion stops.

3. Ans. (c)

Two bodies at same temperature donot exchange heat called thermal equilibrium.

4. Ans. (a)

Thermometer with cylindrical bulb is more sensitive because surface area is more for cylindrical bulb. Hence rate of heat gain is fast

5. Ans. (b)

– On filling N_2 gas at high pressure above mercury, the boiling point of mercury is increased that can extend up to 50°c.

– Oxygen is not used as it may be can burn at high pressure.

6. Ans. (c)

Pyrometer used to measure the temperature of sun.

7. Ans. (d)

Since the range of vapour pressure thermometer is 0.7k to 120k.

8. Ans. (a)

Difference of 100°c = difference of 180°F.

difference of 25°c = $\left(\frac{180}{100}\right) \times 25 = 45°F$

9. Ans. (a)

$\frac{\Delta c}{100} = \frac{\Delta F}{180} = \frac{\Delta k}{100} = \frac{\Delta R}{80}$

$\Delta c = \Delta k. \Rightarrow \Delta k = 25k.$

10. Ans. (b)

Let celcius temperature be x

$\frac{c}{5} = \frac{F-32}{9}$

$\frac{3x-32}{9} = \frac{x}{5}$

$6x = 160$

$x = \left(\frac{80}{3}\right)°c$

11. Ans. (a)

$\frac{R-0}{80} = \frac{F-32}{180} \Rightarrow \frac{x}{4} = \frac{x-32}{9}$

$x = -\frac{128}{5} = -25.6.$

$-25.6°R = -25.6°F$

12. Ans. (b)

$\Delta F = 212°F - 140°F = 72°F$

(B.P of water = 212°F)

$\frac{\Delta c}{100} = \frac{\Delta F}{180} \Rightarrow \Delta c = \frac{5}{9}\Delta F$

$\Delta c = \frac{5}{9}\Delta F = \frac{5}{9} \times 72 = 40°c$

13. Ans. (d)

$\frac{T - LFP}{UFP - LFP} = \text{constant}$

Let temperature be θ

$\frac{\theta - 0}{100 - 0} = \frac{40-0}{160-0}$

$\theta = 25°c.$

14. Ans. (a)

$\frac{T - LFP}{UFP - LFP} = \text{constant}$

$\frac{T-0}{100-0} = \frac{59-5}{95-5}$

$= \frac{54}{90} = \frac{6}{10}$

$\frac{T}{100} = \frac{6}{10} \Rightarrow T = 60°c$

15. Ans. (d)

$\frac{T - LFP}{UFP - LFP} = \text{constant}$

$\frac{50-0}{100-0} = \frac{60-(-10)}{UFP-(-10)}$

$UFP = 140 - 10 = 130°c$

16. Ans. (c)

$\Delta R = R\,\alpha\,\Delta\theta$

$3.7 - 2.71 = 2.71 \times \alpha \times (100 - 10)$ – (i)

$3.26 - 2.71 = 2.71 \times \alpha \times (t - 10)$ – (ii)

$\frac{0.99}{0.55} = \frac{90°}{t-10}$ (Dividing (i) by ii)

$t = 50 + 10 = 60°c.$

17. Ans. (b)

$t = \frac{R_t - R_o}{R_{100} - R_o} \times 100$

$50 = \frac{R_{50} - 6.74}{7.74 - 6.74} \times 100$

$R_{50} = 7.24\Omega$

18. Ans. (c)

$t = \frac{P_t - P_0}{P_{100} - P_0} \times 100$

$= \frac{60-50}{90-50} \times 100 = 25°c$

Past Questions

1. What is the value of –40° Fahrenheit in Celsius scale? [IOM 2010]

a. – 104°c b. 8°c c. – 40°c d. 20°c

2. 40°c is equal to [IOM 2000, MOE 2008]

a. 100°F b. 102°F

c. 104°F d. 106°F

3. The absolute zero temperature is [IOM 96]

a. – 273°c b. – 273°k

d. – 273.14°c d. – 273.15°c

4. The common mercury thermometer can be used to measure temperature between [IOM 04]

a. – 30°c to 100°c

b. – 0°c to 200°c

c. – 30°c to 200°c

d. – 30°c to 357°c

5. The temperature of a body recorded by Celsius thermometer is –50°c. Its temperature recorded by Kelvin scale is [MOE 066]

a. 223k b. 323k

c. 23k c. – 50k

6. Mercury thermometer can be used to measure temperature up to[BPKIHS 08]

a. 100°c b. 260°c

c. 360°c d. 500°c

Answer Sheet

1. c	*2. c*	*3. d*	*4. d*	*5. a*	*6. c*

SOLUTION

1. Ans. (c)

$$\frac{C-0}{100} = \frac{F-32}{180} \Rightarrow \frac{C}{100} = \frac{-40-32}{180}$$

C = – 40 ∴ – 40°F = – 40°c

2. Ans. (c)

$$\frac{C-0}{100} = \frac{F-32}{180} \Rightarrow \frac{40}{100} = \frac{F-32}{180}$$

F – 32 = 72 ⇒ F = 104°

3. Ans. (d)

Absolute zero = 0K

= – 273.15°c

4. Ans. (d)

Mercury thermometer → – 30°c to 357°c

Alcohol thermometers→ –110°c to 80°c

5. Ans. (a)

Temperature in Kelvin = – 50 + 273 = 223k.

6. Ans. (c)

Mercury thermometer

= – 30°c to 357°c.

Chapter: 17

THERMAL EXPANSION

1. Which of the following has maximum value for a given material?
a. linear expansivity
b. cubical expansivity
c. superficial expansivity
d. All have equal value at same temperature

2. 50 gram of benzene weights
a. more in summer
b. more in winter
c. equal in summer & winter
d. None

3. 50 gram of benzene occupies
a. more in summer than in winter
b. equal in summer and in winter
c. less in summer than in winter
d. equal volume always.

4. 50ml of benzene weights
a. more in summer than in winter
b. equal in summer and winter
c. more in winter than in summer
d. zero always

5. A copper disc has a hole. If the disc is heated the size of hole.
a. increases
b. decreases
c. remains unchanged
d. first decreases then increases

6. Two copper rods of equal lengths but unequal diameters are heated through same range of temperature. The increases in length will be
a. more for thiner rod
b. more for thicker rod
c. same for both rods
d. None

7. By increasing the temperature of liquid its density
a. increases
b. decreases
c. remains unchanged
d. sometimes increases, sometimes decreases

8. A beaker is completely filled with water at 4°c. It is over flow when
a. heated b. cooled
c. Both heated or cooled
d. None

9. When water is heated from 0°c to 10°c, its volume
a. increases
b. decreases
c. unchanged
d. first decrease then increase

10. Two spheres one solid and other hollow both of same material and same radius are heated to same temperature, then expansion will be more in
a. solid b. hollow
c. same in both d. None

11. Two sphere one solid and other hollow both of same material and same radius are given same heat. The expansion will be more in
a. solid b. hollow
c. some in both d. None

12. A metallic piece is being weighed in a liquid whose temperature is being raised continuously. Then the apparent weight of metallic piece
a. decreases
b. increases
c. remains unchanged
d. None

13. If a bimetallic strip is heated it will

a. bends & towards the metal with lower thermal expansion coefficient

b. bends towards the metal with higher thermal expansion coefficient

c. remains unchanged

d. Twist itself into a helix

14. On heating liquid of cubical expansion α in a container having linear expansion $\frac{\alpha}{3}$, the level of water in the container will

a. rise b. fall

c. remains almost stationary

d. unpredictable

15. A liquid with coefficient of volume expansion with γ is filled in a container with coefficient of linear expansion α. If the liquid over flows on heating, then

a. $\gamma = 3\alpha$ b. $\gamma > 3\alpha$

c. $\gamma < 3\alpha$ d. $\gamma > 3\alpha^3$

16. The coefficient of linear expansion is α per degree Celsius. If the temperature is measured on Fahrenheit scale, the coefficient of linear expansion will be

a. α per deg F d. $\frac{5}{9}$ per deg F

c. $\frac{9}{5}$ per deg F d. 0.5 α per deg F

17. The density of water at 20°C is 998 kg/m^3. and at 40°C it is 992kg/m^3. Then the mean coefficient of cubical expansion is

a. 1×10^{-4}/°C b. 2×10^{-4}/°C

c. 3×10^{-4}/°C d. 6×10^{-4}/°C

18. An iron cube floats in a vessel containing mercury at 20°C. If the temperature is increased by 100°C the cube will float

a. lower

b. higher

c. at same level

d. lower or higher depending on mass of cube

19. The length of an edge of a cube increase by 2% when it is heated by 50°C. The volume of cube will increase by

a. 2% b. 4%

c. 6% d. 8%

20. The coefficient of cubical expansion of brass and iron are 54 × 10^{-4} °C^{-1} and 36 × 10^{-6} °C^{-1} respectively. If brass and iron rods show the same difference of length at all temperature their lengths are in the ratio

a. 3: 2 b. 2: 3

c. 9: 4 d. 4: 9

21. The moment of Inertia of a rod is I and the coefficient of linear expansion is α. If the temperature rises by a small amount $\Delta\theta$, then the change of moment of inertia is nearly

a. $I \alpha \Delta\theta$ b. $2I \alpha \Delta\theta$

c. $4I \alpha \Delta\theta$ d. $6I \alpha \Delta\theta$

22. Steel rails 40m long are laid on a day when the temperature is – 10°C. The space that must be left between the rails to allow the expansion at a temperature of 40°c is (coefficient of linear expansion = 12 × 10^{-6}.c^{-1})

a. 0.012m b. 0.014m

c. 0.024m d. 0.01m

23. How much temperature of a brass rod (α = 2 × 10^{-5} °C^{-1}) should be increased so as to increase its length by 1%?

a. 100°C b. 200°C

c. 250°C d. 500°C

24. A steel tape gives correct measurement at 20°C. A piece of wood is being measured with steel tape at 0°C. The reading is 25cm on the tape. The real length of the piece of wood must be

a. 25m b. < 25cm

c. > 25cm d. None

25. A iron tyre is to be fitted onto a wooden wheel 1m in diameter. The diameter of the tyre is 6mm smaller than of the wheel. The tyre should be heated so that its temperature increases by a minimum of (coefficient of volume expansion on of iron = 3.6 × 10^{-5} °C)

a. 167°C b. 500°C

b. 1000°C d. 334°C

26. A pendulum clock gains 5 seconds per day at 16°C and loses 15 seconds per day at 40°C. Then the clock keeps correct time at

a. 24°C b. 22°C

c. 20°C d. 30°C

27. A pendulum clock keeps correct time at 20°C. If room temperature is 25°C and the linear temperature coefficient of metal used is 1.2 × 10^{-5}/°C. Then clock will

a. loss 5s per day b. lose 2.6s per day

c. gain 5s per day d. gain 2.6s per day

28. A pendulum clock keeps correct time at 20°C. The temperature falls to 10°C. If the coefficient of linear expansion of metal used is 2 × 10^{-5}°C^{-1}. Then the number of seconds lost or gained by the clock per day is

a. loses 8.64sec b. gains 8.64sec

c. loses 19.28sec d. gains 19.2sec

Answer Sheet

1. b	*2. c*	*3. a*	*4. c*	*5. a*	*6. c*	*7. b*	*8. c*	*9. d*	*10. c*
11. b	*12. b*	*13. a*	*14. c*	*15. b*	*16. b*	*17. c*	*18. a*	*19. c*	*20. b*
21. b	*22. c*	*23. d*	*24. b*	*25. b*	*26. b*	*27. b*	*28. b*		

SOLUTION

1. Ans. (b)

For same rise in temperature α:β:γ = 1: 2: 3

2. Ans. (c)

Mass remains constant with change in temperature.

3. Ans. (a)

$\rho s = \frac{\rho_w}{1 + \gamma\,\Delta\theta}$, $Vs = \frac{m}{\rho s}$

$= \frac{m}{\frac{\rho_w}{1+\gamma\Delta\theta}} = \frac{m}{\rho_w}(1 + \gamma\Delta\theta) = V_w\,(1 + \gamma\Delta\theta)$

$Vs > V_w$

4. Ans. (c) $M_S = v\rho_s = \frac{V\rho_w}{1 + \gamma\Delta\theta}$

$M_S < M_w$

50ml weights more in winter.

5. Ans. (a) Whole disc expands, diameter of hole increases.

6. Ans. (c)

$\Delta l = l_o\,\alpha\Delta\theta$, independent of diameter.

7. Ans. (b)

$\rho = \frac{m}{v} = \frac{m}{V_o(1 + \gamma\Delta\theta)}$

$= \rho_o\,(1 - \gamma\Delta\theta)$

So, density decreases.

8. Ans. (c)

Water has least volume at 4°c i.e. maximum density of water at 4°c.

9. Ans. (d)

Its volume decreases upto 4°c and then increase.

10. Ans. (c)

$(\Delta V)_S = Vo\gamma\Delta\theta$

$(\Delta V)_H = Vo\gamma\Delta\theta$

(ΔV) same in both cases.

11. Ans. (b)

$(\Delta Q)_S = m_S\, c\, (\Delta\theta)_S$

$(\Delta Q)_H = m_H\, c\, (\Delta\theta)_H$

$(\Delta\theta)\ \alpha\ \frac{1}{m}$

$m_S > m_H \Rightarrow (\Delta\theta)_H > (\Delta\theta)_S$

12. Ans. (b)

When temperature increases density of liquid decreases, upthrust decrease hence apparent weight increases.

13. Ans. (a)

When a bimetallic strip is heated the rod with smaller α will be on concave side and larger α on convex side i.e. bimetallic strip bends towards smaller α when heated & reverse when cooled.

14. Ans. (c)

Cubical expansion of container = $3 \times \frac{\alpha}{3} = \alpha$ = that's of liquid. So level of liquid almost remains stationary.

15. Ans. (b)

For overflow

$\gamma a > o$

$\gamma r - \gamma g > o$

$\gamma r > \gamma g$

$\gamma r > 3\alpha$

16. Ans. (d)

$$\alpha/°C = \frac{\alpha}{\text{change in } 1°C}$$

$$= \frac{\alpha}{\text{change in } 1.8°F} = \frac{5}{9}\ \alpha/°F$$

$$\alpha/°C = \frac{5}{9}\ \alpha/°F$$

17. Ans. (c)

$$\rho = \frac{\rho o}{1 + \gamma o\theta}$$

$$\gamma = \frac{\rho o - \rho}{\rho\Delta\theta} = \frac{998 - 992}{992(40 - 20)}$$

$= 3 \times 10^{-4}/°C$

18. Ans. (a) Density of mercury decrease more in comparison to volume of iron cube. So the cube floats lower.

19. Ans. (c)

$V = L^3$ %change in V = $3 \times 2 = 6\%$

20. Ans. (b)

$\Delta L = L\ \alpha\ \Delta\theta$

ΔL, $\Delta\theta$ are given constant

$L_1\,\alpha_1 = L_2\,\alpha_2$

$$\frac{L_1}{L_2} = \frac{\alpha_2}{\alpha_1} = \frac{\gamma_2}{\gamma_1} = \frac{36 \times 10^{-6}}{54 \times 10^{-6}} = \frac{2}{3}$$

21. Ans. (b) Moment of Inertia

$I = ML^2$

$$\frac{\Delta I}{I} = \frac{\Delta L}{L} = 2\ \alpha\ \Delta\theta$$

$\Delta I = 2I\ \alpha\ \Delta\theta$

22. Ans. (c)

$\Delta L = L\ \alpha\ \Delta\theta = 40 \times 12 \times 10^{-6} \times 50 = 0.024$m

23. Ans. (d) $\Delta L = L\ \alpha\ \Delta\theta$

$$\frac{\Delta L}{L} = \alpha\ \Delta\theta$$

$$\frac{1}{100} = 2 \times 10^{-5} \times \Delta\theta \qquad \Delta\theta = 500°C$$

24. Ans. (b)

$L_{20} = L_O\,(1 + \alpha\,(0 - 20)) = L_O\,(1 - 20\alpha)$

$L_{20} = 25\,(1 - 20\alpha) < 25$cm

25. Ans. (b) In order to fit the iron tyre; its diameter should be increased by

$6\text{mm} = 6 \times 10^{-3}$m

$\Delta D = D_O\ \alpha\ \Delta\ \theta$

$$\Delta\theta = \frac{\Delta D}{Do\alpha} = \frac{6 \times 10^{-3}}{1 \times \frac{1}{3} \times 3.6 \times 10^{-5}} = 500°C$$

26. Ans. (b)

Let clock keeps correct time at θ°C with time period To

$\Delta T = T\ \alpha\Delta\ \theta$

$5 = \alpha T_o\,(\theta - 16)$

$15 = \alpha T_o\,(40 - \theta)$

$$3 = \frac{40 - \theta}{\theta - 16} \Rightarrow \theta = 22°C.$$

27. Ans. (b)

At higher temperature, clock lose time

$\Delta T = \frac{1}{2}\ T\ \alpha\ \Delta\theta$

$= 43200 \times 1.2 \times 10^{-5} \times (25 - 30)$

$= 2.59s\ = 2.6s/\ day$

28. Ans. (b)

$\frac{\Delta T}{T} = \frac{1}{2}\alpha\Delta\ \theta$

$= \frac{1}{2} \times 2 \times 10^{-5} \times 10 = 10^{-4}$

$\Delta T = 86400 \times 10^{-4}$

$= 8.64sec$

As temperature falls, clock gains time.

Past Questions

1. **The length of metal is 100cm and the linear expansivity of the metal is 0.00002 k^{-1}.By how much cms will it contract when cooled through 50°k? [IOM 2008]**

a. 1.001cm b. 0.150cm

c. 0.1cm d. 0.50cm

2. **A metallic bar is heated from 0°C to 100°C. The coefficient of linear expansion is 10^{-5} k^{-1}. What will be the percentage increase in length? [IOM 04]**

a. 0.01% b. 0.1%

c. 1% d. 10%

3. **The apparent coefficient of expansion of copper and silver are 'C' & 'S' respectively. The coefficient of linear expansion of copper is A, then coefficient of linear expansion of silver is [IOM 09]**

a. $\frac{C + S - 3A}{3}$ b. $\frac{C - S + 3A}{3}$

c. $\frac{S - C - 3A}{3}$ d. $\frac{C + S + 3A}{3}$

4. **When water is heated from 0°C to 4°C and C_P and C_V are its specific heats at constant pressure and volume respectively, then [MOE]**

a. CP > Cv b. CP < Cv

c. CP = Cv d. CP – Cv = R

5. **Density of a liquid decreases by 0.1%. What is the linear expansivity if temperature is increased by 100°C? [IOM]**

a. 3.3×10^{-5} b. 3.3×10^{-6}

c. 10^{-6} d. 9.9×10^{-5}

6. **Two rods of materials A and B are of the same length. Linear expansivity of A and cubical expansivity of B are 12×10^{-6} k^{-1} and 3×10^{-5} k^{-1} respectively. If both the rods are heated from the same temperature to 80°C. The length of the rod A will be [MOE]**

a. larger than the rod B

b. double the length of rod B

c. equal to length of rod B

d. shorter than the length of rod B

Answer Sheet

1. c	*2. b*	*3. b*	*4. b*	*5. b*	*6. a*

SOLUTION

1. Ans. (c)

$\Delta l = l\,\alpha\Delta\,\theta = 100 \times 0.00002 \times 50$

$= 0.002 \times 50 = 0.1\text{cm}$

2. Ans. (b)

$\Delta l = \ l\,\alpha\Delta\,\theta$

$\frac{\Delta l}{l} \times 100 = \alpha\Delta\,\theta = 10^{-5} \times 100 \times 100\%$

% change in length = 0.1%

3. Ans. (b)

$\gamma\text{real} = \gamma\text{app} + \gamma\text{vessel}$

$= C + 3A = C + 3\alpha.$

$\Rightarrow C + 3A = C + 3\alpha$

$\alpha = \frac{C - S + 3A}{3}$

4. Ans. (b)

water constant from 0°C to 4°C. On contraction work is done on system $C_P < Cv$.

5. Ans. (b)

$\frac{\Delta V}{V} = \frac{\Delta\rho}{\rho} = \gamma\Delta\theta$

$\frac{0.1}{100} = 3\alpha \times 100$

$\alpha = \frac{10^{-5}}{3} = 3.3 \times 10^{-6}$

6. Ans. (a)

$\alpha_A = 1.2 \times 10^{-5}\ k^{-1}$

$\gamma_B = 3\ \alpha_B$

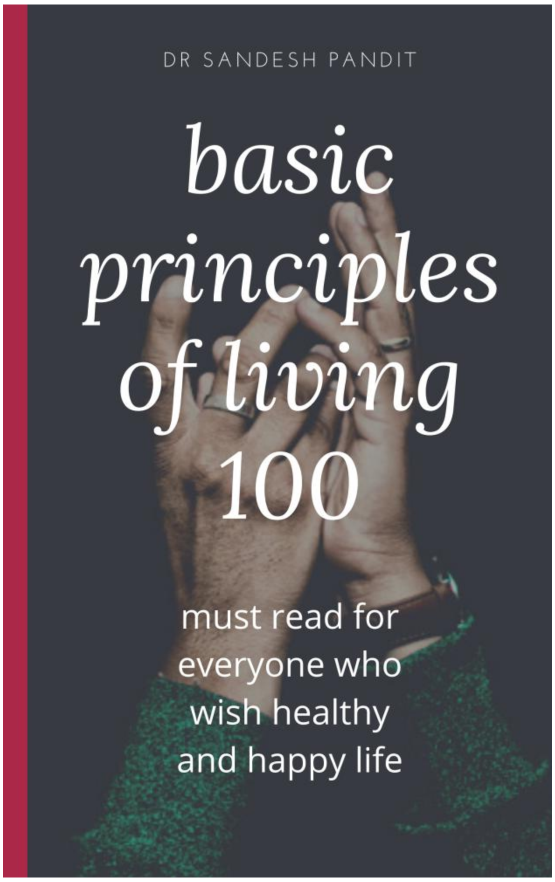
$= 3 \times 10^{-5}\ k^{1}$

$\alpha_B = 10^{-5}\ k^{-1}$

$\Delta l = l\ \alpha\Delta\theta$

$\alpha A > \alpha B \ \Rightarrow \Delta l_A > \Delta l_B$

So length of rod A is larger than B.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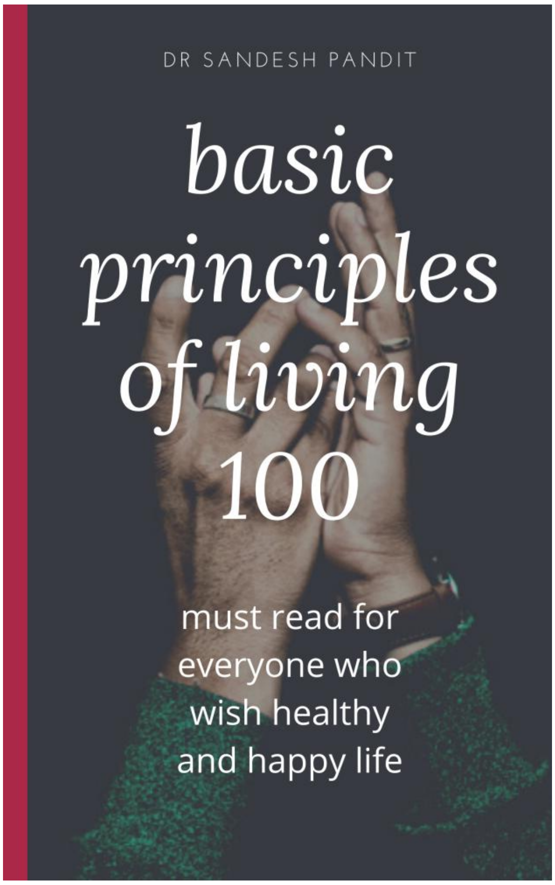
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Chapter : 18

CALORIMETRY, CHANGE OF STATE, HYGROMETRY

1. Which of the following produces more severe burns?

a. boiling water b. steam
c. hot air d. sun rays

2. The specific heat of same substance is expressed in two units i.e. C_1 cal g°C and C_2 cal g°F which of the following relations is true.

a. $C_1 > C_2$ b. $C_1 < C_2$
c. $C_1 = C_2$ d. None

3. Which one of following has highest specific heat

a. aluminum b. copper
c. silver d. water

4. 1g of ice at 0°C is added to 5g of water at 10°C. If the latent heat of ice be 80 cal/g, then final temperature of mixture is:

a. –5°C b. 0°C
c. 5°C d. 10°C

5. 25g of water at 46°C is mixed with 10g of ice at 0°C. What is the resulting of the mixture?

a. 0°C b. 8°C
d. 10°C d. 15°C

6. The temperature of ice is –10°C; specific heat = 0.5 K cal / (kg °C) and that of water 60°C. They are mixed in equal amounts. What fraction of ice will be melted?

a. $\frac{5}{6}$th b. $\frac{11}{6}$th
c. $\frac{5}{11}$th d. whole ice is melted

7. 1 g of ice at 0°C and 1g of steam at 100°C are mixed. The resulting temperature is

a. 0°C b. 230°C
c. 50°C d. 100°C

8. Assuming no heat losses, the heat released by the condensation of 'xg' of steam at 100°C can be used to convert 'y' g of ice at 0°C into water at 100°C the ratio of x: y is

a. 1: 1 b. 1:2
c. 1: 3 d. 3:1

9. 20g of ice at 0°C is mixed with 20g of hot water at 60°C. The resulting temperature will be

a. –10°C b. 0°C
c. 50°C d. 10°C

10. 20g of ice at 0°C is mixed with 20g of hot water at 60°C. The amount of water in mixture in equilibrium condition will be

a. 30g b. 32g
c. 35g d. 25g

11. 50 g of ice at 0°C is mixed with 50g of hot water at 90°C. Then temperature of resulting mixture will be

a. 0°C b. 2°C
d. 50°C d. 25°C

12. Two spheres of densities in the ratio 2: 1 and diameters in the ratio 1:2 have specific heats 1:3. Then ratio of their thermal capacities will be

a. 1:6 b. 1:12
c. 1:3 d. 1:4

13. The boiling water is changing into steam. Under this condition, the specific heat of water is

a. zero b. $4200 Jkg^{-1}C^{-1}$
c. one d. ∞

14. A gas undergoes an adiabatic change. Its specific heat in the process is

a. zero b. 1
c. ∞ d. None

15. At normal temperature and pressure water boils at 100°C. Deep down the mine, water will boil at a temperature.

a. 100°C

b. > 100°C

c. < 100°C

d. will not boil at all

16. Water boils at t °C, The latent heat of steam at t°C is given by

a. 606.5cal/g

b. 536 cal/g

c. 606.5 – 0.695t

d. 467.5 + 0.695t

17. With a rise in boiling point of water, the latent heat of steam

a. increases

b. decreases

c. remains unchanged

d. sometimes increases & sometimes decreases.

18. A closed bottle containing water at 30°C is carried to a moon in spaceship. If it is placed on the surface of moon and lid is opened.

a. water will freeze

b. water boils

c. decompose into H_2 & O_2

d. None

19. Heat required to convert 1gm of ice at 0°C into steam at 100°C is

a. 100cal   b. 10kcal

c. 716cal   d. 1kcal

20. The height of Niagra fall is 50m. The difference between the temperature of water at the top and the bottom of the fall is

a. 117°C   b. 11.7°C

c. 1.17°C   d. 0.117°C

21. The triple point of water is

a. 273.16°C   b. 273.16k

c. 273.16°F   d. 0.15k

22. On a particular day the relative humidity is 100% and the room temperature is 30°C, then dew points is

a. 0°C   b. 30°C

c. 70°C   d. 100°C

23. On four different days, the temperature is same. A man feels hottest when the relative humidity is:

a. 99%   b. 50%

c. 30%   d. 10%

24. The thermal capacity of 40g aluminum (sp. heat = 0.2 cal /g°)is

a. 40cal /°C   b. 20cal /°C

c. 16cal /°C   d. 8cal /°C

25. Equal masses of two liquids at temperature 30°C and 20°C are mixed and resulting temperature is found to be 26°C. Then ratio of their specific heats is

a. 1: 1   b. 3: 2

c. 2: 3   d. 4: 3

26. A metal ball is heated to a temperature of 80°C and is put on a block of ice at 0°C. It 12g of ice melts thermal capacity of metal is

a. 6 cal /°C   b. 12 cal /°C

c. 18 cal /°C   d. 24 cal /°C

Answer Sheet

1. b	*2. a*	*3. d*	*4. b*	*5. c*	*6. b*	*7. d*	*8. c*	*9. b*	*10. c*
11. c	*12. b*	*13. d*	*14. a*	*15. b*	*16. c*	*17. b*	*18. b*	*19. c*	*20. d*
21. b	*22. b*	*23. a*	*24. d*	*25. b*	*26. b*				

SOLUTION

1. Ans. (b)

Steam has additional amount of latent heat of vaporization than boiling water

2. Ans. (a)

C_1 cal/g°C = $\dfrac{C_1 \text{ cal}}{\text{gram} \times \text{change of } 1°C}$

$= \dfrac{C_1 \text{ cal}}{g \times 1.8°F}$

$= \dfrac{C_1}{1.8}$ cal/g°F

$= C_2$ cal/g F° $\Rightarrow C_2 = \dfrac{C_1}{1.8}$

$C_1 > C_2$

3. Ans. (d)

Water has the specific heat of 1 cal g^{-1} c^{-1} = 4200J kg^{-1} c^{-1}

4. Ans. (b)

Amount of heat required by ice to completely melt Q = mL = 1 × 80 = 80 cal heat given off by water from (10°C to 0°C) = mc$\Delta\theta$ = 50 cal. The ice can't melt completely.

5. Ans. (c)

Amount of heat required to melt 10g of ice at 0°C

$Q_1 = 10 \times 80 = 800$ cal.

Amount of heat given off by 25g of water on cooling from 46°C to 0°C.

$Q_2 = 25 \times 1 \times 46$

= 1150 cal.

As $Q_2 > Q_1$ all the ice melts.

Heat remaining to raise the temperature = $Q_2 - Q_1 = 350$ cal.

Now, total amount of water

= 25 + 10 = 35g at 0°C

$mc\Delta\theta = 350$

$35 \times 1 \times \Delta\theta = 350 \Rightarrow \Delta\theta = 10°C$

6. Ans. (b)

Mass of ice & hot water = M & 'm' be the mass of ice melted Heat lost by hot water = Heat gained by ice

M × 1 (60 – 0) = M × 0.5 × (0 – (–10) + m × 80

60M = 5M + 80m

$\dfrac{m}{M} = \dfrac{55}{80} = \dfrac{11}{16}$

7. Ans. (d)

Heat required to convert all ice into water at 100°C

$Q_1 = 1 \times 80 + 1 \times 1 \times 100 = 180$ cal. Heat emitted on condensation of steam into water at 100°C

$Q_2 = 1 \times 536 = 536$ cal

$Q_2 > Q_1$ system remains at 100°C.

8. Ans. (c)

Heat given off by condensation of xg of steam at 100°C

$Q_1 = 540x$ cal

Heat required to convert y g of ice at 0°C into water at 100°C $Q_2 = 80y + y \times 1 \times 100 = 180y$

$Q_1 = Q_2 \Rightarrow 540x = 180y \Rightarrow x : y = 1 : 3$

9. Ans. (b)

When equal amounts of ice at 0°C and hot water at θ°C (≤ 80°C) are mixed, final temperature = 0°C.

10. Ans. (c)

Amount of water

$= \dfrac{m}{80}(80+\theta) = \dfrac{20}{80}(80+60)$

$= \dfrac{1}{4} \times 140 = 35g$

11. Ans. (c)

Resulting temperature

$= \dfrac{\theta - 80}{2}$ (θ > 80°C)

$= \dfrac{90 - 80}{2} = 5°C$

12. Ans. (b)

$$m = \rho \times v = \rho \times \frac{\pi d^3}{6}$$

$$m \;\alpha\; \rho d^3 \Rightarrow m_1 : m_2 = \left(\frac{1}{2}\right)^3 \times \frac{2}{1} = 1:4$$

$$\frac{TC_1}{TC_2} = \frac{m_1 s_1}{m_2 s_2} = \frac{1}{4} \times \frac{1}{3} = 1:12$$

13. Ans. (d)

$$C = \frac{\Delta Q}{m\,\Delta T} = \frac{\Delta Q}{m \times 0} = \infty$$

Change of state is isothermal condition $\Delta T = 0$.

14. Ans. (a)

$$C = \frac{\Delta Q}{m\,\Delta T} = \frac{o}{m\Delta T} = o$$

In adiabatic change, $\Delta Q = 0$

15. Ans. (b)

Inside deep mine pressure increase and increase in pressure causes increase in boiling point.

16. Ans. (c)

When t = 100°C (True)

Latent heat = 606.5 – 0.695 × 100 = 536 cal/g

17. Ans. (b)

Specific latent heat decreases with increase in B.P because intermolecular space increases with increasing temperature.

18. Ans. (b)

Water will boil because there is no atmosphere & no external pressure & B.P α pressure.

19. Ans. (c)

$$\underset{(0^\circ C)}{\text{ice}} \xrightarrow{Q_1} \underset{(0^\circ C)}{\text{water}} \xrightarrow{Q_2} \underset{(100^\circ C)}{\text{water}} \xrightarrow{Q_3} \underset{(100^\circ C)}{\text{Steam}}$$

$Q_1 = 80$ cal $Q_2 = ms\Delta\theta = 100$cal

$Q_3 = 536$ cal

$Q = Q_1 + Q_2 + Q_3 = 716$cal.

20. Ans. (d)

$mc\Delta\theta = mgh$

$$\Delta\theta = \frac{gh}{c}$$

$$= \frac{9.8 \times 50}{4200}$$

$\Delta\theta = 0.117$°C.

21. Ans. (b)

For water, triple point is at

P = 4.58mm Hg & T = 0.01°C

= 273.16k

22. Ans. (b)

If RH is 100%

Room temperature = Dew point.

23. Ans. (a)

At same temperature one would feels hottest when R.H is highest.

24. Ans. (d)

Thermal capacity = ms

= 40 × 0.2

= 8 cal/°C.

25. Ans. (b)

Heat lost = Heat gained

$ms_1 (30 – 26) = ms_2 (26 – 20)$

$4S_1 = 6S_2$

$$\frac{S_1}{S_2} = \frac{3}{2}$$

26. Ans. (b)

Thermal capacity of metal

$$= \frac{\text{Heat lost}}{\text{temperature change}}$$

$$C = \frac{H}{\Delta\theta} = \frac{12 \times 80}{80 - 0}$$

= 12 cal /°C

Past Questions

1. **The final temperature of the mixture of 0.5kg ice at 0°C and 0.5kg of water at 75°C will be [MOE 2068]**
   a. 5°C b. 10°C
   c. 15°C d. 0°C

2. **A body of mass 10gm was given a heat of 420J. Find the rise in temperature [MOE 2067]**
   a. 1°C b. 1°K
   b. 10°C d. 100k

3. **A 10kg iron bar (specific heat 0.11 cal/gm°C at 80°C is placed on a block of ice (latent heat of fusion 80 cal/gm. How much ice melts? [MOE 2010]**
   a. 1.1kg b. 10kg
   c. 16kg d. 60kg

4. **The relative humidity is 100% then the room temperature is equal to[MOE 2068]**
   a. 4°C b. 0°C
   c. dew point d. 100°C

5. **10gm of ice at –10°C is converted into steam at 100°C, the amount of heat required in calories is [MOE 066]**
   a. 725 b. 7250
   c. 350 d. 3000

6. **Melting point of ice [MOE 2065]**
   a. Decreases with decrease of pressure
   b. Increase with increase of pressure
   c. independent of pressure
   d. Decrease with increases of pressure

7. **Heat required to convert 1gm of ice at 0°C into steam at 100°C is [MOE 2063]**
   a. 100 cal b. 0.01k cal
   c. 716 cal d. 1kilo cal

8. **The amount of heat required to melt 1gm of ice without change in temperature is [MOE 2062]**
   a. 80cal b. 80kcal
   c. 740cal d. 740kcal

9. **The latent heat of fusion of ice is 80 cal /gm. The specific heat capacity of ice is 0.5 cal /gm °C. Find the energy required to change 1kg ice from –10°C to 50°C is [MOE 2056]**
   a. 155kcal b. 135kcal
   c. 120kcal d. 180kcal

10. **When liquid changes into vapour on increasing pressure the boiling point of the liquid [MOE]**
    a. increases
    b. decreases
    c. remain unchanged
    d. can't be predicted

11. **When ice is melting [MOE]**
    a. It absorbs heat from surrounding
    b. It gives heat to the surrounding
    c. There is no relation to surrounding
    d. Heat may be given or absorbed

12. **The temperature of dew formation was 4.6°C and the temperature of dew was 5.4°C. The relative humidity is nearly (given SVP of water at 5¯°C = 6.5 mmHg and at 20°C = 17.5mm Hg [MOE 2009]**
    a. 37% b. 100%
    c. 69% d. 70%

Answer Sheet

1. d	*2. c*	*3. a*	*4. c*	*5. b*	*6. d*	*7. c*	*8. a*	*9. b*	*10. a*	*11. a*	*12. a*

SOLUTION

1. Ans. (d)

Energy of melting of ice = mL = 0.5 × 80 = 40 cal

Energy of water at 75°C = $ms\Delta\theta$ = 0.5 ×1 × 75 = 35 cal.

Which is not enough even to melt all ice so mixture remains at 0°C.

2. Ans. (c)

$Q = ms\Delta\theta$

$420 = 10 \times 10^{-3} \times 4200 \times \Delta\theta$

$\Delta\theta = 10° C$

3. Ans. (a)

Heat lost by iron bar ($Ms\Delta\theta$)

= Heat gained by ice (m_iL)

$1000 \times 0.11 \times 80 = m_i \times 80$

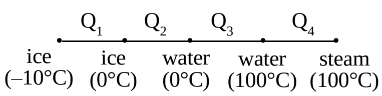
$m_i = \frac{1100}{1000} = 1.1$ kg

4. Ans. (c)

$RH = \frac{\text{SVP at room temp}}{\text{SVP at dew point}} \times 100\%$

If RH = 100% ⇒ SVP at Room temperature = SVP at dew point.

5. Ans. (b)



$Q = Q_1 + Q_2 + Q_3 + Q_4$

= 10 × 0.5 × 10 + 10 × 80 + 10 × 100 × 1 + 10 × 540= 7250 cal.

6. Ans. (d)

For the substance whose volume decrease on melting (e.g. ice, rubber)

↑ pressure → ↓ melting point.

7. Ans. (c)

Total heat required = $mL_f + ms\Delta\theta + mL_V$

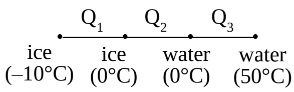
= 1 × 80 + 1 × 1 × 100 + 536 × 1

= 716 cal

8. Ans. (a)

Heat required to change 1gm ice into water without change in temp → Latent heat of fusion of ice = 80 cal / gm.

9. Ans. (b)



$Q_1 = ms\Delta\theta = 1000 \times 0.5 \times 10 = 5000$cal

$Q_2 = mL = 80000$cal

$Q_3 = ms\Delta\theta = 50000$

$Q = Q_1 + Q_2 + Q_3$

= 135kcal.

10. Ans. (a)

Boiling point of liquid increase with increase in pressure & vice – versa.

11. Ans. (a)

During melting ice absorbs latent heat of fusion while it releases the same heat during fusion.

12. Ans. (a)

SVP at 5°C = 6.5mm Hg

SVP at 20°C = 17.5mm Hg

SVP at dew point (5.4°C)

$= 6.5 + \frac{17.5 - 6.5}{20 - 5} \times (5.4 - 5)$

$= 6.8\text{mm Hg}$

$$\text{R.H} = \frac{\text{SVP at dew temperature}}{\text{SVP at room temperature}} \times 100\%$$

$$= \frac{6.8}{17.5} \times 100\%$$

$= 37\%$

Chapter: 19

KINETIC THEORY OF GASES & GAS LAWS

1. **The average speed of gas molecules in equilibrium at constant temperature T.**
   a. Proportional to $\sqrt{T}$
   b. Proportional to T
   c. Proportional to T^2
   d. Zero
2. **The average velocity of the molecules in equilibrium is;**
   a. Proportional to $\sqrt{T}$
   b. Proportional to T
   c. Proportional to T^2
   d. Zero
3. **The mean square speed of gas molecules in equilibrium is;**
   a. Propotional to $\sqrt{T}$
   b. Propotional to T
   c. Propotional to T^2
   d. Zero
4. **The average energy of the molecules of monoatomic gas at temperature T is;**
   a. $\frac{1}{2}$ KT　　b. KT
   c. $\frac{3}{2}$KT　　d. $\frac{5}{2}$ KT
5. **Oxygen and Helium gases are in same container. Which has greater k.ε per molecule?**
   a. Oxygen　　b. Helium
   c. Both have equal K.E
   d. Sometimes oxygen, sometime helium
6. **Which of the following gases possesses maximum root mean square speed at a given temperature?**
   a. Hydrogen　　b. Nitrogen
   c. Oxygen　　d. Helium
7. **The root mean square velocity of gas molecules of mass m at a given temperature is proportional to;**
   a. m°　　b. m
   c. $\sqrt{m}$　　d. $m^{\frac{-1}{2}}$
8. **At 0°K which of the following properties of a gas will be zero;**
   a. k.ε　　b. pε
   c. mass　　d. density
9. **In an ideal gas the molecules possesses:**
   a. only k.ε
   b. only p.ε
   c. both k.ε & p.ε
   d. None
10. **P is pressure and 'd' is density of gas at constant temperature then;**
    a. $p \alpha d$　　b. $p \alpha \frac{1}{d}$
    d. $p \alpha \sqrt{d}$　　d. $p \alpha \frac{1}{\sqrt{d}}$
11. **At constant pressure, the vms velocity 'c' is related to density 'd' as;**
    a. $c \alpha d$　　b. $c \alpha \frac{1}{d}$
    c. $c \alpha \sqrt{d}$　　d. $c \alpha \frac{1}{\sqrt{d}}$
12. **For hydrogen gas $C_P – C_V$ = a & for oxygen gas $C_P – C_V$ - b. So the relation between a & b is;**
    a. a = 16b　　b. 16a = b
    c. a = 4b　　d. a = b
13. **For a gas $\frac{R}{C_V} = 0.67$, this gas is made up of molecules which are;**
    a. Monatomic　　b. diatomic
    c. Polyatomic　　d. None

14. A real gas can be approximated to ideal gas at:

a. Low density b. High pressure
c. High density d. Low temperature

15. In gases of diatomic molecules the ratio of two specific heats of gases $\frac{Cp}{Cv}$ is.

a. 1.66 b. 1.4
c. 1.33 d. 1

16. For a gas is the ratio of specific heats of constant pressure & volume is γ, then degree of freedom is;

a. $\frac{2}{\gamma - 1}$ b. $\frac{\gamma - 1}{2}$
c. $\frac{\gamma - 1}{\gamma + 1}$ d. $\frac{\gamma + 1}{\gamma - 1}$

17. The pressure (p) of ideal gas and mean kinetic energy per unit volume (E) are related as;

a. $P = E$ b. $P = \frac{E}{2}$
c. $P = \frac{2}{3}E$ d. $P = \frac{3}{2}E$

18. Vrms, Vav and Vmp are root mean square, average and most probable speed of molecules of a gas obeying maxwellian velocity distribution. Which of the following statements is correct?

a. $V_{rms} < V_{av} < V_{mp}$
b. $V_{rms} > V_{av} > V_{mp}$
c. $V_{mp} > V_{rms} > V_{av}$
d. $V_{mp} > V_{rms} < V_{ar}$

19. Two gases A and B having the same temperature T, same pressure P and same volume V are mixed.

If the mixture is at the same temperature T & occupies volume V then pressure of mixture is;

a. 2P b. P
c. $\frac{P}{2}$ d. 4P

20. A gas at a pressure P is contained in a vessel. If the masses of all the molecules are halved and their speeds doubled. The resulting pressure P would be equal to;

a. $4p_o$ b. $2P_o$
c. P_o d. $\frac{P_o}{2}$

21. The temperature of an ideal gas is increased from 27°c to 927°c. The root mean square speed of its molecules become;

a. twice b. half
c. four times d. one fourth

22. Electric fan is switched on in a closed room. The air in the room is;

a. cooled
b. heated
c. maintains own temperature
d. None

23. The pressure of a gas in an exclosure is increased from 1 atm to 4 atm, the rootmean square speed of gas molecules is;

a. remains same
b. doubled
c. becomes four times
d. halved

24. A vessel containing 0.1 m^3 of air at 76 cm of Hg is connected to an evacuated vessel of capacity 0.09m^3. The resultant air pressure is;

a. 20 cm of Hg b. 30 cm of Hg
c. 40 cm of Hg d. 60 cm of Hg

25. The root mean square (r.m.s) speed of oxygen molecules (O_2) at certain temperature T is V. If the temperature is doubled and oxygen dissociates into atomic oxygen, then rms speed becomes;

a. V b. 2V
c. $\sqrt{2}V$ d. $\frac{V}{\sqrt{2}}$

26. One mole of a monoatomic ideal gas is mixed with one mole of diatomic ideal gas. The molar specific heat of mixture at constant volume is;

a. $\frac{3}{2}R$ b. $\frac{5}{2}R$

c. 2R d. 4R

27. 22 g of CO_2 at 27°c is mixed with 16g of O_2 at 37°c. If both gases are considered as ideal. Then temperature of mixture is;

a. 31°c b. 27°c

c. 37°c d. 34°c

28. The molecules of monatomic gas do only;

a. Translational motion

b. vibrational

c. rotational

d. all

29. The k.ε of one mole of an ideal gas is E = $\frac{3}{2}$RT . Then CP will be:

a. 0.5R b. 0.1R

c. 1.5R d. 2.5R

30. When a gas filled in a closed vessel is heated through 1°c, its pressure increase by 0.4%. The initial temperature of the gas was;

a. 250k b. 2500k

c. 250°c d. 25°c

31. How much should the pressure of a gas be increased to decrease the volume of the gas by 10% at constant temperature?

a. 10% b. 9.5%

c. 11.11% d. 5.11%

32. The mean kinetic energy of a certain gas in a vessel at 0°c is ε_o. Then mean kinetic energy, when is temperature is increased in 273°c will be;

a. ε_o b. $2\varepsilon_o$

c. $4\varepsilon_o$ d. $\sqrt{2}\varepsilon_o$

33. A vessel has 6 g of oxygen at pressure P and temperature 400 k. A small hole is made in it so that oxygen leaks out. How much oxygen leaks out if final Pressure is $\frac{P}{2}$ and temperature 300k?

a. 5g b. 4g

c. 3 g d. 2g

Answer Sheet

1. a	*2. d*	*3. b*	*4. c*	*5. a*	*6. a*	*7. d*	*8. a*	*9. a*	*10. a*
11. d	*12. d*	*13. a*	*14. a*	*15. b*	*16. a*	*17. c*	*18. b*	*19. a*	*20. b*
21. b	*22. b*	*23. b*	*24. c*	*25. b*	*26. c*	*27. a*	*28. a*	*29. d*	*30. a*
31. c	*32. b*	*33. d*							

SOLUTION

1. Ans. (a)

$$V_{av} = \frac{C_1 + C_2 + ... + C_n}{n}$$

$$= \sqrt{\frac{8RT}{\pi M}} \ \alpha \sqrt{T}$$

2. Ans. (d)

Velocity is vector and gas molecules are is random motion in all possible directions. Hence vector sum of velocity will be zero at any temperature.

3. Ans.: (b)

Mean square speed $C^2 = \dfrac{C_1^2 + C_2^2 + .. + C_n^2}{n}$

$= \dfrac{3PV}{M} = \dfrac{3RT}{M}$

$\therefore$ $C^2 \alpha T$

4. Ans. (c)

$E = \dfrac{f}{2}KT$ per molecule

f = 3 for monoatomic gas

5. Ans. (a)

$E = \dfrac{f}{2}KT \Rightarrow E \alpha f$

Oxygen is diatomic (f = 5)

Helium is monatomic (f = 3)

6. Ans. (a) $V_{rms} = \sqrt{\dfrac{RT}{m}} \alpha \dfrac{1}{\sqrt{m}}$

Hydrogen posses lowest molecular weight.

7. Ans. (d)

$V_{rms} = \sqrt{\dfrac{3p}{\delta}} = \sqrt{\dfrac{3pv}{m}} \alpha \dfrac{1}{\sqrt{m}}$

8. Ans. (a)

$k.\varepsilon = \dfrac{f}{2} RT \alpha T$

9. Ans. (a)

Ideal gas has no force of attraction between molecules hence no p.ε.

10. Ans. (a)

$PV = RT$ & $V = \dfrac{M}{d}$

PM = RTd

p α d

11. Ans. (d)

$C = \sqrt{\dfrac{3RT}{M}}$ $M = \rho \times v$

$C = \sqrt{\dfrac{3RT}{\rho \times v}}$ $C \alpha \dfrac{1}{\sqrt{d}}$

12. Ans. (d)

$C_P - C_V = R$ = constant

$\therefore$ a = b

13. Ans. (a)

$\dfrac{R}{C_V} = 0.67$

$C_V = \dfrac{R}{0.67} = \dfrac{3}{2}R$

14. Ans. (a)

Low density

15. Ans. (b)

f = 5

$\gamma = 1 + \dfrac{2}{f} = 1 + \dfrac{2}{5} = 1.4$

16. Ans. (a)

$\gamma = \dfrac{C_P}{C_V} = \dfrac{\frac{f}{2}}{1 + \frac{f}{2}}$

$\gamma = 1 + \dfrac{2}{f}$

$\dfrac{2}{f} = \gamma - 1$

$\therefore$ $f = \dfrac{2}{\gamma - 1}$

17. Ans. (c)

$P = \dfrac{1}{3}\dfrac{M}{V}c^2$ (c = rms speed)

$= \dfrac{2}{3}\dfrac{\left(\frac{1}{2}mc^2\right)}{V}$

$P = \dfrac{2}{3}E$ [E = Energy density]

18. Ans. (b)

$V_{rms} = \sqrt{\dfrac{3RT}{M}}$

$V_{av} = \sqrt{\dfrac{RT}{\pi m}}$, $V_{mp} = \sqrt{\dfrac{2RT}{M}}$

$R:A:M = \sqrt{3} : \sqrt{2.5} : \sqrt{2}$

19. Ans. (a)

According to Dalton's law of partial pressure, pressure in the mixture = $P_1 + P_2$ = P + P = 2P.

20. Ans. (b)

$P_o = \frac{mn}{3v} C^2$ (n = No. of molecules)

then, $p = \frac{n\left(\frac{m}{2}\right)(2c)^2}{3v} = 2P_o$

21. Ans. (d)

$C = \sqrt{\frac{3RT}{M}} \ \alpha \sqrt{T}$

$\frac{C}{C_O} = \sqrt{\frac{927 + 273}{27 + 273}} = \sqrt{4} = 2$

22. Ans. (b)

Because of increase in rms speed of air molecules, air gets heated.

23. Ans. (b)

$C = \sqrt{\frac{3PV}{M}} \ \alpha \sqrt{P}$ (since M and V are constant)

$\frac{C}{C_O} = \sqrt{\frac{4}{1}}$

$C = 2C_O$

24. Ans. (c)

$P = \left(\frac{V_O}{V}\right) P_O = \left(\frac{0.1}{0.1 + 0.09}\right) \times 76 = 40$ cm of Hg

25. Ans. (b)

$V = \sqrt{\frac{3RT}{M}}$

$V' = \sqrt{\frac{3R(2T)}{\frac{M}{2}}} = 2\sqrt{\frac{3RT}{M}} = 2V$

26. Ans. (c)

$\bar{C}_V = \frac{n_1C_1 + n_2C_2}{n_1 + n_2}$

$= \frac{1 \times \frac{3}{2}R + \frac{5}{2}R}{1 + 1} = 2R$

27. Ans. (a)

For CO_2, $T_1 = 300k$, $n_1 = \frac{22}{44} = 0.5$ moles, $C_1 = \frac{7}{2}R$

For O_2, $T_2 = 310$ k, $n_2 = 0.5$

$C_2 = \frac{5}{2}R$

$T = \frac{n_1c_1T_1 + n_2c_2T_2}{n_1c_1 + n_2c_2}$

$= \frac{0.5 \times \frac{7}{2} \times 300 + 0.5 \times \frac{5}{2} \times 310}{0.5 \times \frac{7}{2} + 0.5 \times \frac{5}{2}}$

$= 304.16k = 31°c$

28. Ans. (c) Monoatomic ($f = 3$) has Translational motion only.

29. Ans. (d) $E = \frac{f}{2}RT \quad f = 3$

$C_P = \left(\frac{f}{2} + 1\right) R = 2.5R$

30. Ans. (a) $\frac{\Delta p}{p} = \frac{\Delta T}{T}$

$\frac{0.4}{100} = \frac{1}{T}$ $(\Delta c = \Delta k)$

$T = 250k$

31. Ans. (c) $PV = $ constant $P \ \alpha \ V^{-1}$ $(n = -1)$

% change in P

$= \left[\left(1 - \frac{x}{100}\right)^n - 1\right] \times 100\%$

$= \left[\left(1 - \frac{10}{100}\right)^{-1} - 1\right] \times 100\%$

$= \left(\frac{100}{90} - 1\right) \times 100\% = 11.11\%$

32. Ans. (b)

Mean k.ε α T

$\frac{\varepsilon}{\varepsilon_o} = \left(\frac{T}{T_O}\right) = \frac{546}{273} = 2$

$\varepsilon = 2\varepsilon_o$

33. Ans. (d)

$P_1V = m_1vT_1$...... (i) $P_2V = m_2rT_2$ ...... (ii)

$\frac{P_1}{P_2} = \frac{m_1}{m_2} \times \frac{T_1}{T_2}$

$\frac{P}{\frac{P}{2}} = \frac{6}{m_2} \times \frac{400}{300}$

$m_2 = 4g$

Amount of O_2 Leaked = 6 – 4 = 2g

Past Questions

1. **In the ideal gas equation PV = nRT the value of gas constant depends only on; [IOM 2011]**
   a. Pressure of gas
   b. Volume of gas
   c. Nature of gas
   d. Units of measurement

2. **When the absolute temperature of gas is increased three times the root mean square velocity of gas molecules will be.[IOM 2011]**
   a. 3 times b. 9 times
   c. $\frac{1}{3}$ times d. $\sqrt{3}$ times

3. **The temperature of a gas is 0°c. To what temperature it must be raised in order that the root mean square speed of the gas is doubled? [IOM 2005]**
   a. 100°c b. 373°c
   c. 819°c d. 1092°c

4. **The state of greatest potential energy is: [IOM 2011]**
   a. Solid b. Liquid
   c. Gas d. all have same

5. **All gas at same temperature have same; [IOM 98]**
   a. K.ε b. density
   c. rms speed d. none

6. **Real gas behaves an ideal gas at: [IOM/BPKIHS]**
   a. High temperature & low pressure
   b. High temperature & high pressure
   c. High pressure, low temperature
   d. low pressure, low temperature

7. **If one mole of an ideal gas at STP is heated through 1k, the work done by gas in heat unit will be; [MOE Curriculum]**
   a. 1.98 cal b. 8.31 cal
   c. 0.831 cal d. 83.1 cal

8. **Average kinetic energy per molecule of a gas depend only upon; [MOE 2068]**
   a. Pressure
   b. Temperature
   c. Volume
   d. Species of gas molecules

9. **Internal energy of N molecules of ideal gas depends upon; [MOE 2067]**
   a. Pressure
   b. volume
   c. Temperature
   d. Pressure & temperature

10. **The ratio of rms speed of hydrogen molecules to that of oxygen molecules at a given temperature will be: [MOE 2066]**
    a. 1:4 b. 1:16
    c. 16:1 d. 4:1

11. **A mass of at a pressure 50 cm of Hg is heated from 27°c to 97°c. If the volume is maintained constant the pressure exerted by the pressure be.... of Hg. [MOE 2064]**
    a. 50 b. 40
    c. 61.67 d. 71.2

12. **A gas has a pressure P, volume V and temperature 500 k. The pressure is doubled at constant volume and volume is reduced to one quarter at constant pressure. The final temperature of the gas in k is; [MOE 2062]**
    a. 125 b. 250
    c. 500 d. 1000

13. **A gas at pressure 1×10^5 and temperature 27°c has ρ = 0.09 kg/m^3 calculate the ρ of the gas when pressure & temperature changes to 4×10^5 pa & 127°c respectively. [MOE 2061]**

a. 0.94 b. 0.27

c. 0.36 d. 0.15

14. An ideal gas has f degrees of freedom per molecule. Then the value of $\gamma = \frac{C_P}{C_V}$ for the gas is; [IOM]

a. f b. $\frac{2}{f}$

c. $1 + \frac{2}{f}$ d. $1 + \frac{f}{2}$

15. A closed vessel containing ideal gas is maintained at a certain temperature and pressure. If both the temperature and pressure are double, then volume will be: [IE]

a. remains unchanged b. doubled

c. quadrapled d. halved

16. The C_{rms} of a gas is V_o when initial pressure P_O is doubled at constant temperature T_0. Then, the new C_{rms} will be:[IE]

a. V_o b. $2V_o$

c. $\frac{V_o}{2}$ d. $4V_o$

17. If the molecular mass of the gases are m_1 and m_2 respectively, then the mean square velocity of the gases are propotional to: [BPKIHS 2011]

a. $\frac{m_1}{m_2}$ b. $\sqrt{\frac{m_1}{m_2}}$

c. $\frac{m_2}{m_1}$ d. $\sqrt{\frac{m_2}{m_1}}$

Answer Sheet

1. d	*2. d*	*3. c*	*4. c*	*5. a*	*6. a*	*7. a*	*8. b*	*9. c*	*10. d*
11. c	*12. b*	*13. b*	*14. c*	*15. a*	*16. a*	*17. c*			

SOLUTION

1. Ans. (d)

Depends only on units of measurement.

$R = 8.314 J\ mole^{-1} k^{-1}$

$= 2\ cal\ mole^{-1} k^{-1}$

$= 0.0821\ lit\ atm\ mole^{-1} k^{-1}$

2. Ans. (d)

$$V_{rms} = \sqrt{\frac{3P}{\rho}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3KT}{M}}$$

$V_{rms} \propto \sqrt{T}$

3. Ans. (c)

$C \propto \sqrt{T}$

Temperature should in Kelvin

$$\frac{C_1}{C_2} = \sqrt{\frac{T_1}{T_2}}$$

$$\Rightarrow \frac{1}{2} = \sqrt{\frac{237}{T_2}}$$

$T_2 = 1092°k = 819°c$

4. Ans. (c)

Gas has greatest potential energy.

5. Ans. (a)

Average kinetic energy per molecule $= \frac{3}{2} kT$

$K.\varepsilon \propto T$

6. Ans. (a)

Real gas behaves as ideal gas at high temperature and low pressure.

7. Ans. (a)

$W = PV = nRT$

$= 1 \times 1.98\ cal \times 1$

$= 1.98\ cal$

8. Ans. (b)

Average k.ε/molecule

$= \frac{f}{2} kT \propto T$

Average transition at k.ε molecule $= \frac{3}{2}kT$

9. Ans. (c)
Internal energy of ideal gas depends on temperature only.

10. Ans. (d)
$V \,\alpha\, \frac{1}{\sqrt{m}}$

$\frac{V_{rms}(H_2)}{V_{rms}(O_2)} = \sqrt{\frac{MO_2}{MH_2}}$

$= \sqrt{\frac{32}{2}}$

$= \sqrt{16} :1 = 4:1$

11. Ans. (c)
P α T (At constant volume)

$\frac{P_1}{P_2} = \frac{T_1}{T_2}$

$P_2 = \frac{P_1}{T_1} \times T_2$

$= \frac{370}{300} \times 50$

= 61.67 cm Hg

12. Ans. (b)
In first case,
P α T (at constant v)
$T_2 = 2T_1$

Now at constant pressure $v_1 = v$ and $v_2 = \frac{v}{4}$, $T_3 = ?$

$\frac{V_2}{V_1} = \frac{T_3}{T_2} \Rightarrow T_3 = \frac{T_2}{4}$

$= \frac{2T_1}{4} = \frac{500}{2} = 250$ k

13. Ans. (b)
$P_1 = 1 \times 10^5$, $P_2 = 4 \times 10^5$
$d_1 = 0.09$ kg/m^3, $d_2 = ?$
$T_1 = 300$ k, $T_2 = 127°c = 400$ k

$Pv = nRT, \frac{Pm}{d} = nRT$

$\frac{P_1}{P_2} = \frac{d_1T_1}{d_2T_2}$

$d_2 = \frac{P_2}{P_1} \times \frac{T_1}{T_2} \times d_1$

$= 4 \times \frac{300}{400} \times 0.09 = 0.27$ kg/m^3

14. Ans. (c)

$C_v = \frac{f}{2} R$, $CP = Cv + R$

$= \left(\frac{f}{2} + 1\right) R$

$\gamma = \frac{CP}{Cv} = \frac{\frac{f}{2} + 1}{\frac{f}{2}} = \left(1 + \frac{2}{f}\right)$

15. Ans. (a)

PV = nRT

$\frac{PV}{T}$ = constant

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$V_2 = \left(\frac{P_1}{P_2}\right) \times \left(\frac{T_2}{T_1}\right)$

$= \frac{1}{2} \times 2 = 1$

16. Ans. (a)

$C_{rms} = \sqrt{\frac{3RT}{m}}$ changes with temperature, independent of pressure.

$C_{rms} = \sqrt{\frac{3P}{\rho}}$ ($\frac{P}{\rho}$ remains unchanged)

17. Ans. (c)

Mean square speed $(C^2) = \frac{3RT}{M} \,\alpha\, \frac{1}{M} \,\alpha\, T$

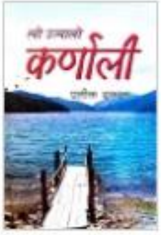
Root mean square speed (C)

$$= \sqrt{\frac{3RT}{M}} \; \alpha \; \frac{1}{\sqrt{m}} \; \alpha \; \sqrt{T}$$

$$\frac{C_1^2}{C_2^2} = \frac{m_2}{m_1}$$

नेपालमा कम्युनिस्ट पार्टीको विकासक्रम, सरकार र नेतृत्व

नेपाली कांग्रेसको इतिहासको प्रारूप



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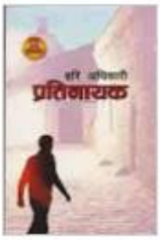


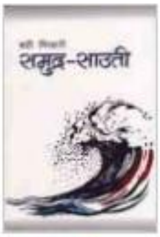
प्रतिनायक

रिकुटे

स्कुल बेच्ने बालक

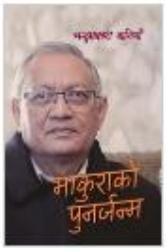
अदभुत तिवारी

छोट्टी



समुन्द्र साउती

गद्य शैलीको रूपविज्ञान



माकुराको पुनर्जन्म

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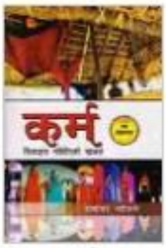
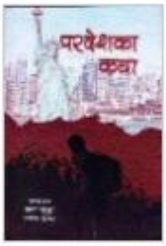


कर्म

वीर्य जमिन

सारङ्गी



परदेशका कथा

डिलको डोब

Of Walls And Pigeons

Chapter: 20

TRANSMISSION OF HEAT

1. The fastest mode of heat transfer is

a. conduction b. convection

c. Radiation d. All are equally fast

2. It is hotter for the same distance over the top of the fire than it is in the side mainly because

a. heat is radiated upwards

b. air conducts heat upwards

c. convection takes more heat upwards

d. None

3. As compared to a person with white skin another person with dark skin will experience

a. less heat, more cold

b. more cold, more heat

c. more heat, less cold

d. less heat, less cold

4. Newton's law of cooling refers to

a. conduction b. convection

c. Radiation d. all of above

5. Four rods with different radii 'r' and length '*l*' are used to connect two reservoirs of heat at different temperature which one will conduct more heat?

a. r = 1cm, l = 1cm

b. r = 2cm, l = 2cm

c. r = 1cm, $l = \frac{1}{2}$ cm

d. r = 2cm, $l = \frac{1}{2}$ cm

6. If '*l*' is the length and 'A' area of cross section of rod and 'k' is thermal conductivity of material, then the thermal resistance is given by

a. $\frac{kl}{A}$ b. $\frac{l}{kA}$

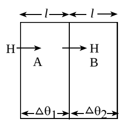
c. $\frac{k}{lA}$ d. $\frac{A}{kl}$

7. A slab consists of two parallel layers of two different materials of same thickness and having thermal conduction k_1 & k_2. The equivalent thermal conductivity of the slab is:

a. $k_1 + k_2$ b. $\frac{2k_1k_2}{k_1 + k_2}$

c. $\frac{k_1 + k_2}{k_1k_2}$ d. k_1k_2

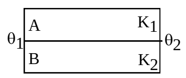
8. A wall has two layers A and B, each made of a different material. Both the layer have the same thickness. The thermal conductivity of material of A is thrice that of B. Under thermal equilibrium the temperature, difference across the wall is 36°C. The temperature different across the layer A is



a. 6°C b. 9°C

c. 12°C d. 27°C

9. Two rods A and B of different material are welded together as shown in the figure. If their thermal conductivities are k_1 & k_2. The thermal conductivity of the composite rod will be:



a. $2(k_1 + k_2)$ b. $\frac{3}{2}(k_1 + k_2)$

c. $k_1 + k_2$ d. $\frac{k_1 + k_2}{2}$

10. Equal temperature difference exists between the ends of two metallic rods of equal lengths. Their thermal conductivities are k_1 & k_2 and cross sectional Area A_1 and A_2 respectively. The condition of equal rate of heat transfer will be

a. $k_1A_2 = k_2A_1$ b. $k_1^2A_2 = k_2^2A_1$

c. $k_1A_1 = k_2A_2$ d. $k_1A_1^2 = k_2A_2^2$

11. Two spheres of different materials one with double the radius and one – fourth wall thickness of the other are filled with ice. If the time taken for complete melting of ice in big sphere is 25 minutes and for small one is 16 minute, the ratio of thermal conductivity of the materials of big to small sphere is

a. 4: 5 b. 5: 4
c. 25: 8 d. 8: 25

12. Two cylindrical rods of the same substance have diameters d_1 and d_2. The amounts of heat conducted by these two rods for same temperature difference between two ends will be equal if their lengths are related by

a. $\frac{L_1}{L_2} = \frac{d_1}{d_2}$ b. $\frac{L_1}{L_2} = \left(\frac{d_1}{d_2}\right)^2$
c. $\frac{L_1}{L_2} = \frac{d_2}{d_1}$ d. $\frac{L_1}{L_2} = \left(\frac{d_2}{d_1}\right)^2$

13. Two solid spheres of radii R_1 and R_2 are made of same material and have similar surface. The spheres are raised to the same temperature and then allowed to cool under identical conditions. Assuming spheres to be perfectly conducting, the rate of cooling of spheres are in the ratio

a. $R_2^2 : R_1^2$ b. $R_1^2 : R_2^2$
c. $R_1 : R_2$ d. $R_2 : R_1$

14. Heat is flowing through two cylindrical rods of same material. The diameters of the rods are in the ratio 1: 2. If the temperature difference between their ends is same, the ratio of amounts of heat conducted through them per unit time will be

a. 1: 1 b. 2: 1
c. 1: 4 d. 1: 8

15. A sphere, a cube and a thin circular plate all made up of same material and having same mass is heated to a temperature of 200°C. When these are left in room which will reach room temperature at last.

a. sphere b. cube
c. circular plate d. all simultaneously

16. The absorptivity of a perfectly black body is

a. zero b. 1
b. less than 1 d. infinity

17. A blue star as compared to red star is

a. hotter b. colder
c. same for both d. None

18. If the temperature of the sun is doubled, the rate of energy received on earth will be increased to a factor of

a. 2 b. 4
c. 8 d. 16

19. Two identical vessels made of different material having conductivities k_1 & k_2 are completely filled with ice at 0°C. Due to temperature of surrounding, the ice in the two vessels melts in 25min and 20min respectively. The ratio of k_1 & k_2 is

a. $\frac{5}{4}$ b. $\frac{4}{5}$
c. $\frac{16}{25}$ d. $\sqrt{\frac{5}{4}}$

20. A metallic rod temperature of 77°C radiates at the rate of 10w. If the temperature is increased to 227°C, it will radiate at the rate of

a. $\left(\frac{227}{77}\right) \times 10w$ b. $\left(\frac{227}{77}\right)^4 \times 10w$
c. 42w d. 160w

21. Ice starts forming in a lake with temperature at 0°C. When the atmospheric temperature is –10°C. If the time taken for 1cm of ice to be formed is 7hrs. The time taken for the ice to change from 1cm to 2cm is

a. 7hrs b. 14hrs
c. 21hrs d. 28hrs

22. A bucket full of hot water is kept in a room and it cools from 75°C in t_1 min, from 70°C to 65°C in t_2 min and from 65°C in t_3 min, then

a. $t_1 = t_2 = t_3$ b. $t_1 < t_2 < t_3$

b. $t_1 > t_2 > t_3$ d. $t_1 < t_2 > t_3$

23. A cup of tea cools from 80°C to 60°C in one minute. The ambidient temperature is 30°C. In cooling from 60°C to 50°C it will take

a. 30s b. 60s

c. 90s d. 48s

Answer Sheet

1. b	*2. c*	*3. b*	*4. c*	*5. d*	*6. b*	*7. b*	*8. b*	*9. d*	*10. c*
11. d	*12. b*	*13. d*	*14. d*	*15. a*	*16. b*	*17. a*	*18. d*	*19. b*	*20. c*
21. c	*22. b*	*23. d*							

SOLUTION

1. Ans. (b)

Heat radiation is in the form of infrared ray travels in the speed of light.

2. Ans. (c)

At side, heat is received due to radiation only while over the top, heat reaches both due to convection & radiation.

3. Ans. (b)

Black is good absorber hence experience more heat & good absorber are good emitters $\rightarrow$ Kirchhoff law. Hence feels more cold also.

4. Ans. (c)

Newton's law of cooling refers radiation of heat.

5. Ans. (d)

$$\frac{Q}{t} = \frac{\kappa A \Delta\theta}{l} = \frac{\kappa \pi r^2 \Delta\theta}{l}$$

$$\frac{Q}{t} \alpha \frac{r^2}{l}$$

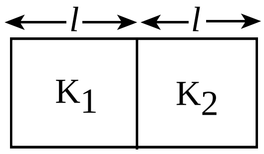
The value of $\frac{r^2}{l}$ is greater for'd'

6. Ans. (b)

Thermal resistance

$$R = \frac{\Delta\theta}{Q/t} = \frac{l}{kA}$$

7. Ans. (b)



The slabs are actually in series as shown fig.

$$Rs = R_1 + R_2$$

$$\frac{l_1 + l_2}{kA} = \frac{l_1}{k_1 A} + \frac{l_2}{k_2 A}$$

$$\frac{2l}{k} = \frac{l}{k_1} + \frac{l}{k_2}$$

$$k = \frac{2k_1k_2}{k_1 + k_2}$$

8. Ans. (b)

Rate of flow of heat will be equal (in series).

So, $\frac{k_1 A \Delta\theta_1}{l_1} = \frac{k_2 A \Delta\theta_2}{l_2}$

$$\frac{3kA}{l}\Delta\theta_1 = \frac{kA}{l}\Delta\theta_2$$

$3\Delta\theta_1 = \Delta\theta_2$ – (i)

But $\Delta\theta_1 + \Delta\theta_1 = 36$ – (ii)

On solving, we get

$$\Delta\theta_1 = 9°C.$$

9. Ans. (d) The rate of flow of heat through each rod is given by

$\frac{Q_1}{t} = \frac{k_1A(\theta_1 - \theta_2)}{d}$ & $\frac{Q_2}{t} = \frac{k_2A(\theta_1 - \theta_2)}{d}$

For composite rod, cross section (2A).

$\frac{Q}{t} = \frac{k\,(2A)\theta_1 - \theta_2}{d}$

$\frac{Q}{t} = \frac{Q_1}{t} + \frac{Q_2}{t}$

$k \times 2A = k_1A + k_2A \Rightarrow k = \frac{k_1 + k_2}{2}$

10. Ans. (c) $\frac{Q_1}{t_1} = \frac{Q_2}{t_2}$

$\frac{k_1A_1\Delta\theta}{l} = \frac{k_2A_2\Delta\theta}{l}$

$k_1A_1 = k_2A_2$

11. Ans. (d)

$Q = \frac{kA\Delta\theta}{x}\,t$, $Q = mL = v\rho L = \frac{4}{3}\pi R^3\rho L$

$\Rightarrow \frac{4}{3}\pi R^3\rho L = k\,(4\pi R^2)\left(\frac{\Delta\theta}{x}\right)t$

$k = \frac{x\rho RL}{3\Delta\theta t}\ \alpha\ \frac{xR}{t}$

$\frac{k_1}{k_2} = \frac{x_1}{x_2} \times \frac{R_1}{R_2} \times \frac{t_2}{t_1}$

$\frac{k_1}{k_2} = \frac{1}{4} \times 2 \times \frac{16}{25} = \frac{8}{25}$

12. Ans. (b) $Q_1 = Q_2$

$\frac{kA_1\Delta\theta}{l_1} = \frac{kA_2\Delta\theta}{l_2}$

$\frac{l_1}{l_2} = \frac{A_1}{A_2} = \left(\frac{d_1}{d_2}\right)2$

13. Ans. (d) $\frac{dQ}{dt} = \sigma AT^4$

Rate of heat loss $\frac{dQ}{dT} = \frac{d}{dt} = \frac{d(mc\theta)}{dt}$

$mc\frac{d\theta}{dt} = \sigma A\,T^4$

$\frac{4}{3}\pi r^3\rho c\,\frac{d\theta}{dt} = \sigma \times (4\pi r^2) \times T^4$

$\frac{d\theta}{dt} = \frac{3\sigma T^4}{r\rho c} \Rightarrow \frac{d\theta}{dt}\ \alpha\ \frac{1}{r\rho c}\ \alpha\ \frac{1}{R}$

$\therefore \Rightarrow R_2 : R_1$

14. Ans. (d)

If Rate of heat flow is R.

$R = \frac{Q}{t} = \frac{KA\Delta\theta}{l}\left(\frac{A_1}{A_2}\right)\left(\frac{l_2}{l_1}\right)$

$= \left(\frac{r_1}{r_2}\right)2 \times \frac{l_2}{l_1}$

$\frac{R_1}{R_2} = \left(\frac{1}{2}\right)2 \times \frac{1}{2} = \frac{1}{8}$

15. Ans. (a)

$\frac{dQ}{dt} = e\sigma AT^4 = mc\frac{d\theta}{dt}$

$\frac{d\theta}{dt} = \frac{e\sigma AT^4}{mc}$

$\frac{d\theta}{dt}\ \alpha$ A, sphere has small surface area hence it cool slowest.

16. Ans. (b)

For perfectly blackbody

a = 1(100%).

17. Ans. (a) hotter

λT = constant

$T\ \alpha\ \frac{1}{\lambda}$ & (λred > λblue)

$\therefore$ T red < T blue.

18. Ans. (d)

$E\ \alpha\ T^4$

So rate of energy received increases to 16 times.

19. Ans. (b)

$Q = mL = \frac{kA\Delta\theta t}{x}$

Since Q = mL be equal in either cases.

$k_1\,t_1 = k_2\,t_2$

$\frac{k_1}{k_2} = \frac{t_2}{t_1} = \frac{20}{25} = \frac{4}{5}$

20. Ans. (c)

$P\ \alpha\ T^4$

$\frac{P_1}{P_2} = \left(\frac{T_1}{T_2}\right)4 = \left(\frac{77 + 273}{227 + 273}\right)4$

$\frac{10}{P_2} = \left(\frac{350}{500}\right)4 = \left(\frac{7}{10}\right)4$

$P_2 = 42w$

21. Ans. (c) Time taken to increase the thickness from y_1 to y_2 is given by

$t = \frac{\rho l}{2k\theta}(y_2^2 - y_1^2)$

$\frac{t_2}{t_1} = \frac{2^2 - 1^2}{1^2 - 0^2} = \frac{3}{1}$

$t_2 = 3 \times 7 = 21$hrs.

22. Ans. (b) $\frac{dQ}{dt} \alpha (\theta - \theta s)$

As the hot water cools decreases, i.e. $(\theta - \theta s)$ decreases, i.e. rate of heat loss decrease. So more time is required to cool through same temperature difference. $t_1 < t_2 < t_3$

23. Ans. (d)

$\frac{d\theta}{dt} \alpha$ (θ mean – θ surrounding)

$\frac{80 - 60}{60} \alpha \left(\frac{80 + 60}{2} - 30\right)$ .... (i)

$\frac{60 - 50}{t} \alpha \left(\frac{80 + 50}{2} - 30\right)$ .... (ii)

$\frac{20 \times t}{60 \times 10}$

$= \frac{75 - 30}{55 - 30} = \frac{45}{25}$

t = 48sec.

Past Questions

1. **If an object cools from 80°C to 70°C in one minute in the room at 30°C, the time it will take to cool from 50°C to 40°C is [IOM 2011]**

   a. 2min b. 3min
   c. 4min d. 5min

2. **A body cools down from 65°C to 60°C in 5minutes. If will cool down 60°C to 55°C in [IOM 2010]**

   a. 5min
   b. less than 5min
   c. less than 5min
   d. less or more than 5min depending on whether its mass is more or less than 1kg

3. **The energy emitted in the sun in between two different temperatures of 27°C & 600k is [MOE 2067]**

   a. 2 b. 4
   c. 8. d. 16

4. **The coefficient of thermal conductivity is expressed in the unit [MOE 2067]**

   a. Watt (Kelvin per metre)
   b. Joule per Kelvin per metre per second
   c. Watt (metre per Kelvin)
   d. Joule (Kelvin per metre per second)

5. **Two perfectly black bodies at Kelvin temperature T and T^1 emit the maximum wave lengths of radiation λ^1m and λm respectively. Which of the following ratio of $\frac{\lambda m}{\lambda m^1}$ is correct? [MOE Curriculum]**

   a. $\lambda m/\lambda m^1$ is directly propotional to $\frac{T}{T^1}$
   b. $\lambda m/\lambda m^1$ is inversely propotional to $\frac{T}{T^1}$
   c. $\lambda m/\lambda m^1$ is directly propotional to $\left(\frac{T}{T^1}\right)4$
   d. $\lambda m/\lambda m^1$ is inversely propotional to $\left(\frac{T}{T^1}\right)4$

6. **If the absolute temperature of the radiating body is suddenly halved, the radiation power will reduce approximately by [MOE 2009]**

   a. 25% b. 12.5%
   c. 6.25% d. 3.12%

7. **The ratio of maximum wave length of sun and moon is in the ratio 1: 400. What is the ratio of the temperature? [MOE 2008]**

a. 200:1 b. 400:1
c. 1:200 d. 1:400

8. If temperature of black body is increased by 50% percentage, increase in emitted radiation is [MOE 2050]

a. 50 b. 100
c. 500 d. 400

9. The most appropriate material for making a cooking pot is the one having [BPKIHS]

a. Low specific heat, high conductivity
b. Low specific heat, low conductivity
c. High specific heat, low conductivity
d. High specific heat, high conductivity

10. A pot is made up of metal is polished on outer side and the top is mainly in order to [IE – 05]

a. pervent loss of heat by convection
b. To minimize rate of heat loss by radiation
c. present loss of heat by conduction
d. to save material

11. One feels hot during morning when he walks on sand near seashore because [IOM]

a. specific heat of sand is low
b. specific heat of sand is high
c. of radiation
d. of convection

12. The rate of loss of heat from a hot body depends on the [IOM]

a. temperature of the body
b. excess temperature of the body over the surrounding
c. thermal capacity of the body
d. temperature of the surrounding

13. A black body heated from 27°C to 127°C, the ratio of their energies of radiation is [I.E.]

a. 9:16 b. 27:64
c. 81:256 d. 3:4

14. Two starts radiate maximum energy at 320nm and 400nm respectively. The ratio of Kelvin temperature is [IOM]

a. 5:4 b. 4:5
c. 2:5 d. 4:25

Answer Sheet

1. b	*2. c*	*3. d*	*4. b*	*5. b*	*6. c*	*7. b*	*8. d*	*9. a*	*10. b*
11. a	*12. b*	*13. c*	*14. a*						

SOLUTION

1. Ans. (b)

Newton's law of cooling

$\frac{d\theta}{dt}$ α (θ mean – θ surrounding)

$\frac{10}{1} \alpha \left(\frac{80+70}{2} - 30\right)$ – (i)

$\frac{10}{t_2} \alpha \left(\frac{50+40}{2} - 30\right)$ – (ii)

$\frac{t_2}{1} = \frac{45}{15} = 3\text{min}$

2. Ans. (c)

$\frac{d\theta}{dt} \alpha (\theta - \theta o)$

$\frac{65-60}{5} \alpha (62.5 - \theta o)$

$\frac{60-55}{t} \alpha (57.5 - \theta o)$

$t = \left(\frac{62.5 - \theta o}{57.5 - \theta o}\right) \times 5 > 5$

i.e. more than 5minutes

3. Ans. (d)

$\varepsilon = \sigma T^4$

$\frac{\varepsilon_1}{\varepsilon_2} = \left(\frac{T_1}{T_2}\right)4$

$= \left(\frac{300}{600}\right)4 = 1: 16$

4. Ans. (b)

$\frac{dQ}{dt} = \frac{kA\,\Delta\theta}{l}$

$K = \frac{dQ}{dt} \times \frac{l}{A\Delta\theta}$

= Joule per Kelvin per sec per metre.

5. Ans. (b)

Wien's law → Wave length corresponding to maximum energy is inversely propotional to Kelvin temperature.

$\lambda m \; \alpha \; \frac{1}{T}$ (λ m T = constant)

$\frac{\lambda m}{\lambda m^1} = \frac{T^1}{T}$ i.e. $\frac{\lambda m}{\lambda m^1}$ is directly propotional to $\frac{T^1}{T}$ or inversely propotional to $\frac{T}{T^1}$.

6. Ans. (c)

$P = \sigma AT^4 \Rightarrow P \; \alpha \; T^4$

$P_2 = \frac{P_1}{16} = 0.0625P_1$

= 6.25%

7. Ans. (b)

Wien's displacement law.

λT = constant

$\lambda \; \alpha \; \frac{1}{T}$

$\frac{Ts}{Tm} = \frac{\lambda m}{\lambda s} = 400:1$

8. Ans. (d)

$\frac{\Delta\varepsilon}{\varepsilon} \times 100\% = \left[\left(1 + \frac{50}{100}\right)4 - 1\right] \times 100\%$

$= \left[(1.5)^{4} - 1\right] \times 100\%$

= 400%

9. Ans. (a)

For a cooking utensil, specific heat should be low so that it absorbs lesser heat, thermal conductivity should be high so that whole of heat absorbed is transmitted to things being cooked.

10. Ans. (b)

The polishing of metal pots decreases the rate of loss of heat radiation keeping the temperature of pot constant.

11. Ans. (a)

Due to low specific heat of sand even with in short period of time, sand absorbs very high amount of heat in the morning, hence he feels hotter.

12. Ans. (b)

Newton's law of cooling

$\frac{d\theta}{dt} = K (\theta mean - \theta surrounding)$

$\frac{d\theta}{dt} \; \alpha \; (\theta - \theta o)$ i.e. difference of temperature of body & surrounding.

13. Ans. (c)

Stefan's law

$\varepsilon \; \alpha \; T^4$

$\frac{\varepsilon_1}{\varepsilon_2} = \left(\frac{T_1}{T_2}\right)4$

$= \left(\frac{300}{400}\right)4 = \frac{81}{256}$

14. Ans. (a)

λ T = constant (Wien's law)

$T \; \alpha \; \frac{1}{\lambda}$

$$\frac{T_1}{T_2} = \frac{\lambda_2}{\lambda_1} = \frac{400}{320}\ \frac{5}{4}$$

Chapter: 21

THERMODYNAMICS

1. The internal of an ideal gas depends only on

a. temperature b. pressure

c. volume d. temperature & volume both

2. The internal energy of a real gas depends only on

a. temperature b. pressure

c. volume d. temperature & volume both

3. The gas law PV = nRT is true for

a. isothermal changes only

b. adiabatic changes only

c. Both isothermal & adiabatic

d. None of these

4. A gas is heated at constant pressure. The fraction of heat energy used to increase the internal energy of gas molecules is

a. γ b. $\frac{1}{\gamma}$

c. $\frac{\gamma}{\gamma + 1}$ d. $\frac{\gamma - 1}{\gamma}$

5. Heat is supplied to a diatomic gas at constant pressure. The ratio of ΔQ: ΔU: ΔW is

a. 5:3:2 b. 7:5:2

c. 2:3:5 d. 2:5:7

6. A gas in a container is suddenly compressed. Its temperature would

a. increase

b. decrease

c. remains unchanged

d. None

7. When the temperature difference between the source and the sink increases, the efficiency of the heat engine.

a. decreases b. increases

c. remains unchanged d. None

8. For an engine operating between t_1°c and t_2°c the efficiency will be

a. $\frac{t_1}{t_2}$ b. $1-\frac{t_2}{t_1}$

c. $\frac{t_1 - t_2}{t_2}$ d. $\frac{t_1 - t_2}{t_1 + 273}$

9. Two samples, A and B of a gas at the same initial temperature & pressure are compressed from volume V to $\frac{V}{2}$; A isothermally and B adiabatically. The final pressure of A will be

a. more than B b. less than B

c. equal to B d. twice the B

10. A heat engine has efficiency 'η'. Temperature of source and sink each decreased by 100K. The efficiency of the engine

a. increases b. decreases

c. remains constant d. becomes 1

11. A gas performs minimum work when it expands

a. adiabatically b. isothermally

c. isobarically d. isochorically

12. For an adiabatic expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal to

a. $-\gamma^{\frac{1}{2}} \frac{\Delta v}{v}$ b. $\frac{-\Delta v}{v}$

c. $-\gamma \frac{\Delta v}{v}$ d. $\gamma^2 \frac{\Delta v}{v}$

13. For isothermal expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal to

a. $-\gamma^{\frac{1}{2}} \frac{\Delta v}{v}$ b. $\frac{-\Delta v}{v}$

c. $-\gamma \frac{\Delta v}{v}$ d. $\gamma^2 \frac{\Delta v}{v}$

14. A carnot engine operates at 800k and 200k. If the engine takes 8J of heat. What is the amount of work done by the engine?

a. 6J b. 4J
c. 10J d. 2J

15. The efficiency of a Carnot engine working between steam point and ice point is

a. 16.8% b. 26.81%
c. 36.8% d. 46.8%

16. 15g of air is heated from 0°C to 5°C at constant volume by adding 150 cal of heat. The change in internal energy per g is

a. 150cal b. 10cal
c. 750cal d. information insufficient

17. During an adiabatic expansion of 2 moles of a gas the change in internal energy was found to be equal to –100J. The work done during this process will be

a. zero b. –100J
c. 200J d. +100J

18. Air is expanded from 50 liters to 150 litres at 2 atmospheric pressure. The external work done is (1 atm pressure = $1 \times 10^5 N/m^2$)

a. $2 \times 10^4 J$ b. 2000J
c. 200J d. $2 \times 10^{-8} J$

19. One mole of an ideal gas expands at a constant temperature of 300k from an initial volume of 10 litres to final volume of 20 litres. The work done in expanding the gas is (R = 8.31J / mole k)

a. 750J b. 1500J
c. 1728J d. 3456J

20. A gas is compressed at constant pressure of $50N/m^2$ from $10m^3$ to a volume of $4m^3$ and 100J of energy is added by heating the gas. Its internal energy gets

a. increased by 200J
b. increased by 100J
c. decreased by 100J
d. increased by 400J

21. In a thermodynamic process the pressure of a fixed mass of a gas is changed in such a way that the gas molecules give out 30J of heat and 10J of work is done on the gas. If initial internal energy of the gas was 40J then the final internal energy will be

a. +20J b. –20J
c. +80J d. zero

22. The molar specific heat of oxygen at constant pressure CP = 7.03cal mole °C and R = 8.31J/mole °C. The amount of heat taken by 5 moles of oxygen when heated at constant volume from 10°C to 20°C will be approximately

a. 25cal b. 50cal
c. 500cal d. 250cal

23. A certain amount of hydrogen gas requires 350J heat to raise the temperature by 5k when heated at constant pressure. If the same gas is heated at constant volume to raise its temperature by 5k then heat required is

a. 300J b. 200J
c. 250J d. 350J

24. The molar specific heats of an ideal gas at constant pressure and volume are Cp & Cv. Further $\frac{Cp}{Cv} = \gamma$ & R is gas constant then

a. Cv = R b. $Cv = \gamma R$
c. $Cv = \frac{R}{\gamma - 1}$ d. $Cv = \frac{\gamma R}{\gamma - 1}$

25. The molar specific heats of an ideal gas at constant pressure and volume are C_P and Cv. Further $\frac{cp}{cv} = \gamma$ & R is gas constant. Then Cp is given by

a. $C_P = R$ b. $C_P = \gamma R$
c. $C_P = \frac{R}{\gamma - 1}$ d. $C_P = \frac{\gamma R}{\gamma \ 1}$

26. What is the change in internal energy of one mole of gas when the volume changes from v to 2v at constant pressure P?

a. $\frac{R}{\gamma - 1}$ b. PV

c. $\frac{PV}{\gamma - 1}$ d. $\frac{\gamma PV}{\gamma - 1}$

27. When 1mole of monatomic gas is mixed with 3 moles of a diatomic gas, the volume of adiabatic exponent γ of the mixture is

a. $\frac{5}{3}$ b. 1.5

c. $\frac{4}{3}$ d. $\frac{13}{9}$

28. A gas at NTP is suddenly compressed to $\frac{1}{4}$ of its volume then final pressure in atmosphere will be (γ = 1.5)

a. 4 b. 1.5

c. 8 d. 0.25

29. An ideal gas is found to obey a law VP^2 = constant. The gas is initially at temperature P and volume V. When it expands to a volume 2V. Calculate the resulting temperature.

a. 2T b. $\sqrt{2}T$

c. $\frac{T}{\sqrt{2}}$ d. $\frac{T}{2}$

30. During an adiabatic process the pressure of an ideal gas is propotional to cube of its temperature. The ratio $\gamma = \frac{cp}{cv}$ is

a. $\frac{3}{5}$ d. $\frac{4}{3}$

c. $\frac{5}{3}$ d. $\frac{3}{2}$

31. The power is least in

a. steam engine b. petrol engine

c. diesel engine d. Carnot engine

32. In four stroke cycle heat engine, power is obtained from

a. First stroke b. second stroke

c. third stroke d. fourth stroke

33. By opening the door of a refrigerator which is inside a room, the temperature of the room

a. increases d. decreases

c. remains unchanged

d. first decreases then increases

34. The coefficient of performance of a refrigerator working between ice point and room temperature 27°C is

a. 6 b. 17

c. 0.5 d. 10

35. The temperature inside & outside of a refrigerator are 273k and 303k respectively. Assuming the refrigerator cycle is reversible. Calculate the heat delivered to the surrounding for every joule of workdone

a. 7.1J b. 8.1J

c. 9.1J d. 10.1J

36. An ideal gas heat engine operates in a Carnot cycle between 227°C and 127°C. It absorbs 6×10^4cal at higher temperature. The amount of heat converted into work is equal to

a. 4.8×10^4cal b. 3.5×10^4cal

c. 1.6×10^4cal d. 1.2×10^4cal

Answer Sheet

1. a	*2. d*	*3. c*	*4. b*	*5. b*	*6. a*	*7. b*	*8. d*	*9. b*	*10. a*
11. d	*12. c*	*13. b*	*14. a*	*15. b*	*16. b*	*17. d*	*18. a*	*19. c*	*20. d*
21. a	*22. d*	*23. c*	*24. c*	*25. d*	*26. c*	*27. d*	*28. c*	*29. b*	*30. d*
31. d	*32. c*	*33. a*	*34. d*	*35. d*	*36. d*				

SOLUTION

1. Ans. (a)
Internal energy of an ideal gas is only kinetic energy given by $E = \frac{3}{2}RT$.

2. Ans. (d)
Internal energy of real gas is the sum of P.∈ + K.∈. P.∈. is the function of configuration i.e. position of molecules, attraction of molecules.

3. Ans. (c)
PV = nRT holds true for both isothermal (constant temperature) & adiabatic (dQ = 0) changes.

4. Ans. (b)
$dU = nCv\,dT$
$dQ = nCpdT$
$\frac{dU}{dQ} = \frac{Cv}{cp} = \frac{1}{\gamma}\left(\gamma = \frac{cp}{cv}\right)$

5. Ans. (b)
$Cv = \frac{5}{2}R$, $Cp = \frac{7}{2}R$ for diatomic.
$\Delta Q = nCpdT = n\left(\frac{7}{2}RdT\right)$
$\Delta U = nCvdT = n\left(\frac{5}{2}RdT\right)$
$\Delta W = P\Delta V = nRdT$
$\Delta Q:\Delta U:\Delta W = \frac{7}{2}:\frac{5}{2}:1 = 7:5:2$

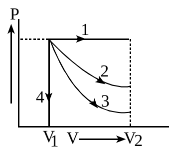
6. Ans. (a)
Suddenly changed are adiabatic (dQ = 0)
dQ = du + dw
du = –dw
nCvdT = +ve (compression dw = Pdv = –ve)
dT = +ve (Temperature increases)

7. Ans. (b)
$\eta = 1 - \frac{T_2}{T_1} = \frac{T_1 - T_2}{T_1}$
When $(T_1 - T_2)$ increase η increases.

8. Ans. (d)
$\eta = \frac{T_1 - T_2}{T_1} = \frac{(t_1 + 273) - (t_2 + 273)}{(t_1 + 273)}$
$= \frac{t_1 + t_2}{t_1 + 273}$
T_1 & T_2 must be in Kelvin.

9. Ans. (b)
For A_1 $(P_2)_A = \frac{P_1V_1}{V_2} = P_1 \times 2$
For B_1 $(P_2)_B = P_1\left(\frac{v_1}{v_2}\right)^{\gamma} = P_1\,(2)^{\gamma}$
$(P_2)_B > (P_2)_A$.

10. Ans. (a)
$\eta = 1 - \frac{T_2}{T_1} = \frac{T_1 - T_2}{T_1}$
When T_1, T_2 both are decreased by 100k. $(T_1 - T_2)$ stays constant. T_1 decrease η increases.

11. Ans. (d)


1 → Isobaric 2 → Isothermal
3 → Adiabatic 4 → Isochoric
Workdone = PΔV = Area under PV graph
1 > 2 > 3 > 4
ΔV = O → w = O in isochoric.

12. Ans. (c)
PV^{γ} = constant (Adiabatic)
$V\Delta P + \gamma P\Delta V = 0$
$\frac{\Delta P}{P} = -\gamma\frac{\Delta V}{V}$

13. Ans. (b)
PV = constant
$P\Delta V + V\Delta P = 0$
$\frac{\Delta P}{P} = \frac{-\Delta v}{v}$

14. Ans. (a)

$\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$

$\frac{8}{Q_2} = \frac{800}{200}$

$Q_2 = 2J$

Workdone = $Q_1 - Q_2 = 8 - 2 = 6J$

15. Ans. (b)

$\eta = \left(1 - \frac{T_2}{T_1}\right) \times 100\%$

$= \left(1 - \frac{273}{100 + 273}\right) \times 100\%$

$= \left(\frac{100}{373}\right) \times 100\% = 26.81\%$

16. Ans. (b)

At constant volume,

$W = P\Delta V = O$

$dQ = dU + P\Delta V = dU$

$\frac{\Delta U}{g} = \frac{150}{15} = 10$ cal/g

17. Ans. (d)

For adiabatic change

$\Delta Q = O = du + W$

$w = -du = -(-100) = +100J$

18. Ans. (a)

$w = P(v_2 - v_1)$

$= 2 \times 10^5 (150 - 50) \times 10^{-3} = 2 \times 10^4 J$

19. Ans. (c)

$W_{iso} = nRT \log e \left(\frac{v_2}{v_1}\right)$

$= 1 \times 8.31 \times 300 \log e \left(\frac{20}{10}\right)$

$= 2493 \times \log e\ 2 = 2493 \times 0.613J = 1728J$

20. Ans. (d)

Work done $w = P(v_2 - v_1)$

$= 50(4 - 10) = -300J$

Heat supplied $\Delta Q = +100J$

$\Delta Q = \Delta U + W$

$100 = \Delta U - 300$

$\Delta U = +400J$

So, internal energy increase by 400J

21. Ans. (a)

Since heat is given out, ΔQ is taken as –ve and work is done on gas. W is also –ve.

$\Delta Q = w + du$

$-30 = -10 + Uf - Ui$

$Uf = -20 + 40 = +20J$

22. Ans. (d)

$C_P = 7.03$cal /mole °C

$R = 8.31$J/mole °C = 2cal /mole

$Cp - Cv = R \Rightarrow Cv = 7.03 - 2$

$= 5.03$cal/mole °C

$\Delta Q = du + dw$

$= nCvdT + O\ (\Delta v = 0)$

$= 5 \times 5.03 \times (20 - 10) = 250$cal

23. Ans. (c)

At constant pressure,

$\Delta Q = vCpdT$

At constant volume

$\Delta Q^1 = nCvdT$

$\frac{\Delta Q}{\Delta Q^1} = \frac{cp}{cv} = \gamma = 1 + \frac{2}{f} = 1 + \frac{2}{5}$

$\Delta Q^1 = \frac{5}{7} \times 350$

$= 250J$

24. Ans. (c)

$Cp - Cv = R$

$\frac{cp}{cv} - \frac{cv}{cv} = \frac{R}{cv}$

$\gamma - 1 = \frac{R}{cv}$

$Cv = \frac{R}{\gamma - 1}$

25. Ans. (d)

$C_P - C_p = R$

$\frac{cp}{cp} - \frac{cv}{cp} = \frac{R}{cp}$

$1 - \frac{1}{\gamma} = \frac{R}{cp}$

$C_P = \frac{\gamma R}{\gamma - 1}$

26. Ans. (c)

Charle's law V α T

As V $\rightarrow$ 2V; T $\rightarrow$ 2T

So,

$\Delta V = nC_v dT$

$$= n\left(\frac{R}{\gamma - 1}\right)(2T - T) = \frac{nRT}{\gamma - 1} = \frac{PV}{\gamma - 1}$$

27. Ans. (d)

Shortcut, $\dfrac{n_1 + n_2}{\gamma - 1} = \dfrac{n_1}{\gamma_1 - 1} + \dfrac{n_2}{\gamma_2 - 1}$

$$\frac{1 + 3}{\gamma - 1} = \frac{1}{\frac{5}{3} - 1} + \frac{3}{\frac{7}{5} - 1}$$

$$\frac{4}{\gamma - 1} = \frac{3}{2} + \frac{15}{2} = 9$$

$$\gamma - 1 = \frac{4}{9} \qquad \therefore \gamma = \frac{13}{9}$$

28. Ans. (c)

When suddenly compressed adiabatic change occurs.

PV^{γ} = constant

$P_2 V_2^{\gamma} = P_1 V_1^{\gamma}$

$$P_2 = \left(\frac{v_1}{v_2}\right)^{\gamma} P_1 = 4^{1.5} \times 1 = (4)^{\frac{3}{2}} = 8 \text{ atm}$$

29. Ans. (b)

VP^2 = constant

$PV^{\frac{1}{2}}$ = constant

Comparing with PV^{γ} = const $\Rightarrow \gamma = \dfrac{1}{2}$

$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$$T_2 = \left(\frac{V}{2V}\right)^{\frac{1}{2} - 1} T$$

$$T_2 = \left(\frac{1}{2}\right)^{-\frac{1}{2}}$$

$T = \sqrt{2}T$

30. Ans. (d)

$T^{\gamma} P^{1-\gamma}$ = constant

$P^{\gamma-1} \,\alpha\, T^{\gamma}$

$P \,\alpha\, (T)^{\frac{\gamma}{\gamma - 1}}$

By question, $P \,\alpha\, T^3$

So, $3 = \dfrac{\gamma}{\gamma - 1} \Rightarrow \gamma = \dfrac{3}{2}$

31. Ans. (d)

$P = \dfrac{w}{t}$ & time taken to complete reversible cycle like carnot cycle is infinitely large.

32. Ans. (c)

Power is obtained only from adiabatic expansion from third stroke.

33. Ans. (a)

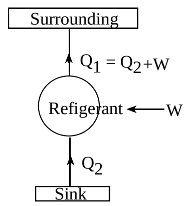
Temperature of room increases because heat drawn from the freezer is rejected to the air in the room.

34. Ans. (d)

$$\beta = \frac{Q_2}{w} = \frac{Q_2}{Q_1 - Q_2} = \frac{T_2}{T_1 - T_2}$$

$$= \frac{273}{27} = 10$$

35. Ans. (d)



$$\beta = \frac{Q_2}{w} = \frac{T_2}{T_1 - T_2}$$

$$\frac{Q_2}{1} = \frac{273}{303 - 273}$$

$Q_2 = 9.1$J

Heat delivered to surrounding $= Q_1 = Q_2 + w = 9.1 + 1 = 10.1$J

36. Ans. (d)

$$\eta = 1 - \frac{T_2}{T_2} = 1 - \frac{400}{500} = \frac{1}{5}$$

$$\eta = \frac{w}{Q_1} \Rightarrow w = \eta Q_1$$

$$w = \frac{1}{5} \times 6 \times 10^4 = 1.2 \times 10^4 \text{cal.}$$

Past Questions

1. When an ideal diatomic gas is heated at constant pressure, the fraction of the heat energy supplied which increase the internal energy of the gas is [MOE 2068]

a. $\frac{2}{5}$ b. $\frac{3}{5}$

c. $\frac{3}{7}$ d. $\frac{5}{7}$

2. Efficiency of Carnot engine working between 27°C to 127°C is [MOE 2068]

a. 50% b. 100%

c. 25% d. 75%

3. A Carnot engine takes in 3000k cal of heat from a reservoir of 627°C and gives it to a sink at 27°C. The workdone by the engine is [MOE 2010]

a. 4.2×10^6J b. 8.4×10^6J

c. 16×10^6J d. o

4. If the gas is allowed to expand adiabatically against external pressure [MOE 2009]

a. Its temperature remains constant

b. Pressure remains constant

c. decrease in internal energy

d. increase in internal energy

5. A Carnot engine takes 300 calories of heat from a source at 500k and rejects 150 calories of heat to sink. The temperature of sink is [MOE 2065]

a. 400k b. 250k

c. 150k d. 100k

6. The maximum efficiency of an engine operating between 30°C and 300°C is [MOE 2061]

a. 4.71% b. 47.1%

c. 90% d. 9%

7. An inflated tyre of bicycle bursts. Which of the following relation between pressure P and temperature T holds good if γ is the ratio of specific heats of air? [MOE 2000]

a. $P^{1-\gamma} T^{\gamma}$ b. $P^{\gamma-1} T^{\gamma-1}$

c. $P^{\gamma-1} T^{\gamma}$ d. $P^{1-\gamma} T^{\gamma-1}$

8. An ideal heat engine working between temperature T_1 & T_2 has efficiency η. If both the temperature are raised by 100k each. The new efficiency of the engine will be [MOE]

a. η

b. more than η

c. less than η

d. depends on nature of working substance.

9. What is the average power of refrigerator consumed when 263J of energy is transfer through –10°C to 25°C? [IOM 2010]

a. 10watt b. 35watt

c. 40watt d. 50watt

10. The temperature of source is 500k with source energy 200J. What is the temperature of sink with sink energy 100J? [IOM 2010]

a. 500k b. 300k

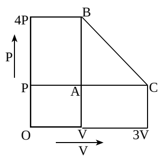
c. 250k d. 150k

11. The specific heat capacity of an ideal gas under isothermal condition is [IOM]

a. 0 b. 8.31
c. 1.4 d. ∞

12. Which of the following is not correct [IOM 97]
a. In an adiabatic condition, the system is allowed to undergo changes in thermal isolation from surrounding
b. In an isothermal condition heat enters & leaves the system
c. Adiabatic process is accompanied by change in temperature & is quick
d. It is possible to cool a gas to absolute zero temperature

13. Find out workdone from the graph [IOM 96]



a. 12pv
b. 6pv
c. 3pv
d. pv

14. Two steam engine A and B, A working between temperature 650k and 700k and another B working between temperature 300k and 350k. Then which is more efficient (Bangladesh 09)
a. A
b. B
c. Both equally efficient
d. Efficiency independent of temperature

15. A gas is initially at 27°C. It is compressed adiabatically from 27 litres to 8 litres. The rise in temperature is [I.E.]
a. 402°C b. 375°C
c. 675°C d. None

16. Which one Cannot be reversed even theoretically without doing work [I.E.]
a. isothermal expansion
b. adabatic expansion
c. adabatic compression
d. isobaric expansion

17. A diatomic gas (γ = 1.4) does 200J of work when it is expanded isobarically, the heat given to the gas in the process will be [BPKI/HS]
a. 400J b. 500J
c. 600J d. 700J

18. One mole of an idea gas with γ = 1.4 is adiabatically compressed so that its temperature rises from 27°c to 35°c. The change in internal energy of the gas is: [MOE 2069]
a. –160J b. 166J
c. –168J d. 168J

Answer Sheet

1. d	*2. c*	*3. b*	*4. c*	*5. b*	*6. b*	*7. a*	*8. c*	*9. b*	*10. c*
11. d	*12. d*	*13. c*	*14. b*	*15. b*	*16. a*	*17. d*	*18. b*		

SOLUTION

1. Ans. (d) $\Delta Q = nC_pdT = n\left(\frac{7R}{2}\right)dT$

$\Delta U = nC_vdT = n\left(\frac{5R}{2}\right)dT$

$C_v = \left(\frac{f}{2}\right)R = \frac{5}{2}R$

$C_p = \left(1 + \frac{f}{2}\right)R = \frac{7}{2}R$

$\frac{\Delta Q}{\Delta U} = \frac{c_p}{c_v} = \frac{7}{5} \Rightarrow \frac{\Delta U}{\Delta Q} = \frac{5}{7}$

2. Ans. (c) $\eta = \left(1 - \frac{T_2}{T_1}\right) \times 100\%$

$= \left(1 - \frac{300}{400}\right) \times 100\% = \left(\frac{1}{4}\right) \times 100\% = 25\%$

3. Ans. (b) $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{900} = \frac{2}{3}$

$\eta = \frac{w}{Q} \Rightarrow w = \eta \times Q = \frac{2}{3} \times 3 \times 10^6 = 2 \times 10^6 cal$

$= 4.2 \times 2 \times 10^6 J = 8.4 \times 10^6 J$

4. Ans. (c) $dQ = du + w = du + Pdv$

In adiabatic $dQ = O$

Workdone $= - du$

= decrease in internal energy

5. Ans. (b) $\frac{Q_1}{Q_2} = \frac{T_1}{T_2}$

$\frac{300}{150} = \frac{500}{T_2}$

$T_2 = 250K.$

6. Ans. (b) $\eta = \left(1 - \frac{T_2}{T_1}\right) \times 100\%$

$T_2 \rightarrow$ sink $T_1 \rightarrow$ source

$= \left(1 - \frac{303}{573}\right) \times 100\% = 47.12\%$

7. Ans. (a) It is case of adiabatic expansion.

$PV^{\gamma} =$ constant

$P\left(\frac{T}{P}\right)^{\gamma} =$ constant $(PV = RT) \rightarrow \left(V = \frac{RT}{P}\right)$

$P^{1-\gamma} T^{\gamma} =$ constant

8. Ans. (c) 1st case: $\eta = 1 - \frac{T_2}{T_1} = \frac{T_1 - T_2}{T_1}$

2nd case: $\eta^1 = \frac{(T_1 + 100) - (T_2 + 100)}{(T_1 + 100)}$

$\eta^1 = \frac{T_1 - T_2}{T_1 + 100} < \eta$

9. Ans. (b) $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{Q_2}{Q_1}$ $\left[\frac{T_2}{T_1} = \frac{Q_2}{Q_1}\right]$

$T_1 = 298K$ $T_2 = 263k$

$Q_2 = 263J$ $Q_1 = 298J$

Power consumed $= Q_1 - Q_2 = 35J/s = 35watt$

10. Ans. (c)

$\eta = \frac{\text{Workdone}}{\text{Heat taken}} = \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1}$

$\frac{Q_2}{Q_1} = \frac{T_2}{T_1} \Rightarrow \frac{100}{200} = \frac{T_2}{250}$

$T_2 = 250k$

11. Ans. (d) $Q = ms\Delta\theta$

$S = \frac{Q}{m\Delta\theta} = \frac{Q}{o} = \infty$

Isothermal $\Delta\theta = o$

12. Ans. (d)

Absolute zero = O°k = – 273.16°C

At which all the molecular motion ceases

13. Ans. (c) Workdone = Area of Pv diagram

$= \frac{1}{2} \times AC \times AB$

$= \frac{1}{2} \times (3v - v) \times (4p - p) = 3pv$

14. Ans. (b) $\eta = 1 - \frac{T_2}{T_1} = \left(1 - \frac{300}{350}\right) > \left(1 - \frac{650}{700}\right)$

So B is more efficient than A.

15. Ans. (b) $TV^{\gamma-1} =$ constant

$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$T_2 = T_1 \left(\frac{v_1}{v_2}\right)^{\gamma-1} = 300 \times \left(\frac{27}{8}\right)^{\frac{5}{3}-1} = 675k$

$\Delta T = T_2 - T_1 = 675 - 300 = 375k$

$= 375°C$ $(\Delta C = \Delta K)$

16. Ans. (a) Isothermal expansion,

Temperature = constant

du = change in internal energy = O

dQ = du + dw = dw

Energy supplied is completely used for work.

So, without doing work it can't be reversed back.

