ECET

PHYSICS

UNITS & DIMENSIONS

SYNOPSIS

- Physics is a branch of science which deals with the study of properties of matter and energy.
- The physical quantities are three types : fundamental, supplementary and derived physical quantities.
- A physical quantity which is independent of any other quantity is called fundamental quantity

  Eg : Length, Mass, Time etc.

  To measure a physical quantity a standard of the same nature is needed. It is called unit.

  Units of fundamental quantities are called fundamental units.

  Eg : metre, kilogram, second etc.
- The physical quantities which can be derived from fundamental quantities are called derived quantities.

  Eg : Force, work, power etc.

  Units of derived quantities are called derived units.

  Eg : newton, joule, watt etc.
- There are two supplementary physical quantities : plane angle and solid angle. These supplementary quantities possess units without dimensions.
- Radam is the angle subtended at the centre of a circle by an arc whose length is equal to the radius.

  1 rad = $57^{\circ}\ 17^{'}\ 45^{''}$

  ◆ Steradian is the solid angle subtended at the centre of the sphere by its surface, the are of which is equal to square of the radius.

  ◆ The plane angle around a point is 2π radian where as the solid angle around a point is 4π steradian
- Special units of length

  ◆ $\boxed{Micron(\mu)=10^{-6}m=10^{4}cm}$ (Size of bacteria)

  ◆ $\boxed{Angstrom(A)=10^{-10}m=10^{-8}cm}$ (Radius of atom)

  ◆ $\boxed{Fermi=10^{-15}m=10^{-13}cm}$ (Radius of nucleus)

  ◆ Astronomical unit (A.U) = Mean distance of the earth from the sun = $1.5\times10^{11}m=1.5\times10^{8}\ km$

  ◆ X ray unit (X.U) = $10^{13}m$ (wavelength of X-rays)

  ◆ light year = Distance travelled by light in vacuum in one year = $9.5\times10^{15}m=9.5\times10^{12}km$

  ◆ Parallactic second (parsec) : It is defined as the distance at which an arc of length one Astronomical unit subtends an angle of 1 second of an arc.

  1 persec = 3.26 light years = $3.1\times10^{16}m$. Light year and per sec are the units used to express the distances of stars and galaxies.

Systems of units :

	System	Length	Mass	Time
i)	C.G.S	Centimeter	gram	Second
ii)	F.P.S	Foot	Pound	Second
iii)	M.K.S	Metre	kilogram	second

S. I units (System International units)

Sl.No	Fundamental Quantity	Unit	Symbol
1.	Length	metre	m
2.	Mass	Kilogram	Kg
3.	Time	second	s
4.	Temperature	Kelvin	K
5.	Electric current	ampere	A
6.	Luminous intensity	candles	Cd
7.	Quantity of matter	mole	mol
Sl.No	**Supplementary Quantity**	**Unit**	**Symbol**
1.	Plane angle	radian	rad
2.	Solid angle	steradian	sr

➡ **Dimensions :**

Dimensions of a physical quantity are the powers to which the fundamental units are to be raised to get one unit of the physical quantity.

➡ **Dimensional formula :**

Dimensional formula of a derived quantity is the expression showing powers to which fundamental units to be rised obtain unit of a derived quantity.

Eg : Dimensional formula of force is $\left[ML\,T^{-2}\right]$

Dimensions of Force is 1 in mass (M), 1 in length (L) and -2 in time (T).

➡ **Some quantities have neither units nor dimensions.**

Eg : Coefficient of friction, strain, poisson's ratio, specific gravity or relative density. Ratio of specific heats of a gas. Refractive indices, Relative permeability, Relative permittivity or Dielectric constant, susceptibility, Trignometrical ratios, logarithmic functions. Exponential functions etc.

➡ **Some quantities have units but not dimensions.**

Eg : Plane angle, solid angle and units radian, steradian decibel respectively but they have no dimensions.

➡ **Dimensionless constants :** Numbers, π, exponential

➡ **Dimensionless constants :**

Universal gravitational constant (G)

Planck's constant (h)

Boltzmann gas constant (R)

Universal gas constant (R)

Permittivity of free space (ϵ_0)

Permeability of free space (μ_0)

Velocity of light in vacuum (c)

➡ **Principle of homogenity of dimensions :**

Quantities having same dimensions only can be added or subtracted or equated.

Eg : X = A + B

If X is displacement, A and B must be also displacement.

➡ **PRACTICAL UNITS**

- Micron (μ) = 10^{-6}m used to express size of bacteria
- Angstrom (A) = 10^{-10}m
- Fermi = 10^{-15}m used to express the radius of nucleus.
- Light year = $9.5\times10^{15}m$ used to express the distances of stars an galaxies
- Astronomical unit (A.U) = $1.5\times10^{11}m$

It is the mean distance of the earth from the sun.

- 1 par sec = 3.26 light year
- X - unit (XU) = 1.00206×10^{-13}m
- The practical unit of mass is Chandra Sekhar limit (CSL). 1 CSL = 1.4 times the mass of sun.

➡ **USES OF DIMENSIONAL FORMULA**

- To check the correctness of the formula or an equation
- To convert one system of units into another system
- To derive the relationship between different physical quantities

➡ **LIMITATIONS OF DIMENSIONAL ANALYSIS**

- The method does not enable us to determine the values of the dimensionless constants such as 2π in the formula for the period of a simple pendulum.
- If a physical quantity possessing three fundamental quantities, is dependent on more than three other physical functions are involved.
- The method is not applicable in relations where trigonometric and exponential functions are involved
- This method is not useful to derive relations which contain more than one term on one or both sides of the sign of equality i.e., equations like $s = ut + \frac{1}{2}at^2$ cannot be derived.

SI Units and Dimensional Formulae of Some Physical Quantities

1.	acceleration	$\frac{\text{change in velocity}}{\text{time}}$	ms^{-2}	M^0LT^{-2}
2.	Acceleration due to gravity	$\frac{\text{weight}}{\text{mass}}$	ms^{-2}	M^0LT^{-2}

3.	**Amplitude**	max. displacement	m	M^0LT^0
4.	**Angle**	$\frac{\text{arc}}{\text{radius}}$	radian	
	Dimensionless			
5.	**Angular displacement**	$\frac{\text{arc}}{\text{radius}}$	radian	
	Dimensionless			
6.	**Angular velocity**	$\frac{\text{ang. displacement}}{\text{time}}$	rad s^{-1}	$M^0L^0T^{-1}$
7.	**Angular acceleration**	$\frac{\text{change in ang.velocity}}{\text{time}}$	rad s^{-2}	$M^0L^0T^{-2}$
8.	**Angular impulse**	force × time	kgm^2s^{-1}	ML^2T^{-1}
9.	**Angular momentum**	moment of inertia × ang. velocity	kgm^2s^{-1}	ML^2T^{-1}
10.	**Area**	length × breadth	m^2	$M^0L^2T^0$
11.	**Coefficient of friction**	$\frac{\text{frictional force}}{\text{normal reaction}}$	No unit	
	Dimensionless			
12.	**Coefficient of viscosity**	$\frac{\text{force}}{\text{area}} \times \frac{\text{distance}}{\text{change in velocity}}$	pascal second	$ML^{-1}T^{-1}$
13.	**Compressibility**	$\frac{1}{\text{bulk modulus}}$	Pa^{-1}	$M^{-1}LT^2$
14.	**Density**	$\frac{\text{mass}}{\text{volume}}$	kgm^{-3}	$ML^{-3}T^0$
15.	**Elastic modulus** (Y, η, K)	$\frac{\text{stress}}{\text{strain}}$	Nm^{-2} *or* Pa	$ML^{-1}T^{-2}$
16.	**Energy**		joule (J)	ML^2T^{-2}
17.	**Energy density**	$\frac{\text{energy}}{\text{volume}}$	Jm^{-3}	$ML^{-1}T^{-2}$
18.	**Force**	mass × acceleration	Newton (N)	MLT^{-2}
19.	**Force constant or**			
	Spring constant	$\frac{\text{force}}{\text{elongation}}$	Nm^{-1}	ML^0T^{-1}

20.	**Frequency**	$\frac{1}{\text{time}}$	second^{-1} or hertz (Hz)	$M^0L^0T^{-1}$
21.	**Impulse**	force × time	Ns	MLT^{-1}
22.	**Inertia**	mass	kg	ML^0T^0
23.	**Joule's constant or Mechanical equivalent of heat**	$\frac{\text{work}}{\text{heat energy}}$	No unit	Dimensionless
24.	**Linear density of Mass per unit length**	$\frac{\text{mass}}{\text{length}}$	kgm^{-1}	$ML^{-1}T^0$
25.	**Modulus of elasticity** (Y, η, K)	$\frac{\text{stress}}{\text{strain}}$	Nm^{-2} or Pa	$ML^{-1}T^{-2}$
26.	**Moment of force (Torque) or Moment of couple**	Force × distance	Nm	ML^2T^{-2}
27.	**Moment of inertia**	mass × Perpendicular distance	kgm^2	ML^2T^0
28.	**Momentum**	mass × velocity distance	$Kgms^{-1}$	MLT^{-1}
29.	**Phase**	angle	radian	Dimensionless
30.	**Poisson's ratio**	$\frac{\text{lateral strain}}{\text{longitudinal strain}}$	No unit	Dimensionless
31.	**Power**	$\frac{\text{work}}{\text{time}}$	Js^{-1} or watt(W)	ML^2T^{-3}
32.	**Pressure**	$\frac{\text{force}}{\text{area}}$	Nm^{-2} or Pa	$ML^{-1}T^{-2}$
33.	**Pressure gradient**	$\frac{\text{pressure}}{\text{length}}$	Nm^{-3}	$ML^{-2}T^{-2}$
34.	**Radius of gyration**	distance	m	M^0LT^0
35.	**Speed**	$\frac{\text{distance}}{\text{time}}$	ms^{-1}	M^0LT^{-1}
36.	**Strain**	$\frac{\text{change in length}}{\text{initial length}}$	No unit	Dimensionless

37.	Stress	$\frac{\text{force}}{\text{area}}$	Nm^{-2} or Pa	$ML^{-1}T^{-2}$
38.	Surface energy	$\frac{\text{work}}{\text{area}}$	Jm^{-2}	ML^0T^{-2}
39.	Thrust	pressure $\times$ area	N	MLT^{-2}
40.	Time period	time for one oscillation or rotation	Second	M^0L^0T
41.	Torque or Moment of force or couple	force $\times$ distance	Nm	ML^2T^{-2}
42.	Universal gravitational constant	$\frac{\text{force}\times(\text{distance})^2}{(\text{mass})^2}$	Nm^2kg^{-2}	$M^{-1}L^3T^{-2}$
43.	Velocity	$\frac{\text{displacement}}{\text{time}}$	ms^{-1}	M^0LT^{-1}
44.	Velocity gradient	$\frac{\text{velocity}}{\text{length}}$	s^{-1}	$M^0L^0T^{-1}$
45.	Volume	length $\times$ breadth $\times$ height	m^3	$M^0L^3T^0$
46.	Wavelength	distance	m	$M^0\,L\,T^0$
47.	Wave number	$\frac{1}{\text{wave length}}$	m^{-1}	$M^0L^{-1}T^0$
48.	Weight	mass $\times$ acc. due to gravity	N	$M\,L\,T^{-2}$
49.	Work	force $\times$ displacement	joule (J)	ML^2T^{-2}

HEAT

50.	Enthalpy	heat energy	J	ML^2T^{-2}
51.	Entropy	$\frac{\text{heat energy}}{\text{temperature}}$	JK^{-1}	$ML^{-2}T^{-2}K^{-1}$
52.	Gas constant or Specific gas constant $M^0L^2T^{-2}K^{-1}$	$\frac{\text{pressure}\times\text{volume}}{\text{mass}\times\text{temp}}$	$Jkg^{-1}K^{-1}$	
53.	Heat	form of energy	joule (J)	ML^2T^{-2}

54.	Heat capacity or Thermal capacity	$\frac{\text{heat energy}}{\text{temperature}}$	JK^{-1}	$ML^2T^{-2}K^{-1}$
55.	Latent heat	$\frac{\text{heat energy}}{\text{mass}}$	Jkg^{-1}	$M^0\,L^2\,T^{-2}$
56.	Mechanical equivalent of heat or Joule's constant	$\frac{\text{work}}{\text{heat energy}}$	No unit	Dimensionless
57.	Molar specific heat or $ML^2T^{-2}mol^{-1}K^{-1}$ Molar heat capacity	$\frac{\text{heat energy}}{\text{no. of moles}\times\text{temp}}$	$J\,mole^{-1}K^{-1}$	
58.	Planck's constant	$\frac{\text{energy}}{\text{frequency}}$	Js	ML^2T^{-1}
59.	Specific heat $M^0L^{-2}T^{-2}K^{-1}$	$\frac{\text{heat energy}}{\text{mass}\times\text{temp}}$	$Jkg^{-1}\,K^{-1}$	
60.	Stefan's constant	$\frac{\text{heat energy}}{\text{area}\times\text{time}\times(\text{temp})^4}$	$Wm^{-2}\,K^{-4}$	$ML^0T^{-3}K^{-4}$
61.	Temperature coefficient of resistance	$\frac{\text{change in resistance}}{\text{initial resistance}\times\text{temperature}}$	K^{-1}	$M^0\,L^0\,T^0\,K^{-1}$
62.	Temperature gradient	$\frac{\text{temperature}}{\text{length}}$	Km^{-1}	$M^0\,L^{-1}T^0\,K$
63.	Universal gas constant $ML^2T^{-2}K^{-1}mol^{-1}$	$\frac{\text{pressure}\times\text{volume}}{\text{no. of moles}\times\text{abs. temp}}$	$Jmol^{-1}K^{-1}$	

ELECTRICITY

64.	Capacity or Capacitance	$\frac{\text{charge}}{\text{potential diff}}$	farad (F)	$M^{-1}L^{-2}T^{4}I^{2}$
65.	Charge	current $\times$ time	coulomb (C)	$M^{0}L^{0}TI$
66.	Conductance	$\frac{1}{\text{resistance}}$	ohm^{-1} (Ω^{-1}) or mho (or) siemen (S)	$M^{-1}L^{-2}T^{3}I^{2}$
67.	Conductivity	$\frac{1}{\text{resistivity}}$	$\Omega^{-1}m^{-1}$ or Sm^{-1}	$M^{-1}L^{-3}T^{3}I^{2}$
68.	Current	$\frac{\text{charge}}{\text{time}}$	ampere (A)	I or $M^{0}L^{0}L^{0}T^{0}I$
69.	Current density	$\frac{\text{current}}{\text{area}}$	Am^{-2}	$M^{0}L^{-2}T^{0}I$
70.	Electric field strength or Intensity of electric field	$\frac{\text{force}}{\text{charge}}$	NC^{-1}	$MLT^{-3}I^{-1}$
71.	Electromotive force (emf)	$\frac{\text{work}}{\text{charge}}$	JC^{-1} or volt(V)	$ML^{2}T^{-3}I^{-1}$
72.	Inductance (self and mutual) or Coefficient of induction (L and M)	$\frac{\text{magnetic flux}}{\text{current}}$	henry (H)	$ML^{-2}T^{-2}I^{-2}$
73.	Linear charge density	$\frac{\text{charge}}{\text{length}}$	Cm^{-1}	$M^{0}L^{-1}TI$
74.	Permittivity	$\frac{(\text{charge})^{2}}{(\text{force})\times(\text{distance})^{2}}$	Fm^{-1}	$M^{-1}L^{-3}T^{4}I^{2}$
75.	Potential or Potential difference	$\frac{\text{work}}{\text{charge}}$	JC^{-1} or volt (V)	$ML^{2}T^{-3}I^{-1}$

76.	Relative permitivity	$\frac{\text{absolute permitivity}}{\text{permitivity of free space}}$	No unit	Dimensionless
77.	Resistance	$\frac{\text{potential diff}}{\text{current}}$	ohm (Ω)	Scalar
78.	Resistivity or specific resistance	$\frac{\text{resistance}\times\text{area}}{\text{length}}$	Ωm	$ML^{3}T^{-3}I^{-2}$
79.	Specific charge	$\frac{\text{charge}}{\text{mass}}$	Ckg^{-1}	$M^{-1}L^{0}TI$
80.	Surface charge density	$\frac{\text{charge}}{\text{area}}$	Cm^{-2}	$M^{0}L^{-2}TI$

Araise ! Awake ! And stop not till the goal is reached

PRACTICE SET - I

01. Which of the following has NO units ?
1) Poisson's ratio 2) Strain
3) Relative permeability 4) All

02. Which of the following constant has units ?
1) Universal gravitational constant
2) Boltzmann's constant
3) Plank's constant 4) All

03. The unit of length is_____
1) angstrom 2) light year
3) fermi 4) All

04. Choose the correct statement
1) A dimensionless quantity always has a unit
2) A dimensionless quantity may or may not have a unit
3) A dimensionless quantity never has a unit
4) A dimensionless quantity does not exist.

05. Choose the correct statement
1) A unitless quantity always has dimensions
2) A unitless quantity may or may not have dimensions
3) A unitless quantity never has dimensions
4) A unitless quantity does not exist.

06. The dimensional formula $\left[ML\,T^{-2}\,I^{-2}\right]$ refers to
1) Magnetic permeability
2) Magnetic susceptibility
3) Magnetic induction
4) Electric permitivity

07. The dimensional formula $\left[ML^{-1}T^{-2}\right]$ refers to
1) Pressure 2) Stress
3) Young's modulus 4) All

08. If pressure P depends on velocity v and density d, then P, v and d are related as
1) $P\,\alpha\,vd$ 2) $P\,\alpha\frac{1}{vd}$ 3) $P\,\alpha\,v^2d$ 4) $P\,\alpha\frac{1}{v^2d}$

09. If 'm' is the mass of a drop of radius 'r', then $(mg/\pi r)$ has the dimensional formula as that of ____ (g is acceleration due to gravity)
1) Surface tension 2) Young's modulus
3) Coefficient of viscosity
4) Rigidity modulus

10. If L,C and R are inductance, capacity and resistance, respectively, then the dimensional formula of RC is same as that of
1) L/R 2) R/L 3) LR 4) None

11. A simple harmonic oscillator has mass 'm', amplitude 'A' frequency 'n', displacement 'x' and kinetic energy T. Its equation is $T = 2\pi^2 n^2\, m(A-x)$ is dimensionally___
1) Correct 2) Incorrect
3) Can't be determined 4) None

12. The fundamental unit which has the same dimensions in the dimensional formula of torque and electric potential is
1) Mass 2) Length 3) Time 4) 1 & 2

13. The unit of mass is 1 gram, the unit of length is 1 mm and the unit of time is 1 micro second. The unit of force is
1) 10^6N 2) 10^{-6}N
3) 10^{-12}N 4) 10^{12}N

14. If $A+B=C$ is dimensionally correct, then
1) A,B and C have the same dimensions
2) A and B have the same dimensions, whereas the dimensions of C are not the same as those of A+B.
3) A and B may not have the same units, but the dimensions of A+B and C are the same
4) None

15. A certain physical quantity is calculated from the formula $\frac{\pi}{3}\left(a^2-b^2\right)h$, where a, b and h are all lengths. The quantity calculated is
1) Length 2) Area 3) Volume 4) None

16. Energy is given by $E = hv$, h is Plank's constant and v is frequency. Using dimensional analysis.
1) The value of h can be determined
2) The dimensions of h can be determined
3) 1 & 2 4) None

17. In the equation $v^2 - u^2 = 2aS$, the value '2' is determined by
1) Dimensional analysis
2) Unit analysis
3) Experiment 4) Imagination

18. If 'm' is mass, 'q' is charge and 'B' is magnetic induction, then m/ Bq has the same dimensions as
1) Frequency 2) 1/Frequency
3) Velocity 4) Acceleration.

19. If the fundamental units is two systems of measurement are in the ratio 2 : 3, then the units of pressure in the systems will be in the ratio of
1) 9 : 4 2) 4 : 9 3) 3 : 2 4) 2 : 3

20. In two systems of measurements, the ratios of the units of mass, length and time are 1 : 2, 1 : 3 and 2 : 3, respectively. The ratio of the units of energy in the systems will be
1) 8 :1 2) 1 : 8 3) 1 : 4 4) 4 : 1

21. The dimension formula for viscosity is :
1) MLT^{-2} 2) $M^1L^1T^{-1}$
3) MLT^{-1} 4) $ML^{-1}T^{-1}$

22. The dimensional formula for Newton's gravitational constant 'G' is :
1) MLT^{-2} 2) ML^2T^{-2}
3) $M^{-1}L^3T^{-2}$ 4) ML^3T^{-2}

23. The dimensional formula ML^2T^{-2} relates to
1) surface tension 2) viscosity
3) work 4) young's modulus of elasticity

24. Dimensions of angular momentum are given by
1) $M^0L^0T^0$ 2) $M^1L^2T^{-1}$
3) ML^0T^{-1} 4) $ML^{-1}T^0$

25. If C and L denote the capacity and inductance the dimensions of LC are :
1) $M^0L^0T^2$ 2) $M^0L^2T^{-2}$
3) $M^2L^0T^{-2}$ 4) MLT^{-2}

26. If h is the Plank's constant and λ is the wave length h/λ has the dimensions of:
1) mass 2) momentum
3) energy 4) angular frequency

27. The quantity $\frac{e^2}{\varepsilon_0 hc}$, where 'e' is the electronic charge, 'h' is the planks constant and 'c' is the velocity of light has the dimensions of ($\varepsilon_0 \rightarrow$ permitivity of free space)
1) mass 2) length 3) time 4) strain

28. The period T of a small drop of liquid under surface tension σ depends on its radius r and density P. Then T is proportional to
1) $\sqrt{\frac{P\sigma}{r^3}}$ 2) $\sqrt{\frac{Pr^3}{\sigma}}$ 3) $\sqrt{\frac{r^3}{P\sigma}}$ 4) $\sqrt{\frac{r\sigma}{P}}$

29. The numerical value of a given quantity is :
1) Inversely proportional to unit
2) Directly proportional to unit
3) Independent of unit
4) Directly proportional to square of the unit

30. Which of the following equations is dimensionally correct ?
1) Volume $\times$ Pressure = Energy
2) Pressure = Energy $\times$ Volume
3) Force $\times$ Velocity = Kinetic energy
4) Momentum $\times$ time = Force

31. Is it possible to have a unit but no dimensions ?
1) yes 2) no
3) it is absorb 4) None

32. If units of length, velocity and force are doubled the unit of energy becomes :
1) unchanged 2) doubled
3) increases four times 4) 1/4

33. C and R represent the physical quantities, inductance and resistance respectively. The combination which has the dimensions of frequency are :

1) $\frac{1}{RC}$ 2) $\frac{R}{L}$ 3) $\frac{1}{\sqrt{LC}}$ 4) All

34. Which of the following has not been expressed in proper units ?

1) $\frac{Stress}{strain} = N/m^2$

2) Surface tension = N/m

3) energy = kgx m / sec 4) Pressure = N/m^2

35. Of the following quantities, which one has dimensions different from the remaining three ?

1) energy per unit volume
2) force per unit area
3) product of voltage and charge per unit volume
4) angular momentum per unit mass

36. The joule- sec could be a unit for :

1) Power 2) Plank's constant
3) Torque 4) Joules constant

37. The quantity represented by $\frac{mass \times pressure}{density}$

1) Energy 2) Power 3) Force 4) Impulse

38. The dimensions of electrical conductivity are :

1) $\left[ML^1T^{-1}A^{-2}\right]$ 2) $\left[MT^{-2}\right]$

3) $\left[MLT^{-2}\right]$ 4) $M^{-1}L^{-2}T^3A^2$

39. The only mechanical quantity which has negative dimension of mass is :

1) Universal gravitational constant
2) Universal gas constant
3) Angular momentum 4) Surface Tension

40. The quantity having the same unit in all the systems of units is :

1) Length 2) Mass
3) Time 4) Temperature

41. The dimensional formula for angular velocity is

1) $M^{-1}L^1T^0$ 2) $M^0L^{-1}T^{-1}$

3) $M^{-1}L^{-1}T^0$ 4) $M^0L^{-0}T^{-1}$

42. Two physical quantities of which one is a vector and the other is a scalar having the same dimensional formula are :

1) Linear momentum and angular momentum
2) Torque and work
3) Impulse and momentum
4) Power and pressure

43. S.I unit of Luminous intensity is :

1) Candela 2) Lux 3) Phot 4) Decibel

44. Which of the following quantities has not been expressed in proper units ?

1) $\frac{stress}{strain} = newton/m^2$

2) surface tension = newton / m

3) Energy = $\frac{kg-m}{s}$

4) Pressure = newton / m^2

45. The unit of luminous intensity is :

1) candela 2) watt 3) lumen 4) ampere

46. S.I unit and C.G.S unit vary by 10^3 times, it is

1) Boltzmann constant 2) Gravitational constant
3) Planck's constant 4) Angular momentum

47. Dimensional formula for angular momentum is

1) ML^2T^{-1} 2) ML^3T^{-1}

3) MLT^{-1} 4) ML^3T^{-2}

48. Dimensions of CR :

1) Frequency 2) Energy
3) Time period 4) Current

49. The physical quantity that has no dimensions :

1) Angular velocity 2) Linear momentum
3) Angular momentum 4) strain

50. The dimensions of ratio of angular momentum to linear momentum is :

1) $M^0L^1T^0$ 2) $M^1L^1T^1$

3) $M^{-1}L^2T^{-1}$ 4) $M^{-1}L^{-1}T$

51. The pair of physical quantities not having the same dimensional formula is :

1) Acceleration, gravitational field strength
2) Torque, Angular momentum
3) Pressure, Modulus of elasticity
4) All of the above

52. Planck's constant has the same dimensions as :

1) energy 2) power
3) linear momentum 4) angular momentum

53. The fundamental unit which has the same power in the dimensional formula of surface tension and viscosity is :

1) mass 2) length
3) time 4) none

54. The work done by a force is 400 units. If the units of mass, length and time are doubled the numerical value of work is :

1) 400 units 2) 800 units
3) 200 units 4) 100 units

55. For the equation $F \propto A^aV^bD^c$ where F is the force. A is the area, V is the velocity and D is the density with the dimensional analysis gives the following values for the exponents : .

1) a = 1 ; b = 2; c = 1
2) a = 2; b = 1; c = 1
3) a = 1; b = 1; c = 2
4) a = 0 ; b = 1 ; c = 1

PRACTICE SET-I KEY

01) 4	02) 4	03) 4	04) 2	05) 3
06) 1	07) 4	08) 3	09) 1	10) 1
11) 2	12) 4	13) 1	14) 1	15) 3
16) 2	17) 3	18) 2	19) 1	20) 2
21) 4	22) 3	23) 3	24) 2	25) 1
26) 2	27) 4	28) 2	29) 1	30) 1
31) 1	32) 3	33) 4	34) 3	35) 4
36) 2	37) 1	38) 4	39) 1	40) 3
41) 4	42) 2	43) 1	44) 3	45) 1
46) 2	47) 1	48) 3	49) 4	50) 1
51) 2	52) 4	53) 1	54) 2	55) 1

PRACTICE SET - II

01. 1 joule = _____ ergs

1) 10^7 2) 10^{-7} 3) 4.2 4) 2.4

02. 1 Pa = ____

1) 1 Nm^{-2} 2) 10 Nm^{-2}

3) 1 Nm^2 4) 10 Nm^2

03. 9.8 ms^{-2} = _____ km - $minute^{-2}$

1) 352.8 2) 3.528 3) 35.28 4) 3528

04. 6000 Å = _____ microns

1) 600 2) 60 3) 6 4) 0.6

05. If ε_0 electric permitivity of free space and E is intensity of electric field, then the dimensional formula of $\frac{1}{2}\varepsilon_0E^2$ is

1) $ML^{-1}T^{-2}$ 2) $ML^{-1}T^{-1}$

3) $ML^{-2}T^{-2}$ 4) None

06. Force F is expressed in terms of time t as $F = at + bt^2$, where a and b are constants. The dimensional formula of a and b are

1) $\left[MLT^{-3}\right], \left[MLT^{-4}\right]$

2) $\left[MLT^{-3}, MLT^{-2}, MLT^{-2}\right]$

3) $\left[MLT^{-3}\right], \left[MLT^0\right]$ 4) None

07. The velocity V of a body is given by $v = G^x M^y R^z$, where G is universal gravitational constant, M is mass and R is radius, then

1) $x=\frac{1}{2}, y=\frac{1}{2}, z=\frac{1}{2}$

2) $x=-\frac{1}{2}, y=-\frac{1}{2}, z=-\frac{1}{2}$

3) $x=\frac{1}{2}, y=\frac{1}{2}, z=-\frac{1}{2}$

4) $x=\frac{1}{2}, y=-\frac{1}{2}, z=-\frac{1}{2}$

08. $v \alpha g^x h^y$, where v is velocity, g is acceleration due to gravity and h is height. The values of x and y are

1) $\frac{1}{2}, \frac{1}{2}$ 2) $-\frac{1}{2}, \frac{1}{2}$

3) $\frac{1}{2}, -\frac{1}{2}$ 4) $-\frac{1}{2}, -\frac{1}{2}$

09. The dimensions of 'a' and 'b' in an equation $\left(P + \frac{a}{V^2}\right)(V - b) = RT$, where P is pressure, V is volume, T is temperature and R is universal gas constant are

1) ML^5T^{-2}, L^3 2) $ML^{-5}T^2, L^3$

3) ML^5T^{-2}, L^{-3} 4) None

10. If pressure P, velocity V and time T are taken as fundamental quantities, then the dimensional formula of force is

1) $[PV^2T^2]$ 2) $[PV^{-2}T^{-2}]$

3) $[PV^2T]$ 4) $[PVT^2]$

11. If the unit of force of 1 kN, the unit of time is 1 ms and the unit of power is 1 kW, then the unit of length is

1) 1m 2) 1 cm

3) 1mm 4) 1 nm

12. If the unit of mass is 0.5 kg, the unit of length is 2m and the unit of time is 1s, then they the unit of pressure is

1) 0.25 Nm^{-2} 2) 2.5 Nm^{-2}

3) 25 Nm^{-2} 4) None

13. In an expression $x = (A^2 - B^2)C$, where A,B and C are measured in the units of length, then x/A is

1) Length 2) Area

3) Volume 4) None

14. $F = G\frac{m_1 m_2}{d^2}$, where F is force, m_1 and m_2 are two masses, d is distance and G is a constant. The unit and dimensional formula of G are

1) $Nm^2\ kg^{-2}, M^{-1}L^3T^{-2}$

2) $Nm^2\ kg^2, M^{-1}L^3T^{-2}$

3) $Nm^2\ kg^{-2}, M^{-1}L^{-3}T^{-2}$

4) $Nm^2\ kg^{-2}, M^{-1}L^{-3}T^{-2}$

15. The equation for time period is $T = \frac{2\pi}{\sqrt{g}} A^x$, where g is acceleration due to gravity. Then

1) $A = length, x = 0.5$ 2) $A = length, x = 1$

3) $A = time, x = 0.5$ 4) $A = time, x = 1$

16. The time period of soap bubble $T \alpha P^a d^b S^c$, where P is pressure, d is density and S is surface tension, then the values of a,b and c are

1) -1, -2, 3 2) $-\frac{3}{2}, \frac{1}{2}, 1$

3) $1, -2, -\frac{3}{2}$ 4) None

17. A wave is represented by $y = a\sin(At - Bx + C)$, where A,B and C are constants. The dimensions of A,B and C are :

1) T^{-1}, L, dimensionless

2) T^{-1}, L^{-1}, dimensionless

3) T^{-1}, L^{-1}, M^{-1} 4) None

18. The dimensional formula of η in an equation $F = 6\pi\ \eta av$, where F is force, a is radius and v is velocity is

1) $M L^{-1} T^{-1}$ 2) $M L^0 T^{-1}$

3) $M L\ T^{-1}$ 4) None

19. The Young's modulus of a material of wire is 12.6×10^{11} dyne - cm^{-2}, its value of SI units is

1) $12.6 \times 10^6\ Nm^{-2}$ 2) $12.6 \times 10^{10}\ Nm^{-2}$

3) $12.6 \times 10^8\ Nm^{-2}$ 4) None

20. The work done by a body 'E' varies with displacement 's' as $E = AS + \frac{B}{(C-S)^2}$, where A,B and C are constants. The dimensional formula of B is

1) M 2) L

3) ML^4T^{-2} 4) MLT^{-2}

21. $\frac{1 \text{ nano metre}}{1 \text{ atto metre}} =$ ____

1) 10^9 2) 10^{-9}

3) 10^{27} 4) 10^{-27}

22. 1 kg- wt = ____ newtons

1) 9.8 2) 98

3) 980 4) 1

23. The value of force 500 dynes in a system based on metre, kg and minute as fundamental units is

1) 18 units 2) 36 units 3) 12 units 4) 9 units

24. If units of mass, length and time are doubled, the unit of energy will increase by

1) 100% 2) 200%

3) 300% 4) 400%

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

1) $M L^3 T^{-4} I^{-2}$ 2) $M^{-4} L^{-3} T^4 I^2$

3) Dimensionless 4) None

PRACTICE SET-II KEY

01) 1	02) 1	03) 3	04) 4	05) 1
06) 1	07) 3	08) 1	09) 1	10) 1
11) 3	12) 1	13) 2	14) 1	15) 1
16) 2	17) 2	18) 1	19) 2	20) 3
21) 1	22) 1	23) 1	24) 1	25) 3

SELF TEST - I

01. The dimensional formula for magnetic flux is

1) $M^1L^2T^{-2}I^{-1}$ 2) $M^1L^2T^{-2}I^{-2}$

3) $M^1L^{-2}T^{-2}I^1$ 4) $M^1L^{-2}T^{-2}I^{-2}$

02. The Vanderwaal's equation for a gas is $\left(P + \frac{a}{V^2}\right)(V - b) = nRT$ where P,V,R, T and n represent the pressure, absolute temperature, and number of moles of gas respectively 'a' and 'b' are constants. The ratio b/a will have the following dimensional formula

1) $M^{-1}L^{-2}T^{-2}$ 2) $M^1L^{-1}T^{-1}$

3) ML^2T^2 4) MLT^{-2}

03. The dimensional formula for coefficient of kinetic viscosity is :

1) $M^0L^{-1}T^{-1}$ 2) $M^0L^2T^{-1}$

3) ML^2T^{-1} 4) $ML^{-1}T^{-1}$

04. In C.G.S system the magnitude of the force is 100 dyne. In another system where the fundamental physical quantities are kilogram, metre, and minute the magnitude of force is
1) 0.036 2) 0.36
3) 3.6 4) 36

05. The dimensional formula for the product of two physical quantities P and Q is ML^2T^{-2}. The dimensional formula of $\frac{P}{Q}$ is MT^{-2}. Then P and Q respectively are :
1) Force and velocity
2) Momentum and displacement
3) Force and displacement 4) Work and velocity

06. The fundamental physical quantities that have same dimension in the dimensional formula of Torque and Angular Momentum are
1) mass, time 2) time, length
3) mass, length 4) time, mole

07. If pressure P, Velocity V, and time T are taken as fundamental physical quantities the dimensional formula for force is
1) PV^2T^2 2) $P^{-1}V^2T^{-1}$
3) PVT^2 4) $P^{-1}VT^2$

08. The physical quantity which has the dimensional formula as that of $\frac{energy}{mass \times length}$ is
1) Force 2) Power
3) Pressure 4) Acceleration

09. The dimensional formula for magnetic induction is
1) $MT^{-1}A^{-1}$ 2) $MT^{-2}A^{-1}$
3) MLA^{-1} 4) $MT^{-2}A$

10. The dimensional formula for latent heat is
1) MLT^{-2} 2) ML^2T^{-2}
3) $M^0L^2T^{-2}$ 4) MLT^{-1}

11. The S.I unit of Moment of inertia is :
1) kg/m^2 2) $kg.m^2$
3) N/m^2 4) Nm^2

12. If m is the mass, Q is the charge and B is the magnetic induction, m/BQ has the same dimensions as :
1) Frequency 2) $\frac{1}{Frequency}$
3) Velocity 4) Acceleration

13. Dimensions of impulse is :
1) MLT^{-2} 2) M^2LT^{-1}
3) MLT^{-1} 4) ML^2T^{-1}

14. Dimensional formula for capacitance is
1) $M^1L^{-2}T^4I^2$ 2) $M^1L^2T^4I^{-2}$
3) $M^1L^2T^2$ 4) MLT^{-1}

15. modulus of Elasticity of dimensionally equivalent to
1) stress 2) surface tension
3) strain 4) coefficient of viscosity

16. If the unit of length, Mass, time each be doubled the unit of work is increased to
1) 5 times 2) 2 times
3) 3 times 4) 4 times

17. Dimensions of C x R (Capacity x Resistance) is
1) frequency 2) energy
3) time period 4) current

18. The physical quantity that has no dimensions is
1) angular velocity 2) linear momentum
3) angular momentum 4) strain

19. $ML^{-1}T^{-2}$ represents
1) Stress 2) Young's modulus
3) Pressure 4) All the above

20. Dimensional formula for angular momentum
1) ML^2T^{-1} 2) $M^1L^3T^{-1}$
3) $M^1L^1T^{-1}$ 4) ML^1T^{-2}

21. The unit of Luminous intensity is :
1) Candela 2) Watt
3) Lumen 4) Ampere

22. S.I unit and c.g.s unit of quantity vary by 10^3 times it is :
1) Soltzman constant
2) Gravitational constant
3) Plank's constant
4) Angular Momentum

23. $V \alpha g^x h^y$ where V is velocity g is acceleration due to gravity and h is height. Then x and y are
1) $\frac{1}{2}, \frac{1}{2}$ 2) $\frac{1}{2}, -\frac{1}{2}$
3) $-\frac{1}{2}, \frac{1}{2}$ 4) $1, \frac{1}{2}$

24. The pair of physical quantities not having the same dimensional formula are
1) acceleration, gravitational field strength
2) Torque, angular momentum
3) Pressure, Modulus of Elasticity
4) All the above

25. A pair of physical quantities having the same dimensional formula are
1) Momentum and impulse
2) Momentum and energy
3) Energy and pressure
4) Force and power

26. The dimensional formula for universal gravitational constant is
1) $M^1L^2T^{-2}$ 2) $M^0L^2T^{-2}$
3) $M^1L^2T^{-2}$ 4) $M^{-1}L^{-3}T^{-2}$

27. A pair of physical quantities having the same dimensional formula are
1) Force and Work
2) Work and Energy
3) Force and Torque
4) Work and Power

28. The pair of physical quantities having the same dimensional formula is
1) Angular Momentum and torque
2) Torque and strain energy
3) Entropy and power
4) Power and Angular momentum.

29. siemen is the S.I unit of (fill in the blanks)
1) Electrical conductance
2) Electricity conductivity
3) Potential difference
4) Inductance

30. Planck's constant has the dimensions as that of
1) Energy 2) Power
3) Linear momentum
4) Angular momentum

31. The SI unit of magnetic flux is
1) Maxwell 2) Waber
3) tesla 4) gauss

32. The fundamental unit which has the same power in the dimensional formula of surface tension and coefficient of viscosity is
1) mass 2) length 3) time 4) none

33. The physical quantity which has no dimensions is
1) stress 2) strain
3) momentum 4) angular velocity

34. Electron volt is the unit of
1) power 2) P.D
3) charge 4) energy

35. Dimensional formula of Torque is
1) MLT^{-2} 2) ML^2T^{-2}
3) ML^2T^{-3} 4) MLT^{-3}

36. Dimensional analysis of . the equation (velocity)^x (Pressure differences.)$^{3/2}$ (density)$^{-3/2}$ gives the value of x as :
1) 1 2) 2 3) 3 4) -3

37. For the equation $F = A^a v^b d^c$ where F is force, A is area 'v' is velocity and d density, with the dimensional analysis gives the following values for the exponents
1) a = 1, b = 2, c = 1 2) a = 2, b = 1, c = 1
3) a = 1, b = 1, c = 2 4) a = 0, b = 1, c = 1

38. The dimensional formula for angular velocity is
1) $M^{-1}L^1T^0$ 2) $M^0L^{-1}T^{-1}$
3) $M^{-1}L^1T^0$ 4) $M^0L^0T^{-1}$

39. The dimensional formula $M^{-1}L^3T^{-2}$ refers to
1) Force 2) Power
3) Gravitational constant
4) Energy

SELF TEST - 1 KEY

01) 1	02) 1	03) 4	04) 3	05) 3
06) 3	07) [illegible]	08) 4	09) 2	10) 3
11) 2	12) 2	13) 3	14) 1	15) 1
16) 2	17) 3	18) 4	19) 4	20) 1
21) 1	22) 2	23) 1	24) 2	25) 1
26) 4	27) 2	28) 2	29) 1	30) 4
31) 2	32) 1	33) 2	34) 4	35) 2
36) 3	37) 1	38) 4	39) 3	

SELF TEST - II

01. Which of the following represents the correct dimensions of the coefficient of viscosity?

1) $M^1L^1T^{-2}$ 2) $M^1L^1T^{-1}$
3) $M^1L^{-1}T^{-1}$ 4) $M^1L^{-2}T^{-2}$

02. The Physical Quantities not having same dimensions are

1) Torque and work
2) Momentum and Plank's constant
3) Stress and Young's modulus
4) Speed and $(\mu_0 \epsilon_0)^{-1/2}$

03. Dimensional formula for permitivity is

1) $M^{-1}L^{-3}T^4A^2$ 2) $M^1L^3T^{-4}A^{-2}$
3) $M^{-1}L^3T^4A^2$ 4) $M^1L^{-3}T^4A^{-2}$

04. Using mass (M) Length (L) Time (T) and current (A) as fundamental quantities, the dimension of permeability is

1) $M^{-1}L^1T^{-2}A^1$ 2) $M^1L^2T^{-2}A^{-1}$
3) $M^1L^1T^{-2}A^{-2}$ 4) $M^1L^1T^{-1}A^{-1}$

05. The dimensional formula of Torque is

1) $M^1L^0T^{-2}$ 2) $M^1L^{-1}T^{-1}$
3) $M^1L^2T^{-2}$ 4) $M^1L^3T^{-3}$

06. Which of the following is the unit of energy

1) Tesla 2) Wall
3) Horse power 4) ev

07. If the energy is represented by V force by F and work by w these quantities are taken as fundamental quantities then the correct dimensions of mass will be

1) $\frac{w}{v^2}$ 2) $\frac{w}{v}$ 3) $\frac{F}{v^2}$ 4) $\frac{v}{w}$

08. The dimension formula of $\frac{1}{2}\epsilon_0 E^2$ is (ϵ_0 & E are permitivity and Electric field)

1) $M^1L^2T^{-2}$ 2) $M^1L^1T^{-2}$
3) $M^1L^{-1}T^{-2}$ 4) $M^1L^{-2}T^{-1}$

09. The numerical value of measurement is

1) directly proportional to unit
2) inversely proportional to unit
3) Both 4) None

10. The displacement in nth second of uniformly accelerated motion is given by $S_{nth} = u + \frac{a}{2}(2n-1)$. This equation is dimensionally

1) correct 2) not correct
3) can be made correct by multiplying the right hand side of equation by n.
4) can be made correct by dividing the left hand side of the equation by n.

11. Torr is the unit of physical quantity

1) density 2) pressure
3) torque 4) None

12. The unit of Young's Modulus is

1) $N.m^{-1}$ 2) $N.m$
3) $N.m^{-2}$ 4) $N.m^2$

13. Force $F = at + bt^2$ where 't' is time. The dimensions of a and b are

1) $\left[MLT^{-3}\right]$ and $\left[MLT^{-4}\right]$
2) MLT^{-3} and MLT^{-2}
3) MLT^{-1} and MLT^0
4) MLT^{-4} and MLT^{-1}

14. Given M is the mass suspended from a spring of force constant k the dimensional formula for $\left(\frac{M}{k}\right)^{\frac{1}{2}}$ is same as that for

1) Wavelength 2) Velocity
3) Time period 4) Frequency

15. Dimensions $\left(ML^{-1}T^{-1}\right)$ are related to

1) Work 2) Torque
3) Energy 4) Coefficient of viscosity

16. The S. I unit of Mechanical equivalent of heat is :

1) joule x calorie 2) joule / calorie
3) calorie x erg 4) erg / calorie

17. The dimensions of calorie are

1) ML^2T^{-2} 2) MLT^{-2}
3) ML^2T^{-1} 4) ML^2T^{-1}

18. Specific heat in joule per ^0C rise of temperature, its dimensions are

1) $MLT^{-1}K^{-1}$ 2) $ML^2T^{-2}K^{-1}$
3) $M^0L^2T^{-2}K^{-1}$ 4) $ML^3T^{-2}K^{-1}$

19. In an inductive circuit current I is flown. The work done is equal to $\frac{1}{2}LI^2$. The dimensions of LI^2 are

1) ML^2L^{-2} 2) Not expressible in M,L,T
3) ML^{-1} 4) $M^2L^2T^2$

20. The dimensional formula for impulse is :

1) MLT^{-2} 2) MLT^{-1}
3) ML^2T^{-1} 4) M^2LT^{-1}

21. Dyne - Second is the unit of

1) Force 2) Momentum
3) Energy 4) Power

22. The displacement in nth second of uniformly accelerated motion is given by

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

This equation s dimensionally

1) correct 2) not correct
3) can be made correct by multiplying the right hand side of equation by n.
4) can be made correct by dividing the left hand side of the equation by n.

SELF TEST - 2 KEY

01) 3	02) 2	03) 1	04) 3	05) 3
06) 4	07) 1	08) 3	09) 2	10) 1
11) 2	12) 3	13) 1	14) 3	15) 4
16) 2	17) 1	18) 2	19) 1	20) 2
21) 2	22) 1			

PREVIOUS ECET BITS

2007

01. Dimensional formula of torque is

1) ML^2T^{-1} 2) MLT^{-2}
3) ML^2T^{-3} 4) ML^2T^{-2}

02. The dimensional formula for impulse is same that of:

1) Torque 2) Momentum
3) Force 4) Power

03. The fundamental unit which is common in C.G.S. and S.I. system is :

1) Gram 2) Kilogram
3) Second 4) Metre

04. The dimensions of the quantities in one of the following pairs is not the same. Identify the pair :

1) Momentum and impulse
2) Pressure and stress
3) Work and Torque
4) Speed and Acceleration

2009

05. If C is the capacitance and V is the potential across the condenser, then the dimensional representation for $\frac{1}{2}CV^2$ is

1) ML^2T^{-2} 2) $ML^{-2}T$
3) $ML^{-2}T^{-2}$ 4) LT^{-2}

06. If 'M' is the cross of a drop of radius 'r' then $\left(\frac{mg}{\pi r}\right)$ has the dimensional formula as that of

1) surface tension 2) Youn'gs modulus
3) coefficient of viscosity 4) Rigidity modulus

2010

07. 1 joule of work is equal to

1) 10^{-7} ergs 2) 10^7 ergs
3) 10^5 ergs 4) 10^{-5} ergs

08. The product of pressure and volume has the same units as

1) Temperature 2) Force
3) Work 4) Power

09. Electrical conductance has the unit of

1) Mho 2) Ohm/m
3) Mho/m 4) M/ohm

10. The SI unit of moment of inertia is

1) Kg/m^2 2) $Kg-m^2$

3) N/m^2 4) $N-m^2$

2011

11. If the force 'F', velocity and time - T are taken as fundamental quantities, find the dimensional formula of energy

1) $E=F^1V^0T^1$ 2) $E=F^0V^0T^1$

3) $E=F^1V^0T^0$ 4) $F^1V^1T^1$

12. The dimensions of the quantities in one of the following pairs are same

1) torque & work

2) angular momentum & length

3) energy & young modulus

4) light year & year

2012

13. Two quantities A and B are related by the relation $\frac{A}{B}=m$ where 'm' is the linear mass density A is force. The dimensions of B will be

1) Same as that of latent heat

2) same as that of pressure

3) same as that of work

4) same as that of momentum

14. The dimensional formula of capacitance in terms of M,L,T and I is

1) $\left[ML^2T^2I^2\right]$ 2) $\left[ML^{-2}T^4I^2\right]$

3) $\left[M^{-1}L^3T^3I\right]$ 4) $\left[M^{-1}L^{-2}T^4I^2\right]$

2013

15. The dimensional formula of the physical quantity torque is represented by (UD)

1) $M^2L^2T^{-2}$ 2) ML^2T^{-2}

3) ML^3T^{-2} 4) MLT^{-2}

16. Which of the following is SI unit of energy? (UD)

1) Joule 2) Dyne 3) Poundal foot 4) Newton

2014

17. The dimensions of angular momentum are ___

1) MLT^{-1} 2) $ML^{-1}T$ 3) ML^0T^{-2} 4) ML^2T^{-1}

18. The SI unit universal gas constant R is ___

1) Newton K^{-1} mol^{-1} 2) Joule K^{-1} mol^{-1}

3) Watt K^{-1} mol^{-1} 4) erg K^{-1} mol^{-1}

T.S ECET 2015

19. $\left[ML^2T^{-2}\right]$ are dimensions of

1) force 2) moment of force

3) momentum 4) power

20. Out of the following pairs, which one does not have identical dimensions

1) moment of inertia and moment of a force

2) work and torque

3) angular momentum and planck's constant

4) impulse and momentum

A.P ECET 2015

21. The dimensional formula of $\frac{1}{2}CV^2$ is

1) MLT^{-2} 2) ML^2T^{-2}

3) ML^2T^2 4) $ML^{-2}T^{-2}$

22. Which of the following physical quantity can be represented by Newton-meter^{-2}.?

1) pressure 2) coefficient of viscosity

3) strain 4) force

T.S ECET 2016

23. The dimensional formula of Planck's constant, h is

1) ML^2T^{-1} 2) MLT^{-1} 3) ML^2T^{-2} 4) MLT^{-1}

24. Which one of the following physical quantity has the dimensional formula MLT^{-1}

1) work 2) power 3) impulse 4) pressure

AP - ECET 2016

25. The SI unit of energy is $J=kgm^2s^{-2}$, that of speed 'v' is ms^{-1} and of accelaration 'a' is ms^{-2}. If 'm' represents the mass of the body, which of the following tells the correct answer for kinetic energy with respect to dimensional formula

1) $K=m^2v^2$ 2) K=ma

3) $K=\frac{1}{2}mv^2$ 4) $K=\frac{1}{2}m^2v^4$

26. With respect to the suitable conversion units, the values of the following blanks respectively are

1kg 1 kg.m^2s^{-2} ____ $g.cm^2s^{-2}$, $3.0s^{-2}$ = ____ $km.h^{-2}$

1) $10^5;3.88\times10^4$ 2) $10^5;3.88\times10^5$

3) $10^4;3.88\times10^7$ 4) $10^5;3.88\times10^7$

T.S ECET 2017

27. The physical quantity having the dimension $\left[ML^2T^{-3}\right]$ is

1) work 2) power 3) pressure 4) impulse

28. Force F is given by F=at + bt^2 where is time. The dimension of a and b are

1) $\left[MLT^{-3}\right]and\left[MLT^{-4}\right]$

2) $\left[MLT^{-1}\right]and\left[MLT^{0}\right]$

3) $\left[MLT^{-3}\right]and\left[MLT^{4}\right]$

4) $\left[MLT^{-4}\right]and\left[MLT^{-1}\right]$

A.P ECET 2017

29. The unit of impulse is the same as that of

1) moment of force 2) linear momentum

3) force 4) pressure

30. If the force is given by F= $at+bt^2$ where t is the time. The dimensions of a and b are

1) MLT^{-4}, MLT^{-2} 2) MLT^{-3}, MLT^{-4}

3) ML^2T^{-3}, ML^2T^{-2} 4) ML^2T^{-3}, ML^3T^{-4}

T.S ECET 2018

31. The dimensional formula for angular momentum is ____

1) MLT^{-1} 2) $ML^{-1}T^{-1}$

3) ML^2T^{-1} 4) $M^1L^2T^{-2}$

32. Which of the following has not been expressed in proper unit

1) stress/strain= N/m^2 2) surface tension = N/m

3) energy = $Kg\times m/s$ 4) pressure = N/m^2

A.P ECET 2018

33. Which of the follwoing is not the unit of energy?

1) watt second 2) pascal metre

3) newton metre 4) kilowatt hour

PREVIOUS ECET BITS KEY

01) 4	02) 2	03) 3	04) 4	05) 1
06) 1	07) 2	08) 3	09) 1	10) 2
11) 4	12) 1	13) 1	14) 4	15) 2
16) 1	17) 1	18) 2	19) 2	20) 1
21) 2	22) 1	23) 1	24) 3	25) 3
26) 1	27) 2	28) 1	29) 2	30) 2
31) 3	32) 3	33) 2		

PREVIOUS ECET BITS HINTS AND SOLUTIONS

01. Torque $\tau=Fr=M^1L^1T^{-2}\times L^1=M^1L^2T^{-2}$

02. Impulse I = Ft = $M^1L^1T^{-2}\times T^1=M^1L^1T^{-1}$ = momentum

03. CGS & SI common fundamental unit in second.

04. Momentum = mV = $M^1L^1T^{-1}$

Impulse I = F+ = $M^1L^1T^{-2}\times T^1=M^1L^1T^{-1}$

05. $\frac{1}{2}Cr^2=M^{-1}L^{-2}T^4I^2K\times(M^1L^2T^{-2}I^{-1})^2$

$=M^{-1}L^{-2}T^4I^2\times M^2L^4T^{-6}I^{-2}$

$\frac{1}{2}Cr^2=M^1L^2T^{-2}$ = energy

06.

$\frac{mg}{\pi r}=\frac{M^1\times L^1T^{-2}}{L^1}=M^{-1}T^{-2}$ = Surface Tension

07. 1 Joule = 1N × 1m = 10^5 dyne × 10^2 cm

1 Joule = 10^7 erg

08. P × v = $M^1L^{-1}T^{-2}\times L^3=M^1L^2T^{-2}=work$

09. Conductance = $\frac{1}{R}=\frac{1}{Ohm}=mho$

10. Moment of inertia I = $MR^2=kg.m^2$

11. Energy α $F^aV^bT^c$

$M^1L^2T^{-2} = M^aL^{a+b}T^{-2a-b+c}$

$M^1L^2T^{-2} = M^aL^{a+b}T^{-2a+b+c}$

$M^a = M^1 \Rightarrow a = 1$

$L^{a+b} = L^2 \Rightarrow a+b = 2$ $\qquad -2a-b+c=-2$

$1+b=2$

$-2\times1-1\times c=-2$

$b = 1 \qquad C = 1$

$T^{-2a-b+c} -2 \qquad \therefore E = F^1V^1T^1$

12. (No answer) Torque & work

13. $\frac{A}{B}=m$ A = force $M^1L^1T^{-2}$

$B=\frac{A}{m}$ m =

Linear mass density $=\frac{mass}{length}=M^1L^{-1}$

$\therefore B=\frac{A}{m}=\frac{M^1L^1T^{-2}}{M^1L^{-1}}=L^2T^{-2}$ = Latent heat

14. Capacitance =

$\frac{q}{v}=\frac{I^{T}}{M^1L^2T^{-3}I^{-1}}=M^{-1}L^{-2}T^4I^2$

15. Torque = Fr = $M^1L^1T^{-2}L^1=M^1L^2T^{-2}$

16. S.I unit of energy Joule

17. Angular momentum L = mvr = $M^1\times L^1T^{-1}\times L^1=M^1L^2T^{-1}$

18. S.I unit of universal gass constant = Joule. $mole^{-1}k^{-1}$

19. Moment of force

20. Moment of inertia and moment of force

21. ML^2T^{-2}

22. Pressure

23. $E=hv\Rightarrow h=\frac{E}{v}=\frac{M^1L^2T^{-2}}{T^{-1}}=M^1L^2T^{-1}$

24. $work = M^1L^2T^2$

$power=\frac{W}{t}=\frac{M^1L^2T^{-2}}{T^1}=M^1L^2T^{-3}$

impulse = $F\times t=M^1L^1T^{-2}\times T^1=M^1L^1T^{-1}$

pressure = $\frac{F}{A}=\frac{M^1L^1T^{-2}}{L^2}=M^1L^{-1}T^{-2}$

25. $J=kgm^2/S^2; V=m/s$

$KE=m.v^2\Rightarrow KE=\frac{1}{2}mv^2$

26. $1kgm^2/s^2=10^3g.10^2cm^2/s^2=10^5gmcm^2/s^2$

$3.0m/s^2=3\times10^{-3}km/\frac{1}{3600}\times\frac{1}{3600}h^2$

$=38880=3.88\times10^4$

27. power

28. $[MLT^{-3}]$ and $[MLT^{-4}]$

29. linear momentum

30. $[MLT^{-3}]$ and $[MLT^{-4}]$

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VECTORS

- Physical quantities having only magnitude are called Scalars.
  Ex : Distance, Speed, Area, Volume, Mass, Density, Work, Power, Energy, Time, Frequency, Temperature, Electric Charge, Electric Current, Potential, Resistance, Capacity, Velocity of Light, Intensity of Sound etc,.
- Physical quantities having both magnitude and direction and that obey vector laws of addition are vectors.
  Ex : Displacement, Velocity, Acceleration, Momentum, Force, Impulse, Angular Displacement, Angular Velocity, Angular Acceleration, Moment of a Force, Torque, Magnetic Moment, Magnetic Induction Field, Intensity of Electric Field.etc,....
- **Pseudo vectors :** Vectors like torque, angular momentum, angular velocity are called "axial vectors" or "Pseudo vectors". In the case of pseudo vectors whenever the coordinate system is transformed from right handed reference frame to left handed reference frame, its direction is reversed. All cross proctors or pseudo vectors
- Unit vector in the direction of $\bar{A}$ is given by

$$\hat{A}=\frac{\bar{A}}{|\bar{A}|}=\frac{A_x\hat{i}+A_y\hat{j}+A_z\hat{k}}{\sqrt{A_x^2+A_y^2+A_z^2}}$$

- The magnitude of null vector is zero and direction is indeterminate.
- **Equal Vectors :** Vectors are equal if they have same magnitude and same direction
- Negative vector of a vector is the vector of same magnitude but opposite direction. When a vector is added to its negative vector, the result is a Null Vector.
- If $\bar{P}$ and $\bar{Q}$ are two vectors their resultant vector is given by $\bar{R}=\bar{P}+\bar{Q}$.
- The magnitude of resultant $\bar{R}$ is

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

- If $\vec{R}$ makes an angle a with $\bar{P}$, then $\tan\alpha=\frac{Q\sin\theta}{P+Q\cos\theta}$
- If $\vec{R}$ makes an angle β with $\bar{Q}$, then $\tan\beta=\frac{P\sin\theta}{Q+P\cos\theta}$
- Resultant of two vectors always lies in the plane containing the vectors closer to vector of larger magnitude.
- Special cases

I) $q = 0^0 \Rightarrow R(max) = P + Q$ $\qquad$ II) $q = 180^0 \Rightarrow R(min) = P - Q$

III) $q = 90^0 \Rightarrow R = \sqrt{P^2 + Q^2}$ and $\tan\alpha = \frac{Q}{P}$ IV) $P = Q \Rightarrow R = 2P\cos\left(\frac{\theta}{2}\right)$ & $\alpha = \frac{\theta}{2}$

⇨ Vector addition follows.

I) Commutative law : $\bar{P} + \bar{Q} = \bar{Q} + \bar{P}$ **II) Associative law :** $\bar{P} + (\bar{Q} + \bar{R}) = (\bar{P} + \bar{Q}) + \bar{R}$

III) Distributive law : $k(\bar{P} + \bar{Q}) = k\bar{P} + k\bar{Q}$, here 'k' is a scalar

⇨ The unit vector parallel to the resultant of $\bar{P}$ and $\bar{Q}$ is given by $\hat{n} = \frac{\bar{P}+\bar{Q}}{|\bar{P}+\bar{Q}|}$

⇨ If $\bar{p}$ and $\bar{q}$ are two vectors then substraction of $\bar{q}$ from $\bar{p}$ is given by $\Rightarrow \bar{S} = \bar{P} + (-\bar{Q}) = \bar{P} - \bar{Q}$

⇨ The magnitude of $\bar{P} - \bar{Q}$ is given by $S = \sqrt{P^2 + Q^2 - 2PQ\cos\theta}$

⇨ Vector Substraction.

I) does not obey commutative law $\bar{P} - \bar{Q} \neq \bar{Q} - \bar{P}$

II) does not obey associative law $\bar{P} - (\bar{Q} - \bar{R}) \neq (\bar{P} - \bar{Q}) - \bar{R}$

C) obeys distributive law $k(\bar{P} - \bar{Q}) = k\bar{P} - k\bar{Q}$

⇨ If $\bar{A}$ is a vector making an angle θ with horizontal, then Horizontal component of $\bar{A}$, is $A_x = A\cos\theta$ and Vertical component of a vector $\bar{A}$ is $A_y = A\sin\theta$.
The components of a vector are scalars. But a vector has vector components also.

⇨ If $\hat{i}$ and $\hat{j}$ are unit vectors along x and y axes respectively then $\bar{A} = A_x\hat{i} + A_y\hat{j}$ and $\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$ or

$\theta = \cos^{-1}\left(\frac{A_x}{A}\right)$

⇨ If $\bar{A}$ is resolved into three mutually perpendicular components in a space then $\bar{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$

I) $A = \sqrt{A_x^2 + A_y^2 + A_z^2}$

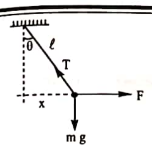
If angles made by $\bar{A}$ with x, y and z axis are α, β and γ, then $\cos\alpha = \frac{A_x}{|A|}$, $\cos\beta = \frac{A_y}{|A|}$, $\cos\gamma = \frac{A_z}{|A|}$

here $\cos\alpha, \cos\beta, \cos\gamma$ are known as direction cosines.

⇨ $\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$.

$\sin^2\alpha + \sin^2\beta + \sin^2\gamma = 2$.

⇨ If the bob of simple pendulum is held atrest by applying a horizontal force F as shown in fig.



I) $T\sin\theta = F$ II) $T\cos\theta = mg$

III) $F = mg\tan\theta$ IV) $\sqrt{F^2 + (mg)^2} = T$

V) $\frac{x}{F} = \frac{\ell}{T} = \frac{\sqrt{\ell^2 - x^2}}{mg}$

⇨ The dot product of two vectors $\bar{P}$ and $\bar{Q}$ is given by $\bar{P}.\bar{Q} = PQ\cos\theta$.

I) It is a Scalar

II) $\bar{P}.\bar{Q} = 0$ when $q = 90^0$ (Perpendicular Vectors)

III) $\bar{P}.\bar{Q} = PQ$ when $\theta = 0^0$ (Parallel Vectors)

IV) Dot product is negative if $q > 90^0$ and $< 180^0$

V) $\bar{P}.\bar{Q} = \bar{P}.\bar{Q}$ (Commutative law)

VI) $\bar{P}.(\bar{Q} + \bar{R}) = \bar{P}.\bar{Q} + \bar{P}.\bar{R}$ (Distributive law)

VII) It does not obey associative law

VIII) $\bar{P}.\bar{P} = P^2$

IX) Angle between two vectors $\bar{P}$ and $\bar{Q}$ is given by the relation $\cos\theta = \frac{\bar{P}.\bar{Q}}{PQ}$.

X) The component of $\bar{P}$ along $\bar{Q}$. $= P\cos\theta = \frac{\bar{P}.\bar{Q}}{|\bar{Q}|}$

XI) The component of $\bar{Q}$ along $\bar{P} = Q\cos\theta = \frac{\bar{P}.\bar{Q}}{|\bar{P}|}$

XII) $\hat{i}.\hat{i} = \hat{j}.\hat{j} = \hat{k}.\hat{k} = 1$, $\hat{i}.\hat{j} = \hat{j}.\hat{k} = \hat{k}.\hat{i} = 0$.

XIII) If $\bar{P} = P_x\hat{i} + P_y\hat{j} + P_z\hat{k}$ and $\bar{Q} = Q_x\hat{i} + Q_y\hat{j} + Q_z\hat{k}$, then $\bar{P}.\bar{Q} = P_xQ_x + P_yQ_y + P_zQ_z$

XIV) Two vectors $\bar{P}$ and $\bar{Q}$ are perpendicular if $\bar{P}.\bar{Q} = 0$ (or) $P_xQ_x + P_yQ_y + P_zQ_z = 0$

XV) Examples of dot product :

Work $W = \bar{F}.\bar{S}$ Power $P = \bar{F}.\bar{V}$

Magnetic Flux $\phi = \bar{B}.\bar{A}$

⇨ The cross product of two vectors $\bar{P}$ and $\bar{Q}$ is given by $\bar{P} \times \bar{Q} = PQ\sin\theta\hat{n}$

Where $\hat{n}$ is a unit vector perpendicular to the plane containing $\bar{P}$ and $\bar{Q}$.

