SRG QUESTION BANK

FOR PRACTICE

E

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

BASIC MATHEMATICS USED IN PHYSICS

1. Sunrays cast $4\sqrt{3}$m long shadow of a pole, when sun is 30° above the horizontal. When sun rises to 60° above the horizontal, length of the shadow becomes

(1) $\frac{4}{\sqrt{3}}$m (2) $2\sqrt{3}$m (3) 2m (4) $2\sqrt{2}$m

2. An airplane takes off at an angle 30° with the horizontal ground traveling at the speed of 180 km/h. If it continues to fly with the same velocity in the same direction, how long will it take to reach an altitude of 9 km above the ground :-

(1) 5 min. (2) 6 min.

(3) 8 min. (4) 9 min.

3. The values of $\sin\theta_1$, $\cos^2\theta_2$ and $\tan\theta_3$ are given as $\frac{1}{2}, -\frac{1}{2}$ and 3 (not in order), for some angles θ_1, θ_2 and θ_3.

Choose correct option :-

(1) $\sin\theta_1 = \frac{1}{2}, \cos^2\theta_2 = 3, \tan\theta_3 = -\frac{1}{2}$

(2) $\sin\theta_1 = -\frac{1}{2}, \cos^2\theta_2 = \frac{1}{2}, \tan\theta_3 = 3$

(3) $\sin\theta_1 = \frac{1}{2}, \cos^2\theta_2 = -\frac{1}{2}, \tan\theta_3 = 3$

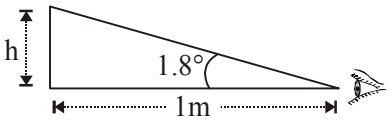
(4) $\sin\theta_1 = -\frac{1}{2}, \cos^2\theta_2 = 3, \tan\theta_3 = \frac{1}{2}$

4. The bottom of an electric pole of height 30m is situated at a distance of $30\sqrt{3}$ m from you due 60° North of East. The magnitude of the position vector of a crow sitting on the top of the pole relative to you is

(1) 30 m (2) $30\sqrt{3}$ m

(3) 60 m (4) 50m

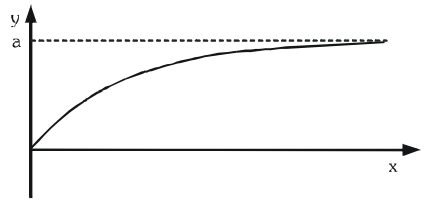
5. A normal human eye can see an object making an angle of 1.8° at the eye. What is the min. height of object which can be seen by an eye placed at a distance of 1 m from the object ?



(1) $\frac{\pi}{2}$ cm (2) π cm

(3) $\frac{\pi}{4}$ cm (4) 2π cm

6. In the following figure the curve represents the function

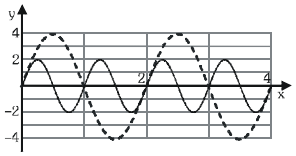


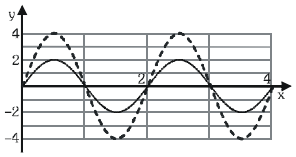
(1) $y = a - e^{-x}$ (2) $y = a(1 + e^{-x})$

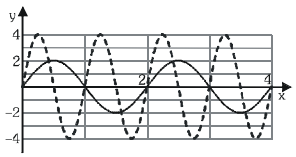
(3) $y = a(1 - e^{-x})$ (4) $y = e^{x}$

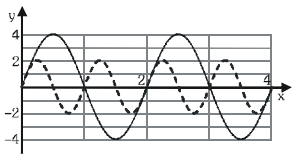
7. In the following figures, a pair of curves is shown. In which of them the solid and the dashed curves represent function

$y_1 = 2\sin(\pi x)$ and $y_2 = 4\sin(2\pi x)$

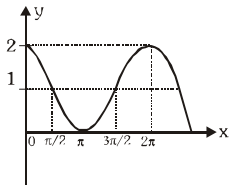
(1) 

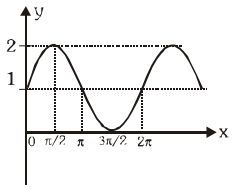
(2) 

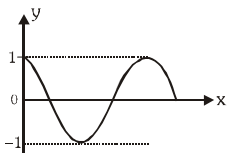
(3) 

(4) 

8. The graph of function y = 1 + cos x will be

(1) 

(2) 

(3) 

(4) None of these

9. Which of the following graph is/are straight line for the equation $y^2 = 2x$?

I. Graph: y versus x^2

II. Graph: y^2 versus x

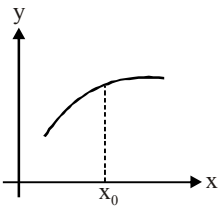
III. Graph: y versus $\sqrt{x}$

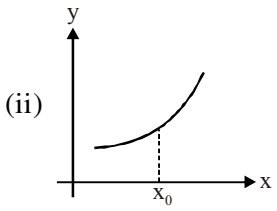
IV. Graph: $\sqrt{y}$ versus x

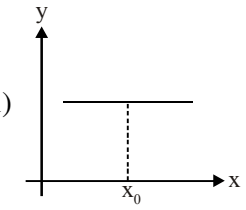
(1) I, IV (2) II, III

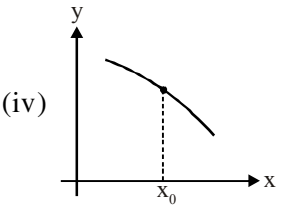
(3) I, III (4) Only II

10. Which of the following statement is **false** based on graphs of y versus x as shown below?

(i) 

(ii) 

(iii) 

(iv) 

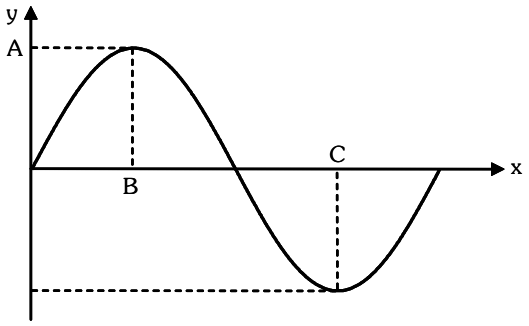
(1) Slope at x_0 is positive in graph (i) and (ii)

(2) Slope is constant in graph (iii)

(3) Slope at x_0 is negative in graph (iv)

(4) Slope at x_0 is negative in graph (ii)

11. In the given figure, a function $y = 9\sin(3\pi x)$ is shown. What is the numerical value of expression $A(B+C)$?



(1) 5 (2) 3 (3) 9 (4) 6

12. A stone is dropped into a quiet lake and waves move in circles spreading out radially at the speed of 5 cm/s. At the instant when the radius of the circular wave is 8 cm, how fast is the enclosed area increasing?

(1) 80 π cm^2/s (2) 90 π cm^2/s

(3) 85 π cm^2/s (4) 40 π cm^2/s

13. A particle moves along the curve $12y = x^3$. Which coordinate changes at faster rate at x=10?

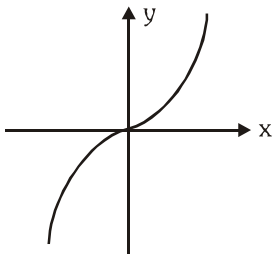
(1) x–coordinate

(2) y–coordinate

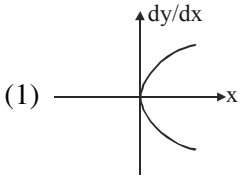
(3) Both x and y–coordinate

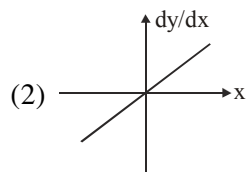
(4) Data insufficient

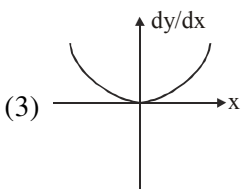
14. Figure shows the graph of the curve $y = \frac{1}{3}x^3$.

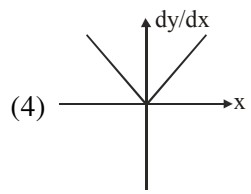


Which of the following shows the variation of slope of the curve with x coordinate ?

(1) 

(2) 

(3) 

(4) 

15. If the volume of a sphere increases at constant rate $\left(\frac{dV}{dt}=4\right)$. If radius of the sphere is denoted by r, then surface area of the sphere increases at the rate :-

(1) $\frac{4}{r}$ (2) $\frac{8}{r}$

(3) $\frac{12}{r}$ (4) $\frac{16}{r}$

16. The position of a particle moving along x-axis varies with time t according as

$x = \sqrt{3}\sin\omega t - \cos\omega t$ where ω is a constant

Find the region in which the particle is confined.

(1) $-2 \le x \le 2$

(2) $-3 \le x \le 3$

(3) $-\sqrt{2} \le x \le \sqrt{2}$

(4) $-1 \le x \le 1$

17. For a spherical balloon, the rate of change of radius with respect to time is $2/\pi$ cm/s Find the rate of change of volume, when radius is $\frac{1}{2}$ cm.

(1) 1 cm^3/s (2) 2 cm^3/s

(3) 3 cm^3/s (4) 4 cm^3/s

18. Given that $y = \sin 3x + \frac{4}{3}\cos 3x$. What is the maximum rate of change in y with respect to x ?

(1) 7 (2) 4 (3) 5 (4) 6

19. Given that $y = \frac{10}{\sin x + \sqrt{3}\cos x}$. Minimum value of y is

(1) zero (2) 2 (3) 5 (4) $\frac{10}{1+\sqrt{3}}$

20. Find the rate of change of radius of a sphere when its radius is 4 cm and when its volume is changing at the rate of $\frac{4\pi}{625}$ m^3/sec.

(1) 1 m/s (2) 2 m/s

(3) π m/s (4) 3 m/s

21. $xy = c^2$, then $\frac{dy}{dx}$ equals :

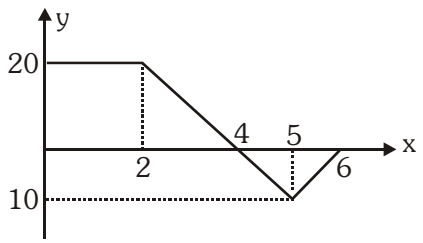
(1) $\frac{x}{y}$ (2) $\frac{y}{x}$ (3) $-\frac{x}{y}$ (4) $-\frac{y}{x}$

22. A metal rod extends on the x-axis from x = 0 m to x = 4 m. Its linear density ρ (mass/length) is not uniform and varies with the distance x from the origin according to equation $\rho = (1.5 + 2x)\,kg/m$. What is the mass of rod :-

(1) 16 kg (2) 22 kg

(3) 28 kg (4) 32 kg

23. The following curve represents a function y = f(x). Find average value of y when x changes from 0 to 6.



(1) $\frac{20}{3}$ (2) $\frac{25}{3}$ (3) $\frac{35}{3}$ (4) $\frac{40}{3}$

24. Electric current in a wire is time rate of flow of charge. The charge in coulombs that passes through a wire after t seconds is given by the function $q(t) = t^3 - 2t^2 + 5t + 2$. Determine the average current (in coulomb per second) during the first two seconds.

(1) 4A (2) 5A (3) 6A (4) 12A

25. Find $\int_{n-1}^{n}(3+4t)dt$:-

(1) 4n + 1 (2) 4n + 5
(3) $2n^2 + 1$ (4) $4n^2 + 5$

26. Given that acceleration due to gravity (g) varies inversely as the square of the distance from the centre of the earth. Find its value at a height of 1600 km from the earth surface. The value of 'g' at the surface is 10 ms^{-2}. Radius of the earth = 6400 km.

(1) 6.4 ms^{-2} (2) 5 ms^{-2}
(3) 10 ms^{-2} (4) 7.2 ms^{-2}

27. A body falls from a height of h = 3m. What is the total distance (in meters) it travels before it stops, if the body falls from a height h, strikes the ground and rebounds to a height e^2h, falls down e^2h and then rebounds back to a height e^4h and so on. The coefficient of restitution between body and ground is $e = \frac{1}{\sqrt{3}}$.

(1) 8 m (2) 6 m (3) 9 m (4) 12 m

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	2	3	2	3	3	1	2	4	4	1	2	3	2	1	2	3	3	1
Que.	21	22	23	24	25	26	27													
Ans.	4	2	2	2	1	1	2													

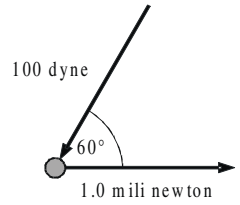
VECTORS

1. A vector may change if -
(1) frame of reference is translated
(2) vector is rotated
(3) frame of reference is rotated
(4) vector is translated parallel to itself

2. Let $\vec{A}=\frac{1}{\sqrt{2}}\cos\theta\hat{i}+\frac{1}{\sqrt{2}}\sin\theta\hat{j}$ be any vector. What will be the unit vector $\hat{n}$ in the direction of $\vec{A}$?
(1) $\cos\theta\hat{i}+\sin\theta\hat{j}$
(2) $-\cos\theta\hat{i}-\sin\theta\hat{j}$
(3) $1/\sqrt{2}(\cos\theta\hat{i}+\sin\theta\hat{j})$
(4) $1/\sqrt{2}(\cos\theta\hat{i}-\sin\theta\hat{j})$

3. Which of the following statement(s) is correct?
(1) The unit vector of velocity and force may be same.
(2) The angle between two unit vectors is always 90°.
(3) The unit vector of velocity is always perpendicular to acceleration.
(4) The difference between magnitudes of two unit vector is equal to magnitude of difference of two unit vectors.

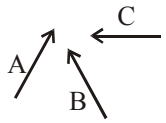
4. Two forces act on a particle simultaneously as shown in the figure. Find net force in milli newton on the particle. [Dyne is the CGS unit of force]



(1) $\sqrt{3}$ (2) $\sqrt{2}$ (3) 1 (4) 2

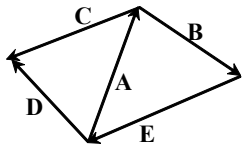
5. The ratio of maximum and minimum magnitudes of the resultant of two vector $\vec{a}$ and $\vec{b}$ is 3 : 1. Now $|\vec{a}|$ is equal to :
(1) $|\vec{b}|$ (2) $2|\vec{b}|$ (3) $3|\vec{b}|$ (4) $4|\vec{b}|$

6. Consider three vector $\vec{A},\vec{B}$ and $\vec{C}$ as shown in figure. Choose the incorrect statement ?



(1) $\vec{A}+\vec{B}$ can be in the direction ↑
(2) $\vec{A}+\vec{B}+\vec{C}$ can be in the direction ↖
(3) $\vec{A}-\vec{B}$ can be in the direction →
(4) $\vec{A}+\vec{B}-\vec{C}$ can be in the direction ↓

7. For figure the correct relation is :-

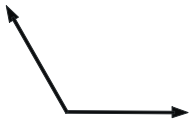


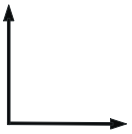
(1) $\vec{A}+\vec{B}+\vec{E}=\vec{0}$ (2) $\vec{C}-\vec{D}=\vec{A}$
(3) $\vec{B}+\vec{E}-\vec{C}=\vec{D}$ (4) all of the above

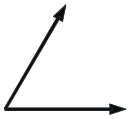
8. Vector $\vec{R}$ is the resultant of the vectors $\vec{A}$ and $\vec{B}$. Ratio of minimum value of $|\vec{R}|$ and maximum value of $|\vec{R}|$ is $\frac{1}{4}$. Then $\frac{|\vec{A}|}{|\vec{B}|}$ may be:-
(1) $\frac{4}{1}$ (2) $\frac{2}{1}$ (3) $\frac{3}{5}$ (4) $\frac{1}{4}$

9. A particle is given successive displacements. Which of the following sets of displacements could be capable of returning the particle to its initial position?
(1) 10 m, 8m, 6 m, 30 m
(2) 20 m, 10 m, 6m, 50 m
(3) 65m, 15 m, 45 m, 30 m
(4) 100 m, 18m, 22 m, 32 m

10. Refer the following arrangements consisting of two vectors of same magnitude. Arrange them in ascending order of resultant magnitudes.

(I) 

(II) 

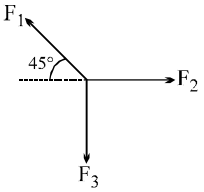
(III) 

(IV) 

(1) I, II, III, and IV (2) IV, III, II and I

(3) II, IV, III and I (4) II, I, III and IV

11. Three forces $\vec{F}_1$, $\vec{F}_2$ and $\vec{F}_3$ are represented as shown. Each of them is of equal magnitude.



List–I (Combination)	List–II (Approximate Direction)
(P) $\vec{F}_1+\vec{F}_2+\vec{F}_3$	(1) 
(Q) $\vec{F}_1-\vec{F}_2+\vec{F}_3$	(2) 
(R) $\vec{F}_1-\vec{F}_2-\vec{F}_3$	(3) 
(S) $\vec{F}_2-\vec{F}_1-\vec{F}_3$	(4) 

Code :

(1) P-1, Q-2, R-3, S-4 (2) P-2, Q-1, R-4, S-3

(3) P-2, Q-3, R-1, S-4 (4) P-4, Q-1, R-2, S-3

12. The initial and final velocities of an object are as shown in figure (a). Which arrows shown in figure (b) can represent change in velocity vector?

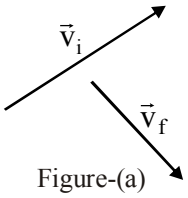


Figure-(a)

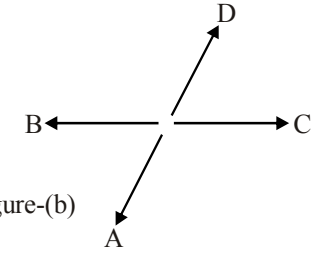
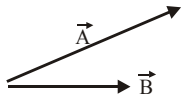


Figure-(b)

(1) A (2) B (3) C (4) D

13. Two vectors $\vec{A}$ & $\vec{B}$ have magnitudes 2 & 1 respectively. If the angle between $\vec{A}$ & $\vec{B}$ is 60°, which of the following vectors may be equal to $\frac{\vec{A}}{2}-\vec{B}$.



(1)  (2) 

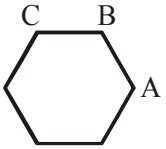
(3)  (4)

14. A particle moves on a circular path of radius R. Find magnitude of its displacement during an interval in which it covers angular displacement θ.

(1) Rθ (2) R sinθ

(3) $2R\cos\frac{\theta}{2}$ (4) $2R\sin\frac{\theta}{2}$

15. Newton approximated motion in a circle as a series of linear motions, as in the polygon below.



If we assume the particle moves at constant speed v_A from A to B, and at constant speed v_B from B to C, the direction of the change in velocity, $\Delta\vec{v}$, at point B, is shown by the arrow:-

(1)  (2) 

(3)  (4) 

16. The position vectors of two balls are given by

$\vec{r}_1 = 2(m)\hat{i} + 7(m)\hat{j}$

$\vec{r}_2 = -2(m)\hat{i} + 4(m)\hat{j}$

What will be the distance between the two balls?

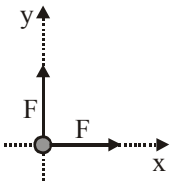
(1) 7 m (2) 5 m (3) 4 m (4) 3 m

17. If $\vec{a} = 2\hat{i} + \sqrt{5}\hat{j}$ & $\vec{b} = 5\hat{i} + \sqrt{5}\hat{j} + 4\hat{k}$, then find a vector of same magnitude as $\vec{a}$ and parallel to vector $\vec{a} - \vec{b}$:-

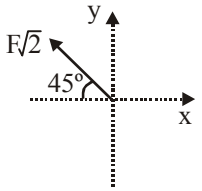
(1) $\frac{7\hat{i} + 2\sqrt{5}\hat{j} + 4\hat{k}}{3}$ (2) $-3\hat{i} - 4\hat{k}$

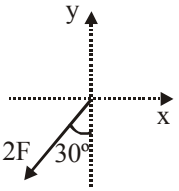
(3) $\frac{-9\hat{i} - 12\hat{k}}{5}$ (4) $9\hat{i} + 12\hat{k}$

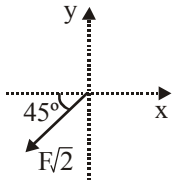
18. Two forces are simultaneously applied on an object.

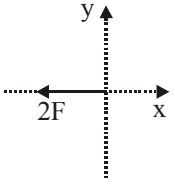


What third force would make the net force to point downwards?

(1) 

(2) 

(3) 

(4) 

19. Two vector $\vec{a} = 3\hat{i} + 8\hat{j} - 2\hat{k}$ and $\vec{b} = 6\hat{i} + 16\hat{j} + x\hat{k}$ are such that the component of $\vec{b}$ perpendicular to $\vec{a}$ is zero. Then the value of x will be :-

(1) 8 (2) – 4 (3) +4 (4) –8

20. Two forces each of magnitude 5N is applied on block. One force is acting towards East and the other acting along 74° North of East. The resultant of the two forces is of magnitude :-

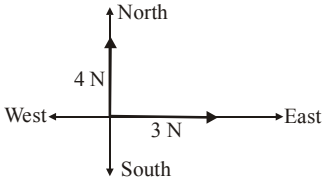
(1) 6 N (2) 10 N

(3) 8 N (4) 12 N

21. Position of a particle at t = 0 is (2, 3, 0). It starts moving with a speed of 10 m/s in direction 37° north of west. Its position after t = 1 sec is (Take North as positive y-axis and East as positive x-axis) :-

(1) (6, 11) (2) (–4, 11) (3) (–8, 6) (4) (–6, 9)

22. Two forces (shown in figure) act on a body simultaneously. Among the given options which force when added will give resultant in North-East direction ?



(1) 1 N in North direction

(2) 1 N in East direction

(3) 3 N in West direction

(4) 1 N in North-East direction

23. For the given vector $\vec{A} = 3\hat{i} - 4\hat{j} + 10\hat{k}$, the ratio of magnitude of its component on the x-y plane and the component on z–axis is

(1) 2 (2) $\frac{1}{2}$

(3) 1 (4) None of these

24. If $\vec{A}$ vector makes angle 90° & 30° with the x and y axis respectively then angle it makes with the z axis can be :

(1) 120° (2) 30° (3) 45° (4) 90°

25. What is the length of projection of $\vec{A} = 3\hat{i} + 4\hat{j} + 5\hat{k}$ on xy plane?

(1) 5 (2) 3 (3) $5\sqrt{2}$ (4) 4

26. A vector $\vec{A}$ is rotated through an angle $\pi/2$, the magnitude of new vector is -

(1) 2A (2) A

(3) A/2 (4) Zero

27. If a vector $\vec{A}$ makes angles α, β and γ respectively with the X, Y and Z axes respectively then $\sin^2\alpha + \sin^2\beta + \sin^2\gamma$ =

(1) 0 (2) 1 (3) 2 (4) 3

28. Three concurrent forces of the same magnitude are in equilibrium. What is the angle between the forces and the name of triangle formed by the forces as sides :-

(1) 60°, 60°, 60° & an equilateral triangle

(2) 120°, 120°, 120° & an equilateral triangle

(3) 120°, 30°, 30° & an isosceles triangle

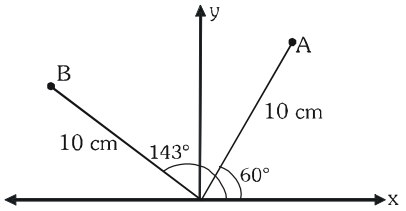
(4) 90°, 60°, 30° & a right angled triangle

29. θ_x and θ_y are the angles made by a vector $\vec{A}$ with positive x and positive y-axis respectively. Which set of θ_x and θ_y is not possible?

(1) 60°, 60° (2) 45°, 60°

(3) 30°, 45° (4) 30°, 65°

30. Refer the given figure and identify incorrect statement



(1) Distance of A from x-axis is $5\sqrt{3}$ cm.

(2) Distance of B from x-axis is 6 cm.

(3) Distance of A from y-axis is 5 cm.

(4) Distance of B from y-axis is 6 cm.

31. $\vec{a}$ = 5 units due South-West

$\vec{b}$ = 5 units due 53° North of East

$\vec{c}$ = 10 units due 37° South of East

Then which of the following is incorrect :

(1) $\vec{a} + \vec{b} = -2\hat{i} - \hat{j}$ (2) $\vec{a} \cdot \vec{b} = -\frac{35}{\sqrt{2}}$

(3) $\vec{b} \cdot \vec{c} = 0$ (4) $\vec{b} + \vec{c} = 11\hat{i} - 2\hat{j}$

32. The angle between two vectors

$\vec{R} = -\hat{i} + \frac{1}{3}\hat{j} + \hat{k}$ and $\vec{S} = x\hat{i} + 3\hat{j} + (x-1)\hat{k}$

(1) Is obtuse angle

(2) Is acute angle

(3) Is right angle

(4) Depends on x

33. If the angle between $\hat{a}$ & $\hat{b}$ is 60°, then which of the following vector(s) have magnitude one :-

(A) $\frac{\hat{a}+\hat{b}}{\sqrt{3}}$ (B) $\hat{a} - \hat{b}$

(C) $\hat{a}$ (D) $\hat{b}$

(1) Only C,D (2) Only B,C,D

(3) Only A,C,D (4) All

34. The dot product of two vectors of magnitudes 3 units and 5 units cannot be

(1) 2 (2) –2 (3) 20 (4) zero

35. If $\vec{a}$ and $\vec{b}$ are two unit vectors such that $\vec{a} + 2\vec{b}$ and $5\vec{a} - 4\vec{b}$ are perpendicular to each other then the angle between $\vec{a}$ and $\vec{b}$ is

(1) 45° (2) 60°

(3) $\cos^{-1}\left(\frac{1}{3}\right)$ (4) $\cos^{-1}\left(\frac{2}{7}\right)$

36. If $\vec{A}, \vec{B}$ and $\vec{C}$ are vectors having a unit magnitude. If $\vec{A}+\vec{B}+\vec{C}=\vec{0}$ then $\vec{A}.\vec{B}+\vec{B}.\vec{C}+\vec{C}.\vec{A}$ will be :-

(1) 1 (2) $-\frac{3}{2}$ (3) $-\frac{1}{2}$ (4) zero

37. If $\vec{A}=2\hat{i}+\hat{j}+\hat{k}$ and $\vec{B}=\hat{i}+2\hat{j}+2\hat{k}$, find the magnitude of component of $\left(\vec{A}+\vec{B}\right)$ along $\vec{B}$:

(1) 4 unit **(2)** 5 unit

(3) 6 unit (4) 7 unit

38. The adjacent sides of a parallelogram are represented by co-initial vectors $2\hat{i}+3\hat{j}$ and $\hat{i}+4\hat{j}$. The area of the parallelogram is-

(1) 5 units along z-axis
(2) 5 units in x-y plane
(3) 3 units in x-z plane
(4) 3 units in y-z plane

39. For a right handed coordinate system, positive x-axis is towards right of you and positive z-axis is upward then positive y-axis will be :

(1) In front of you

(2) At back of you

(3) Towards left

(4) Downwards

40. If a =2, b =5 and $|\vec{a}\times\vec{b}|$ = 8 then $\vec{a}\cdot\vec{b}$ is

(1) 6 (2) 12 (3) 9 (4) 4

41. The sum of magnitudes of two forces acting at a point is 16N. If their resultant is normal to the smaller force and has a magnitude of 8N. Then the forces are-

(1) 6N, 10N (2) 8N, 8N

(3) 4N, 12N (4) 2N, 14N

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	1	1	3	2	4	1	3	3	1	3	1	2	4	2	2	3	2	2	3
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	2	1	1	2	3	2	3	4	1	3	4	3	2	2	2	1	1	1
Que.	41																			
Ans.	1																			

UNITS, DIMENSIONS AND MEASUREMENTS

1. The units of length, velocity and force are doubled. Which of the following is correct change in the other units ?
(1) unit of time is unchanged
(2) unit of mass is unchanged
(3) unit of momentum is doubled
(4) All of these

2. Which of the following combinations of three different physical quantities P, Q, R can never be a meaningful quantity ?

(1) PQ – R (2) $\frac{PQ}{R}$

(3) $\frac{(P-Q)}{R}$ (4) $\frac{(PR-Q^2)}{QR}$

3. The frequency (n) of vibration of a string is given as $n=\frac{1}{2\ell}\sqrt{\frac{T}{m}}$, where T is tension and ℓ is the length of vibrating string. Then, the dimensional formula for m is
(1) $[M^0L^1T^1]$ (2) $[M^0L^0T^0]$
(3) $[M^1L^{-1}T^0]$ (4) $[M^1L^0T^0]$

4. ϕ represents momentum and q represents position, then the dimensions of Plank's constant (h) in terms of q and ϕ are :-
(1) $\phi^1 q^1$ (2) $\phi^2 q^1$
(3) $\phi^1 q^2$ (4) $\phi^2 q^2$

5. If A and B are two physical quantities having different dimensions then which of the following option can't denote a physical quantity?

(1) $A+\frac{A^3}{B}$ (2) $\exp\left(-\frac{A}{B}\right)$

(3) AB^2 (4) $\frac{A}{B^4}$

6. If momentum (P), area (A) and time (T) are taken to be fundamental quantities then energy has dimensional formula :-
(1) $[PA^{-1}T]$ (2) $[P^2AT]$
(3) $[PA^{-1/2}T]$ (4) $[PA^{1/2}T^{-1}]$

7. Which of the following sets cannot enter into the list of fundamental quantities in any newly proposed system of units?
(a) length, mass and velocity
(b) pressure, density and velocity
(c) force, velocity and time
(d) force, momentum and time
(1) a and c (2) b and d
(3) only d (4) only a

8. If unit of mass, length and time are doubled then in this new system which of the following, will not have same magnitude :-
(1) Gravitational constant
(2) Gravitational force
(3) Power of gravitational force
(4) Gravitational energy

9. In the expression $F=\frac{Gm_1m_2}{A}$, where F is force, m_1 and m_2 are masses. G is universal gravitational constant $[M^{-1}L^3T^{-2}]$. Which physical quantity A may represent :-
(1) Breadth (2) Velocity
(3) Volume (4) Area

10. Force(F) and density(d) are related as $F=\frac{\alpha}{\beta+\sqrt{d}}$ then dimensions of α are
(1) $[M^{3/2}\ L^{-1/2}\ T^{-2}]$
(2) $[M^{3/2}\ L^{1/2}\ T^2]$
(3) $[M^{3/2}\ L^{-1/2}\ T^2]$
(4) $[M^{-3/2}\ L^{-1/2}\ T^2]$

11. If K represents kinetic energy, υ velocity and t time and these are chosen as the fundamental units then the dimension of surface tension in terms of K, v and t will be :-
(1) $[Kv^{-2}T^{-2}]$ (2) $[Kv^2T^2]$
(3) $[Kv^{-2}T^2]$ (4) $[KvT^{-1}]$

12. According to Vander Wall's equation pressure (P), volume (V) and temperature (T) are related as $\left(P+\frac{a}{V^2}\right)(V-b)=RT$ [for 1 mole of gas]

Then dimensions of $\frac{ab}{V^2}$ is equivalent to :-

(1) force (2) energy

(3) power (4) pressure

13. If momentum (P), area (A) and time (T) are taken to be fundamental quantities, then power has the dimensional formula

(1) $(P^1\ A^{-1}\ T^1)$ (2) $(P^2\ A^1\ T^1)$

(3) $(P^1\ A^{-1/2}\ T^1)$ (4) $(P^1\ A^{1/2}\ T^{-2})$

14. Dimensional analysis gives :-

(1) no information about dimensionless constants

(2) information about dimensionless constants

(3) information about dimensionless constants if quantity does not depend upon more than three variables

(4) information about dimensionless constants if quantity depends only upon single variable

Paragraph for Questions No. 22 and 23

Surface tension is force per unit length and pressure is force per unit area. Now, answer the following questions on basis of dimensional analysis.