17. Ans. (d) $\Delta Q = nC_P dT$ & $\Delta U = nC_V dT$

$\frac{\Delta Q}{\Delta U} = \gamma \Rightarrow \Delta V = \frac{\gamma}{\Delta Q}$

$\Delta Q = \Delta U + P\Delta V$

$\Delta Q = \frac{\Delta Q}{\gamma} + 200$

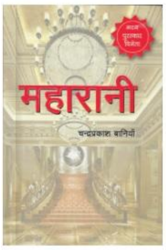
$\Delta Q \left(1 - \frac{1}{\gamma}\right) = 200$

$\Delta Q = \dfrac{200 \times 1.4}{0.4} = 700J$

18. Ans. (b)

$\Delta U = nC_V \, dT$

$= \left(\dfrac{R}{\gamma - 1}\right)dT = \dfrac{8.31}{1.4 - 1} \times (35 - 27) = 166J$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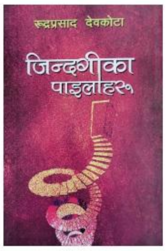
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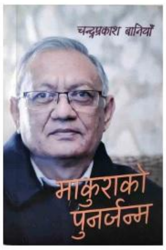
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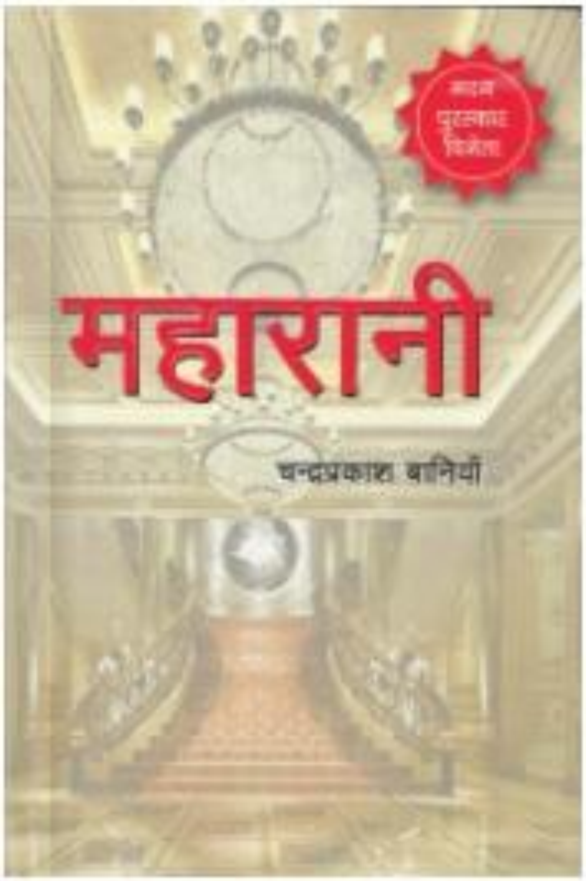
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पुरस्कार
विजेता
महारानी
चन्द्रप्रकाश बानियाँ

Chapter: 22

WAVE

1. When a sound wave goes from one medium to another, the quantity that remains unchanged is

a. speed b. amplitude
c. frequency d. wavelength

2. In progressive wave, which of the following physical quantity is transmitted

a. amplitude c. velocity
c. momentum d. energy

3. With sound waves, one cannot observe the phenomenon of

a. refraction b. interference
c. diffraction d. polarisation

4. A bomb explodes on moon. It's heard on earth in

a. 10 minutes b. 2 hrs 18 minutes
c. 37 minutes d. Never

5. Two sound waves having a phase difference of 60° have path difference of

a. 2λ b. $\frac{\lambda}{2}$
c. $\frac{\lambda}{3}$ d. $\frac{\lambda}{6}$

6. Speed of sound is maximum in

a. monoatomic gas b. diatomic gas
c. polyatomic d. equal in all

7. The increase in the velocity of sound for 1°C rise in temperature is (Vo = 332mls).

a. 0.16m/s b. 0.61 m/s
c. 0.1m/s d. 61m/s

8. The temperature at which the speed of sound in air becomes double of its value at 27°C is

a. 54°C b. 327°C
c. 927°C d. –123°C

9. If pressure amplitude of wave increases by 1% then its intensity

a. increases by 1%
b. decreases by 1%
c. decrease by 2%
d. increases by 2%

10. If $x = a\sin\left(\omega t + \frac{\pi}{6}\right)$ and $x^1 = a\cos\omega t$, then phase difference between the two waves

a. $\frac{\pi}{3}$ b. $\frac{\pi}{6}$
c. $\frac{\pi}{2}$ d. π

11. Two waves are represented by $y_1 = a\sin\left(\omega t + \frac{\pi}{6}\right)$ & $y_2 = a\cos\omega t$. The resultant amplitude

a. a b. $\sqrt{2}a$
c. $\sqrt{3}a$ d. 2a

12. The sound of minimum wavelength and audible to human ear is

a. 1000°A b. 1.6cm at 0°C
c. 4000°A d. 16.5 m at 0°C

13. Sound waves having the following frequency are audible to human being

a. 5cycle/s b. 27000c/s
c. 5000c/s d. 50,000c/s

14. The equation of a wave is given by y = o.5sin (100t – 25x). The ratio of maximum particle velocity to wave velocity is

a. $\frac{25}{2}$ b. 25
c. 4 d. $\frac{1}{8}$

15. A transverse wave is described by the equation

$y = y_o \sin 2\pi\left(ft - \frac{x}{\lambda}\right)$.

The maximum particle velocity is equal to four times the wave velocity if

a. $\lambda = \frac{\pi y_o}{4}$
b. $\lambda = \frac{\pi y_o}{2}$
c. $\lambda = \pi y_o$
d. $\lambda = 2\pi y_o$

16. If Co and C denotes the sound velocity and root mean square speed of molecules in a gas, then

a. Co > C
b. Co = C
c. $Co = C\left(\frac{\gamma}{3}\right)^{\frac{1}{2}}$
d. None

17. A is singing a note and at the same time B is singing a note with exactly one-eight the frequency of note A. The energies of two sound are equal, the amplitude of note of B is

a. same as A
b. twice as of A
c. four times of A
d. eight times of A

18. An infinite line sources emits waves in a non-absorbing medium. The intensity at a distance R from the source varies as

a. R
b. R^{-1}
c. R^2
d. R^{-2}

19. If the Amplitude of waves at a distance r from a line source is A. The amplitude at a distance 4r will be

a. 2A
b. A
c. $\frac{A}{2}$
d. $\frac{A}{4}$

20. The speed of sound in humid hydrogen is v_1 and that of dry hydrogen is v_2, then at the same temperature is

a. $v_1 = v_2$
b. $v_1 > v_2$
c. $v_1 < v_2$
d. $v_1 \geq v_2$

21. The speed of sound in humid air is v_1 & that in dry air is v_2, then at same temperature

a. $v_1 = v_2$
b. $v_1 > v_2$
c. $v_1 < v_2$
d. $v_1 \geq v_2$

22. The ratio of velocity of sound in hydrogen gas $\left(\gamma = \frac{7}{5}\right)$ to that in helium gas $\left(\gamma = \frac{5}{3}\right)$ at the same temperature is

a. $\frac{\sqrt{2}}{5}$
b. 1:1
c. $\frac{\sqrt{42}}{5}$
d. $\sqrt{2}:1$

23. The velocity of sound in hydrogen is 1224m/s. Its velocity in a mixture of hydrogen & oxygen containing 4 parts by volume of hydrogen & 1 part oxygen is

a. 1224m/s
b. 612m/s
c. 306m/s
d. 2448m/s

24. Two progressive waves are represented as

$y_1 = 0.06 \sin 2\pi\ (0.04t + 0.1x)$

$y_2 = 0.03 \sin 2\pi(0.08t + 0.2x)$

The ratio of intensities of two waves produced by the vibration of two particle

a. 1:1
b. 2:1
c. 4:1
d. 16:1

25. A stone is dropped into a lake from a tower 500m height. The sound of the splash will be heard after

a. 10s
b. 11.5s
c. 14s
d. 21s

26. The velocity of transverse waves in steel wire of density $8 g/cm^3$ is 300mls. Then tensile stress in the wire will be

a. $7.2 \times 10^8 N/m^2$
b. $6.4 \times 10^8 N/m^2$
c. $8 \times 10^8 N/m^2$
d. $3.2 \times 10^8 N/m^2$

27. The linear density of a vibrating wire is 1 × 10–2kg/m and transverse wave equation is $y = 0.02 \sin(x + 40t)$ with x & y in metre & t in sec. The tension in the wire is

a. 16N
b. 8N
c. 4N
d. 2N

28. Find the intensity of sound in air if density of air is $1.3\ kg/m^3$; Vair = 330m/s & pressure = $1.01 \times 10^5 N/m^2$.

a. $1.6 \times 10^7\ w/m^2$
b. $16 \times 10^7\ w/m^2$
c. $160 \times 10^7\ w/m^2$
d. $1600 \times 10^7\ w/m^2$

29. A man on the ground finds out that when he sees a jet plane just over his head, the sound is heerd at an angle of 30° with the vertical from his left. If the velocity of sound is v, the velocity of jet plane will be

a. $\frac{v}{2}$ b. 2v

c. $\frac{\sqrt{3}}{2}V$ d. $\frac{2}{\sqrt{3}}V$

30. Elevation of thunder cloud is 60° above the horizon. A thunder is heard 8 sec after the observations of lightening. The speed of sound is 330m/s. The vertical height of cloud from the ground is

a. 2640m b. $1320\sqrt{3}$ m

c. 1320m d. 3300m

Answer Sheet

1. c	*2. d*	*3. d*	*4. d*	*5. d*	*6. a*	*7. b*	*8. c*	*9. d*	*10. a*
11. c	*12. b*	*13. c*	*14. a*	*15. b*	*16. c*	*17. d*	*18. b*	*19. c*	*20. c*
21. b	*22. c*	*23. b*	*24. a*	*25. b*	*26. a*	*27. a*	*28. a*	*29. a*	*30. b*

SOLUTION

1. Ans. (c)

Frequency remains same when sound tavels from one medium to other.

2. Ans. (d)

In all progressive waves (transverse or longitudinal) energy is transimitted. Energy is not transmitted in stationary waves.

3. Ans. (d)

Sound waves are longitudinal so it can't be polarised as only transverse wave can be polarised.

4. Ans. (d)

Sound wave doesn't propagate through vaccum, so it is never heard.

5. Ans. (d)

Path difference $(\Delta x) = \frac{\lambda}{2\pi}$

× Phase difference (ϕ)

$= \frac{\lambda}{2\pi} \times \frac{\pi}{3} = \frac{\lambda}{6}$

6. Ans. (a)

$V = \sqrt{\frac{\gamma p}{\rho}}$ $V \alpha \sqrt{\gamma}$

γ is max for monoatomic (1.67)

7. Ans. (b)

$\frac{v_t}{v_o} = \sqrt{\frac{T_1}{To}} = \sqrt{\frac{273+t}{273}}$

$Vt = Vo\left(1+\frac{t}{273}\right)^{\frac{1}{2}}$

$Vt = Vo\left(1+\frac{t}{273}\times\frac{1}{2}\right)$

$Vt = Vo + Vo \times \frac{t}{546}$

$Vt - Vo = \frac{332}{546} \times 1 = 0.61 m/s$

8. Ans. (c)

$V \alpha \sqrt{T}$ $T \alpha V^2$

$\left(\frac{v_t}{v_{27}}\right)2 = \frac{T_t}{T_{27}} = \frac{t}{300}$

$t = 4 \times 300 = 1200\kappa = 927°C$

9. Ans. (d)

$I = 2\pi^2 f^2 a^2 \rho v = \frac{P^2 max}{2\rho v}$

$I \alpha P^2 max$

$\frac{\Delta I}{I} \times 100\% = 2 \times \frac{\Delta P}{P} \times 100\%$

$= 2\%$

10. Ans. (a) $x = a \sin\left(\omega t + \frac{\pi}{6}\right)$

$x^1 = a \cos\omega t = a \sin\left(\omega t + \frac{\pi}{2}\right)$

Phase difference $(\Delta\phi) = \frac{\pi}{2} - \frac{\pi}{6} = \frac{\pi}{3}$

11. Ans. (c) $y_2 = -a \sin\left(\omega t + \frac{\pi}{2}\right)$

$\Delta\phi = \frac{\pi}{2} - \frac{\pi}{6} = \frac{\pi}{3}$

$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2 \cos\phi}$

$= \left(2a^2 + 2a^2 \cos\frac{\pi}{3}\right)^{\frac{1}{2}} = \sqrt{3}a$

12. Ans. (b)

$\lambda min = \frac{V}{fmax} = \frac{320}{2000}$ m = 0.016m = 1.6cm

13. Ans. (c)

Audible sound frequency range from 20c/s to 20,000c/s.

14. Ans. (a)

Max. Particle velocity

$Vmax = A\omega = 100 \times 0.5 = 50$

Wave velocity $v = \frac{\omega}{k} = \frac{100}{25} = 4$

Hence, $\frac{Vmax}{V} = \frac{50}{4} = \frac{25}{2}$

15. Ans. (b)

Maximum particle velocity $= \omega y_o = 2\pi f y_o$

wave velocity $= f\lambda$

$2\pi f y_o = 4(f\lambda)$

$\lambda = \frac{\pi y_o}{2}$

16. Ans. (c)

$Co = \sqrt{\frac{\gamma p}{\rho}}$ $C = \sqrt{\frac{3p}{\rho}}$

$\frac{Co}{C} = \sqrt{\frac{\gamma}{3}} = \left(\frac{\gamma}{3}\right)^{\frac{1}{2}}$

$Co = C\left(\frac{\gamma}{3}\right)^{\frac{1}{2}}$

17. Ans. (d)

As energies of two sounds in same medium are equal

$f_1^2 a_1^2 = f_2^2 a_2^2$

$\frac{a_1}{a_2} = \frac{f_2}{f_1} = \frac{1}{8}$

$a_2 = 8a_1$

18. Ans. (b) $I = \frac{P}{2\pi R l}$

$I \propto \frac{1}{R}$

19. Ans. (c)

For a line source, $I \propto \frac{1}{r}$ amplitude $\propto \frac{1}{\sqrt{r}}$

$\frac{A_2}{A_1} = \sqrt{\frac{r_1}{r_2}} = \sqrt{\frac{r}{4r}} = \frac{1}{2}$

$A_2 = \frac{A}{2}$

20. Ans. (c)

Humid hydrogen has more density than dry hydrogen

$v \propto \frac{1}{\sqrt{d}}$

So, $v_2 > v_1$

21. Ans. (b)

Humid air has less density than dry air. So, velocity of sound in humid air is more.

22. Ans. (c)

$V = \sqrt{\frac{\gamma p}{\rho}} = \sqrt{\frac{\gamma pv}{M}} = \sqrt{\frac{\gamma RT}{M}}$

$\frac{VH_2}{VHe} = \sqrt{\frac{\gamma H_2 \times MHe}{\gamma He \times MH_2}} = \sqrt{\frac{7/5}{5/3} \times \frac{4}{2}}$

$= \sqrt{42}:5$

23. Ans. (b) If $\rho H_2 = 1$, then

$\rho\ max = \frac{4 \times 1 + 1 \times 16}{4 + 1} = 4$

So $\frac{Vmix}{VH_2} = \sqrt{\frac{\rho H_2}{\rho mix}} = \sqrt{\frac{1}{4}} = \frac{1}{2}$

$Vmix = \frac{VH_2}{2} = \frac{1224}{2} = 612$m/s

24. Ans. (a)
Comparing the waves with equation
$y = a\sin 2\pi\left(ft + \frac{x}{\lambda}\right)$
$a_1 = 0.06, a_2 = 0.03$
$f_1 = 0.04, f_2 = 0.08$
As $I \alpha a^2 f^2$
$\frac{I_1}{I_2} = \frac{a_1^2}{a_2^2} \times \frac{f_1^2}{f_2^2} = \frac{0.06^2}{0.03^2} \times \frac{0.04^2}{0.08^2}$
$= 1:1$

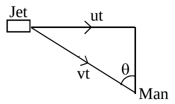
25. Ans. (b)
$T = \sqrt{\frac{2h}{g}} + \frac{h}{v} = \sqrt{\frac{2 \times 500}{10}}$
$+ \frac{500}{332} = 11.5\text{sec}$

26. Ans. (a)
$V = \sqrt{\frac{T}{m}} = \sqrt{\frac{T}{\rho A}} = \sqrt{\frac{\text{stress}}{\text{Density}}}$
$300 = \sqrt{\frac{\text{stress}}{8000}}$
Stress = $(300)^2 \times 8 \times 10^3 = 7.2 \times 10^8 N/m^2$

27. Ans. (a)
$v = \frac{\omega}{k} = \frac{40}{1} = 40m/s$
$V = \sqrt{\frac{T}{m}}$ (m = mass per unit length)
$T = v^2 m = 40^2 \times 1 \times 10^{-2} = 16N.$

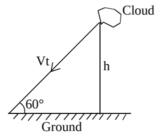
28. Ans. (a)
$I = \frac{Po^2}{2\rho v} = \frac{(1.01 \times 10^5)^2}{2 \times 1.3 \times 330} = 1.6 \times 10^7\ w/m^2$

29. Ans. (a)



If u = velocity of jet, θ = angle with vertical from the left of man at which sound is heard.
$\sin\theta = \frac{ut}{vt} \Rightarrow u = v\sin\theta = v\sin 30 = \frac{v}{2}$

30. Ans. (b)



$\sin 60 = \frac{h}{vt}$
$h = vt\sin 60 = 330 \times 8 \times \frac{\sqrt{3}}{2} = 1320\sqrt{3}m$

Past Questions

1. Two uniform wires of the same length and the same tension have diameters in the ratio of 1:2 when they are plucked together their frequency ratio is [MOE 066]
a. 1:2 b. 2:1
c. 1:4 d. 4:1

2. Velocity of sound in air at STP is $330ms^{-1}$. The distance covered by sound in 2 seconds when atmospheric temperature is 30°C will nearly be [MOE Curriculum]
a. 0.5km b. 0.7km
c. 1km d. 2km

3. Phase difference between two waves y_1 = a sinωt and y_2 = a cosωt [MOE2008]
a. 0° b. π
c. $\frac{\pi}{2}$ d. $\frac{3\pi}{4}$

4. Two wave are represented by $y_1 = 20 \sin\pi\theta$ & $y_2 = 40 \sin 100\pi\theta$. The ratio of their intensities $\left(\frac{I_2}{I_1}\right)$ is [MOE 2063]
a. 1:4 b. 4:1
c. 3:1 d. None

5. The equation of a transverse wave is given by y = 10 sinπ (0.01 π – 2t). Wave x and y are in m & t in sec. Its frequency is [MOE 2063]
a. 10 cps b. 2cps
c. 1 pcs d. o.o1 cps

6. The frequency of radio waves is 15 MHz. What is its wave length? [MOE 2056]

a. 20m b. 15m
c. 5m d. 25m

7. A string of length L is stretched by $\frac{L}{20}$ when the speed of transverse wave is V. If it is stretched by $\frac{L}{10}$ then speed of transverse wave will be [MOE]

a. 4v b. 2v
c. $\frac{v}{\sqrt{2}}$ d. $v\sqrt{2}$

8. Sound wave in rocks are [IOM 2009]

a. Longitudinal stationary
b. Transverse stationary
c. Longitudinal & Transverse wave
d. Wave in rock does not propagte

9. Laplace's rormula for the velocity of sound is: (IOM 08)

a. $V = \sqrt{\frac{P}{\rho}}$ b. $V = \sqrt{\frac{\gamma P}{\rho}}$
c. $V = \sqrt{\frac{\gamma\rho}{P}}$ d. $V = \sqrt{\frac{\gamma R}{M}}$

10. If amplitude of the sound wave triple, the intensity of sound increases [MOE 2068/I.E]

a. 3times b. 6times
c. $\sqrt{3}$times d. 9times

11. The velocity of sound in air is independent of change in [IOM 01]

a. Pressure b. density
c. Temperature d. Humidity

12. A man heard the thunder 6 seconds later he saw a lighting. The temperature of air is 27°C. How far was the flash of light from man? (velocity of sound in air at 0°C = 332 mls) [IOM 01]

a. 1822m b. 2332m
c. 2088m d. 2445m

13. Ultrasonic, infrasonic and audio waves travel through a medium with speed Vu, Vi and Va respectively. Then [BPKIHS]

a. Vu = Vi = Va
b. Vu > Vi > Va
c. Vu < Vi < Va
d. Vu < Vi > Va

14. The equation of progressive wave is y = 0.5 sin 200t. The maximum particle velocity is [MOE 2067]

a. 25 b. 50
c. 50 d. 200

15. A man stands on top of a cliff and shouts. He hears the echo on the third clap when he claps his hands at the rate of two claps per seconds. What is the distance between man & the obstruction, it the velocity of the sound is 320m/s. [IOM 1998]

a. 320m b. 460m
c. 640m d. 160m

16. The velocity of sound is maximum in [BPKIHS 2006]

a. H_2 b. He
c. O_2 d. N_2

17. If distance between source of sound and cliff. is d. If the velocity of sound is V_1 the time taken to hear the 2^{nd} echo is [MOE 2069]

a. $\frac{2V}{d}$ d. $\frac{d}{2V}$
c. $\frac{4V}{d}$ d. $\frac{4d}{V}$

Answer Sheet

1. b	*2. b*	*3. c*	*4. d*	*5. c*	*6. a*	*7. d*	*8. c*	*9. b*	*10. d*

11. a	*12. c*	*13. a*	*14. c*	*15. d*	*16. a*	*17. d*			

SOLUTION

1. Ans. (b)

$f = \frac{1}{2l}\sqrt{\frac{T}{m}} = \frac{1}{2l}\sqrt{\frac{T}{\rho A}}$

$m \rightarrow$ mass per unit length

$f \propto \frac{1}{\sqrt{A}} \propto \frac{1}{\sqrt{d^2}} \propto \frac{1}{d}$

$f_1 : f_2 = d_2 : d_1 = 2:1$

2. Ans. (b)

$V_o = 330$m/s, $T_1 = 273$

$T_2 = 273 + 30 = 303$k Then, $V_{30} = ?$

$\frac{V_o}{V_{30}} = \sqrt{\frac{T_1}{T_2}} \Rightarrow V_{30}\sqrt{\frac{303}{273}} \times 330$

$= 347.7$mls

$d = V_{30} \times t = 347.7 \times 2 = 700$m (0.7km)

3. Ans. (c)

$y_1 = a \sin\omega t$, $\phi_1 = \omega t$

$y_2 = a \cos\omega t = a \sin\left(\omega t + \frac{\pi}{3}\right)$

$\phi_2 = \omega t + \frac{\pi}{2}$

$\Delta\phi = \phi_2 - \phi_1 = \omega t + \frac{\pi}{2} - \omega t = \frac{\pi}{2}$

4. Ans. (d)

$I = 2\pi^2 n^2 a^2 \rho v$

$I \propto a^2 n^2$

$a_1 = 20$, $a_2 = 40$

$\omega_1 = \pi$ or $2\pi n_1 = \pi, n_1 = \frac{1}{2}$

$\omega_2 = 100\pi = 2\pi n_2$

$n_2 = 50$

$\frac{I_2}{I_1} = \left(\frac{40}{20}\right)^2 \times \left(\frac{50}{\frac{1}{2}}\right)^2$

5. Ans. (c)

$y = 10 \sin(0.01\pi x - 2\pi t)$

$y = a \sin(kx - \omega t)$

$a = 10$, $k = 0.01\pi$

$\omega = 2\pi = 2\pi f$

$f = 1$HZ = 1 cycle per sec

6. Ans. (a)

Radio wave is electromagnetic wave

$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{15 \times 10^6}$

$= 20$m

7. Ans. (d)

$V = \sqrt{\frac{T}{m}} \propto \sqrt{T} \propto \sqrt{F}$

Accroding to Hooke's law $F \propto x$ (extension)

$\frac{V_1}{V_2} = \sqrt{\frac{x_1}{x_2}} = \sqrt{\frac{L/20}{L/10}} = \sqrt{\frac{1}{2}}$

$\Rightarrow V_2 = \sqrt{2}V_1 = \sqrt{2}V$

8. Ans. (c)

Sound wave in rocks both transverse and longitudinal i.e. Ripple wave.

9. Ans. (b)

Laplace suggested the propagation of sound wave to be adiabatic rather than the isothermal.

10. Ans. (d)

$I = 2\pi f^2 a^2 \rho v$

$I \propto a^2$

$I^1 = (3a)^2 = 9a^2 = 9I$

11. Ans. (a)

Independent of pressure

$V = \sqrt{\frac{\gamma RT}{M}} = \sqrt{\frac{\gamma P}{\rho}}$

$\left[\left(\frac{P}{\rho}\right)\right.$ remains a constant $\left.\right]$

12. Ans. (c)

$\frac{V_{27}}{V_O}\sqrt{\frac{273 + 27}{273}}$

$V_{27} = 1.048 \times 332$

$= 348 m/s$

$d = v \times t$

$= (348 \times 6) m$

$= 2088 m$

13. Ans. (a)

They differ only in frequency, not in velocity. Velocity of sound is independent fo frequency.

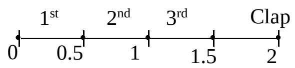
14. Ans. (c)

$V_{max} = a\omega$

$= 0.5 \times 200 = 100.$

15. Ans. (d)

Time taken by the 1^{st} clap to echo $\Rightarrow$ (1.5 – 0.5) = 1sec



So, $2d = v \times t$

$$d = \frac{v \times t}{2} = \frac{320 \times 1}{2} = 160 m$$

16. Ans. (a)

$$V = \sqrt{\frac{\gamma RT}{M}}$$

$\therefore$ $V \propto \sqrt{\frac{\gamma}{M}}$

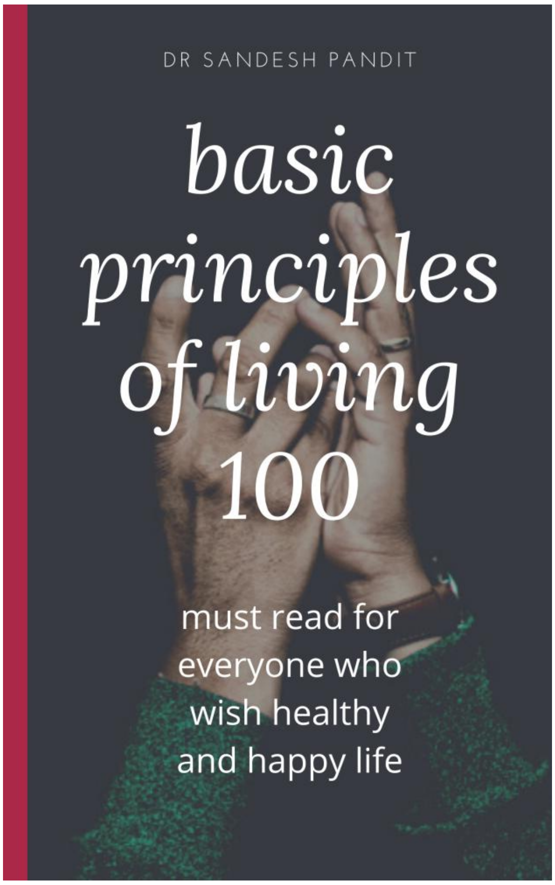
Although, γ for He is 1.67 as compared to H_2 (1 4) but the mass of H_2 (2) is very less than He (4). So speed is maximum is H_2

17. Ans. (d)

For hearing second echo total distance travelled = 4d

$$\text{Velocity} = \frac{\text{total distance}}{\text{time taken}} = \frac{4d}{t}$$

$\therefore$ $t = \frac{4d}{V}$



SHIKHA BOOKS

Chapter: 23

SUPERPOSITION OF WAVE

1. The phenomenon of beats is due
a. superposition of incoherent waves
b. superposition of coherent waves
c. reflection d. refraction

2. When a sound wave is reflected from a rigid surface then its
a. phase & type gets changed
b. phase only chnges by π
c. type only changes
d. Neither phase nor type changes

3. When a sound wave is reflected from rarer medium, then its
a. type & phase gets changed
b. phase only changes
c. type only changes
d. Type & phase remains unchanged

4. A wave travelling along positive x – axis is given by y = Asin(ωt – kx). If it is reflected from rigid boundary such that 80% Amplitude is reflected, then equation of reflected wave is
a. $y = A\sin(\omega t + kx)$
b. $y = -0.8 A\sin(\omega t + kx)$
c. $y = 0.8\sin(\omega t + kx)$
d. $y = A\sin(\omega t + kx)$

5. When the prongs of the tuning fork are cut, its frequency
a. decreases b. increases
c. remains unchanged
d. may increase or decrease are depending upon the matter of the fork.

6. When a tuning fork is vibrating its prongs have a phase difference of
a. zero b. $\frac{\pi}{4}$
c. $\frac{\pi}{2}$ d. π

7. Beats are the result of
a. refraction b. reflection
c. interference d. diffraction

8. If the difference of frequency of two sounding source is more than 10, then the beats
a. are not formed at all
b. are heard with increased clarity
c. cease to be distinguishable
d. are inaudible

9. Two waves $y_1 = 0.25 \sin 320\pi t$ and $y_2 = 0.25 \sin 326\pi t$ are travelling in the same direction. The number of beats produced per second will be
a. 6 b. 4
c. 3 d. 2

10. Two sources when sounded simultaneously produce 4 beats in 0.25 seconds. The difference in their frequencies must be
a. 4Hz b. 8Hz
c. 16Hz d. 1Hz

11. The ratio of intensities of two interfering waves is 4:1. The then ratio of maximum to minimum intensity is
a. 1:4 b. 9:1
c. 4:1 d. 3:1

12. If the amplitude ratio of two sources producing interference is 3:5. The ratio of intensities at maxima and minima is
a. 25:16 b. 5:3
c. 16:1 d. 25:9

13. Two periodic waves of intensities I_1, & I_2 travel in a medium simultaneously in same direction. The difference of maximum intensity will be
a. $\left(\sqrt{I_1} + \sqrt{I_2}\right)^2$ b. $\left(\sqrt{I_1} - \sqrt{I_2}\right)^2$
c. $2(I_1 + I_2)$ d. $4\sqrt{I_1 I_2}$

14. Two waves of equal amplitude 'a' each and equal frequency travel in sane direction in a medium. The amplitude of resultant wave in the medium is
a. zero b. a
c. 2a d. zero to 2a

15. Two waves $y_1 = a \sin \frac{2\pi}{\lambda}(vt - x)$ and $y_2 = a \cos \frac{2\pi}{\lambda}(vt - x)$ are superposed. Then resultant wave has amplitude

a. 2a b. $\sqrt{2}a$
c. a d. zero

16. If two waves of same frequency and same amplitude respectively, on super position produce a resultant disturbance of same amplitude, the waves differ in phase by

a. π b. $\frac{2\pi}{3}$
c. $\frac{\pi}{3}$ d. zero

17. Two waves having intensity I and 9I produced interference. If the resultant intensity at a point is 7I, What is the phase difference between the two waves?

a. 0° b. 60°
c. 90° d. 120°

18. Two plane waves of same frequencies having intensities I and 4I are travelling in the same direction. The resultant intensity at minima is

a. I b. 3I
c. 5I d. 4I

19. Two sound waves of equal intensity produce beats. The maximum intensity of sound produced in beats will be

a. I b. 2I
c. $2\sqrt{2I}$ d. 9I

20. The amplitude of superposition of two waves $y_1 = 5\sin\omega t$ & $y_2 = 5\cos\omega t$ is

a. 0 b. $5\sqrt{2}$
c. 5 d. 10

21. The minimum distance of a reflector to hear the echo of a sharp sound in terms of speed of sound is

a. $\frac{v}{20}$ b. $\frac{v}{10}$
c. $\frac{v}{5}$ d. 10v

22. A man standing in front of a high wall hears echo after 2 sec. If speed of sound is 330m/s. What is distance of the man from the wall

a. 165m b. 330m
c. 495m d. 660m

23. A standing wave is represented as $y = 20 \sin 100t \cos \frac{x}{100}$ (x in metre & t in sec.) The velocity of wave will be

a. 10^4m/s b. 1m/s
c. 10^{-4}m/s d. zero

24. Sound waves from a whistle of frequency 1000 Hz reach a point by two different paths. When the paths differ by 0.12m and 0.48m, there is silence at that point. The speed of sound

a. 340m/s b. 330m/s
c. 350m/s d. 360m/s

25. Consider 10 identical sources of sound all giving the same frequency but having random phase angles. If the average intensity of each source is Io. The average of resultant intensity I due to all these sources will be

a. I = 100 Io b. I = 10 Io
c. I = Io d. I = $\sqrt{10}$ Io

26. A person standing between two parallel hills fires a gun. He hears the first echo after 1.5 second and second echo under 2.5 seconds. If speed of sound in air is 34mls. The distance between the hills will be

a. 340m b. 510m
c. 680m d. 170m

27. Two tuning fork A and B produce 4 beats/sec when sounded together. A is loaded with little wax and sounded again with B, then they produce 26 beats/sec. The frequency of A is 250 Hz. The frequency of B will be

a. 259Hz b. 252Hz
c. 260Hz d. 262Hz

28. Two tuning forks A and B vibrating simulataneously produce 5 beats/sec. The frequency of B is 512Hz. If one of prongs of A is filed, the numer of beats decrease. The frequency of A will be

a. 502Hz b. 507Hz

c. 517Hz d. 522Hz

29. Tuning fork X of frequency 258Hz gives 8 beats/sec with tuning fork Y. When Y's prongs are cut at little and they are sounded again, the number of beats remains same. The frequency of Y before cutting the prongs is

a. 250 Hz b. 258 Hz

c. 264 Hz d. 266 Hz

30. 10 tuning fork are arranged in increasing order of frequency in such a way that two nearest fork produces 4 beat/sec. The highest frequency is octave of the lowest. The possible lowest and highest frequency are

a. 40 and 80 b. 50 and 72

c. 22 and 44 d. 36 and 72

31. A tuning fork vibrating with a sonometer having 20cm wire produces 5 beats/sec. The beat frequency doesn't change if the length of the wire is changed to 21cm. The frequency of tuning fork (in Hertz) must be

a. 200 b. 210

c. 205 d. 215

Answer Sheet

1. b	*2. b*	*3. c*	*4. b*	*5. b*	*6. d*	*7. c*	*8. a*	*9. c*	*10. c*
11. b	*12. c*	*13. d*	*14. d*	*15. b*	*16. b*	*17. d*	*18. a*	*19. d*	*20. b*
21. a	*22. b*	*23. a*	*24. d*	*25. b*	*26. c*	*27. b*	*28. b*	*29. a*	*30. d*
31. c									

SOLUTION

1. Ans. (b)

Beat is the regular variation of intensities of sound when sources of nearly equal frequencies sounded together.

2. Ans. (b)

If compression strikes rigid medium, compression is reflected so no type change. But direction of particles of medium reversed So, $\Delta\phi = \pi$

3. Ans. (c)

If compression strikes a rarer medium, rare fraction is reflected. The direction of wave after reflection is always reversed but direction of vibration of particles in medium remains unchanged.

4. Ans. (b)

When wave is reflected by a rigid surface the phase is changed by π. Amplitude is decrease and direction is reserved.

So, $y = \left(\frac{80}{100}\right) A\sin(\omega t + kx + \pi)$

$y = 0.8A(-\sin(\omega t + kx))$

$= -0.8\, A\sin(\omega t + kx)$

5. Ans. (b)

Frequency of tuning fork increases with decrease in length of prongs. While decrease with decrease in thickness of prongs.

6. Ans. (d)

Prongs of tuning fork vibrates in opposite phase.

7. Ans. (c)

8. Ans. (a)

Beats are detected only if $f_1 - f_2 \leq 10Hz$ because persistance of hearing is 0.1 sec.

9. Ans. (c)

comparing with $y = a \sin 2\pi ft$

$f_1 = 160Hz$, $f_2 = 163Hz$

Beats per sec $= f_2 - f_1$

$= 163 - 160 = 3Hz$

10. Ans. (c)

Difference in frequencies

= beat frequency

$= \frac{4}{0.25} = 16Hz$

11. Ans. (b)

$$\frac{Imax}{Imin} = \frac{(\sqrt{I_1} + \sqrt{I_2})^2}{(\sqrt{I_1} - \sqrt{I_2})^2}$$

$$= \frac{(\sqrt{4} + \sqrt{1})^2}{(\sqrt{4} - \sqrt{1})^2}$$

$$= \left(\frac{3}{1}\right)^2 = 9:1$$

12. Ans. (c)

$$\frac{Imax}{Imin} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2} = \frac{(3 + 5)^2}{(3 - 5)^2}$$

$$= \frac{8^2}{4} = 64:4 = 16:1$$

13. Ans. (d)

$Imax = (\sqrt{I_1} + \sqrt{I_2})^2$

$= I_1 + I_2 + 2\sqrt{I_1 I_2}$

$Imin = (\sqrt{I_1} - \sqrt{I_2})^2$

$= I_1 + I_2 - 2\sqrt{I_1 I_2}$

$Imax - Imin = 4\sqrt{I_1 I_2}$

$Imax + Imin = 2(I_1 + I_2)$

14. Ans. (d)

$Amax = a_1 + a_2 = 2a$

$Amin = a_1 - a_2 = zero$

15. Ans. (b)

Phase difference $(\Delta\phi) = \frac{\pi}{2}$

$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$

$= \sqrt{a^2 + a^2 + 2a^2 \cos\frac{\pi}{2}}$

$= \sqrt{2}a$

16. Ans. (b)

$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$

$A^2 = A^2 + A^2 + 2A^2\cos\phi$ $(A = a_1 = a_2)$

$\cos\phi = -\frac{1}{2} \Rightarrow \phi = \frac{2\pi}{3}$

17. Ans. (d)

I resultant $= I_1 + I_2 + 2I_1 I_2 \cos\phi$

$7I = 9I + I + 2\sqrt{9I.I}\ \cos\phi$

$\cos\phi = -\frac{1}{2} \Rightarrow \phi = 120°$

18. Ans. (a)

$Imin = I_1 + I_2 - 2\sqrt{I_1I_2}$

$= 4I + I - 2\sqrt{4I\ I}$

$= I$

19. Ans. (d)

$Imax = (\sqrt{I_1} + \sqrt{I_2})^2$

$= I_1 + I_2 + 2\sqrt{I_1I_2}$

$= I + I + 2I = 4I$

20. Ans. (b)

$\Delta\phi = 90$

$A = \sqrt{a_1^2 + a_2^2 + 2a_1a_2\cos\phi}$

$= \sqrt{5^2 + 5^2 + 2 \times 5 \times 5 \times \cos 90}$

$= 5\sqrt{2}$

21. Ans. (a)

Echo is heard distinctly if time interval of original sound and its echo is $\frac{1}{10}$ sec.

$2d = v \times t = V \times \frac{1}{10}$

$d = \frac{v}{20}$

22. Ans. (b)

$2d = v \times t$

$d = \frac{v \times t}{2}$

$= \frac{330 \times 2}{2}$

$= 330m$

23. Ans. (a)

Comparing the given with

$y = A \sin\omega t \cos kx$

$\omega = 100 rad/s \ k = \frac{1}{100} m^{-1}$

$v = \frac{\omega}{k} = 10^4 m/s.$

24. Ans. (d)

Seperation between two consecutive minima

$= (n + 1)\lambda - n\lambda = \lambda$

$\lambda = 0.48 - 0.12$

$= 0.36$

$v = f\lambda = 1000 \times 0.36$

$= 360 m/s.$

25. Ans. (b)

For non – coherent sources intensities are algebraically added.

$I = I_1 + I_2 + \ldots\ldots + I_{10}$

$= Io + I o + \ldots..$ 10times

$= 10Io.$

26. Ans. (c)

Let d_1 and d_2 be the distance of the person from these hills.

$2d_1 = Vt_1$ & $2d_2 = Vt_2$

Distance between hills

$= d_1 + d_2 = \frac{v}{2}(t_1 + t_2)$

$= \frac{340}{2}(1.5 + 2.5) = 680m$

27. Ans. (b)

$f_B = f_A \pm f = 256 \pm 4$ (252 0r 260Hz)

Let $f_A > f_B$. then $f = f_A - f_B$

on loading f_A decreases so f should also decrease which is in accordance with the question. So our assumption $f_A > f_B$ is true.

$\therefore f_B = 252Hz.$

28. Ans. (b)

$f_A = f_B \pm f = 512 \pm 5 = 507$ or $517Hz$

Let $f_A > f_B$ then $f = f_A - f_B$ on filing A, f_A inceases f should also increase. So our assumption that $f_A > f_B$ is not true

i.e. $f_B > f_A$

$\therefore f_A = 507Hz.$

29. Ans. (a)

Frequency increases when length of prongs becomes shorter. After cutting prongs its frequency becomes 8Hz more than 258Hz and its frequency is 8Hz less before cutting.

So, $f = 258 - 8 = 250Hz.$

30. Ans. (d)

Let lowest frequency = f, then highest frequency = 2f (octave) since beat frequency between any two nearest fork is 4 beats/sec. They form arthematic progression with common difference 4 beats/sec.

$tn = a + (n - 1) d$

$\Rightarrow 2f = (10 - 1) \times 4$

$f = 36Hz, 2f = 72Hz.$

31. Ans. (c)

$f \propto \frac{1}{l}$

$\Rightarrow \frac{f_1}{f_2} = \frac{l_1}{l_2} = \frac{21}{20}$

$f_1 = \frac{21}{20} f_2$

f = frequency of tuning fork. Then

$f - f_2 = 5$ – (i)

$f_1 - f = 5$ – (ii)

Adding (i) & (ii)

$f_1 - f_2 = 10$

$\Rightarrow \frac{21}{20} f_2 - f_2 = 10$

$f_2 = 200Hz$

$f = 200 + 5 = 205Hz.$

Chapter: 24

WAVES IN ORGAN PIPE & STRINGS

1. The fundamental frequency of a closed organ pipe is f. The frequency of its first overtone is

a. f b. 2f
c. 3f d. $\frac{f}{2}$

2. The fundamental frequency of a stretched string is f. The frequency of its first overtone is

a. f b. 2f
c. 3f d. $\frac{f}{2}$

3. With increase in temperature, the frequency of sound from an organ pipe

a. increases b. decreases
c. remains unchanged d. None

4. With increase in stretching force of a wire its frequency

a. increases b. decreases
c. remains unchanged d. None

5. The fundamental frequency of an open organ pipe is f. If half of it is dipped into water then new fundamental frequency will be

a. f b. $\frac{f}{2}$
c. $\frac{f}{4}$ d. 2f

6. As an empty vessel is filled with water its frequency

a. increases b. decreases
c. remains unchanged d. None

7. A sonometer wire is generally mounted over a large hollow sound box. This increases

a. frequency of sound
b. velocity of sound
c. intensity of sound
d. wave length of sound

8. A resonating column of air contains waves of

a. stationary longitudinal
b. stationary transverse
c. transverse progressive
d. longitudinal progressive

9. In a stationary waves, nodes are point having

a. max. displacement & max. strain
b. max. displacement & min strain
c. min. displacement & min.strain
d. min. displacement & max strain

10. In a stationary waves antinodes are the points having

a. max. displacement, max strain
b. max. displacement, min strain
c. min. displacement, min strain
d. min. displacement, max strain

11. The distance between node and antinode is

a. λ b. $\frac{\lambda}{2}$
c. $\frac{\lambda}{4}$ d. 2λ

12. A vibrating stretched wire is in unison with a vibrating tuning fork of frequency 300Hz. If the tension in the wire is increased by 2%, then number of beats per second with that vibrating tuning fork will be

a. 2 b. 3
c. 4 d. 6

13. If tension in a stretched vibrating wire is decreased by 36%, then frequency of vibration decrease by

a. 18% b. 36%
c. 20% d. 64%

14. The end correction of a resonance column is 1cm. Then, the diameter of tube is nearly

a. 2cm b. 3.3cm

c. 1.65cm d. 6.6cm

15. If an open pipe of length *l* vibrates in fundamental mode, the pressure variation is maxmimum at

a. ends of pipe

b. middle of pipe

c. one fourth from ends of pipe

d. one third from ends of pipe

16. Equation of a stationary wave is

$$y = 10 \sin \frac{\pi x}{4} \cos 20 \pi t$$

Distance between two consecutive nodes is

a. 4 b. 2

c. 1 d. 8

17. If the tension and diameter of a sonometer wire of fundamental frequency f are doubled and density is halved. Then its fundamental frequency becomes

a. $\frac{f}{4}$ d. $\sqrt{2}f$

c. f d. $\frac{f}{\sqrt{2}}$

18. The frequency of a vibrating wire is f. When area of cross section of a wire is halved and tension doubled. The frequency becomes

a. f b. 2f

c. 3f $\sqrt{2}f$

19. Two wires made of the same material are of equal lengths but their diameters are in the ratio of 2%. On stretching each of these two strings by same tension tension, the ratio between the fundamental frequencies of these strings is

a. 1:2 b. 2:1

c. 1:4 d. 4:1

20. If the velocity of sound in air is 350m/s, the frequency of the fundamental note emitted by a tube of length 50cm open at

a. 50Hz b. 175Hz

c. 350Hz d. 750Hz

21. An organ pipe, 1m long, closed at one end, when sounded gives a certain fundamental note. What will be the length of an organ pipe open at both ends, that will sound with the same fundamental note

a. 0.5m b. 1m

c. 2m d. 4m

22. An organ pipe closed at one end has a frequency f. If its lengths is doubled and radius halved. Its frequency will become nearly

a. $\frac{f}{3}$ b. $\frac{f}{2}$

c. f d. 2f

23. A tuning fork of frequency of 500c/s is sounded on a resonance tube. The first and second resonance are obtained at 17cm and 52cm. The velocity of sound in m/s is

a. 170 b. 350

c. 520 d. 850

24. A sonometer wire, 100cm in length has a fundamental frequency of 330c/s. The velocity of propagation of trasverse waves along the wire is

a. 330m/s b. 660m/s

c. 115m/s d. 990m/s

25. An open organ pipe has fundamental frequency 300Hz. The first overtone of the open organ pipe is the same as the first overtone of a closed organ pipe. The length of the closed organ pipe is

a. 10cm b. 41cm

c. 82cm d. 164cm

26. The velocity of waves in a string fixed at both ends is 2m/s. The string forms standing waves with nodes 5cm apart. The frequency of vibration of the string will be

a. 40Hz b. 30Hz

c. 20Hz d. 10Hz

27. An open pipe of length 47cm has a fundamental frequency of 340Hz. Calculate the diameter of pipe if velocity of sound in air is 340m/s.

a. 2cm b. 2.5cm
c. 5cm d. 10cm

28. A wire has frequency f. If length is doubled by stretching, its frequency now will be

a. 1.4f b. 0.7f
c. 2f d. f

29. In a resonance tube apparatus of 5cm diameter, first length of resonance is 16cm with tuning fork of 480Hz. Speed of sound at room temperature is

a. 300m/s b. 336m/s
c. 340m/s d. 360m/s

30. A string of length L is stretched between two points and harmonic waves are set up in the string. The wave length of second harmonic is

a. L b. 2L
c. $\frac{L}{2}$ d. 4L

31. Length of a string tied to two rigid supports is 40cm. Maximum wavelength of a stationary wave produces on it is

a. 20cm b. 40cm
c. 120cm d. 80cm

32. A sonometer is in unison with a tuning fork. Keeping the same tension, the length of the wire between the bridges is doubled. The tuning fork can still be in resonance with the wire, provided the wire now vibrates in

a. 2 segments b. 3 segments
c. 4 segments d. 6 segments

33. The sonometer wire is vibrating in the second overtone. We may say that there are

a. 2 nodes and 2 antinodes
b. 1 node and 2 antinodes
c. 4 nodes and 3 antinodes
d. 3 nodes and 3 antinodes

34. A sonometer wire is to be divided into three segments having fundamental frequencies in the ratio 1:2:3. What should be the ratio of length?

a. 6:3:2 b. 4:3:2
c. 4:2:1 d. 3:2:1

35. If f_1, f_2 and f_3 are the fundamental frequencies of the 3 segments into which a string is divided then the original fundamental frequency f of the string is given by

a. $\frac{1}{f} = \frac{1}{f_1} : \frac{1}{f_2} : \frac{1}{f_3}$

b. $\frac{1}{\sqrt{f}} = \frac{1}{\sqrt{f_1}} + \frac{1}{\sqrt{f_2}} + \frac{1}{\sqrt{f_3}}$

c. $\sqrt{f} : \sqrt{f_1} + \sqrt{f_2} + \sqrt{f_3}$

d. $d = f_1 + f_2 + f_3$

36. In Melde's experiment, the string vibrates in 4 loops. When a 50 gram weight is placed in a pan of weight that has to be removed from the pan is approximately

a. 7g b. 36g
c. 21g d. 29g

37. Two tuning forks when sounded together produces 5 beats per second. The first tuning forks is in resonance with 16 cm wire of a sonometer and the second is in resonance with 16.2cm wire of same resonance. The frequency of tuning fork are

a. 100 Hz, 105Hz b. 200Hz, 205Hz
c. 300Hz, 305Hz d. 400Hz, 405Hz

38. A uniform wire of length 20m and weighing 5kg hangs vertically. If g = 10m/s^2 then speed of the tranverse waves in the middle of the wire is

a. 10m/s b. $10\sqrt{2}$ m/s
c. 4m/s d. zero

39. A string under a tension of 129.6N produces 10 beats/sec when it is vibrated along a tuning fork. When the tension in the string is increased to 160N. It sounds in unison with the same tuning fork. Then frequency of the tuning fork is

a. 100Hz b. 90Hz
c. 110Hz d. 220Hz

40. The end correction of a resonance column is 1cm. If the shortest resonating length with a tuning fork is 15cm. The next resonating length is

a. 31cm b. 45cm

c. 46cm d. 47cm

41. A glass tube of 1m length is filled with water. The water can be drained out slowly at the bottom of the tube. If a vibrating tuning fork of frequency 500Hz is brought at the upper end of tube and velocity of sound is 330m/s. Then the total number of resonance obtained will be

a. 1 b. 2 c. 3 d. 4

Answer Sheet

1. c	*2. b*	*3. a*	*4. a*	*5. a*	*6. a*	*7. c*	*8. a*	*9. d*	*10. b*
11. c	*12. b*	*13. c*	*14. b*	*15. b*	*16. a*	*17. c*	*18. b*	*19. b*	*20. c*
21. c	*22. b*	*23. c*	*24. b*	*25. b*	*26. c*	*27. c*	*28. b*	*29. b*	*30. a*
31. d	*32. a*	*33. c*	*34. a*	*35. a*	*36. b*	*37. d*	*38. a*	*39. a*	*40. d*
41. c									

SOLUTION

1. Ans. (c)
Only odd harmonics are presect in closed organ pipe.
$f_1 : f_2 : f_3 \ldots = 1 : 3 : 5 \ldots (2n - 1)$

2. Ans. (b)
Both odd and even harmonics are present in open organ pipe.
$f_1 : f_2 : f_3 \ldots = 1 : 2 : 3 : 4 \ldots n$

3. Ans. (a) $f = \frac{v}{4l} \Rightarrow f \propto v \propto \sqrt{T}$
As velocity increase so frequency increases.

4. Ans. (a)
$f = \frac{1}{2l}\sqrt{\frac{T}{M}}$ $f \propto \sqrt{T}$.

5. Ans. (a)
$f = \frac{v}{2l}$ (Fundamental frequency of open)
When half dipped, it becomes closed organ pipe with length $\left(\frac{l}{2}\right)$
So $f^1 = \frac{v}{4\left(\frac{l}{2}\right)} = \frac{v}{2l} = f$

6. Ans. (a)
As water is filled length of air column decreases, hence frequency increases.

7. Ans. (c)
The hollow wooden sound box is filled with air molecules that vibrates with larger amplitude and hence larger intensity.

8. Ans. (d)
Organ pipes $\rightarrow$ longitudinal stationary.
Stretched sonometer wire $\rightarrow$ Transverse stationary.

9. Ans. (d)
Nodes are formed at fixed end of string or closed end of pipe where particle velocity is zero, min. displacement, max. pressure variation & max strain.

10. Ans. (b)
Antinodes are formed in open end of organ pipe where max. displacement, min. pressure variation & min. strain.

11. Ans. (c)
Distance between node to node or antinode to antinode is $\frac{\lambda}{2}$.

12. Ans. (b)

$f = \frac{1}{2l}\sqrt{\frac{T}{M}}$

$\frac{\Delta f}{f} = \frac{1}{2}\frac{\Delta T}{T} = \frac{1}{2}\left(\frac{2}{100}\right) = \frac{1}{100}$

$\Delta f = \frac{1}{100} \times 300 = 3Hz.$

13. Ans. (c)

$f = \frac{1}{2l}\sqrt{\frac{T}{M}}$

on decreasing T by 36%

$f^1 = \frac{1}{2l}\sqrt{\frac{0.64T}{M}} = 0.8f$

$\frac{f - f^1}{f} \times 100\% = \frac{f - 0.8f}{f} \times 100\% = 20\%$

14. Ans. (b)

e = 0.3d

$d = \frac{e}{0.3} = \frac{1}{0.3} = 3.3cm$

15. Ans. (b)

In fundamental mode of vibration of an open pipe, a node is formed at the middle of the pipe, where displacement is minimum, pressure is maximum.

16. Ans. (a)

$y = 2a \sin\frac{2\pi x}{\lambda} \cos\frac{2\pi}{T} t$

$\frac{2\pi x}{\lambda} = \frac{\pi x}{4} \Rightarrow \lambda = 8$

Distance between two consecutive nodes = $\frac{\lambda}{2} = \frac{8}{2} = 4$times.

17. Ans. (c)

$f = \frac{1}{2l}\sqrt{\frac{T}{M}} = \frac{1}{2l}\sqrt{\frac{T}{\rho A}} = \frac{1}{lD}\sqrt{\frac{T}{\pi d}}$

When T is doubled , D is doubled, d is halved.

$f^1 = \left(\frac{1}{2}\sqrt{\frac{2}{\frac{1}{2}}}\right) f = f$

18. Ans. (b)

$f = \frac{1}{2l}\sqrt{\frac{T}{\rho A}}$

$f \propto \sqrt{\frac{T}{A}}$

$f^1 = \left(\sqrt{\frac{2T}{\frac{A}{2}}}\right) f = 2f.$

19. Ans. (b)

$f = \frac{1}{2l}\sqrt{\frac{T}{m}} = \frac{1}{2l}\sqrt{\frac{T}{A\rho}}$

$f = \frac{1}{2l}\sqrt{\frac{4T}{\pi d^2 \rho}}$

$f \propto \frac{1}{\rho}$

$\frac{f_2}{f_1} = \frac{d_2}{d_1} = 2:1$

20. Ans. (c)

$f = \frac{v}{\lambda} = \frac{v}{2l} = \frac{350}{2 \times 0.5}$

$= 350Hz$

For open pipe (At fundamental)

$l = \frac{\lambda}{2} \Rightarrow \lambda = 2l$

21. Ans. (c)

$f_C = f_O$

$\frac{v}{4 \times l} = \frac{v}{2l}$ $\quad l = 2m$

22. Ans. (b)

Frequency of the organ pipe doesn't depends on radius but $f \propto \frac{1}{l}$

So, f is doubled when l is halved

23. Ans. (c)

$l_1 + e = \frac{\lambda}{4}$ $\quad l_2 + e = \frac{3\lambda}{4}$

$\lambda = 2(l_2 - l_1)$

$v = f\lambda = 2(l_2 - l_1)\, f$

$= \frac{2\,(52 - 17)}{100} \times 500 = 350m/s.$

24. Ans. (b)

$V = \lambda f \left(\frac{\lambda}{2} = l\right) = 2 \times 1 \times 330 = 660\text{m/s.}$

25. Ans. (b)

$2\left(\frac{v}{2l \text{ open}}\right) = \frac{3v}{4l \text{ closed}}$

$2 \times 300 = \frac{3v}{4l \text{ closed}}$

$l \text{ closed} = \frac{v}{800} = \frac{330}{800} = 0.41\text{m}$

26. Ans. (c)

Seperation between two consecutive nodes $\frac{\lambda}{2} = 5\text{cm}$

$\lambda = 10\text{cm} = 0.1\text{m}$

$f = \frac{v}{\lambda} = \frac{2}{0.1} = 20\text{Hz}$

27. Ans. (c)

$f_O = \frac{v}{2(l + 2e)}$

$l + 2e = \frac{v}{2f} = \frac{340}{2 \times 340} = 0.5\text{m}$

$= 50\text{cm}$

$e = \frac{50 - 47}{2} = 1.5\text{cm}$

$e = 0.3d \quad \Rightarrow d = \frac{1.5}{0.3} = 5\text{cm}$

28. Ans. (b)

$f = \frac{1}{2l}\sqrt{\frac{T}{\rho A}} \quad f \propto \frac{1}{l\sqrt{A}}$

$V = V^1,\ lA = 2l\,A^1\ ;\ A^1 = \frac{A}{2}$

When length doubles, Area is halved.

$f^1 = \frac{l\sqrt{A}}{l_1\sqrt{A_1}} = \frac{1}{2} \times \sqrt{2} = \frac{1}{\sqrt{2}} = 0.7\text{cm}$

29. Ans. (b)

$\frac{\lambda}{4} = l + e = 16\text{cm} + 0.3d$

$= 16 + 0.3 \times 5 = 17.5\text{cm}$

$\lambda = 4 \times 17.5 = 70\text{cm}$

$v = f\lambda = 480 \times 0.7 = 336\text{m/s.}$

30. Ans. (a)

In 2nd harmonic, there are two loops.

$L = \frac{\lambda}{2} + \frac{\lambda}{2} = \lambda$

31. Ans. (d)

λ max occurs at minimum frequency i.e. fundamental frequencies only one loop is formed.

$\frac{\lambda}{2} = L \Rightarrow \lambda\text{max} = 2L$

$= 2 \times 40 = 80\text{cm}$

32. Ans. (a)

As $f = \frac{n}{2l}\sqrt{\frac{T}{M}}$ = constant

So $n \propto l$.

As length becomes twice n also becomes twice.

33. Ans. (c)

2nd overtone $\Rightarrow$ 3rd harmonic No of antinodes = No of harmonic = 3

No. of nodes = No. of antinodes + 1=3+1 = 4

34. Ans. (a)

As $f \propto \frac{1}{l} \Rightarrow l \propto \frac{1}{f}$

$l_1:l_2:l_3 = \frac{1}{f_1} : \frac{1}{f_2} : \frac{1}{f_3}$

$= \frac{1}{1} : \frac{1}{2} : \frac{1}{3} = \frac{1}{1} \times 6 : \frac{1}{2} \times 6 : \frac{1}{3} \times 6 = 6:3:2$

35. Ans. (a)

As $f \propto \frac{1}{L}$

$L = L_1 + L_2 + L_3$

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3}$

36. Ans. (b)

$n\sqrt{T}$ = constant

$\frac{T_2}{T_1} = \frac{n_1^2}{n_2^2} = \frac{4^2}{6^2} = \frac{16}{36}$

$T_2 = \frac{13}{36} T_1 = \frac{13}{36} \times (50 + 15) = 29$

Weight to be removed = 65 – 29 = 36 gram

37. Ans. (d)

Let the frequency of tuning fork be f_1 & f_2 ($f_1 > f_2$) $\therefore$ $f_1 - f_2 = 5$

$f \propto \frac{1}{l}$ So, $\frac{f_1}{f_2} = \frac{16.2}{16} = \frac{162}{160} = \frac{81}{80}$

$f_1 - f_2 = 5 \Rightarrow \frac{81}{80} f_2 - f_2 = 5$

$\frac{f_2}{80} = 5 \Rightarrow f_2 = 400$

$f_1 = f_2 + 5 = 405Hz.$

38. Ans. (a)

$m = \frac{M}{L} = \frac{5}{20} = \frac{1}{4}$ kg/m

Tension in the middle of wire

T = weight of half wire

$= \frac{5g}{2} = 2.5 \times 10 = 25N$

$v = \sqrt{\frac{T}{m}}$

$= \sqrt{\frac{25}{\frac{1}{4}}} = 10m/s$

39. Ans. (a)

f = frequency of tuning fork $f \propto \sqrt{T}$

$\frac{f - 10}{f} = \sqrt{\frac{129.6}{160}}$

$= \sqrt{0.81} = 0.9$

$1 - \frac{10}{f} = 0.9 \Rightarrow \frac{10}{f} = 0.1$

f = 100Hz

40. Ans. (d) $e = \frac{L_2 - 3L_1}{2}$

$1 = \frac{L_2 - 3 \times 15}{2}$

$L_2 = 47cm$

41. Ans. (c)

$L_1 = \frac{v}{4f} = \frac{330 \times 100}{4 \times 500} = 16.5cm$

$L_2 = 3L_1 = 3 \times 16.5cm = 49.5cm$

$L_3 = 5L_1 = 3 \times 16.5cm = 115.5cm$

$L_4 = 7L_1 = 7 \times 16.5cm = 115.5cm$

As glass tube is only 100cm long, 3 resonance positions can be obtained.

Past Questions

1. A tube closed at one end containing air when excited produces the fundamental note of frequency 512Hz. If the tube is open at both ends the fundamental frequency that can be exicted is

[IOM 2010]

a. 1024Hz b. 256Hz

c. 512Hz d. 128Hz

2. In the eqution, y = cos $\frac{(2\pi x)}{60}$ sin (100 at), x and y are in cm & t in sec. At the node find the value of x [IOM 07]

a. $\frac{100}{2\pi}$ cm b. 20cm

c. 15cm d. 12.5cm

3. An organ pipe P_1 closed at one end and vibrating in its first overtone and another pipe P_2 open at both ends are vibrating in its third harmonic are in resonance with a given tuning fork. The ratio of length of P_1 and P_2 is [IOM 05]

a. $\frac{8}{3}$ b. $\frac{3}{8}$

c. $\frac{1}{2}$ d. $\frac{1}{3}$

4. A closed organ pipe and open organ pipe have their first overtone indentical in frequency. Their length are in the ratio

[MOE 2068]

a. 1:2 b. 2:3
c. 3:4 d. 4:4

5. The first and second resonance are obtained at depths of 21.5cm and 65cm in a resonance air column experiment. The third resonance will be obtained at [IOM 2068]

a. 108.5cm b. 98.5cm
c. 118.5cm d. 88.5cm

6. If oil of density higher than water is filled in place of water in a resonance tube its frequency will [MOE 2067]

a. increase
b. decrease
c. remains unchanged
d. depends on the density of material of the tube

7. The third harmonic of open ended pipe of length 50cm is [MOE 2066]

a. 332Hz b. 166Hz
c. 996Hz d. 100Hz

8. In a resonance tube, the air columns for first and second resonance differ by 31.5cm. The wave length of sound waves in the tube is [MOE 2065]

a. 31.5cm b. 63cm
c. 126cm d. 252cm

9. One open organ pipe of l = 27cm and closed organ pipe of length 21cm sound in unison in their 1st overtone. Calculate the end correction for both pipes. [MOE 2061]

a. 1.5 cm b. 0.6 cm
c. 0.9 cm d. 1.2 cm

10. If R is the radius of the resonance tube, the end correction to be applied is [MOE Curriculum]

a. 0.3R b. 0.4R
c. 0.5R d. 0.6R

11. A string has mass 0.01 kg and length 1m. If the tension is 1000N the velocity of tranverse wave in the string is [Bangladesh embassy]

a. $316ms^{-1}$ b. $340ms^{-1}$
c. $336ms^{-1}$ d. $366ms^{-1}$

12. The fundamental frequency of closed organ pipe is equal to first overtone frequency of an open organ pipe. If the length of open organ pipe is 60cm. What is the length of closed pipe? [BPKIHS]

a. 15cm b. 30cm
c. 45cm d. 60cm

13. A plano wire of diameter 0.9mm is replaced by another wire of 0.93mm. Then the percentage change in frequency of plano wire is [BPKIHS]

a. +3.0% b. +3.3%
c. –3.0% d. –3.3%

Answer Sheet

1. a	*2. c*	*3. c*	*4. c*	*5. a*	*6. c*	*7. c*	*8. b*	*9. a*	*10. d*
11. a	*12. a*	*13. d*							

SOLUTION

1. Ans. (a)

For closed organ pipe,

$f_C = \frac{v}{4l}$

for open organ pipe,

$f_O = \frac{v}{2l}$

$f_O = 2f_C = 2 \times 512Hz = 1024Hz.$

2. Ans. (c) $y=2a \sin\frac{2\pi}{\lambda} x . \cos\frac{2\pi t}{T}$ (node at x=0)

$y = 2a \cos\frac{2\pi x}{\lambda} . \sin\frac{2\pi t}{T}$ (antinode at x = o)

Given equation is stationary wave with antinodes at x = o. So, node occurs at $x = \frac{\lambda}{4}$

we get, $\lambda = 60cm \Rightarrow x = \frac{60}{4} = 15cm$.

3. Ans. (c)

1^{st} overtone of closed organ pipe $f_C = \frac{3v}{4l_C}$

3^{rd} harmonic (2^{nd} overtone) for open organ pipe

$f_O = \frac{3v}{4l_O}$

for resonance $f_O = f_C$

$\frac{3v}{4l_C} = \frac{3v}{2l_O}$

$l_C : l_O = 1:2$

4. Ans. (c)

First overtone of closed organ pipe,

$f_1 = \frac{3v}{4l_C}$

First overtone of open organ pipe,

$f_1 = \frac{2v}{2l_O} = \frac{v}{l_O}$

$\frac{3v}{4l_C} = \frac{v}{l_O}$ (By question)

$\frac{l_C}{l_O} = 3:4$

5. Ans. (a)

$l_3 - l_2 = l_2 - l_1$

$l_3 = 2l_2 - l_1$

$= 2 \times 65 - 21.5$

$= 108.5cm$

6. Ans. (c)

The frequency remains unchanged on replacement of liquid because the frequency is due to vibration of air column & not due to liquid.

7. Ans. (c)

3^{rd} harmonic of open organ pipe

$l = \frac{3\lambda}{2} \Rightarrow \lambda = \frac{2l}{3}$

$= \frac{2 \times 0.5}{3} = \frac{1}{3}$

$f = \frac{v}{\lambda} = \frac{332}{1/3} = 332 \times 3$

$= 996Hz$

8. Ans. (b)

l_1 & l_2 be the length of air column for 1^{st} & 2^{nd} resonance.

$\frac{\lambda}{4} = l_1 + e$ and $\frac{3\lambda}{4} = l_2 + e$

$l_2 - l_1 = \frac{\lambda}{2}$

$\lambda = 2(l_2 - l_1) = 2 \times 31.5 = 63cm$

9. Ans. (a)

1^{st} overtone for open organ pice = 1^{st} over tone for closed organ pipe

$\frac{v}{l_1 + 2e} = \frac{3v}{4(l_2 + e)}$

$e = \frac{4l_2 - 3l_1}{2} = \frac{4 \times 21 - 3 \times 27}{2} = 1.5cm$

10. Ans. (d)

end correction

(e) = $0.3 \times d$

$= 0.3 \times 2R = 0.6R$

11. Ans. (a)

$v = \sqrt{\frac{T}{M}}$; T = tension

m = mass per unit length

$v = \sqrt{\frac{\frac{1000}{0.01}}{1}} = \sqrt{10^5} = 316ms^{-1}$

12. Ans. (a)

Fundamental frequency (closed) = 1^{st} overtone (open)

$\frac{v}{4Lc} = \frac{2v}{4Lo} \Rightarrow Lc = \frac{Lo}{4} = \frac{60}{4}$

$= 15cm$

13. Ans. (d)

$f = \frac{1}{2l}\sqrt{\frac{T}{\rho \times A}} \Rightarrow f \propto \frac{1}{\sqrt{A}} \propto \frac{1}{r} \Rightarrow f \propto r^{-1}$

$$\frac{\Delta f}{f} \times 100 = -1\left(\frac{\Delta d}{d} \times 100\%\right)$$

$$= -1\left(\frac{0.93 - 0.90}{0.90} \times 100\%\right)$$

$$= -3.3\%$$

Chapter: 25

DOPPLER'S EFFECT & MUSICAL SOUND

1. **Doppler's effect is applicable for**
   a. light wave only
   b. sound wave only
   c. both light and sound waves
   d. none
2. **The noise level of ordinary conversations is:**
   a. 20 dB   b. 65 dB
   c. 100 dB   d. 120 dB
3. **The maximum tolerable sound intensity in dB is:**
   a. 10 dB   b. 100 dB
   c. 120 dB   d. 20 dB
4. **Loundness is measured in:**
   a. decibel   b. bel
   c. phon   d. both a & b
5. **Doppler's effect is independent of:**
   a. distance between source & listener
   b. velocity of source
   c. velocity of listener
   d. none
6. **Which helps to recognise a person by his voice only?**
   a. intensity   b. pitch
   c. quality   d. wave length
7. **Sweetness of a sound depends up on its:**
   a. wavelength   b. frequency
   c. amplitude   d. periodicity & regulaity
8. **The notes that are seperated by three octaves have a frequency ratio of:**
   a. 3   b. 6
   c. 8   d. 16
9. **The intensity level due to waves of same frequency in a given medium are 1 bel and 5 bel. Then the ratio of their amplitudes is:**
   a. 1:4   b. 1:2
   c. $1:10^4$ d. $1:10^2$
10. **The musical interval between two nodes of frequency 320 Hz and and 240Hz is:**
   a. 80   b. 1.33
   c. 1.78   d. 7
11. **A two fold increase in the intensity of a wave implies on increase in intensity level of:**
   a. 2 dB   b. 10 dB
   c. 3.01 dB   d. 0.5 dB
12. **The reference intensity of audibility is 10^{-12} w/m^2. The sound level for intensity 10^{-6} w/m^2 will be:**
   a. 10^6 dB   b. 6 dB
   c. 60 dB   d. 180 dB
13. **A source of sound emits 200π watt power, which is uniformly distributed over a sphere of radius 10m. What is loudness of sound on the surface of the sphere? ($\log_{10}2 = 0.3$)**
   a. 200π dB   b. 120π dB
   c. 120 dB   d. 117 dB
14. **A passanger is sitting on a fast moving train. The engine of the train blows a whistle of frequency f. If the apparent frequency of sound heard by the passenger is f^1 then:**
   a. $f^1 < f$ b. $f^1 > f$
   c. $f^1 = f$ d. $f^1 > h$
15. **The apparent frequency noted by a moving listener away from the stationary source is 10% less than the real frequency. If the velocity of sound is 330m/s, the velocity of the listener is,**
   a. 16.5 m/s   b. 8.25 m/s
   c. 33 m/s   d. 60 m/s

16. A tuning fork of frequency 90HZ is sounded forward an observer moving with a velocity equal to $\left(\frac{1}{10}\right)^{th}$ velocity of sound. The note heard by the observor will have a frequency.

a. 106 Hz b. 90 Hz
c. 99 Hz d. 590 Hz

17. A source of sound moves towards a stationary observer with a velocity equal to velocity of sound. If the source produces n waves/sec. The observer receives:

a. n waves/sec b. 2n waves/sec
c. $\frac{n}{2}$ waves/sec d. all waves in no time.

18. A source of sound produces n waves/sec. An observer is receding with a velocity equal to velocity of sound. The observer receives:

a. n waves/sec b. 2n waves/sec
c. no waves d. all waves in no time

19. With what velocity a moving source must come towards a stationary listener so that apparent frequency noted by listner is twice the real frequency? The velocity of sound in air is 332m/s.

a. 83 m/s b. 166 m/s
c. 240 m/s d. 332 m/s

20. A moving source of sound passes a stationary observer with a velocity v_s. The velocity of sound is v and frequency of the source is f. If $v_s<<v$; then the apparent decreases in frequency will be:

a. $\frac{2v}{v_s f}$ b. $\frac{2v_s f}{v}$
c. $\frac{2f}{vv_s}$ d. $\frac{v}{2fv_s}$

21. A man is watching two trains, one leaving and the other coming towards him with equal speed of 4m/s. If they sound their whistles each of natural frequency of 240 HZ, the number of beats heards will be (velocity of sound in air = 320 m/s).

a. 6 b. 3
c. zero d. 12

22. The difference between apparent frequency of a source of sound as perceived by an observer during its approach and recession is 2% of its natural frequency of a source. If the velocity of sound in air is 300m/s, the velocity of the source is:

a. 6 m/s b. 3 m/s
c. 1.5 m/s d. 12 m/s

23. A whistle is whirled in a circle of radius 1m and transves the circular path twice per second. An observer is situated outside the circle but in its plane. If the velocity of sound is 332 m/s, then the interval between the highest and lowest observed pitch is:

a. 332:1 b. 332:4π
c. 2:1 d. 1.08:1

24. A car travels at a speed of 20 m/s towards a high wall. The driver sounds a horn of frequency 124 HZ. If the velocity of sound in air is 330m/s. The frequency of reflected sound heard by driver is:

a. 140 HZ b. 280 HZ
c. 1300 HZ d. 124 HZ

25. A whistle of frequency 500 Hz is tied to an end of a string of length 1.2 m revolves at speed 400 rev/min. A listener standing some distance away in the plane of rotation of whistle hears frequencies in the range (speed of sound = 340m/s):

a. 426 to 574 b. 426 to 586
c. 426 to 574 d. 436 to 586

26. An object producing a pitch of 400 Hz approaches a stationary person in a straight line with a velocity of 200 m/s. Velocity of sound is 300 m/s. The person will note a change in frequency as the object past him equal to:

a. 1440 HZ b. 240 HZ
c. 1200 HZ d. 960 HZ

27. A source of sound produces waves of λ = 40 cm air. It is moving with a velocity one fourth the velocity of sound towards east. The apparent wave length noted by a man in opposite direction is:

a. 30 cm b. 60 cm
c. 50 cm d. 75 cm

28. A galaxy is approaching the earth with a velocity of 10^5m/s. As observed on the earth, the shift in the spectral line of wavelength 5700$\mathring{A}$ will be:

a. 1.9$\mathring{A}$ b. 3.8$\mathring{A}$
c. 0.536$\mathring{A}$ d. 1.06$\mathring{A}$

29. When an astronaut in a rocket reaches near the moon, he sends a radio wave of frequency 500 MHZ towards the moon. He finds that the reflected wave from the moon has a frequency 86 KHZ more than the real frequency. The velocity of the rocket with respect to the moon is:

a. 1.29 km/s b. 2.58 km/s
c. 3.87 km/s d. 5.16 km/s

30. The apparent increase in wavelength of light emitted by a moving star is 0.1% of its actual wave length. Then the velocity of the star is:

a. 3×10^4m/s moving towards earth
b. 3×10^4m/s moving away from earth
c. 3×10^6m/s moving towards earth
d. 3×10^6m/s moving away from earth

Answer Sheet

1. c	*2. b*	*3. c*	*4. c*	*5. a*	*6. c*	*7. d*	*8. c*	*9. d*	*10. b*
11. c	*12. c*	*13. d*	*14. c*	*15. c*	*16. c*	*17. d*	*18. c*	*19. b*	*20. b*
21. a	*22. b*	*23. d*	*24. a*	*25. d*	*26.d*	*27. c*	*28. a*	*29. b*	*30. b*

SOLUTION

1. Ans. (c)
The apparent change in frequency during relative motion of source and observer is observed in both.

2. Ans. (b)
Ordinary conversation = 65 dB
Whispering = 20 dB

3. Ans. (c)
Plane taking off and landing (Threshold of pain) = 120 dB

4. Ans. (c)
Intensity $\rightarrow$ decibel & bel
Loudness $\rightarrow$ phon

5. Ans. (a)
Doppler's effect is independent of the distance between source and listener.

6. Ans. (c)
Every person has definite quality with different wave forms. Quality depends on overtones.

7. Ans. (d)
Pitch $\rightarrow$ frequency
Loudness $\rightarrow$ amplitude
quality $\rightarrow$ overtones

8. Ans. (c)
Each octave is double of previous. ie. 2,4,8
3^{rd} octave is 8 times.

9. Ans. (d)

$$1 = \log_{10}\left(\frac{I_1}{I_0}\right) \ \& \ 5 = \log_{10}\left(\frac{I_2}{I_0}\right)$$

subtracting, $4 = \log_{10}\left(\frac{I_2}{I_0}\right) - \log_{10}\left(\frac{I_1}{I_0}\right)$

$$4 = \log_{10}\left(\frac{I_2}{I_1}\right) \Rightarrow \frac{I_2}{I_1} = 10^4$$

$$\frac{I_2}{I_1} = 1:10^4 \Rightarrow \frac{a_1}{a_2} = \sqrt{\frac{I_1}{I_2}} = \frac{1}{10^2}$$

10. Ans. (b)
Musical interval is the ratio of frequencies.
So musical interval $= \frac{320}{240} = \frac{4}{3} = 1.33$

11. Ans. (c)

$n_2 - n_1 = 10 \log \left(\frac{I_2}{I_1}\right)$

$= 10 \times \log_{10} 2 = 10 \times 0.301 = 3.01$ dB

12. Ans. (c)

$L = 10 \log_{10} \left(\frac{I}{I0}\right)$

$= 10 \log_{10} \left(\frac{10^{-6}}{10^{-12}}\right) = 10 \log 10^6 = 60\text{dB}$

13. Ans. (d)

$I = \frac{P}{A} = \frac{200\pi}{4\pi r^2} = \frac{200}{4\times10^2} = 0.5$

No. of dB $= 10 \log_{10} \left(\frac{I}{I_0}\right)$

$= 10 \log_{10} \left(\frac{0.5}{10^{-12}}\right)$

$= 10 \log_{10} \left(\frac{10^{12}}{2}\right)$

$= 10 (\log_{10} 10^{12} - \log_{10} 2)$

$= 10 (12 - 0.3) = 117$ dB

14. Ans. (c)

The relative velocity between the source and the listener is zero. So Doppler's effect is not applicable. so, $f^1 = f$.

15. Ans. (c)

$f^1 = f - \frac{10}{100} f = 0.9f$

When observer moves away from source

$f^1 = \frac{v - v_0}{v} f$

$0.9f = \frac{v - v_0}{v} f$

$0.9v = v - v_0$

$v_0 = 0.1\times v = 0.1\times330 = 33\text{m/s}$

16. Ans. (c)

$f = \left(\frac{V+V_0}{V}\right) fo$

$= \left(1 + \frac{v_0}{v}\right) fo$

$= \left(1 + \frac{1}{10}\right) \times 90 = 99\text{Hz}$

17. Ans. (d)

Observed frequency

$f^1 = \left(\frac{v}{v - vs}\right) f = \left(\frac{v}{v - v}\right) f = \infty$

Hence, observer receives all waves in no time.

18. Ans. (c)

Observed frequency

$f^1 = \left(\frac{v - v_0}{v}\right) f = \left(\frac{v - v}{v}\right) f = 0$

19. Ans. (b)

$2 f_0 = \left(\frac{v}{v - vs}\right) f_0$

$2 = \frac{332}{332 - Vs}$

$2Vs = 664 - 332$

$2 Vs = 332$

$Vs = 166$ m/s

20. Ans. (b)

When the source moves towards the observer $f_1 = \left(\frac{v}{v - v_s}\right)$

When source recedes away from the observer

$f_2 = \left(\frac{v}{v + v_s}\right) f$

$f_1 - f_2 = \left(\frac{v}{v - v_s} - \frac{v}{v + v_s}\right) f$

$= v \left(\frac{2vs}{v^2 - vs^2}\right) f$

$= \frac{2vvsf}{v^2\left(1 - \frac{vs^2}{v^2}\right)} = \left(\frac{2vs}{v}\right) f$

$\left(\frac{vs^2}{v^2} \approx 0\right)$

21. Ans. (a)

No. of beats $= f_1 - f_2$

$= 2\left(\frac{vs}{v}\right) f_0$

$= 2 \times \frac{4}{320} \times 240$

$= 6$ HZ

22. Ans. (b)

$\Delta f = f_1 - f_2 = \left(\frac{2Vs}{v}\right) f_0$

$\frac{\Delta f}{f_o} = \frac{2vs}{v}$

$\frac{2}{100} = \frac{2\times v_s}{300}$

$v_s = 3m/s$

23. Ans: (d)

Speed of whistle = $\omega r = 2 \times 1$ m/s = 2 m/s

$fmax = \left(\frac{v}{v-vs}\right) f_o$ & $fmin = \left(\frac{v}{v+vs}\right) f_o$

$\frac{fmax}{fmin} = \frac{332 + 2}{332 - 2} = 1.08:1$

24. Ans. (a)

$f^1 = \left(\frac{v + u}{v - u}\right) f$

$= \left(\frac{330 + 20}{300 - 20}\right) \times 124$

$= \frac{350}{310} \times 24 = 140$ HZ

25. Ans. (d)

$v_s = r\omega = 1.2 \times 2\pi \times \frac{400}{60} = 50$ m/s

$fmin = \left(\frac{v}{v+vs}\right) f = \frac{340}{340 + 50} \times 500$

$= 436$

$fmax = \left(\frac{v}{v-vs}\right) f$

$= \frac{340}{340-50} \times 500 = 586$

26. Ans. (d)

When a source goes past a stationary listener.

$\Delta f = \frac{2vvs}{v^2 - v_S^2} \times f$

$= \frac{2 \times 300 \times 200}{300^2 - 200^2} \times 400 = 960$ HZ

27. Ans. (c)

$f^1 = \frac{v}{v+vs} \times f$

$\lambda^1 = \frac{v+vs}{v} \lambda = \frac{v + \frac{v}{4}}{v} \times 40 = \frac{5}{4} \times 40 = 50$ cm

28. Ans. (a)

$\Delta\lambda = \frac{v}{c}\lambda = \frac{10^5}{3\times10^8} \times 5700 = 1.9\mathring{A}$

29. Ans. (b)

In case of reflected system

$\Delta f = \frac{2v}{c} f$

$86 \times 10^3 = \frac{2v}{3\times10^8} \times 500 \times 10^6$

$v = 2.58 \times 10^3$ m/s = 2.58 km/sec

30. Ans. (b)

$\Delta\lambda = \frac{v}{c}\lambda \Rightarrow \frac{\Delta\lambda}{\lambda} = \frac{v}{c}$

$\frac{0.01}{100} = \frac{v}{3\times10^8}$

$v = 3\times10^4$ m/s

The wave length increases when the star moves away from earth.

Past Questions

1. If amplitude of sound wave is tripled, the intensity of sound increases

[MOE 2068]

a. 3 times b. 6 times

c. $\sqrt{3}$ times d. 9 times

2. If two source and observer are moving with same speed in opposite direction the apparent frequency heard by observer is: [MOE 2067]

a. $f^1 = f$ b. $f^1 > f$

c. $f^1 < f$ d. $f^1 \le f$

3. **A whistle giving out 450Hz approaches a stationary observer at a speed of 33m/s. The frequency heard by the observer in Hz is: [MOE 2010]**

a. 409 b. 517
c. 429 d. 500

4. **The intensity of threshold of hearing is 10^{-12} w/m^2. The intensity level of sound of intensity 10^{-4} wm^{-2} is: (MOE 08)**

a. 60 db b. 80 db
c. 40 db d. 100 db

5. **Quality of two sound is different because of : [MOE/KU]**

a. frequencies b. intensities
c. amplitudes d. overtones

6. **When air space in musical instrument is increased. What will increase? [IOM]**

a. pitch b. loudness
c. quality d. timber

7. **A source of sound is moving away from a stationary observor with a speed equal to speed of sound. The apparent frequency heard by the observor is : [KU 2010]**

a. n^2 b. 2n
c. $\frac{n}{2}$ d. none

8. **The loudness of two waves of same frequency in a given medium are 100 dB and 20 dB respectively. How many times is the intensity of I_1 greater than I_2? [IE 05]**

a. 50 b. 10^5
c. 10^{-5} d. 5

9. **A policeman sounds a whistle with frequency 300Hz towards a car that move towards him with a velocty 5m/s. Find the frequency of the whistle heard by the driver of the car. (Velocity of sound in air = 320 m/s: [IE 01]**

a. 310Hz b. 305Hz
c. 312 Hz d. 320 Hz

10. **A bus is moving towards a huge wall with a velocity of 5m/s. The driver sounds a horn of frequency 200 Hz. The frequency of the beats heard by a passanger of the bus will be (speed of sound in air = 350 m/s) [BPKIHS]**

a. 206Hz b. 100Hz
c. 209Hz d. 35Hz

11. **A person is standing on a railway station when a train is approaching him, the frequency of whistle heard by him is 220Hz, but when the train has crossed him, The frequency heard by him is 184 Hz. The acutal frequency of the whistle is: [BPKIHS]**

a. 200 Hz b. 202 Hz
c. 207 Hz d. $\sqrt{184 \times 220}$ Hz

12. **A radar sends a signal of frequency 7.8×10^9/s towards aeroplane moving with certain velocity a frequency difference of 2.7×10^3/s is reflected from aeroplane. Find the velocity of the aeroplane [IOM 07]**

a. 1.87×10^2 km/hr b. 2.87×10^2km/hr
c. 0.87×10^2 km/hr d. 3.74×10^3km/hr

Answer Sheet

1. d	*2. b*	*3. d*	*4. b*	*5. d*	*6. b*	*7. c*	*8. b*	*9. b*	*10. a*

11. a	*12. a*								

SOLUTION

1. Ans. (d)

$I = 2\pi^2 f^2 a^2 \rho v$

$I \propto a^2$

$I^1 = (3a)^2 = 9a^2 = 9I$

2. Ans. (b)

Apparent frequency increases when source & observer approach eachother and decreases when source and observer recede from each other.

3. Ans. (d)

When source approaching stationary observor

$f1 = \left(\frac{v}{v-vs}\right) f$

$= \frac{332}{332-33} \times 450$

= 500Hz

4. Ans. (b)

$I = 10.\log\left(\frac{I}{Io}\right)$ db

$= \quad 10.\log\left(\frac{10^{-4}}{10^{-12}}\right)$

$= 10 \times \log(10^8)$

= 80 db

5. Ans. (d)

Overtones $\rightarrow$ Quality

Pitch $\rightarrow$ frequency

Loudness $\rightarrow$ amplitudes

6. Ans. (b)

Increase in air space increases the vibrating surface which increases the intensity of sound (loudness)

7. Ans. (c)

$n^1 = \left(\frac{v}{v+vs}\right) n$

Given,

vs = v

$n^1 = \left(\frac{v}{2v}\right) n = \frac{n}{2}$

8. Ans. (b)

$100 = 10 \log \frac{I_1}{I_0}$ ________ (i)

$20 = 10 \log \frac{I_2}{I_0}$ ________ (ii)

$5 = \log \frac{I_1}{I_2}$

$\frac{I_1}{I_2} = 10^5$

9. Ans. (b)

Source $\rightarrow$ stationary

Car is moving towards source (policeman)

$f1 = \left(\frac{v+v_0}{v}\right) f$

$= \left(\frac{320+5}{320}\right) \times 300$

= 305Hz

10. Ans. (a)

$f^1 = \left(\frac{v}{v-vs}\right) f \rightarrow$ for source towards observer with v.

$f^{11} = \left(\frac{v+vo}{v}\right) f^1 \rightarrow$observor towards source with v.

$f^{11} = \left(\frac{v+vo}{v}\right)\left(\frac{v}{v-vs}\right) f = \left(\frac{v+vo}{v-vs}\right) f$

$= \left(\frac{350+5}{350-5}\right) \times 200$

$= 206$ Hz

11. Ans. (a)

$220 = \frac{v}{v-vs}$

$\rightarrow 220 = \frac{f}{1-\frac{vs}{v}}$

$1 - \frac{vs}{v} = \frac{f}{200}$ ——— (i)

$184 = \left(\frac{v}{v+vs}\right) f$

$1+\frac{vs}{v} = \frac{f}{184}$ ——— (ii)

Adding (i) & (ii)

$2 = f\left(\frac{1}{200} + \frac{1}{184}\right)$

$f = \frac{2\times220\times184}{220+184} = 200\text{Hz}$

12. Ans. (a)

$\frac{\Delta f}{f} = \frac{2v}{C}$

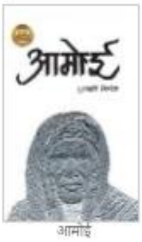
$v = \frac{\Delta fC}{2f}$

$= \frac{2.7\times10^3\times3\times10^8}{2\times7.8\times10^9}$

$= 1.87\times 10^2$km/hr


रमिलानानी


संजीवनी



आमोई

नेपाली रैथाने जडिबुटी


कविताको कथा गीतको कथा


विश्रान्त

घामभन्दा पहिले

पोल्टाभित्र डिही

अर्को भोर

SHIKHA
BOOKS

Chapter: 26

FORCE & CHARGE

1. The sure test of electrification is:

a. attraction b. repulsion
c. both attraction & repulsion
d. none

2. When the distance between two charged praticles is halved, the coulomb force between them becomes:

a. halved b. one-fourth
c. double d. four times

3. The minimum value of charge on any charged body may be:

a. 1.6×10^{-19}c b. 1 coulom b
c. 1 μC d. 4.8×10^{-12} c

4. A charge q_1 exerts some force on a second charge q_2. If third charge q_3 is placed near, the force q_1 exerted on q_2.

a. increases b. decreases
c. remains unchanged
d. depends on sign of charges

5. Two charge are placed at a distance 'd' apart in air. Coulombic force between them is Fo . If a dielectric material of dielectric constant k is placed between them the coulomb force now becomes:

a. Fo/k b. FoK
c. Fo/k^2 d. k^2Fo

6. Two charges are placed at a certain distance apart. If brass sheet is placed between them. The force between them will:

a. increase b. decsease
c. remains unchanged d. zero

7. The proton is 1836 time heavier than electron. The coulomb's force of repulsion between two protons is F. Then columb force between two electron from same distance is:

a. F b. – F
c. $\frac{F}{(1836)^2}$ d. $F\times(1836)^2$

8. The ratio of the forces between two small spheres charged to constant charge in air and medium of dielectric constant k is respectively:

a. 1:k b. k:1
c. 1:k^2 d. k^2:1

9. The ratio of the forces between two small spheres charged to constant potentials in air and in medium of dielectric constant k is:

a. 1:k b. k:1
c. 1:k^2 d. k^2:1

10. There are two charges +1μC and +3μC. The ratio of the forces acting on them will be:

a. 1:3 b. 3:1
c. 1:25 d. 1:1

11. When 10^{14} electrons are removed from a neutral metal sphere, the charge on the sphere becomes:

a. 16 μC b. – 16 μC
c. 32 μC d. – 32 μC

12. Two point charges in air at a distance of 21cm from each other interact with a certain force. At what distance from each other should be placed in oil of relative permittivity 9 to obtain same force of attraction?

a. 14 cm b. 3 cm
c. 9 cm d. 7 cm

13. A polythene piece rubbed with wool is found to have negative charge of 4×10^{-7}C. The number of electrons tranferred from wool to polythene is:

a. 1.5×10^{12} b. 2.5×10^{12}
c. 2.5×10^{13} d. 3.5×10^{13}

14. An isolated conducting sphere is given a positive charge. Its mass:

a. increases b. decreases
c. remains unchanged d. none

15. Two identical spheres having charges Q and –2Q experiences a force F at a certain distance. If the spheres are kept in contact and then placed at some initial distance, the force between will be:

a. F b. $\frac{F}{4}$
c. $\frac{-F}{8}$ d. $+\frac{F}{8}$

16. Three charges + 4q, Q and q are placed in a straight line of length at points distance, O, $\frac{l}{2}$, l respectively. What should be Q in order to make the net force on q be zero.

a. –q b. –2q
c. $\frac{-q}{2}$ d. 4q

17. Three charges of charge q are placed at the corners of an equilateral triangle. If the force between any two charges be F, then the net force on either charge will be:

a. $\sqrt{2}$F b. $\sqrt{3}$ F
c. 2F d. 3F

Answer Sheet

1. b	*2. d*	*3. a*	*4. c*	*5. a*	*6. d*	*7. a*	*8. b*	*9. a*	*10. d*
11. a	*12. d*	*13. b*	*14. b*	*15. c*	*16. a*	*17. b*			

SOLUTION

1. Ans. (b)
A charged body may attract a neutral body or an oppositely charged body but it always repel similarly charged body.

2. Ans. (d) $F = \frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{r^2}$

$F \alpha \frac{1}{r^2}$ $F^1 = 4F$

3. Ans. (a)
Charge are quantized (q = ne)
The minimum charge is $e = 1.6\times10^{-19}c$.

4. Ans. (c)
Coulomb force of attraction between two charges is independent of presence of neighbouring charges.

5. Ans. (a)
In vaccum, $Fo = \frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{r^2}$
In medium of dielectric constant k
$F = \frac{1}{4\pi\varepsilon}\frac{q_1q_2}{r^2} = \frac{1}{4\pi\varepsilon_o k}\frac{q_1q_2}{r^2}$
$F = \frac{Fo}{K}$

6. Ans: (d)
For brass sheet (metal) dielectric constant k = ∞
So, $F = \frac{1}{4\pi\varepsilon_o k}\frac{q_1q_2}{r^2} = 0$

7. Ans. (a)
For protons at distance r
$Fp = \frac{1}{4\pi\varepsilon_o}\frac{e\times e}{r^2} = \frac{e^2}{4\pi\varepsilon_o r^2}$
For electrons at distance r
$Fe = \frac{1}{4\pi\varepsilon_o}\frac{-e\times-e}{r^2}$
$= \frac{e^2}{4\pi\varepsilon_o r^2}$
Fp = Fe (independent of mass of charge particles)

8. Ans. (b)
$Fair = \frac{q_1q_2}{4\pi\varepsilon_o r^2}$
$Fmedium = \frac{q_1q_2}{4\pi\varepsilon_o Kr^2}$
Fair: Fmedium = k:1

9. Ans. (a)

$$Fair=\frac{q_1q_2}{4\pi\varepsilon_o r^2}=\left(\frac{q_1r_1}{4\pi\varepsilon_o r_1}\times\frac{q_2r_2}{4\pi\varepsilon_o r_2}\right)\times\frac{4\pi\varepsilon_o}{r^2}$$

$$Fair=\frac{4\pi\varepsilon_o v_1v_2r_1r_2}{r_2}$$

$$F_{medium}=\frac{q_1q_2}{4\pi\varepsilon_o kr^2}=\frac{q_1q_2}{4\pi\varepsilon_o kr_1}\times\frac{q_1q_2}{4\pi\varepsilon_o kr_2}\times\frac{4\pi\varepsilon_o k}{r^2}$$

$$Fmed=\frac{4\pi\varepsilon_o kv_1v_2r_1r_2}{r^2}$$

Fair:Fmed = 1:k

10. Ans. (d)

$F\ \alpha\ q_1q_2$. Thus coulomb's force exerted by each charge on the other is same ($F_1:F_2=1:1$)

11. Ans. (a)

When electrons are removed the body acquires +ve charge given by

$Q = ne = 10^{14}\times1.6\times10^{-19}$

$= 16\times10^{-6} = 16\ \mu C$

12. Ans. (d)

$$Fa=\frac{1}{4\pi\varepsilon_o}\frac{q_1q_2}{r^2}$$

$$Fm=\frac{1}{4\pi\varepsilon_o k}\frac{q_1q_2}{r_1^2}$$

$$Fm=Fa\rightarrow\frac{r_1^2}{r^2}=\frac{1}{k}$$

$$r_1=\frac{r}{\sqrt{k}}=\frac{21}{\sqrt{9}}=\frac{21}{3}$$

$= 7cm$

13. Ans. (b)

$q = ne$

$-4\times10^{-7} = n\times(-1.6\times10^{-19})$

$$n=\frac{4\times10^{-7}}{1.6\times10^{-19}}$$

$= 2.5\times10^{12}$

14. Ans. (b)

On giving positive charge it loses few electrons so mass decreases.

15. Ans. (c)

$$F=\frac{1}{4\pi\varepsilon_o}\frac{Q(-2Q)}{r^2}=-\frac{1}{4\pi\varepsilon_o}\frac{2Q^2}{r^2}\text{ ------ (i)}$$

After keeping in contact and seperating charge on each sphere $Q_1=\frac{Q-2Q}{2}=\frac{-Q}{2}$

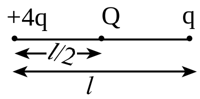
$$F^1=\frac{1}{4\pi\varepsilon_o}\frac{\left(\frac{-Q}{2}\right)\left(\frac{-Q}{2}\right)}{r^2}$$

$$=\frac{Q^2}{4\pi\varepsilon_o 4r^2}\text{ .... (ii)}$$

From (i) & (ii)

$$\frac{F^1}{F}=\frac{-1}{8}\Rightarrow F_1=\frac{-F}{8}$$

16. Ans. (a)



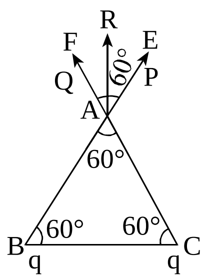
Force on q

$$F=\frac{1}{4\pi\varepsilon_o}\left[\frac{4q.q}{l^2}+\frac{Q.q}{\left(\frac{l}{2}\right)}\right]=0$$

$q + Q = 0$

$Q = -q$

17. Ans. (b)



As the charges are alike they repel each other with a force along AP & AQ. So the net force is given by parallelogram law of vector addition, ie. along $\overrightarrow{AR}$

Net force $=\overrightarrow{F_1}+\overrightarrow{F_2}=\overrightarrow{F}+\overrightarrow{F}$

$=\sqrt{F^2+F^2+2F.F\cos60°}=\sqrt{3}F$

Past Questions

1. **Two ebonite rods A and B of radii 1.5cm an 2cm respectively are rubbed together. The result will be: [IOM 2010]**
   a. A and B both remain neutral
   b. A will be charged positively
   c. A will be charged negatively
   d. A and B will be charged equally with similar charge.
2. **When two bodies are rubbed against each other they are electrified. Which one of the following is correct? [IOM 2063]**
   a. A glass rod becomes negatively charged if rubbed with a metal
   b. A glass rod becomes positively charged if rubbed with a flannel.
   c. A glass rod becomes positively charged if rubbed with ebonite
   d. A glass rod becomes negatively charged if rubbed with amber.
3. **Divergence of gold leaf is used to study:**
   a. Charge b. Potential
   c. Energy d. None
4. **When a wooden sweater worn over a nylon shirtis removed, sparking is observed due to [IOM]**
   a. Static electricity b. Current electricity
   c. Both d. None
5. **A electrically neutral metal is rubbed with wool. It is found that a charge of 32μc is developed on a metal. The number of electrons transfer will be [MOE 2068]**
   a. 12.5×10^{11} b. 2.5×10^{12}
   c. 2×10^{14} d. 5×10^{13}
6. **A 2μc charge is enclosed by a Gaussian surface of radius 0.5m. If the radius of the Gaussian surface is increased two times, the number of flux passing through the new surface will be: [MOE 2068]**
   a. two times b. remains same
   c. four times d. halved
7. **What is the force of attraction between electron and proton seperated by 0.53Å. [MOE 2067]**
   a. 8.2×10^{-6}N b. 8.2×10^{-4}N
   c. 8.2×10^{-5}N d. 8.2×10^{-3}N
8. **A charge q is placed at the centre of the line joining two equal charges Q. The system of three charges will be in equilibrium if q is equal to [MOE]**
   a. – Q/2 b. – Q/4
   c. – 4Q d. Q/2
9. **If the electric field intensity is 10^6v/m. Then find the distance between the plates kept at a potential difference at 10^3V. [KU 2010]**
   a. 10^{-3}m b. 10^9m
   c. 10^{15}m d. 10^{39}m
10. **If the potential of metallic sphere 100v with respect to foraway. Calculate the surface charge density if the radius of sphere 2cm. [IE 2006]**
    a. 4.4×10^{-8} b. 4.4×10^{-7}
    c. 2.4×10^{-6} d. 2.4×10^{-5}
11. **Two concentric spheres are carrying a charge Q and q. Whtn the two spheres are joined by a wire, the charge on the outer surface of the inner sphere is: [IE 2003]**
    a. zero b. Q – q
    c. Q d. Q + q
12. **Five balls number red 1 to 5 are suspended using seperate threads. Pairs (1, 2), (2, 4), (4, 1) shows electrostatic attraction while pairs (2, 3) and (4, 5) shows repulsion. Therefore, ball 1 must be [BPKIHS 2007]**
    a. Positively charged

b. Negatively charged
c. Neutral d. None

13. On penetrating a uniformaly charged sphere, the electric field strength E: [BPKIHS]

a. Remains unchanged
b. Decreases
c. Increases d. Is zero at all points

14. The force between two charges in air is 10N. On inserting dielectric, the force becomes 4N. Then dielectric constant of medium is: [Bangledesh 09]

a. 2.5 b. 0.5
c. 2 d. 4

Answer Sheet

1. a	*2. c*	*3. a*	*4. a*	*5. c*	*6. b*	*7. a*	*8. b*	*9. a*	*10. a*
11. a	*12. c*	*13. d*	*14. a*						

SOLUTION

1. Ans. (a)
Since both rods A and B are made of the same material i.e. ebonite, if they are rubbed together both will remain neutral. Glass rod develops positive charged when rubbed with ebonite.

2. Ans. (c)
Electrostatic series
Fur, Fannel, wax, Glass, cotton, paper silk, humanbody, wood, metals indian rubber, resin lamber, sulphur, ebonite. If they are rubbed against each other +ve charge induced in the one coming earlier in the series and -ve charge in the one coming later in the series.

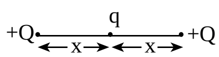
3. Ans. (a)
Gold leaf electroscope is used to determine the presence and nature of charge.

4. Ans. (a)
Static electricity is produced due to friction between two surfaces.

5. Ans. (c)
q = ne
$n = \frac{q}{e} = \frac{32 \times 10^{-6}}{1.6 \times 10^{-19}}$
$n = 2 \times 10^{14}$ electrons.

6. Ans. (b)
We know by Gauss theorem
$\phi = \frac{q}{q_0}$
If charge remains same, flux remains same. Independent of area enclosed.

7. Ans. (a)
$F = \frac{1}{4\pi\varepsilon_0} \frac{q_1q_2}{r^2}$
$= \frac{9 \times 10^9 \times (1.6 \times 10^{-19})^2}{(0.53 \times 10^{-10})^2}$
$= 9.2 \times 10^{-8}$N (Nearest = a) Ans.

8. Ans. (b)


For the system to be in equilibrium. Net force on each charge should be zero. ie. $F_1 + F_2 = 0$
$\frac{Q_q q}{4\pi\varepsilon_0 x^2} + \frac{QQ}{4\pi\varepsilon_0 (2x)^2} = 0$
(Taking Fnet on charge Q).
$\frac{Qq}{x^2} = \frac{-Q^2}{4x^2} \Rightarrow q = -Q/4$

9. Ans. (a)
$E = \frac{V}{d}$
$d = \frac{V}{E} = \frac{10^3}{10^6} = 10^{-3}$

10. Ans. (a)
$V = \frac{q}{4\pi\varepsilon_0 R} = \frac{qR}{4\pi\varepsilon_0 R^2} = \frac{R}{\varepsilon_0}\frac{q}{A}$
$V = \frac{\sigma R}{\varepsilon_0}$

($\sigma = \frac{q}{A} = \frac{q}{4\pi R^2}$ = surface charge density)

$\sigma = \frac{v\varepsilon_0}{R} = \frac{100 \times 8.85 \times 10^{-12}}{2 \times 10^{-2}}$

$= 4.4 \times 10^{-8}$ coulomb/m^2

11. Ans. (a)

When inner and outer spheres are connected with conducting wire, all charge of inner sphere moves to outer sphere. Net charge on inner sphere = 0. Net charge on outer sphere = Q + q

12. Ans. (c)

If ball 1 is neutral, ball 2 may be positive, ball 3 may be positive, ball 4 may be negative & ball 5 may be negative. This would satisfy all the above condition.

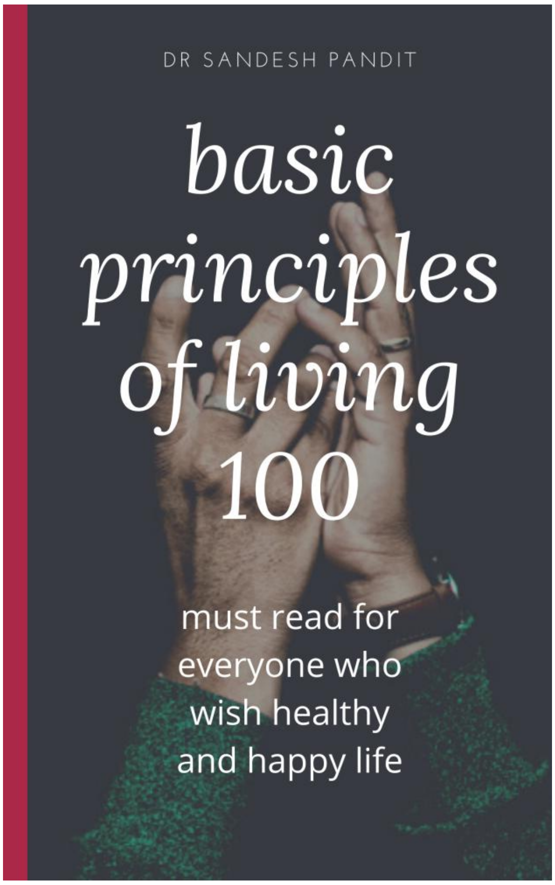
13. Ans. (d)

Whole charge is concentrated on surface of sphere so electric field inside charged sphere is zero.

14. Ans. (a)

Dielectric constant (K)

$K = \frac{F_0}{F} = \frac{10}{4} = 2.5$


DR SANDESH PANDIT
basic principles of living 100
must read for everyone who wish healthy and happy life

Chapter: 27

ELECTRIC FIELD & POTENTIAL

1. If one penetrates a uniformly charged shell, the elctric field strength:

a. increases b. decreases
c. remains same as on the surface
d. remains zero throughout

2. A thin hollow metal sphere having radius 5cm is charged such that the potential on its surface is 10 volts. The potential at a point 2 cm from the centre of the sphere will be:

a. zero b. 4 volts
c. 5 volts d. 10 volts

3. The insulation property of air breaks down at intensity of electric field 3×10^6 V/m. The maximum charge that can be given to a sphere of diameter 5m is:

a. 2×10^{-2}c b. 2×10^{-3}c
c. 2×10^{-4}c d. 2×10^{-5}c

4. When two electrons are brought nearer, the potential energy of the system:

a. increases b. decreases
c. remains same
d. first increases then decreases

5. Two conducting spheres fo radii r_1 and r_2 are charged to some surface charge density. The ratio of electric fields near their surfaces is:

a. $\frac{r_1^2}{r_2^2}$ b. $\frac{r_2^2}{r_1^2}$
c. $\frac{r_2}{r_1}$ d. 1:1

6. Two conducting spheres of radii r_1 and r_2 are charged to the same surface charged density. The ratio of electric potentials on their surfaces is:

a. $\frac{r_1^2}{r_2^2}$ b. $\frac{r_2^2}{r_1^2}$
c. $\frac{r_2}{r_1}$ d. 1:1

7. Proton has a mass 1840 times that of an electron. If a proton is acelerated from rest through a p.d. of 1volt. Its kinetic energy is:

a. 1840 ev b. 1 ev
c. 1 mev d. zero

8. A particle of mass m and charge q is placed at rest in a uniform electric field E and then released. The kinetic energy attained by a particle after moving a distance y is:

a. qEy^2 b. qE^2y
c. qEy d. q_2Ey

9. Find the work done by external agent in moving a charge of 2μc from infinity to a point having potential 10^4v.

a. 1×10^{-2}J b. 2×10^{-2}J
c. 4×10^{-4}J d. 8×10^{-4}J

10. 15J of work is done by an external agent in moving a charge 0.01 c from A to B. Then P.d. between A and B will be:

a. – 1500 v b. + 1500 v
c. – 1200 v d. + 1200 v

11. At the centre of square ABCD, there is situated a charge 10^{-3}μC. The side of the square is 2 cm. The workdone in moving a charge of 1c from corner A to B is:

a. Zero b. 255J
c. 450 ergs d. 450J

12. An electron of mass m and charge e is accelerated from rest through a potential difference of V in vaccum. Its final speed will be:

a. $\sqrt{\frac{e}{m}}$ b. $\sqrt{\frac{2eV}{m}}$
c. $\frac{eV}{2m}$ d. $\frac{2eV}{m}$

13. An electron is accelerated through 1 volt. The velocity of electron is about:

a. 6×10^5m/s b. 6×10^4m/s
c. 6×10^{-6}m/s d. 6×10^3m/s

14. An electron enters in a horizontal electric field of strength 10^5 V/m. Assuming weight of electron to be negligible, its acceleration would be:

a. 1.7×10^{17}m/s^2
b. 1.7×10^{16}m/s^2
c. 1.7×10^{20}m/s^2
d. 1.7×10^{24}m/s^2

15. A proton (mass =1.6×10^{-27}kg) on entering in a vertical field E is balanced. The electric field strength is:

a. 10^{-9}V/m b. 10^{-8}V/m
c. 10^{7}V/m d. 10^{-7}V/m

16. A deuteron and an α-particle are placed in an electric field. If they are accelerated by same potential difference the velocities gained by them will be:

a. 1:1 b. 1:$\sqrt{2}$
c. $\sqrt{2}$:1 d. 1:2

17. A hollow charged metal sphetic has radius r. If the potential difference between is surface and a point at distance 3 r from the centre is V. Then the electric field intensity at a distance 3r from the centre is:

a. $\frac{V}{6r}$ b. $\frac{V}{4r}$
c. $\frac{V}{3r}$ d. $\frac{V}{2r}$

18. An electric dipole is placed inside a cube of side a. The electric fux through the cube is:

a. zero b. $\frac{q}{\varepsilon_o}$
c. $\frac{2q}{\varepsilon_o}$ d. $\frac{2q}{\varepsilon_o a^2}$

19. The electric flux from cube of edge is ϕ. What will be its value if edge of cube is made 2*l* and charge enclosed is haved?

a. $\frac{\phi}{2}$ b. 2ϕ
c. 4ϕ d. ϕ

20. If the electric flux entering and leaving an enclosed surface respectively is ϕ_1 and ϕ_2. The electric charge inside the surface will be:

a. $\frac{\phi_2 - \phi_1}{\varepsilon_o}$ b. $\frac{\phi_1 + \phi_2}{\varepsilon_o}$
c. $\frac{\phi_1 - \phi_2}{\varepsilon_o}$ d. $\varepsilon_o(\phi_1 + \phi_2)$

21. Two infinitely long parallel wires having linear charge densities λ_1 and λ_2 respectively are placed at distance R meter. The force per unit length on either wire will be ($k = \frac{1}{4\pi\varepsilon_o}$):

a. $\frac{k2\lambda_1\lambda_2}{R^2}$ b. $\frac{k2\lambda_1\lambda_2}{R}$
c. $\frac{k\lambda_1\lambda_2}{R^2}$ d. $\frac{k\lambda_1\lambda_2}{R}$

22. The electric potential V as a function of distance x (in metre) is given by V = ($5x^2 + 10x - 9$) volt. The value of electric field at x = 1 m would be:

a. 20 volt/m b. 6 volt/m
c. 11 volt/m d. –23 volt/m

23. The work done in carrying a charge of 5μc from a point. A to a point B in a electric field is 10m J. the potential difference ($V_B - V_A$) is then;

a. +2kV b. –2kV
c. +200V d. –200V

24. A positive charged oil drop remains stationary in an electric field between two horizontal plates seperated by 2cm. If the charge under drop is 3.2×10^{-10} and mass of the drop is 2×10^{-6}g. Find the potential difference between the plates?

a. 0.625V b. 1.25V
c. 2.5V d. 1250V

25. 64 small drops of radius 4mm charged equally to 0.5 V coalesce to form a bigger drop. What will be the potential of bigger drop?

a. 4V b. 8V
c. 16V d. 32V

26. A conducting sphere of radius 10cm is given a charge 10μC. The electric potential at a point distant 5cm from the centre is:

a. 1.8×10^6V b. 9×10^6V
c. 4.5×10^5V d. 9×10^5V

27. If E is the electric field intensity of an electrostatic field then electrostatic energy density is propotional to:

a. E b. E^2
c. $\frac{1}{E^2}$ d. E^3

28. The electric field intensity at the surface at a charged conductor is:

a. zero
b. directed normally to surface
c. Directed tangentially to surface
d. Directed along 45° to the surface

29. An electric dipole kept in a uniform electric field. If experiences:

a. Force and torque
b. Force but no torque
c. Torque but no force
d. Neither force nor torque

Answer Sheet

1. d	*2. d*	*3. b*	*4. a*	*5. d*	*6. c*	*7. b*	*8. c*	*9. b*	*10. a*
11. a	*12. b*	*13. a*	*14. b*	*15. d*	*16. a*	*17. a*	*18. a*	*19. a*	*20. d*
21. b	*22. a*	*23. a*	*24. b*	*25. b*	*26. d*	*27. b*	*28. b*	*29. c*	

SOLUTION

1. Ans. (d)
Because electric field strength is zero inside a hollow sphere.

2. Ans. (d)
The potential at any point inside a hollow sphere is equal to on its surface so potential is 10 volts.

3. Ans. (b)

$E = \frac{Q}{4\pi\varepsilon_0 r^2}$

$Q = E \times 4\pi\varepsilon_0 r^2$

$= 3 \times 10^6 \times \frac{1}{9 \times 10^9} \times (2.5)^2 = 2 \times 10^{-3}C$

4. Ans. (a)

$U = \frac{q_1 q_2}{4\pi\varepsilon_o r} = \frac{(-e)(-e)}{4\pi\varepsilon_o r}$

U = +ve, so it increases. If proton and electron are brought nearer, the P.E. of system decreases.