I) It is a vector. 23

II) Direction is given by right hand screw rule.

III) $\overline{P}\times\overline{Q}=\overline{O}$ when $\theta=0^0$ (Parallel Vectors)

IV) $\left|\overline{P}\times\overline{Q}\right|=PQ$ when $\theta=90^0$ (Perpendicular Vectors)

V) $\overline{P}\times\overline{Q}=-\overline{Q}\times\overline{P}$.

$\overline{P}\times\overline{Q}\neq\overline{Q}\times\overline{P}$ (commutative law is not obeyed)

VI) $\overline{P}\times\left(\overline{Q}\times\overline{R}\right)\neq\left(\overline{Q}\times\overline{P}\right)\times\overline{R}$ (Associative law is not obeyed)

VII) $\overline{P}\times\left(\overline{Q}+\overline{R}\right)=\overline{P}\times\overline{Q}+\overline{P}\times\overline{R}$ (Distributive law is obeyed)

VIII) $\hat{i}\times\hat{i}=\hat{j}\times\hat{j}=\hat{k}\times\hat{k}=0$; $\hat{i}\times\hat{j}=\hat{k},\hat{j}\times\hat{k}=\hat{i},\hat{k}\times\hat{i}=\hat{j}$

IX) If $\overline{P}=P_x\hat{i}+P_y\hat{j}+P_z\hat{k}$ $\overline{Q}=Q_x\hat{i}+Q_y\hat{j}+Q_z\hat{k}$ then $\overline{P}\times\overline{Q}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ P_x & P_y & P_z\\ Q_x & Q_y & Q_z\end{vmatrix}$

$=\left(P_yQ_z-P_zQ_y\right)\hat{i}-\left(P_xQ_z-P_zQ_x\right)\hat{j}+\left(P_xQ_y-P_yQ_x\right)\hat{k}$

X) Unit vector normal to both $\overline{P}$ and $\overline{Q}$ is $\hat{n}=\dfrac{\overline{P}\times\overline{Q}}{\left|\overline{P}\times\overline{Q}\right|}$.

XI) If two vectors $\overline{P}$ and $\overline{Q}$ are parallel $\dfrac{P_x}{Q_x}=\dfrac{P_y}{Q_y}=\dfrac{P_z}{Q_z}=$ constant or $\overline{P}\times\overline{Q}=0$

XII) If $\overline{P}$ *and* $\overline{Q}$ represents the sides of a parallelogram then the area of the parallelogram is $\left|\overline{P}\times\overline{Q}\right|$

XIII) If $\overline{d_1}$ *and* $\overline{d_2}$ represents the diagonals of a parallelogram then the area of the parallelogram is $\frac{1}{2}\left|\overline{d_1}\times\overline{d_2}\right|$

XIV) If $\overline{A}$ *and* $\overline{B}$ represents the sides of a triangle then the area of the triangle is $\frac{1}{2}\left|\overline{A}\times\overline{B}\right|$

XV) $\overline{A},\overline{B}$ and $\overline{C}$ are coplanar, if $\vec{A}\left(\vec{B}\times\vec{C}\right)=0$.

⇨ **Examples of cross product :**

I) Angular momentum $\vec{L}=\vec{r}\times\vec{P}$

II) Linear velocity $\vec{V}=\vec{\omega}\times\vec{r}$

III) Torque $\vec{\tau}=\vec{r}\times\vec{F}$

SOLVED EXAMPLES

01. A vector is represented by $3\vec{i}+\vec{j}+2\vec{k}$. What is its length in x-y plane

Sol : Vector $\vec{A}=3\vec{i}+\vec{j}+2\vec{k}$

Magnitude of the vector in the x-y plane

$=\sqrt{A_x^2+A_y^2}=\sqrt{(3)^2+(1)^2}=\sqrt{9+1}=\sqrt{10}$

$\therefore$ Length in the x-y plane $=\sqrt{10}$ units

02. A force of $F=\vec{i}+5\vec{j}+7\vec{k}$ acts on a particle and displaces it through a distance $\vec{s}=6\vec{i}+9\vec{k}$. Calculate the work done

Sol : $F=\vec{i}+5\vec{j}+7\vec{k}$ $\quad s=6\vec{i}+9\vec{k}$

Work done $=W=\vec{F}.\vec{s}=\left(\vec{i}+5\vec{j}+7\vec{k}\right)\left(6\vec{i}+9\vec{k}\right)$

$=(6+63)=69$

03. If $\vec{P}=3\vec{i}+4\vec{j}+7\vec{k}$, what is the unit vector parallel to $\vec{P}$

Sol : $\vec{P}=3\vec{i}+4\vec{j}+7\vec{k}$ Unit vector $=\hat{P}=\dfrac{\vec{P}}{|\vec{P}|}$

$|\vec{P}|=\sqrt{(3)^2+(4)^2+(7)^2}=\sqrt{9+16+49}$

$=\sqrt{74}$

$\therefore\ \hat{P}=\dfrac{3\vec{i}+4\vec{j}+7\vec{k}}{\sqrt{74}}$

04. If $\vec{A}=2\vec{i}+3\vec{j}-4\vec{k}$ and $\vec{B}=3\vec{i}-4\vec{j}+5\vec{k}$ and $\vec{A}\times\vec{B}$

Sol : $\vec{A}=2\vec{i}+3\vec{j}-4\vec{k}$ $\quad\vec{B}=3\vec{i}-4\vec{j}+5\vec{k}$

$A\times B=\begin{vmatrix}i & j & i\\ 2 & 3 & -4\\ 3 & -4 & 5\end{vmatrix}$

$\therefore \vec{A}\times\vec{B} = \vec{i}\,(15-16)+\vec{j}\,(-12-10)+\vec{k}$

$(-8-9) = -\vec{i} - 22\,\vec{j} - 17\,\vec{k}$

05. The magnitude of the vector product of two vectors is equal to the magnitude of their scalar product. What is the angle between the two vectors ?

Sol : Let $\vec{A}$ and $\vec{B}$ be the two vectors. Let θ be the angle between them

We know that $|\vec{A}.\vec{B}| = AB\cos\theta$

Also $|\vec{A}\times\vec{B}| = AB\sin\theta$

Given $AB\sin\theta = AB\cos\theta$

or $\dfrac{\sin\theta}{\cos\theta} = \dfrac{AB}{AB} = 1$ or $\tan\theta = 1$

or $\tan\theta = 1$ $\quad\therefore \theta = 45^\circ$

06. Two vectors $\vec{P} = 3\vec{i} + 2\vec{j} + \vec{k}$ and $\vec{Q} = 2\vec{i} + 6\vec{j} + c\vec{k}$ are perpendicular to each other. Find the value of c.

Sol : $\vec{P} = 3\vec{i} + 2\vec{j} + \vec{k}$ $\qquad \vec{Q} = 2\vec{i} + 6\vec{j} + c\vec{k}$

$\vec{P}.\vec{Q} = PQ\cos\theta$

Since $\vec{P}$ and $\vec{Q}$ are perpendicular to each other $\theta = 90^\circ$ and $\cos\theta = 0$ $\quad\therefore \vec{P}.\vec{Q} = 0$

$\vec{P}.\vec{Q} = (3\vec{i} + 2\vec{j} + \vec{k})(2\vec{i} + 6\vec{j} + c\vec{k})$

$= (3\times2) + (-2\times6) + (1\times c)$

$= 6 - 12 + c = -6 + c$ since $\vec{P}.\vec{Q} = 0$

$-6 + c = 0$ or $c = 6$

07. The magnitude of the vector product of two vectors is $\sqrt{3}$ times their scalar product. Find the angle between the two vectors.

Sol : Let $\vec{A}$ and $\vec{B}$ be the two vectors and θ is the angle between them.

Magnitude of vector product $= |\vec{A}\times\vec{B}| = AB\sin\theta$

Magnitude of scalar product $= |\vec{A}.\vec{B}| = AB\cos\theta$

Given $AB\sin\theta = \sqrt{3}\,AB\cos\theta$

or $\dfrac{\sin\theta}{\cos\theta} = \sqrt{3}\times\dfrac{AB}{AB}$

or $\tan\theta = \sqrt{3}$ $\qquad \theta = 60^\circ$

Hence the angle between the two vector is 60°

08. What is the angle between two vectors $\left(\vec{i} + \vec{j}\right)$ and $\left(\vec{j} + \vec{k}\right)$

Sol : $\cos\theta = \dfrac{\left(\vec{i} + \vec{j}\right).\left(\vec{j}.\vec{k}\right)}{\left|\vec{i} + \vec{j}\right|\left|\vec{j} + \vec{k}\right|}$

$= \dfrac{1}{\left(\sqrt{2}\right)\left(\sqrt{2}\right)} = \dfrac{1}{2}$ $\qquad \theta = 60^\circ$

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PRACTICE SET - I

01. Which of the following is NOT a vector ?
1) Magnetic force 2) Magnetic induction
3) Magnetic flux
4) Magnetic flux density

02. Which of the following is a vector ?
1) Light year 2) Distance
3) Angle 4) Displacement

03. Which of the following is a pseudo vector ?
1) Linear velocity 2) Force
3) Torque 4) Electric field

04. _____ is an axial vector
1) Angular velocity 2) Angular momentum
3) Moment of force 4) All

05. Which of the following is NOT correct ?
1) $\vec{A}+\vec{B}=\vec{B}+\vec{A}$ 2) $\vec{A}-\vec{B}=\vec{B}-\vec{A}$
3) $\vec{A}.\vec{B}=\vec{B}.\vec{A}$ 4) $\vec{A}\times\vec{B}=-\vec{B}\times\vec{A}$

06. The direction of a null vector
(1) Can be determined (2) Can't be determined
(3) Is long +ve x-axis (4) Is long -ve x-axis

07. If $\vec{C}=\vec{A}+\vec{B}$, then
1) $\vec{C}$ is always equal to $|\vec{A}|+|\vec{B}|$
2) $\vec{C}$ is never equal to $|\vec{A}|+|\vec{B}|$
3) $\vec{C}$ is always greater than $|\vec{A}|$ and $|\vec{B}|$
4) $\vec{C}$ may be less than $|\vec{A}|$ and $|\vec{B}|$

08. The horizontal component of the weight of a body of mass is
1) mg 2) $\frac{mg}{2}$ 3) $\frac{mg}{\sqrt{2}}$ 4) 0

09. The angle between $\vec{A}+\vec{B}$ and $\vec{A}-\vec{B}$ is
1) always 0^0 2) always 90^0
3) always 180^0 4) Between 0^0 and 180^0

10. The resultant of two vectors will be maximum when the angle between then is
1) 0^0 2) 90^0 3) 180^0 4) None

11. Which of the following is NOT a vector ?
1) Acceleration 2) Acceleration due to gravity
3) Angular acceleration 4) None

12. Vector $\vec{A}$ points due west and vector $\vec{B}$ points due south, then $\vec{A}+\vec{B}$ points due
1) South - west 2) South - east
3) West 4) North - east

13. Vector $\vec{A}$ points due east and vector $\vec{B}$ points due south, then $\vec{A}+\vec{B}$ points due
1) North - east 2) North - west
3) South - east 4) Can't be determined

14. The sum of two units vector is
1) A unit vector 2) Not a unit vector
3) 2 units 4) None

15. $\hat{i}\times(\hat{j}\times\hat{k})=$
1) 0 2) 1 3) ∞ 4) Does not exist

16. $\hat{i}.(\hat{j}.\hat{k})=$
1) 0 2) 1 3) ∞ 4) Does not exist

17. If $\vec{a}$ and $\vec{b}$ are two adjacent sides if a triangle, then its area is given by
1) $\frac{1}{2}|\vec{a}\times\vec{b}|$ 2) $|\vec{a}\times\vec{b}|$
3) $\frac{1}{2}|\vec{a}.\vec{b}|$ 4) None

18. Which of the following is NOT a vector ?
1) Intensity of electric field
2) Electromotive force
3) Gravitational force
4) Coulomb attractive force

19. If $\vec{a}$ is a unit vector, then $\vec{a}.\vec{a}=$
1) 0 2) 1 3) -1 4) ∞

20. Which of the following is NOT commutative ?
1) $\vec{A}+\vec{B}$ 2) $\vec{A}-\vec{B}$ & $\vec{A}\times\vec{B}$
3) $\vec{A}.\vec{B}$ 4) All

21. Which of the following is correct about electric current ?
1) SI unit : A, Dimensional formula : $MLT1$, Vector.
2) SI unit : A, Dimensional formula : 1, Vector
3) SI unit : A, Dimensional formula : 1, Scalar
4) None

22. Which of the following is correct about magnetic pole strength ?
1) SI unit : Am, Dimensional formula : M^0LT^01, Scalar
2) SI unit : Am, Dimensional formula : $M\,LT^0\,1$, Scalar
3) SI unit : Am, Dimensional formula : $MLT1$, vector 4) None

23. Which of the following is a scalar ?
1) Impulse 2) Angular Momentum
3) 1 & 2 4) None

24. If $\cos\alpha, \cos\beta$ and $\cos\gamma$ are directional cosines of a vector, then
1) $\cos^2\alpha+\cos^2\beta+\cos^2\gamma=1$
2) $\sin^2\alpha+\sin^2\beta+\sin^2\gamma=1$
3) $\sin^2\alpha+\sin^2\beta+\sin^2\gamma=2$ 4) 1 & 3

25. When a vector is multiplied by a scalar, the product is
1) A vector 2) A scalar
3) Either a Scalar or A vector
4) None

26. A unit vector perpendicular to $\vec{A}$ and $\vec{B}$ is
1) $\vec{A}\times\vec{B}$ 2) $(\vec{A}\times\vec{B})$
3) $\frac{\vec{A}\times\vec{B}}{|\vec{A}\times\vec{B}|}$ 4) None

27. Vector A points vertically downwards and vector B points north. Then $\vec{A}\times\vec{B}$ points
1) East 2) West
3) Upwards 4) Downwards

28. Which of following is an example for product of two vectors giving a scalar ?
1) Impulse 2) Power
3) Moment of force 4) Magnetic induction

29. Which of the following is NOT correct ?
1) A vector can be multiplied by a scalar
2) A vector can be added by a scalar
3) A vector can be divided by a scalar
4) None

30. Which of the following is a null vector ?
1) Velocity vector of a body moving in a circle with a uniform speed
2) Velocity vector of a body moving in a straight line with a uniform speed
3) Position vector of the origin of a rectangular coordinate system
4) None

31. Find the INCORRECT statement
1) Two vectors can be added
2) Two vectors can be subtracted
3) Two vectors can be multiplied
4) Two vectors can be divided

32. Three vectors A,B and C satisfy the relation A.B = 0 and A.C = 0, the vector $\vec{A}$ is parallel to
1) B 2) C 3) B.C 4) B × C

33. Two vectors of the same magnitude, have a resultant equal to either, then the angle between the vectors will be :
1) 30^0 2) 60^0 3) 90^0 4) 120^0

34. The angle between two vectors $(\bar{i}+\bar{j})$ and $(\bar{j}+\bar{k})$ is :
1) 30^0 2) 45^0 3) 60^0 4) 90^0

35. If $|\vec{A}+\vec{B}|=|\vec{A}-\vec{B}|$, then the angle between the two vectors is :

1) 120^0 2) 0^0 3) 90^0 4) 180^0

36. Identify the scalar quantity :

1) Force 2) Torque
3) Electric current 4) momentum

37. Pick up the only vector :

1) speed of light 2) temperature
3) impulse 4) electric potential

38. Angular momentum is :

1) Null vector 2) Unit vector
3) Polar vector 4) Pseudo vector

39. Pick up the physical quantity which has both magnitude and direction but not a vector

1) Impulse 2) Electric current
3) velocity of light 4) Both 2 and 3

40. When a vector is multiplied by a scalar the product is :

1) vector 2) scalar 3) tensor
4) may be a scalar or a vector

41. Pick out the pair of physical quantities having same unit but one is a scalar and another is a vector

1) Impulse, momentum 2) Work, Torque
3) Angular momentum, Planck's constant
4) Force, work

42. The vector quantity among the following is

1) mass 2) Acceleration
3) Temperature 4) electric charge

43. Which of the following quantity is scalar ?

1) Electric field 2) Velocity
3) angular momentum 4) electrical potential

44. $\overline{A},\overline{B}$ are two vectors in a plane and $\overline{C}$ is an other vector perpendicular to the plane, their resultant

1) Can be zero 2) Can never be zero
3) lies between $\overline{A}$ and $\overline{B}$
4) none

45. Angular momentum is :

1) Scalar 2) A polar vector
3) An axial vector 4) None of these

PRACTICE SET - I KEY

01) 3	02) 4	03) 3	04) 4	05) 2
06) 2	07) 4	08) 4	09) 4	10) 1
11) 4	12) 1	13) 1	14) 2	15) 1
16) 4	17) 1	18) 2	19) 2	20) 2
21) 3	22) 1	23) 4	24) 4	25) 1
26) 3	27) 1	28) 2	29) 2	30) 3
31) 4	32) 4	33) 4	34) 3	35) 3
36) 3	37) 3	38) 4	39) 4	40) 1
41) 2	42) 2	43) 4	44) 2	45) 3

PRACTICE SET - II

01. If $A=i-j$ and $B=j-k$ then $A\times B$ is :

1) $i-2j-k$ 2) $i-j-k$
3) $i-k$ 4) $-i-k$

02. Consider a vector $F=4i-3j$. Another vector that is perpendicular to F is

1) $4i-3j$ 2) $6i$ 3) $7k$ 4) $3i-4j$

03. Two vectors are given by $A=2i+3j+k$ and $B=4i-j-2k$. The resultant is :

1) $6i+2j+k$ 2) $2i+2j+k$
3) $6i+2j-k$ 4) $2i-2j-k$

04. The magnitude of vector $(i+4j-2k)$ is :

1) $\sqrt{17}$ 2) 3 3) $\sqrt{21}$ 4) 21

05. The angle made by vector $(i+j)$ with x-axis is

1) 90^0 2) 60^0 3) 45^0 4) 30^0

06. Two vectors are given by $A=-2i+j-3k$ and $B=5i+3j-3k$. If $3A+2B-C=0$, the vector C =

1) $4i+9j-15k$ 2) $4i+9j-10k$
3) $3i+4j$ 4) $7i+2j-6k$

07. $(2i-j).(3i+k)=$

1) 5 2) 8 3) 6 4) 1

08. If $A=2i+aj+k$ and $B=4i-2j-2k$ are perpendicular to each other, then the value of 'a' is

1) 3 2) -3 3) 2 4) -2

09. The work done in moving an object along a vector $3i+2j-5k$. If the applied force is $3i-j-k$ is equal to :

1) 1 unit 2) 12 units 3) 13 units 4) 7 units

10. The direction cosines of a vector are $\cos\alpha=\frac{3}{5\sqrt{2}}$, $\cos\beta=\frac{4}{5\sqrt{2}}$ and $\cos\gamma=\frac{1}{\sqrt{2}}$.

Then the vectors :

1) $\frac{3i+3j+k}{5\sqrt{2}}$ 2) $3i+4j+5k$
3) $3i+4j+k$ 4) None of these

11. A vector is represented by $3\vec{i}+\vec{j}+2\vec{k}$. Its length in XY plane is :

1) 2 2) $\sqrt{14}$ 3) $\sqrt{10}$ 4) $\sqrt{5}$

12. If $0.5\vec{i}+0.8\vec{j}+c\vec{k}$ is a unit vector then c is :

1) $\sqrt{0.89}$ 2) 0.2 3) 0.3 4) $\sqrt{0.11}$

13. If a vector $\vec{A}=2\vec{i}+2\vec{j}+\vec{k}$ and $\vec{B}=-3\vec{i}+6\vec{j}+n\vec{k}$ are perpendicular to each other; then the value of n :

1) 4 2) 12 3) 6 4) -6

14. The angle between two vectors $v_1=i+2j+2k$ and $v_2=2i+3j-4k$ is :

1) 0^0 2) 45^0 3) 90^0 4) 120^0

15. What is the unit vector perpendicular to $5\vec{j}-12\vec{k}$

1) $12\vec{j}+3\vec{k}$ 2) $12\vec{j}+5\vec{k}$
3) $\frac{12\vec{j}+5\vec{k}}{3}$ 4) $\frac{12\vec{j}+5\vec{k}}{169}$

16. What is the unit vector parallel to the resultant of vectors, $A=2\vec{i}+4\vec{j}-5\vec{k}$; $B=\vec{i}+2\vec{j}-3\vec{k}$;

1) $\frac{3}{7}\vec{i}+\frac{6}{7}\vec{j}-\frac{2}{7}\vec{k}$ 2) $\frac{6}{7}\vec{i}+\frac{12}{7}\vec{j}-\frac{6}{7}\vec{k}$
3) $\frac{3}{7}\vec{i}+\frac{6}{7}\vec{j}-\frac{2}{7}\vec{k}$ 4) $\frac{3}{7}\vec{i}-\frac{6}{7}\vec{j}-\frac{2}{7}\vec{k}$

17. Two equal forces acting at a point have the resultant equal to one of the forces. Then the angle between the two forces is :

1) 0^0 2) 60^0 3) 90^0 4) 120^0

18. If $|\vec{A}|^2+|\vec{B}|^2=|\vec{C}|^2$ and $\vec{A}+\vec{B}=\vec{C}$ then the angle between $\vec{A}$ and $\vec{B}$ is :

1) 0^0 2) 60^0 3) 90^0 4) 120^0

19. If $|\vec{A}|+|\vec{B}|=|\vec{C}|$ and $\vec{A}+\vec{B}=\vec{C}$ then the angle between $\vec{A}$ and $\vec{B}$ is

1) 180^0 2) 90^0 3) 0^0 4) 120^0

20. If $|\vec{A}|+|\vec{B}|=|\vec{A}|-|\vec{B}|$ then the angle between $\vec{A}$ and $\vec{B}$ is :

1) 0^0 2) 60^0 3) 90^0 4) 180^0

21. Two forces 5 and 12N act on a body of mass 13 kg at right angles. The acceleration of the body is :

1) $\frac{17}{13}m/sec^2$ 2) $1\,m/sec^2$
3) $\frac{7}{13}m/sec^2$ 4) None

22. The angle between the forces $(x+y)$ and $(x-y)$ if their resultant is $\sqrt{2(x^2+y^2)}$:

1) 0^0 2) 30^0 3) 60^0 4) 90^0

23. Two forces, one of 10N and the other 6N act upon a body. The directions of the forces are unkonwn, the resultant force on the body is:

1) Not less than 4N and not more than 16N
2) More than 15N always
3) More than 6N 4) More than 10N

24. A force $|\vec{F}| = 10N$ acts at an angle 60^0 with the x-axis. Find its components F_x and F_y:

1) $5\sqrt{3}N, 5N$ 2) $5N, 5\sqrt{3}N$
3) $5N, 5N$ 4) $5\sqrt{2}N, 5\sqrt{2}N$

25. If α, β and γ are direction cosines of a vector then $\cos^2\alpha + \cos^2\beta + \cos^2\gamma$ is equal to

1) 4 2) 3 3) 2 4) 1

26. The vector joining the points (1, 1, -1) and (2, -3, 4) is:

1) $3\hat{i}-2\hat{j}+3\hat{k}$ 2) $\hat{i}-4\hat{j}+5\hat{k}$
3) $2\hat{i}-3\hat{j}-4\hat{k}$ 4) $-\hat{i}+4\hat{j}-5\hat{k}$

27. Two vectors are given by $\vec{A} = 2\hat{i}+\hat{j}-3\hat{k}$ and $\vec{B} = 5\hat{i}+3\hat{j}-2\hat{k}$. Find $\vec{C}$ such that $3\vec{A}+2\vec{B}-\vec{C}=0$:

1) $-4\hat{i}+9\hat{j}-13\hat{k}$ 2) $4\hat{i}-9\hat{j}-13\hat{k}$
3) $16\hat{i}+9\hat{j}-13\hat{k}$ 4) None of these

28. If two vector $\vec{A} = 2\hat{i}+3\hat{j}+m\hat{k}$ and $\vec{B} = n\hat{i}+6\hat{j}+2\hat{k}$ are parallel then the values of m, n are:

1) 4, 4 2) 1, 4 3) 2, 2 4) 4, 1

29. A particle moves from position $3\hat{i}+2\hat{j}-6\hat{k}$ to $14\hat{i}+13\hat{j}+9\hat{k}$ due to a uniform force of $4\hat{i}+\hat{j}+3\hat{k}N$. Find the work done if the displacement in metres:

1) 150 J 2) 100 J 3) 50 J 4) None

30. If the angle between two vectors $\vec{A}$ and $\vec{B}$ is 0^0 then $\vec{A}.\vec{B}$ is:

1) AB 2) 0 3) $\sqrt{A^2+B^2}$ 4) $A+B$

31. An aeroplane is climbing with a steady speed of $200ms^{-1}$ at an angle 30^0 to the horizontal. The horizontal and vertical components of velocity are (in ms^{-1})

1) $100\sqrt{3}, 100$ 2) $100, 100\sqrt{3}$
3) $100, 100$ 4) $100\sqrt{3}, 100\sqrt{3}$

32. Which of the following pairs of vectors are not mutually perpendicular

1) $4i+j-3k$ and $i+2j+2k$
2) $3i+2j+k$ and $i-j+k$
3) $i+4j+3k$ and $4i+2j-4k$
4) $3i-2j-k$ and $i+j+k$

33. Three vectors are given by a $a=i+2j-k$ $b=-2i+j+3k$ and $c=2i-2j+k$, then $a(b\times c)$ is

1) 19 2) 20 3) 21 4) 22

34. The resultant of two forces $\vec{A}+\vec{B}$ and $\vec{A}-\vec{B}$ is $\sqrt{3A^2+B^2}$. Then angle between them is

1) 30^o 2) 45^o 3) 60^o 4) 90^o

35. A force of $F=2i+4j+5k$ acts on a body and produces a displacement of $S=3i+2j+k$. The work done is

1) 19 units 2) 18 units
3) 16 units 4) 20 units

PRACTICE SET - II KEY

01) 2	02) 4	03) 1	04) 3	05) 3
06) 1	07) 1	08) 3	09) 2	10) 2
11) 3	12) 4	13) 4	14) 3	15) 4
16) 1	17) 4	18) 3	19) 3	20) 3
21) 2	22) 4	23) 1	24) 2	25) 4
26) 2	27) 3	28) 4	29) 2	30) 1
31) 1	32) 2	33) 3	34) 3	35) 1

SELF TEST

01. If $\vec{A} = \hat{i}+2\hat{j}-4\hat{k}$ and $B = \hat{i}+2\hat{j}-\hat{k}$ then $(\bar{A}+\bar{B})(\bar{A}-\bar{B})$ is:

1) 10 2) 15 3) 20 4) 25

02. $2\hat{j}-3\hat{k}$ and $3\hat{j}+2\hat{k}$ are two vectors having:

1) same magnitude opposite in direction
2) same magnitude and perpendicular to each other
3) same magnitude and differet directions
4) Different magnitude and perpendicular to each other.

03. If $\vec{A} = 4\hat{i}-7\hat{j}-4\hat{k}$ and $\vec{B} = 2\hat{i}-3\hat{j}+6\hat{k}$ and if θ is the angle between the two vectors, $\cos\theta$ si equal to

1) $\frac{27}{63}$ 2) $\frac{27}{65}$ 3) $\frac{37}{65}$ 4) $\frac{5}{63}$

04. If $\vec{A}.\vec{B} = \frac{AB}{\sqrt{2}}$, the angle between the two vectors is

1) 0^0 2) 45^0 3) 30^0 4) 90^0

05. Three vectors $\vec{A}, \vec{B}$ and $\vec{C}$ satisfy the relation $\vec{A}.\vec{B}=0$ and $\vec{A}.\vec{C}=0$. the vector $\vec{A}$ is parallel to

1) $\vec{B}$ 2) $\vec{C}$ 3) $\vec{B}.\vec{C}$ 4) $\vec{B}\times\vec{C}$

06. If $\vec{A} = \hat{i}A\cos\theta - \hat{j}A\sin\theta$ be any vector. Another $\vec{B}$, which is normal to $\vec{A}$ can be expressed as:

1) $\hat{i}B\cos\theta - \hat{j}B\sin\theta$ 2) $\hat{i}B\cos\theta + \hat{j}B\sin\theta$
3) $\hat{i}B\sin\theta - \hat{j}B\cos\theta$ 4) $\hat{i}B\sin\theta + \hat{j}B\cos\theta$

07. The component of vector is

1) vector 2) scalar
3) may be vector or scalar 4) tensor

08. Two vectors $\vec{A}$ and $\vec{B}$ are parallel when:

1) $\vec{A}\times\vec{B}=0$ 2) $\vec{A}.\vec{B}=0$ 3) $\vec{A}\times\vec{B}=1$ 4) $\vec{A}.\vec{B}=1$

09. The area of parallelogram formed from the vectors $\vec{A} = \hat{i}+2\hat{j}+3\hat{k}$ and $\vec{B} = 3\hat{i}-2\hat{j}+\hat{k}$ as adjacent sides is:

1) $8\sqrt{3}$ units 2) 64 units 3) 32 units 4) $\sqrt{3}$ units

10. The area of triangle with sides as $\vec{A} = 2\hat{i}+3\hat{j}$ and $\vec{B} = \hat{i}+4\hat{j}$ is:

1) 5 units 2) 10 units 3) 2.5 units 4) 20 units

11. For vector $\vec{P}.\vec{Q}$ and $\vec{R}$ to be coplanar:

1) $(\vec{P}\times\vec{Q})\vec{R}=0$ 2) $(\vec{P}.\vec{Q})\vec{R}=0$
3) $\vec{P}\times\vec{Q}\times\vec{R}=0$ 4) $(\vec{P}\times\vec{Q})\times\vec{R}=0$

12. If $\vec{A} = 2\hat{i}+3\hat{j}-4\hat{k}$ and $\vec{B} = 3\hat{i}-4\hat{j}+5\hat{k}$ then $\vec{A}\times\vec{B}$ is:

1) $\hat{i}-22\hat{j}-17\hat{k}$ 2) $-\hat{i}-22\hat{j}-17\hat{k}$
3) $\hat{i}+22\hat{j}-17\hat{k}$ 4) $\hat{i}+22\hat{j}+17\hat{k}$

13. The rectangular components of a force of 5 dyne are :
1) 1 dyne, 4 dyne 2) dyne, 3 dyne
3) 3 dyne, 4 dyne 4) 2.5 dyne, 2.5 dyne

14. If a body is under the action of two forces 6N and 8N acting at right angles of each other the resultant of the force is :
1) 14 N 2) 2 N 3) 10 N 4) 48 N

15. Out of the following the resultant of which cannot be 4N :
1) 2N & 2N 2) 2N & 4N
3) 2N & 6N 4) 2N & 8N

16. If $\hat{n}$ is unit vector in the direction of the vector $\vec{A}$ then :
1) $\hat{n}=\frac{\vec{A}}{|\vec{A}|}$ 2) $\hat{n}=\vec{A}|\vec{A}|$
3) $\hat{n}=\left|\frac{\vec{A}}{A}\right|$ 4) $\hat{n}=\hat{n}\times\vec{A}$

17. The resultant of two forces acting at point each equal to P is also P. The angle between the two force is
1) 90^0 2) 60^0 3) 120^0 4) 0^0

18. A body of mass 2 kg is acted upon by two forces each of magnitude 1 newton, making an angle of 60^0 with each other. The net acceleration of the body in $m/\sec^2$ is
1) 0.5 2) 1 3) $\sqrt{3}/2$ 4) $2\sqrt{3}$

19. The resultant of two vectors $\vec{A}$ and $\vec{B}$ depends on the angle θ between thenm. The magnitude of the resultant is always given by
1) 0 2) $\sqrt{A^2+B^2+2AB\sin\theta}$
3) $\sqrt{A^2+B^2+2AB\cos\theta}$
4) $\sqrt{A^2+B^2-2AB\cos\theta}$

20. The vectors of same magnitude have a resultant equal to either, then the angle between the vectors will be :
1) 30^0 2) 60^0 3) 90^0 4) 120^0

21. A horizontal force required to displace a mass of 30gm suspended by a string till the string makes an angle of 30^0 with the vertical is - gm.wt
1) 30×980 2) $30\times\frac{1}{\sqrt{3}}$
3) $30\times980\times\frac{1}{\sqrt{3}}$ 4) $30\times980\times\sqrt{3}$

22. When two vectors of $\vec{a}$ and $\vec{b}$ of magnitudes a and b are added, the magnitude of the resultant is always :
1) equal to a + b 2) less than (a + b)
3) greater than (a + b) 4) not greater than (a+b)

23. The negative vector of $\hat{i}+\hat{j}-\hat{k}$ is
1) $\hat{i}+\hat{j}+\hat{k}$ 2) $-\hat{i}+\hat{j}-\hat{k}$
3) $-\hat{i}-\hat{j}+\hat{k}$ 4) None

24. The magnitude and direction of $4\hat{i}-2\hat{j}$ are
1) $\sqrt{20}, \tan^{-1}(-1/2)$ 2) $\sqrt{12}, \tan^{-1}(-1/2)$
3) $\sqrt{10}, \tan^{-1}(1/2)$ 4) $\sqrt{20}, \tan^{-1}(1/2)$

25. The angle made by a vector $3\hat{i}-2\hat{j}+3\hat{k}$ with X,Y and Z axes are
1) $\cos^{-1}\left(\frac{4}{\sqrt{29}}\right), \cos^{-1}\left(\frac{2}{\sqrt{29}}\right), \cos^{-1}\left(\frac{3}{\sqrt{29}}\right)$
2) $\cos^{-1}\left(\frac{4}{\sqrt{29}}\right), \cos^{-1}\left(-\frac{2}{\sqrt{29}}\right), \cos^{-1}\left(\frac{3}{\sqrt{29}}\right)$
3) $\cos^{-1}\left(\frac{4}{\sqrt{29}}\right), \cos^{-1}\left(\frac{2}{\sqrt{29}}\right), \cos^{-1}\left(-\frac{3}{\sqrt{29}}\right)$
4) None

26. $\vec{A}=3\hat{i}+2\hat{j}-\hat{k}$ and $B=3\hat{i}+2\hat{j}+\hat{k}$. The resultant is
1) Null vector 2) $6\hat{i}+4\hat{j}$ 3) $-2\hat{k}$ 4) None

27. If $|\vec{A}|=|\vec{B}|$ and the angle between $\vec{A}$ and $\vec{B}$ is θ, then $|\vec{A}-\vec{B}|$
1) $2A\sin\theta/2$ 2) $2A\cos\theta/2$
3) $2A\tan\theta/2$ 4) Zero

28. $\vec{A}$ and $\vec{B}$ are perpendicular, if
1) $|\vec{A}+\vec{B}|=|\vec{A}-\vec{B}|$ 2) $|\vec{A}.\vec{B}|=0$
3) $|\vec{A}\times\vec{B}|=0$ 4) 1 & 2

29. The angle between $\hat{i}$ and $\hat{j}$ is
1) 0^0 2) 45^0 3) 90^0 4) None

30. The magnitude of the resultant of $\hat{i}+\hat{j}+\hat{k}$ and $\hat{j}+\hat{k}$ is : 1) 3 2) $\sqrt{3}$ 3) $\sqrt{12}$ 4) 12

31. If the angular velocity $\vec{\omega}=\hat{i}-2\hat{j}+2\hat{k}$ and the radius vector $\vec{r}=4\hat{j}-3\hat{k}$, then the magnitude of linear velocity is
1) $\sqrt{28}$ units 2) $\sqrt{29}$ units
3) $\sqrt{30}$ units 4) None

32. A body of mass 2 kg has radius vector $\vec{r}=\hat{i}+\hat{j}+2\hat{k}$ and linear $\vec{v}=2\hat{i}+\hat{k}$ velocity. Its angular momentum has a magnitude of
1) $\sqrt{25}$ units 2) $\sqrt{52}$ units 3) $\sqrt{50}$ units 4) None

33. If $|\vec{a}|-|\vec{b}|=|\vec{a}+\vec{b}|$, then the angle between $\vec{a}$ and $\vec{b}$ is : 1) 0^0 2) 45^0 3) 90^0 4) 180^0

34. If $|\vec{a}|-|\vec{b}|=|\vec{a}-\vec{b}|$, then the angle between $\vec{a}$ and $\vec{b}$ is : 1) 0^0 2) 45^0 3) 90^0 4) 180^0

35. If $\vec{a}$ is a unit vector, then $\vec{a}.\vec{a}=$___ and $|\vec{a}\times\vec{a}|=$
1) 1,0 2) 0,1 3) 1,1 4) 0,0

SELF TEST KEY

01) 2	02) 2	03) 4	04) 2	05) 4
06) 4	07) 2	08) 1	09) 1	10) 3
11) 1	12) 2	13) 3	14) 3	15) 4
16) 1	17) 3	18) 3	19) 3	20) 4
21) 3	22) 4	23) 3	24) 1	25) 2
26) 2	27) 1	28) 4	29) 3	30) 1
31) 2	32) 2	33) 4	34) 1	35) 1

PREVIOUS ECET BITS

2007

01. Two vectors each of magnitude P are acting at a point such that angle between the two vectors is 60^0. Then the magnitude of their resultant is :
1) 6P 2) $\sqrt{6}.P$ 3) 3P 4) $\sqrt{3}.P$

02. If $R=8i+xj+6k$ and $S=5i-4xj+4k$ are perpendicular vectors, then the value of x is :
1) 16 2) ±3 3) 9 4) ±4

03. The unit vector perpendicular to each vector $A=2i+j+k$ and $B=i+j+2k$ is :
1) $\frac{i-3j+k}{\sqrt{11}}$ 2) $\frac{-i+3j-3k}{\sqrt{19}}$
3) $\frac{3i-j+3k}{19}$ 4) $\frac{i+3j+3k}{19}$

2009

04. The maximum and minimum resultants of two forces are in the ratio 7 : 3. The ratio of the forces is
1) 7 : 3 2) $\sqrt{7}:\sqrt{3}$ 3) 5 : 2 4) 49 : 9

05. The torque acting on a body when a force $\bar{r}=\left(10\hat{i}+4\hat{j}-2\hat{k}\right)$ acts at a point on the body at a distance of $\bar{s}=\left(2\hat{i}-4\hat{j}-2\hat{k}\right)$ from a fixed point is

1) $\left(12\hat{i}+16\hat{j}+4\hat{k}\right)$ 2) $(16\hat{j}-16\hat{j}+48\hat{k})$

3) $\left(12\hat{i}+16\hat{j}-4\hat{k}\right)$ 4) $\left(16\hat{i}+16\hat{j}+4\hat{k}\right)$

06. Which of the following is a vector quantity ?

1) Electric charge 2) Electric current

3) Electric intensity 4) Electric potential

2010

07. Which of the following is not a vector ?

1) Magnetic force 2) Magnetic induction

3) Magnetic flux 4) Magnetic flux density

08. Ratio of vector $\vec{a}$ by its magnitude $|\vec{a}|$ is

1) A null vector 2) A pseudo vector

3) A unit vector 4) A scalar

09. The magnitude of the vector product of two vectors is equal to their scalar product. The angle between them is ...... radians

1) $\pi/2$ 2) $\pi/3$ 3) $\pi/4$ 4) $\pi/6$

2011

10. $\bar{A}$ and $\bar{B}$ are two vectors. If $\vec{A}.\vec{B}=0$, then

1) $\vec{A}$ and $\vec{B}$ are parallel

2) $\vec{A}$ and $\vec{B}$ are antiparallel

3) $\vec{A}$ and $\vec{B}$ are perpendicular

4) $\vec{A}$ and $\vec{B}$ are inclined at 45^0

11. Which of the following is not a vector

1) linear momentum 2) electric field

3) kinetic energy 4) acceleration

2012

12. If l,m and n are the direction cosines of a vector, then

1) $l+m+n=1$ 2) $l^2+m^2+n^2=1$

3) $\frac{1}{l}+\frac{1}{m}+\frac{1}{n}=1$ 4) $lmn=1$

13. The angle between $i+j$ and $j+k$ is

1) 0^o 2) 90^o 3) 45^o 4) 60^o

2013

14. The component of vector is ___

1) Always less than its magnitude

2) Always greater than its magnitude

3) Always equal to its magnitude

4) Greater than or equal to its magnitude

2014

15. The magnitude of the resultant of (A + B) and (A - B) is

1) 2A 2) $\sqrt{\left(A^2+B^2\right)}$

3) 2B 4) $\sqrt{\left(A^2-B^2\right)}$

16. Given A.B = 0 and A × C = 0, the angle between B and C is ___

1) 135° 2) 90° 3) 180° 4) 45°

T.S ECET 2015

17. If the magnitueds of two vectors are 3 and 4 and their scalar product is 6, the angle between the vectors is

1) 30^0 2) 45^0 3) 60^0 4) 90^0

18. The value of λ in the unit vector 0.4i+0.8j+ λ k is

1) $(0.12)^{1/2}$ 2) $(0.2)^{1/2}$

3) $(0.4)^{1/2}$ 4) $(0.8)^{1/2}$

19. Vector product of a vector with itself is

1) 1 2) -1 3) 0 4) ∞

A.P ECET 2015

20. Under a force $(10\vec{i}-3\vec{j}+6\vec{k})$ N, a body of mass 5 kg moves from position $(6\vec{i}+5\vec{j}-3\vec{K})$ m to position $(10\vec{i}-2\vec{j}+7\vec{k})m.$ The work dine is

1) 605 J 2) 27 J 3) 121 J 4) 148 J

21. The x and y components of vector $\vec{A}+\vec{B}$ are 10 m and 9 m respectively. The angle of vector $\vec{B}$ that it makes with the x-axis is

1) 60^0 2) 45^0 3) 30^0 4) 135^0

22. The position vector of a particle is given by $\vec{r}=3t\,\vec{i}-2t^2\,\vec{j}+4\,\vec{k}$ m where 't' is in seconds and the coefficients have the proper units for r to be in meters. Then the magnitude of velocity of the particle at t = 1 sec is

1) 5 m/s 2) 4 m/s 3) 6 m/s 4) 4.5 m/s

23. A motor boat is racing towards north 25 km/hr and the water current in that region is 10 km/hr in the direction of 60^0 east of south. The approximate resultant velocity of the boat is

1) 31 km/hr 2) 22 km/hr

3) 44 km/hr 4) 28 km/hr

T.S ECET 2016

24. The angle in radians between two vectors of equal magnitude whose resultant magnitude is equal to one them is

1) $\frac{2\pi}{3}$ 2) $\frac{\pi}{3}$ 3) π 4) $\frac{\pi}{2}$

25. If two vectors are parallel to each other, then their dot product is

1) minimum and equal to product of their magnitudes

2) minimum and equal to sum of their magnitudes

3) maximum and equal to product of their magnitudes

4) maximum and equal to sum of their magnitudes

26. The area of the parallelgram in square metres formed by adjacent sides 2i+j+3k and 2i+j+k metres is

1) $\sqrt{20}$ 2) 5 3) 6 4) $\sqrt{68}$

AP - ECET 2016

27. The position of an object moving along x-axis is given by $x=a+bt^2$. Here a = 8.5 m, $b=2.5ms^{-2}$. Then the average velocity between t = 2.0s and t = 4.0 s is

1) $150 m.s^{-1}$ 2) $100 m.s^{-1}$

3) $15 m.s^{-1}$ 4) $1.5 m.s^{-1}$

28. If $A=4\hat{i}+3\hat{k}-5\hat{j}, B=2\hat{i}-10\hat{j}-10\hat{j}-7\hat{k}$ and $C=5\hat{i}+7\hat{j}-4\hat{k}$,, the value of $\left(A\times B\right)\times C$ is

1) $7\hat{i}+10\hat{j}+25\hat{k}$ 2) $4\hat{i}+11\hat{j}+28\hat{k}$

3) $74\hat{i}+10\hat{j}+28\hat{k}$

4) $74\hat{i}+110\hat{j}+285\hat{k}$

T.S ECET 2017

29. The magnitudes of two vectors are 4 and 5 and their scalar product is 10. Then the angle between the two vectors is

1) 30^0 2) 45^0 3) 60^0 4) 0^0

30. If $\bar{a}+\bar{b}=\bar{c}$ and $\bar{a}^2+\bar{b}^2=\bar{c}^2$, then the angle between the vectors $\bar{a}$ and $\bar{b}$ is

1) 0^0 2) 20^0 3) 45^0 4) 90^0

31. $\bar{a}$ *and* $\bar{b}$ are two vectors and θ is the angle between them. If $\left|\bar{a}x\bar{b}\right|=\sqrt{3}\left(\bar{a}.\bar{b}\right)$, the value of θ is

1) 30^0 2) 45^0 3) 60^0 4) 90^0

32. A body under action of five forces can be in equilibrium

1) if all focrecs are equal

2) sum of resolved components along x-axis is zero

3) sum of resolved components along y-axis is zero

4) sum of resolved component along x-axis and y-axis, individually zero

AP - ECET 2017

33. Vector parallel to $6\hat{j}+8\hat{j}$ and having a magnitude of 5 is

1) $4\hat{j}+3\hat{j}$ 2) $12\hat{j}+16\hat{j}$

3) $16\hat{j}+8\hat{j}$ 4) $3\hat{j}+4\hat{j}$

34. If $\left|\vec{A}\times\vec{B}\right|=K\left(AB\right)$ then angle between $\vec{A}$ and $\vec{B}$ is

1) $\cos^{-1}K$ 2) $\cos^{-1}\left(1/K\right)$

3) $\sin^{-1}K$ 4) $\sin^{-1}\left(1/K\right)$

35. A 200 m wide river flows with a velcoity of 5 m/sec. A man crosses the river in the shortest time of 25 sec. If there is no flow and he swims with the same velocity, the taken to cross the river is

1) $\frac{200}{5\sqrt{3}}$ sec 2) 20 sec

3) 25 sec 4) $25\sqrt{2}$ sec

T.S ECET 2018

36. Two adjacent sides of a parallelogram are represented by the two vectors I+2J+3K and 3I-2J+K. What is the area of the parallelogram

1) 8 2) $8\sqrt{3}$ 3) $3\sqrt{8}$ 4) 192

37. Given the points A= (0,a) and B= (1,2), what is the value of a if the magnitude of the vector $\overline{AB}$ is 1

1) 3 2) 1 3) 4 4) 2

38. If A and B are perpendicular, vector A = 5i+7j-3k and B = 2i+2j-ak. What is the value of a?

1) -2 2) 8 3) -7 4) -8

AP - ECET 2018

39. Angle made by the vector $\left(\sqrt{3}\,\bar{i}+\bar{j}\right)$ with the X-axis is

1) $\pi/2$ 2) $\pi/4$ 3) $\pi/3$ 4) $\pi/6$

40. The minimum number of unequal force in a plane that can keep a particle in equilibrium is

1) 4 2) 2 3) 3 4) 6

PREVIOUS ECET BITS KEY

01) 4	02) 4	03) 1	04) 3	05) 2
06) 3	07) 3	08) 3	09) 3	10) 3
11) 3	12) 2	13) 4	14) 1	15) 1
16) 2	17) 3	18) 2	19) 3	20) 3
21) 2	22) 1	23) 2	24) 1	25) 3
26) 1	27) 3	28) *	29) 3	30) 4
31) 3	32) 4	33) 4	34) 3	35) 3
36) 2	37) 2	38) 4	39) 4	40) 3

PREVIOUS ECET BITS HINTS AND SOLUTIONS

01. $R = 2P\cos\frac{\theta}{2}$

$R = 2P\cos\frac{60}{2}$

$R = 2P\times\frac{\sqrt{3}}{2} = \sqrt{3}\,P$

02. For $\perp r$ vectors $\bar{R}.\bar{S} = 0$

$R = 8i + xJ + 6k$

$\underline{S = 5i - 4xJ + 4k}$

$\bar{R}.\bar{S} = 40 - 4x^2 + 24 = 0$

$4x^2 = 64 \Rightarrow x^2 = 16$

03. Perpendicular vector $\bar{C} = A\times B$

$$\bar{A}\times B = \begin{vmatrix} 1 & J & K \\ 2 & 1 & 1 \\ 1 & 1 & 2 \end{vmatrix}$$

$\bar{A}\times B = i(2-1) - J(4-1) + K(2-1)$

$A\times B = i - 3J + K$

$|A\times B| = \sqrt{1^2+3^2+1^2} = \sqrt{11}$

Unit vectors $= \frac{A\times B}{|A\times B|} = \frac{i-3J+K}{\sqrt{11}}$

04. $F_1 = \frac{F_{max}+F_{min}}{2} = \frac{7+3}{2} = 5$

$F_2 = \frac{F_{max}-F_{min}}{2} = \frac{7-3}{2} = 2$

05. Torque $\bar{\tau} = r\times F$

$$\bar{\tau} = \begin{vmatrix} i & J & K \\ 2 & -4 & -2 \\ 10 & 4 & -2 \end{vmatrix}$$

$\tau = i(8+8) - J(-4+20) + K(8+40)$

$\tau = 16i - 16J + 48K$

06. Force acting o n unit charge in electric intensity hence it is a vector $E = \frac{F}{q}$

07. Magnetic flux $\phi = \bar{B}.\bar{A}$

Dot product of two vectors is scalar

08. Unit vector $= \frac{\text{Vector}}{\text{magnitude}} = \frac{\bar{a}}{|\bar{a}|}$

09. $|\bar{a}\times\bar{b}| = |\bar{a}.\,b|$

at $\sin\theta = ab\cos\theta$

$\frac{\sin\theta}{\cos\theta} = 1 \Rightarrow \tan\theta = 1 \Rightarrow \theta = 45^o = \frac{\pi}{4}$

10. For perpendicular vectors $\bar{A}.\bar{B} = 0$

11. Kinetic energy in work which is a scalar

12. $\cos^2\alpha + \cos^2\beta = \cos^2\gamma = 1$

$\therefore 1^2 + m^2 + n^2 = 1$

13. $\theta = \cos^{-1}\left(\frac{a.b}{ab}\right)$

$\bar{a}.\bar{b} = (i+j).(j+k) = 1$

$a = \sqrt{1^2+1^2} = \sqrt{2}$ $\quad b = \sqrt{1^2+1^2} = \sqrt{2}$

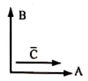
$\theta = \cos^{-1}\left(\frac{1}{\sqrt{2}\times\sqrt{2}}\right) \Rightarrow \theta = \cos^{-1}\left(\frac{1}{2}\right)$

$\theta = 60^o$

14. The component of a vector is less than (or) equal to its magnitude

15. $\left(\bar{A}\times\bar{B}\right) + \left(\bar{A}-\bar{B}\right) = 2A$

16. $A.B = 0$ perpendicular



$A\times C = 0$ parallel

$\times$ Angle between B and C is 90^o

17. Scalar product = ab cos θ

$6 = 3\times 4\cos\theta \Rightarrow \theta = 60^0$

18. $\sqrt{(0.4)^2+(0.8)^2+\lambda^2} = 1$

$\lambda^2 = 1 - 0.8$ $\quad \lambda = \sqrt{0.2}$

19. zero

20. S=(10 i - 2j + 7k) - (6i+5j-3k)

= 4i - 7j + 10 k

F = 10i - 3j + 6k W = F.S

= 40+21+60 = 121J

21. $\vec{A} = 4\vec{i} + 3\vec{j}$

$\vec{A} + \vec{B} = 10\vec{i} + 9\vec{j}$

$\vec{B} = \vec{A} + \vec{B} - \vec{A} = 6\vec{i} + 6\vec{j}$

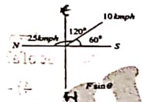
$Tan\alpha = \frac{y}{x} = \frac{6}{6} = 1$ $\alpha = 45^0$

22. $\vec{r} = 3t\bar{i} - 2t^2\bar{j} + 4\bar{k}$, $v = \frac{d\vec{r}}{dt} = 3i - 4 + \vec{j}$

At t = 1s. v= 3i - 4j

Magnitude of $V = \sqrt{3^2+4^2} = 5m/s$

23.



$R = \sqrt{25^2+10^2+2\times 25\times 10\times\cos 120^0}$

= 22 km/hr

24. $R = 2P\cos\frac{\theta}{2}$ But R=P

$P = 2P\cos\frac{\theta}{2} \Rightarrow \cos\frac{\theta}{2} = \frac{1}{2} \Rightarrow \theta = 120 = \frac{2\Pi}{3}$

25. Dot product of two parallel vectors in maximum $\bar{a}\bar{b} = ab\cos\theta = ab$ product of this magnitudes

26 area $= |\bar{a}\times\bar{b}| = \begin{vmatrix} i & j & k \\ 2 & 1 & 3 \\ 2 & 1 & 1 \end{vmatrix} = i(1-3)$

$-j(2-6) + k(2-2) = -2i + 4j \Rightarrow \sqrt{2^2+4^2} = \sqrt{20}$

27. $x = a + b +^2 \Rightarrow x_1 = 8.5 + 2.5\times 2^2 = 18.5m$

$x_2 = 8.5 + 2.5\times 4^2 = 48.5m$

$AV = \frac{s}{t} = \frac{x_2-x_1}{4-2} = \frac{30}{2}$

AV=15m/s

28. $\bar{A} = 4i - 5j + 3k$ $\bar{B} = 2i - 20j - 7k$

$\bar{C} = 5i + 7j - 4k$

$\left(\bar{A}\times\bar{B}\right) = 95i + 34j - 70k$

$\left(\bar{A}\times\bar{B}\right)\times\bar{C} = 354i + 30j + 495k$

29. $\theta = \cos^{-1}\left(\frac{10}{4.5}\right) = \frac{\Pi}{6}$

30. 90^0

31. $\tan\theta = \sqrt{3}$ $\theta = 60^0$

32. sum of resolved component along x-axis and y-axis, individually zero

33. $\frac{xi + yj}{5} = \frac{6i + 8j}{10}$

xi+yj=3i+4j

34. AB sin θ=KAB

sinθ=k $\Rightarrow \theta = \sin^{-1} k$

35. T=2 sec, $\theta = 30^0$

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

$2 = \frac{2u\sin 30^0}{9.8}$

$19.6 = u$

Araise ! Awake ! And stop not till the goal is reached

SPACE FOR IMPORTANT NOTES

KINEMATICS

SYNOPSIS

- i) A body is said to be rest, when it is not changing its position with time, with respect to the surroundings.
  ii) A body is said to be in motion if it is changing its position with time, with respect to the surroundings.
  iii) The terms rest and motion are only relative.
- The distance travelled is scalar but the displacement is a vector
- The distance travelled by a body may be greater than (or) equal to its displacement but never be less than its displacement.
- The displacement may be zero even though the distance travelled is not zero.
  Ex : A body moving on the circumference of a circle for complete rotation the displacement is zero but distance travelled is $2\pi r$
- The distance travelled per unit time is called 'speed is a scalar quantity. Its units are :
  (i) C.G.S system cms^{-1}
  (ii) S. I ms^{-1}
- Average speed = $\frac{\text{Total distance travelled}}{\text{total time taken}}$
- If a body covers 1st half of the distance with a speed 'a' and the 2nd half of the distance with a speed 'b'. the average speed = $\frac{2ab}{a+b}$
- If a body covers first $\frac{1}{3}rd$ of the distance with a speed 'a' second. $\frac{1}{3}rd$ of the distance with a speed 'b' and third $\frac{1}{3}rd$ of the distance with a speed 'c', the average speed = $\frac{3abc}{ab+bc+ca}$
- For a body moving with uniform speed, distance = speed × time.
- The rate of displacement is called "velocity". The speed in a particular direction is called "velocity". Velocity is a vector quantity.
- Average velocity V= $\frac{\text{Total displacement}}{\text{Total timetaken}}$
- If a body covers 1st half of the distance with a uniform velocity v_1 and 2nd half with a uniform velocity v_2

average velocity $V = \frac{2V_1V_2}{V_1+V_2}$

- If a body travels with a uniform velocity 'v_1' for an interval of time 't_1' and with a uniform velocity 'v_2' for an intervals of time 't_2'

  average velocity $= \frac{v_1t_1 + v_2t_2}{t_1+t_2}$

- If a body travells with a uniform velocity 'V_1' in the 1st half of the total time and with a uniform velocity v_2 in the 2nd half of the total time, the average velocity $V = \frac{V_1+V_2}{2}$
- Displacement = (average velocity) x (time)
- **Uniform velocity :** A body is said to move with uniform velocity if it has Equal displacement in equal intervals of time, however small these intervals may be.
- The velocity of a body is said to be changed, if there is a change either in magnitude (or) in direction (or) both in magnitude and direction of its velocity.
- For a body moving with uniform velocity, Speed is uniform, acceleration is zero and the net force acting on it is zero.
- The rate of change of velocity is called "acceleration". It is a vector. Its units are cm^{-2} and ms^{-2}

  $a = \frac{v-u}{t} = \frac{dv}{dt} = \frac{d^2x}{dt^2}$; Instantaneous acceleration $= \Delta t \to 0 = \frac{\Delta v}{\Delta t} = \frac{dv}{dt}$

- If the change in velocity is in the increasing order, the acceleration is called "positive acceleration" and is that is in the decreasing order, the acceleration is known as "Negative acceleration". (or)
- The velocity and acceleration of a body need not be in the same direction.

  Ex : Body projected vertically upwards. In this case velocity is opposite to acceleration.
- The velocity and acceleration of a body need not be zero simultaneously.
- For a body in equilibrium, the only physical quantity that remains zero is acceleration.
- If a body travels with a uniform acceleration 'a_1' for an interval of time 't_1' and 'a_2' for a time 't_2' then the average acceleration $a = \frac{a_1t_1 + a_2t_2}{t_1+t_2}$
- For a body moving with uniform acceleration, average velocity $= \left(\frac{u+v}{2}\right)$ where u is the initial velocity and v is the final velocity. S of displacement $s = \left(\frac{u+v}{2}\right)t$

- When a body is starting from rest, and moving with uniform acceleration the velocity acquired by it is directly proportional to the tame taken $(v \propto t)$
- When a body is starting from rest and moving with uniform acceleration, the distance travelled by it is directly proportional to the square of the time taken by it $(s \propto t^2)$
- When a body is moving with uniform velocity, the distance travelled by it is directly proportional to the time taken by it $(s \propto t)$
- The distance travelled by a body before coming to rest is directly proportional to the square of the velocity with which it is moving $(s \propto u^2)$
- In the case of body starting from rest and moving with uniform acceleration, the distance travelled in 1s, 2s, 3s....etc are in the ration $1^2 : 2^2 : 3^2 : ....$
- In the case of a body starting from rest, and moving with uniform acceleration the distance travelled in successive seconds or successive equal time intervals are in the ratio of 1 : 3 : 5 : 7.....etc ;
- The difference between the distances travelled by a body, in the successive seconds is numerically equal to its acceleration.
- When a body is starting from rest, the distances travelled by a body in the 1st second, in the first two seconds, in the first three seconds__etc are in the ratio of 1 : 4 : 9 : 16 : 25 :___ etc ;
- The acceleration possessed by a freeely falling body due to gravitational attraction is called, "acceleration due to gravity" 'g'. It is constant at a place, but changes from place to place. It is maximum at the poles, minimum on the equator and zero at the centre of the earth. Its values are 980 cms^{-2} are 9.8 ms^{-2}. It is independent of mass of the attracting body.
- a) The equation of motion of a body moving with uniform acceleration

  1) $v = u + at$ 2) $s = ut + \frac{1}{2}at^2$

  3) $v^2 - u^2 = 2as$ 4) $S_n = u + a\left(n - \frac{1}{2}\right)$

- When a body is dropped freely from the top of the tower and simultaneously another body is projected horizontally from the same point both will reach the ground in the same time. $\left[\text{since } t = \sqrt{\frac{2h}{g}} \text{ Here t is independent of u}\right]$
- Freely falling body

  i) Initial velocity $u = 0$ and acceleration, $a = +g$

ii) The distance travelled in the first second of its fall is g/2 ie., 4.9 m (or) 490 cm.

iii) If a body is allowed to fall from a tower of height 'h', its velocity on reaching the ground is $\sqrt{2gh}$.

iv) At the instant, when 'g' disappears the body falls with uniform velocity.

v) If a body is allowed to fall freely from a tower of height 'h', the time taken by it to reach the ground is given by $t=\sqrt{\frac{2h}{g}}$

vi) Equations of a freely falling body

1) $v=gt$ 2) $h=\frac{1}{2}gt^2$ 3) $v^2=2gh$

4) $S_n=g\left(n-\frac{1}{2}\right)$

➩ Body projected vertically up :

i) Final velocity, at the maximum height v = 0 and acceleration, $a=-g$.

ii) Time of ascent = Time of descent = u/g [in absence of air resistance)

iii) In the presence of air resistance, the time of ascent is less than the time of descent.

iv) Maximum height reached, $h=\frac{u^2}{2g}$

v) Time of flight, $T=\frac{2u}{g}$

vi) The velocity on reaching the ground is equal to the velocity with which it is projected. [in magnitude but opposite in direction]

vii) The acceleration of the body at any point in its path is equal while it is going up and coming down.

viii) Equations of a body projected vertically upwards.

1) $v=u-gt$ 2) $h=ut-\frac{1}{2}gt^2$

3) $u^2=2gh$ 4) $S_n=u-g\left(n-\frac{1}{2}\right)$

ix) The velocity of the body at a particular point is its path is equal while it is going up and coming down.

➩ If a body is allowed to fall freely from the top of a tower of height 'h' ann simultaneously another one is projected vertically upwards from the bottom of the tower with a velocity 'u', then they meet after (h/u) seconds.

➩ A body projected up from A, reaches the ground in 't_1' seconds. If it is thrown from A with the same velocity, it reaches the ground in 't_2' seconds, if it falls freely rest from A, it reaches the ground in $\sqrt{t_1t_2}$ seconds.

➩ **Projectile :**

i) The path of the projectile is a parabola, which is called trajectory

ii) The equation of the trajectory is

$$Y=x(\tan\theta)-\left(\frac{g}{2u^2\cos^2\theta}\right)x^2$$

where u is the velocity of projection and θ is the, angle of projection.

iii) The horizontal component of velocity of a projectile is '$u\cos\theta$' which is always constant.

iv) The vertical component of the velocity of the projectile is '$u\sin\theta$' which goes on decreasing due to gravitational pull

v) The horizontal distance travelled in an interval of 't' seconds is given by $x=u\cos\theta .t$

vi) The vertical height reached in an interval of 't' seconds is given by $Y=(u\sin\theta)t-\frac{1}{2}gt^2$

vii) The vertical component of the velocity of the projectile, after the time 't' is given by $V_y = u\sin\theta - gt$

viii) The horizontal component of the velocity of the projetile after the time 't' is given by

$V_x=u\cos\theta$ (constant throughout the motion)

ix) The velocity of the projectile after the time 't' is given by

$V=\sqrt{V_x^2+V_y^2}=\sqrt{(u\cos\theta)^2+(u\sin\theta-gt)^2}$ and where 'α' is the angle with the horizontal.