15. Which relation is dimensionally **INCORRECT**?

(1) Pressure = $\frac{\text{surface tension}}{\text{length}}$

(2) Velocity = (displacement) $^{\frac{1}{2}}$ (Acceleration) $^{\frac{1}{2}}$

(3) Volume = $(\text{Area})^2$ $(\text{length})^{-1}$

(4) Height = (Velocity) $(\text{Acceleration})^{-\frac{1}{2}}$

16. Which relation **CANNOT** be obtained dimensional analysis :

(1) Pressure = $\frac{\text{Force}}{\text{Area}}$

(2) Volume = length × area

(3) Thermal energy = $(\text{momentum})^2$ $(\text{mass})^{-1}$

(4) Distance = velocity × time

17. Which of the following quantities cannot enter into the list of fundamental quantities in any system of units?

(1) Mass, Time and Acceleration

(2) Length, Volume and Linear momentum

(3) Mass, Velocity and time

(4) Length, Force and Time

18. Due to some unknown interaction, force F experienced by a particle is given by the following equation. $\vec{F}=-\frac{A}{r^3}\vec{r}$

Where A is positive constant and r is distance of the particle from origin of a coordinate system. Dimensions of constant A are

(1) $[ML^2T^{-2}]$ (2) $[ML^3T^{-2}]$

(3) $[ML^4T^{-2}]$ (4) $[ML^0T^0]$

19. Given that v is the speed, r is radius and g is acceleration due to gravity. Which of the following is dimensionless?

(1) $\frac{v^2r}{g}$ (2) $\frac{v^2}{rg}$

(3) $\frac{v^2}{g/r}$ (4) v^2rg

20. The damping force (F) on an object moving with velocity (v) in a viscous medium is given by $F=kv^2$. The dimensional formula of quantity k is

(1) $[MT^{-2}]$ (2) $[MT^{-1}]$

(3) $[ML^{-2}]$ (4) $[ML^{-1}]$

21. The force F is given in terms of time t and displacement x by the equation F = AcosBx + CsinDt. The dimensional formulae of D/B is :-

(1) $[M^0L^0T^0]$

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

(3) $[M^0L^{-1}T^0]$

(4) $[M^0L^1T^{-1}]$

22. In a certain system, the units of length, mass and time are chosen to be 1 cm, 100 g and 10 s. The unit of kinetic energy will be

(1) 0.1 erg (2) 1 erg

(3) 10 erg (4) None of these

23. If the unit of length and mass be doubled then the numerical value w.r.t. present value of the universal gravitational constant G will become:-

(1) Half (2) $\frac{1}{4}$ times

(3) 8 times (4) $\frac{1}{8}$ times

24. The wavelength associated with a moving particle depends on p^{th} power of its mass m, q^{th} power of its velocity v and r^{th} power of planck's constant h. Then value of p, q, r, is :-

(1) 1, –1, 1 (2) 1, 1, 1

(3) –1, –1, –1 (4) –1, –1, 1

25. Kinetic energy K of a spinning ball depends on its mass m, radius r and angular velocity ω. Angular velocity is dimensionally equal to change in angle per unit time. Best expression for kinetic energy of the spinning ball is

(1) $K \propto mr^2\omega^2$ (2) $K \propto mr\omega^2$

(3) $K = mr^2\omega^2$ (4) $K = mr\omega^2$

26. The characteristic distance at which quantum gravitational effects are significant, the Planck length, can be determind from a suitable combination of the fundamental physical constants G, $\hbar$ and c. Which of the following correctly gives the Planck length :

(1) $G\hbar^2c^3$ (2) $G^2\hbar c$

(3) $G^{\frac{1}{2}}\hbar^2c$ **(4)** $\left(\frac{G\hbar}{c^3}\right)^{\frac{1}{2}}$

27. Length of a year on a planet is the duration in which it completes one revolution around the sun. Assume path of the planet known as orbit to be circular with sun at the centre. The length T of a year of a planet orbiting around the sun in circular orbit depends on universal gravitational constant G, mass m_s of the sun and radius r of the orbit. If $T \propto G^a m_s^{\,b} r^c$, find the numerial value of $a+b+2c$.

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

28. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of :

(1) 81 (2) $\frac{1}{81}$

(3) 9 (4) $\frac{1}{9}$

29. In a new system of units, unit of mass is 2 kg, unit of length is 4 m and unit of time is 2 second. How much joule is equal to 1 unit of energy in this new system?

(1) 8 (2) 0.125

(3) 4 (4) 0.25

30. If the acceleration due to gravity is $10ms^{-2}$ and the units of length and time are changed in kilometer and hour respectively, the numerical value of the acceleration is :–

(1) 360000

(2) 72,000

(3) 36,000

(4) 129600

31. The internal and external radii of a hollow cylinder are measured with the help of a vernier calliper. Their values are (3.87 ± 0.01) cm and (4.23 ± 0.01) cm, respectively. The thickness of the wall of the cylinder is :

(1) (0.36 ± 0.02) cm (2) (0.18 ± 0.02) cm

(3) (0.36 ± 0.01) cm (4) (0.18 ± 0.01) cm

32. Two resistors of resistance $R_1 = (300 \pm 3)\ \Omega$ and $R_2 = (500 \pm 4)\ \Omega$ are connected in series. The equivalent resistance of the series combination is :-

(1) $(800 \pm 1)\ \Omega$

(2) $(800 \pm 7)\ \Omega$

(3) $(200 \pm 1)\ \Omega$

(4) $(200 \pm 1)\ \Omega$

33. Accuracy and precision are .....(i)..... and these are respectively linked with .....(ii)..... and .....(iii)..... Fill the blanks above in correct order.

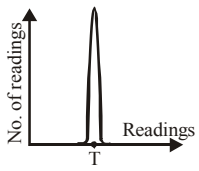
(1) (i) same (ii) systematic error (iii) random error

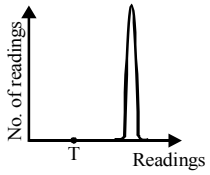
(2) (i) different (ii) systematic error (iii) random error

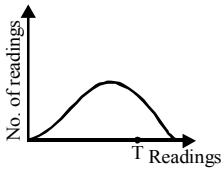
(3) (i) same (ii) random error (iii) systematic error

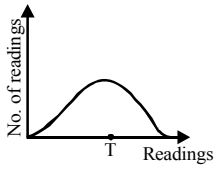
(4) (i) different (ii) random error (iii) systematic error

34. A quantity is measured repeatedly many times with an instrument. The readings are shown in figure where T represent true value of the measurement. Which of the following measurement is imprecise but accurate ?

(1) 

(2) 

(3) 

(4) 

35. Two resistance are measured in ohm and are given as:-

$R_1 = 3\Omega \pm 1\%$ and $R_2 = 6\Omega \pm 2\%$

When they are connected in parallel, the percentage error in equivalent resistance is

(1) 3% (2) 4.5%

(3) 0.67% (4) 1.33%

36. In an experiment of simple pendulum, time period measured was 50 s for 25 vibrations when the length of the simple pendulum was taken 100 cm. If the least count of stop watch is 0.1 s and that of meter scale is 0.1 cm then maximum possible error in value of g is :-

(1) 0.5 % (2) 1 %

(3) 0.4 % (4) 0.1 %

37. Two students A & B carried out an experiment to measure the time period of a pendulum which in actual is 5.40 s. Their experimental readings are as follows:

Students A	**Student B**
5.43 s	5.32 s
5.37 s	5.34 s
5.41 s	5.30 s
5.52 s	5.29 s
5.51 s	5.33 s

Then

(1) Student A is more precise but less accurate

(2) Student B is more precise but less accurate

(3) Student A is more precise as well as accurate

(4) Student B is more precise as well as accurate

38. The mass and volume of a body are 4.237 g and 2.5 cm^3, respectively. The density of the material of the body in correct significant figure is :-

(1) 1.6048 g cm^{-3} (2) 1.69 g cm^{-3}

(3) 1.7 g cm^{-3} (4) 1.695 g cm^{-3}

39. The length of the string of a simple pendulum is measured with a meter scale to be 63.5 cm, the radius of the bob plus the hook is measured with the help of vernier caliper to be 1.65 cm. Select the incorrect statement:-

(1) Least count of meter scale is 0.1 cm

(2) Least count of vernier caliper is 0.01 cm

(3) Effective length of pendulum is 65.1 cm

(4) Effective length of pendulum is 65.2 cm

40. Measure of two quantities along with the precision of respective measuring instrument is:

$A = 2.5\ ms^{-1} \pm 0.5\ ms^{-1}$

$B = 0.10s \pm 0.01\ s$

The value of AB will be

(1) (0.25 ± 0.08) m

(2) (0.25 ± 0.5) m

(3) (0.25 ± 0.05) m

(4) (0.25 ± 0.135) m

41. In a vernier caliper, one main scale division is x cm and n division of vernier scale coincide with (n – 1) division of the main scale. The least count of the vernier caliper in cm is :-

(1) $\left(\frac{n-1}{n}\right)x$ (2) $\frac{nx}{(n-1)}$

(3) $\frac{x}{n}$ (4) $\frac{x}{n-1}$

42. Consider following statements :-

(1) Any physical quantity may have more than one unit

(2) Any physical quantity have only one dimensional formula

(3) More than one physical quantities may have same dimension & same unit

(4) We can add & subtract only those expression having same dimension

Number of correct statement is

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

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	3	3	1	2	4	2	4	4	1	1	2	4	1	4	2	2	2	2	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	2	2	4	1	4	2	3	1	4	1	2	2	4	4	1	2	3	3	1
Que.	41	42																		
Ans.	3	1																		

KINEMATICS

1. A particle moves 21 m along the vector $6\hat{i}+2\hat{j}+3\hat{k}$, then 14 m along the vector $3\hat{i}-2\hat{j}+6\hat{k}$. Its total displacement (in meters) is

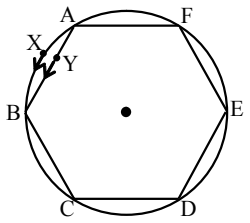
(1) $15\hat{i}+2\hat{j}+12\hat{k}$

(2) $9\hat{i}+12\hat{k}$

(3) $9\hat{i}+6\hat{j}$

(4) $24\hat{i}+2\hat{j}+21\hat{k}$

2. Two particles X and Y are respectively moving on the circular path and regular hexagon as shown. O is centre of circle and hexagon both. When both X and Y have moved from point A to point D, the ratio of distance moved by X to magnitude of displacement of Y is -



(1) $\frac{\pi}{4}$ (2) $\frac{\pi}{2}$

(3) π (4) 2π

3. A blind person after walking 10 steps in one direction, each of length 80 cm, turns randomly to the left or to the right by 90º. After walking a total of 40 steps the maximum possible displacement of the person from his starting position could be :-

(1) 320 m (2) 32 m

(3) $16/\sqrt{2}$ m (4) $16\sqrt{2}$ m

4. A particle moves $4\sqrt{2}$ m in South–West direction, 12m in upward direction and then 1m in East direction. Find the net displacement.

(1) 13 m (2) 17 m

(3) 14 m (4) 18 m

5. Consider East as +ve x axis, North as +ve y-axis. A girl walks 10 m East first time then 10 m in a direction 30° West of North for the 2nd time & then third time in unknown direction and magnitude, so as to return to her initial position. What is her third displacement vector :-

(1) $-5\hat{i}-5\sqrt{3}\hat{j}$ (2) $5\hat{i}-5\sqrt{3}\hat{j}$

(3) $-5\hat{i}+5\sqrt{3}\hat{j}$ (4) she cannot return

6. Two particles positioned at A(5, 3) and B(7, 3) are moving with constant velocity $2\hat{i}+3\hat{j}$ and $x\hat{i}+y\hat{j}$ respectively. After 2 s they collide, then the values of x and y are respectively :-

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

7. For a right handed coordinate system, positive x-axis is towards right of you and positive z-axis is upward then positive y-axis will be :

(1) In front of you (2) At back of you

(3) Towards left (4) Downwards

8. Particle moves in straight line with constant velocity of 10 m/s for 5 sec, then with constant retardation of 10 m/s^2. Find its total displacement before coming to rest :-

(1) 50 m (2) 55 m (3) 45 m (4) 60 m

9. A man starts from his house with uniform speed. After taking a few turns, he reaches his house. There are two ways to reach house :-

(A) Take left turn after 4 min, again left turn after 3 min, again left turn after 6 min, one more left turn after 3 min, finally move 2 min to reach house.

(B) Take right turn after 3 min, left turn after 2 min, right turn after 3 min, again right turn after 1 min, again right turn after 6 min. Finally move 3 min to reach house.

All turns are at 90°. Which of the following is correct :-

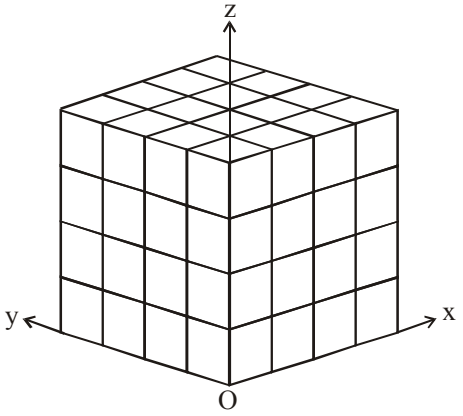
(1) Distance travelled in (A) path is more than (B)

(2) Distance travelled in (B) path is more than (A)

(3) Distance travelled in (A) & (B) both path is same.

(4) Insufficient information

10. A child starts at one corner of a cubical jungle gym in a playground and climbs up to the diagonally opposite corner. The original corner (O) is the coordinate origin, and the x, y and z-axes are oriented along the jungle gym edges. The length of each side is 2 m. The child's displacement is:



(1) $2\hat{i}+2\hat{j}+2\hat{k}$

(2) $2.8\hat{i}+2.8\hat{j}+2\hat{k}$

(3) $2\hat{i}+2\hat{j}+2.8\hat{k}$

(4) $2\hat{i}+2\hat{j}+3.5\hat{k}$

11. A particle is moving towards East with velocity 10 ms^{-1} and acceleration 5 ms^{-2} directed towards West. Find the distance travelled in 8 seconds.

(1) 80 m (2) 70 m

(3) 100 m (4) 60 m

12. The hour hand of a clock is 6 cm long. The magnitude of the displacement of the tip of hour hand between 1:00 pm to 9:00 pm. is :

(1) 6 cm (2) $6\sqrt{3}$ cm

(3) 4π cm (4) $3\sqrt{3}$ cm

13. Position of a particle at t = 0 is (2,3,0). It starts moving with a speed of 10 m/sec in direction 37^o north of west. Its position after t = 1 sec is - (Take north as positive y axis and east as positive x axis)

(1) (6, 11) (2) (–4, 11)

(3) (–8, 6) **(4)** (–6, 9)

14. A body travelling along a straight line with a uniform acceleration has velocities 5 m/s at a point A and 15 m/s at a point B respectively. If M is the mid point of AB, then choose incorrect statement.

(1) The ratio of times taken by the body to cover distance MB and AM is $\left[\frac{\sqrt{5}-1}{2}\right]$

(2) The velocity at M is $5\sqrt{5}$ m/s

(3) Average velocity over AM is $\frac{5\left(\sqrt{5}+1\right)}{2}$ m/s

(4) The product of the acceleration and the distance AB is 200 m^2/s^2.

15. A motor cyclist accelerates from rest with acceleration of 2 m/s^2 for a time of 10 sec. Then he moves with a constant velocity for 20 sec and then finally comes to rest with an deceleration of 1 m/s^2. Average speed for complete journey is :-

(1) 10 m/s (2) 14 m/s

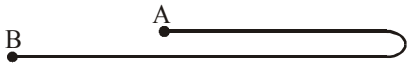
(3) 20 m/s (4) 28 m/s

16. A particle travels with speed 100m/s from the point (10, 20) in a direction $24\hat{i}+7\hat{j}$. Find its position vector after 2 seconds.

(1) $202\hat{i}+76\hat{j}$ (2) $204\hat{i}+78\hat{j}$

(3) $40\hat{i}-151\hat{j}$ (4) $45\hat{i}-151\hat{j}$

17. A car goes A to B along the path with constant acceleration "a" as shown in figure.



Student-1 infers that initial velocity is positive, acceleration is negative and displacement is positive.

Student-2 infers that initial velocity is negative, acceleration is positive and displacement is positive.

(1) Student-1 is correct

(2) Student-2 is correct

(3) Both are correct

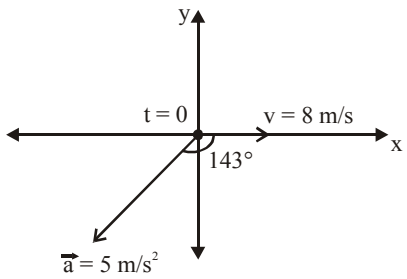
(4) Both are wrong

18. A particle moves with a speed v in a horizontal circular path. The change in its velocity for covering 60° will be :-

(1) $v\sqrt{2}$ (2) $\frac{v}{\sqrt{2}}$

(3) $v\sqrt{3}$ (4) v

19. An object is moving in x-y plane its velocity and acceleration at t = 0 are represented in figure.



At time t = 0 s a car passes a point with velocity of 16 m/s and thereafter slows down with acceleration a = – 0.5 t m/s², where t is in seconds. It stops at the instant t =

(1) 32 s (2) 16 s

(3) 8.0 s (4) 4.0 s

20. Which of the following must be true for magnitude of average velocity of a body if v_1 and v_2 are magnitude of average speeds during successive time intervals t_1 and t_2 in which body covers distances d_1 and d_2 and displacements $\vec{s}_1$ and $\vec{s}_2$?

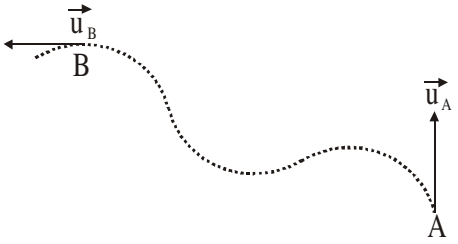
(1) $\left|\frac{v_1+v_2}{2}\right|$ (2) $\left|\frac{v_1t_1+v_2t_2}{\frac{d_1}{v_1}+\frac{d_2}{v_2}}\right|$

(3) $\left|\frac{\vec{s}_1+\vec{s}_2}{\frac{d_1}{v_1}+\frac{d_2}{v_2}}\right|$ (4) None of these

21. A particle is moving on a straight line with constant retardation of $1 m/s^2$. What is the average speed of the particle in the last two meters before it stops (in m/s) ?

(1) 1 (2) 2 (3) 1.5 (4) 3

22. In the figure, path of a particle is shown. Its velocity is shown at points A & B. Which of the following vector correctly represents the average acceleration during its motion from point A to B.



(1) ↙ (2) ↖

(3) ↗ (4) ↘

23. Mark the **INCORRECT** statement for a particle moving on a straight line :-

(1) If velocity and position have opposite sign then object is moving towards origin.

(2) If velocity and acceleration have opposite sign then object is slowing down.

(3) If velocity is zero for a time interval, the acceleration is zero at any instant within the time interval.

(4) If velocity is zero at particular instant, acceleration must be zero at that instant.

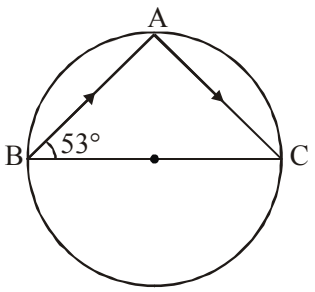
24. Two particles having position vectors (at t = 0) $\vec{r}_1 = \left(3\hat{i}+5\hat{j}\right)$ metres and $\vec{r}_2 = \left(-3\hat{i}-1\hat{j}\right)$ metres are moving with constant velocities $\vec{v}_1 = \left(4\hat{i}+3\hat{j}\right)$ m/s and $\vec{v}_2 = \left(7\hat{i}+\alpha\hat{j}\right)$ m/s respectively. If they collide after 2 seconds, then the value of 'α' is

(1) 6 (2) 4 (3) 5 (4) 10

25. A large procession of people is moving along a road of width 10 m. There is a railway track across the road. The number of people present per square meter of the road is 6 (on an average). The average speed at which the procession is moving is 0.15 m/s. Find the number of people crossing the railway track per second.

(1) 6 (2) 9 (3) 12 (4) 8

26. BC is the diameter of a circle of radius 62.5 cm. A particle moves with constant speed of 2.5 cm/s from B to C through A. Find time taken.



(1) 70 s (2) 50 s

(3) 80 s (4) 100 s

27. The slope of velocity position graph of a particle moving along a straight line is 15 units where velocity is also 15 units. The acceleration of particle at that position is :-

(1) 1 unit

(2) 75 unit

(3) 225 unit

(4) 30 unit

28. Which of the following is(are) example(s) of zero vector?

(A) The displacement vector of a stationary object.

(B) The velocity vector of a stationary object.

(C) The position vector of the origin of coordinate axes.

(D) The acceleration vector of an object moving with uniform velocity.

(1) Only ABC

(2) Only BCD

(3) Only ABD

(4) All

29. Find out the length of train which is moving with constant velocity.

Information I : Train crosses a pole in 5 sec.

Information II : It cross the bridge of length 500 m in 8 seconds.

(1) question can be solved by information I only

(2) question can be solved by information II only

(3) question can be solved by information I & II together only

(4) question can not be solved by using these information alone

30. Some informations are given for a body moving in a straight line. The body starts its motion at t=0.

Information I : The velocity of a body at the end of 4s is 16 m/s

Information II : The velocity of a body at the end of 12s is 48 m/s

Information III : The velocity of a body at the end of 22s is 88 m/s

The body is certainly moving with

(1) Uniform velocity

(2) Uniform speed

(3) Uniform acceleration

(4) Data insufficient for generalization

31. A particle moves half the time of its journey with velocity u. The rest of the half time it moves with two velocities v_1 and v_2 such that half the distance it covers with v_1 and the other half with v_2. Find the net average velocity assume straight line motion :-

(1) $\frac{u(v_1+v_2)+2v_1v_2}{2(v_1+v_2)}$ (2) $\frac{2u(v_1+v_2)}{2u+v_1+v_2}$

(3) $\frac{u(v_1+v_2)}{2v_1}$ (4) $\frac{2v_1v_2}{u+v_1+v_2}$

32. A particle is moving on a straight line represented by x-axis. When its velocity (v) and position coordinate (x) have opposite signs

(1) its speed is decreasing

(2) its speed is increasing

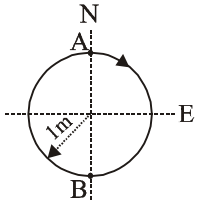
(3) it is moving towards the origin

(4) neither of the above statements can be true

33. A bee sets out of its beehive, flies $15\sqrt{3}$ m in the east, turns down, descends 12 m flying vertically downwards, then turns in the south, flies 9 m and finally reaches a flower 5 s after its sets out off its beehive. What is magnitude of average velocity vector ?

(1) 5 m/s (2) 6 m/s (3) 3 m/s (4) None

34. In one second a particle moves with constant speed from point A to point B along the circular track of radius 1.0 m as shown in the figure. What is the average acceleration of the particle during this motion.



(1) 2π m/s^2 due east

(2) π m/s^2 due west

(3) Zero

(4) 2π m/s^2 due west

35. A car moves with a speed of 60 km/hr from point A to point B and then with the speed of 40 km/hr from point B to point C. Further it moves to a point D with a speed equal to its average speed between A and C. Points A, B, C and D are collinear and equidistant. The average speed of the car between A and D is:

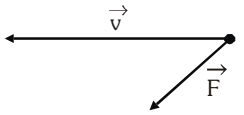
(1) 30 km/hr

(2) 50 km/hr

(3) 48 km/hr

(4) 60 km/hr

36. The force will cause the particle to



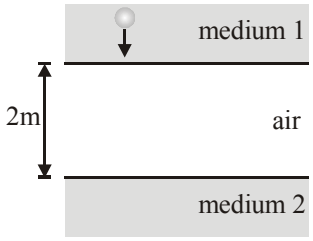
(1) Speed up and curve upward

(2) Speed up and curve downward.

(3) Slow down and curve upward.

(4) Slow down and curve downward.

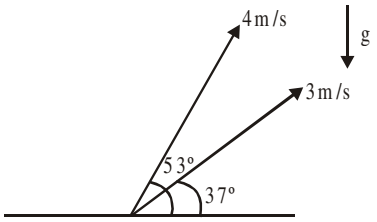
37. A bead is falling in medium 1 with a uniform speed of 3 m s^{-1} for 2 s. Then it enters into air and falls freely under gravity for 2 m. Finally, it enters medium 2 and immediately moves with uniform speed for 3 s. Find the total distance the bead has traveled. (g = 10 m/s^2)



(1) 27 m (2) 18 m

(3) 29 m (4) 23 m

38. Two particles are projected simultaneously with different speed from the same point as shown in figure. Select incorrect statement :-



(1) Their relative acceleration is zero

(2) Their relative velocity is constant

(3) Their relative velocity is along vertical direction

(4) Their relative velocity is along horizontal direction

39. A car covers a distance of 2 km in 2.5 minutes. If it covers half of the distance with speed 40 km/hr, then the rest distance it shall cover with a speed of :-

(1) 56 km/hr (2) 60 km/hr

(3) 48 km/hr (4) 50 km/hr

40. A boy starts towards east with uniform speed 5m/s. After t = 2sec, he turns right and travels 40 m with same speed. Again he turns right and travel for 8 sec with same speed. His average velocity is :-

(1) 5 m/s (2) $\frac{50}{9}$ m/s (3) $\frac{25}{18}$ m/s (4) $\frac{25}{9}$ m/s

41. Which of the following is correct :-

(1) Instantaneous velocity depends upon the instantaneous position vector.

(2) Instantaneous acceleration is independent of instantaneous position vector and instantaneous velocity.

(3) Instantaneous acceleration is independant of instantneous position vector but depends upon intantaneous velocity

(4) Instantaneous acceleration depends upon both instantaneous position vector and instantaneous velocity

42. A man moves on his motorbike with 54 km/hr and takes a U-turn (180^o) and continues to move with same speed. The time by U-turn is 10 sec. Find the average acceleration during U-turn.

(1) 0 (2) 3 ms^{-2}

(3) $1.5\sqrt{2}$ ms^{-2} (4) 6 ms^{-2}

43. A man starts from his home at 10:00 a.m., walks with a speed of 10 kmh^{-1} on a straight road upto market 20 km away, stays at the market till 2 p.m. and returns home by an auto with speed of 20 kmh^{-1}. Average speed over this interval (from home till returning back to home) is :-

(1) 5 kmh^{-1} (2) 8 kmh^{-1}

(3) 10 kmh^{-1} (4) 20 kmh^{-1}

44. Which of the following relation is not true –

(1) |instantaneous velocity| = Instantaneous speed

(2) |Average velocity| > Average speed

(3) |Displaceemnt| $\leq$ Distance travelled

(4) All of the above

45. A particle moves with constant acceleration along a straight line starting from rest. The percentage increase in its displacement during the 4^{th} second compared to its displacement in the 3^{rd} second is

(1) 33 % (2) 40 % (3) 66 % (4) 77 %

46. The engine of a vehicle can produce a maximum acceleration of 4 ms^{-2}. Its brakes can produce a maximum retardation of 6 ms^{-2}. The minimum time in which it can cover a distance of 3 km is

(1) 30 s (2) 40 s (3) 50 s (4) 60 s

47. A motor cyclist accelerates from rest with acceleration of 2 m/s^2 for a time of 10 sec. Then he moves with a constant velocity for 20 sec and then finally comes to rest with an deceleration of 1 m/s^2. Average speed for complete journey is :-

(1) 10 m/s (2) 14 m/s

(3) 20 m/s (4) 28 m/s

48. A car has constant acceleration of 1 m/s^2, constant retardation of 2 m/s^2 and it goes to a maximum speed of 20 m/s. The minimum amount of time it would take to drive this car starting from rest and finishing at rest is

(1) 30 s (2) 35 s (3) 40 s (4) 20s

49. A boy drops a ball from the top of a tower of height 22.5 m and at the same instant another boy throws a ball upwards from the foot of the tower. From a window at the middle height of the tower a third boy observes the balls collide with each other in front of him. What should be the velocity of projection of the lower ball?

(1) 12 m/s (2) 30 m/s (3) 25 m/s (4) 15 m/s

50. A driver applies the brakes on seeing traffic signal 400 m ahead. At the time of applying the brakes, vehicle was moving with 15 m/s and afterwards it starts retarding with 0.3 m/s^2.The distance of vehicle after 1 min, from the traffic light is

(1) 25 m (2) 375 m (3) 360 m (4) 40 m

51. The greatest acceleration or deceleration that a train may have is a. The minimum time in which the train may reach from one station to the other separated by a distance d is :-

(1) $\sqrt{\frac{d}{a}}$ (2) $\sqrt{\frac{2d}{a}}$

(3) $\frac{1}{2}\sqrt{\frac{d}{a}}$ (4) $2\sqrt{\frac{d}{a}}$

52. An object starts from rest with constant acceleration. In which second it will travel same distance as much it travels in first five seconds :-

(1) 3rd s (2) 11th s (3) 13th s (4) 9th s

53. A particle moves through the origin of an x-y coordinate system at t = 0 with initial velocity $\vec{u} = \left(4\hat{i} - 5\hat{j}\right) m/s$. It moves in x-y plane with an acceleration $\vec{a} = 2\hat{i}\ m/s^2$. Speed of the particle at t = 4 second in :-

(1) 12 m/s (2) $8\sqrt{2}$ m/s

(3) 5 m/s (4) 13 m/s

54. A car moving on a straight road with speed 144 km/hr is brought to stop within a distance of 100 m. How long does it take to stop (assuming uniform retardation) and if the speed of car is doubled, then stopping distance will become respectively :-

(1) 5 s, 200 m (2) 10 s, 400 m

(3) 5 s, 180 m (4) 5 s, 400 m

55. The motion of a particle is defined by the position vector

$$\vec{r} = (\cos t)\hat{i} + (\sin t)\hat{j}$$

Where t is expressed in seconds. Determine the value of t for which positions vectors and velocity vector are perpendicular.

(1) 1 sec

(2) 2 sec

(3) for all value of t

(4) None of these

56. Velocity (in m/s) of a particle moving in a straight line is given by V = (t^2 – 2t +1) :-

	List-I	**List-II**
(P)	Velocity (in m/s) of particle at t = 3 sec is	(1) 1
(Q)	Acceleration (in m/s^2) of particle at t = 2 is	(2) 2
(R)	Time when particle is at rest is (in second)	(3) 3
(S)	Magnitude of average acceleration of particle in first one second is (in m/s^2)	(4) 4

Code

P	**Q**	**R**	**S**
(1) 3	2	4	1
(2) 4	3	2	1
(3) 4	2	1	1
(4) 1	4	3	2

57. The height (in meters) at any time t (in seconds) of a ball thrown vertically varies according to equation $h(t) = -12t^2 + 144t$. After what time the ball reaches the highest point ?