5. Ans. (d)

As $\in \alpha \sigma$

So, $\frac{\in_1}{\in_2} = \frac{\sigma_1}{\sigma_2} = 1:1$

6. Ans. (c)

$v= \frac{q}{4\pi\varepsilon_o r} = \frac{qr}{4\pi\varepsilon_o r^2} = \frac{qr}{A\varepsilon_o} = \frac{\sigma r}{\varepsilon_o}$

$v \alpha r$ if σ is constant

$\frac{v_1}{v_2} = \frac{r_1}{r_2}$

7. Ans. (b)

K.E = qv = 1 ev

Mass doesnot matter here.

8. Ans. (c)

ΔK.E = Work done = F × S = qEy

9. Ans. (b)

$W_{ext} = q(vf–vi)$

$= 2\times10^{-6}(VA – V\infty)$

$= 2\times10^{-6}(10^4 – 0) = 2\times10^{-2}J$

10. Ans (a)

Wext = q(vf–vi)

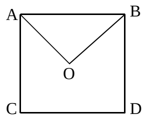
= 0.01(VB – VA)

$VB – VA = \frac{w}{0.01} = \frac{15}{0.01} = 1500$

VA – VB = –1500 v

11. Ans. (a)

The corners A and B of square are at the same distance from the charge ($10^{-3}\mu c$) at the center.



VA = VB

W_{AB}=q(VB–VA)= Zero

12. Ans. (b)

k.E gained = work done

$\frac{1}{2}mv^2 = eV$

$v = \sqrt{\frac{2eV}{m}}$

13. Ans. (a)

$v = \sqrt{\frac{2eV}{m}} = \sqrt{2\times1.8\times10^{11}\times1} = 6\times10^5$ m/s

14. Ans. (b)

Force on electron, F=eE

$= 1.6\times10^{-19}\times10^5 = 1.6\times10^{-14}$N

$a = \frac{F}{m_e} = \frac{1.6\times10^{-14}}{9.1\times10^{-31}}$

$= 1.7\times10^{16}$m/s^2

15. Ans. (d) mg = eE

$E = \frac{mg}{e} = \frac{1.6\times10^{-27}\times10}{1.6\times10^{-19}} = 10^{-7}$ V/m

16. Ans. (a)

$v = \sqrt{\frac{2qV}{m}} \Rightarrow v \propto \sqrt{\text{specific charge}}$

$\frac{v_1}{v_2} = \sqrt{\frac{q_1}{q_2}\times\frac{m_2}{m_1}} = \sqrt{\frac{1e}{2e}\times\frac{4p}{2p}} = 1:1$

17. Ans. (a)

If Q = charge on charged sphere then,

$V_1 = \frac{Q}{4\pi\varepsilon_o r}$ (Potential at surface)

$V_2 = \frac{Q}{4\pi\varepsilon_o(3r)}$ (Potential distance 3r from centre.)

$V_1 - V_2 = V$ (By question)

$\frac{Q}{4\pi\varepsilon_o r} - \frac{Q}{4\pi\varepsilon_o(3r)} = V \Rightarrow Q = 6\pi\varepsilon_o rV$

E(at 3r) $= \frac{Q}{4\pi\varepsilon_o(3r)^2} = \frac{6\pi\varepsilon_o rV}{4\pi\varepsilon_o 9r^2} = \frac{V}{6r}$

18. Ans. (a)

Net charge on dipole = q + (–q) = 0

$\phi = \frac{q}{\varepsilon_o} = 0$

19. Ans. (a)

Electric flux doesnot depend upon the size of the Gaussion surface but only one the charge enclosed on it. ie. $\phi = \frac{q}{\varepsilon_o}$. As q is halved so ϕ is halved.

20. Ans. (d)

If $-q_1$ be the charge due to which flux ϕ_1 is entering the surface. $\phi_1 = \frac{-q_1}{\varepsilon_o}$ or, $-q_1 = \varepsilon_o\phi_1$. If $+q_2$ be the charge due to which flux ϕ_2 is leaving the surface.

$\phi_2 = \frac{q_2}{\varepsilon_o}$ or, $q_2 = \varepsilon_o\phi_2$ electric charge imide the surface $= q_2 - q_1 = \varepsilon_o\phi_2 + \varepsilon_o\phi_1 = \varepsilon_o(\phi_2 + \phi_1)$

21. Ans. (b)

$E = \frac{\lambda_1}{2\pi\varepsilon_o R} = \frac{2\lambda_1}{4\pi\varepsilon_o R} = \frac{K2\lambda_1}{R}$

$\frac{F}{q} = \frac{kL\lambda_1}{R}$ or $\frac{F}{\lambda_2 l} = \frac{K2\lambda_1}{R}$ $(\lambda = \frac{q}{l})$

$\frac{F}{l} = \frac{K2\lambda_1\lambda_2}{R}$

22. Ans. (a)

$V = 5x^2 + 10x - 9$

$E = \frac{-dv}{dx}$ (minus sign signifies that E is in oppostie to potential gradient)

$E = \frac{dv}{dx} = 10x + 10$

For x = 1m ε = 10 × 1 + 10 = 20 volt/metre.

23. Ans. (a)

$w = q(V_B - V_A)$

$V_B - V_A = \frac{w}{q}$

$= \frac{10mJ}{5\mu C} = +2kV$

24. Ans. (b)

$F = mg = qE = \frac{qV}{d}$

$V = \frac{mgd}{q} = \frac{2 \times 10^{-6} \times 10^{-3} \times 10 \times 2}{3.2 \times 10^{-10} \times 100}$

$= 1.25v$

25. Ans. (b)

$V_1 = n^{\frac{2}{3}}V = (64)^{\frac{2}{3}}V$

$= (4)^2 v = 16V = 16 \times 0.5 = 8v$

26. Ans. (d)

Potential inside a charged hollow sphere is equal to its potential at its surface.

$V = \frac{Q}{4\pi\varepsilon_o R}$

$= \frac{9 \times 10^9 \times 10 \times 10^{-6}}{0.1}$

$= 9 \times 10^5 V$

27. Ans. (b)

The energy density (Energy stored per unit volume)

$= \frac{\sigma^2}{2\varepsilon_o} = \frac{1}{2}\varepsilon_o E^2 \alpha E^2$

$P = \frac{F}{A} = \frac{\sigma^2}{2\varepsilon_o}$

28. Ans. (b) A charged conductor has the same potential (V) at all points whatever its shape. So along its surface dv = 0. $E = \frac{dv}{dr}$, along its surface E = 0 ie. the component of E at a point on the surface is zero. Hence, E is normal to the surface at that point.

29. Ans. (c) In a uniform electric field net force = 0, torque $\neq 0$

In non-uniform electric field net force $\neq 0$, torque $\neq 0$

Past Questions

1. Maximum value of elctric intensity due to charged sphere is at: [MOE 2066]

a. centre
b. Surface
c. Infinity
d. Half the radius of the sphere

2. A body of mass 1 kg carrying a charge of 1 coulomb falls in an electric field therough a potential difference of 1 volt. Its velocity is: [MOE 2009]

a. 1 m/s b. 2 m/s
c. 0.5 m/s d. 1.4 m/s

3. If an electron is released in electric field of strength 1N/c, then the acceleration of elctron will be: [MOE 2008]

a. $10^{10} m/s^2$
b. 1.7×10^{11} m/s^2
c. 10^{12} m/s^2
d. None

4. If potential of one small drop is V_o and n such identical drops coelesce together than final potental of larger drop is: [MOE 2008]

a. $v = n^{\frac{1}{3}} v_o$ b. $v = n^{\frac{2}{3}} v_o$
c. $v = v_o$ d. $v = n^{\frac{5}{3}} v_o$

5. A dielectric has strength of 10^6 vm^{-1}. The minimum voltage to be applied across a 1 mm thick specimen to puncture it is: [MOE curriculm]

a. $10^6 V$ b. $10^9 V$
c. $10^3 V$ d. $2\times10^6 V$

6. A charge is kept in isotropic, homo genous medium. The equipotential surface is: [MOE 2061]

a. Spherical b. Cylindrical
c. Elliptical d. Parabolic

7. The energy per unit volume is given by: [MOE 2060]

a. $\frac{E^2}{\varepsilon_o}$ b. $\varepsilon_o E^2$
c. $2\varepsilon_o E^2$ d. $\frac{1}{2}\varepsilon_o E^2$

8. A hollow metal sphere of radius 5 cm is charged such that the potential on its surface is 10V. The potential at the centre of the sphere is: [MOE/IOM]

a. 0V
b. 10V
c. Same as at point 5cm away form the surface
d. Same as at a point 20cm away from the surface.

9. A charged particle of mass 1g is placed between two charged plates of uniform field intensity of 10^4Vm^{-1}. If the particle is in equilibrium the charge on it is nearly: [MOE 2058]

a. 100 μC b. 1000 μC
c. 10 μC d. 1 μC

10. A charge 'q' is placed at the centre of a cube of side a the electric flux through the cube is: [MOE]

a. $\frac{q}{\varepsilon_o}$ b. $\frac{q^2}{\varepsilon_o}$
c. $\frac{q}{6\varepsilon_o}$ d. $\frac{q}{\varepsilon_o a^2}$

11. Two charges +4 coulomb and –10 coulomb are placed at A and B 7cm a part. The distance from a where the potential experienced is zero is: [MOE 2055]

a. 5cm b. 4cm
c. 3 cm d. 2 cm

12. A sphere is charged with charge Q. A small test charge q_0 is placed at a distance x. From the surface of the sphere. The force experienced by the test charge is propotional to: [IOM 2007]

a. $\frac{1}{(R+x)^2}$ b. $(R+x)^2$
c. $(R-x)^2$ d. $\frac{1}{(R-x)^2}$

13. A -ve charge of 1c is moving from –1000 V to + 1000 V. Then the work done will be [IOM/BPKIHS]

a. +2000 J b. –2000J
c. +1000J d. –1000J

14. An electron of charge 'e' in rest in an electric field between 2 plates seperated by distance d and with volts difference V. Then find the force experienced by it: [2010]

a. $\frac{eV}{d}$ b. $\frac{ed}{v}$
c. $\frac{d}{qV}$ d. $\frac{v}{d}$

15. The potential difference between the two charged parallel plates seperated by 1mm is 100v. Then electric field produced is [KU 2008]

a. 10^{-5}V/m b. 10^5 V/m
c. 10^3V/m d. 10^{-3}V/m

16. Identical charges –q each are placed at 8 corners of a cube of each side b. Electrostatic energy of a charge +q which is placed at the centre of the cube will be: [IE 2009]

a. $\frac{-4\sqrt{2}q^2}{\pi\varepsilon_o b}$ b. $\frac{-8\sqrt{2}q^2}{\pi\varepsilon_o b}$
c. $\frac{-4q^2}{\sqrt{3}\pi\varepsilon_o b}$ d. $\frac{8\sqrt{2}q^2}{4\pi\varepsilon_o b}$

Answer Sheet

1. b	*2. d*	*3. b*	*4. b*	*5. c*	*6. a*	*7. d*	*8. b*	*9. d*	*10. a*

11. d	*12. a*	*13. a*	*14. a*	*15. b*	*16. c*				

SOLUTION

1. Ans. (b) Electric intensity is maximum on the surface and zero inside the sphere and decreases outside the sphere as distance increases $\left(E \ \alpha \ \frac{1}{r^2}\right)$.

2. Ans. (d) k.E gained = work done

$\frac{1}{2}mv^2 = eV$

$v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2 \times 1 \times 1}{1}} = \sqrt{2} = 1.4$ m/s

3. Ans. (b) F = ma = qE

$a = \frac{qE}{m} = \frac{1.6 \times 10^{-19} \times 1}{9.1 \times 10^{-31}} = 1.75 \times 10^{11}$ m/s^2

4. Ans. (b) r = radius of small drop,

R = Radius of bigdrop

$\frac{4}{3}\pi R^3\delta = N \times \frac{4}{3}\pi r^3\delta$

$R = n^{\frac{1}{3}} r$

charge on big drop

(Q) = n × charge on small drop (q)

$n = \frac{Q}{q}$

$\frac{V}{v} = \frac{\frac{Q}{C}}{\frac{q}{c}} = \frac{\frac{Q}{q}}{\frac{C}{c}}$

$\frac{V}{v} = \frac{n}{n^{\frac{1}{3}}} = n^{\frac{2}{3}} \Rightarrow V = n^{\frac{2}{3}} v$

$[C = 4\pi\varepsilon_o r \Rightarrow C \ \alpha \ r \Rightarrow \frac{C}{c} = \frac{R}{r} = n^{\frac{1}{3}}]$

5. Ans. (c) $E = \frac{V}{d}$

or, $10^6 = \frac{V}{10^{-3}m}$

$V = 10^3$ volt

6. Ans. (a) A point charge produces spherical electric field where as line charge produces cylindrical electric field.

7. Ans. (d)

Electric energy density $= \frac{\text{Energy}}{\text{volume}} = \frac{1}{2}\varepsilon_o E^2$

8. Ans. (b) Potential at every point inside a hollow sphere is equal to its potential at the surface = 10v. Unlike intensity which is zero inside.

9. Ans. (d) At equilibrium

$F = mg = qE$

$q = \frac{mg}{E} = \frac{10^{-3} \times 10}{10^4} = 10^{-6}C = 1\ \mu C.$

10. Ans. (a) Gauss theorem

Net flux in closed surface

$= \left(\frac{1}{\varepsilon_o}\right) \times$total charge enclosed

$\phi = \frac{q}{\varepsilon_o}$

Flux through one side $\phi = \frac{q}{6\varepsilon_o}$

11. Ans. (d) $V_{AO} + V_{OB} = 0$

$\frac{4}{4\pi\varepsilon_o x} + \frac{(-10)}{4\pi\varepsilon_o (7 - x)} = 0$

$\Rightarrow \frac{4}{x} = \frac{10}{7 - x} \Rightarrow x = \frac{28}{14} = 2$ cm

12. Ans. (a) $F = \frac{1}{4\pi\varepsilon_o} \frac{q_1 q_2}{r^2}$

In case of charged sphere the whole charge may be considered to be concentrated at centre. Then $r = R + x$

$F \propto \frac{1}{(R + x)^2}$

13. Ans. (a)

$W = q\Delta V = -1 \times (-1000 - 1000) = +2000J$

14. Ans. (a) $E = \frac{V}{d}$

$F = qE = \frac{qV}{d} = \frac{eV}{d}$

15. Ans. (b) $E = \frac{V}{d} = \frac{100V}{10^{-3}m} = 10^5$ V/m

16. Ans. (c) Length of body diagonal = $\sqrt{3}$ b. Distance of centre of cube from each other

$r = \sqrt{3}\frac{b}{2}$

Total P.E of charge +q at the centre

$= \frac{8q.(-q)}{4\pi\varepsilon_o r} = \frac{-8q^2}{4\pi\varepsilon_o \sqrt{3}\frac{b}{2}} = \frac{-4q^2}{\pi\varepsilon_o\sqrt{3}b}$

Chapter: 28

Capacitance

1. A capacitor acts as a perfect insulator in:

a. Ac circuit b. DC circuit

c. Both Ac and DC d. None

2. The capacitance of parallel plate capacitor doesnot depends upon:

a. area of plates

b. medium between the plates

c. distance between the plates

d. metal of the plates

3. The energy supplied by a battery in charging a capacitor of capacitance C to potential difference V is:

a. CV^2 b. $\frac{1}{2}CV^2$

c. $\frac{1}{2}C^2V$ d. $\frac{1}{2}C^2V^2$

4. When air in a capacitor is replaced by a medium of dielectric constant K, the capacitance,

a. decreases K times

b. increases K times

c. increases K^2 times

d. remains constant

5. The force between the plates of parallel plate air capacitor is F. If a medium of dielectric constant K is introduced in the region between the plates. The force between plates becomes.

a. F b. KF

c. $\frac{F}{K}$ d. $\frac{F}{K^2}$

6. The capacitors of capacitances C and nc are conected in series, the equivalent capactiance is:

a. $\frac{nc}{n+1}$ b. (n – 1) c

c. (n + 1) c d. $\frac{nc}{n-1}$

7. Two capacitors of capacitances C and nC are connected in parallel, the equivalent capacitance is:

a. $\frac{nc}{n+1}$ b. (n – 1) c

c. (n + 1)c d. $\frac{nc}{n-1}$

8. n equal capacitors are first connected in series and then in parallel. The ratio of maximum to minimum capacitance is:

a. n^2 b. $\frac{1}{n}$

c. n d. $\frac{1}{n^2}$

9. The plates of parallel plate capacitor are charged with a battery so that plates of the capacitor have acquired the potential difference equal to emf of the battery. The ratio of the workdone by the battery and energy stored in the capacitor is:

a. 1:1 b. 1:2

c. 2:1 d. 4:1

10. The capacitance of an isolated conducting sphere of radius R is propotional to:

a. R b. R^2

c. R° d. R^{-2}

11. The force of attraction between the plates of parallel plate air capacitor of capacitance of area A and charged to charge Q is:

a. $\frac{Q^2A}{2\varepsilon_o}$ b. $\frac{Q^2}{2\varepsilon_oA}$

c. $\frac{2\varepsilon_oQ^2}{A}$ d. $\frac{Q^2}{\varepsilon_oA}$

12. Force acting upon a charged particle kept between the plates of charged condenser is F. If one of the plate of the condenser is removed, force acting on some particle becomes:

a. 0 b. $\frac{F}{2}$

c. F d. 2F

13. A 4μF condenser is charged to 400v and then its plates are joined through a resistance of 1KΩ. The heat produced in the resistance is:

a. 1.28 J b. 0.64J

c. 0.32J d. 0.16J

14. A parallel plate air capacitor has a capacitance 18 μF. If the distance between the plates is trebled and a dielectric medium is introduced the capacitance becomes 72 μF. The dielectric constant of the medium is:

a. 4 b. 9

c. 12 d. 2

15. Two condensers of capacity 0.3 μF and 0.6 μF respectively are connected in series. The combination is connected across a potential of 6 volt. The ratio of energies stored in condensers will be:

a. $\frac{1}{2}$ b. 2

c. $\frac{1}{4}$ d. 4

16. For a spherical conductor if the surface area is increased by 2 times, then its capacitance will become / remain.

a. 2 times b. $\frac{1}{2}$ times

c. $\sqrt{2}$ times d. unchanged

17. N drops of mercury each of radius r and charge q combine to form big drop. Then the capacitance of bigger drop as compared to individual drop is:

a. N times b. $N^{2/3}$times

c. $N^{1/3}$times d. N^3 times

18. A capacitor is charged to store an energy U. The charging battery is disconnected. An identical capacitor is now connected to the first capacitor in parallel. The energy in each of the capacitor is:

a. $\frac{3U}{2}$ b. U

c. $\frac{U}{4}$ d. $\frac{U}{2}$

19. If a dielectric of K = 5 is put between the plates of a charged capacitor, the charge on capacitor will become (initial charge = Q)

a. Q b. 5Q

c. $\frac{Q}{5}$ d. 25Q

20. A condenser of capacitance 6μf was originally charged to 10v. Now p.d. is made 20v. The increase in potential energy is:

a. 3×10^{-4}J b. 6×10^{-4}J

c. 9×10^{-4}J d. 12×10^{-4}J

21. A parallel plate cepacitor is charged and possesses energy U. If the charging battery is disconnected and slab of dielectric constant k is introduced in the region between plates, the new energy stored becomes:

a. U b. kU

c. $\frac{U}{k}$ d. k^2U

22. 5 μF capacitor is fully charged across a 12v battery. It is then disconnected from the battery and connected to an uncharged capacitor. The voltage across it is found to be 3 volts. The value of capacity of uncharged capacitor is:

a. 3μF b. 15μF

c. 25μF d. 60μF

23. Two capacitors of 2μF and 4μF are connected in parallel. A third capacitor of 6μf is connected in series. The combination is connected across 12v battery. The voltage across 2μ F capacitor is:

a. 2v b. 8v

c. 6v d. 1v

24. A 800 μF capacitor is charged at the steady rate of 50μc/sec. How long will it take to raise its potential to 10 volt?

a. 160 s b. 50s

c. 10s d. 500s

25. How many capacitors each of 8μF and 250v are required to form a composite capcitor of 16μF and 1 KV?

a. 8 b. 16

c. 20 d. 32

26. A parallel plate capacitor is filled by copper plate of thickness t. The new capacity will be:

a. $\frac{\varepsilon_0 A}{2d - t}$ b. $\frac{\varepsilon_0 A}{d - t}$

c. $\frac{\varepsilon_0 A}{d - \frac{t}{2}}$ d. $\frac{\varepsilon_0 A}{d}$

27. If parallel plate capacitor has capacitance c. If half the seperation between the plates is filled with a copper sheets the new capacitance would be:

a. $\frac{c}{2}$ b. c

c. 2c d. between c and 2c

28. The plates of a parallel plate capacitor are charged upto 100 volt. A 2mm thick slab is inserted between the plates then to maintain the same potential difference, the distance between the plates is increased by 1.6mm. The dielectric constant by the slab is:

a. 5 b. 3

b. 2.5 d. 1.25

29. When two capacitors 3 μF and 6μF are connected in series and the combination is charged to potential of 120 v. The potential difference across the 3μF capacitor is:

a. 40 v b. 80 v

c. 60 v d. 120 v

30. A sphere of radius 1m is charged to a potential of 3 × 10^{4}V. The energy of the charged sphere is:

a. 5J b. 0.5J

c. 50 J d. 0.05J

31. Two insulated spheres of 3μF and 5μF are charged to 300v and 500v respectively. The energy loss when they are connected by wire is:

a. 0.025J b. 2.5J

c. 0.0375J d. 3.75J

32. A parallel plate capacitor is connected across a 2v battery and charged. A glass slab is introduced between the plates. Which of the following pairs of quantities increase?

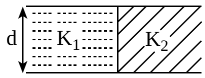
a. potential difference and electric field

b. potential difference and capacitance

c. charge and potential energy

d. charge and potential difference

33. A parallel plate capacitor is charged and then isolated. What is the effect of increasing the plate seperation on charge, potential and capacitance respectively?



a. constant, decreases, decreases

b. increases, decreases, decreases

c. constant, decreases, increases

d. constant, increases, decreases

34. A parallel capacitor is filled with two dielectrics as shown in figure. Its capacity has ratio with capacity without dielectric as:

a. $k_1 + k_2$ b. $\frac{k_1 + k_2}{2}$

c. $\frac{k_1 k_2}{k_1 + k_2}$ d. $2(k_1 + k_2)$

Answer Sheet

1. b	*2. d*	*3. a*	*4. b*	*5. a*	*6. a*	*7. c*	*8. a*	*9. c*	*10. a*
11. b	*12. b*	*13. c*	*14. c*	*15. b*	*16. c*	*17. c*	*18. c*	*19. a*	*20. c*
21. c	*22. b*	*23. c*	*24. a*	*25. d*	*26. b*	*27. c*	*28. a*	*29. b*	*30. d*
31. c	*32. c*	*33. d*	*34. b*						

Solution

1. Ans. (b)

Capacitive reactance $Xc = \frac{1}{2\pi fc}$

For Dc, f = 0, $Xc = \infty$

2. Ans. (d)

Electric field between two parallel plates is so uniform

So, $E = \frac{dv}{dr} = \frac{V}{d}$

$\frac{\sigma}{E_0} = \frac{V}{d} \rightarrow \frac{q}{A\varepsilon_0} = \frac{V}{d}$

$C = \frac{Q}{V} = \frac{\varepsilon_0 A}{d}$

3. Ans. (a)

w = qv = (CV) V

$= CV^2$

Energy stored in capacitor $= \frac{1}{2} CV^2$

4. Ans. (b)

$C_0 = \frac{\varepsilon_0 A}{d}$ for air

$C^1 = \frac{K\varepsilon_0 A}{d}$ for dielectric 'K'

$C^1 = KC_0$

5. Ans. (a)

Electric field between the plates and the force between the plates remain unchanged because equal and opposite charges are induced on opposite faces of dielectric constant.

6. Ans. (a)

$\frac{1}{c^1} = \frac{1}{c} + \frac{1}{nc}$

$\frac{1}{c_1} = \frac{n+1}{nc}$

$c^1 = \left(\frac{n}{n+1}\right)C$

7. Ans. (c)

$C^1 = nC + C = (n + 1) C$

8. Ans. (a)

If C be the capacitance of each capacitors, than

CS $\frac{C}{n}$ & CP = nc

$\frac{C_{max}}{C_{min}} = \frac{CP}{CS} = \frac{nC}{C/n} = n^2:1$

9. Ans. (c)

The battery supplies entire charge at constant potential V (equal to emf) but pd across plate of capacitor increases from zero to v.

Work done by battery q = qv = cv^2 energy on capacitor

$U = \frac{1}{2} qv = \frac{1}{2} cv^2$

W:U = 2:1

10. Ans. (a)

For a isolated conducting sphere

$C = 4\pi\varepsilon_o R$

$C \propto R$

11. Ans. (b)

If x be the seperation between the plates then energy

$U = \frac{Q^2}{2c} = \left(\frac{Q^2}{2\varepsilon_o A}\right) x$

Force (F) $= \frac{dU}{dx} = \frac{Q^2}{2\varepsilon_o A}$

12. Ans. (b)

$F = qE = q\frac{\sigma}{\varepsilon_0}$

For one plate

$F^1 = qE^1 = q\left(\frac{\sigma}{2\varepsilon_0}\right) = \frac{F}{2}$

13. Ans. (c)

Heat produced = Energy stored $= \frac{1}{2} cv^2$

$= \frac{1}{2} \times (4 \times 10^{-6}) \times 400^2 = 0.32J$

14. Ans. (c) $Co = \frac{\varepsilon_0 A}{d} = 18$ .... (i)

$C = \frac{K\varepsilon_0 A}{3d} = 72$ .... (ii)

Dividing (ii) by (i)

$\frac{C}{C_0} = \frac{k}{3} = \frac{72}{18} = 4$

$\therefore$ k = 12

15. Ans. (b) In series, charge remains same

$V = \frac{1}{2}\frac{Q^2}{C} \to U \alpha \frac{1}{C}$

$\frac{v_1}{v_2} = \frac{c_2}{c_1} = \frac{0.6}{0.3} = 2$

16. Ans. (c) For spherical capacitor

$C \alpha R \alpha \sqrt{A}$

So, capacitance becomes $\sqrt{2}$ times when area is doubled.

17. Ans. (c) For each small drops

$C = 4\pi\varepsilon_0 r$

For a large drop

$C' = 4\pi\varepsilon_0 R$

$\frac{4}{3}\pi R^3 = N \times \frac{4}{3}\pi r^3$

$R = N^{1/3} r$

$\frac{C^1}{C} = \frac{R}{r} = N^{1/3}$

18. Ans. (c)

As battery is disconnected total charge Q is shared equally by two capacitors. Energy of each capacitor $= \frac{\left(\frac{Q}{2}\right)^2}{2c} = \frac{1}{4}\frac{Q^2}{2c} = \frac{1U}{4}$

19. Ans. (a)

When a dielectric is introduced, charge remains unchanged though capacitance increases.

20. Ans. (c)

$\Delta U = \frac{1}{2} c (V_2^2 - V_1^2)$

$= \frac{1}{2} \times 6 \times 10^{-6} (400 - 100) = 9 \times 10^{-4} J$

21. Ans. (c) $U = \frac{q^2}{2c}$

Since battery is disconnected so charge = constant

$U^1 = \frac{q^2}{2kc} = \frac{1}{k}\left(\frac{q^2}{2c}\right) = \frac{U}{K}$

22. Ans. (b)

Common potential (v) $= \frac{c_1 v_1 + c_2 v_2}{c_1 + v_1}$

$3 = \frac{5 \times 12 + c \times 0}{5 + C}$

15 + 3c = 60

3c =45

C = 15 μF

23. Ans. (c)

$C_P = 2 + 4 = 6\mu F$

$\frac{1}{C_S} = \frac{1}{6} + \frac{1}{6} \to C = 3\mu F$

Total charge, q = cv = 3 × 12 = 36 μc

voltage across 6 μF $= \frac{36}{6} = 6v$

voltage across each of 2μF and 4μFcapacitor is = 12 – 6 = 6v.

24. Ans. (a)

Total charge to be given,

Q = vc = 10 × 800 = 8000 μc

$I = \frac{dq}{dt} = 50\mu c$

$t = \frac{Q}{I} = \frac{8000}{50} = 160s$

25. Ans. (d)

As each capacitor tolerates 250v, there can be $\frac{1000}{250} = 4$ ie. four capacitors in series in each row.

Capacitance of each row $= \frac{C}{n} = \frac{8}{4} = 2\mu F$

Required no. of rows $= \frac{16}{2} = 8$. These are 4 capacitors in each row. Total no. of capacitors = 8 × 4 = 32.

26. Ans. (b)

K for metal = ∞

$$c = \frac{\varepsilon_0 A}{d - t + \frac{t}{k}}$$

$$= \frac{\varepsilon_0 A}{d - t}$$

27. Ans. (c)

$$C^1 = \frac{\varepsilon_0 A}{d - t\left(1 - \frac{1}{k}\right)}$$

$$= \frac{c}{1 - \frac{t}{d}\left(1 - \frac{1}{\infty}\right)} = \frac{c}{1 - \frac{1}{2}} = 2c$$

28. Ans. (a)

Using the shortcut,

$$x = t\left(1 - \frac{1}{k}\right)$$

$$1.6 = 2\left(1 - \frac{1}{k}\right)$$

$$\frac{4}{5} = 1 - \frac{1}{k}$$

$$\frac{1}{k} = \frac{1}{5} \rightarrow k = 5$$

29. Ans. (b)

In series, charges are equal

$$q = C_1V_1 = C_2V_2 = CV = \left(\frac{C_1C_2}{C_1 + C_2}\right)V$$

$$V_1 = \left(\frac{C_2}{C_1 + C_2}\right) V = \left(\frac{6}{3 + 6}\right) \times 120$$

$$= 80V$$

30. Ans. (d)

$$U = \frac{1}{2}CV^2 = \frac{1}{2}(4\pi\varepsilon o R)V^2$$

$$= \frac{1}{2} \times \frac{1}{9 \times 10^9} \times (3 \times 10^4)^2$$

$$= 0.05J$$

31. Ans. (c)

$$\Delta U = \frac{C_1C_2(V_1 - V_2)^2}{2(C_1 + C_2)}$$

$$= 0.0375J$$

32. Ans. (c)

When the charging battery of a capacitor is on, its potential remains constant ie. v = constant.

Now, C = KCo increases

$Q = VC \rightarrow Q \propto C$ so it increases

$E = \frac{dv}{dr}$ remains constant

$U = \frac{1}{2}cv^2 \Rightarrow U \propto c$ so it increases.

33. Ans. (d)

When the capacitor is disconnected, its charge remains constant ie.

Q = constant

$C = \frac{\varepsilon_0 A}{d} \rightarrow C \propto \frac{1}{d}$ As d increases, C decreases

$Q = VC \rightarrow V \propto \frac{1}{C}$ when Q is constant.

As C decreases, V increases.

34. Ans. (b)

As area divides, the capacitors are in parallel initially

$$C_0 = \frac{\varepsilon_0 A}{d}$$

Now,

$$C_1 = \frac{k_1\varepsilon_0\frac{A}{2}}{d} = \frac{k_1\varepsilon_0 A}{2d}$$

$$C_2 = \frac{k_2\varepsilon_0\frac{A}{2}}{d} = \frac{k_2\varepsilon_0 A}{2d}$$

$$C_P = C_1 + C_2$$

$$= \frac{\varepsilon_0 A}{2d}(k_1 + k_2)$$

$$C_P = \frac{Co}{2}(k_1 + k_2)$$

$$\frac{C_P}{C_O} = \left(\frac{k_1 + k_2}{2}\right)$$

Past Questions

1. **In a charged capacitor, the energy resides**
   a. on the positive plate
   b. on the both positive and negative plates
   c. in the field between the plates
   d. around the edge of capacitor plates
2. **A parallel plate capacitor is charged and the charging battery is then disconnected. If the plates of the capacitor are moved furthur apart by means of insulating handles (IOM 2010)**
   a. The charge on the capacitor increases
   b. The voltage across the plate increases
   c. The capacitence increases
   d. The electrostatic energy stored in the capacitor decreases.
3. **8 small drops of capacitence 'c' and radius 'r' combines to form a big drop of Radius R, then the capacitence of big drop will be (IOM 2009)**
   a. 2c b. 4c
   c. 8c d. 16c
4. **A condenser having a capacity 50 microfarad is charged to 10 volts. Its energy is (IOM 08)**
   a. 12.5×10^{-2}J b. 2.5×10^{-4}J
   c. 5×10^{2}J d. 1.2×10^{5}J
5. **The capacitence of a spherical conductor with radius 1m is (MOE curriculum)**
   a. 1 microfarad b. 9×10^{9} Farad
   c. 1.1×10^{-10} Farad d. 9×10^{-9} Farad
6. **A sphere of radius 10 cm is charged to a potential of 300 volts. The energy of sphere is (MOE 2068).**
   a. 5×10^{-7}J b. 5×10^{-5}J
   c. 5×10^{-3}J d. 5×10^{-2}J
7. **A 600 μF capacitor is charged at the steady rate of 50μC per second. How long will it take to raise its potential to 10 volt ? (MOE 2068)**
   a. 60s b. 120s
   c. 180s d. 240s
   [IOM 2011]
8. **Two capacitors 1μF and 2μF are charged to 300v and 150v respectively and connected by a wire. The potential of the connected system is (MOE 2067)**
   a. 166v b. 185v
   c. 133v d. 200v
9. **Two capacitors of charges Q_1 and Q_2 with different capacitances are charged to the same potential V. They are then connected by a wire. The resulting potential will be (MOE 2009).**
   a. less than v
   b. equal to v
   c. less than 2v
   d. lies between v and 2v
10. **Two parallel plate capacitor of cpaacitence C seperated by a distance have the energy stored E. Now one of the plates is moved so that distance between then is doubled. (Without disconnecting from battery). What will be new energy stored? (MOE 2061)**
    a. 2E b. $\frac{E}{2}$
    c. $\frac{E}{4}$ d. E
11. **In an air parallel plate plate capacitor, the seperation between the plates is doubled, if this causes doubling of the capacitence of the capacitor, then the dielectric constant is (MOE 2055)**
    a. halved b. doubled
    c. quadrapled d. unchanged
12. **In a parallel plate capacitor of area 2m^2, a dielectric of relative permittivity 6 is**

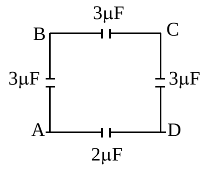
inserted. Then the capacitance becomes........... of the original value. (MOE 2054)

a. 6 times b. $\frac{1}{6}$ times

c. 12 times d. 3 times

13. Four capacitors of capacitance 3μE, 3μF and 2μF are arranged in the form of a rectangle, then the equivalent capacitance across 2μF capacitor is

(Bangladesh 09)



a. 1μF

b. 2μF

c. 3μF

d. 4μF

14. The dielectric Er is given by the relation (Bangladesh Embassy)

a. $\varepsilon r = \varepsilon\varepsilon_0$ b. $\varepsilon r = \sqrt{\varepsilon\varepsilon_0}$

c. $\frac{\varepsilon}{\varepsilon_0}$ d. None

15. Two capacitors C and 2C are connected in parallel and charged with V volt each. Battery is disconnected and then a dielectric of constant k is inserted in C. Find the final p.d. of each capacitor (BPKIHS)

a. $\frac{3v}{k + 2}$ b. $\frac{v}{k}$

c. k.v d. None

16. In A.C motor capacitor is used to [BPKIHS 2000]

a. to reduce ripples

b. to decrease A.C

c. to increase A.C

d. to decrease D.C

17. If the earth is supposed to be metallic sphere of radius 6400 km. What is its capacitance. [BPKIHS 2004]

a. 711 μF b. 811 μF

c. 711 F d. 711 PF

18. The capacity of a parallel plate condenser is 5μF. When a glass plate is placed between the plates of the condenser its P.d. reduces to $\frac{1}{8}$ of its original value. The magnitude of relative diectric constant of glass is [BPKIHS/IOM]

a. 2 b. 6

c. 7 d. 8

19. A metal foil of negligible thickness is introduced between two plates of capacitor at the centre. The capacitance of the capacitor will be [I.E 2009]

a. Same b. Double

c. Half d. K times

20. When a slab is intruduced in parallel plate capacitor then [IE-02]

a. Electric intensity doesn't change

b. Electric intensity increases

c. Electric intensity decreases

d. Electric intensity depends upon thickness of slab.

Answer Sheet

1. c	*2. b*	*3. a*	*4. b*	*5. c*	*6. a*	*7. b*	*8. d*	*9. b*	*10. b*
11. b	*12. a*	*13. c*	*14. c*	*15. a*	*16. b*	*17. a*	*18. d*	*19. a*	*20. c*

Solution

1. Ans. (c)

In a charged capacitor, field exists between the plates. The field stores energy in the space between the plate.

2. Ans. (b)

When the battery is disconnected charge is conserved.

Q = constant

CV = constant

$V \alpha \frac{1}{C}$ .... (i)

$C = \frac{\varepsilon_0 A}{d}$, when d ↑, C ↓

So, capacitence decreases, voltage increases.

3. Ans. (a)

$\frac{4}{3}\pi R^3 = 8 \times \frac{4}{3}\pi r^3$

R = 2r, As $C = 4\pi E_0 R \Rightarrow C \alpha R$

So, capacitence of big drop = 2C

4. Ans (b)

$E = \frac{1}{2}cv^2 = \frac{1}{2} \times 50 \times 10^{-6} \times (10)^2$

$= 25 \times 10^{-4}$J

Nearest answer is b.

5. Ans. (c)

$C = 4\pi\varepsilon_0 R$

$C = \frac{R}{9 \times 10^9} = 1.1 \times 10^{-10}$ Farad

$[\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9]$

6. Ans. (a)

$E = \frac{1}{2}cv^2$

$= \frac{1}{2} \times 4\pi\varepsilon_0 R \times v^2$

$= \frac{1}{2} \times \frac{1}{9 \times 10^9} \times 0.1 \times 9 \times 10^4$

$= 5 \times 10^{-7}$J

7. Ans. (b)

Total charge to be given

$Q = VC = 10 \times 600 = 6000\mu C$

$I = \frac{dq}{dt} = 50\mu C/Sec$

$t = \frac{Q}{I} = \frac{6000}{50} = 160s$

8. Ans. (d)

Common potential (V)

$= \frac{C_1V_1 + C_2V_2}{C_1 + C_2}$

$= \frac{1 \times 300 + 150 \times 2}{1 + 2} = \frac{600}{3}$

= 200V

9. Ans. (b)

Common potential

$(V_R) = \frac{q_1 + q_2}{c_1 + c_2} = \frac{c_1v_1 + c_2v_2}{c_1 + c_2}$

Since, the two capacitors are charged to same potential v.

$V_R = \frac{C_1v + C_2v}{C_1 + C_2} = v$

10. Ans. (b)

Energy stored $(E) = \frac{1}{2}cv^2$

$C = \frac{\varepsilon_0 A}{d}$ ie. $E \alpha c \alpha \frac{1}{d}$

$\frac{E_1}{E_2} = \frac{d_2}{d_1}$

$E_2 = E_1 \times \frac{d_1}{d_2} = \frac{E}{2}$

11. Ans. (b)

$C = \frac{\varepsilon_0 kA}{d}$

$C' = \frac{\varepsilon_0 k'A}{d}$

$2C = \frac{\varepsilon_0 k'A}{2d'} \rightarrow 4c = \frac{\varepsilon_0 k'A}{d} \rightarrow k' = 4k$

12. Ans. (a)

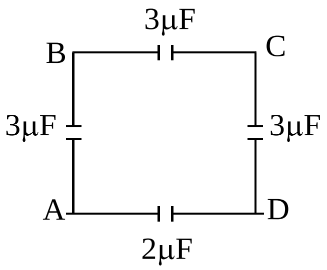
Capacitance of parallel plate capacitor

$C = \frac{k\varepsilon_0 A}{d}$

$C \propto K$

Capacitance of isolated sphere = k = $4\pi\varepsilon_0 R$

13. Ans. (c)



$$\frac{1}{C_1} = \frac{1}{3} + \frac{1}{3} + \frac{1}{3}$$

$C_1 = 1\mu F$

$C_2 = 2\mu F$

$C = C_1 + C_2 = 3\mu F$

14. Ans. (c)

Dielectric constant $(\varepsilon r)/k = \dfrac{\text{absolute permittivity of medium}}{\text{that of vaccum}}$

$$\varepsilon r = K = \frac{\varepsilon}{\varepsilon_0}$$

15. Ans. (a)

After inertion of dielectric in C, its voltage becomes $\frac{v}{k}$ and capacitance kC.

Common potential $= \dfrac{c_1v_1 + c_2v_2}{c_1 + c_2}$

$$= \frac{kc \times \frac{v}{k} + 2c \times v}{kc + 2c} = \frac{3v}{k + 2}$$

16. Ans. (b)

Capacitive reactance for DC

$$Xc = \frac{1}{\omega c} = \infty$$

ie. Capacitor blocks that D.C.

17. Ans. (a)

$C = 4\pi\varepsilon_0 R$

$$= \frac{1}{9 \times 10^9} \times 6.4 \times 10^6$$

$= 711\ \mu F$

18. Ans. (d)

$$\varepsilon r = k = \frac{c}{c_0}$$

$$= \frac{v_0}{v} = \frac{v_0}{\frac{v_0}{8}} = 8$$

19. Ans. (a)

$$C = \frac{\varepsilon_0 A}{d - t\left(1 - \frac{1}{k}\right)}$$

K for metal = ∞

$$C = \frac{\varepsilon_0 A}{d - t}$$

Since t is negligibled $d - t \approx d$

$C = \dfrac{\varepsilon_0 A}{d}$ i.e. remains same

20. Ans. (c)

As total charge remains constant.

$C = kC_0$ So C increases

$v = \dfrac{Q}{C} \Rightarrow V \propto \dfrac{1}{C}$ So V decreases

$E = \dfrac{dv}{dr}$ As V decreases so does E.

Chapter: 29

Electric Current

1. The speed at which the current travels in a conductor is nearly:

a. 3×10^{-4} m/s b. 3×10^{-5} m/s
c. 4×10^{-6} m/s d. 3×10^{8} m/s

2. When the temperature of a metallic conductor is increased, its resistance:

a. increases b. decreases
c. remains unchanged
d. may increase or decrease

3. The length of a conductore is halved, its specific resistance is:

a. doubled b. halved
c. quadrapled d. unchanged

4. A current of 1mA flows through a copper wire. How many electrons will pass a point in each second?

a. 6.25×10^{6} b. 6.25×10^{15}
c. 6.25×10^{19} d. 6.25×10^{21}

5. In a region 10^{19} α–particles and 10^{19} protons move to the left which 10^{19} electrons move to the right per second. The current is:

a. 3.2 A towards left
b. 6.4 A towards left
c. 3.2 A towards right
d. 6.4 A towards right

6. An external resistance R is connected to a cell of emf E and internal Resistance r. The current in the external circuit is maximum when:

a. R<r b. R>r
c. R = r d. R = o

7. When a potential difference applied across a conductor only the electron drift and current flowing is I. If the positive ions had also drifted, then the current would have been:

a. zero b. I
c. < I d. > I

8. Kirchoff's junction law is based on conservation of:

a. charge b. energy
c. mass d. momentum

9. Kirchoff loop law is based on the principle of conservation of:

a. charge b. energy
c. momentum d. mass

10. When a potential difference (v) is applied across a conductor at temperature T, the drift velocity of electrons is propotional to:

a. v^2 b. v^0
c. $\sqrt{v}$ d. v

11. The current of 4.8 A is following in a conductor. The number of electrons passing through any crosssection per second is:

a. 3×10^{19} b. 76.8×10^{20}
c. 7.68×10^{12} d. 3×10^{10}

12. An α particle (mass = $4m_p$ and charge = 2e) is revolving in a circular orbit of radius 1Δ with a speed 3.14×10^{6}m/s. The equivalent current is:

a. 1.6 mA b. 3.2mA
c. 6.4 mA d. 0.8 mA

13. The resistance of wire of length L and diameter D is R. The wire is stretched double its length. The resistance of the wire will now be:

a. $\frac{R}{2}$ b. 2R
c. 4R d. 16R

14. The length and radius of a wire is *l* and r respectively. Its resistance is R. After hamering the radius of the wire is made $\frac{r}{2}$. The the new resistance will be:

a. $\frac{R}{4}$ b. R
c. 4R d. 16R

15. A dry cell has an emf of 1.5v and internal resistance 0.5Ω. If the cell sends a current of 1 A through an external resistance, the p.d across the terminal of the cell will be:

a. 1.5 v b. 1v
c. 0.5v d. zero

16. A cell of emf E volt internal resistance r ohm is being charged with a current of iA. Then the terminal potential difference is:

a. E b. E-ir
c. E + ir d. E-iR

17. Three resistances 2Ω, 3Ω and 5Ω are connected in series and potential difference of 20 v is applied across the terminals of combination. The potential difference across 3Ω resistance is:

a. 3 v b. 6v
c. 9v d. 20v

18. A cell of internal resistance 1Ω is supplying current to an external resistance of 6 Ω . If the current flowing in the external resistance is 0.2A. The terminal p.d. across the cell will be:

a. 3v b. 0.2v
c. 1.4v d. 1.2v

19. A battery of internal resistance r having no load resistance has emf E volts. What is the observed potential difference across the terminals of a battery when a load resistance R = r is connected to its terminals.

a. 2E volts b. E volts
c. E/2 volts d. E/4 volts

20. Two copper wires one of length 1 m and the other of length 9m are found to have the same resistances. Their diameters are in the ratio:

a. 3:1 b. 1:9
c. 9:1 d. 1:3

21. The terminal potential difference of a cell when short circuited is:

a. E b. $\frac{E}{2}$
c. Zero d. ∞

22. The terminal potential difference of a cell when open circuited is:

a. E b. $\frac{E}{2}$
c. zero d. ∞

23. Five dry cells each of emf 1.5v are connected in Parallel. The emf of the combination is:

a. 7.5 v b. 0.3 v
c. 3v d. 1.5 v

24. Two wires of equal lengths and equal cross sectional areas have resistivities ρ_1 and ρ_2. If the wires are connected in series. The equivalent resistivity of the combination will be:

a. $\frac{2\rho_1\rho_2}{\rho_1+\rho_2}$ b. $\frac{\rho_1+\rho_2}{2}$
c. $\rho_1+\rho_2$ d. $\frac{\rho_1\rho_2}{\rho_1+\rho_2}$

25. Two wires of same dimensions but resitivities ρ_1 and ρ_2 are in parallel combination. The equivalent resistivity of the combination will be:

a. $\frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$ b. $\frac{\rho_1+\rho_2}{2}$
c. $\rho_1 + \rho_2$ d. $\sqrt{\rho_1\rho_2}$

26. A uniform wire of resistance RΩ is divided into ten equal parts and all of their are connected in parallel. The equivalent resistance will be:

a. 0.01R b. 0.1R
c. 10 R d. 100 R

27. Out of 3 equal resistance how many different combination are possible?

a. 2 b. 3
c. 4 d. 6

28. A current through a wire depends on a time as I = 10+ut. The charge crossing through the section of the wire in 10 seconds is:

a. 4c b. 50c
c. 300c d. 400c

29. The internal resistance of a primary cell is 4Ω. It generates a current of 0.2A in an external circuit of 21Ω. The rate at which chemical energy is consumed in providing. The current is:

a. 0.42 J/S b. 0.84 J/S
c. 5 J/S d. 1 J/S

30. Two resistors of resistances R_1 and R_2 have their temperature coefficients of resistances α and β. The resistance of their series combination is independent of temperature if their resistance are in the ratio:

a. $\frac{\alpha}{\beta}$ b. $\frac{\beta}{\alpha}$
c. $\frac{\alpha+\beta}{\alpha-\beta}$ d. $\frac{\alpha^2+\beta^2}{\alpha-\beta}$

31. Two identical cells send the same current in 3Ω resistance whether connected in series or in parallel. The internal resistance of the cell is:

a. 1 Ω b. 3 Ω
c. 0.5 Ω d. 3.5 Ω

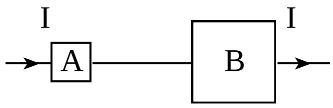
32. Two identical cells connected in series send 1A current through a 5 Ω resistor. When they are connected in parallel, they send 0.8 A current through the same resistor. What is the internal resistance of the cell?

a. 0.5 Ω b. 1.0 Ω
c. 1.5 Ω d. 2.5 Ω

33. To get a maximum current through a resistance of 2.5 Ω, one can use m rows of cells each row having n cells. The internal resistance of each cell is 0.5 Ω. What are the values of m and n if the total number of cells is 20?

a. m = n, n = 10 b. m = 4, n = 5
c. m = 5, n = 4 d. n = 2, m = 10

34. Two square metal plates of same thickness and material are connected in series as shown. The side of B is twice that of A. Then the ratio of their resistance is:

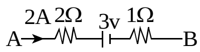


a. 1:1 b. 1:2
c. 2:1 d. 1:16

35. Masses of three wires of same material are in the ratio of 1:2:3 and their lengths are in the ratio of 3:2:1 electrical resistances of these wires will be in the ratio of:

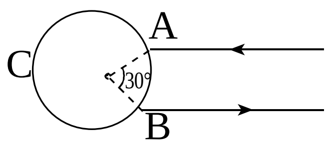
a. 1:1:1 b. 1:2:3
c. 9:4:1 d. 27:6:1

36. represents a part of closed circuit. The potential difference between points A and B (VA–VB) is:



a. +9v b. –9v
c. +3v d. +6v

37. A uniform wire of resistance 36Ω is bent in the form of the circle. The effective resistance across the points A and B is:



a. 36 Ω b. 18 Ω
c. 9 Ω d. 2.75 Ω

38. A potentiometer wire is 10m long. It has a resistance 20 Ω. If it is connected in series with a battery of emf 3v and negligible internal resistance of 10 Ω. The potential gradient along the wire in volt/metre is:

a. 0.02 b. 0.1
c. 0.2 d. 1.2

39. The length of a potentiometer wire is 5 metres. An electron in this wire experiences a force of 4.8×10^{-19}N. The emf of the main cell used in potentiometer is:

a. 1.5v b. 3v

c. 5v d. 15v

40. A cell can be balanced against 110cm and 100cm of potentiometer wire respectively when in open circuit and when short circuited through a resistance of 10 Ω. Find the internal resistance of the cell.

a. 1 Ω b. 6 Ω

c. 3 Ω d. 0.5 Ω

Answer Sheet

1. d	*2. a*	*3. d*	*4. b*	*5. b*	*6. d*	*7. d*	*8. a*	*9. b*	*10. d*
11. a	*12. a*	*13. c*	*14. d*	*15. b*	*16. c*	*17. b*	*18. d*	*19. c*	*20. d*
21. c	*22. a*	*23. d*	*24. b*	*25. a*	*26. a*	*27. b*	*28. c*	*29. d*	*30. b*
31. b	*32. d*	*33. a*	*34. a*	*35. d*	*36. a*	*37. d*	*38. c*	*39. d*	*40. a*

Solution

1. Ans. (d) The speed at which current travels through the conductor means the speed of electric effect travelling through a conductor which is at speed of light 3×10^8 m/s.

2. Ans. (a) Rt = Po(1 + αt);α is +ve for metallic conductor. The Collision frequency of free e⁻ with vibrating ions increases with increase in temperature so resistance increases.

3. Ans. (d) Specific resistance/Resistivity depends on a material independent of dimensions at given temperature.

4. Ans. (b) 1 A = 6.25×10^{18} electrons pass/sec

$1mA = 6.25 \times 10^{18} \times 10^{-3} = 6.25 \times 10^{15}$

5. Ans. (b) An α Particle = charge of 2 protons. Motion of α particles to left, motion of protons to left and motion of e^{-s} towards right all produce conventional correct towards left. Direction of current is in direction of +ve charges.

$I = q/t = \frac{ne}{t} = 10^{19} \times (2 \times 10^{-19}) + 1.6 \times 10^{-19} \times 10^{19} + 10^{19} \times 1.6 \times 10^{19}$

$= 2 \times 1.6 + 1.6 + 1.6 = 6.4$ A

6. Ans. (d) As $I = \frac{v}{R}$, current will be maximum for least value of R. [Note that R = r is true only to obtain maximum power in mixed grouping of cells].

7. Ans. (d)

Electrons and positive ions drift in opposite direction constituting the current in same direction that gets added up.

8. Ans. (a)

Since no charge accumulates at junction, the total charge entering the junction is equal to charge leaving the junction.

9. Ans. (b)

Kirchoof loop law/Mesh law/Second law is based on conservation of energy.

10. Ans. (d)

Drift velocity $(v_d) = \left(\frac{et}{2m}\right) E = \left(\frac{et}{2m}\right)\frac{v}{l}$

$V_d \propto V$

t = relaxation time

11. Ans. (a) $I = \frac{q}{t} = \frac{ne}{t}$

$n = \frac{It}{e} = \frac{4.8\times1}{1.6\times10^{-19}} = 3 \times 10^{19}$

12. Ans. (a)

$I = \frac{q}{t} = \frac{2e}{t} = \frac{2e}{2\pi r/v} = \frac{ve}{\pi r}$

$= \frac{3.14\times10^{6}\times1.6\times10^{-19}}{3.14\times10^{-10}}$

$= 3.2\times10^{-3}A = 3.2mA$

13. Ans. (c)

$R = \frac{\rho l}{A} = \frac{\rho l \times l}{A \times l}$

$R = \frac{\rho l^2}{v}$ R $\alpha\ l^2$ (As volume $V = A \times l$ remains constant during stretching)

$R_2 = 4R.$

14. Ans. (d)

$R = \frac{\rho l}{A} = \frac{\rho l\times A}{A^2} = \frac{\rho v}{A^2}$

$R\ \alpha\ \frac{1}{A^2}\ \alpha\ \frac{1}{r^4}$

$R_2 = 16\ R_1$

15. Ans. (b)

During discharging

v = E–ir

= 1.5 – 1 × 0.5

= 1v

16. Ans. (d)

When a cell is being charged, current is driven into the cell against direction of its emf. V = E + ir.

17. Ans. (b)

$i = \frac{V}{R_{eff}} = \frac{20}{2+3+5} = 2A$

Pd across 3Ω

v = iR = 2×3 = 6V

18. Ans (d)

V = E – ir = iR = 0.2×6 = 1.2v

19. Ans. (c)

$i = \frac{E}{r+R} = \frac{E}{r+r} = \frac{E}{2r}$

Now,

$V = E - ir = E - \frac{E}{2r}.r = \frac{E}{2}$ volts

20. Ans. (d)

$R_1 = R_2$

$\frac{\rho l_1}{A_1} = \frac{\rho l_2}{A_2}$

$\frac{l_1}{l_2} = \frac{A_1}{A_2} = \left(\frac{d_1}{d_2}\right)^2$

$\frac{d_1}{d_2} = \sqrt{\frac{l_1}{l_2}} = \sqrt{\frac{1}{9}} = 1:3$

21. Ans. (c)

V= E – ir

When short circuited $i = \frac{E}{r}$

$\therefore V = 0$

22. Ans. (a)

V = E – ir

The open circuit i = o

$\therefore V = E$

23. Ans (d)

Effective potential difference is equal to the potential of each cell in parallel combination. In series

Enet = nE = 5×1.5 = 7.5

24. Ans. (b)

In series

$R = R_1 + R_2$

$\frac{\rho(2l)}{A} = \frac{\rho_1 l}{A} + \frac{\rho_2 l}{A}$

$\rho = \frac{\rho_1+\rho_2}{2}$

25. Ans. (a)

In parallel combination

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{2A}{\rho_l} = \frac{A}{\rho_1 l} + \frac{A}{\rho_2 l}$

$\frac{2}{\rho} = \frac{1}{\rho_1} + \frac{1}{\rho_2}$

$\rho = \frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$

26. Ans. (a)

Resistance of each part

$R^1 = \frac{R}{n} = \frac{R}{10}$

If they are in parallel

$Rp = \frac{R^1}{10} = \frac{R}{10} = 0.01R$

27. Ans. (b)

For identical resistors number of possible combinations = $2^{n-1} = 2^{3-1} = 4$

For different resistances = 2^n

28. Ans. (c)

$I = \frac{dq}{dt}$ or $dq = Idt = (10+4t)dt$

$q = \int(10+ut)dt = 10t + \frac{4t^2}{2}$

At t = 10S

$q = 10\times10+2\times10^2$

$= 100+200 = 300c$

29. Ans. (d)

Rate of chemical energy consumed = Input power

$= I^2 (R + r) = 0.2^2(21+4) = 1$ J/S

30. Ans (b)

The resistance of the series combination will be independent of temperature if the change of resistance of individual resistors will be equal and in reverse direction.

i.e. $R_1 \alpha\Delta\theta - R_2\beta\Delta\theta = 0$

$R_1\alpha = R_2\beta$

$\frac{R_1}{R_2} = \frac{\beta}{\alpha}$

31. Ans (b)

I series = I parallel

$\frac{2E}{3 + 2r} = \frac{E}{3 + \frac{r}{2}}$

$\frac{2}{3 + 2r} = \frac{2}{6 + r}$

$3 + 2r = 6 + r \therefore r = 3\Omega$

32. Ans. (d)

In series, $I = \frac{E+E}{R+2r} = \frac{2E}{5+2r}$

$1 = \frac{2E}{5+2r} \Rightarrow 2E = 5 + 2r$ ------(i)

In parallel

$I = \frac{E}{R+\frac{r}{2}} = \frac{2E}{2R+r}$

$0.8 = \frac{2E}{2\times5+r}$

$\therefore$ $2E = 0.8(10+r)$--- (ii)

From (i) and (ii)

$5+2r = 0.8\ (10 + r)$

$= 8 + 0.8r$

$1.2r = 3$

$r = \frac{3}{1.2} = 2.5\Omega$

33. Ans. (a)

$mn = 20$ ----- (i)

For maximum curent $R = \frac{nr}{m}$

$2.5 = \frac{n\times0.5}{m}$

$\therefore$ n = 5m

From (i)

$m\times5m = 20$ or, $5m^2 = 20$

$m^2=4, m=2$

$n = \frac{20}{2} =10$

34. Ans. (a)

Area of cross section = breadth × thickness

For a square metal plate

length = breadth

$RA = \frac{\rho l}{A} = \frac{\rho l}{b \times t} = \frac{\rho}{t}$

$RB = \frac{\rho\times2l}{A} = \frac{\rho \times 2l}{b \times t}$

$= \frac{\rho \times 2l}{2l \times t} = \frac{\rho}{t}$

RA: RB = 1:1

35. Ans. (d) $R = \frac{\rho l}{A} \times \frac{l}{l} = \frac{\rho l^2}{v} = \frac{\rho l^2}{\frac{M}{d}} = \frac{\rho d l^2}{M}$

For three wires of same material ie. same resistivity and density

$R \propto \frac{l^2}{M}$

$R_1 : R_2 : R_3 = \frac{l_1^{\,2}}{M_1} : \frac{l_2^{\,2}}{M_2} : \frac{l_3^{\,2}}{M_3}$

$= \frac{3^2}{1} : \frac{2^2}{2} : \frac{1^2}{3} = 9:2:\frac{1}{3} = 9\times3:2\times3:1 = 27:6:1$

36. Ans. (a) Current flow from A to B so A is at higher potential. Using Kirchoft 2nd law, VA –VB = ΣIR = 2×2+3+2×1=9v

[The direction of current flow is from A to B and our *l*oop is also in the direction from A to B. So current is taken as +ve. As +ve pole is encoured first, it is taken +ve.

37. Ans. (d) Resistance of 360° circle = 36 Ω

Resistance of small are $\overset{\circ}{AB}$ of the circle = $\frac{36\times30°}{360°} = 3\ \Omega$

Resistance of the arc

$\overset{\frown}{ACB} = 36 - 3 = 33\Omega$

Now, the two resistances are in parallel, so the effect resistance across two points A and B

$= \frac{33\times3}{33+3} = \frac{33\times3}{36} = \frac{33}{12} = \frac{11}{4} = 2.75\ \Omega$

38. Ans. (c)

Current by the cell

$i = \frac{E}{R+R^1}$

$= \frac{3}{20+10}$

$= \frac{1}{10A}$

P.d. across wire $v = 20\times\frac{1}{10} = 2v$

Potential gradient

$\frac{dv}{dr} = \frac{2}{10} = 0.2Vm^{-1}$

39. Ans. (d)

$F = qE = q\frac{v}{l} = e\frac{v}{l}$

$V = \frac{Fl}{e}$

$= \frac{4.8\times10^{-19}\times5}{1.6\times10^{-19}} = 15V$

40. Ans. (a)

$r = \left(\frac{E}{V} - 1\right) R$

$= \left(\frac{l_1}{l_2} - 1\right) R$

$= \left(\frac{110}{100} - 1\right)\times10 = \frac{10}{100}\times10 = 1\Omega$

Past Questions

1. 'n' number of identical cells in series grouping all in series grouping all in same order have a total emf of 15v. when any one cell is reversed the emf become 12V. 'n' will be (IOM 2011)

a. 15 b. 12

c. 10 d. 8

2. What is the potential drop across an electric hot plate which draws 5A when its hot resistance is 24Ω?(IOM 2010)

a. 120v b.130v

c. 130v d. 150v

3. 5 cells each of emf 'E' and internal restance 'r' are connnected in series by mistake one of the cell was conected wrongly then equivalent emf and internal resistance will be (IOM2066)

a. 5E,3r b. 3E,5r
c. 3E, 3r d. 5E,5r

4. The resistance of two wires conected in parallel is 3.43Ω while the resistance of the same wires conected in series is 14Ω. The resistance are (IOM 08)

a. 5 and 6 b. 6 and 7
c. 7 and 8 d. 6 and 8

5. The specific resistance of a wire 1.1m long 0.4mm in diameter having a resistance of 0.42 ohm will be (IOM08)

a. 4.2×10^{-8} ohm.m
b. 4.2×10^{3} 0hm.m
c. 4.8×10^{8} ohm.m
d. 4.8×10^{3} ohm.m

6. A piece of wire of resistance 4 ohm is bent through 180° mid point and two halves are twisted together . Their resistance is (IOM 09)

a. 8 ohm b. 1 ohm
c. 2 ohm d. 15 ohm

7. When 5.5 ohm and 4.5 ohm resistances are joined together in series and a 10 ohm resistance of the system is (IOM 2003)

a. 2 Ω b. 5Ω
c. 2.5Ω d. 20Ω

8. The terminal potential difference of a circuit having a cell of emf 6 volt with its internal resistance 2Ω and external resistance 8Ω will be (MOE 2068)

a. 2.8 v b. 3.8v
c. 4.8 v d. 1.8v

9. A wire of resistance 2Ω is strctched 1.5 times the resistance of strctched wire becomes (MOF 2068)

a. 1.5Ω b. 3.5Ω
c. 6 Ω d. 4.5Ω

10. Kirchoff 's loop law is based on conservation of (MOE 2067)

a. charge b. energy
c. mass d. momentum

11. If the radius of a copper wire carrying a current is doubled, the drift velocity of electrons will (MOE 2067)

a. remain same
b. increases four times
c. decrease four times
d. Firsr increase , decrease later

12. Two resistors are joined in parallel whose resultant is $\frac{6}{5}$ Ω .one of the resistance wire is broken and the effective resistance is 2Ω. The resistance of the wire that got broken was (MOE 2010)

a. $\frac{3}{5}\Omega$ b. $\frac{6}{15}\Omega$
c. 2Ω d. 3Ω

13. Three equal resistors each of resistance 'R' are conected so as to from equilateral triangle . The equivalent resistance of any two corners is (MOE 066)

a. $\frac{2R}{3}$ b. $\frac{R}{3}$
c. $\frac{3R}{2}$ d. 3R

14. A wire of resistance 16 Ω is bent into circular form. Then equivalent resistance between two points of any diameter is (MOE 2008)

a. 8 Ω b. 32 Ω
c. 16 Ω d. 4 Ω

15. The diameter of a nichrome wire is reduced to half. Now the resistance changes by (MOE 2064)

a. 2 b. 4

c. 8 d. 16

16. A battery of emf 12 v is connected parallel with a voltameter . The voltameter reads 11v .This is because of (MOE 2064)

a. small internal resistance of battery
b . high internal resistance of battery
c. internal resistance of battery comparable with resistance of voltameter
d. internal resistance of battery equal to resistance of voltameter

17. The relation between drift velocity and electric field to obey ohm's law accurately is (MOE 2063)

a. $vd \propto E$ b. $vd \propto E^{-1}$
c. $vd \propto E^{-1/2}$ d. $vd \propto E^{-1/4}$

18. A wire has resistance 1.7Ω at 20° .If the temperature coefficient of resistance wire is 0.0093°C ,than it's resistance at 100°C will be (Bangladesh 09)

a. 1.6Ω b. 2.96Ω
c. 22.6Ω d. 68Ω

19. A cell of emf X is connected across a resistance is measured as R. The potential difference across the resistance is meaured as Y. Then internal resistance of the cell should be (Bengaladesh 09)

a. $(X–Y)R$ b. $\frac{X - Y}{R}$
c. $\frac{(X - Y)R}{X}$ d. $\frac{(X–Y)R}{Y}$

20. If a copper wire is stretched to make it 0.10% longer , the percentage change in it's resistance will be (MOE 2000)

a. 1.2 % b. 32%
c. 0.1 % d. 0.2%

21. Flow of 6.25×10^{12} electrons per secone d in a conductor contributes to a curent (MOE 2058)

a. 1 A b. 1 mA
c. 0.1 A d. 1 μA

22. Three resistance R_1,R_2,and R_3 ohms are connected in a parallel combination. If $R_1 < R_2 < R_3$, the equvalent resistance will be (MOE 2058)

a. less than R_1 b. equal to R_2
c. less than R_2 d. greater than R_3

23. The quantity of electricity analogous to tamperature (MOE 2055)

a. resistance b. potential
c. charge d. inductance

24. Diameter of nichrome wire is reduced to half . Now the resistance becomes (MOE 2055)

a. 2 times b. 4 times
c. 8 times d. 16 times

25. Two 1Ω resistors are connected in paralled. the combination is again connected in series with a 2 Ω resistors. the whole arrangement is than joined to a 10 v battery. The current through any one of 1 Ω resistors is (MOE 2054)

a. 1A b. 3A
c. 2A d. $\frac{1}{2}$ A

26. An electric cell has emf 2v and internal resistance 0.1Ω ,the external resistance in the circuit is 3.9Ω. what is the value of the potential difference between the two ends of the shunt.(MOE 2056)

a. 2.95v b. 3.45 v
c. 1.95 v d. 4.5 v

27. The emf of a source doing 50 of work by 10 c charge is (MOE)

a. 0.5 v b. 2v
c. 6 v c. 4v

28. The power of the heater is 1w.1A current is passed through this . Then find the resistance (KU 2010)

a. 4.2 Ω b. 4200 Ω

c. 1 Ω d. 0.1 Ω

29. The unit of electrical conductivity is (KU2009)

a. ohm.m b. $\frac{\text{ohm}}{\text{m}}$

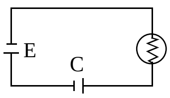
c. ohm^{-1}Metre d. (ohm–metre)$^{-1}$

30. The radius of a conductivity wire is double then it's specific resistance is (KU08)

a. doubled b. becomes 4 times

c. constant d. becomes one fourth

31. A bulb and a battery were initially connected to a circuit. Now an uncharged capacitor is conneced in same circuit then.(KU 08)



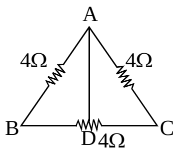
a. The bulb glows more brightly

b. The bulb glows slowly dim and dimmer until it goes off

c. The bulb remain dim

d. The bulb is brighter initially, becomes dimmer until it goes off

32. Three resistances of 4Ω each are connected as shown in figure. If the point D divides the resistance into two equal halves , the resistance between A and D will be (Indian Embassy 2010)



a. 12 b. 6

c. 3 d. $\frac{1}{3}$

33. The eqivalent circle of network of three 4Ω resistant cannot be (IE 07)

a. 1.33 Ω b. 3 Ω

c. 6 Ω d. 12 Ω

34. The p.d. across a resistance is 12 v and internal resistance of 0.02 Ω and delivering current is 10.4A ,the emf of a cell is (IE 05)

a. 12.2 v b. 6.1 v

c. 12.4v d. 11.8 v

35. Which of the following relation is called current density ? (IE 04)

a. $\frac{Iq}{A^2}$ b. $\frac{I^2}{A}$

c. $\frac{A}{I}$ d. $\frac{I}{A}$

36. The length of potentiometer wire is balanced at a length $\frac{l}{3}$ from the positive end of the wire . If the length of the wire is increase by $\frac{l}{2}$ .At what distance will the same cell give a balance point ?

(BPKIHS – 09)

a. $\frac{2l}{3}$ b. $\frac{l}{2}$

c. $\frac{l}{6}$ d. $\frac{4l}{3}$

37. There are two wire A and B . The radious of B is one fourth of A . Then ratio of resistance of B to A if both are of same material is (BPKIHS – 06)

a. 1:2 b. 1:4

c. 1:6 d. 1:256

Answer Sheet

1. c	*2. a*	*3. b*	*4. d*	*5. a*	*6. b*	*7. b*	*8. c*	*9. d*	*10. b*
11. a	*12. d*	*13. a*	*14. d*	*15. d*	*16. a*	*17. a*	*18. b*	*19. d*	*20. d*
21. d	*22. a*	*23. b*	*24. d*	*25. c*	*26. c*	*27. a*	*28. c*	*29. d*	*30. c*
31. d	*32. c*	*33. b*	*34. a*	*35. d*	*36. b*	*37. d*			

Solution

1. Ans:(c)

Let total no of cells be n.Initially , n × x = 15V ....(i) ,when a cell is reversed

(n – 2) × x = 12 v – (ii)

Dividing by (i) by (ii)

$\frac{nx}{(n-2)x} = \frac{15}{12} \Rightarrow n = 10$ cells

2. Ans: (a)

V = IR = 5 × 24 =120v

3. Ans: (b)

direction of emf(voltage) is always from –ve to + ve

Eeq = 4E – E = 3E

but total resistance is simply added. So Req. = 5×r = 5r

4. Ans :(d)

Resistance in series

$R_s = R_1 + R_2 = 14$ – (i)

Resistance in parallel $R_p = \frac{R_1R_2}{R_1+R_2} = 3.43$–(ii)

$R_1R_2 = 3.43 \times 14 = 48$

$R_1 + \frac{48}{R_1} = 14$, $R_1^2 - 14R_1 + 48 = 0$

$(R_1 - 6)(R_1 - 8) = 0$

$R_1 = 6$ or 8 , $R_2 = 8$ or 6.

5. Ans . (a) $\rho = \frac{RA}{l}$

$= \frac{0.42 \times \pi \times (0.4 \times 10^{-3})^2}{4 \times 1.1} = 0.047 \times 10^{-6}$

$= 4.7 \times 10^{-8}$ ohm.m

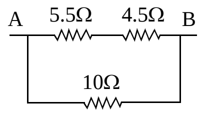
6. Ans. (b)

When wire is bent at 180° resistance of each part became $\frac{R}{2}$

They are in parallel combination ,

Req. = $\frac{\frac{R}{2} \times \frac{R}{2}}{\frac{R}{2} + \frac{R}{2}} = \frac{R}{4} = \frac{4}{4} = 1$ ohm

7. Ans. (b)



Eqivalent resistance of 5.5 Ω and 9.5 Ω is 4.5 + 5.5 = 10 Ω Equivalent resistance between two 10 Ω resistors

$= \frac{(10 \times 10)}{(10 \times 10)} = 5\ \Omega$

8. Ans. (c) $I = \frac{E}{R+r} = \frac{6}{8+2} = \frac{6}{10}$

$v = E - IR = 6 - \frac{6}{10} \times 2 = \frac{24}{5} = 4.8$v

9. Ans. (d) for strctched wire,

$R \propto l^2$ & $R \propto \frac{1}{A^2} \propto \frac{1}{r^4}$

$\frac{R}{R^1} = \left(\frac{l}{\frac{3l}{2}}\right)^2 = \frac{4}{9} \Rightarrow R_1 = \frac{9}{4} \times 2 = 4.5\ \Omega$

10. Ans. (b)

kirchoff loop law 2nd law/mesh law → based on conservation of energy.junctional law →conservation of charge.

11. Ans. (a) $v_d = \frac{-e\vec{E}}{m}\tau = \frac{-eV}{Ml}\tau$

$\vec{E}$ = electric field applied

τ = Relaxation time

$v_d \propto \vec{E} \propto \frac{V}{l}$

independent of radius or diameter of conductor.

12. Ans. (d)

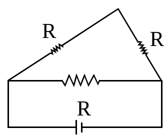
Let R_1 and R_2 are the resistance combained in parallel , then $\frac{R_1 R_2}{R_1 + R_2} = \frac{6}{5}$

When one resistance R_2 is broken.

$R_1 = 2\Omega$, then, $\frac{2R_2}{R_2 + 2} = \frac{6}{5} \Rightarrow R_2 = 3\Omega$

13. Ans. (a)

when two corners are taken there is two



resistance in series (2R) which lie in parallel to one resistor (R)

$\frac{1}{Req} = \frac{1}{2R} + \frac{1}{R} \Rightarrow req = \frac{2}{3}R$

14. Ans. (d)

Resistance of each half = $\frac{R}{2}$

Resistance across the diameter = $\frac{\frac{R}{2} \times \frac{R}{2}}{\frac{R}{2}+\frac{R}{2}}$

$= \frac{R}{4} \quad = \frac{16}{4} = 4\Omega$

15. Ans. (d)

$R \propto \frac{1}{A^2} \propto \frac{1}{r^4} \propto \frac{1}{d^4}$ while Stretching

∴ Resistance becomes 16 times when diameter is reduce to half

16. Ans. (a)

Internal resistance is the resistance offered by the electrolyte and electrodes of a cell when electric curent flows through it depends on

– Distance between the electrodes
– Nature of electrodes & electrolytes
– Area of eletrodes immersed in electrolyte

$r = \left(\frac{E-V}{v}\right)R$

17. Ans. (a)

$vd = \frac{-e\vec{E}}{m}\tau$

$vd \propto E \propto \frac{V}{d}$

–ve sign indicates that electron drift in opposite direction of electric field.

18. Ans. (b)

$R = R_o(1 + \propto \Delta\theta)$

$= 1.7[(1+ 0.093 \times 100 – 20)] = 2.96\ \Omega$

19. Ans. (d)

$X = I(R + r)$

$Y = IR \Rightarrow I = \frac{Y}{R}$

$X = IR + Ir$

$X = Y + \frac{Y}{R}r$

$r = \left(\frac{X-Y}{R}\right)R$

ie, $r = \left(\frac{E-v}{v}\right)R$

20. Ans. (d)

$R = \delta\frac{l}{A}$

$V = Al$ = constant

$R = \frac{\delta l}{\frac{V}{l}} = \frac{\delta l^2}{v} \Rightarrow R \propto \boldsymbol{l}^2$

R = 2 × (% change in length)

= 2 × 0.1 % = 0.2 %

21. Ans. (d)

$q = It \Rightarrow I = \frac{q}{t} = \frac{ne}{t}$

$I = \left(\frac{n}{t}\right)e = 6.25 \times 10^{12} \times 1.6 \times 10^{-19}$

$= 10^{-6}A = 1\mu A$

22. Ans. (a)

In paralled combination, the equivalent resistance is less than the smallest resistor whereas in series

Req > largest resistors.

23. Ans. (b)

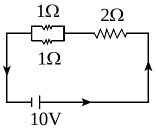
Electric current flow from high voltage to low voltage as heat flows from high temperature to low temperature so,temperature is analogous to voltage

24. Ans. (d)

$R \propto \boldsymbol{l}^2 \propto \frac{1}{r^4} \propto \frac{1}{d^4}$ For stretching

so, $R_{2} = 16 R_1$

25. Ans. (c)



$R_{eff} = \frac{1 \times 1}{1 + 1} + 2 = 2.5\ \Omega$

current through circuit = $\frac{V}{R} = \frac{10}{2.5} = 4$

Acurrent through any of 1Ω resistance = $\frac{4}{2}$

= 2A

26. Ans. (c) current in the circuit

$I = \frac{E}{R+r} = \frac{2}{3.9 + 0.1} = 0.5$ A

p.d across the shunt

v = IR =0.5 × 3.9 = 1.95v

27. Ans. (a) Emf = workdone per unit charge

$E = \frac{w}{q} = \frac{5}{10} = 0.5v$

28. Ans. (c) $p = IV = I^2R$

$R = \frac{P}{I^2} = \frac{1}{1} = 1\Omega$

29. Ans. (d) Resitivity (ρ) = $\frac{RA}{l}$ = ohm metre

conductivity = $\frac{1}{\rho}$ = (ohm metre $)^{-1}$

30. Ans. (c) specific resistance or resitivity is constant for a given material

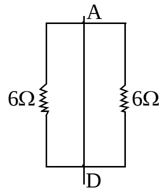
31. Ans. (d)

→ Initially, just at the point of completing the circuit, the capacitor has not been charged yet and potential difference generate by the cell is across the bulb only so glows brightly.

→ As capacitor gets charged more & more potential is establised across the capacitor and lesser and lesser across the bulb hence glows dimmer and dimmer.

→ A**s** capacitor gets fully charged. whole of the potential is establised across it and bulb goes off.

32. Ans. (c)



$R_{net} = \frac{6 \times 6}{6 + 6} = \frac{36}{12} = 3\Omega$

33. Ans. (b)

In series, Req. = 4 × 3 = 12

In parallel Req. = $\frac{4}{3}$ =1.33

Two in parallel and other in series = 4 + 2 = 6Ω

Two in series and other in parallel = 2.67

34. Ans. (a)

For discharging cell

V= E –Ir

E = v + Ir = 12 + 10.4 × 0.02 = 12 v

For charging cell v = V= E +Ir

35. Ans. (d)

Current density (J) = current flowing through a conductor per unit crossectional Area = $\frac{I}{A}$

36. Ans. (b)

If $\frac{v}{l}$ is potential gradient

$V\ 1'st = \frac{l}{3} \times \frac{V}{l} = \frac{V}{3}$ ....(i)

$V\ 2'nd = x \times \frac{v}{l+\frac{l}{2}} = \frac{2v}{3l}\ x = \frac{v}{3}$ [from eq.(i)]

This gives $x = \frac{l}{2}$

37. Ans. (d)

If all remaining quantities remains constant

$R \propto \frac{1}{r^4}$

$\frac{RA}{RB} = \left(\frac{r_B}{r_A}\right)^4 = \left(\frac{1}{4}\right)^4 = \frac{1}{256}$

नेपालमा कम्युनिस्ट पार्टीको विकासक्रम, सरकार र नेतृत्व

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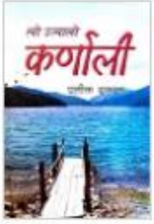

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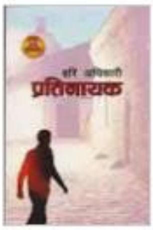


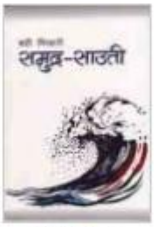
प्रतिनायक

रिकुटे

स्कुल बेच्ने बालक

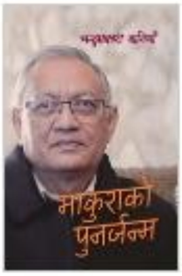
अदभुत तिवारी

छोट्टी



समुन्द्र साउती

गद्य शैलीको रूपविज्ञान



माकुराको पुनर्जन्म

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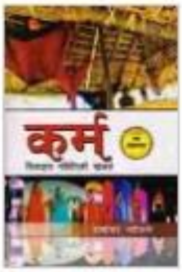

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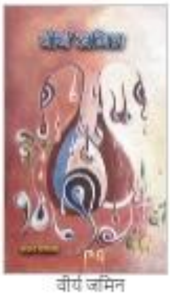
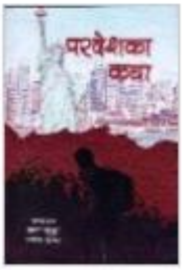


वीर्य जमिन

सारङ्गी



परदेशका कथा

डिलको डोब

Of Walls And Pigeons

Chapter: 30

Heating Effects Of Current

1. A bulb has specifications 1kw and 250v. The resistance of bulb is:

a. 125 Ω b. 62.5 Ω
c. 0.25 Ω d. 625 Ω

2. Two electric lamps of 40 watt each are connected in parallel. The power consumed by the combination will be:

a. 20watt b. 80watt
c. 40watt d. 160watt

3. Two electric lamps of 40 watt 220 v each are connected in across 220v line. The power consumed by the combination is:

a. 20 watt b. 80 watt
c. 40 watt d. 100 watt

4. Two resistances 10Ω, and 20Ω are connected in parallel. If P is the power consumed by 10Ω. Then power consumed by 20Ω is:

a. P b. 2P
c. $\frac{P}{2}$ d. $\frac{2P}{3}$

5. Two head lamps of a car are in parallel. They together consume 48w with the help of a 6v battery. The resistance of each bulb is:

a. $\frac{2}{3}$ Ω b. 3 Ω
c. 4 Ω d. 1.5 Ω

6. What will be the wattage of a 50w, 200v lamp when used on 160v power supply?

a. 32w b. 64w
c. 96w d. 128w

7. Two resistances R and 2R are connected in series in an electrical circuit. The ratio of heat in 2R to that of R is:

a. 2:1 b. 4:1
c. 1:2 d. 1:4

8. Two bulbs are of 25w, 220v and other 100w 220v are connected in parallel across the mains of 220v. The current:

a. in 25w bulb is more
b. in 100w bulb is more
c. same in both the bulbs
d. insufficient data

9. Five equal resistors when connected in series dissipated 5 watt power. If they are connected in parallel, the power dissipated will be:

a. 25w b. 50w
c. 100w d. 125w

10. A uniform wire when connected directly across a 200 v line produces heat H per sec. If the wire is divided into n parts and all parts are connected in parallel across a 200v line. The heat produced per second will be:

a. H b. nH
c. n^2H d. H/n^2

11. The voltage across an electric bulb is increased by 50%. Find the percentage change in power.

a. 100% b. 125%
c. 200% d. 300%

12. Two identical batteries each of emf E = 2v and internal resistance r = 1 Ω are available to produce heat in an external resistance by passing a current through it. The maximum Joulean power that can be developed across R using these batteries is:

a. 1.28w b. 2w
c. 8/9 w d. 3.2w

13. A 25w, 220v bulb and a 100w, 220v bulb are joined in series and connected to the mains. Which bulb will glow brighter?

a. 25w bulb b. 100w bulb
c. first 25w bulb and then 100w bulb
d. both will glow with same brightness

14. A 25w, 220v bulb and a 100w, 220v bulbs are joined in parallel and connected to the 220v mains which bulb will glow more brightly?

a. 25w bulb b. 100w bulb

c. both will glow with same brightness

d. none

15. If two bulbs of power 25W and 100w respectively each rated at 220v are connected in series with the supply of 440v. Which bulb will fuse?

a. 25w bulb b. 100w bulb

c. both the bulbs will fuse

d. none of the bulb will fuse

16. Two electric bulbs each designed to operate with a power of 500 watts and 220 volts line are connected in series in a 110 volts line. The power generated by each bulb will be:

a. 31.25watts b. 40 watts

c. 60watts d. 3.125watts

17. A heating coil is labelled 100w, 220v. The coil is cut into two halves and two pieces are joined in parallel to the same source. The energy now liberated per second is:

a. 25J b. 50J

c. 200J d. 400J

18. Five electric bulbs each of 40watt burns 5 hours each day. Calculate the cost in the months of 30 days, if the cost of 1 unit is Rs 8:

a. Rs 320 b. Rs 240

c. Rs 160 d. Rs 420

19. A 3°c rise of temperature is observed in a conductor by passing a certain current. When the current is doubled the rise of temperature will be:

a. 15°c b. 12°c

c. 9°c d. 3°c

20. According to Joules law if potential difference across a conductor made of material of resistivity ρ, remains constant, then heat produced in the conductor is propotional to:

a. ρ b. ρ^2

c. $\frac{1}{\sqrt{\rho}}$ d. $\frac{1}{\rho}$

21. An electric heater of resistance 6Ω run for 10 minutes on a 120volt line. The energy liberated in this period of time is:

a. 7.2×10^3J b. 14.4×10^5J

c. 43.2×10^4J d. 28.8×10^4J

22. A fuse wire with a radius 1mm blows at 1.5 A. If the fuse wire of the same material should blow at 3A, the radius of the wire must be:

a. $4^{\frac{1}{3}}$ mm b. 2mm

c. 0.5mm d. 8 mm

23. In an ordinary heater if the length of the coil is halved, then a given quantity of water will boil in :

a. less time

b. more time

c. same time

d. can't be compared

24. A cell of emf E and internal resistance r supplies currents for the same time through external resistance R_1 and R_2 seperately. If the heat developed in the external resistance in the external resistance in the two cases is the same, r is equal to:

a. $\frac{R_1+R_2}{2}$ b. $\frac{R_1-R_2}{2}$

c. $\sqrt{R_1R_2}$ d. $\sqrt{\frac{R_1R_2}{2}}$

Answer Sheet

1. b	*2. b*	*3. a*	*4. c*	*5. d*	*6. a*	*7. a*	*8. b*	*9. d*	*10. c*
11. b	*12. b*	*13. a*	*14. b*	*15. a*	*16. a*	*17. d*	*18. b*	*19. b*	*20. d*
21. b	*22. a*	*23. a*	*24. c*						

Solution

1. Ans. (b)

Resistance of bulb

$(R) = \frac{v^2}{p} = \frac{(250)^2}{1000} = 62.5\ \Omega$

2. Ans. (b)

In parallel,

Peff = $P_1 + P_2$

= 40 + 40

= 80w

3. Ans. (a)

In series

$\frac{1}{peff} = \frac{1}{P_1} + \frac{1}{P_2}$

$peff = \frac{P_1P_2}{P_1+P_2} = \frac{40\times40}{40+40} = 20W$

4. Ans. (c)

In parallel, both have equal P.d.

$P = \frac{V^2}{R} \alpha \frac{1}{R}$

For 10Ω power = P

For 20Ω power = $\frac{P}{2}$

5. Ans. (d)

Let R be the resistance of each lamp, then net resistance of two lamps in parallel = $\frac{R}{2}$

Now, $P = \frac{v^2}{\frac{R}{2}}$

$R = \frac{2V^2}{P} = \frac{2\times36}{48} = 1.5\ \Omega$

6. Ans. (a)

$p = \frac{v^2}{R} \rightarrow$ For same resistance $P \alpha V^2$

$\frac{P^1}{P} = \left(\frac{V^1}{V}\right)^2 = \left(\frac{160}{200}\right)^2$

$P^1 = \left(\frac{160}{200}\right)^2 \times 50 = 32W$

7. Ans. (a)

In series combination, current is same,

$H = I^2 Rt \alpha R$

$\frac{H_{2R}}{H_R} = \frac{2R}{R} = 2:1$

8. Ans. (b)

In parallel, voltage are equal.

$V = IR \rightarrow I \alpha \frac{1}{R}$

but $\frac{R_2}{R_1} = \frac{P_1}{P_2}$ $\quad \therefore R \alpha \frac{1}{p}$

$\frac{I_1}{I_2} = \frac{R_2}{R_1} = \frac{P_1}{P_2} = \frac{25}{100} = \frac{1}{4}$

i.e. current is more in 100w bulb

9. Ans. (d)

Power in parallel $(P_p) = n^2$

x power in series

$P_p = n^2P_s = 5^2\times5 = 25\times5 = 125w$

10. Ans. (c)

If R be the resistance of the wire, then $H = \frac{v^2}{R} = \frac{(200)^2}{R}$. After connecting n parts each of resistance $\frac{R}{n}$ in parallel, heat generated in each be $H^1 = \frac{v^2}{\frac{R}{n}} = nH$ and heat generated in combination of these parts

$H'' = \frac{v^2}{\frac{R}{n^2}} = n^2\frac{v^2}{R} = n^2H$

11. Ans. (b)

New voltage $v_2 = v_1 + \frac{50}{100}V_1 = 1.5v_1$

$P = \frac{v^2}{R} \ \alpha\ V^2$

% change in power = $\frac{p_2 - p_1}{p_1} \times 100$

$= \left(\frac{p_2}{p_1} - 1\right) \times 100 = \left[\left(\frac{v_2}{v_1}\right)^2 - 1\right] \times 100\% =$

$[(1.5)^2 - 1] \times 100 = 125\%$

12. Ans. (b) When the cells are in parallel and combination is then connected to the external resistor. The internal resistance will be $\frac{1}{2} \times 1\Omega = 0.5\ \Omega$

Power in external circuit is Max. When external resistance is equal to internal resistance (ie. 0.5 Ω)

Now, $P_{max} = \frac{E^2}{4r} = \frac{2^2}{4r} = \frac{2^2}{2\times0.5} = 2w$

13. Ans. (a) In series combination

$\frac{L_1}{L_2} = \frac{H_1}{H_2} = \frac{R_1}{R_2} = \frac{P_2}{P_1}$

[$H= I^2Rt$; $H\alpha R$ in series]

Rated power is always inversely propotional to resistance

[$P \alpha \frac{1}{R}$]

$\frac{L_1}{L_2} = \frac{P_2}{P_1} \rightarrow L \alpha \frac{1}{p}$

$\therefore$ 25w will grow more brightly

14. Ans. (b) In parallel combination

$\frac{L_1}{L_2} = \frac{H_1}{H_2} = \frac{R_2}{R_1} = \frac{P_1}{P_2}$

[$H=\frac{v^2}{R} t \rightarrow H \alpha \frac{1}{R}$ in parallel]

$L\alpha P$ Thus 100w bulb will glow more brightly.

15. Ans. (a) The bulb will fuse if the supplied voltage > rated voltage

Resistance of 25w bulb

$R_1= \frac{{V_R}^2}{P_R} = \frac{220^2}{25} = 1936\ \Omega$

Resistance of 100w bulb

$R_2 = \frac{{V_R}^2}{P_R} = \frac{220^2}{100} = 484\ \Omega$

P.d across 25w bulb, $v_1= \frac{R_1 v}{R_1+R_2}$

$= \frac{1936}{1936+484} \times 440 = 352v$

P.d across 100w, $V_2 = 440 - 352 = 88v$

so, 25w bulb will fuse.

16. Ans. (a)

If they were connected to the mains of 220 volts, their combined power generation = $\frac{P_1P_2}{P_1 + P_2} = \frac{500 \times 500}{500 + 500} = 250w$

But they are connected to the source of 110 volts, so

$P = \left(\frac{V_S}{V_R}\right)^2 \times P_R = \left(\frac{110}{220}\right)^2 \times 250$

= 62.5 watts

Power generated by each bulb

$= \frac{P}{2} = \frac{62.5}{2}$ watts = 31.25 watts

17. Ans. (d)

Resistance of the coil,

$R = \frac{v^2}{P} = \frac{220^2}{100} = 484\ \Omega$

After cutting resistance of each half $= \frac{R}{2} = \frac{484}{2} = 242\ \Omega$

After joining in parallel, the effective resistance $= \frac{R_1R_2}{R_1+R_2} = \frac{242\times242}{242+242} = 121\Omega$

Now, $P = \frac{v^2}{R} = \frac{220^2}{121} = 400$ watt = 400J/s

18. Ans. (b)

No. of units = Total energy consumed (KWH) $= \frac{\text{Total watt}\times\text{Total hr}}{1000}$

$= \frac{5\times40\times5\times30}{1000} = 30$ units = 30 KWH

Cost of 1 unit = Rs 8

Cost of 30 units = 8×30 = Rs. 240

19. Ans. (b)

$H = i^2Rt$

$H = ms\Delta\theta$

$\Delta\theta \alpha i^2$ Hence rise of temperature is 12°c.

20. Ans. (d)

Heat produced $(H) = \frac{v^2}{R} t = \frac{v^2 t}{\frac{\rho l}{A}} = \frac{V^2At}{l\rho} \alpha \frac{1}{\rho}$

21. Ans. (b)

$H = \frac{V^2}{R} t = \frac{(120)^2}{6} \times 10 \times 60 = 14.4 \times 10^5 J$

22. Ans. (a)

Maximum current in fuse wire, $I^2 \alpha r^3$

So, $\left(\frac{r_2}{r_1}\right)^3 = \left(\frac{i_2}{i_1}\right)^2 = \left(\frac{3}{1.5}\right)^2 = 4$

$r_2 = 4^{\frac{1}{3}} r_1$

23. Ans. (a)

$t \alpha R$ and $R \alpha l$

ie. $t \alpha l$

So, if length is reduced the water will boil in less time.

24. Ans. (c)

Current in the circuit

$I = \frac{E}{R + r}$ and heat produced is I^2Rt. So

$H = I^2Rt = \left(\frac{E}{R+r}\right)^2 . Rt = \frac{E^2Rt}{(R + r)^2}$

According to question

$\frac{R_1}{(R1+r)^2}$

$= \frac{R_2}{(R_2+r)^2}$

On solving, we get $r = \sqrt{R_1R_2}$

Past Questions

1. If the current in an elctric bulb decreases by 2%, then power decreases by (IOM 2010)

a. 1% b. 4%

c. 2% d. 16%

2. In order to light 6w-6v bulb at rated power a battery of emf 6v and internal resistance 2Ω is used, the bulb will light at power.

a. 6w b. $\frac{27w}{8}$

c. 4w d. $\frac{16w}{3}$

3. The power of two heater coils is P_1 & P_2. If they are connected in series, the resultant power is (IOM 02).

a. $P_1 + P_2$ b. $\frac{P_1P_2}{P_1+P_2}$

c. 0 d. $\sqrt{P_1P_2}$

4. The power of a bulb is watt at 220v. When the voltage is 110 v. Power of the bulb is: (IOM 01)

a. 150w b. 50w

c. 120w d. 25w

5. A bulb with 220 volt consume the power of 66 watt. If it is connected with 160 volt, then power consumed by the bulb will be (IOM 1999).

a. 10w b. 40w

c. 60w d. 35w

6. Fuse wire should have: [IOM/MOE/BPKIHS] [IOM 05]

a. High resistivity, low melting point

b. High resistivity, high melting poit

c. Low resistivity, high melting point

d. Low resistivity and melting point

7. A bulb is rated as 60 watt and 120 volt, the current through the bulb when the bulb is lighted at the rated voltage is:

(Bangladesh Embassy)

a. 0.5A b. 5A

c. 25A d. 0.25A

8. Two wires of same mass and material are drawn 1mm and 2mm thick. They are connected in series and a current is sent through them. The heat produced will be in the ratio (MOE curriculum):

a. 1:16
b. 16:1
c. 4:1
d. 2:1

9. If the strength of the current is decreased by 4%, the power of the bulb changes by (MOE 2000)

a. 8%
b. 0.1%
c. 2%
d. nearly 4%

10. The electric bulb have tungsten filaments of same length. If one of them gives 60 watts and other 100watts, then (I.E. 2010).

a. 100 watts bulb have thicker filament
b. 60 watts bulb has thicker filament
c. both filaments are of same thickness
d. insufficient information.

11. A cell of emf E is connected to two resistances 10Ω & 20Ω in parallel. If the power dissipated in 10Ω is P. Then power dissipated in 20Ω is: [IE 2009]

a. 2P
b. $\frac{P}{2}$
c. $\frac{3P}{4}$
d. $\frac{P}{4}$

12. A resistor operated at 100v generates joule heat at a rate of 20w. When placed across a 50v source. It will draw (IE – 07)

a. 0.1A
b. 5A
c. 20A
d. 4A

13. Calculate energy dissipated when 0.3A of current is passes at 6v in 2 minutes. (IE–06)

a. 206J
b. 216J
c. 318J
d. 122J

14. If two bulbs whose resistances are in the ratio 1:2 are connected in series. Then their powers will be in the ratio (IE–04)

a. 1:2
b. 1:1
c. 2:1
d. 1:4

15. A 500 watt heating unit is designed to operate from 115volt line. If the voltage drops to 110 volt the percentage drop in heat output will be (BPKIHS 2010).

a. 10.2%
b. 8.1%
c. 8.6%
d. 7.6%

16. Two heater wires of equal length are first connected in series and then in parallel. The ratio of heat production in the two cases is (BPKIHS–04).

a. 2:1
b. 1:2
c. 4:1
d. 1:4

17. Power dissipated by R_1 and R_2 resistor are 100 watt and 200 watt respectively. When connected to same voltage. Their relation between R_1 and R_2 is: [BPKIHS 02]

a. $R_1=R_2$
b. $R_1 = \frac{R_2}{2}$
c. $R_1 = 2R_2$
d. $R_2 = 3R_1$

18. Three identical bulbs are arranged in parallel across 220v supply and the current across each is 40A. The total consumed in 1hr is (BPKIHS 01)

a. 8.8kwh
b. 16.6kwh
c. 26.4kwh
d. 80kwh

19. Two bulbs 100w, 250 v and 200w, 250v are connected in series across a 500v line. Then [BPKIHS]

a. 100 w bulb will be fused
b. 200w bulb will be fused
c. both bulb will be fused
d. no bulb will be fused

Answer Sheet

1. b	*2. b*	*3. b*	*4. d*	*5. d*	*6. a*	*7. a*	*8. b*	*9. a*	*10. a*
11. b	*12. a*	*13. b*	*14. a*	*15. c*	*16. d*	*17. c*	*18. a*	*19. a*	

Solution

1. Ans. (b) 2%

$P \alpha I^2$

$\frac{\Delta P}{P} \times 100\% = 2\times\frac{\Delta I}{I} \times 100\% = 2\times2\% = 4\%$

2. Ans. (b)

Resistance of bulb $= \frac{v^2}{p} = \frac{6^2}{6} = 6\Omega$

Since, external resistance and internal resistance are in series.

Total Resistance = 6 + 2 = 8Ω

$I = \frac{V}{R} = \frac{6}{8} = \frac{3}{4}$ A

$P = I^2R = \frac{9}{16} \times 6 = \frac{27}{8}$ w

3. Ans. (b)

For power in series

$\frac{1}{Peff} = \frac{1}{P_1} + \frac{1}{P_2} +$ ---------

In parallel

$Peff = P_1+P_2 +$ ----------

4. Ans. (d)

$P = IV = \frac{v^2}{R}$

Resistance of bulb is constant at a particular temperature. $P \alpha V^2$

$\frac{P_1}{P_2} = \left(\frac{V_1}{V_2}\right)^2$

$\frac{100}{P_2} = \left(\frac{220}{110}\right)^2 = 4$

$P_2 = 25$watt

5. Ans. (d)

Resistance of bulb (R) $= \frac{v^2}{p}$

$= \frac{(220)^2}{2} = \frac{2200}{3}\ \Omega$

When connected to 160 v

$P = \frac{v^2}{R} = \frac{(160)^2}{2200} \times 3 = 35$w

6. Ans. (a)

- Fuse wire is made of tin lead alloy
- It has high resistivity low melting point
- Length is immaterial for fuse wire
- $I^2 \alpha r^3$ where I is max current & r is radius.

7. Ans. (a)

$R= \frac{V^2}{P}$

$I = \frac{V}{R} = \frac{V}{\frac{V^2}{P}} = \frac{P}{V} = \frac{60}{120} = 0.5$A

8. Ans.

$H = I^2Rt$, $H\alpha R$ (i = same in series)

$H = KR = \frac{K\rho l}{A} = \frac{K\rho l\times A}{A^2} = \frac{K\rho V}{A^2}$

$H \alpha \frac{1}{A^2}$ (As V = constant)

$\frac{H_1}{H_2} = \left(\frac{A_2}{A_1}\right)^2 = \left(\frac{d_2}{d_1}\right)^4 = \left(\frac{2}{1}\right)^4 = 16:1$

9. Ans. (a)

$P = IV = I^2R$

$\frac{\Delta p}{p} \times 100\% = 2\frac{\Delta I}{I} \times 100\%$

$= 2 \times 4\% = 8\%$

10. Ans. (a)

Related power $(P_o) \alpha \frac{1}{\text{Resistance}} = \frac{Vo^2}{R}$

i.e. $\frac{P_1}{P_2} = \frac{R_2}{R_1}$ -------- (i)

Also, $R = \frac{\rho l}{A}$ $R \alpha \frac{l}{A} \alpha \frac{1}{d^2}$

$\frac{R_1}{R_2} = \left(\frac{d_2}{d_1}\right)^2$ --------- (ii)

From (i) and (ii)

$\frac{p_1}{p_2} = \left(\frac{d_2}{d_1}\right)^2 \rightarrow p \alpha d^2$

So, 100 watts bulbs has thicker filament.

11. Ans. (b)

In parallel $P \alpha \frac{1}{R}$

$P = \frac{V^2}{R} \alpha \frac{1}{R}$ (V = constant in parallel)

$\therefore P_2 = \frac{P}{2}$

12. Ans. (a)

We have $P = \frac{v^2}{R}$

$R = \frac{v^2}{P} = \frac{100^2}{20} = 500\Omega$

When connected to 50 volt line

$P = \frac{v^2}{R} = \frac{50^2}{500} = 5w$

$P = IV = 5 \rightarrow I = \frac{5}{50} = 0.1A$

13. Ans. (b)

Power (P) $= \frac{H}{t} = I^2R = \frac{V^2}{R} = IV$

$\rightarrow H = Ivt$

$= 0.3\times6\times2\times60 = 216J$

14. Ans. (a)

$P = I^2R = \frac{V^2}{R}$

In series, current across resistor is constant.

$P = I^2R \alpha R$

$\frac{P_1}{P_2} = \frac{R_1}{R_2} = \frac{1}{2}$

15. Ans. (c)

$P = \frac{V^2}{R} \alpha V^2$

$\frac{P_1 - P_2}{P_1} \times 100\%$

$= \left(1 - \frac{P_2}{P_1}\right) \times 100\%$

$= \left[1 - \left(\frac{V_2}{V_1}\right)^2\right] \times 100\%$

$= \left[1 - \left(\frac{110}{115}\right)^2\right] \times 100\%$

$= (1 - 0.914) \times 100\% = 8.6\%$

16. Ans. (d)

Using shortcut

Power in parallel

(Pp) $= n^2 \times$ power in series

[n=no. of wires]

$Pp = 2^2 \times Ps$

$Ps:Pp = 1:4$

17. Ans. (c)

$P = \frac{V^2}{R} \alpha \frac{1}{R}$ (For same voltage)

$\frac{P_1}{P_2} = \frac{R_2}{R_1}$

$\frac{100}{200} = \frac{R_2}{R_1}$

$R_1 = 2R_2$

18. Ans. (a)

Heat consumed = VIt

$= 220\times40\times60\times60$

$= 8800\times3600J$

$1Kwh = 3.6\times10^6J$

$\therefore$ Heat consumed

$= \frac{8800\times3600}{36\times10^5}$

= 8.8kwh

19. Ans. (a)

The bulb will fuse if the supplied voltage > applied voltage. Resistance of 100w bulb, $R_1 = \frac{VR^2}{PR} = \frac{(250)^2}{100} = 625\Omega$

Resistance of 200w bulb, R_1

$= \frac{VR^2}{PR} = \frac{(250)^2}{200} = 312.5\Omega$

P.d across 100w bulb $= \frac{VR_1}{R_1 + R_2}$

$= 333.3v$

P.s across 200w bulb $= 500 - V_1 = 166.67$ V.

100w bulb gets more voltage than rated, it will fuse.

Chapter: 31

Thermoelectricity

1. Which of the following combination would give maximum e.m.f?
a. Ni and Cr b. Fe and Bi
c. sb and Bi d. cu and Fe

2. At the temperature of inversion, the emf in a thermocouple is:
a. half of its maximum value
b. maximum
c. reaches infinity d. zero

3. In seeback series, sb appears before Bi, therefore In sb-Bi thermocouple, current flows from:
a. sb to Bi through hot junction
b. sb to Bi though cold junction
c. Bi to sb through cold junction
d. None

4. As the temperature of hot junction increases, the thermo emf:
a. always increase b. always decrease
c. many increase or decrease
d. always remains constant

5. Peltier effect may be used as:
a. thermoelectric generator
b. thermoelectric refigerator
c. both d. none

6. Which of the following is not reversible?
a. Joule effect b. Peltier's effect
c. seebeck effect d. Thomson effect

7. Thermocouple is based on the principle of:
a. seebeck effect b. Thomson effect
c. Peltier effect d. Joule effect

8. The temperature of thermocouple which is independent of temperature of cold junction:
a. neutral temperature
b. temperature of inversion
c. both d. none

9. Amount of energy absorbed or evolved when 1A current passes for 1sec. through a metal kept a temperature difference of 1° C is called:
a. peltier coefficient
b. Thomson coefficient
c. Thermoelectric power
d. Thermo emf.

10. Peltier coefficient for the junction of a pair of metal is propotional to:
a. T b. T^2
c. T^{-1} d. T^{-2}

11. For Peltier effect and Thomson's effect, the heat evolved is proptional to:
a. I b. I^2
c. I^{-1} d. I^{-2}

12. The emf in a thermo couple changes sign at 600K. If the neutral temperature is 210°c, the temperature of cold junction is:
a. 180k b. 117k
c. 93°c d. 90°c

13. For thermocouple, the temperature of cold junction (T_c), the neutral temperature (Tn) and the temperature inversion (T_i) are 0°c 285°c and 570°c respectively. If the temperature of cold junction (T_c) is raised to 10°c, Then:
a. T_n = 275°c and T_i = 570°c
b. T_n = 285°c and T_i = 570°c
c. T_n = 285°c and T_i = 560°c
d. T_n = 295°c and T_i = 580°c

14. An emf of 0.9v is generated when the temperature difference between hot and cold junctions of a thermocouple is 75k. Assuming that the cold junction is heated up by 15k, then to what extent the thermo emf will change?
a. 20% b. 40%
c. 60% d. 80%

Answer Sheet

1. c	*2. d*	*3. b*	*4. c*	*5. b*	*6. a*	*7. a*	*8. a*	*9. b*	*10. a*
11. a	*12. c*	*13. c*	*14. a*						

Solution

1. Ans. (c)

Larger the seperation between two metals of the theromoelectric series, greater is the thermo e.m.f. produced.

2. Ans. (d)

At temperature of inversion the thermo emf of the thermocouple is zero.

3. Ans. (b)

In a thermocouple made of any two metals in seeback series, current flows from a metal coming first in the series to a metal coming later through hot junction.

$Sb \xrightarrow{\text{cold}} Bi$

4. Ans. (c)

Below neutral point, the thermo emf increases while above neutral point it decreases.

5. Ans. (b)

Peltier effect $\rightarrow$Thermoelectric refrigerator & seebeck effect $\rightarrow$Thermoelectric generator.

6. Ans. (a)

Seebeck effect, Peltier effect and Thomson's effect are reversible but Joule's effect is irreversible.

7. Ans. (a)

When two different metals (thermo couple) maintained at different temperatures are joined, the emf is induced at the junction. This is seebeck or thermoelectric effect.

8. Ans. (a)

Neutral temperature is constant for a given thermocouple it doesn't depend on temp. of cold junction. At neutral temperature thermoelectric power is zero.

Inversion temperature depends on temp. of cold junction.

9. Ans. (b) $Q = \sigma IT$

σ = Thomson's coefficient specific heat of electricity can be defined by Thomson's coefficient.

10. Ans. (a) $H = \pi It$, π = peltier coefficient π depends on nature of thermocouple & temperature of junction ($\pi \propto \theta$ or $\pi \propto T$).

11. Ans. (a)

$H \propto I$ for Peltier & Thomson's effect.

$H \propto I^2$ for Joule effect

12. Ans. (c) $\theta i = 600k = 327°c$, $\theta_n = 210°c$

$$\theta_n = \frac{\theta_o + \theta_i}{2}$$

$$210 = \frac{\theta_n + 327}{2}$$

$$\theta_n = 93°c$$

13. Ans. (c)

Neutral temperature is independent of temperature of cold junction. So, it will remain 285°c even if Tc is raised to 10°c.

$$T_n = \frac{T_c + T_i}{2}$$

$$285 = \frac{10 + T_i}{2}$$

$$T_i = 560°c$$

14. Ans. (a) The new temperature difference of two junctions = 75 – 15 = 60k

New thermo emf generated in thermo couple

$$E^1 = \frac{0.9}{75} \times 60 = 0.72v$$

$$\% \text{ decrease in thermo emf} = \frac{E - E^1}{E} \times 100$$

$$= \frac{0.9 - 0.72}{0.9} \times 100 = 20\%$$

Past Questions

1. The neutral temperature of a thermo couple is 160°c. Its electromotive force changes sign at 500K. The temperature of the cold junction will be: (MOE 2068)

a. 93°c
b. 73°c
c. 67°c
d. 27°c

2. Neutral temperature of a thermo couple is 320°c. The cold junction is at 10°c. The inversion temperature is: (MOE 2068 Asadh).

a. 320°c
b. 630°c
c. 640°c
d. 650°c

3. A battery is connected in a thermo couple. The two junctions will (BPKIHS 05)

a. be heated up
b. remain at the same temprature
c. be cooled
d. be heated at one junction and cooled at other.

4. Amount of energy absorbed or evolved when 1 A current passes for one second through a junction of two metals is called: (BPKIHS – 04)

a. Peltier coefficient
b. Thermo emf
c. Thomson coeficient
d. Thermoelectric power

5. Thomson effect is not shown by which element. [BPKIHS – 98]

a. Antimony
b. Iron
c. lead
d. Tin

6. The thermoemf 'e' in volts of a certain thermocouple is found to vary with temperature θ of hot junction while cold junction is kept at 0°c.

$$e = 40\theta - \frac{\theta^2}{20}$$

Then, the neutral temperature of couple is [BPKIHS]

a. 100°c
b. 200°c
d. 400°c
d. 800°c

7. Thermocouple thermometer is based on principle of (Indian Embassy)

a. seebeck effect
b. Peltier effect
c. Joule's effect
d. Thomson's effect

Answer Sheet

1. a	*2. b*	*3. d*	*4. a*	*5. c*	*6. c*	*7. a*

Solution

1. Ans. (a)

Electromotive force changes sign at Temperature of inversion (T_i). T_o = Temp. of cold junction

$$T_n = \frac{T_i + T_o}{2} = 160°c = 433k$$

$$T_o = 2T_n - T_i$$

$$= 2 \times 433 - 500 = 366\ k = 93°c$$

2. Ans. (b)

$$T_n = \frac{T_i + T_o}{2}$$

$T_i = 2T_n - T_o = 2 \times 320 - 10 = 630°c$

3. Ans. (d)

Peltier effect states that if emf is applied in a thermocouple formed of two junction, one is heated and other is cooled.