$\alpha=\tan^{-1}\left(\frac{V_y}{V_x}\right)$

x) The maximum height reached by the projectile $H=\frac{u^2\sin^2\theta}{2g}$ is maximum when $\theta=90^0$.

xi) The horizantal range of the projectile $R=\frac{u^2\sin 2\theta}{g}$

a) R is maximum, when $\theta=45^0$

b) R is same both for θ and $(90^0-\theta)$

c) Maximum range = 4 x maximum height $R_{max}=4H$ $\left[\theta=45^0\right]$

d) When $\theta=\tan^{-1}(4)$ then horizontal range and the maximum height are equal. (R = H)

e) The relations between the horizontal range R, maximum height H and angle of projection θ is $\tan\theta = \frac{4H}{R}$

xii) Time of flight, $T = \frac{2u\sin\theta}{g}$

a) Time of ascent, $t = \frac{u\sin\theta}{g}$

b) Time of descent, $t = \frac{u\sin\theta}{g}$

c) Time of flight = time of ascent + Time of descent

xiii) If a body is projected horizontally with a velocity 'u' from the top of a tower of a height 'h'.

a) Time taken by it to reach the ground, $t = \sqrt{\frac{2h}{g}}$ [independent of horizontal velocity 'u']

b) The horizontal distance travelled. $X = u\sqrt{\frac{2h}{g}}$. Horizontally distance is directly proportional to 'u'.

c) The same two formulae are applicable for a body dropped from an aeroplane, moving horizontally with a velocity 'u' at an alitutde 'h'.

d) The velocity in horizontal direction, after an interval of time 't' is given by $V_x = u$ The velocity in vertically downward direction, after an interval of time 't' is given by $V_y = gt$

$\therefore$ The velocity of the projectile after an interval of time 't' is given by

$V = \sqrt{V_x^2 + V_y^2} = \sqrt{u^2 + g^2t^2}$ and

$\alpha = \tan^{-1}\left(\frac{V_y}{V_x}\right)$ where is the angle with the horizontal

e) At the time of reaching the ground, velocity in horizontal direction $V_x = u$

velocity in down ward direction $V_y = \sqrt{2gh}$

$\therefore$ Velocity $V = \sqrt{V_x^2 + V_y^2} = \sqrt{u^2 + 2gh}$ and $\alpha = \tan^{-1}\left(\frac{\sqrt{2gh}}{u}\right)$ where α is the angle with the horizontal

PRACTICE SET - I

01. The ratio of the displacement to distance is always
1) Less than one 2) Greater than one
3) Less than or equal to one
4) Greater than or equal to one

02. A body moves from one corner of an equilateral triangle of side 10 cm to the same corner. Then the distance and displacement are respectively
1) 30 cm : 20 cm 2) 30 cm and 0
3) 0 and 30 cm 4) 30 cm and 30 cm

03. A body moves from A to B with a constant speed of 20 Kmph and then from B to A with a constant speed 30 Kmph, then the average speed of the car is :
1) 25 Km / hr 2) 24 Km / hr
3) 0 4) none of these

04. A body moves with a speed of 20 Km / hr in the first 5 sec and with a speed of 30 Km / hr int he next 5 sec. Then the average speed of the body is
1) 25 Km /hr 2) 24 Km/ hr
3) 0 4) None of these

05. If a body moves half the distance between two points with a speed of 10 Km / hr and remaining half with constant speed of 15 Kms/hr then the average speed of the body.
1) 12.5 Km / hr 2) 12 Km/ hr
3) zero 4) None of these

06. If a body moves from A to B with a constant velocity of 20 Km / hr and from B to A with a constant velocity of 30 Km/hr then the average velocity is
1) 25 Km / hr 2) 24 Km / hr
3) zero 4) None of these

07. If a trains of length 200 cm moving with a constant velocity takes 10 sec to cross an electric pole, then the time taken by the train to cross a bridge of length 400 m is : cm
1) 20 sec 2) 10 sec
3) 30 sec 4) None of these

08. If a body with uniform acceleration along a straight line describes 20 cm in the 5th second and 30 m in the 8th sec, then the acceleration of the body is
1) 33 m /sec^2 2) 333 m/sec^2
3) 3.3 m/sec^2 4) 0.33 m/ sec^2

09. If a body travels 30 m in a interval of 2 sec and 50 m in the next interval of 2 sec, then the acceleration of the body is :
1) 10 m /sec^2 2) 5m/sec^2
3) 20 m/sec^2 4) 2.5 m/sec^2

10. The distance travelled by a body is given by 2s = 10t + 5t^2. The acceleration of the body is :
1) 5/2 2) 5 3) 10 4) None

11. A man running at 10m/sec observes a bus 16m before him starting from rest and moving with an acceleration of 2m / sec^2. He can catch the bus after :
1) 8 sec 2) 2 sec
3) 5 sec 4) he can't catch the bus

12. The position of the body is given as a function of time by the relation. $x = 2t^3 - 6t^2 + 12t + 6$. The acceleration of the body is zero at 't'.
1) 1 sec 2) 2 sec
3) $2\sqrt{2}$ sec 4) None

13. The velocity of a body moving along the x-axis is given by $v = 4t - 2.5t^2$. Its acceleration after 3 sec is : (Assume v in cm /sec) :
1) 1.5 cm/sec^2 2) -11 cm/sec^2
3) 4 cm / sec^2 4) 5 cm /sec^2

14. If a body is projected vertically upwards from the ground with a velocity of 9.8 m/sec, then the maximum height reached by the body is :
1) 19.6 m 2) 9.8 m 3) 4.9 m 4) None of these

15. A body projected vertically up with a velocity of 10m/sec reaches a height of 20 m. If it is projected with a velocity of 20m/sec, then the maximum height reached by the body is :
1) 20 m 2) 10 m 3) 80 m 4) 40 m

16. If a body is projected upwards vertically with a velocity of 19.6 m/sec then it reaches the ground after :
1) 2 sec 2) 1 sec 3) 4 sec 4) 3 sec

17. A balloon rising vertically with a velocity of 5 m/sec drops a body from a height of 20 m above the ground. The velocity of the body 1 sec after release is :
1) 4.8 m/sec up 2) 4.8 m/sec down
3) 9.8 m/sec up 4) 9.8 m/sec down

18. If a body is projected vertically upwards from the top of the tower with a velocity of 14.7 m/sec reaches the foot of the tower in 1 sec, then its time of free fall is :
1) 1 sec 2) $\sqrt{2}$ sec
3) $2\sqrt{2}$ sec 4) None of these

19. If a body is thrown with a velocity of 19.6 m/sec making an angle of 30^0 with the horizontal, then the time of flight is :
1) 1 sec 2) 2 sec
3) $2\sqrt{3}$ sec 4) None of these

20. At what angle of projection a ball should be thrown with an initial velocity of 50m/s such that it just clears a wall of height 30 m exactly after three seconds (g = 10m/s²)
1) 60^0 2) 30^0 3) 45^0 4) Both 1&3

21. A piolot dropped a bomb from the plane, travelling horizontally, then the path of the bomb that is appeared to the pilot is :
1) Parabola 2) Vertically down wards
3) Horizontally 4) Ellipse

22. The velocity-time graph of a body moving with uniform velocity is a straight line :
1) Parallel to Y-axis 2) Parallel to X-axis
3) inclined to X-axis 4) Inclined to Y-axis

23. A body moves east by a distance of 3 km and turns towards north by a distance of 4 km. The displacement of the body is :
1) 5 km 2) 7 km 3) 1 km 4) 3.5 km

24. A person travels along a straight road for the first half time with a velocity V_1 and the second half time with a velocity V_2. Then the average velocity is :
1) $\frac{V_1+V_2}{2}$ 2) $\frac{2V_1V_2}{V_1+V_2}$ 3) $\sqrt{V_1V_2}$ 4) $\sqrt{\frac{V_2}{V_1}}$

25. Two bodies are thrown vertically upwards with their initial velocities in the ratio 2 : 3. Then the ratio of their heights reached by :
1) 2 : 3 2) 4 : 9 3) 8 : 3 4) 5 :7

26. Two bodies starts from rest and falls from a height of ratio 4 : 9 freely. The ratio of their maximum velocities.
1) 2 : 3 2) 4 : 9 3) 3 : 2 4) 9 : 4

27. Two balls falls freely starting from rest have their times of fall in the ratio 2 : 3. Then the ratio of their maximum velocities is :
1) 4 : 2 2) 3 : 2 3) 2 : 3 4) 3 : 8

28. Two freely falling bodies, starting from rest have their times of fall in the ratio 2 : 3. Calculate the ratio of their heights :
1) 9 : 1 2) 2 : 1 3) 9 : 4 4) 4 : 9

29. A person sitting in a train moving with uniform velocity tossed a coin vertically up. The coin will fall
1) back into the hands of the person
2) behind the person 3) before the person
4) by the side of the person

30. Correct statement among the following is
1) when displacement is zero, distance travelled is not zero
2) When displacement is zero, distance travelled is also zero
3) When distance is zero, displacement is not zero
4) distance travelled and displacement are always equal

31. To reach the same height on the moon as on the earth, a body must be projected up with
1) Higher velocity on the moon
2) Lower velocity on the moon
3) Same velocity on the moon and earth
4) It depends on the mass of the body.

32. A body is projected up with velocity u. It reaches a point in its path at t_1 and t_2 from the time of projection. Then. t_1+t_2 is
1) $\frac{2u}{g}$ 2) $\frac{u}{g}$ 3) $\sqrt{\frac{2u}{g}}$ 4) $\sqrt{\frac{u}{g}}$

33. At the maximum height of a body thrown vertically up
1) Velocity is not zero but acceleration is zero
2) Acceleration is not zero but velocity is zero
3) Both acceleration and velocity are zero
4) Both acceleration and velocity are not zero.

34. The average velocity of a freely falling body is numerically eqaul to half of the acceleration due to gravity. The velocity of the body as if reaches the ground is
1) g 2) $\frac{g}{2}$ 3) $\frac{g}{\sqrt{2}}$ 4) $\sqrt{2}g$

35. From the top of a building a ball A is dropped while another ball B is thrown horizontally at the same time. Then
1) the ball A hits the ground first
2) the ball B hits the ground first
3) both 1 and 2 hit the ground at the same time
4) any ball may hit the ground first

36. The path of one projectile as seen from another projectile is a
1) Straight line 2) Parabola
3) Hyperbola 4) Circle

37. A body starting from rest and travelling with uniform acceleration has a velocity of 40 m/s after 10 second at A. Velocity of the body at 4 second before it crosses the point A is
1) 16 m/s 2) 20 m/s 3) 24 m/s 4) 32 m/s

38. Velocity of a body moving with uniform acceleration of 3 m/s² is changed through 30 m/s in certain time. Average velocity of body during this time is 30 m/s. Distance covered by it during this time is
1) 300 m 2) 200 m 3) 400 m 4) 250 m

39. Starting from rest a body travels 36 m in the first 2 second of its journey. Distance it can travel in the 11th second is
1) 72 m 2) 108 m 3) 144 m . 4) 189 m

40. A bullet travelling horizontally loses 1/20th of its velocity while piercing a wooden plank. Number of such planks required to stop the bullet is
1) 6 2) 9 3) 11 4) 3

41. A body moves from A to B with a constant speed of 20kmph and then from B to A with a constant speed of 30kmph. Then the average speed of the car is
1) 25 kmph 2) 24 kmph
3) 0 kmph 4) 10 kmph

42. A body moves with a speed of 20kmph in the first 5s and with a speed of 30kmph in the next 5sd. Then, the average speed of the body is
1) 25 kmph 2) 24 kmph
3) 0 kmph 4) 10 kmph

43. If a body moves half of the distance between two points with a speed of 10kmph and remaining half with a constant speed of 15kmph, then the average speed of the body is
1) 12.5 Kmph 2) 12 Kmph
3) 0 Kmph 4) 10 Kmph

44. If a body travels 30m in an interval of 2s and 50m in the next interval of 2s, then the acceleration of the body is
1) 10 m/s² 2) 5 m/s² 3) 20 m/s² 4) 25 ms²

45. A body starts from rest and moves with a uniform acceleration of 10 ms^{-2} in the first 10 seconds. During the next 10 seconds. It moves with the maximum velocity attained. The total displacement of the body is
1) 2000 m 2) 1000 m 3) 1500 m 4) 500m

46. A body projected up with a velocity u reaches a height 'h'. To reach double the height, it must be projected up with a velocity of

1) 2u 2) $u/2$ 3) $\sqrt{2}u$ 4) $u/\sqrt{2}$

47. Two balls are projected simultaneously with the same velocity 'u' from the top of a tower, one, vertically upwards and the other vertically downwards. Their respective times of the journeys are t_1 and t_2. At the time of reaching the ground, the ratio of their final velocities is

1) 1 : 1 2) 1 : 2 3) 2 : 3 4) 2 : 1

48. A body dropped from the top of tower reaches the ground in 4s. Height of the tower is

1) 39.2 m 2) 44.1 m 3) 58.8 m 4) 78.4m

49. A ball dropped freely takes 0.2 s to cross the last 6m distance before hitting the ground. Total time of fall is ($g = 10\ m/s^2$)

1) 2.9 s 2) 3.1 s 3) 2.7 s 4) 0. 2s

50. Two bodies are projected simultaneously with the same velocity of 19.6 m/s from the top of a tower, one vertically upwards and the other, vertically downwards. As they reach the ground, the time gap is

1) 0s 2) 2 s 3) 4 s 4) 6s

51. A body projected vertically upwards with a velocity of 19.6 m/s reaches a height of 19.6 m on earth. If it is projected vertically up with the same velocity on moon, then the maximum height reached by it is

1) 19. 18 m 2) 3.3 m 3) 9.9 m 4) 117.6 m

52. A body projected vertically up with a velocity of 10 m/s reaches a height of 20m. If is is projected with a velocity of 20 m/s, then the maximum height reached by the body is

1) 20 m 2) 10 m 3) 80 m 4) 40 m

53. If a body is thrown with a velocity of 19.6 m/s making an angle of 30^0 with the horizontal, then the time of flight is

1) 1s 2) 2 s 3) $2\sqrt{3}s$ 4) 5 s

54. If a body is projected with a velocity of 9.8 m/s making an angle of 45^0 with the horizontal, then the range of the projectile is

1) 39. 2m 2) 9.8 m 3) 49 m 4) 19.6 m

55. A body projected at an angle of 45^0 reaches the top of a wall of height 10m located at a distance of 20 m from the point of projection. Initial velocity of the projectile is ($g = 10\ m/s^2$)

1) 10 m/s 2) 20 m/s 3) 30 m/s 4) 25 m/s

56. If a body is projected with a velocity 'u' making an angle of 30^0 with the horizontal and another with the same velocity making an angle of 60^0 with the horizontal, then maximum heights reached are in the ratio

1) 3 : 1 2) 1 : 2 3) 1 : 3 4) 2 : 1

57. A particle is projected with an initial velocity of 200m/s in a direction making an angle of 30^0 with the vertical. The horizontal distance covered by the particle in 3s is

1) 300 m 2) 150 m 3) 175 m 4) 125 m

58. A boy throws a ball with a velocity of 20 ms^{-1} such that its horizontal range is maximum. If $g = 10\ ms^{-2}$ range of the ball is

1) 20 m 2) 25 m 3) 30 m 4) 40 m

59. A bullet is fired with a velocity of 196 ms^{-1} at an angle of 30^0 with the horizontal. Time of flight of the bullet is

1) 10 s 2) 20 s 3) 30 s 4) 40 s

60. A ball thrown with a velocity of 49 m/s got the maximum range measured in the atmosphere as 225m. The decrease of range due to atmosphere is

1) 0 m 2) 245m 3) 225 m 4) 20 m

61. A bomb is dropped from an aeroplane flying horizontally with a velocity of 720 Kmph at an altitude of 980m. Time taken by the bomb to hit the ground is

1) 1s 2) 7.2 s 3) 14.14 s 4) 0.15s

PRACTICE SET - I KEY

01) 3	02) 2	03) 2	04) 1	05) 2
06) 3	07) 3	08) 3	09) 2	10) 2
11) 1	12) 1	13) 2	14) 3	15) 3
16) 3	17) 2	18) 2	19) 2	20) 2
21) 2	22) 2	23) 1	24) 1	25) 2
26) 1	27) 3	28) 4	29) 1	30) 1
31) 2	32) 1	33) 2	34) 1	35) 3
36) 1	37) 3	38) 1	39) 4	40) 3
41) 2	42) 1	43) 2	44) 2	45) 3
46) 3	47) 1	48) 4	49) 2	50) 3
51) 4	52) 3	53) 2	54) 2	55) 2
56) 3	57) 1	58) 4	59) 2	60) 4
61) 3				

PRACTICE SET - II

01. A stone thrown vertically upwards with an initial velocity u from the top of a tower reaches the ground with a velocity 3u. The height of the tower

1) $3u^2/g$ 2) $4u^2/g$ 3) $6u^2/g$ 4) $9u^2/g$

02. In the presence of considerable resistance of air a stone is thrown vertically upwards. The time of flight upwards is

1) longer than that down wards
2) twice large as that downwards
3) smaller than that downwards
4) same as that down wards

03. A body thrown up vertically reaches a maximum height of 100 m. An other body with double the mass thrown up with double the initial velocity will reach a maximum height of:

1) 400 m 2) 200 m 3) 100 m 4) 25 m

04. From a place where $g = 9.8m/\sec^2$, a stone is thrown upwards with a velocity of 4.9 m/sec. The time taken for the stone to return to the earth is :

1) 2 sec 2) 1 sec 3) 4 sec 4) 8 sec

05. A wooden block of mass 10 gm is dropped from the top of a cliff 100 m high. Simultaneously a bullet of mass 10 gm is fired from the foot of the cliff upward, with a velocity of 100 m/sec. The bullet and the wooden block will meet, after a time in seconds :

1) 10 2) 0.5 3) 1 4) 7

06. A stone is thrown vertically up from the ground. It reaches a maximum height of 50 m in 10 sec. After what time will reach the ground from the maximum height position ?

1) 5 sec 2) 10 sec 3) 20 sec 4) 25 sec

07. A body is thrown vertically up reaches a maximum height of 50m. Another body with double the mass thrown up with double the initial velocity wil reach a maximum height of

1) 100 m 2) 200 m 3) 400 m 4) 50 m

08. If a splash is heard 4.23 sec after a stone is dropped into a well 78.4 m deep, then the velocity of sound is :

1) 3×10^8 m/sec 2) 340 m/sec
3) 354 m/sec 4) 300 m/sec

09. A food packet is released from a helicopter which is rising steadily at 2m/sec. After 2 sec the velocity of the packet is

1) 19.6 m/sec 2) -2 m/sec
3) -17.6 m/sec 4) none

10. A body freely falling from rest has a velocity v after it falls through a distance h. The distance it has to fall down further, for its velocity to become doubled is ___ times h.

1) 2h 2) 3h 3) 4h (4) 5h

11. The displacement is given by $x = 2t^2 + t + 5$ the acceleration at $t = 2\sec$ is :

1) $4m/\sec^2$ 2) $8m/\sec^2$
3) $10m/\sec^2$ 4) $15m/\sec^2$

12. The velocity of a particle at an instant 't' is 10m/sec. After 5 sec the velocity is 20 m/sec. the velocity at 3 sec before is

1) 8m/sec 2) 4m/sec 3) 6m/sec 4) 7m/sec

13. The distance moved by a freely falling body during the 1st sec, 2nd, 3rd second of its motion are proportional to
1) 1:2:3 2) 1:3:5 3) 1:4:9 4) 1:1:1

14. Velocity time graph for a body projected vertically upward is
1) Parabola 2) Ellipse
3) Hyperbola 4) Straight line

15. A body is projected up with a speed u and the time taken by it to reach the maximum height H. pickout the correct statement
1) It reaches H/2 in T/2
2) increase velocity u/2 in T/2 sec
3) It velocity is u/2 at H/2
4) Same velocity at 2T

16. A bus accelerates uniformly from rest and acquires a speed of 36 km/hr in 10 sec. The acceleration is
1) 1m/sec^2 2) 2m/sec^2
3) 1/2 m/sec^2 4) 3m/sec^2

17. An aeroplane when it is vertically above a point A on the ground drops a bomb which hit a target B on the ground. If the plane is moving at a height of 1.96 km from the ground with a speed of 300 m/sec, the distance between A and B is __(neglecting air resistance)
1) 3000 m 2) 6000 m
3) 9000 m 4) 1000 m

18. A bomb is dropped from a aeroplane flying horizontally with a velocity 720 km/hr at an altitude 980 m. When will the bomb hit the ground
1) 1 sec 2) 7.2 sec
3) 14.15 sec 4) 0.15 sec

19. A horizontal stream of water leaves an opening in the side of a tank. If the opening is h metre above the ground, and the stream hits the ground D metre away and the acceleration due to gravity is g the speed of water as it leaves the is tank in terms of g, h and D
1) $u\sqrt{\frac{h}{g}}$ 2) $\sqrt{\frac{uh}{g}}$ 3) $D\sqrt{\frac{g}{2h}}$ 4) $u\sqrt{\frac{2h}{g}}$

20. An aeroplane moving horizontally with a speed of 180 km/hr drops a food packet while flying at a height of 490 m. The horizontal range is :
1) 180 m 2) 980 m 3) 500 m 4) 670 m

21. A gun is fired aiming at a target. At the moment of firing the target is released and freely falls under gravity. Then the bullet
1) misses the target by passing above it
2) hits the target
3) misses the target by passing below it
4) may or may not hit

22. A plane is flying horizontally at 98 m/sec and releases an object which reaches the ground in 10 sec. The angle made by it while it hitting the ground is
1) 30^0 2) 45^0 3) 60^0 4) 75^0

23. A bomb is dropped from an aircraft travelling horizontally at 15 m/sec at a height of 490 m. The horizontal distance travelled by the bomb before it hits the ground is ___ in metres
1) 100 2) 120 3) 150 4) 180

24. When the projectile is at its greatest highest, the ___component of the velocity is zero
1) Horizontal 2) Vertical
3) Both 1 and 2 4) None

25. Two bodies are projected with the same velocity one body is projected at an angle of 30^0 an the other at an angle of 60^0 to the horizontal, the ratio of the maximum heights reached is
1) 3 : 1 2) 1 : 3 3) 1 : 2 4) 2 : 1

26. The directions of velocity and acceleration of a projectile at the highest point on the trajectory are
1) parallel to each other
2) antiparallel to each other
3) perpendicular to each other
4) no specific relation exists between them

27. A bus starts from rest and moves with a uniform acceleration of 1 ms^{-2}. A boy 10m behind the bus at the start runs at a constant speed and catches the bus in 10s. Speed of the boy is
1) 10 m/s 2) 1 m/s 3) 6 m/s 4) 4 m/s

28. A train is running at full speed when brakes are applied. In the first minute, it travels 8 km and in the next minute it travels 3 km. Initial speed of the train is
1) 150 m/s 2) 176 m/s 3) 200 m/s 4) 225 m/s

29. A car travelling at 60 kmph overtakes another car travelling at 42 kmph. Assuming each car to be 5.0 m long, the time taken for the over taking is
1) 6 second 2) 4 second
3) 3 second 4) 2 second

30. A body covers 30 m and 40 m during 10th and 15th second respectively. The acceleration and initial velocity of the body are respectively
1) 2m/s^2 ; 35 m/s 2) 2 m/s^2 , 11 m/s
3) 11 m/s^2 ; 2 m/s 4) 1m/s^2 , 10 m/s

31. A body travels 200 m in the first two second and 220 m in the next four second. The velocity at the end of the seventh second from the start will be
1) 10 m/s 2) 15 m/s 3) 220 m/s 4) 5 m/s

32. The velocity of body moving along the x-axis is given by v = 4t - 2.5 t^2. Its acceleration after 3S is (v in cm/s)
1) 1.5 cm/s^2 2) -11 cm/s^2
3) 4 cm/s^2 4) 5 cm/s^2

33. While moving with uniform acceleration, a body has covered 550 m in 10 second and attained a velocity of 105 m/s. Its initial velocity 'u' and acceleration 'a' respectively are
1) 10 ms^{-1}, 5 ms^{-2} 2) 10 ms^{-1}, -5ms^{-2}
3) 5 ms^{-1}, 10 ms^{-2} 4) 10 ms^{-1}, 0 ms^{-2}

34. While moving with uniform acceleration, a body has covered 100 m in 10th second and attained a, velocity of 105 m/s. Its initial velocity 'u' and acceleration 'a' respectively are
1) 10 ms^{-1}, 5 ms^{-2} 2) 10 ms^{-1}, -5ms^{-2}
3) 5 ms^{-1}, 10 ms^{-2} 4) 10 ms^{-1}, 0 ms^{-2}

35. A particle moving with velocity equal to 0.4 m/s is subjected to an acceleration of 0.15 m/s^2 for 2s in a direction at right angle to its direction of motion. The magnitude of resultant velocity is
1) 0.3 m/s 2) 0.5 m/s
3) 0.27 m/s 4) 0.55 m/s

36. A boy sees a ball going up and then coming down through a window of 2m high. If the total time the ball in sight is 1s, the height above the window that the ball rises is ___ (g = 10 ms^{-2})
1) $\frac{9}{10}m$ 2) $\frac{3}{80}m$ 3) $\frac{9}{80}m$ 4) $\frac{3}{40}m$

37. Two stones are thrown vertically upwards with the same velocity of 49 m/s. If they are thrown one after the other with a time lapse of 3 second, height at which they collide is
1) 58.8 m 2) 111.5 m
3) 117.6 m 4) 122.5 m

38. A ball dropped from a height f 10m, rebounds to a height of 2.5 m. If the ball is in contact with the floor for 0.01 second, its acceleration during contact is (g = 9.8 m/s^2)
1) 20 m/s^2 2) 21 m/s^2 3) 210 m/s^2 4) 2100 m/s^2

39. A ball is dropped from the top of a building. The ball takes 0.5s to fall past the 3m length of a window at certain distance from the top of the building. Speed of the ball as it crosses the top edge of the window is (g = 10 m/s2)
1) 3.5 ms^{-1} 2) 8.5 ms^{-1} 3) 5 ms^{-1} 4) 12 ms^{-1}

40. A stone of mass 200 g is thrown up with certain velocity reaches a maximum height of 30m. Another body of double the mass is thrown up with half the velocity the first. Maximum height reached by it is
1) 30 m 2) 15m 3) 7.5 m 4) 3.5 m

41. A shot fired vertically upwards is known to be at P at the end of two second and also again after six more second. Height of P above the point of projection is,
1) 44. 1 m 2) 78.4m 3) 122.5m 4) 19.6m

42. A stone is dropped from a rising balloon at a height of 300m above the ground and it reaches the ground in 10s. The velocity of the balloon when stone was dropped is
1) 19 m/s 2) 19.6 m/s 3) 29 m/s 4) 0 m/s

43. A balloon is rising vertically with a velocity of 9.8 m/s. A packet is dropped from it when it is at a height of 39.2m. Time taken by the packet to reach the ground is
1) 1s 2) 2s 3) 3s 4) 4s

44. A bag is dropped from a helicopter rising vertically at a constant speed of 2m/s. The distance between the two after 2s is
1) 4.9m 2) 19.6 m 3) 29.4 m 4) 39.2m

45. The velocity with which a ball is to be projected vertically up so that the distance covered in the 5th second is twice that covered in 6th second is ($g = 10\ ms^{-2}$)
1) 20 ms^{-1} 2) 60 ms^{-1} 3) 50 ms^{-1} 4) 65 ms^{-1}

46. A gun mounted on the top of a moving truck is aimed in the backward direction at angle of 30^0 to the vertical. If the muzzle velocity of the gun is 4m/s, the speed of the truck to send the bullet vertically up is
1) 1 m/s 2) $\frac{\sqrt{3}}{2} m/s$ 3) $0.5\ m/s$ 4) 2 m/s

47. A ball is thrown with a velocity of 'u' making an angle 'θ' with the horizontal. Its velocity vector is normal to initial velocity vector (u) after a time interval of
1) $\frac{u\sin\theta}{g}$ (2) $\frac{u}{g\cos\theta}$ 3) $\frac{u}{g\sin\theta}$ 4) $\frac{u\cos\theta}{g}$

48. A body is projected at an angle of 30^0 to the horizontal with a speed of 30m/s. The angle made by the velocity vector with the horizontal after 1.5s is
1) 0^0 2) 60^0 3) 45^0 4) 90^0

49. A grass hopper can jump a maximum horizontal distance of 0.3m. If it spends negligible time on the ground, its horizontal component of velocity is ($g = 10\ m/s^2$)
1) 3/2 m/s 2) $\sqrt{\frac{3}{2}}\ m/s$
3) $1/2\ m/s$ 4) $\sqrt{\frac{2}{3}}\ m/s$

50. A ball is thrown with a velocity of 8 m/s making an angle of 60^0 with the horizontal. Its velocity will be perpendicular to the initial velocity of projection after a time of ($g = 10\ m/s^2$)
1) $\frac{1.6}{\sqrt{3}}$s 2) $\frac{4}{\sqrt{3}}$s 3) 0.6s 4) $1.6\sqrt{3}$ s

51. The minimum and maximum velocities of a projectile are 10 m/s and 20 m/s respectively. The horizontal range and maximum height are respectively ($g = 10\ m/s^2$)
1) $10\sqrt{3}\ m$ and $20\ m$ 2) $20\sqrt{3}\ m$ and 15m
3) 20 m and 15m 4) $10\sqrt{3}\ m$ and 10m

52. A bullet fired at an angle of 15^0 with the horizontal hits the ground 6 km away. Keeping the same velocity of projection for the bullet to attain a range of 12 km, the angle of projection is
1) 15^0 2) 30^0 3) 45^0 4) 60^0

53. A healthy young man standing at distance of 7m from a 11.8 m high building sees a kid slipping from the top floor. His uniform speed of run to catch the kid at the arms height of 1.8m is
1) 4.9 m/s 2) 9.8 m/s 3) 3.5 m/s 4) 7 m/s

54. A body is projected downward at an angle of 30^0 with the horizontal from the top of a building of height 300m. Its initial speed of 40m/s. Time taken by it to hit the ground is ($g = 10\ m/s^2$)
1) 2s 2) 4s 3) 6s 4) 8s

55. A body is sliding down a smooth inclined plane which makes 30^0 with the horizontal. Acceleration of the body is
1) 9.8 m/s^2 2) 4.9 m/s^2
3) 2.45 m/s^2 4) 0 m/s^2

PRACTICE SET - II KEY

01) 2	02) 3	03) 1	04) 2	05) 3
06) 2	07) 2	08) 2	09) 3	10) 2
11) 1	12) 2	13) 2	14) 4	15) 4
16) 1	17) 2	18) 3	19) 3	20) 3
21) 2	22) 2	23) 3	24) 2	25) 2
26) 3	27) 3	28) 2	29) 4	30) 2
31) 1	32) 2	33) 3	34) 3	35) 2
36) 3	37) 2	38) 4	39) 1	40) 3
41) 2	42) 1	43) 2	44) 2	45) 4
46) 4	47) 3	48) 1	49) 2	50) 1
51) 2	52) 3	53) 1	54) 3	55) 2

SELF TEST

01. A body starting from rest and travelling with uniform acceleration has a velocity of 40 m/s after 10 second at A. Velocity of the body at 4 second before it crosses the point A is
1) 16 m/s 2) 20 m/s 3) 24 m/s 4) 32 m/s

02. Velocity of a body moving with uniform acceleration of 3 m/s^2 is changed through 30 m/s in certain time. Average velocity of body during this time is 30 m/s. Distance covered by it during this time is
1) 300 m 2) 200 m 3) 400 m 4) 250 m

03. Starting from rest a body travels 36 m in the first 2 second of its journey. Distance it can travel in the 11th second is
1) 72 m 2) 108 m 3) 144 m 4) 189 m

04. A bullet travelling horizontally loses 1/20th of its velocity while piercing a wooden plank. Number of such planks required to stop the bullet is
1) 6 2) 9 3) 11 4) 3

05. A body moves from A to B with a constant speed of 20kmph and then from B to A with a constant speed of 30kmph. Then the average speed of the car is
1) 25 kmph 2) 24 kmph
3) 0 kmph 4) 10 kmph

06. A body moves with a speed of 20kmph in the first 5s and with a speed of 30kmph in the next 5sd. Then, the average speed of the body is
1) 25 kmph 2) 24 kmph
3) 0 kmph 4) 10 kmph

07. If a body moves half of the distance between two points with a speed of 10kmph and remaining half with a constant speed of 15kmph, then the average speed of the body is
1) 12.5 Kmph 2) 12 Kmph
3) 0 Kmph 4) 10 Kmph

08. If a body travels 30m in an interval of 2s and 50m in the next interval of 2s, then the acceleration of the body is
1) 10 m/s^2 2) 5 m/s^2 3) 20 m/s^2 4) 25 ms^2

09. A body starts from rest and moves with a uniform acceleration of 10 ms^{-2} in the first 10 seconds. During the next 10 seconds. It moves with the maximum velocity attained. The total displacement of the body is
1) 2000 m 2) 1000 m 3) 1500 m 4) 500m

10. A body projected up with a velocity u reaches a height 'h'. To reach double the height, it must be projected up with a velocity of
1) 2u 2) $u/2$ 3) $\sqrt{2}u$ 4) $u/\sqrt{2}$

11. Two balls are projected simultaneously with the same velocity 'u' from the top of a tower, one, vertically upwards and the other vertically downwards. Their respective times of the journeys are t_1 and t_2. At the time of reaching the ground, the ratio of their final velocities is
1) 1 : 1 2) 1 : 2 3) 2 : 3 4) 2 : 1

12. A body dropped from the top of tower reaches the ground in 4s. Height of the tower is
1) 39.2 m 2) 44.1 m 3) 58.8 m 4) 78.4m

13. A ball dropped freely takes 0.2 s to cross the last 6m distance before hitting the ground. Total time of fall is (g = 10 m/s²)
1) 2.9 s 2) 3.1 s 3) 2.7 s 4) 0. 2s

14. Two bodies are projected simultaneously with the same velocity of 19.6 m/s from the top of a tower, one vertically upwards and the other, vertically downwards. As they reach the ground, the time gap is
1) 0s 2) 2 s 3) 4 s 4) 6s

15. A body projected vertically upwards with a velocity of 19.6 m/s reaches a height of 19.6 m on earth. If it is projected vertically up with the same velocity on moon, then the maximum height reached by it is
1) 19. 18 m 2) 3.3 m 3) 9.9 m 4) 117. 6 m

16. A body projected vertically up with a velocity of 10 m/s reaches a height of 20m. If is is projected with a velocity of 20 m/s, then the maximum height reached by the body is
1) 20 m 2) 10 m 3) 80 m 4) 40 m

17. If a body is thrown with a velocity of 19.6 m/s making an angle of 30^0 with the horizontal, then the time of flight is
1) 1s 2) 2 s 3) $2\sqrt{3}s$ 4) 5 s

18. If a body is projected with a velocity of 9.8 m/s making an angle of 45^0 with the horizontal, then the range of the projectile is
1) 39.2m 2) 9.8 m (3) 49 m (4) 19.6 m

19. A body projected at an angle of 45^0 reaches the top of a wall of height 10m located at a distance of 20 m from the point of projection. Initial velocity of the projectile is (g = 10 m/s²)
1) 10 m/s 2) 20 m/s 3) 30 m/s 4) 25 m/s

20. If a body is projected with a velocity 'u' making an angle of 30^0 with the horizontal and another with the same velocity making an angle of 60^0 with the horizontal, then maximum heights reached are in the ratio
1) 3 : 1 2) 1 : 2 3) 1 : 3 4) 2 : 1

21. A particle is projected with an initial velocity of 200m/s in a direction making an angle of 30^0 with the vertical. The horizontal distance covered by the particle in 3s is
1) 300 m 2) 150 m 3) 175 m 4) 125 m

22. A boy throws a ball with a velocity of 20 ms⁻¹ such that its horizontal range is maximum. If g = 10 ms⁻² range of the ball is
1) 20 m 2) 25 m 3) 30 m 4) 40 m

23. A bullet is fired with a velocity of 196 ms⁻¹ at an angle of 30^0 with the horizontal. Time of flight of the bullet is
1) 10 s 2) 20 s 3) 30 s 4) 40 s

24. A ball thrown with a velocity of 49 m/s got the maximum range measured in the atmosphere as 225m. The decrease of range due to atmosphere is
1) 0 m 2) 245m 3) 225 m 4) 20 m

25. A bomb is dropped from an aeroplane flying horizontally with a velocity of 720 Kmph at an altitude of 980m. Time taken by the bomb to hit the ground is
1) 1s 2) 7.2 s 3) 14.14 s 4) 0.15s

26. In between two hills of heights 100 m and 92m, there is a valley of breadth 16m. If a vehicle jumps from the first hill to the second one, the minimum velocity of the vehicle is (assume g = 9m/s²)
1) 16 m/s 2) 12 m/s 3) 9 m/s 4) 10 m/s

27. A body is sliding down a smooth inclined plane which makes 30^0 with the horizontal. Acceleration of the body is
1) 9.8 m/s² 2) 4.9 m/s²
3) 2.45 m/s² 4) 0 m/s²

28. The velocity of a car decreases from 30 m/s to 15 m/s, when it travels a distance of 100 m. The distance travelled from this position before it comes to rest is
1) 100m 2) $\frac{100}{3}m$ 3) $\frac{200}{3}m$ 4) $\frac{100}{9}m$

29. The position of a body is given as a function of time by the relation, $x = 2t^3 - 6t^2 + 12t + 6$. The acceleration of the body is zero at time t =
1) 1 s 2) 2 s 3) $2\sqrt{2}\,s$ 4) 3s

30. A body falls from a height of 200m. If gravitational attraction ceases after 2s, further time taken by it to reach the ground is (g = 10 ms⁻²)
1) 5s 2) 9s 3) 13s 4) 17s

31. A stone is dropped from the top of a tower of height 49m. Another stone is thrown up vertically with velocity of 24.5 m/s from the foot of the tower at the same instant. They will meet in a time of
1) 1 s 2) 2 s 3) 0.5 s 4) 0.25 s

32. A ball is dropped from the top of a tower. Another ball thrown up vertically with a velocity of 20m/s from the ground level at the same instant meets the first after 1.5s. Height of the tower is
1) 20 m 2) 30 m 3) 40m 4) 50 m

33. A ball is projected vertically upwards with a velocity of 100m/s. After 2 second, a second ball is projected vertically upwards from the same point with a velocity 110 m/s. When they meet, time taken by the first ball to meet the second one is (g = 10 ms⁻²)
1) 6s 2) 8s 3) 10s 4) 12s

34. Two bodies are projected vertically upwards with a velocity of 49 m/s. They are projected with a time gap of 2s. After the projection of the first body, they will meet in a time of
1) 5s 2) 3s 3) 6s 4) 7s

35. A projectile shot at an angle of 45^0 above the horizontal strikes the wall of a building 30m away at a point 15m above the point of projection. Initial velocity of the projectile is
1) 14 m/s 2) $14\sqrt{2}\,m/s$
3) $14\sqrt{3}\,m/s$ 4) $14\sqrt{5}\,m/s$

36. A helicopter is flying at an altitude H with a uniform velocity 'u', it drops a bomb so as to hit a target on the ground Distance of the helicopter from the target while dropping the bomb is
1) $u\sqrt{\frac{2H}{g}}$ 2) $\sqrt{\frac{2u^2H}{g}+H^2}$
3) $3H$ 4) $\sqrt{\frac{uH}{g}}$

37. The maximum height reached by a projectile is 4m. The horizontal range is 12 m velocity of projection is ___ (g - acceleration due to gravity)
1) $5\sqrt{\frac{g}{2}}$ 2) $3\sqrt{\frac{g}{2}}$ 3) $\frac{1}{3}\sqrt{\frac{g}{2}}$ 4) $\frac{1}{5}\sqrt{\frac{g}{2}}$

38. A projectile has initially the same horizontal velocity as it would acquire if it had moved from rest with uniform acceleration of 3 m/s² for 0.5 minute. If the maximum height reached by it is 80m, then the angle of projection is (g = 10 m/s²)
1) $\tan^{-1}(3)$ 2) $\tan^{-1}(3/2)$
3) $\tan^{-1}(4/9)$ 4) $\sin^{-1}(4/9)$

39. A body is thrown horizontally from the top of a tower of 5m height. It touches the ground at a distance of 10m from the foot of the tower. The initial velocity of the body is (g = 10 ms⁻²)
1) 2.5 m/s 2) 5.0 m/s 3) 10 m/s 4) 20 m/s

40. The angle of projection of a projectile for which the horizontal range and the maximum height are equal is
1) $\tan^{-1}(\sqrt{3})$ 2) $\tan^{-1}(4)$
3) $\tan^{-1}(\sqrt{2})$ 4) $\tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$

41. A bomb is dropped from an aircraft travelling horizontally at 150 m/s at a height of 490m. The horizontal distance travelled by the bomb before it hits the ground is (in metre)
1) 1000 2) 1200 3) 1500 4) 1800

42. A stone thrown vertically up from the ground reaches a maximum height of 50m in 10s. Time taken by the stone to reach the ground from maximum height is
1) 5s 2) 10s 3) 20s 4) 25 s

43. A body thrown up with some initial velocity reaches a maximum height of 50m. Another body with double the mass thrown up with double the initial velocity will reach a maximum height of
1) 100m 2) 200m 3) 400m 4) 50m

44. Two bodies are projected with the same velocity. One body is projected at an angle of 30^0 and the other at an angle of 60^0 to the horizontal. The ratio of the maximum heights reached is
1) 3 :1 2) 1 : 3 3) 1 : 2 4) 2 : 1

45. An aeroplane is flying horizontally at 98 m/s and releases an object which reaches the ground in 10s. The angle made by it while hitting the ground is
1) 55^0 2) 45^0 3) 60^0 4) 75^0

46. An aeroplane moving horizontally with a speed of 180kmph drops a food packet while flying at a height of 490m. The horizontal range is
1) 180 m 2) 980 m 3) 500m 4) 670m

47. A car travelling at a speed of 30 kmph is brought to rest in 8m by applying brakes. If the same car is travelling at 60 kmph, it can be brought to half with the same breaking force in a distance
1) 8m 2) 16m 3) 24m 4) 32m

48. If a body of mass M is thrown with a velocity 'v' at an angle of 30^0 to the horizontal and another body B of the same mass is thrown at an angle of 60^0 to the horizontal. The ratio of range of A to that of B will be
1) 1:2 2) 2: 1 3) 1 : 3 4) 1 : 1

49. A cricket ball is hit for a six leaving the bat at an angle of 45^0 to the horizontal with kinetic energy K. At the top, K.E. of the ball is
1) zero 2) k 3) $k/2$ 4) $k/\sqrt{2}$

50. In between two hills of heights 100 m and 92m, there is a valley of breadth 16m. If a vehicle jumps from the first hill to the second one, the minimum velocity of the vehicle is (assume $g=9m/s^2$)
1) 16 m/s 2) 12 m/s 3) 9 m/s 4) 10 m/s

SELF TEST KEY

01) 3	02) 1	03) 4	04) 3	05) 2
06) 1	07) 2	08) 2	09) 3	10) 3
11) 1	12) 4	13) 2	14) 3	15) 4
16) 3	17) 2	18) 2	19) 2	20) 3
21) 1	22) 4	23) 2	24) 4	25) 3
26) 2	27) 2	28) 2	29) 1	30) 2
31) 2	32) 2	33) 2	34) 3	35) 3
36) 1	37) 1	38) 3	39) 3	40) 2
41) 3	42) 2	43) 2	44) 2	45) 2
46) 3	47) 4	48) 4	49) 3	50) 2

PREVIOUS ECET BITS

2007

01. If a gun of mass 40 kg fires a bullet of mass 0.01 kg with a velocity of 400 m/sec, then the recoil velocity of the gun is :
1) $-0.01\,m/\sec$ 2) $0.01\,m/\sec$
3) $0.1\,m/\sec$ 4) $-0.1\,m/\sec$

02. If a shell of mass M moving with a velocity V breaks into two fragment. One of the mass m comes to rest. Then the velocity of second fragment is
1) $\frac{M+m}{mV}$ 2) $\frac{M-m}{mV}$ 3) $\frac{MV}{M-m}$ 4) $\frac{MV}{M+m}$

03. A body of thrown vertically up reaches a maximum height of 40m. Another body with double the mass is thrown up with double the initial velocity will reach a maximum height of:
1) 80m 2) 160 m 3) 120 m 4) 200m

04. The angle of projection of a projectile for which the horizontal range and the maximum height are equal is :
1) $\tan^{-1}\sqrt{2}$ 2) $\tan^{-1}(1/\sqrt{2})$
3) $\tan^{-1}4$ 4) $\tan^{-1}\sqrt{3}$

2009

05. A body moving along a circular path of radius 'R' describes an angle of 60^0 at the centre of the circle while moving from the point to the other. The displacement of the body is
1) R 2) 2R 3) 3R 4) 4R

06. A stone thrown vertically up with an initia velocity 'u' from the top of a tower reaches the ground with a velocity '3u'. The height of the tower is
1) $\frac{3u^2}{g}$ 2) $\frac{6u^2}{g}$ 3) $\frac{4u^2}{g}$ 4) $\frac{9u^2}{g}$

07. An aeroplane is flying horizontally at 98 ms^{-1} and releases an object which reaches the ground in 10 sec. the angle made by it while hitting the ground is
1) 45^0 2) 30^0 3) 15^0 4) 60^0

2010

08 A body thrown up with a velocity reaches maximum height of 100m. Another body with double the mass thrown up with the same initial velocity will reach the maximum height of
1) 480 m 2) 200 m
3) 100 m 4) 25 m

09. From the top of a tower, a stone is projected vertically upwards with a velocity of 20 m/s and it reaches the ground in 8 sec. If $g=10\,m/\sec^2$ the height of the tower is
1) 100 m 2) 120 m 3) 160 m 4) 320 m

10. Velocity-time curve for a body projected vertically upward is
1) Straight line 2) Parabola 3) Ellipse 4) Hyperbola

2011

11. Two balls are projected simultaneously with the same speed from top of the tower, one vertically upwards and other vertically downwards. They reach ground 9s and 4s respectively. Find the height of the tower (g = 10 mb²)
1) 80 m 2) 180m 3) 980m 4) 380m

12. For a freely falling b ody, the nature of velocity and time graph
1) a straight line passing through origin
2) a straight line with positive y-axis intercept
3) a parabola 4) an ellipse

13. A person in parachute drops freely from an aeroplane for 10 sec and then the parachute opens out. Then he descends with a net radiation of $12m/s^2$. If he strikes ground with a velocity of 20m/s, then the height at which he gets out of a plane is (take $g=10\,m/s^2$)
1) 40m 2) 600m 3) 900m 4) 1100m

2012

14. A particle is moving eastwards with a velocity of 5 ms^{-1}. In 10 seconds the velocity changes to 5 ms^{-1} northwards. The average acceleration in this time is
1) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north - west 2) zero
3) $\frac{1}{2}ms^{-2}$ towards north
4) $\frac{1}{\sqrt{2}}ms^{-2}$ towards north east

15. The linear momentum of a particle varies with time t as $p=a+bt+ct^2$ which of the following is correct ?
1) Force varies with time in a quadratic manner
2) Force is time - dependent
3) The velocity of the particle is proportional to time
4) The displacement of the particle is proportional to t.

16. A shell of mass m moving with a velocity v suddenly explodes into two pieces. One part of mass m/4 remains stationary. The velocity of the other part is
1) v 2) $2v$ 3) $3v/4$ 4) $4v/3$

17. The velocity of a freely falling body after 2s is

1) $9.8\,ms^{-1}$ 2) $10.2\,ms^{-1}$

3) $18.6\,ms^{-1}$ 4) $19.6\,ms^{-1}$

18. A large number of bullets are fired in all directions with the same period u. The maximum area on the ground on which these bullets will spread is

1) $\frac{\pi u^2}{g^2}$ 2) $\frac{\pi u^4}{g^2}$ 3) $\frac{\pi u^2}{g^4}$ 4) $\frac{\pi u}{g^4}$

2013

19.. A body freely falling from rest has a velocity v after it falls through a distance h. The distance it has to fall down further, for its velocity to become doubled is ___

1) 4h 2) 3h 3) 2h 4) h

20. From the top of a tower of height 39.2m a stone is thrown vertically up with a velocity of $9.8\,m^{-1}$ sec. How long will take to reach the ground.

1) 1 sec 2) 2 sec 3) 3 sec 4) 4 sec

21. The acceleration of a moving body can be found from ____

1) Area under velocity-time graph
2) Area under distance-time graph
3) Slope of the velocity - time graph
4) Slope of distance - time graph

22. A hydrogen balloon released on the moon

1) Move up with acceleration 9.8 ms^{-2}
2) Move down with acceleration 9.8 ms^{-2}
3) Move down with acceleration 9.86 ms^{-2}
4) Neither move up nor move down

2014

23. A projectile has a maximum range of 200m. The maximum height attained by it is ___

1) 75 m 2) 100 m 3) 25 m 4) 50 m

T.S - ECET -2015

24. For an object thrown at 45^0 to the horizontal, the maximum height (H) and horizontal range (R) are related as

1) R = 16 H 2) R = 8 H 3) R = 4 H 4) R = 2 H

25. At the uppermost point of a projectile, its velocity and acceleration are an angle of

1) 0^0 2) 45^0 3) 90^0 4) 180^0

26. A particle A is dropped from a height and another particle B is projcted in horizontal direction with speed of 5 m/sec from the same height, then correct statement is

1) both paricles will reach at ground simulaneously
2) particle A will reach at ground first with respect to particle B
3) particle B will reach at ground first with respect to particle A
4) both particles will reach at ground with same speed

27. A missile is fired for maximum range with an initial velocity of 20 m/s. If g = 10 m/s^2, the range of the missile is

1) 20 m 2) 40 m 3) 50 m 4) 60 m

A.P - ECET -2015

28. A cricket ball is thrown at a speed of 28 m/s in a direction 30^0 above the horizontal. The distance from the thrower to the point when the ball returns to the same level is

1) 40 m 2) 34.5 m 3) 69 m 4) 80 m

29. A ball is thrown upwareds with a velocity of 25 m/s. The time taken to reach maximum height is ($g = 10 m/s^2$)

1) 250 s 2) 25s 3) 0.25 s 4) 2.5 s

T.S - ECET -2016

30. If a body is projected vertically up with a velocity 'u' and acceleration due to gravity 'g' then time of flight is

1) $\frac{u}{g}$ 2) $\frac{2u}{g}$ 3) $\frac{3u}{g}$ 4) $\frac{u^2}{g}$

31. The initial velcoity of a body projected upwares from the ground reaches maximum height of 10 metres is (given that $g = 9.8 m/s^2$)

1) 225 m/s 2) 196 m/s
3) 15 m/s 4) 14 m/s

32. A body is falling freely from a height of 78.4. Its velocity on reaching ground is (given that $g = 9.8 m/s^2$)

1) 19.6 m/s 2) 39.2 m/s
3) 78.4 m/s 4) 156.8 m/s

33. The maximum height reached by a ball thrown at an angle 60^0 to the horizontal with an inital velocity 9.8m/s is (given that $g = 9.8 m/s^2$)

1) 7.35 m 2) 14.70 m
3) 29.4 m 4) 3.675 m

AP - ECET -2016

34. A body moving with uniform accelaration covers a distance of 19m in its third second and 43 m in its seventh second of its motion. The initial velcoity and accelaration of the body respectively are

1) $4m.s^{-1}; 6m.s^{-2}$ 2) $6m.s^{-1}; 4m.s^{-2}$

3) $8m.s^{-1}; 6m.s^{-2}$ 4) $4m.s^{-1}; 12m.s^{-2}$

35. A body is projected upwards with a velocity of 14.7 ms^{-1} from ground. The time taken for the body to reach the ground is $\left(Assume\ g = 9.8\,m.s^{-2}\right)$

1) 5s 2) 2s 3) 3s 4) 4s

36. A ball projected upwards with an initial velocity of 40 $m.s^{-1}$, reaches a maximum height of 25m. The horizontal distance covered by the when it touches the ground is $\left(Assume\ g = 9.8\,m.s^{-2}\right)$

1) 100m 2) 50m 3) 150.5m 4) 15.5m

37. An aeroplane is flying horizontally at an altitude of 49 m with a velocity of 200 $m.s^{-1}$. When it is just above the target a bomb is dropped. The bomb touches the ground missing the target at a horizontal distacne of $\left(Assume\ g = 9.8\,m.s^{-2}\right)$

1) 632.4m 2) 63.24m
3) 6.324m 4) 0.6324m

T.S - ECET -2017

38. A balloon is ascending at the rate of $9.8\,ms^{-1}$ at a height of 39.2 m above the ground when a food packet is dropped from the balloon. The velcoity with which the food packet reach the ground is

1) $-9.8\,ms^{-1}$ 2) $-58.8\,ms^{-1}$

3) $-4.9\,ms^{-1}$ 4) $-29.4\,ms^{-1}$

39. If Water falls from a dam into a turbine wheel 19.6 m below, then the velcoity of water at the turbine is $\left(given\ g = 9.8ms^{-2}\right)$

1) $9.8ms^{-1}$ 2) $19.6\,ms^{-1}$

3) $39.2\,ms^{-1}$ 4) $98\,ms^{-1}$

AP - ECET -2017

40. A circket ball is thrown at a speed of 28 m/s in a direction 30^0 above the horizontal. The maximum height reached by the ball is

1) 10 m 2) 20 m 3) 30 m 4) 40 m

41. Two bodies are projected at angles of 45^0 and 60^0 with the horizontal with same velocity simultaneously. Ratio of their horizontal ranges is

1) $\sqrt{3}:2$ 2) $2:\sqrt{3}$ 3) 1:2 4) 2:1

42. A ball thrown by a boy is caught 2 seconds later by another at some distance away on the same level. If the angle of projection is 30^0, the velcoity of projection is

1) 19.6 m/sec 2) 9.8 m/sec
3) 4.9 m/sec 4) 5.2 m/sec

T.S - ECET -2018

43. A body of mass 2 Kg is hung on a spring balance mounted in a lift. If the lift descends with an acceleration equal to the acceleration due to gravity g, the reading on the spring balance will be changed by______

1) 2 Kg 2) 4 Kg 3) 2/g Kg 4) zero

44. If g is the acceleration due to gravity at the earth surface, the gain in the potenital energy of an object of mass is raised, then the surace of the earth to a height equal to the radius R of earth is ______

1) $\left(\frac{1}{2}\right)mgR$ 2) 2mgR 3) mgR 4) $\left(\frac{1}{4}\right)mgR$

45. A ship of mass 3×10^7 Kg initially at rest is pulled by a force of 5×10^4 N through a distance of 3m. Assume that the resistance due to water is negligible, the speed of the ship is ______

1) 1.5 m/s 2) 60 m/s 3) 0.1 m/s 4) 5 m/s

46. Clock A is based on oscillations of a spring and clock B is based on pendulum motion. Both clocks run at the same rate on earth. On a planet having the same density as earth but twice the radius______

1) a will run faster than B
2) B will run faster than A
3) both run at the same rate as on earth
4) both run at equal rates but not the same as on earth

AP - ECET -2018

47. For a projectile, the ratio of maximum height reached to the square of time of flight is

1) 5:4 2) 5:2 3) 5:1 4) 10:1

48. The graph of acceleration as a function of displacement in the case of a body executing simple harmonic motion is
1) parabola 2) hyperbola
3) strainght line with positive slope
4) straight line with negative slope

49. The product of linear momentum and velocity of a body represents
1) kinetic energy of the body
2) potential energy of the body
3) half the kinetic energy of the body
4) twice the kinetic energy of the body

50. The pendulum of length 'L' swings from mean position to mean position 'n' times in one second. THe value of acceleration due to gravity is
1) $\pi^2 n^2 L$ 2) $2\pi^2 n^2 L$
3) $\left(\pi^2 n^2 L\right)/2$ 4) $4\pi^2 n^2 L$

51. The ratio of distances travelled by a body, starting from rest and travelling with uniform acceleration in successive intervals of time of equal duration will be
1) 1:2:3 2) 1:4:9 3) 1:3:5 4) 1:9:16

52. A person in a lift, which ascends up with accelearation $10ms^{-2}$, drops a stone from a height of 10m. The time of descent is $\left(g = 10ms^{-2}\right)$
1) 0.5 s 2) 1s 3) 1.5 s 4) 2 s

53. A body is thrown with a velocity of $\left(4\bar{i} + 3\bar{j}\right)$ m/s. The maximum height attained by the body is $\left(g = 10ms^{-2}\right)$
1) 2.5 m 2) 4.5 m 3) 0.8 m 4) 0.45 m

PREVIOUS ECET BITS KEY

01) 3	02) 3	03) 2	04) 3	05) 1
06) 3	07) 1	08) 3	09) 3	10) 1
11) 2	12) 1	13) 3	14) 1	15) 3
16) 4	17) 4	18) 2	19) 2	20) 4
21) 3	22) 1	23) 4	24) 3	25) 3
26) 1	27) 2	28) 3	29) 4	30) 2
31) 4	32) 2	33) 4	34) 1	35) 3
36) 3	37) 1	38) 4	39) 2	40) 1
41) 2	42) 1	43) 4	44) 1	45) 3
46) 2	47) 1	48) 4	49) 4	50) 1
51) 3	52) 2	53) 4		

PREVIOUS ECET BITS HINTS AND SOLUTIONS

01. Recoil velocity of a gun $= \dfrac{mv}{M}$

$$= \frac{0.01 \times 400}{40} = 0.1 m/\sec$$

02. According to law of conservation of linear momentum:

$$MV = m(0) + (M-m)\,v$$

velocity of second fragment $v = \dfrac{MV}{M-m}$

03. $\dfrac{h_1}{h_2} = \dfrac{u_1^2}{u_2^2}$

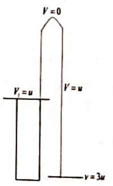
$$\frac{40}{h_2} = \left(\frac{u}{2u}\right)^2 \Rightarrow h_2 = 160m$$

04. $\dfrac{u^2 \sin 2\theta}{g} = \dfrac{u^2 \sin^2\theta}{2g} \Rightarrow \theta = \tan^{-1}(4)$

05. Displacment of a body in a circular path is
$D = 2r\sin\theta/2$
where $\theta = 60^0$

$$D = 2R\sin 60/2 \Rightarrow R$$

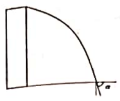
06.



From
$v^2 - u^2 = 2as$
$(3u)^2 - (u)^2 = 2(g)(h)$

$$h = \frac{4u^2}{g}$$

07.



$$\tan\alpha = \frac{V_y}{V_x} = \frac{\sqrt{2gh}}{u}$$

$$h = \frac{1}{2}gt^2 = \frac{1}{2} \times 9.8 \times 10^2 \Rightarrow 490$$

$$\tan\alpha = \frac{\sqrt{2 \times 9.8 \times 490}}{98} = 1$$

$$\alpha = 45^0$$

08. $h = \dfrac{u^2}{2g}$

Here height of the body depen on intial velocity but it will not depend on mass of body so that max. Height reached by body remain same, even mass increases therefore the maximum height is **100 m.**

09. From $-h = ut - \dfrac{1}{2}gt^2$

$$-h = (20)(8) - \frac{1}{2} \times 10 \times 8^2$$

h = 160 m

10. Straight line

11. $h = \dfrac{1}{2}gt_1t_2$

$$= \frac{1}{2} \times 10 \times 9 \times 4 \quad = 180 \text{ m}$$

12. straight line passing through origin

13. $s = s_1 + s_2$
s_1 = displacement for freely falling body

$$s_1 = \frac{1}{2}gt^2 = 500\text{m}$$

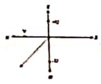
velocity after 10 sec= $10 \times 10 = 100$ m/s

$$v^2 - u^2 = 2as_2$$

$$S_2 = \frac{100^2 - 20^2}{2 \times 12} = 400$$

$$s = s_1 + s_2 = 500 + 400 = 900$$

14. Resultant velocity $= \sqrt{5^2 + 5^2} = 5\sqrt{2} m/s$
change in velocity = v - u



Average accleration $= \dfrac{V}{t} = \dfrac{5\sqrt{2}}{10} = \dfrac{1}{\sqrt{2}}$

$\therefore \dfrac{1}{\sqrt{2}} ms^{-2}$ towards north - west

15. The velociy of the particle is proportional to time

16. According to law of conservation

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$mv = \frac{m}{4}(0) + \frac{3m}{4}(v_2)$$

$$v_2 = \frac{4v}{3}$$

17. v = gt = 9.8x2 = 19.6

18. $A = \prod r^2$

$$\therefore \frac{\pi u^4}{g^2}$$

19. $h = \dfrac{u^2}{2g}$

$$\frac{h_1}{h_2} = \left(\frac{u}{2u}\right)^2$$

h = 4h
further distance falling 4h - h = 3h

20. $-h = ut - \dfrac{1}{2}gt^2 \Rightarrow -39.2 = 9.8t - \dfrac{1}{2}9.8t^2$

= (t-4) (t+2) = u ⇒ t=4 or -2
$t \neq -ve$

$\therefore t = 4$

21. slope of the velocity - time graph
22. move up with accelartion 9.8 ms^{-2}
23. R_{max} at $\theta = 45^0$

$R\tan\theta = 4h$
$200 = 4h$
$h = 50$ m

24. $R\tan\theta = 4h$

$\theta = 45^0$
$\therefore R = 4h$

25. At maximum hight
velocity = $u\cos\theta$
i.e, horizontal velocity
acceleration is towards earth
so they are perpendicular to each other
26. both paricles will reach at ground simultaneoush
27. Maximum range in projectile

$$R_{max} = \frac{u^2}{g} = \frac{20^2}{10} = 40m$$

28. $R = \frac{u^2 \sin 2\theta}{g} = \frac{(28)^2 \times \sin 2(30)}{9.8} = 69m$

29. $t = \frac{u}{g} = \frac{25}{10} = 2.5s$

30. time of flight $T = \frac{2u}{g}$

31. $h = \frac{u^2}{2g} \Rightarrow u = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 10} = 14m/s$

32. $v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 78.4} = 39.2m/s$

33. $h = \frac{u^2 \sin^2\theta}{2g} = \frac{9.8^2 \sin^2 60}{2 \times 9.8} = \frac{29.4}{8} = 3.675m$

34. $a = \frac{s_2 - s_1}{n_2 - n_1} = \frac{43 - 19}{7 - 3} = \frac{24}{4} = 6m/s^2$

$s_n = u + a\left(n - \frac{1}{2}\right) \Rightarrow 19 = u + 6\left(3 - \frac{1}{2}\right)$

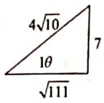
$19 = u + 6 \times \frac{5}{2} \Rightarrow 4 = 4m/s$

35. $T = \frac{2u}{g} = \frac{2 \times 14.7}{9.8} = 3$ sec

36.

$h = \frac{u^2 \sin^2\theta}{2g} = 25 = \frac{40^2 \sin^2\theta}{2 \times 9.8} \Rightarrow \sin^2\theta = \frac{490}{1600}$

$\sin\theta = \frac{7}{4\sqrt{10}}$ $\quad$ $Tan\theta = \frac{7}{\sqrt{111}}$



$R\tan\theta = 4h \Rightarrow R = \frac{4 \times 25}{\frac{7}{\sqrt{111}}} = 150.5m$

37. $h = \frac{1}{2} g \frac{x^2}{u^2} \Rightarrow 49 = \frac{1}{2} \times 9.8 \times$

$\frac{x^2}{200^2} \Rightarrow x^2 = 200^2 \times 10$
x=632.45m

38. $a = 9.8m/s$ $\quad$ $h = 39.2$

$v = \sqrt{4^2 + 2gh}$

$= \sqrt{900 + 2 \times 10} \times^{40}$

$= 30 \approx -29.4$

39. $v = \sqrt{2gh}$

$= \sqrt{2 \times 9.8 \times 19.6}$
=19.6

40. Given u=28m/s $\theta = 30^0$
$\Rightarrow$ Maximum height reached

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

$= \frac{28 \times 28 \times \frac{1}{4}}{2 \times 9.8} = 10$m

41. $= R \propto \sin 2\theta$

$= \frac{R_1}{R_2} = \frac{\sin 90^0}{\sin 120^0} = R_1 : R_2 = 2 : \sqrt{3}$

42. $T = \frac{2u\sin\theta}{g}$

$\Rightarrow u = 19.6m/s$

FRICTION

FRICTIONAL FORCE

- Friction is the force which opposes the relative motion between two surfaces that are in contact. Friction is the tangential force between the contact surfaces of two bodies.
- Friction is due to interlocking or cold welding of irregulating on the surface in contact.
- Friction is due to the electromagnetic forces between the surfaces in contact.
- Friction is independent of the area of contact.
- Friction is self adjusting force upto a limit and it is equal to the external force tending to move it upto that limit.
- Friction need not be oppose motion. It may favour motion. But it always opposes relative motion.
- Friction is of three types (a) static friction (b) kinetic friction (dynamic or sliding friction) (c) rolling friction.
- If a body is on a horizontal surface (at rest or in motion) then the normal force is equal to the weight of that body, i.e., N = mg
- If a body is on an inclined plane (at rest or in motion) the normal reaction on the body is $N = mg\cos\theta$ (if θ is the inclination with horizontal).
- If a body of mass m is on the floor of a lift which is moving with uniform acceleration a. normal force on the body or its apparent weight is

$N = mg \pm ma = m(g \pm a)$

a) if the lift moves up $N = m(g + a)$

b) if the lift moves down $N = m(g - a)$

c) if the lift falls freely $N = 0$

d) if the lift moves with uniform velocity $V = 0$ then $N = mg$

STATIC FRICTION

- The friction that acts due to tendency of relative motion between two surfaces to contact is called static friction.

- When there is no component of external force parallel to the two surfaces in contact with each other, the frictional force is zero.
- Where an external force is applied parallel to one of the surfaces in contact with each other, and there is no relative motion. Static frictional force between the two surfaces is equal to the applied force.
- Limiting friction is the least force necessary to set a body into motion.

Law of static friction :

a) Static friction is independent of area of contact.

b) Static friction depends on the nature of the surfaces in contact

c) Maximum value of static friction is directly proportional to the normal force.

$$f_{ms} \propto N$$

$$f_{ms} = \mu_s N \Rightarrow \mu_s = \frac{f_{ms}}{N}$$

Where μ_s is called coefficient of static friction.