(1) 4 s (2) 6 s (3) 3 s (4) 9 s

58. The acceleration of a particle (in m/s^2) is given by $a(t) = 6t^2$. Given that $v(0) = 4$ m/s, what is the velocity of the particle at t = 3 s?

(1) 36 m/s (2) 50 m/s

(3) 54 m/s (4) 58 m/s

Paragraph for Question 59 to 61

Path traced by a moving particle in space is called trajectory of the particle. Shape of trajectory is decided by the forces acting on the particle and its initial velocity. When a coordinate system is associated with a particle's motion, the curve equation in which the particle moves [y = f(x)] is called equation of trajectory. It is just giving us the relation among x and y coordinates of the particle i.e. the locus of particle. To find equation of trajectory of a particle, find first x and y coordinates of the particle as a function of time and eliminate the time factor.

59. The position vector of a car w.r.t. its starting point is given as $\vec{r} = at\,\hat{i} - bt^2\,\hat{j}$ where a and b are positive constants. The locus of the particle is :-

(1) $a^2y + bx^2 = 0$

(2) $a^2y = bx^2$

(3) $y = \frac{b}{a^2}x$

(4) $ay^2 = b^2x$

60. The velocity $\left(\text{i.e.}\frac{d\vec{r}}{dt}\right)$ at t = 0 is :-

(1) $2b\hat{j}$ (2) $a\hat{i}$

(3) $(a-2b)\hat{i}$ (4) $-2b\hat{j}$

61. Initial acceleration $\left(\text{i.e.}\frac{d^2\vec{r}}{dt^2}\right)$ of particle is :-

(1) $2b\hat{j}$ (2) $a\hat{i}$ (3) $-2b\hat{j}$ (4) $2a\hat{i}$

62. If velocity of particle moving along x-axis is given as $v = k\sqrt{x}$. Then (a is acceleration) :-

(1) $x \propto \sqrt{t}$ (2) $x \propto t$

(3) $a \propto x$ (4) a = constant

63. The co-ordinates of a particle in x-y plane are given as

$x = 2t^2 + t$ and $y = 16t^2 + 8t$

The motion of the particle is :-

(1) Along a straight line

(2) Along a circular path

(3) along a parabolic path

(4) along a hyperbolic path

64. The relation between time t and distance x is given by $t = Ax^2 + Bx$, where A and B are constants. Then the

(A) velocity is given by $v = 2Ax + B$

(B) velocity is given by $v = (2Ax + B)^{-1}$

(C) retardation is given by $2Av^3$

(D) retardation is given by $2Bv^3$

(1) Only (C)

(2) Only (D)

(3) Only (B) & (C)

(4) Only (B) & (D)

65. A point moves such that its position as a function of time is given by $x^2 = t^2 + 1$. Its acceleration at time t is

(1) $\frac{1}{x^3}$

(2) $\frac{1}{x} - \frac{t^2}{x^3}$

(3) $\frac{1}{x} - \frac{t}{x^2}$

(4) both (1) and (2)

66. The path of a ground to ground projectile near earth surface is represented by $y = ax - bx^2$. Accelration due to gravity is represented by g

List I		List II	
(P)	Horizontal range	(1)	$\sqrt{\frac{g}{2b}}$
(Q)	Tangent of angle of projection	(2)	$\frac{a^2}{4b}$
(R)	Speed at highest point	(3)	$\frac{a}{b}$
(S)	Maximum height	(4)	a

Codes

	P	Q	R	S
(1)	3	4	2	1
(2)	3	4	1	2
(3)	4	3	1	2
(4)	2	4	1	3

67. If position of particle is given by $x = t^3 - 3t^2 - 30$ then speed of particle when its acceleration is zero is : (Here x is in meters and t is in second)

(1) 30 m/s (2) 3 m/s

(3) 0 m/s (4) 34 m/s

68. Co-ordinate of moving particle at any time t are given by $x = 2t^2$, $y = \frac{5}{2}t^2$. Here x and y are in meters and t is in seconds. Its speed at t = 1 sec is :-

(1) 3m/s (2) 4 m/s

(3) 5 m/s (4) $\sqrt{41}$ m/s

69. The position of an object moving along x-axis is given by $x = a + bt + ct^2$ where a = 2m, b = 5m/s and $c = 4\ m/s^2$. The average velocity between t = 1sec and t = 3sec is :-

(1) 49 m/s (2) 36 m/s

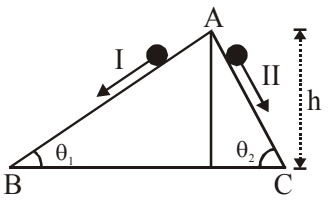
(3) 29 m/s (4) 21 m/s

70. Position vector of a particle is given as $\vec{r} = \left(t^2 - 4t + 6\right)\hat{i} + \left(t^2\right)\hat{j}$. The time after which, the velocity vector and acceleration vector becomes perpendicular to each other is equal to -

(1) 1 sec (2) 2 sec

(3) 1.5 sec (4) 10 sec

71. Two inclined frictionless tracks, one gradual and the other steep meet at A from where two stones are allowed to slide down from rest, one on each track as shown in figure. Which of the following statement is correct?



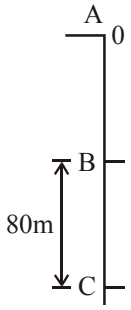
(1) Both the stones reach the bottom at the same time but not with the same speed.

(2) Both the stones reach the bottom with the same speed and stone I reaches the bottom earlier than stone II.

(3) Both the stones reach the bottom with the same speed and stone II reaches the bottom earlier than stone I.

(4) Both the stones reach the bottom at different times and with different speeds.

72. A ball is released from point A. During its motion ball takes two seconds from B to C. Find the time taken by ball from A to C.



(1) 4 s (2) 5 s

(3) 6 s (4) 7 s

73. A man on a moving cart, facing the direction of motion, throws a ball straight up with respect to himself -

(1) The ball will always return to him

(2) The ball will never return to him

(3) The ball will return to him if the cart moves with a constant velocity

(4) The ball will fall behind him if the cart moves with some retardation

74. A person throws balls into air vertically upwards at regular intervals of time of one second. The next ball is thrown when the velocity of the ball thrown earlier becomes zero. The height to which the balls rise is : (Assume, g = 10 ms^{-2})

(1) 5 m (2) 10 m

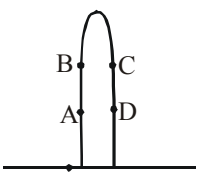
(3) 7.5 m (4) 20 m

75. A body is thrown up vertically with 100 m/sec. It travels a distance 5 m in last second of its' journey while going up, (before coming to rest momentarily). If it is thrown up by 500 m/s, how much distance it travels in last second of journey while going up.

(1) 5 m (2) 10 m

(3) 15 m (4) 20 m

76. The path of a projectile thrown vertically upwards is as shown. Select incorrect statement:-



(1) time taken from A to B = time taken from C to D

(2) time taken from A to C = time taken from B to D

(3) velocity at B = velocity at C

(4) None

77. A particle is thrown upward from ground. It experiences a constant resistive force, which produces retardation of $2m/s^2$. The ratio of time of ascent to the time of descent is :-

(1) 1 (2) $\sqrt{\frac{2}{3}}$

(3) $\sqrt{\frac{3}{2}}$ (4) $\frac{3}{4}$

78. From the top of a tower two stones, whose masses are in the ratio 1 : 2 are thrown; one straight up with an initial speed u and the second straight down with the same speed u. Then, neglecting air resistance :

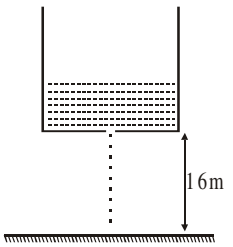
(1) the heavier stone hits the ground with a higher speed.

(2) the lighter stone hits the ground with a higher speed.

(3) both the stones will have the same speed when they hit the ground

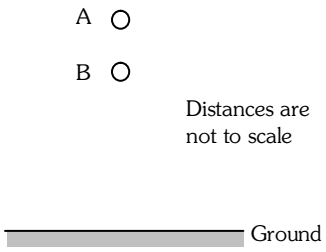
(4) the speed can't be determined with the given data.

79. Water drops fall with negligible velocity at regular intervals from a hole at the bottom of a vessel placed 16 m from the ground. The ninth drop is about to fall when the first drop just falls on the floor. Find the distance between the third and fifth drop at this instant in meters.



(1) 2 (2) 5 (3) 8 (4) 9

80. Two identical metal spheres are held above the ground as shown. The separation between them is small compared to their distance above the ground. Both the spheres are released simultaneously. If effects of air drag is negligible, the separation of the spheres before any one of them hits the ground will



(1) remain constant.

(2) decrease continuously.

(3) increase continuously.

(4) increase initially and then remain constant.

81. A particle projected vertically upwards with a velocity u from a point O. When it returns to the point of projection :

(1) its average speed is u/2

(2) Average speed is u

(3) Average speed is zero

(4) None of these

82. A boy is standing on a lift moving up with uniform speed of 9.8 m/s. He throws a ball up with speed of 98 m/s w.r.t. lift. Assuming the lift to be opened from up, find the time taken by ball to return to his hands.

(1) 10 sec (2) 20 sec

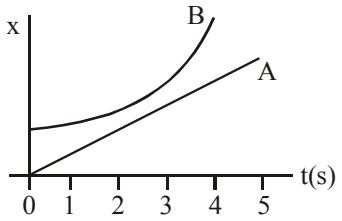
(3) 25 sec (4) 40 sec

83. A player throws a ball vertically upwards. If it returns back in his hands after 20 s, then find the max. height attained by the ball.

(1) 980 m (2) 490 m

(3) 295 m (4) 100 m

84. In the figure shown below, the position versus time graph of two particles A and B is shown. Select the correct statement :



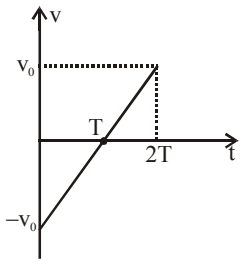
(1) The speed of B was initially greater than that of A and finally less than that of A.

(2) The speed of B was initially less than that of A and finally greater than that of A.

(3) The speed of B was initially as well as finally greater than that of A.

(4) The speed of B was initially as well as finally less than that of A.

85. Figure shows the velocity (v) of particle plotted again time 't' :-



(A) Particle changes its direction of motion at some point

(B) Acceleration of particle remains constant and positive

(C) Speed of particle is always increasing

(D) Velocity of particle first decreases and then increases

(E) Displacement of particle is zero

(F) Speed of particle is first decreases and then increases

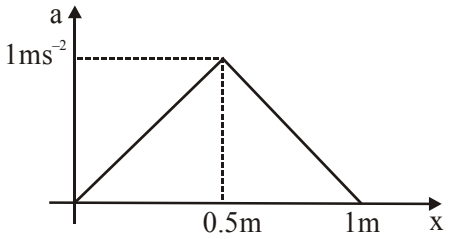
(G) Velocity of particle is always increasing

Choose correct statement(s) :-

(1) Only A,B,D,E,F (2) Only A,B,C,D,E

(3) Only B,C,D,E (4) Only B,C,D

86. A body initially at rest, starts moving along x-axis in such a way so that its acceleration vs displacement plot is as shown in figure. The maximum velocity of particle is :-



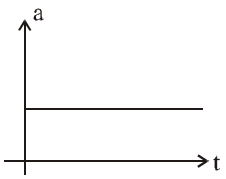
(1) 1 m/s

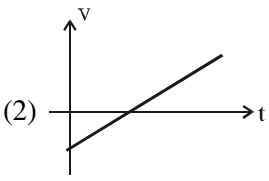
(2) 6 m/s

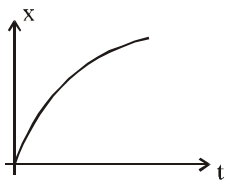
(3) 2 m/s

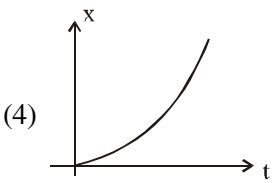
(4) none

87. For a particle moving along x-axis, speed must be increasing for the following graph :

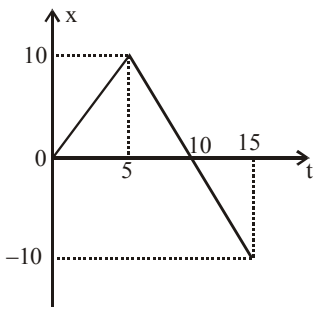
(1) 

(2) 

(3) 

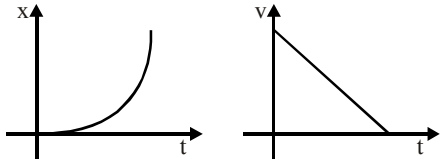
(4) 

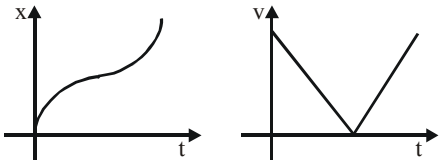
88. Position-time graph is given find average speed in time t = 0 and t = 15 sec is :-

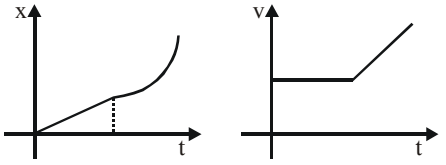


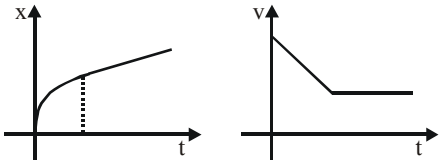
(1) 5 m/s (2) $\frac{5}{3}$ m/s (3) 2 m/s (4) $\frac{2}{3}$ m/s

89. Which of the following pairs of graphs does not represent the motion of the same particle in the same interval (curves are parabolic):-

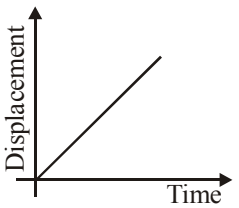
(1) 

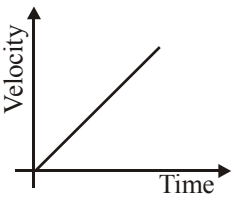
(2) 

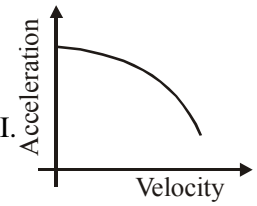
(3) 

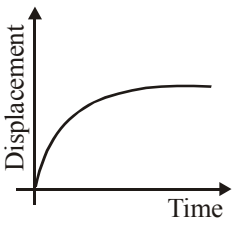
(4) 

90. In which of the graphs the particle moving on straight line is speeding up?

I. 

II. 

III. 

IV. 

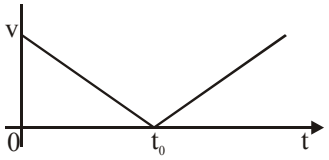
(1) II, III, IV

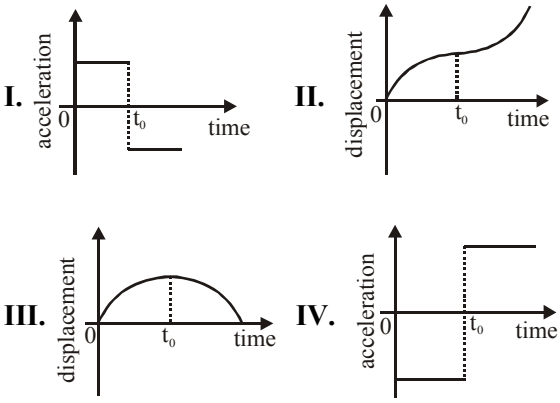
(2) II, IV

(3) II, III

(4) Only II

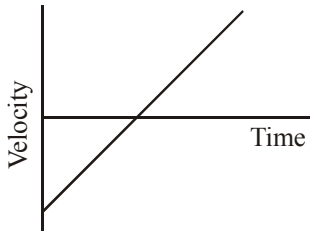
91. Velocity time graph of a particle starting from origin is given below. Choose the **CORRECT** option for corresponding acceleration and displacement graphs :-





(1) II, I (2) III, I (3) II, IV (4) III, IV

92. The graph below shows the velocity with respect to time of an object moving in a straight line. The positive direction is to the right and the negative direction is to the left. Which of the following statements best describes the motion of this object?



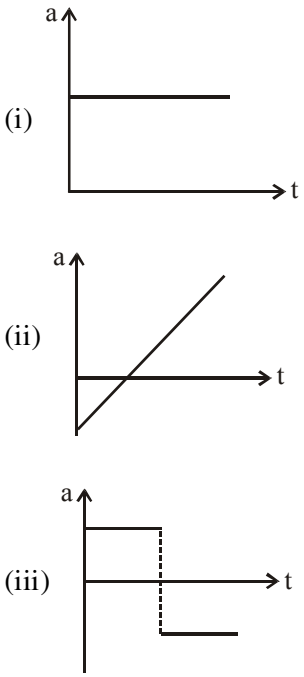
(1) The object starts at a location to the left of the origin and travels at a constant speed toward the right.

(2) The object starts at a location to the left of the origin at a slow speed and speeds up as it moves to the right.

(3) The object slows down as it moves to the left, stops, and starts moving to the right.

(4) The object slows down as it moves to the right, stops, and continues moving to the right.

93. A particle (initially in motion) is subjected to different accelerations separately. These acceleration vary with time as shown. In which of these case(s) particle will definitely return to its initial position.



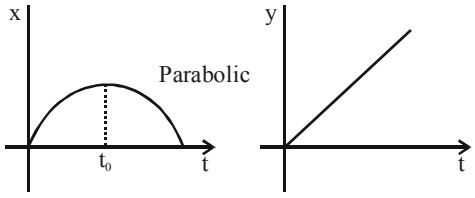
(1) (i) only

(2) (ii) & (iii) only

(3) in all cases

(4) in no case

94. An object is moving in x-y plane and its position-time graphs are given. Select the correct statement:-



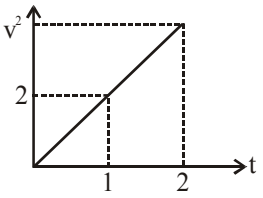
(1) motion of object is non-uniformly acceleration

(2) x co-ordinate is continuously increasing

(3) speed is maximum at time t_0

(4) at time t_0 velocity and acceleration are perpendicular

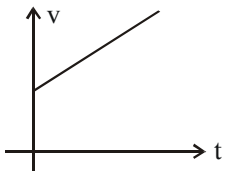
95. A particle moving along x-axis, its velocity at time t is 'v' then its "v^2–t" graph is shown below. Its acceleration at t = 1sec is :-

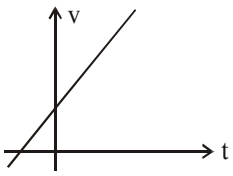


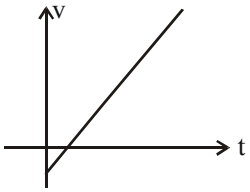
(1) 2 m/s² (2) 1 m/s²

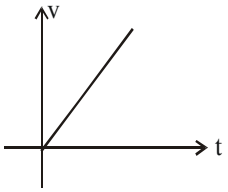
(3) 0.5 m/s² (4) 0.7 m/s²

96. The position time relation of a particle moving along the x-axis is given by $x = 6 - 2t + 3t^2$ then for velocity time graph

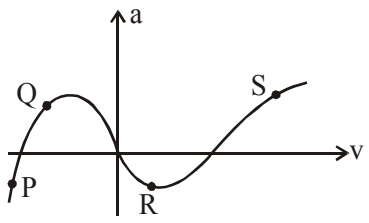
(1) 

(2) 

(3) 

(4) 

97. Acceleration-velocity graph of a moving particle is shown in figure.



The particle is :-

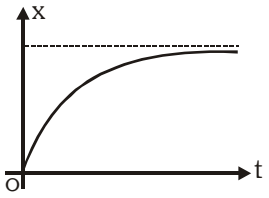
(1) Speeding up at P

(2) Speeding up at Q

(3) Speeding down at S

(4) Speeding up at R

98. The graph shows the displacement of a body as a function of time.



(A) The graph represents motion with constant velocity.

(B) The graph represents accelerated motion

(C) The body comes to rest after a long time.

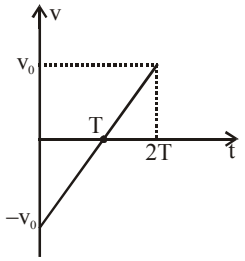
(D) The graph represents a retarded motion.

Which of the following is/are the conclusion/s?

(1) A and B (2) A and C

(3) C and D (4) A, C and D

99. Figure shows the velocity (v) of particle plotted again time 't' :-



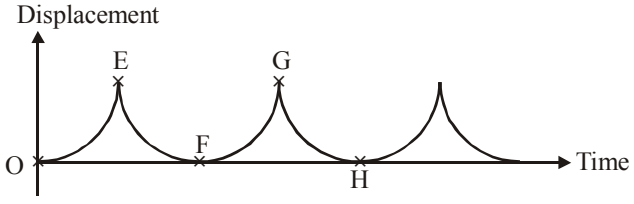
(1) Particle changes its direction of motion at some point

(2) Acceleration of particle remains constant

(3) Displacement is zero

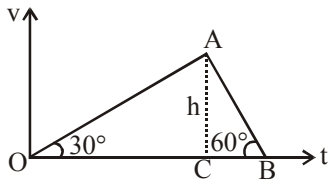
(4) All of these

100. The following is a displacement-time graph of a ping-pong ball that is released from a height with zero initial speed. The ping-pong ball bounces for several times. Neglecting the air resistance, which point in the graph represents the second bounce?



(1) E (2) F (3) G (4) H

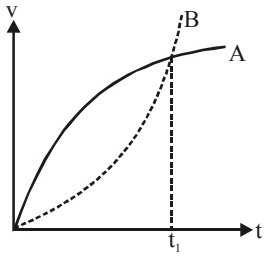
101. The velocity time (v – t) graph of a body is shown in figure. For the intervals OC & CB, the ratio of the distances covered is :-



(1) 3 : 1 (2) 1 : 3

(3) $\sqrt{3}:1$ (4) $\sqrt{3}:2$

102. At t = 0, two trucks A and B were at same point on the road. At t = t_1, (motion of trucks A and B is represented by bold and dotted lines respectively):-



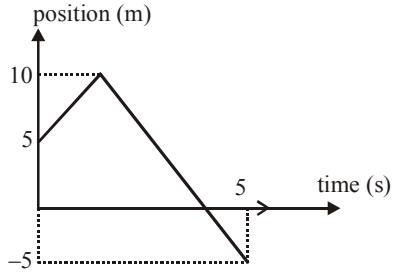
(1) Truck A overtakes truck B

(2) Acceleration of truck A and B are equal

(3) Speed of truck A decreases and speed of truck B increases

(4) Truck A is ahead of truck B

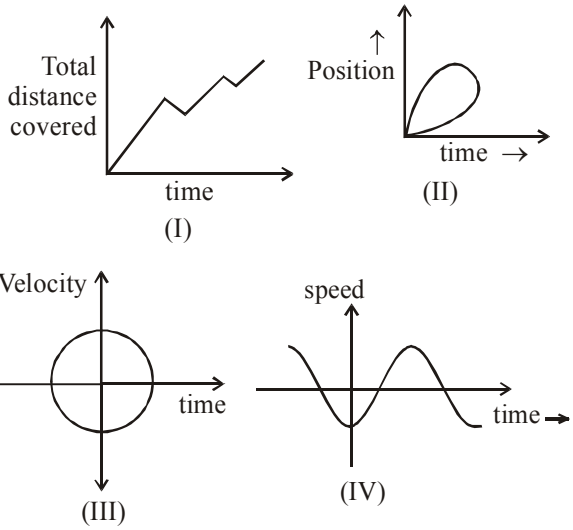
103. Average velocity of the particle in time t = 0 to t = 5 s is :-



(1) 2 m/s (2) – 2 m/s

(3) 1 m/s (4) – 1 m/s

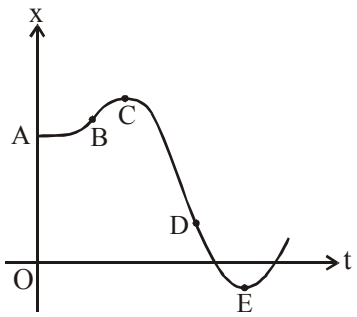
104. Which of the following graphs cannot possibly represent one dimensional motion of a particle :-



(1) I and II (2) II and III

(3) II and IV (4) All four

105. For the position (x)–time (t) graph shown of a particle in one-dimenstional motion. Choose the correct alternatives from below :-



(a) Particle was released from rest at t = 0

(b) At C particle will reverse its direction of motion

(c) Average velocity for motion between B and D is positive

(d) At E, velocity = 0 and acceleration > 0

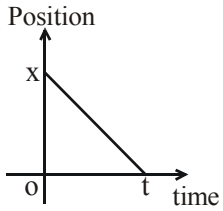
(1) a, b

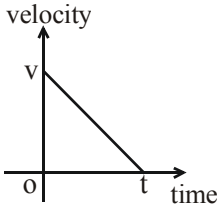
(2) a, b, d

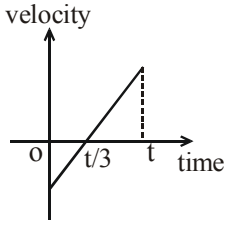
(3) a, d

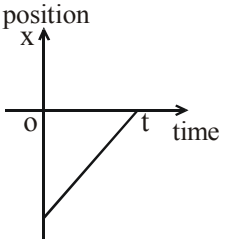
(4) b, c, d

106. For which of the following graphs the average velocity of a particle moving along a straight line for time interval 0 to t must be negative :-

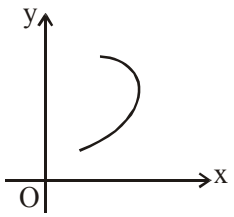
(1) 

(2) 

(3) 

(4) 

107. If the given graph is possible in realistic situations, then y and x variables may represent, respectively:



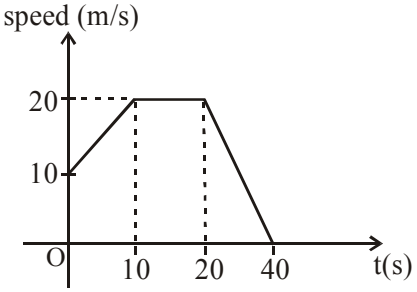
(1) acceleration & time

(2) velocity & time

(3) velocity & displacement

(4) displacement & time

108. For the given speed-time graph find distance travelled during the interval t = 2 to 25 sec.



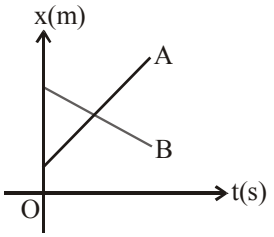
(1) 400 m

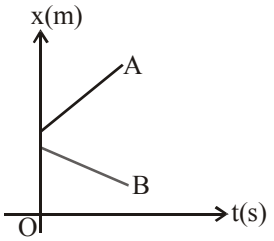
(2) 415.5 m

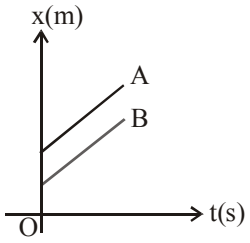
(3) 450 m

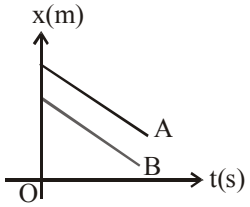
(4) 500 m

109. Which of the following position-time graphs represent two object having velocities in opposite directions and not meeting ever.

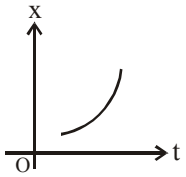
(1) 

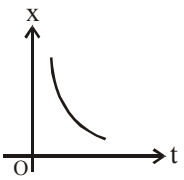
(2) 

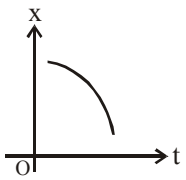
(3) 

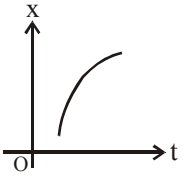
(4) 

110. Which of the following position-time graph represents positive acceleration with slowing down:

(1) 

(2) 

(3) 

(4) 

111. Two trains one of length ℓ_1 = 630 m and other of length ℓ_2 = 120 m move uniformly in two parallel paths in opposite direction with speed u_1 = 48 km/h and u_2 = 102 km/h respectively.

(1) The relative speed of trains is 54 km/hr.

(2) The relative speed of trains is 50 km/hr.

(3) Time taken by one train to completely pass another is 15 s.

(4) Time taken by one train to completely pass another is 18 s.

Passage (Q. 112 to Q. 114)

A man in a boat crosses a river from point A. If he rows perpendicular to the banks then, 10 minutes after he starts, he will reach point C lying at a distance S = 120 m downstream from point B. If the man heads at a certain angle α to the straight line AB (AB is perpendicular to the banks) against the current he will reach point B after 12.5 minutes. Assume the speed of the boat relative to the water to be constant and of the same magnitude in both cases.

112. Width of the river *l* is -

(1) 100 m (2) 50 m

(3) 150 m (4) 200 m

113. Velocity of the boat v relative to the water is-

(1) 5 m/min (2) 20 m/min

(3) 10 m/min (4) 25 m/min

114. Speed of the current u is -

(1) 12 m/min (2) 6 m/min

(3) 20 m/min (4) 15 m/min

115. The distance between them at time t is :-

(1) $\sqrt{(200)^2+(100)^2}$ m

(2) $\sqrt{(200-4t)^2+(100-2t)^2}$ m

(3) $[(200-4t)+(100-2t)]$m

(4) $\sqrt{(200-2t)^2+(100-4t)^2}$ m

116. The distance between them will be shortest at t = ...

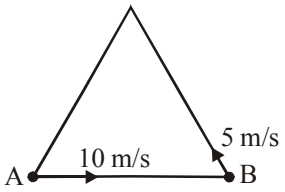
(1) 50 s

(2) $\frac{125}{3}$s

(3) $\frac{250}{3}$s

(4) 40 s

117. Two boys A & B are standing at the corners of equilateral triangle of side 5 m. They start moving along the sides with constant speed as shown. The time at which they meet for 2nd time is :-



(1) 1 s (2) 3 s

(3) 5 s (4) 4 s

118. If a ball is projected vertical upward from ground such that total distance traveled is 3.6 times of distance travel by the ball in 1st second. Then find time of flight of ball ?