Peltier effect is used in refrigeration.

4. Ans.(a)

The evolution or absorption of heat in conductor on passing current through it is called Peltier effect.

The evolution or absorpiton of heat along the length of conductor on passing current through it is called Thomson effect.

5. Ans. (c)

See beck series

Bi, Ni, Co, Pt, Cu, Mn, Hg, *Pb*, Sn, Au, Ag, Zn, Cd, Fe, As, Sb.

Thomson's effect is +ve for metal coming after lead & vice versa. It is zero (nil) for lead.

6. Ans. (c)

$e = 400 - \frac{\theta^2}{20}$

Comparing with $e = a\theta + b\theta^2$

We get, a= –40 and b = $\frac{1}{20}$

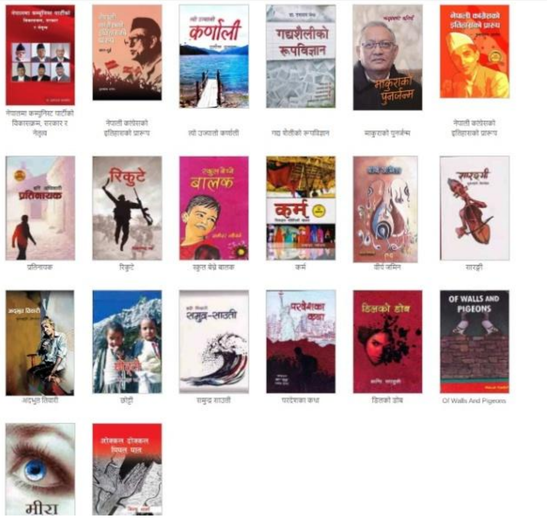
$\theta_n = \frac{-a}{2b} = \frac{-40}{2\times -\frac{1}{20}} = 400°c$

Inversion temperature (Ti) = $\frac{-a}{b}$

7. Ans. (a)

Thermo couple thermometer is formed by joining two wires of different material at junction and maintaining the junction at different terperatures.

- It is based on seebeck's effect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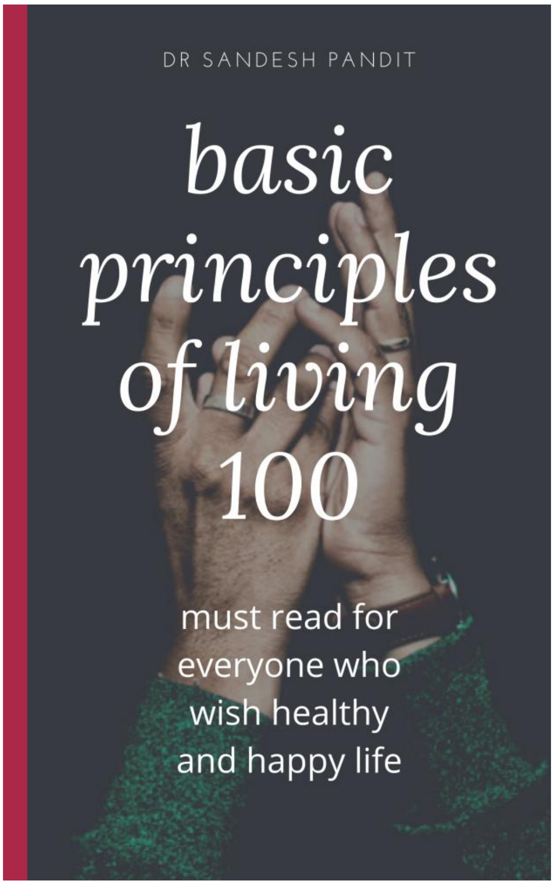
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Chapter: 32

Chemical Effects Of Current

1. **The unit of electric charge is equal to:**
   a. Faraday/Avogadro No.
   b. Avogadro No/ Faraday
   c. Faraday × Avogadro No.
   d. None

2. **A current of 1.6 A is passed through $CuSo_4$ solution. The number of cu^{++} ions liberated per minute are:**
   a. 6×10^{19} b. 6×10^{18}
   c. 3×10^{20} d. 3×10^{17}

3. **The e.c.e. of silver is 1.118×10^{-6}kg/coulomb. Its atomic weight is 108 and Avogadro's number is 6.02×10^{23} per gm mole. The charge on one Ag ion is:**
   a. 1.6×10^{-19}c b. 3.2×10^{-19}c
   c. 4.8×10^{-19}c d. 2.4×10^{-19}c

4. **The current capacity of a storage cell is 3Ah. The maximum current it can supply for half hour is:**
   a. 1.5A b. 3A
   c. 4.5A d. 6A

5. **What is the amount of charge required to convert 0.2 moles of cu++ to cu?**
   a. 4×9650c b. 4×96500c
   c. 2×9650c d. 2×96500c

6. **An electric charge of 7.2×10^{3} coulombs is passed through an electrolyte of $AgNO_3$ in 1 hour. The number of Ag^{+} ions liberated during electrolysis is:**
   a. 6.7×10^{22} b. 9.5×10^{21}
   c. 4.5×10^{22} d. 7.8×10^{22}

7. **When 1 gram hydrogen (e.c.e = 1.044×10^{-8} kg c^{-1}) forms water, 34 kilo calories heat is liberated. The minimum voltage required to decompose water is:**
   a. 0.75v b. 1.5v
   c. 3v d. 4.5v

8. **When a copper voltameter is connected with a battery of emf 12v,2g of copper is deposited in 30 minutes. If the same votameter is connected across a 6V battery, the mass of copper deposited in 45 minutes would be:**
   a. 1 g b. 1.5g c. 2g c. 2.5g

9. **If Cu and Ag voltameter are connected in series and same amount of current is passed for same time, when mass of Ag deposited is xmg, then mass of cu deposited in mg will be:**
   a. $\frac{29x}{108}$ b. $\frac{108x}{29}$
   c. $\frac{108}{29x}$ d. $\frac{29}{108x}$

10. **A certain charge liberates 0.8g of oxygen. The mass of silver liberated by the equal charge is:**
    a. 10.8g b. 108g
    c. 0.8g d. $\frac{108}{0.8}$ g

11. **In an electroplating experiment 4A current for 2 minutes deposits mg of silver. When 6A current flows for 40 S, then the deposited silver will be:**
    a. 4m b. $\frac{m}{2}$ c. $\frac{m}{4}$ d. 2m

12. **A Leclanche cell supplies a current of 1Amp for 1 hour, Atomic weight of Mn=55, of oxygen = 16, of zinc = 65 and ECE of hydrogen = 1.04×10^{-5} g/coul. Then (I) mass of hydrogen liberated is:**
    a. 0.63744g b. 3.744g
    c. 1.217g d. 3.258g

    (II) In above question, the mass of zinc consumed is:
    a. 0.03744g b. 1.217g
    c. 3.258g d. 0.1217g

Answer Sheet

1. a	*2. c*	*3. a*	*4. d*	*5. a*	*6. c*	*7. b*	*8. b*	*9. a*	*10. a*	*11. b*	*12.a,b*

Solution

1. Ans. (a)

$F = Ne$

$\rightarrow e = \frac{F}{N} = \frac{\text{Faraday}}{\text{Avogadro No.}}$

2. Ans. (c)

No. of copper ions liberated

$n = \frac{q}{2e} = \frac{It}{2e}$

$= \frac{1.6\times60}{2\times1.6\times10^{-19}} = 3\times10^{20}$

3. Ans. (a)

The valency of silver is 1. Therefore a silver ion (Ag+) has +ve charge equal to charge of 1 electron = 1.6×10^{-19}c

4. Ans. (d)

Current capacity of a cell = current × time

$\text{Current} = \frac{\text{current capacity}}{\text{time}} = \frac{3}{0.5} = 6A$

5. Ans. (a)

To convert 1 mole M from $Mn^{+}+ne^{-}\rightarrow M$, n faradays is require ie. $cu^{++} + 2e^{-} \rightarrow 2u \rightarrow n=2$

So, To convert 1 mole of cu^{++} to cu $\rightarrow$2F is required. To convert 0.2 moles of cu^{++} = 0.2×2F = 0.2×2×96500 = 4×9650c

6. Ans. (c)

$q = ne$

$n = \frac{q}{e} = \frac{7.2\times10^{-3}}{1.6\times10^{-19}}$

$= 4.5\times10^{22}$

7. Ans. (b)

$m = 1g = 10^{-3}kg$

H= 34 kcal = 34×1000×4.2J

$q = \frac{m}{z}$, $H = qv$

$v = \frac{H}{q} = \frac{Hz}{m}$

$= \frac{34\times1000\times4.2\times1.044\times10^{-8}}{10^{-3}} = 1.5v$

8. Ans. (b) $m = zIt = m\frac{V}{R}.t$

$\rightarrow m \alpha vt$

$\frac{m_2}{m_1} = \frac{v_2t_2}{v_1t_1}$

$m_2 = \frac{v_2t_2}{v_1t_1} \times m_1 = \frac{6\times45}{12\times30}\times2 = 1.5g$

9. Ans. (a) According to Faraday's 2nd law of electrolysis

$\frac{m_1}{m_2} = \frac{E_1}{E_2}$

or, $\frac{m_{Ag}}{m_{Cu}} = \frac{E_{Ag}}{E_{Cu}}$

or, $\frac{x}{m_{Cu}} = \frac{E_{Ag}}{E_{Cu}}$

$\therefore$ $m_{Cu} = \frac{29x}{108}$

10. Ans. (a) $\frac{m_1}{m_2} = \frac{E_1}{E_2} = \frac{16/2}{108/1} = \frac{8}{108}$

or, $\frac{0.8}{m_2} = \frac{8}{108}$

$m_2 = \frac{108\times0.8}{8} = 10.8g$

11. Ans. (b) We know, w = zIt

$\frac{w_1}{w_2} = \frac{i_1t_1}{1_2t_2}$

$\frac{m}{w_2} = \frac{4\times120}{6\times40} = 2$

$\rightarrow$ $w_2 = \frac{m}{2}$ gm

12. Ans. I(a)

$m = zIt = 1.04\times10^{-5}\times1\times3600 = 0.03744g$

Ans. II (b)

$\frac{z_1}{z_2} = \frac{w_1}{w_2}$

$Z\ zinc = \frac{wzinc}{W_H} \times Z_H$

$= \frac{\frac{65}{2}}{1} \times(1.04\times10^{-5})g/c = 33.8\times10^{-5}g/c$

$m = zIt = 33.8\times10^{-5}\times1\times3600 = 1.217g$

Chapter: 33

Meters

1. To convert a moving coil galvanometer into ammeter one has to connect (IOM/MOE).

a. a small resistance in series
b. a small resistance in parallel
c. a high resistance in series
d. a high resistance in parallel

2. Galvanometer can be converted into voltameter by connecting: (IOM/MOE)

a. a high resistance in series
b. a low resistance in parallel
c. a low resistance in series
d. a high resistance in parallel

3. The resistance of an ideal voltmeter is (IOM)

a. zero
b. very low
c. very large
d. infinite

4. The resistance of an ideal ammeter is (IOM/BPKIHS).

a. zero
b. very low
c. very large
d. infinite

5. A galvanometer of resistance 20Ω gives a full scale deflection when a current of 0.04A is passed through it. It is desired to convert it into an ammeter reading 20A in full scale. The only shunt available is 0.05 Ω. The resistance that must be connected in series with a coil of the galvanometer is (BPKIHS–09)

a. 4.95 Ω
b. 5.94 Ω
c. 9.45 Ω
d. 12.62 Ω

6. A moving coil galvanometer has a resistance of 900 Ω. In order to send only 10% of the main current through this galvanometer the resistance of the required shunt is: (BPKIHS-08)

a. 0.9 Ω
b. 405 Ω
c. 100 Ω
d. 90 Ω

7. Ten identical cells each of E and internal resistance r are connected in series to from a closed circuit. An ideal voltmeter connected across three cells will read (BPKIHS-08)

a. 10E
b. 3E
c. 13 E
d. 7E

8. Which of the following is likely to have largest resistance? (BPKIHS-07)

a. Moving coil galvanometer
b. Ammeter of range 1A
c. Voltmeter of range 10V
d. A copper wire of length 1m and diameter 3mm.

9. A ammeter having resistance 10Ω allows a current of 0.002 A to flow through it. for it to allow a current of 2A, we should join a resistance of: (BPKIHS-01)

a. 0.02 Ω in series
b. 0.02 Ω in parallel
c. 0.01 Ω in series
d. 0.01 Ω in parallel

10. The resistance of a voltmeter should be large to ensure that (BPKIHS)

a. it doesnot get over heated
b. it doesnot draw excessive current
c. it can measure large potential difference
d. it does not appreciably change the p.d to be measured

Answer Sheet

1. b	*2. a*	*3. d*	*4. a*	*5. a*	*6. c*	*7. b*	*8. c*	*9. d*	*10. d*

Solution

1. Ans. (b)

The ammeter is a low resistance galvanometer. So, to convert a galvanometer into ammeter a small resistance of proper value (shunt) is connected in parallel.

2. Ans. (a)

A voltmeter is high resistance galvanometer. So to convert a galvanometer into voltmeter a high resistance should be connected in series with the galvanometer.

3. Ans. (d)

The resistance of an ideal voltameter should be infinite so that no current may pass through it.

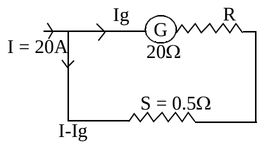
4. Ans. (a)

The resistance of an ideal ammeteris zero so that almost all current passes through it.

5 Ans. (a)

Ig(G+R) = (I–Ig)S = p.d

$\frac{Ig}{I-Ig} = \frac{S}{G+R}$



$R = S\left(\frac{I}{Ig} - 1\right) - G$

$= 0.05\left(\frac{20}{0.04} - 1\right) - 20$

$= 4.95\ \Omega$

6. Ans. (c)

$Ig = \frac{I}{10}$

$Ig\ G = (I - Ig)S$

$Ig \times 900 = \left(I - \frac{I}{10}\right) \times S$

$\frac{I}{10} \times 900 = \frac{9I}{10} \times S$

$S = \frac{900}{9} = 100\ \Omega$

7. Ans. (b)

Total emf = 10E & total resistance = 10r

Total current $= \frac{10E}{10r} = \frac{E}{r}$

Now, upto 3 cell, resistance = 3r

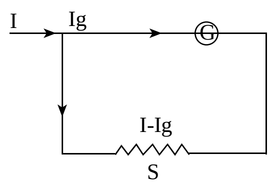
So, potential upto 3r $= \frac{E}{r} \times 3r = 3E$

8. Ans. (c)

To make ammeter from galvanometer, a low resistance is connected in parallel but to make voltmeter a high resistance in series to galvanometer. Strength of resistance: voltmeter > Galvanometer > Ammeter

9. Ans. (d)

Low resistance (shunt) is connected in parallel. so have same P.d.



$V_s = V_g$

$(I - I_g)S$

$S = \frac{I_g \times G}{(I - I_g)} = \frac{0.002}{2-0.01} \times 10$

$= \frac{0.02}{1.98} = 0.01\Omega$

11. Ans. (d)

i. Shunt (low resistance) is used in ammeter so that it doesnot appreciably change the current to be measure.

ii. The resistance of a voltmeter should be large to ensure that is doesnot appreciably change the P.d. to be measured.

Chapter: 34

Magnetism

1. The magnetic lines of force inside a bar magnet.

a. Do not exist

b. Depends on area of cross section of bar magnet

c. Are from N- to S-Pole of magnet

d. Are from S pole to N pole of magnet

2. A diamagnetic substance is:

a. repelled by South Pole

b. repelled by North pole

c. repelled by both the poles

d. attracted by both the poles

3. A diamagnetic material in a magnetic field moves:

a. from stronger to weaker parts of field

b. perpendicular to field

c. from weaker to stronger part

d. none

4. If the magnetic dipole moment of an atom of diamagnetic material, paramagnetic material and ferromagnetic material are denoted by μd, μp and μf respectively then:

a. $\mu p = 0, \mu p \neq 0$ b. $\mu d \neq 0, \mu p = 0$

c. $\mu d \neq 0, \mu f \neq 0$ d. $\mu d = 0, \mu p \neq 0$

5. Relative permeability of iron is 5500. Its magnetic susceptibility is:

a. 5500×10^{7} b. 5499

c. 5501 d. 5500×10^{-7}

6. Relative permittivity and permeability of material are E_r and μ_r respectively. Which of the following values of these quantities are allowed for diamagnetic material?

a. $E_r = 1.5, \mu_r = 1.5$

b. $E_r = 0.5, \mu_r = 1.5$

c. $E_r = 1.5, \mu_r = 0.5$

d. $E_r = 0.5, \mu_r = 0.5$

7. The magnetic moment μ of a revolving electron around the nucleus varies with principal quantum no. n as:

a. $\mu \propto n$ b. $\mu \propto \frac{1}{n}$

c. $\mu \propto n^2$ d. $\mu \propto \frac{1}{n^2}$

8. The most suitable metal for permanent magnets is:

a. copper b. aluminium

c. steel d. iron

9. Water is:

a. diamagnetic b. paramagnetic

c. ferromagnetic d. none

10. Hysterisis is the phenomenon of lagging of:

a. I behind B b. B behind I

c. I and B behind H d. H behind I

11. The hysteresis cycle for material of transformer core is:

a. short and wide b. Tall and narrow

c. Tall and wide d. short and narrow

12. The hysteresis cycle for material of permanent magnet is:

a. short and wide b. tall and narrow

c. tall and wide d. short and narrow

13. Among which, the magnetic susceptibility does not depends on the temperature?

a. Diamagnetism b. Paramagnetism

c. Ferromagnetism d. Ferrite

14. A bar magnet is cut into two equal halves by a plane parallel to the magnetic axis of the following physical quantities. The one which remains unchanged is:

a. pole strength b. magnetic moment

c. Intensity of magnetisation

d. Moment of Inertia

15. Unit of pole strenght of a magnet are:

a. Am^{-1} b. Am^{2}

c. Am^{-2} d. Am

16. $\frac{B^2}{\mu_0}$ has the unit of:

a. energy b. energy density

c. potential d. capacity

17. The lines of force due to earth's horizontal magnetic field are:

a. straight, parallel, horizontal

b. concentric circle

c. elliptical d. curved lines

18. The angle of dip at the poles and the equator are:

a. 30°, 60° b. 90°, 0°

c. 30, 90° d. 0°, 0°

19. The angle of dip at a certain place where the horizontal and vertical components of earth's magnetic field are equal is:

a. 30° b. 75°

c. 60° d. 45°

20. At a place of latitude 5°, the angle of dip is nearly:

a. 5° b. 10°

c. 2.5° d. 7.5°

21. A compass needle is placed at the magnetic pole of earth:

a. points N-S b. points E-W

c. becomes vertical

d. may stay in any direction

22. Lines passing through points of zero declination are:

a. isogonic lines b. isoclinic lines

c. agonic lines d. aclinic lines

23. At a certain place, horizontal component is $\sqrt{3}$ times the vertical component. The angle of dip at this place is:

a. 0 b. $\frac{\pi}{3}$

c. $\frac{\pi}{6}$ d. $\frac{\pi}{2}$

24. When 2A current is passed through a tangent galvanometer, it gives a deflection 30°. For deflection of 60°, the current must be:

a. 1A b. $2\sqrt{3}$ A

c. 4A d. 6A

25. The points A and B are situated perpendicular to the axis of 2 cm long bar magnet at large distance x and 3x from the centre of opposite sides. The ratio of magnetic field at A and B will be approximately equal to:

a. 27:1 b. 1:27

c. 9:1 d. 1:9

26. The force between two short bar magnets with magnetic moments M_1 and M_2 whose centres are r meter apart is 8N, when their axes are in the same time. If the seperation is increased to 2r, the force between then is reduced to:

a. 4N b. 8N

c. 1N d. 0.5N

27. A magnetic needle lying parallel to a magnetic field required w units of work to turn it through 60°. The torque required to maintain the neddle in this position is:

a. $\sqrt{3}$ w b. w

c. $\frac{\sqrt{3}}{2}$ w d. 2w

28. A bar magnet is held at right angles to a uniform magnetic field. The couple acting on the magnet is to be halved by rotating it from this position. The angle of rotation is:

a. 30° b. 45°

c. 60° d. 75°

29. A thin bar magnet of length 2L and magnetic moment M is bent at the midpoint so that the angle between them is 60°. The new magnetic moment is:

a. M b. $\frac{M}{2}$

c. 2M d. $M\sqrt{3}$

30. A magnetized steel wire having dipole moment M is bent at 30° at the midpoint. Find the dipole moment of new wire:

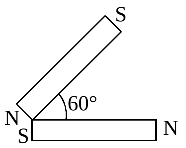
a. $\frac{M}{3}$ b. $\frac{M}{2\pi}$

c. $\frac{M}{3\pi}$ d. $\frac{3M}{\pi}$

31. Two magnets of equal magnetic moments M each are placed as shown in figure. The resultant magnetic moment is:

a. M b. $\sqrt{3}M$

c. $\sqrt{2}$ d. M/2



32. The ratio of magnetic fields due to a small bar magnet at a given distance in the end on position to broad on position is:

a. $\frac{1}{4}$ b. $\frac{1}{2}$

c. 2 d. 1

33. The ratio of magnetic potentials due to magnetic dipole in the end on position to that in broad on side position for the same distance from it is:

a. zero b. ∞

c. 1 d. 2

34. A large magnet is broken into pieces so that their lengths are in the ratio of 2:1. The pole strengths of the two pieces will have ratio:

a. 2 : 1 b. 1 : 2

c. 4 : 1 d. 1 : 1

35. The magnet of pole strength m but magnetic moment M is cut into two pieces along its axis. Its pole strength and magnetic moment now become:

a. $\frac{m}{2}, \frac{M}{2}$ b. m, $\frac{M}{2}$

c. $\frac{m}{2}$, M d. m, M

36. When a thin magnet is cut into two equal parts by cutting it parallel to its length. If the original time period of vibration is 4 sec. The time period of each Part in the same field will be:

a. 4S b. 2S

c. $4\sqrt{2}$ s d. $2\sqrt{2}$ S

37. When a thin bar magnet is cut in length into two equal halves and joined and above the other facing same pole together, the final time period of the magnet is equal to (if initial time period = T)

a. T b. $\frac{T}{2}$

c. $\frac{T}{4}$ d. 2T

38. Two magnets are held together in a vibration magnetometer and are allowed to oscillate in the earth's magentic field with like poles together, 12 oscillations per minute are made but for unlike poles together only 4 oscillations per minute are executed. The ratio of their magnetic moments is:

a. 3:1 b. 1:3

c. 3:5 d. 5:4

39. Two small magnets each of magentic moment 100 Am^2 are placed in end on position 0.1m apart from their centres. The force acting between them is:

a. 0.6×10^7N b. 0.66×10^7N

c. 0.6N d. 0.06N

40. A bar magnet A of magnetic moment M_A is found to oscillate at a frequency twice that of magnet B of magnetic moment M_B when placed in a vibrating magnetometer.

a. $M_A = 2M_B$ b. $M_A = 4M_B$

c. $M_B = 4M_A$ d. $M_B = 8 M_A$

41. The moment of magnet 0.1 $A\times m^2$ and the force acting on each pole in a uniform magnetic field of strength 0.36 oersted is 1.44×10^{-4} N. The distance between the poles of the magnet is:

a. 1.56cm b. 0.78cm

c. 2.50cm d. 1.17cm

Answer Sheet

1. d	*2. c*	*3. a*	*4. d*	*5. b*	*6. c*	*7. a*	*8. c*	*9. a*	*10. c*
11. b	*12. c*	*13. a*	*14. c*	*15. d*	*16. b*	*17. a*	*18. b*	*19. d*	*20. b*
21. d	*22. c*	*23. c*	*24. d*	*25. a*	*26. d*	*27. a*	*28. c*	*29. b*	*30. d*
31. a	*32. c*	*33. b*	*34. d*	*35. a*	*36. a*	*37. b*	*38. d*	*39. c*	*40. b*
41. c									

Solution

1. Ans. (d)

As the magnetic lines of force are closed continuous curves, and their direction outside the magnet is from North to South. Therefore inside the magnet, the magnetic lines of force are form S pole to N pole of magnet.

2. Ans. (c)

A diamagnetc substance is repelled by both the North and South Poles of magnet.

3. Ans. (a)

A diamagnetic material in magnetic field tends to move from stronger to weaker part of the field.

4. Ans. (d)

According to electron theory of magnetism, an atom of diamagnetic material has no intrinsic dipole moment where as paramagnetic material has some intrinsic dipole moment

i.e. $\mu d = 0$ & $up \neq 0$

5. Ans. (b)

$\mu_r = 1 + X_m$

$X_m = \mu_r - 1 = 5500 - 1 = 5499$

6. Ans. (c)

For diamagnetic material $0 < \mu_r < 1$ and Er or $K > 1$

So, the correct option is (c).

$\mu_r = 1 + X_m$

$X_m = \mu_r - 1$

So, X_m is –ve and small $-1 < X_m < 0$

7. Ans. (a)

From knowledge of theory

$$\mu = \frac{neh}{4\pi m}$$

$\therefore$ $m \ \alpha \ n$

8. Ans. (c)

For permanent magnets, steel is preferred because of large coercivity.

9. Ans. (a)

Water is diamagnetic $\rightarrow$ Bi, Zn, cu, Ag, Au, diamond, Nacl, H_2O, N_2, H_2.

10. Ans. (c)

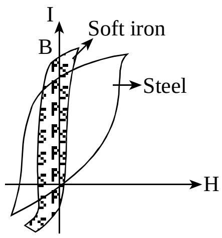
The phenomenon of lagging of B and I behind H. When a ferromagnetic substance is subjected for magnetisation is called hysteresis.

11. Ans. (b)

Transformer core is soft iron which has large retentivity and small coercivity. Therefore its hysteresis loop is tall and narrow.

12. Ans. (c)

Permanent magnet has large coercivity & large retentivity. So tall and wide.



13. Ans. (a)

In diamagnetism the susceptibility doesnot depends on the temperature.

14. Ans. (c)

For each half pole strength m becomes half

$M = m \times 2l$ becomes half

$V = a \times 2l$ also becomes half

Intensity of magnetisation = magnetic moment per unit volume

$= \frac{M}{V}$ (remains constant)

15. Ans. (d)

Pole strength $m = \frac{M}{2l} = \frac{Am^2}{m} = Am$

16. Ans. (b)

As magnetic energy density $U_B = \frac{B^2}{2\mu_0}$

$\frac{B^2}{\mu_0}$ = energy per unit volume

17. Ans. (a)

Due to horizontal component of earth's field, the magnetic lines of force are parallel, straight and horizontal.

18. Ans. (b)

At poles, $\delta = 90°$

At equator $\delta = 0°$

19. Ans. (d)

$\tan \delta = \frac{V}{H} = \frac{H}{H} = 1$

$\tan\delta = \tan 45°$

$\rightarrow \delta = 45°$

20. Ans. (b)

Angle of dip $= 2\lambda = 2\times5 = 10°$

21. Ans. (d)

At magnetic pole, H = 0. Therefore compass may stay in any direction.

22. Ans. (c)

Isogonic lines $\rightarrow$ lining joining equal angle of declination

Isoclinic lines $\rightarrow$ lines joining equal angle of dips

Aclinic $\rightarrow$ joining zero angles of dip

23. Ans. (c) $\tan \delta = \frac{V}{H} = \frac{V}{\sqrt{3}V} = \frac{1}{\sqrt{3}} = \tan 30°$

$\delta = 30° = \frac{\pi}{6}$ radian

24. Ans. (d) $I \propto \tan \theta$

$\frac{I_1}{I_2} = \frac{\tan \theta_1}{\tan\theta_2}$

$\frac{2}{I_2} = \frac{\tan 30}{\tan 60} = \frac{1}{\sqrt{3}.\sqrt{3}} = \frac{1}{3}$

$I_2 = 6A$

25. Ans. (a)

$B \propto \frac{1}{d^3}$

$\frac{B_1}{B_2} = \frac{d_2^3}{d_1^3} = \left(\frac{3x}{x}\right)^3 = \frac{27}{1}$

26. Ans. (d) $F \propto \frac{1}{r^4}$

$\frac{F_1}{F_2} = \frac{r_2^4}{r_1^4} = \left(\frac{2r}{r}\right)^4 = \frac{16}{1} \Rightarrow \frac{8}{F_2} = 16$

$\rightarrow F_2 = 0.5N$

27. Ans. (a)

$W = MB \cos 60° = \frac{MB}{2}$

$MB = 2w$

$\tau = MB \sin\theta = 2w \times \frac{\sqrt{3}}{2} = \sqrt{3}\, w$

28. Ans. (c) $T_1 = MB \sin 90 = MB$

$T_2 = \frac{1}{2} T_1 = \frac{1}{2} MB$

or, $MB \text{ Sin}\theta = \frac{MB}{2}$

or, $\text{Sin}\theta = \frac{1}{2} = \text{Sin } 30$

$\theta = 30°$

Angle of rotation $= 90° - 30° = 60°$

29. Ans. (b) Using shortcut, we have

$2L' = 2L \text{ Sin} \frac{\theta}{2} = 2L \text{ Sin} \frac{60}{2} = 2L \times \frac{1}{2} = L$

$M = m \times 2L$

$M1 = m\times2L^1 = m\times L = \frac{M}{2}$

30 Ans. (d)

$\theta = 30° = \frac{\pi}{6}$

Using the shortcut,

$M^1 = \frac{M\sin\theta}{\theta} = \frac{M \sin 30}{\frac{\pi}{6}} = \frac{M/2}{\pi/6} = \frac{3M}{\pi}$

31. Ans. (a)

Using shortcut,

When unlike pole are touching each other at angle θ

$M^1 = \sqrt{M_1^2+M_2^2 - 2M_1M_2\cos\theta}$

$= \sqrt{M^2 + M^2 - 2M^2.\frac{1}{2}} = M$

32. Ans. (c)

$B_{axial} = \frac{\mu_o}{4\pi}\frac{2M}{d^3}$

$B_{equational} = \frac{\mu o}{4\pi}\frac{M}{d^3}$

$\frac{Ba}{Be} = 2$

33. Ans. (b)

The magnetic potential on the broad side on position (equational line) is zero.

So the ratio must be infinite.

34. Ans. (d)

Pole strength is independent of length but depends on the cross sectional area. So, it changes only when cut parallel to its length.

35. Ans. (a)

As the magnet is cut along its axis, its area reduces to half. As such its pole strength becomes $\frac{m}{2}$.

Also, $M = m \times 2l$

In this case, the effective length remains the same. As m decreases to half so does M. Hence, new magnetic moment = $\frac{M}{2}$

36. Ans. (a)

$T = 2\pi\sqrt{\frac{I}{MH}} \alpha \sqrt{\frac{I}{M}}$

$I = \frac{ml^2}{12}$; $M = m \times 2l$

When cut along length

$I^1 = \frac{I}{2}$ and $M' = \frac{M}{2}$ as mass becomes half ratio of I/M remains same. So Time period remains unchanged.

37. Ans. (b)

When a magnet is cut into number of pieces perpendiculary, the time period of each half = T/n = T/2. If two identical bar magnets each having same time period are kept one other such that the similar poles coincide the time period of combination is equal to that of each piece = T/2.

38. Ans. (d)

$T_1 = \frac{60}{12} = 5s$

$T_2 = \frac{60}{4} = 15s$

$\frac{M_1}{M_2} = \frac{T_2^2+T_1^2}{T_2^2-T_1^2} = \frac{15^2+5^2}{15^2-5^2} = \frac{250}{200} = \frac{5}{4}$

39. Ans. (c)

$F = \frac{\mu_o}{4\pi}\frac{6M_1M_2}{r^4} = 10^{-7}\times\frac{6\times100\times100}{(0.1)^2} = 0.6N$

40. Ans. (b)

$f = \frac{1}{2\pi}\sqrt{\frac{MB}{I}}$

$\frac{fA}{fB} = \sqrt{\frac{MA}{MB}}$

$\rightarrow \frac{MA}{MB} = \left(\frac{fA}{fB}\right)^2 = 2^2 = 4$

41. Ans. (c)

Force (F) = mB

$m = \frac{F}{B} = \frac{1.44\times10^{-4}}{0.36\times10^{-4}} = 4amp - m$

Now, $M = m.2l$

$2l = \frac{0.1}{4} = 0.025m = 2.50$ cm

Hence, the distance between the poles is 2.50 cm.

Past Questions

1. **A unit magnetic pole placed at a point on a perpendicular bisector line of a bar magnet placed in magnetic meridian experiences force due to magnet. The direction of force experienced by it will be (MOE 2068 Kartik).**
   a. 45° to the magnetic axis
   b. 90° to the magnetic axis
   c. Parallel to the magnetic axis
   d. 60° to the magnetic axis
2. **Material A is used as a permanent magnet. IT means: (MOE curriculum)**
   a. A has high coercivity
   b. A has high retentivity
   c. A has low coercivity
   d. A has low retentivity
3. **S.I unit equivalent to magnetic field Tesla (T) may be (MOE 09)**
   a. Vsm^2 b. Vsm^{-2}
   c. $Vs^{-1}m^2$ d. $V^{-1}sm^{-2}$
4. **The value of magnetising field (H) when magnetic flux density (B) = 0 is called (B) = 0 is called (Bangladesh 09)**
   a. Retentivity
   b. curie temperature
   c. coercivity
   d. curie's temperature
5. **The ratio of magnetic moment of two short magnets, which give null deflection in tan B position at 12cm and 18cm from the centre of a deflection magnetometer is (MOE 2000).**
   a. 27:8 b. 8:27
   c. 2:3 d. 4:9
6. **When a thin bar magnet is cut in length into two equal halves and joined one above another facing same pole together the final time period of magnet is equal to (if initial time period of magnet =T) (IOM03)**
   a. T b. $\frac{T}{2}$
   c. $\frac{T}{4}$ d. 2T
7. **At a place the vertical and horizontal component of earth's magnetic field are equal. The angle of dip at the place is (KU 09)**
   a. 30° b. 45°
   c. 60° d. 90°
8. **Area of hysteresis curve indicates (KU 08)**
   a. retentivity
   b. coercivity
   c. loss of energy per cycle
   d. all of the above
9. **Superconductor exhibits perfect (IE 2010)**
   a. ferromagnetism b. ferrimagnetism
   c. diamagnetism d. paramagnetism
10. **Null point is observed at the equatiorial line of a bar magnet then the north pole of bar magnet must have faced (IE - 03)**
    a. geographical north pole
    b. geographical south pole
    c. east
    d. west
11. **Permanent magnets are made up of (BPKIHS 2010)**
    a. steel b. soft iron
    c. copper d. Tungsten
12. **When a magnet is broken into two equal pieces the pole strength will be (BPKIHS 2010)**
    a. halved d. doubled
    c. one fourth d. same
13. **Above curie temperature? (BPKIHS 06)**
    a. Ferromagnetic substances becomes paramagnetic
    b. Paramagnetic becomes ferromagnetic
    c. Paramagnetic becomes diamagnetic
    d. Diamagnetic becomes paramagnetic
14. **The time period of magnet is 2sec. It is cut into two equal parts by cutting it parallel to its length. What is the new**

period of each part when liberated in the same magnetic field? (BPKIHS-06)

a. 2sec b. 4sec
c. 6sec d. 8sec

15. The magnetic field strength at a distance 'd' from a short bar magnet in longitudinal and transverse position are in the ratio of (BPKIHS-05)

a. 1:1 b. 1:2
c. 2:1 d. 4:1

16. The apparent angles of dip at two meridians perpendicular to each other about magnetic meridian are 45° and 45°. Then cot of the true angle of dip at that place is: (BPKIHS-02)

a. $\sqrt{2}$ b. 1
c. $\frac{1}{2}$ d. 2

17. When a temperature increases the magnetic moment of a magnet

(BPKIHS-1999)

a. increases b. decreases
c. remains same
d. sometimes increases, sometimes decreases

18. A dip needle in a plane perpendicular to magnetic meridian will remain.

(IOM/MOE/BPKIHS/IE).

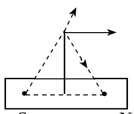
a. vertical b. horizontal
c. in any direction
d. inclined at 45° with horizontal

Answer Sheet

1. c	*2. a*	*3. b*	*4. a*	*5. b*	*6. b*	*7. b*	*8. c*	*9. c*	*10. a*
11. a	*12. d*	*13. a*	*14. a*	*15. c*	*16. a*	*17. b*	*18. a*		

Solution

1. Ans. (c)



2. Ans. (a)
Retentivity is high for both temporary and permanent magnets. So it is not specific coercivity is high for permanent magnet and low for temporary magnet (soft iron).

3. Ans (b)

Velocity (v) = $\frac{\text{Electric field (E)}}{\text{Magnetic field (B)}}$

$ms^{-1} = \frac{V}{m \times T}$

T = Vsm^{-2}

4. Ans. (a)
Corecivity→ Magnetising field in opposite direction for which intensity of magnetisation becomes zero.

Ferromagnetic material behaves as a paramagnetic at curie's temperature.

5. Ans. (b) For short magnet at tanB position

$B = \frac{\mu_o}{4\pi}\frac{2M}{d^3}$

ie. $M \propto d^3$

$\frac{M_1}{M_2} = \left(\frac{d_1}{d_2}\right)^3 = \left(\frac{12}{18}\right)^3 = 8:27$

6. Ans. (b)

$T = 2\pi\sqrt{\frac{I}{MH}}$, $I = \frac{Ml^2}{12}$

When magnet is cut $L' = \frac{L}{2}$

$I' = \frac{m\left(\frac{L}{2}\right)^2}{12} = \frac{I}{4}$

'M' for each piece = $\frac{M}{2}$, Total 'M' = $\frac{M}{2} + \frac{M}{2} = M$

New time period = $2\pi\sqrt{\frac{\frac{I}{4}}{MH}} = \frac{T}{2}$

7. Ans. (b)

Angle of dip is the angle made by resulant magnetic field with horizontal.

$\tan\theta = \frac{V}{H} = 1 \therefore \theta = 45°$

At poles, $\theta = 90°$ and at equator $\theta = 0°$

8. Ans. (c)

Area of hysteresis loop is directly propotional to energy loss per cycle of magnetication and demagnetization.

9. Ans. (c)

Diamagnetism is universal property of all substances. They have zero resultant magnetic moment. Superconductor exhibits perfect diamagnetism.

10. Ans. (a)

Lines of force of earth are horizontal parallel lines directing from geographical South to North of earth. When North pole of magnet face geographical North, line of forces are cancelled on equational plane of magnet to form neutral point. When North pole faces South they are cancelled on axial line.

11. Ans. (a)

Steel Permanent $\rightarrow$ magnets

soft iron $\rightarrow$ transformers, moving coil galvanometer electromagnets etc.

12. Ans. (d)

Pole strength is independent of length but depends on cross sectional area of bar magnet.

13. Ans. (a)

Curie temperature is fixed for any substance above which a magnetic substance loses its magnetic property so above curie temperature ferromagnetic substances becomes paramagnetic. Curie point of iron is 770° c.

14. Ans. (a)

$I = \frac{mL^2}{12}$ when cut along its axis, length remains asme $I^1 = \frac{I}{2}$ (mass halved)

$M' = \frac{M}{2}$

$T = 2\pi\sqrt{\frac{I}{MH}} \alpha \sqrt{\frac{I}{M}}, \frac{I}{M}$ remains same

$\therefore T_2 = T_1 = 2sec$

15. Ans. (c)

For longitudinal (Axial/Tan A position)

$B_A = \frac{\mu_0{}^2 2M}{4\pi d^3}$ for short dipole

For tranverse/Broadon side (TanB position)

$B_B = \frac{\mu_0}{4\pi}\frac{M}{d^3}$

Hence, $B_A:B_B = 2:1$

16. Ans. (a)

$\cot^2\delta = \cot^2\delta_1 + \cot^2\delta_2$

$\cot^2\delta = \sqrt{\cot^2\delta_1 + \cot^2\delta_2}$

$= \sqrt{\cot^2 45 + \cot^2 45}$

$= \sqrt{1+1} = \sqrt{2}$

$\therefore \cot\delta = \sqrt{2}$

17. Ans. (b)

When the temperature increases, the magnetic moment of the magnet decreases due to which magnetic property gets reduced.

18. Ans. (a) At pole$\delta = 90°$

$H = R\cos\delta = R\cos 90 = 0$

$V = R\sin 90° = R$

At pole, horizontal component of earth's magnetic field is zero so stands vertical.

Chapter: 35

Magnetic Effect Of Current

1. A charged particle enters in a magnetic field perpendicular to magnetic lines of force. The path of the particle is:

a. Straight line b. Circular
c. elliptical d. spiral

2. A charged particle enters at 45° to the magnetic field. Its path becomes.

a. Circular b. Straight line
c. elliptical d. spiral

3. A moving charge will produce.

a. An electric field b. a magnetic field
c. Both 'a' and 'b' d. None

4. A current carrying wire produces

a. Only electric field
b. Only magnetic field
c. both electric and magnetic field
d. None.

5. Two parallel wires carrying currents in opposite direction.

a. repel each other b. attract each other
c. cancel each other d. None

6. A proton moving with a constant velocity passes through a region of space without change in its velocity. If E and B represents electric and magnetic fields respectively, this region of space may not have.

a. $E = 0, B = 0$ b. $E = 0, B \neq 0$
c. $E \neq 0, B = 0$ d. $E \neq 0, B \neq 0$

7. If two streams of protons move parallel to each other in the same direction, then there.

a. Do not interact at all
b. Attract each other
c. Repel each other
d. Deflect perpendicular to plane of streams.

8. A strong magnetic field is applied on a stationary electron, then the electron.

a. Moves in direction of field
b. Moves in an opposite direction of field
c. remains stationary
d. starts spinning.

9. A uniform electric field and a uniform magnetic field are produced, pointed with its velocity pointed in same direction the electron velocity will.

a. increase b. decrease
c. Not change d. change in direction

10. If a long copper rod carries a direct current the magnetic field associated with the current will be.

a. Only inside the rod
b. only outside the rod
c. both inside and outside the rod
d. neither inside nor outside the rod.

11. A conductor of length 1m and carrying current of 1 A is placed perpendicular to the magnetic field of 1 gauss the magnetic force acting on the conductor is:

a. Zero b. 1N
c. 10^{-4} N d. 1 dyne

12. A proton, deuteron and an $\propto$ particle enters a magnetic field perpendicular to field with the same velocity. What is the ratio of the radii of the circular paths?

a. 1:2:2 b. 2:1:1
c. 1:1:2 d. 1:2:1

13. If a charged particle is describing a circle of radius r in a magnetic field with a time period T_1 then

a. $T^2 \propto r^3$ b. $T^2 \propto r$
c. $T \propto r^2$ d. $T \propto r^0$

14. A proton, deuteron and an ∝ particle accelerated through the same potential difference enters a region of uniform magnetic field, moving at right angles to B. What is the ratio of their k.ε?

a. 2:1:1 b. 2:2:1

c. 1:2:1 d. 1:1:2

15. A proton of energy 1 Mev moves in a uniform magnetic field along a circular path. The energy of ∝ particle is circulate along the same orbit in same magnetic field is:

a. 1Mev b. 2Mev

c. 3Mev d. 4 Mev

16. Two particles x and y having equal charges, after being accelerated through the same potential difference, enter a region of uniform magnetic field and describe circular path of radius R_1 and R_2 respectively. The ratio of mass of x to y is:

a. $\sqrt{\frac{R_1}{R_2}}$ b. $\frac{R_2}{R1}$

c. $\left(\frac{R_1}{R_2}\right)^2$ d. $\frac{R_1}{R_2}$

17. If B_1 is the magnetic field induction at a point on the axis of a circular coil of radius r situated at a distance $R\sqrt{3}$ and B_2 is the magnetic field at the centre of the coil, the ratio of $\frac{B_1}{B_2}$ is equal to.

a. $\frac{1}{3}$ b. $\frac{1}{8}$

c. $\frac{1}{4}$ d. $\frac{1}{2}$

18. A long, straight, solid metal wire of radius 2mm carries a current uniformly distributed over its circular cross section. The magnetic field induction of a distance 2mm from its axis is B. Then the magnetic field induction at distance 1mm from the axis will be.

a. B b. $\frac{B}{2}$

c. 2B d. 4B

19. Ratio of magnetic field induction at the centre of a current carrying coil of radius r and at a distance 3r on its axis is:

a. $\sqrt{10}$ b. $2\sqrt{10}$

c. $10\sqrt{10}$ d. $20\sqrt{10}$

20. The mass of a proton is 1847 times that of electron. If an electron and a proton are injected in a uniform electric field at right angle to the direction of the field with the same kinetic energy, then:

a. Trajectory of proton is less curved

b. Trajectory of electron is less curved.

c. Both the trajectories will be straight.

d. Both the trajectories will be equally curved.

21. An electron and a proton having same kinetic energy enter a magnetic field perpendicularly. Which of the following is true?

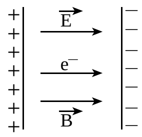
a. Trajectory of electron is lees curved

b. Trajectory of protons is less curved.

c. Both the trajectories are equally curved

d. Both move on straight line path.

22. A uniform electric field and uniform magnetic field are pointed in same direction. If an electron is projected the same direction, the electron.



a. Will turn to its left

b. will turn to its right

c. velocity will increase in magnitude

d. velocity will decrease in magnitude

23. A particle of charge q and mass m moves in a circular orbit of radius r with angular speed ω. The ratio of the magnitude of its magnetic moment to that of its angular momentum depends on.

a. ω and q b. ω, q and m

c. q and M d. ω and M

24. Two wires of same length are shaped into a square and a circle. If they carry same currents the ratio of magnetic moments is:

a. 2:π b. π:2
c. π:4 d. 4:π

25. An electron moving upwards vertically enters a uniform magnetic field directed towards the north. The force on the electron will be towards.

a. North b. east
c. west d. south

26. The frequency of the charged particle moving at right angle to the magnetic field is independent of:

a. The radius of circular trajectory
b. The speed of the particle
c. both 'a' and 'b'
d. the magnetic induction B.

27. an electron accelerated through a potential difference of 'v' volt enter normally in a uniform magnetic field and experiences force experienced by the electron will be

a. $\sqrt{2}$ F b. $\frac{F}{\sqrt{2}}$
c. F d. None

28. An electron moves in a circular orbit with a uniform speed V. It produces a magnetic field B at the centre of the circle. The radius of the circle is proportional to.

a. $\sqrt{\frac{V}{B}}$ b. $\frac{V}{B}$
c. $\frac{B}{V}$ d. $\frac{B}{V^2}$

29. Two protons move parallel to each other with equal speeds 3 × 10^5m/s. The ratio of the magnetic and electrical force between them is:

a. 10^{-3} b. 10^{-9}
c. 10^{-6} d. 1

30. A proton of kinetic energy 2Mev is moving perpendicular to a uniform magnetic field of 2.5T the force on the proton is:

a. 8 × 10^{-12}N b. 2.5 × 10^{-10}N
c. 2.5 × 10^{-11} N d. 8 × 10^{-11}N

31. An electric field of 1 volt/cm and magnetic field of 2T act on a moving electron to produce no force. What is the speed of electron?

a. 50m/s b. 2cm/s
c. 0.5cm/s d. 20cm/s

32. A current of 10A is flowing in a wire of length 1.5m which experiences a force of 15N in magnetic field of 2 Tesla. The angle between the magnetic field and the direction of the current is.

a. 30° b. 45°
c. 60° d. 90°

33. A proton and α particle enter a uniform magnetic field perpendicular with the same speed. If proton takes 20μ second to make 5 revolutions, then the periodic time for α particle would be:

a. 5 μ sec b. 8μ sec
c. 10μ sec d. 16μ sec

34. A wire is wound in the form of solenoid of length *l* and diameter d. When a strong current is passed through a solenoid there is tendency to.

a. Kept both *l* and d comtant
b. decrease both *l* and d
c. increase both *l* and d
d. decrease *l* and increased d.

35. A current carrying coil is subjected to a uniform magnetic field. The coil will orient so that its plane becomes.

a. inclined at 45° to the magnetic field.
b. Inclined at any arbitrary angle to the magnetic field.
c. Parallel to magnetic field
d. Perpendicular to magnetic field.

36. The force existing between two parallel current carrying conductors is F. If the current in each conductor is doubled, then the value of force will be.

a. 2F b. 4F

c. F d. $\frac{F}{2}$

37. Force per unit length at one end of each of two parallel wires, carrying current I each, kept distance r apart is:

a. $\frac{\mu_0 I^2}{4\pi r}$ b. $\frac{\mu_0}{4\pi}\frac{2I^2}{r}$

c. $\frac{\mu_0}{4\pi}\frac{(2I)^2}{r}$ d. $\frac{\mu_0}{4\pi}\frac{I^2}{4r}$

38. In a current carrying long solenoid the field produced doesnot depend upon

a. Number of turns per unit length

b. Current flowing

c. Radius of the solenoid

d. all of them

39. Two long parallel wires are at a distance of 1 metre. both of them carry one ampere of current. The force of attraction per unit length between two wires is:

a. 2×10^{-7}N/m

b. 2×10^{-8}N/m

c. 10^{-8}N/m

d. 10^{-7} N/m

40. A long solenoid has 800 turns per meter length of solenoid. A current of 1.6A Flows through it. The magnetic induction at the end of the solenoid on its axis is:

a. 16×10^{-4}T

b. 8×10^{-4}T

c. 32×10^{-4}T

d. 4×10^{-4}T

Answer Sheet

1. b	*2. d*	*3. c*	*4. b*	*5. a*	*6. c*	*7. c*	*8. c*	*9. b*	*10. c*
11. c	*12. a*	*13. d*	*14. d*	*15. a*	*16. c*	*17. b*	*18. b*	*19. c*	*20. d*
21. b	*22. d*	*23. c*	*24. c*	*25. b*	*26. c*	*27. a*	*28. a*	*29. c*	*30. a*
31. a	*32. a*	*33. b*	*34. d*	*35. d*	*36. b*	*37. a*	*38. c*	*39. a*	*40. b*

Solution

1. Ans. (b)

When projected perpendicular to field, path followed is circular.

work done = zero

2. Ans. (d)

If electron moves in a direction parallel or anti parallel to magnetic field $\rightarrow$ straight line path. If angle other than 0°, 90°, 180° $\rightarrow$ Spiral path.

3. Ans. (c)

When an electric charge is moving in free space both electric and magnetic fields are produced.

4. Ans. (b)

When current flows through a wire, electrons move inside it along a definite direction. So magnetic field is produced.

A current carrying wire conductor is electrically neutral so doesn't produce electric field.

5. Ans. (a)

Force is attractive if current are parallel and repulsive if current are anti parallel.

6. Ans. (c)

Magnetic field has no effect on velocity magnitude. If E = 0, Velocity is constant.

If $E \neq 0$, Effect of E may be cancelled by B which is possible in option d.

So, $E \neq 0$, $B = 0$ is not possible for its constant velocity.

7. Ans. (c)

Since, they constitute current in same direction, there is magnetic attraction between the streams. But by virtue of being like charges, there is also electrostatic force of repulsion.

Fe > Fm so repulsion > attraction

8. Ans. (c)

$Fm = Bqv \sin\theta$

As $V = 0$, $Fm = 0$

So, No magnetic force acts on a stationary charge.

9. Ans. (b)

Magnetic field has no effect on velocity. In the direction of electric field, velocity of electron decreases and that of proton increases.

10. Ans. (c)

If a direct current is passed through a long copper rod, the magnetic field exists both inside and outside the rod. The magnetic field induction inside the rod, bar and outside the rod,

$B \propto \frac{1}{r}$

11. Ans. (c)

$F = BIL \sin\theta = 10^{-4} \times 1 \times 1 \times \sin 90 = 10^{-4}$

12. Ans. (a)

$r = \frac{Mv}{Bq}$

As v is same

$r_1 : r_2 : r_3 = \frac{m_1}{q_1} : \frac{m_2}{q_2} : \frac{m_3}{q_3}$

$= \frac{p}{e} : \frac{2p}{e} : \frac{4p}{2e} = 1:2:2$

13. Ans. (d)

Time period is independent of radius and velocity for a charged particle describing a circular path in uniform magnetic field.

$T = \frac{2\pi M}{Bq}$

14. Ans. (d)

K.ε gained by charged particle of charge 'q' when accelerated under potential difference v is.

Ek = qv for given v, $Ek \propto q$ for proton, deuteron and $\propto$ particle, the ratio of charges is 1:1:2

Hence ratio of their k.E = 1:1:2

15. Ans. (a)

$r = \frac{mv}{Bq} = \frac{p}{Bq} = \frac{\sqrt{2mE_k}}{Bq}$

$\frac{r_1}{r_2} = \sqrt{\frac{m_1}{m_2} \times \frac{Ek_1}{Ek_2} \times \frac{q_2}{q_1}}$

$1 = \sqrt{\frac{p}{4p} \times \frac{Ek_1}{Ek_2} \times \frac{2e}{e}}$

$1 = \sqrt{\frac{Ek_1}{Ek_2}}$

$EK_2 = Ek_1 = 1Mev$

16. Ans. (c) $\frac{1}{2}mv^2 = qV$

$v = \sqrt{\frac{2qV}{m}}$ Now,

$r = \frac{mv}{Bq} = \frac{m}{Bq}\sqrt{\frac{2qV}{m}} = \frac{1}{B}\sqrt{\frac{2mV}{q}}$

$r \propto \sqrt{m}$, $r^2 \propto m$

$\frac{m_1}{m_2} = \left(\frac{r_1}{r_2}\right)^2 = \left(\frac{R_1}{R_2}\right)^2$

17. Ans. (b)

$B_1 = \frac{\mu_0 NIR^2}{2(R^2 + x^2)^{\frac{3}{2}}} = \frac{\mu_0 NIR^2}{2[R^2 + (\sqrt{3}R)^2]^{\frac{3}{2}}}$

$B_2 = \frac{\mu_0 NI}{2R}$

$\frac{B_1}{B_2} = \frac{R^2 \times R}{(R^2 + 3R^2)^{\frac{3}{2}}} = \frac{R^3}{4^{3/2} \times R^3} = \frac{1}{8}$

18. Ans. (b)

At a point inside the solid metal wire carrying current, $B \propto r$

i.e. $\frac{B_1}{B_2} = \frac{r_1}{r_2}$

$\therefore\ B_2 = \frac{r_2}{r_1} \times B_1 = \frac{1}{2} B = \frac{B}{2}$

19. Ans. (c)

$$\frac{B_1}{B_2} = \frac{\frac{\mu_0 NI}{2R}}{\frac{\mu_0 NIR^2}{2[R^2 + (3R)^2]^{\frac{3}{2}}}} = \frac{10^{\frac{3}{2}} R^3}{R^3} = 10\sqrt{10}$$

20. Ans. (d)

$Ek = \frac{1}{2} mv^2$

$\Rightarrow mv^2 = 2Ek$ Now,

$y = \frac{1}{2} at^2 = \frac{1}{2} \frac{F}{M} t^2$

$y = \frac{1}{2} \frac{qE}{m} \frac{x^2}{v^2}$

or, $y = \frac{1}{2} \frac{qEx^2}{2Ek} = \frac{qEx^2}{4Ek}$

y is independent of m, so for same Ek, both the trajectories will be equally curved.

21. Ans. (b)

$r = \frac{mv}{Bq} = \frac{P}{Bq} = \frac{\sqrt{2MEk}}{Bq}$

or, $\frac{re}{rp} = \sqrt{\frac{me}{mp}}$

$\therefore$ re < rp

As the radius of proton is greater, its trajectory will be less curved.

22. Ans. (d)

The electron experiences no force due to the magnetic field (F = Bqv sin o° = 0) The electron experiences a force due to the electric field which is $\vec{F} = -e\vec{E}$

This force acts opposite to the direction of electric field and caused retardation of electron. Hence the velocity will decrease in magnitude.

23. Ans. (c)

Magnetic moment, M = IA

$= \frac{q}{t} \times \pi r^2 = \frac{q\omega}{2\pi} \times \pi r^2 = \frac{1}{2} q\omega r^2$

Angular momentum,

$L = Mvr = m(r\omega).\ r = m\omega r^2$

$$\frac{M}{L} = \frac{\frac{1}{2} q\omega r^2}{m\omega r^2} = \frac{q}{2m}$$

Hence, this ratio depends on q and m.

24. Ans. (c)

For a square $L = 4l \Rightarrow l = \frac{L}{4}$

$A_1 = l \times l = l^2 = \frac{L^2}{16}$

For a circle

$L = 2\pi r \Rightarrow r = \frac{L}{2\pi}$

$A_2 = \pi r^2 = \pi \left(\frac{L}{2\pi}\right)^2 = \frac{L^2}{4\pi}$

$$\frac{M_1}{M_2} = \frac{A_1 I}{A_2 I} = \frac{\frac{L^2}{16}}{\frac{L^2}{4\pi}} = \frac{\pi}{4}$$

25. Ans. (b) Using fleming's left hand rule for a +vely charged particle, the force is towards west. So for a -vely charged particle electron, the force is towards the east.

26. Ans. (c) $f = \frac{Bq}{2\pi m}$

i.e. independent of

radius of circular trajectory and speed of the particle.

27. Ans. (a)

$\frac{1}{2} MV^2 = eV$

$v = \sqrt{\frac{2eV}{m}}$

$F = Bev = Be\sqrt{\frac{2eV}{m}} = \frac{\mu_0 eV}{4\pi r^2}$

$F = Be\sqrt{\frac{2eV}{m}}$

$F \propto \sqrt{v}$

$F = \sqrt{2}\ F$ when v is doubled.

28. Ans. (a)

$I = \frac{e}{T} = \frac{e}{\frac{2\pi r}{v}} = \frac{eV}{2\pi r}$

$B = \frac{\mu_0}{4\pi} \times \frac{2\pi I}{r}$

$= \frac{\mu_0 I}{2r} = \frac{\mu_0}{2r} \times \frac{eV}{2\pi r} = \frac{\mu_0 eV}{4\pi r^2}$

$r^2 = \frac{\mu_0 ev}{4\pi B} \Rightarrow r \propto \sqrt{\frac{V}{B}}$

29. Ans. (c)

$\frac{Fm}{Fe} = \frac{V_1V_2}{C^2}$

$= \left(\frac{3 \times 10^5}{3 \times 10^8}\right)^2 = 10^{-6}$

30. Ans. (c)

$F = Bqv = Bq\sqrt{\frac{2e}{M}}$

$= 2.5 \times 1.6 \times 10^{-19} \sqrt{\frac{4 \times 1.6 \times 10^{-13}}{1.67 \times 10^{-27}}}$

$= 8 \times 10^{-12}N$

31. Ans. (a)

For no deflection

F = eE = Bev

$\Rightarrow v = \frac{E}{B} = \frac{10^2}{2} = 50m/s$

32. Ans. (a)

$F = BIL \sin\theta$

$\sin\theta = \frac{F}{BIL}$

$= \frac{15}{2 \times 10 \times 1.5} = \frac{1}{2} = \sin 30$

$\Rightarrow \theta = 30°$

33. Ans. (b)

Time taken by proton for one revolution.

$= \frac{20}{5} = 4\mu s$

Now, $T = \frac{2\pi m}{Bq} \alpha \frac{m}{q} \Rightarrow \frac{T_2}{T_1} = \frac{m_2}{q_2} \times \frac{q_1}{m_1}$

$T_2 = \frac{T_1 \times q_1 \times m_2}{q_2 \times m_1} = \frac{4 \times q \times 4m_1}{2q \times m_1} = 8\mu S$

34. Ans. (d)

Two circular coils carrying current in the same direction attract each other. Due to which length of the solenoid decreases. A radial outward force is acting on each turn of the solenoid by the virtue of current and magnetic field set up, hence diameter of solenoid will increase.

35. Ans. (d)

Torque $\vec{\tau} = \vec{M} \times \vec{B} = MB \sin\theta$ where $\vec{M}$ is perpendicular to plane of the coil. Due to this torque, the coil will orient itelf so that torque in coil is zero i.e. $\theta = 0°$. It means $\vec{M}$ is parallel to $\vec{B}$. So the plane of coil is perpendicular to the direction of magnetic field.

36. Ans. (b)

As $F = \frac{\mu_0 2 i_1 i_2}{4\pi r}$

i.e. $F \propto i_1 i_2$

F' = 4F

37. Ans. (a)

Magnetic field induction at a point distance r near one end of a linear wire carrying current I is :

$B = \frac{\mu_0 I}{4\pi r}$ (Sin0° + sin 90°)

$= \frac{\mu_0 I}{4\pi r}$

Force acting per unit length of each wire

$= BIl = \frac{\mu_0 I}{4\pi r} \times I \times 1$

$= \frac{\mu_0 I^2}{4\pi r}$

38. Ans. (c)

In a current carrying long solenoid the field produced is $B = \mu_0 ni$ independent of radius of solenoid.

39. Ans. (a)

The force of attraction between two wires is given by:

$$F = \frac{\mu_0}{4\pi}\frac{2i_1i_2}{r}$$

$$= \frac{10^{-7} \times 2 \times 1 \times 1}{1} = 2 \times 10^{-7}\text{N/m}$$

40. Ans. (b)

We know In case of solenoid, B = $\mu_0$ni At the end.

$$B_{end} = \frac{\mu_0 ni}{2}$$

$$= \frac{4\pi \times 10^{-7} \times 800 \times 1.6}{2} = 8 \times 10^{-4}\text{T}$$

Past Questions

1. An electron enters in a magnetic field of 10^{-3}T normally with velocity 10^6m/s. The radius of path of electrons is (MOE 2068 Asadh)

a. 11.4cm b. 11.4mm
c. 5.7cm d. 5.7mm

2. An alpha particle makes a complete revolution in a circular path of radius 0.8m in 2 seconds. The magnetic field induction in tesla at the centre of the circle will be (MOE 2068 Kartik)

a. $0.5 \times 10^{-19}\mu_0$ b. $0.3\times10^{-19}\ \mu_0$
c. $1 \times 10^{-19}\ \mu_0$ d. $0.2 \times 10^{-19}\ \mu_0$

3. If electron, Proton, neutron and alpha particle are deflected in the same electric field with same velocity. Which will have greater deflection? [MOE 2060]

a. Electron b. Proton
c. Neutron d. α Particle

4. An electron passing in direction east and perpendicular to magnetic field acts towards electron. The direction of the effect of electron is towards (MOE 2067)

a. South b. East
c. West d. North

5. An electric charge q moves with a constant velocity v parallel to the lines of force of uniform magnetic field B. The force experienced by the charge is (MOE 2067)

a. qVB b. $\frac{qv}{B}$
c. $\frac{BV}{q}$ d. Zero

6. A solenoid of length 20cm and diameter 2cm has 4250 turns If a current of 2A is flowing through it, what is the magnetic field at the centre of the solenoid? (MOE 066)

a. 5.2×10^{-2} web/m^2
b. 2.3×10^2 web/m^2
c. 6.3×10^2 web/m^2
d. 10.3×10^2web/m^2

7. An electron enter in magnetic field with velocity 2×10^6m/s perpendiuclar to the field of 2×10^{-5}T. What is the radius of the path of electon? (MOE 2065)

a. 0.57m b. 7.5m
c. 2.4cm d. 0.24m

8. An electron is moving with a velocity V and enters a uniform electric field perpendicularly. Its trajectory within the field will be (MOE 2009)

a. Parabolic b. circular
c. Hyperbolic d. Elliptical

9. A charged particle enters in a magnetic field perpendiular to the magnetic lines of force. The path of the particle is (Banglandesh 09)

a. Straight line b. Circular
c. Ellipse d. Spiral

10. A long wire caries a current of 0.5A. The flux density at a distance of 0.01 m is

(Bangladesh Emb.)

a. 2×10^{-5} b. 5×10^{-5}
c. 10^{-5} d. 10^{-7}

11. A coil of area 50cm^2 is perpendicular to a uniform field of flux density 10^{-3} w/m^2. The flux passing through the coil is [MOE 2002]

a. 5×10^{-5}weber b. 5×10^{6}weber
c. 6×10^{-6}weber d. 6×10^{-6}weber

12. A magnetic needle is kept in a non – uniform magnetic field. If experiences (MOE 2062)

a. A force and a torque
b. A force but not torque
c. A torque but not force
d. Neither a force nor torque

13. An electron is moving in circular path in a magnetic field intensity B, then its time period is independent of (MOE 2050)

a. Speed b. Mass
c. Magnetic field d. Charge

14. Suppose, we double the current flowing, the number of turns and length of the coil of a long solenoid. If the original value of magnetic field inductions is B, then what is the value of new magnetic field induction (MOE 2053)

a. 2B b. $\frac{B}{2}$
c. 3B d. 8B

15. When a charged particles enters in strong magnetic field, its K.E (IOM 2011)

a. Increases
b. Decreases
c. Remains constant
d. First increases and becomes constant.

16. Two thin long parallel wires separated by a distance 'b' are carrying a current 'i' each. the magnitude of force per unit length exerted by one wire on the other is (IOM 08)

a. $\frac{\mu_0 i^2}{b}$ b. $\frac{\mu_0 i^2}{2\pi b}$
c. $\frac{\mu_0 i}{2\pi b}$ d. $\frac{\mu_0 i^2}{2\pi b^2}$

17. If a wire carrying current 'I' is bent to two arms making right angles between them, then the magnetic field intensity 'B' at a distance 'a' from both arms is: (IOM 03)

a. $\frac{\mu_0 I}{4\pi a}$ b. $\frac{\mu_0 I}{2a}$
c. $\frac{\mu_0 I}{\sqrt{2}\, 2\pi a}$ d. $\frac{\mu_0 I}{2(a+\sqrt{a})}$

18. When a charge moves in a direction perpendicular to magnetic field, then (BPKIHS, 2010)

a. KE is constant, Momentum changes.
b. Momentum is constant, KE changes
c. Both KE and Momentum changes
d. Both velocity and momentum are constant.

19. A charged particle enters a magnetic field at right angles to the magnetic field. The field exists for a length equal to 1.5 times the radius of the circular path of the particle. The particle will be deviated from its path by (BPKIHS – 09)

a. 90° b. $\text{Sin}^{-1}\left(\frac{2}{3}\right)$
c. 30° d. 180°

20. A wire of length '*l*' carries a steady current. It is about first to form a circular plane loop of one turn. The magnetic field at the centre of the loop is B. The same length is now bent more sharply to give a double loop of smaller radius. The magnetic field at the centre caused by same is (BPKHS - 08)

a. B b. $\frac{B}{4}$
c. 4B d. $\frac{B}{2}$

21. When an electric beam is shot horizontally an electric field and perpendicular to a magnetic field, then beam follows: (BPKIHS)

a. Circular paths in both fields

b. Circular path in electric and parabolic in magnetic
c. Parabolic paths in both fields
d. Parabolic path in electric and circular in magnetic field.

22. A charge of 1C is moving in a magnetic field of 0.5T with velocity of 10m/s, force experienced by charge is (IE 2010)

a. 5N b. 10N
c. 50N d. 100N

23. An electron of mass = 9 × 10^{-31} kg, charge = 1.6 × 10^{-19}C moving with a velocity of 10^{6} M/s enters a region where magnetic field exists. It is described on a circle of radius 0.1m, the strength of magnetic field must be (IE-08)

a. 1.8 × 10^{-4}T
b. 5.6 × 10^{-5}T
c. 14.4 × 10^{-1}T
d. 1.4 × 10^{-6} T

24. Magnetic filed donot interact with (IE-08)

a. Stationary electric charge
b. Moving electric charge
c. Stationary permanent magnet
d. Moving permanent magnet

25. Magnetic field invariably contain (IE–07)

a. a ferromagnetic material
b. inductance
c. electric current
d. Energy

26. The net force on a magnetic dipole in a uniform magnetic field (IE – 07)

a. Towards south pole
b. Towards North Pole
d. Zero
d. Not enough information given

27. Energy stored in magnetic field of 2.5 × 10^{-3}T is: (IE – 05)

a. 2.48J b. 0.48J
c. 3.48J d. 4.48J

28. If a rectangular coil is set with plane of symmetry alone z – axis in a parallel magnetic field, then torque experienced by coil is (IE–05)

a. BINA b. Zero
c. BAN d. BIL

Answer Sheet

1. d	*2. c*	*3. a*	*4. a*	*5. d*	*6. a*	*7. a*	*8. a*	*9. b*	*10. c*
11. b	*12. a*	*13. a*	*14. a*	*15. c*	*16. b*	*17. c*	*18. a*	*19. d*	*20. c*
21. d	*22. b*	*23. b*	*24. a*	*25. d*	*26. c*	*27. a*	*28. b*		

Solution

1. Ans: (d)

$$r = \frac{mv}{Bq} = \frac{V}{\left(\frac{e}{m}\right)B}$$

$$= \frac{10^{6}}{1.76 \times 10^{11} \times 10^{-3}}$$

$$\left[\frac{e}{m} \text{ for electron} = 1.76 \times 10^{11}\right]$$

$= 5.6 \times 10^{-3}$m

= 5.6mm

2. Ans. (c)

$$B = \frac{\mu_0 I}{2R} \text{ [At centre]}$$

$$I = \frac{q}{t} = \frac{ne}{t} = \frac{2e}{t}$$

$$= \frac{2 \times 1.6 \times 10^{-19}}{2} = 1.6 \times 10^{-19}$$

$B = \frac{\mu_0 I}{2R} = \frac{\mu_0 \times 1.6 \times 10^{-19}}{2 \times 0.8} = 10^{-19}\mu_0$

3. **Ans. (a)**

Deflection in electric field $y = \frac{1}{2}at^2 = \frac{1}{2}\left(\frac{qE}{m}\right)t^2$

$y \ \alpha \ \frac{q}{m}$

$\left(\frac{q}{m}\right)_e > \left(\frac{q}{m}\right)_p > \left(\frac{q}{m}\right)_\alpha > \left(\frac{q}{m}\right)_n$

4. **Ans. (a)**

Using right hand thumb rule, representing direction of motion of electron (east), four fingers representing the direction of magnetic field (downwards) and the darker side hand representing the direction of electron. (South)

5. **Ans. (d)**

F = Bqvsinθ where = θ = angle between $\vec{V}$ & $\vec{B}$

Here, θ = 0°

F = Bqvsin0° = 0

6. **Ans. (a)**

$B = \mu_0 nI$

$= 4\pi \times 10^{-7} \times \frac{4250}{0.2} \times 2$

$= 0.053 = 5.3\times 10^{-2}$ web/m^2

7. **Ans. (a)**

$F = BqV = \frac{Mv^2}{r}$

$r = \frac{Mv}{Bq} = \frac{9.1 \times 10^{-31} \times 2 \times 10^6}{2 \times 10^{-5} \times 1.6 \times 10^{-19}} = 0.57$m

8. **Ans. (a)**

Path of electron in transverse electric field is parabolic.

$y = \frac{1}{2}at^2 = \frac{1}{2}\ \frac{eE}{m}\ t^2$

$y = \frac{1}{2}\frac{eE}{m}\left(\frac{x^2}{v^2}\right) = \frac{eE}{4Ek}x^2$

Since e, E, Ek are constant for given equation

$\therefore$ y α x^2 (parabolic equation)

9. **Ans. (b)**

If electron moves in a direction parallel or anti-parallel to the magnetic field. The path is straight line.

If angle between direction of charged particle and magnetic field is other than 0°, 90° or 180° then path is helical (Spiral)

10. **Ans. (c)**

$\phi = BA \Rightarrow B = \frac{\phi}{A}$ = Fluxdensity for straight current carrying conductor of infinite length.

$B = \frac{\mu_0 I}{2\pi r} = \frac{4\pi \times 10^{-7} \times 0.5}{2\pi \times 0.01}$

$= 10^{-5}$Tesla.

11. **Ans. (b)**

$B = \frac{\phi}{A} \Rightarrow \phi = BA$

$\phi \Rightarrow (10^{-3}$ wbm$^{-2}) \times 50 \times 10^{-4}$m^2

$= 5 \times 10^{-6}$ weber

12. **Ans. (a)**

Magnetic needle in non uniform magnetic field experiences → force and a torque .

Magnetic needle in uniform magnetic field → a torque but not a force.

13. **Ans. (a)**

$T = \frac{2\pi m}{Bq}$

So, time period and frequency independent of speed & radius of circular path. Magnetic force changes only the direction of particles

So, work done = zero

14. **Ans. (a)**

Magnetic Field at the axis of solenoid

$B = \mu_0 nI = \frac{\mu_0 NI}{l}$

Where, n = no. of turns

Per unit length and

N = Total no. of turns

$$B^1 = \frac{\mu_0 (2N)2I}{(2l)} = 2B$$

15. Ans. (c)

When a charged particle enters, a strong magnetic field, it moves in a circular path of radius (R) = $\frac{mv}{Bq}$.

In this case, velocity change continuously as direction changes but magnitude = constant. Hence KE = constant.

16. Ans. (b)

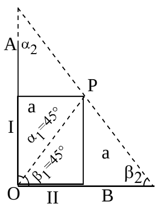
Force per unit length between two infinitely long current carrying conduction at a separation r is given by:

$$\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2\pi r}$$

Hence, in given condition

$$\frac{F}{l} = \frac{\mu_0 i.i}{2\pi b} = \frac{\mu_0 i^2}{2\pi b}$$

17. Ans. (c)



Magnetic field intensity at 'p' due to segment I.

$$B_1 = \frac{\mu_0}{4\pi a}\ (\text{Sin}45 + \sin\alpha 2)$$

α_2 = 180 for infinitely long wire

$$B_1 = \frac{\mu_0}{4\sqrt{2}\pi a}$$

Since the field by both arms is in same direction resultant

$$B = 2 \times \frac{\mu_0}{4\sqrt{2}\pi a} = \frac{\mu_0 I}{2\sqrt{2}\pi a}$$

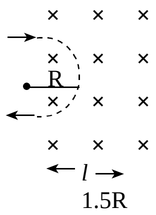
18. Ans. (a)

The charge starts moving in a circular path of radius r = $\frac{mv}{Bq}$

Velocity changes direction continuously but magnitude remains same so KE = constant but momentum changes direction.

19. Ans. (d) 180°

A charged particle entering perpendicular to a magnetic field can suffer 180° deflection if length of magnetic field ≥ radius of the path.



20. Ans. (c)

For circular loop of one turn

$$B = \frac{\mu_0 nI}{2r} = \frac{\mu_0 I}{2r}$$

For circular loop of two is formed $r^1 = \frac{r}{2}$

and n = 2

$$B^1 = \frac{\mu_0 n' I}{2r^1} = \frac{2\mu_0 I}{2\,\frac{r}{2}} = \frac{4\mu_0 I}{2r}$$

$B^1 = 4B$

∴ $\boxed{B^1 = n^2 B}$, where 'n' is the no. of loops in which wire is bent.

21. Ans. (d)

Any charged particle in electric field always move in parabolic path and in magnetic field depends on angle of projection.

If parallel or antiparallel to magnetic fields is straight line.

– At 90°, its circular

– If angle between direction of charged particle is other than 0, 90, 180° then spiral

22. Ans. (b)

F = Bqv = 0.5 × 1 × 10= 5N

23. Ans. (b)

$$Bev = \frac{Mv^2}{r}$$

$$B = \frac{Mv}{re} = \frac{9.1 \times 10^{-31} \times 10^6}{0.1 \times 1.6 \times 10^{-19}} = 5.6 \times 10^{-5} T$$

24. Ans. (a)

Magnetic force (fB) = Bev

When v = 0 [V = velocity of charged particle]

$\therefore$ Force = 0

25. Ans. (d)

Magnetic field stores magnetic energy. Energy in inductor is stored in magnetic field and in capacitor it is stored in electric field.

26. Ans. (c)

For magnetic dipole in uniform magnetic field.

Net force on dipole = zero

27. Ans. (a)

$$E = \frac{B^2}{2\mu_0} = \frac{(2.5 \times 10^{-3})^2}{2 \times 4\pi \times 10^{-7}} = 2.48J$$

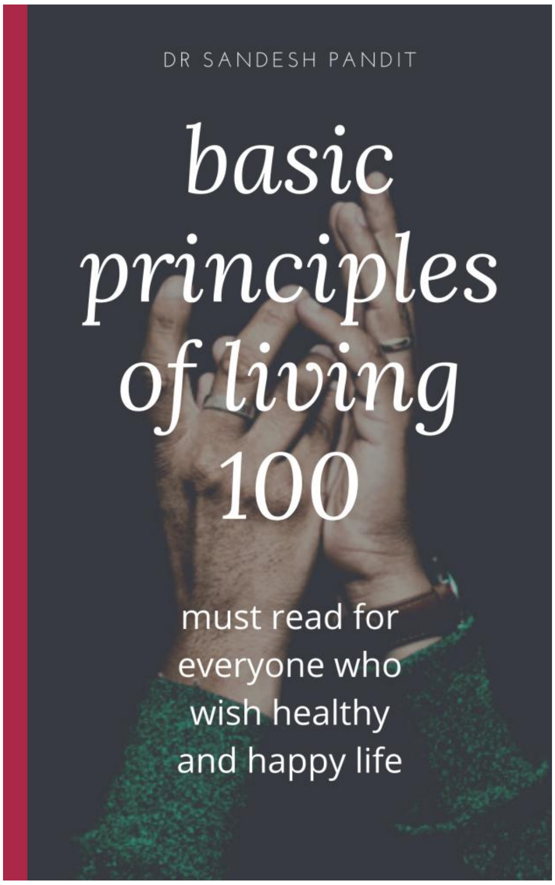
28. Ans. (b)

When magnetic field is parallel to z – axis than angle between plane of symmetry and magnetic field is 90°. As we know τ = BINA cosθ

where (θ = angle between the normal to the plane of the loop with the direction of uniform magnetic field.)

since $\theta = 90°$

$\therefore \tau = 0$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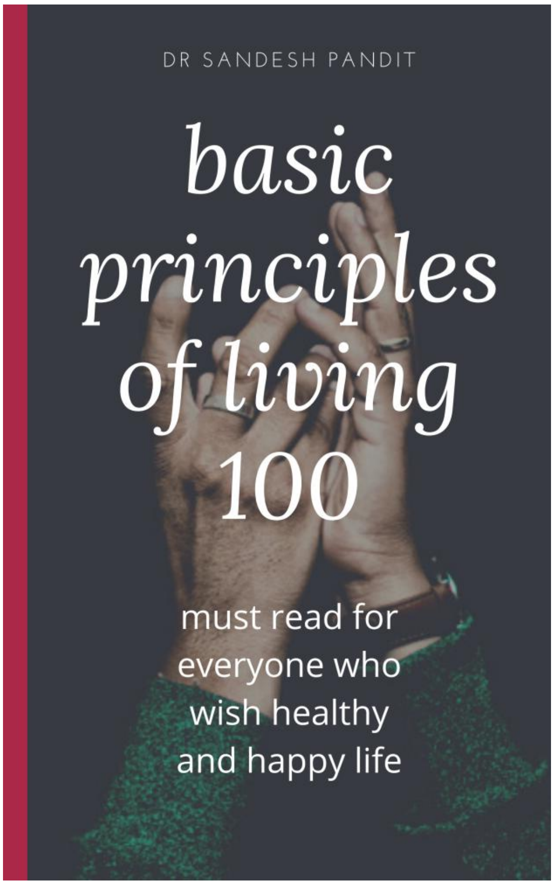
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Chapter: 36

Electromagnetic Induction

1. The self inductance of a coil is a measure of:
- a. Electrical inertia
- b. Electrical friction
- c. Induced emf
- d. Induced current

2. If N is the number of a coil, the value of self inductance varies as:
- a. N° b. N
- c. N^2 d. N^{-2}

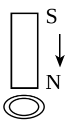
3. To induce emf in a coil, the magnetic flux linking:
- a. Must increase
- b. Must decrease
- c. Can either decrease or increase
- d. Must remain constant

4. The self inductance of straight wire is:
- a. Zero b. Infinity
- c. Negative d. Positive

5. Two pure inductors each of self inductance L are connected in series, the net inductance is:
- a. L b. 2L
- c. $\frac{L}{2}$ d. $\frac{L}{4}$

6. An inductor coil of inductance L is divided into two equal parts and both are connected in parallel. The net inductance is:
- a. $\frac{L}{2}$ b. $\frac{L}{4}$
- c. L d. 2L

7. A copper ring is held horizontally and bar magnet is dropped through the ring with its length along the axis of the ring. The acceleration of the falling magnet is:



- a. a > g b. a < g
- c. a = g d. None

8. A copper ring having a cut such as not to form a complete loops held horizontally and bar magnet is dropped through the ring with its length along the axis of the ring. Then acceleration of falling magnet is:
- a. g b. less than g
- c. more than g d. zero

9. When a bar magnet falls through a long hollow metal cylinder fixed with its axis vertical. The final acceleration of the falling magnet is .
- a. equal to g b. less than g
- c. greater than g d. zero

10. A magnet is moved towards a coil through a certain distance slowly in one case and quickly in second case. The induced emf is:
- a. More in first case
- b. More in second case
- c. equal in both case
- d. zero in either cases

11. A magnet is moved towards a coil through certain distance slowly in one case and quickly in second case The induced charge is.
- a. more in 1st case b. more in 2nd case
- c. equal in both cases
- d. zero in either cases

12. A current passing through a choke coil of 5H is decreasing at the rate of $2As^{-1}$. the emf developed across the coil is
- a. – 10V b. +10V
- c. 2.5V d. – 2.5V

13. A coil of inductance 10 Henry is broken in two equal parts, if both parts are placed close to each other such that flux linkage is complete, the mutual inductance of coils is:
- a. 10H b. 5H
- c. $\sqrt{10}$ H d. 20H

14. If the flux associated with a coil varies at the rate of 1 weber/min, the induced emf is:

a. 1V b. $\frac{1}{60}$V

c. 60V d. zero

15. The magnetic field in a coil of 100 turns and 40 square cm area is increased from 1 Tesla to 6 Tesla in 2 seconds. The magnetic field is perpendicular to the coil. The emf generated in it is:

a. 10^4V b. 1.2V

c. 1V d. 10^{-2}V

16. A squares coil of 10^{-2} m^2 area is placed perpendicular to a uniform magnetic field of intencity 10^3 Tesla. The magnetic flux through the coil is:

a. 10 Weber b. 10^{-5} weber

c. 10^5 weber d. zero

17. A cylindrical bar magnet is kept along the axis of a circular coil. The magnet is rotated about its axis such that north pole faces the coil. The induced current in the coil is:

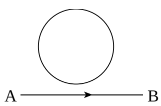
a. zero

b. anticlockwise from magnet side

c. clockwise from magnet side

d. may be clockwise or anticlockwise.

18. The current from A to B is increase in magnitude what is the direction of induced current, if any, in the loop shown?



a. no current is induced

b. clockwise current

c. anticlockwise current

d. alternating current

19. A circular coil and a bar magnet placed near by are made to move in the same direction. If the coil covers a distance of 1m in 0.5 sec and the magnet a distance of 2m in 1 sec, the induced emf. produced in the coil is:

a. 2v b. 1v

c. 0.5v d. zero

20. A coil is wound on a core of rectangular cross section. If all the linear dimensions of the case are increased by a factor 2 and number of turns per unit length of coil remains same the self inductance increases by a factor of.

a. 16 b. 8

c. 4 d. 2

21. If a coil of 40 turns and area 4cm^2 is suddenly removed from a magnetic field, it is observed that a charge of 2 × 10^{-4}C flows into the coil. If the resistance of the coil is 80Ω. The magnetic flux density in wb/m^2 is:

a. 0.5 b. 1

c. 1.5 d. 2

22. The inductance of a coil in which current increases linearly from zero to 0.1A in 0.2s producing a voltage of 5v is

a. 2H b. 5H

c. 10H d. 20H

23. The inductance of a coil in which a current of 0.1 A fields an energy storage in 0.05J is:

a. 2H b. 5H

c. 10H d. 20H

24. A helicopter rises vertically with a speed of 10m/s.

If helicopter has length of 10m and horizontal component of earth's magnetic field is 1.5 × 10^{-3} wb/cm^2, the emf. induced between the tip of the hose and tail of helicopter is:

a. 0.15V b. 125V

c. 130V d. 5V

25. A copper rod of length 1m is rotated about one end perpendicular to a uniform magnetic field of strength 2 gauss with a constant velocity of ω = 10 rad/sec. The emf. induced is:

a. 1V b. 1mV

c. 2mV d. 10V

26. A coil of mean area $500cm^2$ and having 100 turns is held perpendicular to a uniform field of 0.4 gauss. The coil is turned through 180° in $\frac{1}{10}$ second, the induced emf. is:

a. 4v b. 0.4v
c. 0.04v d. 4×10^{-3}v

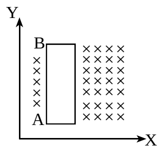
27. A rod of a material inserted between a coil increases the self – inductance appreciably the rod must be.

a. copper b. Aluminicum
c. iron d. wood

28. A coil and an electric bulb are connected in series with a DC source. A soft iron is now inserted in the coil, then

a. Intensity of bulb increases
b. Intensity of bulb decrease
c. Intensity of bulb remains same
d. The bulb ceases to glow

29. A conducting rod AB moves parallel to x–axis in a uniform magnetic field. Pointing inwards to the plane of the paper. The end A of the rod gets:



a. +vely charged b. –vely charged
c. neutral
d. first +vely charged then –vely charged

30. Magnetic flux ϕ in weber in a closed circuit of resistance 10Ω varies with the time t (sec) as. $\phi = 6t^2 - 5t + 1$. The magnitude of induced current at t = 0.25s is:

a. 0.2 A b. 0.6 A
c. 1.2 A d. 0.8 A

31. A coil of area A and Resistance R is kept inside a uniform magnetic field B normal to plane of coil, then charge induced in the coil if it is revolved end for end is:

a. zero b. $\frac{BA}{R}$
c. $\frac{BA}{2R}$ d. $\frac{2BA}{R}$

32. A coil of area $100cm^2$ having 50 turns is perpendicular to a magnetic field of intensity 0.02 weber/m^2. The resistance of the coil is 2 ohm. If it is removed in 1 sec from magnetic field, the induced charge produced is:

a. 5c b. 0.5c
c. 0.05c d. 0.005c

33. Two solenoids of same cross sectional area have their lengths and number of turns in ratio of 1:2. The ratio of self inductance of two solenoids is:

a. 1:1 b. 1:2
c. 2:1 d. 1:4

34. A coil of cross sectional area 100 cm^2 is placed in the magnetic field, which changes to 4×10^{-2} wb/m^2 within 5 sec. What will be current across 5Ω resistance?

a. 0.016A b. 0.16A
c. 1.6A d. 16A

35. A coil is wound on an iron core and looped back to itself so that core has two sets of closely wound coils carrying currents in opposite directions. The self inductance is:

a. zero b. 2L
c. 2L + M d. 2L + 2M

36. The number of turns of primary and secondary coils of a transformer are 5 and 10 respectively and mutual inductance of the transformer is 25H. Now the number of turns of primary and secondary are made 5 and 10 respectively. Mutual inductance of the transformer will be:

a. 25H b. 12.5H
c. 6.25H d. 50H

37. A transformer is used to reduce the mains supply of 220v to 11v. If the current in primary and secondary coils are 5A and 90A respectively. Efficiency of transformer is:

a. 90% b. 75%
c. 60% d. 40%

38. In a noiseless transformer an alternating current of 2A is following in the primary coil. The number of turns in the primary and Secondary coils are 100 and 20 respectively. The current in the secondary coil is:

a. 0.08A b. 0.4A

c. 5A d. 10A

39. The number of turns in a secondary coil is twice the number of turns in primary. A Leclanche cell of 1.5v is connected across the primary. The voltage across the secondary is:

a. 1.5v b. 3v

c. 240v d. zero

40. The number of turns in primary and secondary coils are 500 and 5000 respectively. Input voltage is 20v and frequency is 50 Hz. Then in output we have:

a. 5Hz b. 50 Hz

c. 500 Hz d. 2.5 Hz

41. When an electric motor is run at 120 volt, 10 ampere current flows through it and induced back emf is 115 volt. What will be the current flowing in the coil at the time of switch off ?

a. 230 A b. 240 A

c. 10 A d. zero

Answer Sheet

1. a	*2. c*	*3. c*	*4. a*	*5. b*	*6. b*	*7. b*	*8. a*	*9. d*	*10. b*
11. c	*12. b*	*13. b*	*14. b*	*15. c*	*16. a*	*17. a*	*18. b*	*19. d*	*20. b*
21. b	*22. c*	*23. c*	*24. a*	*25. b*	*26. c*	*27. c*	*28. b*	*29. b*	*30. a*
31. d	*32. d*	*33. b*	*34. b*	*35. a*	*36. a*	*37. a*	*38. d*	*39. d*	*40. b*
41. a									

Solution

1. Ans. (a)
the self–induction opposes both the growth and decay of the current in the coil.

2. Ans. (c)
Self inductance, $L = \frac{\mu_0 A N^2}{l}$
$L \alpha N^2$

3. Ans. (c)
To induce emf there must be rate of change of magnetic flux. The magnetic flux linking can either decrease or increase.

4. Ans. (a)
A straight wire has no number of turns as well as cross sectional area of turns is zero
As $L \alpha N^2$, $L \alpha A$

5. Ans. (b)
In Series,
$L_{eff} = L_1 + L_2 = L + L = 2L$

6. Ans. (b)
When an inductor of inductance L is divided into two equal parts, then each part has inductance $\frac{L}{2}$.

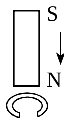
$\frac{1}{L_{eff}} = \frac{1}{L_1} + \frac{1}{L_2}$ (In parallel)

$L_{eff} = \frac{L}{4}$

7. Ans. (b)
The bar magnet is repelled upward due to existence of N–pole of induced current when the magnet falls down towards the coil and later on it is attracted towards the coil after passing through it hence a < g.

8. Ans. (a)

The ring is cut. so circuit is no closed. There will be no induction and magnet falls at constant acceleration 'g'.



9. Ans. (d)

Eddy current induced on the cylinder due to falling magnet exerts retarding force of increasing magnitude until the acceleration due to weight of the magnet is balanced.

10. Ans. (b)

$E = \frac{d\phi}{dt}$

As dt is small when magnet is moved quickly, therefore E is larger.

11. Ans. (c)

$q = \frac{\Delta\phi}{R}$

The induced charge that flows in the circuit depends on the change of flux only and not on how fast or slow the flux changes.

12. Ans. (b)

$E \;= -\frac{Ldt}{dt}$

$= -5 \times (-2)$

$= +10V$

13. Ans. (b)

$L = \mu 0 n^2 A l \; \alpha l$

After breaking in two parts of equal length

$L_1 = L_2 = \frac{L}{2} = 5H$

When coils are placed close to each other with perfect coupling, the mutual inductance is $M = \sqrt{L_1 \times L_2}$

$= \sqrt{5 \times 5} = 5H$

14. Ans. (b)

$E = \frac{d\phi}{dT} = 1Wb/min$

$= \frac{1}{60} wb/s$

$= \frac{1}{60}$ volt

15. Ans. (c)

Induced emf= rate of charge in magnetic flux

$E = \frac{d\phi}{dt} = NA\frac{\Delta B}{\Delta t}$

$= 100 \times 40 \times 10^{-4} \times \left(\frac{6-1}{2}\right) = 1V.$

16. Ans.(a)

$\phi \;= NaB\cos\theta$

$= 1 \times 10^{-2} \times 10^{3} \times \cos 0 = 10$ Weber

17. Ans. (a)

The cross section area of the cylindrical magnet is constant from every angle. on rotating the magnet no change in flux is linked with the coil. There fore the emf or current is zero.

18. Ans. (b)

According to right hand thumb rule, the magnetic flux through the loop due to the straight conductor is upwards and it is increasing due to increasing current along AB. So, the current induced in the loop should have magnetic flux in the down ward direction so as to oppose the increasing flux. Again, using right hand Thumb Rule, the direction of induced current in the loop is clockwise.

19. Ans.(d)

Velocity of coil $= \frac{1}{0.5} = 2m/s$

velocity of the magnet $= \frac{2}{1} = 2m/s$

As they are made to move in the same direction, their relative velocity is zero. Therefore, induced emf. = 0.

20. Ans. (b)

Self inductance of coil $L = \frac{\mu o N^2 A}{l}$ where N is total number of coil turns and l is its length. If n is number of turns perunit length, then $N = nl$

So, $L = \mu_0 n^2 A l \alpha \; A l \alpha$ (linear dimension)^3

$L \rightarrow 2^2 \times 2 \rightarrow 8$ times.

21. Ans. (b)

$q = \frac{\Delta\phi}{R} = \frac{NBA}{R}$

$B = \frac{q \times R}{N \times A} = \frac{2 \times 10^{-4} \times 80}{40 \times 4 \times 10^{-4}} = 1$

$\therefore$ B = 1wb/m^2

22. Ans. (c)

$E = \frac{d\phi}{dt} = \frac{LdI}{dt}$ (ϕ = LI)

$5 = L\left(\frac{0.1 - 0}{0.2}\right)$

$\Rightarrow$ L = 10H

23. Ans. (c) $U = \frac{1}{2}LI^2$

$L = \frac{2U}{I^2} = \frac{2 \times 0.05}{(0.1)^2} = 10H$

24. Ans. (a)

$E = Bl V = 1.5 \times 10^{-3} \times 10 \times 10 = 0.15V.$

25. Ans. (b)

$E = \frac{1}{2}B\omega l^2 = \frac{1}{2} \times 2 \times 10^{-4} \times 10 \times 1^2$

$= 10^{-3}V = 1mV$

26. Ans. (c)

$E = \frac{-d\phi}{dt} = \frac{-NBA(\cos 180° - \cos 0°)}{t}$

$= -\frac{-NBA(-1-1)}{t} = \frac{2NBA}{t}$

$= \frac{2 \times 1000 \times 0.4 \times 10^{-4} \times 500 \times 10^{-4}}{\frac{1}{10}}$

$= 4 \times 10^{-2} = 0.04V$

27. Ans. (c)

Ferromagnetic substance increases self inductance because it permeability is very high. So iron is the rod.

28. Ans. (b) $L = \frac{\mu_0\mu_r N^2 A}{l}$

A ferromagnetic material like a soft iron core has very high Permeability due to which L increases. Increase in L increases induced emf. as $E = \frac{LdI}{dt}$, due to which the intensity of the bulb decreases.

29. Ans. (b)

According to Fleming's Right Hand Rule, the direction of induced current is from A to B. The conventional direction of current flow in the direction of +ve charges and opposite to the direction of electron (–ve charges). So electrons get accumulated at end A. Thus, end A gets

–vely charged and end B gets +vely charged.

30. Ans. (a)

$E = \frac{d\phi}{dt} = \frac{-d}{dt}(6t^2 - 5t + 1)$

$= -12t + 5 = -12(0.25) + 5 = 2$ volt

$I = \frac{E}{R} = \frac{2}{10} = 0.2A$

31. Ans. (d)

$\phi i = BA$

$\phi f = BA \cos 180 = -BA$

$q = \frac{\Delta\phi}{R} = \frac{BA - (-BA)}{R} = \frac{2BA}{R}$

32. Ans. (d)

$q = \frac{Nd\phi}{R} = \frac{NBA}{R}$

$= \frac{50 \times 0.02 \times 100 \times 10^{-4}}{2} = 0.005$ c

Also Note charge induced is independent of time.

33. Ans. (b)

$L = \frac{\mu o N^2 A}{l} \; \alpha \; \frac{N^2}{l}$

$\frac{L_1}{L_2} = \frac{\left(\frac{1}{2}\right)^2}{\frac{1}{2}}$

$\frac{L_1}{L_2} = \frac{1}{2}$

34. Ans. (b)

$I = \frac{E}{R} = \frac{\frac{d\phi}{dt}}{R}$

$= \frac{A}{K}\left(\frac{dB}{dt}\right) = \frac{100 \times 4 \times 10^{-2}}{5 \times 5} = 0.16$ A

35. Ans. (a)

$L_s = L_1 + L_2 - 2m$ (As current is in opposite directions)

$= L + L - 2\sqrt{L.L} = 2L - 2L = 0$

36. Ans. (a)

$m = \dfrac{\mu_0 N_1 N_2 A}{l}$

$m \propto N_1N_2$

The product of $N_1N_2 = 50$ remains same in both the cases. So M remains unchanged.

37. Ans. (a)

$\eta = \dfrac{\text{Poutput}}{\text{Pinput}} \times 100\%$

$= \dfrac{V_2I_2}{V_1I_1} \times 100\% = \dfrac{11 \times 90}{220 \times 5} \times 100\% = 90\%$

38. Ans. (d)

$\dfrac{N_2}{N_1} = \dfrac{I_1}{I_2}$

or, $\dfrac{20}{100} = \dfrac{2}{I_2}$

or, $I_2 = 10A$

39. Ans. (d)

A Leclanche cell provides direct current. A transformer works only with ac and not with dc. So voltage across the secondary is Zero.

40. Ans. (b)

Frequency is not changed by transformer. A transformer actually transforms power. The main use of transformer is in transmission of ac over long distances at extremely high voltages.

41. Ans. (a)

$R = \dfrac{E - V}{I}$

$= \dfrac{120 - 115}{10}$

$= 0.5\ \Omega$

At the time of switch off, E = 0

$I = \dfrac{V}{R}$

$= \dfrac{115}{0.5} = 230$ A

Past Questions

1. Lenz's law is a consequence of the law of conservation of (MOE 09)

a. charge b. momentum

c. mass d. energy

2. The two conductors carrying current in same direction attract each other due to existence of (MOE 2063)

a. electric force b. magnetic force

c. gravitational force

d. nuclear force

3. The energy per unit volume is given by (MOE 2060)

a. $\dfrac{E^2}{\varepsilon_0}$ b. $\varepsilon_0 E^2$

c. $2\varepsilon_0 E^2$ d. $\dfrac{1}{2}\varepsilon_0 E^2$

4. If the flux associated with a coil varies at the rate of 1 weber per minute, the induced emf is: ?(MOE 2000)

a. 1v b. $\dfrac{1}{60}$ v

c. zero d. 60v

5. A freely falling magnet passes lengthwise through a horizontal circular coil of conductor. The correct expression relating the acceleration of the falling magnet 'a' and the acceleration due to gravity 'g' is (MOE 2054)

a. a < g

b. a > g
c. a = g
d. can't be said from given data

6. Laminated cores are used in transformer in order to (MOE)
a. reduce eddy curent
b. increases electric flux
c. use the transformer as a rectifier
d. use the transformer in AC.

7. Transformer is a device to (IOM)
a. convert mechanical energy to electrical energy
b. convert AC to DC
c. convert DC to AC
d. transform Ac voltage

8. When a wire loop is rotated in a magnetic field, the direction of induced emf changes in every (IE 2008)
a. 1 revolution b. $\frac{1}{2}$ revolution
c. $\frac{1}{4}$ revolution d. 2 revolution

9. If a wire of resistance 10Ω is moving in a non uniform magnetic field in such a way that decrease in K.E. is 10 J/S. What is current induced in wire? (IE-06)
a. 0 b. 0.28A
c. 4A d. 4A

10. A circular coil is moving parallel to magnetic field then value emf is (IE-02):
a. zero
b. depends upon the value of magnetic field
c. depends upon the area of coil
d. depends upon velocity

11. A circular loop of radius 0.1 m and carrying a current of 10A is placed parallel to a magnetic fied of 0.1 T. The torque acting on the loop in Nm is (BPKIHS 05)
a. 0.1 π b. 0.0001π
c. 0.01 π d. 0.001 π

12. The armature of a shunt wound motor can with stand current upto 8A before it overheats and is damaged. If the armature resistance is 0.5 Ω minimum back emf that must be generated to avoid motor damage, when the motor is connected to a 120v line is (BPKIHS).
a. 120v b. 124v
c. 116v d. 4v

Answer Sheet

1. d	*2. b*	*3. d*	*4. b*	*5. a*	*6. a*	*7. d*	*8. b*	*9. b*	*10. a*
11. c	*12. c*								

Solution

1. Ans. (d)
Energy
Lenz law states that the direction of induced emf is such that it opposes the cause of it.
$$E = \frac{-d\phi}{dt} = -L\frac{di}{dt}$$

2. Ans. (b)
Two parallel wires carrying currents in the same direction attract eachother due to magnetic force while carrying currents in the opposite direction repel eachother.

3. Ans. (d)
Electric energy density = $\frac{\text{Energy}}{\text{Volume}}$
$$= \frac{1}{2}\varepsilon_0 E^2$$
Magnetic energy density = $\frac{B^2}{2\mu_0}$

4. Ans. (b)

$\varepsilon mf = \frac{d\phi}{dt} = \frac{-1}{60}$

$\therefore$ Emf = $\frac{1}{60}$ v

5. Ans. (a)

- According to Faraday's law of electromagnetic induction whenever there is change in magnetic flux linked to a circuit, there is induction of emf which lasts as long as change in magnetic flux continues.
- Magnitude of induced emf α rate of change in magnetic fluk:

  In this case emf induced in the coil due to downward acceleration of magnet. Hence emf opposes the motion. Hence a < g.

6. Ans. (a)

Eddy currents are the currents in the body of a conductor when the amount of magnetic flux linked with the conductor changes.

Eddy current produces heat leading to loss of power.

7. Ans. (d)

- Dynamo or generator: converts mechanical energy to electrical
- Rectifier, diode: Convert AC to DC
- Oscillator converts DC to AC
- Triode, transistor - Amplification of voltage

8. Ans. (b)

The direction of induced emf is reversed after every half revolution of the loop.

9. Ans. (b)

In non-uniform magnetic field, induced current decreases exponentially with time and becomes zero at infinity.

$\frac{E}{t} = I^2R$

$10 = I^2 \times 10 \therefore I = 1A$

Maximum current induced is 1A. As it decreases furthur. When K.E decreases its instaneous current lies between 0 and 1.

10. Ans. (a)

Induced emf (E) = $Bvl \sin\theta$

When circular coil is parallel to magnetic field, $\theta = 0°$

Emf (E) = $Bvl \sin\theta = 0$

11. Ans. (c)

$\tau = BINA \sin\theta = MB \sin\theta$

$\theta \rightarrow$Angle between $\vec{A}$ and $\vec{B}$

Here, $\theta = 90°$

$\tau = BINA \sin\theta = 0.1 \times 10 \times 1 \times \pi r^2$

$= 1 \times \pi \times (0.1)^2 = 0.01\,\pi$ Nm

12. Ans. (c)

$R = \frac{E - V}{I}$

or, $0.5 = \frac{120 - v}{8}$

$\therefore$ V = 116v

Chapter: 37

Alternating Current

1. The frequency of DC in our country is:
a. 30 cycles/sec b. 50 cycles/sec
c. 60 cycles/sec d. 0 cycles/sec

2. If Eo is the Peak Value of an Ac supply, then root mean square voltage is:
a. $\frac{E_0}{2}$ b. $\sqrt{\frac{E_0}{2}}$
c. $\frac{E_0}{\sqrt{2}}$ d. $E_0\sqrt{2}$

3. In a circuit, the value of the alternating current is measured by hot wire ammeter is 10 ampere. Its peak value will be:
a. 10 A b. 20A
c. 14.14 A d. 7.07A

4. In an Ac circuit, the maximum value of voltage is 423 volt. Its effective voltage is:
a. 400 volt b. 300 volt
c. 323 volt d. 340 volt

5. The capacitive reactance of a capacitor in dc circuit (in ohm) is:
a. zero b. ωc
c. $\frac{1}{\omega c}$ d. ∞

6. The inductive reactance of a capacitor in dc circuit (in ohms) is:
a. zero b. ωc
c. $\frac{1}{\omega c}$ d. ∞

7. With increase in frequency of an AC supply the impedance of a series LCR circuit:
a. increases b. decreases
c. Remains same
d. First decreases becomes minimum and the increases

8. The resonant frequency of an LCR series circuit is:
a. $2\pi\sqrt{LC}$ b. $2\pi RC$
c. $\frac{R}{2\pi\sqrt{LC}}$ d. $\frac{1}{2\pi\sqrt{LC}}$

9. The average power dissipation in pure capacitor is:
a. $\frac{1}{2}CV^2$ b. CV^2
c. $\frac{1}{4}CV^2$ d. zero

10. A sinusoidal Ac current flows through a resistance R. If the peak current is I_O, then power dissipated is.
a. $Io^2R\cos\phi$ b. $\frac{I_o^2R}{2}$
c. $\frac{4}{\pi}I^2_0R$ d. $\frac{I_0^2R}{\pi^2}$

11. In a circuit I is given by $I = Io\sin(\omega t - \frac{\pi}{2})$ When Ac potential of $E = E_0\sin\omega t$ has been applied. Then the power consumption in the circuit would be:
a. $\frac{I_OE_O}{\sqrt{2}}$ b. $\frac{E_OI_O}{2}$
c. $\frac{EI}{\sqrt{2}}$ d. zero

12. A highly inductive circuit has a power factor which is
a. low b. high
c. zero d. fluctuating

13. In an Ac circuit, the electrical energy is dissipated in:
a. R only b. L only
c. C only d. all L, C and R

14. Power factor is defined as:
a. apparent power x true power
b. true power/apparent power

c. apparent power/true power

d. $\frac{1}{2}$ × apparent power × true power

15. Which of the following is true for a wattless circuit:

a. inductance is zero

b. capacitance is zero

c. resistance is zero

d. net reactance is zero

16. If resistance is an ac circuit is increased then its power factor:

a. decreases b. increases

c. remains same

d. decreases and becomes zero

17. The value of impedance in series LCR circuit at resonance is:

a. minimum b. maximum

c. infinite d. zero

18. The value of impedance in parallel LC circuit at resonance is (assuming inductor and capacitor to be ideal).

a. minimum b. maximum

c. infinite d. zero

19. The frequency of Ac is 50Hz. How many times the curent becomes zero in one second?

a. 25 times b. 50 times

c. 100 times d. 200 times

20. In the non-resonant circuit, what will be the nature of circuit for frequencies higher than resonant frequency?

a. resistance b. capacitative

c. inductive d. none

21. In an Ac circuit, voltage applied is V = 220 sin 100t. If the impedance is 110 Ω and the phase difference between current and voltage is 60°, the power consumption is equal to:

a. 55w b. 110w

c. 220w d. 330w

22. Alternating voltage v= 400 sin(500πt) is applied across a resistance of 0.2KΩ. The rms value of current will be equal to:

a. 2A b. 0.414A

c. 1.414A d. 14.14A

23. The power factor of a series RL circuit is 0.5. If R = 100Ω, f = 50 Hz then L is:

a. $\frac{\sqrt{3}}{\pi}$ H b. πH

c. $\sqrt{2}\pi$ H d. $\frac{4\pi}{\sqrt{2}}$ H

24. A coil having an inductance of $\frac{1}{\pi}$ H is connected in series with a resistance of 300 ohm. If 20v–200Hz Ac source is impressed across the combination, the phase angle between voltage and current is:

a. $\tan^{-1}\left(\frac{5}{4}\right)$ b. $\tan^{-1}\left(\frac{4}{5}\right)$

c. $\tan^{-1}\left(\frac{3}{4}\right)$ d. $\tan^{-1}\left(\frac{4}{3}\right)$

25. An alternating voltage E = 200 $\sqrt{2}$ sin100 t voltage is connected to 1 μF capacitor through an Ac ammeter. The reading of the ammeter is.

a. 10mA b. 20mA

c. 40mA d. 80mA

26. In L-R circuit, the Ac source has voltage 220v. If potential difference across the induction is 176v, the potential difference across the resistance will be:

a. 44v b. 110v

c. 132v d. 220v

27. A coil has an inductance of 0.7 H and is joined in series with a resistance of 220 Ω. When an alternating emf of 220V at 50 cycles per second is applied to it, the wattless component of the current in the circuit is:

a. 7A b. 5A

c. 0.7A d. 0.5A

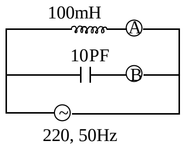
28. A pure resistance and a pure inductance are connected in series across 100 volt

Ac line. A voltmeter gives the same reading whether connected across resistance or inductance. What does it read?

a. 50v b. 70.7v

c. 88.2v d. 100v

29. If A and B are identical bulbs, which bulb glows brighter in the circuit shown?



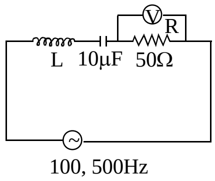
a. A

b. B

c. both equally bright

d. none

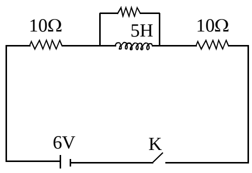
30. In the circuit shown, voltmeter reads 100v. Then L is:



a. 0.1 H b. 0.2H

c. 0.02H d. 0.01H

31. In the circuit shown initial value of current through the battery on closing the circuit (ie. K pressed) is:



a. 0.2A b. 0.24A

c. 0.3A d. incalculable

Answer Sheet

1. d	*2. c*	*3. c*	*4. b*	*5. d*	*6. a*	*7. d*	*8. d*	*9. d*	*10. b*
11. d	*12. a*	*13. a*	*14. b*	*15. c*	*16. b*	*17. a*	*18. c*	*19. c*	*20. c*
21. b	*22. c*	*23. a*	*24. d*	*25. b*	*26. c*	*27. c*	*28. b*	*29. a*	*30. d*
31. c									

Solution

1. Ans. (d)

The frequency of DC is always zero. The frequency of AC is 50 cycles/sec in Nepal.

2. Ans. (c)

$$E_{rms} = \frac{E_0}{\sqrt{2}}$$

$$I_{rms} = \frac{I_0}{\sqrt{2}}$$

$$E_{rms} = 0.707\ E_0$$

3. Ans. (c)

The measurement of alternating current by hot wire ammeter is based on heating effect of current so it measure rms current.

$$I_{rms} = 10\ A \Rightarrow \frac{I_0}{\sqrt{2}} = 10A$$

$$I_O = 10\sqrt{2} = 14.14\ A$$

4. Ans. (b) Peak voltage vo = 423 v

Effective voltage

$$V_{rms} = \frac{Vo}{\sqrt{2}} = \frac{423}{1.414} = 300v$$

5. Ans. (d)

Capacitive reactance $X_c = \frac{1}{\omega c}$

$= \frac{1}{2\pi fc}$

For dc f = 0

$\therefore X_c = \infty$

6. Ans. (a)

Inductive reactance $XL = 2\pi fL$

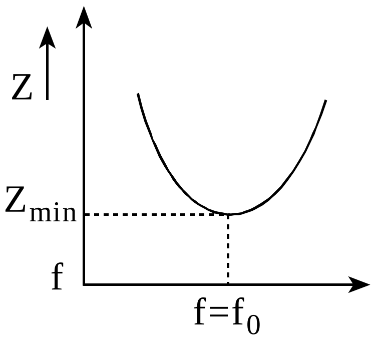
So for dc, f = 0

$\therefore$ XL = 0

7. Ans. (d)

Impedence of LCR circuit is

$z = \sqrt{R^2 + (XL - XC)^2} \geq R$



Hence on increasing frequency z, first decreases becomes min (z min = R) for resonant frequency and then increases.