Coefficient of static friction

$$(\mu_s) = \frac{\text{Limiting friction}(f_{ms})}{\text{Normal force}(N)}$$

- The static frictional force between any two surfaces is $f_s \leq \mu_s N$.
- Generally coefficient of static friction is less than 1 but in some cases it may exceed 1.
- The angle made by the resultant of normal force and the limiting friction with normal force is called angle of friction. The tangent of this angle gives coefficient of static friction.
- Limiting angle of friction $\alpha = \tan^{-1}(\mu_s)$ or $\tan\alpha = \mu_s$

KINETIC FRICTION OR DYNAMIC FRICTION OR SLIDING FRICTION

- Kinetic friction that acts when there is relative motion between two surfaces is called kinetic friction (f_k).
- Kinetic friction is not a self adjusting force.
- Kinetic friction is less than limiting friction.

Laws of Kinetic Friction :

a) Kinetic friction is independent of area of contact.

b) Kinetic friction is independent of relative speed between the two contact surfaces.

c) Kinetic friction is directly proportional to the normal force.

ie $f_k \propto N$ or $f_k = \mu_k N \Rightarrow \mu_k = \frac{f_k}{N}$

Where μ_k is called coefficient of kinetic friction.

Coefficient of kinetic friction

$$(\mu_k) = \frac{\text{Kinetic friction}(f_k)}{\text{Normal force}(N)}$$

- Only static friction is self adjusting force kinetic friction does not adjust itself with the external force.
- As $\mu_s > \mu_k$, it is difficult to set a body into motion than to maintain its uniform motion.

ROLLING FRICTION

- When one body rolls over another body, the friction that acts between those rolling friction (f_r).
- Rolling friction is due to the deformation of the surface on which the body rolls and due to the deformation of the rolling body at the point of contact with the surfaces.
- Greater the deformation greater is the rolling frictional force.
- Rolling friction is inversely proportional to the radius of the rolling body.
- Rolling friction is directly proportional to the normal force

$$f_r \propto N \text{ or } f_r = \mu_r N \Rightarrow \mu_r = \frac{f_r}{N}$$

Where μ_r is called coefficient of rolling friction.

$$\text{Coefficient of rolling friction } (\mu_r) = \frac{\text{Rolling friction}(f_r)}{\text{Normal force (N)}}$$

- Rolling friction between two surfaces is lesser than the kinetic friction.
- For a given pair of surfaces $\mu_s > \mu_k > \mu_r$.
- Radial tyres are used in cars to reduce rolling friction.
- By using ball bearings in machine parts, sliding friction can be converted into rolling friction.

ADVANTAGES OF FRICTION

- We can walk safely on the ground due to friction.
- We can light a match stick due to friction
- We can hold and lift any object due to friction
- By applying brakes a vehicle can be stopped due to friction.
- Screws can be fixed to boards, nails can be fixed to walls due to friction.
- Motion can be transferred from one wheel to the other using bells of chains due to friction.

DISADVANTAGES OF FRICTION

- Friction causes wear and tear of machine parts.
- Friction produces unnecessary heat which damages the machines.
- Friction reduces the efficiency of a machine.

METHODS OF REDUCING FRICTION

- By polishing the surfaces in contact friction can minimised
- Automobiles and aeroplanes are streamlined to decrease air friction.
- By using ball bearings sliding friction can be converted into rolling friction.

MOTION OF A BODY ON A ROUGH HORIZONTAL SURFACE

- Minimum horizontal force applied on a body to move it $P = f_s = \mu_s \; mg = mg \tan \alpha$

  $(\because \mu_s = \tan\alpha)$

- If a body with some initial velocity is moving on a rough horizontal surface, it moves with a retardation equal to μg where μ is coefficient of kinetic friction.

  a) $v - u = -\mu gt$ b) $v^2 - u^2 = -2\mu gs$

  c) $s = ut - \frac{1}{2}\mu gt^2$

- A body moving with velocity v on a rough horizontal surface is brought rest in a distance S. (in time t)

$v^2 = 2\mu gS; \quad v = \mu gt$

or $S = \frac{v^2}{2\mu g}; \quad t = \frac{v}{\mu g}$

$\frac{S_1}{S_2} = \frac{v_1^2}{v_2^2}$ (on the same rough surface)

$\frac{S_1}{S_2} = \frac{\mu_2}{\mu_1}$ (for the same initial velocity on different surfaces)

- A bullet of mass m strikes a block of mass M horizontally with velocity v and gets embedded in it. Later if that block moves on a rough horizontal surface before coming to rest, distance travelled by it is $S = \frac{V^2}{2\mu_k g}$

  Where $V = \frac{mu}{(M+m)}$

- **PUSHING AND PULLING**

01. Consider a body of mass m on a rough horizontal surface. F is the force applied on it at an angle θ to the horizontal.

a) If F is a pulling force, normal force

$N = mg - F\sin\theta$

$F\cos\theta = f_s$ (for the body just to move)

$F\cos\theta = \mu_s(mg - F\sin\theta)$

or $F = \frac{\mu_s mg}{(\cos\theta + \mu_s \sin\theta)}$

$F = \frac{mg\sin\alpha}{\cos(\theta-\alpha)}$ (from $\mu_s = \tan\alpha$)

$F = \frac{\mu_k mg}{(\cos\theta + \mu_k \sin\theta)}$

02. If F is a pushing force

normal force $N = mg + F\sin\theta$

or $F = \dfrac{\mu_s mg}{\cos(\theta+\alpha)}$ (from $\mu_s = \tan\alpha$)

If the body moves with uniform velocity,

$$F = \frac{\mu_k mg}{(\cos\theta - \mu_k \sin\theta)}$$

FRICTION BETWEEN TWO VERTICAL SURFACES

- A block of mass m is pressed towards a vertical wall by applying a force 'P'. As a result if the block is prevented from sliding down.

  $mg = \mu_s P \quad (\because P = N)$

- A block is held in between both the hands and pressed normally applying a force P by each hand, to prevent it from sliding down,

  $mg = 2\mu_s P$

  (Here there are two normal forces and each is equal to P)

MOTION OF A BODY ON SMOOTH INCLINED PLANES

- Acceleration when it slides down $a = g\sin\theta$

  when it moves up $a = -g\sin\theta$

- As it slides down work done by gravitational force $W = mgl\sin\theta$ (l is length of the inclined plane)
- Time taken to travel from the top to the bottom of inclined plane

  $t = \dfrac{\sqrt{2l}}{g\sin\theta} = \dfrac{\sqrt{2h/g}}{\sin\theta}$ (h is height)

- Velocity of the body on reaching the bottom (if released from the top) is $v = \sqrt{2gl\sin\theta} = \sqrt{2gh}$
- Velocity with which is should be pushed from the bottom so that it just reaches the top most point is $u = \sqrt{2gh} = \sqrt{2gl\sin\theta}$

DOWNLOAD MOTION OF A BODY ON A ROUGH INCLINED PLANE

- If $\theta < \alpha$ (α is angle of repose), body does not slide down and static friction $f = mg\sin\theta$

- If $\theta = \alpha$, body just tends to slide and $mg\sin\alpha = f_s = \mu_s mg\cos\alpha$ (f_s is limiting friction).
- If $\theta = \alpha$, body slides down with uniform acceleration 'a' and $a = g(\sin\theta - \mu_k\cos\theta)$
- Time taken by the body to move from top to bottom of the inclined plane is

  $$t = \sqrt{\frac{2l}{g(\sin\theta - \mu_k\cos\theta)}}$$

- Velocity of the body on reaching the bottom is $V = \sqrt{2gh(\sin\theta - \mu_k\cos\theta)}$
- Work done by gravitational force = $(mg\sin\theta)l$

  Work done against frictional force = $(\mu\, mg\cos\theta)l$

UPWARD MOTION OF A BODY AN A ROUGH INCLINED PLANE

- If the body is pushed up with some initial velocity, body will be subjected to retardation $a = g(\sin\theta + \mu_k\cos\theta)$
- Distance travelled by the block projected up the plane before it stops is

  $$S = \frac{u^2}{2g(\sin\theta + \mu_k c)}$$

  Here time of its ascent is $t = -\dfrac{u}{g(\sin\theta + \mu_k\cos\theta)}$

  Note : If $\theta \geq \alpha$ in this case, the block will come down after reaching the highest point.

- If the block on the rough inclined plane has a tendency to slide down, the force applied on the block parallel and up the plane to prevent the block from sliding is

  $F = (mg\sin\theta - \mu_s mg\cos\theta)$

MISCELLANEOUS POINTS

- A block of mass m is kept on a smooth wedge as shown. If the wedge moves with acceleration a such that 'm' does not slide relative to the wedge, then $a = g\tan\theta$
- When a person walks on a rough road, the frictional force exerted by the road on him is along his direction of motion.
- A car with flattened tyres stops sooner when pushed than a car with inflated tyres. Friction is more in the first case.

⇨ During rainy season iron rails are dusted with sand to increase friction.

⇨ On an unbounded curved road, friction between the road and tyres of a vehicle provides centripetal force

$$\mu mg = \frac{mv^2}{r}$$

So, safe maximum speed of vehicle $v = \sqrt{\mu gr}$.

SOLVED EXAMPLES

01. The angle of friction between two surfaces is $37°$. If $\cos 37° = 4/5$, coefficient of static friction between those two surfaces is

1) 3/4 2) 4/3 3) 3/5 4) 5/3

Sol: If μ_s is coefficient of friction and α is angle of friction, $\tan\alpha = \mu_s$

ie $\mu_s = \tan 37° = 3/4$ **Ans : 1**

02. A horizontal force of $4\sqrt{3}$ Kg wt is just sufficient to pull a body of 8 Kg wt on a horizontal surface. The coefficient of friction between the surfaces is

1) $\frac{\sqrt{3}}{4}$ 2) $\sqrt{\frac{3}{4}}$ 3) $\frac{\sqrt{3}}{2}$ 4) $\sqrt{\frac{3}{2}}$

Sol: Force when can just move the body = limiting friction

$P = f_s = \mu_s mg$

$$4\sqrt{3}\times 9.8 = \mu_s \times 8\times 9.8 \Rightarrow \mu_s = \frac{4\sqrt{3}}{8} = \frac{\sqrt{3}}{2}$$

Ans : 3

03. A block of mass 10 Kg is on a rough horizontal surface. A horizontal force 4N is applied on it. If coefficient of static friction between those two surfaces is 0.5, frictional force between the two surface in contact is

1) 20N 2) 49N 3) 4.9N 4) 4N

Sol : Here external force is less than limiting friction (f_s)

So, frictional force = 4N (self adjusting property)

So, the correct answer is 4

Ans : 4

04. A force of 50 N acting on a body of mass 200 Kg produces uniform velocity. If the force is tripled, then the acceleration produced is

1) 1 ms^{-2} 2) 0.5 ms^{-2}

3) 0.25 ms^{-2} 4) 5 ms^{-2}

Sol: Here frictional force = 50N

In the second case, from $ma = p - f$

$$200\times a = 150 - 50 = 100 \Rightarrow a = \frac{100}{200} = 0.5\, ms^{-2}$$

Ans : 2

5. A block of mass 500 g rests on a horizontal surface. If the coefficient of friction is 1/4, the work done in moving the block through 1 m on that surface is

1) 1.225 J 2) 2.45 J 3) 4.9J 4) 9.8 J

Sol: Work done against fraction is $W = \mu_s mg\, S$

$$W = \frac{1}{4}\times\frac{500}{1000}\times 9.8\times 1 = 1.225\text{ J}$$

Ans : 1

06. A body of mass 10 kg just slides down a rough inclined plane that rises 3 in 5. Then coefficient of static friction between the body and inclined plane is

Sol: Given $\sin\alpha = 3/5$ where α is angle of repose

So coefficient of static friction is $\mu_s = \tan\alpha = 3/4 = 0.75$

Ans : 3

07. A body of mass 1 Kg lies on an inclined plane of angle $60°$ to the horizontal. If the coefficient of friction is 0.4, the frictional force along the inclined plane is

1) 1.96N 2) 0.98N

3) 0.49N 4) 0.245N

Sol: Frictional force = $\mu\, mg \cos\theta$

$(\because N = mg\cos\theta)$

$$= 0.4\times 1\times 9.8\times\frac{1}{2}\left(as\ \theta = 60°\right) = 1.96\text{N}$$

Ans : 1

08. A cube of weight 10N is on a rough inclined plane of slope 3 in 5. If the coefficient of friction is 3/5, the minimum force necessary to start the cube moving up the inclined plane is

1) 5.4N 2) 10.8N 3) 9.6N 4) 7.2N

Sol : If P is the minimum force which can move the body up the plane,

$P = (mg\sin\theta + \mu\, mg\cos\theta)$

given $\sin\theta = 3/5 \Rightarrow \cos\theta = 4/5$ and $\mu = 3/5$

Then

$$P = \left(10\times\frac{3}{5}\right) + \left(\frac{3}{5}\times 10\times\frac{4}{5}\right) = 10.8\text{ N}$$

Ans : 2

09. A block of mass 2 Kg slides on an inclined plane which makes an angle of 30° with the horizontal. The coefficient of friction between the block and the surface is $\sqrt{3}/4$. Then the force that should be applied so that it moves up with out any acceleration is $(g = 10\ ms^{-1})$.

1) 17.5 2) 35 N 3) 70 N 4) 105 N

Sol: Here force applied = force opposing the motion

ie $P = mg\ \sin\theta + f_k$

$= mg(\sin\theta + \mu_k \cos\theta)$

or $P = 2\times10\left(\frac{1}{2}+\frac{\sqrt{3}}{4}\frac{\sqrt{3}}{2}\right) = 20\left(\frac{1}{2}+\frac{3}{8}\right) = 17.5N$

Ans : 1

10. A box is slowly lowered on to a conveyor belt moving horizontally at a speed of $6\ ms^{-1}$. If coefficient of friction is 0.3, the distance through which that box slide relative to the belt is $(g = 10\ ms^{-2})$

1) 3 m 2) 6 m 3) 9 m 4) 12 m

Sol: From work energy theorem, $\frac{1}{2}mv^2 = \mu\ mgS$

or $S = \frac{V^2}{2\mu g} = \frac{6\times6}{2\times0.3\times10} = 6m$

So, the correct answer is 2

11. A motor of power 0.98 KW drags a mass 100 Kg through 4 m on a surface having coefficient of friction 0.3. Time of motions of that mass is

1) 0.4 s 2) 0.8 s 3) 1.2 s 4) 1.6 s

Sol: Power = work/time i.e $P = \frac{\mu\ mg\ s}{t}$

$0.98\times1000 = \frac{0.3\times100\times9.8\times4}{t} \Rightarrow t = 1.2s$

Ans : 3

THERE IS NO SUBSTITUTE TO HARDWORK

PRACTICE SET - I

01. A block of weight 100kg is kept on the horizontal plane of coefficient of friction 0.5. The amount of work done in dragging it with a velocity of 10 ms^{-1} for 10s is

1) $49\times10^3 J$ 2) $4.9\times10^3 J$
3) $98\times10^3 J$ 4) $9.8\times10^3 J$

02. A body is at rest on a rough horizontal surface. The coefficients of static and kinetic friction are 0.8 and 0.6. A force equal to limiting friction is applied on the body and continued to act. Then acceleration produced in the body is

1) 0.98 ms^{-2} 2) 1.96 ms^{-2}
3) 9.8 ms^{-2} 4) 19.6 ms^{-2}

03. A force equal to the weight of the body acts on a body for 't' seconds. If the horizontal force is equal to half the weight of the body the distance travelled in 't' seconds is

1) $s = g^2 l^2/4$ 2) $s = gt^2/4$
3) $gt/4$ 4) $g^{-1}t^{-1}/4$

04. A block is placed on a rough table. The force required just to move the block is F. If a similar block is placed on the first block, the force required just to move that system is

1) F/2 2) F 3) 2F 4) 4F

05. A force F acting on a body horizontally makes the body to move with constant speed. If that force is tripled, body moves with acceleration a. Then mass of the body is

1) F/a 2) $2F/a$ 3) $3F/a$ 4) $3F/2a$

06. A cube of 10N rests on plane of coefficient of friction 0.6. The slope of the plane is 3 in 5. The minimum force required to start the cube moving up the plane is

1) 10.8N 2) 100.8N 3) 0.8N 4) 1.8N

07. If the coefficient of static friction is 0.75, the angle through which an inclined plane must be raised so that a block placed on it may begin to slide is $(\sin 37° = 3/5)$

1) 53° 2) 37° 3) 45° 4) None

08. An inclined plane rises 7 in 25. A block placed on this plane is just about to slide down. Then coefficient of static friction between the block and the inclined plane is

1) 7/24 2) 7/25 3) 24/25 4) 18/25

09. An engine of 1000 kg is moving up an inclined plane 1 in 2 at the rate of 20 ms^{-1}. If the coefficient of friction is $\frac{1}{\sqrt{3}}$, power of the engine is

1) 98 KW 2) 196 KW
3) 392 KW 4) 49 KW

10. A body of mass m is kept on an inclined plane of inclination 30° to the horizontal. If the angle of repose is 45° static friction on the body is

1) $\frac{mg}{\sqrt{2}}$ 2) $\frac{mg}{2}$
3) mg 4) $\sqrt{2}\ mg$

11. A block slides down an inclined plane of inclination θ with constant velocity. It is then projected up the same plane with in initial velocity 'u'. How far up the incline will it move before coming to rest?

1) $\frac{u^2}{2g\sin\theta}$ 2) $\frac{u}{2g\sin\theta}$
3) $\frac{u^2}{4g\sin\theta}$ 4) $\frac{u}{4g\sin\theta}$

12. A body projected up with certain velocity along an inclined plane of coefficient of friction 0.6 and slope $\frac{3}{4}$ travels for 't' seconds and comes to rest. Its time of descent from that position is

1) t 2) 9t 3) 3t 4) t/3

13. A force required just to prevent a body sliding down a rough inclined plane of angle 45° and coefficient of friction 0.6 is F. The minimum force required to move the body up the plane is

1) 4F 2) F/4 3) 2F 4) F/2

14. The maximum angular velocity of a car travelling along a curved path of radius 'r' if the coefficient of static friction is μ

1) $\sqrt{\mu gr}$ 2) $\sqrt{\frac{\mu r}{g}}$ 3) $\sqrt{\frac{\mu g}{r}}$ 4) $\sqrt{\frac{gr}{\mu}}$

15. A block of mass 2kg rests on a rough inclined plane making an angle of $30°$ with the horizontal. If $\mu_s = 0.7$, the frictional force on the block is

1) 9.8N 2) $(0.7\times0.98)\sqrt{3}N$

3) $(9.8)\sqrt{3}N$ 4) None

16. A force of 25N acting on a body of mass 100Kg produces uniform velocity. If the force is doubled then acceleration produced will become

1) 0.5 2) 1.0 3) 0.75 4) 0.25

17. Which of the following statements is incorrect ?

1) Coefficient of static friction is always greater than coefficient of kinetic friction.

2) Limiting friction is always greater than the kinetic friction.

3) Limiting friction is never less than static friction.

4) Static friction is always greater than kinetic friction

18. A particle is projected up along a rough inclined plane of inclination $45°$ with the horizontal. If the coefficient of friction is 0.5 the retardation is

1) $\frac{g}{2}$ 2) $\frac{g}{2\sqrt{2}}$ 3) $\frac{3g}{2\sqrt{2}}$ 4) $\frac{g}{\sqrt{2}}$

19. $\mu_s . \mu_k$ and μ_r are the coefficients of static, kinetic and rolling friction between two surfaces. In their increasing order of magnitude one an write

1) $\mu_r < \mu_k < \mu_s$ 2) $\mu_r < \mu_k < \mu_s$

3) $\mu_r < \mu_k > \mu_s$ 4) $\mu_r = \mu_k = \mu_s$

20. If μ_s is the coefficient of static friction between two surfaces in constant and θ is the angle of friction. The relation between μ_s and θ is

1) $\mu_s = \theta$ 2) $\mu_s = \sin\theta$

3) $\mu_s = \tan\theta$ 4) $\mu_s = \cot\theta$

21. If the coefficient of friction is $\sqrt{3}$. The angle of friction is

1) $30°$ 2) $60°$ 3) $45°$ 4) $37°$

22. The maximum angular velocity of a car travelling along a curved path of radius 'r' if the coefficient of static friction is μ __

1) $\sqrt{\mu gr}$ 2) $\sqrt{\mu r/g}$

3) $\sqrt{\mu g/r}$ 4) $\sqrt{gr/\mu}$

23. A body of mass 'm' is placed on rough horizontal surface. (no force is applied on the body)

i) The coefficient of friction between two surfaces depends on the weight of the body.

ii) The frictional force between two surfaces is zero

1) (i) is false, but (ii) is true

2) (i) is true, but (ii) is false

3) Both (i) and (ii) are true

4) Both (i) & (ii) are false

24. Study the following :

a) Static friction is always greater than the kinetic friction

b) Coefficient of static friction is always greater than the coefficient of kinetic friction

c) Limiting friction is always greater than the kinetic friction

d) Limiting friction is never less than static friction

Correct statements are :

1) a,b,c,d 2) a,b 3) c,d 4) b,c,d

25. Match List I with List II :

List - I	List - II
a) Frictional force	e) Reduction of friction
b) Rolling friction	f) Adhesive force
c) Ball bearings	g) Deformation at the point of contact
d) Excessive polishing	h) Increase of friction
	i) Conservative force

1) a-f, b-g, c-h, d-e 2) a-i, b-g, c-e, d-h

3) a-f, b-h, c-e, d-h 4) a-f, b-g, c-e, d-h

PRACTICE SET - I KEY

01) 1	02) 2	03) 2	04) 3	05) 2
06) 1	07) 2	08) 1	09) 2	10) 2
11) 3	12) 3	13) 1	14) 3	15) 1
16) 4	17) 4	18) 3	19) 3	20) 3
21) 2	22) 3	23) 1	24) 4	25) 4

PRACTICE SET - II

01. A 100kg body is resting on horizontal plane having coefficient of friction 0.2. A force of 196N is required to pull the body horizontally. The acceleration developed by the body is

1) 0 ms^{-2} 2) 2 ms^{-2} 3) 4 ms^{-2} 4) 6 ms^{-2}

02. A force of 20 kg wt is required to just slide a wooden box weighing 50 kg over ice. Then coefficient of static friction between the surfaces in contact is

1) 0.2 2) 0.4 3) 0.8 4) 0.1

03. A body of mass 5 kg moving with a velocity 10 ms^{-1} on a rough horizontal surface is stopped after a distance of 10m. Then frictional force acting on it is.

1) 25N 2) 50N 3) 100N 4) 200N

04. A motor car runs with a speed of 7 ms^{-1} is stopped by applying brakes. Before stopping, the motor car moves through a distance of 10m. The ratio of frictional force and the weight of the motor car is

1) 2 : 5 2) 2 : 3 3) 1 : 5 4) 1 : 4

05. When a block of weight 40N is pushed by a force $20\sqrt{3}$N making an angle $30°$ with the vertical, the frictional force is 14N. The coefficient of kinetic friction is

1) 0.5 2) 0.2 3) 0.3 4) 0.4

06. A train of mass 500 metric tonnes moves with a velocity of 20 ms^{-1} on a level track. The force of friction acting on the train due to track is 10N per metric tonne. Then the power of engine to move the train is

1) 100 KW 2) 1000 KW

3) 10 KW 4) 100 W

07. When a body slides down a smooth inclined plane the force acting on it parallel to the plane is $\sqrt{3}$ times the normal reaction. The slope of the planeis

1) $\sqrt{3}$ 2) $1/\sqrt{3}$ 3) 3 4) 1

08. A vehicle of mass 2 tons is taken up an inclined plane 1 in 10 at constant speed 36 kmph if $g = 10\ ms^{-2}$ and the frictional force is equal to 200N, power of that engine is

1) 22KW 2) 220 KW

3) 2200KW 4) None

09. A body is projected from the bottom of the smooth inclined plane with a velocity 9.8 ms^{-1}. The angle of inclination of the plane is $30°$ to the horizontal. If it comes to rest after reaching the top of the plane, then the time of ascent is

1) 2s 2) 1s 3) 0.5s 4) 1.5s

10. A body of mass 1kg falls from rest and after falling through 100m acquires a speed of 30 ms^{-1}. Then work done against air friction is

1) 530J 2) 430J 3) 490J 4) zero

11. A boy of mass 25 kg slides down a rope hanging vertically down. Force of friction against him is 200N. If $g = 10\,ms^{-2}$, his down ward acceleration is

1) $4\,ms^{-2}$ 2) $3\,ms^{-2}$ 3) $2\,ms^{-2}$ 4) $1\,ms^{-2}$

12. A cube of weight 10N rests on rough inclined plane of slope 3 in 5. The coefficient of friction is 0.6. The minimum force necessary to start the cube moving up the plane is

1) 5.4N 2) 10.8N 3) 2.7 N 4) None

13. A body of mass 60 kg is pushed with just enough force to start it moving on a rough surface with $\mu_s = 0.5$ and $\mu_k = 0.4$ and the force continues to act afterwards, the acceleration of the body is

1) $0.98\,ms^{-2}$ 2) $3.92\,ms^{-2}$

3) $4.9\,ms^{-2}$ 4) zero

14. If the coefficient of friction is $\sqrt{3}$, the angle of friction is

1) 30° 2) 60° 3) 45° 4) 37°

15. A brick of mass 2 kg just begins to slide down an inclined plane at an angle of 45° with the horizontal The force of friction is

1) 19.6 cos 45° 2) 9.8 sin 45°

3) 19.6 sin 45° 4) 9.8 cos 45°

16. A 30 kg box has to move up an inclined slope of 30° to the horizontal at a uniform velocity of $5\,ms^{-1}$. If the frictional force retarding the motion is 150N, the horizontal force in newton to move up is (g = $10\,ms^{-2}$)

1) $300\times\frac{2}{\sqrt{3}}N$ 2) $300\times\frac{\sqrt{3}}{2}N$

3) 300N 4) None

17. A particle is projected up along a rough inclined plane of inclination 45° with the horizontal. If the coefficient of friction is 0.5, the retardation is

1) $\frac{g}{2}$ 2) $\frac{g}{2\sqrt{2}}$ 3) $\frac{3g}{2\sqrt{2}}$ 4) $\frac{g}{\sqrt{2}}$

18. A marble block of mass 2kg lyig on ice when given a velocity of 6 m/s is stopped by friction in 10s. Then the coefficient of friction is

1) 0.02 2) 0.03 3) 0.06 4) 0.01

19. A block of mass 200g rests on a horizontal surface. The coefficient of friction between the block and the horizontal surface is $1/4$. It has to move through 4m distance. The amount of energy needed is

1) 1.96 J 2) 9.6 J 3) 4.9 J 4) 1.96eV

20. A motor drags 50 Kg mass through 4m in 1 second on a rough surface having coefficient of friction 0.2.The power delivered by the motor is (g = $10\,ms^{-2}$)

1) 400 w 2) 2000 w

3) 200 w 4) 40 w

21. A body of mass $100\sqrt{2}$ Kg is dragged along a rough inclined plane of inclined plane of inclination 45 and coefficient of friction 0.5 with uniform velocity 0.5 ms^{-1}. The power required is 1g = 9.8 ms^{-2}

1) 2. 2w 2) 735 w 3) 270 w 4) 245 w

22. The work done in dragging a block of mass 5 Kg on an inclined plane of height 2m is 150J. The work done against the frictional force will be

1) 50J 2) 100J 3) 150 J 4) 200J

23. A body of weight 50N is placed on a smooth surface. If the force required to move the body on the surface is 30N, coefficient of friction is

1) 0.6 2) 1.2 3) 0.3 4) 1.67

24. A body is projected along a rough horizontal surface with a velocity $6\,ms^{-1}$. If the body comes to rest after travelling a distance 9m, the coefficient of sliding friction is

1) 0.5 2) 0.6 3) 0.4 4) 0.2

25. A van is moving with a speed of 72 Km/hr on a level road, where the coefficient of friction between the tyres and road is 0.5. The minimum radius of curvature, the road must have for safe driving of van is (g = 10 ms^{-2})

1) 80 m 2) 40 m 3) 20 m 4) 4 m

26. A body of 6 Kg rests in limiting equilibrium on an inclined plane whose slope is 30°. If the plane is raised to slope of 60°. The force in kg weight along the plane required to support it is

1) 3 2) $2\sqrt{3}$ 3) $\sqrt{3}$ 4) $3\sqrt{3}$

PRACTICE SET - II KEY

01) 1	02) 2	03) 1	04) 4	05) 2
06) 1	07) 1	08) 1	09) 1	10) 1
11) 3	12) 2	13) 1	14) 2	15) 3
16) 1	17) 3	18) 3	19) 1	20) 4
21) 2	22) 1	23) 1	24) 4	25) 1
26) 2				

PRACTICE SET - III

01. A gun of mass 50kg fires a bullet of mass 0.5 kg with velocity of 200 ms^{-1}. If the gun moves through 1 m back before coming to rest, the frictional force on the gun is

1) 50N 2) 100N 3) 200N 4)) zero

02. An object moving with a velocity of 5.6 ms^{-1} on a surface comes to test after travelling a distance of 16m. Then the coefficient of friction between the surface and the object is

1) 0.1 2) 0.2 3) 0.5 4) 0.8

03. A block slides with an initial velocity of 10 ms^{-1} on a rough horizontal surface. It is brought to rest after covering a distance of 50m. Then coefficient of kinetic friction is $(g = 10\,ms^{-2})$

1) 0.1 2) 0.2 3) 0.3 4) 0.4

03. A bullet of mass $1\times10^{-2}\,kg$ moving horizontal with a velocity of $2\times10^{2}\,ms^{-1}$ strikes the block and gets embedded into it. If the coefficient of kinetic friction of the block and the horizontal surface is 0.25. Then the distance moved by the block with the bullet is before coming to rest is

1) 20.4m 2) 40.8m 3) 61.2 m 4) 10.2m

04. A body of mass 2 kg moves with a uniform of 2 ms^{-1} on a horizontal plane of coefficient of friction 0.2. If Joule's constant J is 4.2 J/cal and $g = 9.8\,ms^{-2}$. Then the amount of heat generated in 5 second is

1) 9.33 cal 2) 93.3 cal

3) 18.66 cal 4) 18.6cal

05. An ice block of mass 10kg is moving on a rough horizontal surface through a distance of 42m. If 10gm of ice melts due to friction, coefficient of friction between the block and the surface is $(g = 10\,ms^{-2})$ $(J = 4.2\,J/cal)$

1) 0.4 2) 0.8 3) 0.2 4) none

06. A body is projected along a rough horizontal surface with a velocity if 6 ms^{-1}. If the body comes to rest after travelling a distance of 9m, the coefficient of sliding friction is [g = 10 ms^{-2}]

1) 0.5 2) 0.6 3) 0.4 4) 0.2

07. A block of weight 200N is pulled along a rough inclined plane of inclination 45° with the horizontal. If the coefficient of friction is 0.5, the retardation is

1) 0.43 2) 0.58 3) 0.75 4) 0.83

08. A box is lying on an inclined plane. If the box sliding when the angle of inclination is 60o, then the coefficient of static friction of the box and the plane is

1) 2.732 2) 1.732 3) 0.267 4) 0.176

09. A motor car running at the rate of $7 ms^{-1}$ is stopped by the breaks in 15m. Then the ratio between the frictional force and weight of the car is

1) 1 : 2 2) 1 : 4 3) 1 : 6 4) 1 : 1

10. A block of mass 2 Kg just begins to slide down on inclined plane at an angle of 4.5 with horizontal. The force of friction will be

1) $19.6 \cos 45^\circ$ 2) $19.6 \sin 45^\circ$

3) $9.8 \sin 45^\circ$ 4) $9.8 \cos 45^\circ$

11. A conveyor belt is moving horizontally at a speed of $8 ms^{-1}$. A box is slowly lowered on to it. In order to move the box 4m relative to the belt what should be the coefficient of friction between belt and box

1) 0.3 2) 0.8 3) 0.5 4) 1.0

12. An aeroplane requires for take off a speed of 72 Km/hr. The run on the ground is 100m. The mass of the plane is 10^4 Kg and coefficient of friction between the plane and ground is 0.3. The plane accelerates uniformly during take off. What is the acceleration of the plane ?

1) $1 ms^{-2}$ 2) $2 ms^{-2}$

3) $3 ms^{-2}$ 4) $4 ms^{-2}$

13. A body of weight 64N is pushed with just enough force so start it moving across a horizontal floor and same force continuous to act afterwards. If the coefficient of static and dynamic frictions are 0.6 and 0.4 respectively. The acceleration of the body is

1) $g/6.4$ 2) 0.64 g 3) $g/32$ 4) 0.2 g

14. A block of weight 20N is pressed between two hands and each hand exerts a force of 40N. If the block just starts to slide down, the coefficient of friction is :

1) 0.25 2) 0.2 3) 0.5 4) 0.1

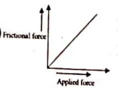
15. Statement A : Rolling friction is less than kinetic friction.
Statement B : The Rolling body deforms the surface on which it is rolling

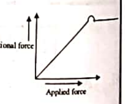
1) A true, B false 2) A false, B true
3) Both A and B are true
4) Both A and B are false

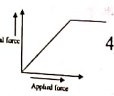
16. Which of the following is correct

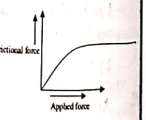
1) Using ball bearings, sliding friction changes to rolling friction
2) Lubricants decrease friction since intermolecular are weak in liquids
3) Over polishing increases friction since surface adhesion increases 4) All of the above

17. Find the correct one

1) 

2) 

3) 

4) 

18. The angle of friction is $Cos^{-1}\left(\frac{12}{13}\right)$. The coefficient of friction is

1) $\frac{5}{13}$ 2) $\frac{5}{12}$ 3) $\frac{12}{13}$ 4) $\frac{13}{12}$

(Hint : $\mu = Tan\theta$ where $\theta = \cos^{-1}\left(\frac{12}{13}\right)$)

19. A 60 Kg block is pushed with just enough force to start it moving across a floor and the same force continues to act afterwards. If $\mu_s = 0.5$ and $\mu_k = 0.4$ then the acceleration of the body is (g= $10 m/s^2$)

1) $1 ms^{-2}$ 2) $2 ms^{-2}$

3) $3 ms^{-2}$ 4) $4 ms^{-2}$

(Hint : $a = g(\mu_s - \mu_k)$)

20. A horizontal force of 100 N produces an acceleration of $1 m/s^2$ in a body placed on a horizontal surface. A horizontal force of 150 N produces an acceleration of $2 m/s^2$. The mass of the body and coefficient of kinetic friction are (g= $10 m/s^2$)

1) 50 Kg. 0.1 2) 25 Kg. 0.1
3) 50 Kg. 0.5 4) 50 Kg. 0.2

(Hint : $ma = F - \mu mg$)

21. On a rough horizontal surface a body of mass 2 kg is given a velocity of 10 m/s. If the coefficient of friction is 0.2 and g = 10 m/s^2, the body will stop after covering a distance of

1) 10m 2) 50 m 3) 25 m 4) 250 m

(Hint : $S = \frac{u^2}{2\mu_k g}$)

22. A force of 100N when applied on a body of mass 20Kg produced an acceleration of 3 ms^{-2} in it. If the force acting on the body is doubled, its acceleration is

1) $8 ms^{-2}$ 2) $4 ms^{-2}$ 3) $2 ms^{-2}$ 4) $1 ms^{-2}$

(Hint : Applied force - frictional force = Net force)

23. A man holds a book weighing 5 Kg between his hands and keeps it from falling by pressing his hands together. If the minimum force exerted by each hand horizontally is 49 N, the coefficient of friction between the block and the hands is

1) 0.4 2) 0.2 3) 0.3 4) 0.5

(Hint : $2\mu N = mg$)

24. A block of mass 0.2 kg is held against a wall by applying a horizontal force of 10 N on the block. If the coefficient of friction between the block and the wall is 0.5, the frictional force acting on the block is (g = 10 ms^{-2})

1) 10 N 2) 5N 3) 2 N 4) 8 N

(Hint : $F = mg$)

25. The maximum velocity with which a car driver can travel the car along a flat curve of radius 200 m and coefficient of friction 0.2 to avoid skidding is (10 ms^{-2})

1) 62 ms^{-1} 2) 20 ms^{-1} 3) 15 ms^{-1} 4) 25 ms^{-1}

(Hint : $v = \sqrt{\mu rg}$)

26. A body moves along a circular path of radius 5m. The coefficient of friction between the surface of the path and body is 0.5. The angular velocity in rad s^{-1} with which the body should move so that it does not leave the path is (g = 10 ms^{-2})

1) 4 2) 3 3) 2 4) 1

27. A body of mass 10 kg is kept on a rough inclined plane of inclination 30^0. If coefficient of kinetic friction between the body and surface is 0.75. The frictional force acting on the body.

1) $49\sqrt{3}$ N 2) 49 N 3) $\frac{49\sqrt{3}}{2} N$ 4) $98\sqrt{3} N$

(Hint : f= $mg \sin\theta$)

28. A block slides down a rough inclined plane of inclination 30^0. If coefficient of kinetic friction is

1) 0.67 ms^{-2} 2) 0.82 ms^{-2}

3) 0.43 ms^{-2} 4) 0.25 ms^{-2}

(Hint : $a = g(\sin\theta - \mu_k \cos\theta)$)

29. A body slides down a rough inclined plane of inclination 30^0. If $\mu_k = \frac{3\sqrt{3}}{10}$ and if the body starts from rest and reaches the bottom of the inclined plane with a velocity of 14 m/s, the length of the inclined plane is

1) 50 m 2) 100 m 3) 200 m 4) 150 m

(Hint: $V = \sqrt{2g(\sin\theta - \mu_k \cos\theta)L}$)

30. A piece of ice slides down a 45^0 inclined plane in twice the time it takes to slide down a frictionless 45^0 inclined. The coefficient of friction between the inclined plane and the block is

1) 1/4 2) 3/4 3) 1/3 4) 1/2

(Hint: $\sqrt{\frac{2\ell}{g(\sin\theta - \mu_k \cos\theta)}} = 2\sqrt{\frac{2\ell}{g\sin\theta}}$)

31. A block of Ice slides down a 45^0 smooth inclined plane in time 't'. the same block of Ice slides down a rough inclined plane of same inclination. If the coefficient of kinetic friction is 3/4, then time taken in this case is

1) $\frac{4t}{3}$ 2) $\frac{3t}{4}$ 3) $\frac{t}{2}$ 4) 2t

(Hint : $t = \sqrt{\frac{2l}{g\sin\theta}}, t' = \sqrt{\frac{2l}{g(\sin\theta - \mu_k \cos\theta)}}$)

32. A block slides down an inclined p lane of slope angle 30^0 with a constant velocity. It is then projected up the plane with an initial velocity $5ms^{-1}$. The distance upto which it will rise before coming to rest is ($g = 10\, ms^{-2}$)

1) 5.25 m 2) 4.25 m 3) 1.25 m 4) 2.25 m

(Hint : $S = \frac{u^2}{2g(\sin\theta + \mu\cos\theta)}$ where $\mu = Tan\theta$)

33. A body of mass "m" is sliding down a rough inclined plane of angle 'θ' with uniform velocity. The work done in moving with uniform velocity through a distance L along the inclined plane from the bottom is.

1) mg L $\sin\theta$ 2) 2 mg L $\sin\theta$
3) 3 mg L $\sin\theta$ 4) 4 mg L $\sin\theta$

(Hint : $w = mg(\sin\theta + \mu\cos\theta)L$ where $\mu = Tan\theta$)

34. An engine of mass 500 kg is going up an inclined plane, 3 in 5 at the rate of 36 kmph. If the coefficient of friction is 0.5, the power of engine is

1) 98 KW 2) 98 W 3) 49 KW 4) 30 W

(Hint: $P = F.V = mg(\sin\theta + \mu_k \cos\theta).V$)

35. A particle is projected up a 45^0 rough inclined plane with a velocity v. The coefficient of friction is 0.5.The speed with which it return back to the starting point is v^1. Then v^1 / v is

1) $\frac{1}{\sqrt{2}}$ 2) $\frac{1}{2}$ 3) $\frac{1}{\sqrt{3}}$ 4) 1/3

(Hint : $V_{sp} = \sqrt{2g(\sin\theta + \mu\cos\theta)\ell}$,
$V_{down} = \sqrt{2g(\sin\theta - \mu\cos\theta)\ell}$)

PRACTICE SET - III KEY

01) 2	02) 1	03) 1	04) 1	05) 1
06) 4	07) 2	08) 2	09) 3	10) 2
11) 2	12) 2	13) 4	14) 1	15) 3
16) 4	17) 2	18) 2	19) 1	20) 1
21) 3	22) 1	23) 4	24) 3	25) 2
26) 4	27) 1	28) 3	29) 3	30) 2
31) 4	32) 3	33) 2	34) 3	35) 3

PREVIOUS ECET BITS

2009

01. The maximum speed with which a car can be driven round a curve of radius 18m without skidding in kmph is (given g = 10 ms^{-2}) and coefficient of friction = 0.2)

1) 21.6 2) 36 3) 18 4) 48

02. Given the coefficient of friction = 0.7 and g = 10 ms^{-2}. The work done in pulling a body of mass 80 kg through 100 meters is

1) 560 J 2) 56 J 3) 56000 J 4) 5600 J

2010

03. A body of weight 50 N is placed on a smooth surface. If the force required to move the body on the smooth surface is 30N, the co-efficient of friction is

1) 0.6 2) 1.2 3) 0.3 4) 1.67

04. As soon as an artificial satellite enters the atmosphere, it begins to burn due to

1) Viscous force 2) Temperature
3) Forces inside the satellite 4) Frictional forces

2011

05. The time taken by a body to slide down a smooth inclined plane can be doubled by

1) increasing the height of the plane 2 times
2) increasing the length of the plane 4 times
3) decrease the angle of inclination to half the original value
4) increasing the angle of inclination to half the original value.

2012

06. The minimum stopping distance for a car of mass m, moving with a speed v along a level road, if the coefficient of friction between the tyres and the road is μ, will be

1) $\frac{v^2}{2\mu g}$ 2) $\frac{v^2}{\mu g}$ 3) $\frac{v^2}{4\mu g}$ 4) $\frac{v^2}{2\mu g}$

07. When a bicycle is in motion, the force of friction excerted by the ground on the two wheels is such that it acts

1) In the backward direction on the front wheel and in the forward direction on the rear wheel
2) In the forward direction on the front wheel and in the backward direction on the rear wheel
3) In the backward direction on both the front and the rear wheels
4) In the forward direction on both the front and the rear wheels

2013

08. Theoretically, which of the following are best lubricants

1) Solids 2) Liquids
3) Gases
4) All have the same lubricating capacity

09. The maximum speed of a car on a curved of radius 'r' and the coefficient of friction (μ) is

1) $\sqrt{\mu g}$ 2) $\sqrt{\mu g r}$
3) $\sqrt{\mu r / g}$ 4) $\sqrt{g r / \mu}$

2014

10. A block of weight 200N is pulled along a rough horizontal surface at a constant speed by a force of 100N acting at an angle of 30o. The coefficient of friction between the block and the surface is __

1) 0.58 2) 0.75
3) 0.45 4) 0.65

11. A horizontal force F pulls a 20 kg box at a constant speed along a horizontal floor. If the coefficient of friction between the box and the floor is 0.25. The work done by the force F in moving the box through a distance of 2 m ___

1) 49 J 2) 147 J
3) 196 J 4) 98 J

T.S - ECET - 2015

12. If the normal force is doubled, then coefficient of firction is

1) halved 2) tripled
3) doubled 4) remains same

A.P - ECET - 2015

13. A box which is lying on inclined plane starts sliding with an anlge of incllination 60^0. Then the coefficient of static friction is

1) 1.173 2) 1.371 3) 1.732 4) 17.32

T.S - ECET - 2016

14. Which of the following statements is wrong pertaining to coefficient of static friction (μ_s)

1) μ_s is different for different pairs of surfaces

2) μ_s=0 when there is no applied force

3) μ_s>0 when there is an applied force

4) μ_s<0 when there is an huge applied force

15. If θ is the angle of inclination of inclined plane and α is the angle of repose then the body slides down with some acceleration when

1) $\theta=\alpha$ 2) $\theta>\alpha$
3) $\theta<\alpha$ 4) $\theta>2\alpha$

A.P - ECET - 2016

16. A body is at rest on the tip of a smooth inclined plane of length 15 m and angle of inclination 60^0 with the horizontal. neglecting the frictional forces, the time taken for the body to reach the bottom of the inclined plane is $\left(Assume\, g=9.8\,ms^{-2}\right)$

1) 18.8s 2) 1.88s
3) 0.18s 4) 0.018s

17. A force of 100N is acted on a body of mass 20.0 kg placed on a rough horizontal surface. If the direction of the force is parallel to the surface and the coefficient of friction is 0.4, the accelaration produced is

1) $10.8ms^{-2}$ 2) $0.108ms^{-2}$
3) $1.08ms^{-2}$ 4) $108ms^{-2}$

T.S - ECET - 2017

18. A body of mass m is placed on a rough surface with coefficient of friction μ inclined at θ. If the mass is in equilibrium, then the value of θ is

1) $Tan^{-1}\mu$ 2) $Tan^{-1}(1/\mu)$
3) $Tan^{-1}(m/\mu)$ 4) $Tan^{-1}(\mu/m)$

A.P - ECET - 2017

19. A body of mass 1 kg lies on an inclined plane of angle 60^0 to the horizontal. If the coefficient of friction is 0.4, the frictional force along the inclined plane is

1) 1.96 N 2) 0.98N 3) 0.49N 4) 0.254 N

20. A force of 20 kg weight is required to just slide a wooden box weighing 50 Kg over ice. Then coefficient of static friction between the surfaces in contact is

1) 0.2 2) 0.4 3) 0.8 4) 0.1

T.S - ECET - 2018

21. A block of mass 2 Kg rests on a rough inclined plane making an angle of 30^0 with the horizontal. The coefficient of static friction between the block and plane is 0.7. The frictional force on the block is______

1) 9.8 N 2) $0.7\times9.8\times\sqrt{3}N$
3) $9.8\times\sqrt{3}N$ 4) $0.7\times0.9N$

22. A body sliding on a smooth inclined plane required 4 seconds to reach the bottom starting from rest at the top. How much time does it take to cover one-fourth the distance strating from rest at top?

1) 1 second 2) 2 seconds
3) 4 seconds 4) 16 seconds

A.P - ECET - 2018

23. A force of 12 N acts on a body of mass 4 kg placed on a rough surface. The coefficient of friction between body and surface is 0.2 and take $g=10ms^{-2}$. The accelearation of the body in ms^{-2} is

1) 1 2) 0.5 3) 0.25 4) zero

24. Breakes stop a train in a certain distance d. when the breaking force is made one fourth, the breakes will stop the train in a distance which is

1) d/2 2) 4d 3) 2d 4) d

PREVIOUS ECET BITS KEY

01) 1	02) 3	03) 1	04) 4	05) 2
06) 1	07) 1	08) 3	09) 2	10) 1
11) 4	12) 4	13) 3	14) 4	15) 2
16) 2	17) 3	18) 1	19) 1	20) 2
21) 2	22) 2	23) 1	24) 2	

PREVIOUS ECET BITS HINTS AND SOLUTIONS

01. $\frac{mv^2}{r}=umg \Rightarrow v=\sqrt{urg}=\sqrt{0.2\times18\times10}$
$=21.6\text{kmph}$

02. $w=FS=\mu\,mgs=0.7\times80\times10\times100$
$=56000J.$

03. $F=\mu\,mg$
$\mu=\frac{F}{mg}=\frac{F}{W}=\frac{30}{50}=0.6$

04. Frictional forces

05. $s=ut+\frac{1}{2}at^2$

$t=\sqrt{\frac{2s}{a}}\quad(\because u=0)$

$t^2\propto s\Rightarrow\frac{t_1^2}{t_2^2}=\frac{s_1}{s_2}$

$=\left(\frac{t}{2t}\right)^2=\frac{s}{s_2}$

$=s_2=4s$

$\therefore$ Length of the plane increasing by 4 times

06. $v^2-u^2=2as\ (\because u=0\ \&\ a=\mu g)$

$v^2=2\mu gs$

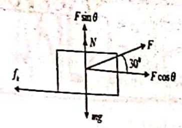
$s=\frac{v^2}{2\mu g}$

07. In the backward direction on the front wheel and in the forward direction onthe rear wheel

08. Gases

09. $\frac{mv^2}{r}=\mu mg$

$v=\sqrt{\mu rg}$

10. 

$F\cos\theta=f_k$

$N+F\sin\theta=mg$

$N=ng-F\sin\theta$

$F\cos\theta=\mu_k N$

$F\cos\theta=\mu_k(mg-F\sin\theta)$

$\mu_k=\frac{F\cos\theta}{mg-F\sin\theta}$

$=\frac{100\cos30}{200-100\sin30}=0.58$

11. $W=FS$
$=\mu mgs=0.25\times20\times9.8\times2=98J$

12. remains same

13. $\mu=\tan\alpha\Rightarrow\mu=\tan60^0=\sqrt{3}=1.732$

14. $\mu_s<0$ is not possible

15. If $\theta>\alpha$ the body moves with acceleration

16. $S=\frac{1}{2}g\sin\theta t^2\Rightarrow15=\frac{1}{2}\times9.8\times\sin60t^2$

$t^2=\frac{15\times4}{9.8\times1.732}\Rightarrow t=1.88\sec$

17. $F-f_k mg=ma\Rightarrow100-0.4\times20\times9.8=20a$

$a=\frac{100-78.4}{20}=1.08m/s^2$

18. $Tan^{-1}\mu$

19. $F=\mu_k mg\cos\theta$
$=0.4\times1\times9.8\times\cos60^0$
$=1.96\text{ N}$

20. $F=\mu_s N$
$=0.4$

SPACE FOR IMPORTANT NOTES

WORK, POWER AND ENERGY

SYNOPSIS

- Work is said to be done when the point of application has some displacement in the direction of force.
- The amount of work done is given by the dot product of force and displacement $W=\vec{F}.\vec{s}=Fs\cos\theta$.
- Work is independent of time taken and is scalar.
- If the force and displacement are perpendicular to each other, then the work done is zero.
- If the work is done by a uniformly varying force such as restoring force in a spring, then the work done is equal to the product of average force and displacement.
- If the force is non-uniformly varying, then the work done $=\int F.ds$.
- The area of F-s graph gives the work done.
- S.I. unit of work is joule. Joule is the work done when a force of one Newton displaces a body through one metre in the direction of force.
- CGS unit of work is erg; gravitational unit of work is 1 kg-m; $1J=10^7$ ergs; 1 kgm = g joule.
- The work done in lifting an object = mgh.
- When a body of mass 'm' is raised from a height h_1 to a height h_2, then the work done $=mg(h_2-h_1)$.
- The work done on a spring in stretching or compressing it through a distance x is given by $W=\frac{1}{2}kx^2$ where k is the force constant or spring constant.
- Work done in changing the elongation of a spring from x_1 to x_2 is $W=\frac{1}{2}k(x_2^2-x_1^2)$.
- The work done in pulling the bob of a simple pendulum of length L through an angle θ as shown is $W=mgL(1-\cos\theta)$.
- The work done in rotating a rod or bar of mass m through an angle θ about a point of suspension is $W=mgL(1-\cos\theta)$. Where L is the distance of center of gravity from the point of suspension.
- The work done by any expanding gas : if the pressure is constant, $W=P\times\Delta V$. if the pressure is variable W = area under the P.V graph.
- Rate of doing work is called power.

  $\text{Power}=\frac{\text{work}}{\text{time}}=\text{force X velocity}$.
- S.I. unit of power is watt and CGS unit is erg/second.

If a vehicle travels with a speed of v overcoming a total resistance of F, then the power of the engine is given by P=Fv.

If a machine gun fires n shots each of mass m per minute at a speed of v, then its power = $\frac{mnv^2}{120}$.

If a pump delivers V liters of water over a head of h meter in one minute, then the power of the engine (p)= $\frac{Vgh}{60}$

The power of the lungs=K.E. of air blown per second= $\frac{1}{2}$(mass of air blown per second)x(velocity)^2 = $\frac{1}{2}\left(\frac{m}{t}\right)v^2$.

The power of the heart = pressure x volume of blood pressure per second.

One horse power=746 watt.

The capacity to do work is called energy. Work and energy have the same units.

Potential energy of a body or system is the capacity for doing work possessed by the body or system by virtue of the relative positions of its parts.

Water stored in a dam, stretched rubber cord, wounded spring of a clock or toy etc., possess potential energy. A wounded spring (such as in a clock or toy car) has potential energy

$U=\frac{1}{2}K\theta^2$(K is torque constant and θ is the number of radians through which it is wond).

Gravitational potential energy of mass m situated at a height h above the ground is given by:

$P.E.=\frac{mgRh}{R+h}$; $P.E.=mgh(h \ll R)$

(Exact formula) (Approximate Formula)

The potential energy stored in a spring of force constant k when extended through a distance x is $\frac{1}{2}kx^2$

The energy possessed by a body by virtue of its motion is called kinetic energy. It is measured by the amount of work which the body can do before coming to rest.

Running water, a released arrow, a bullet fired from a gun, blowing wind etc., are the examples for kinetic energy.

If a body of mass m is moving with a velocity v, then its kinetic energy = $\frac{1}{2}mv^2$

A flying bird possesses both K.E. and P.E.

The work done on a body at rest in order that it may acquire a certain velocity is a measure of its kinetic energy.

If the kinetic energy of a body of mass m is E and its momentum is p, then E = $\frac{p^2}{2m}$.

When the resistance force is applied on a car and on a toy which are having the same momentum, the car comes to rest at a shorter distance.

If K.E. of a heavier body and a lighter body are equal, the heavier body will have greater momentum and lesser velocity.

$P_1 : P_2 = \sqrt{m_1} : \sqrt{m_2} = v_2 : v_1$

If the velocities of a heavier body and a lighter body are equal, the heavier body will have greater energy and greater momentum. $E_1 > E_2$ and $P_1 > P_2$; $P_1 : P_2 = m_1 : m_2$

Work – energy theorem: The work done by the resultant force acting on a body is equal to the changes in its kinetic energy. W =Fs; $W=\frac{1}{2}m(v^2-u^2)=\frac{1}{2}mv^2-\frac{1}{2}mu^2$. In general, the work done = change in energy.

Stopping distance of a vehicle is directly proportional to the square of its velocity and inversely proportional to the braking force.

When a body of mass m falls freely from a height h, its total energy is mgh. When it falls through a distance x, its K.E. mgx and P.E. is mg(h-x).

For a falling body or a body thrown up K.E. at the bottom is equal to P.E. at the maximum height.

Rest mass energy: Every body of matter possesses a certain inherent amount of energy called rest energy even if it is not moving (so that K.E.=0) and is not being acted by a force (so that P.E.=0). This rest mass energy is given by E= mc^2.

Araise ! Awake ! And stop not till the goal is reached

PRACTICE SET - I

01. A machine gun fires 60 bullets each of mass 10 gm with a velocity of $100ms^{-1}$ in 1 minute. The power of the gun is :
1) 3000 w 2) 50 w
3) 6 w 4) 0.06 w

02. Area of force – displacement curve gives
1) Energy 2) Power
3) Acceleration 4) Momentum

03. A simple pendulum of length 100cm is turned through an angle 60^0. If the mass of the bob is 100 gm, the increase in P.E. is
1) 0.49 J 2) 4,900 ergs
3) 490000 J 4) 0.134

04. When the K.E. of a body is increased by 300%, the momentum of the body is increased by:
1) 120% 2) 150% 3) 100% 4) 200%

05. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time 't' is proportional to:
1) $t^{2/3}$ 2) $t^{3/4}$ 3) $t^{3/2}$ 4) t^2

06. A particle moves under the effect of a force F=CX from X=0 to X=X_1. The work done in the process is:
1) CX_1^2 2) $\frac{1}{2}CX_1^2$ 3) CX_1^3 4) zero

07. The same retarding force is applied to stop a train. If the speed is doubled, then the distance will be:
1) the same 2) doubled
3) half 4) four times

08. A man in a lift weight more when:
1) the lift begins to go up
2) the lift is going up steadily
3) the lift is slowing down
4) the lift is descending freely

09. A body falling from a height of 10m rebounds from a hard floor. If it loses 20% of its energy in impact it will rise:
1) 10m 2) 8m 3) 5m 4) 12m

10. The energy stored in a watch spring is:
1) K.E. 2) P.E.
3) Heat 4) Chemical energy

11. If a body of mass 300kg is moved by an elevator from a mine of depth 20m to a height of 20 m in 1 min, the power of the elevator is:
1) 19.6 kw 2) 0.98 w 3) 9.8 kw 4) 1.95 kw

12. The kinetic energy of two bodies of masses 2 m and m are in the ratio 8 : 1 than the ratio of their moment a is
1) $\sqrt{8}:1$ 2) 2:1 3) 1:4 4) 4:1

13. A particle is moved from A=i+2j-k by unit distance along X-axis by the application of force F=2i-2j+k then the work done is:
1) 1 unit 2) 2 units 3) -3 units 4)-2 units

14. Two bodies with kinetic energies in the ratio 4:1 are moving with equal linear momentum. The ratio of their masses is:
1) 1:2 2) 1:1 3) 4:1 4) 1:4

15. A 2kg body and a 3 kg body have equal momentum. If the kinetic energy of 3kg body is 10 joule, the kinetic energy of 2 kg body will be in joule.
1) 6.66 2) 15 3) 22.5 4) 45

16. Two bodies of masses m_1 and m_2 have equal moments. Their kinetic energies E_1 and E_2 are in the ratio
1) $\sqrt{m_1}:\sqrt{m_2}$ 2) $m_1:m_2$
3) $m_2:m_1$ 4) $m_1^2:m_2^2$

17. A body of mass 2 kg is thrown up vertically with a K.E. of 490J. if the acceleration due to gravity is $9.8m/s^2$, the height at which the K.E. of the body becomes half of the original value is
1) 50 m 2) 25m 3) 12.5 m 4) 10m

18. A chain is held on a fiction less horizontal table with $\left(\frac{1}{n}\right)th$ of its length hanging over edge of the change has length L and mass M then the work required to pull the hanging part back on the table is
1) $\frac{MgL}{n^2}$ 2) $\frac{MgL}{n}$ 3) $\frac{MgL}{2n}$ 4) $MgLn^2$

19. A person draws water from a 5m deep well in a bucket of mass 2 kg of capacity 8 liter by a rope of mass 1 kg. What is the total work done by the person? (Assume g=10 m/sec²)
1) 550 J 2) 525 J 3) 125 J 4) 500 J

20. The work done in taking a body of mass m to a height equal to the radius of the earth R
1) mgR 2) mgR/2 3) 2mgR 4) zero

21. A man weighing 80 kg climbs up a stair case carrying a load of 20kg over his head. The stair case has 50 steps and each step has a height of 20 cm. then the work done by the man is
1) Zero 2) 980 J 3) 4900 J 4) 9800 J

22. A rectangular block has dimensions 8m x 4m x 2m. it has a mass of 100kg. It is initially on the ground with the shortest side vertical. If it is to be turned so that the longest side is vertical, calculate the work done
1) 29.4 J 2) 2.94×10^3 J
3) 58.8×10^2 J 4) 580 Joule

23. The displacement x of a particle of mass 1 kg is moving in one dimension, under the action of a constant force is related to the time by the equation $t=\sqrt{x}+3$, where x is in meter and t in se. find the work done by the force in first 6 sec?
1) 6 J 2) 18 J 3) 16 J 4) 12 J

24. A particle of mass m is moving in a horizontal circle of radius r under centripetal force equal to $-\frac{K}{r^2}$, where K is a constant. The total energy of the particle is
1) $-\frac{K}{2r^2}$ 2) $\frac{K}{2r}$ 3) $-\frac{K}{2r}$ 4) $-\frac{K}{r^2}$

25. A 300gm mass has a velocity $V=(3\bar{i}+4\bar{j})m/sec$ at a certain instant. Its kinetic energy is
1) 1.35 J 2) 2.4 J 3) 3.75 J 4) 7.35 J

26. Springs A and B are identical except that A is stiffer than B (i.e., KA>KB) on which spring more work expended if they are stretched by the same amount
1) $W_A>W_B$ 2) $W_A<W_B$
3) $W_A=W_B$ 4) Data insufficient

27. If spring of spring constant 10 N/cm is compressed by 2 cm. Then its potential energy is
1) 20 J 2) 10 J 3) 0.2 J 4) 2 J

28. A ship of mass 3×10^7 kg initially at rest is pulled by a force of 5×10^4 N though a distance of 3m. Assuming that the resistance due to water is negligible, calculate the speed of the ship
1) 10 m/sec 2) 0.1 m/sec
3) 2 m/sec 4) 0.2 m/sec

29. At certain point the potential and kinetic energies of a body of mass 100gm projected vertically up are 3.6×10^7 erg and 6.2×10^7 erg respectively. The maximum height reached by the body and the velocity with which it is projected from the ground are
1) 10 m, 14 m/sec 2) 15m, 19 m/sec
3) 10m, 24 m/sec 4) 20 m, 17 m/sec

30. At her maximum height a girl in a swing is 3m above the ground and at the lowest point she is 2m above the ground. What is her maximum velocity?
1) $\sqrt{29.4}m/sec$ 2) $\sqrt{9.8}\,m/sec$
3) $\sqrt{19.6}m/sec$ 4) 9.8 m/sec

31. If the velocity of the car is trebled its KE is
1) doubled 2) increase 9 times
3) increases 15 times 4) none

32. If the KE of given particle is doubled its momentum will be
1) doubled 2) tripled
3) increases by $\sqrt{2}$ times
4) remains unchanged

33. If the stone is thrown up vertically and returns to the ground. Its potential energy is maximum
1) during the upward journey
2) at the maximum height
3) during the return journey
4) at the bottom

34. The potential of a body at a height is 'mgh' When it falls freely to the ground, its kinetic energy becomes
1) 2 mgh 2) 1/2 mgh 3) mgh 4) mgh^2

35. One kilo-watt hour is
1) 36 joules 2) 36×10^3 joules
3) 36×10^4 joules 4) 36×10^5 joules

36. The gravitational unit of work in SI system is
1) Joule 2) erg 3) gm.cm 4) kg.m

37. In a certain situation, it is found that vectors 'F' and 'S' are not equal to zero, but the work done is zero. From this it can be concluded that
1) F and S are in the same direction
2) F and S are in opposite directions
3) F and S are at right angles
4) F and S are parallel to each other

38. If the mass of the body is reduced to half and its velocity is doubled its KE
1) remains same 2) is doubled
3) increases 4 times of the original value
4) reduced to half the original value

39. A block of mass m slides down along the surface of the bowl of radius r from the rim to the bottom. The velocity of the block at the bottom will be
1) $\sqrt{(\pi rg)}$ 2) $\sqrt{(\pi rd)}$ 3) $\sqrt{(2\pi g)}$ 4) $\sqrt{(\pi g)}$

40. A simple pendulum of length l has of mass m. If it is displaced from the vertical position through an angle, what is the increase in the PE of the bob
1) mgl 2) mgl Cos θ
3) mgl Sinθ 4) mgl (1-Cosθ)

41. Two bodies A and B have the same momentum. But the mass of B twice than A then
1) the kinetic energies of A and B are equal
2) KE of A is 4-times greater than that of B
3) KE of A is 4 times less than that of B
4) KE of A is 2 times greater than that of B

42. If the KE of a given particle is doubled, its momentum will
1) remain unchanged 2) be doubled
3) be quadrupled 4) increases $\sqrt{2}$ times

43. Two balls of different masses have the same kinetic energy. Then the
1) heavier ball has greater momentum than the lighter ball
2) lighter ball has a greater momentum that the heavier ball
3) both balls have equal momentum
4) both balls zero momentum

44. Two bodies of masses m_1 and m_2 have equal kinetic energies. If p_1 and p_2 are their respective momenta then $p_1 : p_2$ is equal to
1) $m_1 : m_2$ 2) $m_2 : m_1$
3) $m_1^2 : m_2^2$ 4) $\sqrt{m_1} : \sqrt{m_2}$

45. The dimensional formula for kinetic energy is
1) $M^0L^2T^{-2}$ 2) ML^2T^{-2}
3) ML^2T^2 4) $M^2L^2T^{-2}$

PRACTICE SET - I KEY

01) 2	02) 1	03) 1	04) 3	05) 3
06) 2	07) 4	08) 1	09) 2	10) 2
11) 4	12) 4	13) 3	14) 4	15) 1
16) 3	17) 3	18) 3	19) 2	20) 2
21) 4	22) 2	23) 2	24) 3	25) 3
26) 1	27) 3	28) 2	29) 1	30) 3
31) 2	32) 3	33) 2	34) 3	35) 4
36) 4	37) 3	38) 2	39) 1	40) 4
41) 4	42) 4	43) 1	44) 4	45) 2

PRACTICE SET - II

01. A body is moved along a straight line by a machine delivering constant power. If the distance moved is proportional to t^x, what is the value of x?
1) 2 2) 3/2 3) 2/3 4) 3

02. How many 2.5 kg bricks can a man carry up a stair 3.6 m high in one hour if he works at the average rate of 9.8 watt?
1) 800 2) 200 3) 600 4) 400

03. A train of mass 100 metric tons is drawn up an incline of 1 in 49 at the rate of 360 km per hour by an engine. If the resistance due to friction is 10 N per metric ton. Calculate the power of the engine
1) 2×10^4 watt 2) 5×10^4 watt
3) 2.5×10^6 watt 4) 2.1×10^6 watt

04. An engine pumps up 10 kg of water through a height 10 m in 5 seconds. Given that the efficiency of engine in 60%. What is the power of the engine? (take $g = 10 m/sec^2$)
1) 33 Kw 2) 3.3 Kw
3) 0.33 Kw 4) 0.033 Kw

05. A motor pump set lifts 120 kg of water per minute from a well of depth 20 m and delivered to a height 20 m then its power is
1) 0.392 Kw 2) 0.784 Kw
3) 1.96 Kw 4) 1 Kw

06. A pump is required to lift 1000 kg of water per minute from well of depth 10m and eject it with a speed of 10m/sec. the horse power of the engine needed is (Assume $g = 10 m/sec^2$)
1) 3.33 2) 4.33 3) 5.35 4) 2.35

07. An engine expends 45 HP in propelling a car along a level track at 15 m/sec. The total retarding for u acting on the car is nearly
1) 2238 N 2) 3900 N 3) 3228 N 4) 4280 N

08. Two masses of 1 gm and 4 gm are moving with equal kinetic energies. The ratio of the magnitudes of their linear momentum is
1) 4:1 2) $\sqrt{2}$:1 3) 1:2 4) 1:16

09. A lorry and a car have same kinetic energy. If the same retarding force is applied which one comes to rest in shorter distance.
1) car 2) Lorry
3) Both 4) Data is not sufficient

10. The mass of a proton is 1840 times mass of electron. What is the ratio of their K.E. if they have equal momentum
1) 1840 2) $\sqrt{1840}$: 1
3) 1: $\sqrt{1840}$ 4) 1:1840

11. If the momentum of a body is increased by 50% what would be the percentage increase in K.E
1) 100% 2) 500%
3) 125% 4) 150%

12. If the K.E of a particle increases by 300%. By what percent its momentum has changed
1) 100% 2) 150% 3) 50% 4) 125%

13. A body falling from a height of 10 m rebounds from a hard floor rises to a height of 2.5 m, then the coefficient of restitution is
1) 1 2) 0.25 3) 0.5 4) 0.4

14. A body of mass 2 kg moving with a velocity of 3m/sec. collides head on with a body of mass 1 kg moving with a velocity of 4 m/sec. after collision the bodies stick together and move with a common velocity which in the units m/s is equal to
1) 1/4 2) 1/3 3) 2/3 4) 3/4

15. A 5 kg shell kept at rest suddenly splits up into three parts. If two parts of mass 2kg each are found flying due north and east 5 m/s each. What is the velocity of the third part after explosion?
1) 10 m/sec due north-east
2) $10/\sqrt{2}$ m/sec south-east
3) $10\sqrt{2}$ m/sec south-west
4) $10\sqrt{2}$ m/sec south-east

16. 10 gm bullet is fired from a riffle horizontally into a 5 kg block of wood suspended by a string and the bullet get embedded in the block. The impact causes the block to swing to a height of 2.5 cm its initial level. Calculate the velocity of bullet?