(1) 2.4 s (2) 3 s

(3) 6 s (4) 4.8 s

119. A lift is moving with a uniform downward acceleration of $2ms^{-2}$. A ball is dropped from a height 2m from the floor of lift. Find the time taken after which ball will strike the floor (in s) :-

(1) $\sqrt{2}$

(2) 2

(3) $1/\sqrt{2}$

(4) 1/2

120. Rain is falling with a velocity $\left(-4\hat{i}+8\hat{j}-10\hat{k}\right)$ m/s.

A person is moving with a velocity of $\left(6\hat{i}+8\hat{j}\right)$ m/s on the ground. The speed with which the rain drops hit the person is :-

(1) 10 m/s (2) $10\sqrt{2}$ m/s

(3) $\sqrt{180}$ m/s (4) $\sqrt{360}$ m/s

121. A projectile is given an initial velocity of $(\hat{i}+2\hat{j})$m/s. The equation of its path is : (g = 10m/s^2) :-

(1) $y = 2x - 5x^2$

(2) $y = x - 5x^2$

(3) $4y = 2x - 5x^2$

(4) $y = 2x - 25x^2$

122. A particle is thrown in vertical plane with initial speed 10 m/s and angle of projection with horizontal is 30°. At maximum height its speed suddenly becomes zero. Find the time of complete journey.

(1) 2 s (2) $\frac{1}{2}$ s

(3) 1 s (4) $\frac{3}{2}$ s

123. Particle is projected with a velocity of $(10\hat{i}+12\hat{j})ms^{-1}$. If it has a constant acceleration of $(3\hat{i}-3\hat{j})ms^{-2}$. Then select the correct statement:

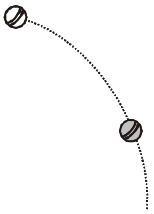
(1) Initially speed of particle increases

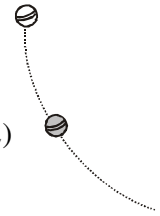
(2) Initially speed of particle decreases

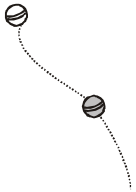
(3) Speed remain constant throughout the motion but its direction changes.

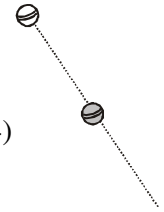
(4) Speed and direction both remain constant.

124. A ball is dropped from a height and falls due to gravity and wind simultaneously imparts it a uniform horizontal acceleration. Which one of the following figures best represents its path?

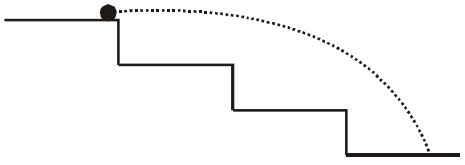
(1) 

(2) 

(3) 

(4) 

125. A staircase contains three steps each of 10 cm high and 20 cm wide (figure). What should be the minimum horizontal velocity of a ball rolling off the uppermost plane so as to hit directly the lowest plane :



(1) 1 m/s (2) 1.5 m/s

(3) 2 m/s (4) 3 m/s

126. Particle is projected upward with velocity 100 m/s at an angle of 30° with horizontal. Find the time when its velocity is perpendicular to the acceleration :-

(1) 10 s

(2) 5 s

(3) 20 s

(4) 10 s

127. If the velocity of projection is increased by 1% (other things remains constant) the horizontal range will increase by

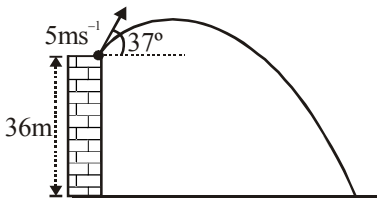
(1) 1%

(2) 2%

(3) 4%

(4) 8%

128. A ball is thrown from the top of 36 m high tower with velocity 5 m/s at an angle 37° above the horizontal as shown. Its horizontal distance on the ground is closest to [g = 10 m/s^2]



(1) 12 m (2) 18 m

(3) 24 m (4) 30 m

129. A particle having a mass of 0.5 kg is projected under gravity with a speed of 98 m/s at an angle of 60°. The magnitude of the change of momentum of the particle after 10 sec is :-

(1) 0.5 Ns (2) 49 Ns

(3) 98 Ns (4) 490 Ns

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	**4**	**2**	**4**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**1**	**2**	**4**	**4**	**2**	**1**	**2**	**4**	**3**	**3**
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	**1**	**1**	**4**	**1**	**2**	**1**	**3**	**4**	**3**	**4**	**1**	**3**	**2**	**4**	**3**	**2**	**3**	**1**	**2**	**4**
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**1**	**4**	**1**	**1**	**3**	**4**	**4**	**3**	**3**	**2**	**4**	**2**	**2**
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	**3**	**4**	**3**	**3**	**4**	**2**	**2**	**4**	**4**	**1**	**3**	**2**	**3**	**1**	**1**	**3**	**2**	**3**	**2**	**1**
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	**1**	**2**	**3**	**2**	**1**	**1**	**4**	**3**	**1**	**3**	**3**	**3**	**4**	**4**	**4**	**3**	**1**	**3**	**4**	**3**
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	**1**	**4**	**2**	**2**	**2**	**1**	**3**	**2**	**2**	**2**	**4**	**4**	**2**	**1**	**2**	**1**	**4**	**3**	**3**	**2**
Que.	121	122	123	124	125	126	127	128	129											
Ans.	**1**	**3**	**2**	**4**	**3**	**2**	**2**	**1**	**2**											

LAW OF MOTION AND FRICTION

1. Inertia means :-

(1) Resistance to uniform motion

(2) Resistance to rest

(3) Resistance to deform

(4) Resistance to change in its motion

2. Which of the following is a non contact force:-

(1) Gravitational force (2) Tension

(3) Friction (4) Air drag

3. If a constant external force starts acting on a moving particle, which of the following is essentially true?

(1) the line of motion of the particle will keep changing

(2) the speed of the particle will keep changing

(3) the particle will never stop

(4) none is essentially true

4. A bullet of mass 0.08 kg moving with a speed of 80m/s enters a heavy wooden block and is stopped after a distance of 40cm. What will be average resistive force exerted on bullet by block.

(1) 800 N (2) 400 N (3) 640 N (4) 720 N

5. Choose the **INCORRECT** statement (with respect to the 2nd law of motion)

(1) Any internal force in the system are not included in net force while writing equation.

(2) Acceleration here and now is determined by the force here and now, not by any history of the motion of the particle.

(3) In the second law, F = 0 implies a = 0. The second law is obviously consistent with the first law.

(4) If a force is not parallel to the velocity of the body, but makes some angle with it, it changes only component of velocity along the direction perpendicular to direction of force.

6. A bullet of mass 5 gram is accelerated in a rifle barrel with an approximately constant force of 2500 N. The mass of the rifle is 5 kg. What is the force pushing the rifle back ?

(1) 2.5 N (2) 2500 N

(3) 250000 N (4) 0 N

7. A particle of mass 2kg moves in free space such that its position vector varies with time as $\vec{r} = \left[(3+4t^2)\hat{i} + (2t)\hat{j} + (3-6t)\hat{k}\right]$m where t is in second. Net force acting on the particle is

(1) zero

(2) parallel to x-axis

(3) parallel to y-axis

(4) time dependent

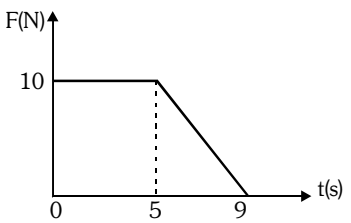
8. A machine gun fires 10 bullets per second in horizontal direction. Mass of each bullet is 80 g and muzzle velocity is 500 m/s. If the average horizontal force the shooter must apply to keep the machine gun stationary is F × 10^2 N, find numerical value of F.

(1) 4 (2) 5 (3) 8 (4) 12

9. A cricket ball of mass 160 g is moving horizontally directly towards a batsman. Its speed just before it hits the bat is 30 m/s. It leaves the bat at 40 m/s at 90° to its original direction. Find the magnitude of the impulse (in N-s) imparted to the ball.

(1) 4.8 (2) 8 (3) 6.4 (4) 10

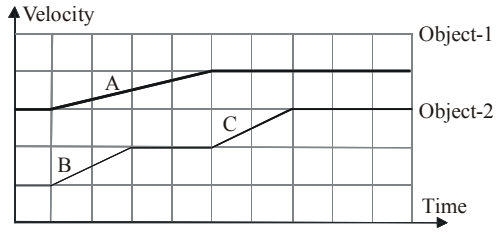
10. A body of mass 4 kg is acted on by a force which varies as shown in the graph below. The momentum acquired is :-



(1) 280 N–s (2) 140 N–s

(3) 70 N–s (4) 210 N–s

11. The graph shows the velocities of two objects as function of time. Mass of object-1 is twice of that of object-2. Net forces F_A, F_B, and F_C are acting on the objects during intervals A, B, and C, respectively. Which one of the following choices is the correct relationship between the magnitudes of the net forces?



(1) $F_B = F_C > F_A$ (2) $F_C = F_B = F_A$

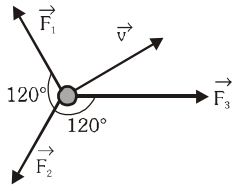
(3) $F_A > F_B = F_C$ (4) $F_A > F_B > F_C$

12. A ball of mass 200 gm, moving with a speed of 40 m/s, is deflected exactly with the same speed but at 90° with its incident direction after striking with a bat. if the striking time is 2s, the average force acts on the ball is :

(1) 4.0 N (2) $\frac{4}{\sqrt{2}}$ N

(3) $4\sqrt{2}$ N (4) zero

13. A particle is moving in free space with some velocity as shown. It is applied by force $\vec{F}_1$, $\vec{F}_2$ & $\vec{F}_3$ of magnitudes 10 N, 10 N and 15 N respectively



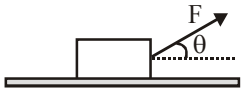
(1) its velocity changes only in magnitude

(2) its velocity changes only in direction

(3) its velocity changes in both magnitude and direction

(4) its velocity remains constant

14. A block is being pulled by a force F on a long frictionless level floor. Magnitude of the force is gradually increased from zero until the block lifts off the floor. Immediately after the block leaves the floor, its acceleration is



(1) gcosθ

(2) gcotθ

(3) gsinθ

(4) More information is required to decide.

15. A force 'F_0' start acting on a stationary particle of mass 'm' then velocity of particle after covering a distance 'd' is :-

(1) $\sqrt{\frac{m}{2F_0d}}$ (2) $\frac{2F_0d}{m}$

(3) $\sqrt{\frac{2F_0d}{m}}$ (4) Zero

16. Among the given cases, in which cases net force on the object will be zero ?

(a) An ice cube of 50g mass floating on water

(b) A body moving with uniform velocity in space

(c) A satellite revolving around the earth

(d) A book at rest on a table

(1) In a, b and c

(2) only in a

(3) In a, b and d

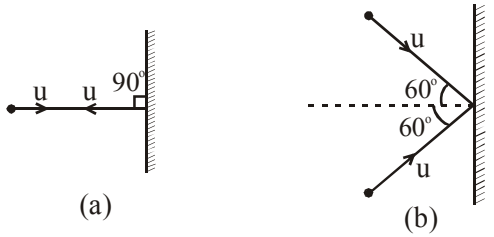
(4) in all cases

17. Motion of a particle of mass 5kg is described by the relation $x = (5t + 10t^2)$ m force on the particle is :-

(1) 20 N (2) 40 N

(3) 80 N (4) 100N

18. Two identical billiard balls strikes a rigid vertical wall with the same speed but at different angles and get reflected without any change in speed as shown in the figure (a) & (b). The ratio impulses imparted to the balls by the wall is :-



(a) (b)

(1) 1 : 2 (2) $\sqrt{3}$: 2

(3) 2 : $\sqrt{3}$ (4) 2 : 1

19. A batsman hits back a ball straight in the direction of the bowler without changing its initial speed of 25 ms^{-1}. If the mass of ball is 0.4 kg, then assuming linear motion of the ball, determine the impulse imparted to the ball :-

(1) 20 N-s (2) 40 N-s

(3) 50 N-s (4) 60 N-s

20. Which of the following statement is correct :-

(1) If force is along velocity, then it can change the direction of motion.

(2) If force is perpendicular to velocity, then it can change the magnitude of velocity,

(3) If force is in the opposite direction of velocity, then it can not change the direction of motion.

(4) If force is perpendicular to velocity then it can change direction of velocity.

21. Mass of a particle is 0.50 kg. It is moving initially with the speed by 80 m/s towards east. At t = 0, when particle is at x = 0, a force of 20N directed towards west is being applied on it for 4 sec. Its position after 5 sec is :-

(1) 80 m (2) 0 (3) –40m (4) –80m

22. A student unable to answer a question on Newton's laws of motion attempts to pull himself up by tugging on his hair. He will not succeed.

(1) as the force exerted is small

(2) the frictional force while gripping, is small

(3) Newton's law of inertia is not applicable to live beings

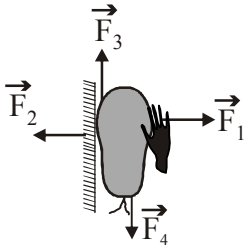
(4) as the force applied is internal to the system

23. In the figure shown, a balloon is pressed against a wall. It is in equilibrium and maximum compresed state.

$\vec{F}_1$ = force of balloon on hand of man ;

$\vec{F}_2$ = force of balloon on wall ;

$\vec{F}_3$ = friction force ; $\vec{F}_4$ = weight of balloon. Choose the correct statement (s).



(A) $\vec{F}_1$ and $\vec{F}_2$ are action reaction pairs.

(B) $\vec{F}_3$ and $\vec{F}_4$ are action reaction pairs.

(C) $\vec{F}_2$ and $\vec{F}_3$ are action reaction pairs.

(D) $\vec{F}_4$ and gravitational force exerted by balloon on earth are action reaction pairs.

(1) Only A & D

(2) Only A, B & D

(3) Only D

(4) Only C & D

24. In a tonga, horse pulls a wagon. Which is the correct analysis of the situation?

(1) The tonga moves forward because the horse pulls forward slightly harder on the wagon than the wagon pulls backward on the horse.

(2) Because action always equals reaction, the horse cannot pull the wagon. The wagon pull backward just as hard as the horse pulls forward, there is no motion.

(3) The horse's force on the wagon is as strong as the force of the wagon on the horse.

(4) The horse can pull the wagon forward only if it weighs more than the wagon.

25. A block of weight 9.8 N is placed on a table. The table surface exerts an upward force of 10N on the block. Taking g = 9.8 m/s^2 , which of the following statement are correct ?

(a) The block exerts a force of 10 N on the table

(b) The block exerts a force of 19.8 N on the table

(c) The block exerts a force of 9.8 N on the table

(d) The block has an upward acceleration

(1) only a

(2) a and d

(3) b and d

(4) c and d

26. A ball of mass m is thrown vertically upward. Instead of neglecting air resistance, assume that the force of air resistance has a magnitude proportional to the ball's velocity, but pointing in the opposite direction. The acceleration of the ball at the highest point is

(1) 0

(2) Less than g

(3) g

(4) Greater than g

27. A body is placed over a smooth inclined plane of angle $\pi-\theta$. The angle between normal reaction and the weight of the body is

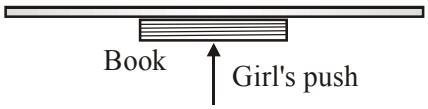
(1) $\pi-\theta$

(2) θ

(3) less than θ

(4) greater than θ

28. A girl pushes her physics book up against the horizontal ceiling of her room as shown in the figure.



The book weighs 20 N and she pushes upwards with a force of 25 N. The choices below list the magnitudes of the contact force F_{CB} between the ceiling and the book, and F_{BH} between the book and her hand. Select the correct pair.

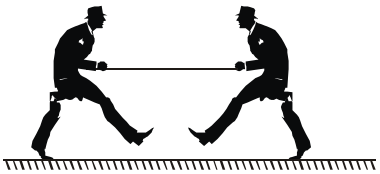
(1) F_{CB} = 20 N and F_{BH} = 25 N

(2) F_{CB} = 25 N and F_{BH} = 45 N

(3) F_{CB} = 5 N and F_{BH} = 25 N

(4) F_{CB} = 5 N and F_{BH} = 45 N

29. In a tug–of–war contest, two men pull on a horizontal rope from opposite sides. The winner will be the man who



(1) exerts greater force on the rope

(2) exerts greater force on the ground

(3) exerts a force on the rope which is greater than the tension in the rope

(4) makes a smaller angle with the vertical

30. Three forces are acting on a body to make resultant force zero. Which set can do it without the angle between any of the forces being 0° or 180°?

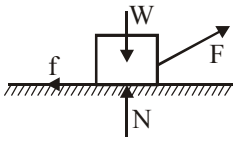
(1) 3N, 3N, 7N

(2) 10N, 8N, 2N

(3) 3N, 3N, 6N

(4) 6N, 10N, 8N

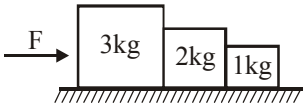
31. A person pulls a block by applying a force F and the block remains at rest. The arrows in the diagram correctly show the directions, but not necessarily the magnitudes, of the various forces on the block. Which of the following relations among the force magnitudes F, W, N, and f must be true? Here f is friction and W is the weight (the force of gravity), and N is the normal reaction.



(1) F = f and N = W (2) F = f and N > W

(3) F > f and N < W (4) F > f and N = W

32. Consider the following statement about the blocks shown in the diagram that are being pushed by a constant force on a frictionless table.

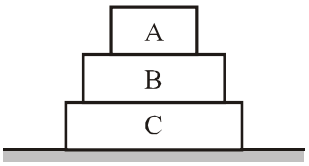


(i) All blocks move with the same acceleration.
(ii) The net force on each block is the same.
Which of these statement are/is correct

(1) (i) only (2) (ii) only

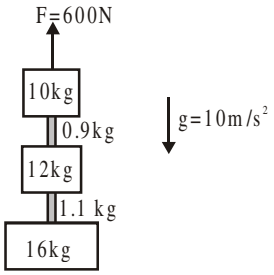
(3) both (i) and (ii) (4) neither (i) nor (ii)

33. Consider three blocks A, B and C. Block A is placed on block B, which is placed on block C and block C is placed on the ground. Normal reaction between blocks B and C is three times of that between blocks A and B. Normal reaction between block C and ground is two times of that of between blocks B and C. Possible values of the masses of blocks A, B and C respectively are



(1) 5kg, 15 kg and 10 kg
(2) 5 kg, 10 kg and 15 kg
(3) 5 kg, 15 kg and 30 kg
(4) 5 kg, 30 kg and 60 kg

34. Three blocks shown in figure are connected by two heavy uniform ropes. An upward force of 600 N is applied as shown in figure. What is the acceleration of the system?



(1) 15 m/s^2

(2) 5 m/s^2

(3) 10 m/s^2

(4) None of these

35. The force exerted by the floor of an elevator on the foot of a person standing there is less than the weight of the person if the elevator is

(A) going up and slowing down

(B) going up and speeding up

(C) going down and slowing down

(D) going down and speeding up

(1) Only A (2) Only C

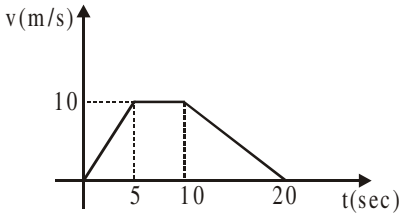
(3) A & D (4) B & C

36. A uniform rope of mass 1.0 kg is connected with a box of mass 2.0 kg, which is placed on a smooth horizontal surface. The free end of the rope is pulled horizontally by a force 6 N. Find the tension at the midpoint of the rope.

(1) 4 N (2) 1 N

(3) 5 N (4) 2 N

37. Velocity of a lift moving upwards varies with time as shown in figure. If a mass of 60 kg is placed on a weighing machine in the lift, then Reading of weighing machine at t = 3 s and at t = 15 s are



(1) 60 kg-wt and 54 kg-wt

(2) 72 kg-wt and 54 kg-wt

(3) 48 kg-wt and 48 kg-wt

(4) 75 kg-wt and 48 kg-wt

38. A block is kept at rest in a lift which is initial at rest. If lift starts moving downward with an acceleration of $15m/s^2$, then acceleration of block will be :- ($g = 10m/s^2$)

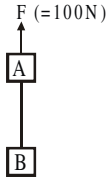
(1) $15m/s^2$

(2) $5m/s^2$

(3) $25m/s^2$

(4) None of these

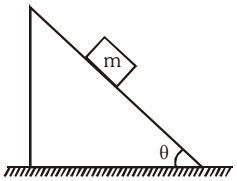
39. Consider the shown arrangement where the blocks A and B connected by means of a uniform string is being moved vertically up by the force F. Each block weighs 2 kg while the mass of string is 1000 gm. The tension at bottom of the string equals



(1) 20 N (2) 40 N

(3) 60 N (4) 270 N

40. If block is sliding down on a rough fixed inclined plane with constant velocity as shown in the figure then net force acting on the wedge due to block is:-



(1) $\frac{mg}{\cos\theta}$ (2) mg

(3) $mg\cos\theta$ (4) None of these

41. A rope of length L and mass M is hanging from a rigid support.The tension in the rope at a distance x from the rigid support is :-

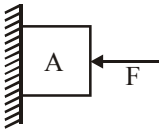
(1) Mg (2) $\left(\frac{L-x}{L}\right)Mg$

(3) $\left(\frac{L}{L-x}\right)Mg$ (4) $\frac{x}{L}Mg$

42. A chain consisting of 5 links of mass 0.1 kg each is lifted vertically upwards with a constant acceleration 5 m/s^2 as shown in figure. The force of interaction between the top link and the link immediately below it will be : ($g = 10\ m/s^2$)

(1) 6 N (2) 4 N (3) 3 N (4) 2 N

43. A block A of mass m is kept at rest against a rough vertical wall by applying a horizontal force F. Minimum value of F to keep the block in equilibrium is F_m, then find the acceleration of block when $F = \frac{F_m}{5}$.



(1) $4\ m/s^2$ (2) $8\ m/s^2$ (3) $10\ m/s^2$ (4) $1\ m/s^2$

44. Force F = 100 N is applied on a combination of mass M and m in two situations as shown in figure (i) & (ii). If contact force between M & m in two cases is N_1 & N_2 respectively then calculate $\frac{N_2}{N_1}$. (Given : M = 10 kg, m = 2kg). Friction is absent everywhere.

figure (i)

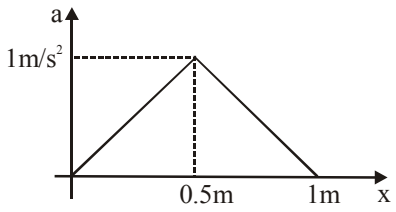
figure (ii)

(1) 2 (2) 5 (3) 4 (4) 6

45. **91.** A block is placed on horizontal floor. Block is in equilibrium under the action of three forces F_1 = 10N, F_2 = 2N and friction force. If F_2 is removed then net force on block will be :-

(1) 2N left
(2) 2N right
(3) 0 N
(4) Cannot be determined

46. A body initially at rest, starts moving along x-axis in such a way so that its acceleration vs displacement plot is as shown in figure. The maximum velocity of particle is :-

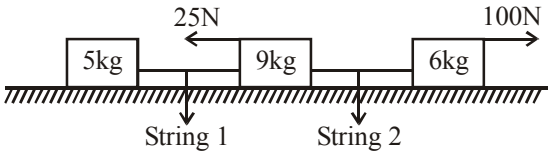


(1) 1 m/s (2) 6 m/s
(3) 2 m/s (4) none

47. A mass 1 kg is suspended by a thread. It is
(i) lifted up with an acceleration 4.9 m/s²
(ii) lowered with an acceleration 4.9 m/s².
The ratio of the tensions is :-

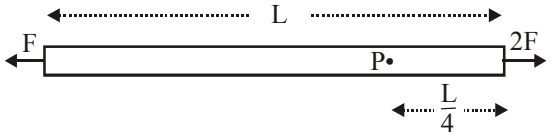
(1) 3 : 1 (2) 1 : 3
(3) 1 : 2 (4) 2 : 1

48. In the given figure tension at the mid-point of string-2. If mass of string-1 is 6 kg and mass of string-2 is 4 kg.



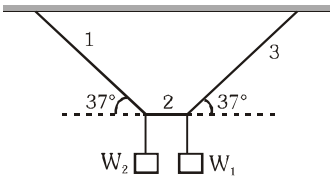
(1) 70 N
(2) 60 N
(3) 80 N
(4) 50 N

49. A uniform rod of mass M and length L lies flat on a frictionless horizontal surface. Two forces F and 2F are applied along the length of the rod as shown. The tension in the rod at point P is



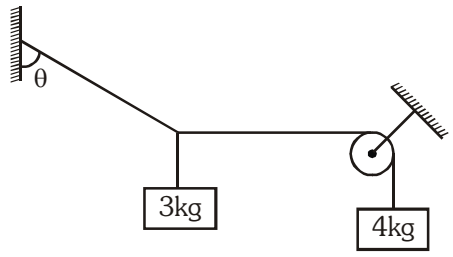
(1) F (2) 3F
(3) $\frac{5F}{4}$ (4) $\frac{7F}{4}$

50. In the given figure, system is in equilibrium. If W_1 = 300 N, then W_2 is approximately equal to:-



(1) 500 N (2) 400 N
(3) 670 N (4) 300 N

51. In shown system, each of the block is at rest. The value of θ is



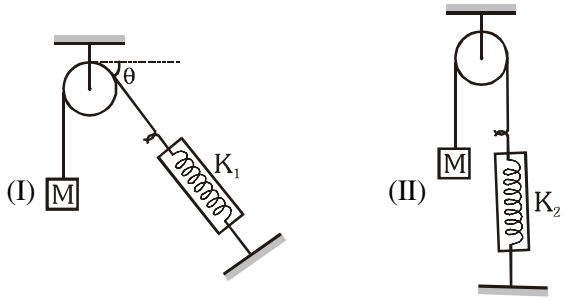
(1) $\tan^{-1}(1)$

(2) $\tan^{-1}\left(\frac{3}{4}\right)$

(3) $\tan^{-1}\left(\frac{4}{3}\right)$

(4) $\tan^{-1}\left(\frac{3}{5}\right)$

52. Two situations are shown in the diagram.



Tension in spring in case I is represented as $T_{S\,I}$ and tension in spring in case II is $T_{S\,II}$ and $K_1 \neq K_2$

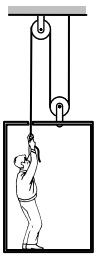
(1) $T_{SI} \sin\theta = T_{S\,II}$

(2) $T_{S\,I} = T_{S\,II}$

(3) Extension in spring in case I less than extension in spring in case II.

(4) Extension in spring in case I is equal to extension in spring in case II.

53. A man standing in a lift according to the arrangement shown in figure is trying to move the lift upwards by pulling the rope down. Is it always possible to do this? (contact of man from floor does not break)



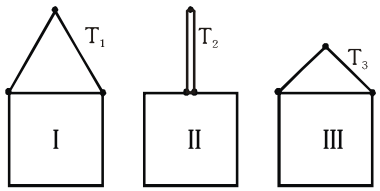
(1) Yes, provided that the man is capable of pulling the rope hard enough.

(2) Yes, only if mass of the man is greater than or equal to that of the lift.

(3) Yes, only if mass of the man is greater than or equal to half of that of the lift.

(4) Yes, only if mass of the man is greater than or equal to one third of that of the lift.

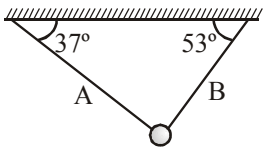
54. A picture can be hung on a wall with string in three different ways, as shown. The magnitude of the tension force of the string is:



(1) $T_1 > T_2 > T_3$ (2) $T_3 > T_1 > T_2$

(3) $T_2 > T_1 > T_3$ (4) $T_3 > T_2 > T_1$

55. A small ball of weight 10 N is suspended by two strings A and B as shown in the figure. Values of tensions in the strings A and B are :-



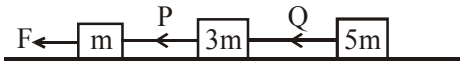
(1) 80 N and 60 N respectively.

(2) 60 N and 80 N respectively

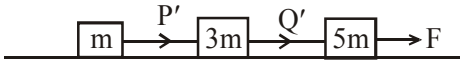
(3) 6 N and 8 N respectively

(4) 8 N and 6 N respectively.

56. Three blocks of mass m, 3m and 5m are connected by massless strings and pulled by a force F on a frictionless surface as shown in the figure below. The tension P in the first string is 16N .



If the point of application of F is changed as given below.



The value of P' and Q' will be :-

(1) 16N, 10N

(2) 10N, 16N

(3) 2N, 8N

(4) 10N, 6N

57. A man squatting on the ground gets straight up and stand. The force of reaction of ground on the man during the process is :-

(1) constant and equal to mg in magnitude

(2) constant and greater than mg in magnitude

(3) variable but always greater than mg

(4) at first greater than mg and later becomes equal to mg

58. Mass of a monkey is 50 kg. It climbs up a rope having breaking strength 800 N. In which of the following cases, the rope will break :- (g = 10 m/s^2)

(1) climbs down with an acceleration of $6ms^{-2}$

(2) climbs up with an acceleration of $5ms^{-2}$

(3) climbs up with an acceleration of 6.5 ms^{-2}

(4) All of the above

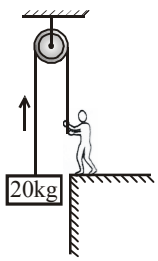
59. Mass of a block is 20kg. A man of mass 60kg raises it with constant velocity as shown in the figure. Force exerted by man on the floor will be :-

(1) 400 N

(2) 600 N

(3) 200 N

(4) None of the above

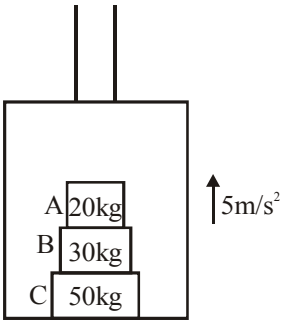


60. A shell of mass 0.01 kg is fired by a gun of 50 kg. If the muzzle speed of shell is $60ms^{-1}$, then the recoil speed of gun is :-

(1) 1.2 m/s (2) 1.6 m/s

(3) 1.2 cm/s (4) 1.6 cm/s

61. In shown situation elevator is moving upward with acceleration of 5 m/s^2.



Column I	**Column II**
(1) Net force acting on B	(P) 150 N
(2) Normal reaction between A and B	(Q) 300 N
(3) Normal reaction between B and C	(R) 450 N
(4) Normal reaction between C and elevator	(S) 750 N
	(T) 1500 N

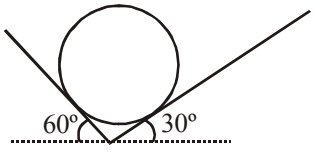
(1) (1)-P (2)-Q (3)-S (4)-T

(2) (1)-Q (2)-Q (3)-R (4)-T

(3) (1)-P (2)-R (3)-S (4)-S

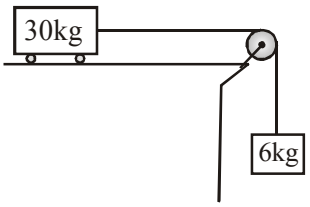
(4) (1)-Q (2)-R (3)-R (4)-T

62. A cylinder of mass $\frac{1}{\sqrt{3}}$ kg is placed on the corner of two inclined planes as shown in the figure. Find the normal reaction at contact point of cylinder with the slope of inclination 30°.