8. Ans. (d)

Resonance = max.current & min impedance

So, XL – Xc = 0

$\rightarrow XL = Xc$

$\frac{1}{2\pi fc} = 2\pi fL$

$f = \frac{1}{2\pi\sqrt{LC}}$

9. Ans. (d)

In pure inductive and capacitive Ac circuit,

$\phi = \frac{\pi}{2}$

$P_{av} = \frac{1}{2} I_o E_0 \text{Cos}\phi$

$= \frac{1}{2}$ Io Eo Cos $\frac{\pi}{2} = 0$

10. Ans. (b)

For resistive Ac circuit $\phi = 0$

$P = \frac{1}{2}$ IoEo cos 0° $= \frac{1}{2}$ Io.IoR $= \frac{Io^2R}{2}$

11. Ans. (d)

Here, $\phi = \frac{\pi}{2}$

P = Erms Irms cos ϕ

$= \frac{\text{EoIo}\cos\phi}{2}$

$= \frac{1}{2}$ IoEo $\cos\frac{\pi}{2} = 0$

12. Ans. (a)

$\cos\phi = \frac{R}{Z}$

$= \frac{R}{\sqrt{R^2 + (\omega L)^2}}$

In highly inductive circuit

$\omega_L >>> R$

$\cos\phi = \frac{R}{\omega L}$ = Low

13. Ans. (a)

Energy disipated

E = Irms Erms cos ϕ

For L and c, $\phi = \frac{\pi}{2}$ $\therefore$ E = 0

For R, $\phi = 0$

$\therefore$ E = Irms Erms

14. Ans. (b)

Apparent power = Irms Erms

True power = Irms Erms cos ϕ

power factor $(\cos\phi) = \dfrac{\text{True power}}{\text{Apparent power}}$

15. Ans. (c)

A current is said to be wattless when it doesn't consume any power when passed through a circuit

P_{av} = Irms Erms $\cos\phi = 0$

Also $\cos\phi = \dfrac{R}{2}$ $\therefore R = 0$

16. Ans. (b) Power factor, $\text{Cos}\phi = \dfrac{R}{Z} \propto R$

So, power factor increases on increasing resistance.

17. Ans. (a)

$z = \sqrt{R^2 + (XL - Xc)^2}$

At resonance, XL = XC

So, impedence is minimum

zmin = R

18. Ans.(c)

For a parallel combination of R, L and C connected to Ac at resonance, the current through the parallel combination of L and C is zero. The potential difference across combination is maximum hence the reactance of L and C combination is infinite.

19. Ans. (c)

The current in Ac circuit becomes zero twice in a cycle. So if frequency of Ac is 50Hz then current becomes zero 100 times in a second.

20. Ans. (c)

At resonance, $\omega L = \dfrac{1}{\omega c}$ (XL = XC)

When $\omega > \omega r$ then

XL > XC

ie. The circuit is inductive dominated.

21. Ans. (b)

Vo = 220 volt, Z = 110Ω

$Io = \dfrac{vo}{z} = \dfrac{220}{110} = 2A$

P = Vrms Irms $\cos\phi$

$= \dfrac{Vo}{\sqrt{2}} \times \dfrac{I_0}{\sqrt{2}} \times \cos 60°$

$= \dfrac{1}{2} \times 220 \times 2 \times \dfrac{1}{2} = 110w$

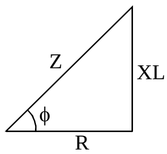
22. Ans. (c)

Eo = 400 volt, R = 0.2KΩ = 200Ω

$Irms = \dfrac{Vrms}{R} = \dfrac{Eo}{\sqrt{2}R} = \dfrac{400}{200\sqrt{2}}$

$= \sqrt{2} = 1.414A$

23. Ans. (a)



$\cos\phi = 0.5 = \dfrac{1}{2} = \cos 60°$

$\phi = 60°$

From impedence triangle $\tan\phi = \dfrac{XL}{R}$

$= \dfrac{\omega L}{R} = \dfrac{2\pi fL}{R}$

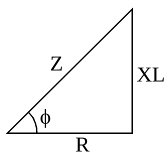
$\Rightarrow \tan 60° = \dfrac{2\pi fL}{R}$

$L = \dfrac{R\sqrt{3}}{2\pi f} = \dfrac{100\sqrt{3}}{2\pi f}$

$= \dfrac{100\sqrt{3}}{2\pi \times 50} = \dfrac{\sqrt{3}}{\pi}$ H

24. Ans. (d)

From impedence triangle



$\tan\phi = \dfrac{XL}{R}$

$= \dfrac{2\pi fL}{R}$

$= \dfrac{2\pi \times 200 \times \frac{1}{\pi}}{300} = \dfrac{4}{3}$

$\phi = \tan^{-1}\left(\frac{4}{3}\right)$

25. Ans. (b)

The ammeter reads rms current given by

$$Irms = \frac{Erms}{z} = \frac{\frac{Eo}{\sqrt{2}}}{XC} = \frac{200}{\frac{1}{2\pi fc}}$$

$= 200 \times 100 \times 10^{-6} = 20mA$

[comparing $E = 200\sqrt{2} \sin 100t$ with

$E = Eo \sin \omega t$]

26. Ans. (c)

$V = \sqrt{VR^2 + VL^2}$

$V^2 = VR^2 + VL^2$

$VR = \sqrt{V^2 - V_L^2}$

$= \sqrt{220^2 - 176^2}$

VR = 132 volt

27. Ans. (c)

$XL = 2\pi fL = 2\pi \times 50 \times 0.7 = 220\Omega$

$R = 220\ \Omega$

$Z = \sqrt{R^2 + XL^2} = 220\sqrt{2}\ \Omega$

$Irms = \frac{vrms}{z}$

$= \frac{220}{220\sqrt{2}} = 0.707A$

Through L, this current is wattless.

28. Ans. (b)

VR = VL

$IR = IX_L$ $\therefore R = XL$

$z = \sqrt{R^2 + XL^2} = \sqrt{R^2 + R^2} = \sqrt{2}\ R$

ie. $z = \sqrt{2}$ times current becomes $\frac{1}{\sqrt{2}}$

Similarly, voltage read = $\frac{1}{\sqrt{2}}$ times

$= \frac{1}{\sqrt{2}} \times 100 = 70.7v.$

29. Ans. (a)

$XL = \omega L = 2\pi fL = 2\pi \times 50 \times 100$

$10^{-3} = 10\ \pi\ \Omega$

$XL = \frac{1}{\omega c} = \frac{1}{2\pi \times 50 \times 10 \times 10^{-12}} = \frac{10^9}{\pi}\ \Omega$

As XC > XL, more current flows through bulb A

Thus A glows brighter

30. Ans. (d)

As the emf of the source is 100v, the p.d. across R is also 100v only at resonance. So at resonance

$X_L = X_C$

$2\pi fL = \frac{1}{2\pi fC}$

$L = \frac{1}{4\pi^2 f^2 c} = \frac{1}{4 \times 10 \times 500^2 \times 10 \times 10^{-6}} = 0.01\ H$

31. Ans. (c)

As 5H coil offers no resistance to DC, therefore, all the current passes through it, by passing the 10Ω resistance in parallel.

Total resistance in the circuit = 10 + 10 = 20Ω

$I = \frac{V}{R} = \frac{6}{20} = \frac{3}{10} = 0.3A$

Past Questions

1. In Nepal, the supply of Ac voltage is 220V. The peak voltage is

(MOE 2067 kartik)

a. 310 v b. 220v

c. 110v d. 350v

2. In a series combination of R, L and C to an ac source at resonance. If R = 20 Ω, then impedance of the combination is

(MOE 2010)

a. 20Ω b. 10Ω

c. zero d. 400Ω

3. Admittance of an alternating circuit is defined as reciprocal of (MOE 2009)

a. impedance b. inductance

c. capacitance d. alternating Emf

4. In an AC circuit capacitance is 20μF, inductance is 500mH and resistance is 40Ω. If 2.5 amperes current flows in the circuit then the power delivered to the circuit is (MOE 2060)

a. 35w b. 65w

c. 25w d. 45w

5. Capacitative reactance for DC is (MOE 2058)

a. infinity b. one

c. zero d. none

6. In an a.c circuit vrms = 100v, capacitance 20μF, current 0.628 A, the frequency of a.c is (MOE 2056)

a. 1 Hz b. 2 Hz

c. 50 Hz d. 100 Hz

7. You and your friends are listening to the radio. Your friend wants to decrease the capacitive reactance (Xc) of the radio transmitor (MOE 2053)

a. increase frequency

b. decrease frequency

c. increase wavelength

d. decrease wave length

8. A wire of mass 200 kg has capacitance 0.0014 μF/kg and frequency 50 KHz. Then what is the inductance when impedance is minimum? (IOM 2066)

a. 0.30 b. 0.37

c. 0.477 d. 0.50

9. An a.c. having angular frequency 1000 rad/sec is passed through a capacitor of 1μF, the capacitative reactance is (KU).

a. 100Ω b. 500Ω

c. 200Ω d. 1000Ω

10. A choke coil should have. (BPKIHS-08)

a. high resistance and low inductance

b. high resistance and high inductance

c. low resistance and high inductance

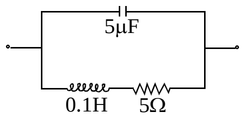
d. low resistance and low inductance

11. The inductance L and a resistance R are connected in series with a battery of emf E . Find the maximum rate at which the energy is stored in magnetic field. (BPKIHS)

a. $\frac{E^2}{R}$ b. $\frac{E^2}{2R}$

c. $\frac{E^2}{3R}$ d. $\frac{E^2}{4R}$

12. In the circuit shown the resonant frequency is: [BPKIHS]



a. 22 K c/s b. 220 K c/s

c. 0.22 K c/s d. 0.22 m c/s

13. If the capacitance is increased then reactance of capacitor and current respectively (IE – 05)

a. increases, decreases

b. increases, increases

c. decreases, decreases

d. decreases, increases

14. In a LCR circuit, inductor capacitor and Resistor are in series working at $\omega = \frac{1}{\sqrt{LC}}$ and emf V_0. Then the sum of potential dropped across inductor and capacitor is:

a. zero b. $\frac{V_0}{\omega L}$

c. $\frac{2V_0}{\omega L}$ d. $2V_0$

Answer Sheet

1. a	*2. a*	*3. a*	*4. c*	*5. a*	*6. c*	*7. a*	*8. b*	*9. d*	*10. c*
11. d	*12. c*	*13. d*	*14. a*						

Solution

1. Ans. (a)

$$Vrms = \frac{Vo}{\sqrt{2}}$$

$V_0 = \sqrt{2} \times Vrms$

$= \sqrt{2} \times 220 = 310$ v

2. Ans. (a)

At resonance

$X_L = X_C$

$\therefore$ z = R = 20Ω

3. Ans. (a)

$$\text{Admittance (Y)} = \frac{1}{\text{Impedance(z)}}$$

4. Ans. (c)

Power consumed by pure conductor or pure inductor is zero. So power consumed by resistor.

$P = I^2R = (2.5)^2 \times 4 = 25$ watt

5. Ans. (a) $Xc = \frac{1}{c\omega} = \frac{1}{c\times 2\pi f}$

Since, frequency for dc =0

$\therefore$ Xc (capacitative reactance) = ∞

6. Ans. (c)$Xc = \frac{1}{\omega c}$

$$\frac{vrms}{I} = \frac{1}{2\pi f \times C}$$

$$f = \frac{I}{2\pi \times c \times vrms} = 50Hz$$

7. Ans. (a) In capacitor circuit,

$$Xc = \frac{1}{\omega c} = \frac{1}{2\pi fc}$$

ie. $Xc \propto \frac{1}{f}$

Hence, $\downarrow xc \rightarrow \uparrow f$

In inductor circuit

$X_L = \omega L = 2\pi fL$

8. Ans. (b) c/kg=0.0014 μF/kg = 0.28×10^{-6}F

For resonance, $X_L = X_C$

$$L\omega = \frac{1}{\omega c} \rightarrow L2\pi f = \frac{1}{2\pi fc}$$

$$L = \frac{1}{4\pi^2 f^2 c}$$

$$= \frac{1}{4 \times (3.14)^2 \times (50 \times 10^3)^2 \times 0.28 \times 10^{-6}}$$

$= 3.57 \times 10^{-5}H = 0.36\mu H$

9. Ans.(d) capacitative reactance (z) $= \frac{1}{\omega c}$

$$= \frac{1}{2\pi fc}$$

$$= \frac{1}{100\times 10 \times 10^{-6}}$$

= 1000Ω

10. Ans. (c)

- A choke coil is a coil which has high inductance and negligible resistance so that power factor (cos ϕ) almost zero.
- It controls the alternating current without any appreciable loss of energy.

11. Ans. (d) Inductive reactance for DC current = zero, as f = 0 and $X_L = L\omega$

$\therefore$ Impedance (z) = R

Also, for max. energy R = r

$$P_{max} = \frac{E^2}{(R + r)^2}$$

$$= \frac{E^2}{4R^2} \times R = \frac{E^2}{4R}$$

12. Ans. (c)

It is parallel circuit

$$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$= \frac{1}{2 \times 3.14}\sqrt{\frac{1}{0.1 \times 5 \times 10^{-6}} - \frac{(5)^2}{(0.1)^2}}$$

$= 0.22 \times 10^3$ c/s = 0.22 K c/s

13. Ans. (d)

Reactance of capacitor, $z = \frac{1}{\omega c}$

$$z = \frac{1}{2\pi fc}$$

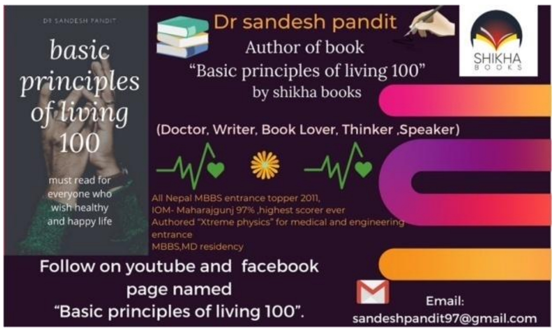
If capacitance increases, z, decreases

$I = \frac{V}{Z}$ so, current increases.

14. Ans. (a)

$\omega = \frac{1}{\sqrt{LC}}$ This is condition of resonance in LCR circuit. At resonance, Voltage drop across inductor and capacitor are equal and opposite as $X_C = X_L$

Thus, net potential drop = zero.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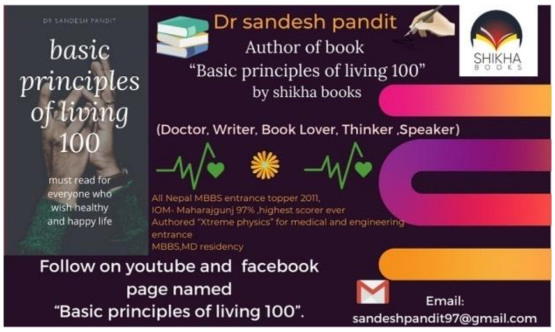
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Chapter: 38

Reflection At Plane & Curved Mirrors

1. A ray of light is incident on a plane mirror at an angle of incidence 30°. The deviation produced by the mirror is:

a. 30° b. 60°
c. 90° d. 120°

2. The number of images formed by two plane mirrors inclined at 60° of an object placed asymmetrically between mirrors is:

a. 6 b. 5
c. 1 d. infinity

3. The number of images formed by two plane mirrors inclined at 60° of an object placed symmetrically between mirror is:

a. 6 b. 5
c. 1 d. infinity

4. The number of image formed of a object between two parallel plane mirrors and facing each other is:

a. 1 b. 2
c. 4 d. infinity

5. Two plane mirriors inclined at an angle θ form 9 images of an object placed symmetrically between them. Then the angle θ is equal to:

a. 360° b. 45°
c. 60° d. 75°

6. A ray reflected successively from two plane mirrors inclined at a certain angle undergoes a deviation of 240°. Then the number of images obtained is:

a. 3 b. 5
c. 7 d. 9

7. A man approaches a plane mirror at speed of 2m/s. with what speed does he approach his image?

a. 2m/s b. 4m/s
c. 1 m/s d. 0 m/s

8. A ray is reflected in turn by three plane mirrors mutually at right angles to eachother. The angle between incident and the relfected rays is:

a. 0 b. $\frac{\pi}{2}$
c. π d. $\frac{3\pi}{2}$

9. How many images of himself does an observer see if two adjacent walls and the ceiling of a rectangular room are mirror surfaced:

a. 7 b. 5
c. 6 d. 9

10. Two plane mirrors are at right angles to each other. A man standing between them combs his hair with his right hand. In how many of the images will be seen using his right hand?

a. 1 b. 2
c. 3 d. none

11. An object is moving towards a plane mirror with a velocity v making a certain angle θ with normal to the mirror. The velocity of image w.r.t object is:

a. v cosθ b. v sinθ
c. 2v cosθ d. 2v sinθ

12. A person is approaching a plane mirror with speed 10cm/s. If the initial distance between person and mirror is 1m, then the distance between person and his image after 2.5 seconds will be:

a. 0.25m b. 0.5m
c. 0.75m d. 1.5m

13. It is desired to photograph the image of an object placed at a distance 3m from the plane mirror. The camera, which is at distance of 4.5m from the mirror should be focused for a distance of:

a. 3m b. 4.5m
c. 6m d. 7.5m

14. A ray of light incident to the first mirror and parallel to the second mirror is reflected from the second mirror parallel to the first mirror. The angle between two mirrors is:

a. 30° b. 60°
c. 75° d. 90°

15. A shaving mirror of focal length f produces an image n times the size of the object. If the image is real, then the distance of the object from the mirror is:

a. (n+1)f b. $\left(\frac{n+1}{n}\right)$ f
c. $\left(\frac{n-1}{n}\right)$ f d. (n–1)f

16. The focal length of a concave mirror is f and the distance of object to the principal axis is p. Then the ratio of the size of image to the size of the object is:

a. $\frac{f}{p}$ b. $\frac{p}{f}$
b. fp d. $\sqrt{\frac{p}{f}}$

17. A short linear object of object b lies along the axis of a concave mirror of focal length at a distance u from the pole of the mirror. The size of image is approximately equal to:

a. $b\sqrt{\frac{u-f}{f}}$ b. $b\left(\frac{u-f}{f}\right)$
c. $b\sqrt{\frac{f}{u-f}}$ d. $b\left(\frac{f}{u-f}\right)^2$

18. How far should an object be held from a concave mirror of focal length 40cm. so as to obtain real image twice the size of the object?

a. 10 cm b. 20 cm
c. 30 cm d. 60 cm

19. A bright spot situated at 60cm in front of a convex mirror forms a virtual image 20cm behind the mirror. The focal length of the mirror is:

a. 30cm b. 50cm
c. 60cm d. 75cm

20. The image formed by a convex mirror of focal length 10cm is half the size of the object. Then the distance of the object from the mirror is:

a. 10cm b. 5cm
c. 15cm d. 30cm

21. An object is placed at a distance $\frac{f}{2}$ from the pole of convex mirror of focal length f. The image formed is:

a. at $\frac{f}{2}$ virtual erect b. at f virtual inverted
c. at $\frac{f}{4}$ virtual erect d. at $\frac{f}{3}$ virtual erect

22. A luminous object is placed 20cm from surface of convex mirror and a plane mirror is set so that virtual images formed by two mirrors coincide. If plane mirror is at a distance of 12cm from the object. Then focal length of convex mirror is:

a. 5cm b. 10cm
c. 20cm d. 40cm

23. A wall clock with numbers not printed on dial records time 3:25. When seen through a plane mirror, the time will appear to be:

a. 8:25 b. 8:35
c. 9:35 d. 7:35

24. A concave mirror of focal length F is immersed in water ($\mu_w = \frac{4}{3}$). The focal length of mirror inside water is:

a. more than f b. less than f
c. f d. $\frac{4}{3}$ f

Answer Sheet

1. d	*2. a*	*3. b*	*4. d*	*5. a*	*6. b*	*7. b*	*8. c*	*9. a*	*10. a*	*11. c*	*12. d*
13. d	*14. b*	*15. b*	*16. a*	*17. d*	*18. d*	*19. a*	*20. a*	*21. d*	*22. a*	*23. b*	*24. c*

Solution

1. Ans. (d)

$\delta = 180 - 2i = 180 - 2\times 30 = 120°$

2. Ans. (a)

When object is placed asymetrically

$n = \frac{360}{\theta} = \frac{360}{60} = 6$

3. Ans. (b)

When object is placed symmetrically

$n = \frac{360}{\theta} - 1 = \frac{360}{60} - 1 = 5$

4. Ans. (d)

$n = \frac{360}{0} - 1 =$ infinity

5. Ans. (a)

$n = \frac{360}{\theta} - 1$

$9 = \frac{360}{\theta} - 1$

$10 = \frac{360}{\theta}$ $\therefore$ $\theta = 36°$

6. Ans. (b)

If θ be the angle between mirrors, Then

$\delta = 360 - 2\theta$

$240 = 360 - 2\theta \rightarrow \theta = 60°$

$n = \frac{360}{\theta} - 1 = \frac{360}{60} - 1 = 5$

7. Ans. (b)

$V_I = 2Vm + Vo$

$V_{Io} = 2(Vm + Vo)$

$V_{IM} = Vm + Vo$

Velocity of Image w.r.t

Object $V_{IO} = 2(2+0) = 4$m/s

8. Ans. (c)

Incident ray and reflected ray are in the same plane. So, deviation is produced by any two mutually perpendicular mirrors.

So, $d = 2\theta = 2\times\frac{\pi}{2} = \pi$

9. Ans. (a)

Mirror in two perpendicular walls forms 3 images and mirror in ceiling forms 4 images.

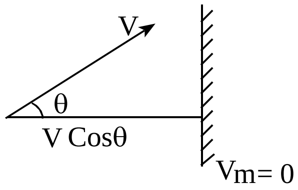
10. Ans. (a)

Among three images formed 2 are laterally inverted.

$n = \frac{360}{90} - 1 = 3$

The images formed after even numbered reflections are not laterally inverted. One image is formed after double reflection in each of the mirrors.

11. Ans. (c)



$VIO = 2(Vm+Vo) = 2(0+v\cos\theta)$

$= 2V\cos\theta$

12. Ans. (d)

Initial distance between person and his image in the plane mirror is 2m.

Decrease in seperation = 2d= 2vt

$= 2\times\frac{10}{100}\times 0.5 = 0.5$m

Hence, seperation between person and image after 2.5s = 2 – 0.5 = 1.5cm

13. Ans. (d)

From question, the camera is focused at the image of an object.

For a plane mirror, image distance = object distance = 3m

distance of camera from the mirror = 4.5

$\therefore$ Distance to be focused by camera = 3+4.5 = 7.5m

14. Ans. (b)

$\supseteq M_1 OM_2 = \supseteq ABM_1 = \supseteq DCM_2 = \theta$

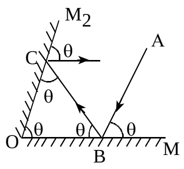
(corresponding ⊇s)

$\supseteq BCO = \supseteq CBO$

(being glancing angles)

$\theta + \theta + \theta = 180$ (From fig)

$3\theta = 180 \therefore \theta = 60°$



15. Ans. (b) $\frac{v}{u} = n \rightarrow v = nu$

Now, $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{nu} = \frac{n+1}{nu}$

$\frac{1}{f} = \left(\frac{n+1}{n}\right)\frac{1}{u}$

$u = \left(\frac{n+1}{n}\right) f$

16. Ans. (a)

From Newton's formula,

$f^2 = xy = py$

$\therefore\ y = \frac{f^2}{P}$

$\therefore\ m = \sqrt{\frac{y}{x}} = \sqrt{\frac{f^2}{p \times p}} = \frac{f}{p}$

17. Ans. (d)

As the object lies along the principal axis of the mirror, its axial/areal magnification is taken.

ie. $\frac{\text{size of Image(I)}}{\text{size of object (o)}} = m^2$

$\frac{I}{b} = \left(\frac{f}{u-f}\right)^2 \left[m = \frac{v-f}{f} = \frac{f}{u-f}\right]$

$I = b\left(\frac{f}{u-f}\right)^2$

18. Ans. (d)

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightarrow \frac{u}{f} = \frac{u}{u} + \frac{u}{v}$

$\frac{u}{f} = \left(1 + \frac{1}{m}\right)$

$u = (1 + \frac{1}{2}) \times 40 = 60\text{cm}$

19. Ans. (a) $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{1}{f} = \frac{1}{60} + \frac{1}{-20}$

$\therefore\ f = -30\text{cm}$

20. Ans. (a)

$\frac{1}{f} = \frac{1}{u} - \frac{1}{v} \Rightarrow \frac{u}{f} = 1 - \frac{u}{v}$

$u = \left(1 - \frac{1}{m}\right) f = \left(1 - \frac{1}{\frac{1}{2}}\right) \times -10 = 10\text{cm}$

21. Ans. (d)

focal length = –f (for convex mirror)

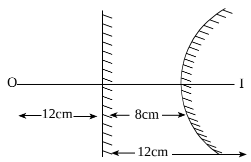
$\frac{1}{-f} = \frac{1}{u} + \frac{1}{u}$

$\frac{1}{-f} = \frac{2}{f} + \frac{1}{v}$

$v = \frac{-f}{3}$

Image is virtual and erect.

22. Ans. (a)



A plane mirror forms an image at an equal object distance from mirror.

For convex mirror,

u = 20cm, V = – 4cm (virtual image)

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{20} - \frac{1}{4} = \frac{-1}{5}$

f = – 5cm

23. Ans. (b)

Shortcut, adding the total should be 12:00 . 8:35 + 3:25 = 12:00

A plane mirror forms image with lateral inversion.

24. Ans. (c) As $f = \frac{R}{2}$, the focal length of spherical mirror doesn't change when immersed in any medium.

The focal length of spherical mirror is same for all colours of light.

Past Questions

1. **Power of plane mirror in dioptre is:** **(MOE 2068 Kartik)**
   a. +1 b. – 1
   c. 0 d. infinity

2. **An erect object of size 1m is placed in front of a concave mirror at infinity. The size of the image formed will be** **(MOE 2068 Kartik)**
   a. of the same size of object
   b. half of the size of the object
   c. two times the size of object
   d. a point image of no definite size

3. **Rays of light strike a horizontal plane mirror at an angle of 45°. A second plane mirror is arranged at an angle θ with it. If the ray after reflection from the second mirror runs horizontally parallel to first mirror, then θ is (IOM 2066)**
   a. 45° b. 60°
   c. 67° d. 135°

4. **When a mirror is rotated through an angle 30° keeping incident ray constant then reflected ray is rotated through an angle**
   a. 25° b. 60°
   c. 45° d. 90°

5. **An ant moves towards the plane mirror with speed 2m/s and mirror is moved towards the ant with same speed. What is the relative velocity between ant and its image? (IOM/MOE)**
   a. 2m/s b. 4m/s
   c. 8m/s d. 16m/s

6. **A person approaches a plane mirror with velocity v then the relative velocity of approach of person and his image is** **(BPKIHS)**
   a. zero b. v
   c. 2v d. $\frac{v}{2}$

7. **A concave mirror has radius of curvature 20cm. An object is placed 10cm from pole of the mirror. The image will be at (BPKIHS)**
   a. 10 cm from pole on same side
   b. infinity
   c. 20cm from the pole on same side
   d. will not be formed

8. **If an object is placed symmetrically between two plane mirrors inclined at an angle of 72°. The number of images will be [KU] (IE – 04)**
   a. 4 b. 2
   c. 5 d. infinity

Answer Sheet

1. c	*2. d*	*3. d*	*4. b*	*5. c*	*6. c*	*7. b*	*8. a*

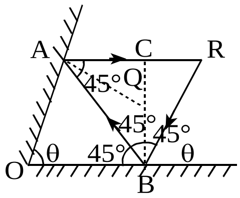
Solution

1. Ans. (c)
   For plane mirror focal length = α
   $p = \frac{1}{f} = \frac{1}{\infty} = 0$

2. Ans. (d)

Image of object at infinity is always formed at focus which is highly diminished point image.

3. Ans. (d)



$\angle ABC = \angle CBR = 45°$ [$\angle ABR = 90°$]

$\angle ABO = 45°$ [$\angle OBC = 90°$ and AB bisects $\angle OBC$]

$\angle ABO = \angle RAB$ [alternate angle]

$\angle QAB = \angle QAR = 22.5$, $\angle BAO = 67.5°$

On solving $\angle\theta = 67.5$

4. Ans. (b)

If the mirror is rotated through angle θ, then reflected ray is rotated through 2θ.

5. Ans. (c)

vo= 2m/s, v_m = 2m/s

$V_{Io} = 2(Vo + Vm) = 2(2+2) = 8$m/s

6. Ans. (c)

$V_{IO} = 2(Vm + Vo) = 2(o + v) = 2v$

7. Ans. (b)

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{2}{R} - \frac{1}{u} = \frac{2}{20} - \frac{1}{10} = \frac{1}{10} - \frac{1}{10} = 0$$

$$v = \frac{1}{0} = \infty$$

8. Ans. (a)

For symmetric placement

$$\eta = \frac{360}{\theta} - 1 = \frac{360}{72} - 1 = 5 - 1 = 4$$

अनुभूतिको अवतरण

उजाले के संग

आवारा बादल

बालउद्यान

नेपाली बालसाहित्यको इतिहास

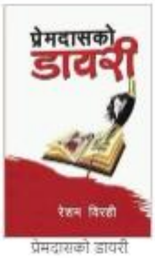
समाजवाद र बी.पी. कोइराला

मायामहल


अख्तियारको धुना

महारानी

एक्लो महारथी



प्रेमदासको डायरी


पाठशालाका लघुकथा - १

भौज्याहा

कलावती

मान्छे टोक्ने बोक्सी

अन्तिम प्रश्न

दाइबुबु

मनपरेका केही कविता

Chapter: 39

Refraction At Plane Surfaces & Total Internal Reflection

1. Speed of light is maximum in:

a. water b. air
c. glass d. diamond

2. Total internal reflection occurs if light travels from:

a. air to water b. water to glass
c. glass to diamond d. glass to water

3. The refractive index (μ) of the medium is greatest for:

a. red light b. yellow light
c. green light d. violet light

4. Critical angle of light passing from glass to air minimum for:

a. red b. green
c. yellow d. violet

5. The length of a day due to earth's atmosphere:

a. shorter b. longer
c. remains unchanged d. None

6. Stars twinkle due to:

a. refraction b. scattering
c. diffraction d. dispersion

7. If critical angle of a material to air is 30°. The refractive index of the material will be:

a. 1 b. 1.5
c. 2 d. 2.5

8. The refractive index of diamond is 2.4. The speed of light in diamond is:

a. 1.25×10^8 m\s b. 8×10^7 m\s
c. 2.4×10^8 m\s d. 3×10^8 m\s

9. A mono chromatic beam of light of wave length 600nm in vaccum enters a medium of refractive index 1.5. In the medium its wavelength is:

a. 600nm b. 900nm
c. 450nm d. 400nm

10. Two media are seperated by a plane surface having speeds of light 2×10^8 m/s and 2.4×10^8m/s respectively. What is the critical angle for a ray going from first medium to second medium.

a. $\sin^{-1}\left(\frac{3}{4}\right)$ b. $\sin^{-1}\left(\frac{5}{6}\right)$
c. $\sin^{-1}\left(\frac{5}{12}\right)$ d. $\sin^{-1}\left(\frac{1}{\sqrt{2}}\right)$

11. If the refractive index of water is $\frac{4}{3}$ and that of given slab of glass immersed in it is $\frac{5}{3}$. What is the critical angle for a ray of light tending to go from glass to water?

a. $\sin^{-1}\left(\frac{3}{4}\right)$ b. $\sin^{-1}\left(\frac{3}{5}\right)$
c. $\sin^{-1}\left(\frac{4}{5}\right)$ d. None

12. Rays of light falls on a glass plate of refractive index μ. If angle between reflected and refracted rays is 90°. Then the angle of incidence is:

a. $\sin^{-1}(\mu)$ b. $\cos^{-1}(\mu)$
c. $\tan^{-1}\mu$ d. $\tan^{-1}\left(\frac{1}{\mu}\right)$

13. A beam of light of frequency n, wave length λ travelling with velocity v in air, enters a glass slab of refractive index μ. The frequency, wavelength and velocity of light beam in glass slab will be respectively.

a. $\frac{n}{\mu}, \frac{\lambda}{\mu}, \frac{v}{\mu}$ b. $n, \frac{\lambda}{\mu}, \frac{v}{\mu}$
c. $n, \lambda, \frac{v}{\mu}$ d. $n, \mu\lambda, \mu v$

14. A diver inside a pond looks at an object whose natural colour is green one sees the object as:

a. green b. blue

c. red d. yellow

15. Mono chromatic light is refracted from air into glass of refractive index μ.The ratio of the wavelength of incident and refracted waves is:

a. μ:1 b. 1:μ

c. $1:\mu^2$ d. 1:1

16. $_i\mu_j$ is refractive index when a ray of light goes from medium i to j, then the product of $_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3$ is equal to:

a. $_3\mu_1$ b. $_3\mu_2$

c. $_4\mu_1$ d. $_4\mu_2$

17. A glass slab of thickness 4cm contains the same number of waves as 5cm of water when both are travelled by the same monochromatic light. If the refractive index of water is $\frac{4}{3}$. What is that of glass?

a. $\frac{5}{3}$ b. $\frac{5}{4}$

c. $\frac{16}{15}$ d. $\frac{3}{2}$

18. A light wave of frequency 5×10^{14} H_Z enters a medium of refractive index 1.5. In this medium, the wavelength of the light wave is:

a. 3333.3Δ b. 4000Δ

c. 6000 Δ d. 7500 Δ

19. A plane glass slab is placed on the letters of different colours. The letters of which colour are raised by least amount?

a. red b. yellow

c. blue d. equally raised for all colours

20. A microscope is focused on a mark. Then a glass of refractive index 1.5 and thickness 6 cm is placed on the mark. To get the mark again in focus the microscope should be moved:

a. 2cm downward b. 2cm upward

c. 4cm upward d. 9cm upward

21. A ray of light from denser medium strikes a rarer medium at an angle of incidence i. The reflected and refracted rays make an angle 90° with each other. The angle of reflection and refraction are r and r¹. The critical angle is:

a. $\sin^{-1}(\cot r)$ b. $\sin^{-1}(\tan i)$

c. $\sin^{-1}(\tan r^1)$ d. $\tan^{-1}(\sin i)$

22. A ray of light passes from vaccum into a medium of refractive index μ, the angle of incidence is found to be twice the angle of refraction. The angle of incidence is:

a. $\cos^{-1}\left(\frac{\mu}{2}\right)$ b. $2\cos^{-1}\left(\frac{\mu}{2}\right)$

c. $2\sin^{-1}(\mu)$ d. $2\sin^{-1}\left(\frac{\mu}{2}\right)$

23. A mark at the bottom of the tank 1m deep appears to be raised by 0.1m. The value of refractive indes of liquid tank is:

a. $\frac{10}{9}$ b. 10

c. $\frac{4}{3}$ d. $\frac{1}{10}$

24. A layer of water of refravtive index 1.3 and thickness 4 cm floats on benzene of refractive index 1.5 and thickness 6 cm. Then the apparent depth at the bottom of the beaker from free surface of water is:

a. 6cm b. 5cm

c. 8 cm d. 7 cm

25. A vessel of depth is half filled with oil of refractive index μ_1 and other half is filled with water of refractive index μ_2. Find the effective refractive index of the combination.

a. $\frac{2\mu_1\mu_2}{\mu_1+\mu_2}$ b. $\frac{\mu_1\mu_2}{\mu_1+\mu_2}$

c. $\frac{\mu_1+\mu_2}{2}$ d. $\frac{\mu_1\mu_2}{2}$

26. An air bubble is viewed inside an ice cube. Its distance is 4cm when viewed through one face and 6 cm when viewed through the opposite face. If the refractive index of ice is given as 1.5, What is the actual length of the cube?

a. 8 cm b. 10 cm

c. 15 cm d. 18 cm

27. A pond water is 5m deep. A flame is held 3m above the surface of water. A fish is at depth 4m from water surface. Refractive index of water is $\frac{4}{3}$. The apparent height of flame eyes of fish is:

a. 8m b. 6m

c. 9m d. 12m

28. A fish rising vertically at speed 3m/s to the surface of water sees a bird diving vertically upwards itself at speed 9m/s. If the refractive index of water is 4.3, the actual velocity of diving bird is:

a. 4m/s b. 4.5m/s

c. 6m/s d. 8.4m/s

29. A half of the beaker is filled with liquid of refractive index 1.5μ and other half is filled with refractive index μ. The total apparent depth is equal to 50% of the total real depth then μ is equal to:

a. $\frac{4}{3}$ b. $\frac{5}{3}$

c. 1 d. 1.5

30. To what height a beaker 21cm is to be filled with water (refractive index = $\frac{4}{3}$). So that it appears half filled if viewed from the top ?

a. 8cm b. 9cm

c. 10.5cm d. 12cm

31. When the surface of the lake is calm, a fish submerged in water will see the entire outside world within inverted cone whose apex is situated at the eye of fish and the cone subtends an angle of:

a. 10° b. 60°

c. 90° d. 30°

32. A fish inside water 12 m below the surface looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\frac{4}{3}$, the radius of circle is:

a. $36\sqrt{5}$ b. $36\sqrt{7}$

c. $12\sqrt{\frac{5}{3}}$ d. $\frac{36}{\sqrt{7}}$

33. The cause of the mirage observed in the desert is:

a. reflection

b. refraction

c. diffraction

d. Total internal reflection

Answer Sheet

1. b	*2. d*	*3. d*	*4. d*	*5. b*	*6. a*	*7. c*	*8. a*	*9. d*	*10. b*
11. c	*12. c*	*13. b*	*14. b*	*15. a*	*16. c*	*17. a*	*18. b*	*19. a*	*20. b*
21. b	*22. b*	*23. a*	*24. d*	*25. a*	*26. c*	*27. a*	*28. b*	*29. b*	*30. d*
31. c	*32. d*	*33. d*							

Solution

1. Ans. (b)

$V = \frac{c}{\mu}$

$V \propto \frac{1}{\mu}$

Refractive index is minimum for air.

2. Ans. (d)

Light must pass from denser to rarer medium

glass ($\mu = 1.5$) $\rightarrow$ water ($\mu = 1.33$)

water ($\mu = 1.33$) $\rightarrow$ air ($\mu \approx 1$)

Diamond (2.4) $\rightarrow$ glass (1.5)

3. Ans. (d)

Cauchy's relation,

$\mu = A + \frac{B}{\lambda^2}$ $\qquad \mu \propto \frac{1}{\lambda^2}$

λ is min for violet so μ = max for violet

4. Ans. (d)

$\text{Sin } c = \frac{1}{\mu}$, μ is max for violet, so 'c' is min.

5. Ans. (b)

Due to refraction of light through earth surface, rays of light gets bent. So, sunrise is observed 2 min earlier than actual and sets 2 min later. So, day become 4 min longer.

6. Ans. (a)

Twinkling of stars is due to fluctuation of refractive index of atmosphere.

7. Ans. (c)

$\mu = \frac{1}{\text{Sin } c}$

$\mu = \frac{1}{\sin 30} = 2$

8. Ans. (a)

$\mu = \frac{C}{V} \rightarrow v = \frac{C}{\mu}$

$v = \frac{3\times10^8}{2.4} = 1.25 \times 10^8 \text{m\textbackslash s}$

9. Ans. (d)

Wave length in denser medium

$\lambda = \frac{\lambda \text{ vaccum}}{\mu} = \frac{600}{1.5} = 400 \text{ nm}$

10. Ans. (b)

Refractive index of denser relative to rarer is ${}_2\mu_1 = \frac{v_2}{v_1} = \frac{2.4 \times 10^8}{2 \times 10^8} = \frac{6}{5}$

$c = \text{Sin}^{-1}\left(\frac{1}{{}_2\mu_1}\right) = \sin^{-1}\left(\frac{5}{6}\right)$

11. Ans. (c)

${}_d\mu_r = \frac{\mu r}{\mu d} = \sin c$

$C = \sin^{-1}\left(\frac{\mu r}{\mu d}\right) = \sin^{-1}\left(\frac{4/3}{5/3}\right)$

$= \sin^{-1}\left(\frac{4}{5}\right)$

12. Ans. (c)

If angle of incidence is 'i', then angle of refraction will be (90°– i).

so, $\mu = \frac{\sin i}{\sin r} = \frac{\sin i}{\sin (90 - i)} = \tan i$

$i = \tan^{-1}(\mu)$

13. Ans. (b)

During refraction, frequency remains unchanged but velocity and wavelength decreases by μ.

$v_1 = \frac{v}{\mu}, \lambda_1 = \frac{\lambda}{\mu}$

14. Ans. (b)

λmedium < λair

Blue lighter has shorter wavelength than green among the given option.

15. Ans. (a)

$m = \frac{c}{v} = \frac{f\lambda 1}{f\lambda 2} = \frac{\lambda_1}{\lambda_2}$

$\therefore \frac{\lambda_1}{\lambda_2} = \frac{\mu}{1} = \mu:1$

16. Ans. (c)

$${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3 = \frac{\mu_1}{\mu_2} \times \frac{\mu_2}{\mu_3} \times \frac{\mu_3}{\mu_4} = \frac{\mu_1}{\mu_4} = {}_4\mu_1$$

17. Ans. (a)

$$\frac{\mu_1}{\mu_2} = \frac{\lambda_2}{\lambda_1} = \frac{n_2}{n_1}$$

i.e. $\frac{4}{\lambda g} = \frac{5}{\lambda w}$ (No. of waves = $\frac{\text{Total length}}{\text{Wave length}}$

$$\therefore \quad \frac{\lambda g}{\lambda w} = \frac{4}{5} = \frac{\mu w}{\mu g} = \frac{4/3}{\mu g}$$

$\mu g = 5/3$

18. Ans. (b) $\mu = \frac{c}{v}$ or $v = \frac{3\times10^8}{1.5}$

or, f $\lambda = 2 \times 10^8$

$5 \times 10^4 \times \lambda = 2 \times 10^8$m/s

$\lambda = 4 \times 10^{-7}$m = 4000Δ

19. Ans. (a)

Displacement (x) = $t\left(1 - \frac{1}{\mu}\right)$

$\mu \ \alpha \ \frac{1}{\lambda^2}$. So, μ is less for red

So displacement x will be minimum for red colour and maximum for violet colour.

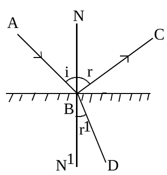
20. Ans. (b)

Displacement of the mark after keeping the glass slab,

$$d = \left(1 - \frac{1}{\mu}\right) t = \left(1 - \frac{1}{1.5}\right) \times 6 = 2 \text{ cm upward}$$

As the mark shifts 2 cm upward the microscope should also moved 2 cm upward to focus on the mark again.

21. Ans. (b)



i = r and

$r + r^1 + 90 = 180$

$r^1 = (90 - r) = (90 - i)$

Snell's law,

$$\frac{\text{Sin } i}{\text{Sin } r^1} = \frac{\mu \text{ rarer}}{\mu \text{ denser}} = \sin C$$

$$\therefore \text{ Sin } c = \frac{\sin i}{\sin(90 - i)} = \frac{\sin i}{\cos i} = \tan i$$

$c = \sin^{-1}(\tan i)$

22. Ans. (b)

$\mu = \frac{\sin i}{\sin r}$ Given i = 2r

$$\mu = \frac{\sin 2r}{\sin r} = \frac{2 \sin r . \cos r}{\sin r}$$

$\mu = 2\cos r$

$$\cos r = \frac{\mu}{2} \Rightarrow r = \cos^{-1}\frac{\mu}{2}$$

$$\therefore \quad i = 2r = 2\cos^{-1}\left(\frac{\mu}{2}\right)$$

23. Ans. (a)

$$\mu = \frac{\text{Real Depth}}{\text{Apparent Depth}} = \frac{1}{1-0.1} = \frac{1}{0.9} = \frac{10}{9}$$

24. Ans. (d)

Apparent depth

$$= \frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} = \frac{4}{1.3} + \frac{6}{1.5} = 3 + 4 = 7\text{cm}$$

25. Ans. (a)

$$\frac{t_1 + t_2}{\mu} = \frac{t_1}{\mu_1} + \frac{t_2}{\mu_2}$$

$$\frac{t/2 + t/2}{\mu} = \frac{t/2}{\mu_1} + \frac{t/2}{\mu_2}$$

$$\frac{2}{\mu} = \frac{1}{\mu_1} + \frac{1}{\mu_2} = \frac{\mu_1 + \mu_2}{\mu_1\mu_2}$$

$$\mu = \frac{2\mu_1\mu_2}{\mu_1 + \mu_2}$$

26. Ans. c

Apparent length of the cube =6+ 4 = 10cm

As $\mu = \frac{\text{Real length}}{\text{Apparent length}}$

Real length = $\mu \times 10 = 1.5 \times 10 = 15$ cm

27. Ans. (a)

As the observor is inside and the object is outside.

So, $\mu = \frac{\text{Apparent height}}{\text{Real height}}$

Apparent height = $\frac{4}{3} \times 3 = 4$m

Apparent height from the eyes of the fish = 4+4 = 8m

28. Ans. (b)

For fish inside water,

$$\mu = \frac{\text{Apparent height of bird}}{\text{Real height of bird}}$$

Apparent height = μx where

x = real height. Let actual depth of fish be y.

Then, Total distance between bird and fish is

$$S = y + \mu x \rightarrow \frac{ds}{dt} = \frac{dy}{dt} + \mu\frac{dx}{dt}$$

$$9 = 3 + \frac{4}{3}\frac{dx}{dt}$$

$$\therefore \frac{dx}{dt} = 4.5\text{m/s}$$

29. Ans. (b)

$$\mu eq = \frac{2\mu_1\mu_2}{\mu_1 + \mu_2} = \frac{2\times1.5\mu\times\mu}{1.5\mu+\mu}$$

$$\mu eq = \frac{3\mu^2}{2.5\mu} = \frac{6}{5}\mu$$

$$\mu eq = \frac{\text{Real depth}}{\text{Apparent depth}} = \frac{1}{2}$$

$$\therefore \frac{6}{5}\mu = \frac{1}{2} \rightarrow \mu = \frac{5}{3}$$

30. Ans. (d)

Let h be the actual height of water filled in beaker

$\therefore$ length of the air column above the water surface = 21 – h

As beaker appear half-filled. Apparent depth of water = Height of air column = 21 – h

$$\mu = \frac{\text{Real depth}}{\text{app.depth}} = \frac{h}{21-h} = \frac{4}{3}$$

$\therefore$ 7h = 84 $\rightarrow$ h = 12cm

31. Ans. (c) Angle of cone = 2c

$$= 2\ \text{Sin}^{-1}\left(\frac{1}{\mu}\right) = 2\ \text{Sin}^{-1}\left(\frac{3}{4}\right) = 98°$$

Maximum angle with vertical to see setting sun = c = 49°.

Angle with horizon = 90° – 49° = 41°

32. Ans. (d) r = h tan c

$$= \frac{h}{\sqrt{\mu^2-1}} = \frac{12}{\sqrt{\frac{16}{9}-1}} = \frac{12\times3}{\sqrt{7}} = \frac{36}{\sqrt{7}}\text{ cm}$$

33. Ans. (d)

The cause of mirage observed in desert is total internal reflection.

Past Questions

1. For which colour the velocity of light is maximum for diamond? (MOE 2068)

a. Red b. Yellow

c. Violet d. Blue

2. A glass of μ = 1.5 thickness 10cm What is the optical path in lens (MOE 2068).

a. 15cm b. 10cm

c. 5cm d. 20cm

3. What is critical angle of glass water interface ($a\mu w = \frac{4}{3}$, $a\mu g$ = 1.5) then (MOE 2068)

a. 62° b. 42° c. 45° d. 50°

4. The index of reflection of diamond is 2.4, velocity of light in diamond is (MOE 2010)

a. 1.25×10^8m/s b. 2.5×10^8 m/s

c. 1.5×10^8m/s d. 2×10^8 m/s

5. A beam of monochromatic blue light of wave length 420 m in air travels in water of refractive index 1.33. Its wavelength in nm in water will be (MOE 2065)

a. 560nm b. 400nm

c. 315nm d. 280nm

6. The refractive index of glass is 1.5. Then velocity of which light is minimum in the glass (MOE 2008).

a. violet b. red

c. yellow d. green

7. The refractive index (μ) and wavelength of light (λ) when light passes from one medium to another medium (MOE 2063)

a. $\mu \propto \lambda^1$ b. $\mu \propto \lambda^2$

c. $\mu \propto \lambda^3$ d. $\mu \propto \lambda^4$

8. A monochromatic beam of light passes from a denser medium to a rearer medium. As a result (MOE 2062)

a. Its speed decreases

b. Its frequency increases

c. Its speed increases

d. Its frequency decreases

9. A glass slab has thickness 6mm and μ= 1.5. Calculate the time in nano second for an instant of light to pass through it. (MOE 2061)

a. 0.02 b. 0.03

c. 0.05 d. 0.04

10. A monochromatic beam of light of wavelength 600nm in air enters a medium of refractive index 1.5. Its wave length in the medium will be (MOE 2058)

a. 600nm b. 400nm

c. 450nm d. 900nm

11. A person inside water can see the sun setting at an angle of (MOE 2053)

a. 41° b. 60°

c. 90° d. 49°

12. If the refractive index of water is $\frac{4}{3}$ and that of glass slab immersed in it is $\frac{5}{3}$. What is the critical angle for a ray of light tending to go from glass to water? (Bangladesh 09)

a. $\sin^{-1}\left(\frac{2}{3}\right)$ b. $\sin^{-1}\left(\frac{5}{4}\right)$

c. $\text{Sin}^{-1}\left(\frac{4}{3}\right)$ d. $\sin^{-1}\left(\frac{4}{5}\right)$

13. A driver in water at a depth 1m sees the whole world through a horizotal circle of radius when the refractive index is μ. (IOM 04)

a. $\frac{1}{\mu - 1}$ b. $\frac{1}{\sqrt{\mu^2 - 1}}$

c. $\frac{\mu}{\sqrt{\mu^2 - 1}}$ d. $\frac{1}{\mu}$

14. When light passes through glass slab (IOM 1997)

a. wavelength decreases

b. wavelength increases

c. velocity increases

d. frequency decreases

15. Which wavelength of light falls under visible wavelength? (KU 2010)

a. 900Δ b. 640nm

c. 640Δ d. 9000Δ

16. Which of the following is not correct for TIR to occur? (KU 2010)

a. The light passes from denser to rarer medium

b. The angle of incidence must be greater than critical angle

c. The light should pass from rarer medium to denser medium

d. Both (a) and (b)

17. Critical angle of light passing from glass to air is minimum for (IOM/MOE/BPKIHS)

a. red b. green

c. yellow d. violet

18. To a bird flying in a sky a fish in water appears to be at 30cm from surface. If refractive index of water with respect to air is $\frac{4}{3}$, then real distance of fish from water surface is (BPKIHS 2010)

a. 30cm b. 22.5cm

c. 40cm d. 60cm

19. Light from vaccum enters to a medium of μ= 1.5. If it crosses it within a nano second, the thickness of the medium is (BPKIHS)

a. 10cm b. 20cm

c. 40cm d. 70cm

20. The optical fibre is based on the principle (IE-2009)

a. diffraction b. reflection

c. total internal reflection d. interference

21. A ray of light of travelling from one medium to another. The wavelength of the light at former and later medium is 4000 and 6000 respectively. Then the value of the critical angle is (IE – 03)

a. 30° b. 45° c. 60° d. $\sin^{-1}\left(\frac{2}{3}\right)$

22. A vessel of depth 't' is half filled with water of refractive index μ_1 and other half is filled with liquid of refractive index μ_2. The apparent depth of vessel as seen from above is (IE – 2009)

a. $\frac{2\mu_1\mu_2}{\mu_1+\mu_2}$ b. $\frac{\mu_1\mu_2}{2(\mu_1+\mu_2)}$

c. $\frac{t(\mu_1+\mu_2)}{2\mu_1\mu_2}$ d. $\frac{2t(\mu_1\mu_2)}{\mu_1\mu_2}$

23. An air bubbles in a glass slab (μ = 1.5) is 5 cm deep when viewed through one face and 2cm deep when viewed through the other face. The thickness of the slab is (IE – 2010)

a. 7cm b. 7.5cm

c. 10cm d. 10.5cm

24. A ray of light travelling inside a rectangular glass block of refractive index $\sqrt{2}$ is incident on glass air surface at an angle of 45°. The ray (BPKIHS)

a. will emerge into air without any deviation

b. will be reflected back into glass

c. will be absorbed

d. will emerge into air with an angle of refraction 90°

Answer Sheet

1. a	*2. a*	*3. a*	*4. a*	*5. c*	*6. a*	*7. b*	*8. c*	*9. b*	*10. b*
11. d	*12. d*	*13. b*	*14. a*	*15. b*	*16. c*	*17. d*	*18. c*	*19. b*	*20. c*
21. d	*22. c*	*23. d*	*24. d*						

Solution

1. Ans. (a)

Decreasing order of wavelength

Red > Orange > Yellow > green > blue > Indigio > violet

Velocity = f $\lambda \alpha \lambda$ as in the same medium frequency of different colours of light is constant.

2. Ans. (a)

Optical path (L) = μ × path in medium (d)

$L = \mu d = 1.5 \times 10$

$= 15$cm

3. Ans. (a)

Sin c = ${}_D\mu_R = {}_g\mu_w$

$${}_g\mu_w = {}_g\mu_a \times {}_a\mu_w = \frac{{}_a\mu_w}{{}_a\mu_g} = \frac{4/3}{3/2} = \frac{8}{9}$$

$$c = \sin^{-1}\left(\frac{8}{9}\right) = 62.7°$$

4. Ans. (a)

$$\mu = \frac{C}{V}\ (\mu\ \alpha\ \frac{1}{v})$$

$$2.4 = \frac{3\times10^8}{v}$$

$$v = \frac{3\times10^8}{2.4} = 1.25\times10^8 \text{ m/s}$$

5. Ans. (c) As $\mu\ \alpha\ \frac{1}{\lambda}$

$$\frac{\mu w}{\mu a} = \frac{\lambda a}{\lambda w}$$

$\frac{1.33}{1} = \frac{420}{\lambda w}$

$\lambda w = 315nm$

6. Ans. (a) $\mu = \frac{c}{v}$, $v = \frac{c}{\mu}$

$v = n\,\lambda$

$\mu \;\alpha\; \frac{1}{\lambda^2}$, $\mu \;\alpha\; \frac{1}{v}$

λ is least for violet so velocity minimum.

7. Ans. (b)

The refractive index (μ) of a medium varies with wavelength (λ), according to cauchy's formula.

$\mu = A + \frac{B}{\lambda^2} + ...$

$\mu \;\alpha\; \frac{1}{\lambda^2}$

8. Ans. (c)

As μ is greater for denser medium and less for rarer medium.

$v \;\alpha\; \frac{1}{\mu}$

Thus velocity increases in rarer medium. Frequency remains unchanged.

9. Ans. (b)

Velocity of light in glass

Slab $(v) = \frac{c}{\mu} = \frac{3\times10^8}{1.5} = 2\times10^8$

$t = \frac{d}{v} = \frac{6\times10^{-3}}{2\times10^8} = 3\times10^{-1}s$

$= \frac{3\times10^{-11}}{10^{-9}}$ nano sec = 0.03ns

10. Ans. (b)

$\lambda \text{ medium} = \frac{\lambda \text{ air}}{\mu} = \frac{600}{1.5} = 400nm(\lambda\alpha\frac{1}{\mu})$

Frequency remains unchanged when light passes from one medium to another.

11. Ans. (d)

Rays of setting sun will be incident on eyes at critical angle. Critical angle of air water interface = 49°

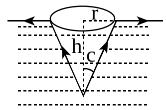
12. Ans. (d) $_D\mu_R = \frac{\sin c}{\sin 90} = \sin c$

$_g\mu_w = \frac{\mu w}{\mu g} = \sin c$

$\text{Sin } c = \frac{4/3}{5/3} = \frac{4}{5}$

$c = \sin^{-1}(4/5)$

13. Ans. (b)



$r = \frac{h}{\sqrt{\mu^2 - 1}}$

$\tan c = \frac{r}{h} \rightarrow r = h \tan c$

$\text{Sin } c = \frac{1}{\mu} = \frac{p}{h}$

∴ $b = \sqrt{\mu^2 - 1}$

$\tan c = \frac{p}{b} = \frac{1}{\sqrt{\mu^2 - 1}}$

14. Ans. (a)

$v = f\,\lambda$ since frequency is constant $v \;\alpha\; \lambda$.

$v = \frac{c}{\mu} \;\alpha\; \frac{1}{\mu}$ so,

velocity decreases in glass slab, as a result wave length ' λ ' also decreases.

15. Ans. (b)

The range of visible spectrum ranges from 4200Δ to 7800Δ

640nm = 6400 Δ, which lies within visible region.

16. Ans. (c)

Conditions for Total internal Reflection (TIR)

→ Angle of incidence should be greater than critical angle.

→ The ray of light should travel from denser to rarer medium.

Note: If the angle of incidence is less than critical angle, the ray undergoes refraction.

17. Ans. (d)

$\sin c = \frac{1}{\mu}$ and $\mu \;\alpha\; \frac{1}{\lambda^2}$

Sin c $\alpha\ \lambda^2$

Wave length is minimum for violet so violet has minimum critical angle.

18. Ans. (c)

$\mu = \frac{\text{Real length}}{\text{apparent length}}$. If observor is outside and object is inside.

Real length = μ × apparent length

$= \frac{4}{3} \times 30\text{cm} = 40\text{cm}$

19. Ans. (b) Refractive index (μ) = $\frac{c}{v}$

$v = \frac{\text{thickness (d)}}{\text{time (t)}}$

$\therefore \quad \mu = \frac{c}{d/t}$

$d = \frac{ct}{\mu} = \frac{3\times10^8\times10^{-9}}{1.5}$

$= 0.2\text{m} = 20\text{cm}$

20. Ans. (c)

The working of optical fibres and light pipes used for endoscope are based on total internal reflection.

21. Ans. (d) The velocity is less in former.

V = f λ, V $\alpha\ \lambda$, The former one is denser (D) later is rarer (R)

${}_D\mu_R = \sin c = \frac{\mu R}{\mu D}$

Also, $\quad \mu\ \alpha\ \frac{1}{\lambda}$

$\rightarrow \frac{\lambda D}{\lambda R} = \frac{\mu R}{\mu D}$

$\text{Sin c} = \frac{\lambda D}{\lambda R} = \frac{4000}{6000} = \frac{2}{3}$

$c = \text{Sin}^{-1}\left(\frac{2}{3}\right)$

22. Ans. (c)

If the number of slaps of thickness t_1, t_2, t_3....... tn of refractive index μ_1, μ_2, μ_3 .... μ_n are placed over an object, then apparent depth is given by

$$d = \frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} + \frac{t_3}{\mu_3} + \text{........} + \frac{t_n}{\mu_n}$$

Here, $t_1 = t_2 = \frac{t}{2}$

$$d = \frac{t/2}{\mu_1} + \frac{t/2}{\mu_2} = \frac{t}{2\mu_1} + \frac{t}{2\mu_2} = \frac{t}{2}\ \frac{\mu_1 + \mu_2}{\mu_1\mu_2}$$

23. Ans. (d)

Apparent length of the glass slab =5+2=7cm

$\mu = \frac{\text{Real length}}{\text{Apparent length}}$

Real length = μ × Apparent length

$= 7 \times 1.5$

$= 10.5$ cm

24. Ans. (d)

From snell's law

$\frac{\sin i}{\sin r} = \frac{\mu_2}{\mu_1}$

$\frac{\sin 45}{\sin r} = \frac{1}{\sqrt{2}} \rightarrow \sin r = 1$

$\rightarrow r = 90°$

So, ray emerges at an angle 90° in air.

Chapter: 40

Refraction Through Prism & Dispersion Of Light

1. A prism causes:

a. Deviation only
b. Dispersion only
c. Deviation and dispersion both
d. Neither deviation nor dispersion

2. When white light is passed through a glass prism. One gets spectrum on the other side. In the emergent beam, the ray which is deviated the most is:

a. violet
b. green
c. red
d. yellow

3. If i_1 is the angle of incidence and i_2 the angle of emergence for ray reflected from a glass prism, then the devation will be minimum if:

a. $i_1 = i_2$
b. $i_1 > i_2$
c. $i_1 < i_2$
d. $i_1 + i_2 = 90°$

4. If i_1 is angle of incidence and i_2 the angle of emergence for a ray refracted from a glass prism, then deviation will be maximum if.

a. $i_1 = i_2$
b. either i_1 or $i_2 = 0$
c. either i_1 or $i_2 = 90°$
d. none

5. In a thin prism of glass (aμg=1.5) which of the following relations between the angle of minimum deviation δm and angle of refraction r will be correct?

a. $\delta m = r$
b. $\delta m = 1.5r$
c. $\delta m = 2r$
d. $\delta m = \frac{r}{2}$

6. A spectrum is formed by a prism whose dispersive power is ω. If the deviation of the mean ray is δ, the angular deviation of the spectrum is:

a. $\frac{\omega}{f}$
b. $\frac{\delta}{\omega}$
c. $\frac{1}{\omega\delta}$
d. $\omega\delta$

7. The angle of prism is 6° and its refractive index for green light is 1.5. If a green ray passes through it, the deviation will be:

a. 3°
b. 9°
c. 15°
d. 30°

8. If the prism in above question, is immersed in water (refractive index $\frac{4}{3}$), the deviation produced would be:

a. 3°
b. 45^{1}
c. 12°
d. 2°

9. White light is passed through a prism of angle 5°. If the refractive indices for red and blue colours are 1.641 and 1.659 respectively, what is the angle of dispersion between them?

a. 5°
b. 2°
c. 0.009°
d. 0.9°

10. Which of the following colours is scattered minimum?

a. violet
b. blue
c. red
d. yellow

11. The refractive indices of a material for red and violet colours are 1.514 and 1.524. Then its dispersive power of the material will be:

a. 0.012
b. 0.019
c. 0.03
d. 0.4

12. The deviation produced by a crown glass prism for red, yellow and violet colours are 2.84°, 3.28° and 3.72°. The dispersive power of the material of the prism will be:

a. 0.152
b. 0.134
c. 0.268
d. 0.168

13. If the critical angle for the medium of a prism is C and angle of prism is A, then there will be no emergent ray when:

a. A < 2c
b. A = 2c
c. A > 2c
d. A ≥ 2c

14. What should be the refractive index of the prism for no emergence?

a. $\mu > \cot\frac{A}{2}$
b. $\mu < \cot\frac{A}{2}$
c. $\mu > \operatorname{cosec}\frac{A}{2}$
d. $\mu < \operatorname{cosec}\frac{A}{2}$

15. A prism of refractive index μ_g deviates the incident ray towards its base. If it is immersed in a transparent liquid of refractive index such that $\mu_l > \mu g$ then prism would:

a. deviate the ray towards its base
b. deviate the ray away from the base
c. not deviate the ray at all
d. none

16. A glass prism of refractive index 1.5 and the refracting angle is 90°. If a ray falls of it at an angle of incidence of 30°, then what will be the angle of emergence?

a. 60°
b. 30°
c. 45°
d. the ray will not emerge out of the prism.

17. For which of the following the dispersive power is zero?

a. lens
b. prism
c. glass slab
d. none

18. Dispersion for a medium of wavelength λ is D. Then the dispersive power for the wave length 2λ will be:

a. $\frac{D}{8}$
b. $\frac{D}{4}$
c. $\frac{D}{2}$
d. D

19. A thin prism of glass is placed in air and water successively. If $\mu g = \frac{3}{2}$ and $\mu w = \frac{4}{3}$ then the deviation produced by the prism for a small angle of incidence when placed in air and water are in the ratio:

a. 9:8
b. 4:3
c. 3:4
d. 4:1

20. An equilateral prism has refractive index $\sqrt{2}$. The angle of incidence which gives minimum deviation is:

a. 60°
b. 45°
c. 90°
d. 30°

21. A ray is incident at an angle of incidence i on one face of a prism of small Angle A and emerges normally from the opposite surface. If the refractive index for the material of prism is μ.The angle of incidence is nearly equal to:

a. A/μ
b. A/2μ
c. μA
d. μA/2

22. A ray of light is incident at an angle of 60° on one face of a prism, which has an angle of 30°. The ray emerging out of the prism makes an angle of 30° with the incident ray. The refractive index of the material of the prism is:

a. $\sqrt{2}$
b. $\sqrt{3}$
c. 1.5
d. 1.6

23. A ray of monochromatic light is incident on one refracting face of a prism of angle 75°. It passes through the prism and is incident on the other face at the critical angle. If the refractive index of the material of the prism is $\sqrt{2}$, the angle of incidence on the first face of the prism is:

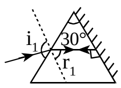
a. 30°
b. 45°
c. 60°
d. 0°

24. A ray of light incidents normally on one of the perpendicular face of a right angled isoceles prism and suffers total internal reflection. The minimun value of refractive index should be:

a. 1 b. $\sqrt{2}$

c. 1.5 d. $\sqrt{3}$

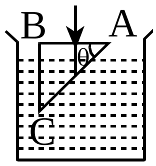
25. There is a prism with refractive index equal to $\sqrt{2}$ and the refracting angle equal to 30°. One of the refracting surfaces of the prism is doubled. A beam of monochromatic light will retrace its path if its angle of incidence over the refracting surface of the prism is:



a. 0° b. 30°

c. 45° d. 60°

26. A glass prism of refractive index 1.5 is immersed in water ($_a\mu_w = \frac{4}{3}$). A light beam incident normally on the face AB is totally reflected to reach the face BC if:



a. $\sin\theta > \frac{8}{9}$

b. $\sin\theta < \frac{8}{9}$

c. $\frac{2}{3} < \sin\theta < \frac{8}{9}$

d. $\sin\theta < \frac{2}{3}$

27. A ray of light is incident normally on the first face of an equilateral prism undergoes total internal reflection at the second face if refractive index is:

a. $\mu > \frac{2}{\sqrt{3}}$ b. $\mu < \frac{2}{\sqrt{3}}$

c. $\mu > \frac{3}{\sqrt{2}}$ d. $\mu < \frac{3}{\sqrt{2}}$

28. What should be the refractive index of an equilateral prism for total internal reflection?

a. $\mu > 2$ b. $\mu < 2$

c. $\mu > \sqrt{2}$ d. $\mu < \sqrt{2}$

29. Angle of prism is A and its one surface is silvered. Light rays falling at an angle of incidence 2A on first surface return back through the same path after suffering reflection at second surface. Refractive index of the material of the prism is:

a. 2 sin A b. 2 cos A

c. $\frac{\cos A}{2}$ d. $\cos\frac{A}{2}$

30. A thin prism P1 with angle 4° and made from glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 2.72 to produce dispersion without deviation. The angle of prism P_2 is:

a. 5.33° b. 40

c. 3° d. 2.6°

31. To make an achromatic combination a convex lens of focal length 42 cm having dispersive power 0.14 is placed in contact with concave lens of dispersive power 0.21. The length of the concave lens should be:

a. 14 cm b. 21 cm

c. 63 cm d. 42cm

32. From two projectors, beam of redlight and green light are sent on the same spot of the screen. The screen will look:

a. black b. violet

c. yellow d. white

33. A red postage stamp is viewed in yellow light. It appears:

a. light grey b. orange

c. black d. green

Answer Sheet

1. c	*2. a*	*3. a*	*4. c*	*5. a*	*6. d*	*7. a*	*8. b*	*9. c*	*10. c*
11. b	*12. c*	*13. c*	*14. c*	*15. b*	*16. d*	*17. d*	*18. b*	*19. d*	*20. b*
21. c	*22. b*	*23. b*	*24. b*	*25. c*	*26. a*	*27. a*	*28. a*	*29. b*	*30. c*
31. c	*32. c*	*33. c*							

Solution

1. Ans. (c)
   - Angular deviation = $(\mu - 1)A$ and
   - Angular dispersion = $(\mu v - \mu r)$ A
   - Hollow prism causes no dispersion
   - A glass slab causes neither deviation nor dispersion
2. Ans. (a)
   Deviation $(\delta) = (\mu - 1)$ A
   $\mu \ \alpha \ \frac{1}{\lambda^2}$ cauchy relation.
   μ is more for violet so, violet is deviated the most.
3. Ans. (a)
   In minimum deviation, the refracted ray from the first face becomes parallel to the base of the prism. In this case, $i_1 = i_2 = i$ & $r_1 = r_2 = r$.
4. Ans. (c)
   Deviation is maximum at grazing incidence or grazing emergence ie. $i_1 = 90$ or $i_2 = 90°$.
5. Ans. (a)
   At minimum deviation
   $A = r_1 + r_2 = r + r = 2r$
   For thin prism,
   $\delta m = (\mu - 1)\ A = (1.5 - 1)\ 2r$
   $= r$
6. Ans. (d)
   Angular dispersion
   $= (\mu v - \mu r)A$
   $= \frac{(\mu v - \mu r)}{(\mu - 1)}\ (\mu - 1)A = \omega\delta$
7. Ans. (a)
   $\delta = (\mu g - 1)A = (1.5 - 1) \times 6° = 3°$
8. Ans. (b)
   $\delta = (w\mu g - 1)$ A
   $= \left(\frac{\mu g}{\mu w} - 1\right) A = \left(\frac{3}{2}\times \frac{3}{4} - 1\right) 6° = \left(\frac{6}{8}\right)^{\circ} = 45^1$
9. Ans. (c)
   $\delta = (\mu b - \mu r)A = (1.059 - 1.641) \times 5 = 0.09°$
10. Ans. (c) Intensity of scattering
    $I \ \alpha \ \frac{1}{\lambda^4}$ Red is scattered minimum and violet the most.
11. Ans. (b)
    $\mu y = \frac{\mu v + \mu r}{2} = \frac{1.524 + 1.514}{2} = 1.51$
    Now, $\omega = \frac{\mu v - \mu r}{\mu y - 1} = \frac{1.524 - 1.514}{1.519 - 1} =$
    $\frac{0.010}{0.519} = 0.019$
12. Ans. (c) $\omega = \frac{\delta y - \delta r}{\delta y} = \frac{3.72 - 2.84}{3.28} = 0.268$
13. Ans (c) During grazing incidence and grazing emergence
    $\rightarrow$ $i_1 = 90°$ & $r_1 = c \rightarrow i_2 = 90$ & $r_2 = c$
    $A = r_1 + r_2 = 2c \ \therefore\ A = 2c$ is limiting angle of prism. If $A > 2c$, light is totally reflected from second face and there is no emergent ray.
14. Ans. (c) We know for no emergence $A > 2c$
    $\frac{A}{2} > c \rightarrow \sin\frac{A}{2} > \sin c$
    $\text{Sin}\frac{A}{2} > \frac{1}{\mu}$ $(\sin c = \frac{1}{\mu})$
    $\therefore\ \mu > \text{cosec}\frac{A}{2} \ \therefore\ \mu \text{ min} = \text{cosec}\frac{A}{2}$
15. Ans. (b)
    Angle of deviation 'δ' by a prism of refractive index μg surrounded by liquid of refractive index μl is δ
    $\delta = ({}_l\mu_g - 1)\ A = \left(\frac{\mu g}{\mu l} - 1\right) A$
    $= \left(\frac{\mu g - \mu l}{\mu_l}\right) A$
    If $\mu l > \mu g$, the deviation δ is –ve. It means light gets deviated away from the base.

16. Ans. (d)

$A = r_1 + r_2 \rightarrow r_2 = A - r_1$

Here, $r_1 < i \rightarrow r_1 < 30°$

$r_2 > (90 - 30) = 60°$

$c = \sin^{-1}\left(\frac{1}{\mu}\right) = \sin^{-1}\left(\frac{1}{1.5}\right) = 42°$

$r_2 > c$ ie. the angle of incidence at an other face will be greater than critical angle hence ray willn't emerge.

17. Ans. (d)

Dispersive power is zero only for vaccum. All other media have +ve value of dispersive power.

18. Ans. (b)

$D \alpha \mu$ and $\mu \alpha \frac{1}{\lambda^2}$

$\therefore D \alpha \frac{1}{\lambda^2}$

As λ becomes twice, D becomes one fourth.

19. Ans. (d)

$\delta a = (a\mu g - 1) A = \left(\frac{3}{2} - 1\right) A = \frac{A}{2}$

$\delta w = (w\mu g - 1) A = \left(\frac{\mu g}{\mu w} - 1\right) A$

$= \left(\frac{\frac{3}{2}}{\frac{4}{3}} - 1\right) \times A = \frac{A}{8}$

$\frac{\delta a}{\delta w} = \frac{A/2}{A/8} = 4:1$

20. Ans. (b)

At minimum deviation, $r = A/2 = \frac{60°}{2} = 30°$

so, $\mu = \frac{\sin i}{\sin r}$

$\text{Sin } i = \mu \sin r = \sqrt{2} \times \frac{1}{2}$

$= \frac{1}{\sqrt{2}} = \sin 45°$

$\therefore i = 45°$

21. Ans. (c)

As refracted ray emerges normally from opposite face, $r_2 = 0$

As $A = r_1 + r_2 = r_1 + 0 = r_1$

Now, $\mu = \frac{\sin i_1}{\sin r_1} = \frac{i_1}{r_1} = \frac{i_1}{A}$ (For small angle)

$\therefore i_1 = \mu A$

22. Ans. (b)

Given $i_1 = 60°$, $A = 30°$, $D = 30°$

We know, $A + D = i_1 + i_2$

$30° + 30° = 60° + i_2 \rightarrow i_2 = 0°$

i.e. Normal incidence occurs at another face so $r_2 = 0$

Also $A = r_1 + r_2$ or, $30° = r_1 + 0°$

$\therefore r_1 = 30°$

$\mu = \frac{\sin i_1}{\text{Sin } r_1} = \frac{\sin 60}{\sin 30} = \sqrt{3}$

23. Ans. (b)

$A = 75°$, $r_2 = c$, $i_2 = 90°$

$\therefore \quad \mu = \frac{\sin i_2}{\sin r_2} = \frac{\sin 90}{\sin r_2} = \frac{1}{\sin r_2}$

or, $\sin r_2 = \frac{1}{\mu} = \frac{1}{\sqrt{2}} = \sin 45°$

$\therefore r_2 = 45°$ Also, $A = r_1 + r_2 = 75° = r_1 + 45$

$\therefore r_1 = 30°$

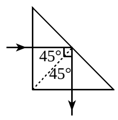
Now,

$\mu = \frac{\sin i_1}{\sin r_1}$

$\text{Sin } i_1 = \mu \sin r_2 = \sqrt{2} \times \frac{1}{2} = \sin 45°$

$\therefore i_1 = 45°$

24. Ans. (b)



For total internal reflection

$i > c$

Here, $c = 45°$

$\mu \geq \frac{1}{\sin c} \geq \frac{1}{\sin 45°} \qquad \therefore \mu \geq \sqrt{2}$

25. Ans. (c)

The ray will retrace its path if the angle of incidence on the second face is zero. i.e $r_2 = 0°$

As $A = r_1 + r_2 = r_1 + o = r_1$

$\therefore\ r_1 = 30°$

$\mu = \frac{\sin i_1}{\sin r_1}$ $\sin i_1 = \mu \sin r_2$

$\sin i_1 = \sqrt{2} \times \frac{1}{2}$

$= \frac{1}{\sqrt{2}} = \sin 45$

$\therefore\quad i_1 = 45°$

26. Ans. (a)

$d\mu r = \text{Sin } c = {}_g\mu_w$

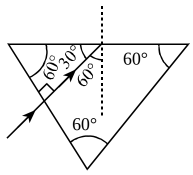
$\sin c = \frac{1}{w\mu g} = \frac{\mu w}{\mu g} = \frac{4}{3\times 1.5} = \frac{8}{9}$

For total internal reflection,

$\theta > C$ ie. $\sin\theta > \text{Sin } C$

$\therefore\ \sin\theta > \frac{8}{9}$

27. Ans. (a)



As it is clear from figure

$i = 60°$

For total internal reflection to take place

$i > c$

$\sin i > \sin c$ $\qquad \sin 60 > \frac{1}{\mu}$

$\frac{3}{\sqrt{2}} > \frac{1}{\mu}\ \therefore\ \mu > \frac{2}{\sqrt{3}}$

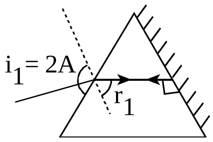
28. Ans. (a)

For no emergence $\mu > \text{cosec } \frac{A}{2}$

or, $\mu > \text{cosec } \frac{60}{2}$

$\mu > \text{cosec } 30 \rightarrow \mu > 2$

29. Ans. (b)



Since the ray traces back its original path

$r_2 = 0\ \&\ i_2 = 0$

$r_1 + r_2 = A \rightarrow r_1 = A$

$\rightarrow r1 = A$

Using snell's law on 1st face

$\mu = \frac{\sin i_1}{\sin r_1} = \frac{\sin 2A}{\sin A} = \frac{2\sin A \cos A}{\sin A}$

$\mu = 2 \cos A$

30. Ans. (c)

Condition for dispersion without deviation.

$\delta + \delta_1 = 0$

$A(\mu - 1) + A1(\mu^1 - 1) = 0$

$A^1 = \frac{-\mu - 1}{\mu_1 - 1} \times A = \frac{-1.54 - 1}{1.72 - 1} \times 4°$

$= -3°$ (–ve sign indicates opposite nature).

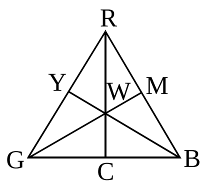
31. Ans. (c)

$\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$

$\frac{0.14}{42} + \frac{0.21}{f_2} = 0$

$f_2 = \frac{-0.2 \times 42}{0.14} = -63\text{cm}$

32. Ans. (c)



We know,

R + G = Y (using triangle)

33. Ans. (c)

A red postage stamp appears red only if it reflects the red light faling falling on it but the incident light is yellow which is absorps and reflects none. So it appears black.

Past Questions

1. Colour of sky is due to (MOE 2067)

a. scattering of light b. reflection
c. reflection d. polarisation

2. An impure spectrum of Green, Blue, Orange and Yellow is observed on a screen when light passes through a transparent prism. The refractive index of the prism with respect to colours will be maximum for (MOE Curriculum)

a. Blue b. Green
c. Orange d. Yellow

3. In the Sun's spectrum, there are several visible and invisible specrum. If blue and green lights are passed through a transparent prism the deviation of green light will be (MOE 2063).

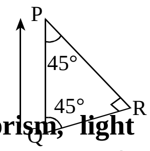
a. equal so they will form achromatic
b. greater than that of blue light
c. smaller than than of blue light
d. can't be predicated

4. The angle of prism is A and the minimum deviation is (180 – 2A). Then the refractive index of the material of the prism (MOE 2062)

a. sin A/2 b. cos A/2
c. tan A/2 d. cot A/2

5. An object PQ is placed facing the hypotenuse of 45°– 90°– 45° glass prism. What is the nature of the image formed? (Refractive index of prism is 1.5)

a. erect and diminished
b. erect and same size
c. inverted and magnified
d. inverted and same size



6. In a right-angled glass prism, light is normally incident through smaller face. Then deviation is (MOE 2054)

a. 90° b. 45°
c. 30° d. 60°

7. Chromatic aberration is due to (MOE 2054)

a. Deviation b. Dispersion
c. Interference d. Diffraction

8. Angle of deviation when passing through a prism is greatest for light. (MOE/KU)

a. red b. violet
c. blue d. yellow

9. An achromatic lens forms an image of a white object. The colour of image seen wil be (Bangladesh 09)

a. black b. green
c. yellow d. white

10. In an equilateral prism, if angle of incidence equals to angle of emergence and the angle of incidence is $\frac{3}{4}^{th}$ of angle of prism. Then find the deviation produced (KU2010)

a. 60° b. 90°
c. 120° d. 30°

11. An achromatic doublet is constructed by lenses of crown glass and flint glass of dispersive powers 0.02 and 0.03. If the focal length of crown glass in 20 cm, then focal length of crown glass is 20cm, then focal length of the doublet becomes

(IOM 05)

a. – 60cm b. – 30cm
c. 12cm d. 12cm

12. In a right angled isosceles prism, when the light falls from flat face and for total internal reflection to takes place in the second face, the minimum refractive index of the prism is (IOM 03)

a. 1.34 b. 1.41($\sqrt{2}$)
c. 1.55 d. 1.66

13. For minimum deviation inside the prism, the angle of emergence should be equal to (IOM 1999)

a. angle of prism
b. angle of incidence
c. angle of refraction
d. angle of deviation

14. The power produced by a prism of small angle A (BPKIHS)

a. depends on material of prism only
b. depends of A only
c. depends both on material and A
d. depends neither on material nor on A

15. The principle of which of the following is based on deviation without dispersion? (BPKIHS)

a. Chromatic doublet
b. Achromatic doublet
c. Spectrometer
d. Direct vision spectroscope

16. A prism can produce a minimum deviation of δ in a light beam. If three such prisms are combined the minimum deviation that can be produced in this beam is (BPKIHS)

a. 0 b. δ
c. 2 δ d. 3 δ

17. A prism of refracting angle 60° produces a minimum deviation of 30°. Then the angle of incidence is [IE]

a. 30° b. 60°
c. 45° d. 90°

Answer Sheet

1. a	*2. a*	*3. c*	*4. d*	*5. d*	*6. a*	*7. b*	*8. b*	*9. d*	*10. d*
11. a	*12. b*	*13. b*	*14. a*	*15. b*	*16. b*	*17. c*			

Solution

1. Ans. (a)

Colour of sky →scattering of light & colour of soap bubbles →interference

2. Ans. (a)

$\mu \propto \frac{1}{\lambda^2}$ (cauchy relation)

Therefore among given colors λ is minimum for blue, so refractive index will be maximum for blue light and minimum for orange in given question.

3. Ans. (c) For a prism,

Deviation(δ) = (μ –1) A & $\mu \propto \frac{1}{\lambda^2}$

'μ' is the refractive index and 'A' is angle of prism. 'μ' for blue light is greater than green light. So, deviation of green light is smaller than that of blue light.

4 Ans. (d)

$$\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin A/2} = \frac{\sin\left[\frac{A+180-2A}{2}\right]}{\sin A/2}$$

$$= \frac{\sin[90-A/2]}{\sin A/2} = \frac{\cos A/2}{\sin A/2} = \cot A/2$$

5. Ans (d)

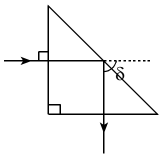
critical angle $c = \sin^{-1}\frac{1}{\mu} = 41.8°$

and rays falling normaly to first face makes and angle 45° with the refracting face as a result of which the ray gets total internally reflected. So the image is inverted and of same size.

6. Ans. (a)

Critical angle for glass = 42°.

Hence, light suffers total internal reflection and is deviated 90°. If light falls normally on the larger face deviation produced = 180°.



7. Ans.(b)

Chromatic aberration: Inability of a lens to form images of different colour at the same point on principal axis.

8. Ans. (b)

Deviation (δ) = (μ–1)A

$\mu \ \alpha \ \frac{1}{\lambda^2}$

μ is higher for lower wave length ie. violet. So deviation is higher for violet.

9. Ans. (d)

If fv and fR are focal lengths of convex lens for violet and red light respectively then

fv < fR

For concave lens

fv < fR

10. Ans. (d) Angle of incidence (i) = angle of emergence (e)

$i = \frac{3}{4}$ A For equilaterial triangle A = 60°

$i = e = \frac{3}{4} \times 60 = 45°$

Then, $i = \frac{A+\delta m}{2}$

$45 = \frac{60+\delta m}{2}$ or, δm = 30° m

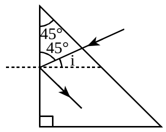
11. Ans. (a) For achromatism $\frac{\omega_1}{\omega_2} = \frac{-f_1}{f_2}$

$\therefore \ f_2 = -f_1 \times \frac{\omega_2}{\omega_1} = -20 \times \frac{0.03}{0.02} = -30\text{cm}$

For combination (considering they are very close)

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{2} - \frac{1}{30} = \frac{-1}{60}$

f = – 60cm so, focal length of doublet is –60cm



12. Ans. (b)

For total internal reflection inthe second face∠i>∠c (critical angle) ie. imax= 45°=c

$\mu = \frac{1}{\sin c} = \frac{1}{\sin 45} = \sqrt{2} = 1.414$

13. Ans. (b) In the minimum deviation, the refracted ray from the first face becomes parallel to the base of the prism.

angle of incidence (i) = angle of emergence (e)

14. Ans. (a) Dispersive power of prism

$\omega = \frac{\text{Angular dispersion}}{\text{mean deviation}} = \frac{\delta v - \delta R}{\delta y} = \frac{\mu v - \mu R}{\mu - 1}$

Hence, dispersive power depends on refractive index (ie. material of prism) only but not on angle of prism A. However, Angular dispersion depends on both. i.e. Angular dispersion = δv – δr = (μv –μr) A

15. Ans. (b)

→ Achromatic combination causes deviation only, no dispersion.

→ Direct vision spectroscope = dispersion without deviation

→ Spectrometer measures deviation caused by prism

16. Ans. (b) Deviation produced by first prism is cancelled by deviation produced by second prism. So, only noticeable deviation is δ.

17. Ans. (c) δm + A = i + e

For minimum deviation,

i = e

δm + A = 2i

$i = \frac{\delta m + A}{2} = \frac{30+60}{2} = 45°$

Chapter: 41

Refraction Through Lenses

1. A lens behaves as a converging lens in air and a diverging lens in water. The refractive index of the material is:

a. 1 b. 1.33

c. between 1 and 1.33 d. > 1.33

2. An air bubble in water behaves as a

a. convex lens b. concave lens

c. plane glass plate

d. plano – convex lens

3. The minimum distance between an object and its real image formed by thin convex lens of focal length f is:

a. 4 f b. 2 f

c. f d. $\frac{f}{2}$

4. Two lens of power 1.75D and –1.25D are combined to form a single lens. The focal length of the combination will be:

a. 25 cm b. 10 cm

c. 200 cm d. 50 cm

5. A convex lens of focal length 40cm is in contact with a concave lens of focal length 25cm. The power of the combination is:

a. –1.5D b. –6.5D

c. 6.5 D d. 6.67 D

6. A convex lens of focal length f_1 is placed in contact with a concave lens of focal length f_2. The combination will act as a convergent lens if:

a. $f_1 < f_2$ b. $f_1 > f_2$

c. $f_1 = f_2$ d. $f_1 > 2f_2$

7. A convex lens A of focal length 30cm and concave lens B of focal length 10cm are kept along the same axis with distance 'd' between them. It a parallel beam of light falling A leaves B as parallel beam. Then seperation between lenses 'd' is equal to:

a. 40cm b. 20cm

c. 60cm d. zero

8. The plane faces of two identical plano - convex lenses each having focal length of 40cm are pressed against each other to form an usual convex lens. The distance from this lens at which an object must be placed to obtain real, inverted image with magnification unity is:

a. 80cm b. 160cm

c. 20cm d. 40cm

9. A convex lens of focal length f produces a real image n times the size of the object. Then the distance of the object from the lens is.

a. (n–1)f b. (n+1)f

c. $\left(\frac{n-1}{n}\right)f$ d. $\left(\frac{n+1}{n}\right)f$

10. A concave lens of focal length and produces an image $\frac{1}{n}^{th}$ of the size of the object the distance of the object from the lens is:

a. (n –1)f b. (n + 1)f

c. $\left(\frac{n-1}{n}\right)f$ d. $\left(\frac{n+1}{n}\right)f$

11. A glass convex lens (μg = 1.5) has a focal length 8cm when plced in air. The focal length of the lens when it is immersed in water (μw = $\frac{4}{3}$) will be:

a. 2cm b. 4cm

c. 16cm d. 32cm

12. The focal length of a Plano-convex lens is equal to radius of a curvature of its

curved surface. Then refractive index of the lens material is:

a. 1.33 b. 1.5
c. 1.6 d. 2

13. **A plano-convex lens of focal length 20cm is silvered at plane surface. Now new focal length will be:**

a. 20cm b. 30cm
c. 40cm d. 10cm

14. **The curved surface of a plano convex lens is silvered. If μ be the refractive index and R the Radius of curvature of its curved surface.Then the system behaves like a concave mirror of radius:**

a. $\frac{R}{\mu-1}$ b. $\frac{R}{2(\mu-1)}$
c. $\frac{R}{2\mu}$ d. $\frac{R}{\mu}$

15. **The diameter of aperture of plano-convex lens is 6cm and maximum thickness is 3mm. If the velocity of light in the material of lens is 2×10^8m/s then focal length of the lens will be:**

a. 15cm b. 20cm
c. 30cm d. 60cm

16. **An equicovex glass lens having focal length f and power P is cut into symmetical halves by a plane containing the principal axis. The two pieces are recombined is the inverted position side by side. The power of new combination is:**

a. P b. $\frac{P}{2}$
c. 2P d. Zero

17. **An equiconvex lens having focal length f and power P is cut into two symmetrical halves by a plane containing the principal axis. If the two half lenses are arranged side by side in upright position. Then power of the combination is:**

a. P b. $\frac{P}{2}$
c. 2P d. zero

18. **An equiconvex glass lens having focal length f and power P is cut into two symmetrical halves by a plane perpendicular to principal axis so that two plano-convex lenses is formed. If they are arranged side by side with their plane side opposite to eachother. Then power of the combination is:**

a. P b. $\frac{P}{2}$
c. 2P d. zero

19. **A lens has focal length f. If half of the body of lens is covered with black paper, its focal length becomes:**

a. f b. $\frac{f}{2}$ c. 2f d. 4f

20. **A lens is made of three transparent materials. An object O is placed on the principal axis of the lens. The number of images formed by lens is:**

a. 1 b. 2 c. 3 d. 4

21. **A thin lens has focal length f and its aperture has diameter d. It forms an image of intensity I. Now the central part of the aperture upto diameter $\frac{d}{2}$ is blocked by an opaque paper. The intensity will change to:**

a. $\frac{I}{2}$ b. $\frac{I}{4}$ c. $\frac{3I}{4}$ d. I

22. **An object 5 cm long is placed 20cm from a concave lens of focal length 30cm. The size of the image must be:**

a. 3cm inverted b. 3cm erect
c. 6cm inverted d. 6cm erect

23. **The distance between then convex lens and a plane mirror is 10cm. The parallel rays of light are incident on the convex lens. After reflection from the plane mirror, the final image is formed at the optical centre of the lens. The focal length of the lens is:**

a. 5 cm b. 10 cm d. 20 cm d.40 cm

24. **The rays of light from a luminous object are focused at a point A. If a convex lens of focal length 30cm is put at a distance 30cm from the point A such that rays fall upon the lens after focusing at the**

point A. If now, the rays are focused at B, What is the distance AB?

a. 45cm b. 15cm

c. 22.5cm d. 30cm

25. An aeroplane is fitted with a camera containing a lens of 5 cm focal length. In order to photograph a strip of 5cm terrain 1km long on a film strip, the aeroplane would fly at an approximate height of:

a. 1km b. 2km d. 3km d.4km

26. A lens form an image on a screen, which is placed at a distance 50cm from an object.When the lens is shifted towards the screen by 10cm, another image is formed on the screen. The focal length of the lens is:

a. 5cm b. 7cm

c. 9cm d. 12cm

27. A biconvex lens has different media on its two sides. Its focal length is 10cm. An object when placed at a distance of 15cm from the first focus form a real image at a distance 20cm from the second focus. The second focal length must be

a. 10cm b. 20cm

c. 30cm d. 35cm

28. A convex lens makes a real image 4cm long on a screen. When the lens is shifted to a new position without disturbing the object and the screen, a real image is again formed on the screen which is 16cm long. The length of the object must be:

a. 64cm b. 8cm

c. 10cm d. 6cm

29. An object and a screen are fixed at certain distance. When a convex lens is moved from object to the screen real images of magnifications 2 and $\frac{1}{2}$ are formed on the screen for two positions of lens seperated by 30cm. Then focal length of the lens will be:

a. 10cm b. 20cm

c. 30cm d. 60cm

Answer Sheet

1. c	*2. b*	*3. a*	*4. c*	*5. a*	*6. a*	*7. b*	*8. d*	*9. d*	*10. a*
11. d	*12. d*	*13. d*	*14. d*	*15. c*	*16. d*	*17. c*	*18. a*	*19. a*	*20. c*
21. c	*22. b*	*23. c*	*24. b*	*25. a*	*26. d*	*27. c*	*28. b*	*29. b*	

Solution

1. Ans. (c)

To be have as a converging lens in air $\mu > \mu_{air}$. To behave as a diverging lens in water $\mu < \mu_{water}$. so, $\mu_{air} < \mu < \mu_{water}$ ie. $1 < \mu < 1.33$

2. Ans. (b)

$$\frac{1}{f_w} = ({}_w\mu_a - 1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

$$\frac{1}{f_w} = \left(\frac{\mu_a}{\mu_w} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

f_w = –ve as $\mu a < \mu w$

So concave lens

3. Ans. (a)

When object is placed at 2F point on one side, A real image is formed at 2F point on other side. So, minimum distance = 2F + 2F = 4F

4. Ans. (c)

$P_{eq} = P_1 + P_2 = 1.75 - 1.25 = 0.5D$

$$\therefore \quad F_{eq} = \frac{1}{Peq} = \frac{1}{0.5} = 2m = 200cm$$

5. Ans. (a)

$$F = \frac{f_1 f_2}{f_1 + f_2} = \frac{40 \times (-25)}{40 - 25} = \frac{-40 \times 25}{15} = \frac{-1000}{15} \text{ cm}$$

$P = \frac{100}{F(cm)} = \frac{-100\times15}{1000} = -1.5D$

6. Ans. (a)

$F = \frac{f_1 f_2}{f_1+f_2}$

The combination will act as convergent lens if F is +ve. Here, f_1 is +ve and f_2 is –ve. For F to be +ve, the denomination part should be –ve, ie. $f_1 < f_2$.

7. Ans. (b)

Parallel beam of light falling on A will leave B as parallel beam only if the combination has nature as that of glass slab. For glass slab, power = 0

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

$0 = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$ $\left[P = \frac{1}{F} = 0\right]$

$d = f_1+f_2 = 30+(-10) = 20cm$

8. Ans. (d)

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{40} + \frac{1}{40}$

F = 20 cm

For unit magnification, the object must be placed at 2F.

2F = 2×20 = 40cm

9. Ans. (d)

$\frac{v}{u} = n \rightarrow v = nu$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{nu}$

$\frac{1}{u}\left(1 + \frac{1}{n}\right) = \frac{1}{f}$

$\therefore u = \left(n+\frac{1}{n}\right) f$

10. Ans. (a) concave lens →Diminished virtual image, Focal length –ve

$\frac{v}{u} = \frac{-1}{n}$ $\therefore v = \frac{-u}{n}$

$\frac{1}{-f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{u} + \frac{1}{\frac{-u}{n}}$

$\frac{1}{-f} = \frac{-n}{u} + \frac{1}{u} = \frac{1}{u}(1-n)$

$u = (n-1)f$

11. Ans (d)

$f_w = \left(\frac{\mu g - 1}{\mu g - \mu w}\right) \mu w\ f$

$= \frac{1.5-1}{1.5-\frac{4}{3}} \times \frac{4}{3} \times f = 4f = 4\times8 = 32cm$

12. Ans. (a)

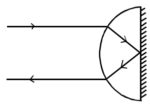
$\frac{1}{f_l} = (\mu-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$\frac{1}{f_l} = (\mu-1)\left(\frac{1}{R} + \frac{1}{\infty}\right)$

$\frac{1}{R} = (\mu-1) \times \frac{1}{R}$ $[f_l = R]$

$\mu = 1+1 = 2$

13. Ans. (d)



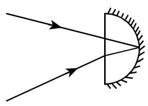
$\frac{1}{F} = \frac{2}{f_l} + \frac{1}{f_m}$

$\frac{1}{F} = 2(\mu-1)\left(\frac{1}{R} + \frac{1}{\infty}\right) + \frac{2}{\infty}$

$\frac{1}{F} = \frac{2(\mu-1)}{R}$

$F = \frac{R}{2(\mu-1)} = \frac{f_l}{2} = \frac{20}{2} = 10cm$

14. Ans. (d)



$\frac{1}{F} = \frac{1}{f_l} + \frac{1}{f_m} + \frac{1}{f_l}$

$\frac{1}{F} = \frac{2}{f_l} + \frac{1}{f_m}$

$\frac{1}{F} = 2(\mu-1)\left(\frac{1}{R} + \frac{1}{\infty}\right) + \frac{2}{R}$

$\frac{1}{F} = \frac{2\mu}{R}$

$F = \frac{R}{2\mu} \rightarrow R = 2F = \frac{R}{\mu}$

15. Ans. (c)

radius of aperture, $r = \frac{d}{2} = \frac{6}{2} = 3cm$, t=3mm=0.3cm

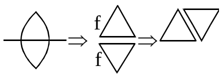
$R = \frac{r^2}{2t} = \frac{3\times3}{2\times0.3} = 15\text{cm}$

$\mu = \frac{c}{v} = \frac{3\times10^8}{2\times10^8} = 1.5$

$\frac{1}{f} = (\mu-1)\left(\frac{1}{R}+\frac{1}{\infty}\right) = (1.5-1)\times\frac{1}{15} = \frac{1}{30}$

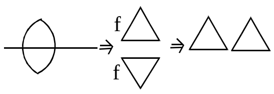
$\therefore$ f = 30cm

16. Ans. (d)



The net focal length cancels that of other side. It behaves as a glass slab. So focal length of combination = ∞ and power = 0.

17. Ans. (c)



Focal length of combination

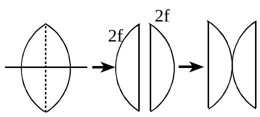
$\frac{1}{F_{eq}} = \frac{1}{f} + \frac{1}{f}$ $\quad F_{eq} = \frac{f}{2}$

$\text{Power} = \frac{1}{F_{eq}} = 2P$

18. Ans. (a)

$f_1 = f_2 = 2f$

$F_{eq} = \frac{f_1 f_2}{f_1+f_2} = f$



$P_{eq} = \frac{1}{F_{eq}} = P$

19 Ans. (a)

Focal length remains unchanged because neither material of lens nor curvature of surface is changed after covering with black paper. So new focal length is f.

20 Ans. (c)

Because the nature of materials forming the lens are different, 3 seperate images will be formed by each piece.

21. Ans. (c)

On blocking the central part, area of lens decreases $A_1 = \frac{\pi d^2}{4}$. New area of lens that transmits light,

$A_2 = \frac{\pi d^2}{4} - \frac{\pi(d/2)^2}{4} = \frac{3\pi d^2}{4}$

$\frac{A_2}{A_1} = \frac{3}{4} \rightarrow \frac{I_2}{I_1} = \frac{3}{4}$

$I_2 = \frac{3I}{4} = \frac{3I}{4}$

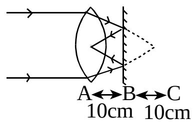
22. Ans. (b)

$m = \frac{f}{u-f}$

$\frac{I}{5} = \frac{-30}{20-(-30)} = \frac{-3}{5}$

I = –3cm, so 3cm long erect image is formed.

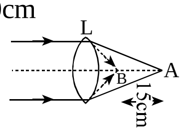
23. Ans. (c)



The parallel rays of light converge at focus which acts as virtual object for plane mirror. For plane mirror object distance = Image distance AB = BC. Focal length of Plane mirror = AC = 20cm.

24. Ans. (b)

For lens u = –30cm, f = 30cm



$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \rightarrow \frac{1}{v} = \frac{1}{f} - \frac{1}{4}$

$\frac{1}{v} = \frac{1}{30} - \left(\frac{-1}{30}\right) = \frac{1}{15}$

v = 15cm

Distance AB = 30–15 = 15cm

25. Ans. (a) As image is formed on the strip

So, $m = \frac{I}{O} = \frac{5\times10^{-2}}{10^3} = 5\times10^{-5}$

$f = 5\text{cm} = 5\times10^{-2}\text{m}$, u = ?

We know, $m = \frac{f}{u-f}$

$u = \left(\frac{m+1}{m}\right) f = \left(1+\frac{1}{m}\right) f$

$= \left(1+\frac{10^5}{5}\right)\times 5\times10^{-2} = 0.05 + 10^3\text{m}$

≈1km

26. Ans. (d)

$$f = \frac{D^2 - d^2}{4D} = \frac{50^2 - 10^2}{4 \times 50} = \frac{2400}{4 \times 50} = 12cm$$

27. Ans. (c) From Newton's formula

$f_1f_2 = xy$

$10 \times f_2 = 15 \times 20$

$f_2 = 30cm$

28. Ans. (b) From displacement method

$= \sqrt{I_1I_2} = \sqrt{4 \times 16} = 8cm$

29. Ans. (b)

From displacement method

$$f = \frac{d}{m_1 - m_2} = \frac{30}{2 - \frac{1}{2}} = 20cm$$

Past Questions

1. A biconvex lens of 8 cm and 6cm radius of refractive index 1.5 then focal length is (MOE 2068)

a. 6.9cm b. 10cm

c. 12cm d. 8cm

2. The focal length of two lens in contact having power –3.75D and +2D is (MOE2067)

a. +80cm b. +40cm

c. –40cm d. –80cm

3. Focal length of convex lens will be maximum for (MOE2067)

a. yellow light b. blue light

c. green light d. red light

4. If in a plano-convex lens radius of curvature of convex lens is 10cm and focal length is 30cm the refractive index of the material of the lens will be (MOE 2010)

a. 1.5 b. 1.66

c. 1.33 d. 3

5. Two lenses of power +12 diopters (D) and –2 D are placed in contact. The focal length of the combination is (MOE 066)

a. 10cm b. 12.5cm

c. 16.6cm d. 8.33cm

6. The effective power in diopter it lenses of focal length +10cm and –20cm are combined is (MOE 2050)

a. +5 b. –5

c. +3 d. –2

7. If we put the object at the focus of convex lens the refracted rays are. (MOE)

a. converging

b. diverging

c. both converging and diverging

d. parallel

8. When a convex lens having focal length 12cm is immersed in water, its focal length becomes (Bangladesh Embassy)

a. 12cm b. 24cm

c. 36cm d. 48cm

9. Two thin tenses of focal lenght f_1 and f_2 are placed at a distance 'd' between them. For power of the combination to be zero; then seperation 'd' is (IOM 2011)

a. $f_1 - f_2$ b. $f_1 + f_2$

c. $\frac{f_1}{f_2}$ d. $\frac{f_2}{f_1}$

10. A plano convex lens is silvered at the plane surface. If the radius of curvature of convex part is R and refractive index is n. Then find the radius of curvature of convex mirror so formed is (IOM 07)

a. $\frac{R}{n}$ b. $\frac{R}{n-1}$

c. $\frac{R^2}{n}$ d. $R\left(\frac{n+1}{n-1}\right)$

11. The distance between an object and a diverging lens is 'p' times the focal length of the lens. The lateral magnification 'm' produced by lens will be (IOM 06)

a. P b. P^{-1}

c. 1 + P d. $(1 + P)^{-1}$

12. The focal length of lens in air is 30cm. Find the focal length of the lens in water (given μ_w = 1.33, μg = 1.5) (IOM 02)

a. 120cm b. 20cm

d. 90cm d. 60cm

13. A plano convex lens fit exactly into a plano concave lens. Their plane surfaces are parallel to each other. If the lenses are made of different materials of refractive indices μ_1 and μ_2 and 'R' be the radius of curvature of curved surface of the lenses then focal length of the combination is (BPKIHS –09)

a. $\frac{R}{\mu_1-\mu_2}$ b. $\frac{2R}{\mu_2-\mu_1}$

c. $\frac{R}{2(\mu_1-\mu_2)}$ d. $\frac{R}{2-(\mu_1+\mu_2)}$

14. A plano convex lens is made of refractive index 1.5. If radius of the curvature of curved surface is 20cm then focal length of lens is (BPKIHS–08)

a. 10cm b. 20cm

c. 30cm d. 40cm

15. A converging lens in mounted on an optical bench and a candle is placed in front of it so that an image of the flame appers on the screen 1.5f beyond the lens. The objectis (IE–07)

a. between f and 2f b. beyond 2f

c. closer than f d. near infinity

16. An object is placed 1cm from lens having magnification 5. Then its focal length is (IE-06)

a. 0.8cm b. 1.2cm

c. –1.2cm d. – 0.8cm

17. Image from a convex lens is formed beyond 1.5F. The object should be placed at (IE-05)

a. between F and 3F b. at F

c. beyond 2F d. infinity

18. A convex lens is dipped in a liquid whose refractive index is equal to refractive index is equal to refractive index of lens. Then its focal length will (IE–04)

a. become zero

b. become infinite

c. remains unchanged

d. becomes small but not zero

19. An object is placed 10cm in front of a diverging lens of focal length 20cm. The image will be (IE-01).

a. Real, inverted, large

b. Real, erect, diminished

c. virtual, inverted, large

d. virtual, erect, diminished

Answer Sheet

1. a	*2. c*	*3. d*	*4. c*	*5. a*	*6. a*	*7. d*	*8. d*	*9. b*	*10. b*
11. d	*12. a*	*13. a*	*14. d*	*15. b*	*16. a*	*17. c*	*18. b*	*19. d*	

Solution

1. Ans. (a)

$\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1}+\frac{1}{R_2}\right) = (1.5-1)\left(\frac{1}{8}+\frac{1}{6}\right) = 0.14$

$\therefore$ f = 6.9cm

2. Ans. (c)

$P = P_1 + P_2 = -3.75 + 2 = -1.75$

$f = \frac{1}{p} = \frac{-1}{1.75} = -57\text{cm}$

$\Rightarrow$ Close is (c)

3. Ans. (d)

$\frac{1}{f} = (\mu-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

$f \alpha \frac{1}{\mu}$ and $\mu \alpha \frac{1}{\lambda}$

$f \alpha \frac{1}{\mu} \alpha \lambda$

Red light = λ is max = focal length max

4. Ans. (c)

For Plano – convex lens

$\frac{1}{f} = (\mu-1)\frac{1}{R}$

$\frac{1}{30} = \frac{\mu-1}{10}$

$\mu = \frac{1}{3} + 1 = \frac{4}{3} = 1.33$

5. Ans. (a)

Power of combination

$P_{eq} = P_1+P_2 = 12 - 2 = 10D$

Focal length of combination,

$F_{eq} = \frac{1}{P_{eq}} = \frac{1}{10} = 0.1m = 10cm$

6. Ans. (a)

$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{10} - \frac{1}{20} = \frac{1}{20}$

$p = \frac{1}{f} = \frac{1}{20} \times 100 = +5D$

7. Ans. (d)

u = f

$\frac{1}{f} = \frac{1}{u}+\frac{1}{v} = \frac{1}{f}+\frac{1}{v}$

$\frac{1}{v} = 0 \Rightarrow v = \infty$

$\therefore$ Rays will be parallel

8. Ans. (d)

$\frac{f_w}{f_a} = \left(\frac{\mu_g-1}{\mu_g-\mu_w}\right) \times \mu w$

$= \frac{1.5-1}{1.5-1.33} \times 1.33 \; (\mu_w = \frac{4}{3} = 1.33) = 4$

$f_w = 4l_a = 4\times12 = 48cm$

9. Ans. (b)

For seperation d,

$\frac{1}{F_{eq}} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

$p = \frac{1}{F_{eq}} = 0$

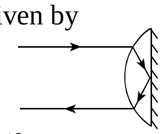
$\frac{d}{f_1 f_2} = \frac{f_1+f_2}{f_1 f_2}$

$\therefore$ $d = f_1+f_2$

10. Ans. (b)

When one surface of lens is silvered, it acts as mirror of focal length F given by

$\frac{1}{F} = \frac{1}{f_l} + \frac{1}{f_m} + \frac{1}{f_l} = \frac{2}{f_l} + \frac{1}{f_m}$



f_m = focal length of mirror = ∞

$\frac{1}{F} = 2(\mu-1)\left(\frac{1}{R}+\frac{1}{\infty}\right) + \frac{1}{\infty}$

$F = \frac{R}{2(n-1)}$

Radius of curvature = $2F = \frac{R}{n-1}$

11. Ans. (d)

Let focal length of diverging lens be –x.

u = px, Image distance = –v for diverging lens

$\frac{1}{u} - \frac{1}{v} = -\frac{1}{x}$

$\frac{u}{u} - \frac{u}{v} = \frac{-u}{x} \rightarrow 1 - \frac{1}{m} = \frac{-Px}{x}$

$\frac{1}{m} = 1+P \rightarrow m = (1+P)^{-1}$

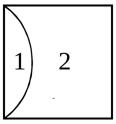
12. Ans. (a)

$\frac{f_l}{fa} = \left(\frac{\mu g - 1}{\mu g - \mu_l}\right) \times \mu_l$

For water, putting $\mu_w = \frac{4}{3} = 1.33$ in above equation , we get

$\frac{fw}{fa} = 4 \Rightarrow fw = 4fa = 4\times30 = 120cm$

13. Ans. (a)



$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$

$\frac{1}{f} = (\mu_1 - 1)\left(\frac{1}{\infty} + \frac{1}{R}\right) + (\mu_2 - 1)$

$\left(\frac{-1}{R} - \frac{1}{\infty}\right)$

$\frac{1}{f} = \frac{\mu_1 - \mu_2}{R}$

$f = \frac{R}{\mu_1 - \mu_2}$

14. Ans. (d)

$\frac{1}{f} = \frac{(\mu - 1)}{R}$

$f = \frac{R}{\mu - 1} = \frac{20}{4.5 - 1}$

f = 40 cm

15. Ans. (b)

Image distance (v) = 1.5f

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{1}{f} - \frac{1}{v} = \frac{1}{u}$

$\frac{1}{f} - \frac{1}{1.5f} = \frac{1}{u} \Rightarrow \frac{1}{u} = \frac{1.5 - 1}{1.5f}$

u = 3f (ie. beyond 2f)

16. Ans. (a)

$u = 1cm, m = 5; m = \frac{v}{u}; v = mu$

$= 5\times1 = 5cm$

$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ or, $1 + \frac{1}{5} = \frac{1}{f}$

$f = \frac{5}{6} = +0.8cm$

17. Ans. (c)

When the object lies beyond 2f, the image will be formed between f and 2f ($\simeq$1.5f) and image will be real, inverted and smaller in size.

18. Ans. (b)

$\frac{f_l}{fa} = \left(\frac{\mu g - 1}{\mu g - \mu_l}\right) \times \mu_l$

As $\mu g = \mu l$

$f_l = \infty$, power becomes zero, lens behaves as a glass slab.

19. Ans. (d)

→ Diverging lens (concave lens) always form virtual, erect and diminished image at any position.

→ Virtual, erect, magnified image is formed by convex lens between focus and pole of lens (0<U<f), on other positions image are real.