1) 286.8 m/sec 2) 350.7 m/sec
3) 1000 m/sec 4) 523 m/sec

17. The minimum slopping distance for a car of mass 'm' moving with a speed v along a level road is (μ is the coefficient of friction between tyres and road)

1) $v^2/\mu g$ 2) $V^2/2\mu g$
3) $2V^2/\mu g$ 4) $3V^2/\mu g$

18. A car is moving with a uniform velocity on a rough horizontal road. According to Newton's laws of motion

1) No force is being applied by the engine
2) The kinetic energy of the car is increasing
3) the kinetic energy of the car is decreasing
4) a force is surely being applied by its engine

19. A uniform chain of mass 'M' and length 'L' lies on a horizontal table such that one third of its length hangs from the edge of the table. The work done in pulling the hanging part on the table will be

1) MgL/3 2) MgL
3) MgL/9 4) MgL/18

20. A man and a child are holding a uniform rod of length L in the horizontal direction in such a way that one fourth weight is supported by the child. If the child is at end of the rod then the distance of man from another end will be

1) 3L/4 2) L/4 3) L/3 4) 2L/3

21. The kinetic energy of a man is half the kinetic energy of a boy of half of his mass. If the man increases his speed by 1 m/s then his kinetic energy becomes equal to that of the boy. The ratio of the velocity of the boy and that the man is

1) 2/1 2) 1/2 3) 3/4 4) 4/3

22. A body of mass 'M' slides down from the edge to the bottom a bowl of radius 'R'. The velocity of the body at the bottom will be

1) $\sqrt{gR}$ 2) $\sqrt{2gR}$ 3) $\sqrt{\pi gR}$ 4) $2\sqrt{\pi Rg}$

23. The bob (mass m) of simple pendulum of length 'l' is held horizontal and then released. It collides elasticity with a block of equal mass 'm' lying on a frictionless table. The kinetic energy of the block will be

1) zero 2) mgl 3) 2mgl 4) mgl/2

24. A block of mass 'M" is being lowered with the help of a string with an acceleration 'g/2, through distance d. The work done by the string on the block will be

1) $-\frac{Md}{2}$ 2) $\frac{Md}{2}$ 3) $\frac{Mgd}{2}$ 4) $-\frac{Mgd}{2}$

25. When a body is stationary

1) there is no force acting on it
2) the forces acting on it are not in contact with it
3) the forces acting on it balance each other
4) the body is in vacuum

PRACTICE SET - II KEY

01) 2	02) 4	03) 4	04) 2	05) 2
06) 1	07) 1	08) 3	09) 3	10) 4
11) 3	12) 1	13) 3	14) 3	15) 3
16) 2	17) 2	18) 4	19) 4	20) 3
21) 1	22) 2	23) 2	24) 4	25) 3

**ALL POWER IS WITHIN YOU
YOU CAN DO ANY THING
AND EVERY THING**

PRACTICE SET - III

01. If K.E. of a body increases by 21% what is the % increase in momentum

1) 10% 2) 30% 3) 20% 4) 40%

02. A motor is pumping water with a velocity of 20 m/s from a pipe of cross sectional area 10cm². Its average power is

1) 20k watt 2) 4 k watt
3) 12 k watt 4) 6 k watt

03. A body is projected vertically downwards with a certain velocity from certain height. During the impact with the ground it loses 50% of energy and then raises back to same height. The initial height at which it is projected down is 10 m. the velocity with which it is projected down is

1) 7 m/s 2) 14 m/s
3) 2 m/s 4) 12 m/s

04. A spring is held vertically and if a load is attached to it, it elongates through a distance 'd'. If the body attached to the spring is allowed to fall freely. The maximum compression produced in the spring is

1) 3d 2) 2d 3) d/2 4) d

05. A motor is used to lit water from a well of depth 10 m. it fills a tank of capacity 2m x 3m x4m in 5 min. if 20% energy is wasted in overcoming fictional losses power of the engine is

1) 100 w 2) 10^4 w 3) 1000w 4) 10w

06. A block of mass 2 kg is allowed to fall from a height of 40 cm onto a vertical spiral spring of constant 1960 N/m. the max compression produced is

1) 0.1 cm 2) 100 cm
3) 10 cm 4).01 cm

07. A block of mass 10 kg is to be raised from the bottom to the top of a smooth incline of inclination 30^0 and length 5m. work done

1) 245 Joule 2) 250 Joule
3) 240 Joule 4) 975 Joule

08. A uniform chain of mass m and length L is held on a smooth over its edge. Work to be done to pull the hanging part back on the table

1) mgL/5 2) mgL/10
3) mgl/6 4) mgl/50

09. A running man has one fourth kinetic energy that a boy of half his mass has. Then the velocity of the body is

1) 4 times the velocity of the man
2) 2 times the velocity of the man
3) equal to that of the man
4) $2\sqrt{2}$ times the velocity of the man

10. A particle of mass 2kg starting from rest moves with an acceleration $2m/s^2$ for two seconds. The gain in K.E. of the body is

1) 16 Joule 2) 8 Joule
3) 3.4 Joule 4) 2 Joule

11. The mass of a body is halved and velocity is doubled. Percentage increase in the K.E. of the body is

1) 400% 2) 300%
3)200% 4) 100%

12. Two spheres of different materials are in motion. If their densities are in the ratio 1 : 2 radii are in the ratio 1 : 2 and velocities are in the ratio 2:1 their kinetic energies are in the ratio

1) 1:4 2) 4:1 3) 1:1 4) 8:1

13. One KW is equal to

1) 3600 J 2) 36×10^5 J
3)1000 W 4) 36×10^5 W

14. A river is flowing at a speed $4ms^{-1}$. The K.E. of cubic meter of water is

1) 8 J 2) 800 J 3) 1600 J 4) 8000 J

15. The K.E. of a body is twice its momentum velocity of the body is

1) $4ms^{-1}$ 2) $1ms^{-1}$ 3) $2ms^{-1}$ 4) $\sqrt{4}ms^{-1}$

16. When a spring is compressed by 3 cm its P.E. is U. its P.E. when it is compressed by 6cm

1) U 2) 2U 3) 3U 4) 4U

17. A knife edge of mass m is dropped from a height h onto a wooden block. If it penetrates through distance 's' in the block, the resistance offered by the block is

1) mgh/s 2) mgs/h 3) s/mgh 4) none

18. The potential developed in elongating a spring is 'V'. If it is elongated 'n' times, the potential is

1) V 2) V/n 3) nV 4) n^2V

19. When a bullet from the gun explodes in air is K.E

1) decreases 2) increases
3) does not change 4) none

20. When a ball of mass m strikes a bat and rebounds with the same velocity, change in its K.E is

1) 1/2 mv^2 2) mv^2
3) 0 4) 3/2 mv^2

21. The area of the force-displacement curve gives

1) Impulse 2) work
3) power 4) acceleration

22. A body is falling freely. Which of the following is a constant of motion ?

1) $gh+\frac{1}{2}v^2$ 2) $gh-\frac{1}{2}v^2$
3) gh 4) mgh

23. The momentum of a body of mass 'm' is 'p'. Its K.E is

1) $\frac{1}{2}mp^2$ 2) $\frac{p^2}{m}$ 3) $\frac{p^2}{2m}$ 4) $\frac{2p^2}{m}$

24. Which of the following possesses K.E.?

1) Flowing water 2) A body kept at a height
3) A stretched string
4) A block placed on the table

25. A body moving along a circular path with uniform speed covers a distance 15 m. If the centripetal force acting on it is 10 N, the work done by the force is

1) zero 2) 150 J 3) 75 J 4) 300 J

PRACTICE SET - III KEY

01) 1	02) 2	03) 2	04) 2	05) 2
06) 3	07) 1	08) 4	09) 4	10) 1
11) 4	12) 1	13) 2	14) 4	15) 1
16) 4	17) 1	18) 4	19) 2	20) 3
21) 2	22) 1	23) 3	24) 1	25) 1

SELF TEST

01. A) When a body is thrown into air, at its maximum height its KE is zero always.
B) If a body is moved along a rough circular path in the horizontal plane, work done by the force applied is zero

1) A is true, B is false 2) A is false, B is true
3) Both A and R are true
4) Both A and B are false

02. A constant force is applied on a 10kg mass at rest. The ratio of works done is 1st, 2nd and 3rd second is

1) 1 : 2 : 3 2) 1 : 3 : 5 3) 1 : 4 : 9 4) 1 : 1 : 1

(Hint : $W \propto s_{n^{th}} \propto \left(n-\frac{1}{2}\right)$)

03. A uniform chain of mass 'm' and length 'ℓ' is kept on horizontal table with half of its length hanging freely from one end. The workdone in allowing only 1/4th of chain hanging from the edge is

1) $\frac{mg\ell}{8}$ 2) $\frac{mg\ell}{32}$ 3) $\frac{3mg\ell}{32}$ 4) $\frac{mg\ell}{16}$

(Hint : $w=\frac{mg\ell}{2n^2}=\frac{mg\ell}{2}\left(\frac{1}{2^2}-\frac{1}{4^2}\right)$)

04. If 10 J of work is done to turn a vertically suspended rod through 60^0 from its mean position. The additional work to be done to turn it further through 120^0 is

1) 30 J 2) 20 J 3) 10 J 4) 40 J

05. A bucket filled with water having a mass of 15 kg is raised from a well of depth 12m with the help of a rope. If the work done to do so is 2160J, the linear density of the rope is (g = 10 ms^{-2})

1) 0.2 kg/m 2) 0.1 kg/m
3) 1 kg/m 4) 0.5 kg/m

(Hint : $W=Mgh+\frac{1}{2}mgh$)

06. A body constrained to move in y-direction is subjected to a force given by : $\vec{F}=\left(-2\hat{i}+15\hat{j}+6\hat{k}\right)N$. The work done by this force in oving the body a distance of 10m along the x-axis is

(Hint : $W=F_x\times d=(-2)(10)$)

1) –20J 2) 150 J 3) –150 J 4) 20 J

07. A spring of force constant 1000 Nm^{-1} is stretched by 4 cm. The work done in stretching it further by 4 cm is

1) 12 J 2) 0. 8 J 3) 4. 8 J 4) 2. 4 J

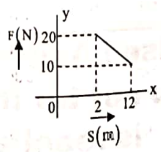
(Hint : $W=\frac{1}{2}kx^2$)

08. A body of mass 6 kg in under a force which causes displacement $S=\frac{t^2}{4}$ meters. Where 't' is time, then the workdone by the force in 2 seconds is

1) 12 J 2) 9 J 3) 6 J 4) 3 J

(Hint : W = mas where $a=\frac{d^2s}{dt^2}$)

09. The force-displacement graph is shown in the figure. The work done is



1) 252 N 2) 27.5 N 3) 150 J 4) 110 J
(Hint : W = Area under the graph

10. A rectangular wooden block of dimensions 50cm, 20 cm and 10 cm is with its larger surface in constant with a horizontal table. The amount of workdone to keep with smaller surface in contact with the table is

($d_{wood}=2000\ kg/m^3, g=10\ ms^{-2}$))

1) 20 J 2) 40 J 3) 60 J 4) 80 J

(Hint : $W=mg\left(\frac{50}{2}-\frac{10}{2}\right); W=vdg(25-5)$)

11. Water in a river is flowing at a speed of 4 ms^{-1}. The kinetic energy per cubic meter of water is,

1) 8 J/m^3 2) 800 J/m^3
3) 1600 J/m^3 4) 8000 J/m^3

(Hint : $KE=\frac{1}{2}mv^2 \Rightarrow \left(\frac{KE}{V}\right)=\frac{1}{2}\rho v^2$)

12. A body of mass 2kg, initially at rest, is acted upon simultaneously by two forces, one of 4N and the other of 3N, acting at right angles to each other. The kinetic energy of the body after 20 s is

1) 500 J 2) 1250 J 3) 2500 J 4) 5000 J

(Hint: $F_R=5N$;

$KE=\frac{1}{2}mv^2=\frac{1}{2}m(at)^2=\frac{1}{2}m\left(\frac{F_R}{m}t\right)^2$)

13. If the momentum of a body is increased by 50%, its kinetic energy will increase by

1) 100% 2) 125 % 3) 150 % 4) 200 %

(Hint: $KE \propto p^2$)

14. A body is projected vertically up. At certain height 'h' above the ground, its PE and KE are in the ratio 1 : 4. Then at what height above the ground PE and KE will be in the ratio 4 : 1

1) h/4 2) 5h 3) h/5 4) 4h

(Hint : $\frac{PE}{KE}=\frac{h}{H-h}=\frac{1}{4}; \frac{h^1}{H-h^1}=\frac{4}{1}$)

15. When a body is thrown vertically upwards with a velocity of 50 m/s. The percentage of its kinetic energy converted into potential energy after 4 seconds is $(g = 10\ ms^{-2})$

1) 96% 2) 50% 3) 24% 4) 4%

(Hint ; $1-\left(\frac{V_2}{V_1}\right)^2 \times 100$ where $V_2 = V_1 - gt$)

16. A stone is projected vertically up reaches a maximum height 'h'. The ratio of P.E to K.E at a height of 'h/5' from the ground is

1) 1 : 5 2) 3 : 4 3) 1 : 4 4) 4 : 5

(Hint : $\frac{PE}{KE} = \frac{h}{H-h}$)

17. A body falls from a height of 10 m and rebounds from a hard surface to a height of 8m. The percentage loss of energy during the collision is

1) 40 % 2) 20 % 3) 50% 4) 100 %

(Hint : % loss = $\frac{h_2 - h_1}{h_1} \times 100$)

18. A body of mass 'm' thrown vertically upwards attains a maximum height 'h'. The height at which its K.E. be 75% of its initial value is

1) h/6 2) h/5 3) h/4 4) h/3

19. Two trucks, one loaded (A) and other unloaded (B) are moving and have same kinetic energy. The mass of A is doubled that of B. Breaks are applied to both and are brought to rest. If distance covered by A before coming to rest is s_1 and that by B is s_2, then (Hint : $KE = F.S$)

1) $s_1 = s_2$ 2) $s_1 = 2s_2$ 3) $2s_1 = s_2$ 4) $s_1 = 4s_2$

20. A ball is thrown downwards from a height with a velocity $\sqrt{4gh}$. The ball losses 50% of its velocity upon impact with the ground. The height to which the ball would rise after the impact is

1) 3h/4 2) 3h/2 3) 2h 4) h

(Hint : $mgh + \frac{1}{2}m\left(\sqrt{4gh}\right)^2 = 3mgh \therefore mgx = \frac{1}{4}(3mgh)$)

21. A body is allowed to fall freely from a height h. Then match the following energies with the heights from the ground.

List - I	List - II
a) $K.E = PE$	e) $\frac{4h}{5}$
b) $K.E = \frac{1}{4}PE$	f) $\frac{2h}{3}$
c) $\frac{1}{4}K.E = PE$	g) $\frac{h}{2}$
d) $K.E = \frac{1}{2}PE$	h) $\frac{h}{5}$
	i) 3h

1) a-g, b-e, c-h, d-f 2) a-g, b-i, c-f, d-h
3) a-h, b-e, c-g, d-f 4) a-f, b-h, c-g, d-e

22. If a man increases his speed by 2 m/s, his kinetic energy is doubled. The original speed of the man is

(Hint : $K.E = \frac{1}{2}mv^2, \frac{1}{2}m(v+2)^2 = 2KE$)

(1) $\left(1+2\sqrt{2}\right)m/s$ (2) 4 m/s

(3) $\left(2+2\sqrt{2}\right)m/s$ (4) $\left(2+\sqrt{2}\right)m/s$

23. A man carries a load of 50 kg to a height of 40 m in 25 s. If the power of the man is 1568 W, the mass of the man is :

1) 20 kg 2) 50 kg 3) 100 kg 4) 75 kg

(Hint : $P = \frac{(M+m)\times gh}{t}$)

24. Two men with weights in the ratio 5 : 3 run up a staircase in times in the ratio 11 : 9. The ratio of power of first to that of second is

1) 15/11 2) 11/15 3) 11/9 4) 9/11

Araise ! Awake ! And stop not till the goal is reached

25. An electric pump on the ground floor of a building take 10 minutes to fill a tank of volume $30m^3$ with water. If the tank is 60m above the ground and the efficiency of the pump is 30%. How much electric power is consumed by the pump in filling the tank ? (Take $g = 10\ ms^{-2}$)

1) 100 KW 2) 150 KW
3) 200 KW 4) 250 KW

(Hint : 30% of $P = \frac{(V\rho)gh}{t}$)

26. A train weighing 1000 ton is movuing on a horizontal track with a uniform velocity of 10 ms^{-1}. The total resistance to the motion of the train is 5 Kg wt perton. If $g = 10\ ms^{-2}$, then the power of the engine is (Hint : $P = Fv$)

1) 200 KW 2) 400 KW
3) 500 KW 4) 800 KW

27. The power required to push a body of mass 60 Kg up an incline of 30^0 at a uniform speed of 4 m/s is

(Hint : $P = (mg\sin\theta)$V)

1) 120 W 2) 240 W
3) $588\sqrt{3}$ W 4) 1176 W

28. Power applied to a particle varies with time as $P = \left(3t^2 - 2t + 1\right)$ watt, where t is in second. The change in its kinetic energy between time t =2 sec, and t = 4 sec. is

(Hint :
$KE = W = \int p(t)dt, KE = \int_2^4 \left(3t^2 - 2t + 1\right)dt$)

1) 32 J 2) 40 J 3) 61 J 4) 102 J

29. A simple pendulum of length 20 cm and of mass 0.1 kg is pulled to one side through an angle 'θ' and released. If its maximum velocity is 1.4 ms^{-1}, the value of 'θ' is

1) 30^0 2) 45^0 3) 60^0 4) 90^0

(Hint ; $mgl(1-\cos\theta) = \frac{1}{2}mv^2$)

30. A machine gun fires 360 bullets per minute. Each bullet moves with a velocity of 600 ms^{-1}. If the power of the gun is 5.4 kW, then the mass of bullet is

(Hint : $P = \frac{\frac{1}{2}mnv^2}{t}$)

1) 5 kg 2) 0.5 kg 3) 0.05 kg 4) 0.005 kg

31. A body of mass m accelerates uniformly from rest to a velocity υ_0 in time t_0. The instantaneous power delivered to the body at any time t is

1) $\frac{m\upsilon_0 t}{t_0}$ 2) $\frac{m\upsilon_0^2 t}{t_0}$ 3) $\frac{m\upsilon_0 t^2}{t_0}$ 4) $\frac{m\upsilon_0^2}{t_0^2}t$

(Hint : $a = \frac{v_0}{t_0}, v =$ at and P = m a v)

32. A running man has half the kinetic energy of a body of half his mass. The man speeds up by 1.0 ms^{-1} and then has the same kinetic energy as the boy. The original speed of the boy was

1) 2.4 ms^{-1} 2) 9.6 ms^{-1}

3) 4.8 ms^{-1} 4) 7.2 ms^{-1}

(Hint : $KE_{man} = \frac{1}{2}KE_{boy}, M_{boy} = \frac{1}{2}M_{man}$,

and $\frac{1}{2}M_{man}\left(V_{man}+1\right)^2 = \frac{1}{2}M_{boy}V_{boy}^2$)

33. A body is projected downwards with certain velocity from a power of height 10 m on stricking ground it losses 50 % of it's energy and rebounds to same height. The velocity with which it is projected down is

1) 7 m/sec 2) 14 m/sec 3) 21 m/sec 4) 12 m/sec

(Hint : $Mgh = 50\%$ of

$\left(Mgh + \frac{1}{2}MV^2\right) \Rightarrow V = \sqrt{2gh}$)

34. A body is projected vertically up with an energy 'E'. The potential energy of the body at a tpoint 'P' in its path is 'U'. If the body were projected with double the velocity, the kinetic energy of the body at the same point 'P' is
(1) E - U (2) 2 E-U (3) 4E - U (4) E + U
(Hint : When velocity is doubled, the total energy becomes 4 times)

35. A body moves along a straight line by a machine delivering constant power. The distance moved by the body in time 't' is proportional to
1) $t^{1/2}$ 2) t^2 3) $t^{4/3}$ 4) $t^{3/2}$
(Hint : $P=\frac{mas}{t}$ (or) $P=\frac{ms^2}{t^3}$ (or) $s^2\alpha t^3$)

36. A body of mass 'm' is dropped from a height 'h' on a sand floor. If the body penetrates 'x' cm into the sand, the average resistance offered by the sand to the body is
1) $mg\left[1-\frac{h}{x}\right]$ 2) $mg(h+x)$
3) $mg\left[1+\frac{h}{x}\right]$ 4) $mg\frac{h}{x}$
(Hint : $mg(h+x)=F.x$)

37. If a freely falling body loses x units of potential energy and gains a velocity 'V'. The mass of body is
1) $\frac{2x}{V^2}$ 2) $\frac{x^2}{2V}$ 3) $\frac{2g}{V^2}$ 4) $2gV^2$
(Hint: According to L.C.E
loss in P.E. = Gain in KE $X=\frac{1}{2}mv^2$)

38. A body is projected vertically upwards with some velocity. At a point 'p' on its path, the ratio of PE to KE is 9 : 16, then the ratio of velocity of projection to the velocity at that point 'p' is
1) 3 : 4 2) 5 : 4 3) 9 : 25 4) 25 : 16
(Hint : According to L.C.E.
$\frac{\text{Total Energy (KE) of the point of projection}}{\text{K.E at the point P}}=\frac{25}{16}$)

39. A bdoy projected vertically up with a velocity of $20\,ms^{-1}$ returns to the ground with a velocity of $18\,ms^{-1}$. The maximum height attained by the body is $\left(g=10\,ms^{-2}\right)$)
1) 12 . 1m 2) 22.5m 3) 25 m 4) 18.1 m

SELF TEST KEY

01) 4	02) 2	03) 3	04) 2	05) 4
06) 1	07) 4	08) 4	09) 3	10) 2
11) 4	12) 3	13) 2	14) 4	15) 1
16) 3	17) 2	18) 3	19) 3	20) 1
21) 1	22) 3	23) 2	24) 1	25) 1
26) 3	27) 4	28) 2	29) 3	30) 4
31) 4	32) 3	33) 2	34) 3	35) 4
36) 3	37) 1	38) 2	39) 4	

PREVIOUS ECET BITS

2007

01. If a gun of mass 40 kg fires a bullet of mass 0.01 kg with a velocity of 400 m/sec, then the recoil velocity of the gun is :
1) $-0.01\,m/\sec$ 2) $0.01\,m/\sec$
3) $0.1\,m/\sec$ 4) $-0.1\,m/\sec$

02. If a shell of mass M moving with a velocity V breaks into two fragment. One of the mass m comes to rest. Then the velocity of second fragment is :
1) $\frac{M+m}{mV}$ 2) $\frac{M-m}{mV}$
3) $\frac{MV}{M-m}$ 4) $\frac{MV}{M+m}$

03. The work done in taking a body of mass m to a height to the radius of the earth R :
1) $\frac{mgR}{2}$ 2) mgR 3) $2mgR$ 4) zero

04. A motor pumpset lifts 80 kg of water per minute from a well of depth 20 m and delivers to a height of 10 m, then its power is :
1) 3.92 kW 2) 39.2 kW
3) 0.392 kW 4) 3920 kW

05. A particle moves along half the circumference of a circle of 0.1 m radius. What is the work done if the force acting on the particle at any point has a magnitude of 0.5 N and is inclined at 60^0 to the tangent at the point ?
1) 0.00785 J 2) 0.0785 J
3) 0.785J 4) 7.85 J

06. If the kinetic energy of a given particle is doubled, its momentum will be :
1) Doubled 2) Decreased by $\sqrt{2}$ times
3) Increased by 2 times
4) Increased by $\sqrt{2}$ times

07. Two bodies of masses 3 kg and 4 kg have same momenta. Kinetic energy of 4 kg mass is 12 J. Then kinetic energy of 3 kg mass is :
1) 0.16 J 2) 1.6 J 3) 16 J 4) 160 J

2009

08. A running man has $1/4^{th}$ kinetic energy that a boy of half his mass. Then the velocity of the body is
1) 2 times the velocity of the man
2) $4\sqrt{2}$ times the velocity of the man
3) $2\sqrt{2}$ times the velocity of the man
4) none

09. A ball is dropped from 30 meters height. On hitting the ground if it loses 30% of its energy, then it rebounds to a height equal to
1) 9 m 2) 18 m 3) 3 m 4) 21 m

10. If the kinetic energy of a body becomes four times of its initial value, then the new momentum will be
1) four times the initial value
2) three times the initial value
3) twice its initial value 4) unchanged

11. In a nuclear fusion process, four protons are fused to form a helium nucleion. During this process it releases energy of
1) 1 MeV 2) 27.6 MeV
3) 26.7 MeV 4) 26.7 Joules

2010

12. 1 Joule of work is equal to
1) 10^{-7} ergs 2) 10^7 ergs
3) 10^5 ergs 4) 10^{-5} ergs

13. A box weighing 0.1 kg is moved 2 metres along the ground by a force of 20 newtons making an angle of 60^0 with the horizontal. The net work done is
1) 40 Joules 2) 200 Joules
3) 4 Joules 4) 20 Joules

14. A force of 40 newtons pulls a 20 kg box through 8 meters on a smooth floor at a constant speed. If the force is directed at 60^0 above the horizontal, then the work done by the force is
1) 160 Joules 2) 320 Joules
3) 68 Joules 4) 800 Joules

15. If the kinetic energy of a body becomes four times of its initila value, then the new momentum will be
1) three times the initial value
2) four times its initial value
3) twice its initial value
4) unchange

16. A 20 kg block moves with a constant speed of $10\,m/\sec$ on a smooth horizontal surface. The work done on the block is
1) Zero 2) 200 Joules
3) 196 Joules 4) 980 Joules

2011

17. A force of 20 N acts on a body of mass 1 kg at rest. The work done in 8 sec is
1) 6400 J 2) 3200 J
3) 12800 J 4) 19200 J

18. A bomb of mass 12 kg explodes into two pieces of mass 4 kg and 8 kg. Velocity of 8 kg mass is 6m/sec. Find the kinetic energy of other mass
1) 288 J 2) 388 J
3) 488 J 4) 588 J

19. When a force acts on a body
1) Its kinetic energy increases
2) its kinetic energy decreases
3) its potential energy decreases
4) its potential energy increases

20. A girl of mass 40kg slips at the rate of 10 skips per minute through an average height of 0.25m. Find the power developed (take $g = 10\ m/s^2$)
1) 10.66 W 2) 12.66W
3) 14.66W 4) 16.66 W

21. The slope of the time and work graph gives
1) work 2) power
3) energy 4) change in momentum

22. A particle moves from position $3\bar{i} + 2\bar{j} - 6k$ to $14\bar{i} + 13\bar{j} - 9k$ due to a uniform force of $4i + j + 3kN$. Find the work done if the displacement its in meters.
1) 46 J 2) 100 J
3) 150 J 4) 200 J

2012

23. The linear momentum of a particle varies with time t as $p = a + bt + ct^2$ which of the following is correct ?
1) Force varies with time in a quadratic manner
2) Force is time - dependent
3) The velocity of the particle is proportional to time
4) The displacement of the particle is proportional to t.

24. A shell of mass m moving with a velocity v suddenly explodes into two pieces. One part of mass m/4 remains stationary. The velocity of the other part is
1) v 2) $2v$
3) $3v/4$ 4) $4v/3$

25. In a perfectly inelastic collision, the two bodies
1) strike and explode 2) explode without striking
3) impode and explode
4) combine and move together

26. Under the action of constant force a particle is experiencing a constant acceleration, then the power is
1) zero 2) positive 3) negative
4) increasing uniformly with time

27. Consider the following two statements :
A : Linear momentum of a system of particles is zero
B : Kinetic energy of a system of particles is zero
Then
1) A implies B & B implies A
2) A does not imply B & B does not imply A
3) A implies B but B does not imply A
4) A does not imply B but B implies A

28. An engine develops 10 kW of power. How much time will it take to lift a mass of 200 kg to a height of 40 m ? (Given $g = 10\ ms^{-2}$)
1) 4s 2) 5s 3) 8s 4) 10s

2013

29. A body of mass 5 kgs moving along a straight line is accelerated from $4 ms^{-1}$ to $8 ms^{-1}$ with the application of a force of 10N in the same direction. Then the workdone by the force is
1) 120 Joules 2) 60 Joules
3) 240 Joules 4) 30 Joules

30. A car without passengers moving with certain velocity on a travel ground can be stopped in a distance of 10m. If the passengers add 25% of its weight, its stopping distance for the same braking force and velocity is (ignore friction)__
1) 15 m 2) 10 m
3) 7.5 m 4) 12.5 m

2014

31. A block of mass M is lying on a horizontal frictionless surface. One end of a rope mass m is fixed to the block and force F is applied at the free end parallel to the surface. The force acting on the block will be
1) FM / (M - m) 2) Fm / (M + m)
3) FM / (M + m) 4) F

32. A boy wants to climb down a rope. The rope can withstand a maximum tension equal to two-thirds the weight of the boy. If g is the acceleration due to gravity, the minimum acceleration with which the boy should climb down the rope is
1) g/3 2) 2g/3 3) 3g/2 4) g

33. N bullets each of mass m kg are fired with a velocity v m/s, at the rate of n bullets per second, upon a wall. The reaction offered by the wall to the bullets is given by
1) nNv/m 2) $nNmv$
3) Nmv/n 4) nNm/v

34. A machine gun fires a bullet of mass 40 g with a velocity of 1200 m/s.The man holding it can exert a maximum force fo 144 N on the gun. The number of bullets he can fire per second is __
1) 4 2) 1
3) 3 4) 8

35. A uniform rod of mass m and length l is made to stand vertically on one end. The potential energy of the rod in this position is ___
1) mgl/4 2) mgl/2
3) mgl 4) mgl/3

36. If momentum is increased by 20%, the kinetic energy increases by
1) 44% 2) 77%
3) 55% 4) 66%

T.S - ECET - 2015

37. A body of mass 2 kg is kept stationary by pressing to a vertical wall by a force of 100 N. The coefficient of friction between wall and body is .3 . Then the frictional force is equal to
1) 6 N 2) 20 N 3) 600 N 4) 700 N

38. A picture hall has a volume of 8000 m^3. It is required to have reverberation time of 1.5 seconds. The total absorption in the hall is
1) 440 OWU 2) 880 OWU
3) 1980 OWU 4) 72.72 OWU

39. The problem of echelon effect can be removed by using
1) iron board 2) stair carpet
3) coir 4) wooden board

40. Doppler effect is applicable when the velocities of the source of sound and the observer are
1) more than velocity of light
2) equal to velocity of light
3) less than velocity of light
4) not comparable with velocity of light

A.P - ECET - 2015

41. If F, U and X are the force acting on a particle, the potential energy and the displacement respectively, then
1) $F = -\left(\frac{dU}{dX}\right)$ 2) $F = -\left(\frac{dX}{dU}\right)$
3) $F = \frac{1}{X}\left(\frac{dU}{dX}\right)$ 4) $F = UX$

42. A bomb of mass 9 kg explodes into pieces of 3 kg and 6 kg. The velocity of 3 kg piece is 16 m/s. The kinetic energy of 6 kg piece is
1) 192 J 2) 786 J 3) 768 J 4) 687 J

43. Which of the following choices best describes or defines BIOMASS
1) massive living things
2) inorganic matter that can be converted to fuel
3) petroleum
4) organic matter that can be converted to fuel

44. A bullet of mass 0.04 kg moving with a speed of 90 m/s enters a heaby wooden block and is stopped after a distance of 60 cm. The average resistive force exerted by the block on the bullet is
1) 972 N 2) 2700 N 3) 27 N 4) 270 N

T.S - ECET - 2016

45. The mass of a person in kg, if the work done in carrying a box of mass 20 kg through a vertical height of 10 m is 9800 J is $\left(g = 9.8ms^{-2}\right)$
1) 80 2) 40 3) 60 4) 70

46. The horse power of the engine required to lift 0.54×10^6 kg of coal in 30 minutes from a mine of 37.3 m deep is $\left(g = 9.8ms^{-2}\right)$
1) 294 2) 588 3) 688 4) 147

47. In hydroelectric stations
1) kinetic energy is converted into heat energy
2) potential energy is converted into electrical energy
3) kinetic energy is converted into electrical energy
4) kinetic energy is converted into potential energy

A.P-ECET-2016

48. A man carries a load of 50 kg through a height of 40m in 25s. If the power of the man is 1568W, his mass is $\left(Assume\ g = 9.8 ms^{-2}\right)$

1) 150kg 2) 75kg 3) 50kg 4) 100kg

49. A 5 kg mass is dropped from a height. The kinetic energy of the mass at the end of third second of its travel is $\left(Assume\ g = 9.8 ms^{-2}\right)$

1) 2161J 2) 21.61J 3) 2.161J 4) 0.2161J

50. Which of the following law is called the law of inertia

1) newton's second law 2) newton's first law
3) newton's third law 4) conservation law

T.S-ECET-2017

51. Two springs of spring constants 1000 N/m and 1500 N/m respectively are stretched with a same force. Their potential energies will be in the ratio of

1) 2:3 2) 1:3 3) 3:2 4) 2:1

52. The mass of a body at the centre of earth is

1) less than that at the surface
2) remain constant
3) more than that at the surface
4) zero

A.P-ECET-2017

53. A cyclist comes to a skidding stop in 10m. During this process, the force on the cycle due to the road is 200N and is directly opposed to the motion. The work done by the road on the cycle is

1) 1000J 2) 2000J 3) -1000J 4) -2000J

54. A sphere of mass 4 kg is dropped from a certain height. After 5s, its kinetic energy is $\left(g = 10 m/s^2\right)$

1) 5J 2) 50 J 3) 5 KJ 4) 50 KJ

55. An elevator weighing 500 kg is to be lifted up at a constant velocity of 0.20 m/s. What would be the minimum power of the motor to be used

1) 100W 2) 500 W 3) 980 W 4) 900 W

T.S-ECET-2018

56. The potential energy at a point r when a particle is moving under the central force $F = -Kr^2$ is_____

1) K^2/r 2) K/r 3) K/r^2 4) -K/r

57. When the body is acted upon by a resultant force, then work done by the resultant force is equal to_____

1) its intial kinetic energy
2) its initial potential energy
3) change in the kinetic energy
4) change in momentum

58. A jet engine works on the principle of_____

1) conservation of energy
2) conservation of mass
3) conservation of linear momentum
4) conservation of angular momentum

A.P-ECET-2018

59. A man weighing 60 kg eats plum cake whose energy content is 9800 calories. If all this energy could be utillsed by him, he can ascend to a height of

1) 17 m 2) 100 m 3) 70 m 4) 60 m

60. A crane can lift up 10,000kg of coal in 1 hour from a mine of depth 180m. If the efficiency of the crane is 80%, its input power must be $\left(g = 10 ms^{-2}\right)$

1) 62.5 kW 2) 6.25 kW
3) 50 kW 4) 5 kW

PREVIOUS ECET BITS KEY

01) 3	02) 3	03) 1	04) 3	05) 2
06) 4	07) 3	08) 3	09) 4	10) 3
11) 3	12) 2	13) 4	14) 1	15) 3
16) 1	17) 3	18) 1	19) 1	20) 4
21) 2	22) 1	23) 3	24) 4	25) 4
26) 4	27) 1	28) 3	29) 1	30) 4
31) 3	32) 1	33) 2	34) 3	35) 2
36) 1	37) 2	38) 1	39) 1	40) 3
41) 1	42) 1	43) 4	44) 4	45) 1
46) 4	47) 2	48) 3	49) 1	50) 2
51) 3	52) 2	53) 4	54) 3	55) 3
56) 2	57) 3	58) 3	59) 3	60) 2

PREVIOUS ECET BITS HINTS AND SOLUTIONS

01. Recoil velocity of a gun $= \frac{mv}{M}$

$$= \frac{0.01 \times 400}{40} = 0.1 m/sec$$

02. According to law of conservation of linear momentum:

$$MV = m(0) + (M-m)v$$

velocity of second fragment $v = \frac{MV}{M-m}$

03. $\frac{mgR}{2}$

04. $P = \frac{work}{time}$; given

m = 80 kg; g = 9.8 m/s²
h = 20 + 10 = 30 m
t = 1 min = 60 sec

$$P = \frac{mgh}{60}$$

$$= \frac{80 \times 9.8 \times 30}{60} = 0.392 \text{ kw.}$$

05. Given

r = 0.1 m; F = 0.5 N; $\theta = 60^0$; $S = \prod r$

$W = FS \cos \theta$

$= 0.5 \times 3.14 \times 0.1 \times \cos 60^0 = 0.0785$ J.

06. Increased by $\sqrt{2}$ times

07. $K.E \propto \frac{1}{m}$

$$\frac{E_1}{E_2} = \frac{m_2}{m_1} = \frac{E_1}{12} = \frac{4}{3}$$

$E_1 = 16J$

08. $\frac{1}{2} m V_{man}^2 = \frac{1}{2}\frac{m}{2} V_{body}^2$

$V_{body}^2 = 8V_{man}^2$

$V_{body} = 2\sqrt{2}V_{man}$

09. Energy = mgh

energy $\propto$ height.

$\therefore$ 30% of energy loss means, 30% of height losses while it rebounce.

Loss of height $= \frac{30 \times 30}{100} = 9m$

Height of rebounce = 30-9 = 21m

10. $K.E \propto p^2$

$$\frac{E}{4E} = \frac{P^2}{P_2^2} \Rightarrow P_2 = 2P$$

11. 26.7 MeV

12. 10^7 ergs

13. $W = FS\cos\theta = 20 \times 2 \times \frac{1}{2} = 20J$

14. $W = FS\cos\theta = 40 \times 8 \times \frac{1}{2} = 160J$

15. $K.E \propto P^2$ $\frac{E}{4E} = \frac{P^2}{P_2^2}$

$P_2^2 = 4P^2$

$P_2 = 2P$

twice its initial value

16. zero

17. F = ma

$$a = \frac{20}{1} = 20 m/s^2$$

$$v = u + at \Rightarrow 0 + 20 \times 8 = 160 m/s$$

$$\text{work} = \frac{1}{2}mv^2 = \frac{1}{2} \times 1 \times 160^2 = 12800J$$

18. According to law of conservation of momentum

$0 = 8 \times 6 + 4V$
V = 12 m/s

$$K.E = \frac{1}{2}mV^2$$

$$= \frac{1}{2} \times 4 \times (-12)^2 = 288J$$

19. Its kinetic energy increases

20. $P=\frac{W}{t}=\frac{mgh}{t}=\frac{40\times10\times(0.25\times10)}{60}$

$=16.66w$

21. power

22. $s=14i+13j-9k-(3i+2j-6k)$

s = 11i + 11j - 3k

F = 4i + j + 3k

W = F.S

W = 44 + 11 - 9

= 46 J.

23. The velocity of the particle is proportional to time

24. According to law of conservation of linear momentum

$mv=\frac{m}{4}(0)+(m-\frac{m}{4})v$

$mv=\frac{3m}{4}v \qquad v=\frac{4v}{3}$

25. combine and move together

26. increasing uniformly with time

27. A implies B & B implies A

28. $P=\frac{w}{t}\Rightarrow t=\frac{w}{p}=\frac{200\times10\times40}{10\times10^3}=8s$

29. $w=\frac{1}{2}m(v_2^2-v_1^2)$

$=\frac{1}{2}\times5(8^2-4^2)=120J$

30. $\frac{1}{2}mv^2=F\times s$

velocity, force & $\frac{1}{2}$ are constants

$S\propto m$

$\frac{s_1}{s_2}=\frac{m_1}{m_2} \qquad \begin{bmatrix} m_1=m \\ m_2=m+\frac{m}{4}=\frac{5m}{4}\end{bmatrix}$

$\frac{10}{s_2}=\frac{m}{\frac{5m}{4}}$

$s_2=12.5m$

31. F = (M+m)a $\qquad a=\frac{F}{M+m}$

$f=Ma\Rightarrow f=\frac{FM}{M+m}$

32. T = m (g-a)

$\frac{2}{3}mg=m(g-a)\Rightarrow a=\frac{g}{3}$

33. F = ma

But $a=\frac{v}{t};\ m^1=Nnm\ \&\ t=1sec$

$F=Nnm\times v \qquad$ F = nNmv

34. F = n m v

$n=\frac{F}{mv}=\frac{144}{\frac{40}{1000}\times1200}=\frac{144}{48}=3$

35. $h=\frac{l}{2}$ *why because*

stand vertically means, displacement while standing is $\left(\frac{l}{2}\right)$ (centre of mass)

$\therefore$ P. E $=\frac{mgl}{2}$

36. $K.E\propto P^2$

$\left(\frac{E_2}{E_1}-1\right)\times100=? \qquad \frac{E_2}{E_1}=\frac{P_2^2}{P_1^2}$

$\frac{E_2}{E_1}=\left(\frac{120P}{100P}\right)^2=\left(\frac{6}{5}\right)^2$

$\left(\left(\frac{6}{5}\right)^2-1\right)\times100=\frac{36-25}{25}\times100=44\%$

37. $f_s=mg=2\times10=20N$

38. FS $\cos\theta=w$

$5\times10\times\cos\theta=25$

$\theta=60^0$

39. $\frac{p_1^2}{p_2^2}=\frac{m_1}{m^2}\Rightarrow\frac{p_1}{p_2}=\sqrt{\frac{m}{4m}}$

$p_1:p_2=1:2$

40. $\frac{E_1}{E_2}=\frac{p_1^2}{p_2^2}\Rightarrow\sqrt{\frac{E}{4E}}=\frac{p_1}{p_2}$

$p_1:p_2=1:2$

$\therefore$ become twice its initial value

41. $F=-\left(\frac{dU}{dX}\right)$

42. Accoreding to law of conservation of linear momentum

$0=3\times16+6v$

v = - 8 $\qquad$ K.E. $=\frac{1}{2}mv^2$

$=\frac{1}{2}\times6\times(-8)^2=192J$

43. Organic matter that can be converted to fuel

44. Average resistive force exerted by the block on the bullet is

$\frac{1}{2}mv^2=Fx\Rightarrow F=\frac{\frac{1}{2}mv^2}{x}$ F = resistive force

x = penetrating distance

$F=\frac{\frac{1}{2}\times0.04\times(90)^2}{0.6}=270$ N

45. $W=(M+m)gh\Rightarrow9800=$

$(M+20)\times9.8\times10\Rightarrow M+20=1w$, M = 80kg

46.

$p=\frac{w}{t}=\frac{mgh}{t}=\frac{0.54\times10^6\times9.8\times37.3}{30\times60}=109662w$

$=\frac{109662}{746}=147HP$

47. In hydroelectric station potential energy is converted in to electrical energy

48. $P=\frac{w}{t}=\frac{(M+m)gh}{t}\Rightarrow$

$1568=\frac{(M+50)\times9.8\times40}{25}\Rightarrow M=50kg$

49. $KE=\frac{1}{2}mv^2$

$v=gt=9.8\times3=29.4m/s$

$KE=\frac{1}{2}\times5\times(29.4)^2=2161J$

50. newton's first law in law of inertia

51.

52. remain constant

53. Given stopping distance = 10m, Force = -200N (opposed to the motion)

work done by road on the cycle is

$W=F\times S$

$=-200\times10$

= - 2000J

54. $V=u+at$

$V=10\times5=50$ m/s

KE $=\frac{1}{2}mv^2$

$\frac{1}{2}\times4\times50\times50$

= 5KJ

55. Power = Force × Velcoity

$=500\times9.8\times0.2$

= 980 Wats

ALL POWER IS WITHIN YOU

YOU CAN DO ANYTHING AND EVERYTHING

SPACE FOR IMPORTANT NOTES

SIMPLE HARMONIC MOTION

SYNOPSIS

PERIODIC MOTION:

- Any motion that repeats itself at regular intervals of time is known as periodic motion.
  Eg : motion of the earth round the sun, osillations of a simple pendulum
- If the particle in periodic motion moves to and fro over the same path, then its motion is called oscillatory or vibratory motion.
- All periodic motions are not simple harmonic but all simple harmonic motions are periodic
- Motion of the earth round the sun is periodic but not simple harmonic. Oscillations of a simple pendulum are simple harmonic. Which are periodic also.

SIMPLE HARMONIC MOTION (SHM)

- If a particle moves along a straight line with its accleration directed towards a fixed point in its path and the magnitude of the acceleration is directly proportional to the displacement from its equilibrium position, then it is known as simple harmonic motion.
  Eg : Oscillations of the bob of a simple pendulum for small amplitude, vertical oscillations of a loaded spring, vibrations of the prongs of an excited tuning fork, particles of the medium during the propagation of sound, oscillations of liquid level in U, tube.
- If the particle executes SHM along a straight line, it is known as linear SHM.
  Eg : Oscillations of loaded spring.
- The necessary and sufficient condition for a motion to be SHM is that the restoring force is directly proportional to the displacement from the mean position (resorting torque proportional to angular displacement in angular SHM)
- When a particle executes SHM,
  restoring force $\propto$ - displacement
  restoring force = - K (displacement)
  Here proportionally constant K is called force constant negative sign suggests that restoring force is in opposite direction with respect to displacement
- For a simple harmonic oscillator,
  Restoring force $\propto$ displacement
  or F $\propto$ - y and F = - Ky
  Here K is force constant
- Force constant = $\dfrac{\text{Restoring force}}{\text{displacement}}$
- For a simple harmonic oscillator
  acceleration $\propto$ - displacement
  $a \propto -y$
  or $a = -\omega^2 y$
  $a + \omega^2 y = 0$ ($\omega \rightarrow$ angular frequency)

$\Rightarrow \frac{d^2y}{dt^2}+\omega^2 y=0$ (Equation in differential form)

CHARACTERISTICS OF S.H.M AND IMPORTANT DEFINITIONS

- a) The motion is periodic
- a) **Displacement :** Change of position of the particle in SHM with respect to mean equilibrium point at any instant of time.

b) **Amplitude :** Maximum in displacement of the particle executing SHM

c) **Phase :** It is that which gives the state of the vibrating particle as regards position and direction of motion at that instant.

d) **Time period :** The time taken by the particle in SHM to complete one oscillation

e) **Frequency :** The number of Oscillations made by the particle in SHM in one second. (Reciprocal of time period is known as frequency (In SI frequency is measured in hertz or cps).

f) **Phase constant :** It is the initial phase of the particle in SHM (also known as epoch)

g) **Restoring force :** The force which acts on the particle in a direction opposite to the direction of its displacement.

DISPLACEMENT EQUATION FOR SHM

- If the particle starts oscillating from mean position

$y = A\sin(\omega t \pm \phi)$

y is displacement at time 't'

A is Amplitude

ω is angular frequency

ϕ is epoch

$(\omega t \pm \phi)$ is the phase angle (at $t=t$)

If the particle starts is used if the particle starts from mean position only)

- The above equation oscillating from the extreme position, we can write the equation for displacement as

$y = A\cos(\omega t \neq \phi)$

- A simple harmonic oscillator has certain displacement at time 't_1'. If the same position is achieved by it first time at time 't_2', then $(t_2 - t_1) = \frac{2\pi}{\omega} = T$ (T is time period).
- If two particles executing SHM cross their mean position in same direction, then they are in same phase of vibration. If they cross the mean position in opposite directions, they are in out of phase.
- Linear combination of two SHMs results SHM again consider two SHMs amplitudes A_1 and A_2 moving along the same line. Let ϕ be the phase difference between those two displacements corresponding those two are given by $y_1 = A_1 \sin\omega t$ and

$y_2 = A_2\sin(\omega t+\phi)$. Due to the linear combination, resulting displacement is given by

$y = y_1 + y_2 = A_1\sin\omega t + A_2\sin(\omega t+\phi)$. $\quad y = A\sin(\omega t+\alpha)$

Here A is amplitude of resultant SHM. α is phase difference between the SHMs with displacement y_1 and y.

$A=\sqrt{A_1^2+A_2^2+2A_1A_2\cos\alpha}$

$\tan\alpha = \frac{A_2\sin\phi}{A_1+A_2\cos\phi}$

If $\phi = 0$, then $y=(A_1+A_2)\sin\omega t$

If $\phi=\pi$, then $y=(A_1-A_2)\sin\omega t$

- If superposition takes place between two SHMs with the same direction same amplitude A but different frequencies,

$y = y_1 + y_2 = A\sin\omega_1 t + A\sin\omega_2 t$

on simplification, we get

$y = 2A\cos\left(\frac{\omega_1-\omega_2}{2}\right)t\sin\left(\frac{\omega_1+\omega_2}{2}\right)t$

$\Rightarrow y = A_0\sin\left(\frac{\omega_1+\omega_2}{2}\right)t$

Here angular frequency of the resultant SHM is $\left(\frac{\omega_1+\omega_2}{2}\right)$. Here amplitude of the resultant SHM is also periodic, angular frequency of amplitude is $\left(\frac{\omega_1-\omega_2}{2}\right)$.

- Two simple harmonic motions are combined perpendicular to each other, and

a) the resultant path is straight line if the phase difference is zero between those two

$x = A\sin\omega t$ and $y = B\sin\omega t$

$\Rightarrow y = \frac{B}{A}x$ which is equation of a straight line.

Here resultant motion is simple harmonic with amplitude $\sqrt{A^2+B^2}$

b) the resultant path is an ellipse if the phase difference is $\pi/2$

$x = A\sin\omega t$ and $y = B\sin(\omega t+\pi/2)$

$\Rightarrow \frac{x^2}{A^2}+\frac{y^2}{B^2}=1$ which is equation of ellipse

c) the resultant path is circle if phase difference is $\pi/2$ and amplitudes are same

$x = A\sin\omega t$ and $y = A\sin(\omega t+\pi/2)$

$\Rightarrow x^2+y^2=A^2$ which is equation of a circle

d) the resultant path is a straight line if phase difference is π

$x = A\sin\omega t$ and $y = B\sin(\omega t + \pi)$

$\Rightarrow y = \frac{-B}{A}x$ which is equation of a straight line

VELOCITY AND ACCELERATION OF SIMPLE HARMONIC OSCILLATOR

- The rate of change of displacement of particle is SHM is known as its velocity $V = \frac{dy}{dt}$ or $\frac{dx}{dt}$
- Velocity of the particle at any instant 't' is given by

$v = \frac{dy}{dt} = \frac{d}{dt}\left[A\sin(\omega t)\right]$

[If $y = A\sin(\omega t)$]

$= A\omega\cos(\omega t)$ or $v = \omega\sqrt{A^2 - y^2}$

a) At the mean position $y = 0$ and velocity is maximum $V_{max} = \omega A$.

b) At the extreme position $y = A$ and velocity is minimum $V_{min} = 0$

- Acceleration of the particle at instant 't' is given by

$a = \frac{dV}{dt} = \frac{d}{dt}\{A\cos(\omega t)\}$

$= -\omega^2 A\sin(\omega t) = -\omega^2 y$

a) At the mean position $y = 0$ and acceleration is minimum, $a_{min} = 0$

b) At the extreme position $y = A$ and acceleration is maximum

ie $a_{max} = \omega^2 A$ (magnitude)

- A simple harmonic oscillator has
  a) Zero velocity and non zero acceleration at the extreme position.
  b) Zero acceleration and non zero velocity at the mean position.

TIME PERIOD AND FREQUENCY

- If T is the time period and n is frequency of oscillation, then

$T = \frac{2\pi}{\omega}$ and $n = \frac{\omega}{2\pi}$

a) $T = 2\pi\sqrt{\frac{displacement}{acceleration}}$ and $n = \frac{1}{2\pi}\sqrt{\frac{acceleration}{displacement}}$

or $T = 2\pi\frac{\sqrt{y}}{a}$ and $n = \frac{1}{2\pi}\frac{\sqrt{a}}{y}$

(from $a = -\omega^2 y$ $\omega^2 = a/y$ and $\omega = \frac{\sqrt{a}}{y}$ b) $T = 2\pi\frac{\sqrt{mass}}{force\ constant}$ and

$n = \frac{1}{2\pi}\frac{\sqrt{force\ constant}}{mass}$

or $T = 2\pi\sqrt{\frac{m}{k}}$ and $n = \frac{1}{2\pi}\frac{\sqrt{k}}{m}$

(from $\omega^2 = k/m$, $\omega = \frac{\sqrt{k}}{m}$)

POTENTIAL ENERGY OF OSCILLATOR

- When the displacement of the particle in SHM is y, its PE is $U = \frac{1}{2}Ky^2$

or $U = \frac{1}{2}m\omega^2 y^2$

or $U = \frac{1}{2}m\omega^2 A^2\sin^2(\omega t \pm \phi)$

[if $y = A\sin(\omega t \pm \phi)$]

a) At the extreme $y = A$ (amplitude) and P.E is maximum

Maximum P.E is U_{max} or $U_0 = \frac{1}{2}m\omega^2 A^2 = \frac{1}{2}KA^2$

b) At the mean position, $y = 0$ and P.E is minimum minimum P.E = $U_{min} = 0$

c) Average P.E in one oscillation is

$U_{av} = \frac{U_0}{2} = \frac{1}{4}m\omega^2 A^2$

d) $P.E \propto y^2$ (square of displacement)

$\propto m$ (mass of the body)

$\propto \omega^2$ (square of angular frequency)

KINETIC ENERGY OF OSCILLATOR

- Kinetic energy of simple harmonic oscillator is given by $K = \frac{1}{2}mv^2$

or $K = \frac{1}{2}m\omega^2(A^2 - y^2)$

a) At the extreme position $y = A$ and KE is minimum

Minimum K.E = $K_{min} = 0$

b) At the mean position $y = 0$ and KE is maximum

Maximum K.E = K_{max} or

$K_0 = \frac{1}{2} m\,\omega^2 A^2 = \frac{1}{2} KA^2$

c) Average K.E. in one oscillation is

$K_{av} = \frac{K_0}{2} = \frac{1}{4} m\omega^2 A^2$

d) $K.E \propto \left(A^2 - y^2\right)$

$\propto m$

$\propto \omega^2$

TOTAL ENERGY OF OSCILLATOR

➔ Total energy of simple harmonic oscillator is constant at any instant.

Total energy = P.E + K.E

or $E = U + K$

$E = \frac{1}{2} m\,\omega^2 A^2 = \frac{1}{2} KA^2$

$= P.E_{max} = K.E_{max}$

Average total energy of oscillator is E only ie $\left(\frac{1}{2} m\omega^2 A^2\right)$

➔ Total energy of the oscillator is not periodic

➔ $E = \frac{1}{2} m\,\omega^2 A^2 = \frac{2\pi^2}{T^2} mA^2 = 2\pi^2 n^2 mA^2$

$\Rightarrow E \propto m$ (mass of the body)

$\propto A^2$ (square of amplitude)

$\propto T^2$ (square of time period)

$\propto \frac{1}{n^2}$ (n is frequency)

OSCILLATIONS OF MASS LOADED SPRING

1. If a mass is attached at one end of the spring and the other end is attached to a fixed end, it performs SHM if the spring is pulled and released.

➔ Time period of mass loaded spring depends on the mass attached, spring constant only. It is independent of acceleration due to gravity

➔ Spring constnat of a spring $K = \frac{YA}{l}$.

➔ If a mass 'm' attached at the end of a spring oscillates, time period $T = 2\pi \frac{\sqrt{m}}{K}$

frequency $n = \frac{1}{2\pi} \frac{\sqrt{K}}{m}$

(if mass of the spring is negligible)

If m_s is spring mass, then

$T = 2\pi \frac{\sqrt{m + ms/3}}{K}$

$n = \frac{1}{2\pi} \frac{\sqrt{K}}{m + ms/3}$

➔ If a mass 'm' oscillates at the end of a spring, $T \propto \sqrt{m}$, $n \propto \frac{1}{\sqrt{m}}$

$T \propto \frac{1}{\sqrt{K}}$, $n \propto \sqrt{K}$.

➔ If the same mass attached to free ends of two different springs oscillates, then $\frac{T_1}{T_2} = \frac{\sqrt{K_2}}{K_1} \Rightarrow \frac{\omega_2}{\omega_1} = \frac{\sqrt{K_2}}{K_1}$

a) If they have same maximum velocities, $\omega_1 A_1 = \omega_2 A_2$ and ratio of their amplitudes

$A_1 / A_2 = \sqrt{K_2 / K_1}$

b) If they have same maximum accelerations, $\omega_1^2 A_1 = \omega_2^2 A_2$ and ratio of their amplitudes is $A_1 / A_2 = K_2 / K_1$.

(K_1, K_2 are spring constants)

➔ Potential energy of the spring $U = \frac{1}{2} Kx^2$

$U = \frac{1}{2} Fx$ or $U = \frac{F^2}{2K}$ (x is extension, F is force)

a) If a spring is elonged by x, PE stored is U if the same is elongated by nx, then PE stored $U^1 = n^2 U$

b) Work done in increasing the elongation of spring from x_1 to x_2 is

$W = \frac{1}{2} K\left(x_2^2 - x_1^2\right)$

➔ If l is length of the spring and n is number of turns in it then its spring constant K varies as

$K \propto \frac{1}{l} \Rightarrow K_1 l_1 = K_2 l_2$

$K \propto \frac{1}{n} \Rightarrow K_1 n_1 = K_2 n_2$

$K \propto Y$ (Y is young's modulus)

➔ If a spring of spring constant K is cut into two pieces of lengths in the ratio $l_1 : l_2$, then the spring constants of those two pieces are given by

$K_1 = \frac{(l_1+l_2)}{l_1}K$ and $K_2 = \frac{(l_1+l_2)}{l_2}K$

If those two pieces have n_1 and n_2 turns then $K_1 = \frac{(n_1+n_2)}{n_1}$ K and $K_2 = \frac{(n_1+n_2)}{n_2}K$

- If two springs of spring constants K_1 and K_2 are joined in series, the effective spring constant K is given by

$$\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2}$$

or $K = \frac{K_1 K_2}{K_1 + K_2}$

For many spring in series $\frac{1}{K} = \frac{1}{K_1} + \frac{1}{K_2} + \frac{1}{K_3} + ...$

- If two spring of spring constants K_1 and K_2 are joined in parallel, the effective spring constant K is given by $K = K_1 + K_2$

For many springs, $K = K_1 + K_2 + K_3 + ...$

- A spring of spring constant K is cut into n equal parts. If all those parts are connected in parallel, the effective spring constant is $n^2 K$.

SIMPLE PENDULUM

- Time period of a simple pendulum

$$T = 2\pi \frac{\sqrt{\text{length}}}{\text{acceleration to gravity}}$$

Frequency $n = \frac{1}{2\pi}\sqrt{\frac{\text{acceleration due to gravity}}{\text{length}}}$

(If amplitude is small)

- Time period of simple pendulum is independent of the amplitude provided the amplitude is smaller.
- If length of simple pendulum is increased, its time period increases, frequency decreases

Time period $\propto \sqrt{\text{length}}$

- Time period of simple pendulum is inversely proportional to square root of acceleration due to gravity.

Time period $\propto \frac{1}{\sqrt{g}}$ Frequency $\propto \sqrt{g}$

- If l is length of the simple pendulum, its time period is $T = 2\pi\frac{\sqrt{l}}{g}$ (for small amplitudes)

Frequency $f = \frac{1}{2\pi}\frac{\sqrt{g}}{l}$

Angular frequency $\omega = \frac{\sqrt{g}}{l}$

Force constant $K = \frac{mg}{l}$

Laws of Simple pendulum :

- a) Law of lengths : Time period of a simple pendulum is directly proportional to square root of its length

$T \propto \sqrt{l}$ or $\frac{l}{T^2}$ is constant (at a given place) $\frac{l_1}{T_1^2} = \frac{l_2}{T_2^2}$

If length of the pendulum is increased to P times, time period increases to $\sqrt{P}$ times.

b) Law of gravity : Time period of a simple pendulum is inversely proportional to square root of acceleration due to gravity at that place.

$T \propto \frac{1}{\sqrt{g}}$ or $T^2 g$ = constant (for same length) $T_1^2 g_1 = T_2^2 g_2$.