(1) 15 N (2) 10 N (3) 5 N (4) 7 N

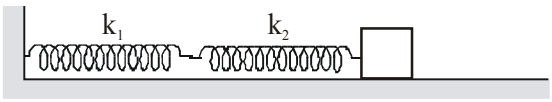
63. If the coefficient of kinetic friction between the trolley and surface is 0.1, then tension in the string connecting masses is – (Take g = 10m/s^2)



(1) 48 N (2) 51 N

(3) 53 N (4) 55 N

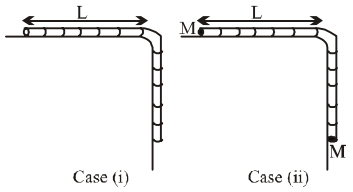
64. The mass in the figure can slide on a frictionless surface. When the mass is pulled out, spring 1 is stretched a distance x_1 and spring 2 is stretched a distance x_2. The spring constants are k_1 and k_2 respectively. Magnitude of spring force on the mass is



(1) k_1x_1 (2) $(k_1x_1 - k_2x_2)$

(3) $(k_1x_1 + k_2x_2)$ (4) All of these

65. A chain of mass M & length 2L is placed on smooth table in case(i). In case (ii) two identical small balls each of mass M is attached at ends with the same chain as shown in the figure.The case in which the chain will leave the edge of table early (chain during its motion touches the table)



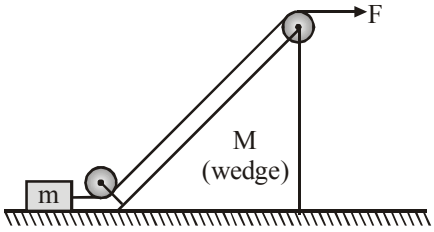
(1) case (i)

(2) case (ii)

(3) both will leave the edge simultaneously

(4) information are insufficient to decide the release

66. In the figure shown, the acceleration of wedge is (Neglect friction)



(1) $\frac{F}{M}$ (2) $\frac{F}{m+M}$

(3) zero (4) $\frac{F}{m}$

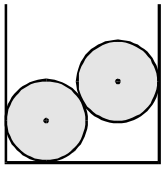
67. Two smooth spheres each of radius 5 cm and weight W rest one on the other inside a fixed smooth cylinder of radius 8 cm. The reactions between sphere and vertical side of the cylinder & between the two spheres are :-

(1) W/4 & 3 W/4

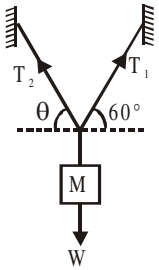
(2) W/4 & W/4

(3) 3W/4 & 5 W/4

(4) W & W



68. A weight W is supported by two cables as shown. The tension in the cable making angle θ with horizontal will be minimum, when the value of θ is



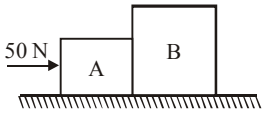
(1) 0

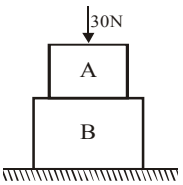
(2) 30°

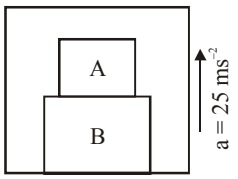
(3) 60°

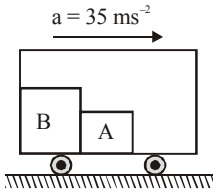
(4) None of these

69. In which of the following cases the contact force between A & B is maximum : ($m_A = m_B = 1kg$)

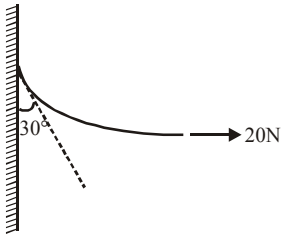
(1) 

(2) 

(3) 

(4) 

70. One end of a rope is fixed to a vertical wall and the other end is pulled by a horizontal force of 20N. The shape of the flexible rope is shown in figure. The mass of the rope is-



(1) 2 kg (2) 3 kg

(3) 3.5 kg (4) 4.5 kg

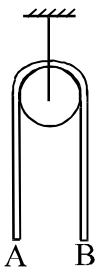
71. A uniform chain of length 2L is hanging in equilibrium position, if end B is given a slightly downward displacement the imbalance causes an acceleration. Here pulley is small and smooth & string is inextensible. The acceleration of end B when it has been displaced by distance x, is :-

(1) $\frac{x}{L}g$

(2) $\frac{2x}{L}g$

(3) $\frac{x}{2}g$

(4) g



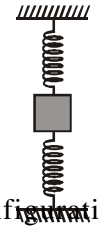
72. A block tied between two identical springs is in equilibrium. If upper spring is cut then the acceleration of the block just after cut is 6 m/s² downwards. Now, if instead of upper spring, lower spring is being cut then the acceleration of the block just after the cut will be.

(1) 4 m/s² downwards

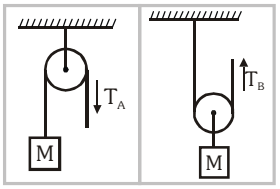
(2) 6 m/s² downwards

(3) 4 m/s² upwards

(4) 6 m/s² upwards



73. Consider the two configurations shown in equilibrium. Find ratio T_A/T_B.
(Ignore the mass of the rope & the pulley)

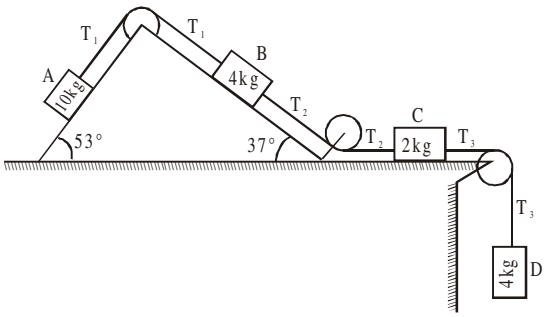


(1) 2:1 (2) 1:2

(3) 3:4 (4) 4:3

Paragraph for Q. 74 to 76

In shown system all surfaces are frictionless. All strings are massless and all pulleys are frictionless and massless. System is released from rest from shown position. [g = 10 m/s²]



74. Acceleration of block C is

(1) 0.6 m/s² towards right

(2) 0.8 m/s² towards left

(3) 0.8 m/s² towards right

(4) $\frac{8}{9}$ m/s² towards left

75. Value of tension T_3 is

(1) 40.3 N (2) 43.2 N

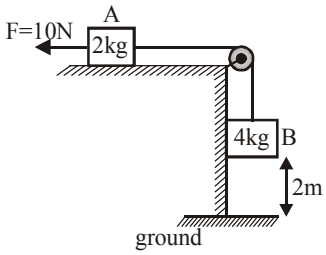
(3) 36.8 N (4) 48.6 N

76. Value of $T_1 + T_2$ is

(1) 44.8 N (2) 78 N

(3) 112.6 N (4) 116.8 N

77. The system shown in the diagram is released from rest. Pulley and string are massless. Neglect friction everywhere. ($g = 10\ ms^{-2}$)



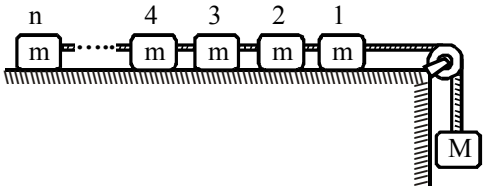
(1) Tension in the string during motion of both blocks is 20N

(2) Acceleration of blocks during motion is $5\ ms^{-2}$

(3) Block B reaches ground in $\frac{2}{\sqrt{5}}$ s

(4) All of the above statements are correct

78. In the given arrangement, n number of equal masses are connected by strings of negligible masses. The tension in the string connected to the n^{th} mass is–



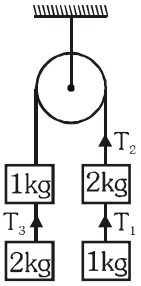
(1) $\frac{mMg}{nm+M}$

(2) $\frac{mMg}{nmM}$

(3) mg

(4) mng

79. In the figure shown all the strings are massless and friction is absent everywhere. Choose the correct option.



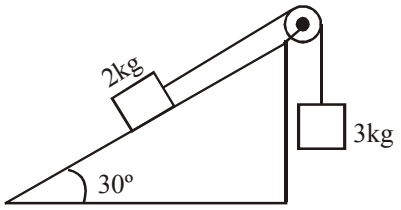
(1) $T_1 > T_2 > T_3$

(2) $T_2 > T_1 > T_3$

(3) $T_2 > T_3 > T_1$

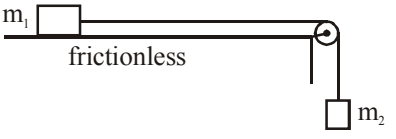
(4) $T_3 > T_2 > T_1$

80. In the arrangement shown, the 2 kg block is held to keep the system at rest. The string and pulley are ideal. When the 2 kg block is set free, by what amount the tension in the string changes? [$g = 10\ m/s^2$]



(1) Increase of 12 N
(2) Decrease of 12 N
(3) Increase of 18 N
(4) Decrease of 18 N

81. In the arrangement shown, the blocks of unequal masses are held at rest. When released, acceleration of the blocks :-



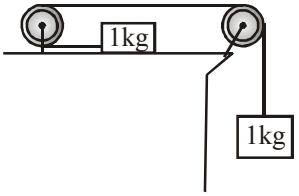
(1) is $\frac{g}{2}$

(2) is g

(3) is between zero and g

(4) could be greater than g

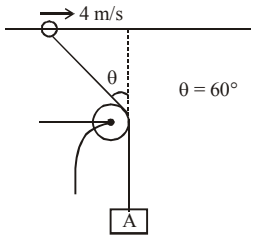
82. Find tension in the string. Surface is frictionless :-



(1) 0 N (2) 1 N

(3) 2 N (4) 5 N

83. For the given fig. find the speed of block A when $\theta = 60°$:-



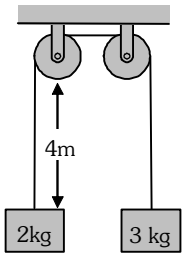
(1) $2\sqrt{3}$ m/s

(2) 4 m/s

(3) 2 m/s

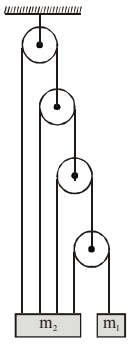
(4) None

84. How long it will take for the 2 kg block to strike the pulley after the system shown is released from rest?



(1) 1 s (2) 2 s (3) 3 s (4) 4 s

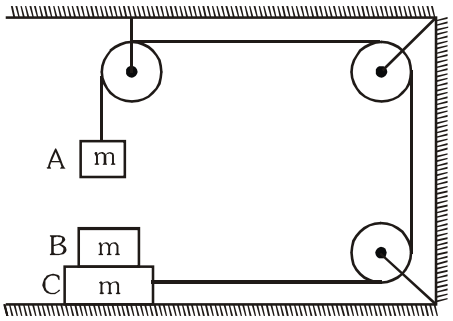
85. If system is in equilibrium then find relation between m_1 and m_2.



(1) $\frac{m_1}{m_2} = \frac{1}{2}$ (2) $\frac{m_1}{m_2} = \frac{1}{15}$

(3) $\frac{m_1}{m_2} = \frac{1}{10}$ (4) $\frac{m_1}{m_2} = 1$

86. Friction is absent everywhere. Find accelerations of blocks A, B and C at shown instant.



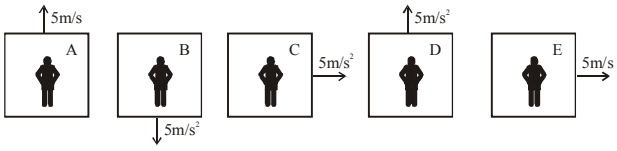
(1) $a_A = \frac{g}{2}; a_B = 0; a_c = \frac{g}{2}$

(2) $a_A = g; a_B = 0; a_c = g$

(3) $a_A = \frac{g}{3}; a_B = \frac{g}{3}; a_c = \frac{g}{3}$

(4) $a_A = \frac{g}{3}; a_B = 0; a_c = \frac{g}{3}$

87. 5 men each of mass 100 kg are travelling in different cars as shown. Choose the correct alternative(s)



(1) pseudo force on A as seen by B will be 500 N.

(2) pseudo force on C as seen by B will be $500\sqrt{2}$ N.

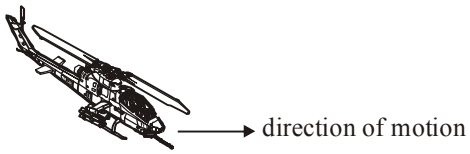
(3) pseudo force on D as seen by B will be 1000 N

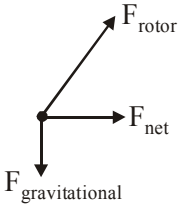
(4) pseudo force on B as seen by E will be 1000 N

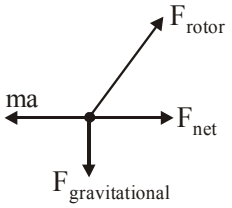
88. There is a long chain containing infinite link. If mass of links of chain is M, $\frac{M}{2}, \frac{M}{4}, \frac{M}{8}$ ....., then the net force on third link is :-

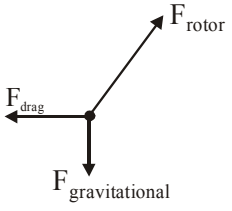
(1) 2F (2) $\frac{F}{2}$ (3) $\frac{F}{4}$ (4) $\frac{F}{8}$

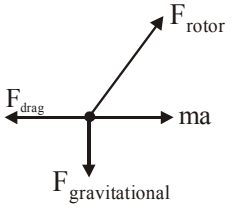
89. A helicopter is moving to the right in horizontal plane. It experiences three forces $\vec{F}_{gravitational}$, $\vec{F}_{drag}$ & upthurst force on it caused by rotor $\vec{F}_{rotor}$ and its net acceleration being 'a'. Which of the following diagrams can be correct free body diagram w.r.t. to a stationary observer on ground?



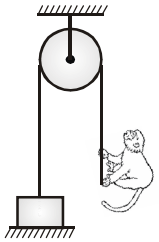
(1)


(2)


(3)


(4)


90. A monkey weighing 10 kg is climbing up a light rope which passes over an ideal pulley. The other end of the rope is attached a 15 kg mass as shown in the figure. In order to raise the 15 kg mass off the ground the monkey should climb up



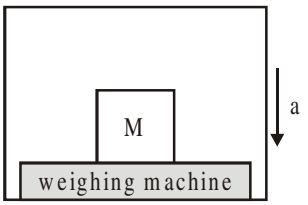
(1) with constant acceleration $\frac{g}{3}$.

(2) with an acceleration greater than $\frac{g}{2}$.

(3) with an acceleration equal to $\frac{g}{4}$.

(4) It is not possible because weight of monkey is lesser than the block.

91. With what acceleration 'a' shown the elevator descends so that the block of mass M exerts a force of $\frac{Mg}{10}$ on the weighing machine :



(1) –0.1 g

(2) 0.1 g

(3) 0.9 g

(4) –0.9 g

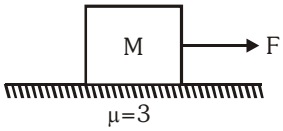
92. A block of mass M placed on rough surface of coefficient of friction equal to 3. If F is the (4/5) of the minimum force required to just move. Find out the force exerted by ground on the block.

(1) 2.6 Mg

(2) Mg

(3) 4 Mg

(4) 3.4 Mg



93. A box is lying on the floor of the carriage of a truck. If the coefficient of friction between the box and floor is 0.2, then max. acceleration of truck so that the box lying on its floor remains stationary, is :-

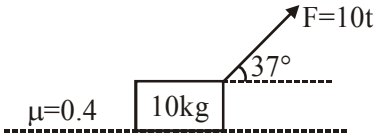
(1) 1 m/s^2

(2) 1.5 m/s^2

(3) 2 m/s^2

(4) None of these

94. A force acts on a block as shown in figure. Find time when block loses contact with surface.



(1) $t = \frac{25}{3}$ s (2) $t = \frac{50}{3}$ s

(3) $t = \frac{100}{3}$ s (4) t = 50 s

95. A block of mass 10 kg is kept on an inclined plane of inclination 30°. If the coefficient of friction between the block and plane's surface is 0.6, then force of friction on block is :-

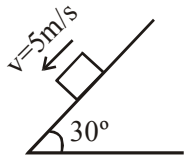
(1) 100 N

(2) 50 N

(3) $30\sqrt{3}$ N

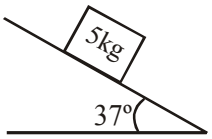
(4) None of these

96. A block of mass 5 kg is moving on rough fixed inclined plane with constant velocity of 5 m/s as shown in figure. Force of friction force acting on block by plane is .



(1) 25 N (2) 20 N (3) 30 N (4) None

97. A block of mass "5kg" is placed on a wedge having inclination of 37° with the horizontal. Coefficient of friction between block and wedge is 0.8. Then select the correct statement:



(1) Friction force between block and the wedge is 32 N.

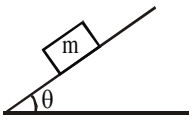
(2) Friction force between block and the wedge is 30 N.

(3) Contact force between block and wedge is 80 N.

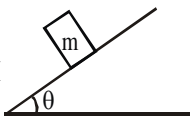
(4) Contact force between block and wedge is 40 N.

98. A block is first placed on its long side and then on its short side on the same inclined plane (see figure). The block slides down in situation II but remains at rest in situation I. A possible explanation is

Situation–I



Situation–II



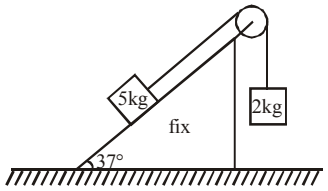
(1) The normal contact force is less in situation-II.

(2) The frictional force is less in situation-II because the contact area is less.

(3) The longer side is smoother.

(4) In situation-I, frictional force is more.

99. In the arrangement shown in figure coefficient of friction between 5kg block and incline plane is $\mu = 0.5$. Friction force acting on the 5kg block is:-



(1) 20 N (2) 15 N (3) 10 N (4) 5N

100. A block takes twice as much time to slide down a 45° rough inclined plane as it takes to slide down a similar smooth plane. The coefficient of friction is:

(1) $\frac{3}{4}$ (2) $\frac{\sqrt{3}}{2}$

(3) $\frac{1}{4}$ (4) $\frac{1}{3}$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	2	3	4	2	2	1	2	3	2	3	3	2	3	3	4	4	1	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	4	3	3	2	3	1	3	2	4	3	1	2	2	3	3	2	4	2	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	1	2	2	4	1	1	3	4	4	3	2	3	2	3	3	4	3	1	1
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	3	4	1	1	3	3	2	2	3	1	1	1	2	2	4	4	1	3	2
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	4	1	2	2	1	1	4	3	2	3	1	3	2	2	1	2	4	3	1

WORK, ENERGY & POWER

1. A force of magnitude of 30 N acting along $\hat{i}+\hat{j}+\hat{k}$, displaces a particle from point (2, 4, 1) to (3, 5, 2). The work done during this displacement is

(1) 90 J (2) 30 J (3) $30\sqrt{3}$ J (4)30/$\sqrt{3}$ J.

2. A ball of mass m is attached to a string whose other end is fixed. The system is free to rotate in vertical plane. When the ball swings, no work is done on the ball by the tension in the string. Which of the following statements is the correct explanation?

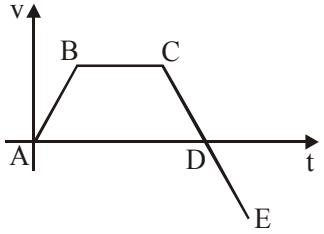
(1) Tension is always perpendicular to the direction of motion of the ball.

(2) Tension is an internal force for the ball.

(3) Tension is an external force for the ball.

(4) Since the ball is swinging about the axis, total displacement is zero.

3. Velocity time graph of a particle is shown in the diagram. Choose the **INCORRECT** option.



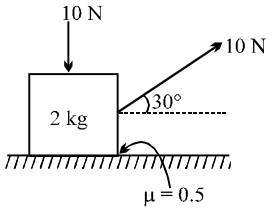
(1) Work done by net force for part AB is positive.

(2) Work done by net force for part BC is zero.

(3) Work done by net force for part DE is negative.

(4) Work done by net force for part CD is negative

4. A body of mass 2 kg is kept on a rough horizontal surface as shown in the figure. Find the work done by frictional force in the time interval t = 0 to t = 5 sec.



(1) zero (2) + 15 J

(3) – 20 J (4) data insufficient

5. A force given by the relation F = 8t, acts on a body of mass 2 kg, initially at rest. Find the work done by this force on the body during first 2 seconds of its motion .

(1) 64 J (2) zero

(3) –64 J (4) none of these

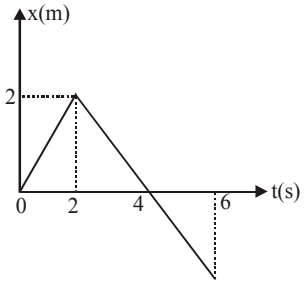
6. Forces acting on a particle have magnitudes of 14N, 7N and 7N and act in the direction of vectors

$6\hat{i}+2\hat{j}+3\hat{k}$, $3\hat{i}-2\hat{j}+6\hat{k}$, $2\hat{i}-3\hat{j}-6\hat{k}$

respectively. The forces remain constant while the particle is displaced from point A: (2, –1, –3) to B: (5, –1, 1). Find the work done. The coordinates are specified in meters.

(1) 75 J (2) 55 J (3) 85 J (4) 65 J

7. Position-time graph of a particle of mass 2 kg is shown in figure. Total work done on the particle from t = 0 to t = 4s is



(1) 8 J

(2) 4 J

(3) 0 J

(4) can't be determined

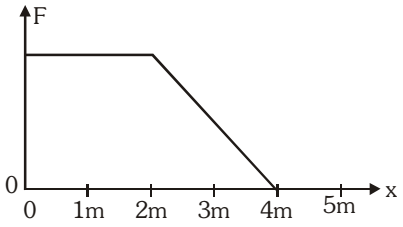
8. In one dimensional motion, a 1 kg object at rest experiences a force, which is a linear function of time t given as F = 2t acting in the direction of motion. The work done by the force in first 4 seconds is

(1) 16 J (2) 32 J (3) 64 J (4) 128 J

9. Force acting on a particle is $(2\hat{i}+3\hat{j})$ N. Work done by this force is zero, when a particle is moved on the line 3y + kx = 5. Here value of k is

(1) 2 (2) 4 (3) 6 (4) 8

10. A body of mass 2.0 kg, free to travel in the x-direction, is subjected to a force directed in the positive x-direction that varies with position as shown in the graph. The force does 9.0 J of work on the body as it moves from x = 0 to x = 5.0 meters. What is the value of F at x = 1.0 meters?



(1) 2 N (2) 3 N (3) 6 N (4) 9 N

11. A particle moves on x-axis such that its KE varies as a relation KE = $3t^2$ then the average kinetic energy of a particle in 0 to 2 sec is given by :

(1) 6 J (2) 8 J (3) 4 J (4) 16 J

12. Two bodies of masses m_1 and m_2 are acted upon by a constant force F for a time t. They start from rest and acquire kinetic energies E_1 and E_2 respectively. Then $\frac{E_1}{E_2}$ is :

(1) $\frac{m_1}{m_2}$ (2) $\frac{m_2}{m_1}$

(3) 1 (4) $\frac{\sqrt{m_1 m_2}}{m_1+m_2}$

13. A force acts on a 3 g particle in such a way that the position of the particle as a function of time is given by $x = 3t - 4t^2 + t^3$, where x is in meters and t is in seconds. The work done during the first 4 second is :-

(1) 384 mJ (2) 168 mJ

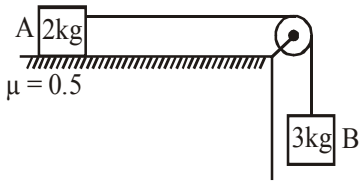
(3) 528 mJ (4) 541 mJ

14. A time dependent force F = 6t acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1 sec. will be :

(1) 9 J (2) 18 J

(3) 4.5 J (4) 22 J

15. The system shown is released at rest. Speed of block A, after block B has descended by 2 cm, is :- (take g = 10 m/s²)



(1) 0.4 m/s (2) 0.5 m/s

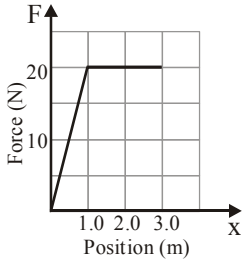
(3) 0.6 m/s (4) 0.8 m/s

16. A block of mass m = $\frac{1}{3}$ kg is kept on a rough horizontal plane. Friction coefficient is μ = 0.75. The work done by minimum force required to drag the block along the plane by a distance 5 m, is :-

(1) 8 J (2) 4 J

(3) 2 J (4) 6 J

17. The graph below shows how the force on a mass depends on the position of the mass. What is the change in the kinetic energy of the mass as it moves from x = 0.0 m to x = 3.0 m?



(1) 0.0 J (2) 20 J (3) 50 J (4) 60 J

18. The only force acting on a block is along x-axis is given by $F = -\left(\frac{4}{x^2+2}\right)N$. When the block moves from x = – 2 m to x = 4 m, the change in kinetic energy of block is -

(1) Positive (2) Negative

(3) Zero (4) May be positive or negative

19. Which of the following forces can never, under any circumstances, does work?

(1) Static friction (2) Tension

(3) Normal (4) None of these

20. A body of mass m dropped from a height h reaches the ground with a speed of $1.4\sqrt{gh}$. The work done by air drag is-

(1) –0.2 mgh (2) –0.02 mgh

(3) –0.04 mgh (4) mgh

21. A particle is projected vertically upwards with a speed of 16 m/s, after some time, when it again passes through the point of projection, its speed is found to be 8 m/s. It is known that the work done by air resistance is same during upward and downward motion. Then the maximum height attained by the particle is (g = 10 m/s^2):

(1) 8 m (2) 4.8 m

(3) 17.6 m (4) 12.8 m

22. A point mass of 0.5 kg is moving along x-axis as $x = t^2 + 2t$, where, x is in meters and t is in seconds. Find the work done (in J) by all the forces acting on the body during the time interval [0, 2s].

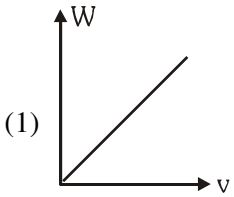
(1) 6 J (2) 7 J

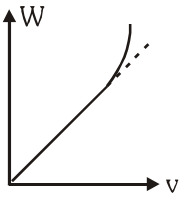
(3) 8 J (4) 9 J

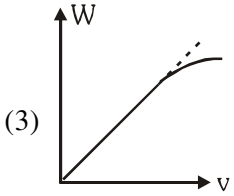
23. A particle of mass 0.01 kg travels along a space curve with velocity given by $4\hat{i}+16\hat{k}$ m/s. After some time its velocity becomes $8\hat{i}+20\hat{j}$ m/s due to the action of a conservative force. The work done on particle during this interval of time is :-

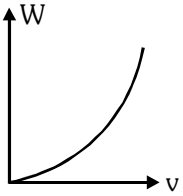
(1) 0.32 J (2) 6.9 J (3) 9.6 J (4) 0.96 J

24. A crate is initially at rest on a horizontal frictionless table. A constant horizontal force F is applied. Which of the following four graphs is a correct plot of work W as a function of the crate's speed v ?

(1) 

(2) 

(3) 

(4) 

25. Select the incorrect statement :

(1) Work done by the friction on him is negative

(2) Work done by the ball on him is negative

(3) Work done by ground on him is zero

(4) Work done by the man on the ball is positive

26. Energy spent by bowler in throwing one ball is :-

(1) 3500 J

(2) 200 J

(3) 4070 J

(4) 3700 J

27. If he accelerates uniformly to the stumps find the average friction force acting on him :-

(1) 750 N

(2) 70.25 N

(3) 90.25 N

(4) 70 N

28. Choose the incorrect statement :

(1) Total work done by internal force does not depend on the choice of reference frame even if they are non conservative

(2) Change in potential energy does not depend on the choice of reference frame

(3) Kinetic energy does not depend on choice of reference frame

(4) Total work done by action & reaction force does not depend on choice of reference frame.

29. A 700-N man jumps out of a window into a fire net 10m below. The net stretches 2m downwards before bringing the man to rest and tossing him back into the air. The maximum potential energy of the net, compared to its unstretched potential energy, is:

(1) 8400 J (2) 5600 J

(3) 1400 J (4) 7000 J

30. The potential energy (in joules) function of a particle in a region of space is given as :

$$U = (2x^2 + 3y^3 + 2z)$$

Here x, y and z are in metres. Find the magnitude of x component of force (in newton) acting on the particle at point P (1m, 2m, 3m).

(1) 2 (2) 3 (3) 0 (4) 4

31. A body (initially at rest) is falling under gravity. When it loses a gravitational potential energy by U, its speed is v. The mass of the body shall be :

(1) $\frac{2U}{v}$ (2) $\frac{U}{2v}$ (3) $\frac{2U}{v^2}$ (4) $\frac{U}{2v^2}$

32. For conservative force field, $\vec{F} = -\frac{\partial U}{\partial x}\hat{i} - \frac{\partial U}{\partial y}\hat{j} - \frac{\partial U}{\partial z}\hat{k}$ where $F \rightarrow$ Magnitude of Force, $U \rightarrow$ Potential energy and $\frac{\partial U}{\partial x}$ = Differentiation of U w.r.t. x keeping y and z constant and so on.

Column – I		Column – II	
(A)	For $U = x^2 yz$, at (5,0,0)	(P)	$F_x = 0$
(B)	For $U = x^2 + yz$ at (5, 0,0)	(Q)	$F_y = 0$
(C)	For $U = x^2 (y+z)$ at (5, 0,0)	(R)	$F_z = 0$
(D)	For $U = x^2y+z$ at (5,0,0)	(S)	U = 0

Choose incorrect matching :-

(1) (A) $\rightarrow$ (P, Q, R, S)

(2) (B) $\rightarrow$ (Q, R)

(3) (C) $\rightarrow$ (P, S)

(4) (D) $\rightarrow$ (P, R, S)

33. A particle with total energy E moves in one direction in a region where, the potential energy is U. The acceleration of the particle is zero, where,

(1) U = E (2) U = 0

(3) $\frac{dU}{dx} = 0$ (4) $\frac{d^2U}{dx^2} = 0$

34. A spring of force constant k is cut in two parts at its one third length. When both the parts are stretched by same amount, the work done in the two parts, will be :-

(1) equal in both

(2) greater for the longer part

(3) greater for the shorter part

(4) data insufficient

35. The potential energy for a force field $\vec{F}$ is given by U(x,y) = cos (x+y). The force acting on a particle at position given by coordinates $\left(0,\frac{\pi}{4}\right)$ is

(1) $-\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$

(2) $\frac{1}{\sqrt{2}}(\hat{i}+\hat{j})$

(3) $\left(\frac{1}{2}\hat{i}+\frac{\sqrt{3}}{2}\hat{j}\right)$

(4) $\left(\frac{1}{2}\hat{i}-\frac{\sqrt{3}}{2}\hat{j}\right)$

36. A particle of mass 5 kg moving in the X-Y plane has its potential energy given by U = (–7x + 24y) J. The particle is initially at origin and has a velocity $\vec{u}=(14.4\hat{i}+4.2\hat{j})$ m/s.