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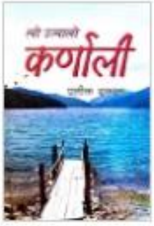
नेपाली कांग्रेसको इतिहासको प्रारूप



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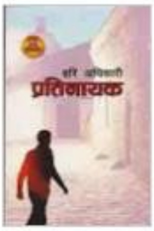


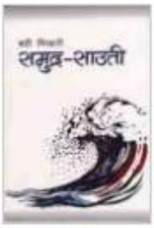
प्रतिनायक

रिकुटे

स्कुल बेंच्ने बालक

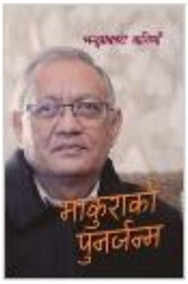
अदभुत तिवारी

छोट्टी



समुद्र साउती

गद्य शैलीको रूपविज्ञान



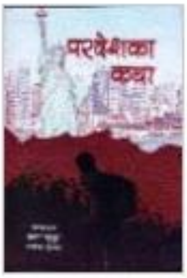
माकुराको पुनर्जन्म

नेपाली कांग्रेसको इतिहासको प्रारूप

कर्म

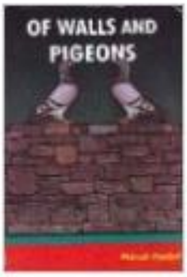
वीर्य जमिन

सारङ्गी



परदेशका कथा

डिलको डोब



Of Walls And Pigeons

Chapter: 42

Chromatic Aberration In Lens, Optical Instruments & Human Eye

1. Near and far points of human eye are:

a. 25cm and infinite b. 50cm and 100cm
c. 25cm and 50cm d. 0cm and 25cm

2. If the focal length of a simple magnifier is 5cm. The magnifying power of lens for relaxed and strained eye are:

a. 6, 6 b. 5, 5
c. 5, 6 d. 6, 5

3. When the length of a compound microscope tube increases its magnifying power.

a. decrease b. increase
c. doesn't change d. none

4. In the compound microscope the intermediate image is:

a. virtual, erect and magnified
b. real, erect, magnified
c. real, inverted, magnified
d. virtual, erect, magnified

5. The magnifying power of telescope can be increased:

a. by increasing focal length of both lenses
b. by fitting eye piece of high power
c. by fitting eye piece of low power
d. by increasing distance of object

6. The resolving power of a telescope depends on the:

a. focal length of eye lens
b. focal length of objective lens
c. length of telescope
d. diameter of objective lens

7. If fo is the focal length of objective and fe is the focal length of eye piece in a compound microscope, then

a. fo = fe b. fo > fe
c. fo < fe d. none

8. An achromatic combination is to be obtained using a convex and a concave lens. The two lenses chosen should have:

a. their power equal
b. their refractive indices equal
c. their dispersive power equal
d. the product of their power and dispersive powers equal

9. An achromatic convergent doublet of two lenses in contact has power of +2D. The convex lens has power +5D.What is the ratio of Dispersive power of the convergent and divergent lenses?

a. 2:5 b. 3:5
c. 5:3 d. 5:2

10. Two lenses of focal lengths 20cm and 30cm will forman achromatic combination if they are seperated by:

a. 5cm b. 10cm
c. 25cm d. 50cm

11. A convex lens has mean focal length 20cm. The dispersive power of the material of the lens is 0.02. The longitudinal chromatic aberration for an object at infinity is:

a. 0.10 b. 0.20
c. 0.40 d. 0.80

12. A parallel beam of white light falls on a convex lens. Images of blue, yellow and red light are formed on other side of the lens at distance 20cm, 20.5 cm and 21.4cm respectively. The dispersive power of the material of the lens is:

a. $\frac{619}{1000}$ b. $\frac{9}{200}$
c. $\frac{14}{205}$ d. $\frac{5}{214}$

13. Which of the following forms erect image?

a. compound microscope

b. astronomical telescope
c. eye
d. galilean telescope

14. The magnifying power of a telescope is 9. Then it is adjusted for parallel rays, the distance between the objective lens and the eye piece is found to be 20cm. The focal length of lenses are:

a. 18cm,2cm
b. 11cm,9cm
c. 10cm,10cm
d. 15cm,5cm

15. The resolving power of a microscope is maximum for:

a. infrared
b. yellow
c. ultraviolet
d. electron beam

16. Large aperture telescope are used for:

a. greater magnification
b. greater resolution
c. reducing lens aberration
d. easy manufacture

17. The limit of resolution of 100cm telescope is (λ = 5.5×10–7m)

a. 0.14" b. 0.3" c. 1' d. 1°

18. A Galilean telescope has lenses of focal length 100cm and 5cm respectively. The length of the telescope for normal vision is:

a. 105cm
b. 95cm
c. between 95 and 100cm
d. less than 95 cm

19. Lengh of telescope for distinct vision in above question is:

a. 105 cm
b. 95cm
c. between 95 and 100cm
d. less than 95cm

20. The objective of a terrestrial telescope has focal length of 80cm and its magnifying power is 20 when adjusted for parallel rays. If the erecting lens has a focal length 20cm, the total length of such a telescope must be:

a. 84cm
b. 100cm
c. 124cm
d. 164cm

21. The magnifying power of an astronomical telescope is 5. The power of its eye piece is 10D. What is the power of its objective?

a. +1D
b. +2D
c. –2D
d. +4D

22. The magnifying power of Galilean telescope is 5. The power of its objective is +2D. What is the power of its eye lens?

a. +1D
b. +10D
c. –10D
d. –20D

23. In a Huygen's eye piece the eye lens has a focal length of 'f'. The equivalent focal length of eye piece is:

a. $\frac{3}{4}f$
b. 4f
c. 2f
d. $\frac{3}{2}f$

24. A convex lens of focal length 2cm is used in a simple microscope. The magnification produced for normal vision is equal to

a. 12.5
b. 13.5
c. 11.5
d. 50

25. At a distance 'x' from the eye, two persons stand with a lateral seperation of 3m. For the two persons to be just resolved by the naked eyes, x should be:

a. 10km
b. 15km
c. 20km
d. 30km

26. The average distance between the earth and moon is 38.6 × 10^4km. The minimum seperation between two points on the surface of moon that can be resolved by telescope whose objective lens has a diameter of 5m with light of wavelength 600nm is:

a. 5.65m
b. 28.25m
c. 11.3m
d. 56.51m

Answer Sheet

1. a	*2. c*	*3. b*	*4. c*	*5. b*	*6. d*	*7. c*	*8. d*	*9. d*	*10. c*
11. c	*12. c*	*13. d*	*14. a*	*15. d*	*16. b*	*17. a*	*18. b*	*19. d*	*20. d*
21. b	*22. c*	*23. d*	*24. a*	*25. a*	*26. d*				

Solution

1. Ans (a)

   The near and far points of human eye are 25cm and infinite respectively.

2. Ans. (c)

   For relaxed eye, $m = \frac{D}{f} = \frac{25}{5} = 5$

   For strained eye

   $m = 1 + \frac{D}{f} = 5 + 1 = 6$

3. Ans. (b)

   $M = \frac{L}{fo}\left[1+\frac{D}{fe}\right]$

   When L is increased, m is also increased.

4. Ans. (c)

   Intermediate Image: Real inverted, magnified (RIM)

   Final image: Virtual, inverted, magnified (VIM)

5. Ans.(b)

   Magnifying power of telescope

   $m = \frac{fo}{fe}$ in Normal adjustment and $m = \frac{fo}{fe}$

   $(1+\frac{fe}{D})$ at least distance of distinct vision.

   $m \propto \frac{1}{fe} \propto Pe$

   So, If power of eye piece is more magnifying power is more.

6. Ans. (d)

   Resolving power of telescope $= \frac{D}{1.22\lambda}$

   D = Diameter of objective lens, λ = wave length of light used.

7. Ans. (c)

   In compound microscope fe>fo, so that field of view may be increased.

8. Ans. (d)

   For achromatic combination of two lenses in contact

   $\frac{\omega_1}{\omega_2} + \frac{f_1}{f_2} = 0$

   $\frac{\omega_1}{\omega_2} = \frac{f_1}{f_2}$

   $\omega_1 P_1 = -\omega_2 P_2$

   where power $= \frac{1}{f}$

9. Ans. (d)

   $\frac{\omega}{\omega_1} = \frac{-f}{f_1} = \frac{P_1}{p} = \frac{5}{2}$

10. Ans. (c)

    $d = \frac{f+f_1}{2}$

    $= \frac{20+30}{2}$

    = 25cm

11. Ans. (c)

    Longitudinal chromatic aberration $\Delta f = \omega f = 0.02\times20 = 0.40$ cm

12. Ans. (c)

    $fr - fb = \omega fy$

    $\omega = \frac{fr - fb}{fy} = \frac{21.4 - 20}{20.5}$

    $= \frac{1.4}{20.5} = \frac{14}{205}$

13. Ans. (d)

    Since the eye-piece is concave in Galilean telescope the final image formed is erect.

14. Ans. (a)

    $m = \frac{fo}{fe} = 9$

    $\therefore$ fo = 9fe

    Also, L = fo+fe

    20 = 9fe+fe=10fe

    $\therefore$ fe =2cm

    fo = 9fe = 9×2 = 18cm

15. Ans. (d)

RP of microscope = $\frac{2\mu \sin\theta}{\lambda} \alpha \frac{1}{\lambda}$

As electron beam has smaller wavelength its Rp will be more.

16. Ans. (b)

Resolving power of telescope (RP) = $\frac{d}{1.22\lambda}$ α d is directly propotional to diameter of aperature.

17. Ans. (a)

Limit of resolution of telescope $\theta = \frac{1.22\lambda}{d}$

$= \frac{1.22 \times 5.5 \times 10{-}7}{1}$ rad = 0.14"

18. Ans. (b)

For normal vision, final image is formed at infinity L = fo – fe = 100 – 5 = 95cm

19. And. (d)

For distinct vision

$L = f_0 - u_e$

$\frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e} \rightarrow \frac{-1}{5} = \frac{1}{25} - \frac{1}{u_e}$

$u_e = \frac{1}{5} - \frac{1}{25} = \frac{25}{4} = 6.25\text{cm}$

L = 100 – 6.25cm = 93.75cm

20. Ans. (d)

$m = \frac{fo}{fe}$

$20 = \frac{80}{fe} \rightarrow fe = 4\text{cm}$

Total length = fo+uf+fe

= 80+4×20+4

= 164cm

21. Ans. (b)

For astronomical telescope

$\mu = \frac{fo}{fe} = \frac{pe}{po}$

$\rightarrow \frac{10}{po} = 5$ Po = +2D

22. Ans. (c)

For Gaelilean telescope,

$m = \frac{fo}{fe} = \frac{-Pe}{Po}$

$5 = \frac{-Pe}{+2}$ ∴ Pe = –10D

23. Ans. (d)

$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

$F = \frac{f_1 f_2}{f_1 + f_2 - d}$

In Huygen's eye piece

$f_1 = 3f_1$ & $f_2 = f_1$ and d = 2f

$F = \frac{3f \times f}{3f + f - 2f} = \frac{3}{2} f$

24. Ans. (a)

For normal vision, image is formed at infinity. least distance of distinct vision D is 25cm

$m = \frac{D}{f} = \frac{25}{2} = 12.5\text{cm}$

25. Ans. (a)

$\frac{d}{D} > 1$

For the persons to be just resolved

$\frac{d}{D} = 1^1 = \frac{1}{60°} = \frac{1}{60} \times \frac{\pi}{180}$

$\frac{3}{x} = \frac{\pi}{60 \times 180}$

x = 10309 m = 10km

26. Ans. (d)

If d = min. distance between two points on the surface of moon D = distance of moon from earth limit of resolution $\theta = \frac{d}{D}$

For telescope,

$\theta = \frac{1.22\lambda}{\text{Diameter of objective}}$

$\frac{d}{D} = \frac{1.22\lambda}{5} = \frac{1.22 \times 600 \times 10^{-9} \times 38.6 \times 10^{7}}{5}$

d = 56.51m

Past Questions

1. A short sighted person wearing a glass of focal length of 60cm then what is the power of lens? (MOE 2068)

a. –1.65D b. –1.25D
c. –1.35D d. –1.75D

2. A person can't see object lying above 50cm from the eye. What is the focal length of lens to be used to correct the defect the vision? (MOE 2008)

a. –50cm b. +50cm
c. +100cm d. –100cm

3. The far point of a defective eye is 1.5m. The lens needed to correct this defect is a (MOE 2062)

a. converging lens of focal length 1.5m
b. converging lens of focal length 0.3m
c. diverging lens of focal length 0.3m
d. diverging lens of focal length 1.5m

4. An oldman cannot see the object nearer than 150cm. If he wishes to see objects upto 58cm he should put (MOE 2061)

a. diverging lens of f = 150cm
b. diverging lens of f = 30cm
c. converging lens of f = 150cm
d. converging lens of f = 75cm

5. A person cannot see an object beyond 100cm. The lens to be used to remove this defect will be of the power (MOE 2058)

a. –2D b. +2D
c. –1D d. 1D

6. A long-sighted person has a minimum distance of distinct vision of 50cm. He wants to reduce it to 25cm. He should use a (MOE 2055)

a. concave lens of focal length 50cm
b. convex lens of focal length 25cm
c. convex lens of focal length 50cm
d. concave lens of focal length 25cm

7. Resolving power of human eye is nearly (MOE curriculum)

a. 342 b. $\frac{1}{342}$
c. 3420 d. $\frac{1}{3420}$

8. An object is placed at a distance 'u' from a simple microscope of focal length 'f'. The angular magnification obtained depends on (IOM 2010)

a. on 'f' but not 'u' b. on 'u' but not on 'f'
c. on 'f' as well as 'u' d. neither on 'f' nor on 'u'

9. Chromatic aberration in the formation of images by a lens arise because (IOM 08)

a. of non-paraxial rays
b. radii of curvature of the two sides are not the same.
c. of the defect in grinding
d. the focal length varies with wavelength.

10. The magnification of compound microscope increases when focal length of eye piece is (IOM 01)

a. large b. small
c. same as object d. as great as infinity

11. Find the magnigying power of a telescope with focal length of eye piece 25cm and that of object lens 100cm (IOM 96)

a. 4 b. 40
c. 44 d. 20

12. Our eye is most sensitive to which colour? (BPKIHS-2010)

a. red b. blue
c. green d. black

13. Magnification of a telescope can be increased by increasing (BPKIHS)

a. focal length of the objective
b . focal length of the eye piece
c. length of the telescope d. all

Answer Sheet

1. a	*2. a*	*3. d*	*4. d*	*5. c*	*6. c*	*7. d*	*8. a*	*9. d*	*10. b*	*11. a*	*12. c*	*13.a*

Solution

1. Ans. (a) On removing myopia, the person must be able to see object at infinity ie. $u = \infty$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{-v} = \frac{1}{\infty} - \frac{1}{v}$

$f = -v = -60cm$

$P = \frac{1}{f} = \frac{-100}{60} = -1.65D$

2. Ans. (a) $u = \infty$ (infinite), our aim to see

$v = -50cm$ (always –ve sign is used)

$\frac{1}{f} = \frac{1}{4} + \frac{1}{v} = \frac{1}{\infty} - \frac{1}{50}$

$f = -50cm$

3. Ans. (d) $v = -1.5m = -150cm$

$u = \infty$

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{\infty} - \frac{1}{150}$

$f = -150cm = -1.5m$

As defect is myopia lens used is concave i.e. diverging lens.

4. Ans. (d)

u (aim to see after using glass) = 50cm

v (now he can see) = –150cm

$\frac{1}{f} = \frac{1}{4} + \frac{1}{v} = \frac{1}{50} - \frac{1}{150}$

$\frac{1}{f} = \frac{3-1}{150} \Rightarrow f = 75cm$

So required is converging lens of focal length 75cm.

5. Ans. (c) $v = -100cm$, $u = \infty$

$\frac{1}{f} = \frac{1}{\infty} - \frac{1}{100}$

$f = -100cm = -1m$

$P = \frac{1}{f} = \frac{-1}{1} = -1D$

6. Ans. (c) $v = -50cm$, $u = 25cm$

$\frac{1}{f} = \frac{1}{25} - \frac{1}{50} = \frac{1}{50}$ $\quad \therefore f = 50cm = 0.5m$

So, to correct the defect of long sightness or hypermetropia, he should wear a convex (converging lens) of focal length 50cm.

7. Ans. (d)

Resolving power of human eye

$= 1 \text{ minute} = \left(\frac{1}{60}\right)^\circ = \frac{1}{60} \times \frac{\pi}{180} = \frac{1}{3420}$ radian

8. Ans. (a)

For simple microscope. If image is at infinity, $m = \frac{D}{f}$. If image is at distance of distinct vision, $m = -\left(1 + \frac{D}{f}\right)$.This shows clearly that angular magnification depends on 'f' but not on 'u'.

9. Ans. (d)

Chromatic aberration: inability of lens to form white image of an object. Due to different wavelength of different colour of light.

$\mu \propto \frac{1}{\lambda^2}$ (cauchy's formula)

$f \propto \frac{1}{\mu} \propto \lambda^2$, so focal length varies with wave length $f_{red} > f_{violet}$

10. Ans. (b)

For compound microscope,

$m = \frac{v_o}{u_o}\left(1 + \frac{D}{fe}\right)$

$m \propto \frac{1}{fe}$ and

$m = mo \times me$

11. Ans. (a) $m = \frac{fo}{fe} = \frac{100}{25} = 4$

12. Ans. (c)

Human eye is most sensitive to yellowish green light of wavelength $\lambda = 5500A$

13. Ans. (a) magnification of telescope

$$m = mo \times me = \frac{fo}{fe}\left(1+\frac{fe}{ve}\right)$$

$m \alpha fo$

Chapter: 43

Photometry

1. The unit of illuminance is:

a. lumen
b. lux
c. candela
d. watt

2. The inverse square law for illuminance is valid for:

a. isotropic point source
b. cylindrical source
c. search light
d. all types of sources

3. For a cylindrical source of light, the illuminace L on a screen varies with distance r as:

a. $L \alpha r^{-2}$
b. $L \alpha r^{-1}$
c. $L \alpha r^{\circ}$
d. $L \alpha r^{2}$

4. If the distance between a point source of light and the screen is doubled the illuminance on screen becomes:

a. same
b. twice
c. one half
d. one fourth

5. In a cinema hall, the distance between the projector and screen is increased by 2%. Everything else remaining unchanged then the intensity of illumination on the screen is:

a. decreased by 2%
b . decreased by 4%
c. increased by 2%
d. increased by 4%

6. A bulb is situated at a height of 2m above the centre of table. If the height is decreased by 1m, then illumination at the centre of table will:

a. decrease by 30%
b. increase by 30%
c. increase by 100%
d. increase by 300%

7. A 100 watt lamp has luminous intensity 125 Candela (isotropic). The luminous flux of the lamp is:

a. 400 lumens
b. $\frac{4\pi}{125}$ lumens
c. $\frac{4\pi}{5}$ lumens
d. 500 π lumen

8. At what distance 16 candela lamp should be placed from a book to get the illuminance of 1lumen/m^2?

a. 1m
b. $\frac{1}{4}$ m
c. 2m
d. 4m

9. Two lamps A and B of 64 and 16 Candela respectively are placed 4m apart. At what distance from lamp A screen should be placed between the lamps. So, that it equally illuminated by both lamps?

a. $\frac{8}{3}$ m
b. $\frac{4}{3}$ m
c. 4m
d. 8m

10. Two stars A and B which are 4 and 12 light year apart from the earth. The ratio of their real luminous intensities is:

a. 1:3
b. 1:9
c. 3:1
d. 9:1

11. A lamp of 100 cd power is suspended at a distance of 6m above center of circular table of radius 8m. The illuminance at the corner of the table is:

a. 0.6 lux
b. 6 lux
c. 1 lux
d. 0.8 lux

12. The luminous efficiency of a lamp is 5 lumen/watt and its luminous intensity is 35 candela. The power of the lamp is:

a. 80w
b. 176w
c. 88w
d. 36w

13. A parallel beam of light incident normally on a surface has illuminance 1000 lux. If it is oriented at an angle 30° with the normal, the same surface will have illuminance of:

a. 500 lux b. 1000 lux

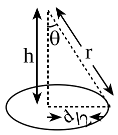
c. 866 lux d. $\frac{2000}{\sqrt{3}}$ lux

14. The luminous flux from a 100 watt electric lamp is 6850 lumen. The luminous efficiency of the lamp is:

a. 1% b. 5%

c. 10% d. 20%

15. A lamp is suspended at height h above the centre of table of diameter d, then the ratio of illuminance on the centre of table to that one edge is:



a. $1+\frac{d^2}{4h^2}$ b. $\left(1+\frac{d^2}{4h^2}\right)^{\frac{3}{2}}$

c. $\left(1+\frac{d^2}{h^2}\right)^{\frac{3}{2}}$ d. $\left(1+\frac{d^2}{4h^2}\right)^{-\frac{3}{2}}$

16. A lamp is hanging along the axis of a circular table of radius r. At what height should the lamp be placed above the table so that the illuminance at the edge of the table is $\frac{1}{8}$ of that at its centre?

a. $\frac{r}{2}$ b. $\frac{r}{\sqrt{2}}$

c. $\frac{r}{3}$ d. $\frac{r}{\sqrt{3}}$

17. An electric bulb emits 13.7 lumen/watt. Its luminous efficiency is:

a. 1% b. 2%

c. 10% d. 20%

18. Five identical lamps grouped together produces a certain illumination on a screen kept 5m from the lamps. If three of the lamps are switched off, through what distance should the group of lamps be moved to obtain the same illumination on the screen? Assume normal incidence.

a. $\sqrt{10}$ m towards the screen

b. $(5+\sqrt{10})$m towards the screen

c. $(5-\sqrt{10})$m towards the screen

d. $(5+\sqrt{10})$m away from screen

19. Two lamps of luminous intensity 8cd and 32cd respectively are lying at a distance of 1.2 m from eachother. Where should a screen be placed between two lamps such that its two faces are equally illuminated by the two sources.

a. 10cm from 8 cd lamp

b. 10cm from 32 cd lamp

c. 40cm from 8cd lamp

d. 40cm from 32 cd lamp

20. The seperation between the screen and a perfectly reflecting plane mirror is 2r. An isotropic point source of light is placed exactly midway between the mirror and screen. The ratio of illuminance of the screen with and without mirror is:

a. 10:9 b. 2:1

c. 10:1 d. 9:1

Answer Sheet

1. b	*2. a*	*3. b*	*4. d*	*5. b*	*6. d*	*7. d*	*8. d*	*9. a*	*10. b*
11. a	*12. c*	*13. c*	*14. a*	*15. b*	*16. d*	*17. b*	*18. c*	*19. c*	*20. a*

Solution

1. Ans. (b)

Radiant flux →watt

Luninous flux →Lumen

Luminous Intensity →Candela

2. Ans. (a)

$$\text{Intensity} = \frac{\text{Power}}{\text{Area}}$$

For point isotropic source, wavefront is spherical.

$$\text{So, } I = \frac{P}{A} = \frac{P}{\pi r^2} \propto \frac{1}{r^2}$$

For cylindrical source

$$I = \frac{P}{A} = \frac{P}{2\pi r l} \propto \frac{1}{r}$$

3. Ans. (b)

For cylindrical source of length l, intensity at distance r is:

$$I = \frac{\text{Power}}{\text{Area}} = \frac{P}{2\pi r l} \propto \frac{1}{r} \propto r^{-1}$$

4. Ans. (d)

Illuminance

$$L = \frac{I}{r^2} \propto \frac{1}{r^2}$$

$$\frac{L_1}{L} = \left(\frac{r}{r_1}\right)^2 = \left(\frac{1}{2}\right)^2 = \frac{1}{4}$$

$$\therefore L^1 = \frac{L}{4} \text{ so reduced to one fourth}$$

5. Ans. (b)

$$\text{Illumination } L = \frac{I}{r^2}$$

$$\text{or, } \frac{\Delta L}{L} = -2\left(\frac{\Delta r}{r}\right)$$

% change in illumination,

$$= \frac{\Delta L}{L} \times 100\%$$

$$= -2\left(\frac{\Delta r}{r} \times 100\%\right)$$

$$= -2(+2\%) = -4\%$$

= decreases by 4%

6. Ans. (d)

$$\% \text{ increase} = \left(\frac{L}{Lo} - 1\right) \times 100\%$$

$$= \left[\left(\frac{ro}{r}\right)^2 - 1\right] \times 100\%$$

$$= \left[\left(\frac{2}{1}\right)^2 - 1\right] \times 100\% = 300\%$$

7. Ans. (d) $\phi = 4\pi I = 4\pi \times 125 = 500\ \pi$ lumen

8. Ans (d)

$$L = \frac{I}{r^2} \quad \text{or, } 1 = \frac{16}{r^2}$$

$$\therefore r^2 = 16m$$

$$\therefore r = 4m$$

9. Ans. (a) If illuminance will be equal at x from lamp A then

$$\frac{64}{x^2} = \frac{16}{(4-x)^2}$$

$$\left(\frac{4-x}{x}\right)^2 = \frac{16}{64}$$

$$\frac{4-x}{x} = \frac{1}{2}$$

$$8 - 2x = x$$

$$\therefore x = \frac{8}{3} \text{ m}$$

10. Ans. (b)

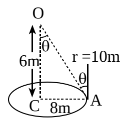
$$L_1 = \frac{I_1}{r_1^2} \text{ and } L_2 = \frac{I_2}{r_2^2}$$

But $L_1 = L_2$

$$\frac{I_1}{r_1^2} = \frac{I_2}{r_2^2}$$

$$\therefore \frac{I_1}{I_2} = \left(\frac{r_1}{r_2}\right)^2 = \left(\frac{4}{12}\right)^2 = 1:9$$

11. Ans. (a)



$$L = \frac{I\cos\theta}{r^2} = \frac{100 \times \frac{6}{10}}{(10)^2} = 0.6 \text{ lux}$$

12. Ans. (c)

$$\eta = \frac{\text{Luminous flux emitted}}{\text{Input electric power}}$$

$$= \frac{\phi}{p} = \frac{4\pi I}{p} = \frac{4\pi \times 35}{5} = 4 \times \frac{22}{7} \times \frac{35}{5} = 88w$$

13. Ans (c)

$$\frac{L}{Lo} = \frac{I\cos 30°/r^2}{I\cos 0/r^2} = \frac{\sqrt{3}}{2}$$

$$L = \frac{\sqrt{3}}{2} \times 100 = 866 \text{ lux}$$

14. Ans. (a)

$$1 \text{ lumen} = \frac{1}{685} \text{ Watt}$$

$\therefore$ 685° lumen = 10watt

$$\eta = \frac{10}{100} \times 100\% = 10\%$$

15. Ans. (b)

$$\text{Lcentre} = \frac{I}{h^2}$$

$$\text{Iedge} = \frac{I\cos\theta}{r^2}$$

$$= \frac{I}{\frac{d^2}{4}+h^2} \times \frac{h}{\sqrt{\frac{d^2}{4}+h^2}}$$

$$= \frac{8Ih}{(d^2+4h^2)^{3/2}}$$

$$\frac{\text{Icentre}}{\text{Iedge}} = \left(1+\frac{d^2}{4h^2}\right)^{\frac{3}{2}}$$

16. Ans. (d)

$$Ee = \frac{1}{8} Ec$$

$$\text{or, } \frac{Ec}{Ee} = 8$$

$$\left(1+\frac{r^2}{h^2}\right)^{\frac{3}{2}} = 8$$

$$\left(1+\frac{r^2}{h^2}\right) = 8^{\frac{2}{3}} = 4$$

$$\frac{r^2}{h^2} = 4-1 = 3$$

$$h = \frac{r}{\sqrt{3}}$$

17. Ans. (c)

1watt = 685 lumen

$$\eta = \frac{\text{output power}}{\text{input power}} = \frac{13.7}{685} \times 100\% = 2\%$$

18. Ans. (c)

$$E_1 = \frac{5I}{r_1^2} = \frac{5I}{5^2} = \frac{I}{5}$$

$$E_2 = \frac{2I}{r_2^2} = \frac{2I}{(5-x)^2}$$

From Question $E_1 = E_2$

$$\frac{I}{5} = \frac{2I}{(5-x)^2}$$

or, $(5-x)^2 = 10$

or, $5-x = \sqrt{10}$

or, $x = (5-\sqrt{10})$m

Lamps should be moved towards the screen.

19. Ans. (c)

Let x be the distance from 8 cd lamp. For equal illumination.

$$\frac{I_1}{x^2} = \frac{I_2}{(1.2-x)^2}$$

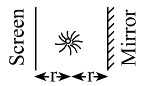
$$\frac{1.2-x}{x} = \sqrt{\frac{I_2}{I_1}} = \sqrt{\frac{32}{8}} = \sqrt{4} = 2$$

or, 12–x = 2x

or, 3x =1.2

$$\therefore x = \frac{1.2}{3} = 0.4\text{m} = 40\text{cm}$$

20. Ans. (a)



Without mirror

$$E_1 = \frac{I}{r^2}$$

When mirror, light traverses a total distance of 3r after being reflected from the mirror.

So, $$E_2 = \frac{I}{(3r)^2} + \frac{I}{r^2} = \frac{10\,I}{9r^2} = \frac{10E}{9}$$

$$\therefore \frac{E_2}{E_1} = \frac{10}{9}$$

Past Questions

1. The Luminous intensity of light source of illuminance 100 lux at a distance of 2m is (MOE 2068)

a. 400 b. 300
c. 200 d. 100

2. Two bulbs A and B are placed respectively at 20cm and 30cm on opposite sides of an oily screen. The two sides of the screen are equally intense. The ratio of power of the bulb A to that of B will be (MOE 2066)

a. 4:9 b. 9:4 c. 2:3 d. 3:2

3. The time of exposure of camera is 4 sec. What will be the time of exposure if its aperture is double? (MOE 2008)

a. 1sec b. 2sec
c. 3sec d. 8sec

4. If the luminous energy of lamp is 100w, it is kept hanging above the table at 5m above, calculate the value of intensity at the centre of the table (IOM 2011).

a. 4 b. $\frac{1}{4}$ c. $\frac{1}{\pi}$ d. π

5. Illuminance at a point 2m from a source of light of luminous intensity 100 candela is (IOM)

a. 50 lux b. 25 lux
c. 50 cd/m^2 d. 25/2π

6. If the luminous intensity of a mid-directional bulb is 100 candela then total luminous flux emitted from the bulb is (BPKIHS 2008)

a. 1250 *l*m
b. 986 *l*m
c. 861 *l*m
d. 156 *l*m

7. A photographer finds that for a certain aperature of his camera the correct exposure time is 0.25 sec. If the diameter of the aperatuer is doubled then the exposure time will be (BPKIHS–07)

a. 0.125 sec b. 0.5 sec
c. 1 sec d. 0.062 sec

Answer Sheet

1. a	*2. a*	*3. a*	*4. c*	*5. b*	*6. a*	*7. d*

Solution

1. Ans. (a)

$L = \frac{I\cos\theta}{R^2}$ (I = Luminous intensity)

$I = LR^2 = 100\times2^2 = 400$ cd

2. Ans. (a)

I_1, I_2 are the luminous intensities of two sources and r_1, r_2 are the distances of the source from grease spot. If the illumination on two sides of the grease spot are equal.

Then, $\frac{I_1}{I_2} = \frac{r_1^2}{r_2^2}$

So, $\frac{I_1}{I_2} = \frac{20^2}{30^2} = \frac{4}{9}$

3. Ans.(a)

Time of exposure of camera (t) $\alpha \frac{f^2}{d^2}$

$\frac{t_1}{t_2} = \frac{d_2^2}{d_1^2} \rightarrow \frac{4}{t^2} = \left(\frac{2x}{x}\right)^2$

$\therefore t_2 = \frac{4}{4} = 1$ sec

4. Ans. (c)

Power = Intensity×Area

or, Intensity $= \frac{\text{Power}}{\text{Area}} = \frac{100}{4\pi\times(5)^2} = \frac{1}{\pi}$ watt/m^2

5. Ans. (b)

Illuminance (L) $= \frac{\text{Luminous intensity (I)}}{r^2}$

$= \frac{100}{4} = 25$ lux

6. Ans. (a) $\phi = 4\pi I = 4\pi \times 100 = 1256$ lumen

7. Ans. (d) Time of exposure $\alpha \frac{f^2}{d^2}$

$\frac{T_1}{T_2} = \left(\frac{d_2}{d_1}\right)^2 = \left(\frac{2d_1}{d_1}\right)^2 = 4$

$\therefore T_2 = \frac{T_1}{4} = \frac{0.25}{4} = 0.062$ sec

Chapter: 44

Wave Theory Of Light (Interference, Diffraction & Polarisation)

1. Huygens wave thory of light cannot explain:

a. diffraction b. interference
c. polarisation d. photoelectric effect

2. Electromagnetic waves are transverse in nature is evident by:

a. polarisation b. interference
c. reflection d. diffraction

3. The penetration of light in the region of geometrical shadow is called:

a. polarisation b. interference
c. diffraction d. refraction

4. The diffraction effect can be observed in:

a. sound waves b. light waves
c. ultrasonic waves d. Both (a) and (b)

5. Polarisation of light takes place due to many processes. Which of the following will not cause polarisation?

a. reflection b. double refraction
c. scattering d. diffraction

6. In a double slit experiment, the fringe width will be minimum for:

a. violet b. red
c. green d. yellow

7. In young's double slit experiment, the seperation between the slits is halved and the whole apparatus is immersed in water of refractive index $\frac{4}{3}$, the fringe width becomes:

a. unchaged b. $\frac{3}{2}$ times
c. doubled d. $\frac{3}{8}$ times

8. In a young's double slit experiment the fringe width is found to be 0.4mm. If the whole apparatus is dipped in water of refractive index $\frac{4}{3}$, without disturbing the arrangement, the new fringe width will be:

a. 0.30mm b. 0.4mm
c. 0.53mm d. 0.2mm

9. In young's double slit experiment, if the width of 3^{rd} fringe is 10^{-2}cm. Then the width of 5^{th} fringe will be:

a. 5×10^{-2}cm b. 3×10^{-2}cm
c. 1.67×10^{-2}cm d. 10^{-2}cm

10. The amplitude ratio of two waves is 2:1. The ratio of maximum and minimum intenities:

a. 1:1 b. 2:1
c. 4:1 d. 9:1

11. In YDSE, if the widths of the slits are in the ratio 4:9, the ratio of the maximum to minimum intensity will be:

a. 25:1 b. 81:16
c. 13:5 d. 9:4

12. Two waves A and B with amplitude 4a and a respectively interfere. If the phase difference at a point is 60°. The intensity at this point is:

a. 5 units b. 17 units
c. 21 units d. 25 units

13. In a two slit experiment with monochromatic light fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 5×10^{-2} m towards the slits, the change in fringe width is 3×10^{-5}m. If seperation between the slits in 10^{-3}m, then wavelength.

a. 6000 Δ b. 5000Δ
c. 3000 Δ d. 4500Δ

14. In a young's experiment two coherent sources are placed 0.90mm apart and fringes are observed 1 metre away. If it produces the second dark fringe at a distance of 1mm

from the central fringe, the wave length of monochromatic light used is:

a. 6×10^{-3}cm b. 10^{-3}cm

c. 10^{-4} cm d. 6×10^{-5}cm

15. The distance between two coherent sources is 0.1mm. The fringe width on a screen 1.2m away from the source is 6mm. The wavelength of light used is:

a. 4000 Δ b. 5000 Δ

c. 6000 Δ d. 7200 Δ

16. In young's experiment the wavelength of red light is 7800Δ and that of blue light is 5200Δ. The value of n for which $(n+1)^{th}$ blue band coincides with n^{th} red band is:

a. 4 b. 3

c. 2 d. 1

17. Two light waves of wavelengths λ_1 and λ_2 become incident simultaneously on double slits in Young's interference experiment. If third bright fringe of wave length λ_1 meets fourth bright fringe of wavelength λ_2, then

a. $\lambda_1 = 3\lambda_2$ b. $\lambda_2 = 3\lambda$

c. $3\lambda_1 = 4\lambda_2$ d. $4\lambda_1 = 3\lambda_2$

18. A beam of electron is used in YDSE experiment. When the velocity of electron is increased then,

a. no interference is observed

b. fringe width increases

c. fringe width decreases

d. fringe width remains the same

19. The two coherent sources with intensity ratio β produces interference. The fringe visibility will be:

a. $\frac{2\sqrt{\beta}}{1+\beta}$ b. 2β

c. $\frac{2}{1+\beta}$ d. $\frac{\sqrt{\beta}}{1+\beta}$

20. In YDSE, the distance between two sources is 0.1mm. The distance of the screen from the source is 20cm. Wave length of light used is 5460Δ. The angular position of the first dark fringe is:

a. 0.08° b. 0.16°

c. 0.20° d. 0.32°

21. In YDSE, the two slits acts are coherent sources of equal amplitude a and of wavelength λ. In other experiment with the same setup, the two slits are sources of equal amplitude a and wavelength λ but are in coherent. The ratio of intensity of light at the midpoint of the screen in the two cases will be:

a. 2:1 b. 1:2

c. 3:4 d. 4:3

22. In young's experiment one slit's covered with a blue filter and other with a yellow filter. Then the interference pattern:

a. will be blue b. will be yellow

c. will be green

d. will not be formed

23. In YDSE, the two equally bright slits are coherent but of phase difference $\frac{\pi}{3}$. If maximum intensity on the screen is I_o. The intensity at the point on the screen equidistant from the slits is:

a. Io b. $\frac{Io}{2}$

c. $\frac{Io}{4}$ d. $3\frac{Io}{4}$

24. A parallel beam of monochromatic light is incident normally on a slit. The diffraction pattern is observed on a screen placed at the focal plane of a convex lens. If the slit width is increased. The central maximum of the diffraction pattern will become:

a. broader and fainter

b . broader and brighter

c. narrower and fainter

d. narrow and brighter

25. A parallel beam of light of wavelength 5000Δ is incident normally on a single

slit of width 0.001mm. The light is focused by a convex lens on a screen placed in focal plane. The first minimum is formed for the angle of diffraction equal to:

a. 0° b. 15°
c. 30° d. 60°

26. A slit of width 12×10^{-7} m is illuminated by light of wavelength 6000Δ. The angular width of the central maximum is approxmiately.

a. 30° b. 60°
c. 90° d. 0°

27. The centre bright fringe of the interference pattern produced by light of wavelength 6000Δ is shifted to the position of fifth bright fringe by introducing a thin glass plate of refractive index 1.5. Then the thickness of the glass plate is:

a. 6×10^{-8}m b. 2×10^{-6}m
c. 6×10^{-6}m d. 2×10^{-8}m

28. Oil floating on water looks coloured due to interference of light. The approximate thickness of oil for such effect to be visible is:

a. 100Δ b. 10,000Δ
c. 1mm d. 1cm

29. In a diffraction experiment with light waves, the size of the obstacle in path should be of order of:

a. 1mm b. 0.1mm
c. 10^{-4}mm d. 1cm

30. A ray of light strikes a glass plate at an angle of 60°. If the reflected and refracted rays are perpendicular to each other, the index of refraction of glass is:

a. $\frac{1}{2}$ b. $\sqrt{\frac{3}{2}}$
c. $\frac{3}{2}$ d. 1.732

31. An unpolarised beam of intensity Io is incident on a pair of Nicol's making an angle of 60 with eachother. The intensity of the light emergent from the pair is:

a. Io b. $\frac{Io}{2}$
c. $\frac{Io}{4}$ d. $\frac{Io}{8}$

32. When interference of light takes place:

a. energy is created at the positions of maxima
b. energy is destroyed at the positions of minima
c. Energy is neither created not destroyed but merely redistributed
d. none

33. The tip of a needle doesnot give a sharp image on the screen. This is due to:

a. polarisation b. Interference
c. Diffraction d. Refraction

34. In Newton's ring arrangement in reflected light, the centre (t = 0) is:

a. dark b. bright
c. dark or bright d. coloured

Answer Sheet

1. d	*2. a*	*3. c*	*4. d*	*5. d*	*6. a*	*7. b*	*8. a*	*9. d*	*10. d*
11. a	*12. c*	*13. a*	*14. d*	*15. b*	*16. c*	*17. c*	*18. c*	*19. a*	*20. b*
21. a	*22. d*	*23. d*	*24. d*	*25. c*	*26. b*	*27. c*	*28. b*	*29. c*	*30. d*

31. d	*32. c*	*33. c*	*34. a*						

Solution

1. Ans.(d)Photoelectric effect can be explained on the basis of quantum theory.
2. Ans.(a)Electromagnetic waves are transverse in nature are evident by phenomenon of polarisation.
3. Ans. (c) The bending of the light round the corners is known as diffraction of light. So, the light penetrates into region of geometrical shadow.
4. Ans. (d) The diffraction can be observed in both light and sound waves.
5. Ans. (d) The phenomenon of diffraction will not produce the polarisation of light. Only transverse nature of light can be polarised.
6. Ans. (a) $\beta = \frac{\lambda D}{d} \propto \lambda$

   Hence fringe width is minimum for violet and maximum for red.
7. Ans. (b) Fringe width $\beta = \frac{\lambda D}{d} \propto \frac{\lambda}{d}$

   $\frac{\beta_2}{\beta_1} = \left(\frac{\lambda_2}{\lambda_1}\right)\frac{d_1}{d_2}$

   $\frac{\beta_2}{\beta} = \frac{3}{4} \times 2 = \frac{3}{2}$

   $\beta_2 = \frac{3}{2}\beta$
8. Ans. (a) $\beta = \frac{\lambda D}{d} \propto \lambda$

   $\frac{\beta w}{\beta a} = \frac{\lambda w}{\lambda a}$

   $\beta w = \left(\frac{\lambda w}{\lambda a}\right) \beta a$

   $\beta w = \frac{1}{\mu_w} \ \beta a$

   $\therefore \ \mu = \frac{\lambda a}{\lambda w}$

   $\beta w = \frac{3}{4} \times 0.4 = 0.3\text{mm}$
9. Ans. (d)

   width of all fringes is same in interference.

   $\beta = \frac{\lambda D}{d}$
10. Ans. (d)

    $\frac{a_1}{a_2} = \frac{2}{1}$

    $\therefore \ \frac{Imax}{Imin} = \left(\frac{a_1+a_2}{a_1-a_2}\right)^2 = \left(\frac{2+1}{2-1}\right)^2 = 9:1$
11. Ans. (a)

    $\frac{d_1}{d_2} = \frac{I_1}{I_2} = \frac{4}{9}$

    $\frac{Imax}{Imin} = \left(\frac{\sqrt{I_1} + \sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)^2$

    $= \left(\frac{\sqrt{4} + \sqrt{9}}{\sqrt{4}-\sqrt{9}}\right)^2 = \left(\frac{2+3}{2-3}\right)^2 = 25:1$
12. Ans. (c)

    $I_1 = Ka_1^2 = K(4a)^2 = 16\ Io$

    $I_2 = Ka_2^2 = Ka^2 = I_0$

    Resultant intensity I at point

    $I = I_1+I_2+2\sqrt{I_1I_2}\cos\phi$

    $= 16\ Io + Io + 2\sqrt{16\ Io^2}\cos 60$

    $= 17I_0 + 4I_0$

    $= 21\ Io$

    Where $Io = Ka^2$
13. Ans. (a)

    $\beta = \frac{\lambda D}{d}$ so, if screen is moved through certain distance ΔD, fringe width also changed by $\Delta\beta$.

    $\Delta\beta = \frac{\lambda}{d}\Delta D$

    $3\times10^{-5} = \frac{\lambda}{10^{-3}} \times 5\times10^{-2}$

    $\therefore \ \lambda = \frac{3\times10^{-5}\times10^{-3}}{5\times10^{-2}}$

$= 6\times10^{-7}m = 6000\Delta$

14. Ans. (d) Position of dark fringe

$y_n = \frac{(2n-1)\lambda D}{2d}$

$\lambda = \frac{yn.2d}{(2n-1)D}$

$= \frac{10^{-2}\times2\times(0.9\times10^{-3})}{(2\times2\times-1)\times1} = 6\times10^{-7}m = 6\times10^{-5}cm$

15. Ans. (b) $\beta = \frac{\lambda D}{d}$

$\therefore \lambda = \frac{\beta d}{D}$

$= \frac{6\times10^{-3}\times0.1\times10^{-3}}{1.2} = 5\times10^{-7}m = 5000\Delta$

16. Ans. (c)

For the coincidence of bands

$yn = yn^1$

$\frac{nD\lambda r}{d} = \frac{(n+1)D\lambda b}{d}$

$n\lambda r = (n+1)\lambda b$

$n \times 7800 = (n+1) \times 5200$

$3n = 2(n+1)$

$\therefore n = 2$

17. Ans. (c)

For bright fringe (maxima)

$yn = \frac{n\lambda D}{d}$

$yn = yn^1$

$\frac{n_1\lambda_1 D}{d} = \frac{n_2\lambda_2 D}{d}$

$n_1\lambda_1 = n_2\lambda_2$

$3\lambda_1 = 4\lambda_2$

18. Ans. (c)

$\beta = \frac{\lambda D}{d} \rightarrow \beta \propto \lambda$

Also, for electron $\lambda = \frac{h}{mv}$

$\rightarrow \lambda \propto \frac{1}{v}$

As the velocity of electron is increased, its wavelength decreases and so does fringe width.

19. Ans. (a) $\frac{I_1}{I_2} = \frac{\beta}{1}$

$\therefore \quad v = \frac{Imax - Imin}{Imax + Imin}$

$= \frac{2\sqrt{I_1 I_2}}{I_1+I_2} = \frac{2\sqrt{\beta}.1}{\beta+1}$

$= \frac{2\sqrt{\beta}}{1+\beta}$

20. Ans. (b) For first dark fringe, n=1

$\therefore x = (2n-1)\frac{\lambda D}{2d} = \frac{\lambda D}{2d}$

$\therefore$ Angular position,

$\alpha = \frac{x}{d} = \frac{\lambda}{2d}$

$= \frac{5460\times10^{-10}}{2\times10^{-4}}$ radian

$= 2730\times\frac{10^{-6}\times180}{\pi}$ degree

$= 0.16°$

21. Ans. (a) If two sources are coherent, the resulting intensity at the mid point of the screen due to interference is;

$Imax = K(a_1+a_2)^2 = K(a+a)^2 = K4a^2$

If two sources are in coherent, their intensities simply add up at the mid-point.

$I^1 = I_1 + I_2 = Ka_1^2 + Ka_2^2 = K2a^2$

$\frac{Imax}{I^1} = \frac{K\times4a^2}{K\times2a^2} = \frac{2}{1}$

22. Ans. (a) The waves do not become coherent. For interference the source must be coherent. The source should emit continuously waves of same wavelngth and frequency.

23. Ans. (d) For two sources having phase difference ϕ

$I = Io\cos^2\frac{\phi}{2}$

$= Io\cos^2\frac{60}{2}$

$= Io\cos^2 30$

$= Io\left(\frac{\sqrt{3}}{2}\right)^2 = \frac{3Io}{4}$

24. Ans. (d) Width of central maximum in diffraction

pattern is $\beta = \frac{2\lambda D}{d}$

As slit width d is increased, β decrease. i.e. central maximum becomes narrower. As same energy is distributed over a smaller area, therefore central maximum becomes brighter.

25. Ans. (c)

$d\sin\theta = n\lambda = 1 \times \lambda = \lambda$

or, $\sin\theta = \frac{\lambda}{d}$

or, $\sin\theta = \frac{5000\times10^{-10}}{0.001\times10^{-3}}$

or, $\sin\theta = \frac{1}{2}$

$\therefore$ $\theta = 30°$

26. Ans. (b)

Angular width = 2θ

But $\sin\theta = \frac{n\lambda}{d}$

$= \frac{1\times6000\times10^{-10}}{12\times10^{-7}}$

$= \frac{1}{2} = \sin 30$

$\therefore \theta = 30 \ \therefore 2\theta = 60°$

27. Ans.(c)

$(\mu-1)t = n\lambda$

or, $(1.5-1)t$

$= 5\times6000\times10^{-10}$

or, $0.5\times t = 3\times10^{-6}$

$\therefore$ $t = 6\times10^{-6}$m

28. Ans. (b)

For interference, thickness should be of the order of wavelength of light which is 10,000Δ among these option.

29. Ans. (c)

For diffraction of light size of obstacle should be of the order of wavelength of light which is 10^{-4}mm among given choices.

30. Ans. (d)

When the reflected and refracted ray are perpendicular to each other, i= polarising angle

$\mu = \tan i = \tan 60\sqrt{3} = 1.732$

31. Ans. (d)

Intnesity of light emerging from Nicol's prism is $\frac{Io}{2}$.

According to Malus law

$I = \frac{Io}{2}\cos^2\theta(\theta = 60°)$

$= \frac{Io}{2} \times \cos^2 60$

$= \frac{Io}{2} \times \frac{1}{4} = \frac{Io}{8}$

32. Ans. (c)

- Interference energy is redistributed
- Interference takes place in all the wave
- Interference is based on division of wave fronts.

33. Ans. (c)

Diffraction - Bright colours exhibited by spider's web exposed to sunlight

- Sunlight filtering through a tree often makes circular patches on ground.

34. Ans. (a)

For air-flim, the ray reflected from glass plate suffers a phase change of π, so the centre is dark.

Past Questions

1. **Light of λ is incident on a slit of width. The resulting diffraction pattern is observed on a screen at a distance D. The linear width of the principal maximum is equal to the width of the slit of D equals (MOE 2068)**
   a. $\frac{d^2}{2\lambda}$ b. $\frac{d}{\lambda}$
   c. $\frac{2\lambda^2}{d}$ d. $\frac{2\lambda}{d}$
2. **A glass of μ = 1.5 thickness 10cm. What is the optical path in lens (MOE 2068)**
   a. 15cm b. 10cm
   c. 5cm d. 20cm
3. **The intensity produced are in the ratio 9:16. If two waves are superimposed the maximum intensity is: (MOE 2067)**
   a. 49 b. 16
   c. 25 d. 9
4. **Two coherent monochromatic light beams of intensities in the ration 1:4 are superimposed, the ratio of maximum to minimum possible intensities in the resulting beam is (MOE 2067):**
   a. 5:1 b. 5:3
   c. 9:1 d. 9:3
5. **Fringe width between two consecutive fringes is 11780Δ and slit seperation is 0.1mm. If the distance between screen and slit is 0.2mm, then wavelength of light used is: (MOE 2008).**
   a. 5890Δ b. 58900Δ
   c. 589Δ d. 8950Δ
6. **In a diffraction expirement a plane transmission grating having 5500 lines/cm is illuminated by a source of light of wavelength 6000 Angstrom. Number of maxima observed on the screen will be (MOE curriculum)**
   a. 2 b. 3
   c. 5 d. 6
7. **Two waves of the same wavelength and amplitude interfere to produce a minimum when their phase difference is (MOE 2065)**
   a. $\frac{\pi}{2}$ b. π
   c. zero d. $\frac{3\pi}{2}$
8. **In an interference pattern minima are obtained when phase difference between interfering waves (MOE)**
   a. $\frac{\pi}{2}$ b. 2π
   c. $n\frac{\pi}{2}$ d. $(2n+1)\pi$
9. **The frequency of radiowaves is 15MHz. What is its wavelength? [MOE]**
   a. 20m b. 15m c. 5m d. 25m
10. **Young's experiment is performed inside water the fringe width will (MOE/IOM)**
    a. decrease b. remains same
    c. incease d. none
11. **In young's double slit experiment, 12 fringes are obtained in a certain fragment of screen when light of wavelength 600nm is used. If the wavelength of light is changed to 400nm, number of fringes obtained in the same segment of screen will be (IOM 2011)**
    a. 12 b. 18
    c. 24 d. 30
12. **The fringe width interference of monochromatic light produced by double slit experiment is β. The**

wavelength of light is λ. Then the ratio of the slit seperation to the distance of the slits and screen is : (IOM 063)

a. $\beta\lambda$ b. $\frac{\lambda}{\beta}$

c. $\frac{1}{\lambda\beta}$ d. $\frac{\beta^2}{\lambda}$

13. **A beam of light is passed through two parallelly placed tourmaline plates. Now, when one of the plates is rotated, brightness is changed due to (IOM)**

a. polarisation b. dispersion

c. diffraction d. interference

14. **In young's double slit experiment fringe width is 2mm. Seperation between 9th bright fringe and 2^{nd} dark fringe from the centre of fringe system is: (IE-2010)**

a. 5mm b. 10mm

c. 15mm d. 20mm

15. **In a young's double slit experiment when one of the slit is closed then its intensity become: (IE-09)**

a. I b. $\frac{I}{2}$

c. $\frac{I}{4}$ d. $\frac{I}{8}$

16. **Coherent light waves never arises from (IE-07):**

a. two laser b. two pinholes

c. two candles d. two slits

17. **In a double slit diffraction, Central bright fringe is obtained if path difference is multiple of (IE-06)**

a. $\frac{\lambda}{2}$ b. $\frac{\lambda}{4}$

c. $\frac{3\lambda}{2}$ d. λ

18. **Diffraction isn't seen incase (IE-06).**

a. If screen is far

b. wavelength of light is small than slit

c. wavelength of light is greater than slit

d. wavelength is very large

19. **Newton's corpuscular theory couldn't explain (BPKIHS 2010)**

a. Refraction

b. Reflection

c. Diffraction

d. Rectilinear propagation

20. **Young's double slit experiment is made in a liquid. The 10th bright fringe in liquid lies where 6th dark fringe lies in vaccum. The refractive index of liquid is approximately (BPKIHS 2009)**

a. 1.8 b. 1.54

c. 1.67 d. 1.2

21. **Soap bubble shines in different colour due to (BPKIHS)**

a. diffraction b. interference

c. polarisation d. refraction

22. **Interference occurs mostly due to (IE,01)**

a. reflection b. refraction

c. polarisation d. diffraction

Answer Sheet

1. a	*2. a*	*3. a*	*4. c*	*5. a*	*6. b*	*7. b*	*8. d*	*9. a*	*10. a*
11. b	*12. b*	*13. a*	*14. c*	*15. c*	*16. c*	*17. d*	*18. b*	*19. c*	*20. a*
21. b	*22. b*								

Solution

1. Ans. (a) The linear width of central Principal maximum = $\frac{2\lambda D}{d}$

If it equal to width of slit (d), then

$\frac{2\lambda D}{d} = d$

$\therefore$ D = $\frac{d^2}{2\lambda}$

2. Ans. (a)

Optical Path (L) = μ ×Path in medium (d)

$L = \mu \times d$

$= 1.5 \times 10$

$= 15$cm

3. Ans. (a) $\frac{I_1}{I_2} = \frac{9}{16}$

$I_{max} = \left(\sqrt{I_1} + \sqrt{I_2}\right)^2$

$= \left(\sqrt{9} + \sqrt{16}\right)^2$

$= 7^2 = 49$

4. Ans. (c)

$\frac{I_1}{I_2} = \frac{1}{4}$

$\frac{I_{max}}{I_{min}} = \left(\frac{\sqrt{I_1}+\sqrt{I_2}}{\sqrt{I_1}-\sqrt{I_2}}\right)$

$= \left(\frac{1+2}{1-2}\right)^2 = 9:1$

5. Ans. (a)

Fringe width (β) = $\frac{\lambda D}{d}$

$\lambda = \frac{\beta d}{D} = \frac{11780\times10^{-10}\times10^{-4}}{2\times10^{-4}}$

$= 5890\Delta$

6. Ans. (b)

$\lambda = 6000\Delta = 6\times10^{-7}$m

No. of lines/cm = 5500 lines

No. of lines/m = 550,000 lines

For maxima $\theta = 90°$

$a+b = \frac{1}{N} = \frac{1}{550000}$

$(a+b) = n\lambda$

$n = \frac{a+b}{\lambda}$

$= \frac{1}{55000\times6\times10^{-7}} = 3$

7. Ans. (b)

Condition for minima

$\Delta\Phi = (2n+1)\pi$ (n = 0,1,2.....)

$\Delta x = (2n+1)\frac{\lambda}{2}$

Condition for maxima

Phase difference ($\Delta\Phi$) = $2n\pi$

Path difference (Δx) = $n\lambda$

8. Ans. (d)

Condition for constructive interference or maxima

$\Delta\Phi = 2n\pi$, $\Delta x = n\lambda$

Condition for destructive interference or minima

$\Delta\Phi = (2n+1)\pi$

$\Delta x = (2n+1)\frac{\lambda}{2}$

9. Ans. (a)

Radiowaves- Electromagnetic wave travels with speed of light.

$\lambda = \frac{c}{f} = \frac{3\times10^8}{15\times10^6}$

$= \frac{3\times10^2}{15} = 20$m

10. Ans. (a) Fringe width (β) = $\frac{\lambda D}{d}$

Inside water (β_w) = $\frac{\lambda_w D}{d}$

$\lambda_w = \frac{\lambda}{\mu}$, $\lambda_w < \lambda$ so, wavelength decreases so does Fringe width.

11. Ans. (b) $n_1\beta_1 = n_2\beta_2$

$n_1\frac{\lambda_1 D}{d} = n_2\frac{\lambda_2 D}{d}$

$n_2 = \frac{\lambda_1}{\lambda_2}\times n_1 = \frac{600}{400}\times 12 = 18$

12. Ans. (b)

β = fringe width

λ = wavelength of light

d = slit seperation

D = Distance between slit and screen

We know

$\beta = \frac{\lambda D}{d} \rightarrow \frac{d}{D} = \frac{\lambda}{\beta}$

13. Ans. (a)

- Tourmaline plates are used as polarizers
- Tourmaline plates ane Dichoric which polarises light because of double refraction.

14. Ans. (c)

Location of nth bright fringe

$yn = \frac{n\lambda D}{d} = n\beta$

$y_9 = 9 \times 2mm = 18mm$

Location of nth dark fringe is

$y_n = \frac{(2n-1)\lambda D}{2d}$

$y_2 = \frac{(2n-1)\beta}{2} = \frac{3}{2} \times 2 = 3mm$

$\therefore$ $y_9 - y_2 = 18 - 3 = 15mm$

15. Ans. (c)

When both slits are open

$I \propto (a_1+a_2)^2$

$I \propto (2a)^2$

$I \propto 4a^2$

When one slit is closed

$I_2 \propto a^2$

$I_2 = \frac{I}{4}$

16. Ans. (c)

Coherent source has same frequency amplitude may be same or sightly different. 2 candles do not have light of same frequency.

17. Ans. (d)

For observing central bright fringe, phase difference should be multiple of 2π.

So, path difference

$\Delta x = \frac{\lambda}{2\pi} \times 2\pi = \lambda$

So, Δx must be multiple of λ .

18. Ans. (b)

For observing diffraction pattern, wavelength (λ) of light should be nearly equal to size of slit (d)

ie. $d \approx \lambda$

When $d > \lambda$ geometrical shadow occurs and when $d < \lambda$ reflection and not diffraction occurs, Best is (b).

19. Ans. (c)

Newton suggested that light propagates as corpuscles. It can explain only reflection, refraction and rectilinear propagation but not interference, diffraction, polarization and photoelectric effect.

20. Ans. (a)

$\beta = \frac{\lambda D}{d}$ and $\beta^1 = \frac{\beta}{\mu}$

For 6^{th} dark fringe

$x = \left(\frac{2n-1}{2}\right)\beta = 5.5\beta$

For 10^{th} bright fringe

$x = n\beta^1 = 10\beta^1$

By Question, $10\beta^1 = 5.5\beta$

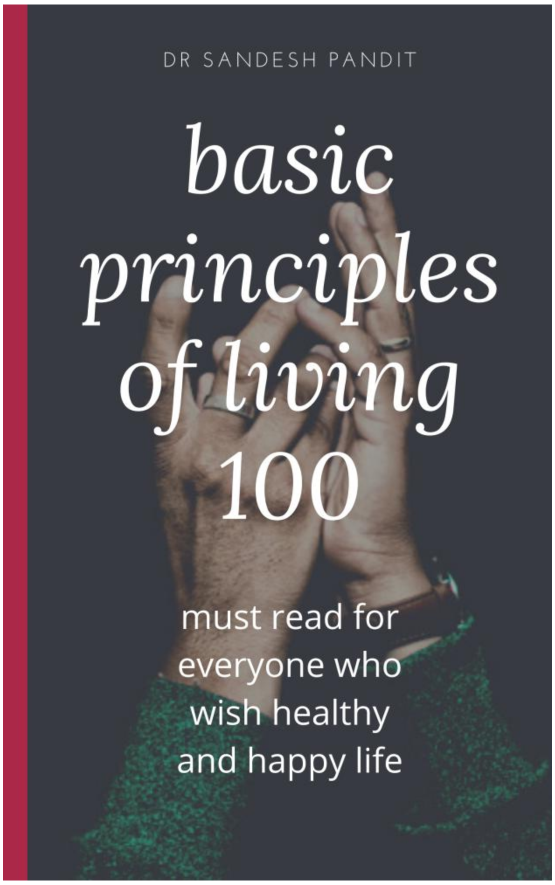
$\frac{10\beta}{\mu} = 5.5\beta \therefore \mu = 1.8$

21. Ans. (b)

The colours in case of thin film are due to interference which is due to division of wavefront.

22. Ans. (b)

- Interference occurs mostly due to refraction.
- Colour of soab bubble and kerosene due to interference.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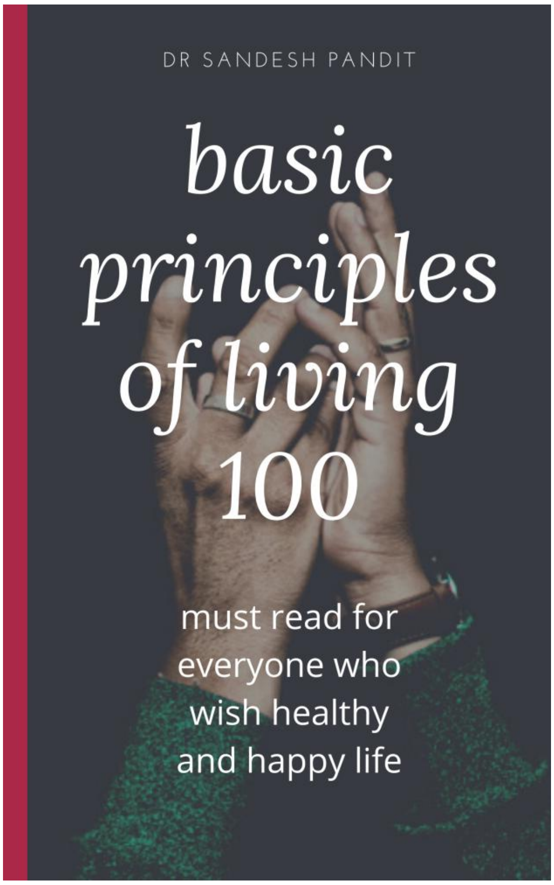
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Chapter: 45

cathode rays, positive rays & electrons

1. **Cathode rays are:**
   a. stream of electrons
   b. stream of protons
   c. stream of α particles
   d. stream of neutrons
2. **Cathode rays are produced when the pressure in the discharge tube is of the order of:**
   a. 76cm of Hg b. 10^{-6}cm of Hg
   c. 1cm of Hg d. 10^{-2}–10^{-3}mm of Hg
3. **The speed of Cathode rays is ($C=3\times10^8$m/s).**
   a. equal to c b. less than c
   c. more than c d. none
4. **If an electron has no initial velocity in a direction different from that of electric field, the path of electron is:**
   a. a straight line b. parabola
   c. circle d. an ellipse
5. **If an electron has an initial velocity perpendicular to direction of electric field. The path of the electron is:**
   a. straight line b. parabola
   c. circle d. an ellipse
6. **An electron moves with constant velocity v parallel to the direction of uniform electic field E. The force experienced by the electron is:**
   a. vE b. $\frac{ev}{E}$
   c. $-e\vec{E}$ d. $e\vec{E}$
7. **A cathode ray tube has a potential difference of V volts between the cathode and anode. Then the speed (v) of Cathode rays is given by:**
   a. $v \propto V$ b. $v \propto V^{-1}$
   c. $v \propto \sqrt{V}$ d. $v \propto V^2$
8. **A cathode ray tube has a potential difference of V volts between the Cathode and anode. If potential V is not very large, the speed v is nearly equal to:**
   a. $6\times10^3\sqrt{V}$ m/s b. $6\times10^5\sqrt{V}$ m/s
   c. $6\times10^7\sqrt{V}$ m/s d. $6\times10^5V^2$ m/s
9. **An electron is accelerated through a potential differnce of 1000V volt. Its velocity is nearly.**
   a. 3.8×10^7m/s b. 1.9×10^6 m/s
   c. 1.9×10^7 m/s d. 5.7×10^7m/s
10. **The ratio of specific charge $\frac{e}{m}$ of an electron to that of a hydrogen ion is:**
   a. 1:1 b. 1840:1
   c. 1:1840 d. 2:1
11. **An α particle is accelerated through a p.d. of 200 volts. The increase in its kinetic enegry in electron volt will be:**
   a. 100 eV b. 200 eV
   c. 400 eV d. 800 eV
12. **An electron at rest is accelerated through a potential difference of 200 volts. If electron acquires a velocity 8.4×10^6m/s. The value of e/m of electron is:**
   a. 1.76×10^{-11}C/kg b. 1.76×10^{11}C/kg
   c. 1.76×10^{14}C/kg d. 1.76×10^{-14}C/kg
13. **Doubly ionised helium atom are accelerated from rest, through the same potential difference.The ratio of final velocities of helium and hydrogen are:**
   a. $1:\sqrt{2}$ b. $\sqrt{2}:1$
   c. 1:2 d. 2:1
14. **A beam of electrons is moving with a constant velocity in a region having electric and magnetic fields of strength $20Vm^{-1}$ and 0.5T at right angles to**

direction of motion of electrons. What is the velocity of electrons?

a. 20m/s b. 40m/s
c. 8m/s d. 5.5m/s

15. In millikan oil drop experiment, a drop of charge Q and radius r is kept constant between two plates of potential difference 800 volt. Then charge on other drop of radius 2r which is kept constant with a potential difference of 3200 v is:

a. $\frac{Q}{2}$ b. 2Q
c. 4Q d. $\frac{Q}{4}$

16. In millikan's oil drop experiment a charged drop of mass 1.6 × 10^{-14} kg is stationary between its plates. The distance between the plates is 1cm and potential difference 2 kilovolts. The number of electron on the drop is:

a. 500 b. 50
c. 5 d. 10

17. An oil drop carrying a charge q has a mass m kg. It is falling freely in air with terminal velocity v. The electric field required to make the drop move upwards with the same speed is:

a. $\frac{mg}{q}$ b. $\frac{2mg}{q}$
c. $\frac{mgv}{q^2}$ d. $\frac{2mgv}{q}$

Answer Sheet

1. a	*2. d*	*3. b*	*4. a*	*5. b*	*6. c*	*7. c*	*8. b*	*9. c*	*10. b*
11. c	*12. b*	*13. a*	*14. b*	*15. b*	*16. c*	*17. b*			

Solution

1. Ans. (a)

Cathode rays are stream of electrons so deflected by both electric and magnetic fields.

2. Ans. (d)

When pressure ≈ 10^{-2}–10^{-3}mm of Hg, whole tube is filled with Crook's dark space. At this pressure cathode rays are produced.

3. Ans. (b)

Cathode rays travel nearly with velocity $\frac{c}{10}$

4. Ans. (a)

A stationary electon (e^-) experiences force in the direction opposite to that of electric Field. So, the path of e^- is straight line.

5. Ans. (b)

Here, Force acts perpendicular to initial velocity so the path of the electron is parabolic.

6. Ans. (c)

Force on charged particle = charge×field

$\vec{F} = -e\vec{E}$

7. Ans. (c)

K.E. gained = workdone

$\frac{1}{2}mv^2 = eV$

$v = \sqrt{\frac{2eV}{m}}$

$v \propto \sqrt{V}$

8. Ans. (b)

$v = \sqrt{2\left(\frac{e}{m}\right)V}$

$= \sqrt{2\times1.8\times10^{11}} \times \sqrt{V} = 6\times10^5\sqrt{V}$ m/s

9. Ans. (c)
$v = 6\times10^5\sqrt{V}$ m/s $= 6\times10^5\sqrt{1000}$ m/s
$= 6\sqrt{10}\times10^6$ m/s $= 6\sqrt{10}\times10^6$ m/s
$= 6\times3.1\times10^6 = 1.9\times10^7$ m/s

10. Ans. (b)
$\frac{e/me}{e/m_H} = \frac{M_H}{Me} = 1840:1$

11. Ans. (c) Increase in K.E = q × V
= 2e × 200 Volt = 400eV

12. Ans. (b) $\frac{1}{2}mv^2 = eV$
$\frac{e}{m} = \frac{V^2}{2\nu} = \frac{(8.4\times10^6)^2}{2\times200} = 1.76\times10^{11}$ C/kg

13. Ans. (a) $\frac{1}{2}mv^2 = qV$
$v = \sqrt{\frac{2qV}{m}} \rightarrow v \,\alpha \sqrt{\frac{q}{m}}$
$\frac{V_{He}}{V_H} = \sqrt{\frac{q_{He}}{q_H}\times\frac{M_H}{M_{He}}}$
$= \sqrt{\frac{2e}{e}\times\frac{m}{4m}} = \frac{1}{\sqrt{2}}$

14. Ans. (b) If $\vec{E} \perp \vec{B} \perp \vec{V}$
Then, $V = \frac{E}{B} = \frac{20}{0.5} = 40$ m/s

15. Ans. (b)
$QE = mg = \frac{4}{3}\pi r^3\rho g$
$\frac{QV}{d} = \frac{4}{3}\pi r^3\rho g \rightarrow QV \alpha\, r^3$
$\frac{Q_1V_1}{Q_2V_2} = \frac{r_1^3}{r_2^3}$
$\frac{Q\times800}{Q_2\times3200} = \left(\frac{r}{2r}\right)^3 = \frac{1}{8}$
$Q_2 = 2Q$

16. Ans. (c)
For the charge to be stationery.
$qE = mg$
$ne\frac{V}{d} = mg$
$n = \frac{mgd}{Ve} = \frac{1.6\times10^{-14}\times1\times10\times10^{-2}}{2\times10^3\times1.6\times10^{-19}}$
$\therefore n=5$

17. Ans. (b) When the oil drop is falling freely under the effect of gravity in a viscous medium with terminal velocity v, then
$mg = 6\pi\eta rv$ .... (i)
To move the oil drop upwards with terminal velocity v, if E is the electric field required then,
$qE = mg+6\pi\eta rv$
$qE = mg+mg$ [From i]
$E = \frac{2mg}{q}$

Past Questions

1. In millikan's oil drop experiment, an oil drop is held stationary by a potential difference of 400V. If another drop of double the radius but carry the same charge to be held stationary. The potential difference required is (MOE 2010).

a. 800V b. 1600V
c. 3200V d. 400V

2. An electron of mass 'm' and charge 'e' is accelerated from rest through a potential difference of 'V' volts in vaccum. The speed of electron will be: (MOE 2066)

a. $\left(\frac{eV}{m}\right)^{\frac{1}{2}}$ b. $\left(\frac{mV}{e}\right)^{\frac{1}{2}}$
c. $\left(\frac{m}{eV}\right)^{\frac{1}{2}}$ d. $\left(\frac{2eV}{m}\right)^{\frac{1}{2}}$

3. Work done in carrying an electron across a potential difference of 10v is (MOE 2065)

a. 0.1 eV b. 1 eV
c. 10 eV d. 100 eV

4. The kinetic energy of a proton accelerated by 1V is (MOE curriculum)

a. $\frac{1}{1840}$ eV b. 1840 eV
c. 1 eV d. $(1840)^{\frac{1}{2}}$ eV

5. The ratio of charge to mass ratio of a proton to a particle equals (MOE 2054)

a. 2 b. $\frac{1}{2}$
c. 4 d. $\frac{1}{4}$

6. Cathode rays are deflected by (IOM/MOE/BPKIHS)

a. electric field b. magnetic field
c. both d. none

Answer Sheet

1. c	*2. d*	*3. c*	*4. c*	*5. a*	*6. c*

Solution

1. Ans. (c)

From millikan's oil drop experiment,

mg = qE (For stationary drop)

$\frac{4}{3}\pi r^3 \rho g = q\frac{V}{d}$

i.e. $V \alpha r^3$

$\therefore \frac{V^1}{400} = \left(\frac{2R}{R}\right)^3$

$V^1 = 8 \times 400$

$= 3200V$

2. Ans. (d)

Energy of electron when accelerated through a p.d. 'V' is given by

E = eV

$\frac{1}{2}mV^2 = eV$

$v = \sqrt{\frac{2eV}{m}}$

3. Ans. (c)

Work done = Charge × P.d

= e ×10V

= 10 eV

4. Ans. (c)

The K.E. of charged particles in an electric field doesn't depend on their mass but only on their charge and accelerating potential. K.E = qV = 1eV.

5. Ans. (a)

Specific charge = $\frac{\text{charge (q)}}{\text{mass (m)}}$

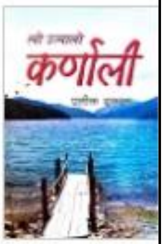
$\frac{(q/m)p}{(q/m)\alpha} = \frac{1/1}{2/4} = 2$

6. Ans. (c)

As Cathode rays are streams of electrons, they deflected by both electric and magnetic fields.

नेपालमा कम्युनिस्ट पार्टीको विकासक्रम, सरकार र नेतृत्व

नेपाली कांग्रेसको इतिहासको प्रारूप



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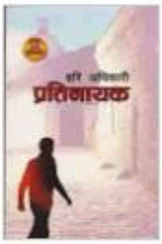

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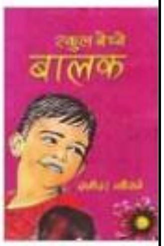

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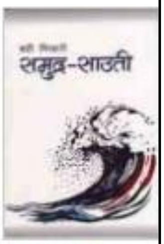

समुन्द्र साउती

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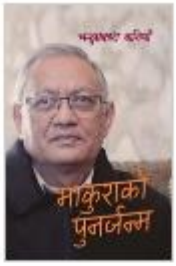


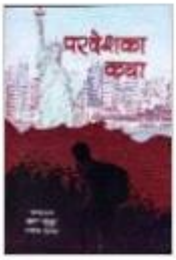
माकुराको पुनर्जन्म

नेपाली कांग्रेसको इतिहासको प्रारूप

कर्म

वीर्य जमिन

सारङ्गी



परदेशका कथा

डिलको डोब

Of Walls And Pigeons

Chapter: 46

Photoelectric Effect

1. **Photoelectric effect was discovered by:**
   a. Plank b. Einstein
   c. Bohr d. Hallwach
2. **The momentum of a photon is P. The corresponding wavelength is:**
   a. $\frac{h}{p}$ b. hp
   c. $\frac{p}{h}$ d. $\frac{hc}{\sqrt{p}}$
3. **The rest mass of a photon of wavelength λ is:**
   a. Zero b. $\frac{h}{c\lambda}$
   c. $\frac{\lambda}{h}$ d. $\frac{hC}{\lambda}$
4. **The dynamic mass of a photon of wavelength λ is:**
   a. zero b. $\frac{h}{c\lambda}$
   c. $\frac{\lambda}{h}$ d. $\frac{hc}{\lambda}$
5. **For light of wavelength 5000Δ, the photon energy is nearly 2.5 ev. For xray of wavelength 1Δ photon energy will be close to:**
   a. 5×10^{-4} eV b. 1×10^{-7}eV
   c. 1.25×10^{4}eV d. 1.25×10^{7}eV
6. **The energy of photon corresponding the visible light of maximum wavelength is nearly:**
   a. 1ev b. 1.6ev
   c. 3.2ev d. 7ev
7. **Given Plank's constant h = 6.6×10^{-34} JS. The momentum of each photon in a given radiation is 3.3×10^{-29} kgm/s. The frequency of radiation is:**
   a. 3×10^{3}Hz b. 6×10^{10}Hz
   c. 7.5×10^{12}Hz d. 2.5×10^{13} Hz
8. **If h is Plank's constant the momentum of photon of wavelenght 0.01Δ is:**
   a. 10^{-2}h b. h
   c. 10^{2}h d. 10^{12}h
9. **Two photons of energy 2.5ev each are incident on a metal plate whose work function is 4ev. Then the number of electrons emitted from metal surface will be:**
   a. one b. two
   c. none d. more than two
10. **When ultraviolet radiation is incident on a surface no photo electrons are emitted. If a second beam cause photo electron to be emitted, it may consists of:**
    a. radio waves b. infrared rays
    c. visible light rays d. x-rays
11. **Light of frequency 1.5 times the threshold frequency is incident on a photo sensitive material. If the Frequency is halved and intesity is doubled, the photoelectric current becomes:**
    a. Quadrapled b. Doubled
    c. Halved d. Zero
12. **Light of frequency 3 times the threshold frequency is incident on a photo sensitive material. If the frequency is halved and intensity is doubled, the photo electric current becomes:**
    a. zero b. doubled
    c. halved d. quadrupled
13. **If the work function of the metal is ϕ and the frequency of incident light is f, then there is no emission of photo electron when:**
    a. $f < \frac{\phi}{h}$ b. $f = \frac{\phi}{h}$
    c. $f > \frac{\phi}{h}$ d. $f > \frac{h}{\phi}$

14. The maximum kinetic energy of photo electrons emitted from a surface when the photons of energy 5.6ev falls on it is 4ev. The stopping potential in volts is:

a. 1.6v b. 3.2v
c. 4v d. 9.6v

15. The maximum energy of photoelectrons emitted in a photcell is 2ev. For no photelectons to reach the anode, the stopping potential should be:

a. 2v b. –2v
c. 4v d. –4v

16. Photons of energy 6eV falls on a photo metal of work function 4eV. The minimum Kinetic energy of the emitted photo electrons is:

a. 0 eV b. 1 eV
c. 2 eV d. 10 eV

17. X-rays are used to irradiate sodium and copper surfaces in two seperate experiments and stopping potential is dermined.

a. Greater for sodium
b. Greater for copper
c. equal in both cases
d. infinite in both cases

18. Radiation of two photon's energy, twice and ten times the work function of metal are incident on the metal surface successively. The ratio of maximum velocities of photoelectrons emitted in two cases is:

a. 1:2 b. 1:3
c. 1:4 d. 1:1

19. When a certain metallic surface is illuminated with monochromatic light is wavelenth λ, the stopping potential for photoelectric current is $3v_o$. When the same surface is illuminated with light of wavelength 2λ, the stopping potential is V_o. The threshold wavelength of this surface for photoelectric effect is:

a. 6λ b. 8λ
c. 4λ d. $\frac{\lambda}{4}$

20. If the distance of 100 watt lamp is increased from a photo cell, the saturation current i, in the photo cell varies with distance 'd' as:

a. $i \propto d^2$ b. $i \propto d$
c. $i \propto \frac{1}{d}$ d. $i \propto \frac{1}{d^2}$

21. A source of light is placed at a distance of 1m from a photo cell and the cut off potential is found to be Vo. If the distance is doubled, cut off potential will be:

a. Vo b. 2Vo
c. $\frac{Vo}{2}$ d. $\frac{Vo}{4}$

22. The photoelectric threshold frequency of a metal is fo. When light of frequency 4fo is incident on the metal, the maximum K.E. of emitted photo electrons is:

a. 4h fo b. 3h fo
c. $\frac{h\,fo}{4}$ d. $\frac{h\,fo}{2}$

23. Of the following particles, moving with same kinetic energy, the one which has largest wavelength is:

a. An electron b. A proton
c. an α particles d. all have same

24. The de-Broglie wave length of a neutron at 927°c is λ. What will be its wavelength at 27°c?

a. $\frac{\lambda}{2}$ b. $\frac{\lambda}{4}$
c. 4λ d. 2λ

25. A proton and an α particle are accelerated through the same potential difference. The ratio of their de-Broglie wavelength $\left(\frac{\lambda_p}{\lambda_e}\right)$ is:

a. 1 b. 2
c. $\sqrt{8}$ d. $\frac{1}{\sqrt{8}}$

26. The de-Broglie wavelenght of 150ev elctron will be:

a. 1Δ b. 12.27Δ
c. 0.5Δ d. 1.5Δ

27. The de-Broglie wavelength of an electron is 1.224Δ. The energy of electron in (ev) is:

a. 1ev b. 10 ev
c. 100 ev d. 1224 ev

28. A proton is accelerated with a potential of V volt has wavelenght λ. An α particle in order to have same wavelength must be accelerated through a potential of:

a. $\frac{V}{2}$ b. $\frac{V}{4}$
c. $\frac{V}{8}$ d. $\frac{V}{16}$

Answer Sheet

1. d	*2. b*	*3. a*	*4. b*	*5. c*	*6. b*	*7. d*	*8. d*	*9. c*	*10. d*
11. d	*12. b*	*13. a*	*14. c*	*15. b*	*16. a*	*17. a*	*18. b*	*19. c*	*20. d*
21. a	*22. b*	*23. a*	*24. d*	*25. c*	*26. a*	*27. c*	*28. c*		

Solution

1. Ans. (d)
Photoelectric efect was discovered in Hallwach but explained by Einstein

2. Ans. (b) $E = mc^2 = \frac{hc}{\lambda}$

$\therefore$ $P = mc = \frac{h}{\lambda}$

3. Ans. (a) Rest mass $m_o = m\sqrt{1-\frac{v^2}{c^2}}$

For Photon, $v = c \rightarrow m_o = 0$
It also means that, photon cannot exist at rest.

4. Ans. (b) $E = mc^2 = \frac{hc}{\lambda}$

$\rightarrow mc = \frac{h}{\lambda}$

$\therefore\ m = \frac{h}{c\lambda}$

5. Ans. (c) $E = \frac{hc}{\lambda}\ \alpha\ \frac{1}{\lambda}$

$\rightarrow \frac{E_2}{E_1} = \frac{\lambda_1}{\lambda_2}$

$\frac{E_2}{2.5} = \frac{5000}{1}$

$E_2 = 2.5\times5000$
$= 1.25\times10^4$ev

6. Ans. (b)
Maximum wavelength of visible light (i.e. redlight) is $\lambda max = 7800\Delta$

$E = \frac{hc}{\lambda} = \frac{12400}{7800}$ ev

= 1.6ev

7. Ans. (d)

$\lambda = \frac{h}{p}$ and $f = \frac{c}{\lambda}$

$f = \frac{C}{h/p} = \frac{pc}{h}$

$= \frac{3.3\times10^{-29}\times3\times10^{8}}{6.6\times10^{-34}} = 1.5\times10^{13}$ Hz

8. Ans. (d)

$p = \frac{h}{\lambda} = \frac{h}{0.01\Delta} = \frac{h}{10^{-12}} = 10^{12}h$

9. Ans. (c)
Photoemission is one to one effect. Energy of each photon is less than work function. So, no electrons are emitted.

10. Ans. (d)
For photo emission, wavelength of radiation should be less than wavelength of ultraviolet. So, incident radiation should be x-rays.

11. Ans. (d)
When the incident frequency is made half, it becomes:
$f_1 = \frac{1.5fo}{2} = 0.75$ fo $\quad\therefore f_1 < f_o$
Thus, photo electric effect doesnot occur, So, these is no effect of doubling the intensity and hence photo electric current becomes zero.
12. Ans. (b)
$f_1 = \frac{3fo}{2} = 1.5fo$
$\therefore f_1 > f_o$. So, photoelectic effect occurs.
As photo electric current (I) α intensity (I). The current becomes double on doubling the intensity.
13. Ans. (a)
$\phi = hfo$ i.e. $fo = \frac{\phi}{h}$
There will be no emission of photoelectrons if f < fo
ie. if $f < \frac{\phi}{h}$.
14. Ans. (c)
Maximum K.E = 4ev
or, eVo = 4ev
$\therefore$ Vo = 4v
15. Ans. (b)
$ev_o = KE_{max}$=2ev
$\therefore v_o$=2v
However, –ve sign is chosen because stopping potential is the maximum –ve potential so that photoelectric current becomes zero.
16. Ans. (a)
E = K.E + Wo
6 = K.E+4
$\therefore$ KE=2ev which is the value of maximum K.E of emitted electrons. But, minimum K.E is always zero.
17. Ans. (a) $eVo = hf - w_o$
Sodium, being an alkali metal, has less work function than that for copper. Hence, the value of stopping potential is more for sodium.
18. Ans. (b)
$\frac{1}{2} mv_1^2 = 2w_o - w_o = w_o$ .... (i)
$\frac{1}{2} mv_2^2 = 10w_o - w_o = 9w_o$ .... (ii)
Dividing (i) by (ii) we get
$\frac{v_1^2}{v_2^2} = \frac{1}{9} \quad \therefore \frac{v_1}{v_2} = \frac{1}{3}$
19. Ans. (c) $eVo = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda o}\right)$
$V_o = \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda o}\right)$
$3V_o = \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda o}\right)$ .... (i)
$V_o = \frac{hc}{e}\left(\frac{1}{2\lambda} - \frac{1}{\lambda o}\right)$ .... (ii)
Dividing (i) by (ii), we get
$3 = \frac{1/\lambda - 1/\lambda_o}{1/2\lambda - 1/\lambda_o}$
$\frac{3}{\lambda} - \frac{3}{\lambda_o} = \frac{1}{\lambda} - \frac{1}{\lambda_o}$
$\frac{3}{2\lambda} - \frac{1}{\lambda} = \frac{3}{\lambda_o} - \frac{1}{\lambda_o} = \frac{2}{\lambda_o}$
$\frac{1}{2\lambda} = \frac{2}{\lambda_o}$
$\therefore \lambda_o = 4\lambda$
20. Ans. (d)
Satuaration current depends on intensity of incident light and intensity varies inversely as square of distance,
So, $i \; \alpha \; \frac{1}{d^2}$
21. Ans. (a)
Cut off potential (stopping potential) depends on frequency of incident light and is independent of intensity.
22. Ans. (b)
$E_k = hf - hfo = h(4fo - fo) = 3h\, fo$
23. Ans. (a)
$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}} \; \alpha \; \frac{1}{\sqrt{m}}$

When KE = constant mass is least for electron. So, electron has largest de-Broglie Wavelength.

24. Ans. (d)

$\lambda = \frac{h}{\sqrt{3mKT}} \rightarrow \lambda\ \alpha\ \frac{1}{\sqrt{T}}$

$\frac{\lambda 27}{\lambda 927} = \sqrt{\frac{927+273}{27+273}}$

$= \sqrt{\frac{1200}{300}} = 2$

$\lambda_{27} = 2\lambda_{927} = 2\lambda$

25. Ans. (c)

$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}} = \frac{h}{\sqrt{2mqV}}$

so, $\frac{\lambda p}{\lambda e} = \sqrt{\frac{m_\alpha}{m_p} \times \frac{q_\alpha}{e}}$

$= \sqrt{\frac{4m_p}{m_p} \times \frac{2e}{e}} = \sqrt{8} : 1$

26. Ans. (a)

$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

$= \frac{h}{\sqrt{2mqv}} = \sqrt{\frac{150°}{V}}\ \Delta$

$\lambda = \sqrt{\frac{150}{150}}\ \Delta = 1\Delta$

27. Ans. (c)

$\lambda = \frac{h}{\sqrt{2meV}} = \sqrt{\frac{150}{V}}\ \Delta$

$V = \frac{150}{\lambda^2}$

$= \frac{150}{(1.224)^2} = 100$ volts

K.E(in eV) = 100eV

28. Ans. (c)

$\lambda p = \lambda\alpha$

$\frac{h}{\sqrt{2m_p q_p V}} = \frac{h}{\sqrt{2m_\alpha q_\alpha V_\alpha}}$

$m_p q_p V = m_\alpha q_\alpha V_\alpha$

$m_p \times e \times V = 4m_p \times 2e \times V_\alpha$

$V_\alpha = \frac{V}{8}$

Past Questions

1. Light of wave length 400nm is incident on metal surface having threshold wavelength 600nm and a photo electric current I flows. If the wavelength is doubled the magnitude of photoelectric current will be (MOE 2068)

a. I
b. 2I
c. $\frac{I}{2}$
d. zero

2. Electron, proton, neutron and alpha particle have the same kinetic energy. The de-Broglie wavelength will be maximum for (MOE 2068)

a. electron
b. proton
c. neutron
d. alpha particle

3. The threshold frequency of a metal whose work function is 4.5 ev is [MOE 2068]

a. 1.09×10^{15}Hz
b. 1.09×10^{12} Hz
c. 10.9×10^{6} Hz
d. 1.09×10^{3} Hz

4. The work funciton for a photo electric material is 3.3ev. The threshold frequency would be (MOE 066)

a. 8×10^{4} Hz
b. 8×10^{10} Hz
c. 8×10^{14} Hz
d. 5×10^{20} Hz

5. If the work function of metal is 2.2eV. The maximum wavelenght of the light which can cause photoelectric emmission is (MOE Bangladesh 2009)

a. 597nm
b. 567nm
c. 546nm
d. 967nm

6. An x-ray photon has a wavelength 0.01Δ. Its momentum (in kgms^{-1}) is (Given h = 6.6×10^{-34}Js) (MOE 2008)

a. 6.6×10^{-22}
b. 6.6×10^{-32}

c. 3.3×10^{-32} d. 0

7. The uv photon is incident on a metal of photoelectric work function 2eV and produces a photo electron of energy 2eV. The wavelength associated with photon is (MOE 2065)

a. 9300Δ b. 6200Δ
c. 4900Δ d. 3100Δ

8. Photoelectric effect is based on the principle of conservation of (MOE 2063)

a. energy b. momentum
c. angular momentum d. power

9. What will be the ratio of de-Broglie wavelength of proton and α-particle of same energy? (IOM/BPKIHS)

a. 2:1 b. 1:2
c. 4:1 d. 1:4

10. In which of the following specific charge is not constant? (IE 2010)

a. α-rays b. cathode rays
c. canal rays d. β-rays

11. The threshold wavelength for a metal whose work function is ϕ_o is λ_o wave length for a metal of work function $\frac{\phi_o}{2}$ is (IE-2010)

a. $2\lambda o$ b. $\frac{\lambda o}{2}$ c. $4\lambda_o$ d. $\frac{\lambda_o}{4}$

12. If the wavelength of the two moving electron and proton is constant. It suggests they have (IE-2009)

a. Constant energy b. Same momentum
c. Electron has greater energy
d. Proton has greater momentum

13. In photoelectric emission behind cut off voltage emission of electron is directly propotional to (IE-06)

a. voltage b. K.E.
c. no. of proton striking atoms d. field

14. Threshold wavelength of metal is 5200Δ. Photoelectron will be ejected if it is illuminated by light from (I.E)

a. 50w infrared lamp
b. 25w red light lamp
c. 50w green light lamp
d. All of the above

15. The photo electrons emitted from a given cathode on incident of given monochromatic beam of light have a/an (BPKIHS-08)

a. Energy spread with no sharp limits
b. Energy spread with a lower limit
c. Definite energy only
d. Energy spread with an upper limit

16. Ultraviolet radiation of 6.2ev falls on an aluminium surface (work function = 4.2eV). The KE_{max} will be (BPKIHS-05)

a. 4.2×10^{-17}J b. 3×10^{-19}J
c. 1.4×10^{-18}J d. 2.65×10^{-16}J

17. Current produced in photo cell is (BPKIHS–04)

a. directly propotional to intensity
b. directly propotional to sq. of intnesity
c. inversely propotional to sq. of intensity
d. inversely propotional to intensity

18. When frequency of incident light is increased. Which among the following is correct? (BPKIHS-02)

a. photocurrent increases
b. maximum K.E of electron increases
c. stopping potential decreases
d. photo current decreases

19. With the increase in intensity of light (BPKIHS-02)

a. Photoelectric current increases
b. frequency increases
c. max. KE. increases
d. photoelectric current decreases

Answer Sheet

1. d	*2. a*	*3. a*	*4. c*	*5. b*	*6. a*	*7. d*	*8. a*	*9. a*	*10. c*
11. c	*12. c*	*13. b*	*14. c*	*15. d*	*16. b*	*17. a*	*18. b*	*19. a*	

Solution

1. Ans. (d) When wavelength is doubled, the incident wavelength (λ) > threshold wavelength (λo) and photoelectric effect doesn't take place so photoelectric current = zero. For photoelectric effect $\lambda < \lambda o$ and $f > fo$.

2. Ans. (a) $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

   $\lambda = \alpha \frac{1}{\sqrt{m}}$ [K.E is same for all]

   mass is least for neutron so de-brogile wavelength will be maximum.

3. Ans. (a) $\phi = 4.5ev$

   $hf_o = 4.5ev$

   $fo = \frac{4.5\times1.6\times10^{-19}}{6.6\times10^{-34}} = 1.07\times10^{15}Hz$

4. Ans. (c) Work function(ϕ) = hf_o

   f_o = threshold frequency

   $f_o = \frac{\phi}{h} = \frac{3.3\times1.6\times10^{-19}}{6.62\times10^{-34}} = 8\times10^{14}Hz$

5. Ans. (b) $f = h\,fmin = \frac{hc}{\lambda max}$

   $\lambda max = \frac{hc}{\phi} = \frac{6.6\times10^{-34}\times3\times10^{8}}{2.2\times1.6\times10^{-19}} = 567nm$

6. Ans. (a)

   momentum (P) $= \frac{h}{\lambda} = \frac{6.6\times10^{-34}}{0.01\times10^{-10}}\,kgms^{-1}$

   $= 6.6\times10^{-22}kgms^{-1}$

7. Ans. (d) $hf = hf_o + \frac{1}{2}mV^2_{max}$

   In this case, ϕ = 2eV and

   K.E = 2eV, hf = 4eV

   $\frac{hc}{\lambda} = 4\times1.6\times10^{-19}$

   $\lambda = \frac{6.62\times10^{-34}\times3\times10^{8}}{6.4\times10^{-19}}$

   $= 3.1\times10^{-7}m = 3100\Delta$

8. Ans. (a) Photoelectric effect $\rightarrow$ conservation of energy.

   $\rightarrow$ Discoverd by Hallwach but explained by Einstein.

9. Ans. (a)

   $\lambda = \frac{h}{mv} = \frac{h}{p} = \frac{h}{\sqrt{2mE}}\ \alpha\ \frac{1}{m}$ at constant K.E.

   $\frac{\lambda p}{\lambda e} = \sqrt{\frac{m\alpha}{mp}} = \sqrt{\frac{4mp}{mp}} = 2:1$

10. Ans. (c) For positive rays or canal rays the specific charge is not a universal constant.

11. Ans. (c) $\phi_o = \frac{hc}{\lambda_o} \rightarrow \lambda_o = \frac{hc}{\phi_o}$

    $\lambda = \frac{hc}{\phi_o/2} = \frac{2hc}{\phi_o} = 2\lambda_o$

12. Ans. (c) $\lambda = \frac{h}{p} = \frac{\text{plank's constant}}{\text{momentum}}$

    If they have same wavelength, momentum must be constant.

13. Ans. (b) $hf = KE_{max} + \phi_o$

    Behind cut off voltage, more electrons gets emitted from surface leading increase in photo current and in turn increases K.E. of electron.

14. Ans. (c) $P = \frac{nhc}{\lambda}\ \ \therefore P\ \alpha\ \frac{1}{\lambda}$

    For photoelectric emission $\lambda < \lambda_o$. Thus, we select a light having less wavelength. Wavelength of green light is less than red light.

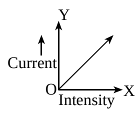
15. Ans. (d) $KE_{max} = hf - \phi_o$

    So, their energy have an upper limit.

16. Ans. (b) $E = KE_{max} = E - \phi = (6.2–4.2)ev$

    $= 2ev = 2\times1.6\times10^{-19}J = 3.2\times10^{-19}J$

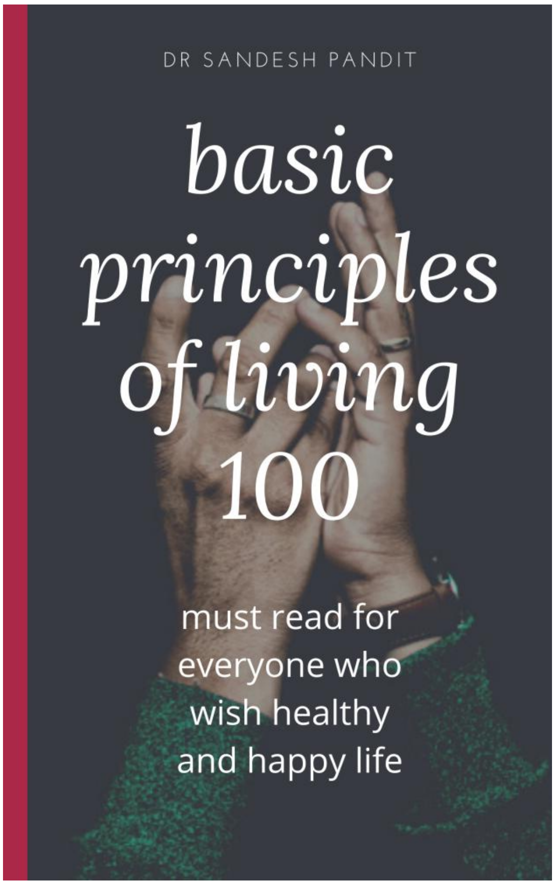
17. Ans. (a) In photoelectric effect, current α intensity of light. But KE_{max} of photo electrons remains unchanged.

18. Ans. (b) Rate of emission of photoelecrons (no. of photoelectrons emitted per sec) α intensity of incident light.

    Max velocity and max. K.E of electrons depends upon frequency of incident light.

19. Ans. (a) Photoelectric current α intensity & stopping potential α frequency.



SHIKHA BOOKS

Chapter: 47

X-rays

1. X-rays were discovered by:

a. Roentgen b. Becquerel
c. Madam curie d. Rutherford

2. X-rays are:

a. stream of electrons
b. stream of neutral particles
c. stream of positive ions
d. eletromagnetic radiation

3. X-rays are deflected by:

a. electric field b. magnetic field
c. both d. none

4. For the production of x-rays the target should be made of:

a. steel b. copper
c. tungsten d. aluminium

5. X-ray are:

a. longitudinal waves
b. transverse waves
c. mechanical waves
d. stationary waves

6. A metal block is exposed to beam of x-rays. X-rays of which wavelength are most penetrating.

a. 1Δ b. 2Δ
c. 4Δ d. 10Δ

7. When high speed electrons hit a target of high atomic number, the efficiency of production of X-rays is:

a. 100% b. 99%
c. 50% d. less than 1%

8. The penetrating power of x-rays in coolidge tube is controlled by:

a. potential difference between cathode and anticathode
b. current in filament
c. changing target material
d. decreasing pressure inside the tube

9. The minimum wavelength of x-rays produced by electron accelerated by a potential difference of V volts is:

a. $\frac{eV}{fc}$ b. $\frac{eV}{hc}$
c. $\frac{hc}{eV}$ d. $\frac{h}{f}$

10. An x-ray tube operates on 30KV. What is the minimum wavelength emitted?

a. 0.133Δ b. 0.4Δ
c. 1.2Δ d. 6.6Δ

11. An x-ray tube is being operted at 10kv. The maximum frequency of x-rays produced is:

a. 2.4×10^{20}Hz b. 2.4×10^{19}Hz
c. 2.4×10^{18}Hz d. 2.4×10^{11}Hz

12. X-rays and gamma rays of same energies may be distinguished by their:

a. velocity b. ionising power
c. intensity d. method of production

13. Mosley law relates the frequency of the lines of x-rays with the following characteristic of target material.

a. Its density b. Its atomic number
c. Its atomic weight
d. Interplanar spacing of atomic planes

14. An x-ray tube is operated at 20kv.The maximum speed of electrons striking the anticathode will be:

a. 4.2×10^{7}m/s b. 8.4×10^{7} m/s
c. 8.4×10^{3}m/s d. 4.8×10^{7}m/s

15. An x-ray tube operated at 50KV produces heat at the target at the rate of 796 watt. If 0.5% energy of incident electrons is converted into x-rays, then the number of electrons striking the target per second will be:

a. 10^{19} b. 10^{18}
c. 10^{17} d. 10^{16}

16. When x-rays wavelength 1Δ passes through a gold foil of thichness 2.303mm, then their intensity reduces to half. The coefficient of absorption for gold (in mm^{-1}) will be:

a. 0.2 b. 0.3 c. 0.4 d. 0.5

17. The distance between interatomic lattice planes is 15Δ. The maximum wavelength of x-rays that are diffracted by this crystal will be:

a. 15Δ b. 20Δ c. 30Δ d. 45Δ

18. X-rays of wavelength λ are incident normally on a crystal and the second order reflection on diffraction from the crystal is observed at an angle of 45°. What is the distance between the inter atomic planes?

a. $\frac{\lambda}{\sqrt{2}}$ b. $\sqrt{2}\lambda$ c. λ d. 2 λ

19. Continuous x-ray is produced when

a. The source of electrons emit a monoenergetic beam

b. Electrons are accelerated to fixed energy

c. Incident electrons are decelerated near heavy nuclei of target atoms

d. The bombarding electrons knock out electrons from inner shell of target atoms and one of the outer electrons fall into this vacancy.

20. X-rays absorption will be maximum for the sheets of:

a. copper

b. lead

c. gold

d. uranium

Answer Sheet

1. a	*2. b*	*3. d*	*4. c*	*5. b*	*6. a*	*7. d*	*8. a*	*9. c*	*10. b*
11. c	*12. d*	*13. b*	*14. b*	*15. c*	*16. b*	*17. c*	*18. b*	*19. c*	*20. b*

Solution

1. Ans. (a)

X-rays were discovered by Roentgen so called Roentgen Rays.

2. Ans. (b)

X-ray are electromagnetic radiation and travels with speed of light (3×10^8m/s).

3. Ans. (d)

As x-rays are electromagnetic radiation, they remain undeflected by electric and magnetic field.

4. Ans. (c)

Target → should have high melting and high atomic weight like Tungsten, platinum, molybdenum.

5. Ans. (b)

X-rays are electromagnetic waves and hence transverse in Nature.

6. Ans. (a)

$$hf_{max} = \frac{hc}{\lambda min} = eV = \frac{1}{2}mv^2$$

Greater the Kinetic energy of e^{-s}, more penetrating x-rays are produced.

7. Ans. (d)

The efficiency of production of x-rays is less in 1%. Rest of incident electrons produces heat.

8. Ans. (a)

Penetrating power of x-rays depends on its frequency or energy and frequency depends on accelerating potential (V) as

hf = eV

$$f= \frac{eV}{h} \alpha V$$

9. Ans. (c)

$\frac{hc}{\lambda min} = eV$

$\lambda min = \frac{hc}{eV} = \frac{12400}{V}\ Å$

10. Ans. (b)

$\lambda min = \frac{hc}{eV} = \frac{12400}{V}\ Å = \frac{12400}{30000}\ Å = 0.41Å$

11. Ans. (c)

$f_{max} = \frac{c}{\lambda min} = \frac{eV}{h}$

$= \frac{1.6\times10^{-19}\times10000}{6.6\times10^{-34}} = 2.4\times10^{18}$ Hz

12. Ans. (d)

γ rays are produced from radioactive nucleus while x-rays are produced from outer part of the atom.

13. Ans. (b)

Moseleys law:$\rightarrow$ square root of frequency of characteristic x-rays spectrum line is propotional to the atomic number of target material.

$\sqrt{f} = a(z-b)$

Where a and b are constants.

14. Ans. (b)

$V = \sqrt{\frac{2eV}{m}}$

$= \sqrt{\frac{2\times1.6\times10^{-9}\times20\times10^{-3}}{9.1\times10^{-31}}}$

$= \quad 8.4\times10^{7}$m/s

15. Ans. (c)

Heat produced per second = 100–0.5=99.5% = 0.995IV

i.e. 796= 0.995×V×ne [I=ne per second]

or, $n= \frac{795}{0.995\times50\times10^{3}\times1.6\times10^{-19}}$

$\therefore\ n = 10^{17}$

16. Ans. (b) $\mu = \frac{0.693}{x^{1/2}} = \frac{0.693}{2.303} = 0.3$

17. Ans. (c) From Bragg's equation

$\lambda_{max} = 2d = 2\times15 = 30Å$

18. Ans. (b)

n = 2 and θ=45°

From Bragg's law

$2d \sin\theta = n\lambda$

$d = \frac{n\lambda}{2\sin\theta} = \frac{n\lambda}{2\sin45°} = \sqrt{2}\ \lambda$

19. Ans. (c)

- Continuous x-rays are produced due to retardation of bombarding electrons in the electric field of nucleus.
- Characteristic x-rays are produced due to jumping of electrons to vacant shell in atoms of heavy substances.
- Characteristic x-rays spectrum depends upon the nature of target element.

20. Ans. (b)

Coefficient of absorption (μ) is highest for lead (Pb) due to which it is used for making radiations shield.

Past Questions

1. The x-rays of wavelength 0.5Å are scattered by a target. What will be the energy of incident x-rays if these are scattered at an angle of 72°? (MOE 2068)

a. 12.41 KeV
b. 6.2 KeV
c. 18.6 KeV
d. 24.82 KeV

2. The shortest wavelength of x-ray in continous spectrum from an x-ray tube depends on. (MOE 2068)

a. current in the tube
b. voltage applied across the tube
c. nature of gas used in the tube

d. atomic number of the target material

3. The wavelength of the most energetic x-rays emitted when a metal target is bombarded by 40kv supply is (MOE 2065)

a. 300Δ b. 10Δ

c. 4Δ d. 0.31Δ

4. X-rays are produced by energy changes in (MOE 2062)

a. Electrons close to nucleus

b. Electrons far from nucleus

c. Electrons and protons

d. The nucleus

5. What should be the nature of anticathode in an x-ray tube? (MOE 2061)

a. high atomic weight, low thermal conductivity

b. high atomic weight, high thermal conductivity

c. low atomic weight, high thermal conductivity

d. high atomic no, low thermal conductivity

6. Which of the following formula is applicable to calculate the transversed intensity of x-rays? (IOM 2008).

a. $I_o = I_e^{-\mu\backslash x}$ b. $I_o = Ie^{-x/\mu}$

c. $I = I_o\, e^{-\mu x}$ d. $I_o = Ie^{-\mu x}$

7. Bragg equation 2d sinθ=nλ will have no solution if (BPKIHS)

a. λ< 2d b. λ>2d

c. λ< d d. λ>d

8. Hard and soft x-rays depends or (BPKIHS-09)

a. Frequency b. wavelength

c. velocity d. energy

9. When a beam of acclerated electron hit a target a continuous Xray spectrum is emitted from the target. Which one of the following wavelengths is absent in the x-ray spectrum if the x-ray tube is operated at 40,000v? (BPKIHS-07)

a. 0.25 Δ b. 0.5Δ

c. 1Δ c. 1.5Δ

Answer Sheet

1. d	*2. b*	*3. d*	*4. a*	*5. b*	*6. c*	*7. b*	*8.b*	*9. a*

Solution

1. Ans. (d) The energy of x-rays are independent of angle of scattering.

$$E = \frac{hc}{\lambda} = \frac{6.6\times10^{-34}\times3\times10^{8}}{0.5\times10^{-10}} J$$

$$= \frac{6.62\times10^{-34}\times3\times10^{8}}{0.5\times10^{-10}\times1.6\times10^{-19}} eV$$

$= 24.82\times10^{3}$ev = 24.82 keV

2. Ans. (b) The minimum wavelength of continuous x-rays is

$$\lambda_{min} = \frac{hc}{eV} = \frac{12400}{V}\ \Delta$$

The square root of frequency of characteristic x-rays spectrum line is propotional to atomic number of target material. $\sqrt{f}$ = a (z-b)

3. Ans. (d)

$$\lambda_{min} = \frac{hc}{eV} = \frac{12400}{V}\ \Delta = \frac{12400}{40000} = 0.31\Delta$$

4. Ans. (a)

X-rays are produced by energy changes in electron close to the nucleus where as light ray spectrum is produced due to the change in energy of electrons far from nucleus.

5. Ans. (b)

High melting point as it may not melt on heating by collision of electrons. High atomic number as x-rays of higher energy may be emitted. Like Tungsten, platinum, molybdemum etc.

6. Ans. (c)

If x-rays are passed through successive metal sheets, their hardness (penetrating power) remains unchanged but their intensity decreases. The intensity of emerging x-rays is $I = Io\ e^{-\mu x}$

7. Ans. (b)

$$\lambda = \frac{2d\ \text{Sin}\theta}{n}$$

For λmax n = 1 & $\sin\theta = 1$

λmax = 2d

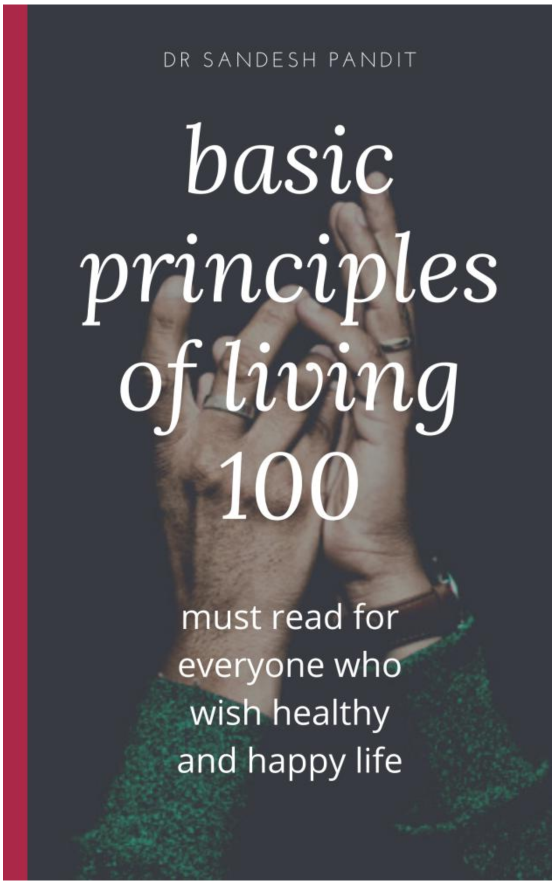
8. Ans. (b)

X-rays having wavelength upto 10 Δ are hard x-rays and greater than 10Δ →soft x-rays.

9. Ans. (a)

$$\lambda\ \text{min} = \frac{12400}{v}\ \Delta = \frac{12400}{40000}\ \Delta = 0.31\Delta$$

It is minimum wavelength of x-ray emitted. So, wavelength above this value can only exist and below it are absent in spectrum.