- If a simple pendulum is taken from the equator to the poles, its time period decreases and frequency increases.
- If a simple pendulum is taken from the surface of the earth to an altitude or to certain depth, its timeperiod increases and frequency decreases
- If a simple pendulum is taken from the surface of the earth to the surface of moon, its time period increases and frequency decreases.
- The time period of a simple pendulum is independent of size, shape, material and mass of the bob
- Length of simple pendulum is the distance between centre of the bob and point of suspension.
- A spherical shell filled completely with water is having a small hole at its bottom. If it is used as bob of simple pendulum, water slowly flows out of the hole and length of the pendulum first increases and then decreases to the initial length. So, its time period also first increases and then decreases to its initial value.
- Pendulum suspended in a lift : If T_0 is the time period of the pendulum suspended in the lift when it is stationary, then $T_0 = 2\pi\frac{\sqrt{l}}{g}$, and frequency $f_0 = \frac{1}{2}\pi\frac{\sqrt{g}}{l}$

a) When the lift is moving up with uniform acceleration 'a', its time period is given by $T = 2\pi\sqrt{\frac{l}{g+a}}$ and

frequency $f = \frac{1}{2\pi}\frac{\sqrt{g+a}}{l}$

b) When the lift is moving down with uniform acceleration 'a', its time period is given by $T = 2\pi\frac{\sqrt{l}}{g-a}$ and

frequency $f = \frac{1}{2\pi}\sqrt{\frac{g-a}{l}}$

c) If the lift moves up or down with uniform velocity, then its time period is given by $T = 2\pi\sqrt{\frac{l}{g}}$ and

$$f = \frac{1}{2\pi}\frac{\sqrt{g}}{l}$$

Here $T = T_0$ and $f = f_0$

d) When the lift is freely falling, $T = \infty$ and $f = 0$

Here the pendulum doesnot oscillate.

e) If the lift moves down with uniform acceleration a such that $a > g$, then the pendulum turns upside down and oscillates about highest point with a time period

$$T = 2\pi\frac{\sqrt{l}}{a-g}$$

Simple Pendulum in electric field :

- Time period of a simple pendulum is infinitely
  - a) In-an artificial satellite
  - b) At the centre of the earth
  - c) In a freely falling lift
- If a graph is plotted between length of pendulum (L) and square of time period (T2), it is a straight line passing through origin.
  If a graph is plotted between length of pendulum (L) and time period (T) it is a parabola. These two graphs intersect at T = 1 sec.
- If a simple pendulum makes n_1 oscillation at one place and n_2 oscillation at another place in a given time (say t seconds), then $\frac{g_1}{n_1^2} = \frac{g_2}{n_2^2}$

  or $\frac{n_1}{n_2} = \frac{\sqrt{g_1}}{g_2}$ where g_1 and g_2 are accelerations due to gravity at those two places.
- At a given place two simple pendulum of different lengths l_1 and l_2 make n_1 and n_2 oscillations respectively in a given time. Then $n_1^2 l_1 = n_2^2 l_2$.

  or $\frac{n_1}{n_2} = \sqrt{l_2/l_1}$
- Two pendulums of lengths l_1 and l_2 $(l_2 > l_1)$ start vibrating from the mean position in the same phase. They will be again in the same phase at the mean position after longer pendulum completes n oscillations and shorter pendulum completes (n+1) oscillation such that

  $n_1\sqrt{l_1} = n_2\sqrt{l_2}$

  where $n_2 = n$ and $n_1 = (n+1)$ or $\frac{n}{n+1} = \frac{\sqrt{l_1}}{l_2}$

SOLVED EXAMPLES

1. When the displacement of a particle in SHM from the mean position is 4cm, the force acting on the particle is 6N. Then the force acting on it when its displacement is 6 cm from the mean position is

1) 3N 2) 16N 3) 8N 4) 9N

Sol: We know that $F \propto -x$

and $\frac{F_1}{F_2} = \frac{x_1}{x_2} \Rightarrow \frac{6}{F_2} = \frac{4}{6}$ or $F_2 = 9N$

Ans : (4) : 9N

2. The acceleration of a simple harmonic oscillator is 1 ms^{-2}, when its displacement from mean position is 0.5m. Then its frequency of oscillation is

1) $\sqrt{2}\,\pi Hz$ 2) $\pi/\sqrt{2}\,Hz$

3) $\frac{1}{\sqrt{2}\pi}Hz$ 4) $\frac{\sqrt{2}}{\pi}Hz$#

Sol: Frequency $n = \frac{1}{2\pi}\sqrt{\frac{\alpha}{x}} = \frac{1}{2\pi}\frac{\sqrt{1}}{0.5} = \frac{1}{\sqrt{2}\pi}Hz$

Ans : (3) : $\frac{1}{\sqrt{2}\pi}Hz$

3. Displacement 'x' of a simple harmonic oscillator varies with time according to the differential equation $\frac{d^2x}{dt^2} + 4x = 0$. Then its timeperiod is

1) $\frac{\pi}{2}$sec 2) π sec 3) 2π sec 4) 4π sec

Sol: On comparing the given equation with the standard from $\frac{d^2x}{dt^2} + \omega^2 x = 0$, we have $\omega^2 = 4$ and $\omega = 2$ So

time period $T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = \pi$ sec.

Ans : (2) : π sec

4. The displacement of a simple harmonic oscillator is given by $y = 4\cos(2\pi t + \pi/4)$ m. Then velocity of the oscillator at $t = 2$ seconds is

1) $4\sqrt{2}\,\pi\ ms^{-1}$ 2) $\frac{4\pi}{\sqrt{2}}ms^{-1}$

3) $\frac{\sqrt{2}\pi}{4}ms^{-1}$ 4) $\frac{4\sqrt{2}}{\pi}ms^{-1}$

Sol: On comparing the given equation with the standard form, amplitude $A = 4m$, $\omega = 2\pi$

Displacement y at $t = 2$sec is

$y=4\cos(4\pi+\pi/4)=\frac{4}{\sqrt{2}}=2\sqrt{2}m$

Velocity at $t=2s$ is $V=\omega\sqrt{A^2-y^2}$

Or $V=2\pi\sqrt{4^2-(2\sqrt{2})^2}=2\pi\sqrt{16-8}=4\sqrt{2}\pi ms^{-1}$

Ans : (1) : $4\sqrt{2}\pi ms^{-1}$

5. Velocity of a simple harmonic oscillation is given by $V=\sqrt{144-16x}\ ms^{-1}$ where x is displacement in metre. Then maximum velocity of that oscillator is

1) $6\ ms^{-1}$ 2) $12\ ms^{-1}$ 3) $16\ ms^{-1}$ 4) $8\ ms^{-1}$

Sol: Comparing this with standard form $V=\omega\sqrt{A^2-x^2}$

We have $V=4\sqrt{3^2-x^2}\Rightarrow A=3m,\ \omega=4$

Maximum velocity $V_0=A\omega=12\,ms^{-1}$

Ans : (2) - $12\ ms^{-1}$

6. A particle executes SHM from the mean position. Its amplitude is A and time period is T. At an instant of time 't' its speed is half of the maximum speed. The displacement at that position is

1) A/2 2) $A/\sqrt{2}$

3) $\sqrt{3}A/2$ 4) $2A/\sqrt{3}$

Sol: If ω is angular frequency, maximum velocity of the particle is given by ωA.

If V is the velocity at any instant and y is the displacement then $V=\omega\sqrt{A^2-y^2}$

But $V=\frac{\omega A}{2}$

Then $\frac{\omega A}{2}=\omega\sqrt{A^2-y^2}$

$A^2-y^2=\frac{A^2}{4}\Rightarrow y=\frac{\sqrt{3}A}{2}$

Ans : (3) - $\sqrt{3}A/2$

7. The velocity of a body executing SHM at the mean position is numerically equal to the acceleration at the extreme position. Then the period of oscillation is

1) π 2) 2π 3) π^2 4) $4\pi^2$

Sol: If A is amplitude, ω is angular frequency velocity at the mean position is $A\omega$

Acceleration at the extreme position $\omega^2 A$

Given $\omega^2 A=A\omega$

and $\omega=1\Rightarrow T=2\pi$

Ans : (2) - 2π

8. If A is amplitude of a particle in SHM, its displacement from the mean position when its kinetic energy is thrice that of its potential energy.

1) A 2) $A/4$ 3) $A/2$ 4) $3A/4$

Sol: Potential energy $U=\frac{1}{2}m\omega^2y^2$

Kinetic energy $K=\frac{1}{2}m\omega^2(A^2-y^2)$

Given $K=3U$

ie $\frac{1}{2}m\omega^2(A^2-y^2)=3\frac{1}{2}m\omega^2y^2$

$\Rightarrow A^2-y^2=3y^2$

$A^2=4y^2$ and $y=A/2$

Ans : (3) - $A/2$

9. A particle is executing SHM of amplitude A and with timeperiod 4 seconds. Then the time taken by it to move from the extreme position to half the amplitude is

1) 1 sec 2) $\frac{1}{3}$sec 3) $\frac{2}{3}$sec 4) $\frac{4}{3}$sec

Sol: If the particle in at the extreme position at $t=0$, its displacement is given by

$y=A\cos\omega t$

$\Rightarrow\frac{A}{2}=A\cos\omega t\Rightarrow\cos\omega t=\frac{1}{2}=\cos\pi/3$

$\Rightarrow\omega t=\pi/3$ or $\frac{2\pi}{T}t=\frac{\pi}{3}$

and $t=\frac{T}{6}=\frac{4}{6}=\frac{2}{3}$ sec

Ans : (3) - $\frac{2}{3}$sec

10. A linear harmonic oscillator of force constant $2\times10^6\ N/m^{-1}$ and amplitude 0.01m has a total mechanical energy of 160J. Its

1) Maximum P.E is 100J

2) Maximum K.E is 100J

3) Maximum P.E is 160J

4) Maximum P.E is zero

Sol: Maximum elastic P.E $=\frac{1}{2}KA^2=\frac{1}{2}\times2\times10^6(0.01)^2=100J$

As the oscillator goes from the extreme to mean position, this is converted into KE.
So, maximum KE is 100J. Since total energy is 160J, maximum PE is 160J.

Ans : (2, 3) -
Maximum K.E is 100J
Maximum P.E is 160J

11. The kinetic energy of a particle in SHM is 4J when it passes through the mean position. If its mass is 2kg and amplitude is 1m, its time period is

1) $\frac{\pi}{2}$ sec 2) π sec 3) 2π sec 4) 4π sec

Sol: At the mean position K.E is maximum and is given by $\frac{1}{2}m\omega^2A^2$.

$$\frac{1}{2}m\omega^2A^2 = 4$$

$$\Rightarrow \omega = \sqrt{\frac{8}{mA^2}} = \frac{\sqrt{8}}{2\times1} = 2\,rads^{-1}$$

$$\frac{1}{2}m\omega^2A^2 = 4 \Rightarrow \omega = \frac{\sqrt{8}}{mA^2} = \frac{\sqrt{8}}{2\times1} = 2\,rads^{-1}$$

Time period $T = 2\pi/\omega = \pi$ sec

Ans : (2) : π sec

12. When a mass m is suspended from a spring its frequency of oscillation is 'n'. If an additional mass 3m is attached, its frequency is n_2. Then $n_2/n_1 =$

1) 2 2) 1/2 3) 4 4) 1/4

Sol: $n_1 = \frac{1}{2\pi}\sqrt{\frac{K}{m}}$ and $n_2 = \frac{1}{2\pi}\sqrt{\frac{K}{m+3m}} = \frac{n_1}{2}$

Then $n_2/n_1 = 1/2$

Ans : (2) - 1/2

You are the creator of your own destiny

PRACTICE SET - I

01. The acceleration of a particle executing SHM at a distance of 3 cm from equilibrium position is 5 cms^{-2}. Its acceleration at a distance of 2 cm from equilibrium position is

1) $\frac{10}{3}$ cms^{-2} 2) 10 cms^{-2}
3) 7.5 cms^{-2} 4) 4.5 cms^{-2}

02. A particle executing SHM has a frequency of 10Hz as it crosses its equilibrium position with a velocity of $2\pi\ ms^{-1}$. Then amplitude of vibration is

1) 0.1m 2) 0.2 m 3) 0.4m 4) 1m

03. A particle of mass 0.5 kg executes SHM. Its period of oscillation is π seconds and total energy is 0.04J. Then its amplitude is

1) 40 cm 2) 20 cm 3) 15cm 4) 10cm

04. A particle of mass 1 kg is moving in a simple harmonic motion with a time period of $\frac{1}{60}$ s and an amplitude of $2\times10^{-2}m$. The maximum force acting on a particle is

1) $2.88\pi^2N$ 2) $28.8\pi^2N$
3) $288\pi^2N$ 4) $2880\pi^2N$

05. An oscillating mass spring system has a mechanical energy 1J when it has an amplitude 0.1m and maximum speed of 1 ms^{-1}. Then force constant of the spring is

1) 100 Nm^{-1} 2) 200 Nm^{-1}
3) 300 Nm^{-1} 4) 50 Nm^{-1}

06. The PE of a simple harmonic oscillator 0.1 seconds after crossing the mean position is $\frac{1}{4}$ of its total energy. Then the period of its oscillation is

1) 0.2s 2) 0.3s 3) 0.9s 4) 1.2s

07. The amplitude of a simple harmonic oscillator is 13cm. When it is at a distance 12 cm from the mean position, its velocity is 50 cms^{-1}. Then its frequency of oscillation is

1) $\frac{4}{\pi}Hz$ 2) $\frac{5}{\pi}Hz$ 3) $\frac{6}{\pi}Hz$ 4) $\frac{7}{\pi}Hz$

08. A particle is executing SHM given by $y = 10\sin(8t + \pi/3)m$. Its velocity when its displacement is $6m$ is

1) 36 ms^{-1} 2) 10 ms^{-1}
3) 80 ms^{-1} 4) 64 ms^{-1}

09. A mass m attached to a spring oscillates with a period of 3s. If the mass is increased by 1kg, the period increases by 1s. Then initial mass m is

1) $\frac{7}{9}$Kg 2) $\frac{9}{7}$Kg 3) $\frac{14}{9}$Kg 4) $\frac{18}{7}$Kg

10. When a mass 1Kg is suspended from a spring it oscillates with a frequency of $\frac{4}{\pi}Hz$. Then a force of 6.4 N can stretch that spring through

1) 0.1m 2) 0.2m 3) 0.4m 4) 0.8m

11. The time period of a simple pendulum in a stationary lift is T. When the lift is in motion, its timeperiod changes to $\sqrt{\frac{2}{3}}T$. Then the lift moves.

1) with a uniform acceleration $g/2$ up
2) With a uniform acceleration g/2 down
3) with a uniform acceleration 2g/3 up
4) none

12. The time period of a simple pendulum is T. If its length is increased by 2%, the new time period becomes

1) 0.98 T 2) 1.02T
3) 0.99T 4) 0.01T

13. The length of a seconds pendulum is 100cm. To have a period half of this value the length is to reduced by

1) 25 cm 2) 75 cm 3) 50 cm 4) 100 cm

14. A seconds pendulum on the earth is taken on the moon with out changing its length. If 'g' on the moon is $\frac{1}{6}$th that on the earth, that pendulum will have new time period equal to

1) $6\sqrt{2}s$ 2) $2\sqrt{4}s$ 3) $4\sqrt{2}s$ 4) $2\sqrt{6}s$

15. A seconds pendulum is suspended in car. When the car is moving with uniform acceleration $\sqrt{3}g$ in the horizontal direction, then its new period willbe

1) $\sqrt{3}s$ 2) $2\sqrt{3}s$ 3) $\sqrt{2}s$ 4) $\frac{\sqrt{3}}{2}s$

16. The mass and diameter of a planet are twice those of the earth. What will be the time period of oscillation of a pendulum on the planet if it is a seconds pendulum on earth ?

1) $\sqrt{2}s$ 2) $2s$ 3) $\frac{1}{\sqrt{2}}s$ 4) $2\sqrt{2}s$

17. The maximum speed of a body vibrating with SHM with a period of $\pi/4s$ and amplitude of 7cm is

1) 488 cms^{-1} 2) 56 cms^{-1}
3) 38.5 cms^{-1} 4) 55 cms^{-1}

18. In SHM the velocity of the particle at mean position is 1 ms^{-1} and acceleration at the extremely is 2 ms^{-2}. Then the angular velocity of the motion is

1) 2 $rad\ s^{-1}$ 2) 1 $rad\ s^{-1}$
3) 0.5 $rad\ s^{-1}$ 4) 3 $rad\ s^{-1}$

19. What should be the displacement of a simple pendulum whose amplitude is 'A' at which potential energy is 1/4th of the total energy

1) $\frac{A}{\sqrt{2}}$ 2) $\frac{A}{2}$ 3) $\frac{A}{4}$ 4) $\frac{A}{2\sqrt{2}}$

20. A particle executes simple harmonic motion with a period of T seconds and amplitudee A metre. The shortest time it takes to reach a point $\frac{A}{\sqrt{2}}m$ from its mean position in seconds is

1) T 2) $T/4$ 3) $T/8$ 4) $T/16$

21. The length of a second pendulum at the surface of earth is 1m. The length of seconds pendulum at the surface of moon where g is 1/6 th that at earth's surface is

1) 1/6m 2) 6m 3) 1/36m 4) 36m

22. The magnitude of acceleration of particle executing SHM at the position of maximum displacement is

1) A minimum 2) zero
3) A maximum
4) Neither a minimum nor a maximum

23. If the period of oscillations of mass M is suspended from a spring is 1sec, then the period of mass 4M will be

1) 1/2 sec 2) 1/4sec 3) 2 sec 4) 4sec

24. Two springs of constants K_1 and K_2 have equal highest velocities when executing SHM. Then, the ratio of their amplitudes (given their masses are equal) will be

1) K_1/K_2 2) $\sqrt{K_1/K_2}$
3) K_2/K_1 4) $\sqrt{K_2/K_1}$

25. In a simple harmonic motion when the displacement is one half of the amplitude, what fraction of the total energy is potential energy?

1) 1/4 2) 1/2 3) 3/4 4) 0

PRACTICE SET - I KEY

01) 1	02) 1	03) 2	04) 3	05) 2
06) 4	07) 2	08) 4	09) 2	10) 1
11) 2	12) 4	13) 2	14) 4	15) 3
16) 4	17) 2	18) 1	19) 2	20) 3
21) 1	22) 3	23) 3	24) 4	25) 1

PRACTICE SET - II

01. A particle of 0.25 kg vibrates with a period of 2 seconds. If its greatest displacement is 0.4m, its maximum velocity in ms^{-1} is

1) $\pi/5$ 2) $\pi/10$ 3) $2\pi/5$ 4) none

02. The acceleration of a particle in SHM is 0.8 ms^{-2}, when its displacement is 0.2m. Then frequency of its oscillations is

1) $\frac{\sqrt{2}}{\pi}Hz$ 2) $\frac{2}{\pi}Hz$
3) $\frac{1}{\pi}Hz$ 4) $\frac{1}{2\pi}Hz$

03. The period of a simple harmonic oscillator is 2 seconds. If it crosses mean position at an instant, the time after which its displacement from the mean position will be half of the amplitude is

1) 1/8 sec 2) 1/6 sec 3) 1/4 sec 4) 1/2 sec

04. A body of mass 5×10^{-3}kg is making S.H.M. with amplitude $1\times10^{-1}m$ with maximum velocity 1 ms^{-1}, its velocity will be half at displacement of\

1) $5\times10^{-3}m$ 2) $2.5\times10^{-3}m$
3) $5\sqrt{3}\times10^{-2}m$ 4) $\frac{5}{4}\times10^{-3}m$

05. The K.E of a particle making S.H.M. is 8×10^{7} ergs, when the particle is at mean rest position its mass is 4×10^{3} gm and amplitude is 1×10^{2}cm. Then its time period is

1) πs 2) $2\pi s$ 3) $4\pi s$ 4) $3\pi s$

06. The velocity of a simple harmonic oscillator 0.3 seconds after crossing its mean position is half of maximum velocity. Then its frequency of oscillation is

1) $\frac{5}{9}Hz$ 2) $\frac{9}{5}Hz$ 3) $\frac{4}{9}Hz$ 4) $\frac{9}{4}Hz$

07. The displacement of a particle executing SHM is given by $x=0.34\ \sin(300t+0.68)m$. Then its frequency is

1) $\frac{300}{\pi}Hz$ 2) $\frac{300}{2\pi}Hz$
3) $\frac{150}{2\pi}Hz$ 4) 300 Hz

08. A simple harmonic oscillator has its displacement varying as $y=15\sin(2\pi t+\pi/4)$ metre. Its initial displacement is

1) 15 m 2) $15/\sqrt{2}\ m$
3) $15\sqrt{2}\ m$ 4) 7.5m

09. Two simple harmonic motions are represented by the equation $y_1=10\sin(4\pi t+\pi/4)$

1) 1:1 2) 2:1 3) $2:\sqrt{3}$ 4) $\sqrt{3}:2$

10. Two identical springs are attached to a mass and the system is made to oscillate. T_1 is the time period when the springs are joined in parallel and T_2 is the time period when they are joined in series. Then

1) $T_1=2T_2$ 2) $T_1=\sqrt{2}T_2$
3) $T_2=2T_1$ 4) $T_2=\sqrt{2}T_1$

11. The work done by the string of a simple pendulum during one complete oscillations is equal to

1) zero 2) $mgl\cos\theta$
3) $\frac{1}{2}\left[2\pi\frac{\sqrt{l}}{g}\right]^2$ 4) $\frac{2\pi l}{8}$

12. Amplitude of bob of a simple pendulum is A and its timeperiod is T. Then speed of the pendulum when it is exactly at the middle mean and extreme positions is

1) $3\pi A/T$ 2) $2\pi A/T$
3) $\sqrt{3}\pi A/2T$ 4) $\sqrt{3}\pi A/T$

13. Two identical simple pendulums oscillate with amplitudes 6cm and 2cm respectively. Then the ratio of their energies of oscillation are
1) 3:1 2) 1:3 3) 9:1 4) 1:9

14. A seconds pendulum is arranged in a lift. If the lift is moving up with an acceleration g/4, its new perioid would be
1) $4\sqrt{2}s$ 2) $\frac{1}{\sqrt{2}}s$ 3) $\frac{4}{\sqrt{5}}s$ 4) none

15. If the length of seconds pendulum on the earth is 1 metre, on a planet where the acceleration due to gravity is $\frac{1}{4}$ that on the earth, length of seconds pendulum should be
1) 4m 2) 2m 3) 1m 4) $\frac{1}{4}m$

16. A second's pendulum has a hollow spherical bob of mass 25×10^{-3}kg. It is replaced by another solid bob of same radius but of mass $50\times10^{-3}kg$. Then the new time period will be
1) 6s 2) 4s 3) 3s 4) 2s

17. A mass of 0.98 kg is suspended by a spring of force constant $2Nm^{-1}$. The spring will execute simple harmonic motion with a period
1) 0.49s 2) 1.96s 3) 4.40s 4) 4.90s

18. A particle of mass 1 kg is moving in SHM with an amplitude of 0.02m and a frequency of 60Hz. The maximum force acting on the particle is
1) $144\pi^2$N 2) $72\pi^2$N
3) $288\ \pi^2$N 4) none

19. The time period of a simple pendulumis 2sec. If its length is increased by four times period becomes
1) 4s 2) 6s 3) 8s 4) 2s

20. A particle executing simple harmonic motion has an amplitude of 6cm. Its accleration at a distance from the mean position 2 cm is $8cms^{-2}$. The maximum speedof the particle is
1) 8 cms^{-1} 2) 12 cms^{-1}
3) 16 cms^{-1} 4) 24 cms^{-1}

21. Two springs of force constants 1000 Nm^{-1} and 2000 Nm^{-1} are stretched by same force. The ratio of their respective potential energies is
1) 2 : 1 2) 1 : 2 3) 4:1 4) 1 : 4

22. A spring of force constant K is cut into equal parts. The force constant of each part will be
1) K/3 2) K/9 3) 3K 4) 9K

23. A particle executes SHM with a frequency f. The frequency with which its kinetic energy oscillates is
1) $4f$ 2) $2f$ 3) f 4) $f/2$

24. A particle is executing SHM given by $x=5\sin(4t-\pi/6)$. The velocity of the particle when its displacement is 3 units is
1) $\frac{2\pi}{3}$ units 2) $\frac{5\pi}{6}$ units
3) 20 units 4) 16 units

25. The velocities of a body executing S.H.M. are 3 and $4\ cms^{-1}$ when the displacements are 4 and 3 cm period is
1) $\frac{1}{2\pi}s$ 2) $\frac{\pi}{2}s$ 3) $\frac{2}{\pi}s$ 4) $2\pi\ s$

PRACTICE SET - II KEY

01) 3	02) 3	03) 2	04) 3	05) 1
06) 1	07) 2	08) 2	09) 1	10) 3
11) 4	12) 4	13) 3	14) 3	15) 4
16) 4	17) 3	18) 3	19) 1	20) 2
21) 1	22) 3	23) 2	24) 4	25) 4

ALL POWER IS WITHIN YOU
YOU CAN DO ANYTHING AND EVERYTHING

PRACTICE SET - III

01. If the maximum velocity of a body executing SHM is numerically equal to maximum acceleration the frequency of its oscillation is
1) $\frac{1}{2\pi}Hz$ 2) $\frac{1}{\pi}Hz$ 3) $\frac{2}{\pi}Hz$ 4) $2\pi Hz$

02. A person of weight 60 kg stands on a board which oscillates up and down with a time period of 0.5 sec and an amplitude of 0.05m. If $g=10\ ms^{-2}$ and $\pi^2=10$, his maximum and minimum, weights recorded by the weighing machine on the board would b e
1) 90 kg wt, 30 kg wt 2) 80 kg wt, 40 kg wt
3) 108 kg wt, 12 kg wt 4) 72 kg wt, 48 kg wt

03. A particle making S.H.M along a straight line with a time period of 12s. Then the time taken for a displacement equal to the half of its amplitude from its mean rest position is
1) 0.1s 2) 1s 3) 0.01s 4) 1.1s

04. The K.E of a particle in SHM 0.2 sec after passing the mean position is half of its total energy. Then its period of oscillation is
1) 0.8s 2) 1.6s 3) 0.4s 4) 1.2s

05. The amplitude of a simple harmonic oscillator is 2 cm. At certain instant its PE and KE are equal. Then, its displacement from mean position at that instant
1) $\sqrt{2}$ cm 2) $2\sqrt{2}$ cm
3) $\frac{1}{\sqrt{2}}$ cm 4) $\frac{1}{2}$ cm

06. A particle executes SHM ascending to the displacement equations $y=6\sin(3\pi t+\pi/6)m$. The magnitude of its acceleration at $t=2$ sec is
1) $3\pi^2 ms^{-2}$ 2) $9\pi^2 ms^{-2}$
3) $18\pi^2 ms^{-2}$ 4) $27\pi^2 ms^{-2}$

07. If the amplitude of SHM is 0.14m and maximum velocity is $56ms^{-1}$. its displacement can be represented by
1) $y=0.1\sin 400t$ 2) $y=0.14\sin 4t$
3) $y=0.14\sin 20t$ 4) $y=0.14\sin 40t$

08. A uniform spring of force constant 'K' is cut into two pieces whose lengths are in the ratio 1:2. The force constant of the larger piece of the spring is
1) $\frac{2K}{3}Nm^{-1}$ 2) $\frac{3K}{2}Nm^{-1}$
3) $2K\ Nm^{-1}$ 4) $3K\ Nm^{-1}$

09. When a load of 5Kg is suspended from a spring it extends by 5 cm. When distributed, it begins to oscillate with a period of
1) $\frac{2\pi}{7}s$ 2) $\frac{\pi}{14}s$ 3) $\frac{\pi}{7}s$ 4) πs

10. The periods of oscillation of a pendulum at two places are 1.4s and 1.6s. Then the ratio of the acceleration due to gravity at those two places is
1) 49.64 2) 64.49 3) 7.8 4) none

11. Time period of a pendulum is 2 seconds. If its length is reduced to half, then its new frequency would be
1) 2Hz 2) $\frac{1}{2}Hz$ 3) $\sqrt{2}Hz$ 4) $\frac{1}{\sqrt{2}}Hz$

12. The length of the seconds pendulum is decreased by 0.3 cm when it is shifted to Guntur to Tenali. If the acceleration due to gravity at Tenali is 981 cms^{-2}, the acceleration due to gravity at Guntur (Assume $\pi^2=10$)
1) 981 cms^{-2} 2) 978 cms^{-2}
3) 984 cms^{-2} 4) 975 cms^{-2}

13. A seconds pendulum is suspended in a car. When the car moves down on the inclined plane of inclination 60° with horizontal without friction, its new time period would be
1) $\sqrt{3}s$ 2) $2\sqrt{3}s$ 3) $2\sqrt{2}s$ 4) $\frac{1}{\sqrt{2}}s$

14. A seconds pendulum is taken from the surface of the earth to that of the moon in order to maintain the period constant
1) the length of the pendulum has to be decreased
2) the length of the pendulum has to be increased
3) the amplitude of the pendulum should be decreased
4) no change is required

15. A body executes SHM with a period of $\frac{11}{7}$ sec and a amplitude of 0.025m. The maximum value of its acceleration is

1) 0.2 ms^{-2} 2) 0.1 ms^{-2}

3) 0.4 ms^{-2} 4) 0.5 ms^{-2}

16. A spring of force constant K is cut into two equal parts. Then the force constant of each piece is

1) K_1 2) $K/2$ 3) 4K 4) 2K

17. The period of oscillation of a simple pendulum of constant length at earth's surface is T. Its period inside a mine is

1) Greater than T 2) Less than T
3) Equal to T
4) Can not be compared

18. A spring having a spring constant K is loaded with a mass m. The spring is cut into two equal parts and one of these is loaded with the same mass. The new spring constant is

1) K/2 2) K 3) 2K 4) K^2

19. A simple harmonic socillator has displacement 0.02m and acceleration equal to $2ms^{-1}$ at any time, then the angular frequency of the oscillator is equal to

1) 10 $rads^{-1}$ 2) 0.1 $rads^{-1}$

3) 100 $rads^{-1}$ 4) 1 $rads^{-1}$

20. If a watch with wound spring is taken to moon, it
1) Runs faster 2) Runs shower
3) Shows no change 4) Does not work

21. A particle of mass 200g executes SHM. The restoring force is provided by a spring of force constant 80 Nm^{-1}. The time period of oscillation is

1) 0.31s 2) 0.15s 3) 0.05s 4) 0.02s

22. A body executes SHM with amplitude A. At what displacement from the mean position, the potential energy of the body is one-fourth of its total energy

1) A/4 2) A/2 3) 3A/4 4) $A/\sqrt{2}$

23. If a body of mass 0.98kg is made to oscillate on a spring of force constant 4.84N/m, the angular frequency of the body is
1) 1.22 rad/s 2) 2.22 rad/s
3) 3.22 rad/s 4) 4.22 rad/s

24. A child swinging on a swing in sitting position stands up, then the time period of swint will
1) increase 2) decrease
3) remains same
4) increases if the child is long and decreases if the child is short

25. If a spring of force constant K is cut into three equal parts, then force constant of each part will be

1) $K/3$ 2) K 3) 3K 4) 6K

PRACTICE SET - III KEY

01) 1	02) 3	03) 2	04) 2	05) 3
06) 4	07) 1	08) 2	09) 3	10) 2
11) 4	12) 2	13) 3	14) 2	15) 3
16) 4	17) 1	18) 3	19) 1	20) 3
21) 1	22) 2	23) 2	24) 2	25) 3

PREVIOUS ECET BITS

2009

01. A spring of force constant K is cut into n equal parts, then the force constant of each part is

1) K 2) K/n 3) nK 4) $(2n+1)K$

02. A particle is executing SHM and is described by $x = A\sin\omega t$. The maximum acceleration in this motion is

1) ωA 2) $\omega^2 A$ 3) ω^2/A 4) $\omega^2 t$

03. The simple harmonic motion of a particle is described by $x = A\sin(\omega t+\delta)$. The velocity V of the particle at a displacement X is

1) $V = \sqrt{A^2-x^2}$ 2) $V = \omega\sqrt{\omega^2-A^2}$

3) $V = \omega\sqrt{A^2-x^2}$ 4) $V = \omega A$

04. Two simple pendulums oscillate simultaneously from each position. The first pendulum made 20 oscillations in certain time in which the second pendulum made 25 oscillations. Then the ratio of length of the pendulum is

1) 5 : 4 2) 4 : 5 3) 25:16 4) 16:25

2010

05. A body is executing simple harmonic motion, then the total energy of the body is
1) proportional to its amplitude
2) inversely proportional to its amplitude
3) proportional to its square of amplitude
4) inversely proportional to its square of amplitude

06. When the displacement of a particle is SHM from mean position is 4cm, the force acting on the particle is 6N. Then the force acting on it when its displacement is 6cm from mean positon is

1) 3N 2) 16N 3) 8N 4) 9N

2011.

07. A particle is performing simple harmonic motion with a time period T. The time taken by the particle to go directly from its mean position to half the amplitude is

1) $T/3$ 2) $T/12$ 3) $T/6$ 4) $T/18$

08. At what distance potential energy of a simple harmonic particle will be half of its total energy, if the amplitude of the particle is 'A'

1) $A\sqrt{2}$ 2) $A\sqrt{3}$ 3) $A\sqrt{6}$ 4) $A\sqrt{7}$

09. Time period of a pendulum suspended from the roof of a lift travelling upwards with uniform acceleration?

1) increases 2) decrease 3) remains same 4) 0

2012

10. If a spring has time period T, and is cut into n equal parts, then the time period will be

1) $T\sqrt{n}$ 2) $T/\sqrt{n}$

3) nT 4) T

11. When temperature increases. The frequency of tuning fork
1) increases 2) decrease
3) remains same
4) increases (or) decreases depending on the materials

12. If a simple harmonic motion is represented by $\frac{d^2x}{dt^2}+\alpha x=0$, its time period is

1) $2\pi\sqrt{\alpha}$ 2) $2\pi\alpha$

3) $2\pi/\sqrt{\alpha}$ 4) $2\pi/\alpha$

2013

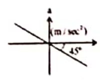
13. In S.H.M. there is always a constant ratio between the displacement of the body and its ___
1) Velocity 2) Acceleration
3) Mass of the particle 4) All of the above

14. When the amplitude of oscillation of a particle in S.H.M. is increased to two times, the time period___
1) Is doubled 2) Is halved
3) Is unaltered
4) Increased to $\sqrt{2}$ times

15. A hole is drilled along the diameter of the earth and pen is dropped into it. The time taken by the pen in reaching the other end of the earth is ___
1) 84 min 2) 42 min
3) 21 min 4) 102 min

16. A simple pendulum is vibrating in an evacuated chamber____
1) Come to rest eventually
2) Oscillate forever with the same amplitude and frequency
3) Oscillate with same frequency but amplitude will decrease with time
4) Oscillate with same amplitude but frequency will decrease with time

17. Acceleration displacemnet graph of a particle executing S.H.M. as shown in given figure. The time period of its oscillation is (in sec)



1) $\pi/2$ 2) 2π 3) π 4) $\pi/4$

2014

18. A particle is executing linear SHM of amplitude A. When the displacement is half the amplitude the fraction of kinetic energy is ___
1) 1/5 2) 3/4
3) 1/2 4) 1/4

19. For a particle executing S.H.M. starting from equilibrium position the phase is $\pi/2$ when it has
1) maximum displacement
2) maximum energy
3) half the displacement
4) maximum velocity

20. A particle executes SHM between $x=-A$ and $x=+A$. The time taken for it to go from 0 to A/2 is T1 and to go from A/2 A is T2. Then
1) $T_1=2T_2$ 2) $T_1=T_2$
3) $T_1<T_2$ 4) $T_1>T_2$

T.S - ECET - 2015

21. If a spring has time period T and is cut into n equal parts, then the time period of each part will be
1) $T\sqrt{n}$ 2) $T/\sqrt{n}$ 3) nT 4) T

22. In a simple harmonic oscillator, at the mean position
1) kinetic energy is minimum, potential energy is maximum
2) both kinetic and potential energies are maximum
3) kinetic energy is maximum, potential energy is minimum
4) both kinetic and potential energy are minimum

23. The ratio of frequencies of two pendulums are 2:3, then their lengths are in the ratio
1) $\sqrt{2}/\sqrt{3}$ 2) $\sqrt{3}/\sqrt{2}$ 3) 4/9 4) 9/4

A.P - ECET - 2015

24. The maximum velocity of a harmonic oscillator is α and its maximum acceleration is β. Its time period will be
1) $\frac{2\pi\alpha}{\beta}$ 2) $\frac{2\pi\beta}{\alpha}$ 3) $2\pi\alpha\beta$ 4) $\frac{\pi\alpha}{\beta}$

25. The length of a second's pendulum at a place where g is 980 cm/sec² is nearly
1) 200 cm 2) 50 cm 3) 100 cm 4) 25 cm

T.S - ECET - 2016

26. If 'X' is displacement and 'a' is acceleration of a partical executing simple harmonic motion then its time period (T) is given by
1) $2\pi\sqrt{\frac{X}{a}}$ 2) $2\pi\sqrt{\frac{a}{X}}$
3) $\frac{1}{2\pi}\sqrt{\frac{X}{a}}$ 4) $\frac{1}{2\pi}\sqrt{\frac{a}{X}}$

27. If T is time period of a partical executing simple harmonic motion then the phase of the particle when $t=\frac{T}{4}$ is
1) zero 2) $\frac{\pi}{2}$ 3) π 4) $\frac{3\pi}{2}$

28. The displacement of a particle executing simple harmonic motion is given by $y=8\sin\left(0.4\pi t+\frac{\pi}{2}\right)$. Then its time period in seconds is
1) 20 2) 10 3) 5 4) 2.5

29. A seconds pendulum is taken to a planet where acceleration due to gravity is one-fourth of the value on the earth, then the time period on that planet is
1) 1 s 2) 2 s 3) 4 s 4) 8 s

30. On a planet a freely falling body takes 2 seconds when dropped from a height of 32 metres. If the time period of a simple pendulum is 2π seconds, then the length on the planet is
1) 4m 2) 8 m 3) 32 m 4) 16 m

A.P - ECET - 2016

31. The frequency of a body executing simple harmonic motion is 6 Hz, with an amplitude 0.2m. The maximum velocity and accelaration of the body are respectively given by
1) $7.54ms^{-1}; 284.2ms^{-2}$
2) $284.2ms^{-1}; 7.54ms^{-2}$
3) $75.4ms^{-1}; 284.2ms^{-2}$
4) $7.54ms^{-1}; 28.42ms^{-2}$

32. A pendulum of length 80 cm has time period of 1.8s at a place. If the period were to be 1.6s at the same place, the length of the pendulum is
1) 63.2m 2) 0.632m 3) 0.0632m 4) 6.32m

33. If the length of a second's pendulum is halved, its period of oscillations will be
1) 14s 2) 0.14s 3) 1.414s 4) 14.14s

T.S - ECET - 2017

34. The maximum velocity of a particle executing simple harmonic motion with an amplitude 7 mm is $4.4\,ms^{-1}$. The period of oscillation is
1) 0.01s 2) 0.1s 3) 10 s 4) 100 s

35. In a simple harmonic oscillator, at the mean position
1) both kinetic energy and potenital energies are minimum
2) kinetic energy is maximum, potenitial energy is minimum
3) kinetic energy is minimum, potential energy is maximum
4) both kinetic energy and potential energies are maximum

36. In a simple harmonic motion, the particle
1) always acceleatred
2) alternately accelerated and retarded
3) always retarded
4) neither accelerated nor retarded

37. Two vibrating systmes are said to be in resonance, if theri
1) amplutides are equal 2) temperatures are equal
3) frequencies are equal
4) phase vcalues are equal

A.P - ECET - 2017

38. At t=0 the dispalcement of a particle in SHM is half its amplitude. Its intial pahse is (referring to mean position)
1) $\frac{\pi}{6}$ 2) $\frac{\pi}{3}$ 3) $\frac{2\pi}{3}$ 4) $\frac{\pi}{2}$

39. The length of seconds pendulum is 100 cm. To have a period half of this value, the length is to be reduced bt
1) 25 cm 2) 75 cm 3) 50 cm 4) 100 cm

T.S - ECET - 2018

40. A particle is vibrating in simple haromonic motion with an amplitude of 4 cm. At what displacement from the equilibrium position is its energy half potential and half kinetic?
1) 1 cm 2) $\sqrt{2}cm$ 3) 2 cm 4) $2\sqrt{2}cm$

PREVIOUS ECET BITS KEY

01) 3	02) 2	03) 3	04) 3	05) 3
06) 4	07) 3	08) 1	09) 3	10) 2
11) 4	12) 3	13) 2	14) 3	15) 2
16) 2	17) 2	18) 2	19) 4	20) 3
21) 2	22) 3	23) 4	24) 1	25) 3
26) 1	27) 2	28) 3	29) 3	30) 4
31) 1	32) 2	33) 3	34) 1	35) 2
36) 2	37) 3	38) 1	39) 2	40) 4

PREVIOUS ECET BITS KEY HINTS AND SOLUTIONS

01. nk

02. displacement $x = A\sin\omega t$

Acceleration $\frac{d^2x}{dt^2}=\frac{d}{dt}(A\omega\cos\omega t)$

$=-A\omega^2\sin\omega t$

At extreme postion acceleration is maximum

i.e, $x=A$

$A=A\sin\omega t$

$\omega t=90^0$

$\therefore a=\omega^2 A$

03. $V=\omega\sqrt{A^2-x^2}$

04. $\frac{l_1}{l_2}=\frac{T_1^2}{T_2^2}=\frac{n_2^2}{n_1^2}\Rightarrow\frac{l_1}{l_2}=\left(\frac{250}{20}\right)^2=\frac{25}{16}$

$\therefore 25:16$

05. proportinal to its square of amplitude

06. $F\propto y$

$\frac{F_1}{F_2}=\frac{y_1}{y_2}\Rightarrow\frac{6}{F_2}=\frac{4}{6}$

$F_2 = 9$

07. $y = A\sin\omega t = A/2$

$\omega t = \Pi/6$

$t = \frac{T}{2\Pi} \times \frac{\Pi}{6}$

$t = \frac{T}{12}$

08. $\frac{T.E}{2} = P.E$

$\frac{\frac{1}{2}m\omega^2 A^2}{2} = \frac{1}{2}m\omega^2 y^2$

$y = \frac{A}{\sqrt{2}}$

09. $T \propto \frac{1}{\sqrt{g}}$

$\therefore$ T will be decrease

10. If spring is cut into n equal parts $k_2 = nk_1$

$\frac{T_1}{T_2} = \sqrt{\frac{k_2}{k_1}} = \sqrt{\frac{nk_1}{k_1}} \Rightarrow T_2 = \frac{T}{\sqrt{n}}$

11. increases (or) decreases depending on the materials

12. In s.h.m $\frac{d^2x}{dy^2} = -\omega^2 x$

from equation $\frac{d^2x}{dy^2} = -\alpha x$

$-\alpha x = -\omega^2 x$

$\frac{2\Pi^2}{t^2} = a$

$T = \frac{2\Pi}{\sqrt{a}}$

13. Acceleration

14. Is unaltered

15. $T = 2\Pi\sqrt{\frac{1}{g\left(\frac{1}{l}+\frac{1}{R}\right)}} \therefore L = \infty$

$T = 2\Pi\sqrt{\frac{R}{g}} = 2\Pi\sqrt{\frac{6400\times1000}{9.8}}$

T = 84 min

It is for one oscillation but to reach other end time taken is T/2 = 42 min

16. Oscillate forever with the same amplitude will decrease with time

17. $\tan\theta = -\frac{a}{y} = -(-\frac{\omega^2 y}{y})$

$\omega = \sqrt{\tan\theta} \Rightarrow \frac{2\Pi}{T} = \sqrt{\tan\theta}\ (\because \theta = 45^0)$

$T = 2\Pi$

18. $K.E = \frac{1}{2}m\omega^2(A^2 - y^2)$

$= \frac{1}{2}m\omega^2(A^2 - (\frac{A}{2})^2)$

$= \frac{3}{4}\left(\frac{1}{2}m\omega^2 A^2\right) = \frac{3}{4}$ total energy

19. maximum displacement

at $\Pi/2$

y=a

20. As displacement increases velocity decreases so that $T_1 < T_2$

21. $\frac{T_1}{T_2} = \sqrt{\frac{k_2}{k_1}} \quad \Rightarrow \frac{T}{T_2} = \sqrt{\frac{nk}{k}}$

$T_2 = \frac{T}{\sqrt{m}}$

22. Kinetic energby is maximum, potential energy is minimum

23. $\frac{n_1}{n_2} = \sqrt{\frac{l_2}{l_1}}$

$\left(\frac{2}{3}\right)^2 = \frac{l_2}{l_1}$

$l_1 : l_2 = 9:4$

24. $\alpha = \omega A$

$\beta = \omega^2 A$

from 1st option

$\frac{2\Pi\alpha}{\beta} = \frac{2\Pi\omega A}{\omega^2 A} = \frac{2\Pi}{\omega} = \frac{2\Pi}{\frac{2\Pi}{T}} = |T$

$\therefore \frac{2\Pi\alpha}{\beta} = T$

25. $T = 2\Pi\sqrt{\frac{l}{g}} = 2\Pi\sqrt{\frac{l}{980}}$

$\frac{l}{980} = \left(\frac{2}{2\Pi}\right)^2 = \frac{1}{\Pi^2} = \frac{1}{10}(\because \Pi^2 \approx 10)$

$l = \frac{980}{10} = 100cm$

26. $a = w^2 x \Rightarrow w^2 = \frac{a}{x} \Rightarrow w = \sqrt{\frac{a}{x}}$

$\frac{2\Pi}{T} = \sqrt{\frac{a}{x}} \Rightarrow T = 2\Pi\sqrt{\frac{x}{a}}$

27. Phase $\theta - wt \Rightarrow \theta = \frac{2\Pi}{T}.\frac{T}{4} = \frac{\Pi}{2}$

28. $y = 8\sin\left(0.4\Pi t + \frac{\Pi}{2}\right)$

$y = A\sin\left(wt + \phi\right)$

$w = 0.4\Pi \Rightarrow \frac{2\Pi}{T} = 0.4\Pi \Rightarrow T = \frac{2}{0.4} = 5\sec$

29. $T \propto \frac{1}{\sqrt{g}} \Rightarrow \frac{T_1}{T_2} = \sqrt{\frac{g_2}{g_1}}$

$\Rightarrow \frac{2}{T_2} = \sqrt{\frac{\frac{g}{4}}{g}} = \frac{1}{2} \Rightarrow T_2 = 4\sec$

30. $h = \frac{1}{2}gt^2 k \Rightarrow 32 = \frac{1}{2}\times g\times 2^2 \Rightarrow g = 16m/s^2$ on planet

$T = 2\Pi\sqrt{\frac{L}{g}} \Rightarrow T^2 = 4\Pi^2\frac{L}{g} \Rightarrow 4\Pi^2$

$= 4\Pi^2.\frac{L}{16} \Rightarrow L = 16m$

31. $w = 2\Pi n = 2\Pi\times6 = 12\Pi$; A = 0.2m

$V_{max} = WA = 12\Pi\times0.2 = 7.54m/s$

$a_{max} = w^2 A = (12\Pi)^2\times0.2 = 284m/s^2$

32. $T \propto \sqrt{L}\ \frac{T_1}{T_2} = \sqrt{\frac{L_1}{L_2}} \Rightarrow \frac{1.8}{1.6} = \sqrt{\frac{80}{L_2}} \Rightarrow$

$\frac{9^2}{8^2} = \frac{80}{L_2} \Rightarrow L_2 = 63.2cm$

$L_2 = 0.632m$

33. $T \propto \sqrt{L}$

$\frac{T_1}{T_2} = \sqrt{\frac{L_1}{L_2}} \Rightarrow \frac{2}{T_2} = \sqrt{\frac{L}{\frac{L}{2}}} = \sqrt{2}$

34. $V = \omega A$

$\frac{44}{10} = \frac{2\times22}{T\times7}\times7\times10^{-3} \Rightarrow T = 0.01sec$

35. kinetic energy is maximum, potenitial energy is minimum

36. alternately accelerated and retarde

37. frequencies are equal

38. $y = A\sin(\omega t + \phi) \Rightarrow \frac{A}{2} = A\sin(\phi)$

$\phi = \sin^{-1}\left(\frac{1}{2}\right) \Rightarrow \phi = \frac{\pi}{6}$

39. $T \propto \sqrt{2}$

$\frac{2}{1} = \sqrt{\frac{100}{L_2}}$

$L_2 = 25cm$

Is means it should be reduced to 75 cm

SPACE FOR IMPORTANT NOTES

ACOUSTICS

01. **Acoustics :** The branch of physics which deals with the process of generation, reception and propagation of sound is called acoustics.

- Acoustics is of three types : architectural or building acoustics, electro-acoustics and musical acoustics.
- Architectural or Building acoustics deals with the construction and design of buildings, halls, auditoria, etc. for proper propagation of sound.
- Electro-acoustics deals with the sound production and recording using electrical means.
- Musical acoustics deals with the relationship of sound with music.

02. **Sound :** Sound is a form of energy which causes the sensation of hearing on reaching the ear.

- A vibrating body can produce the sound.
- Sound waves are mechanical waves.
- Sound travels in the form of longitudinal waves (longitudinal waves comprise of compressions and rarefractions).
- Sound can travel in any material medium (solids, liquids and gases).
- Sound cannot travel through vacuum.
- Velocity of sound in solids > velocity of sound in liquids > velocity of sound in gases.
- During the propagation of sound through a medium, the particles of the medium do not move from one place to another.
- Sound waves exhibit reflection, refraction, interference and diffraction.
- Sound waves can't exhibit polarisation and dispersion. (Light waves can exhibit polarisation and dispersion).
- All the sounds are not audible.
- Sound, based on its frequency is of three types : Audible sounds or Sonics, Ultrasonics and Infrasonics.
- **Audible Sounds or Sonics :** Sounds with frequencies between 20 Hz and 20,000 Hz are called audible sounds.
- Ultrasonics : Sounds with frequencies greater than 20,000 Hz are called ultrasonics.
- Infrasonic : Sounds with frequencies less than 20 Hz are called infrasonics.
- Ultrasonic waves can be produced by piezo-electric method and magnetostriction method.
- Bats, dogs and fish can hear ultrasonic sounds
- Ultrasonic waves can have adverse effect on eardrums.

- Ultrasonic waves have greater penetrating power and hence they are used in detecting mines in the seas and in ultrasound scanning of babies in the womb.
- Infrasonic waves are produced during earthquakes and eruption of volcanoes.
- Infrasonics sound waves can cause damage to the internal organs of the body.
- Audible sounds and inaudible sounds (ultrasonics and infrasonics) travel with same velocity.
- The velocity of audible, infrasonic and ultrasonic sounds in air at $0^\circ C$ is $330\ ms^{-1}$.
- If 'n' is frequency of the sound wave and 'λ' is its wavelength, then its velocity is $\boxed{v = n\lambda}$.
- When a sound wave travels from one medium to another medium its frequency and time period remain unchanged; whereas its wavelength, velocity, amplitude and intensity will change.
- Intensity of a sound wave is the average energy flowing per unit time through unit area perpendicular to the direction of propagation of a wave $\left(I = \dfrac{E}{A \times t}\right)$

  S.I unit : watt - metre^{-2} (Wm^{-2})
- Intensity $I = 2\pi^2 n^2 a^2 v d$. where n is frequency, a is amplitude, v is velocity and d is density of the medium.

03. **Persistence of Hearing :** The effect of a sound wave on the human ear lasts for $\dfrac{1}{10}$th of a second, ie., 0.1 second. This is called persistence of hearing.

- Due to persistence of hearing, the human ear can identify a maximum of 10 sound waves per second.
- If two sound waves reach the human ear, with a gap of 0.1 second, then only they are identified clearly. If the time gap between them is less than 0.1 second, the individual sounds are not identified but their combined effect is received.

04. **Intensity Level of Sound :**

- Intensity Level L (dB) $= 10 \log_{10}\left(\dfrac{I}{I_0}\right)$, where I is the intensity of sound and I_0 represents threshold of hearing.
- Intensity level is also known as relative intensity.
- The lowest intensity of sound that can be heard by the human ear is called 'threshold of hearing' or 'threshold of audibility' or 'zero-level' of hearing'.
- For a sound of frequency 1000 Hz, the threshold of audibility $I_0 = 10^{-12}\ Wm^{-2}$.
- Intensity level is measured in bel (B) or decibel (dB).

$1\ dB = \dfrac{1}{10}$ bel or 1 bel = 10 dB

- **Bel :** The intensity level of sound is said to be 1 bel if the intensity is 10 times that of the threshold of hearing.
- $L(bel) = \log_{10}\left(\dfrac{I}{I_0}\right)$ or $L(dB) = 10 \log_{10}\left(\dfrac{I}{I_0}\right)$
- Threshold of audibility $I_0 = 10^{-12}\ Wm^{-2} = 0$ dB (zero decibel)
- 1 dB = 1.26 I_0, i.e., if the intensity level changes by 1 dB, the intensity of sound changes by 26%
- 10 dB = 10 I_0, hence 10 dB means 10 times of threshold of hearing.
- The lowest change that can be detected by the human ear is 1 dB.
- Threshold of Pain : The maximum intensity level of sound that can be tolerated by the human ear without the sensation of pain is called threshold of pain or threshold of feeling.
- Threshold of pain = 120 dB or 1 Wm^{-2}.

05. **Musical Sound :** The sound that produces pleasing effect on the ear is called musical sound.
e.g. : Sounds produced by musical instruments like Veena, Violin, etc.

06. **Noise :** The sound that produces unpleasant effect on the ear is called noise.
e.g., Rattling sound of a cart - wheel, roaring of thunder, etc.

Sl.No	Musical Sound	Noise
1.	Produces pleasing effect on the ear	Produces unpleasant effect on the ear.
2.	Vibrations are periodic	Vibrations are irregular.
3.	Characterised by pitch, intensity and quality	Does not have uniform pitch, intensity and quality
4.	There are no sudden changes in amplitude	Sudden changes in amplitude take place.
5.	Different notes reach the ear periodically and successively so that they appear to be heard simultaneously	Different notes reach the ear irregularly and they are not heard simultaneously.
6.	**Examples :** Sounds produced by musical instruments like Veena, Violin, etc.	**Examples :** Rattling sound of a cart-wheel, thunder roar, etc.

07. **Important Characteristics of a Musical Note :**

i. **Pitch :**

- The pitch of a note is determined by its frequency.
- The pitch increases as frequency increases.
- The pitch is the subjective sensation of hearing, while frequency is measurable.
- The pitch of the buzzing of a bee is higher than that of roaring of a lion.
- Women and children have greater pitch than men.

ii. **Intensity or Loudness :**

- The loudness depends on intensity of the wave.

- As Intensity increases, loudness increases.
- The loudness is subjective sensation of hearing, while intensity is measurable.
- The roar of a lion is louder than the buzz of a bee.

iii. Quality or Timbre :

- The quality or timbre of a note enables us to distinguish between two different musical instruments or different human voices, even if they produce a note of the same frequency and same intensity.
- The quality depends on the source of the sound, wave form, harmonics and overtones.

08. Musical Scale :

- It is a sequence of frequencies.
- A widely used musical scale is diatomic scale.
- The diatomic scale has eight (8) frequencies covering an octave (two times the original frequency).
- Each frequency is called a note.
- Lowest frequency is 256 Hz and highest frequency is 512 Hz
- Octave : $\frac{n_2}{n_1} = 2$

09. Noise Pollution : An unwanted sound damped into the environment without regard to the adverse effect it may have is called noise pollution.

- If the intensity level of sound exceeds 120 dB (threshold of pain), then the sound is said to be polluted.

10. Causes or Sources of Noise Pollution :

1. Natural sources like thunders.
2. Man made sources like transport system, crackers, loud speakers, etc.

11. Effects of Noise Pollution :

1. Noise pollution affects human health causing contraction of blood vessels, damaging nervous system and increasing blood pressure.
2. It also affects heart kidneys and liver.
3. It causes emotional disturbance.
4. It can have hazardous effect on eardrum.
5. It may cause damage to the buildings.

12. Methods of Control of Noise Pollution :

1. Restricting unnecessary blowing of horns.
2. Establishing noise - free zones, wherever necessary like hospitals, educational institutions, etc.
3. Allowing loud speakers to a limited period and with limited sound level.
4. Constructing air ports and railway stations away from residential areas.
5. Covering the noise-creating machinery with insulating materials.
6. Designing new machinary which can produce less noise.

13. Beats :

- When two sound waves which have slight difference in their frequencies travelling in the same direction superimpose over each other, then the intensity of the resultant wave becomes maximum and minimum periodically. This phenomenon is called beats.
- One rise and one fall of sound intensity is called one beat.
- The number of beats occuring per second is called beat frequency.
- Beat frequency, i.e., the number of beats per second, is equal to the difference in the frequencies of two interfering sound waves.

Beat frequency = $n_1 \sim n_2$, where n_1 and n_2 are the frequencies of two waves.

- The time interval between two successive maxima or two successive minima = $\frac{1}{n_1 \sim n_2}$.
- The time-interval between a maximum and its next minimum = $\frac{1}{2(n_1 \sim n_2)}$
- The human ear can perceive a maximum of 10 beats per second which is due to persistence of hearing.
- The phenomenon of beats is due to interference of sound waves.
- To produce beats, the two waves must have a slight difference in their frequencies and they should travel in the same direction.
- The number of beats produced is zero if the two interfering sound waves have the same frequency $(n_1 \sim n_1 = 0)$.
- An echo (or a reflected sound) and its direct sound can't produce beats, as the two waves have the same frequency.
- If a_1 and a_2 are the amplitudes of the two interfering sound waves, then the amplitude of the maximum is $(a_1 + a_2)$ and the amplitude of the minimum is $(a_1 - a_2)$.
- $I_{max} \propto (a_1 + a_2)^2$ and $I_{min} \propto (a_1 - a_2)^2$.

Applications of Beats :

1. Beats are used in tuning musical instruments.
2. Beats are used in detecting dangerous gases in mines.
3. The phenomenon of beats can be used to find the unknown frequency of a sound note and of a tuning fork.
4. The phenomenon of beats is used in heterodyne receivers.

14. Echoes :

- A sound reflected from and abstacle is called an echo.
- The time interval to hear an echo is $t = \frac{d+d}{v} \Rightarrow t = \frac{2d}{v}$, where d is the distance from the source of sound to reflecting surface and v is the velocity of sound.

⇨ The minimum distance from the source to the reflecting surface to hear an echo is $\frac{v}{20}$.

$\left[t = \frac{2d}{v} \Rightarrow d = \frac{vt}{2} \text{ and } t = 0.1\,s\right]$

⇨ If $v = 330\ ms^{-1}$ at $0°C$, the minimum distance to hear an echo is 16.5 m.

⇨ The minimum time interval to hear an echo is 0.1 second (persistence of hearing).

⇨ An echo and its direct sound have the same frequency, wavelength and velocity, but their amplitude and intensity are different.

⇨ **Applications of Echoes :**

1. The velocity of sound can be determined.
2. The depth of a sea and the height of an aeroplane can be found.
3. Stethoscope and megaphone work on the principle of echoes.
4. SONAR (Sound Navigation and Ranging) uses the principle of echoes to detect the presence of a submarine in a sea.

15. Acoustics of Buildings :

⇨ Acoustics of buildings deals with the construction and design of buildings, halls, auditoria, etc. for proper propagation of sound.

⇨ It prescribes the necessary methods and requirements for a good auditorium or good sound effects in a hall or building.

⇨ W.C. Sabine is the founder of Acoustics of Buildings.

16. Absorption Coefficient (a) : It is the ratio of the sound energy absorbed by a surface (E_s) to the sound energy absorbed by an open window (E_w) of the same area in the same time.

⇨ Absorption coefficient $a = \frac{E_s}{E_w}$

⇨ 'a' has no units and no dimensions.

⇨ Open windows and open doors have absorption coefficient $a = 1$ i.e., they are perfect absorbers.

⇨ Carpets, mats, curtains, thick screens are some examples for good sound absorbers.

⇨ If a is absorption coefficient of a surface of area S, then the total energy absorbed by it is given by total absorption $A = aS$

⇨ The unit of total absorption is metric sabine.

⇨ If a window or door is opened while speech is going on in an auditorium, its absorption increases.

17. Reverberation : The phenomena of persistence of hearing in a closed room as a result of multiple reflections of sound even after the source of sound is turned off is called reverberation.

18. Reverberation Time (T) : The reverberation time is defined as the time required by the sound intensity to decrease to the threshold of audibility from an initial intensity of 10^6 times the threshold of audibility after the source of sound is turned off.

⇨ The reverberation time should not be very large or very small.

⇨ For a good auditorium, T = 0.5 to 1 second for music and T = 1 to 2 seconds for speeches.

⇨ A room with zero reverberation time (T = 0) is called a dead room.

19. Sabine's Formula :

⇨ According to Sabine's formula, the reverberation time (T) varies directly as the volume (V) of the room and inversely as the total absorption (A) in the room.

Reverberation time $T = \frac{0.17V}{A}$ or $T = \frac{0.17V}{\Sigma aS}$ $(\because A = aS)$

⇨ If some visitors enter a hall, its reverberation time decreases as its total absorption increases.

⇨ The reverberation time depends on the frequency of the sound, the size of the room, the nature of the reflecting material and the area of the reflecting surfaces.

⇨ The reverberation time is independent of the shape of the room and the positions of the source of sound and the listener.

20. Characteristics of a Good Building :

1. The music or speech produced on the dias should be audible in the entire hall.
2. The quality of sound should be uniform throughout the hall.
3. The syallables should be clear without overlapping.
4. There should not be any variation in the sound level due to interference or reflection.
5. Outside sounds should not enter the hall.
6. The focussing effect and the echelon effect should be eliminated.

⇨ **Focussing effect :** The unnecessary concentration of sound at a point is called focussing effect.

⇨ It arises due to the presence of cylindrical or spherical surfaces on the wall or in the ceiling.

⇨ It can be eliminated by making surfaces parabolic instead of cylindrical or spherical.

⇨ **Echelon effect :** The sharp sound produced infront of the stairs may produce an unwanted musical note due to successive reflections. This phenomenon is called echelon effect.

⇨ It can be eliminated by covering the staircase with carpets.

7. The loud speakers should be kept a little above the speaker's head.
8. The hall should contain suitable reflecting surfaces for maintaining proper reverberation time.
9. The hall should be equipped with suitable absorption materials like carpets and curtains to have sufficient absorption in the hall.

PRACTICE SET - I

01. A sound wave is a
1) Transverse mechanical wave
2) Longitudinal mechanical wave
3) Longitudinal electromagnetic wave
4) Transverse electromagnetic wave

02. Sound can't travel through
1) Solids 2) Liquids
3) Gases 4) Vacuum

03. Which of the following is/are correct about 'sound'?
A) Sound is mechanical wave
B) Sound travels in the form longitudinal waves
C) Sound is a form of energy
D) A material medium is essential for the propagation of sound
E) Sound can not travel through vacuum
1) A,B,C, E 2) A, B, C, D
3) A,C,D,E 4) A,B,C,D,E

04. The audible range of (frequency of the sound is)
1) 20 Hz - 2000 Hz 2) 20 Hz - 200 Hz
3) 20 Hz - 20000 Hz 4) None

05. The audible range of wavelength of the sound is (velocity of sound at $0^\circ C = 330\ ms^{-1}$)
1) 16.5 m - 0.0165 m 2) 1.65m - 0.165 m
3) 165 m - 0.165 m 4) None

06. A sound wave is produced by a
1) Vibrating body 2) Heating body
3) Current carrying body
4) All

07. The velocity of sound is maximum in
1) Water 2) Air 3) Vacuum 4) Metal

08. The frequency of ultrasonic sound is
1) < 20 Hz 2) > 20 Hz
3) < 20,000 Hz 4) > 20,000 Hz

09. The intensity level of sound is measured in
1) decibel 2) bel 3) 1 and 2 4) None

10. If the velocity of audible sound at $0^\circ C$ is $330\ ms^{-1}$, then the velocity of ultrasonic sound at $0^\circ C$ is
1) $330\ ms^{-1}$ 2) $< 330\ ms^{-1}$
3) $> 330\ ms^{-1}$ 4) None

11. An astronaut can't hear his companion on the surface of the moon, because
1) Frequency of the sound produced is above audio frequencies
2) There is no medium for sound propagation
3) Temperature is too low
4) There are many bats

12. One important similarly between sound and light waves is
1) Both can travel through vacuum
2) Both are transverse waves
3) Both are mechanical waves
4) Both can show interference effect

13. The unit of intensity level of sound is 'bel'. Its intensity is .... times the threshold of hearing
1) 2 2) 5 3) 10 4) 100

14. The intensity of threshold of pain is
1) 12 dB 2) 120 bel 3) 120 dB 4) 0 dB

15. Which of the following is/are the characteristics of musical sound ?
1) Pitch 2) Intensity 3) Quality 4) All

16. Bells are made of metal, but not of wood. This is because
1) Thermal conductivity of metal is greater than that of wood
2) Density of metal is greater than that of wood
3) Sound is not conducted by metals but is radiated
4) Wood dampens vibrations while metal are elastic.