(1) The particle has speed 20 m/s at t = 4 sec

(2) The particle has an acceleration 25 m/s^2

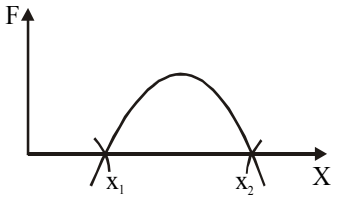
(3) The acceleration of particle is normal to its initial velocity

(4) None of the above each correct

37. The work done in moving a unit mass particle from a point (1,1) to (2,3) in a plane and in a force field with potential V = λ(x + y)

(1) 3λ (2) –3λ (3) 0 (4) λ

38. The force acting on a body moving along x-axis varies with the position of the particle as shown in the figure. The body is in stable equilibrium at :-



(1) $x = x_1$

(2) $x = x_2$

(3) both x_1 and x_2

(4) neither x_1 nor x_2

39. A particle A is projected vertically upwards. Another identical particle B is projected at an angle of 45°. Both reach the same height. The ratio of the initial kinetic energy of A to that of B is-

(1) 1 : 2

(2) 2 : 1

(3) 1 : $\sqrt{2}$

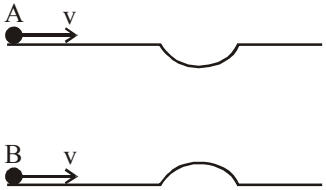
(4) $\sqrt{2}$: 1

40. A particle of mass 2 kg is moving on the x-axis with a constant mechanical energy 20 J. Its potential energy at any x is U = (16 – x^2) J where x is in metre. The minimum velocity of particle is :-

(1) 2 m/s (2) 4 m/s

(3) 6 m/s (4) zero

41. Two marbles A & B roll along two horizontal track with same initial speed. A moves on the track which has a dip and B moves on the track which has a bump of the same shape. Which marble wins? (Assume no marble leaves contact at any point.)



(1) B

(2) A

(3) Both will reach at the same time

(4) None of these

42. When work is done on a body by an external force, then :

(1) Only kinetic energy increases.

(2) Only potential energy increases.

(3) Both kinetic and potential enegies may increase.

(4) Sum of kinetic and potential energies remains constant.

43. In case of an ideal spring, we take the reference point (where potential energy is assumed to be zero) at extension of x_0 instead of taking at natural length. Then potential energy when spring is extended by x is :

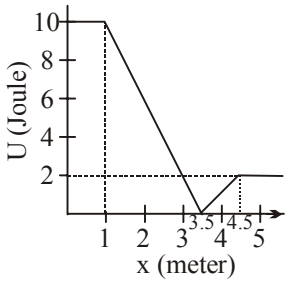
(1) $\frac{1}{2}k\left(x-x_0\right)^2$

(2) $\frac{1}{2}k\left(x^2-x_0^2\right)$

(3) $\frac{1}{2}k\left(x^2-2xx_0\right)$

(4) $\frac{1}{2}k\left(2xx_0-x^2\right)$

44. A body with mass 2 kg moves in one direction in the presence of a force which is described by the potential energy graph. If the body is released from rest at x = 2m, then its speed when it crosses x = 5 m is :-



(1) zero (2) 1 ms^{-1}

(3) 2 ms^{-1} (4) 3 ms^{-1}

45. Select the correct alternative

(1) Work done by kinetic friction on a body always results in a loss of its kinetic energy.

(2) Work done on a body, in the motion of that body over a close loop is zero for every force in nature.

(3) Total mechanical energy of a system is always conserved no matter what type of internal and external forces on the body are present.

(4) When total work done by a conservative force on the system is positive then the potential energy associated with this force decreases.

46. Which of the following statements is/are **INCORRECT**?

(a) Mechanical energy is the sum of kinetic energy and potential energy.

(b) Potential energy is a relative quantity. It depends on the choice of reference point.

(c) Kinetic energy must be non negative.

(d) Potential energy must be positive.

(1) (b) only

(2) (a) and (b) only

(3) (d) only

(4) (c) and (d) only

47. A particle of mass 2kg is moving under influence of a force which always act towards the centre & whose potential energy is given by $U(r) = 2r^3$ joule. If the particle is moving in a circular orbit of radius r = 5m, find its energy.

(1) 500 J

(2) –150 J

(3) 250 J

(4) 625 J

48. Power supplied to a particle of mass 2 kg varies with time as $P = \frac{3t^2}{2}$ W. Here, t is in second. If velocity of particle at t = 0 is v = 0. The velocity of particle at time t = 2s will be :-

(1) 1 m/s (2) 4 m/s

(3) 2 m/s (4) $2\sqrt{2}\,m/s$

49. A force (F) acting on a body is dependent on its displacement (s) as $F \propto s^{-1/3}$. Therefore, the power delivered by the force varies with its displacement as

(1) $s^{2/3}$ (2) $s^{1/2}$ (3) $s^{-5/3}$ (4) s^0

50. A particle of mass 1 kg moves in a circular path of radius 1m such that its speed varies with time as per equation $v = 3t^2$ m/s where time t is in seconds. The power delivered by the force acting on the particle at t = 1s, is :-

(1) 36 W (2) 20 W

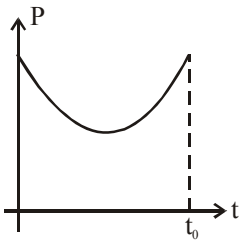
(3) 18 W (4) Zero

51. A small block is attached to a source supplying constant power to it. If its displacement at t = 4sec is 16m on a horizontal smooth surface then its displacement at t = 9sec will be :-

(1) 36 m (2) 48 m

(3) 64 m (4) 54 m

52. Power versus time graph for a given force is given below. Work done by the force upto time $t(\leq t_0)$.



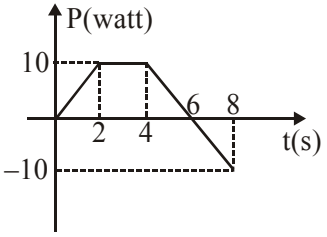
(1) First decreases then increases

(2) First increases then decreases

(3) Always increases

(4) Always decreases

53. Power due to a force acting on a block varies with time t as shown in figure. Then angle between force acting on the block and its velocity is :-



(1) Obtuse at t = 1s (2) 90° at t = 3s

(3) Acute at t = 7s (4) 90° at t = 6s

54. A toy car can deliver a constant power of 20W. The resistive force on the car is αv ,where v is velocity of car in m/s. If maximum velocity of car is 2m/s, the value of α is.

(1) 10 kg/s (2) 5 kg/s

(3) 15 kg/s (4) 5 kg/s^2

55. An escalator is used to move 5 people (60 kg each) per minute from the first floor of a department store to the second floor, 20 m above. Neglecting friction calculate the power required ?

(1) 1 kW (2) 2 kW (3) 3 kW (4) 4 kW

56. A force F acting on a body depens on its displacement x as $F \propto x^n$. The power delivered by F will be independent of x if n is–

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

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

57. An elevator can carry a maximum load of 1800 kg (elevator + passengers) is moving up with a constant speed of 2 ms^{-1}. The frictional force opposing the motion is 4000 N. What is minimum power delivered by the motor to the elevator ?

(1) 22 kW **(2)** 44 kW

(3) 66 kW (4) 88 kW

58. A sports car accelerates from zero to a certain speed in *t* seconds. How long does it take for it to accelerate to twice that speed starting from rest, assuming the power of the engine to be constant (independent of velocity) and neglecting any resistance to motion?

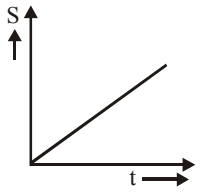
(1) $\sqrt{2}$ t sec. (2) 2t sec.

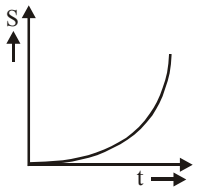
(3) 3t sec. (4) 4t sec.

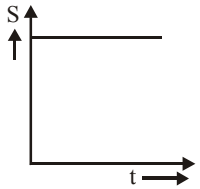
59. A body is moved along a straight line by a machine delivering a constant power. The distance moved by the body in time t is proportional to :-

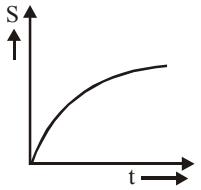
(1) $t^{3/4}$ (2) $t^{3/2}$ (3) $t^{1/4}$ (4) $t^{1/2}$

60. A body is moving unidirectionally under the influence of a source of constant power supplying energy. Which of the diagram shown in figure correctly show the displacement-time curve for its motion ?

(1) 

(2) 

(3) 

(4) 

61. A train of mass 100 metric tons is ascending uniformly on an incline of 1 in 250, and the resistance due to friction, etc is equal to 6 kg per metric ton. If the engine be of 7.84×10^4 watts and be working at full power, find the speed at which the train is going.

(1) 2 m/s (2) 16 m/s (3) 8 m/s (4) 10 m/s

62. A particle of mass m is moving in a circular path of constant radius r such that its centripetal acceleration a_c is varying with time t as $a_c = k^2rt^2$ where k is a constant. The power delivered to the particle by the force acting on it :-

(1) $2\pi mk^2r^2$ (2) mk^2r^2t

(3) $\frac{mk^4r^2t^5}{3}$ (4) zero

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	3	1	1	1	3	4	1	2	3	2	3	3	1	1	3	2	4	2
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	3	4	4	1	3	2	1	1	4	3	4	3	3	2	3	2	2	1	1
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	2	3	4	3	4	3	4	3	4	3	4	2	1	2	2	4	2	2
Que.	61	62																		
Ans.	3	2																		

CIRCULAR MOTION

1. A particle is moving with a velocity of $\vec{v} = (3\hat{i} + 4t\hat{j})\,m/s$. Find the ratio of tangential acceleration to that of normal acceleration at t = 1 sec.

(1) 4/3 (2) 3/4 (3) 5/3 (4) 3/5

2. In a circular motion of a particle, the tangential acceleration of the particle is given by a_t = 9 m/s^2. The radius of the circle is 4 m. The particle was initially at rest. Time after which acceleration of the particle makes an angle of 45° with the radial acceleration is :

(1) $\frac{1}{3}$ sec (2) $\frac{2}{3}$ sec

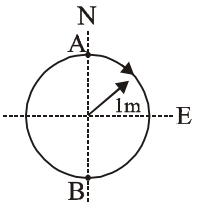
(3) 1 sec (4) $\frac{4}{3}$ sec

3. If the radii of circular path of two particles are in the ratio of 1 : 2, then in order to have same centripetal acceleration their speeds should be in the ratio of :-

(1) 1 : 4 (2) 4 : 1

(3) $1:\sqrt{2}$ (4) $\sqrt{2}:1$

4. In one second a particle moves with constant speed from point A to point B along the circular track of radius 1.0 m as shown in the figure. What is the average acceleration of the particle during this motion.



(1) 2π m/s^2 due east

(2) π m/s^2 due west

(3) Zero

(4) 2π m/s^2 due west

5. A particle is moving on a circular path such that at any instant its position vector, linear velocity, angular velocity, angular acceleration with respect to centre are $\vec{r}, \vec{v}, \vec{\omega}, \vec{\alpha}$ respectively. Net acceleration of the particle is :-

(1) $(\vec{\omega}\times\vec{v}) - (\vec{r}\times\vec{\alpha})$

(2) $(\vec{\omega}\times\vec{v}) + (\vec{r}\times\vec{\alpha})$

(3) $(\vec{v}\times\vec{\omega}) + (\vec{r}\times\vec{\alpha})$

(4) $(\vec{v}\times\vec{\omega}) - (\vec{r}\times\vec{\alpha})$

6. A car is moving on circular path of radius 100 m such that its speed is increasing at the rate of 5 m/s^2. At t = 0 it starts from rest. What is the radial acceleration of car at the instant it makes one complete round trip ?

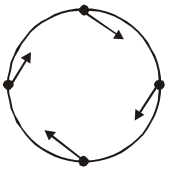
(1) 20π ms^{-2}

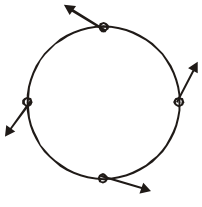
(2) 10π ms^{-2}

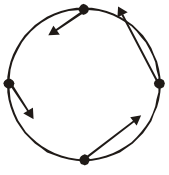
(3) 5π ms^{-2}

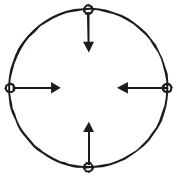
(4) None of these

7. A car speeds up in a circular path, which of the following figure illustrates the acceleration of the car?

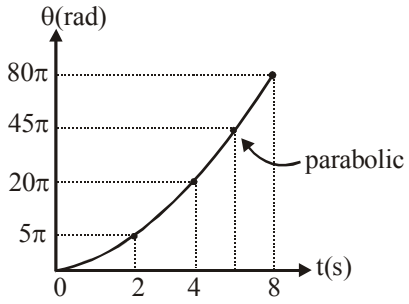
(1) 

(2) 

(3) 

(4) 

8. The angular displacement(θ) of the blades of a ceiling fan, when the fan is switched on at t = 0, is shown in figure. The average angular velocity of the fan blades during the first 8 seconds will be



(1) 40π rad/s (2) 20π rad/s

(3) 10π rad/s (4) 5π rad/s

9. An aeroplane flying at constant speed 115 m/s towards east, makes a gradual turn following a circular path to fly south. The turn takes 15 seconds to complete. The magnitudes of the centripetal acceleration and average acceleration during the turn, are

(1) $\frac{23\sqrt{2}}{3}\text{m/s}^2, \frac{23\sqrt{2}}{3}\text{m/s}^2$

(2) $\frac{46\pi}{3}\text{m/s}^2, \frac{23\sqrt{2}}{3}\text{m/s}^2$

(3) $\frac{23\pi}{6}\text{m/s}^2, \frac{23\sqrt{2}}{3}\text{m/s}^2$

(4) none of these

10. The track of motorcycle-race is circular and unbanked. There are two bikers on the road, one travels along a path of greater radius than the other. They both lean towards the centre at the same angle. Which one completes the circular path in less time?

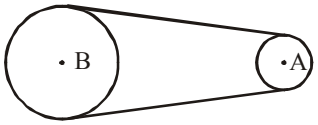
(1) biker having path of smaller radius.

(2) biker having path of larger radius.

(3) both will complete circle in same time.

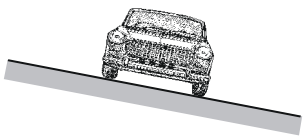
(4) Both can not lean at same angle if radius is different.

11. A wheel of radius 0.1 m (wheel A) is attached by a non stretching belt to a wheel of radius 0.2 m (wheel B). The belt does not slip. By the time, wheel B turns through one revolution, wheel A will rotate through x revolution. Find the value of x.



(1) 6 (2) 4 (3) 2 (4) 0

12. At a turn a track is banked for optimum speed of 40 km/h. At the instant shown in the figure a car is traveling out of the plane of the figure.



If the car travels at 60 km/h, the net frictional force acting on the wheels must be

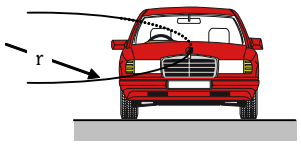
(1) static in nature and point downward along the bank of the track for safe driving.

(2) static in nature and points upward along the bank of the track for safe driving.

(3) kinetic in nature and points upward along the bank of the track for safe driving.

(4) kinetic in nature and points downwards along the bank of the track for safe driving.

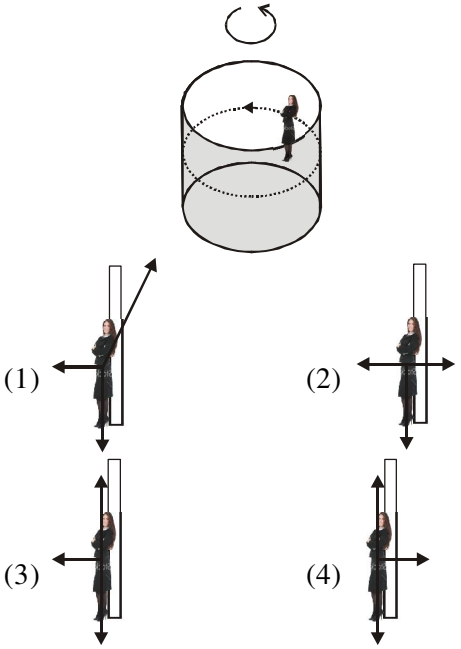
13. Two-wheeler can tilt while turning, but four-wheeler cannot. Estimate maximum safe speed of a four-wheeler on turn of radius 10 m assuming coefficient of static friction between tires and the flat road to be 0.64 and acceleration due to gravity to be 10 m/s^2.



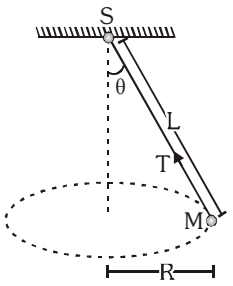
(1) 6.4 m/s (2) 2.8 m/s

(3) 8 m/s (4) 10 m/s

14. A girl finds herself stuck with her back to the wall of a cylinder rotating about its axis. Which diagram correctly shows the forces acting on her?



15. A string of length L is fixed at one end and carries a mass M at the other end. The string makes $2/\pi$ revolutions per second around the vertical axis through the fixed end as shown in the figure, then tension in the string is



(1) ML (2) 2 ML

(3) 4 ML (4) 16 ML

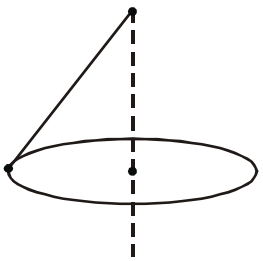
16. When a ball at rest hangs by a single vertical string, tension in the string is mg. If the ball is made to move in a horizontal circle so that the string describes a cone, string tension

(1) is mg.

(2) is greater than mg, always.

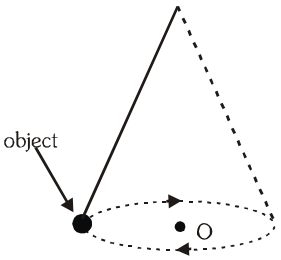
(3) is less than mg, always.

(4) may be greater or less than mg depending on the speed of the ball.



17. A small object, suspended by a string, rotates with constant speed, in a horizontal circle as shown in the figure. Point O is at the centre of the circle. Neglect air drag.

Which one of the following statements is correct?



(1) The object is in equilibrium.

(2) There is a resultant force on the object directed away from O.

(3) A force acts on the object in the direction of its motion.

(4) There is a resultant force on the object directed towards O.

18. A circular road of radius r is banked for a speed v = 40 km/hr. A car of mass m attempts to go on the circular road. The friction coefficient between the tyre and the road is negligible.

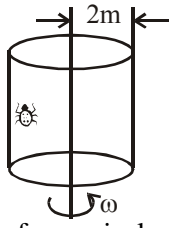
(1) The car cannot make a turn without skidding

(2) If the car turns at a speed less than 40 km/hr, it will slip up

(3) If the car turns at the correct speed of 40 km/hr, the force by the road on the car is equal to $\frac{mv^2}{r}$

(4) If the car turns at the correct speed of 40 km/hr, the force by the road on the car is greater than mg as well as greater than $\frac{mv^2}{r}$

19. An insect of mass m = 3 kg is inside a vertical drum of radius 2 m that is rotating with an angular velocity of 5 rad/sec. The insect does not fall off, then the minimum co-efficient of friction required is :



(1) 0.5
(2) 0.4
(3) 0.2
(4) none of these

20. The length of the string of a conical pendulum is ℓ and the mass of the bob is m. The point of support is at a height h above the horizontal plane in which the bob revolves. The tension in the string is :-

(1) $\frac{mg\ell}{h}$ (2) $\frac{mg\sqrt{\ell^2-h^2}}{\ell}$

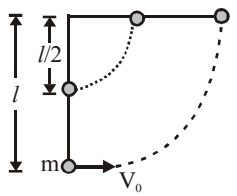
(3) $\frac{mgh}{\ell}$ (4) $\frac{mg\ell}{\sqrt{\ell^2-h^2}}$

21. A circular curve of a highway is designed for traffic moving at 72 km/h. If the radius of the curved path is 100 m, the correct angle of banking of the road should be given by :

(1) $\tan^{-1}\frac{2}{3}$ (2) $\tan^{-1}\frac{3}{5}$

(3) $\tan^{-1}\frac{2}{5}$ (4) $\tan^{-1}\frac{1}{4}$

22. A light rod of length ℓ is pivoted at the upper end. Two masses (each m), are attached to the rod, one at the middle and the other at the free end. What horizontal velocity must be imparted to the lower end mass, so that the rod may just take up the horizontal ?



(1) $\sqrt{\frac{6\ell g}{5}}$ (2) $\sqrt{\frac{\ell g}{5}}$ (3) $\sqrt{\frac{12\ell g}{5}}$ (4) $\sqrt{\frac{2\ell g}{5}}$

23. A body crosses the top most point of a vertical circle with critical speed. What will be its centripetal acceleration when the string is horizontal :-

(1) g (2) 2g (3) 3g (4) 6g

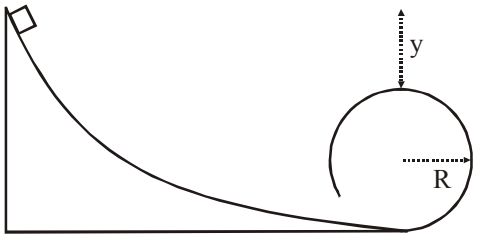
24. A particle is moving in a vertical circle the tension in the string when passing through two position at angle 30° & 60° from vertical from lowest position are T_1 & T_2 respectively :-

(1) $T_1 = T_2$ (2) $T_1 > T_2$ (3) $T_1 < T_2$ (4) $T_1 \geq T_2$

25. For a particle rotating in a vertical circle with uniform speed, the maximum and minimum tension in the string are in the ratio 5 : 3. If the radius of vertical circle is 2 m, the speed of revolving body is ($g = 10\ m/s^2$)

(1) $\sqrt{5}$ m/s (2) $4\sqrt{5}$ m/s
(3) 5 m/s (4) 10 m/s

26. A small object of mass m starts from rest at the position shown and slides along the frictionless loop-the-loop track of radius R. What is the smallest value of y such that the object will slide without losing contact with the track?



(1) R/2 (2) R (3) R/4 (4) 3R/4

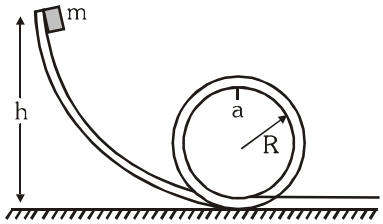
27. A weightless thread can bear a tension upto 3.7 kg-wt. A stone of mass 500 g is tied to it and revolved in a circular path of radius 4 m in a vertical plane. If $g = 10\ ms^{-2}$, then the maximum angular velocity of the stone will be:-

(1) 4 rad s^{-1} (2) 16 rad s^{-1}
(3) $\sqrt{21}$ rad s^{-1} (4) 2 rad s^{-1}

28. A bead is arranged to move with constant speed around a loop that lies in a vertical plane. The magnitude of the net force on the bead is

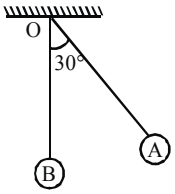
(1) maximum at the bottom
(2) maximum at the top
(3) maximum at the side points
(4) the same at all points

29. An object of mass m is released from rest at a height h above the surface of a table. The object slides along the inside of the loop. The loop track consisting of a ramp and a circular loop of radius R shown in the figure. Assume that the track is frictionless. When the object is at the top of the circular track it pushes against the track with a force equal to three times its weight. What height was the object dropped from ?



(1) 3R (2) 4R (3) 5R (4) 6R

30. A pendulum is released from rest from the point A as shown in the figure. The string of the pendulum is taut. OA makes an angle 30° with the vertical. The acceleration of the pendulum bob at this instant would be



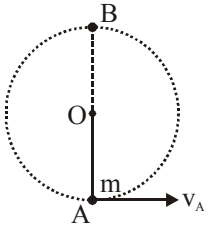
(1) along $\overrightarrow{AO}$

(2) along the vertical

(3) in a direction perpendicular to OA

(4) In a direction making an angle less than 30° with the vertical

31. A small ball of mass m is suspended from a light rod as shown. The ball is given a horizontal velocity at A equal to twice the minimum velocity required by the ball to complete the loop. Find the tension in the rod when the ball passes through the topmost point:-



(1) 15 mg (2) mg (3) 11 mg (4) 12 mg

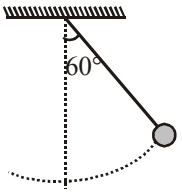
32. In vertical circular motion of a bob, match the entries of list–I with entries of list–II. Here v_0 is the velocity of bob at lowest point & T is tension in string.

	List-I (speed at lowest point)	**List-II (possible situation)**
(P)	$v_0 = \sqrt{5g\ell}$	(1) $T_{lowest} = 6mg$
(Q)	$v_0 = \sqrt{g\ell}$	(2) string will slack for a finite time
(R)	$v_0 = 2\sqrt{g\ell}$	(3) bob will oscillate
(S)	$v_0 = 3\sqrt{g\ell}$	(4) $T_{highest} = 4mg$

Code

	P	**Q**	**R**	**S**
(1)	1	2	3	4
(2)	4	2	3	1
(3)	1	3	2	4
(4)	4	3	2	1

33. A pendulum of length ℓ = 1m is released from $\theta_0 = 60°$. The rate of change of speed of the bob at $\theta = 30°$ is ($g = 10\ m/s^2$) :-



(1) $5\sqrt{3}\ m/s^2$ (2) 2.5 m/s^2

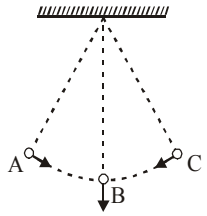
(3) 10 m/s^2 (4) 5 m/s^2

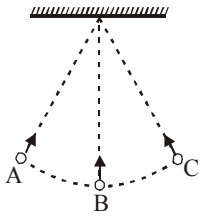
34. A weightless thread can withstand tension upto 30 N. A stone of mass 0.5 kg is tied to it and is revolved in a circular path of radius 2m in a vertical plane. If $g = 10\ m/s^2$, then the maximum angular velocity of the stone can be:–

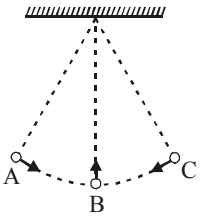
(1) 5 rad/s (2) $\sqrt{30}$ rad/s

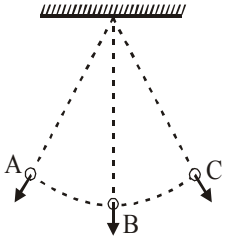
(3) $\sqrt{60}$ rad/s (4) 10 rad/s

35. A simple pendulum of mass m swings about point B between extreme positions A and C. Net force acting on the bob at these three points is correctly shown by

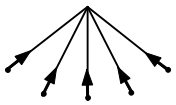
(1) 

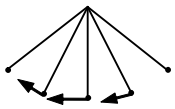
(2) 

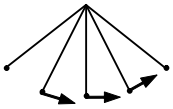
(3) 

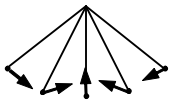
(4) 

36. Which of the following figures best illustrates the acceleration of a pendulum bob at different points between two extreme positions?

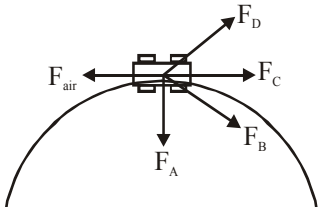
(1) 

(2) 

(3) 

(4) 

37. A car travels with constant speed on a circular road on level ground. In the diagram above, F_{air} is the force of air resistance on the car. Which of the other forces shown, best represents the horizontal force of the road on the car's tires?



(1) F_A (2) F_B (3) F_C (4) F_D

38. In non uniform circular motion rate of work done by force acting on particle is

(1) zero (2) non zero

(3) both (1) & (2) (4) none of these

39. If the overbridge is concave instead of being convex, the thrust on the road at the lowest position will be :-

(1) $mg + \frac{mv^2}{r}$

(2) $mg - \frac{mv^2}{r}$

(3) $\frac{m^2v^2g}{r}$

(4) $\frac{v^2g}{r}$

40. When a bus suddenly take a turn, the passengers are thrown outwards because of :-

(1) speed of motion

(2) inertia of motion

(3) acceleration of motion

(4) none of these

41. A car with closed windows takes a left turn. A helium filled balloon in the car will be pushed to the (as seen from car)

(1) right (2) left (3) front (4) back

42. A particle of mass m is observed from an inertial frame of reference, and is found to move in a circle of radius r with a uniform speed v. The centrifugal force on it is

(1) $\frac{mv^2}{r}$ towards the centre

(2) $\frac{mv^2}{r}$ away from the centre

(3) $\frac{mv^2}{r}$ along the tangent through the particle

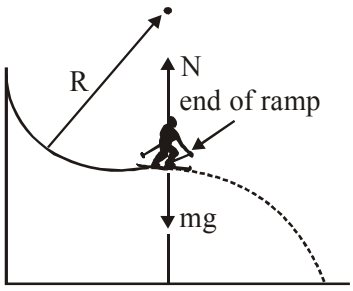
(4) Zero

43. A particle is projected with velocity u horizontally from the top of a fixed smooth sphere of radius 'a' so that it slides down the outside of the sphere. If the particle leaves the sphere when it has fallen a vertical distance $\left(\frac{a}{4}\right)$, the value of u is

(1) $\sqrt{ag}$ (2) $\sqrt{2ag}$

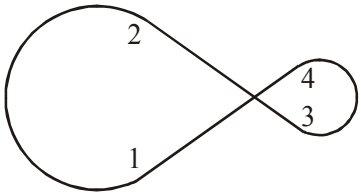
(3) $\frac{\sqrt{ag}}{2}$ (4) $\frac{3\sqrt{ag}}{2}$

44. A skier of mass M slides down a ramp shaped as a circle of radius R . At the end point of the ramp just before the skier is in the air, the magnitude of the normal force exerted by the ramp on the skier is N. The acceleration due to gravity is g. Then :-



(1) The magnitude of the normal force N is greater than Mg
(2) The magnitude of the normal force N is equal to Mg
(3) The magnitude of the normal force N is less than Mg
(4) The magnitude of the normal force N can be greater than, equal to, or less than Mg depending on the speed of the skier.

45. A car runs at constant speed around the horizontal race track shown in the figure. Over which portion of the track is the magnitude of the acceleration the greatest?



(1) From 1 to 2 (2) From 2 to 3
(3) From 3 to 4 (4) From 4 to 1

ANSWER KEY

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

COLLISIONS AND CENTRE OF MASS

1. A thin rod of length 6 m is lying along the x-axis with its ends at x=0 and x = 6 m. Its linear density (mass/length) varies with x as kx^4. Find the position of centre of mass of rod in meters.