DR SANDESH PANDIT
basic principles of living 100
must read for everyone who wish healthy and happy life

Chapter: 48

Atomic Structure & Spectrum

1. An electron recolves about a proton in second excited state. The angular momentum of electron is:

a. $\frac{h}{2\pi}$ b. $\frac{h}{\pi}$

c. $\frac{3h}{2\pi}$ d. zero

2. According to Bohr's theory the radius of electron in an orbit described by principal quantum number n and atomic number z is propotional to:

a. z^2n^2 b. $\frac{z^2}{n^2}$

c. $\frac{z^2}{n}$ d. $\frac{n^2}{z}$

3. The radius of electron's second stationary orbit in Bohr's atom is R. The radius of third orbit will be

a. 3R b. 2.25R

c. 9R d. $\frac{R}{3}$

4. The radius of 1st Bohr orbit of hydrogen is 0.53Δ. The radius of 2^{nd} Bohr orbit of He^+ is:

a. 0.53Δ b. 1.06Δ

c. 0.265Δ d. 2.12Δ

5. The total energy of an electron in the atom is:

a. positive b. negative

c. zero

d. sometimes positive, sometimes negative

6. As the quantum number increase, the difference of energy between consecutive levels.

a. Remains the same b. Decreases

c. Increases

d. First deceases and then increases

7. In Bohr's model of Hydrogen atom, let PE be potential energy and TE be total energy. In going to higher level:

a. PE decrease,TE increases

b. PE increaes,TE decreases

c. PE decreases,TE decreases

d. PE increases, TE increase

8. Which series of Hydrogen atom was first discovered?

a. Lyman b. Balmer

c. Brackett d. All at same time

9. Hydrogen atom as compared to Helium atom is:

a. bigger b. smaller

c. of same size d. unpredictable

10. The minimum energy required to excite a hydrogen atom is:

a. 3.4ev b. 10.2ev

c. 12.1ev d. 13.6ev

11. A hydrogen atom is in first excited state. To ionise the atom, the minimum energy required is:

a. 13.6ev b. 3.4ev

c. 10.2ev d. 1.51ev

12. If En and Ln denote the magnitude of total energy and angular momentum of an electron in n^{th} orbit of an Bohr atom, then:

a. $En \propto Ln$ b. $En \propto \frac{1}{Ln}$

c. $En \propto Ln^2$ d. $En \propto \frac{1}{Ln^2}$

13. The frequency of the line Balmer series in hydrogen atom is fo. The frequency f of the line emitted by doubly ionised lithium atom Li^{++} is:

a. 2fo b. 4fo

c. 9fo d. $\frac{fo}{9}$

14. Which of the following transitions in a hydrogen atom emits the photon of highest frequency?

a. n = 2 to n = 6 b. n = 6 to n = 2

d. n = 1 to n = 2 d. n = 2 to n = 1

15. If the shortest wavelength in the Lyman series is 918Δ, the longest wavelength in the same series will be:

a. 1600Δ b. 2430Δ

c. 1224Δ d. ∞

16. The ratio of energy of the hydrogen atom in the first to second excited states is:

a. $\frac{1}{4}$ b. $\frac{4}{9}$

c. $\frac{9}{4}$ d. 1:1

17. When a hydrogen atom is bombarded, the atom is excited to n=4 state. The energy released when the atom goes from n=4 state to ground state is:

a. 1.275eV b. 12.75eV

c. 0.85eV d. 14.45eV

18. A gas of monochromatic hydrogen is bombarded with a stream of electrons that have been accelerated from rest through a potnetial difference of 12.75 volt. In the emission spectrum one cannot observe any line of:

a. Lyman series b. Balmer series

c. Paschen series d. Pfund series

19. Ionization potential of hydrogen atom is 13.6eV. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy 12.1ev. The spectral lines emitted by hydrogen atom according to Bohr's theory will be:

a. 1 b. 2

c. 3 d. 4

20. Hydrogen atom emits blue light when it changes from n = 4, n=2 level. Which colour of light would the atom emit when it changes n=5 to n=2 level?

a. violet b. red

c. yellow d. green

21. The speed of electron in fourth Bohr orbit of hydrogen atom is:

a. $\frac{C}{137}$ b. $\frac{4C}{137}$

c. $\frac{C}{274}$ d. $\frac{C}{548}$

22. If mass of electron is reduced to half the Rydberg constant:

a. Remains unchanged

b. Becomes half

c. Becomes double

d. Becomes one-fourth

23. Number of spectral lines of hydrogen atom is:

a. 3 b. 6

c. 15 d. Infinite

24. When an electron jumps from n = 4 to n = 1, the momentum of the recoiled hydrogen atom will be:

a. 6.8×10^{-27} kg m/s

b. 12.75×10^{-19} kg m/s

c. 13.6×10^{-19} kg m/s d. Zero

25. The angular momentum of electron in hydrogen atom is propotional to:

a. r b. $\sqrt{r}$ c. r^2 d. $\frac{1}{r}$

26. In an atom, the two electron move round the nucleus in circular orbits of Radii R and 4R. The ratio of the times taken by them to complete one revolution is:

a. $\frac{1}{4}$ b. 4 c. 8 d. $\frac{1}{8}$

27. If elements with principal quantum n>4 were not allowed in nature, the number of possible element will be:

a. 4 b. 32 c. 60 d. 64

28. Uncertainty in position of the electron is of the order of de-Broglie wavelength. Making use of Heisenberg uncertainty principle, it will be found that uncertainity in velocity v is of the order of:

a. v b. 2v

c. $\frac{v}{2\pi}$ d. $2\pi v$

Answer Sheet

1. c	*2. d*	*3. b*	*4. d*	*5. b*	*6. b*	*7. d*	*8. b*	*9. a*	*10. b*
11. b	*12. d*	*13. c*	*14. d*	*15. c*	*16. c*	*17. b*	*18. d*	*19. c*	*20. a*
21. d	*22. b*	*23. d*	*24. a*	*25. b*	*26. d*	*27. c*	*28. c*		

Solution

1. Ans. (c)

   2nd excited state means

   n = 3 ie. 3rd orbit

   $L = \frac{nh}{2\pi} = \frac{3h}{2\pi}$

2. Ans. (d)

   $r_n = \left(\frac{\varepsilon_0 h^2}{\pi m e^2}\right)\frac{n^2}{z}$

   $r_n \alpha \frac{n^2}{z}$

3. Ans. (b)

   $r_n = n^2 r_o$ where ro = 0.53Δ

   $\frac{r_3}{r_2} = \frac{3^2}{2^2} = \frac{9}{4}$

   $r^3 = 2.25R$

4. Ans. (b)

   $r \alpha \frac{n^2}{z}$

   $\frac{r_H}{r_{He}} = \frac{n_1^2}{n_2^2} \times \frac{z_2}{z_1} = \left(\frac{1}{2}\right)^2 \times \frac{2}{1} = \frac{1}{2}$

   $r_{He} = 2r_H = 2\times0.53 = 1.06\Delta$

5. Ans. (b)

   Total energy $= \frac{-Ze^2}{8\pi\varepsilon_0 r} = \frac{-zme^4}{8\varepsilon_o^2 n^2 n^2}$

   The –ve energy of the orbit indicates $e^-$are bound to nucleus.

6. Ans. (b)

   $E_2 - E_1 = -\left(\frac{13.6}{2^2} - \frac{13.6}{1^2}\right) = 10.2 \text{ eV}$

   $E_3 - E_2 = -\left(\frac{13.6}{3^2} - \frac{13.6}{2^2}\right) = 1.89 \text{ eV}$

Hence,

   $E_2 - E_1 > E_3 - E_2 >$ .... so on .....

7. Ans. (d)

   P.E α T.E α $\frac{-1}{n^2}$

   Hence, PE and T.E both increases in going to higher level

   K.E α $\frac{1}{n^2}$ So, KE decreases.

8. Ans. (b)

   Because Balmer lies in the visible region.

9. Ans. (a)

   $r = r_o \frac{n^2}{z}$

   The value of n is same for both as their e^- are present only in 1st orbit.

   $r \alpha \frac{1}{z}$ (z is less for hydrogen than Helium.)

10. Ans. (b)

    Electron is present in(n=1)

    So, excitation energy is minimum for n = 1 to n = 2.

    $\Delta E = 13.6\left(\frac{1}{1} - \frac{1}{4}\right) = 10.2\text{ev}$

11. Ans. (b)

    Ionisation energy for 1st excited state (n=2) is

    $\Delta E_i = E_\infty - E_2$

    $= 0 - \left(\frac{-13.6}{2^2}\right)$

    $= 0 - (-3.4) = 3.4\text{eV}$

12. Ans. (d)

    En α $\frac{1}{n^2}$ and L_n α n

    So, En α $\frac{1}{L_n^2}$

13. Ans. (c) $f \,\alpha\, z^2$

So, for Li^{++}(z=3)

$f = f_o \times 3^2 = 9f_o$

14. Ans. (d)

Emission spectra is obtained for transitions from n = 2 to n = 1 and from n = 6 to n = 2

Frequency (f) = $\frac{\Delta E}{h} \,\alpha\, \Delta E$ and ΔE is more for n = 2 to n = 1.

15. Ans. (c) For longest wavelength the transition is from n = 2 to n = 1 and for shortest wavelength, the transition is from n = ∞ to n = 1.

So, $\frac{1}{\lambda_S} = Rz^2\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) = Rz^2$

$\frac{1}{\lambda_L} = Rz^2\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{3}{4}Rz^2$

$\frac{\lambda_L}{\lambda_S} = \frac{4}{3}$

$\lambda_L = \frac{4}{3}\ \lambda_s = \frac{4}{3} \times 918 = 1224\Delta$

16. Ans. (c) 1^{st} excited state means n = 2 & 2^{nd} excited state means n = 3

As $E \,\alpha \left(\frac{-1}{n^2}\right)$

So, $\frac{E1}{E2} = \left(\frac{n_2}{n_1}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$

17. Ans. (b) Energy released = $E_4 - E_1$

$= \frac{-13.6}{4^2} - \left(\frac{-13.6}{1^2}\right) = -0.85 + 13.6 = 12.75eV$

18. Ans. (d) Energy of electron stream = 12.75ev

The ground state electron having energy –13.6ev will acquire their energy and have total energy,

E=–13.6+12.75=–0.85ev

Now, $E = \frac{-13.6}{n^2}$

$0.85 = \frac{-13.6}{n^2} \quad \therefore n = 4$

It jumps from 4th orbit to lower orbit. Hence Pfund series cannot be observed.

19. Ans. (c)

Total energy of electron in the excited states

E = –13.6+12.1= –1.5ev

Now, $E = \frac{-13.6}{n^2}$

or, $1.5 = \frac{-13.6}{n^2} \quad \therefore n=3$

Number of spectral lines emitted

$= \frac{\Delta n(\Delta n+1)}{2} = \frac{(3-1)(3-1+1)}{2} = \frac{2\times3}{2} = 3$

20. Ans. (a)

$E_5 - E_2 > E_4 - E_2$

i.e. emitted energy increases, wavelength decreases and colour must change to violet.

21. Ans. (d)

$V = \left(\frac{Z}{n}\right)\frac{C}{137} = \frac{1}{4}\times\frac{C}{137} = \frac{C}{548}$

22. Ans. (b)

$R = \frac{me^4}{8\varepsilon_o^2 n^2 ch^3}$

As m is reduced to half R also becomes half.

23. Ans. (d)

Number of spectral lines in hydrogen to atom can be infinite as single electron can be in any one of the infinite number excited states.

24. Ans. (a)

$E = E_4 - E_1 = \frac{-13.6}{4^2} - \left(\frac{-13.6}{1^2}\right)$

= 12.75eV

∴ $E = 12.75\times1.6\times10^{-19}J$

$P = \frac{E}{C} = \frac{12.75\times1.6\times10^{-19}}{3\times10^8}$

$= 6.8\times10^{-27}$ m/s

25. Ans. (b)

$L = \frac{nh}{2\pi} \rightarrow L \,\alpha\, n$

Also, $r \,\alpha\, n^2 \rightarrow n \,\alpha\, r^{\frac{1}{2}}$

∴ $L \,\alpha\, r^{1/2}$

26. Ans. (d) $r \propto \frac{n^2}{z}$ and $v \propto \frac{z}{n}$

$\therefore \quad T = \frac{2\pi r}{V}$

ie. $T \propto \frac{n^2}{\left(z \times \frac{z}{n}\right)} \rightarrow T \propto \frac{n^3}{z^2}$

As $r \propto n^2 \rightarrow n \propto r^{\frac{1}{2}}$

So, $T \propto \frac{\left(r^{\frac{1}{2}}\right)^3}{z^2}$

ie. $T \propto \frac{r^{\frac{3}{2}}}{z^2}$

$\frac{T_1}{T_2} = \left(\frac{R}{4R}\right)^{\frac{3}{2}} = \left(\frac{1}{4}\right)^{\frac{3}{2}} = \frac{1}{8}$

27. Ans. (c)

The maximum possible principal quantum number n= 3

$\therefore$ Total number of elements

$N = 2(1^2 + 2^2 + 3^2) = 60$

28. Ans. (c)

$\Delta x.\Delta p = \frac{h}{2\pi}$

or, $\Delta x.m\Delta v = \frac{h}{2\pi}$ ($\therefore p = mv$)

or, $\lambda m\Delta v = \frac{h}{2\pi}$

or, $\frac{h}{mv} . m\Delta v = \frac{h}{2\pi}$

$\therefore \Delta v = \frac{v}{2\pi}$

Past Questions

1. **If an electron jumps from fourth excited state to second excited state, the number of emission transitions between these states will be: (MOE 2068)**
   a. 6 b. 4
   c. 3 d. 2

2. **The ratio of wave length of 1st member of Balmer series to 1st member of Lyman Series is: (MOE 2008)**
   a. 32:27 b. 27:5
   c. 32:5 d. 32:7

3. **In Lyman series, the excited electron falls from higher energy (MOE 2067).**
   a. n=1level b. n=2 level
   c. n=3 level d. n=4 level

4. **Radiations coming from Lyman series falls in the range (MOE 2066)**
   a. visible b. infrared
   c. ultraviolet d. far infrared

5. **Balmer series lies approximately between (MOE 066).**
   a. 7000Δ–4000Δ b. 1Δ–10Δ
   c. 1cm–10cm d. 70Δ–40Δ

6. **In an electronic transition atom cannot emit (IOM 2011)**
   a. uv radiation b. IR radiation
   c. visible light d. Gamma rays

7. **The radius of hydrogen atom in the ground state is 0.53Δ. After excitation, it is found that this radius increases to 2.12Δ. The value of principal quantum number will be (IOM 2010)**
   a. 5 b. 4
   c. 3 d. 2

8. **The ionization energy of e– is 13.6v. The ionization energy when the e– is already in 1st excited state is: (BPKIHS 2010)**

a. 13.6ev b. 10.2ev
c. 3.4ev d. 6.8ev

9. According to Bohr's theory of hydrogen atom, ther product of Binding energy of the electron in nth orbit and its radius in the nth orbit (BPKIHS 2009).

a. is propotional to n^2
b. is inversely propotional to n^3
c. Has a constant value of 10.2ev Δ
d. Has a constant value of 7.2ev Δ

10. The ratio of Rydberg constant for helium to the Rydberg constant for hydrogen is (BPKIHS-08)

a. 1:1 b. 4:1
c. 1:4 d. 1:2

11. If total energy of electron is Eo. Then its PE is (BPKIHS -06)

a. Eo b. 2Eo
c. $\frac{Eo}{2}$ d. $\frac{Eo}{4}$

12. If r be the radius of the Bohr orbit of H atom, then the radius of same orbit of He^{++} is (BPKIHS-06)

a. r b. 2r
c. $\frac{r}{2}$ d. $\frac{r}{4}$

13. The frequency of electron around first Bohr orbit is: (BPKIHS–06)

a. $\frac{h}{4\pi^2mr^2}$ b. $\frac{4\pi^2mr^2}{h}$
c. $\frac{h}{2\pi^2mr^2}$ d. $\frac{2\pi^2mr^2}{h}$

14. The energy of lowest level of hydrogen atom is –13.6ev. The energy of the emitted protons in transitions from n=4 to n=2 is (BPKIHS–05)

a. 1.2ev b. 2.55ev
c. 1.85ev d. 2.86ev

15. Emission line spectrum is obtained from (BPKIHS-04)

a. Sun b. Candle flame
c. White not filament of electric bulb
d. Sodium vapour lamp

16. In Bohr model of hydrogen atom, the ratio of K.E to total energy of electron in a quantum state n is (IE 2010)

a. –1 b. 1
c. $\frac{1}{n}$ d. $\frac{1}{n^2}$

17. Bohr's postulate's correctly measures (IE-06)

a. Radius of atom
b. Angular momentum
c. Rydberg's constant
d. None

Answer Sheet

1. c	*2. b*	*3. a*	*4. c*	*5. a*	*6. d*	*7. d*	*8. c*	*9. d*	*10. b*
11. b	*12. c*	*13. a*	*14. b*	*15. d*	*16. a*	*17. b*			

Solution

1. Ans. (c)

Fourth excited state (n_2)=5

Second excited state (n_1) = 3

Δn = 5–3=2

Shortcut, no. of transitions

$= \frac{\Delta n(\Delta n+1)}{2} = \frac{2\times3}{2} = 3$

2. Ans. (b) For 1st member of Balmer series

$\frac{1}{\lambda_B} = R\left(\frac{1}{4} - \frac{1}{9}\right) = \frac{5}{36}R$

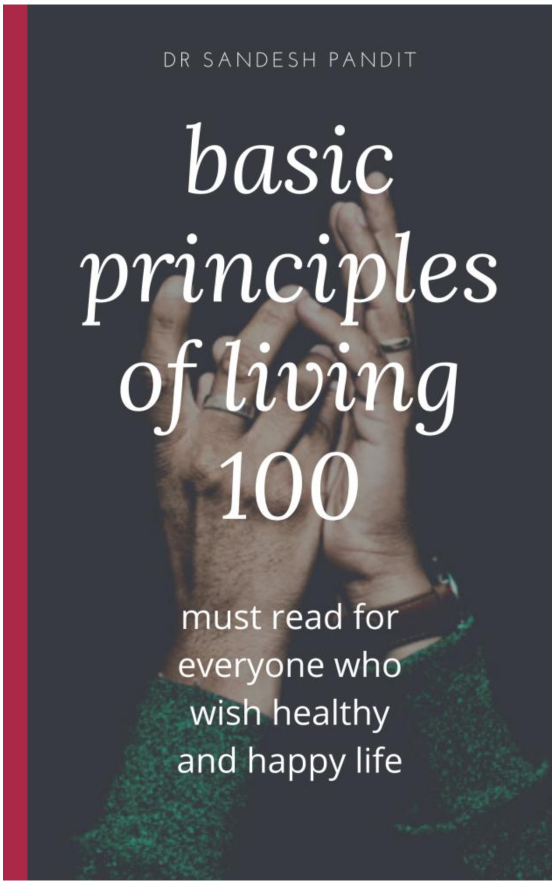
For 1st member of Lyman series

$\frac{1}{\lambda_L} = R\left(\frac{1}{1} - \frac{1}{4}\right) = \frac{3}{4}R$

$$\frac{\lambda_B}{\lambda_L} = \frac{3/4}{5/36} = 27:5$$

3. Ans. (a)
   Lyman n_1=1, n_2= 2,3,4,5.........
   Lies in ultraviolet region.
4. Ans. (c)
   Lyman→ultraviolet region
   Balmer→Visble
   Paschan→Infrared
   Brackett, Pufund, Humpres→Far IR
5. Ans. (a)
   Lyman series → (1000–1200 Δ)
   Balmer series → (4000–7000 Δ)
   Paschen series → (8000–19000Δ)
   Brackett series → (15000–40000Δ)
   Pfund series → (23000–75000Δ)
6. Ans. (d)
   In electronic transition given by Bohr model, we find only uv, visible and IR rays and hence gamma rays don't emit in electronic transition.
7. Ans. (d)
   We know that, for hydrogen atom
   $r_n = r_o \times n^2$ (r_o = 0.53Δ)
   $2.12=0.53\times n^2$
   $n^2 = 4 \therefore n=2$
8. Ans. (c) 1st excited state means n=2
   $$E = \frac{-13.6}{n^2} = \frac{-13.6}{2^2} = 3.4\text{ev}$$
9. Ans. (d) $En = \frac{13.6}{n^2}$ and $r_n = 0.53n^2\Delta$
   $$E_n r_n = \frac{13.6}{n^2} \times 0.53n^2 \text{ ev}\Delta = 7.2\text{ev}\Delta$$
10. Ans. (b)
   $$R = \frac{mz^2e^4}{8\varepsilon_0^2ch^3} \qquad \therefore R \alpha z^2$$
   Hence, $\frac{R_{He}}{R_H} = \frac{(2)^2}{(1)^2} = 4:1$
11. Ans. (b)
   $$E_T = \frac{1}{2} Ep = -EK$$
   $E_P = 2E_T = 2Eo$
12. Ans. (c)
   $$R \alpha \frac{n^2}{z}$$
   $$\frac{RHe^{++}}{RH^{+}} = \left(\frac{n_2}{n_1}\right)^2 \times \frac{z_1}{z_2} = \left(\frac{1}{1}\right)^2 \times \frac{1}{2} = \frac{1}{2}$$
   $$RHe^{2+} = \frac{r}{2}$$
13. Ans. (a)
   $$mvr = \frac{nh}{2\pi} \to v = \frac{nh}{2\pi mr}$$
   $$r\omega = \frac{nh}{2\pi mr} = r\times 2\pi f$$
   $$f = \frac{nh}{4\pi^2 mr^2}$$
   For 1st Bohr orbit
   $$f = \frac{h}{4\pi^2 mr^2}$$
14. Ans. (b) We have,
   $\Delta E = E_4 - E_2$
   $$= \frac{-13.6}{4^2} - \frac{-13.6}{2^2} = -13.6\left[\frac{1}{16} - \frac{1}{4}\right]$$
   $$= -13.6\left[\frac{1-4}{16}\right] = \frac{3\times 13.6}{16} = 2.55 \text{ ev}$$
15. Ans. (d)
   Line spectrum: Atomic state
   Band spectrum: Molecular state
   Incandescent electric bulb: Continuous emission spectrum
   Sun's Spectrum: continous spectrum with few absorption lines called fraunhofer spectrum.
16. Ans. (a) K.E = –T.E
   P.E = 2TE
   PE = –2K.E
17. Ans. (b)
   Bohr's theory
   → Quantization of angular momentum

→ Only those orbits are possible for which angular momentum of electron is an integral multiple of $\frac{h}{2\pi}$.



SHIKHA BOOKS

Chapter: 49

Radioactivity

1. An electric field can deflect:

a. X-rays b. neutrons

c. α-particles d. γ-rays

2. The relation between half life $T^{1/2}$ of a radioactive sample and its mean life τ is:

a. $T^{\frac{1}{2}} = 0.693\tau$ b. $\tau = 0.693\ T^{1/2}$

c. $\tau = T^{1/2}$ d. $\tau = 2.718\ T^{1/2}$

3. In a given reaction

$_{z}X^{4} \rightarrow {}_{z-2}Y^{A-4} \rightarrow {}_{z-2}Z^{A-4} \rightarrow {}_{z-1}K^{k-4}$

The decay in the sequency

a. α,β,γ b. β,γ,α

c. α, γ,β d. γ,β,α

4. Microcurie of radioactivity is equal to:

a. 1micro Becquerel

b. 3.7×10^{2} Becquerel

c. 3.7×10^{10} Becquerel

d. 3.7×10^{4} Becquerel

5. The half period of a radioactive sample depends on:

a. temperature b. pressure

c. nature of substance d. all

6. Nucleus A is converted into C through the following reaction:

$A \rightarrow B + \alpha$

$B \rightarrow C + 2\beta$

a. A and B are isobars

b. A and C are isotopes

c. A and C are isobars

d. A and B are isotopes

7. In the uranium radioactive series, the initial nucleus is $_{92}U^{238}$ and that the final nucleus is $_{82}Pb^{206}$. When uranium decays into lead, the number of α and β particles emitted are:

a. $8\alpha,6\beta$ b. $6\alpha,7\beta$

c. $6\alpha,8\beta$ d. $4\alpha,3\beta$

8. When a radioactive isotope $_{88}Ra^{228}$ decays in series by the emission of 3 alpha particles and a beta particle, the isotope finally formed is:

a. $_{84}X^{228}$ b. $_{86}X^{222}$

c. $_{83}X^{216}$ d. $_{83}X^{215}$

9. Which of the following is not a mode of radioactive decay?

a. position emission

b. electron capture

c. fusion

d. Alpha decay

10. In the reaction $_{1}H^{1}+{}_{1}H^{1}+{}_{1}H^{2} \rightarrow X+{}_{1}e^{0}$ the emitted particle x is:

a. Neutron b. Proton

c. Neutrino d. α particle

11. A radioactive substance has a half life of 60 minutes. During 3 hours the fraction of atoms that have decayed would be:

a. 87.5% b. 12.5%

c. 8.5% d. 25.1%

12. Two radioactive sources A and B of half lives 1 hour and 2 hour respectively initially contain the same number of radioactive atoms. At the end of two hours, their rates of distintegration are in the ratio of:

a. 1:4 b. 1:3

c. 1:2 d. 1:1

13. A radioactive elements has half life period of 800 years. After 6400 years, the amount that would have been decayed is:

a. $\frac{1}{16}$ b. $\frac{255}{256}$

c. $\frac{1}{256}$ d. $\frac{1}{4}$

14. 20% of the active nuclei present in a substance decays in 5 days. The percentage of undecayed nuclei left after 10 days will be:

a. 64% b. 76%
c. 81% d. 90%

15. A sample contains 16g of a radioactive material, the half life of which is two days. After 32 days the amount of radioactive material left in the sample is:

a. less than 1mg b. $\frac{1}{4}$ g
c. $\frac{1}{2}$ g d. 1g

16. A radioactive substance disintegrates to $\frac{1}{64}$ of its initial value in 60seconds. The average life of this substance is:

a. 10s b. 14.4s
c. 7.2s d. 21.4s

17. Two radioactive materials $X_1$and X_2 have decay constants 10 λ and λ respectively. If initially they have the same number of nuclei, the ratio of the number of nuclei of X_1 to that of X_2 will be $\frac{1}{e}$ after a time:

a. $\frac{1}{10\lambda}$ b. $\frac{1}{11\lambda}$
c. $\frac{11}{10\lambda}$ d. $\frac{1}{9\lambda}$

18. The fraction of the radioactive substances decayed in a time equal to the average life:

a. $\frac{e-1}{e}$ b. $\frac{1-e}{e}$
c. $\frac{1}{1-e}$ d. $\frac{1}{e}$

19. In a sample of radioactive substance what percentage decays in one mean life time:

a. 50% b. 64%
c. 69% d. 36%

Answer Sheet

1. c	*2. a*	*3. c*	*4. d*	*5. c*	*6. b*	*7. a*	*8. c*	*9. c*	*10. d*
11. a	*12. c*	*13. b*	*14. a*	*15. a*	*16. b*	*17. d*	*18. a*	*19. b*	

Solution

1. Ans. (c)

Only the α-particles have charge.

2. Ans. (a)

$T^{1/2} = \frac{0.693}{\lambda}$

Tav $(\tau) = \frac{1}{\lambda}$

$T^{1/2} = 0.693\tau$

3. Ans. (c)

${}_zX^4$

$\rightarrow {}_{z-2}Y^{A-4}$

$\rightarrow {}_2He^4(\alpha)$

$\rightarrow {}_{z-2}Z^{A-4}+(Y)$

$\rightarrow {}_{-1}\beta^{\circ} + {}_{z-1}K^{A-4}$

4. Ans. (d)

1 curie = 3.7×10^{10} Becquerel

10^{-6}curie = 3.7×10^{4} Becquerel

Becquerel is SI unit of Radioactivity.

5. Ans. (c)

$T^{1/2} = \frac{0.693}{\lambda}$

Here, λ depends only on nature of the substance.

6. Ans. (b)

- 1 α decay + 2β decay produces Isotopes
- β decay produces Isobars
- γ decay produces Isomers
- α decay produces Isodiaphers

7. Ans. (a) ${}_{92}U^{238} \rightarrow {}_{82}Pb^{206}$

Change in mass number = 238 – 206 = 32

Change in atomic number = 92 –82 = 10

Using shortcut,

4α = Change in mass no. = 32

$\alpha = 8$

$2\alpha - \beta$ = Change in atomic no. = 10

$2 \times 8 - \beta = 10 \therefore \beta = 6$

$\therefore$ Decay involves 8α , 6β

8. Ans. (c) Emission of an a-particle decreases mass no. (A) by 4 while β particle don't.
Decrease in A = 3×4=12. Emission of a particle decreases the charge by 2 while β particle increase it by 1.
Total decrease in charge = 3×2 –1 = 5
For resulting element
A = 228 – 12 = 216 and z = 88 – 5 = 83
i.e. $_{83}X^{216}$

9. Ans. (c) Positron emission and electron capture are methods of artifical radioactive decay. Alpha decay is a natural radioactive decay. Fusion is not a mode of decay.

10. Ans. (d)
Σz of L.H.S = Σz of R.H.S$\Rightarrow 1+1+1 = z+1$
$\therefore z = 2$
ΣA of L.H.S = ΣA of R.H.S $1+1+2 = A+0$
$\therefore A=4$
$\therefore {}_ZX^A = {}_2X^4 = {}_2He^4$

11. Ans. (a) $n=\dfrac{3\times60}{60} = 3$

$\therefore \dfrac{N}{No} = \left(\dfrac{1}{2}\right)^2 \times 100\% = \left(\dfrac{1}{2}\right)^3 \times 100\% = 12.5\%$

ie. 12.5% of sample remains
= 100 –12.5 = 87.5% of sample decays

12. Ans. (d) Rate of distintegration α No. of atoms left.
In case of source A,

$\dfrac{NA}{N_O} = \dfrac{1}{2^2} = \dfrac{1}{4}$

In case of source B, $\dfrac{NB}{N_O} = \dfrac{1}{2^1} = \dfrac{1}{2}$

$\dfrac{RA}{RB} = \dfrac{NA/N_O}{NB/N_O} = \dfrac{1/4}{1/2} = \dfrac{1}{2}$

13. Ans. (b)

No. of half lives, $n = \dfrac{t}{T^{1/2}} = \dfrac{6400}{800} = 8$

$\therefore \dfrac{N}{N_0} = \dfrac{1}{2^n} = \dfrac{1}{2^4} = \dfrac{1}{256}$

The amount that would have been decayed

$= N_0 - N = 1 - \dfrac{1}{256} = \dfrac{255}{256}$

14. Ans. (a) No. of half lives, $n=\dfrac{10}{5} = 2$

In one half life, the percentage decayed is 20% ie. 80% remains.
In 2nd half life, 20% of 80% decays

$= \dfrac{20}{100} \times 80 = 16\%$ decays

= 80 –16 = 64% remains

15. Ans. (a) $n = \dfrac{32}{2} = 16$ half lives

$\therefore$ Amount of sample left,

$N = \dfrac{No}{2^n} = \dfrac{16}{2^{16}}\,g = \dfrac{16\times100}{16\times16\times16\times16} < 1mg$

16. Ans. (b) $\dfrac{N}{No} = \dfrac{1}{2^n}$

or, $\dfrac{1}{64} = \dfrac{1}{2^n}$

or, $\dfrac{1}{2^6} = \dfrac{1}{2^n}$ $\therefore n = 6$

or, $\dfrac{t}{T_{\frac{1}{2}}} = 6$

or, $\dfrac{60}{T_{\frac{1}{2}}} = 6$ $\therefore T_{\frac{1}{2}} = 10$ S

$\therefore$ Tav = $1.44\, T_{\frac{1}{2}} = 1.44\times10 = 14.4s$

17. Ans. (d) $\dfrac{NX1(t)}{NX2(t)} = \dfrac{1}{e}$

or, $\dfrac{Noe^{-10\lambda t}}{Noe^{-\lambda t}} = \dfrac{1}{e}$

or, $e = \dfrac{e^{-\lambda t}}{e^{-10\lambda t}} = e^{9\lambda t}$

or, $9\lambda t = 1$ $\therefore t = \dfrac{1}{9\lambda}$

18. Ans. (a)

Average life $(\tau) = \dfrac{1}{\lambda}$

Putting this time in $N = Noe^{-\lambda t}$

We get $N = Noe^{-1}$

$\frac{N}{No} = \frac{1}{e}$ (fraction of atom left

Fraction of atom decayed

$= \frac{1-N}{No} = 1 - \frac{1}{e} = \frac{e-1}{e}$

19. Ans. (b)

$N = No\, e^{-\lambda t}$

mean life $T = \frac{1}{\lambda}$

$N = No\, e^{-\lambda \cdot \frac{1}{\lambda}}$

$\frac{N}{No} = e^{-1} = (2.72)^{-1} = 0.36$

Fraction decayed = 1–0.36

= 0.64 = 64%

Past Questions

1. **The disintegration constant of a radiactive substance is $3\times10^{-6}S^{-1}$. Its half life is (MOE 2068)**
   a. 21.6 days b. 10.8 days
   c. 5.4 days d. 2.7 days
2. **Correct decay scheme for an emission of a β emission from a radioactive nucleus $_ZX^A$ may be (MOE 2067):**
   a. $_ZX^A = {}_{Z+1}Y^{A+1} + \beta$
   b. $_ZX^A = {}_{Z+1}Y^{A+1} + \beta$
   c. $_ZX^A = {}_ZY^{A-1} + \beta$
   d. $_ZX^A = {}_{Z-1}Y^{A+1} + \beta$
3. **Law of radioactivity is generally expresses as N= N_0 exp (–λt) where symbols have usual meanings. A plot of N against time t will be (MOE 2067)**
   a. Exponential b. Straight line
   c. Parabola d. Hyperbola
4. **Initial mass of a radioactive sample of half life 6 hours is 0.8kg. The amount of the day sample left after 1 day (24 hours) is (MOE 2066)**
   a. 0gm b. 50gm
   c. 100gm d. 200gm
5. **A radioactive sample has life of 5 days. What time is taken by $\frac{7}{8}^{th}$ of the sample to decay. (MOE 066)**
   a. 3.4 days b. 10 days
   c. 15 days d. 20 days
6. **A radioactive elements $_ZX^A$ emit a praticle and changed into $_{z-1}X^A$. The particle emitted is (Bangladesh 09)**
   a. position b. beta particle
   c. neutron d. Gamma particle
7. **Which of the following doesnot belong to the electromagnetic spectrum. (MOE 2063)**
   a. beta rays b. x-rays
   c. optical rays d. microwaves
8. **50% of a radio active substance decomposes in 5 years. What is the time for the 99.9% decomposition? (MOE 2062)**
   a. 10 years b. 50 years
   c. 10-50years d. none
9. **In a most stable elements the number of proton and neutron is (MOE 2062)**
   a. even–even b. even–odd
   c. odd–even d. odd–odd
10. **The % of radioactivity remained after 5 half life time periods is (MOE).**
    a. 50 b. 6
    c. 3 d. none
11. **What is the average life of a radioactive substance having half-life period of 1600 years. (MOE)**
    a. 2309 b. 2954
    c. 5632 d. 2435

12. Power of ionization of a gamma particle is (IOM 2010)

a. More than that of an alpha particle

b. More than that of a beta particle

c. Less than those of alpha particle and more than those of beta particle.

d. Less than both alpha and beta particles.

13. Activity of 1.85×10^{12} disintegration per second is nearly equivalent to (IOM 2010)

a. 40 curie b. 30 curie

c. 50 curie d. 60 curie

14. The half life of a radio active substance is 2 months. then the amount of substance left after 1 year is: (IOM 2009)

a. $\frac{M}{64}$ b. $\frac{M}{32}$

c. $\frac{M}{16}$ d. $\frac{M}{8}$

15. 75% of substance decay in 32 min, the 50% decay in (IOM)

a. 24 min b. 16 min

c. 8 min d. 32 min

16. The mass of a radioactive salt of half life 2 days is 10gm. What amount of the salt will be left after 10 days? (IOM 05)

a. 2.54gm b. 5gm

c. 6.24gm d. 0.31gm

17. Penetrating power in decreasing order is (BPKIHS 2010)

a. $\gamma > \beta > \alpha$ b. $\gamma > \alpha > \beta$

c. $\alpha > \beta > \gamma$ d. $\beta > \alpha > \gamma$

18. When gamma rays is emitted then (BPKIHS 2010)

a. atomic number changes

b. mass number changes

c. neither mass nor atomic no. changes

d. no. of neutrons decreased

19. A radioactive nucleus is being produced at a constant rate a per second. Its decay constant is λ. If No are the number of nuclei at time t = 4s will be (BPKIHS-09)

a. $\frac{\alpha}{\lambda}$ b. $No + \frac{\alpha}{\lambda}$

c. No d. $\frac{\lambda}{\alpha} + N_O$

20. Half life of a substance is 20 minutes. What is time between 33% decay and 67% decay? (BPKIHS–08)

a. 40 minutes b. 20 minutes

c. 30 minutes d. 25 minutes

21. One sixteenth of the initial amount of radioactive isotope remains undecayed after two hours. The half life of isotope is (BPKIHS-06)

a. 15 min b. 45 min

c. 30 min d. 60 min

22. Which of the following has maximum energy? (BPKIHS-06)

a. x-rays b. Y-ray

c. cosmic rays d. UV ray

23. A radioactive source has decayed to $\frac{1}{64^{th}}$ of its initial activity after 60 days. The half time of the source is (BPKIHS-05)

a. 5 days b. 10 days

c. 15 days d. 30 days

24. ${}_{92}U^{238} \longrightarrow {}_{90}Th^{234}$ + ... the products are (BPKIHS-02)

a. alpha particle and positron

b. alpha particle and electron

c. 2 positrons and alphaparticle

d. 1 alpha particle

25. The rate of decay of a radioactive element (BPKIHS)

a. increases with increase in time

b. decreases with increase in time

c. remains constant with increasing time

d. decreases exponentially with time

26. A radioactive elements has half life of 75 yrs. What is the fraction that will remain after 150 yr. (BPKIHS)

a. 75% b. 50% c. 68% d. 25%

27. Naturally occuring radioactive atoms can spontaneously emit (IE-07)

a. δ, γ and ε rays
b. α, β, γ rays
c. N-rays
d. π-rays

28. The particle (?) in the reaction (IE-07)

$\gamma + {}_{80}p^{198} + \longrightarrow {}_{79}Au^{179} + (?)$

a. electron
b. neutron
c. proton
d. gamma rays

29. Cu^{66} (z = 29) is converted to Cu^{66} (z = 30) by emission of (IE-06)

a. electron
b. α-particle
c. neutron
d. proton

30. A nuclei having maximum number of neutrons emits (IE- 02)

a. electron
b. proton
c. positron
d. α-particle

Answer Sheet

1. d	*2. a*	*3. a*	*4. b*	*5. c*	*6. a*	*7. a*	*8. b*	*9. a*	*10. c*
11. a	*12. d*	*13. b*	*14. a*	*15. b*	*16. d*	*17. a*	*18. c*	*19. a*	*20. b*
21. c	*22. c*	*23. b*	*24. d*	*25. d*	*26. d*	*27. b*	*28. c*	*29. a*	*30. d*

Solution

1. Ans. (d)

$T_{\frac{1}{2}} = \frac{0.693}{\lambda}$

$= \frac{0.693}{3\times10^{-6}} = 231000S$

$= \frac{231000}{86400} = 2.67$ days

2. Ans. (a)

In radioactive decay β emission leads to formation of element having atomic no. greater than 1 and atomic mass remains same.

3. Ans. (a)

$N = N_o e^{-\lambda t}$

Here, plot of N against t will be exponential

$T_{\frac{1}{2}} = \frac{0.693}{\lambda}$ and Mean life $(\tau) = \frac{1}{\lambda}$

4. Ans. (b)

$\left(\frac{N}{No}\right) = \left(\frac{1}{2}\right)^n$ where $n = \frac{t}{T_{\frac{1}{2}}}$

In question, t = 24hrs, $T_{\frac{1}{2}} = 6$ hrs

$n = \frac{24}{6} = 4$

$\left(\frac{N}{No}\right) = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$ Where

$N = \frac{1}{16} \times 0.8kg = 50gm$

5. Ans. (c)

No. of atoms remaining after 'n' half lives $= \left(\frac{1}{2}\right)^n$

Amount of sample remaining $= 1 - \frac{7}{8} = \frac{1}{8}$

$= \left(\frac{1}{2}\right)^3$

$\therefore$ No. of half lives = 3

No. of days = 3×5 = 15 days

6. Ans. (a)

Positron decay

$_{Z}X^{A} \rightarrow {}_{Z+1}Y^{A+1} + {}_{+1}e^{\circ}$(Positron)

β-decay

$_{Z}X^{A} \rightarrow {}_{Z+1}Y^{A} + {}_{-1}e^{\circ}$ (β particle)

7. Ans. (a)

β (Beta rays) is the stream of fast moving electrons. So, it doesn't belong to electromagnetic spectrum.

8. Ans. (b)

A radioactive substance decomposed 99.9% in 10 half lives.

Total time for 99.9% decomposition = 5×10 = 50 years

9. Ans. (a)

In a most stable element the number of proton and neutron is →even–even

10. Ans. (c)

% of atom remaining

$= \left(\frac{1}{2}\right)^5 \times 100\% = 3\%$

11. Ans. (a)

$T\frac{1}{2} = \frac{0.693}{\lambda}$

Average life (Tav) = $\frac{1}{\lambda}$

$\text{Tav} = \frac{T\frac{1}{2}}{0.693} = \frac{1600}{0.693}$

= 2309 years

12. Ans. (d)

Ionization power alpha particle > beta particle > gamma particle

Penetrating power

gamma particle > beta particle > alpha particle

13. Ans. (b)

1 curie = 3.7×10^{10} dis/sec

1 Becquerel = 1dis/sec

3.7×10^{10} dis/sec = 1 curie

1.85×10^{12} dis/sec = 50 curie

14. Ans. (a)

Amount of substance left after n half life = $\left(\frac{1}{2}\right)^n$

$n = \frac{T}{T\frac{1}{2}} = \frac{12}{2} = 6$

Substance left = $M\left(\frac{1}{2}\right)^6 = \frac{M}{64}$

15. Ans. (b)

Subsance left = 100–75 = 25%

$\frac{N}{N_O} = \left(\frac{1}{2}\right)^n \rightarrow \frac{25}{100} = \left(\frac{1}{2}\right)^n$

$\left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^n \quad \therefore n = 2$

We have, $n = \frac{t}{T\frac{1}{2}}$

$T\frac{1}{2} = \frac{t}{n} = \frac{32}{2} = 16$ min

16. Ans. (d)

M_O →initial mass M→ mass left

$\frac{M}{M_O} = \left(\frac{1}{2}\right)^n$ No. of half life = $\frac{10}{2} = 5$

$\frac{M}{10} = \left(\frac{1}{2}\right)^5 \quad \therefore M = \frac{1}{32}\times10 = 0.31$gm

17. Ans. (a)

Penetrating power γ > β > α

Ionising power α > β > γ

18. Ans. (c)

- γ rays are electromagnetic wave like X-rays
- They are chargeless or neutral
- There is no change in mass or atomic no.

$_{Z}X^{A} \xrightarrow{\gamma \text{ emission}} {}_{Z}X^{A} + \lambda$

19. Ans. (a)

Maximum no. of nuclei will be present when rate of decay = rate of formation

or, $\lambda N = \alpha$

$\therefore N = \frac{\alpha}{\lambda}$

20. Ans. (b)

For 33% decay $\frac{67}{100} = \left(\frac{1}{2}\right)^{\frac{t_1}{20}}$ ------- (i)

For 67% decay $\frac{33}{100} = \left(\frac{1}{2}\right)^{\frac{t_2}{20}}$ --------(ii)

From (i) and (ii)

$\frac{33}{67} = \left(\frac{1}{2}\right)^{\frac{t_2-t_1}{20}}$

$\therefore \frac{t_2-t_1}{20} = 1 \therefore t_2-t_1 = 20$

21. Ans (c)

$\frac{N}{No} = \left(\frac{1}{2}\right)^n \rightarrow \frac{1}{16} = \left(\frac{1}{2}\right)^n$

$\left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^n$

$\therefore$ n = 4

So, $\frac{t}{T_{\frac{1}{2}}} = 4 \rightarrow T_{\frac{1}{2}} = \frac{t}{4}$

$= \frac{2\times60}{4} = 30$ min

22. Ans. (c)

In given rays, cosmic rays has lowest wavelength

$E = \frac{hc}{\lambda} \alpha \frac{1}{\lambda}$ so has high energy

23. Ans. (b)

$\frac{N}{No} = \left(\frac{1}{2}\right)^n$

$\frac{1}{64} = \left(\frac{1}{2}\right)^n$

$\rightarrow$ n = 6

$n = \frac{t}{T_{\frac{1}{2}}}$

$\rightarrow T_{\frac{1}{2}} = \frac{t}{n}$

$= \frac{60}{6}$

= 10 days

24. Ans. (d)

${}_zX^A \xrightarrow[\text{emission}]{\alpha\text{particle}} {}_{z-2}X^{A-4}$

${}_{92}U^{238} \longrightarrow {}_{90}Th^{234} + \alpha$ particle

25. Ans. (d)

$\frac{-dN}{dt} \alpha N$

$\frac{-dN}{dt} = \lambda N = \lambda N_0 e^{-\lambda t}$

i.e. Rate of decay decrease exponentially with time.

26. Ans. (d)

$n = \frac{t}{T_{\frac{1}{2}}} = \frac{150}{75} = 2$

Fraction remain,

$\frac{N}{N_o} = \left(\frac{1}{2}\right)^n$

$= \left(\frac{1}{4}\right) \times 100\%$

= 25%

27. Ans. (b)

In radioactive disintegration α and β particle are not emitted simultaneously but they may be emitted along with γ rays.

28. Ans. (c)

$\gamma + {}_{80}Pt^{198} \longrightarrow {}_{79}Au^{197} + {}_1H^1$ (proton)

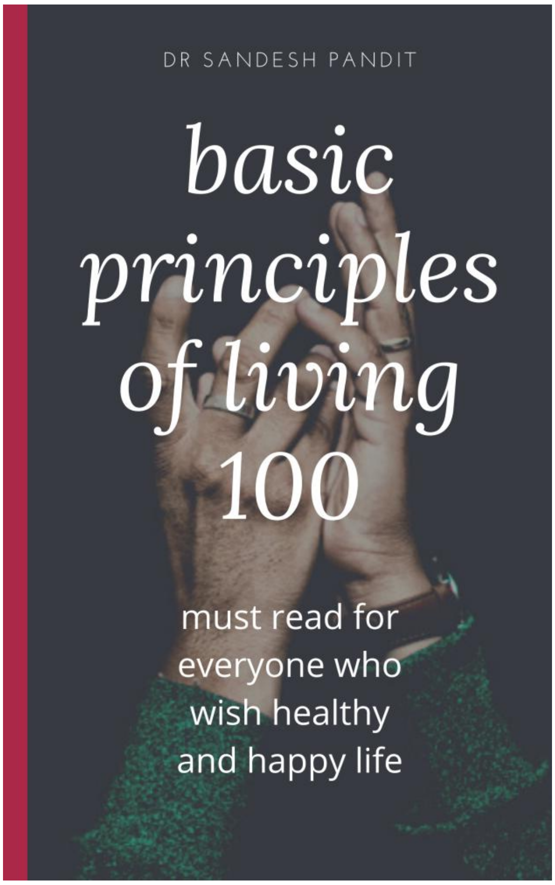
29. Ans. (a)

${}_{29}Cu^{66} \longrightarrow 30Cu^{66} + {}_{-1}\beta^0$

Atomic number increases by one unit without change in mass number in β-emission.

30. Ans. (d)

Electron, proton and positron are not radioactive particles . Radioactive particles like α-particle and β-particle are emitted when no. of neutron is more than that of protons. ie. $\frac{n}{p}$ ratio is more.



SHIKHA BOOKS

Chapter: 50

Nuclear Physics

1. If M is atomic mass, A is mass number then $\frac{M-A}{A}$ is called:

a. binding energy b. fermi energy
c. mass defect d. packing fraction

2. The atomic weight of C^{12} is 12.0032. Its mass defect is:

a. 12 b. 0.0032
c. 0.032 d. 0.32

3. The packing fraction of $_7N^{14}$ isotope whose mass is 14.003 amu is:

a. 3×10^{-3} b. 2.1×10^{-4}
c. 1.0002 d. 0.9

4. The Radius R of a nucleus changes with the nucleon number A of nucleus as:

a. $R \alpha A^{2/3}$ b. $R \alpha A^{1/3}$
c. $R \alpha \Delta$ d. $R \alpha A$

5. Density 'ρ' of a nuclear matter varies with nucleon number A on:

a. $\rho \alpha A^3$ b. $\rho \alpha A^2$
c. $\rho \alpha A$ d. $\rho \alpha \Delta$

6. The volume of a nucleus is smaller than that of atom by a factor of:

a. 10 b. 10^5
c. 10^{10} d. 10^{12}

7. The rest mass of electron is equivalent to:

a. 1 ev b. 0.51 ev
c. 0.51 Mev d. 931Mev

8. 1 amu is equivalent to:

a. 1ev b. 931ev
c. 931 Kev d. 931 Mev

9. The energy equivalent to a kilogram of matter is about:

a. 10^{11}Joule b. 10^{14} Joule
c. 10^{17}Joule d. 10^{20} Joule

10. Fission of a nucleus is achieved by bombarding it with:

a. neutrons b. protons
c. x-rays d. electrons

11. Which of the following is best nuclear fuel.

a. Thorium-236 b. Plutonium-239
c. Uranium-236 d. Neptunium-239

12. In a reactor the control rods are made of:

a. cadmium b. graphite
c. helium d. heavy water

13. The mass defect for the nucleus of helium is 0.0303 amu. What is the binding energy per nucleon for helium in Mev.

a. 1 b. 4
c. 7 d. 27

14. If the nuclei of masses x and y fused to form a nucleus of mass m and some energy is released, then:

a. x+y = m b. x+y<m
c. x+y>m d. x–y=m

15. The energy released by one atom of $U^{235}$is nearly 200Mev. What is the energy relaeased by one gram of U^{235}.

a. 200Mev b. 5×10^{23}Mev
c. 931Mev d. 10^{29}Mev

16. In each fission of $_{92}U^{235}$ releases 200Mev, how many fission must occur per second to produce a power of 1kw.

a. 3.125×10^{13} b. 1.25×10^{18}
c. 1.25×10^{13} d. 3.2×10^8

17. In the nucleus of $_{11}Na^{23}$ the number of protons, neutrons and electrons is:

a. 11,12,11 b. 11,23,11
c. 23,12,11 d. 11,12,0

18. If the speed of light were $\frac{1}{3}$ of the present value, the energy released in a given explosion will be decreased by a fraction:

a. $\frac{2}{3}$ b. $\frac{1}{3}$

c. $\frac{1}{9}$ d. $\frac{8}{9}$

19. If the mass defect in the formation of helium from hydrogen is 0.5%, then the energy obtained in kwh in forming helium from 1kg of hydrogen will be:

a. 1.25 b. 1.25×10^4

c. 1.25×10^8 d. [illegible]

20. A gamma ray photon creates an electron positron pair. If the rest mass energy of an electron is 0.51 mev and total kinetic energy of the electron positron pair is 0.78 mev, then the energy of gamma ray photon must be:

a. 0.78mev b. 1.8mev

c. 0.24mev d. 1.05mev

21. The principle of controlled chain reaction is used in:

a. atomic nuclear reactons

b. atom bomb

c. the core of sun

d. hydrogen bomb

22. A nucleus with mass number 220 initially at rest emits an alpha particle. If the Q value of the reaction is 5.5Mev, calculate the KE of the α particle.

a. 4.4 mev b. 5.4 mev

c. 5.6 mev d. 6.5 mev

Answer Sheet

1. d	*2. b*	*3. b*	*4. b*	*5. d*
6. d	*7. c*	*8. d*	*9. c*	*10. a*
11. b	*12. a*	*13. c*	*14. c*	*15. b*
16. a	*17. d*	*18. d*	*19. c*	*20. b*
21. a	*22. b*			

Solution

1. Ans. (d)

The mass defect per nucleon is called packing fraction.

$\therefore$ packing fraction $= \frac{\Delta m}{A} = \frac{M-A}{A}$

$\Delta m = M-A =$ mass defect

Binding Energy (B.E) $= \Delta m\times931$Mev

2. Ans. (b)

Mass defect $\Delta m = M-A$

$= 12.0032 - 12 = 0.0032$

3. Ans. (b)

Packing fraction $= \frac{M-A}{A}$

$= \frac{14.003-14}{14} = 2.1\times10^{-4}$

4. Ans. (b) $R = R_0 A^{1/3}$

Where $R_0 = 1.3$ Fermi $= 1.3\times10^{-15}$m

5. Ans. (d)

$R = R_0 A^{1/3}$

$\rho = m\frac{A}{V}$

$v = \frac{4}{3}\pi R^3 = \frac{4}{3}\pi R^3{}_0 A$

$\rho = \frac{3m}{4\pi R_0^3}$ independent of mass Number.

6. Ans. (d)

$\frac{\text{Volume of atom}}{\text{Volume of nucleus}} = \left(\frac{\text{radius of atom}}{\text{radius of nucleus}}\right)$

$\left(\frac{10^{-10}m}{10^{-14}m}\right)^3 = 10^{12}$

7. Ans. (c)

$E = \frac{mc^2}{e} = \frac{9.1\times10^{-31}\times(3\times10^8)^2}{1.6\times10^{-19}}$

$= 0.51$Mev $= 510$Kev

8. Ans. (c)

$E = \frac{mc^2}{e} = \frac{1.66\times10^{-27}\times(3\times10^8)^2}{1.6\times10^{-19}}$

= 931 Mev

9. Ans. (c)

$E = mc^2 = 1\times(3\times10^8)^2 = 10^{17}J$

10. Ans. (a)

- Neutrons are chargeless so easily pass into the nucleus.
- It increases $\frac{n}{p}$ ratio and makes the nucleus unstable.

11. Ans. (b)

- Plutonium $_{94}P4^{239}$ followed by $_{92}U^{235}$ is best nuclear fuel.

12. Ans. (a)

Control rods → Cadmium, boron rods

Moderator→Heavy water, graphite, berryllium

13. Ans. (c)

Mass defect Δm = 0.0303 amu

Binding energy E = 0.0303×93MeV

Binding energy per nucleon = $\frac{0.0303\times93}{4}$

= 7

14. Ans. (c)

Energy released due to mass defect.

So, x+y>m

15. Ans. (b)

Number of atoms in one gram of uranium is $6.02\times10^{23}/235$

Energy released = $\left(\frac{6.02\times10^{23}}{235\times200}\right)$ = 5×10^{23}mev

16. Ans. (a)

Each fission releases 200 Mev. So, no. of fissions per second = $\frac{\text{power}}{\text{energy per fission}}$

$= \frac{1\times10^3}{200\times1.6\times10^{-19}}$

$= 3.125\times10^{13}$

17. Ans. (d)

Number of protons = z = 11

Number of neutrons = A–z = 23–11= 12

Electrons do not exist in the nucleus, so number of electrons in the nucleus = 0

18. Ans. (d)

$E_0 = mc^2$

$E^1 = m(c/3)^2 = \frac{mc^2}{9}$

$\frac{\Delta E}{E} = \frac{E_0 - E}{E} = \frac{mc^2 - \frac{mc^2}{9}}{mc^2}$

$= 1 - \frac{1}{9} = \frac{8}{9}$

19. Ans. (c)

$E = \Delta mc^2 = \frac{0.5}{100}\times(3\times10^8)^2$

$= 0.5\times9\times10^{14}J$

$= \frac{0.5\times9\times10^{14}}{36\times10^6}$ Kwh

$= 1.25\times10^8$ kwh

20. Ans. (b)

$\gamma \xrightarrow[\text{production}]{\text{pair}} {}_{-1}e^\circ + {}_1e^\circ$

Energy of L.H.S = Energy of R.H.S

∴ Energy of γ-ray photon = 2 × 0.51 + 0.78

= 1.8 Mev

21. Ans. (a)

Atom bombs → uncontrolled nuclear fission

Hydrogen bomb and source of solar energy →Nuclear fusion.

22. Ans. (b)

$X^{220} \rightarrow Y^{216} + {}_2He^4$ conservation of linear momentum

$P_1 = P_2$ and $P = \sqrt{2mE}$

$\sqrt{2\times(216m)\times E_1} = \sqrt{2\times(4m)\times E_2}$

$E_2 = \frac{2\times216E_1}{8} = 54E_1$

As, $E_1 + E_2 = 5.5$ mev

$E_2 = 5.4$ mev

Past Questions

1. When a particle and its antiparticle are annihilated the energy released is E. What is the mass of each particle? (MOE 2068)

a. $\frac{E}{C^2}$ b. $\frac{E}{2C^2}$

c. $\frac{E}{C}$ d. $\frac{E}{2C}$

2. The approx radius of nucleus of cu in Fermi (MOE 2008)

a. 3 b. 4

c. 4.5 d. 6

3. The radius of gold nucleus is approimately (MOE 2065)

a. 4.29×10^{-14}m b. 1.5×10^{-10}m

c. 2.5×10^{-8}m d. 6×10^{-24}m

4. A positron has the same mass as (MOE 2063)

a. neutron b. neutrino

c. an electron d. a proton

5. The radius of $A1^{27}$ nucleus in Fermi is nearly (MOE curriculum)

a. 1.5 b. 2.5

c. 4.5 d. 13.5

6. The percentage of mass which changes into energy fission is in the order of (IOM 2011)

a. 10% b. 1%

c. 0.4% d. 0.1%

7. A nucleus of mass number A, originally at rest, emits an a with speed v. The daughter nucleus recoils with a speed (BPKIHS 2008)

a. $\frac{2v}{A+4}$ b. $\frac{4v}{A+4}$

c. $\frac{4v}{A-4}$ d. $\frac{2v}{A-4}$

8. Binding energy per nucleon is highest for the atom. (IE-06)

a. He b. Cd

c. Fe d. U

9. Neutrino is a particle which has (IE-04)

a. spin a chargeless

b. no spin and chargless

c. spin and charged like electron

d. no spin and charge like electrons

Answer Sheet

1. b	*2. d*	*3. a*	*4. c*	*5. c*	*6. d*	*7. c*	*8. c*	*9. a*	

Solution

1. Ans. (b)

When a particle like electron (e^-) and Antiparticle like positron (e+) each of mass 'm' are annihilated. Its masses are converted into energy.

$E = (2m)\, C^2$

$m = \frac{E}{2C^2}$

2. Ans. (d)

$R = R_o A^{\frac{1}{3}}$ [Atomic wt of cu=63.5 $\simeq$ 64

$R = 1.3\times10^{-15}\times(64)^{1\backslash3}$

$= (1.3\times4)\times10^{-15}$

= 5.2 Fermi

3. Ans. (a)

Size of atom is of order 10^{-10}m. Size of nucleus is of order 10^{-15}m

4. Ans. (c)

Antiparticle of electron is positron ie. particle having same mass but opposite charge.

5. Ans. (c)

$R = R_o A^{1/3} = 1.4 \times (27)^{1\backslash 3}$

$= 1.4 \times 3 = 4.2$ Fermi

6. Ans. (d)

- In the fission, the percentage of mass converted into energy is 0.1%
- Energy released per fission of $_{92}U^{235}$ is nearly 200 Mev.

7. Ans. (c)

Using conservation of momentum

$0 = 4V + (A - 4) V^1$

$V^1 = \dfrac{4v}{A - 4}$

8. Ans. (c)

With↑ in mass no; binding energy ↑ becomes maximum for iron ($_{26}Fe^{56}$) and then ↓.

9. Ans. (a)

Neutrino is a disintegrated part of neutron. Neutrino has spin and no charge so behaves as neutron.

Chapter: 51

SEMICONDUCTOR & ELECTRONICS

1. **To obtain a p-type germanium semiconductor it must be doped with:**
   a. arsenic b. antimony
   c. indium d. phosphorus
2. **Which of the following is not a semiconductor?**
   a. selenium b. Arsenic
   c. silicon d. none
3. **With rise in temperature, the electrical conductivity of intrinsic semiconductor:**
   a. increases b. decreases
   c. first increases then decreases
   d. first decreases then increases
4. **In a good conductor, the energy gap between the conduction band and valence band is:**
   a. infinity b. wide
   c. narrow d. zero
5. **In a p-type semiconductors, the majority charge carriers are:**
   a. holes b. electrons
   c. protons d. neutrons
6. **In N-type semiconductors, majority charge carriers are:**
   a. holes b. electrons
   c. protons d. neutrons
7. **Depletion layer consists of:**
   a. electrons b. protons
   c. mobile ions d. immobile ions
8. **At O°K, intrinsic semoconductor behaves as:**
   a. a perfectly conductor
   b. super conductor
   c. semi conductor
   d. a perfect insulator
9. **An N-type semiconductor is:**
   a. negatively charged
   b. positively charged
   c. neutral d. none
10. **In a junction diode, the holes are due to:**
    a. protons
    b. neutrons
    c. extra electrons
    d. missing of electrons
11. **A P-N junction diode can be used as:**
    a. amplifier b. regulator
    c. condenser d. rectifier
12. **In Forward bias, the width of potential barrier in P-N junction diode:**
    a. increases
    b. decreases
    c. remains constant
    d. First a then b
13. **The depletion layer in the P-N junction region is caused by:**
    a. drift of holes
    b. diffusion of charge carries
    c. migration of impurity ions
    d. drift of electrons
14. **On increasing the reverse bias to a large value in a P-N junction diode current.**
    a. increases slowly
    b. remains fixed
    c. suddenly increases
    d. decreases slowly
15. **Potential barrier developed in a junction diode opposes:**
    a. minority carriers in both regions only
    b. majoriy carriers only
    c. electrons in N-region
    d. holes in p-region
16. **The ratio of forward biased to reverse biased resistance for P-N junction diode is:**
    a. $10^{-1}:1$ b. $10^{-2}:1$
    c. $10^{-3}:1$ d. $10^{-4}:1$

17. When N-P-N transistor is used as an amplifier, then
a. holes moves from emitter to base
b. electrons move from base to collector
c. holes move from bast to emittor
d. electrons move from collector to base

18. The transistor provides good power amplification when it is used in:
a. common collector configuration
b. common emitter configuration
c. common base configuration
d. none

19. The part of a transistor which is heavily doped to produce large number of majority carriers is:
a. base b. emitter
c. collector d. none

20. In a P-N junction:
a. Higher potential at N side
b. Higher potential at P-side
c. Both at same potential
d. undetermined

21. In the middle of the depletion layer of reverse biased p-n junction, the:
a. potential is zero
b. electric field is zero
c. potential is maximum
d. electric field is maximum

22. The dominant mechanism for motion of charge carriers is forward and reverse biased P-N junction are respectively:
a. drift, diffusion
b. diffusion, drift
c. diffusion in both
d. drift in both

23. When the conductivity of a semi conductor is only due to breaking of covalent bond, the semi conductor is:
a. extrinsic b. intrinsic
c. n-type d. p-type

24. Current gain of a transistor in common base mode is 0.95. Its value in common emitter mode is:
a. 0.95 b. 1.5
c. 19 d. 95

25. The ratio of electron and hole currents in a semiconductor is $\frac{7}{4}$ and the ratio of drift velocities of electrons and holes is $\frac{5}{4}$, then the ratio of concentrations of electrons and holes will be:
a. $\frac{5}{7}$ b. $\frac{7}{5}$
c. $\frac{25}{49}$ d. $\frac{49}{25}$

26. The depletion layer in silicon diode is 1μm wide and the knee potential is 0.6v, then the electric field in the depletion layer will be:
a. zero b. $0.6vm^{-1}$
c. $6\times10^4vm^{-1}$ d. $6\times10^5vm^{-1}$

27. In a half wave rectifier circuit operating from 50Hz mains frequency the fundamental frequency in the ripple would be:
a. 25 Hz b. 50 Hz
c. 70.7 Hz d. 100 Hz

28. A transistor amplifier is found to have an input signal vi=2sin (157t + $\frac{\pi}{2}$) and the output signal Vo = 200 sin (157t + 3 $\frac{\pi}{2}$). Then the transistor is connected as:
a. a common collector amplifier
b. a common base amplifier
c. a common emitter
d. an oscillator

29. The current gain of a transistor in a common emitter configuration is 40. If the emitter current is 8.2mA, then base current is:
a. 0.02mA b. 0.2mA
c. 2mA d. 0.4mA

30. In an NPN transistor, the collector current is 24 mA. If 80% of electrons reach collector the base current is:

a. 36mA b. 26mA

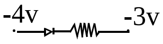
c. 16mA d. 6mA

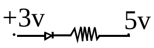
31. In a common emitter transistor amplifier $\beta = 60, R_0 = 5000\Omega$ and internal resistance of a transistor is 500Ω. The voltage amplification of amplifier will be:

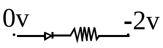
a. 500 b. 460

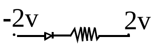
c. 600 d. 560

32. The forward bias diode is:

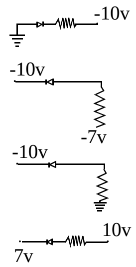
(a) 

(b) 

(c) 

(d) 

33. Which of the following junction diode is reversed biased?

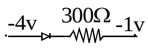


34. The value of current in the following diagram will be:

a. 0 b. 10^{-2}A

c. 10A d. 0.025A

35. The value of current will be:



a. 0 b. 0.1

c. 10^{-2}A d. 10^{-3}A

Answer Sheet

1. c	*2. b*	*3. a*	*4. d*	*5. a*	*6. b*	*7. d*	*8. d*	*9. c*	*10. d*
11. d	*12. b*	*13. b*	*14. c*	*15. b*	*16. d*	*17. b*	*18. b*	*19. b*	*20. a*
21. d	*22. b*	*23. b*	*24. c*	*25. b*	*26. d*	*27. b*	*28. c*	*29. b*	*30. d*
31. c	*32. c*	*33. c*	*34. b*	*35. a*					

Solution

1. Ans. (c)

For p-type semiconductor, the doping impurity should be trivalent. Here Indium is trivalent.

2. Ans. (b)

Arsenic is not a semiconductor

3. Ans. (a)

With the rise in temperature, the number of charge carrier increases due to breaking of covalent bonds.

4. Ans. (d)

The conduction and valance bands in the conductors merge into each other.

5. Ans. (a)

Holes are the majority charge carrier of current in P-type semi conductor.

6. Ans. (b)

Electrons are the majority charge carrier of current in N-type semi conductor.

7. Ans. (d)

The depletion layer consists of immobile ions.

8. Ans. (d)

At O°K, intrinsic semiconductor behaves as a perfect insulator.

9. Ans. (c)
Both types of semi conductors p-type or N-type are neutral in Nature.
10. Ans. (d)
In a semi conductor, when the electron leaves its place, a positive charge is left behind it and a hole is created. So, holes are formed due to missing of electrons.
11. Ans. (d)
P-N junction diode can be used as a rectifier.
12. Ans. (b)
In forward bias, the width of potential barrier in P-N junction diode decreases.
13. Ans. (b)
The holes and electrons (both) acts as charge carriers and they diffuse across the junctions.
14. Ans. (c)
On increasing the reverse to a large value in P-N junction diode, the junction breaks down. Now a large reverse current is set up due to minority charge carriers.
15. Ans. (b)
Potential barrier developed in a junction diode opposes majority carrier only.
16. Ans. (d)
The ratio of forward biased to reversed biased resistance for P-N junction diode is 10^{-4}:1
17. Ans. (b)
When N-P-N transistor is used as an amplifier, then emitter base junction is forward baised while collector base junction is reversed biased. Now the majority carriers which are electrons in emitter are repelled towards base where as they are collected by reverse biased collector.
18. Ans. (b)
The transistor provides good power amplification. When it is used in common emitter configuration as $\beta > \alpha$.
Where $\beta = \frac{IC}{IB}$ and $\alpha = \frac{IC}{IE}$
19. Ans. (b)
To produce a large number of majority carriers, the emitter of a transistor is $\rightarrow$ heavily doped, Base $\rightarrow$ Least doped, collector $\rightarrow$ moderately doped
20. Ans. (a)
In a P-N junction there is higher potential at N side and low potential at P-side because of diffusive transfer of carriers across the depletion layer.
21. Ans. (d)
In the middle of the depletion layer of a reverse biased P-N junction, the electric field is maximum.
22. Ans. (b)
The Dominant mechanism of motion of charge carrier in forward biased and reverse biased are diffusion and drift of charge carrier respectively.
23. Ans. (b)
In intrinsic semiconductor very few electrons and holes are produced due to breaking of covalent bond.
24. Ans. (c)
Current gain in CB mode = α = 0.95
Current fain in CE mode = β

We know, $\frac{1}{\alpha} - \frac{1}{\beta} = 1$

$$\frac{1}{\beta} = \frac{1-\alpha}{\alpha} = \frac{1-0.95}{0.95} = \frac{1}{19}$$

$\therefore \beta = 19$
25. Ans. (b)
$I = neV_dA \rightarrow I \alpha nV_d$

ie. $\frac{Ie}{Ih} = \frac{n_e v_h}{n_n v_h}$

or, $\frac{5}{6} = \frac{ne}{nh} \times \frac{5}{4}$

or, $\frac{ne}{nh} = \frac{7}{5}$
26. Ans. (d)

$$E = \frac{\Delta v}{\Delta x} = \frac{0.6}{10^{-6}} = 6 \times 10^5 \text{V m}^{-1}$$

27. Ans. (b)
In half wave rectifier we get output only in one half cycle of input Ac, therefore, the frequency of the ripple of the output is same as that of input Ac ie. 50Hz.

28. Ans. (c) $\Delta\phi = \frac{3\pi}{2} - \frac{\pi}{2} = \pi$

As the input signal and output signal are out of phase it must be a common emitter amplifier.

29. Ans. (b) $\beta = 40$, IE = 8.2mA

We know, $\beta = \frac{IC}{IB} = \frac{IE - IB}{IB} = \frac{IE}{IB} - 1$

or, $\beta + 1 = \frac{IE}{IB}$

or, $41 = \frac{8.2}{IB}$

$\therefore$ $IB = \frac{8.2}{41} = 0.2$ mA

30. Ans. (d) $I_C = \frac{80}{100} I_E$ (From Ques)

or, $24 = \frac{8}{10} . I_E$

or, $I_E = 30$

or, $I_B + I_C = 30$

or, $I_B + 24 = 30$

$\therefore$ $I_B = 6$mA

31. Ans. (c)
Voltage amplification = current gain × Resistance gain (V =IR)

$= \beta \times \frac{R_0}{R_i} = 60 \times \frac{5000}{50} = 600$

32. Ans. (c)
In forward bias, the p-region should be at high potential and N– region should be at low potential as in option (c)

33. Ans. (c)
In reverse bias, the P-region must be connected negative/low potential and N-region to positive high potential. This in case of option (c), where vp = –10v and VN = 0V

34. Ans. (b)
Here, P – N junction is forward biased with voltage = 5 – 3 = 2v

$I = \frac{V}{R}$

$= \frac{2}{100} = 10^{-2}$A

35. Ans. (a)
P – N junction is reversed biased, hence it will offer infinite resistance. So, the current is zero.

Past Questions

1. The energy gap between the conduction band and the valance band of a certain material is 0.7ev. The material is

(MOE curriculum).

a. an insulator b. a conductor
c. semiconductor d. semimetal

2. When antimony is doped with silicon, instrinsic semiconductore obtained is

(MOE 2067)

a. n type b. p type
c. n-p-n d. p-n-p type

3. The silicon semiconductor formed by doping trivalent atoms will be

(MOE-2009)

a. n-type b. p-type
c. n-p-n type d. p-n-p type

4. When P-N junction diode is forward biased, the width of depletion layer (MOE 2008)

a. increases
b. decreases

c. remains unchanged
d. none

5. Zener diodes are used for (MOE 2067)
a. rectification b. amplification
c. stabilization of voltage
d. detector

6. Silicon and silver both are cooled from 100°c to 0°c their conductivity changes as (MOE 2055)
a. conductivity of silicon increases
b. conductivity of silicon decreases
c. both a and b
d. conductivity of silicon decreases and that of silver increases

7. For proper use of a transistor (MOE 2053)
a. Emitter and base are forward biased and base and collector are reverse biased
b. Both are reversed biased
c. Both are forward biased
d. None

8. 'P' type semi conductor is obtained by doping Germanium with (BPKIHS 2010)
a. trivalent impurity
b. tetravalent impurity
c. pantavalent
d. divalent

9. In a semiconductor diode P-side is earthed and N side is applied to a potential of –2v, the diode shall (BPKIHS–07)
a. breakdown b. conduct partially
c. conduct d. not conduct

10. Which of the following is correct? (BPKIHS-06)
a. $\alpha = \frac{\beta}{1-\beta}$ b. $\alpha = \frac{\beta}{1+\beta}$
c. $\alpha = \frac{\beta+1}{\beta}$ d. $\alpha = \frac{1-\beta}{\beta}$

11. The resistivity of semiconductor depends on (BPKIHS – 06)
a. Atomic nature of semi conductor
b. Atomic reactivity of semiconductor
c. Atomic number of semiconductor
d. None

12. A transistor is essentially a (BPKIHS-05)
a. current operating device
b. voltage operated device
c. power driven device
d. resistance operated device

13. Forbidden energy gap shows the order (BPKIHS-02)
a. Conductor < Semi conductor < Insulator
b. Semi conductor < conductor < Insulator
c. All the same
d. Conductor = Insulator < semi conductor

14. In a PN junction diode, When no potential is applied (BPKIHS-02)
a. holes diffuse from P to N and electrons from N to P
b. a small electric field is set up
c. no effect
d. holes only diffuse from P toN.

15. A N-P-N transistor in a common emitter circuit has (BPKIHS)
a. Low transfer ratio
b. A low Ac current gain
c. Leakage of current independent of temperature
d. Valid Kirchoff's law

16. In which of the following transistor amplifies configuration, the voltage gain is highest. (IE 2010)
a. common base b. common emitter
c. common collector d. none

17. The potential barrier in the depletion layer is due to. (IE–08)
a. ions b. electrons
c. holes d. forbidden gap

18. A conductor and charging non conductor when brought together (IE–05)
a. they attract each other
b. they repel each other
c. nothing happen
d. charge transfer from conductor to non conductor

19. A device for generating an alternating current of a desired frequency is known as (IE-04)

a. oscillator b. amplifier
c. rectifier d. diode

Answer Sheet

1. c	*2. a*	*3. b*	*4. b*	*5. c*	*6. d*	*7. a*	*8. a*	*9. c*	*10. b*
11. a	*12. a*	*13. a*	*14. a*	*15. d*	*16. b*	*17. d*	*18. a*	*19. a*	

Solution

1. Ans. (c)

Forbidden gap for semiconductor is in the order of 1ev.

For silicon, si = 1.1ev, Ge = 0.7ev

2. Ans. (a)

N type semiconductors are obtained by doping with the atoms of Nitrogen family, Nitrogen (N), phosphorous (P), Arsenic (As), Antimony (Sb) and Bismuth (Bi)

3. Ans. (b)

An intrinsic semi conductor doped with trivalent impurity (eg Al, B, In, Ga) is called p-type semiconductor.

4. Ans. (b)

- Forward biasing of p-n junction offers low resistances and decrease potential barrier.
- If the forward voltage of P-N junction diode is increased. The electrons flow will increase hence reducing the width of depletion layer.

5. Ans. (c)

- zener diodes are used for voltage stabilizer.
- oscillator used the positive feedback mechanism but amplifier uses negative feedback mechanism.

6. Ans. (d)

$R_t = R_o (1 + \alpha t)$

α = temp. coefficient of resistance

→ α is +ve for conductors resistance increases with temp. ie. conductivity decreases

→ α is –ve for semiconductors (Si,Ge) so resistance decreases ie. conductivity increases with rise in temperature.

7. Ans. (a)

At emitter base junction forward biasing decreases depletion layer and hence current flows easily.

At base collection juction, reverse biasing increases depletion layer and hence increases resistance at this junction.

8. Ans. (a)

'P' type →Trivalent

'n' type →Pentavalent

9. Ans. (c)

Earth is taken as zero potential. Here P, side is earthened and N-side is connected to –2v ie. the process is forward biased because N-side is more negative compared to P-side. so it conducts.

10. Ans. (b)

$\beta = \dfrac{\alpha}{1-\alpha}$

α = current gain in common bases

β = current gain in common emitter

or, $\beta - \beta\alpha = \alpha$

or, $\beta = \alpha + \alpha\beta$

$\rightarrow \beta = \alpha (1 + \beta)$

$\therefore \alpha = \dfrac{\beta}{1+\beta}$

11. Ans. (a)

- The resistivity always depends upon nature of atom and temperature.
- Semiconductor has –ve temp. coefficient whereas conductor has +ve temp. coefficient.

12. Ans. (a)

Transistor is mainly used as amplifier. It can amplify current, voltage and even small amount of loss also occur but it is essentially a current operating device because in transistor emitter current controls the collector current.

13. Ans. (a)
    - Valence band and conduction band overlap in conductor
    - Fobidden gap between valence and conduction band > 3ev in insulator
    - Forbridden gap between valence and conduction band nearly 1ev in semiconductior

14. Ans. (a)

When no potential is applied in a P–N junction diode electrons diffuse from N to P and holes diffuse from P to N as a result N type crystals acquire +ve potential and P-type crystal acquire –ve potential. And the potential difference is developed known as barrier potential.

15. Ans. (d)

In N-P-N transistor, In forward bias: current moves from base to emitter.

In Reversed bias: current moves from emitter to base which are equal in magnitude in accordance to Kirchoff law which states that current entering and leaving at a certain point's magnitude = constant.

17. Ans. (d)

Barrier potential difference is the potential difference across depletion layer.

18. Ans. (a)

When a charging non conductor is placed near the conductor, it induces opposite charge of it to the conductor so, always results attraction.

19. Ans. (a)

Oscillator is used for converting DC to AC and rectifier for AC to DC oscillator uses positive feedback while amplifier uses Negative feedback

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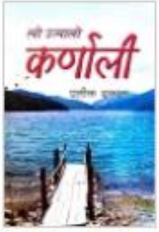

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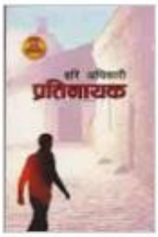


प्रतिनायक

रिकुटे

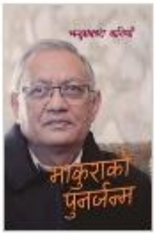
स्कुल बेच्ने बालक

अदभुत तिवारी

छोट्टी

समुन्द्र साउती

गद्य शैलीको रूपविज्ञान



माकुराको पुनर्जन्म

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कर्म

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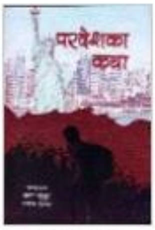


परदेशका कथा

डिलको डोब

Of Walls And Pigeons

Chapter: 52

Diode & Triode Valves

1. **Triode is an:**
   a. amplifier b. rectifier
   c. both d. none
2. **In a triode valve, the current in the plate circuit is controlled by:**
   a. anode b. cathode
   c. grid d. ammeter
3. **Plate current is maximum when:**
   a. grid is negative and anode is positive
   b. grid is positive and anode is negative
   c. both the grid and anode are positive
   d. both grid and anode are negative
4. **The space charge limited current ip and plate voltage vp are related as:**
   a. ip α vp b. ip α vp^2
   c. ip α vp^3 d. ip α vp$^{3\backslash 2}$
5. **A diode valve operates in the region of space charge limited current. If the voltage is increased four times, how many times the space charge limited current will increase?**
   a. 2 times b. 4 times
   c. 8 times d. Remains unchanged
6. **In thermionic emission, the thermionic current varies with temperature of the filament as:**
   a. T b. T^2
   c. T^{-1} d. T^{-2}
7. **For a triode:**
   a. μ = rp × gm b. gm = μ × rp
   c. rp = μ × gm d. $\mu = \dfrac{rp}{rp + gm}$
8. **The amplification factor of a triode is 22 and its plate resistance is 6600 Ω, the mutal conductance of the valve:**
   a. $\dfrac{1}{300}$ mho b. 25×10^{-2} mho
   c. 2.5×10^{-2} mho d. 0.25×10^{-2} mho
9. **In a triode valve, gm = 2.5 × 10^{-3} mho and Δvg = –2v. The chage in Plate current is:**
   a. 5A b. 5×10^{-3}A
   c. 1.25×10^{-3}A d. 40A
10. **In diode, when there is a saturation current, the plate resistance (r_p) is:**
    a. zero b. infinite
    c. finite d. Date insufficient
11. **The amplification factor of a triode is 20. If the grid voltage is reduced by 1 volt, how much the plate voltage be increased so that the plate current remains constant?**
    a. 10 volt b. 20 volt
    c. $\dfrac{1}{10}$ volt d. $\dfrac{1}{20}$ volt
12. **In a triode valve circuit when the plate voltage is increased from 200 to 220 volts and the grid potential is decreased from –0.5 volt to –1.3 volt, there is no change in Plate current. The amplification factor of the triode is:**
    a. 15 b. 20
    c. 25 d. 35
13. **The ratio of slope of mutual characteristics to that of the corresponding anode characteristics for a triode valve gives:**
    a. mutual conductance
    b. anote resistance
    c. amplification factor
    d. voltage gain
14. **When a triode is used as an amplifier with a finite load resistance the voltage amplification A is given by:**
    a. Av = μ b. Av < μ
    c. Av > μ d. Av ≤ μ

15. A triode has mutual conductance of 2×10^{-3} mho and an amplification factor of 50. The anode is connected through a resistance of 25 kiloohm to a 250 volt supply. The voltage gain of this amplifier is:

a. 25 b. 50
c. 100 d. 125

16. In a triode, the grid is at –ve potential of 2v with respect to cathode. An electron is ejected with an initial kinetic energy of 5ev. The energy of the electron when it reaches the grid is:

a. zero b. 5ev
c. 7ev d. 3ev

17. In a triode cathode, grid and plate are at O, – 2 and 80 volts respectively. The electron is emitted from the cathode with energy 3ev. The energy of the electrons reaching the plate is:

a. 85ev b. 80ev
c. 83ev d. 3ev

18. The slope of anode and mutual characterstics of a triode valve are 0.02 MA/volt and 1 MA/volt respectively. The amplification factor of the valve is:

a. 10.5 b. 5
c. 50 d. 500

19. The plate potential of a triode valve is 120 V. If the amplification factor of the triode be 20, What is the minimum grid potential at which no plate current flows.

a. – 20v b. – 5v
c. – 6v d. – 10v

20. The amplification on factor of a triode valve is 15. If the grid voltage is changed by 0.3 volt. The change in plate voltage in order to keep the current constant (in volt) is:

a. 0.02 b. 0.002
c. 4.5 d. 5

Answer Sheet

1. a	*2. c*	*3. c*	*4. d*	*5. c*	*6. b*	*7. a*	*8. a*	*9. b*	*10. b*
11. b	*12. c*	*13. c*	*14. b*	*15. a*	*16. d*	*17. c*	*18. c*	*19. c*	*20. c*

Solution

1. Ans. (a)
Diode is rectifier. Triode can be used as Amplifier, oscillator, modulator.

2. Ans. (c)
In a triode valve, grid is introduced between anode and cathode to control the electrons emitted by cathode. Hence, grid controls the plate current.

3. Ans. (c)
For a given plate voltage the plate current in a triode valve is maximum when the potential of both grid and plate is +ve.

4. Ans. (d)
In space charge limited region, child's three half power law is obeyed.
$I_p \propto v_p^{3/2}$

5. Ans. (c)
According to child's law, in space charge limited region
$I_P \propto v_p^{3/2}$
or, $\frac{I_2}{I_1} = \left(\frac{v_2}{v_1}\right)^{\frac{3}{2}}$
$= (4)^{\frac{3}{2}} = 8$
$\therefore I_2 = 8I_1$

6. Ans. (b)
According to Richardson Dushmann equation
$I = CAT^2 e^{\phi/FT}$
$\therefore I \propto T^2$

7. Ans. (a)

Amplification factor (μ) = plate resistance (rp) × mutual conductance (gm)

$\mu = \frac{\Delta vp}{\Delta vg}$

$= \frac{\Delta V_P}{\Delta I_P} \times \frac{\Delta I_P}{\Delta Vg}$

$\mu = rp \times gm$

8. Ans. (a)

$g_m = \frac{\mu}{r_p}$

$= \frac{22}{6600}$

$= \frac{1}{300}$ mho

9. Ans. (b)

$g_m = \frac{\Delta I_P}{\Delta Vg}$

$\therefore$ $\Delta I_P = gm \times \Delta V_g$

$= 2.5 \times 10^{-3} \times 2$

$= 5 \times 10^{-3}$A

10. Ans. (b)

At saturation current

$I_P = 0$

$\therefore R_p = \frac{\Delta V_P}{\Delta I_P} = \infty$

11. Ans. (b)

$\mu = \frac{\Delta vp}{\Delta vg}$ at constant I_P

or, $20 = \frac{\Delta vp}{1}$

$\therefore$ $\Delta vp = 20$ for I_P to be constant.

12. Ans. (c)

$\mu = \frac{\Delta Vp}{\Delta Vg}$ at constant Ip

$= \frac{220 - 200}{-0.5 - (-1.3)}$

$= \frac{20}{0.8} = 25$

13. Ans. (c)

If m_1 and m_2 be slopes of mutual and anode (plate) characteristics respectively.

$m_1 = \frac{\Delta ip}{\Delta vg}$

$m_2 = \frac{\Delta ip}{\Delta vp}$

$\therefore \frac{m_1}{m_2} = \frac{\Delta vp}{\Delta vg} = \mu$

14. Ans. (b)

$Av = \frac{\mu RL}{R_P + R_L} < \mu$

15. Ans. (a)

$Av = \frac{\mu RL}{R_P+R_L} = \frac{\mu RL}{\frac{\mu}{gm} + R_L}$

$= \frac{50 \times 25 \times 10^3}{\frac{50}{2 \times 10^{-3}} + 25 \times 10^3} = 25$

16. Ans. (d)

E = 5ev – 2ev = 3ev

17. Ans. (c)

E = 80ev + 3ev = 83ev

18. Ans. (c)

$rp = \frac{1}{\text{slope}}$

$= \frac{1}{10^{-3} \times 10^{-3}}\ \Omega$

$= 10^6\ \Omega = 10^3\ K\ \Omega$ static

19. Ans. (c)

$V_g = -\frac{Vp}{\mu}$

$= \frac{-120}{20} = -6v$

20. Ans. (c)

$\mu = \frac{\text{change in plate potential}}{\text{change in grid potential}}$

$15 = \frac{\Delta vp}{0.3}$

or, $vp = 15 \times 0.3 = 4.5$

Chapter: 53

Logic Gates

1. NAND gate is:

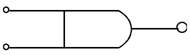
a. a basic gate
b. a basic universal gate
c. not a universal gate
d. none

2. When two inputs of NAND gates are shorted. This gate is equivalent to:

a. OR gate b. AND gate
c. NOT gate d. NOR gate

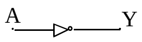
3. The symbol represents which logic gate

a. AND b. NAND
c. NOR d. OR



4. Identify the logic gate:

a. NOT b. OR
c. NOR d. XOR

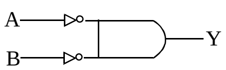


5. What is the name of the gate obtained by combination shown in figure?

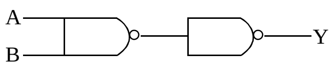
a. NAND b. NOR
c. NOT d. XOR

6. What is the output of the gate in the circuit shown?

a. $\overline{A.B}$ b. $\bar{A}.\bar{B}$
c. $\overline{\bar{A}.\bar{B}}$ d. $\bar{A}+\bar{B}$

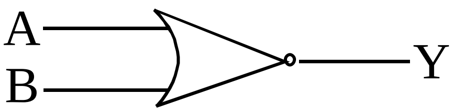


7. Following diagram performs the logic function of:



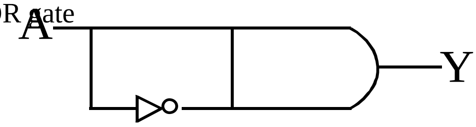
a. OR gate b. XOR gate
c. AND gate d. NAND gate

8. Identify the logic gate:



a. OR b. NOR
c. XOR d. NOT

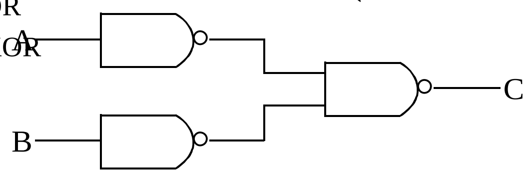
9. What is the Boolean expression for the gate circuit shown?



a. $A.0 = O$ b. $A.\bar{A} = O$
c. $A.1 = A$ d. $A.\bar{A} = A$

10. The combination of NAND gates shown here under are equivalent to

(BPKIHS 2011)

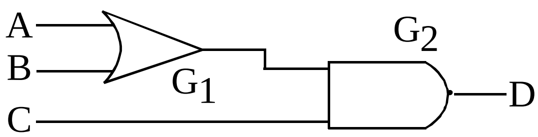


a. AND gate b. NAND gate
c. NOR gate d. OR gate

11. What is the value of $A + \bar{A}$ in the Boolean algebra?

a. 0 b. 1
c. A d. $\bar{A}$

12. For the given combination of gates if the logic inputs are A = 1, B = 1 and C = 0, the logic state of output D is:



a. 0 b. 1
c. ∞ d. both o and 1

13. The following table is truth table of (IE 2010)

A	B	X
0	0	1
1	0	1
0	1	1
1	1	0

a. NAND b. XOR

c. NOR d. AND

14. Truth table for NOT gate is. (IE-2009)

a. $\begin{bmatrix} 1 & 1 \\ 0 & 0 \end{bmatrix}$ b. $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$

c. $\begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}$ d. $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

Answer Sheet

1. b	*2. c*	*3. a*	*4. a*	*5. a*	*6. b*	*7. c*	*8. b*	*9. b*	*10. d*
11. b	*12. b*	*13. a*	*14. d*						

Solution

1. Ans. (b)

- NAND is universal gate
- Digital circuit are made by repetitive use of NAND gates
- NOR is an invert gate

2. Ans. (c)

When the two inputs of NAND gates are shorted it is equivalent to NOT gate.

3. Ans. (a)

AND gate is device having two or more input and one output

Boolean experession is $A \times B = y$

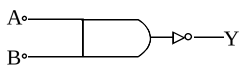
or, $A.B = y$

4. Ans. (a)

NOT is a device having one input and one output boolean expression is $\overline{A} = y$.

5. Ans. (a)

The first gate is an AND gate whose output is made input of NOT gate. Hence the resultant combination is NAND gate.



6. Ans. (b)

A is input for NOT gate whose output is $\overline{A}$

B is input for NOT gate whose output is $\overline{B}$.

$\overline{A}$ and $\overline{B}$ are input for AND gate whose output is $y = \overline{A} . \overline{B}$.

7. Ans. (c)

Let the output of first gate be x. Then

$X = \overline{A} . \overline{B}$ and $y = \overline{X}$ using De – Morgan's theorem,

We get, $y = \overline{X} = \overline{\overline{A.B}} = \overline{\overline{A} + \overline{B}} = \overline{\overline{A}} . \overline{\overline{B}} = A.B$

$\therefore$ y = A.B which is a AND gate

8. Ans. (b)

NOR gate is obtained when input of OR is made as input of NOT gate Boolean expression $y = \overline{A + B}$

9. Ans. (b)

A is input for AND gate and also for NOT gate. The output of NOT gate is $\overline{A}$. This output $\overline{A}$ together with A are the inputs AND gate. Hence, the output of the AND gate is $Y = A . \overline{A} = O$.

10. Ans. (d)

Output of $A = \overline{A}$ and output of $B = \overline{B}$ A NAND gate is complement to AND gate

The output of $\overline{A} . \overline{B}$ in an AND gate is $x = \overline{A} . \overline{B} = \overline{A + B}$

[De-morgan's law]

The output of x in a NAND gate is $C = \overline{X} = \overline{\overline{A + B}} = A + B$. Which is OR gate.

11. Ans. (b)

When A = 1 then $\bar{A} = 0$

$A + \bar{A} = 1 + 0 = 1$

When A = 0, $\bar{A} = 1$

$A + \bar{A} = 0 + 1 = 1$

12. Ans. (b)

G_1 is an OR gate whose inputs are 1 and 1. Thus the output of G_1 is also 1. The output of G_1 (1) and C are inputs for G_2 which is a NAND gate ie, D is complement to the output obtained from AND gate of G_1 and C.

ie. $D = \overline{G_1 . C} = \overline{1.0} = \bar{0} = 1$

13. Ans. (a)

Boolean expression for NAND gate is $y = \overline{A . B}$

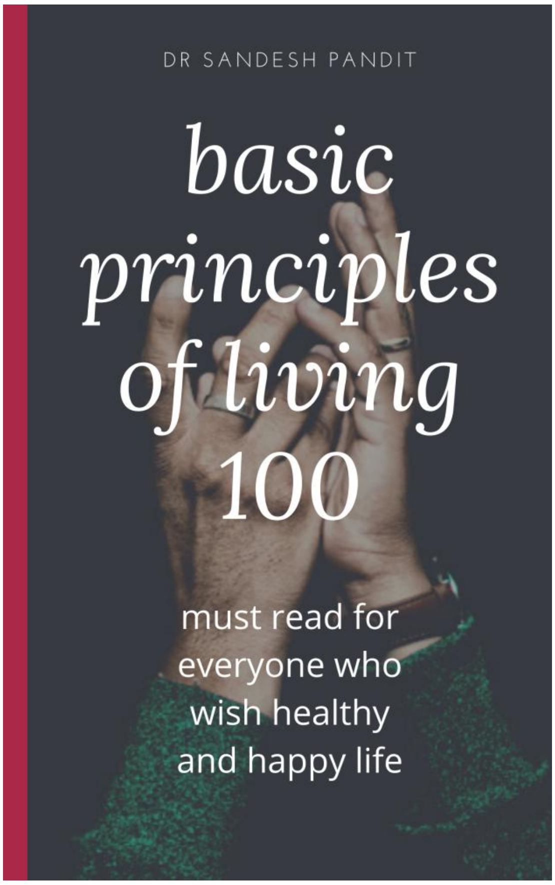
It is obtained when the output of AND gate is made as the input of NOT gate.

14. Ans. (d)

Boolean expression for NOT gate is

$y = \bar{A}$.

It has one input and one output.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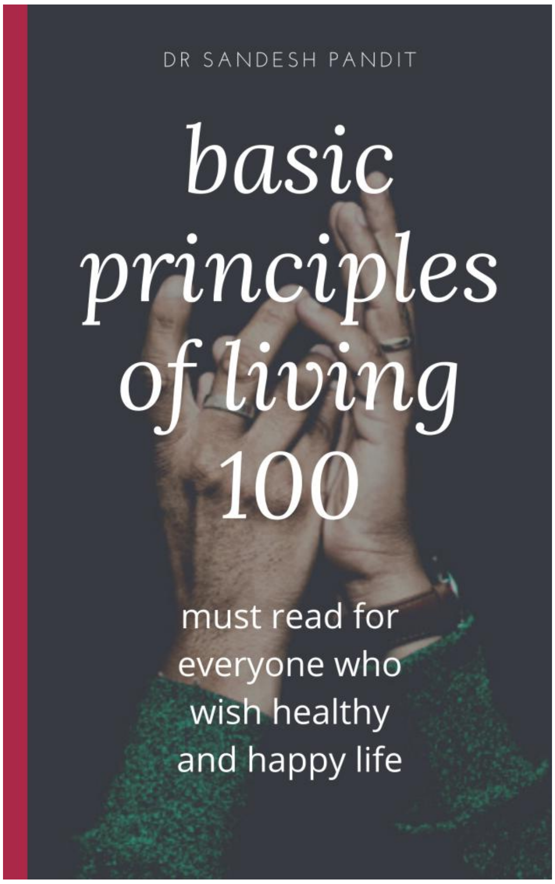
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IOM 2070

1. **Fielder can throw a cricket ball to a maximum horizontal distance of 100m.How high the fielder can throw the same ball?**
   a. 25m b. 40m
   c. 50m d. 100m
2. **A liquid is placed in graduated glass cylinder, the coefficient of real expansion of liquid is thrice that of linear expansion of the glass. On heating the liquid will:**
   a. first decreases then increases
   b. increases
   c. decreases
   d. Approximately remains the same
3. **The polarising angle between reflected and refracted rays is**
   a. 0° b. 45°
   c. 90° d. 180°
4. **The direction of the two force 6N and 2N acting on the body of mass 2kg is same, the minimum acceleration of the body cannot be less than;**
   a. $2m/s^2$ b. $2.5m/s^2$
   c. $3m/s^2$ d. $4m/s^2$
5. **At the same temperature and pressure and volume of the gases, which of the following quantities is constant?**
   a. total number of molecules
   b. Average kinetic energy
   c. Root mean square velocity
   d. mean free path
6. **A positively charged particle moving due east enters a region of uniform magnetic field directed vertically upwards, the particle will**;
   a. Get deflected vertically upwards
   b. Move in circular orbit with its speed increased
   c. Move in circular orbit with its speed unchanged
   d. continue to move due east
7. **A current is is flowing through a circular wire in clockwise direction.What will be the direction of magnetic lines of force:**
   a. parallel to the plane of the coil
   b. perpendicular to the plane of the coil away from the reader
   c. perpendicular to the plane of the coil towards the reader
   d. at any angle
8. **A source &listener is moving in the same direction with the velocity equal to half the velocity of the sound .what is the change in frequency**
   a. 0% b.100%
   c. 25% d. 50%
9. **Which of the following is always conserved in collision?**
   a. Linear momentum
   b. Angular momentum
   c. kinetic energy
   d. Torque
10. **If the biconvex lens is silvered on one side than it will behave as:**
    a. concave mirror
    b. convex mirror
    c. plane mirror
    d. converging lens
11. **The intensity of sound night increases because of**
    a. Low temperature
    b. Increase in density
    c. decrease in density
    d. calmness
12. **The product of moment of inertia and angular acceleration gives**
    a. Linear momentum
    b. Angular momentum
    c. Torque
    d. Force

13. A boat having a length 3m and breadth 2m is floating on a lake.The boat sinks by 1cm when a man gets on it.The mass of a man is

a. 60kg b. 72kg

c. 100kg d. 90kg

14. When two tuning forks of frequencies 484Hz and 486Hz are sounded together. What will be beat frequency?

a. 4Hz b. 2 Hz

c. 3 Hz d. 6Hz

15. In D.C. circuit power dissipated per unit volume is proportional to:

a. Current

b. Resistance

c. square of electric field

d. Electric field

16. A body travels with velocity 30m/s for 1st half time and with velocity 40m/s for 2nd half time. What would be average velocity?

a. 50m/s b. 35m/s

c. 40m/s d. 30m/s

17. The internal structure of crystal can be studied by

a. X rays b. γ rays

c. IR rays d. UV rays

18. When a rod of length 2m carrying current 10A is placed perpendicular to magnetic flux density of strength of 0.15T.what is the the force experienced by it

a. 2N b. 0.3N

c. 1N d. 3N

19. If no internal force is applied in a body the velocity of center of mass:

a. zero

b. increases

c. decreases

d. remains constant

20. In a dynamo, voltage is 6V current 0.5 A. What is the power generated?

a. 12 b. 1.5

c. 3 d. 5

Answer Sheet

1.c	*2.d*	*3.c*	*4.a*	*5.a*	*6.c*	*7.b*	*8.a*	*9.a*	*10.a*
11.c	*12.c*	*13.a*	*14.b*	*15.c*	*16.b*	*17.a*	*18.d*	*19.d*	*20.c*

Solution

1. Ans (c)

$R = \frac{u^2 \sin 2\theta}{g}$, $R_{max} = \frac{u^2}{g}$ ($\theta = 45°$ for max range)

$H = \frac{u^2 \sin^2\theta}{g}$, $H_{max} = \frac{u^2}{2g}$

$H_{max} = \frac{R_{max}}{2}$

2. Ans (d)

The level of liquid remains same if change in expansion of cylinder = change in expansion of liquid.

$\gamma_g V\Delta\theta = \gamma_l V\Delta\theta$

$\gamma_g = 3\alpha$ [γ_l=3α]

3. Ans. (c) According to the Brewster law.

4. Ans. (a)

For minimum acceleration, force should be minimum

$f_{min} = F_1 - F_2 = 6 - 2 = 4$ N

$F = m \times a_{min}$

$4 = 2 \times a_{min}$

$a_{min} = 2$ m/s^2

5. Ans. (a)

Under similar condition of temperature and pressure equal volume of gases contains equal no. of molecules by Avogadro's hypothesis.

6. Ans. (c)

The angle between direction of charged particle and direction of magnetic field is 90°. So, the particle experiences the maximum force and move in circular path.

7. Ans. (b)

The direction of magnetic lines of force is given by right hand thumb rule.

8. Ans. (a)

$$f^1 = \frac{v - u_0}{v - u_s} \times f$$

$$u_0 = u_s = \frac{v}{2}$$

$$f^1 = \frac{v - \frac{v}{2}}{v - \frac{v}{2}} \times f$$

$\therefore$ $f^1 = f$

Change in frequency $= \frac{f^1 - f}{f} \times 100\% = 0\%$

9. Ans. (a)

Linear momentum, total energy is conserved in every collision. Kinetic energy is conserved only in elastic collision.

10. Ans. (a)

Biconvex lens silvered on one side behaves as concave mirror and Biconcave lens silvered on one side then behaves as convex mirror.

11. Ans. (c)

Intensity (I) $= \frac{P^2}{2\rho v}$

ρ = density of medium

12. (c)

Torque (τ) = Rate of change of angular momentum $= \frac{dL}{dt} = I\frac{d\omega}{dt} = I\alpha$ [$\therefore$ $L = I\omega$]

13. Ans. (a)

Weight of a man = Weight of liquid displaced = $v\rho g$

or, $mg = 3 \times 2 \times 1 \times 10^{-2} \times 1000$ g

$\therefore$ m = 60 kg

14. Ans. (b)

Beat frequency = $f_1 - f_2 = 486 - 484 = 2$ HZ

15. Ans. (c)

$$P = \frac{V^2}{R} = \frac{V^2 \times A \times l}{\rho l \times l} = \frac{v^2}{\rho l^2} \times \text{volume}$$

$$\frac{\text{Power}}{\text{Volume}} = \left(\frac{V}{l}\right)^2 \times \frac{1}{\rho} = \frac{E^2}{\rho} \alpha E^2$$

16. Ans. (b)

$$V_{av} = \frac{\text{Total displacement}}{\text{Total time}} = \frac{S_1 + S_2}{t_1 + t_2}$$

$$= \frac{v_1 t_1 + v_2 t_2}{t_1 + t_2} \qquad \left[t_1 = t_2 = \frac{t}{2}\right]$$

$$= \frac{\frac{t}{2}(v_1 + v_2)}{t} = \frac{v_1 + v_2}{2} = \frac{30 + 40}{2} = 35 \text{ m/s}$$

17. Ans. (a) x-rays

18. Ans. (d)

$F = BIl \sin\theta = 0.15 \times 10 \times 2$ ($\theta = 90°$) = 3N

19. Ans. (d)

In the absence of external force, the velocity of centre of mass remains constant.

20. Ans. (c)

$P = \frac{V^2}{R} = IV = 6 \times 0.5 = 3W$

MOE 2070

1. **When a particle and its antiparticle are annihilate the energy released is E. What is the mass of each particle?**
   a) E / c^2 b) $E / 2c$
   c) $E / 2c^2$ d) E / c
2. **Two protons and deuteron fuse to from a muceus with a positron. The product nucleus with a positron. The product nucleus may be**
   a) neutron b) Proton
   c) neutrino d) alpha particle
3. **An X-ray tube is operated at 20 kV. The maximum speed of electrons striking the anticathode will be**
   a) 4.2×10^7 m/s
   b) 8.4×10^7 m/s
   c) 8.4×10^3 m/s
   d) 4.8×10^7 m/s
4. **The ratio of energy of hydrogen atom in the first to second excited state is**
   a) 1 : 1 b) 1 : 4
   c) 4 : 9 d) 9 : 4
5. **Planck's constant has the dimensions of**
   a) energy
   b) mass
   c) frequency
   d) angular momentum
6. **An oil drop carrying a charge q has a mass m kg. it is falling freely in air with terminal velocity v. The electric field required to make the drop move upwards with the same speed is.**
   a) mg/q b) 2 mg/q
   c) mgv/q^2 d) 2mgv/q
7. **An alpha particle of mass 6.65×10^{-27} kg travels at right angle to a magnetic field of 0.2 T with a speed of 6×10^5 m/s. The acceleration of the particle will be**
   a) 5.77×10^{12} m/s^2
   b) 5.77×10^{11} m/s^2
   c) 7.55×10^{12} m/s^2
   d) 7.55×10^{11} m/s^2
8. **When 2A current is pased through a tangent galvanometer, it gives a deflection of 30°. For deflection of 60°, the current must be**
   a) 1A b) $2\sqrt{3}$ A
   c) 4 A d) 6 A
9. **At resonance condition the effective resistance is LCR series circuit is**
   a) maximum
   b) minimum
   c) zero
   d) infinity
10. **Two straight parallel conductors carrying current is opposite directions**
    a) attract each other
    b) repel each other
    c) do not experience any force
    d) cancel each other force
11. **Ratio of magnetic field induction at the centre of a current carrying coll of**

radius R and at a distance 3R on its axis will be.

a) $\sqrt{10}$ b) $2\sqrt{10}$

c) $10\sqrt{10}$ d) $20\sqrt{10}$

12. Series combination of 2 Ω and 3Ω resistors are connected in parallel to the series combination of 1 Ω and 2 Ω resistors. The whole combination is further connected to a battery of 10 V and internal resistance 1 Ω . The potential difference between the ends of 4 Ω resistor will be

a) 5.71 V b) 4.29 V

c) 2.86 V d) 1.43 V

13. An electron moving vertically upward enters a uniform magnetic field directed towards the north. The force on the electron will be towards.

a) North b) South

c) East d) West

14. If pressure amplitude of a sound wave is doubled the intensity of sound increases to

a) 4 times b) 3 times

c) 2 times d) 9 times

15. A sonometer wire is vibrating in its second overtone. There are

a) 2 nodes and 2 antinodes

b) 1 nodes and 2 antinodes

c) 4 nodes and 3 antinodes

d) 3 nodes and 3 antinodes

16. A car travels at a speed of 20 m/s towards a high wall. The driver sound a horn of frequency 124 Hz. If the velocity of sound in air is 330 m/s, the frequency of the reflected sound heard by the driver will be

a) 109 Hz b) 140 Hz

c) 149 Hz d) 280 Hz

17. Time taken by light to cross a glass slab of thickness 5 cm and refractive index 1.5 will be

a) 2×10^{-10} s

b) 2.5×10^{-10} s

c) 3×10^{-10} s

d) 3.5×10^{-10} s

18. The width of the third fringe in Young's double slit interference experiment is 0.1 mm. The width of the fifth fringe will be

a) 0.17 mm b) 0.06 mm

c) 1.5 mm d) 0.1 mm

19. Lumen is an unit representing

a) Luminous flux

b) Luminous intensity

c) Illuminance

d) Luminance

20. Two starts radiate maximum energy at λ = 3200 A° and 4000 A° respectively. The ratio of their temperature in Kelvin scale will be

a) 4 : 5 b) 5 : 4

c) 25 : 16 d) 2 : 5

21. If relative humidity is 100%, it means, the temperature of the toom is equal to

a) 4° C b) 0° C

c) dew point d) 20° C

22. Two liquids of same volume have densities in the ratio 1 : 3 and specific

heats in the ratio 3 : 1. The ratio of their heat capacities will be

a) 1 : 1 b) 1 : 9

c) 9 : 1 d) 1 : 3

23. Two bodies are moving with velocities V_1 and V_2 respectively. V_1 is along X-axis and V_2, moving in the first quadratnt, makes an angle θ with V_1. The relative velocity of V_1 with respect to X- component of V_2 will be

a) $V_1 - V_2 \cos\theta$ b) $V_1 - V_2 \sin\theta$

c) $V_1 \cos\theta - V_2$ d) $V_2 \sin\theta + V_2$

24. Dimension of the coefficient of viscosity may be

a) $ML^{1}T^{-1}$ b) $M^{-1}L^{1}T^{-1}$

c) $ML^{-1}T^{-1}$ d) $ML^{-1}T^{1}$

25. The value of acceleration due to gravity at a depth below earth's surface is one-fourth its value on the surface. The depth will be nearly

a) 3/4 R b) 1/2 R

c) $\sqrt{2}$ /3 R d) 1/4 R

26. A particle is vibrating in a SHM amplitude A . At what distance from equilibrium position is its potential and kinetic energies be equal?

a) A b) $A/\sqrt{2}$

c) $\sqrt{3}/2$ A d) $2/\sqrt{3}$ A

27. How much leads of specific gravity 11 must be added to piece of cork of specific gragity 0.2 weighting 10g so that it just float on water?

a) 2.2 g b) 4.4 g

c) 44 g d) 440 g

28. Breaking stress (in Nm^{-2}) of a wire of radius 3 mm is F. The breaking stress of the same material of radius 6 mm will be

a) F/4 b) F/3

c) F/2 d) F

29. Two point masses of 1 kg and 2 kg separated by 0.5 m constitute a system. The distance of the centre of mass of the system from 1 kg mass is

a) 0.15 cm b) 0.25 cm

c) 0.33 cm d) 0.4 cm

30. Time taken by a train of length 150m and travelling with a uniform velocity of 60 km/hr to cross completely a bridge of length 1.5 km will be

a) 9s b) 9.9 s

c) 90 s d) 99 s

Answer Sheet

1. c	*2. d*	*3. b*	*4. d*	*5. d*	*6. b*	*7. a*	*8. d*	*9. b*	*10. b*
11. c	*12.*	*13. c*	*14. a*	*15. c*	*16. d*	*17. b*	*18. d*	*19. a*	*20. d*
21. c	*22. a*	*23. a*	*24. c*	*25. a*	*26. b*	*27. c*	*28. d*	*29. c*	*30. d*

Solution

1. Ans. (c) In pair annihilation, particle and antiparticle combined to release energy

$E = mc^2 + mc^2 = 2mc^2$

$\therefore\ m = \dfrac{E}{2c^2}$

2. Ans. (d)

$2\,{}_1H^1 + {}_1H^2 \rightarrow {}_2He^4 + {}_{+1}\beta + Q$

Proton + Deuteron → (α – particle) + Positron

3. Ans. (b)

$eV = \dfrac{1}{2}mv^2$

or, $v_{max} = \sqrt{\dfrac{2eV}{m}}$

$= \sqrt{\dfrac{2 \times 1.6 \times 10^{-19} \times 20 \times 10^3}{9.1 \times 10^{-31}}} = 8.4 \times 10^7 m/s$

4. Ans. (d)

1^{st} excited state corresponds to n = 2

2^{nd} excited state corresponds to n = 3

As $E \,\alpha \left(\dfrac{1}{n^2}\right)$

$\dfrac{E_1}{E_2} = \dfrac{n_2^{\,2}}{n_1^{\,2}}$

$= \dfrac{3^2}{2^2} = \dfrac{9}{4}$

5. Ans. (d)

$E = hf \rightarrow h = \dfrac{E}{f} = \dfrac{[M\,L^2\,T^{-1}]}{[T^{-1}]}$

$= [M\,L^2\,T^{-1}]$

Angular momentum = mvr = $[M\,L^2\,T^{-1}]$

6. Ans. (b)

When the oil drop is falling freely under the effect of gravity in a viscous medium with terminal speed v, then

$mg = 6\,\pi\eta rv$…… (i)

To move the oil drop upwards with terminal velocity v, If E is the electric field intensity required, the $qE = mg + 6\pi\eta rv$

or, qE = mg + mg [From (i)]

$\therefore\ E = \dfrac{2mg}{q}$

7. Ans. (a)

$F = BqV \sin\theta$

$ma = 0.2 \times 2e \times 6 \times 10^5$

$a = \dfrac{0.2 \times 6 \times 10^5 \times 2 \times 1.6 \times 10^{-19}}{6.6 \times 10^{-27}}$

$= 5.77 \times 10^{12}\ m/s^2$

8. Ans. (d)

For Tangent galvanometer

$I = K \tan\theta$

Where $K = \dfrac{2Rn}{\mu_0 H}$ = Reduction factor

$\dfrac{I_2}{I_1} = \dfrac{\tan\theta_2}{\tan\theta_1} = \dfrac{\tan 60}{\tan 30} = 3$

$I_2 = 3 \times 2 = 6A$

9. Ans. (b)

Effective resistance (impedance) of LCR series

$z = \sqrt{R^2 + (X_L - X_C)^2}$

At resonance $X_L = X_C$

$\therefore$ z = R (minimum)

10. Ans. (b)

In opposite direction = Repel

In same direction = Attract

11. Ans. (c)

$\dfrac{B_1}{B_2} = \dfrac{\dfrac{\mu_0 NI}{2R}}{\dfrac{\mu_0 NIR^2}{2[R^2 + (3R)^2]^{3/2}}}$

$= \dfrac{10^{3/2} \times R^3}{R^3}$

$= 10\sqrt{10}$

13. Ans. (d)

Direction of force is given by Fleming's left hand rule.