17. A tuning fork of frequency 256 Hz produces a wave of length 100 cm in air. The speed of sound in air is
1) $256\ ms^{-1}$ 2) $2560\ ms^{-1}$
3) $25.6\ ms^{-1}$ 4) $2.56\ ms^{-1}$

18. The frequency of a tuning fork is 500 Hz and the velocity of sound in air is $300\ ms^{-1}$. The distance travelled by the sound when the fork executes 100 vibrations is
1) 30 m 2) 45 m 3) 60 m 4) 75 m

19. Best frequency is always equal to the ....the frequencies of the two sound sources
1) Sum of 2) Product of
3) Difference between 4) Ratio of

20. Beats can't be perceived if the beat frequency is more than
1) 5 2) 10 3) 20 4) None

21. Beats are the result of
1) Constructive interference only
2) Destructive interference only
3) Constructive and destructive interference
4) None

22. The frequencies of two sources of sound are 512 Hz and 516 Hz. The time interval between two consecutive beats is
1) 0.5 s 2) 0.25 s 3) 1 s 4) 4 s

23. The velocity of sound in a gas in which two sound waves of wavelength 50 cm and 50.4 cm produce 6 beats per second is .... ms^{-1}
1) 350 2) 378 3) 387 4) 300

24. The necessary condition for producing beats is
1) Two waves should travel in opposite directions
2) Two waves should have slightly different frequencies
3) Two waves should have equal wavelength
4) Two waves should have equal amplitude

25. Two forks, when vibrated simultaneously, produce 4 beats per second. If one fork has a frequency of 256 Hz, the frequency of the other is
1) 252 Hz 2) 260 Hz
3) Either 1 or 2 4) 1 & 2

26. Two sound waves have same amplitude of 20 cm produce beats. The amplitudes of maximum and minimum of the produced beats are
1) 40 cm, 20 cm 2) 20 cm, 20 cm
3) 40 cm, zero 4) 20 cm, zero

27. The phenomenon of sound used to tune the musical instruments is
1) Beats 2) Echoes 3) Absorption 4) Refraction

28. The minimum distance to hear an echo is ($V = 330\ ms^{-1}$)
1) 16.5 m 2) 165 m 3) 1.65 m 4) None

29. Which of the following uses the phenomenon of echoes ?
1) Stethoscope 2) Megaphone
3) Sonar 4) All

30. An echo of sound is due to ..... of sound.
1) Refraction 2) Reflection
3) Re-construction 4) Dispersion

31. The time interval (t) between direct and reflected sounds to hear an echo is
1) t > 0.1 s 2) t = 0.1 s
3) $t \geq 0.1$ s 4) t < 0.1 s

32. The number of beats heard due to direct sound and its echo is
1) 1 2) 2 3) 10 4) Zero

33. A gun is fired and the echo is heard after 2.5 s. The distance of the gun from the cliff is (velocity of sound in air = $332\ ms^{-1}$)
1) 415 m 2) 830 m 3) 420 m 4) 840 m

34. The echo and the direct sound differ in
1) Frequency 2) Wavelength
3) Velocity 4) Intensity

35. The ratio of frequencies of two musical notes is
1) 1 2) > 1 3) ≥ 1 4) 0

36. If the intensity level changes by 1 dB, the change in the intensity of the sound is
1) 62% 2) 26% 3) 74% 4) None

37. The ratio of intensities of sound with 2 dB and 1 dB is
1) 2 2) 10 3) 20 4) 100

38. A sound has an intensity level of 30 dB, its intensity in Wm^{-2} is
1) 10^{-15} 2) 10^{-9} 3) 10^{-12} 4) 10^{-10}

39. The reverberation of sound is due to
1) Multiple reflections 2) Multiple refractions
3) Multiple deviations 4) None

40. The absorption coefficient of an open window is
1) 0   2) 1   3) ∞ 4) None

41. The SI unit of absorption coefficient is
1) metric sabine   2) metric debye
3) metric dyne   4) No unit

42. If 'a' is the absorption coefficient of a surface and 'S' is the surface area, then the total absorption aS has the SI unit of
1) metric sabine   2) metric debye
3) metric dyne   4) No unit

43. Which of the following is/are perfect absorber(s) of sound?
1) Human body   2) Carpet
3) Open door   4) Closed Window

44. Reverberation time of an auditorium depends on
1) size of the auditorium
2) Nature of the reflecting materials in the room
3) Area of the reflecting surfaces
4) All

45. The Sabine's formula for the reverberation time of a hall of volume V and total absorption A is
1) T = VA   2) T = 0.17 VA
3) $T = 0.17\frac{A}{V}$ 4) $T = 0.17\frac{V}{A}$

46. When speech is going on in an auditorium, a window is opened beside the audience. The absorption coefficient of the auditorium
1) Increases   2) Decreases
3) Remains the same   4) Becomes zero

47. A 'dead room' has .... reverberation time.
1) Zero   2) One second
3) Infinite
4) Less than one second

48. The reverberation time for a moderate sized auditorium should be of the order of (in seconds)
1) 1-2   2) 2-3   3) < 1   4) > 3

49. 'Focussing effect' means
1) A musical note produced due to successive reflections
2) Unnecessary concentration of sound at a point
3) Rattling sound in a room   4) None

50. Parabolic reflecting surfaces in a room minimise
1) Echelon effect   2) Focussing effect
3) Noise   4) All

PRACTICE SET - I KEY

01) 2	02) 4	03) 4	04) 3	05) 1
06) 1	07) 4	08) 4	09) 1	10) 1
11) 2	12) 4	13) 3	14) 3	15) 4
16) 4	17) 2	18) 3	19) 3	20) 2
21) 3	22) 2	23) 2	24) 2	25) 3
26) 3	27) 1	28) 1	29) 4	30) 2
31) 3	32) 4	33) 1	34) 4	35) 3
36) 2	37) 1	38) 2	39) 1	40) 2
41) 4	42) 1	43) 3	44) 4	45) 4
46) 1	47) 1	48) 1	49) 2	50) 2

PRACTICE SET - II

01. The shortest wavelength of the ultrasonic waves emitted by a bird is 3.41 mm. If the velocity of the sound in air is 341 ms^{-1}, the frequency of the ultrasonic wave emitted is
1) 5^5 Hz   2) 10^5 Hz
3) 5^{10} Hz   4) 10^{10} Hz

02. A stone is dropped into a well 490 m deep. The time after which the sound of splash heard is.... (acceleration due to gravity = $9.8\ ms^{-2}$ and velocity of sound in air = 350 ms^{-1})
1) 10 s   2) 1.4 s   3) 11.4 s   4) 8.6 s

03. The ratio of the amplitudes of two waves is 3:4. The ratio of the intensities of these waves is
1) $\sqrt{3}:\sqrt{4}$ 2) $\sqrt{4}:\sqrt{3}$
3) 9:16   4) 16:9

04. The phase difference between direct sound and its echo is
1) π 2) $\pi/2$ 3) $\pi/3$ 4) 0

05. A sound has an intensity of $3\times10^{-8}\ Wm^{-2}$. The sound level in dB is (log 3 = 0.477)
1) 4.48   2) 44.8   3) 448   4) 4480

06. The pitch of a musical note depends on
1) Frequency   2) Amplitude
3) Intensity   4) None

07. The same musical note played on Sitar and Veena differs in
1) Pitch 2) Frequency 3) Quality 4) Intensity

08. The threshold of hearing is $10^{-12}\ Wm^{-2}$. Its value in dB is
1) 0   2) 1   3) 0.5   4) None

09. The velocity of sound in a gas in which two waves of wavelengths 1m and 1.01 m produce 10 beats in 3 seconds is
1) 336.7 ms^{-1} 2) 337.6 ms^{-1}
3) 363.7 ms^{-1} 4) 333.3 ms^{-1}

10. A man sounds a horn of frequency of 256 Hz near a hill and the sound is reflected. The man hears.... beats.
1) 0   2) 1   3) 2   4) 256

11. A tuning fork of frequency of 300 Hz and another tuning fork of unknown frequency are vibrated together. If they produce 10 beats in one second, the frequency of the second tuning fork is
1) 310 Hz   2) 290 Hz
3) Either 310 Hz or 290 Hz   4) None

12. A tuning fork of frequency of 300 Hz and another tuning fork of unknown frequency are vibrated together. If they produce 10 beats in one second, the time interval between two consecutive beats is
1) 0.1 s   2) 0.2 s   3) 0.5 s   4) None

13. A tuning fork of frequency of 300 Hz and another tuning fork of unknown frequency are vibrated together. If they produce 10 beats in one second, the time interval between maximum and next minimum is
1) 0.1 s   2) 0.2 s   3) 0.05 s   4) None

14. A man standing at a certain distance blows a horn towards a big wall. He hears an echo after 5s. The distance between the man and the wall is.... (V = 340 ms^{-1})
1) 850 m   2) 1700 m   3) 425 m   4) 85 m

15. A man standing between two cliffs fires a gun. He hears the first echo after 2 seconds and the next after 5 seconds. The distance between the cliffs is .....m. (V = 350 ms^{-1})
1) 875   2) 350   3) 525   4) 1225

16. If V is the velocity of sound in air, the minimum distance between the reflecting surface and the source to hear an echo is
1) $\frac{V}{20}$ 2) $\frac{V}{10}$ 3) 20V   4) 10V

17. A heterodyne receiver is based on the phenomenon of
1) Echoes   2) Beats
3) Reverberation   4) None

18. Which of the following statements is wrong?
1) Sound travels in a straight line
2) Sound travels in the form of longitudinal waves
3) Sound is a form of energy
4) Sound travels faster in vacuum than in air

19. Which of the following physical quantity remains constant when a sound wave goes from one medium to another?
1) Velocity   2) Amplitude
3) Frequency   4) Wavelength

20. The persistence of hearing of sound is
1) 0.1 s   2) 1s   3) 10 s   4) 101 s

21. SONAR uses the principle of..... of sound.
1) Echoes 2) Beats 3) Refraction 4) Scattering

22. SONAR emitts .... waves
1) Radio 2) Light 3) Ultrasonics 4) Infrasonics

23. The total energy of a sound wave E is related to its frequency n as
1) $E \alpha \frac{1}{n^2}$ 2) $E \alpha n^2$ 3) $E\alpha\frac{1}{n}$ 4) $E \alpha n$

24. Reverberation time of an enclosure is
1) The time in seconds required to reduce the intensity of sound by 60 dB after the source of sound is stopped.
2) The time in seconds required to achieve maximum echo
3) The time in seconds required to achieve minimum echo
4) The time in seconds required to die down the sound.

25. Which of the following does NOT affect the reverberation time of an auditorium ?
1) Size of the auditorium
2) Frequency of the sound 3) Nature of waves
4) Area of the walls, ceiling and floor

26. The successive sounds overlap when the reverberation time is
1) Very small 2) Zero
3) Very large 4) None

27. Reverberation time of an enclosure is
1) Directly proportional to volume and area of absorption
2) Inversely proportional to volume and area of absorption
3) Directly proportional to volume and inversely proportional to absorption coefficient
4) Directly proportional to absorption coefficient and inversely proportional to volume.

28. Reverberation time of an enclosure is
1) The time required to fall in intensity to 10^{-6} times of its original intensity
2) The time required to fall in intensity to 10^{6} times of its original intensity
3) The time required to fall in intensity to 10^{-12} times of its original intensity 4) None

29. The reverberation time of a room of $10^5\ m^3$ volume and $2\times10^4\ m^2$ area is ..... seconds. (absorption coefficient of the surface is 0.20)
1) 0.425 2) 4.25 3) 42.5 4) 425

30. The total sound absorption of a hall of volume $4\times6\times10\ m^3$ with a reverberation time of 1.5 s is .... metric sabine
1) 24.2 2) 25.2 3) 26.2 4) 27.2

31. A rectangular hall of internal dimensions $20\times30\times16\ m^3$ has a surface whose average absorption coefficient is 0.04. The reverberation time of the room is ..... seconds.
1) 13.57 2) 14.57 3) 44.57 4) None

32. A big room of volume $100\times30\times10\ m^3$ has a reverberation time of 2.5 s. The total absorption of the hall is (in metric sabine)
1) 204 2) 2040 3) 20.4 4) 20400

33. A big room of volume $100\times30\times10\ m^3$ has a reverberation time of 2.5 s. The total absorption of the hall is (in metric sabine). If 500 visitors are in the room, the total absorption of the hall is.... metric sabine (absorption coefficient of each visitor = 0.5).
1) 2040 2) 250 3) 2290 4) None

34. A big room of volume $100\times30\times10\ m^3$ has a reverberation time of 2.5 s. The total absorption of the hall is (in metric sabine). If 500 visitors are in the room, the total absorption of the hall is.... metric sabine (absorption coefficient of each visitor = 0.5). The new reverberation time is...seconds
1) 3.22 2) 2.23 3) 2.32 4) None

35. An auditorium of volume V has total absorption A and reverberation time T. If 100 audience each having some absorption coefficient enter the auditorium, then the new absorption of the auditorium will be
1) Less than A 2) Greater than A
3) Equal to A 4) None

36. An auditorium of volume V has total absorption A and reverberation time T. If 100 audience each having some absorption coefficient enter the auditorium, then the new reverberation time is
1) Less than T 2) Greater than T
3) Equal to T 4) None

37. The reverberation time of a cinema hall is 0.1 s. The volume of another small theatre is half that of the cinema hall. If the absorbing area is same for two, then the reverberation time of the small theatre is .... seconds
1) 0.2 2) 0.1 3) 1 4) 0.05

38. The sharp sound produced infront of staircase produces a musical note. This phenomenon is called
1) Focussing effect 2) Echelon effect
3) Music 4) Noise

39. Echelon effect in an auditorium can be avoided by
1) Using staircase made of iron
2) Covering staircase with carpets
3) Making reflecting surfaces parabolic
4) None

40. The absorption coefficient of an open window made of fibre glass is 1. If the window is closed, then its absorption coefficient will be
1) Greater than 1 2) Less than 1
3) Equal to 1 4) None

41. The sound waves of wavelength 5m and 6m formed 30 beats in 3 seconds. The velocity of sound is
1) 300 ms^{-1} 2) 310 ms^{-1}
3) 320 ms^{-1} 4) 330 ms^{-1}

42. Two tuning forks of frequencies 500 Hz and x Hz are vibrated together. If they produce 10 beats per second, then x = ...
1) 510 Hz 2) 490 Hz
3) Either 510 Hz or 490 Hz
4) 500 Hz

43. The time interval between two consecutive minima if two tuning forks of frequencies 100 Hz and 110 Hz are vibrated together to produce beats is
1) 0.1 s 2) 1 s 3) 0.05 s 4) 0.2 s

44. The time interval between two consecutive minima if two tuning forks of frequencies 100 Hz and 110 Hz are vibrated together to produce beats is the time interval between a maximum and next minimum is
1) 0.1 s 2) 1 s 3) 0.05 s 4) 0.2 s

45. Two sound waves which are travelling in opposite directions have frequencies 150 Hz and 152 Hz. The number of beats heard is
1) 2 2) 4 3) 1 4) Zero

46. The reverberation time of a cinema hall is 0.2s. The reverberation time of an auditorium whose volume is same as that of the cinema hall but the absorbing area of the auditorium is half of the cinema hall is
1) 0.1 s 2) 0.05 s 3) 0.2 s 4) 0.4 s

47. Two reverberation time of a hall is 0.6 s. Another hall whose volume and absorbing area are half those of first hall will have a reverberation time of....s.
1) 0.6 2) 1.2 3) 0.3 4) 0.15

48. Two cinema halls have their volumes in the ratio 1 : 4 and absorbing areas in the ratio 1 : 2. The ratio of their reverberation times is
1) 1 : 8 2) 2 : 1 3) 1 : 2 4) 8 : 1

49. When a music concert is going on in an auditorium, the doors and windows are opened suddenly. Now, the reverberation time will
1) Increase 2) Decrease
3) Remain unchanged 4) None

50. Reverberation time of an enclosure is independent of
1) Shape of the enclosure
2) Position of the source of sound
3) Position of the listener
4) All

51. An empty cinema hall has reverberation time of 0.5 s. If the hall is filled with 1000 audience, then the reverberation time will be
1) 0.5 s 2) > 0.5s 3) < 0.5 s 4) None

52. The threshold of hearing is 10^{-12} Wm^{-2} at a frequency of
1) 10 Hz 2) 100 Hz
3) 1000 Hz 4) 10000 Hz

53. If the absorption changes by 2%, then th e percentage change in the reverberation time is
1) 1% 2) 2% 3) 3% 4) 4%

PRACTICE SET - II KEY

01) 2	02) 3	03) 3	04) 1	05) 2
06) 1	07) 3	08) 1	09) 1	10) 1
11) 3	12) 1	13) 3	14) 1	15) 4
16) 1	17) 2	18) 4	19) 3	20) 1
21) 1	22) 3	23) 2	24) 1	25) 3
26) 3	27) 3	28) 1	29) 2	30) 4
31) 2	32) 2	33) 3	34) 2	35) 2
36) 1	37) 4	38) 2	39) 2	40) 1
41) 1	42) 3	43) 1	44) 3	45) 4
46) 4	47) 1	48) 1	49) 2	50) 4
51) 3	52) 3	53) 2		

PREVIOUS ECET BITS

2012

01. A cinema shall has volume of 7500 m^3. It is required to have reverberation time of 1.5 seconds. The total absorption in the hall should be
1) $850W-m^2$ 2) $82.50W-m^2$
3) $8.250W-m^2$ 4) $0.825W-m^2$

02. To absorb the sound in a hall which of the follwoing are used
1) glasses, stores 2) carpets, curtains
3) polished surface 4) platforms

2014

03. Two sounds of wavelengths 5m and 6m, travelling in a medium produce 10 beats per second. The speed of sound in the medium ____
1) 300 m/s 2) 320 m/s
3) 350 m/s 4) 1200 m/s

04. An observer moves towards a stationary source of sound with a velocity one tenth the velocity of sound. The apparent increase in frequency ____
1) 3% 2) 0.1%
3) 5% 4) 10%

T.S - ECET 2015

05. Sourc of sound and observer are moving towards each other, the observer will hear
1) high frequency, high wavelength
2) low frequency, low wavelength
3) high frequency, low wavelength
4) low frequency, high wavelength

06. The two wave of the same frequency moving with swame speed in the same direction give rise to
1) beats 2) interference
3) stationary waves 4) diffraction

A.P - ECET 2015

07. A picture hall has a volume of 8000 m^3. It is required to have reverberation time of 1.5 seconds. The total absorption in the hall is
1) 440 OWU 2) 880 OWU
3) 1980 OWU 4) 72.72 OWU

08. The problem of echelon effect can be removed by using
1) iron board 2) stair carpet
3) coir 4) wooden board

09. Doppler effect is applicable when the velocities of the source of sound and the observer are
1) more than velocity of light
2) equal to velocity of light
3) less than velocity of light
4) not comparable with velocity of light

T.S - ECET 2016

10. A boy hears an echo of his own voice from a distant hill after 5 seconds. If the velcoity of sound is 330 m/s, the distance of the hill is
1) 425 m 2) 825 m 3) 1650 m 4) 850 m

A.P - ECET 2016

11. A pipe of 30 cm long is open at both ends. The harmonic mode of the pipe that resonates a 1.1kHz source is (Speed of sound in air is 330 ms^{-1})
1) first harmonic 2) third harmonic
3) second harmonic 4) fourth harmonic

12. A train standing at the outer signal of a railway station blows a whistle of frequency 400 Hz in still air. The frequency of the whistle for an observer on the platform when the train approaches him at a speed of $10ms^{-1}$ is
1) 412Hz 2) 41.2Hz 3) 4.12Hz 4) 400Hz

T.S - ECET 2017

13. The intensity of sound produced by thunder is 0.1 Wm^{-2}. The intensity level in decibels is
1) 110 dB 2) 100 dB
3) 90 dB 4) 140 dB

14. A classroom had dimensions $20x15x5\,m^3$. The reverberation time is 3.5 s. The average absorption coefficient is
1) 0.05 2) 0.09 3) 0.03 4) 0.07

15. Which of the following is not a characteristic of musical sound
1) pitch 2) loudness 3) frequency 4) quality

16. The walls of hall built for music concerts should
1) amplify sound 2) reflect sound
3) transmit sound 4) absorb sound

17. When a star approaches the earth, the waves are shifted to wards
1) green colour 2) yellow colour
3) blue end 4) red end

A.P - ECET 2017

18. Inside a big hall, the reverberation time is
1) directly propoetional to volume
2) inversely proportional to sound absorption
3) depends on temperature
4) both 1&2

19. The voice of lion is different from that of a mosquito because
1) the sounds have different pitch
2) they are of different size
3) the two voices travel with different velocities
4) the sounds have different phases

20. A car is travelling $at\frac{V}{10}m/s$ and sounds horn of frequency 990 Hz. The apparent frequency heard by a police chasing the car at $\frac{v}{9}m/s$ (V is the velocity of sound) is
1) 990 Hz 2) 900 Hz
3) 100 Hz 4) 1000 Hz

T.S - ECET 2018

21. The walls of Hall built for music concerns should____
1) amplify sound 2) reflect sound
3) transmit sound 4) absorb sound

22. When a surrounding body and listener approach each other the pitch appears to rise and when they move away from each other pitch apperas to decrease. This is known as________
1) doppler's principle 2) newton's formula
3) interference 4) sabine's formula

23. An engine driver moving towards a wall with a velcoity of 50 m/sec.. emits a note of 1.2 KHz. Speed of sound in air is 350 m/sec. The frequency of the note after reflection from the wall as heard by the engine driver is____
1) 1.2 KHz 2) 1.6 KHz
3) 0.24 KHz 4) 2.4 KHz

24. What is the maximum number of syllables a person can spack in one second?
1) 1 2) 3 3) 4 4) 5

25 The speed of sound in air at NTP is 300m/s, if the air pressure becomes four times then the speed of sound will be_______
1) 150 m/s 2) 300 m/s
3) 600m/s 4) 1200 m/s

A.P - ECET 2018

26. The voice of a male person is different from that of a female person because
1) two sounds have different phases
2) two persons are of different size
3) two sounds travel with different velocities
4) two sounds have different pitch

27. If the sound absorption of ahall is changed by 2%, then the percentage change in the reverberation time is
1) 2% 2) 4% 3) 1% 4) No change

28. When a source of sound is in motion towards a stationary observer, the effect observed is

1) decrease in velocity of sound
2) increase in velocity of sound
3) increase in frequency of sound
4) decrease in frequency of sound

PREVIOUS ECET BITS KEY

01) 1	02) 2	03) 1	04) 4	05) 3
06) 2	07) 2	08) 2	09) 3	10) 2
11) 3	12) 1	13) 1	14) 4	15) 3
16) 4	17) 3	18) 4	19) 1	20) 4
21) 4	22) 1	23) 2	24) 4	25) 3
26) 4	27) 1	28) 3		

PREVIOUS ECET BITS HINTS AND SOLUTIONS

2012

01. $T=\frac{0.17V}{\Sigma as} \Rightarrow \Sigma as=\frac{0.17V}{T}$

$\Rightarrow \Sigma as=\frac{0.17\times 7500}{1.5}$

$\Sigma as = 850W-m^2$

02. Carpets, curains

2014

03. $Beat = n_2 - n_1$ $\left[\because n=\frac{v}{\lambda}\right]$

$10=\frac{v}{\lambda_2}-\frac{v}{\lambda_1}$

$=v\left[\frac{1}{5}-\frac{1}{6}\right]=v\left[\frac{1}{30}\right]$

v= 300 m/s

04. $v_0=\frac{1}{10}v$

$\frac{n_2-n_1}{n_1}\times 100=?$ $\left(\frac{n_2}{n_1}-1\right)100=?$

$n_2=\left(\frac{v+v_0}{v}\right)n_1$ $\frac{n_2}{n_1}=\left(\frac{v+\frac{v}{10}}{v}\right)=\frac{11}{10}$

$\left(\frac{11}{10}-1\right)100=\frac{1}{10}\times 100=10\%$

05. high frequency, low wavelength
06. interference
07. $T=\frac{0.165v}{\Sigma as}$

$\Sigma as=\frac{0.165V}{T}\ \frac{0.165\times 8000}{1.5}=880ms$

$=880$ owu

08. Stair carpet
09. less than velocity of light
10. $d=\frac{Vt}{2}\Rightarrow d=\frac{330\times 5}{2}=165\times 5=825m$
11. $l=30cm$

$n=1.1KH_W=1100H_z$

$n=\frac{V}{2l}=\frac{330\times 100}{2\times 30}=550H_z$

first harmonic in open pipes harmonic ratio 1:2:3
1100Hz in second harmonic

12. source towards observer

$n^1=\left(\frac{V}{V-Vs}\right)_n=\left(\frac{340}{340-20}\right)400=412h_z$

13. $L=10\log\frac{I}{I_0}\Rightarrow =110$ dB
14. $RT=\frac{0.17v}{\sum as}\Rightarrow a=\frac{0.17\times 20\times 15\times 5}{3.5\times 2(300+75+100)}$
15. frequency
16. absorb sound
17. blue end
18. both 1 & 2
19. the sounds have different pitch

HEAT

EXPANSION OF GASES

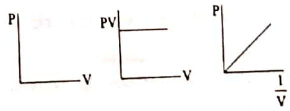
- The important measurable properties of gases are P,V,T and n.
- A change in one of the factors P, V and T produces a change in the other two factors.
- Pressure (P) of a gas is measured by Manometer, Bourden gauge (high pressures) and Mcleod gauge (low pressures ; works on Boyle's law).
- Volume of a gas is measured by a gas burette ro Eudiometer.
- Vapour is a gas which can be liquidified by the application of pressure alone.

a. Critical temperature (T_c), critical pressure (P_c) and critical volume (V_c) are called critical constants of a gas.

- The temperature above which a gas can not be liquidfied by more application of pressure is called critical temperature.
- Gases below their critical temperature are called vapours and vapours above their critical temperature are called gases.
- **Boyle's law :** At constant temperature, the pressure of given mass of a gas is inversely proportional to its volume. $P\propto\frac{1}{V}$ or $PV=K.$ (n.T are constant) or $P_1V_1=P_2V_2$. In $PV=K$, the value of K depends on the mass and temperature of the gas and the system of units.
- Boyle's law can also be defined as follows. At constant temperature, the pressure of a given mass of gas is directly proportional to its density.

$P\propto d$ or $\frac{P}{d}=K$ or $\frac{P_1}{d_1}=\frac{P_2}{d_2}$.

- P-V graph at a constant temperature (isothermal) is a rectangular hyperbola.



- PV -V graph is a straight line parallel to volume axis.
- $P-\frac{1}{V}$ graph is a straight line passing through the origin.

- Real gases obey Boyle's law only at high temperature and low pressures.
- Assuming a uniform temperature, the volume of an air bubble increases as it rises from the bottom of a lake.
- **Charles law :** At constant pressure, the volume of a given mass of a gas increases by $1/273th$ of its original volume at 0^0C for every 1^0C rise of temperature. (or) At constant pressure, the volume of a given mass of gas is directly proportional to the absolute scale of temperature. $V \propto T$ or $\frac{V}{T} = K$
- V-T graph is a straight line passing through the origin.
- V-T (in 0^0C) graph is a straight line which when produced meets the temperature axis at -273.15^0C or 0K
- The pressure of a given mass of gas at constant volume increases by $1/273th$ of its original pressure at 0^0C for every 1^0C rise of temperature. (or) At constant volume, the pressure of a given mass of gas is directly proportional to absolute scale of temperature. $P \propto T$ or $\frac{P}{T} = K$ (n, V are constants).
- For a given mass of gas, the temperature at which the volume at constant pressure or pressure at constant volume becomes zero is called absolute zero.
- No molecular movement will be there at absolute zero.
- The lowest temperature attainable is -273.1^0C or 0 K.
- The scale of temperature on which the zero corresponds to -273^0C and each degree is equal to the celsius degree is called the absolute scale of temperature or thermodynamic scale of temperature.
- The temperature t^0C is equal to $(273+t)^0$ on the absolute scale.
- Perfect gas equation is $PV = nRT$. (when n moles of a gas is taken) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} = K$ (constant)
- **Ideal gas :**

(a) A gas is said to be an ideal or perfect gas
(i) If its molecules are mere point masses occupying no finite volume
(ii) If its molecules have no mutual attraction or repulsion.
(b) A gas that obeys gas laws at all pressures and temperatures, whether high or low, is called a perfect or (or) ideal gas. No such gas exists.

- Hydrogen behaves closely as perfect gas. That is why it is being used in constant volume thermometers.
- In constant volume hydrogen gas thermometer if P_0, P_{100}, P_t are the pressures at $0^0C, 100^0C$ and at t^0C then $t = \frac{P_t - P_0}{P_{100} - P_0} \times 100$

- If 'x' is any thermometer property such as pressure (or) volume (or) resistance which has values at $0^0, 100^0, t^0$ on any scale as X_0, X_{100} and X_t then $t = \frac{P_t - P_0}{P_{100} - P_t} \times 100$
- $\frac{PV}{T}$ for one mole of a gas is constant for all gases and is called universal gas constant or molar gas constant 'R'.
- PV = RT or PV = nRT where n = number of moles of the gas. $n = \frac{m}{M} = \frac{mass}{molecular\ weight}$
- $\frac{PV}{T}$ for one gram of a gas is called specific gas constant 'r' which is different for different gases.
- PV = rT or PV = mrT where m = mass of the gas in kilograms.
- $r = R /$ molecular weight of the gas.
- R = 8.314 J / mol - K or 1.987 Cal/mol - K or 0.0821 lit-atm/mol - K
- Relation between pressure, density and temperature

The gas equation is $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

i The gas equation can be expressed in terms of the density. The other from of the gas equation is $\frac{P_1}{d_1T_1} = \frac{P_2}{d_2T_2}$

- When a gas is heated both its volume and pressure increase.
- At constant temperature and pressure, the volume of a gas is directly proportional to the mass of the gas.
- At constant temperature and volume, the pressure of a gas is directly proportional to the mass of the gas.
- At constant pressure, the ratio of increase of volume per 1^0C rise of temperature to its original volume at 0^0C is called volume coefficient of a gas (α). Unit is $/^0C$ or K^{-1}

$\alpha = \frac{V_t - V_0}{V_0 t} \Big/ {}^0C$ or $\alpha = \frac{V_2 - V_1}{V_1t_2 - V_2t_1} \Big/ {}^0C$ or $V_t = V_0(1+\alpha t)$

- At constant volume, the ratio of increase of pressure per 1^0C rise of temperature to its original pressure at 0^0C is called pressure coefficient of gas

(β) Unit is $/ {}^0C$ or K^{-1}, $\beta = \frac{P_t - P_0}{P_0 t}$

${}^0C$ or $\beta = \frac{P_2 - P_1}{P_1t_2 - P_2t_1}$

$°C$ or $\beta = \frac{P_2 - P_1}{P_1 t_2 - P_2 t_1} \Big/ °C$ or $P_t = P_0(1+\beta t)$

⇨ For all gases

$\alpha = \beta = \frac{1}{273} \Big/ °C = 0.00366\ °C$ or K^{-1}

⇨ Regnault's apparatus is used to determine the pressure coefficient of a gas.

⇨ Jolly's bulb apparatus is used to determined the pressure coefficient of a gas

⇨ **Dalton's law of partial pressures :** Total pressure of non-reacting mixture of gases is equal to the sum of the partial pressures. Partial pressure = mole fraction x total pressure.

⇨ If a vessel of volume V_1 containing a gas at pressure P_1 is joined with a second vessel of volume V_2 containing a gas at pressure P_2, then the resultant pressure assuming the gases to be at the same temperature is given by $P = \frac{P_1V_1 + P_2V_2}{V_1 + V_2}$

⇨ If two vessels of the same capacity containing air at $T_1 K$ and $T_2 K$ and at pressures P_1 and P_2 atmosphere is given by $P = \frac{P_1V_1 + P_2V_2}{V_1 + V_2}$

⇨ The gas constant for one molecule of gas is called Boltzmann constant. $K = \frac{R}{N} = 1.38 \times 10^{-23}\ J\ K^{-1}$ where R = universal molar gas constant and N = Avogadro's number.

⇨ All the molecules of an ideal gas are identical and they are considered as point masses.

⇨ The molecules of an ideal gas are supposed to behave like rigid perfectly elastic spheres.

SOLVED EXAMPLES

01. 100 c.c of air are measured at $20°C$. If the temperature be raised to $50°C$, what will be the volume, pressure remaining constant

Sol : Here $V_1 = 100$ c..c

$T_1 = 273 + 20 = 293°A$ or 293 K

$T_2 = 273 + 50 = 323°A$ or 323 K

$V_2 = ?$

According to Charle's law

$\frac{V_1}{V_2} = \frac{T_1}{T_2}$ $\quad\therefore \frac{100}{V_2} = \frac{293}{323}$

or $V_2 = \frac{100 \times 23}{293} = 110.24$ c.c.

02. A given mass of a gas exerts of pressure of 72 cm of mercury at $27°C$. It is heated at constant volume and the pressure was found to be 90 cm of mercury. What is the final temperature ?

Sol : Here $P_1 = 72$ cm; $\quad P_2 = 90$ cm

$T_1 = 273 + 27 = 300$ K $\quad T_2 = ?$

Applying Charle's law we get

$\frac{P_1}{P_2} = \frac{T_1}{T_2}$ $\quad\therefore \frac{72}{100} = \frac{300}{T_2}$

or $T_2 = \frac{300 \times 90}{72} = 375$ K

$\therefore$ Final temperature = 375 K or 375 - 273 = $102°C$

03. A flask is filled with 8 gm of gas $10°C$ and then heated to $47°C$. Due to escape of some gas, the pressure in the flask remains unchanged. Calculate the mass of the that has escaped

Sol : We have the formula $\frac{P_1}{d_1T_1} = \frac{P_2}{d_2T_2}$

Let m_1 and m_2 be the masses of gas at T_1^0A and T_2^0A $\quad d_1 = \frac{m_1}{V_1}$ and $d_2 = \frac{m_2}{V_2}$

$\therefore \frac{P_1 \times V_1}{m_1T_1} = \frac{P_2 \times V_2}{m_2T_2}$

Since the pressure and volume remain unchanged

$P_1 = P_2$ and $V_1 = V_2$

$\therefore m_1T_1 = m_2T_2$

Here $m_1 = 8$ gm; $m_2 = ?$

$T_1 = 273 + 10 = 283$ K

$T_2 = 273 + 47 = 320$ K

From $m_1 T_1 = m_2T_2$ we get

$8 \times 283 = m_2 = 320$

or $m_2 = \frac{8 \times 283}{320} = 7.075$ gm

$\therefore$ mass of gas that has escaped

$= 8 - 7.075 = 0.925$ gm

04. A vessel containing 10 litres of an ideal gas at 760 mm pressure is connected to an evacuated 9 litre vessel. What is the resultant pressure ?

Sol : Here $P_1 = 760$mm, $V_1 = 100$ litre

Since the vessels are connected, the gas now occupies a volume $(10 + 9) = 19$ litres

$\therefore$ In this case $P_2 = ?$ $V_2 = 19$ litres

By Boyle's law $P_1V_1 = P_2V_2$

$760 \times 10 = P_2 \times 19$ or $P_2 = \frac{760 \times 10}{19} = 400$mm

$\therefore$ Resultant pressure = 400 mm.

05. What is the percentage increase in pressure of a sample of gas when heated at constant volume from 27°C to 87°C ?

Sol : Let P_1 and P_2 be the pressures at 27°C and 87°C respectively

$T_1 = 27 + 273 = 300°C$

$T_2 = 87 + 273 = 360°C$

We have the formula

$$\frac{P_1}{P_2} = \frac{T_1}{T_2} \qquad \frac{P_2}{P_1} = \frac{T_2}{T_1}$$

$$\text{or } \frac{P_2}{P_1} - 1 = \frac{T_2}{T_1} - 1 \text{ or } \frac{P_2 - P_1}{P_1} = \frac{T_2 - T_1}{T_1}$$

$\therefore$ Percentage increase in pressure $= \frac{P_2 - P_1}{P_1} \times 100$

$$\text{or } \frac{P_2 - P_1}{P_1} \times 100 = \frac{T_2 - T_1}{T_1} \times 100$$

$$= \frac{360 - 300}{300} \times 100 = \frac{60}{300} \times 100 = 20\%$$

06. Calculate the specific gas constant (r) for oxygen if the molecular weight of oxygen is 32 and the universal gas constant R = 8.32 joule/mole/kelvin

Sol : Given molecular weight of oxygen (M) = 32

Universal gas constant (R) = 8.32 joule/mole/kelvin

For one gram of the gas, the gas constant is equal to universal gas constant (R).

$\therefore$ For 1 gram of the gas, the gas constant $= \frac{R}{M}$

But for 1 gram of the gas, the gas constant is known as specific gas constant (r)

i.e., $r = \frac{R}{M}$

$\therefore$ For oxygen, specific gas constant

$= \frac{8.32}{32} = 0.26$ joule/gram/kelvin

07. 16 gm of oxygen gas and 'x' gm of hydrogen gas occupied the same volume at the same temperature and pressure. Find the value of x.

Sol : $PV = nRT$ $\qquad P \times V = \frac{m}{M}RT$

where m is the mass of the gas $\qquad$ M is molecular weight

n is the number of moles

since P,V,R and T are constant $m \propto M$ $\qquad \therefore \frac{m_1}{m_2} = \frac{M_1}{M_2}$

Here $m_1 = 16$gm, $M_1 = 32$ Where M_1 is the molecular weight of oxygen

$m_2 = x$gm, $M_2 = 2$ Where M_2 is the molecular weight of hydrogen

$\therefore \frac{16}{x} = \frac{32}{2} \qquad x = \frac{16 \times 2}{32} = 1$ gm

08. A gas at 27°C and pressure 30 atmosphere is allowed to expand to atmospheric pressure and volume 15 times larger. Calculate the final temperature of the gas

Sol : Here $P_1 = 30$ atmospheres,

P_2 = atmospheric pressure = 1 atm

Let $V_1 = V$, then $V_2 = 15V$

$T_1 = 27°C = 273 + 27 = 300$ K

$T_2 = ?$

We have the gas equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{30 \times V}{300} = \frac{1 \times 15V}{T_2} \quad \therefore T_2 = \frac{300 \times 15V}{30 \times V} = 150\text{K}$$

or $t_2 = 150 - 273 = -123°C$

PRACTICE SET - I

01. The gas thermometers are more sensitive than liquid thermometers because
1) gases expand more than liquids
2) gases are easily obtained
3) gases are much lighter
4) gases do not easily change their states.

02. For a perfect gas, the ratio of volume coefficient of expansion to pressure coefficient is
1) equal to one 2) less than one
3) more than one
4) an imaginary quantity

03. Boyle's law holds good for an ideal gas during
1) isobaric changes 2) isothermal changes
3) isochoric changes 4) isotopic changes

04. A simple of an ideal gas occupies a volume V at a pressure P and absolute temperature T. The mass of each molecule is m. The expression for the density of gas is
1) mKT 2) P / KT
3) P / KTV 4) Pm/KT

05. An ideal gas is allowed to expand freely against vacuum in a rigid insulated
1) increase in internal energy
2) increase in temperature
3) decrease in internal energy but increase in temperature
4) none of these

06. A closed vessel contains some gas at atmosphere pressure and room temperature. It is then given a high speed by placing it in a fast moving train. The temperature of the gas
1) will increase 2) will decrease
3) will remain unchanged
4) increase or decrease depending on the chemical composition of the gas.

07. In the thermal expansion of an ideal gas
1) there is not change in the temperature of the gas
2) there is no change in the internal energy of the gas
3) the work done by the gas is equal to the heat supplied to the gas
4) work is done by the gas and there is change in its internal energy.

08. The general gas equation PV = RT was improved by Vander wall who introduced a correction factor a/V^2 which is added to P. The term a/V^2, relates to
1) volume of the molecules
2) effective area of the molecules
3) average velocity of the molecules
4) force of attraction of molecules.

09. For a gram molecule of a gas, the value of constant R in the equation PV = RT is nearly
1) 2 cal / K 2) 20 cal / K
3) 0.2 cal / K 4) 200 joule / K

10. When vapour condenses into liquid
1) it absorbs heat 2) it liberates heat
3) its temperature rises
4) its temperature decreases

11. Avogadro's number is the number of molecules present in
1) one litre of the gas at N.T.P.
2) 22.4 litres of the gas at N.T.P.
3) 22.4 milli litres of the gas at N.T.P.
4) 44.8 litres of the gas at N.T.P.

12. An ideal gas is that which
1) can not be liquified
2) can be easily liquified
3) has strong intermolecular forces
4) has a larger size of molecules

13. The unit of the universal gas constant in S.I. unit is
1) calories per degree celsius
2) joule per mole
3) joule / (K x mole) 4) joule per kg.

14. The motion of the molecules of a monatomic gas is
1) translatory 2) vibratory
3) rotatory 4) all of these

15. The temperature of a gas is due to
1) the potential energy of its molecules
2) the kinetic energy of its molecules
3) the attractive force between its molecules
4) the repulsive force between its molecules

16. If the pressure on the gas in increased from P to 2P atmosphere, then its heat conductivity
1) decreases 2) increases
3) remains constant
4) decreases logarithmically

17. According to Boyle's law
1) PV^2 is constant 2) P^2V is constant
3) $\frac{P}{V}$ is constant 4) PV is constant

18. An open mouthed bottle contains a gas at 60°C. What is the temperature to which the gas is to be heated so that 1/4 th mass of the gas may leave it?
1) 143°C 2) 171°C 3) 414°C 4) 416°C

19. One litre of helium gas at a pressure of 76cm of Hg and temperature 27°C is heated till its pressure and volume are doubled. The final temperature attained by the gas is
1) 90°C 2) 927°C 3) 627°C 4) 327°C

20. A jar A is filled with a gas characterised by parameter, P, V, T and another jar B is filled with a gas with parameters 2P, V/4, 2T where the symbols have their usual meanings. The ratio of the number of molecules of jar A to those of jar B is
1) 1 : 1 2) 1 : 2 3) 2 : 1 4) 4 : 1

21. A certain amount of gas at 27°C is heated so that 1/3 mass of the gas is expelled out from the mouth of the container. The temperature to which it is heated is
1) 277°C 2) 177°C 3) 377°C 4) 77°C

22. The lowest temperature attainable is
1) −273°C 2) 0°C 3) −272°C 4) −274°C

23. Boyle's law stated as PV = constant. Now the constant depends upon
1) Pressure and mass 2) Volume and mass
3) Mass and temperature
4) Volumne and temperature

24. If P_1, V_1, T_1 are initial conditions of gas of mass m_1 and P_2, V_2, T_2 are final conditions of the same gas but mass is m_2 then the gas equation is
1) $\frac{P_1V_1m_1}{T_1} = \frac{P_2V_2m_2}{T_2}$ 2) $\frac{P_1m_1}{V_1T_1} = \frac{P_2m_2}{V_2T_2}$
3) $\frac{P_1m_1}{m_1T_1} = \frac{P_2V_2}{m_2T_2}$ 4) $\frac{P_1m_1}{V_1T_1} = \frac{P_2m_2}{V_2T_2}$

25. A gas in an enclosure is heated keeping volume and pressure constants so that some gas is expelled out. Then the suitable gas equation is
1) $\frac{P_1V_1}{m_1T_1} = \frac{P_2V_2}{m_2T_2}$ 2) $\frac{m_1}{T_1} = \frac{m_2}{T_2}$
3) $m_1T_1 = m_2T_2$ 4) $\frac{m_1T_2}{P_1} = \frac{m_2T_1}{P_2}$

26. Keeping volume constant of a given mass of gas. If the temperature is increased through 1°C, then increase in the pressure of the gas equal to
1) 273 times of volume at 0°C
2) 1/273 times of volume at 0°C
3) 273 times of volume at 0°C
4) 1/273 times of volume at −273°C

28. In the graph drawn temperature in Celsius versus volume of a given mass volume of a given mass of gas constant pressure gives
1) Hyperbola
2) Parabola
3) Straight line with positive slope
4) Straight line with negative slope

29. Boyle's law is an example of
1) Adiabatic process
2) Isothermal process
3) Mechanical process
4) Isochromic process

30. The relation between universal gas constant R and Avagadro's number N is
1) R = N/K 2) R - K = N
3) R = NK 4) R = K - N

PRACTICE SET - I KEY

01) 1	02) 1	03) 2	04) 4	05) 4
06) 3	07) 4	08) 4	09) 1	10) 2
11) 2	12) 1	13) 3	14) 1	15) 2
16) 3	17) 4	18) 2	19) 2	20) 4
21) 2	22) 1	23) 3	24) 3	25) 3
26) 2	27) 2	28) 3	29) 2	30) 3

PRACTICE SET - II

01. The vessel containing 10 litre of an ideal gas at 760mm pressure is connected to an evacuated 9 litre vessel. The resultant pressure is
1) 1440 mm 2) 760 mm 3) 400 mm 4) 40 mm

02. A perfect gas at 27^0C is heated at constant pressure so as to double its volume. The temperature of the gas will be
1) 600^0C 2) $327\,K$ 3) $327^o\,C$ 4) $54^o\,C$

03. A car tyre has air at 1.5 atm at 300^0K. If the pressure increase to 1.75 atm. With volume remaining the same, the temperature will be
1) 300 k 2) 350 3) 273 k 4) 576 k

04. How much should the pressure of gas be increased to decrease the volume by 10% at constant temperature
1) 10% 2) 9.5% 3) 11.11% 4) 5.11%

05. A real gas can be approximately to an ideal gas at
1) low density 2) high pressure
3) high density 4) low temperature

06. For a constant volume gas thermometer one should fill the gas at
1) high temperature and high pressure
2) high temperature and low pressure
3) low temperature and low pressure
4) low temperature and high pressure

07. A gas at a temperature of 27^0C is heated at a constant pressure to triple its volume. The final temperature of the gas will be ____
1) 27^0C 2) 627^0C 3) $627\,K$ 4) $900^o\,C$

08. If the volume of the gas is to be increased by 4 times
1) Temperature and pressure must be doubled
2) At constant P, the temperature must be increased by 4 times.
3) At constant T, the temperature must be increased by 4 times 4) It cannot be increased.

09. A perfect gas at 27^oC is heated at constant pressure so as to double its volume. The temperature of the gas will be
1) 327^oC 2) $327\,K$ 3) $600^o\,C$ 4) None

10. The graph between temperature in ^oC and pressure of a perfect gas is
1) hyperbola
2) a straight line passing through the origin
3) a straight line parallel to pressure axis intercepting temperature axis at -273^oC
4) a straight line with a +ve intercept on pressure axis intercepting temperature axis at -273^oC

11. 16gm of O_2 gas and x gm of H_2 gas occupy the same volume at the same temperature and pressure. Then x = ____
1) 1/2 gm 2) 1 gm 3) 8 gm 4) 16 gm

12. The pressure coefficient of a gas is
1) -273 2) 981 3) 3.14 4) $0.00367/^oC$

13. 1000 c.c of a permanent of a gas at constant pressure is heated from 27^oC to 327^oC. The new volume will be ____
1) 333.3c.c 2) 1000 c.c 3) 2000c.c 4) 3000 c.c

14. A constant volume thermometer works on
1) Charles law 2) Pascals law
3) Boyles law 4) Archimedis principle

15. The temperature at which the volume of all gases becomes zero is
1) + 274 2) -273
3) -273^0 4) $273\,K$

16. From which of the graphs absolute zero can be determined (d = density) (t = temperature)
1) V-t graph at constant pressure
2) P-V graph at constant temperature
3) V-d graph at constant pressure
4) P-d graph at constant volume

17. An ideal is found to obey the law PV^1 = constant. The gas is initially at temperature T and pressure P. Keeping V constant if P is raised to 2P then the temperature is
1) $\sqrt{2T}$ 2) 2T 3) $T/\sqrt{2}$ 4) T/2

18. The equation for the volume coefficient of gas at pressure P is
1) $\frac{V_2-V_1}{V_1(t_1-t_2)}$ 2) $\frac{V_2-V_1}{V_1t_2-V_2t_1}$
3) $\frac{V_2-V_1}{V_1t_2-V_1t_1}$ 4) $\frac{V_2-V_1}{P(t_2-t_1)}$

19. The condition at which the real gas behaves like perfect gas
1) High temperature high pressure
2) High temperature low pressure
3) Low temperature high pressure
4) Low temperature low pressure

20. How much should be the pressure of the gas be decreased to increase the volume by 10% at constant temperature
1) 9.1% 2) 11% 3) 10% 4) 5.11%

21. The volume of gas at 27°C and 1 atm pressure is 1 litre. If the pressure is doubled and absolute temperature is made half. What will be the volume of the gas
1) 0.5 lit 2) 0.25 lit 3) 0.75 lit 4) 1.6lit

22. A vessel has 18 gm of Oxygen at a pressure P and temperature 400°K. A small hole is made so that gas leaks out. If the final pressure P/3 and final temperature is 300K, what is the amount of oxygen left
1) 10 gm 2) 8 gm 3) 9 gm 4) 6 gm

23. Two gasses A & B having the same temperature T, pressure P and volume V, are mixed. If the mixture is at the same temperature and same volume as A then pressure is
1) 2P 2) P/2 3) P 4) 4P

24. Two vessels of capacity 4 & 6 litres contain a gas respectively under pressure of 18 & 12 cm of Hg are joined by narrow tube, then the resultant pressure is
1) 14.4 cm of Hg 2) 30 cm of Hg
3) 16 cm of Hg 4) 24 cm of Hg

25. A small bulb is filled with air at 27°C. 1 atm pressure and constant for a perfect gas to be taken as
1) 2 atm 2) 1.5 atm 3) 2.5 atm 4) 0.5 atm

PRACTICE SET - II KEY

01) 3	02) 3	03) 2	04) 3	05) 1
06) 2	07) 2	08) 2	09) 1	10) 4
11) 2	12) 4	13) 3	14) 1	15) 3
16) 1	17) 1	18) 2	19) 2	20) 1
21) 2	22) 1	23) 1	24) 1	25) 2

THERMODYNAICS

⇨ Thermodynamics is a branch of physics that deals with the relations between heat and other forms of energy.

⇨ Internal energy depends only on temperature and is independent of pressure and volume.

⇨ Internal energy = P.E. + K.E. P.E is due to molecular configuration, K.E is due to molecular motion.

⇨ Internal energy of an ideal gas consists of only the K.E of molecules (P.E is absent because there are no intermolecular forces among the molecules in an ideal of perfect gas.

⇨ Internal energy of real gas consists of P.E & K.E

⇨ The amount of work performed is directly proportional to the amount of heat produced $(W \,\alpha\, H)$

⇨ W = JH, where J = mechanical equivalent of heat or Joule's constant. J is equal to the amount of work required to produce one calorie of heat. Its value is equal to 4.2 joule / calories S.I unit is J/Kcal. The statement W = JH is also called onon differential from of first law of thermodynamics

⇨ If a bullet just melts when stopped by an abstacle and if all the heat produced is absorbed by the bullet, then $\frac{1}{2}\times\frac{mv^2}{J}=(mst+mL)$

⇨ When water falls from a height h, then the rise of temperature at the bottom of the waterfall is $t=\frac{gh}{Js}$

⇨ The height 'h' from which an ice ball at $0°C$ must fall so that is completely melts on reaching the ground is given by $h=\frac{JL}{g}$

⇨ When a body of mass 'm' moving with a velocity 'v' is stopped and all of its energy is retained by it, the increase in temperature is $\frac{1}{2}mv^2 = J\times m\times s\times t,\; t=\frac{v^2}{2JS}$

⇨ When a block of ice mass M is dragged with a constant velocity on a rough horizontal surface of a coefficient of friction μ through a distance 'd', so that all the work done against friction is used as heat energy the mass of ice method is given by $W = JH$; $\mu Mgd = mL$; $m=\frac{\mu Mgd}{JL}$

⇨ Calculation of work done from graphs
i) Work done for open curve graph
- Work done is given by an area enclosed on v-axis
- shaded area is work done

ii) Work done for closed curves are enclosed is the work done in the system.
- work done = area = 2V × P = 2PV

⇨ If a gas expands from a volume V_1 to a volume V_2 at the same pressure P, then work done by the gas = W = $P\times(V_2-V_1)$

⇨ A process is said to be isothermal if throughout the process the temperature remains constant

⇨ Isothermal process obeys Boyle's law PV = K or $P_1V_1 = P_2V_2$. It takes place very slowly

⇨ Heat must be supplied or taken out from the system in isothermal process to maintain temperature constant.
Work done by expanding gas = P.dV = pressure × change in volume
Work done during isothermal expansion

$= nTR.\log_e\left[\frac{V_2}{V_1}\right] = 2.3023RT$

$\log_{10}\left[\frac{V_2}{V_1}\right]$ or $2.3023\,RT\log_{10}\left[\frac{P_1}{P_2}\right]$. The heat that must be supplied during the expansion of gas under isothermal process to maintain constant temperature is $\frac{nTR}{J}\log_e\left[\frac{V_2}{V_1}\right]$. In this process there will be no change in internal energy.

⇨ **Applications of Isothermal Process :**
i) During verification of Boyle's law the pressure of the enclosed air or gas is slowly changed so as to keep the temperature constant.
ii) A gas is slowly compressed in a cylinder so that the temperature of the gas is constant

⇨ **Isochoric process :** A process is said to be isochoric if throughout the process, the volume of the system remains constant. Gay Lussaic's law is obeyed. dW = 0 and dQ = dU

⇨ **Isobaric process :** A process is said to be isobaric if throughout the process the pressure of the system remains constant. Charle's law is obeyed. During this process $W \neq U$ i.e., some work is done.

⇨ The quantity of heat required to heat one mole of a gas at constant pressure through $1°C$ is called molar specific heat of the gas at constant pressure (C_v).

⇨ The quantity of heat required to heat one mole of gas at constant pressure through $1°C$ is called molar specific heat of the gas at constant pressure (C_v).

⇨ At constant pressure, the heat supplied is used to increase in internal energy and also to do work so as to keep the pressure constant, Hence $C_p > C_v$.

⇨ At constant volume, the heat supplied is used only to increase the internal energy i.e., the temperature of the gas.

- $C_p - C_v = R$ (all the same units) [Mayer's relation]

$C_p - C_v = r\,C_p.C_v$ units are given as $JKg^{-1}K^{-1}$.

$\frac{C_p}{C_v} = \gamma$, where γ is called ratio of specific heats.

Gas	C_p	C_v	γ
Manoatomic	$\frac{5R}{2}$	$\frac{3R}{2}$	$\frac{5}{3}$ or 1.67
Diatomic	$\frac{7R}{2}$	$\frac{5R}{2}$	$\frac{7}{5}$ or 1.4

- **Adiabatic process :** A process is said to be adiabatic if through out the process, the system exchanges no heat with the surroundings. This process takes place quickly under thermal isolation from the surroundings. In an adiabatic expansion, the external work is done wholly at the expense of the internal energy of the gas and the gas therefore cools.
- In an adiabatic compression all the work done in the gas by the compressing agent appears as an increase in its thermal energy and hence temperature rises.
- When a gas expands adiabatically pressure and temperature decrease. When a cycle tube bursts, its temperature decreases.
- When a thermoflask containing a liquid is shaken vigorously, the temperature of the liquid increases.
- The specific heat of gas under isothermal change is infinity. The specific heat of a gas under adiabatic change is zero
- **Applications of adiabatic process :**

1. The compression of the mixture of oil vapour and air during compression stroke of an internal combustion engine is an adiabatic process and there is rise in temperature
2. Sudden compressions and expansions of a gas are adiabatic
3. The expansion of air inside a cycle tube when it bursts is an adiabatic process.
4. Changes that occur in atmospheric air when sound wave travels through it are adiabatic.

- If the door of a working refrigerator is opened, the temperature of the room increases.
- Adiabatic gas laws are $PV^{\gamma} = K$; $TV^{\gamma-1} = K$ and $T^{\gamma}P^{1-\gamma} = K$
- The slope of an adiabatic curve at any point is γ times greater than the slope of an isothermal curve.
- In an adiabatic process enthalpy (total quantity of heat) remains constant.
- **First law of thermodynamics :** It heat is supplied to a system which is capable of doing work, then quantity of heat absorbed by the system will be equal to the sum of external work done by the system and the increase in its internal energy. If dQ is the amount of heat, dW is the external work and dU is the increase in its internal energy, then $dQ = dU + dW$
- If dV, is the expansion of a gas against a constant pressure P, the work done dW by the gas is given by $dW = P.dV$.
- In the case of a cyclic process (the one that originates and ends up at the same state). $dU = 0$ or $dQ = dW$. It means that the net work done per cycle is equal to the area enclosed by the path representing the process on the P-V diagram
- The change in the internal energy depends on the initial and final states of the system and is independent of the path.
- Entropy is a thermodynamic property. In a system its change is given by $ds = \frac{dQ}{T}$ Unit cal/K or J/K During an adiabatic process the entropy remains constant hence the name isoentropic process.
- **Enthalpy :** the sum of internal energy of a system plus the PV product is called enthalpy. It is also called the heat constant.
- **Efficiency of a heat engine :** The efficiency of heat engine is given by

$$e = \frac{\text{heat converted to work}}{\text{total heat absorbed}} \times 100 = \frac{W}{Q} \times 100$$

$$\text{or } e = \frac{Q_1 - Q_2}{Q_1} = 1 - \frac{Q_2}{Q_1} = 1 - \frac{T_2}{T_1} = \frac{T_1 - T_2}{T_1}$$

Where Q_1 is the heat extracted by the source and Q_2 is the amount of heat rejected to the sink.
The efficiency of a heat is always less than 1 or 100%

SOLVED EXAMPLES

01. A gas at $10°C$ temperature and 1.103×10^5 Pa pressure is compressed adiabatically, the ratio of specific heats of the gas is 1:41. What is its final temperature ? $V_2 = V_1/2$

Sol : Given $T_1 = 10°C = 273 + 10 = 283$ K

$P_1 = 1.013 \times 10^5$ Pa, $\gamma = 1.41$

Let $V_1 = V$, then $V_2 = \frac{V}{2}$, $T_2 = ?$

Since the gas is compressed adiabatically

$T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$$T_2 = T_1\left[\frac{V_1}{V_2}\right]^{\gamma-1} = 283\left[\frac{V}{\frac{V}{2}}\right]^{\gamma-1}$$

$$= 283\times 2^{\gamma-1} = 283\times 2^{1.41-1} = 283\times 2^{0.41}$$

$$= 283\times 1.3287 = 376K \text{ or } 376-273 = 103°C$$

02. A bullet is suddenly stopped and all its energy is converted in to heat resulting in a rise of temperature of the bullet by $100°C$. If the specific heat of the bullet is 0.21, calculate the velocity of the bullet ($J = 4.2\times10^7$ ergs/cal)

Sol : Let m = mass of the bullet

v = velocity of the bullet

K.E. of the bullet $= \frac{1}{2}mv^2$

Since all the K.E is converted into heat

$\frac{1}{2}mv^2 = JH$ where H is the heat produced

But H = mst where s is the specific heat and 't' is the rise in temperature

Given s = 0.21, t = 100°C, J = 4.2×10^7 engs/cal.

$$\frac{1}{2}mv^2 = Jmst$$

$$\frac{v^2}{2} = 4.2\times10^7\times0.21\times100$$

or $v^2 = 4.2\times10^7\times0.42\times100$

$$= (42)^2\times10^6$$

$\therefore\ v = 42\times10^3 = 4200$ cm/s

or $v = 420$ m/s

03. A block of ice at $0°C$ whose mass is initially 42 kg slides along a horizontal surface starting with an initial velocity of 4 m/s and comes to rest. Calculate the mass of ice that melts as a result of frictional force between the block and the table.

(Latent heat of ice = 80 kilocal/kg)

Sol : Mass of ice = M = 42 kg v = 4 m/s

K.E. of block of ice $= \frac{1}{2}Mv^2 = \frac{1}{2}\times42\times(4)^2 = 21\times16$ joules

This K.E. is equal to the work done by the frictional force to stop the block of ice.

$\therefore$ W = 21×16 joules.

Let 'm' be the mass of ice melted

$H = m\times L_1 = m\times80$ $W = JH$

$$21\times16 = 4.2\times10^3\times m\times80$$

$$\therefore\ m = \frac{21\times16}{4.2\times10^3\times80} = 0.001\text{ kg} = 1\text{ gm.}$$

04. A certain gas is suddenly compressed to $\frac{1}{3}$rd of its volume. If the initial temperature is 34°C and $\gamma = 1.5$. Find the final temperature.

Sol : $V_1 = V,\ V_2 = \frac{V}{3}$

$T_1 = 273+34 = 307$ K $T_2 = ?$

Since the gas is suddenly compressed the change obtained is adiabatic. The formula to be used here is

$$T_1\ V_1^{\gamma-1} = T_2\ V_2^{\gamma-1}$$

$$307\times V^{1.5-1} = T_2\times\left(\frac{V}{3}\right)^{1.5-1}$$

or $$307\times V^{0.5} = T_2\times\left(\frac{V}{3}\right)^{0.5}$$

or $$307\times V^{0.5} = T_2\times\frac{V^{0.5}}{3^{0.5}}$$

$$\therefore\ T_2 = 307\times3^{0.5} = 307\times1.732 = 531.7\text{ K}$$

Final temperature = 531.7 - 273 = 258.7°C

05. 400 joules of work is performed on a gas for reducing its volume by compression. If the change done is adiabatically, find the change in internal energy of the gas

Sol : Since the change is adiabatic, the amount of heat energy (dQ) given to the system is zero

We have $dQ = dU + dW$

i.e., $0 = dU + dW$

$\therefore dU = -dW$

Since the gas is compressed dW is negative

Hence $dU = -(-dW) = dW$

Given $dW = 400$ J

$\therefore$ Change in interval energy $dU = 400$ joules

ALL POWER IS WITHIN YOU
YOU CAN DO ANYTHING AND EVERYTHING

PRACTICE SET - I

01. The molar heat capacity of an ideal gas at constant pressure is greater than that at constant volume because :
1) work has to be done against external pressure as the gas expands
2) work has to be done against intermolecular forces as the gas expands
3) molecules rotate more easily when the gas expands
4) none of these

02. The specific heat of a gas
1) has only two values C_p and C_v
2) has a unique value at a given temperature
3) can have any value between 0 and ∞
4) depends upon the mass of the gas

03. A process in which the temperature and pressure of a gas change, at constant volume, is known as
1) isobaric 2) isothermal
3) isochoric 4) adiabatic

04. Supporting the distance between the atoms of a diatomic gas to be constant, its specific heat at constant volume per mole is
1) 5/2R 2) 3/2R 3) R 4) 1/2R

05. The internal energy of an ideal gas depends only upon
1) pressure 2) volume
3) temperature 4) size of the molecules

06. The heat given to an ideal gas in isothermal condition is used
1) in raising the temperature
2) in doing external work
3) in raising the temperature and doing external work
4) in increasing the internal energy

07. Heat added to a system is equal to
1) a change in its internal kinetic energy
2) a change in its internal potential energy
3) the work done by it
4) the sum of all the above three

08. The internal energy U of a system is a unique function of any state because change in U
1) does not depend upon path
2) depends upon path
3) corresponds to an adiabatic process
4) corresponds to an isothermal process

09. The area under a curve on P-V diagram represents
1) the condition of a system
2) the work done or by the system
3) the work done in a cyclic process
4) a thermodynamic process

10. The area inside a closed curve of P-V diagram represents
1) the condition of a system
2) the work done on or by the system
3) the work done in a cyclic process
4) a thermodynamic process

11. The first law of thermodynamics is concerned with the conservation of
1) number of molecules 2) energy
3) number of moles 4) temperature

12. The first law of thermodynamics is a special case of
1) Newtons' law
2) the law of conservation of energy
3) Charle's law
4) the law of heat exchange

13. The second law of thermodynamics implies
1) whole of the heat can be converted into a mechanical energy
2) no heat engine can be 100% efficient
3) every heat engine has an efficiency of 100%
4) a refrigerator can reduce the temperature of heat into useful mechanical work.