(1) 5 m (2) 3 m (3) 2 m (4) 4 m

2. A man of mass M stands at one end of a plank of length L which lies at rest on a frictional surface. The man walks to the other end of the plank. If mass of the plank is 3M, the distance that man moves relative to the ground is :-

(1) $\frac{L}{4}$ (2) $\frac{3L}{4}$ (3) $\frac{2L}{3}$ (4) $\frac{L}{3}$

3. There are three small particles A, B and C where A & B has mass 5m & m respectively but C is very light and all three particles are moving under their mutual interaction. At t = 0, C is at (2, 3, 5) and at t = 2 sec, C is at (5, –1, 5). If centre of mass of system always lies on C and at t = 2 sec velocity of A is $2\hat{i}$ then velocity of B at this instant. (Assume all units in SI)

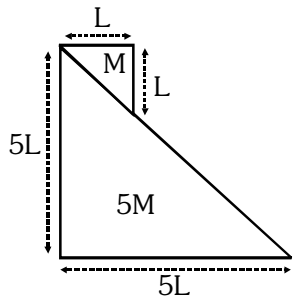
(1) $\left(\hat{i}+\hat{j}\right)$

(2) Zero

(3) $\left(-\hat{i}-12\hat{j}\right)$

(4) Can not find because velocity of centre of mass is not constant

4. In the figure shown, the small prism of mass M slides down on the bigger prism of mass 5M from top of the bigger prism to the bottom of the bigger prism. By what distance does the combination move to the left if the bigger prism initially rests on a frictionless floor.



(1) $\frac{L}{5}$ (2) $\frac{4L}{5}$ (3) $\frac{2L}{3}$ (4) $\frac{L}{6}$

5. A non–zero external force acts on a system of particles. The velocity and acceleration of the centre of mass are found to be v_0 and a_C respectively at any instant t. It is possible that

(i) $v_0=0$, $a_C=0$

(ii) $v_0 \neq 0$, $a_C=0$

(iii) $v_0= 0$, $a_C\neq0$

(iv) $v_0\neq 0$, $a_C\neq0$

Then

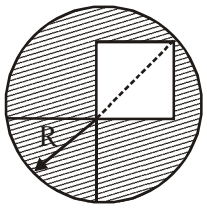
(1) (iii) and (iv) are true.

(2) (i) and (ii) are true.

(3) (i) and (iii) are true.

(4) (ii), (iii) and (iv) are true.

6. From a circular disc of radius R, a square is cut out with a radius as its diagonal. The center of mass of remainder part is at a distance (from the centre):-



(1) $\frac{R}{(4\pi-2)}$

(2) $\frac{R}{2\pi}$

(3) $\frac{R}{(\pi-2)}$

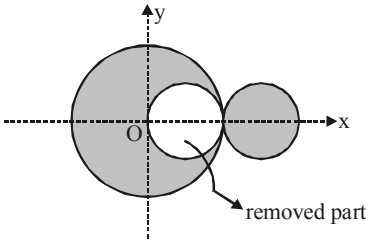
(4) $\frac{R}{(2\pi-2)}$

7. A uniform thin rod AB of length L has linear mass density $\mu(x) = a + \frac{bx}{L}$, where x is measured from A. If the CM of the rod lies at a distance of $\left(\frac{7}{12}L\right)$ from A, then a and b are related as :-

(1) a = b (2) a = 2b

(3) 2a = b (4) 3a = 2b

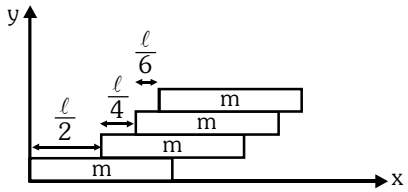
8. Figure shows a disc of radius R = 20 cm with a portion of it removed symmetrically. The removed part is a disc of radius R/2. The removed part is now placed in contact with the larger disc as shown in figure. Disc has uniform mass distribution. With respect to origin at centre of larger disc find x-coordinate of centre of mass of system.



(1) 20cm (2) 10cm

(3) 15cm (4) 5 cm

9. Find the x coordinate of the centre of mass of the bricks shown in figure : (Each rod has length ℓ)



(1) $\frac{24}{25}\ell$ (2) $\frac{25}{24}\ell$

(3) $\frac{15}{16}\ell$ (4) $\frac{16}{15}\ell$

10. Mass centers of a system of three particles of masses 1, 2, 3 kg is at the point (1 m, 2 m, 3 m) and mass center of another group of two particles of masses 2 kg and 3 kg is at point (–1 m, 3 m, –2 m). Where a 5 kg particle should be placed, so that mass center of the system of all these six particles shifts to mass center of the first system?

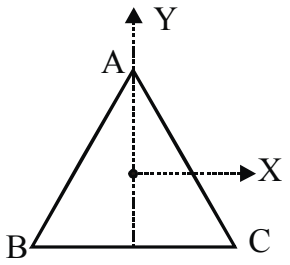
(1) (1 m, –3 m, 2 m)

(2) (3 m, 3 m, 2 m)

(3) (–1 m, 2 m, 3 m)

(4) (3 m, 1 m, 8 m)

11. A uniform wire frame ABC is in the shape of an equilateral triangle in xy-plane with centroid at the origin. Then :-



(1) If AB is removed, the centre of mass of the remaining figure is in fourth quadrant.

(2) If BC is removed, the centre of mass of the remaining figure is on the positive Y-axis.

(3) If AC is removed, the centre of mass of the remaining figure is in third quadrant.

(4) All of above

12. Two equal rods joined at one end are kept on a smooth surface as shown and released. Trajectory of centre of mass of both rods is -

(1) parabola

(2) straight vertical line

(3) straight inclined line

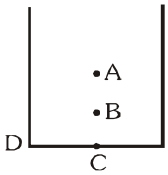
(4) straight horizontal line

13. The centre of mass of a non uniform rod of length L whose mass per unit length varies as $\rho = kx^2/L$ (where k is a constant and x is the distance measured form one end) is at the following distance from the same end.

(1) $\frac{3L}{4}$ (2) $\frac{L}{4}$

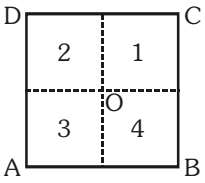
(3) $\frac{2L}{3}$ (4) $\frac{L}{3}$

14. A thick uniform wire is bent into the shape of the letter "U" as shown. Which point indicates the location of the center of mass of this wire? A is the midpoint of the line joining mid points of two parallel sides of 'U' shaped wire.



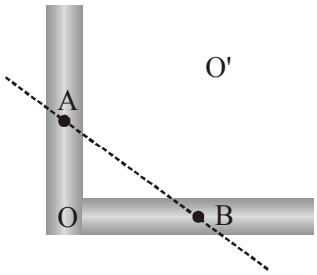
(1) A (2) B (3) C (4) D

15. In the given figure four rods AB, BC, CD and DA have mass m, 2m,3m and 4m respectively. In which of the regions (numberd 1, 2, 3, 4) the centre of mass of system lies?



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

16. Figure shows two cylindrical rods whose center of mass is marked as A and B. Line AB divides the region in two parts one containing point O (region 1) and other containing point O' (region 2). Choose the correct option regarding the center of mass of the combined system ?



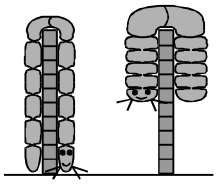
(1) The center of mass of the system lies in region 1

(2) The center of mass of the system lies in region 2

(3) The center of mass of the system lies on line AB

(4) The center of mass of the system may lie in region 1 or region 2 depending on the mass of the rods

17. Two 20 g worms climb over a 10 cm high, very thin wall. One worm is thin and 20 cm long the other is fat and only 10 cm long. What is the ratio of the potential energy (w.r.t. the base of wall) of the thin worm as compared to that of the fat worm when each is half way over the top of the wall as shown?



(1) 1 : 1 (2) 2 : 1

(3) 2 : 3 (4) 1 : 2

18. A cubical block of ice of mass m and edge L is placed in a large tray of mass M. If the ice melts, how far does the centre of mass of the system "ice plus tray" come down ?

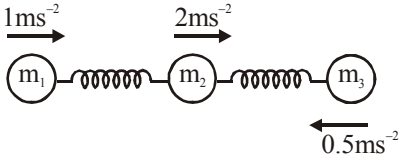
(1) $\frac{mL}{2(m+M)}$ (2) $\frac{2mL}{m+M}$

(3) $\frac{mL}{2m+M}$ (4) $\frac{mL}{m+2M}$

19. The reduced mass of two particles having masses m and 2m is :-

(1) 2m (2) 3m (3) $\frac{2m}{3}$ (4) $\frac{m}{2}$

20. Shown in the figure is a system of three particles having masses m_1 = 1 kg, m_2 = 2 kg and m_3 = 4kg connected by two springs. At an instant, accelerations of these particles are 1 m/s^2, 2 m/s^2 and 0.5 m/s^2 respectively as shown? The external force at this instant acting on the system is



(1) 1 N rightward

(2) 3 N leftward

(3) 3 N rightward

(4) Zero

21. A system of particles consists of several particles. Total mass of all the particles is 10 kg. To apply Newton's laws of motion in centroidal frame to one of the particles of mass 2 kg, you have to assume a pseudo force of $\left(4\hat{i}-2\hat{j}\right)$ N acting on it. What is the net external force acting on the whole system?

(1) $\left(10\hat{i}-20\hat{j}\right)$N

(2) $\left(-10\hat{i}+20\hat{j}\right)$N

(3) $\left(20\hat{i}-10\hat{j}\right)$N

(4) $\left(-20\hat{i}+10\hat{j}\right)$N

22. The linear density of a non-uniform rod of length 2m is given by $\lambda(x)=a(1+bx^2)$ where a and b are constants and $0\le x\le 2$. The centre of mass of the rod will be at, X =

(1) $\frac{3+6b}{6+8b}$

(2) $\frac{6+2b}{3+4b}$

(3) $\frac{3+6b}{3+4b}$

(4) $\frac{(1+2b)}{(3+4b)}$

23. A bullet of mass m moving with velocity v strikes a block of mass M at rest and gets embedded into it. The kinetic energy of the composite block will be :-

(1) $\frac{1}{2}mv^2\times\frac{m}{(m+M)}$

(2) $\frac{1}{2}mv^2\times\frac{M}{(m+M)}$

(3) $\frac{1}{2}mv^2\times\frac{(M+m)}{M}$

(4) $\frac{1}{2}Mv^2\times\frac{m}{(M+m)}$

24. One projectile moving with velocity v in space, gets burst into 2 parts of masses in the ratio 1 : 3. The smaller part becomes stationary. What is the velocity of the other part ?

(1) 4v (2) v

(3) $\frac{4v}{3}$ (4) $\frac{3v}{4}$

25. A body of mass 4m at rest explodes into three fragments. Two of the fragments, each of mass m move with speed v in mutually perpendicular directions.

(1) Total kinetic energy released in the process is mv^2

(2) Total kinetic energy released in the process is $3mv^2/2$

(3) Velocity of third fragment is $\sqrt{2}$ v

(4) Velocity of third fragment is 2v

26. A canon shell moving along a straight line bursts into two parts. One part moves with momentum 20 N-s making an angle 30º with original line of motion. The minimum momentum other part of shell can have is.

(1) 0 N-s

(2) 5 N-s

(3) 10 N-s

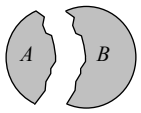
(4) Depends on mass of individual particles.

27. A particle of mass 4m which is at rest explodes into masses m, m and 2m, two of the fragments of masses m and 2m are found to move with equal speed v each in opposite directions. The total mechanical energy released in the process of explosion is

(1) mv^2 (2) $2mv^2$

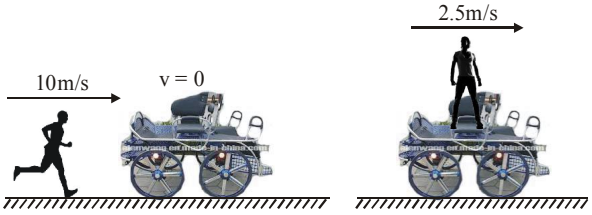
(3) $\frac{1}{2}mv^2$ (4) $4mv^2$

28. A shell in free space initially at rest explodes into two pieces, A and B, which then move in opposite directions. Piece A has less mass than piece B. Ignore all external forces. Identify correct statement ?



(1) Both have the same momentum after the explosion.
(2) Piece B has greater magnitude of momentum after the explosion.
(3) Piece A has greater kinetic energy after the explosion.
(4) Both have the same kinetic energy after the explosion.

29. A 50 kg boy runs at a speed of 10 m/s and jumps onto a cart as shown in the figure. The cart is initially at rest. If the speed of the cart with the boy on it is 2.50 m/s, what is the mass of the cart?
(Assuming friction is absent between cart and ground)



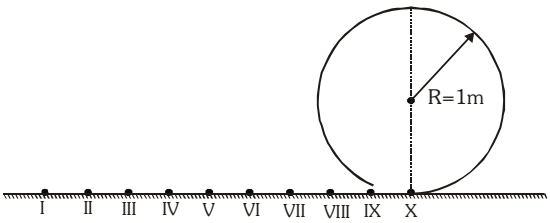
(1) 150 kg (2) 210 kg
(3) 175 kg (4) 260 kg

30. A ball is thrown with a velocity of 6 m/s vertically from a height H = 3.2 m above a horizontal floor. If it rebounds back to same height then coefficient of restitution e is [g = 10 m/s^2]
(1) 0.5 (2) 0.6 (3) 0.7 (4) 0.8

31. A particle strikes a smooth horizontal surface at an angle of 45° with a velocity of 100 m/s and rebounds. If the coefficient of restitution between the floor and the particle is 0.57 then the angle which the velocity of the particle after it rebounds will make with the floor is
(1) 30° (2) 45°
(3) 60° (4) 90°

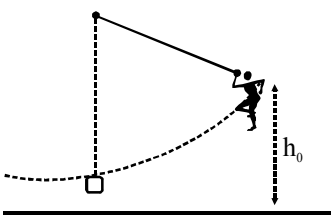
32. Two balls of equal mass have a head-on collision with speed 6 m/s each. If the coefficient of restitution is $\frac{1}{3}$, find the speed of each ball after impact in m/s.
(1) 2 (2) 3 (3) 4 (4) 6

33. There are 10 small identical elastic balls placed at rest on a smooth horizontal surface as shown in figure. Find the least velocity which should be provided to the first ball such that 10th ball completes the circle. [g = 9.8 m/s^2]



(1) 70 m/s (2) 7 m/s
(3) 35 m/s (4) 14 m/s

34. Starting from rest on her swing at initial height h_0 above the ground, Saina swings forward. At the lowest point of her motion, she grabs her bag that lies on the ground. Saina continues swinging forward to reach maximum height h_1. She then swings backward and when reaching the lowest point of motion again, she simple lets go off the bag, which falls freely. Saina's backward swing then reaches maximum height h_2. Neglecting air resistance, how are the three heights related?



(1) $h_0 > h_1 > h_2$ (2) $h_0 = h_1 = h_2$
(3) $h_0 > h_1 = h_2$ (4) $h_0 = h_2 > h_1$

35. A particle is thrown vertically upward with a speed u from the top of a tower of height h from ground level. If after first impact with ground it just reaches to height h from ground the coefficient of restitution for the collision is:-

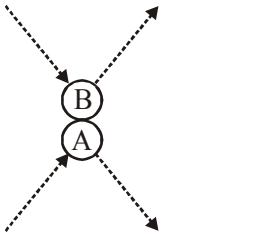
(1) 1

(2) u^2

(3) $\sqrt{\frac{2gh}{u^2+2gh}}$

(4) $\frac{\sqrt{2gh}}{u}$

36. The figure below depicts the paths of two colliding steel balls, A and B. Which of the arrows 1-4 best represents the impulse applied to ball A during the collision?



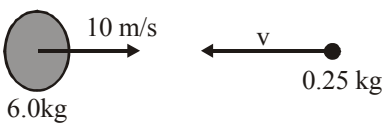
(1) 

(2) 

(3) 

(4) 

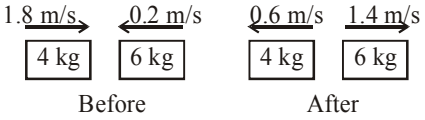
37. A 6.0 kg mass is moving to the right at 10 m/s. A 0.25 kg mass is fired towards left at the larger mass. What speed (v) must the smaller mass have to completely stop both masses?



(1) 4.2 m/s (2) 15 m/s

(3) 150 m/s (4) 240 m/s

38. In figure, determine the character of the collision. The masses of the blocks, and the velocities before and after are given. The collision is



(1) Perfectly elastic

(2) Partially inelastic

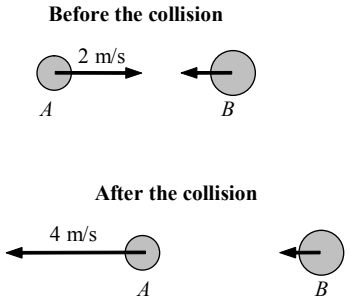
(3) Completely inelastic

(4) This collision is not possible

39. A small sphere of mass 1kg is moving with a velocity $(6\hat{i}+\hat{j})ms^{-1}$. It hits a fixed smooth wall and rebound with velocity $(-4\hat{i}+\hat{j})ms^{-1}$. The coefficient of restitution between the sphere and the wall is-

(1) 3/2 (2) 2/3 (3) 9/16 (4) 4/9

40. Ball A of mass 1 kg moving right with speed 2 m/s bounces off ball B of mass 1.5 kg, and then moves left with speed 4 m/s. Calculate magnitude of impulse (SI Units) received by ball B.



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

41. A mass m_1 moves with a large velocity. It strikes another mass m_2 at rest in a head on elastic collision. It comes back along its path with lesser speed after collision. Then :

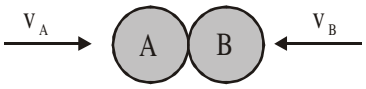
(1) $m_1 > m_2$

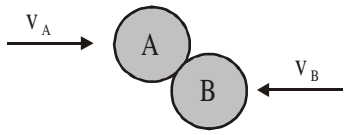
(2) $m_1 < m_2$

(3) $m_1 = m_2$

(4) There is no relation between m_1 and m_2

42. Two bodies, A and B, collide as shown in Figures a and b below.

(a) 

(b) 

Which statement is true?

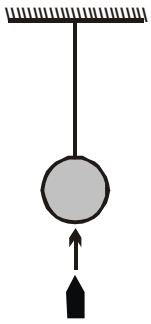
(1) They exert equal and opposite forces on each other in (a) but not in (b).

(2) They exert equal and opposite force on each other in both (a) and (b).

(3) The forces are equal and opposite to each other in (a), but only the components of the forces parallel to the velocities are equal in (b).

(4) The forces are equal and opposite in (a), but only the components of the forces perpendicular to the velocities are equal in (b)

43. A bullet of mass 50 g is fired from below into the bob of mass 450 g of a long simple pendulum as shown in Figure. The bullet stays inside the bob and the bob rises through a vertical height 1.8 m. What was the speed of bullet when it striked the bob?



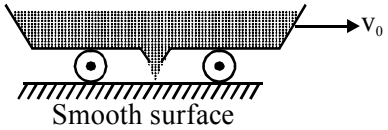
(1) 40 m/sec

(2) 50 m/sec

(3) 60 m/sec

(4) 35 m/sec

44. A trolley filled with sand moves on a smooth horizontal surface with a velocity v_0. A small hole is made at the base of it from which sand is leaking out at constant rate. As the sand leaks out then which of the following is **incorrect**?



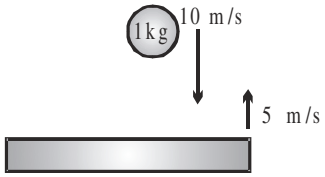
(1) The velocity of the trolley increases

(2) The velocity of the trolley remains constant

(3) The momentum of the trolley is conserved

(4) The momentum of the total system (trolley with sand + leaked out sand) is conserved in horizontal direction

45. A ball of mass 1 kg strikes a heavy platform, elastically, moving upwards with a velocity of 5m/s. The speed of the ball just before the collision is 10 m/s downwards. Then the impulse imparted by the platform on the ball is



(1) 15 N–s (2) 10 N–s

(3) 20 N–s **(4)** 30 N–s

46. A steel ball strikes a fixed smooth steel plate placed on a horizontal surface at an angle θ with the vertical. If the coefficient of restitution is e, the angle at which the rebound will take place is:

(1) θ **(2)** $\tan^{-1}\left[\frac{\tan\theta}{e}\right]$

(3) $e\tan\theta$ (4) $\tan^{-1}\left[\frac{e}{\tan\theta}\right]$

47. A ball of mass m moving with speed u undergoes a head on elastic collision with a ball of mass nm initially at rest. The fraction of the initial energy transferred to the second ball is :-

(1) $\frac{n}{1+n}$

(2) $\frac{n}{(1+n)^2}$

(3) $\frac{2n}{(1+n)^2}$

(4) $\frac{4n}{(1+n)^2}$

48. Two billiard balls P and Q, each of mass 20g and moving in opposite directions with speed of 5 m/s each, collide and rebound with the same speed. If the collision lasts for 10^{-3}sec, which of the following statements are true?

(a) The impulse imparted to each ball is 0.2 N-s

(b) The impulse imparted to each ball is 0.4 N-s and the force exerted on each ball is 400N

(c) The impulse imparted to each ball is 0.4 kgm/s and the force exerted on each ball is 4×10^{-5} N

(d) The impulse and the force on each ball are equal in magnitude and opposite in direction

(1) a & d (2) b & d

(3) c & d (4) b only

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	3	3	1	1	3	4	2	4	4	2	1	2	2	3	3	1	3	3
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	4	3	1	3	2	3	2	3	1	4	1	1	2	3	3	2	4	1	2	3
Que.	41	42	43	44	45	46	47	48												
Ans.	2	2	3	1	4	2	4	1												

ROTATIONAL MOTION

1. A rigid body rotates about a fixed axis with variable angular velocity equal to $\alpha - \beta t$, where t is time and α,β are constants. The angle (in radian) through which it rotates before its stops :-

(1) $\frac{\alpha^2}{2\beta}$ (2) $\frac{\alpha^2-\beta^2}{2\alpha}$

(3) $\frac{\alpha^2-\beta^2}{2\beta}$ (4) $\frac{(\alpha-\beta)\alpha}{2}$

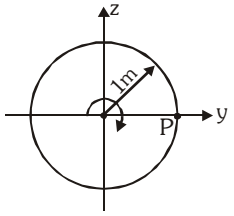
2. A ring rotates about x–axis as shown in figure. The plane of rotation is y–z. At a certain instant the acceleration of the particle P on the ring is $\left(-9\hat{j}-6\hat{k}\right)ms^{-2}$. Find the ratio of magnitude of tangential acceleration to angular velocity $\left(\omega=\frac{v}{R}\right)$.

(1) 2

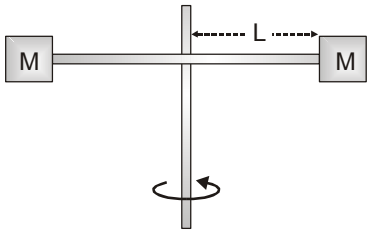
(2) 1.5

(3) 0.5

(4) 0.67



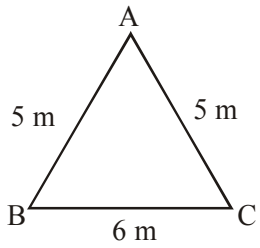
3. Two blocks each of mass M are connected to the ends of a light frame as shown in figure The frame is rotated about the vertical line of symmetry. The rod breaks if the tension in it exceeds T_0. Find the maximum frequency with which the frame may be rotated without breaking the rod.



(1) $\frac{1}{4\pi}\sqrt{\frac{T_0}{ML}}$ (2) $\frac{1}{2\pi}\sqrt{\frac{T_0}{ML}}$

(3) $\frac{1}{6\pi}\sqrt{\frac{2T_0}{3ML}}$ (4) $\frac{1}{2\pi}\sqrt{\frac{3T_0}{2ML}}$

4. A triangular metal sheet of uniform thickness 10 cm and uniform density 5000 kg/m^3. The lengths of sides AB, BC and CA are 5 m, 6 m and 5m respectively. The moment of inertia about the side BC is :



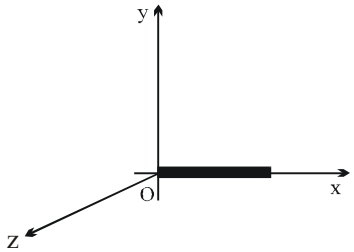
(1) 12×10^3 kgm^2 (2) 14×10^3 kgm^2

(3) 16×10^3 kgm^2 (4) 18×10^3 kgm^2

5. The moment of inertia of a uniform cylinder of length ℓ and radius R about its perpendicular bisector is I. What is the ratio ℓ/R such that the moment of inertia is minimum ?

(1) 1 (2) $\frac{3}{\sqrt{2}}$ (3) $\sqrt{\frac{3}{2}}$ (4) $\frac{\sqrt{3}}{2}$

6. The figure shows a uniform rod lying along the x-axis. The locus of all the points lying on the xy-plane, about which the moment of inertia of the rod is same as that about z axis is



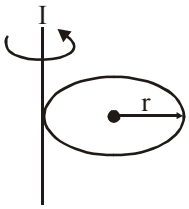
(1) an ellipse (2) a circle

(3) a parabola (4) a straight line

7. Moment of inertia of a rigid body is expressed in units of kg-m^2. There are two rods A and B made of same metal. Both of them have equal cross-sectional area but rod A is double in length as compared to rod B. What is the ratio of moment of inertia of rod A to that of rod B?

(1) 1 (2) 2 (3) 4 (4) 8

8. A solid sphere of radius R has moment of inertia I about its geometrical axis. It is melted into a disc of radius r and thickness t. If it's moment of inertia about the tangential axis (which is perpendicular to plane of the disc), is also equal to I, then the value of r is equal to :-



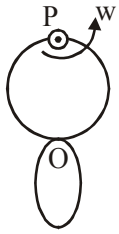
(1) $\frac{2}{\sqrt{15}}R$

(2) $\frac{2}{\sqrt{5}}R$

(3) $\frac{3}{\sqrt{15}}R$

(4) $\frac{\sqrt{3}}{\sqrt{15}}R$

9. Two identical rings each of mass m and radius with their planes mutually perpendicular are welded at their point of contact O. If the system is free to rotate about an axis passing through the point P perpendicular to the plane of the paper, then the moment of inertia of the system about this axis is equal to



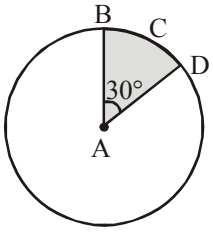
(1) 6.5 mR^2

(2) 12 mR^2

(3) 6 mR^2

(4) 11.5 mR^2

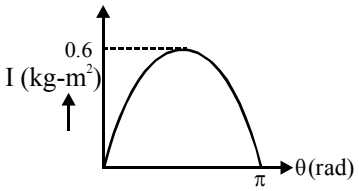
10. The moment of inertia of a uniform flat disc about its own axis is I. The radius of the disc is a. A section ABCD of the disc (as shown in figure) is cut off and separated. The moment of inertia of the remaining part of the disc about the same axis will be



(1) $\frac{5}{6}I$ (2) $\frac{11}{12}I$

(3) $\frac{4}{5}I$ (4) $\frac{2}{3}I$

11. Figure shows the variation of the moment of inertia of a uniform rod, about an axis passing through its centre and inclined at an angle θ to the length. The moment of inertia of the rod about an axis passing through one of its ends and making an angle $\theta = \frac{\pi}{3}$ will be :



(1) 0.45 kg–m^2 (2) 1.8 kg–m^2

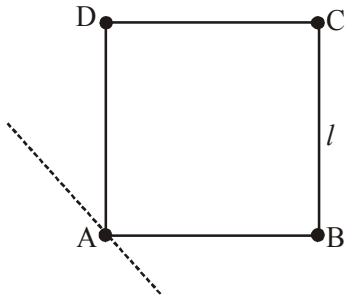
(3) 2.4 kg–m^2 (4) 1.5 kg–m^2

12. Five masses each of 2 kg are placed on a horizontal circular disc, which can be rotated about a vertical axis passing through its centre and all the masses be equidistant from the axis and at a distance of 10 cm from it. The moment of inertia of the whole system (in gm-cm^2) is: (Assume disc is of negligible mass)

(1) 10^5 (2) 10^4

(3) 10^6 (4) 10^8

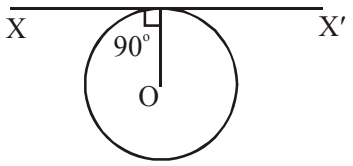
13. Four point masses each of value *m* are placed at the corners of a square ABCD of side *l*. The moment of inertia of this system about an axis passing through A and parallel to BD is :-



(1) $2ml^2$ (2) $\sqrt{3}\,ml^2$

(3) $3\,ml^2$ (4) ml^2

14. A thin wire of length L and uniform linear mass density ρ is bent into a circular loop with centre at O as shown. The moment of inertia of loop about axis XX' is :



(1) $\frac{\rho L^3}{8\pi^2}$ (2) $\frac{\rho L^3}{16\pi^2}$

(3) $\frac{5\rho L^3}{16\pi^2}$ (4) $\frac{3\rho L^3}{8\pi^2}$

15. Two circular Discs of same material and same thickness rotating about their own axis. If ratio of their radii are 1 : 3, then ratio of their moment of inertia about their axis will be :-

(1) 1 : 9 (2) 1 : 81

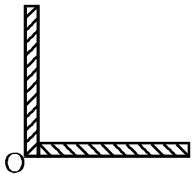
(3) 1 : 27 (4) 1 : 1

16. A wire of length *l* and mass m is bent in the form of a rectangle ABCD with (AB/BC) = 2. The moment of inertia of this wire about the side BC is

(1) $\frac{11}{252}\,ml^2$ (2) $\frac{8}{203}\,ml^2$

(3) $\frac{5}{136}\,ml^2$ (4) $\frac{7}{162}\,ml^2$

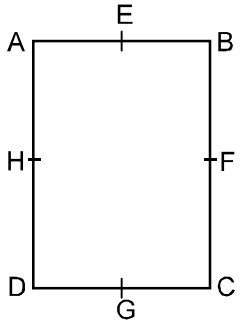
17. Two identical rods each of mass M and length L are kept according to figure. The moment of inertia of rods about an axis passing through O and perpendicular to the plane of rods, is :-



(1) $\frac{1}{3}ML^2$ (2) $\frac{2}{3}ML^2$

(3) $2ML^2$ (4) $\frac{1}{2}ML^2$

18. In a system of four thin uniform rods are each of mass m as shown. If AE = EB, AH = HD and BC = 2 AB then choose the **CORRECT** statement:-



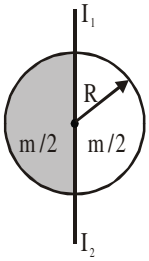
(1) Moment of inertia of the system is minimum about EG

(2) Moment of inertia of the system is maximum about HF

(3) Moment of inertia of the system is minimum about HF

(4) Moment of inertia of the system is maximum about EG

19. A solid hemisphere and a hemispherical shell are joined as shown. Both of them has mass m/2 individually. Find out moment of inertia about axis I_1 I_2 .

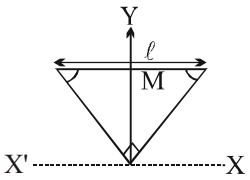


(1) $\frac{8mR^2}{15}$ (2) $\frac{2}{7}mR^2$

(3) $\frac{2}{5}mR^2$ (4) $\frac{2}{3}mR^2$

Paragraph for Questions 20 & 21

The figure shows an isosceles triangular plate of mass M and base L. The angle at the apex is 90°. The apex lies at the origin and the base is parallel to X–axis.