14. (a)

$I = \dfrac{{P_{max}}^2}{2\rho v}\ \alpha\ {P_{max}}^2$

Where P_{max} = Pressure amplitude

15. Ans. (c)

2^{nd} overtone = 3^{rd} harmonic

i.e 4 nodes and 3 antinode

16. Ans. (b)

$f^1 = \frac{V + u_0}{V - us} \times f$

$= \frac{330 + 20}{330 - 20} \times 124$

= 140HZ

17. Ans. (b)

Time taken= $\frac{\mu t}{c}$

$= \frac{1.5 \times 5 \times 10^{-2}}{3 \times 10^{8}}$

$= 2.5\times10^{-10}$s

18. Ans. (d)

Fringe width = $\frac{\lambda D}{d}$

19. Ans. (a)

Lumen $\rightarrow$ luminous flux

Candela $\rightarrow$ Luminous intensity

Lux $\rightarrow$ Illuminance

20. Ans. (d)

Wein's displacement law

$\lambda \ \alpha \ \frac{1}{T}$

21. Ans. (c)

At RH = 100%

Room temperature = dew point

RH = $\frac{\text{SVP at dew point}}{\text{SVP at room temperature}} \times 100\%$

22. Ans. (a)

Q = msdt

$Q = \rho \times v \times s \times dt$

$Q \;\alpha\; \rho s$

$\frac{Q_1}{Q_2} = \frac{1}{3} \times \frac{3}{1} = 1:1$

23. Ans. (a)

$v_1 - V_2 \cos\theta$

24. Ans. (c)

$ML^{-1}\,T^{-1}$

25. (a)

Refer to the Chapter, if you want solution

26. (b)

Refer to the Chapter, if you want solution

27. (c)

Refer to the Chapter, if you want solution

28. (d)

Refer to the Chapter, if you want solution

29. (c)

Refer to the Chapter, if you want solution

30. (d)

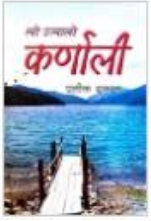
$S = ut$

$$150 + 1500 = \frac{60 \times 1000}{60 \times 60} \times t$$

$\therefore$ $t = 99$ s

नेपालमा कम्युनिस्ट पार्टीको विकासक्रम, सरकार र नेतृत्व

नेपाली कांग्रेसको इतिहासको प्रारूप



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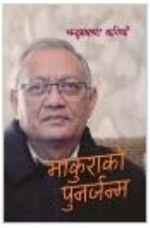
गद्य शैलीको रूपविज्ञान



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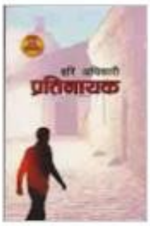


प्रतिनायक

रिकुटे

स्कुल बेन्ने बालक

कर्म

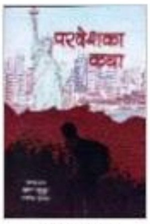
वीर्य जमिन

सारङ्गी

अदभुत तिवारी

छोट्टी

समुन्द्र साउती



परदेशका कथा

डिलको डोब

Of Walls And Pigeons

BPKIHS 2015

1. which of the following has the same dimension of as energy?

a. work b. pressure
c. stress d. young's modulus

2. when momentum of body increases by 50% K.E. increases by ?

a.50% b.100%
c.125% d.150%

3. A body is projected at 45° to horizontal .what is the time required for it to return to the same height if its initial speed was 40m/s.

a.$20\sqrt{2}$ b.$40\sqrt{2}$
c.$40\sqrt{2}/g$ d.$20\sqrt{2}/g$

4. A body is moving in a circular track. when it completes a half circle, its distance and displacement are respectively given by

a.2r and $2\pi r$ b. $2\pi r$ and 2r
c. πr and 2r d . πr and πr

5. If $\vec{P}+\vec{Q}$ And $\vec{P}-\vec{Q}$ are perpendicular to each other, then

a. P and Q have same direction.
b. P and Q have equal magnitude
c. both d. none

6. If length of string is increased is increased by 1% ,strain developed is

a.1/1000 b.1/10
c.1/10000 d.1/100

7.In the given graph,body is moving with

a. zero velocity
b .constant velocity
c. accelerated motion
d.non uniform motion

8. A body is moving around a curve with velocity of 20m/s.when velocity is doubled tendency to overturn is

a. doubled b. quadrapled
c.8 times d.6 times

9. A body of mass 0.5 kg is moving with velocity of 2m/s. It then collides with velocity with a body of mass 1 kg inelastically ,then loss of energy is

a.0.5J b.0.34J
c.0.67J d.1J

10. During rainbow formation ,which takes place?

a.Scattering and focusing
b. Rarefaction
c.Depression and diffraction
d.Dispersion and total internal reflection

11. A cylinder is rotated in inclined plane, find its acceleration

a.$g\sin\theta$ b.$\frac{1}{2}g\sin\theta$
c. $\frac{2}{3}g\sin\theta$ d. $\frac{3}{2}g\sin\theta$

12. Mars has mass 1/10 times earth and radius ½ times earth,then acceleration due to gravity in moon is

a.2/5 g b.5/2 g
c.g d.4g

13. 8 drops coalease to form a single drop.If the initial speed of drops is v, then final speed of drop is

a. v b. 2v
c.4v d.8v

14. our eyes are most sensitive to

a. green b. yellow
c. red d. yellow -green

15. The emf developed when one junction of a loop formed by two wires is kept in ice and another junction is kept in hot water is called

a. Seeback effect b. Peltier effect
c. Thompson effect d. Joule's effect

16. which of the following substance shows increase in resistivity when temperature is increased?

a.carbon b.electrolytes
c.pure metal d.Germanium

17. If the length of closed pipe is 10cm ,find the length of organic pipe when fundamental frequency of the closed organ pipe resonates with the first overtone of the open pipe?

a.10cm b.20cm
c.40cm d.80cm

18. If two equation of plane progressive wave is y_1=Asin π (506t+ $\frac{2x}{\lambda}$) and y_2=Asin π(500t+$\frac{2x}{\lambda}$), then beats in one minute is

a.6 b.3
c.360 d.180

19. The equation of wave is given by y=10sin10t ,find the time period

A $\frac{2\pi}{5}$sec b. $\frac{\pi}{5}$sec
c. $\frac{4\pi}{5}$sec d. $\frac{5}{\pi}$sec

20. Choke coil is used for high frequency ac source is

a.iron core b.air core
c.diamagnetic d.paramagnetic

21. A microscope is focused on a dot. When a slab of μ = 3/2 and thickness 3 cm is kept above dot ,how should the position of microscope be changed to mark the dot again ?

a. 1 cm upward b. 2 cm upward
c. 1 cm downward d. 2 cm downward

22. Find the velocity of sound in solid if young's modulus is 3×10^{11} N/m^2 and density is 10000 kg/m^3

a. 4477 m/s b. 5477 m/s
c. 6477 m/s d. 6000 m/s

23. When two waves of same frequency, constant initial phase and same direction superimpose, the phenomenon is called

a. beats b. Interference
c. Doppler's effect d. standing waves

24. A ray of light is incident on first face of prism of refracting angle 60^0 and suffers a minimum deviation of 30^0 . Find the velocity of light in medium?

a. $3\times10^8 m/s$ b. $2\times10^8 m/s$
c. $2.2\times10^8 m/s$ d. $1.5\times10^8 m/s$

25. In young's double slit experiment, light of wavelength 660 nm is used and 0.44 mm of fringe width is obtained. When another monochromatic source of light is used, then 10 fringes are obtained at 3.3 mm. Find have wavelength of light used

a. 495 nm b. 600 nm
c. 650 nm d. 590 nm

26. Power developed by a person consuming 60 gram of ice per minute if latent heat of ice 80 cal/gm is

a. 80 J b. 336J
c. 400J d. 100J

27. A gas in a vessel expands with the decrease in internal energy. The process is

a. reversible b. irreversible
c. isothermal d. adiabatic

28. Two trains moving towards each other with velocity 60 km/hr and 45 km/hr. The frequency produced by 60 km/hr is 500 Hz. Then the frequency heard by passenger of train moving a 45 km/hr is (speed of sound = 340 m/s)

a. 450 Hz b. 545 Hz
c. 525 Hz d. 600 Hz

29. Two identical metal plates are given positive charges $Q_1$and Q_2 respectively (Q_1>Q_2), If they are now brought close together to form a parallel plate capacitor of capacitance C, the potential difference between them is.

a. $\frac{Q_1+Q_2}{2C}$ b. $\frac{Q_1+Q_2}{C}$
c. $\frac{Q_1-Q_2}{C}$ d. $\frac{Q_1-Q_2}{2C}$

30. A bar magnet of length l is bent in the form of semicircle. The new magnetic moment is (Initial magnetic moment is P).

a. P b. $\frac{2P}{\pi}$
c. $\frac{P}{\pi}$ d. $\frac{P}{2\pi}$

31. An oil drop of charge equal to 4 times of electron is in equilibrium due to electric field. If the density of oil drop is 2× 10^{-6} kg/m^3 and radius is 1mm. Then the required electric field intensity is

a. 128282 V/m b. 182244 V/m
c. 178288 V/m d. 128822 V/m

32. In a resonance tube, oil is kept instead of water. What is the change in frequency ?

a. Increases b. Decreases
c. Remains same d. Depends on density

33. A point source is kept at a certain distance from a screen. If the distance is halved, the intensity observed at later case is

a. 4 times b. 2 times
c. same d. 3 times

34. A water is flowing in a tube of radius 'r' and length 'l'. The flow of liquid per minute is 'v'. flow of liquid per minute will be.

a. 4 times b. 2 times
c. same d. 3 times

35. Mercury is heated through 20^0c . If the change in volume be 0.06%, then the linear expansivity of liquid is

a. $1 \times 10^{-5}/^0c$ b. $2 \times 10^{-5}/^0c$
b. $3 \times 10^{-5}/^0c$ d. $4 \times 10^{-5}/^0c$

36. A uniform electric field E is applied along the axis of a hemispherical surface of radius R, the electric flux through the surface is

a. $2\pi R^2 E$ b. $4\pi R^2 E$
c. $2\pi R^2 E$ d. $\pi R^2 E$

37. When X-rays are incident on a crystal, diffraction occurs when

a. Wavelength of X-ray is in order of crystal lattice
b. Wavelength of X-ray in order nuclear size
c. wavelength of X-ray is greater than crystal lattice
d. wavelength of X-ray is smaller than crystal lattice

38. A bucket full of water is rotated in a vertical circle. The tension at the highest point is

a. Centrifugal force+weight of the rope
b. Centrifugal force-weight of the rope
c. Centrifugal force
d. Weight of the bucket

39. X-ray tube is operating at 3.2 mA and at 50 KV. The number of electrons striking cathode per second is

a. $2 \times 10^{16}/sec$ b. $2 \times 10^{17}/sec$
b. $3 \times 10^{16}/sec$ d. $4 \times 10^{17}/sec$

40. Thick wire is used in transformer. It is because

a. Decrease eddy loss
b. Total linkage of flux
c. Increase Joule's heating loss
d. Decrease Joule/s heating loss

41. The inductance of a coil is 1 μH and capacitance 0.01μF.Then the wavelength produced due to combination is

a. 0.5 b. 50
c. 1000 d. 0.05

42. A substance X when decays forms stable product Y. The initial number of atoms of X is 8× 10^{20} with its half life 2 hours.The energy released per atoms is 1 × 10^{-7}joules.Then the amount of energy released after 6 hours is

a. 7×10^{13}Joule b. 10^{13}Joule
b. 3×10^{13}Joule d. 5×10^{13}Joule

43. A simple pendulum has its length 'l'. Its time period will be doubled when

a. Its length is made 4 times
b. its length is made 2 times
c. its mass is made 2 times
d. mass is made 4 times

44. Which of the following has negative sp. heat capacity?

a. metal b. water
c. steam d. lce

45. When like current is passed through two wires,

a. they attract each other
b. they repel each other
c.they don't show any attraction and repulsion
d. None

46. The stem of tuning fork contains.

a. Longitudinal wave b. Transverse wave
c. Stationary wave d. Pressure wave

47. A bird is flying over a train of 1 km length in a direction just opposite to train. The velocity of both train and bird is 50 m/s. The time taken by bird to cross bridge is

a. 10 sec b. 5 sec
c. 15 sec d. 1 sec

48. The terminal p.d of a cell kept in open circuit is;

a. E b. E/2
c. 0 d. ∞

49. When water is heated from 0^0c to 4^0c.

a. $Cp < Cv$ b. Cp = Cv
c. $Cv < Cp$ d. Cp - Cv = 0

50. The Gajiabad express travels from Mujaffanagar to assam having a charge 711 μc covers distance 960 km in two hours. The value of magnetic field being 5×10^{-4}T . The force required to oppose the motion is;

a. 4.47×10^{-5}N b. 4.74×10^{-5}N
c. 7.47×10^{-7}N d. 7.74×10^{-5}N

BPKIHS 2015 Answers

1 Ans (a)

Energy = work = (ML^2T^{-2})

2Ans (c)

$K\in = {}^{1}/_{2}\ mv^2 = \frac{m^2v^2}{2m} = \frac{p2}{2m}$

$K\in \propto p^2\ so\ \frac{\Delta K\in}{K.\in} \times 100\% =$

$\left[\left(\frac{100+x}{100}\right)^n - 1\right] \times 100\%$

$=\left[\left(\frac{100+50}{100}\right)^2 - 1\right] \times 100\%$

=125%

3Ans (c)

Time of flight (T) = $\frac{2u \sin\theta}{g}$

T = $\frac{2\times40\times Sin\ 45}{g} = \frac{40\sqrt{2}}{g}$

4Ans (c)

Distance = length travelled = half the perimeter of circle = πr
Displacement = Twice the radius = 2r

5Ans (b)

When two vectors are perpendicular to each other, their dot product is zero.

$(\vec{P} + \vec{Q})\ (\vec{P} - \vec{Q}) = 0$

$\vec{P} - \vec{P}.\vec{Q} + \overrightarrow{Q.P}$- $Q^2 = 0$

$P^2 - Q^2 = 0$

P = Q

6Ans. (d) Strain = $\frac{\Delta l}{l} = \frac{1}{100}$

7Ans (b)

With the increase in time, the value of velocity is same. so, the body is moving with constant velocity.

8Ans (b)

Tendency to overturn is the force

F = $\frac{mv^2}{r} \propto v^2$

So, when velocity is doubled, tendency to overturn is quadrupled.

9Ans (c)

Initial kinetic energy ($K\in_1$) = $\frac{1}{2} \times \frac{1}{2} \times 2^2$ = 1 joule

After collision $m_1 u_1 + m_2 u_2 = (m_1+m_2)v$

$1/2\times2=1.5v \therefore v=2/3$

$KE_2 = 1/2(m_1 m_2)V^2 = \frac{1}{2}(0.5+1)\times \frac{2}{3} \times \frac{2}{3} = \frac{1}{3}$ joules

$\therefore$ loss of energy=$1-\frac{1}{3} = \frac{2}{3}$=0.67 joules

10Ans (c)

Formation of rainbow = dispersion of light by water droplets (rain drops) in the atmosphere & total internal reflection of light.

11Ans (c).

Moment of inertia for cylinder (solid) about its geometrical axis = $\frac{1}{2}MR^2 = MK^2$

$\frac{K^2}{R^2} = \frac{1}{2}$

Acceleration down the plane

a = $\frac{g \sin\theta}{1+\frac{K2}{R2}}\ \frac{g\ sin\theta}{1+{}^{1}/_{2}} = {}^{2}/_{3}\ g \sin\theta$

12 Ans. (a)

g at earth = $\frac{GM}{R^2}\ at\ surface$

gm at mars = $\frac{GM/10}{({}^{R}/_{2})^2} = {}^{2}/_{5}\ g$

13Ans. (c)

Drop of water fall with uniform critical velocity

v = $\frac{2}{9}\ \frac{r^2(\rho - \sigma)g}{\eta}$

$v \propto r^2$

By volume conservation,

$n.\ {}^{1}/_{3}\ \pi r^3 = {}^{4}/_{3}\ \pi\ R^3$

$R = n^{1/3}\ r$

$R = 8^{1/3}\ r = 2r$

$v^1 \propto r^2$

$\therefore v^1 = 4v$

14 Ans (d)

Our eyes are most sensitive to $5500\ \overset{0}{A}$ wavelength corresponding to yellow - green

15 Ans. (a)

16Ans. (c)

The resistance of metal conductor at temperature t^0 c is given by
R_t = Ro (1+∝t)
∝ is the for pure metals '∝' is -ve for semi conductors and insulators.

17 Ans (c)

Length of closed pipe (L_c) = 10 cm
Length of open pipe (L_0) = ?
Fundamental frequency of closed pipe =
first overtone of open pipe.
$\frac{V}{4Lc} = (n+1)\frac{V}{2Lo}$
$\frac{V}{4Lc} = \frac{2V}{2Lo}$
L_0 = 4Lc = 4×10 = 40cm

18Ans (d)

y_1 = A sin π (506t + ϕ)
y_2 = A sin π (500 $t+\ \phi$)
comparing the equations with
y = Asin (wt +ϕ)
= A sin (2πft +ϕ)
$2f_1 = 506 \Rightarrow f_1 = 253$
$2f_2 = 500 \Rightarrow f_2 = 250$
Beats = f_2 - f_1 = 253 – 250=3
= 3 per second
= 3× $60 = 180\ /\ min$

19 Ans. (b)

ω = 10
$\frac{2\pi}{T} = 10\ \Rightarrow T = \ ^{\pi}/_{5}$ sec

20 Ans (b)

Choke coil used for high frequency ac source has air core because air core will minimize L and hence X_L.

21Ans. (b)

The microscope should be raised upward since the dot will be apparently shifted upward due to refraction.

Shift in height = Real depth - Apparent depth
= RD (1-$^1/_\mu$)
= $3(1-\frac{1}{3/2})=1$

22 Ans (b)

velocity of sound in medium is given by
v = $\sqrt{\frac{Y}{\rho}} = \sqrt{\frac{3\times10^{11}}{1000}} = 5477m/s$

23 Ans. (b)

24Ans. (c)

condition for minimum deviation is
Angle of incidence = Angle of emergence (i = e)
Angle of refraction in 1^{st} face = angle of incidence in 2^{nd} face
$r_1 = r_2 = r$
ϱ_{min} = i+e - (r_1 + r_2)
= 2i - A (r_1 +r_2 = A)
= 2 i - A
i = $\frac{\varrho min + A}{2}$
r = $^A/_2$
$\mu = \frac{sini}{sinr} = \frac{\sin \frac{\varrho min + A}{2}}{sinA/2}$
= Sin $\frac{\frac{30+60}{2}}{\sin 60/2}$
$\mu = \sqrt{2}$
$\mu = \frac{Speed\ of\ light\ in\ air\ (C)}{Speed\ of\ light\ in\ medium\ \ (V)}$
V = $\frac{3\times108}{\sqrt{2}}$ = 2.2 ×10^8m/s

25.Ans. (a)

Fringe Width (β) = $\frac{\lambda D}{d}$
D = Distance between slit & screen
condition (i) 10 fringe are obtain at 3.3mm
Fringe width (β) = $\frac{3.3}{10} = 0.33mm$
0.33 = $\frac{\lambda D}{d}$
Dividing (i) by (ii)

$\frac{0.44}{0.33} = \frac{660}{\lambda 1}$

λ_1 = 495mm

∴ wavelength of light used is 495mm

26 Ans. (b)

Power = $\frac{workdone}{time} = \frac{ml}{t} = \frac{60\times80}{60}$

= 80 calorie = 80 × 4.2

= 336 Joule

27 Ans. (d)

In an adiabatic process, the system is allowed to undergo changes in thermal isolation from the surroundings.

First, law of thermodynamics

$\Delta Q = \Delta U + \Delta w$

For adiabatic processΔQ=0

0 = $\Delta U + \Delta w$

0 = $\Delta U + P\Delta v$

p$\Delta v = -\Delta U$

Internal energy is decreased when a gas in a vessel expands ⇒ the condition for adiabatic process.

28 Ans. (b)

f1 = $\left(\frac{V+Vo}{V-VS}\right) f$

V_S = 60 km/hr =50/3 m/s

V_O = 45 km/hr = $^4/_2$ m/s

$f_1 = \left(\frac{340+{}^{25}/_2}{340-{}^{50}/_3}\right) \times 100$

=545 Hz

29Ans. (b) see chapter

30Ans. (b)

Initial displacement between two end joints = l

final displacement between two end points = 2r

πr = l

r = $^{\lambda}/_{\pi}$

2r = $\frac{2l}{\pi}$

Initial magnetic moment p∝ـ⅄

final magnetic moment $p^1 \propto \frac{2l}{\pi}$

∴ $\frac{P1}{P} = \frac{2l}{\pi/\lambda}$

∴ p1 = $\frac{2p}{\pi}$

31 Ans. (a)

Electric force = weight of oil drop

q$\in = mg$

4 e $\in = mg$

$\in = \frac{mg}{4e} = \frac{V\times\varrho\times g}{4\,e} = {}^4/_3\,\frac{\pi r^3\times\varrho\times g}{4\,e}$

$\frac{4\pi\times(16^{-3})^3\times2\times10^{-6}\times9.8}{3\times4\times1.6\times10^{-19}}$

=1828282 v/m.

32 Ans. (c)

The frequency is due to vibration of air column and not due to liquid so frequency is unchanged.

33 Ans. (a)

In a non- absorbing medium

power = constant

I = $^P/_A \propto {}^1/_A \propto {}^1/_{4\pi r2}$

34 Ans. (d)

Rate of flow of liquid through a capillary tube of radius 'r', length 'l' under streamlined motion for constant pressure (Δp) across the capillary is given by

$\frac{v}{t} = \frac{\pi r^4}{8\,ml}\ \Delta P$

=

$\frac{\Delta p}{8\eta l/\pi r^4} = \frac{\Delta p}{R}\,(R = fluid\ resistance)$

$\frac{v}{t} \propto \frac{(2r)^4}{2l}\ \frac{16r^4}{2l}$

∴ $\left(\frac{v}{t}\right)^1 = 8({}^v/_t)$

The flow of liquid will be 8 times the initial

35 Ans (a)

$\Delta v = v\Upsilon\Delta\theta$

$\Upsilon = \frac{\Delta V}{V\Delta\theta} = \frac{0.06}{100\times20} = 3\times10-5/°c$

$\propto = {}^{r}/_{3} = 1 \times 10^{-5}/°c$

36Ans (a)

$\phi = \in . dA . \cos\theta$

$= \in . \frac{1}{2}(4\pi R^2)\cos 0$

$= 2\pi R^2 \in$

37Ans. (a)

X- rays beam of wavelength (λ) when incident on a crystal of space 'd' between interaction planes at a glancing angle 'θ' diffraction maxima is given by

2d sin $\theta = n\lambda$

Thus, wavelength for intensity of X-rays is $\lambda \leq 2d$.

Diffraction occurs only when λ is in order of crystal lattice.

38 Ans. (b)

At highest Point

$T + mg = \frac{mv^2}{R}$

$T = \frac{MV^2}{R} - mg$

39 Ans. (a)

q = ne

It = ne

$${}^{n}/_{t} = {}^{I}/_{e} = \frac{3.2mA}{1.6 \times 10^{-19}} =$$

$2 \times 10^{16}/_{sec}$

40 Ans. (d)

41Ans. (b)

Under Resonance condition

$X_L = Xc$

$\omega L = \frac{1}{\omega C}$

$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-6} \times 0.01 \times 10^{-6}}} = 10^7$

$2\pi f = 10^7$

$f = 10^7/2\pi$

$C = f\lambda = \frac{3 \times 10^8}{10^7/_{2\pi}} = 60\pi$

Nearest answer 'b'

42. ans (a)

Number of atoms left after n half lives

$N = \left(\frac{1}{2}\right)^n No$

N_0 = initial number of atoms

Energy released per atom $= 1\times 10^{-7} joule$

$n = \frac{Total\ time\ given}{half\ life} = \frac{6hrs}{2hrs} = 3$

$N = \left(\frac{1}{2}\right)^3 \times 8 \times 10^{20}$

$No = 10^{20}$

Number of atoms decayed

$= 8\times10^{20} - 10^{20}$

$= 7 \times 10^{20}$

Total energy released = Decayed atoms ×energy released per atom

$= 7\times10^{20} \times 10^{-7}$

$= 7\times 10^{13}$ Joule

43 Ans. (a)

$$T = 2\pi\sqrt{{}^{l}/_{g}}$$

Ans. (c)

Ans. (a)

46Ans. (a)

Waves produced in stem are longitudinal stationary while in prongs are transverse stationary.

47 Ans. (a)

Time taken by bird to cross bridge

$= \frac{length\ of\ train}{Relative\ velocity\ of\ bird\ w.r.t\ to\ train}$

$= \frac{1\ km}{v1+v2} = \frac{1000}{50+50} = 10\ sec$

48.Ans. (a)

For open circuit

current (I) = 0

Terminal P.d. (V) =E-ir

$\therefore V = E$

Terminal P.d. is zero only when there is short circuit.

49Ans (a)

Cp>Cv for the substance which expands on heating, when water is heated from 0^0c to 4^0c it contracts so cp<Cv

50Ans. (b)

Force experienced by train

$F = q\times(\vec{V}\times\vec{B})$

$= 711\times 10^{-6}\times\frac{960\times100}{2\times60\times60}\times 5\times 10^4$

Where $V = \frac{distance}{time}$

$= 474\times 10^{-5}N.$

Answer Sheet

1. a	*2. c*	*3. c*	*4. c*	*5. b*	*6. d*	*7. b*	*8. b*	*9. c*	*10. c*
11. c	*12.a*	*13. c*	*14. d*	*15. a*	*16. c*	*17. c*	*18. d*	*19. b*	*20. b*
21. b	*22. b*	*23. b*	*24. c*	*25. a*	*26. b*	*27. d*	*28. b*	*29. b*	*30. b*
31. a	*32. c*	*33. a*	*34. d*	*35. a*	*36. a*	*37. a*	*38. b*	*39. a*	*40. d*
41. b	*42.a*	*43. a*	*44. c*	*45. a*	*46. a*	*47. a*	*48. a*	*49. a*	*50. b*

BPKIHS 2016

1. **What is the dimensional formula of plank's constant?**

a. MLT^{-2} b. MLT^{-1}
c. ML^2T^{-1} d. ML^2T^{-3}

2. **Which of the following below have unit electron - volt?**

a. Coulomb
b. Potential difference
c. Energy d. Power

3. **Which of the following is vector quantity?**

a. Gravitational potential
b. Current density
c. Electric density
d. Angle

4. **If the linear momentum of a body increases by 50% then the percentage increase in its KE will be**

a. 50% b. 125%
c. 100% d. 225%

5. **The voltage of domestic ac is 22V. This represents:**

a. peak voltage b. Rms value
c. mean voltage d. none

6. **Intensity of x-ray can be increased by**

a. Increasing potential difference across the target.
b. Decreasing potential difference across the target
c. by increasing the current
d. by decreasing the current

7. **At above curies temperature, ferromagnetic behaves as,**

a. Diamagnetic substance
b. paramagnetic
c. Superconductor
d. None

The most appropriate material for making cooking pot is the having.

a. Low sp. heat and high conductivity
b. Low sp. heat and low conductivity
c. High sp. heat and low conductivity
d. High sp. heat and high conductivity

9. **Among 5 resistors each of having 1Ω resistance, 3 resistors are connected in parallel and 2 are in series then the effective resistance is,**

a. 3/7 b. 7/3
c. 5 d. 3

10. **Water contracts when**

a. Heated from 4ºC b. Heat above 0**ºC**
c. Cooled from 10ºC d. Cooled from 4ºC

11. **A man goes 10 Km to north and 20 Km/hr east. Find the relative velocity?**

a. 22.46 km/hr b. 24.36km/hr
c. 22.36 km/hr d. 25.56 km/hr

12. **AC is directly converted into DC by .**

a. motor b. transmitter
c. transformer d. rectifiers

13. **A cricket player catches a ball of mass 150 gm and moving with a velocity 20m/sec. If the ball is caught in 0.1 sec. The force of the below exerted on hand of the player is,**

a. 30 N b. 300 N
c. 3000N d. 30000 N

14. **The magnetic lines of forces inside bar magnet is from,**

a. do not exist b. north to south
c. south to north d. none

15. **A copper ring is help horizontally and a bar magnet is dropped though the ring with its length along the axis of the ring. Then the acceleration of the falling magnet is**

a. equal to 'g' b. less than 'g'

c. more than 'g'   d. none

16. which of the following is independent upon the transformer?

a. Voltage   b. Frequency
c. Current   d. eddy current

17. A body sliding on a smooth inclined plane requires 4 seconds to reach the bottom starting from rest at the top. How much time does it take cover one-fourth distance starting from rest at the top?

a. 1S   b. 2S
c. 4S   d. 16S

18. When a bucket filled with water is rotated in a vertical circle then the tension in the uppermost point is,

a. Centripetal force
b. Centripetal force + wt. of rope
c. Centripetal force -wt. of rope
d. None

19. The weight of the body is maximum in lift when the lift is

a. Moving downward
b. moving upward
c. slowly moving upward
d. freely falling

20. The mass of the mars planet is $\frac{1}{10}th$ of mass of the earth & half of the diameter of earth. If the acceleration due to gravity of the earth is 9.8 m/s^2. Then, what is the acceleration, due to gravity of the planet (Mars) is,

a. 9.8 m/s^2 b. 3.9 m/s^2
c. 1.76m/s^2 d. 3.2m/s^2

21. The colour of the sky is seen blue due to

a. Dispersion
b. Scattering
c. Interference   d. Refraction

22. The no. of images when the object is placed between two mirrors making an angle 60º is,

a. 7   b. 6
c. 5   d. 3

23. The angle of incidence of light 15º is incident on a prism, having angle of prism 60º. If the angle of deviation is 55º then the angle of emergence will be

a. 45º   b. 55º
c. 95º   d. 100º

24. A body floats with three-fourth of its volume inside another liquid. The density of another liquid is

a. 0.75 gm/cm^3 b. 4.9 gm/cm^3
c. 0.25 gm/cm^3 d. 1 gm/cm^3

25. Depletion layer is due to

a. Charge   b. Mobile ions
c. Immobile ions   d. electrons

26. Which of the following was used in nuclear atom bomb?

a. $_{92}U^{238}$ b. $_{92}U^{235}$
c. $_{84}PO^{212}$ d. $_{73}Ta^{181}$

27. When two holes is made in copper plate and it is heated then distance in it is

a. increases   b. decreases
c. remains constant   d. none

28. The velocity of sound wave is 340 m/s.The velocity of sound is 330 m/s at 0º C. Then the temperature is the sound wave is

a. 32º   b. 30º
c. 20º   d. 17º

29. Thick wire is used in the transformer

a. to decrease joules heating effect
b. to increase joules heating effect
c. to reduce leakage of flux
d. to reduce eddy current

30. The black skinned person with respect to white skinned person feels

a. more hot in summer & more cold in winter
b. more hot in summer & less cold in winter
c. less hot in summer & cold in winter
d. less hot is summer & less cold in winter

31. When an object is thrown upward with initial velocity 100 m/sec. The time taken by the object to reach the ground is

a. 5 sec b. 10 sec
c. 15 sec d. 20 sec

32. Mercury is used in thermometer because it has

a. high sp. heat & high conductivity
b. high sp. heat & low conductivity
c. low sp. heat & high conductivity
d. low sp. heat & low conductivity

33. Hypermetropia can be corrected by

a. Concave lens b. Concave mirror
c. Convex lens d. Convex mirror

34. During isothermal condition which of the following is True.

a. Average kinetic energy remains constant
b. Process will be quickly changed
c. Heat exchange with surrounding
d. Workdone will be zero

35. A source & observer are moving in same direction with same velocity then the frequency is,

a. increases b. decreases
c. remains constant d. none

36. To have an earth satellite synchronous with rotation of earth, it must be launched.

a. east to west in equatorial plane
b. west to east in equatorial plane
c. south to north in geostationary
d. North to south in polar plane

37. The length of a rod was increased by 1% while a body of mass 2 kg is stretching. Then the increase in linear strain is

a. 0.1 b. 0.01
c. 1/1000 d. 1/10000

38. In winter season the wheel of the vehicles are jammed because

a. increase in surface tension
b. decrease in surface tension
c. increase in viscosity
d. decrease in viscosity.

39. Hydraulic law is based on

a. Archimedes' principle
b. Law of flotation
c. Boyle's law
d. Pascal's law

40. Which of the following is not a unit of time?

a. leap year b. solar day
c. parallactic sec d. light year

41. A lamp is hanging at a height 2 m from the centre of a table. if its height is increased by 1 m, the luminance on the table will decrease by

a. 33.33% b. 55.5%
c. 100% d. 125%

42. Water on a pan during in evaporation

a. Slightly decreases b. Slightly increases
c. Remain unchanged d. abruptly increases

43. The human heart pumps 75cc of blood through aorta at each beat against a constant average pressure of mercury.

Assuming that the pulse frequency is 72 per minute, the power of human heart is, (a = 10 m/s^2, p = 13.6 g/cm^3, h= 100 mm).

a. 1.225 W b. 1.36W
c. 7.2 W d. 7.5 W

44. In a thermometer having reading 56^o c. the lower fixed point and upper fixed point are 4 and 94. The corrected temperature at 56^o C is,

a. 72 b. 55.5
c. 47 d. 59

45. Ice skaters use the principle of ___ for spinning.

a. moment of inertia b. angular momentum
c. torque d. radius of gyration

46. If F number of the camera is 4.5 then it means,

a. The focal length of camera leans is 4.5
b. Radius of curvature of lens is 4.5
c. The ratio of aperture of camera to focal length is 4.5
d. All

47. Induction is due to

a. Eddy current
b. Electric current
c. Magnetic current
d. Electromagnetic current

48. A substance decay (1/8)th of initial concentration. half live is 14 sec. Then find time.

a. 14 sec b. 42 sec
c. (14) ^{3}sec d. (14)^{2}sec

49. A substance with 2 gm has half life 7. than half live of 1 gm is

a. 7 b. 14
c. 28 d. 32

50. A substance decay by (1/8)th and initial concentration. If half life is 4 year. Than find time

a. 6 yrs b. 12 yrs
c. 18 yrs d. 16 yrs

BPKIHS 2016 ANSWERS

1Ans. (c)

E = hf

h = $\frac{E}{f} = \left(\frac{ML^2T^{-2}}{T^{-1}}\right) = ML^2T^{-1}$

2Ans (c).

eV = $\frac{1}{2}$ mv^2 (k.∈.)

3Ans. (b)

All flux densities, gradient of all quantities, all field strength or intensity and all dipole movement are vectors.
All potentials fluxes and intensity of energy are scalars.

4Ans. (b)

KE=P^2/2m i.e. KE α P^2

for % change ≥ 10%

% change in k∈= $= \left[\left(\frac{100+\Delta\%p}{100}\right)^n - 1\right] \times 100\%$

$= \left[\left(\frac{100+50}{100}\right)^2 - 1\right] \times 100\%$

$= \left[\left(\frac{3}{2}\right)^2 - 1\right] \times 100\%$

$= \left[\left({}^9/_4 - 1\right)\right] \times 100\%$ = ${}^5/_4 \times 100\%$

= 125%

5. Ans. (b)

The ratings of domestic are based on effective or virtual value which is the root mean square value.

6 Ans. (c)

Intensity ∝ current. As the number of electrons per-second ie. current of filament increases the no. of X-rays photons produced from the target increases.

7 Ans (b)

Above curie temperature, magnetic moments of atoms are completely random due to their motion and ferromagnetic substances becomes paramagnetic.

8 Ans. (a)

Low specific heat capacity and high conductivity in order to have greater increase in temperature in short time.

9 Ans. (b)

Were connected in parallel

$\frac{1}{Rp} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{Rp} = \frac{1}{1} + \frac{1}{1} + \frac{1}{1} = 3$

Rp = $1/3$ Ω

Also Resistance in series combination (Rs) is Rs = $R_4 + R_5$ = 2Ω

∴ Effective resistance across the whole combination is (R) = Rs +Rp

= 2+1/3 = $7/3 \Omega$

10 Ans. (b)

Above 4°C water expand on heating as normal Due to an anomalous expansion of water it contracts on heating from 0^0C to 4^0C and expand on cooling from 4^0C to 0^0C.

11 Ans. (c)

Relative velocity =

$\sqrt{Vn^2 + V \in^2 + 2v_n V \in \cos 90^0}$

$= \sqrt{Vn^2 + v \in^2}$

$= \sqrt{10^2 + 20^2}$ = 22.36 km/ hr

12 Ans. (d)

13 Ans. (a)

$F = ma = \frac{mdv}{d_t} = 0.15 \times \frac{20}{0.1}$ = 30N

14 Ans. (c)

magnetic lines of force are continuous curves from north to south poles, outside to body of the magnet where as from south to north inside the body of magnet.

15. Ans. (b)

When the magnet is dropped through the ring with its length along the axis of horizontal ring, electromagnetic induction takes place that tries to oppose the change in magnetic flux responsible for it. (According to Lenz law) .

16. Ans (b)

Alternative current or voltage gets changed by transformer but frequency remains constant.

17. Ans (b)

If S is the length of inclined plane then from rest

S = $\frac{1}{2}$ g sin θ X$(4)^2$ − (i)

If 't' is the time to cover

$1/4$ *th distance* starting from rest at top.

$S/4 = 1/2 \times$ g sinθ × t^2 − (ii)

dividing (ii) by (i)

t=2 sec

18 Ans. (c).

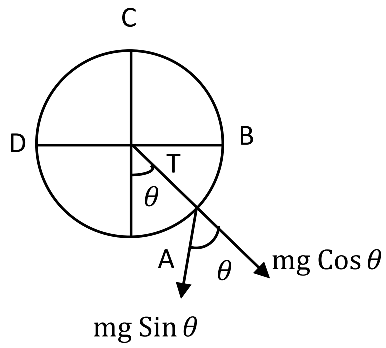
Tension in a vertical circle at any point is

T = mg cos θ = $\frac{mv^2}{r}$

At topmost point, $\theta = 180°$

So, T=$\frac{mvc^2}{r}$ - mg (minimum)

= Centripetal force - wt of rope



19. Ans. (b)

when lift is stationary or moving with constant velocity (a = 0) then R = mg & T = (M+m) g
when lift moves with constant acceleration 'a' upwards then
T - (m+m)g = (M+m) a.
T = (M+m) (g + a) which is maximum.

20. Ans. (b).

$g = \frac{GM}{R2}$ $ie. g \propto \frac{M}{R2}$
So, $g_{mars} = \frac{1}{10} \times 4 \times g$ at earth
$= \frac{4}{10} \times 9.8 = 3.92\ m/s^2$

21. Ans (b)

22. Ans. (c)

No. of images formed in two mirrors making angle θ to each other (n) = $\frac{360}{\theta}$ -1
$= \frac{360}{60} - 1 = 5$

23. Ans. (d)

Angle of deviation = i+e - ($r_1 + r_2$)
55^0 = i+e - A (A = angle of prism)
55 = 15 + e -60
e = 55 + 45 = 100^0

24. Ans. (a)

According following of flotation,
wt of water displaced = wt of body
$\rho_w \times \frac{3}{4} \times v\, xg = \rho b \times v \times g$ ($v = volume\ of\ body$)
ρ_b = ¾ gm/cm^3
When it just floats an another liquid of density ρ_l then $\rho_l = \rho_b = 3/4$ = 0.75 gm/cm^3

25. Ans (c).

26. Ans (b)

Atom bomb dropped on Herosima was made of $_{92}U^{235}$

27. Ans (c).

28. Ans (d)

velocity of sound $\propto \sqrt{T}$
$\frac{340}{330} = \sqrt{\frac{c+273}{273}}$
c = 16.79 = 17^0c.

29. Ans. (a).

H=I^2Rt and R=$\frac{\rho l}{A}$i
A = area of cross section. As thick wire is used resistance becomes less due to greater cross - sectional area and hence decreases the loss of energy in the form of heat as joule’s effect of heating.

30. Ans (a).

Kirchhoff’s law, Good absorbers are Good emitters and black substance are, good absorber of heat radiation, also good emitters.

31. Ans. (d)

V = u - gt upward motion under gravity as final velocity become zero, So
u = gt
t=u/g=100/10=10 sec[t=time for ascend]
∴ Time taken by object to reach the ground = 2t = 20s

32. Ans. (c)

33. Ans. (d)

In hypermetropia, light rays intersect behind the retira so it needs to be focused to be cured to retire by using converging or convex lens.

34.Ans (a)

In isothermal condition, dT = 0 i.e. temp is constant. So average kinetic energy remains constant as K∈∝ T.

35. Ans (c).

Dopplers effect is not seen when there is no relative motion between source & observers. So, frequency remains constant.

36. Ans (b).

As the earth rotates from welt to east counter clockwise the satellite must be launched from west to east in equatorial plane to have synchrocity with rotation of earth. valves of 'g' is least at equator that also adds up for easy launching.

37. Ans. (b)

If 'L' is the initial length of rod,then

Final length = $\frac{101}{100} \times L$

So, Increase in linear strain = $\left(\frac{101}{100} - 1\right)\frac{L}{L}$ = 0.01

38. Ans. (c)

The increase in viscosity of fluid of vehicles is indirectly proportional to the temperature, as temperature decreases in winter, the viscosity increases offering more resistance.

39. Ans. (d)

Hydraulic law is based on Pascal's law which states that liquid exerts pressure equally in all possible directions.

40. Ans (c).

Parsec is the unit of distance.

1 Parsec = 3.084×10^{16}m = 3.26 light year.

41. Ans. (a)

In cylindrical wave front, Illuminace I$\propto {}^{1}/_{d}$

$I_2/I_1=d_2/d_1$ or, $I_2/I_1=2/3$

∴%decrease =(1-2/3)× 100% =33.33%

42. Ans. (a)

43. Ans. (a)

Power = $\frac{workdone}{time\ \ taken} = workdone\ Xfrequency$

= P× $V \times f = \rho gh \times v \times f$

$= 13600\times 10 \times \frac{100}{1000} \times 75 \times 10^{-6} \times \frac{72}{60}$

= 1.225w.

44. Ans. (b)

$= \frac{c-o}{100} = \frac{56-4}{90}$

=

$\frac{Heading\ \ in\ faculty\ -LFP}{UFP-LFP} = \frac{Reading\ \ of\ correct\ -LFP}{UFP-LFP}$

$= \frac{C}{100} = \frac{52}{90}$ $\therefore C = 55.5°c.$

45. Ans. (b)

Ice skaters use the principle of angular momentum for spinning i.e. Iω = constant.

46. Ans. (c).

The ratio ${}^{d}/_{f}$ is defined as the ratio of relative aperture to focal length and is expressed in terms of number called F number.

47. Ans. (a).

Eddy current may be defined as current induced in a conductor when placed in changing magnetic field.

48. Ans (b).

$\frac{N}{N0} = \left(\frac{1}{2}\right)^n$ where N = Remaining no. of substance

N = Initial no. of substance

n = no. of half life.

$\frac{1}{8} = \left(\frac{1}{2}\right)^n \therefore n = 3$

Time = n × t ${}^{1}/_{2} = 3 \times 14 = 42sec$

49. Ans (a).

Radioactive disintegration follow first order chemical kinetics.

t ${}^{1}/_{2}$ = $\frac{0.693}{\lambda}$ $(\lambda = disintegration\ constant)$

Hence, t $^{1}/_{2}$ is independent of initial concentration. so half life of 1 gm will also be 7.

50. Ans. (b)

$$\frac{N}{No} = \left(\frac{1}{2}\right)^n$$

$$\frac{1}{8} = \left(\frac{1}{2}\right)^n$$

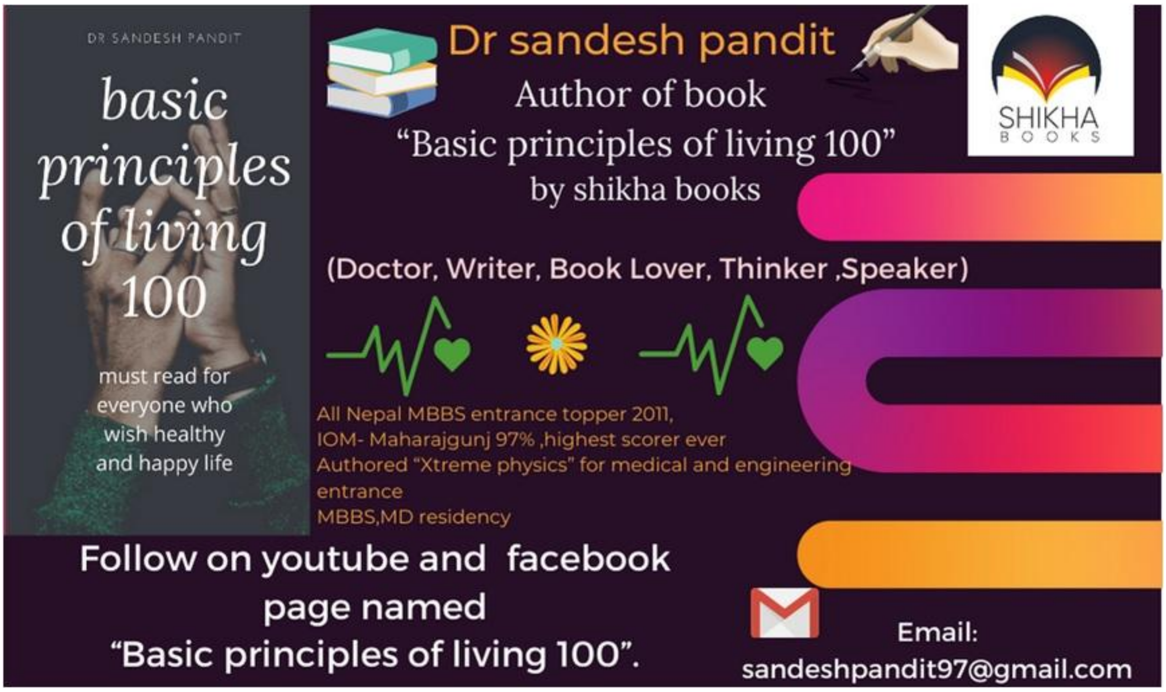
$$\left(\frac{1}{2}\right)^3 = \left(\frac{1}{2}\right)^n$$

$\therefore n = 3$

Hence, time = n$\times$ $t\ ^{1}/_{2}$= $3\times 4 = 12\ yrs$

Answer Sheet

1. c	*2. c*	*3. b*	*4. b*	*5. b*	*6. c*	*7. b*	*8. a*	*9. b*	*10. b*
11. c	*12.d*	*13. a*	*14. c*	*15. b*	*16. b*	*17. b*	*18. c*	*19. b*	*20. b*
21. b	*22. c*	*23. d*	*24. a*	*25. c*	*26. b*	*27. c*	*28. d*	*29. a*	*30. a*
31. d	*32. c*	*33. d*	*34. a*	*35. c*	*36. b*	*37. b*	*38. c*	*39. d*	*40. c*
41. a	*42.a*	*43. a*	*44. b*	*45. b*	*46. c*	*47. a*	*48. b*	*49. a*	*50. b*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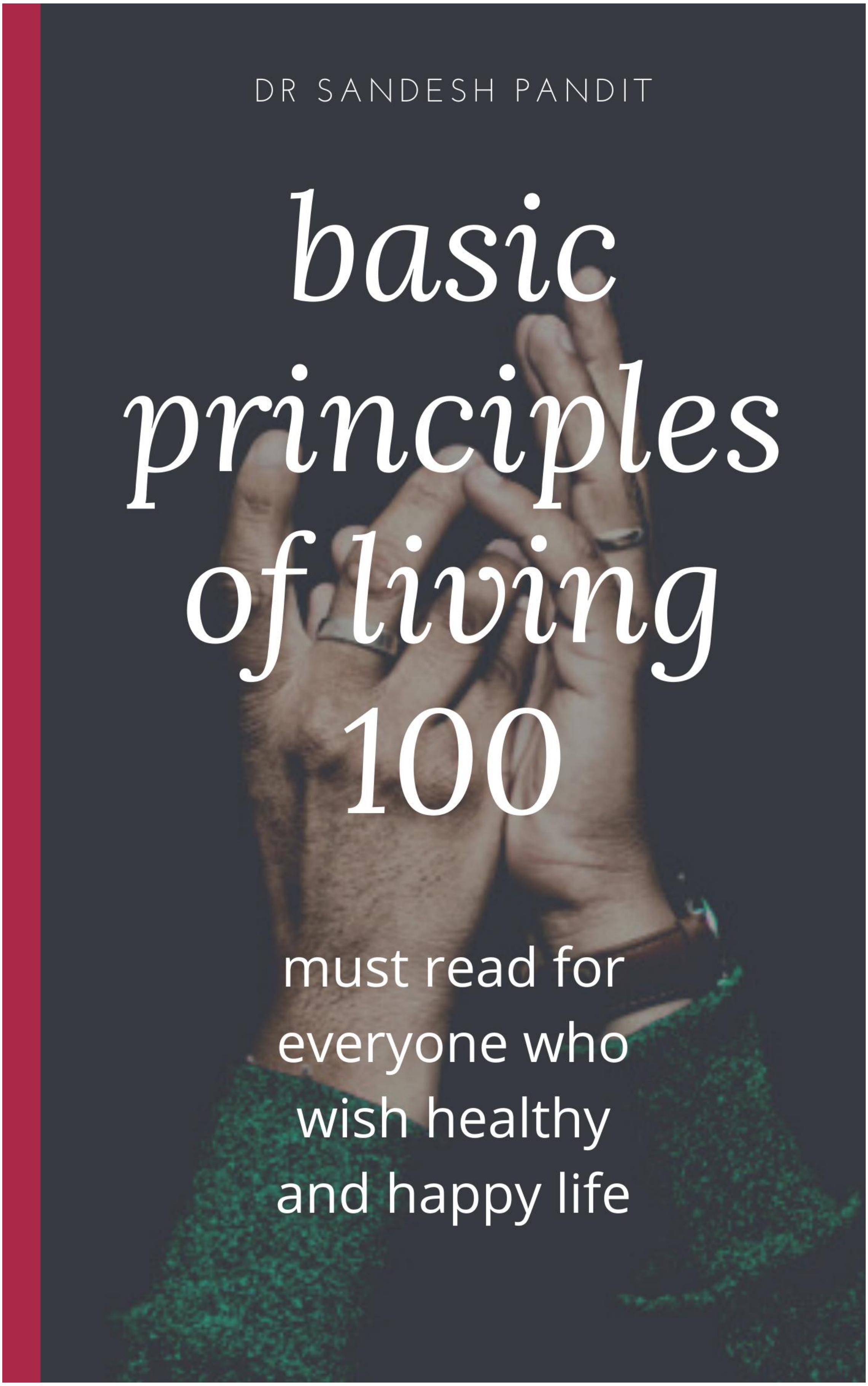
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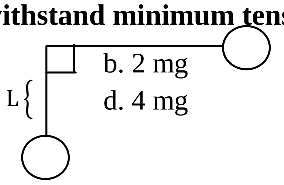
IOM 2015

1. When a pendulum is displaced through 90º, the length 'l'and mass 'm' of the pendulum the strength of string that can withstand minimum tension is



a. 1 mg b. 2 mg
c. 3 mg d. 4 mg

2. Transmission of heat through the actual movement of particles of medium is

a. Conduction b. Convection
c. Reflection d. Radiation

3. The frictional force exerted by air on a body of mass 0.25 kg moving with acceleration 9.2 m/s^2 is

a. 2.3 N b. 0.20 N
c. 0.25 N d. 0.12 N

4. If the temperature difference between two sides of a wall is increased from 10º C to 20º C, then thermal activity will be

a. Remains same b. Doubled
c. Quadruped d. Halved

5. If the length of a solenoid is doubled and no. of turns doubled, keeping the area constant, then inductance becomes.

a. Doubled b. Halved
c. Constant d. Quadrupled

6. If a gymnast on a rotating stool with his arms outstretched suddenly lower his arms

a. The angular velocity decrease
b. The moment of inertia decrease
c. The angular velocity remains constant
d. The angular momentum increase

7. If the object is real, a convex mirror always forms

a. Real and inverted image
b. Real and erect image
c. Virtual and erect image
d. Virtual and inverted image

8. Coefficient of viscosity η has a unit Nm^{-2}s. If is equivalent to :

a. Pascal second b. Decipoise
c. Centipoise d. Millipoise

9. Two bodies of masses 1m and 3m are moving opposite to each other with velocities 2v and v respectives. After collision their common velocity is

a. $\frac{v}{4}$ b. $\frac{5v}{4}$
c. $\frac{v}{2}$ d. $\frac{3v}{4}$

10. If lens behaves as converging in air and diverging in water. Then refractive index is

a. Less than 1.33 b. Between 1 to 1.33
c. More than 1.33 d. 1.33

11. A body of mass 'm' is released from height 'h' in time 't'. Then acceleration is determined by

a. Height and time b. Mass and time
c. Mass and height d. mass only

12. Which of the following stress changes shape of object

a. Bulk stress b. Shear stress
c. Tensile stress d. Longitudinal stress

13. Focal length of convex mirror is 45cm. If image is 5 times magnified. Then object distance will be?

a.30cm b.36cm c.40cm d.50cm

14.which of the following is paramagnetic ?

a. Bismuth b. Chromium
c. Antimony d. Water

15. Starting from rest a car of mass 1000kg accelerates steadily to 20ms^{-1}in 10

seconds. The average power developed in the time period is

a. 40 kw b. 4.0 kw
c. 20 kw d. 0.2 kw

16. The de-Broglie wave of body with mass 'm' having energy E is

a. $\sqrt{\frac{h}{2mE}}$ b. $\frac{\sqrt{h}}{2mE}$
c. $\frac{h}{\sqrt{2\,mE}}$ d. $\frac{h}{2mE}$

17. Highly energetic electron is bombarded to a metal causing fluorescence in which process ?

a. Electron gun
b. Photoelectric effect
c. Cathode tube oscilloscope
d. Thermionic effect

18. A parallel plate capacitor has a capacitance of 50 μ F in air and 110 μ F when immersed in oil. The dielectric constant of oil is

a. 0.45 b. 1.10
c. 0.55 d. 2.20

19. Young's modulus is

a. Ratio of normal stress to lateral strain
b. Ratio of normal stress to longitudinal strain
c. Product of normal stress to longitudinal strain
d. Ratio of shear stress to lateral strain

20. When an object is cooled from 80º C to 60ºC it takes 1 minute. The room temperature is 30ºC, find the time taken for the temperature to decrease from 60ºC to 50ºC

a. 10 s b. 50s
c. 90s d. 120s

IOM 2015 Answers

1. Ans. (c)

When a pendulum is displaced through ($\theta = 90^0$) with vertical then velocity with which pendulum tends to tall if it lets to do so, then

v $=\sqrt{3g\,L\,(1-\cos\theta)}$
$= \sqrt{3gL\,(1-cos90°}$
$= \sqrt{3gL}$

At point B,
Strength to withstand minimum tension is

T = mgcosθ = $\frac{mv^2}{L}$

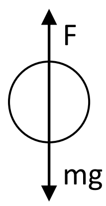
T = mgcos 90 = $\frac{m\times\left(\sqrt{3gL}\right)^2}{L}$

T = 3mg.

∴ Strength of string to withstand minimum tension for fall is 3mg.

2. Ans. (b)

3. Ans (b)



Mg - f = ma

$0.25 \times 10 - f = 0.25 \times 9.2$
f = 0.25×8=0.2N

4. Ans. (b)

$\frac{Q}{t} = \frac{kA\Delta\theta}{l}$
k : thermal conductivity
A : Area of cross - section
$\frac{\Delta\theta}{l} =$
$Temperature\ gradient\ across\ wall$

If temperature difference ($\Delta\theta$) is doubled from 10 to 20^0c and other variables contest $\theta/_t \propto \Delta\theta$ gives thermal activity is doubled.

5. Ans. (a)

Self inductance (L_1) = $\frac{\mu o\,N^2A}{l}$

$L_{2=}$ $\frac{\mu o\ (2N)^2A}{2l} = 2\left(\frac{\mu o\ N^2A}{l}\right) = 2L_1$

Hence inductance becomes doubled.

6. Ans. (b)

If torque (I = 0) ; angular momentum is conserved or constant so

$I_1\omega_1 = I_2\omega_2$

Lowering of outstretched arm causes less distribution of mass which decreases moment of Inertia (I).

As I ↓ Ses, angular velocity (ω) increases.

7.Ans (c).

A convex mirror always forms virtual erect and diminished image on other side of mirror with respect to real object.

8. Ans. (a).

Dimension of coefficient of viscosity (n) = $Nm^{-2}S$

As Nm^{-2} = Pascal [P = ${}^{E}/_{A}$] its equivalent to Pascal second.

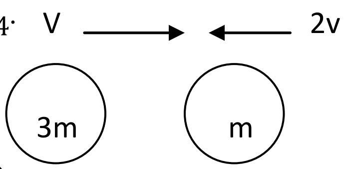
9. Ans. (a)

According to law of conservation of momentum

$3m \times v + m \times (-2v) = (m + 3m) \times Vc$

mV = 4mVc

Vc = ${}^{V}/_{4}$.



10. Ans. (b)

Lens behaves as converging means act as convex lens with +ve focal length.

Lens behaves as diverging means acts as concave lens with -ve focal length.

In air $\frac{1}{f} = (a\mu g - 1)\left(\frac{1}{R1} + \frac{1}{R2}\right) - (i)$

In water $\frac{1}{f}\ (a\mu g - 1)\left(\frac{1}{R1} + \frac{1}{R2}\right) - (ii)$

$\frac{1}{f}\ (w\mu a \times a\mu g - 1)\left(\frac{1}{R1} + \frac{1}{R2}\right)$

$(w\mu g = w\mu a \times a\mu g)$

$\frac{1}{f}\ = \left(\frac{a\mu g}{a\mu w} - 1\right)\left(\frac{1}{R1} + \frac{1}{R2}\right)\left(w\mu a = \frac{1}{a\mu w}\right)$

∴ f is –ve in water $a\mu g\ < a\mu w\ (1.33)$

f is + ve in air $a\mu g > 1$

∴ $1 < a\mu g < 1.33$

So, refractive index must be between 1 to 1.3

11. Ans (a)

When a body is released from height 'h'

Initial velocity (u) = 0.

h = ut + $1/2at^2$

a = $\frac{2h}{t2}$

∴ Acceleration is determined by height (h) & time 't'

(12) Ans. (b)

Shear stress is tangential stress to the surface of body that changes the shape of the body.

13. Ans. (b).

$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\frac{u}{f} = 1 + {}^{1}/_{m}.$

Since convex mirror is given ;so m = - ve

$\frac{u}{f} = 1 - {}^{1}/_{5} = {}^{4}/_{5}$

u = ${}^{4}/_{5} \times -45 = \ -36$cm.

object distance = 36cm & object = virtual

14. Ans. (b)

Fe, Co, Ni and their alloys are Paramagnetic.

15. Ans. (c)

P = F$\times V$

dP = m$\times\ a \times v$

$= \frac{m\ \times dv \times v}{t}$

Over a due of course of 10 sec

$\int\ \ dp = \frac{m}{t}\int_{o}^{v} vdv$

Pav = $\frac{1000}{10} \times \frac{v^2}{2} = 100 \times \frac{(20)^2}{2}$

= 20 kw.

16. Ans. (c)

$\lambda =\ {}^{h}/_{p}$

E = P ${}^{2}/_{2m}$

P = $\sqrt{2mE}$

∴ $\lambda = \frac{h}{\sqrt{2m\epsilon}}$

17. Ans. (c).

18. Ans (d)

In parallel plate capacitor,

C air = $\frac{\varepsilon_0 A}{d} - (i)$

C med = $\frac{K\,\varepsilon_0\,A}{d} - (ii)$

$\frac{C\ med}{C\ air} = k \;\Rightarrow K = \frac{110}{30} = 2.20$

19. Ans. (b)

young's modulus of elasticity (Y)

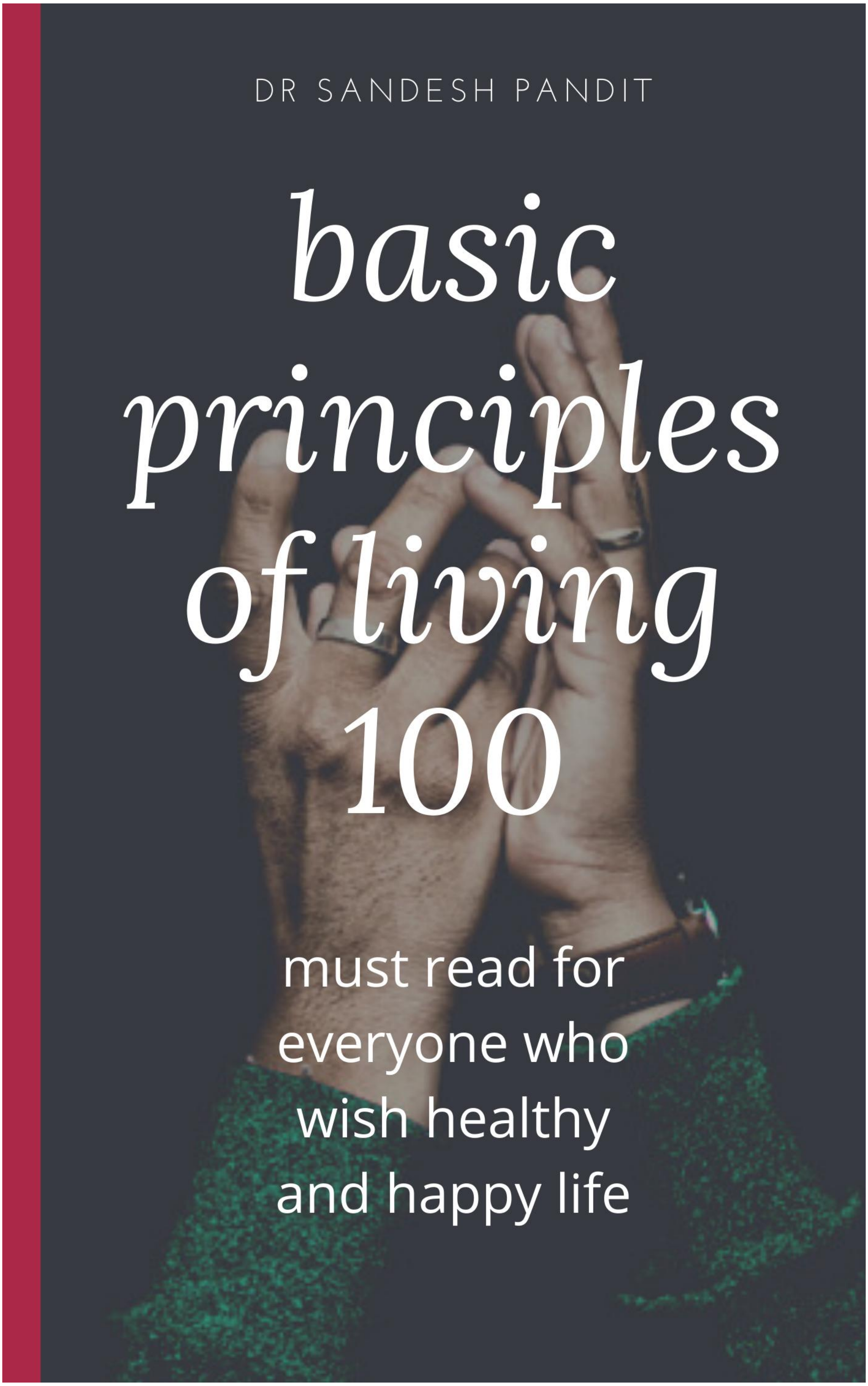
$= \frac{Normal\ \ stress}{longitudinal\ \ \ strain}$

20. Ans. (b)

See chapter

Answer Sheet

1. c	*2. b*	*3. b*	*4. b*	*5. a*	*6. b*	*7. c*	*8. a*	*9. a*	*10. b*
11. a	*12.b*	*13. b*	*14. b*	*15. c*	*16. c*	*17. c*	*18. d*	*19. b*	*20. b*


DR SANDESH PANDIT
basic
principles
of living
100
must read for
everyone who
wish healthy
and happy life

IOM 2016

1. $\frac{e^2}{\varepsilon_0 hc}$ **has dimension of**
   (a) Time (b) length
   (c) Mass (d) Dimensionless
2. **Mercury is cooled to 4k, it behaves as**
   (a) Semiconductor
   (b) Insulator
   (c) Superconductor
   (d) conductor
3. **A can driver travels to 40 km with velocity of 80 km/hr and again travel next 40 km with velocity of 40 km/hr. then average speed travelled by him is**
   (a) 40 km/hr. (b) 48 km/hr
   (c) 45 km/hr (d) 53 km/hr
4. **A person is travelling at 4 m/s towards east. The rain is apparently falling vertically downwards with 3m/s, then actual velocity of rain is**
   (a) 3/4 m/s (b) 5 m/s
   (c) 4/3 m/s (d) 7 m/s
5. **A cyclist turned at 15 miles/hr. If doubled the speed of cycle then what is the chance of overturning?**
   (a) Doubled (b) Halved
   (c) Quadrupled (d) Constant.
6. **In an electrolytic solution, the density of $CuSo_4$ during electrolysis.**
   (a) Increases (b) Decreases
   (c) Remains Constant (d) fluctuates.
7. **The slope of P-V graph of adiabatic process and isothermal process gives**
   (a) Υ (b) Υ^2
   (c) $1/\Upsilon$ (d) $1/\Upsilon^2$
8. **A person is driving in a car with velocity 30 m/s towards the rock and the sound is reflected from rock. The person horned the car with frequency 600Hz. The apparent velocity heard by the person (velocity of sound 330 m/s)?**
   (a) 555.5 Hz (b) 550 Hz
   (c) 610 Hz (d) 720 Hz
9. **Soap bubbles shine colorful due to**
   (a) Refraction (b) Diffraction
   (c) Polarization (d) Interference.
10. **A two pipe are joined which has length L and 2L and radius R & 2R. What is the pressure difference between those two pipes.**
    (a) 1/8 (b) 4
    (c) 2 (d) 8
11. **With the increase in temperature the young modulus**
    (a) Increases (b) Decreases
    (c) Remains constant
    (d) First increases then decreases
12. **The refractive index of diamond is 2.4 The velocity of light in diamond is**
    (a) 1.25×10^8 m/s (b) 2.9×10^8 m/s
    (c) 3×10^8 m/s (d) 8×10^8 m/s
13. **A vessel is blast into three pieces. Among them two similar pieces moves perpendicularly with each other with equal velocity of 30 m/s. If the third piece is 3 times the mass of each piece. Find the velocity of third piece.**
    (a) 9.8 m/s (b) 10 m/s
    (c) 14.4 m./s (d) 20 m/s
14. **A water has temperature 22^0c. A geyser ejects 1 L water per minute at 37^0c. What is the power of geyser?**
    (a) 1050 watt (b) 760 watt
    (c) 2055 watt (d) 2100 watt
15. **The lens used in Reflecting telescope is**
    (a) Convex mirror (b) concave mirror
    (c) Plano - convex lens (d) prism
16. **Centrifugal force in rotational motion acts as**
    (a) Centripetal force (b) Gravitational force
    (c) Apparent force on rotating frame
    (d) Viscous force
17. **Stationary observer heard twice the original frequency of the source moving towards the observer. What is the**

velocity of source? Given the velocity of sound 332 m/s

(a) 99 m/s (b) 166 m/s

(c) 272 m/s (d) 332 m/s

18. An object is rotating with radius of 25 cm of 2 rev/sec. Then what is the acceleration produced?

(a) π^2 (b) $4\pi^2$

(c) $2\pi^2$ (d) $\pi^2/4$

19. An radioactive particle at rest is disintegrated into two 2 pieces. what its ratio of de-brogile wavelength λ_1/λ_2

(a) m1/m2 (b) m2/m1

(c) 1:1 (d) $\sqrt{m_2/m_1}$

20. A circular coil with its horizontal axis is perpendicular to the magnetic field. What is the angle between magnetic field and and the plane of coil when the induced emf is maximum ?

a.0° b.45° c.30° d.90°

ANSWERS IOM 2016

1. Ans (d)

F = $\frac{e^2}{4\pi E0R^2}$

E = $\frac{hc}{\lambda}$ hc = Eλ (I)

$\frac{e^2}{\epsilon_\circ}$ = FR^2 ×4 π- (II)

$\frac{e^2}{\epsilon_0} = \frac{FR^2 \times 4\pi}{\epsilon\lambda} = \frac{(MLT-2)\,(L^2)}{(ML^2T-^2)(L)} = (M^\circ L^\circ T^\circ)$ = dimensionless

2. Ans (c)

When mercury is cooled to 4k behaves as superconductor, below 4 k, it loses all electric resistance.

3. Ans (d)

Average speed = $\frac{Total\ distance}{Total\ time}$

$= \frac{d1+d2}{\frac{d\,1}{v1}+\frac{d2}{v2}} = \frac{d+d}{d/_{v1}+d/_{v2}} = \frac{2}{1/_{80}+1/_{40}}$ = 53 km/hr

4. Ans (b).

V_P = velocity of person

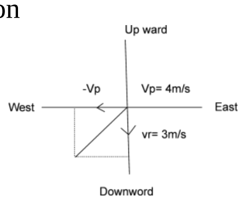
Vr = velocity of rain

V = relaxant velocity

V = $\underset{Vrp}{\longrightarrow} = \underset{Vr}{\rightarrow} - \underset{Vp}{\rightarrow}$

$= \sqrt{Vr^2 + Vp^2}$

$= \sqrt{3^2 + 4^2 =}$ 5 m/s .



5. Ans(c)

The chance of overturning $\alpha\ v^2$

∴ If velocity is doubled, The chance of over turning is quadrupled.

6. Ans(c)

7. Ans(a)

Isothermal

PV = constant

Pdv + Vdp = 0

Vdp = -Pdv

$\frac{dp}{dv} = {}^{P}/_{v}$ =slope of isothermal P-V graph

Adiabatic

PV$^{\Upsilon}$ = constant

PdV$^{\Upsilon}$ + V$^{\Upsilon}$dp = 0

V$^{\Upsilon}$dp = -ΥPV$^{\Upsilon\text{-}1}$dV

$\frac{dp}{dv} = \frac{\Upsilon p}{V}$ = slope of adiabatic

Adiabatic slope = Υ×slope of isothermal

8. Ans (d)

f^1 = $\frac{V+VL}{V-Vs} \times f$

$= \frac{330+30}{330-30} \times 600 = 720$Hz

9. Ans (d)

10. Ans (d)

From poiseuille's equation

${}^{v}/_{t} = \frac{\pi r4}{8\eta L}\ \Delta p\ Where\ \Delta P =$pressure difference

$\Delta P\alpha\, {}^{L}/_{r4}$

$\frac{\Delta P1}{\Delta P2} = \frac{L1/_{(r1)^4}}{L2/(r2)^4} = \frac{L1}{L2} \times \left(\frac{r2}{r1}\right)^4$

$= \frac{1}{2L} \times \left(\frac{2R}{R}\right)^4 = 8$

11.Ans (b)

12. Ans (a)

μ= 2.4

μ = C/V

V = $\frac{3\times108}{2.4} = 1.25 \times 10^8$ m/s

13. Ans (c)

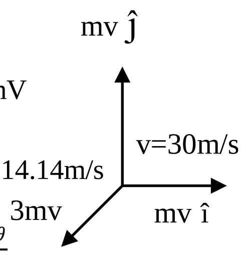
Applying conservation of linear momentum

mvî+mvĵ+3mv=0

30Vî + 30Vĵ = -3mV

V = -10ĵ – 10î

|V|= $\sqrt{10^2 + 10^2}$=14.14m/s



14. Ans (a)

P = $\frac{Energy}{Time} = \frac{MC\Delta\theta}{t}$

$= \frac{V\times\varrho\times c\times dt}{t}$

$= \frac{10-3\times1000\times4200\times15}{60}$ $(1L = 10^{-3}m^3)$

= 1050 watt

15. Ans (b)

Reflecting telescope consists of objective with concave mirror of large focal length & eye piece is a convex lens of short focal length.

16. Ans (c)

17. Ans (b)

$f^1 = \frac{v}{v-vs} \times f$

2f = $\frac{332}{332-vs} \times f$

332 - Vs = 166

Vs = 166 m/s.

18. Ans (b)

r = 25 cm = 0.25 m.

f = 2 rev/sec

a = $\omega^2 r = (2\pi f)^2 r$

$= (2\pi \times 2)^2 \times 0.25$

= $4\pi^2 m/s^2$

19. Ans (c)

From conservation of angular momentum

$m_1v_1+m_2(-v_2) = 0$

$m_1v_1=m_2v_2$

Now, λ α 1/m^2

$\frac{\lambda1}{\lambda2} = \frac{m2v2}{m1v1} = 1:1$

20. Ans (a)

E = Eosinωt

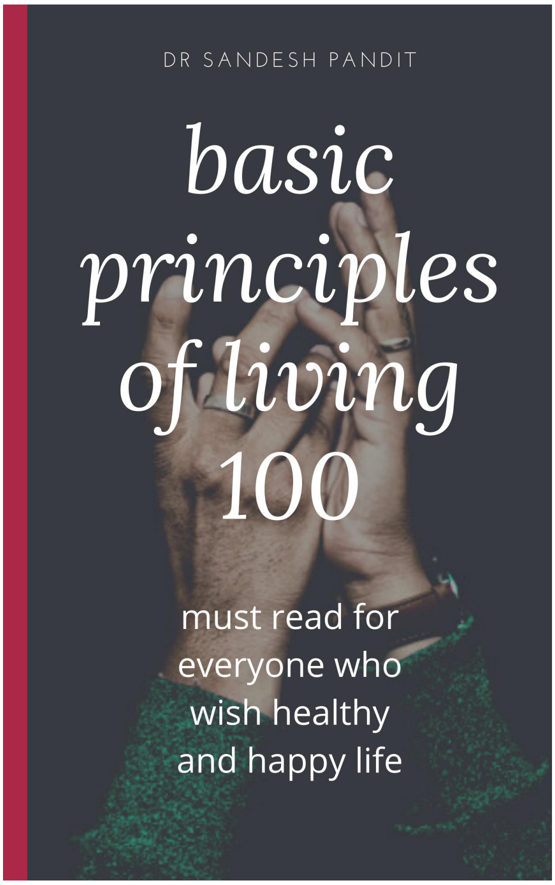
= BNA $\sin\theta$ where θ = angle between Normal to plane of coil & the magnetic field for Maximum value of emf.

$\sin\theta = 1, \theta = 90°$

Answer Sheet

1. d	*2. c*	*3. d*	*4. b*	*5. c*	*6. c*	*7. a*	*8. d*	*9. d*	*10. d*
11. b	*12.a*	*13. c*	*14. a*	*15. b*	*16. c*	*17. b*	*18. b*	*19. c*	*20. a*

mv ĵ



SHIKHA
BOOKS

KU 2015

1. Dimension of the universal constant of gravitation is

a. $ML^{-1}T^{-3}$ b. $M^{-1}L^{3}T^{-2}$
c. $ML^{-3}T^{-1}$ d. $M^{2}L^{2}T^{-2}$

2. Let the angles between two non-zero vectors $\vec{P}$ and $\vec{Q}$ be 120° and its resultant be $\vec{R}$ Then

a. $|\vec{R}|$ must be equal to $|\vec{P} - \vec{Q}|$
b. $|\vec{R}|$ must less than $|\vec{P} - \vec{Q}|$
c. $|\vec{R}|$ must be greater than $|\vec{P} - \vec{Q}|$
d. $|\vec{R}|$ may equal to $|\vec{P} - \vec{Q}|$

3. A man in a train moving with a constant velocity drops a ball on the platform. The path of the ball as seen by an observer standing on the platform is

a. straight line b. a circle
c. a parabola d. helix

4. A force F_1 acts on a particle so as to accelerate it from rest to velocity v. The force F_1 is replaced by a force F_2 which decelerates it to rest. Then

a. F_1 must be equal to F_2
b. F_1 may be equal to F_2
c. F_1 must be unequal to F_2
d. none of these

5. Kinetic energy of a body of mass 10g and momentum 500 gcm/s is equal to

a. 1.25×10^{3}ergs b. 1.25×10^{4} ergs
c. 1.25×10^{3}J d. 50,000 ergs

6. A motorcycle is going on in an over bridge of radius R. The driver maintains a constant speed. When the motorcycle is ascending on the bridge, the normal force on it.

a. increases b. decreases
c. remains the same d. fluctuates

7. Let $\vec{F}$ be a force acting on a particle having position vector $\vec{r}$. Let $\vec{\tau}$ be the torque of this force about the origin, then

a. $\vec{r}.\vec{\tau} = 0$ and $\vec{F}.\vec{\tau} = 0$
b. $\vec{r}.\vec{\tau} = 0$ but $\vec{F}.\vec{\tau} \neq 0$
c. $\vec{r}.\vec{\tau} \neq 0$ but $\vec{F}.\vec{\tau} = 0$
d. $\vec{r}.\vec{\tau} \neq 0$ but $\vec{F}.\vec{\tau} \neq 0$

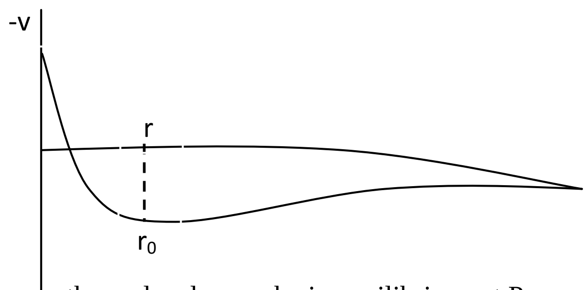
8. The motion of a particle is given by x = a sinωt + B cosωt. The motion of the particle is

a. not simple harmonic
b. Simple harmonic with amplitude A + B
c. simple harmonic with amplitude $\frac{(A+B)}{2}$
d. simple harmonic with amplitude $\sqrt{A^2 + B^2}$

9. Which one of the following statement is correct?

a. value of g is same at all places
b. the value of g is more at the equator than at the poles
c. the value of g is more at the poles that at the equator
d. the value of g is maximum at the center of the earth.

10. The fig. shows the variation of potential 'V' with separation 'r' of two molecules.



a. the molecules can be in equilibrium at P

b. at distance r >r_0 the intermolecular force is repulsive
c. at distance r<$r_0$the intermolecular force is attractive
d. both (a) and (c)

11. The system of aluminum ions of sea of electron, is an example of

a. metallic crystals
b.molecular crystals
c. covalent crystals
d. Ionic crystals

12. When an elastic materials with Young's modulus Y is subjected to a stretching stress X, the elastic energy stored per unit volume is

a. 2X/Y b. $Y^2/2X$
c. $X^2Y/2$ d. $X^2/2Y$

13. According to standard Model spin half particles are known as

a. Fermion b. Bosons
c. Photons d. None

14. The force necessary to pull a circular plate of radius 5 cm from the surface of water (surface tension 75 dynes/cm) is

a. 375 dynes b. 375 π dynes
c. 750 dynes d. 750 π dynes

15. If the work done in blowing a bubble of volume V is w, then the work done in blowing a bubble of volume 2V will be

a. W b. 2W
c. $(2)^{1/3}$W d. $(4)^{1/3}$ W

16. 32 units of a liquid flow per unit time through a capillary tube connected to a pressure head. If a tube of half the radius and same length is connected to the same pressure head, the quantity of water flowing per unit time will be

a. 1 units b. 2 units
c. 4 units d. 8 units

17. A vessels of volume V and linear coefficient of expansion α contains a liquid. The level of liquid does not change on heating. The volume coefficient of real expansion of the liquid is

a. 3α b. $\frac{V}{V-\alpha}$
c. $\frac{V+\alpha}{V}$ d. $\frac{V-\alpha}{V}$

18. If the temperature difference between the two sides of a wall is double its thermal conductivity

a. is halved b. is doubled
c. remains unchanged d. becomes four times

19. The sun radiates energy in all directions. The average radiation received on the earth's surface from the sun per second is 1.4 kW/m^2. The average sun earth distance is 1.5 × 10^{11} m. The mass lost by the sun per day is

a. 3.8×10^{12}kg b. 3.8×10^{14}kg
c. 4.4×10^{6}kg d. 7.6×10^{14}kg

20. A vessel contains one mole of O_2 gas (molar mass 32) at a temperature T. The pressure of the gas is P. An identical vessel containing one mole of He gas (molar mass 4) at a temperature 2T has a pressure of

a. P b. 2P
c. 8P d. P/8

21. When an ideal diatomic gas is heated at constant pressure, the fraction of the heat energy supplied which increases the internal energy of the gas is

a. 2/5 b. 3/5
c. 3/7 d. 5/7

22. A man is 180 cm tall and his eyes are 10 cm below the top of his head. In order to see his entire height right from the feet to the head he uses a plane mirror at a distance of 1 m from him. The minimum height of the plane mirror required is

a. 85 cm b. 90cm
c. 170 cm d. 180 cm

23. Each of two small non conducting spheres is charged positively, the combined charge being 40 μC. When the two spheres are 50 cm apart, each sphere is repelled from the other by a force of magnitude 2.0N. The magnitude of the smaller of the two charges is

a. 1.4 μC b. 1.1μC
c. 2.0 μC d. 3.3 μC

24. Charge Q is distributed uniformly along a semicircle of radius a. Which formula below gives the correct magnitude of the electric field at the center of the circle?

a. $E = \frac{1}{4\pi\epsilon_0}\frac{Q}{\pi a}$ b. $E = \frac{1}{4\pi\epsilon_0}\frac{Q}{\pi a^2}$
c. $E = \frac{1}{4\pi\epsilon_0}\frac{2Q}{\pi a}$ d. $E = \frac{1}{4\pi\epsilon_0}\frac{2Q}{\pi a^2}$

25. A hemispherical surface (half of a spherical surface) of radius R is located in a uniform electric field of magnitude E that is parallel to the axis of the hemisphere. The magnitude of the electric flux through the hemisphere surface is

a. πR^2E b. $\frac{4}{3}\pi R^2E$
c. $\frac{2}{3}\pi R^2E$ d. $\frac{1}{2}\pi R^2E$

26. Which one of the following cannot be a statement of Gauss's Law for some physical situation?

a. $4\pi r^2\epsilon_0 E = Q$ b. $2\pi rL\epsilon_0 E = Q$
c. $\epsilon_0 \int E.dA = \int \rho.dv$
d. $\epsilon_0 \int E.dA = \rho$

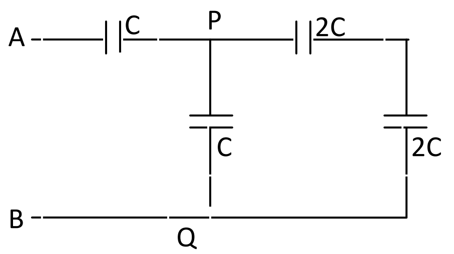
27. When a positive charge is released and moves along an electric field line, it moves to a position of

a. lower potential to lower potential energy.
b. Lower potential to higher potential energy.
c. Higher potential to lower potential energy
d. higher potential to higher potential energy

28. How much energy is dissipated as heat during a two-minute time interval by a 1.5k Ω resistor which has a constant 20 V potential difference across its leads?

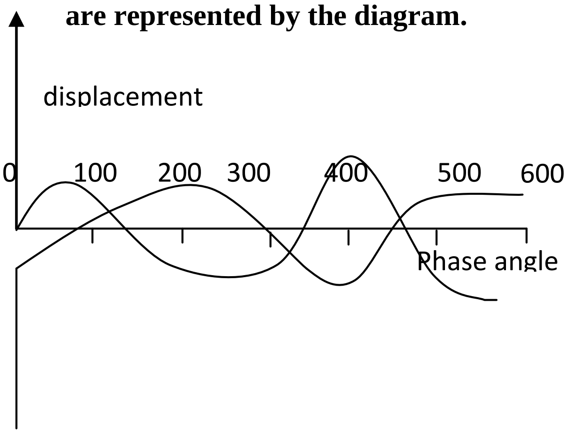
a. 53J b. 46J
c. 32 J d. 72 J

29. The equivalent capacitance of the combination shown when C = 45 μ F is



a. 36 μF b. 32 μF
c. 34μF d. 30 μF

30. Two light waves of the same frequency are represented by the diagram.



What could be the phase difference between the two waves?

a.150° b.220° c.260° d.330°

K.U. 2015 Answers

1. Ans. (b).

F = $\frac{Gm_1m_2}{r^2}$

G = $\frac{(MLT^2)(L^2)}{M^2}$ = ($M^{-1}L^{-3}T^{-2}$)

2. Ans. (b)

If $|\vec{R}| = \sqrt{P^2+Q^2+2PQ\cos\theta}$

$= \sqrt{P^2+Q^2+2PQ\cos 120}$

$= \sqrt{P^2+Q^2+PQ}$

$|\vec{R} - \vec{Q}| = |\vec{P} + (-\vec{Q})|$

$= \sqrt{P^2+Q^2-2PQ\ \cos 120}$

$= \sqrt{P^2+Q^2+PQ}$

$\therefore\ |\vec{R}| < |\vec{P} - \vec{Q}|$

3. Ans. (c)

4. Ans. (b)

When it accelerates from rest to velocity 'v'

V = u + at

V = at or, V=$\frac{F1}{m}t_1$ - (i)

t_1 = time taken to acquire velocity.

When it is decelerated to rest,

0 = V - at_2

V = $\frac{F2}{m}$t2 $-(ii)$

So from equation (i) and (ii).

$\frac{F1}{m}$t1 $= \frac{F_1}{m}t_2$

$\frac{F_1}{F_2} = \frac{t_1}{t_2}$

Depending on the time t_2 & t_1, F_1may be equal to F_2. If $t_2 = t_{1,}$ but it is not necessary that F_1 must be equal to F_2 or it is also not necessary that F_1 must be unequal to F_2

5. Ans. (b)

$KE = \frac{P^2}{2m} = \frac{(500)^2}{2\times10}$ = 12500 = 1.25× 10^4 ergs.

6. Ans. (c)

mgcosθ- N = $\frac{mv^2}{r}$

N = mg cos $\theta - \frac{mv^2}{r}$

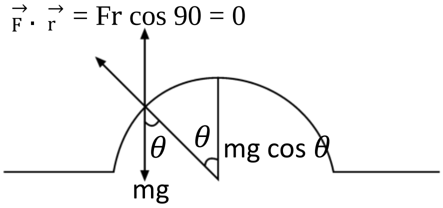
N = Normal force given by the surface. So, there is increase in normal force as the 'Q' decreases as the motorcycle ascends and it maintain constant speed.

7. Ans. (a)

Since $\vec{\tau}$ is perpendicular to plane consisting $\vec{F}$ and $\vec{r}$ as $\vec{\tau} = \vec{r} \times \vec{F}$ .So,

$\vec{r}.\vec{\tau}$ = r τ cos 90 = 0

$\vec{F}.\vec{r}$ = Fr cos 90 = 0



8. Ans. (d)

Motion of particle given by

x = A sin ωt + B cos ωt.

= A sin ωt + B sin $\left(\omega t + {}^{\pi}/_{2}\right)$

Since, both are sinusoidal weaves resultant equation is also simple harmonic and the amplitude is

R = $\sqrt{A^2+B^2+2AB\cos\theta}$

= $\sqrt{A^2+B^2+2AB\cos 90}$

R = $\sqrt{A^2+B^2}$

9. Ans. (c)

10. Ans. (a).

11. Ans. (a).

The system of aluminum ions in the sea of electron is like metallic crystal where metallic bonding arises from electrostatic attractive force between conduction electrons and positively cheered metal ions.

12. Ans. (d)

Sec chapter.

13. Ans. (a)

Fermion →leptons + Quarks
(Here half spin).

14. Ans. (d)

Surface tension (T) = 75 dynes/cm.
Radius (R) = 5 cm.
L = Effective length of constant = 2πr
T= $\frac{F}{2\pi r}$ $\therefore F = T \times 2\pi r = 75 \times 2\pi \times 5 = 750\,\pi\, dynes.$

15. Ans. (d)

See Chapter

16. Ans. (b)

According to poiiseulle's formula.

$$Q/_{t} = \frac{\pi\, r4}{8\eta l} \times \Delta P.$$

ΔP and length is same,η is same for same liquid.So

$Q/_{t} \propto r^4$

$\therefore \frac{Q1/t1}{Q2/t2} = \left(\frac{r1}{r2}\right)^4$

$\left(\frac{32}{Q_2/_{t_2}}\right) = 32 \times \frac{1}{16} = 2$

17 Ans. (a)

Refer chapter

18. Ans. (c)

$$Q/_{t} = \frac{kA\Delta\theta}{l}$$

19. Ans. (b)

Average radiation received on earth's surface from sun per second = 1.4 kw/m^2
So, energy radiated by sun per second
= $4\pi\, a^2 \times 1.4$
= $4\pi \times 1.4 \times (1.5 \times 10^{11})^2 \times 86400$
using Einstein energy mass equivalence law,
$mc^2 = 4\pi \times 1.4 \times (1.5 \times 10^{11})^2 \times 86400$

m = $\frac{4\pi \times 1.4 \times (1.5\times10^{11})^2 \times 86400}{(3\times10^9)^2}$
= 3.8×10^{14} kg

20. Ans. (b)

Vessel A = O_2 gas
molar mass (m_l) = 32
No of moles (n_1) = 1
Vessel B = He gas
molar mass (m_2) = 4; n2 = 1
P αT or $\frac{P_2}{P_0} = \frac{T_2}{T} = 2$
∴ P_2 = 2P (on $T_B = 2T_A$).

21. Ans. (d)

$\frac{dQ}{du} = \frac{n\, C_v dT}{nCpdT} = \frac{1}{\Upsilon}$
For ideal diatomic gases, Υ = 1.4 = $7/_5$
Hence, Fraction (f_l = $1/_{\Upsilon} = 5/_7$)

22. Ans (b)

23. Ans. (a)

24. Ans (d)

25. Ans. (a)

Electric flux (∅) =$\vec{E} \cdot \vec{A}$
If A = area of cross section $\vec{E} \cdot \vec{A}$ = EA cos 0^0
= $E \times \pi r^2$
=πr^2E

26. Ans. (d)

According to Gauss law,
$\emptyset\, net = q/_{\varepsilon_0}$
Also, ϕ = $\oint \vec{\in}\, \vec{A}$
$\frac{q}{\varepsilon_0} = \oint \vec{\in}\, \vec{A}$
q = $\varepsilon_0 \oint \vec{\in}\, \vec{A}$
Option
(a) $4\pi r^2$
$\varepsilon_0 \in = q \Rightarrow [A = curved\ surface\ area\ of\ cylinder]$
(b) 2 πrL$\boldsymbol{\varepsilon}_0$∈ = Q⇒[A = curred surface area of cylinder]
(c) $\boldsymbol{\varepsilon}_0 \oint \in A = \int \varrho dv$

So its dimensionally equivalent to
$\boldsymbol{\varepsilon}_0 \oint E.A = Q$

(d) $\varepsilon_0 \oint \in dA = \varrho \left[\frac{Q}{v}\right]$

So, d is not the statement of Gauss's law for some physical situation.

27. Ans(c)

When a positive charge is released and moves along an electric field line, it moves to position of higher potential to lower potential.

28. Ans. (c)

Energy dissipated as heat (E)

$= \frac{V^2}{R} \times time\ (t)$

$= \frac{(20)^2}{1.5\times(10)^3}\ 3 \times 2 \times 60$

$=$ 32J

29.Ans (d)

capacities 2c and 2c use in series.

$= \frac{1}{c1} = \frac{1}{2c} + \frac{1}{2c} \quad \therefore C_1 = C$

Again between 'P' & 'Q' C & 'C' are in parallel so

$C_2 = C_1 + C = 2C$

Between A & B, C & 2C are in series so,

$\frac{1}{C_e} = \frac{1}{C} + \frac{1}{2C} \quad C_e$=2C/3 = $\frac{2\times45}{3}$=30μC

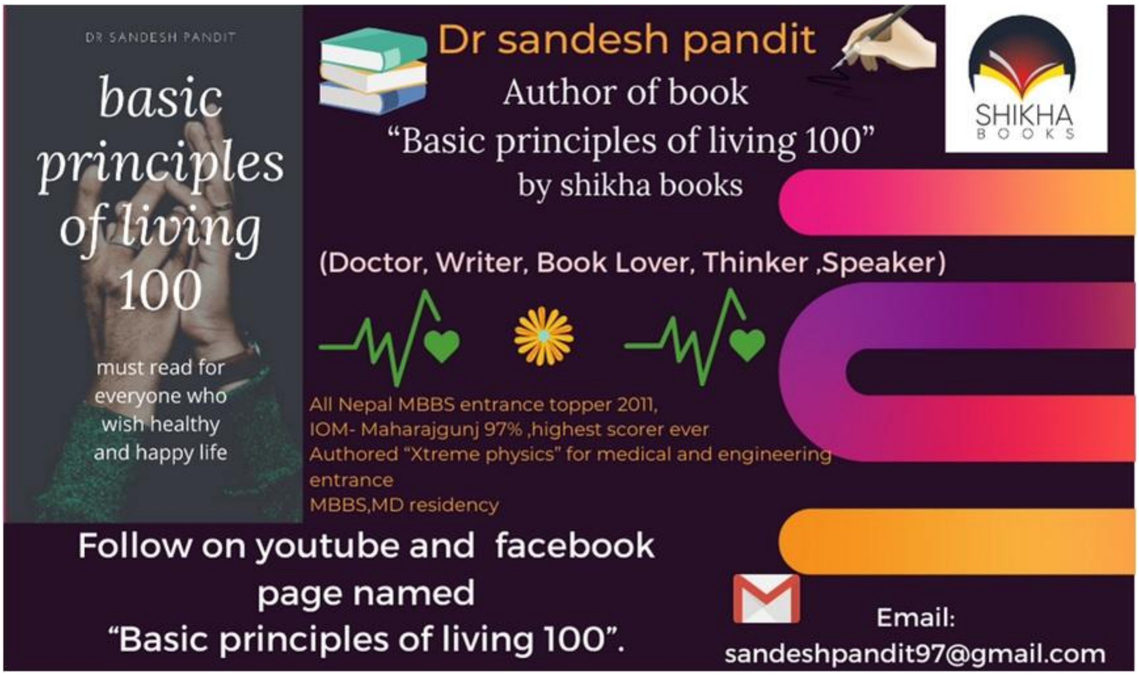
30 .Ans. (c).

fig shows phase path difference = $\frac{3\lambda}{4}$

Phase difference (ϕ) = $\frac{2\pi}{\lambda} = 270 \approx 260°$

Answer Sheet

1. b	*2. b*	*3. c*	*4. b*	*5. b*	*6. c*	*7. a*	*8. d*	*9. c*	*10. a*
11. a	*12.d*	*13. a*	*14. d*	*15. d*	*16. b*	*17. a*	*18. c*	*19. b*	*20. b*
21. d	*22. b*	*23. a*	*24. d*	*25. a*	*26. d*	*27. c*	*28. c*	*29. d*	*30. c*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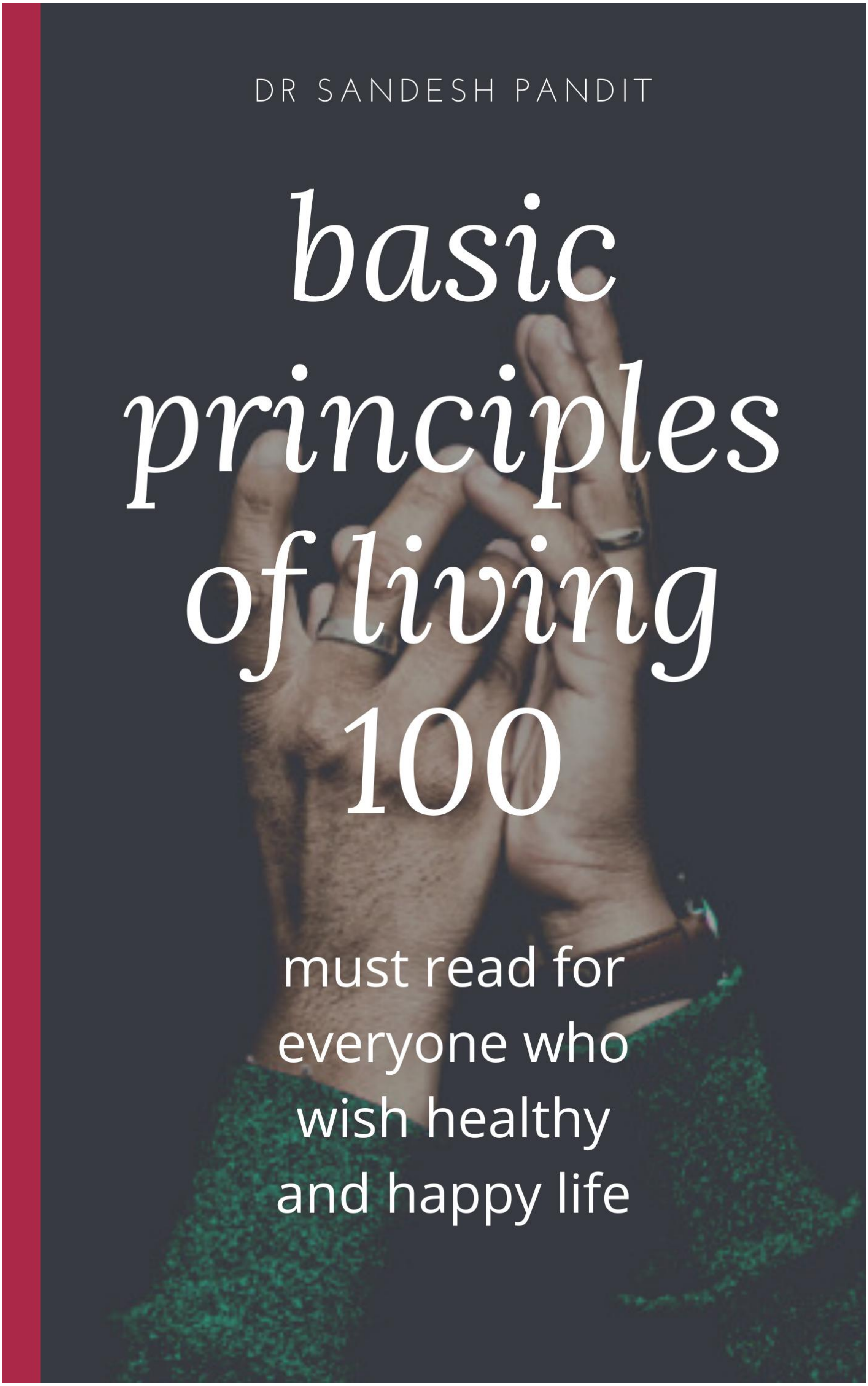
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basic
principles
of living
100
must read for
everyone who
wish healthy
and happy life

KU 2016

1. The unit of Resistance in SI system is

a. $kgm^2sec^{-2}A^{-1}$ b. $kgm^2sec^{-3}A$-2
c. $kgm^2sec^{-3}A^{-1}$ d. $kgm^2sec^{-2}A^{-2}$

2. Escape velocity of a body projected from earth

a. $\sqrt{\frac{2GM}{R}}$ b. $2\sqrt{\frac{GM}{R}}$
c. $\sqrt{\frac{GM}{R}}$ d. $\sqrt{\frac{GM}{2R}}$

3. If two vectors V_1&V_2, have same magnitude then which of the following isn't true about magnitude of their vector sum ?

a. 0 b. 1/4V
c. 2V d. 4V

4. Geostationary satellite of the earth

a. Rotate about the polar axis
b. At rest in positional
c. Stays stationary in space
d. Has its time period less than that of earth

5. Total internal reflection occur when the light travels from

a. Denser to rearer b. Rearer to denser
c. The μ is same d. None

6. Optical fiber is based on

a. TIR b. Reflection
c. Polarization d. Interference

7. When an aeroplane moves with 600 km/hr due east and return with 400 km/hr, then what is average speed for entire journey?

a. 240 b. 480
c. 500 d. 720

8. A cathode ray is

a. Positive b. Positron
c. Negative d. Electron

9. Quantum theory is explained by

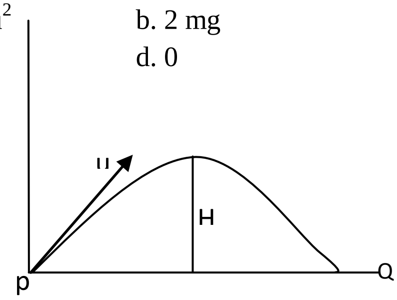
a. photon b. Positron
c. Negative d. None

10. When the magnetic field is applied across the north & and positive charge is deflected toward the east then current flows

a. Towards East b. Towards west
c. Downward d. Upward

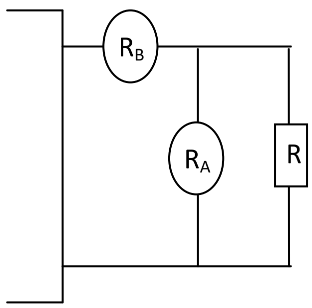
11. When a body projected from P to O with velocity u m/sec, the work done in these points from P to O is (air resistance is neglected)

a. $1/2mu^2$ b. 2 mg
c. mg d. 0



12. If the resistance of ammeter (R_A) is connected across the series and voltmeter of(R_B) across parallel then resistance of R will be

a. R is much less than R_A
b. R is much less then R_B
c. R is much more than R_A
d. R is much than R_B



13. A thief stole the book weighing 'w' then jump vertically down the wall, What is the resultant wt, of the book before he reach the ground ?

a. Zero b. 2w
c. W d. w/2

14 .The person who cannot see nearer than 25 cm. Then

a. Size of eye ball has been increased
b. Size of eyeball has been decreased
c. Distance between eye retina can't be decreased
d. Focal length can't be decreased up to certain limit

15. Green house effect is caused by

a. Infrared rays b. UV rays
c. X-ray d. Visible ray

16. A sample with half time 2 hr is 64 times stronger than safer amount. After how much time, it's safe to work with the sample?

a. 12 b. 24
c. 48 d. 36

17.At what position the maximum kinetic energy is suspected for particle in S.H.M.

a. at the extreme
b. at the mean
c. nearer to mean position
d. in between extreme and mean positions

18. If a body is projected with velocity V less than escape velocity of earth then the total energy of the projected body is

a. + ve b. -ve
c. Zero d. may be +ve or -ve

19. What happens to the dispersive power of a prism when is is immersed in water

a. Increases b. decreases
c. remain constant d. Depends on angle of prism

20. When a monochromatic light passes in young Double slit experiment then the resultant interference's fringe is

a. Straight line b. Circular
c. parabola d. Hyperbola

21. During photoelectric effect, the intensity of emitted electrons depend upon

a. current b. frequency
c. wavelength d. potential difference

22. The source of energy of sun is

a. Nuclear fission b. Nuclear fusion
c. Geothermal d. Radioactivity

23. A 5 kg mass with a string 1 m length moves in a vertical circle with the velocity of 4m/s. then net tension in the string is 130 N then, the position of body is

a. at the top position b. at the bottom position
c. at mid way d. can't be predicted

24. When a man weighing 10 kg in lift accelerated downward with the acceleration of $1 m/s^2$ then apparent wt. of man is

a. 98 N b. 88 N
c. 72 N d. 68 N

25. When the convex mirror of refractive index (μ), immersed in water of same refractive index (μ) then, its focal length is:

a. 0 b. ∞
c. decreases d. increases

26. At particular point, the gravity is always constant for same or different mass because

a. Gravitational force is constant
b. inertial mass & gravitational mass constant.
c. Gravitational force is directly proportion to inertial mass
d. All

27. When intrinsic semiconductor is doped with impurity then its conductivity

a. Increase b. Decrease
c. constant d. None

28. In a charged capacitor the energy resides

a. On the positive plate
b. On both positive and negative plates
c. In fields between the plates
d. Around the edge of capacitor plates

29. If the half life of a radioactive material is 1600 yrs, Then find the undecayed material after 4800 yrs

a. 1/8 b. ½
c. 7/8 d. 8/7

30. A pendulum clock keeping correct time is taken to high altitudes

a. It will keep correct time
b. Its length should be decreased to keep correct time
c. Its length should be increased to keep correct time
d. It will not keep correct time even if length is changed

(KU 2016. Answers)

1. Ans (b).
H = I^2 Rt, R = $\frac{H}{I^2 t}$
= $\frac{kgm^2s^2}{A^2s}$ = $kgm^2sec^{-3}A^{-2}$

2. Ans (a)
Escape velocity (ve) = $\sqrt{\frac{2GM}{R}}$
Orbital velocity (Vo) = $\sqrt{\frac{GM}{R}}$

3. Ans (d).
$V_1 = V_2 = V$
$V_1 - V_2 \le x \le v_1 + v_2$
$O \le x \le 2v$
The minimum magnitude is zero & maximum is 2v. So, 4v doesn't come.

4. Ans (a).
Geostationary satellite of earth revolves in the same direction the earth rotates ie. from west to east.

5. Ans (a).
Conditions for total internal Reflection (TIR)
- Light should travel from denser to rarer medium
- The angle of incidence should be greater than critical angle

6. Ans (a)
Optical fiber is based on TIR.

7. Ans (b)
v_1 = 600 km/hr.
v_2 = 400 km/hr.
Average speed = $\frac{total\ dictance}{total\ time}$
= $\frac{d+d}{\frac{d}{v1}+\frac{d}{v2}}$ = $\frac{2}{1/600+1/400}$ = 480 km/hr.

8. Ans. (d)
9. Ans. (a)
10. Ans. (c)
Using Right hand palm rule
- The four fingers gives direction of magnetic field.
- Thumb gives the direction of electric current
- Direction of force is considered from the positive base of palm because current is the direction of photon.

11. Ans. (d).

The force is acting downwards and displacement is along Po. so the force and displacement are perpendicular to earth other as a result.

workdone = Fdcosθ = 0

12. Ans. (a)

They are in parallel connection.

Resistance of R is much less then R_A.

13. Ans. (a).

It is the case of free fall. When the thief Jump with the weight 'w" then there is no any work done on the books on the body is freely falling under the influence of gravity.

14. Ans. (d)

The least distance of distinct vision is 25 cm.

15. Ans. (a)

16. Ans. (a).

$\frac{A}{A0} = \left(\frac{1}{2}\right)^{t/T}$ $where\ t = time\ period$

T = half life time

$\frac{A}{A0} = \frac{1}{64} = \left({}^{1}/_{2}\right)^{t/T}$

$\left(\frac{1}{2}\right)^{6} = \left({}^{1}/_{2}\right)^{t/T}$

$\frac{t}{T} = 6 \therefore t = 6T = 6 \times 2 = 12\ hrs.$

17. Ans. (b)

y = asinωt ; A = Amplitude

v = $\frac{dy}{dt}$ = ω A coswt = w$\sqrt{A^2 - y^2}$

vmax = ωA (at mean position (y=o)

vmin = 0 at extreme position (y = A)

18. Ans. (b)

If v<ue ; total energy <0 ie -ve.

v = ve, total energy = 0

v > ve ; total energy > 0

19. Ans. (c).

Dispersive power depends upon the nature of chromatic lights and nature of material of prism.

20. Ans. (d)

21. Ans. (a)

The intensity of emitted electrons depends upon the current whereas K.E. depends upon the frequency of incident radiation.

22. Ans. (b)

23. Ans. (b)

T- mgcosθ= $\frac{mv^2}{r}$

mgcosθ= T- $\frac{mv^2}{r}$

cosθ= $\frac{T}{mg}$- $\frac{v^2}{gr}$

cosθ=1 ∴θ=1

i.e.postion of the body =Bottom

24. Ans. (b)

mg-T=ma

T=m(g-a)

=10(9.8-1)

=88

25. Ans. (b)

In air $\frac{1}{f1} = (a\mu g - 1)\left(\frac{1}{R1} + \frac{1}{R2}\right) - (i)$

In water $\frac{1}{f2}$ $(w\mu g - 1)\left(\frac{1}{R1} + \frac{1}{R2}\right) - (ii)$

$\frac{f2}{f1} = \left(\frac{a\mu g - 1}{w\mu g - 1}\right)$

$\frac{f2}{f1} = \left(\frac{\mu g - 1}{\mu g - \mu w}\right) \times \mu w$

$\therefore \mu g = \mu w$

$\frac{f2}{f1} = \infty$

So,its focal length is infinity.

26. Ans. (b)

27. Ans. (a)

28. Ans. (c)

29. Ans. (a)

$\frac{N}{No} = \left(\frac{1}{2}\right)^{t/T}$

$\frac{N}{No} = \left(\frac{1}{2}\right)^{4800/1600}$

$\frac{N}{No} = \left(\frac{1}{8}\right)$ which is the undecayed material.

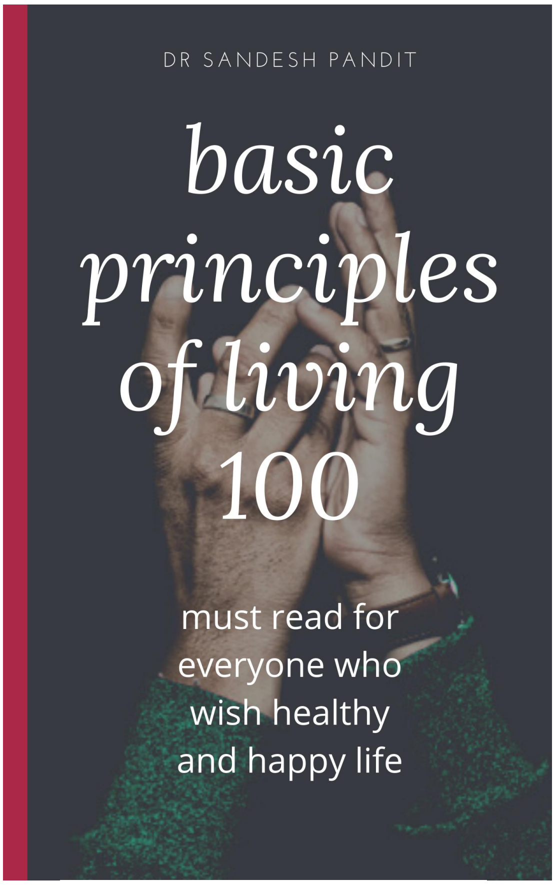
30. Ans. (a)

T=2π$\sqrt{\frac{l}{g}}$

At high altitudes value of ‘g’ decreases. To compensate increase in time period ,length of pendulum should be decreased.

Answer Sheet

1. b	*2. a*	*3. d*	*4. a*	*5. a*	*6. a*	*7. b*	*8. d*	*9. a*	*10. c*
11. d	*12. a*	*13. a*	*14. d*	*15. a*	*16. a*	*17. b*	*18. b*	*19. c*	*20. d*
21. a	*22. b*	*23. b*	*24. b*	*25. b*	*26. b*	*27. a*	*28. c*	*29. a*	*30. b*



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