14. A gas expands under constant pressure P from volume V_1 to V_2. The work done by gas is
1) $P(V_2 - V_1)$ 2) $P(V_1 - V_2)$
3) $P(V_1^\gamma - V_2^\gamma)$ 4) none of these

15. From what minimum height a block of ice has to be dropped in order that it may melt completely on hitting the ground ? (L is the latent heat of ice and J is Joule's constant)
1) mgh 2) mgh / J
3) JL/g 4) J/Lg

16. Internal energy of a gas decreases when
1) it absorbs heat
2) the change is cyclic
3) the change is adiabatic
4) none of these

17. 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
1) 2/5 2) 3/5 3) 3/7 4) 5/7

18. A thermodynamical energy goes from state
i) P_1, V to $2P_1$,V
ii) P_1, V or P_1, 2V. Then the work done in the two cases if it is closed system
1) (i) zero (ii) zero 2) (i) zero (ii) P_1V
3) P_1V (ii) zero 4) (i) P_1V (ii) P_1V

19. An ideal gas undergoing isothermal expansion means
1) its heat content remains constant
2) its temperature and heat content remain constant
3) its temperature and pressure remain constant
4) its temperature remains constant

20. An adiabatic process occurs at constant
1) temperature 2) pressure
3) heat
4) temperature and pressure

21. A physical process during which there is neither gain nor loss of heat from the system is called
1) adiabatic 2) isothermal
3) thermodynamical 4) entropy

22. In an adiabatic expansion of a gas
1) heat is gained or lost
2) heat is neither gained nor lost
3) temperature is kept constant
4) volume is kept constant

23. An ideal gas is isothermally expanded. Its internal energy will
1) increase 2) decrease
3) increase or decrease depending upon the nature of the gas
4) remain the same

24. When a gas expands adiabatically
1) no energy is required to expansion
2) energy is required and it comes from the wall of the container of the gas
3) internal energy of the gas is used in doing the work
4) law of conservation of energy does not hold good

25. The pressure temperature relationship for an ideal gas undergoing adiabatic change is
1) $P^{1-\gamma}\,T^{\gamma}$ = constant 2) $P^{\gamma-1}\,T^{\gamma}$ = constant
3) $P^{\gamma}\,T^{1-\gamma}$ = constant 4) $P^{\gamma}\,T^{\gamma-1}$ = constant

26. Adiabatic index for air is ________
1) 1.6 2) 1.4 3) 1.2 4) 1.3

27. Isentropic process is ________
1) adiabatic 2) reversible adiabatic
3) Irreversible process
4) both 2 and 3

28. The gas law (PV/T) = constant is true for
1) isothermal change only 2) adiabatic
3) both isothermal and adiabatic changes
4) neither isothermal nor adiabatic changes

29. The work done in an isothermal expansion of a gas depends upon
1) temperature only 2) expansion ratio only
3) both temperature and expansion ratio
4) neither temperature nor expansion ratio

30. The work done is an adiabatic change in a particular gas depends only upon
1) the change in volume
2) the change in pressure
3) the change in temperature 4) none of these

31. The slope of isothermal and adiabatic curves are related as
1) isothermal curve slope = adiabatic curve slope
2) isothermal curve slope = γ x adiabatic curve slope
3) adiabatic curve slope = γ x isothermal curve slope
4) adiabatic curve slope = (1/2) x isothermal curve slope

32. A quantity of heat 'Q' is supplied to a monoatomic idea gas which expands at constant pressure. The fraction of heat that goes the work done by the gas is
1) 2/5 2) 3/5 3) 2/3 4) 1

33. A boy weighing 4.2 kg eats bananas whose energy content is 980 calories. If this energy is used to lift him from the ground, the height through which he can be lifted is
1) 1m 2) 10 m 3) 100 m 4) 50 m

34. The amount of work to be done for producing 500 calories of heat is
1) 500 ergs 2) 500 joules
3) 21,000 ergs 4) 2100 joules

35. The mono atomic gas $\left(\gamma = \frac{5}{3}\right)$ is suddenly compressed to 1/8 of its volume adiabatically. Then the pressure of the gas will change by
1) $\frac{24}{5}$ times 2) 8 times
3) $\frac{40}{3}$ times 4) 32 times

PRACTICE SET - I KEY

01) 1	02) 3	03) 3	04) 1	05) 3
06) 2	07) 4	08) 1	09) 2	10) 3
11) 2	12) 2	13) 2	14) 1	15) 3
16) 3	17) 4	18) 2	19) 4	20) 3
21) 1	22) 2	23) 4	24) 3	25) 1
26) 2	27) 4	28) 3	29) 3	30) 3
31) 3	32) 1	33) 3	34) 4	35) 4

PRACTICE SET - II

01. Two samples A and B of a gas initially of the same temperature and pressure are compressed from a volume V to a volume V/2 such that A is compressed isothermally and B adiabatically. The final pressure of
1) A is greater than that of B
2) A is equal to that of B
3) A is less than that of B
4) A is twice the pressure of B

02. If a gas is heated at constant pressure, its isothermal compressibility
1) remains constant
2) increases linearly with temperature
3) decreases linearly with temperature
4) decreases inversely with temperature

03. If γ denotes the ratio of the two specific heats of a gas, the ratio of the slopes of adiabatic and isothermal P - V curves at their point of intersection is
1) $1/\gamma$ 2) γ 3) $\gamma - 1$ 4) $\gamma + 1$

04. When an ice cube melts and becomes water the ice water system undergoes a change such that
1) the entropy of the system increases and the internal energy increases
2) the entropy of the system decreases and the internal energy decreases
3) the entropy of the system decreases and the internal energy increases
4) the entropy of the system increases and the internal energy decreases

05. The law obeyed by isothermal process
1) Gay Lussac's law 2) Charle's law
3) Boyle's law 4) Dalton's law

06. In P-V graphs, the ratio of the slope of adiabatic to isothermal is
1) $\gamma - 1$ 2) $1/\gamma$ 3) 1 4) γ

07. dQ = dw and du = 0 is true for
1) Isothermal 2) adiabatic process
3) Isoboric process 4) Isochoric process

08. An ideal gas is isothermally expanded its internal energy will
1) Increase 2) decrease
3) increase of decrease depending an nature of gas 4) Remains same

09. When a gas expands adiabatically
1) no energy is required for expansion
2) energy is required & it comes from the wall of container of gas
3) Internal energy of gas is used in doing work
4) Law of conservation of energy does not hold good.

10. The isothermal compressibility of a gas at pressure p is
1) P 2) $\frac{1}{P}$ 3) γ P 4) $\frac{P}{\gamma}$

11. The adiabatic compressibility of a gas at pressure P is
1) γP 2) $\frac{1}{\gamma P}$ 3) 2p 4) $\frac{P}{2}$

12. Isothermal relation between pressure and volume of given mass of a gas is
1) pv = constant 2) pv = RT
3) pv^{γ} = constant 4) $p^{\gamma}v$ = constant

13. Adiabatic relation between pressure and volume is
1) pv = cosntant 2) pv = Rt
3) pv^{γ} = constant 4) $p^{\gamma}v$ = constant

14. The gas law $\frac{pv}{T}$ = constant is true for
1) Isothermal change only
2) Adiabatic change only
3) Both isothermal & adiabatic change
4) neither isothermal nor adiabatic changes

15. During an adiabatic process the pressure p of a fixed mass of an ideal gas changes by Δp and its volume V changes by Δv. The value of $\frac{\Delta V}{V}$ is given by
1) $-\frac{\Delta P}{P}$ 2) $-\gamma\frac{\Delta P}{P}$ 3) $-\frac{1}{\gamma}\frac{\Delta P}{P}$ 4) $-\frac{1}{\gamma^2}\frac{\Delta P}{P}$

16. The pressure temperature relationship for an ideal gas undergoing adiabatic change is
1) $P^{1-\gamma}T^{\gamma}$ = constant 2) $P^{\gamma-1}T^{\gamma}$ = constant
3) $P^{\gamma}T^{\gamma-1}$ = constant
4) $P^{\gamma}T^{1-\gamma}$ = constant

17. For isothermal expansion of a perfect gas, the value of $\Delta P/P$ is equal to
1) $-\gamma\left(\frac{\Delta V}{V}\right)$ 2) $-\left(\frac{\Delta V}{V}\right)$
3) $\gamma\left(\frac{\Delta V}{V}\right)$ 4) $\gamma^2\left(\frac{\Delta V}{V}\right)$

18. For an adiabatic expansion of a perfect gas, the value of $\frac{\Delta P}{P}$ is equal to
1) $-\gamma\left(\frac{\Delta V}{V}\right)$ 2) $-\gamma^{1/2}\left(\frac{\Delta V}{V}\right)$
3) $\gamma\left(\frac{\Delta V}{V}\right)$ 4) $\gamma^2\left(\frac{\Delta V}{V}\right)$

19. The work done in an adiabatic change in a particular gas depends upon only
1) Change in temperature
2) Change in pressure
3) Change in volume 4) none

20. Two sample A and B of a gas initially of the same temperature and pressure are compressed from a volume V to a volume V/2 such that A is compressed isothermally and B adiabatically. The final pressure of
1) A is greater than that of B
2) A is equal to that of B
3) A is less than that of B
4) A is twice the pressure of B

21. A water fall is 420m high. The rise in temperature of water as it reaches the bottom is (g = 9.8 m/s)
1) 1°C 2) 0.98°C
3) 2°C 4) 1.96°C

22. If P is the pressure, dU the change in internal energy, and dV the increase in volume of a system, then by definition
1) dU = dQ + Pdv 2) dQ = dU - PdV
3) dQ = PdV - dU 4) dU = dQ - PdV

23. An ideal gas is heated from 20°C to 40°C under constant pressure. The change in internal energy is
1) zero under constant pressure
2) double the original value
3) proportional to change in volume
4) proportional to change in temperature

24. The internal energy of an ideal gas depends on
1) its temperature
2) its pressure
3) its volume
4) its shape of molecule

25. The two specific heats of a perfect gas are related as
1) $C_p - C_v = R$ 2) $C_p - C_v = \frac{R}{J}$
3) $C_p - C_v = 0$ 4) $C_p + \frac{1}{C_v} = 2.4$ cal

26. If the amount of heat given to a system be 35 joules and the amount of work done by the system be 15 joule, the change in the internal energy of the system is
1) - 50 joule 2) 20 joule
3) 30 joule 4) 50 joule

27. A heat engine is device to convert continuously heat supplied to it into
1) electrical energy
2) mechanical energy
3) chemical energy
4) any one of the above

28. In a process 500 cal of heat is given to a system and 100 joules of work is done by the system. If J = 4.2 J/cal the increase in its internal energy is
1) 600 cal 2) 600 joules
3) 476 cal 4) 942 cal

29. In a thermodynamic process pressure of a fixed mass of a gas is changed in such a manner that the gas releases 20 J of heat and 8 J of work is done on the gas. If initial internal energy of the gas was 30 J, what will be the final internal energy ?
1) 4.2 J 2) 42 J
3) 1.8 J 4) 18 J

PRACTICE SET - II KEY

01) 3	02) 1	03) 3	04) 2	05) 3
06) 4	07) 1	08) 4	09) 3	10) 2
11) 2	12) 1	13) 3	14) 3	15) 3
16) 1	17) 1	18) 2	19) 1	20) 3
21) 2	22) 4	23) 4	24) 1	25) 1
26) 2	27) 2	28) 3	29) 4	

THERE IS NO SUBSTITUTE TO HARDWORK

PREVIOUS ECET BITS

2007

01. An aluminium rod of length 40 cm elongates by 1 mm when it is heated from 0^0 to 100^0C. What is the coefficient of linear expansion?
1) $0.25\times10^{-6}/^oC$ 2) $2.5\times10^{-6}/^oC$
3) $25\times10^{-5}/^oC$ 4) $25\times10^{-6}/^oC$

02. A glass bulb of volume 200 c.c. is completely filled with mercury at 30^0C. The temperature of the system is raised to 100^0C. If the coefficient of linear expansion of glass is $9\times10^{-6}/^oC$ and coefficient of real expansion of mercury is $1.8\times10^{-4}/^oC$, the volume overflow is:
1) 0.2142 c.c. 2) 2.142 c.c.
3) 21.42 c.c. 4) 1.071 c.c

03. When a gas is supplied 'dQ' heat, it performs a work 'dW'. The increase in its internal energy 'dU' is__
1) du = dQ + dW 2) dU = dQ - dW
3) dQ = dW - dU 4) dU = dQ - dW/2

04. Heat given to a system is 35 joules and work, done by the system is 15 joules. The change in the internal energy of the system will be ____
1) -50 J 2) 20 J 3) 30 J 4) 50 J

05. For a manometric gas the ratio of their specific heats C_p/C_v is
1) 1.3 2) 1.4 3) 2 4) 1.66

2009

06. The differential form of first law of thermodynamics is
1) $dQ = dU - dW$ 2) $dQ = dU + dW$
3) $dQ = TdS + dW$ 4) $dQ = TdS + dU$

07. The temperature at which the volume of all gases becomes zero is
1) 0^oC 2) 273^0C
3) $-273K$ 4) -273^0C

2010

08. For an ideal gas, the internal energy is
1) Dependent on pressure
2) Independent of volume
3) Dependent on volume
4) Dependent on the size of the atom

09. The product of pressure and volume has the same units as
1) Temperature 2) Force
3) Work 4) Power

10. The densities of two substances are in the ratio 5 : 6 and their specific heats are in the ratio 3 : 5. Then ratio of their thermal capacities per unit volume is
1) 1 : 2 2) 2 : 1 3) 1 : 4 4) 4 : 1

2011

11. A given mass of gas at $27°C$ is heated in a glass flask at constant pressure so that its volume is doubled. Find the final temperature in Kelvin
1) 227 2) 327 3) 427 4) 527

12. At constant temperature the volume of given mass of the gas is increased by 10%. Find the percentage change in pressure
1) 60.9 % 2) 70.9%
3) 80.9% 4) 90.9%

13. According to kinetic theory of gases, the molecule of a gas behaves like
1) in elastic spheres
2) perfectly elastic rigid spheres
3) perfectly elastic non-rigid spheres
4) inelastic non-rigid spheres

2012

14. If N represents avagadro's number, then the number of molecules in 6gm of hydrogen at NTP is
1) 2N 2) 3N 3) N 4) N/6

15. The mean translational kinetic energy of a perfect gas molecule at the temperature TK is
1) $\frac{1}{2}kT$ 2) kT 3) $\frac{3}{2}kT$ 4) $2kT$

16. The amount of heat given to a body which raises its temperature by 1^oC
1) water equivalent
2) thermal heat capacity
3) specific heat
4) temperature gradient

17. During an adiabatic process, the pressure of a gas is found tobe proportional to the cube of its absolute temperature. The ratio Cp/Cv for gas is
1) 3/2 2) 4/3 3) 2 4) 5/3

2013

18. Water is used in car radiators as coolant because of
1) Its density is more
2) High thermal conductivity
3) High specific heat 4) Free availability

19. A glass of water contains ice cubes floating on it. When all ice melts the level of water in the glass ___
1) Increases 2) Decreases
3) Remains the same 4) Doubled

20. When a gas is supplied 'dQ' heat, it performs a work 'dW'. The increase in its internal energy 'dU' is__
1) du = dQ + dW 2) dU = dQ - dW
3) dQ = dW - dU 4) dU = dQ - dW/2

21. Heat given to a system is 35 joules and work, done by the system is 15 joules. The change in the internal energy of the system will be ____
1) -50 J 2) 20 J 3) 30 J 4) 50 J

22. For a monometric gas the ratio of their specific heats C_p/C_v is
1) 1.3 2) 1.4 3) 2 4) 1.66

2014

23. In thermodynamics, dQ = 0 and dU = – dW is true for
1) Isothermal process 2) Adiabatic process
3) Isochoric process 4) Isobaric process

24. A sample of an ideal gas has volume, V, pressure P and temperature T. The mass of each molecule of the gas is m. The density of the gas is _____
1) P/kVT 2) mkT 3) mP/kT 4) P/kT

25. A does 4.5 J of external work during adiabatic expansion. Its temperature falls by 2 K. Its internal energy will be
1) increase by 4.5 J 2) increase by 9.0 J
3) decrease by 4.5J 4) decrease by 2.25 J

26. One mole of an ideal gas ($\gamma = 5/3$) is mixed with one mole of diatomic gas ($\gamma = 7/5$). The value of γ of the mixture
1) 3/2 2) 4/3 3) 23/15 4) 35/23

27. In a given process on an ideal gas, dW = 0 and dQ < 0. Then for the gas ____
1) the temperature will decrease
2) the volume will increase
3) the pressure will remain constant
4) the temperature will increase

T.S - ECET- 2016

28. A litre of gas is at 27^oC. Then the temperature required to heat to make its volume double is
1) 600^oC 2) 300^oC
3) 100^oC 4) 327^oC

29. Which one of the following statement is correct in case of a isothermal process of a gas
1) temperature changes
2) exchange of heat takes place between gas and surroundings
3) internal energy changes
4) it is a quick process

30. It the pressure of a gas is increased four times and its absolute temperautre is reduced to half of its initial value, then the ratio of initial to final volume is
1) 8 : 1 2) 4 : 1 3) 1 : 8 4) 1 : 4

A.P - ECET- 2016

31. The molecular kinetic enery of 1 gram of Helium at 127^oC is (Assume Molecular weight of Helium=4, R=8.31 $J.mol^{-1}.K^{-1}$)
1) 130J 2) 1247J 3) 2471J 4) 2147J

32. 1 gm of steam is sent into 1 gm of ice. The resultant temperature of the mixture is
1) 270^oC 2) 230^oC 3) 100^oC 4) 50^oC

33. Heat energy of 2100J is given to a gas at a constant pressure 1.05×10^5 Pa, changing its volume to $5\times10^{-3}m^3$. The increase in its internal energy is
1) 157J 2) 175J 3) 1575J 4) 575J

34. The unit of water equivalent is
1) calorie 2) dyne 3) gram 4) erg

35. Two thermally insulated vessels of volumes V_1 and V_2 are joined with a value and filled with air at temperature T_1 and T_2 at pressures $P_1 and P_2$ respectively. If the values joining the two vessels are opened, the temperature inside the vessels at equilibrium is

1) $\frac{(P_1V_1+P_2V_2)T_1T_2}{(P_1V_1T_2+P_2V_2T_1)}$

2) $\frac{P_1V_1+P_2V_2}{(T_1T_2)(P_1V_1T_1+P_2V_2T_2)}$

3) $\frac{P_1V_1T_1+P_2V_2T_2}{P_1+P_2}$ 4) $\frac{P_1V_1}{P_2V_2}\left(\frac{T_1}{T_2}\right)$

T.S - ECET- 2017

36. 100 g of water is heated from 30^0C to 50^0C. Ignoring the slight expansion of water, the change in its internal energy is (specific heat of water is 4200 J $kg^{-1}K^{-1}$)

1) 4.2kJ 2) 84 kJ 3) 2.1 kJ 4) 8.4 kJ

37. An ideal gas in a cylinder is compressed adiabatically to one-third its original volume. During the proecess 50J of work is done on the gas the compressing agent. The change in the internal energy of the gas in the gas in the process is

1) 50J 2) 50/J 3) 150 J 4) 45 J

A.P - ECET- 2017

38. When ice cube melts and becomes water, the ice-water system undergoes achange such that

1) entropy of the system decreases and internal energy decreases

2) entropy of the system decreases and internal energy increases

3) entropy of the system increases and internal energy increases

4) entropy of the system increases and internal energy decreases

39. A mass of 300 gm falls from a height of 3 m $(g=9.8m/s^2)$. Assuming that the whole energy is converted into heat, the amount of heat produced is

1) 2 cal 2) 2.1 cal
3) 4 cal 4) 4.2 cal

40. During an adiabatic expansion of 2 moles of a gas, the change in interanl energy was found to be equal to 100 J. The work done during the process will be equal to

1) zero 2) -100 J 3) 200 J 4) 100 J

41. The pressure and ensity of a diatomic gas $\left(\gamma=\frac{7}{5}\right)$ change adiabatically from (P,d) to (P^1,d^1). If $\frac{d^1}{d}=32$, then $\frac{P^1}{P}$ is

1) 128 2) 32 3) 256 4) 64

42. Boyle's law holds good for an ideal gas during

1) isobaric changes
2) isothermal changes
3) isochoric changes 4) isotopic changes

T.S - ECET- 2018

43. For the efficiency of the carnot cycle to be maximum____

1) the temperature of the source should be infinity

2) the temperauture of the sink should be infinity

3) the temperautre of the source should be zero

4) both should be infinity

44. Specific heat of a gas at constant volume C_V and at constant pressure C_p are related as______

1) $C_p/C_v=1-R/J$

2) $C_p-C_v=R/J$

3) $C_p-C_v=J/R$

4) $C_p+C_v=R/J$

45. If the pressure remains constant the volume of the gas will________

1) increase with the increase in temperautre

2) decrease with the increase in temperature

3) not change with the temperature

4) become zero

A.P- ECET- 2018

46. In which of the following process, the internal energy of the system remains constant?

1) adiabatic 2) isothermal
3) isobaric 4) isochoric

47. Specific heat aluminium is $0.25\,cal/g/^0C$. The water equivalent of an aluminium vessel of mass one kilogram is

1) 40 cal/^{0}C 2) 400 cal/^{0}C
3) 250 cal/^{0}C 4) 25 cal/^{0}C

48. The specific heat of a gas in an isothermal process is

1) infinity 2) zero
3) finite positive 4) finite negative

PREVIOUS ECET BITS KEY

01) 4	02) 2	03) 2	04) 2	05) 4
06) 2	07) 4	08) 2	09) 3	10) 1
11) 2	12) 3	13) 2	14) 3	15) 3
16) 2	17) 1	18) 3	19) 3	20) 2
21) 2	22) 4	23) 2	24) 1	25) 3
26) 1	27) 1	28) 4	29) 2	30) 1
31) 2	32) 3	33) 3	34) 3	35) 1
36) 4	37) 1	38) 3	39) 2	40) 2
41) 1	42) 2	43) 1	44) 2	45) 1
46) 2	47) 3	48) 1		

PREVIOUS ECET BITS HINTS AND SOLUTIONS

01. $n=\frac{m}{M}=\frac{68}{2}=3$ mole

$\therefore$ number of molecules = 3N

02. Translational Degree of freedom = 3

K.E of molecule $=\frac{3}{2}KT$

03. According to definition of thermal capacity of a gas it is specific heat × mass

U = mS

04. $P\alpha T^3$

But $\frac{T^\gamma}{P^{\gamma-1}}\ldots\Rightarrow P^{\gamma-1}=T^\gamma\Rightarrow P\propto T^{\frac{\gamma}{\gamma-1}}$

$\therefore\frac{\gamma}{\gamma-1}=3$

$\gamma=3r-3\Rightarrow2\gamma=3$

$\gamma=\frac{3}{2}=\frac{C_p}{C_v}$

05. $V\alpha T$

$\frac{V_1}{V_2}=\frac{T_1}{T_2}$ $\frac{V}{2V}=\frac{300}{T_2}$

$T_2=600K$ $T_2=327^\circ C$

06. $P_1V_1=P_2V_2$

$\frac{P_2}{P_1}=\frac{V_1}{V_2}=\frac{100}{110}=\frac{10}{11}$

$\left(\frac{P_2}{P_1}-1\right)\times100=\left(\frac{10}{11}-1\right)100$

$=-\frac{1}{11}\times100=-90.9\%$

07. Gas molecule is perfect elastic rigid sphere.

08. For ideal gas internal energy depends kinematic energy of molecule $=\frac{3}{2}KT$

Which depends on Temperature

09. Product of PV $=\frac{F}{A}\times A\times S$

= FS = work done

10. $d_1:d_2=5:6$

$s_1:s_2=3:5$

U = mS = VdS

But volume = 1

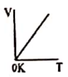
$\therefore U=dS$

$\frac{U_1}{U_2}=\frac{d_1}{d_2}.\frac{S_1}{S_2}$

$\frac{U_1}{U_2} = \frac{5}{6} \times \frac{3}{5} = \frac{3}{6} = \frac{1}{2}$

11. First law of thermodynamics
$dQ = du + dw$

12. At absolute zero $= -273^\circ C$
Volume becomes zero



$V_t = V_0(1+\alpha t)$

$0 = V_0\left(1 + \frac{1}{273}t\right)$

$t = -273^\circ C$

13. $L_2 = L_1(1 + \alpha\Delta t)$
$L_2 - L_1 = \alpha L_1 \Delta t$

$\alpha = \frac{L_2 - L_1}{L_1 \Delta t} = \frac{1\times10^{-1} cm}{40\times100}$

$\alpha = 0.25\times10^{-4} = 25\times10^{-6} /^\circ C$

14. $\gamma_a = \frac{V_2 - V_1}{\gamma_1(t_2 - t_1)}$

But $\gamma_r = \gamma_a + 3\alpha \Rightarrow r_a = \gamma_r - 3\alpha$

$V_2 - V_1 = (r_r - 3\alpha)V_1(t_2 - t_1)$

$= (180\times10^{-6} - 3\times9\times10^{-6})200\times70$

$V_2 - V_1 = 153\times10^{-16}\times14000$

$V_2 - V_1 = 2142\times10^{-3} = 2.142$ c.c.

15. $dQ = dU + dw$
$dU = dQ - dw$

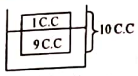
16. $dQ = dU + dw$
$35 = dU + 15 \Rightarrow dU = 35 - 15 = 20J$

17. Formano atomic

$\frac{C_p}{C_v} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3} \Rightarrow 1.66$

18. Coolant should have high thermal capacity
$U = mS$
$\therefore$ high specific heat

19. Water level remain th e same



10 C.C of ice = 9 C.C of water
density of ice = 0.9 gm/ C.C
density of water = 1 gm/C.C
when 10 C.C ice melts give 9 C.C water which fills the gap
hence water level remain the same

20. $dQ = dU + dW$
$\therefore dU = dQ - dw$

21. $dQ = dU + dw$
$35 = dU + 15 \Rightarrow dv = 20J$

22. $\frac{C_p}{C_v} = \frac{\frac{5}{2}R}{\frac{3}{2}R} = \frac{5}{3} \Rightarrow 1.66$

23. $dQ = 0$; $dU = -dw$ is adiabatic

24. $d = \frac{mass}{volume} = \frac{mass\ of\ each\ particle \times no\ of\ particles}{volume}$

$d = \frac{mnN}{v}$

$pv = nRT \Rightarrow \frac{n}{v} = \frac{P}{RT}$

$d = mN\frac{P}{RT}$

But $K = \frac{R}{N} \Rightarrow \frac{N}{R} = \frac{1}{K}$

$d = \frac{mP}{KT}$

25. $dw = -dU$
$\therefore$ dU decreased by 4.5J

26. $r = \frac{n_1c_p + n_2cp_2}{n_1cr_1 + n_2cr_2} = \frac{1\times5 + 1\times7}{1\times3 + 1\times5}$

$r = \frac{12}{8} = \frac{3}{2}$

27. $dW = 0$ no change in volume
$dQ < 0 \Rightarrow$ Heat lost
$\therefore$ temperature decreases

28. $v \propto T \Rightarrow \frac{V_1}{V_2} = \frac{T_1}{T_2} \Rightarrow \frac{1}{2} = \frac{3w}{T_2} \Rightarrow T_2 = 600k = 327^\circ c$

29. exchange of heat takes place between gas and surrondings in isothermal procenn

30. $\frac{P_1v_1}{T_1} = \frac{P_2v_2}{T_2} \Rightarrow \frac{pv_1}{T} = \frac{4p\times v_2}{\frac{T}{2}} \Rightarrow \frac{v_1}{v_2} = \frac{8}{1}$

31. Molecular kinetic energy of one molecule $= \frac{3}{2}k_BT$

$K_B = \frac{R}{N}$ for one molecule

for 'n' mole $E = \frac{3}{2}.\frac{R}{N}.nNT = \frac{3}{2}RnT$

for $\frac{1}{4}$ mole of helinm $E = \frac{3}{2}\times8.31\times\frac{1}{4}\times400$
E=12475

32. $mL + ms\theta_{steam} = mL + ms\theta_{ice}$

$1\times540 + 1\times1\times(100-7) = 1\times80 + 1\times1\times(t-0)$

$540 + 100 - t = 80 + t \Rightarrow 2+ = 560 \Rightarrow t = 280^0c$

But $+ > 100^0c$ not possible $\therefore t = 100^0C$

33. $d\theta = du + dw \Rightarrow d\theta = du + pdv$

$2100 = dv + 1.05\times10^5\times5\times10^{-3} \Rightarrow dv = 1575j$

34. water equivalent in mass of the water equal to thermal capacity units in gram

35. $\frac{P_1V_1}{T_1} + \frac{P_2V_2}{T_2} = \frac{P_1V_1}{T} + \frac{P_2V_2}{T}$

$\frac{P_1V_1T_2 + P_2V_2T_1}{T_1T_2} = \frac{P_1V_1 + P_2V_2}{T}$

$T = \frac{(P_1V_1 + P_2V_2)T_1T_2}{P_1V_1T_2 + P_2V_2T_1}$

36. $W = ms\theta$

$100\times10^{-3}\times4200\times20$
$= 8.4$ KJ

37. Adiapiatic process
$dq = 0,\ dw = -du,\ dw = +50j$

38. entropy of the system increases and internal energy increases

39. Given $W = JH$
$Mgh = JH$

$H = \frac{0.3\times9.8\times3}{4.2} = 2.1$cal

40. $dw = -du$
dw = -100J

41. PV^γ = constant

$V \propto \frac{1}{d}$

$P \propto d^\gamma$

$\frac{P_1}{P_2} = \left(\frac{d_1}{d_2}\right)^\gamma$

$\frac{P_1}{P_2} = (32)^{7/5}$

$\frac{P_1}{P_2} = 128$

42. isothermal changes

Araise ! Awake ! And stop not till the goal is reached

SPACE FOR IMPORTANT NOTES

MODERN PHYSICS

Photo Electric Effect :

- It is the phenomenon in which electrons are emitted from the surface of a metal illuminated by light of suitable wavelength or frequency.
- The photo electric effect was first discovered by Hertz
- The current due to photoelectrons is called photoelectric current.
- It is independent of frequency of light and energy of incident light.
- The photo electric current does not follow Ohm's law.
- The photoelectric effect is based on law of conservation of energy.
- Alkali metals like Lithium, Sodium, Potassium etc emit electrons with visible light only.
- **Work function**

The energy required to liberate on electron from a metal surface with zero kinetic energy is called work function.

Work function W = $w = h\nu_0 \frac{hc}{\lambda_0}$

where γ_0 threshold frequency

λ_0 = Threshold wavelength

h = Plank's constant = $6.625 \times 10^{-34} J-S$

It W is in eV and λ_0 in 'A', the above equation can be written as

$$W = \frac{12400}{\lambda_0} ev.$$

- **Threshold frequency** (γ_0) **:**

It is the minimum frequency of incident radiation below which photo electrons are not emitted from a metal surface (γ_0).

- **Threshold wavelength** (λ_0) **:**

It is the minimum wavelength of incident radiation above which there is no photo electric emission from the surface of a metal.

Conditions for photo electric effect :

(i) $v > v_0$ (ii) $\lambda < \lambda_0$

Stopping potential (V_S): Stopping potential is the retarding potential difference to be applied between the surface of photosensitive plate and the electrons of collector which is just sufficient to stop energitic photo electrons emitted.

$$9V_S = \frac{1}{2}mv^2$$

where q is charge of electron V_S is stopping potential $V_S \times \frac{1}{\text{work function}}$

- Stopping potential for violet light is greater than red light because frequency of violet light is greater than red light.
- Stopping potential is independent of intensity of incident radiation because work function photo metal increases stopping potential increases because work function decreases.

Laws of photo electric effect :

a) The number of electrons emitted per second or photo electric current is directly proportional to intensity of incident radiation and is independent of frequency of radiation.

b) For each photosensitive surface there is a minimum frequency called threshold frequency below which photo electrons are not emitted.

c) The maximum kinetic energy of electrons from the surface of a metal varies linearly with the frequency of incident radiation and is independent of intensity of radiation.

(or) There is no time log between incidence of radiation and emission of photo electrons.

Einstein equation of photo electric field :

According to Einstein's photoelectric equation, the maximum KE of emitted photo electrons is given by

$$K = \frac{1}{2}mv^2 = h\nu - w \quad K = h\nu - h\nu_0 = h(\nu - \nu_0)$$

Where m is mass of ejected photo electron. v is maximum velocity ν frequency of incident radiation. w is work function of given metal

Note : If the frequency of incident light increases, maximum KE of photo electron also increases.

Photo cell :

a) It is an arrangement to convert light energy into an electrical energy

b) It is also called magnetic eye.

Types of photo cells :

1. Photo emissive cell :

It acts as a switch in electric circuit. It is divided into two types.

1. Vacuum type photo emissive cell

2. Gas filled photo emissive cell

Vacuum photo emissive cell is used in television and photometry Gas filled photo emissive cell is used in cinematograph and recording and reproducing of sound.

Photo voltaic cell :

- It consists of copper plate coated with a twin layer of Cu_2O.
- When light falls on layer, the electrons are emitted from the layer and move towards the silver layer.
- This cell give current without any external source of ballery

Photo conductive cell :

It works on the principle that when a light is incident on a semiconductor its resistance is reduced. It is rarely used.

Photo multiplier :

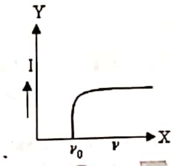
It is used to amplify the very weak light signals

Uses of photo cell :

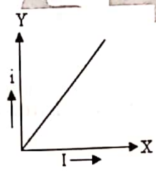
1. Connecting system
2. Fire alarm
3. Solar energy
4. Photometry
5. Sound production in films.
6. Remote control operation in T.V.
7. Light exposer meters.
8. Atomatic switch for street lights.

Graphs :

The graph between frequency of incident photon (ν) and photo electric current is



The graph between intensity of incident light (I) and photoelectric current is



Super conductivity

When the temperature of a metallic conductor is decreased, the resistivity first decrease generally At a particular temperature called the critical temperature or superconducting point, the resistance suddenly falls to zero.

- In 1911 Heike Kamerling Onnes discovered super conductivity.
- Onnes was awarded Nobel Prize for the study of malter at low temperature and lique faction of helium.
- Onnes found that at 4.15K the resistance of mercury dropped to as close to zero.

Critical temperature (T_C)

The characteristic temperature of a material below which the electric resistance of the material disappears is called critical temperature (T_C)

- For mercury $T_C = 4.15\,K$

For $La - Ba - Cu - O \cdot T_C = 30K$

For Thallium cuprate $T_C = 125\,K$

Explanation

When the temperature of material decreases, vibrations of atom decrease. This decrease the probability of collision of ion and electron. Thus as temperature approaches zero the resistivity of material becomes zero and the material becomes superconductor.

Critical magnetic field :

By applying a suitable magnetic field, Super conductivity can be desctroyed. "The value of magnetic field at which the superconductivity vanishes" is called critical magnetic field.

Persistent currents :

If once current set up in a superconducting ring which has zero resistance, it will flow indefinitely and it will not decrease. The current persists without only applied voltage. These currents are called persistent currents or super currents.

Properties of super conductors :

01. Super conductors have zero resistance at very low temperature.
02. Super conductor are perfectly diamagnetic i.e., no magnetic lines of force can exist inside them.
03. When impurities are added to super conductors, their property is not lost but the critical temperature is lowered.
04. The crystal lattice remains uncharged during the transition from normal to superconductivity state.
05. Current persisting for a long time without the aid of an external voltage can be induced.
06. A very high frequency (above 10 MHz) of alternating current. the zero resistance of superconductor changes slightly.
07. Super conductor do not show any thermo electric effect.
08. There is no change in photoelectric properties of super conductors.

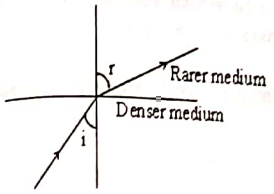
Applications of super conductivity :

01. Using the property of zero resistance of superconductors it is possible to develop a low lass electric power transmission.
02. To fabricate high field magnets low temperature liquid helium superconductors are used.
03. In NMR spectrometers and NMR imaging used in medical diagnostics, super conducting magnets are used

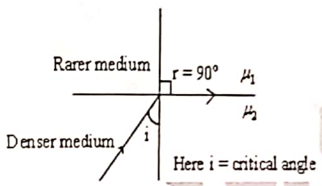
    (NMR - Nuclear Magnetic Resonance)
04. If superconductivity fluxes are used to inter connect computer chips, chip size could be reduced and high speed could be attained.
05. The SQUIDC (Superconducting quantum interference device) magnetometer can be used to detect magnetic field less than 10^{-4} A-M.
06. SQUIDS fabricated using high temperature superconductors find applications in submairen detection, geophysical prospecting medical diagnostics and under Sea communication
07. Super conductors are used to produce electro magnetic shields and magnetic levitation trains.

Critical angle and total internal reflection

- When light ray travels from denser medium to rarer medium, the light ray bends away from normal.
- If the angle of incidence in denser medium is increased, the angle of refraction is also is increased.



- For a pair of media, the angle of incidence in the denser medium. For which the corresponding angle of refraction in the rarer medium is $90°$ or the refracted ray of light just grazes the surface of separation between the media is called critical angle.



- Since the ray from denser medium of refractive index μ_2 ro rarer medium of refractive index μ_1.

$\mu_1 \sin r = \mu_2 \sin i$

but $r = 90°$ and $i = c$, we get $\frac{\mu_2}{\mu_1} = \frac{1}{\sin c}$

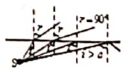
Where C is critical angle of the pair of media.

- If the rarer medium is air (or) vacuum, $\mu_1 = 1$ then $\mu_2 = \frac{1}{\sin c}$ or in general $\mu = \frac{1}{\sin c}$.
- Critical angle depends upon the colour of light, nature of medium and its temperature.
- Critical angle is maximum for red and minimum for violet.

  If the angle of incidence in the denser, medium is greater than critical angle, then light is totally internally reflected i.e., into the same denser medium. This phenomenon is called total internal reflection.
- For total internal reflection to take place

(a) The ray of light should travel from a denser medium to a rarer medium.

(b) angle of incidence in the denser medium should be greater than critical of the pair of media.



- Examples for total internal reflection.

  (a) The sparkling nature of diamond.

  (b) Air bubble in water appears silvery white

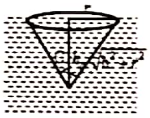
  (c) Rainbow is formed due to dispersion and total internal reflection.

(d) forming of mirages and loomings.

(e) optical fibre works on the principle of total internal reflection.

- **Depth of fish in water :**

  A fish inside water at a depth his seeing the outside world through a circular aperature on surface of water. If fis critical angle is 'C' then $r = h\ Jan C$



$$\mu = \frac{1}{\sin c}$$

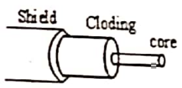
$$r = \frac{h}{\sqrt{\mu^2 - 1}} \text{ (or) } r = h_i \tan\theta$$

(or) $h = r\sqrt{\mu^2 - 1}$

Optical fibre :

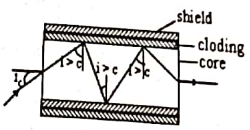
- Optical fibres are works on the principle of total internal reflection.
- Optical fibres is a transmission medium to carry the optical signal without any appreciable loss.
- Optical fibre consists of three parts

  1. Core 2. Cladding 3. Shield
- Core is hairthin transparent material made up of glass or plastic. The refractive index of core is 1.7. It behave as a denser medium.



- Core is surrounded by a layer of material called cladding. The refractive index of cladding is 1.6. It behave as a rarer medium.
- The clading is enclosed in an additional layer called shield
- It is used to protect the fibre from physical damage.
- $\mu_{Core} > \mu_{Clading}$

  The light travelling through the core always incidents on the clading (at the interface) at an angle greater than critical angle and suffers total internal reflection.



If μ_1 and μ_2 are the refractive indexes of core and clading, the launching angle of incidence for which light will be confined in the core is

$$i_L \leq \sin^{-1}\left(\sqrt{\mu_1^2 - \mu_2^2}\right)$$

Uses of optical fibre

01. Optical fibre is useful in communications than traditional copper cables because it is cheaper, has long life and cross talk is eliminated.
02. Optical fibre is flexible and is used to observe the inner port of the body to make the surgery which are called endoscopic operations.
03. Optical fibers are used to transmit communication signals over large distances without any loss of energy.
04. The temperature and pressure can be determined by using optical fibre sensors.
05. The blood flow in the heart can be measured by using optical fibre photometric sensors.

IT IS TRUTH ALONE THAT GIVES STRENGTH

PRACTICE SET - I

01. A microscope is focussed on the coin at the bottom of a beaker. Water is poured into it and the microscope is focussed again on the coin. Some lycopodium powder in sprinkled on surface of water and microscope is focussed on to the powder. If the corresponding readings are 1.17, 2.02 and 4.57 cm respectively, find the R.I of water.
1) 2/3 2) 4/3 3) 3/2 4) 1/2

02. The refractive index of glass is $\frac{3}{2}$. If a ray of light travels 9 cm. in glass medium, find the distance it travels in air during the same time
1) 13.5 cm 2) 1.35 cm
3) 135 cm 4) 0.135 cm

03. Light entering an air glass ($\mu = 1.5$), boundary is partly reflected and partly refracted. If the incident and reflected rays are at right angles to each other, find the angle of refraction
1) $2/\sqrt{3}$ 2) $\sqrt{2}/3$ 3) $2/3$ 4) $\sqrt{2}/\sqrt{3}$

04. In optical fibre, R.I of inner part in 1.68 and R.I of outer part is 1.44. Find the numerical aperature of the fibre.
1) 0.836 2) 0.765
3) 0.8653 4) 0.9

05. By how much would an ink dot appear raised when covered by a glass plate 4.5cm thick if the velocity of light in glass is 2×10^{10} cm/s and in air 3×10^{10} cm/s ?
1) 1.5cm 2) 1.7 cm 3) 2cm 4) 2.5 cm

06. Total internal reflection can take place only when a ray of light travels from a given medium towards medium
1) denser 2) rarer
3) both (1) and (2) 4) none

07. For a fish under water, the outside, world appears to lie within a cone. This is due to
1) special vision of fish
2) absorption of light by water
3) scattering of light by water
4) total internal reflection

08. A fish inside a water tank, when looking up sees the outside world in an angular separation of
1) 101° 2) 98° 3) 90° 4) 49°

09. The colour of light is determined by its
1) velocity 2) frequency
3) amplitude 4) intensity

10. If μ_1 and μ_2 are refractive indices of two media and v_1 and v_2 the velocities of light in the media, then the relation connecting them is
1) $\mu_1\mu_2 = v_1v_2$ 2) $\mu_1v_1 = \mu_2v_2$
3) $\mu_1v_2 = \mu_2v_1$ 4) none of these

11. The conductance of a super conductor at absolute zero temperature is
1) zero 2) infinity 3) 4Ω 4) 26Ω

12. A setting sun appears to be at an altitude higher than it really is. This is because of
1) absorption of light 2) reflection of light
3) refraction of light 4) dispersion of light

13. When light waves travels from one medium into another, its
1) velocity does not change
2) wavelength does not change
3) frequency does not changed
4) velocity frequency and wavelength does not change

14. Brilliance of diamond is due to
1) shape 2) cutting
3) reflection
4) total internal reflection

15. Light of wavelength 400 A is incident on a metal whose work function is 2 eV. Calculate the maximum possible K.E of the photo electrons
1) 1.1 eV 2) 11 eV
3) 0.11 eV 4) 1.2eV

16. Energy of a photon is 3 eV. Find the frequency and wavelength of radiation.
1) 420 A° 2) 312 A°
3) 4120 A° 4) 3051 A°

17. Calculate the energy of a photon of wavelength 6600 A.U.
1) $5\times10^{-20}J$ 2) $3\times10^{-20}J$
3) $5\times10^{19}J$ 4) $3\times10^{-19}J$

18. Find the wavelength of 100eV photon.
1) 124 AU 2) 140 AU
3) 150 AU 4) 120 AU

19. Find the wavelength of an α - ray photon whose energy is equal to rest mass energy of an electron
1) $2\times10^{-12}m$ 2) $2.42\times10^{-12}m$
3) $1.2\times10^{11}m$ 4) $1.2\times10^{-11}m$

20. Will photoelectrons be emitted by a copper surface of work function 4.4 eV, when illuminated by visible light ?
1) 30 AU 2) 2818 AU
3) 2900AU 4) 2720 AU

21. Of the following which has photons of least energy
1) X-rays 2) U.V. rays
3) Light rays 4) Infrared rays

22. In a photo electric experiment the maximum velocity on photo electrons emitted
1) depends on intensity of incident radiation
2) doesn't depend on the cathode material
3) depends on frequency of incident radiation
4) doesnot depend on wavelength of the incident radiation.

23. The photoelectric threshold of a certain metal is 3000 A°. If the radiation is 2000 A°. is incident on the metal
1) positrons will be emitted
2) protons will be emitted
3) electrons will not be emitted
4) electrons will be emitted

24. Photoelectric current can be increased by using
1) Higher frequency radiation
2) Higher intensity radiation
3) Higher work function metal plates
4) None of these

25. The photo-electric cell converts
1) electric energy to light energy
2) light energy to electric energy
3) light energy to heat energy 4) none

26. The work function is less for
1) Cu 2) Ag 3) Al 4) Cs

27. What happens when the light intensity on a photoelectric surface is doubled ?
1) The frequency of the emitted photons is doubled
2) The number of photons is double
3) The number of photons is tripled
4) None

28. The resistance of a super conductor at its super conducting state is
1) zero 2) infinity 3) 5Ω 4) 15Ω

29. Photoelectric effect is a phenomenon in which
1) photons come out of a metal when it is hit by a beam of electrons
2) Photons come out of the nucleus of an atom under the action of an electric field
3) electrons come out of a metal with a constant velocity which depends on the frequency and intensity of incident light wave
4) electrons come out of a metal with different velocities not greater than a certain value which depends only on the frequency of the incident light wave and not on its intensity

30. The photoelectric effect occurs only when the incident light has more than a certain minimu
1) frequency 2) wavelength
3) speed 4) charge

PRACTICE SET - I KEY

01) 2	02) 1	03) 2	04) 3	06) 1
07) 2	08) 4	09) 2	10) 2	11) 2
12) 2	13) 3	14) 3	15) 2	16) 1
17) 3	18) 4	19) 1	20) 2	21) 2
21) 4	22) 3	23) 3	24) 4	25) 1
26) 3	27) 2	28) 3	29) 4	30) 4

PRACTICE SET - II

01. The work function of a metal surface is 2eV. When light of frequency 1.5×10^{15} Hz is incident on it, the maximum kinetic energy of the photo electron, approximately is
1) 8 eV 2) 6 eV
3) 2 eV 4) 4 eV

02. The threshold wavelength is 2000 °A. The work function is
1) 16.25 eV 2) 6.2 eV
3) 6.2 MeV 4) 6.2 KeV

03. Work function for potassium is 2 eV. If light of 3600 °A is incident on potassium then stopping potential is
1) 1.44 eV 2) 3.44eV
3) 2.44 eV 4) 5.44 eV

04. The photoelectric threshold frequency of a metal is ν_0. When light of frequency $4\nu_0$ is incident on the metal, the maximum K.E. of the emitted photo-electrons is
1) $4h\nu_0$ 2) $3h\nu_0$ 3) $h\nu_0/4$ 4) $\nu_0/2$

05. Photons of energy 6 eV are incident on a potassium surface whose work function is 2.1eV. What is its stopping potential?
1) -6 V 2) -2.1 V 3) -3.9 V 4) -8.1 V

06. The work function of a metal is 4 eV. The wavelength of incident light, required to emit photo electrons of zero energy from its surface, will be
1) 5000 °A 2) 3100 °A
3) 1700 °A 4) 2700 °A

07. The work function of aluminium is 4.2 eV. The threshold wavelength for it for photo electric emission will be
1) 2955 °A 2) 4200 °A
3) 1100 °A 4) 3000 °A

08. The work function of a metal is 1.5eV. Light of wavelength 6600 °A is made incident on it. The maximum K.E of emitted electrons will be
1) 1.6×10^{-19}J 2) 0.6×10^{-19}J
3) 1.6×10^{-13}J 4) 1.6×10^{19}J

09. The photoelectric work function for a metal surface is 4.125 eV. The cut-off wavelength for this surface is
1) 4125 °A 2) 2062.5 °A
3) 3000 °A 4) 6000 °A

10. The transition temperature of most superconducting elements lie in the range
1) zero to 10K 2) 10 K to 20K
3) 20 K to 50K 4) above 50 K

11. The transition temperature of mercury is
1) 1K 2) 1.14 K
3) 4.12 K 4) 9.22K

12. The R.I of water is 4/3. If ray travels 24cm, in air in a given time t, the distance travelled by light in water in the same time is
1) 32 cm 2) 24 cm 3) 18 cm 4) none

13. The critical angle of a medium w.r.t. to vacuum is 30°, velocity of light in this medium in m/s is
1) 3×10^8 2) 6×10^8
3) 1.5×10^8 4) $\sqrt{2}\times10^8$

14. Critical angles of two different media are 45° and 60° respectively. The ratio of velocities of light in those two media is
1) 2 : 3 2) $\sqrt{3}:\sqrt{2}$
3) $\sqrt{2}:\sqrt{3}$ 4) $2:\sqrt{3}$

15. If the refractive index of water is 4/3, the velocities of light in vacuum is 3×10^{10} cm/sec. the time required to travel a distance of 450 cm. in water will be
1) 0.2 µs 2) 0.02 µs 3) 2 µs 4) 2000 µs

16. If 'C' is the velocity of light in free space, the time taken by light to travel a distance x in medium of refractive index μ is given by
1) μxc 2) $\mu x/c$ 3) $\mu c/x$ 4) $x/\mu c$

17. The colour of light which travels with maximum speed in glass is
1) blue 2) green 3) red 4) violet

18. The refractive index of a certain glass is 1.50 for light of wavelength 6000 A°. When the light passes through this glass, its wave length will be (velocity of light in vacuum $c = 3\times10^8\ m/s$)
1) 6000 A° 2) 4000 A°
3) 9000 A° 4) 7500 A°

19. The Einstein's photoelectric equation is based upon the conservation of
1) Mass 2) momentum
3) angular momentum 4) energy

20. A point source of light is used in a photoelectric effect. If the source is removed farther from the emitting metal, the stopping potential
1) will increase 2) will decrease
3) will remain constant
4) will either increase or decrease

21. In a photo electric experiment, the maximum velocity of photoelectrons emitted
1) depends on intensity of incident radiation
2) does not depend on cathode material
3) depends on frequency of incident radiation
4) does not depend on wavelength of incident radiation

22. Emission of electrons in photoelectric effect is possible, if
1) metal surface is highly polished
2) the incident light is of sufficiently high intensity
3) the light is incident at right angles to the surface
4) the incident light is of sufficiently low wavelength

23. Light of frequency 1.5 times the threshold frequency is incident on a photo sensitive metal. If the frequency of the incident light is halved and the intensity is doubled, the photo electric current becomes
1) quadrupled 2) doubled
3) halved 4) zero

24. If the distance of 100W lamp is increased from a photocell, the saturation current i in the photo cell varies with distance d as
1) $i \propto d^2$ 2) $i \propto d$
3) $i \propto \frac{1}{d}$ 4) $i \propto \frac{1}{d^2}$

25. The process of emission of photons due to the incidence of electrons on a metal plate is called
1) photoelectric effect 2) pair production
3) production of x-rays
4) production of γ - rays

26. With the decrease in the wave length of the incident radiation the velocity of the photoelectrons emitted from a given metal
1) remains same 2) increases
3) decreases
4) increases first and then decreases

27. Sodium surface is illuminated with ultraviolet light and visible radiation successively and the stopping potentials are determined. Then the potential
1) is equal in both the cases
2) greater for ultraviolet light
3) more for visible light 4) varies randomly

28. Work function is the energy required
1) to excite an atom 2) to produce X-rays
3) to eject an electron just out of the surface
4) to explode the atom

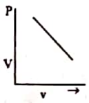
29. In photo electric effect, the slope of the straight line graph between stopping potential and frequency of the incident light gives the ratio of Planck's constant to
1) charge of electron 2) work function
3) photo electric current
4) K.E of electron

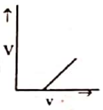
30. The best suitable metal for photo electric effect is
1) Iron 2) Steel
3) Aluminium 4) Caesium

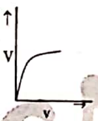
31. Photo electric effect can be explained only by assuming that light
1) is a form of transverse waves
2) is a form of longitudinal waves
3) can be polarized 4) consists of quanta

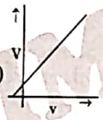
32. The threshold wavelength of lithium is 8000 A°. When the light of wavelength 9000 A° is made to be incident on it, then the photo electrons
1) Will not be emitted 2) Will be emitted
3) Will sometimes be emitted and sometimes not
4) Nothing can be said

33. The curve between the frequency (v) and stopping potential (V) in a photo electric cell will be

1) 

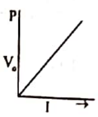
2) 

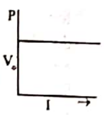
3) 

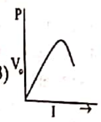
4) 

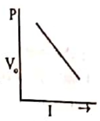
34. If the work function of a metal is ϕ_0, then its threshold wavelength will be
1) $hc\phi_0$ 2) $\frac{c\phi_0}{h}$ 3) $\frac{h\phi_0}{c}$ 4) $\frac{hc}{\phi_0}$

35. The correct curve between the stopping potential (V_0) and intensity of incident light (I) is

1) 

2) 

3) 

4) 

PRACTICE SET - II KEY

01) 2	02) 2	03) 1	04) 3	05) 3
06) 2	07) 1	08) 2	09) 3	10) 1
11) 3	12) 3	13) 3	14) 2	15) 2
16) 2	17) 3	18) 4	19) 4	20) 3
21) 3	22) 4	23) 4	24) 4	25) 3
26) 2	27) 2	28) 3	29) 1	30) 4
31) 4	32) 1	33) 2	34) 4	35) 2

SEFL TEST

01. Speed of light an vacuum is $3\times10^8\ m/s$. If refractive index of glass is 1.5, find the time taken by the light to travel 400m in glass
1) $4\sqrt{3}$ s 2) $8\mu s$ 3) $2\mu s$ 4) $4\mu s$

02. The speed of light in water is three-fourth that in air. If wavelength of same light in air is $6000°A$, its wavelength in water is
1) $6000°A$ 2) $6500°A$
3) $4000°A$ 4) $4500°A$

03. The refractive index of medium is 2. The critical angle for the medium is
1) $30°$ 2) $60°$ 3) $45°$ 4) $37°$

04. A fish under water at a depth of 20 cm can see the outer atmosphere through an aperature of radius of [critical angle of water is $45°$]
1) 5 cm 2) 20 cm 3) 10 cm 4) $\frac{20}{\sqrt{3}}$

05. Which of the following pair is suitable to make core and cladding of an optical fibre
1) 1.6, 1.3 2) 1.6, 1.7
3) 1.3, 1.6 4) 1.24, 1.14

06. Light wave of frequency 4×10^{14}Hz and $\lambda = 5\times10^{-7}$m passes through a medium. The refractive index of the medium is
1) 2/3 2) 4/3 3) 3/2 4) 1.414

07. The critical angle for light going from a medium in which wave length is 4000 A° to medium in which its wavelength is 6000 A° is
1) $30°$ 2) $45°$ 3) $60°$ 4) $\sin^{-1}\left(\frac{2}{3}\right)$

08. Intensity of light incident on a photo sensitive surface is doubled. Then
1) the number of emitted electrons is trebled
2) the number of emitted electrons is doubled
3) the K.E of emitted electrons is doubled
4) the momentum of emitted electrons is doubled

09. Light of wavelength λ on a metal having work function hc/λ_0. Photoelectric effect will take place only if
1) $\lambda \geq \lambda_0$ 2) $\lambda \geq 2\lambda_0$ 3 $\lambda \leq \lambda_0$ 4) $\lambda < \lambda_0/2$

10. The number of electrons emitted by a surface exposed to light is directly proportional to
1) frequency of light 2) work function
3) threshold wavelength
4) intensity of light

11. In photoelectric effect, when photons of energy hv are incident electrons are emitted from the metallic surface with a kinetic energy. It is possible to say that
1) All ejected electrons hace same K.E equal to hv_0
2) The ejected electrons have a distribution of K.E. from zero to $hv - hv_0$
3) The most energetic electrons have K.E equal to hv
4) All ejected electrons have K.E. equal to hv.

12. The stopping potential for a photo cell depends
1) on the nature of the cathode and intensity of light
2) on both the intensity and frequency of incident light
3) only on the intensity of light
4) on both the nature of the cathode and frequency

13. The work function of a metal
1) is different for different metals
2) is the same for all the metals
3) depends on the frequency of the light
4) depends on the intensity of the incident light

14. In photoelectric effect, which of the following property of incident light will not effect the stopping potential
1) Frequency 2) Wavelength
3) Energy 4) Intensity

15. A graph is drawn between frequency of the incident radiation (on X-axis) and stopping potential (on Y-axis). Then the slope of the straight line indicates
1) h.e 2) h/e 3) e/h 4) (e-h)

16. A source of light is placed at a distance 4m from a photocell and the stopping potential is then 7.7 volt. If the distance is halved. the stopping potential now will be
1) 7.7 volt 2) 15.4 volt
3) 3.85 volt 4) 1.925 volt

17. If the threshold wavelength is double the incident wavelength λ, the maximum K.E of the photoelectrons is
1) $\frac{hc}{\lambda}$ 2) $\frac{hc}{3\lambda}$ 3) $\frac{hc}{2\lambda}$ 4) $\frac{2hc}{\lambda}$

18. If intensity of radiation incident on a photocell be increased four times keeping frequency constant, then number of photoelectrons and energy of photoelectrons emitted become
1) four times, doubled
2) doubled, remains unchanged
3) remains unchanged, doubled
4) four times, remains unchanged

19. If an experiment of photo electric emission for incident light of 4000 A°, the stopping potentials is A°, the stopping potential is 2V. If the wavelength of incident light is made 3000 A°, then the stopping potential will be
1) Less than 2 volt 2) More than 2 volt
3) 2 volt 4) Zero

20. At stopping potential, the photo electric current becomes
1) Minimum 2) Maximum
3) Zero 4) Infinity

21. The threshold wave length for photo electric emission from a material is 5.200 A°. Photo electrons will be emitted when this material is illuminated with monochromatic radiation from a
1) 50 watt infrared lamp
2) 1 watt infrared lamp
3) 1 watt ultraviolet lamp
4) 50 watt sodium vapour lamp

22. The necessary conditions for photo electric emission is
1) $h\nu \le h\nu_0$ 2) $h\nu \ge h\nu_0$
3) $E > h\nu_0$ 4) $E_k < h\nu_0$

23. The process of photo electric emission depends on
1) Work function of surface
2) Nature of surface
3) Wavelength of incident light
4) All of the above

24. On reducing the wavelength of light incident on a metal, the velocity of emitted photo electrons will become
1) zero 2) less 3) more 4) infinity

25. The photo electric effect proves that light consists of
1) Photons 2) Electrons
3) Electromagnetic waves
4) Mechanical waves

SELF TEST KEY

01) 3	02) 3	03) 1	04) 2	05) 1
06) 3	07) 4	08) 2	09) 3	10) 4
11) 2	12) 4	13) 1	14) 4	15) 2
16) 1	17) 3	18) 4	19) 2	20) 3
21) 3	22) 2	23) 4	24) 3	25) 1

PREVIOUS ECET BITS

2012

01. Cladding in the optical fiber is mainly used to
1) to protect the fiber from mechanical stresses
2) to protect the fiber from corrosion
3) to protect the fiber from mechanical strength
4) to protect the fiber from electromagnetic guidance. **Ans : 4**

2013

02. In an optical fiber, the refractive index of the core and cladding are n_1 and n_2 respectively. The numerical operature of the fiber is
1) $n_1 - n_2$ 2) $n_1^2 - n_2^2$
3) $\frac{n_1^2}{n_2^2}$ 4) $\sqrt{n_1^2 - n_2^2}$ **Ans : 4**

2014

03. The threshold wavelength for a metal whose work function is W0 is λ_0. The threshold wavelength for a metal whose work function is W0/2
Ans : 4
1) $\lambda_0/4$ 2) $\lambda_0/2$ 3) $4\lambda_0$ 4) $2\lambda_0$

04. The propagation of light through an optical fiber goes by the principle **Ans : 2**
1) Refraction 2) Total internal reflection
3) Interference 4) Diffraction

T.S - ECET 2015

05. In photoelectric effect, the KE of electons emitted from the metal surface depends upon
1) intensity of light
2) frequency of incident light
3) velcity of incident light
4) both intensity and velocity of ligh

06. The propagation of light through an optical fiber is due to
1) polarizationo flight
2) rectilinear propagationof light
3) total internal reflection of light
4) interference of light

A.P - ECET 2015

07. On making ultraviolet ligh of energy 6.2 eV, incident on aluminium surface, faster photo electons are emiteed. If the work-funciton of aluminium surface is 4.2 eV, then the kinetic energy of these fastest electons will be
1) $3.2\times10^{-17} J$ 2) $3.2\times10^{-16} J$
3) $3.2\times10^{-11} J$ 4) $3.2\times10^{-19} J$

T.S - ECET 2016

08. Light transmitted through the optical fiber by the phenomenon of
1) reflection 2) refraction
3) interference
4) toal internal reflection

09. The superconductivity of a substance below critical temperature can be destroyed by
1) increasing temperature
2) decreasing temperature
3) application of magnetic field
4) application of electric field

A.P - ECET 2016

10. The potential differnece that should be applied to stop the fastest photoelectrons emitted by nickel surface under the action of 20 nm uv radiations is
($h = 6.63\times10^{-34} J.s.; c = 3\times10^{8} ms^{-1}$; work function of nicel is 5.01 eV)
1) 5.714eV 2) 571.4eV
3) 0.5714eV 4) 57.14V

11. The critical current which can flow through a long thin superconducting wire of diameter $10^{-3} m$ is
1) 24.81A 2) 2.481A
3) 2.481mA 4) 24.81mA

T.S - ECET 2017

12. Which of the following is correct
1) $(T_1/H_2)+(T_2/H_1)=0$
2) $(H_1/T_1)=(H_2/T_2)$
3) $H_1T_1 = H_2T_2$ 4) $H_1T_1 + H_2T_2 = 0$

13. For a light wave to undergo total internal reflection ('i_c' is critical angle, 'i' is incident angle)
1) light moves from rater to denser medium and $i > i_c$
2) light moves from denser of rater medium and $i > i_c$
3) light moves from rater to denser medium and $i < i_c$
4) light moves from denser to rater medium and $i < i_c$

14. The maximum kinetic energy of photoelectrons ejected from a potassium surface by ultraviolet light of wavelength 200 mn is (photoelectric threshold wavelength for potassium is 440 nm)
1) 2.82 eV 2) 4.40 eV
3) 6.20 eV 4) 3.38 eV

A.P - ECET 2017

15. The threshold frequency of metal is v_0. When a light of frequency $4v_0$ is incidednt on metal then the $K.E_{max}$ of emitted electrons is
1) $2v_0h$ 2) $3v_0h$ 3) $4v_0h$ 4) v_0h

16. Superconductors are ____________ materials
1) dielectric 2) paramagnetic
3) ferromagnetic 4) diamagnetic

T.S - ECET 2018

17. A super conducting material when placed in a magnetic field will______
1) attract the magnetic field towards its centre
2) attract the magnetic field but transfer it into a concentrated zone
3) repel all the magnetic lines of force passing through it
4) not influence the magnetic field

18. For long distance communication______
1) grand index fibers are more suitable
2) single mode step index fibers are more suitable
3) step index fibers are more suitable
4) silica fibers are more suitable

19. If the maximumm kinetic energy of emitted photo electrons from a metal is 0.9 eV and work function is 2.2eV, then the wavelength of incident radiation is

1) $4000\,\mathring{A}$ 2) $8000\,\mathring{A}$

3) $3000\,\mathring{A}$ 4) $2000\,\mathring{A}$

20. If the angle of incidence of a ray is greater than the critical angle at the core-cladding interface in an optical fiber, then the ray travels

1) in the core 2) in the cladding

3) in the buffer 4) along the interface

PREVIOUS ECET BITS KEY

01) 4	02) 4	03) 4	04) 2
05) 2	06) 3	07) 4	08) 4
09) 3	10) 4	11) 1	12) 2
13) 2	14) 4	15) 2	16) 4
17) 3	18) 2	19) 1	20) 4

PREVIOUS ECET BITS HINTS AND SOLUTIONS

01. to protect the fiber from electromagnetic guidance.

02. $\sqrt{n_1^2 - n_2^2}$

03. $\lambda_1 = \lambda_0$; $\omega_1 = \omega_0$; $\lambda_2 = ?$; $\omega_2 = \frac{\omega_0}{2}$

$\omega = E_0 = h\upsilon_0 = \frac{hc}{\lambda_0}$

$\omega = \frac{hc}{\lambda_0}$ $\quad \because \omega \alpha \frac{1}{\lambda_0}$

$\frac{\omega_1}{\omega_2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{\omega_0}{\omega_0/2}$

$\because \lambda_2 = 2\lambda_0$

04. Total internal reflection

05. frequency of incident light

06. Total internal reflection

07. K.E = energy of incidednt light photon - work function

$= 6.2 - 4.2$

$= 2eV$

$= 2\times1.6\times10^{-19}$

K.E $= 3.2\times10^{-19} J$

08. Optical fibre works on the phenomenon of total internal reflection

09. Super conductivity of a substance between critical temperature can be destroyed by the application of magnetic field (Hc)

10. $\frac{1}{2}mv^2 = E - W \Rightarrow ev_o = \frac{hc}{\lambda} - W$

$1.6\times10^{-19} v_0 = \frac{6.63\times10^{-34}\times3\times10^8}{20\times10^{-9}} - 5.01\times1.6\times10^{-19}$

$V_0 = 57.14 volt$

11. $I_c = 2\prod aH_c$

12. Critical magnetic feild $\propto \frac{1}{Temp}$

13. light moves from denser of rater medium and $i > i_c$

14.

15. $KE = hv - hv_0$

$= 4hv_0 - hv_0$

$= 3v_0 h$

16. diamagnetic

PUT YOUR FULL EFFORTS
DONOT WORRY ABOUT THE RESULT
THEY ARE BOUND TO COME TO YOU