20. The moment of inertia of the plate about its base parallel to the x-axis is

(1) $\frac{ML^2}{18}$ (2) $\frac{ML^2}{36}$

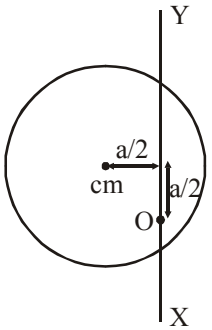
(3) $\frac{ML^2}{24}$ (4) none of these

21. The moment of inertia of the plate about the y-axis is

(1) $\frac{ML^2}{6}$ (2) $\frac{ML^2}{8}$

(3) $\frac{ML^2}{24}$ (4) none of these

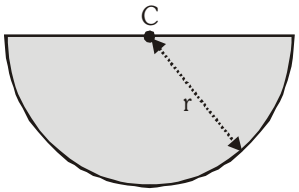
22. The diagram shows a uniform disc of mass M & radius 'a'. If the moment of inertia of the disc about the axis XY is I, its moment of inertia about an axis through O and perpendicular to the plane of the disc is



(1) $\frac{4}{3}Ma^2$ (2) $I + \frac{1}{4}Ma^2$

(3) 2I (4) $\frac{I}{2}$

23. A semicircular lamina of mass m has radius r and centre C. Its centre of mass is at a distance x from C. Its moment of inertia about an axis through its centre of mass and perpendicular to its plane is–



(1) $\frac{1}{2}mr^2$ (2) $\frac{1}{4}mr^2$

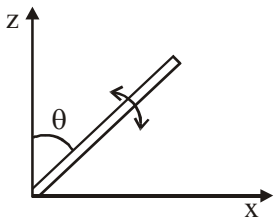
(3) $\frac{1}{4}mr^2 + mx^2$ (4) $\frac{1}{2}mr^2 - mx^2$

24. A square sheet of edge length L is used to form a hollow cylinder. The moment of inertia of this cylinder about the central axis is :-
(Where "σ" is surface mass density of sheet)

(1) $\frac{2\sigma L^4}{\pi^2}$ (2) $\frac{\sigma L^4}{8\pi^2}$

(3) $\frac{\sigma L^4}{4\pi^2}$ (4) $\frac{\sigma L^4}{3\sqrt{2}\pi^2}$

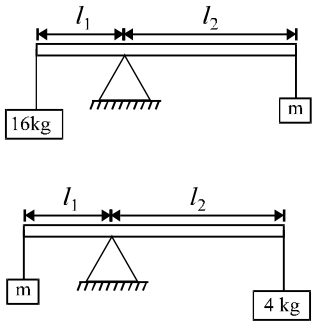
25. A uniform rod of mass M and length ℓ is pivoted at one end so that it can rotate in a vertical plane (see figure). There is negligible friction at the pivot. The free end is held vertically above the pivot and then released. The angular acceleration of the rod when it makes an angle θ with the vertical is :



(1) $\frac{3g}{2\ell}\cos\theta$ (2) $\frac{2g}{3\ell}\cos\theta$

(3) $\frac{3g}{2\ell}\sin\theta$ (4) $\frac{2g}{3\ell}\sin\theta$

26. In an experiment with a beam balance an unknown mass m is balanced by two known masses of 16 kg and 4 kg as shown in figure.



Find the value of the unknown mass m in kg.

(1) 2 kg (2) 4 kg (3) 8 kg (4) 12 kg

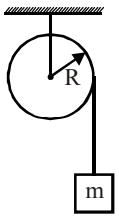
27. A mass m = 1 kg hangs from the wheel of radius R = 1m. When released from rest the mass falls through a height h = 2m in 1 second. The moment of inertia of the wheel is (g = 10 m/s^2):-

(1) 2.6 kg m^2

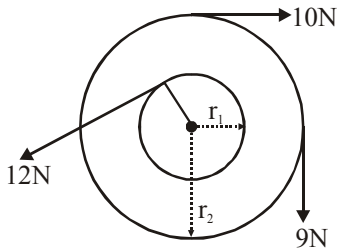
(2) 3.6 kg m^2

(3) 1.5 kg m^2

(4) 3.0 kg m^2



28. In the following figure r_1 and r_2 are 5 cm and 30 cm respectively. If the moment of inertia of the wheel is 5100 kg-m^2 then its angular acceleration will be :-



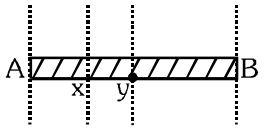
(1) 10^{-4} rad/s^2

(2) 10^{-3} rad/s^2

(3) 10^{-2} rad/s^2

(4) 10^{-1} rad/s^2

29. A rod has non uniform mass distribution. The mass increases uniformly from left end (A) to right end (B). It is most difficult to rotate the rod about an axis



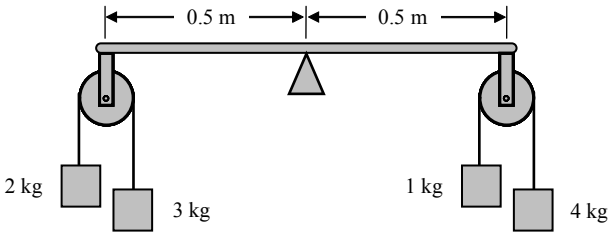
(1) Passing through A

(2) Passing through B

(3) Passing through x

(4) Passing through y

30. In the balance machine shown in the figure, which arm will move downward after the system is released from rest (assuming string, arm of balance machine and the pulley to be light)



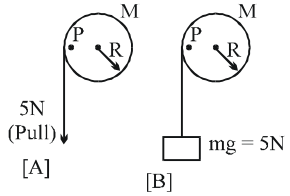
(1) Left

(2) Right

(3) remains stationary

(4) none of these

31. A uniform disc of mass M = 2.50 kg and radius R = 0.20 m is mounted on an axle supported on fixed frictionless bearings. A light cord wrapped around the rim is pulled with a force 5N. On the same system of pulley and string, instead of pulling it down, a body of weight 5N is suspended. If the first process is termed A and the second B, the tangential acceleration of point P will be



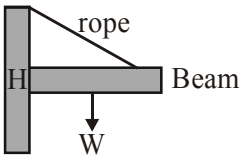
(1) equal in the processes A and B.

(2) greater in process A than in B.

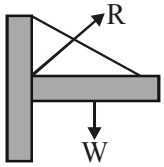
(3) greater in process B than in A.

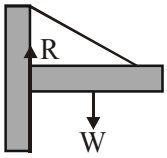
(4) independent of the two processes.

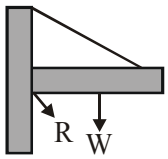
32. A uniform beam of weight W is attached to a vertical wall by a hinge H. The beam is held horizontal by a rope as shown below.

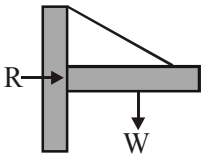


Which one of the following best shows the direction of the reaction force R at the hinge ?

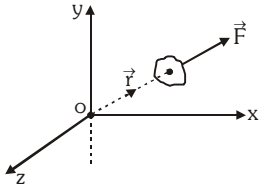
(1) 

(2) 

(3) 

(4) 

33. A body is free to rotate about an axis parallel to y–axis. A force of $\vec{F}=\left(3\hat{i}+2\hat{j}+6\hat{k}\right)N$ is acting on the body the position vector of whose point of application is $\vec{r}=\left(2\hat{i}-3\hat{j}\right)m$. The moment of inertia of body about y–axis is 10 kgm^2. The angular acceleration of body is:-



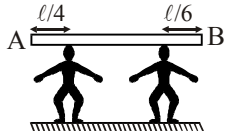
(1) $\left(-1.8\hat{i}-1.2\hat{j}+1.3\hat{k}\right)rad/s^2$

(2) $-1.8\hat{i}$ rad/s^2

(3) $-1.2\hat{j}$ rad/s^2

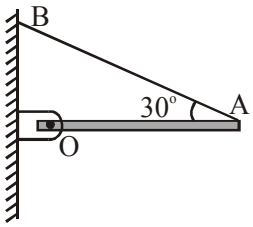
(4) $1.3\hat{k}$ rad/s^2

34. Two persons of equal height are carrying a long uniform wooden beam of length *l*. They are at distance *l*/4 and *l*/6 from nearest end of the rod. The ratio of normal reaction at their heads is



(1) 2 : 3 (2) 3 : 2 (3) 4 : 3 (4) 3 : 4

35. A 10 kg uniform rod OA is pivoted at O on a vertical wall with help of cable AB. Find reaction force applied by pivot.



(1) 100 N (2) $100\sqrt{2}$ N

(3) 50 N (4) $50\sqrt{2}$ N

36. In a physical balance working on the principle of moments, when 5 mg weight is placed on the left pan, the beam becomes horizontal. Both the empty pans of the balance are of equal mass. Which of the following statements is correct ?

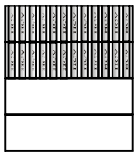
(1) Left arm is longer than the right arm

(2) Both the arms are of same length

(3) Left arm is shorter than the right arm

(4) Every object that is weighed using this balance appears lighter than its actual weight.

37. Same number of books are placed in four book cases as shown. Which bookcase is most likely to topple forward if pulled a little at the top towards right ?

(1) 

(2) 

(3) 

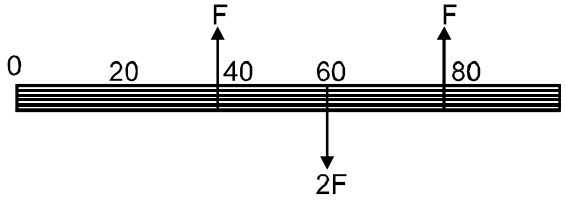
(4) 

38. A car weighs 1800 Kg. The distance between its front and back axles is 1.8 m. Its centre of gravity is 1.05 m behind the front axle. Force exerted by the level ground on each front wheel is :-

(1) 3675 N (2) 7350 N

(3) 5145 N (4) 10290 N

39. Three parallel forces are acting on a rod at distances of 40 cm, 60 cm and 80 cm respectively from one end of the rod (as shown in figure). Assuming no other forces, the rod under the influence of these forces will :-



(1) be at rest

(2) exhibit rotational motion only

(3) exhibit translational motion

(4) exhibit combined rotational and translational motion

40. A person holds a spinning bicycle wheel while sitting stationary on a chair that is free to rotate about a vertical axis. As the person changes the axis of the spinning bicycle wheel, the chair begin to rotate about it axis. The chair's rotation is a result of :

(1) Conservation of angular momentum.

(2) A torque due to the force of gravity.

(3) Conservation of rotational kinetic energy.

(4) The mechanical advantage of double-axis rotational system.

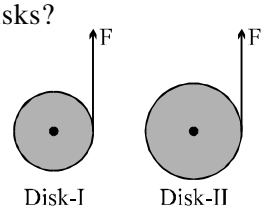
41. Two solid uniform disks of equal mass each are mounted to rotate about an axis fixed through the center of the disk. Each disk is initially at rest. The radii of the disks are $r_1 < r_2$. A force F is applied to each disk at its edge for the same amount of time. Assume that friction at pulley axis is negligible. What statement is true about the kinetic energy (K) and magnitude of angular momentum (L) of the disks?

(1) $L_1 = L_2$ and $K_1 < K_2$

(2) $L_1 < L_2$ and $K_1 = K_2$

(3) $L_1 < L_2$ and $K_1 > K_2$

(4) $L_1 < L_2$ and $K_1 < K_2$



42. A particle of mass m is describing a circular path of radius r with uniform speed. If L is the angular momentum of the particle (about the axis of the circle), then the kinetic energy of the particle is

(1) $\frac{L^2}{mr^2}$ (2) mr^2L

(3) $\frac{L^2}{2mr^2}$ (4) $\frac{L^2r^2}{m}$

43. A particles of mass m = 5 units is moving with a uniform speed $v = 3\sqrt{2}$ in the XOY plane along the line Y = X + 4. The magnitude of the angular momentum of the particle about the origin is :-

(1) zero (2) 60 unit

(3) 7.5 unit (4) $40\sqrt{2}$ unit

44. A child is standing with folded hand at the centre of a plateform rotating about its central axis. The kinetic energy of the system is K. The child now stretches his arm so that the moment of inertia of the system doubles. The kinetic energy of the system now is :-

(1) 2 K (2) K/4

(3) 4 K (4) K/2

45. A circular platform is mounted on vertical frictionless axle. Its radius is r = 2m and its moment of inertia is I = 200 kg-m^2. It is initially at rest. A 70 kg man stands on the edge of the platform and begins to walk along the edge at speed v_0 = 1.0 m/s relative to ground. The angular velocity of the platform is :-

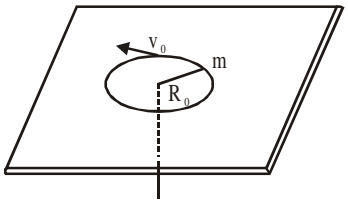
(1) 1.2 rad/s (2) 0.4 rad/s

(3) 2.0 rad/s (4) 0.7 rad/s

46. A spinning ice skater has an initial kinetic energy $\frac{1}{2}I\omega^2$. She pulls in her outstretched arms, decreasing her moment of inertia by 75%. What is her new angular speed ?

(1) $\omega/4$ (2) $\omega/3$ (3) $4\omega/3$ (4) 4ω

47. A mass m moves in a circle on a smooth horizontal plane with velocity v_0 at a radius R_0. The mass is attached to a string which passes through a smooth hole in the plane as shown. The tension in the string is decreased gradually and finally m moves in a circle of radius $2R_0$. The final value of the kinetic energy is :-



(1) $\frac{1}{4}mv_0^2$ (2) $2mv_0^2$

(3) $\frac{1}{2}mv_0^2$ (4) $\frac{1}{8}mv_0^2$

48. Four rigid bodies, each with the same mass and radius, are spinning freely with the same angular momentum. Which object requires the maximum work to stop it ?

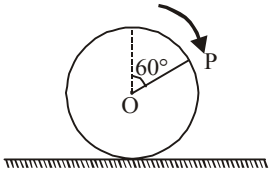
(1) A solid sphere spinning about a diameter.
(2) A hollow sphere spinning about a diameter.
(3) A solid disc spinning about an axis perpendicular to the plane of the disc and passing through the centre.
(4) A hoop spinning about an axis along a diameter.

49. A uniform smooth rod of mass M and length L rotating about own axis with angular speed ω. There are two beads each of mass m ($m << M$) at the centre and its opposite sides to rotational axis. During rotation of rod beads starts to slide on opposite ends of rod. Then angular speed of system when beads reached up to ends of rod.

(1) $\frac{M\omega}{M+6m}$ (2) $\frac{M\omega}{M+2m}$

(3) ω (4) None of these

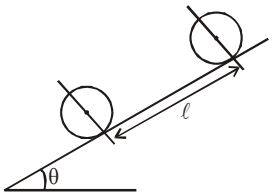
50. A wheel of radius R = 0.1 m is rolling without slipping on a horizontal surface as shown in the figure. Centre of the wheel moves with a constant speed $\sqrt{3}$ m/s. The speed of the point P with respect to ground is



(1) $2\sqrt{3}$ m/s (2) zero

(3) 3 m/s (4) $\sqrt{3}$ m/s

51. A solid sphere of mass m is placed on a rough inclined plane as shown in figure. The coefficient of friction μ is not sufficient for pure rolling. The centre of sphere slides a length ℓ on the incline from rest and its kinetic energy becomes k. Then work done by friction will be :-



(1) $-\mu mg\ell\cos\theta$

(2) $-mg\ell\sin\theta + k$

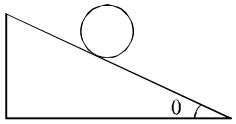
(3) $-\frac{2}{5}\mu mg\ell\sin\theta + k$

(4) $-\frac{2}{5}mg\ell\sin\theta$

52. A solid sphere is under pure rolling on a rough fixed incline plane of angle θ. Choose the correct options if only contact forces and gravity are acting:

(1) Frictional force will be down the incline if sphere rolls up the incline and it will be up the incline if sphere rolls down the incline.
(2) Frictional force will be down the incline whether spheres rolls up the incline or down the incline
(3) Frictional force and acceleration of the body will increase with the increase in angle of incline plane
(4) Velocity and acceleration of the point of contact of sphere with incline will be zero during the motion.

53. A solid cylinder is rolling down the inclined plane without slipping.
Which of the following is correct ?



(1) The friction force is dissipative
(2) The friction force is kinetic
(3) The friction force will aid rotation but hinder translation
(4) The friction force is increased if θ is reduced

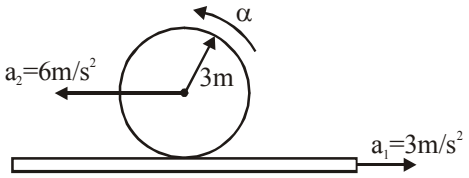
54. A solid sphere is released from rest on the incline having friction coefficient $\frac{1}{7}\tan\theta$:-

(1) it will start pure rolling
(2) it will make pure translation motion
(3) it will start rolling with slipping
(4) the angular momentum of the sphere about its centre will remain constnat

55. A body is rolling down an inclined plane. If kinetic energy of rotation is 40% of total kinetic energy in same state, then the body is :-
(1) Solid sphere
(2) Cylinder
(3) Ring
(4) Hollow ball

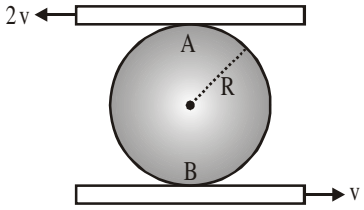
56. Three identical solid spheres move down three inclines A, B and C–all of the same dimensions. A is without friction, the friction between B and a sphere is sufficient to cause rolling without slipping, the friction between C and a sphere causes rolling with slipping. The kinetic energies of A, B, C at the bottom of the inclines are E_A, E_B, E_C.
(1) $E_A = E_B = E_C$
(2) $E_A = E_B > E_C$
(3) $E_A > E_B > E_C$
(4) $E_A > E_B = E_C$

57. In the following figure, a sphere of radius 3 m rolls on a plank. The accelerations of the sphere and the plank are indicated. The value of α is



(1) 3 rad/s²
(2) 6 rad/s²
(3) 3 rad/s² (opposite to the direction shown in figure)
(4) 1 rad/s²

58. A disc of the radius R is confined to roll without slipping at A and B. If the plates have the velocities v and 2v as shown, the angular velocity of the disc is



(1) $\frac{3v}{2R}$ Anticlockwise
(2) $\frac{3v}{2R}$ Clockwise
(3) $\frac{v}{2R}$ Anticlockwise
(4) $\frac{v}{2R}$ Clockwise

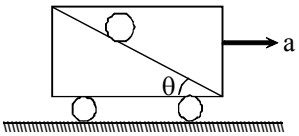
59. Many cars are now equipped with anti-lock brakes (ABS), which prevents locking of the wheels during emergency braking. What is the main advantage ?
(1) This saves the tyres. Otherwise too much rubber is left on the road
(2) Provides more control over the car but stopping distance increases slightly
(3) This leads to a shorter stopping distance because tyres exert rolling friction which is larger than static friction
(4) This leads to a shorter stopping distance because tyres exert static friction which is larger than kinetic friction

60. A uniform solid disc of radius R and mass m is free to rotate on a frictionless pivot through a point on its rim. The disc is released from rest in the position where the diameter through the pivot is along horizontal. The speed of its centre of mass when the diameter through the pivot is vertical is

(1) $(2/3)\,(gR)^{1/2}$ (2) $(gR)^{1/2}$

(3) $(2gR)^{1/2}$ (4) $2(gR/3)^{1/2}$

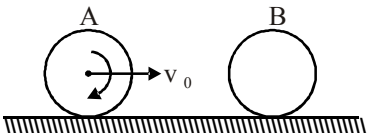
61. Figure shows a smooth inclined plane of inclination θ fixed in a car. A sphere is set in pure rolling on the incline. For what value of 'a' (the acceleration of car in horizontal direction) the sphere will continue pure rolling?



(1) g cos θ (2) g sin θ

(3) g cot θ (4) g tan θ

62. A hollow smooth uniform sphere A of mass 'm' rolls without sliding on a smooth horizontal surface. It collides head on elastically with another stationary smooth solid sphere B of the same mass m and same radius. The ratio of kinetic energy of 'B' to that of 'A' just after the collision is :



(1) 1 : 1 (2) 2 : 3

(3) 3 : 2 (4) 5 : 2

63. The moment of inertia of a body is I and its coefficient of linear expansion is α. If temperature of body rises by a small amount ΔT, then change in moment of inertia about the same axis is :-

(1) $\alpha\, I\, \Delta T$

(2) $2\,\alpha\, I\, \Delta T$

(3) $4\alpha I\, \Delta T$

(4) $\frac{\alpha I \Delta T}{2}$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	2	3	3	2	4	1	4	2	2	3	3	4	2	4	2	1	1	3
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	4	3	3	3	3	2	1	1	2	1	3	3	1	3	3	1	1	1
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	2	4	4	4	4	1	1	3	2	3	3	3	4	2	1	1	4	4
Que.	61	62	63																	
Ans.	4	3	2																	

GRAVITATION

1. Earth exerts a gravitational force on the Moon, keeping it in its orbit. The reaction to this force, in the sense of Newton's third law, is:

(1) the centripetal force on the Moon

(2) the nearly circular orbit of the Moon

(3) the gravitational force on Earth by the Moon

(4) the tides due to the Moon

2. How does the magnitude of the gravitational force with which the Moon attracts the Earth compare to the magnitude of the gravitational force with which the earth attracts the Moon ?

(1) They are equal

(2) The first is greater

(3) The first is smaller

(4) None

3. Choose the correct statement from the following

(1) The magnitude of the gravitational force between two bodies of mass 1 kg each and separated by a distance of 1m is 9.8 N.

(2) Higher the value of escape velocity for a planet, the higher is the abundance of lighter gases in its atmosphere.

(3) Force of friction arises due to gravitational attraction.

(4) The gravitational force of attraction between two bodies of ordinary mass is not noticeable because the value of the gravitation constant is extremely small.

4. Two light plastic shopping bags of negligible mass are placed 2 meters apart. Each bag contains 15 identical oranges. If 10 oranges were moved from one bag to the other, the gravitational force between the two bags would

(1) increase to 3/2 of the original value.

(2) decrease to 2/5 of the original value.

(3) increase to 5/3 of the original value.

(4) decrease to 5/9 of the original value.

5 A small area is removed from a uniform spherical shell of mass M and radius R. Then the gravitational field intensity near the hollow portion is :-

(1) $\frac{GM}{R^2}$ (2) $\frac{GM}{2R^2}$ (3) $\frac{3GM}{2R^2}$ (4) 0

6. Consider two point masses of mass m_1 & m_2 kept at a distance r from each other. The magnitude of gravitational force between them is denoted by F, then if the mass of one is doubled while that of other is halved & their seperation is increased by a factor of 3, then magnitude of gravitational force between them will be :-

(1) F (2) $\frac{F}{9}$ (3) $\frac{4F}{9}$ (4) 9F

7. A particle is dropped in a tunnel passing through centre of earth. The tunnel is very smooth. The distance of particle r is measured from earth's centre, then :-

(1) acceleration of particle $\propto \frac{1}{r^2}$

(2) acceleration of particle $\propto \frac{1}{r}$

(3) acceleration of particle $\propto r$

(4) acceleration of particle is independent of r

8. If the speed of rotation of earth about its axis increases, then the apparent weight of the body at the equator will -

(1) increase

(2) decrease

(3) remain unchanged

(4) sometimes decrease and sometimes increase

9. Let A and B be the points respectively above and below the earth's surface each at a distance equal to half the radius of the earth. If the acceleration due to gravity at these points be g_A and g_B respectively, then $g_B : g_A$ is

(1) 1:1 (2) 9:8 (3) 8:9 (4) zero

10. A Space shuttle starts upward from ground with some initial velocity. A stone is dropped from this space shuttle. This stone always reaches ground with same speed no matter from what height it was dropped. Mark the correct statement (Assume acceleration due to gravity does not vary with height)

(1) Shuttle decelerates with a value $\frac{g}{4}$

(2) Shuttle decelerates with a value g

(3) Shuttle decelerates with a value 2g

(4) Shuttle accelerates with a value g

11. The fractional change in the value of free-fall acceleration g for a particle when it is lifted from the surface to an elevation h (h < < R) is:-

(1) $\frac{h}{R}$ (2) $\frac{2h}{R}$ (3) $-\frac{2h}{R}$ (4) $-\frac{h}{R}$

12. The escape speed of a projectile on the earth's surface in 11.2 km/s. A body is projected out with thrice this speed. What is the speed of the body far away from the earth. (Ignore the presence of sun and other planets) :-

(1) 2 × 11.2 km/s (2) $2\sqrt{2}\times 11.2$ km/s

(3) $\sqrt{2}\times 11.2$ km/s (4) 4 × 11.2 km/s

13. Maximum height reached by a rocket fired with a speed equal to 60% of the escape velocity from earth's surface is :-

(1) $\frac{R}{2}$ (2) $\frac{16R}{9}$ (3) $\frac{9R}{16}$ (4) $\frac{R}{8}$

14. The escape velocity from a spherical planet is v. The escape velocity corresponding to another planet of twice the radius and half the mean density is :-

(1) $\sqrt{2}$ v (2) $\frac{v}{2}$ (3) 2 v (4) 4 v

15. The orbital velocity of an artificial satellite in a circular orbit just above the earth's surface is v_0. The orbital velocity of satellite orbiting at an altitude of double the radius of earth is:

(1) $\sqrt{3}\,v_0$ (2) $\sqrt{2}\,v_0$

(3) $\frac{v_0}{\sqrt{3}}$ (4) $\frac{v_0}{\sqrt{2}}$

16. Consider a statellite in bound orbit around earth.

(A) If the satellite is to be geostationary it must orbit in equatorial plane

(B) If satellite is in an elliptical orbit around the earth, radius of curvature of orbit both at perigee and apogee are equal.

(C) If the satellite is to escape from the earth completely by firing the satellite's rocket it will required same additional kinetic energy at all the point on its circumference.

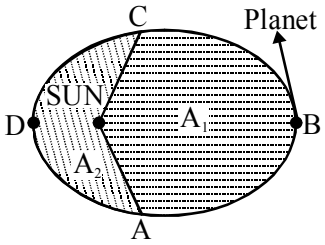
(D) Angular momentum of a satellite is conserved during its orbital motion.

Mark the **CORRECT** statement(s) :-

(1) A, B and C (2) B, C and D

(3) A and D (4) All of these

17. Time taken by the planet to cover path ABC is t_1 and time taken by the planet to cover path CDA is t_2, then



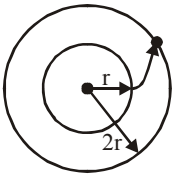
(1) $t_1 = t_2$

(2) $t_2 > t_1$

(3) $t_1 > t_2$

(4) cannot be determined

18. A satellite is in a circular equatorial orbit of radius 7000 km around the Earth. If it is transferred to a circular orbit of double the radius then its angular momentum will be :-



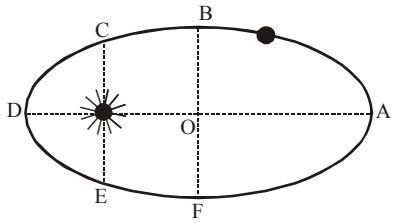
(1) Increases

(2) Decreases

(3) Remain unchanged

(4) None of these

19. A planet is revolving around the sun in an elliptical orbit as shown in figure. Select correct alternative(s)



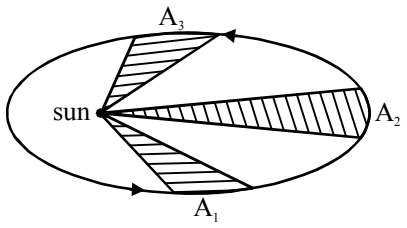
(1) Its total energy is negative at D.

(2) Its angular momentum is constant

(3) Net torque on planet about sun is zero

(4) All of these

20. A planet moving around sun sweeps area A_1 in 2 days, A_2 in 3 days and A_3 in 6 days. Then the relation between A_1, A_2 and A_3 is :-



(1) $3A_1 = 2A_2 = A_3$ (2) $2A_1 = 3A_2 = 6A_3$

(3) $3A_1 = 2A_2 = 6A_3$ (4) $6A_1 = 3A_2 = 2A_3$

21. A satellite is moving round the earth in a circular orbit. The following statements are given.

(i) It is moving with a constant velocity

(ii) It suffers no acceleration

(iii) Its angular momentum w.r.t. the earth remains conserved

(iv) Its distance from centre must be equal to $\sqrt{2}$ times of earth's radius

The correct option is

(1) i and ii are true (2) i, iii and iv are true

(3) only iii is true (4) i and iv are true

22. Kepler's third law can be stated that $T^2 = kR^3$. The value of k (const) is not same for

(1) Planet Mars and planet Venus

(2) Planet Neptune and planet Earth

(3) Planet Earth and its moon

(4) The two moons of Mars

23. Satellites orbiting the earth have finite life and sometimes debris of satellites fall to the earth. This is because,

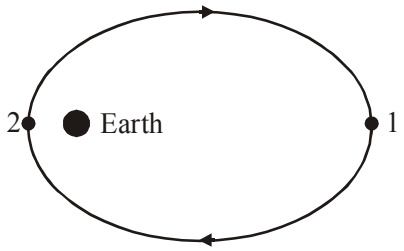
(1) the solar cells and batteries in satellites run out.

(2) the laws of gravitation predict a trajectory spiralling inwards.

(3) of viscous forces changing the speed of satellite and hence height to gradually decrease.

(4) of collisions with other satellites.

24. A small satellite is in elliptical orbit around Earth as shown. If L denotes the magnitude of its angular momentum and K denotes kinetic energy, then :-



(1) $L_2 > L_1$ and $K_2 > K_1$

(2) $L_2 > L_1$ and $K_2 = K_1$

(3) $L_2 < L_1$ and $K_2 = K_1$

(4) $L_2 = L_1$ and $K_2 > K_1$

25. Which of the following quantities does not depend upon the orbital radius of the satellite.

(1) $\frac{T}{R}$ (2) $\frac{T^2}{R^2}$ (3) $\frac{T^2}{R}$ (4) $\frac{T^2}{R^3}$

26. Consider the following statements for a satellite S moving in an elliptical orbit around the earth (Mass of satellite is negligibly small compared to earth)

I : The acceleration of S is always towards earth

II: The total mechanical energy of S varies periodically with time

III: The linear momentum of S remains constant in magnitude

The correct sequence of True (T) and false (F) for the above statements is

(1) TTF (2) TFT (3) TFF (4) FFF

27. A satellite is revolving round the earth with orbital speed v_o. If it is imagined to stop suddenly, the speed with which it will strike the surface of the earth would be (v_e – escape velocity of a body from earth's surface) :

(1) v_e^2 / v_o (2) v_o

(3) $(v_e^2 - v_o^2)^{1/2}$ (4) $(v_e^2 - 2v_o^2)^{1/2}$

28. A satellite of mass m is launched from earth surface to an orbit of radius 2R, after that it is shifted from this orbit to another orbit of radius 3R. How much energy is required to launch it from surface of earth to the orbit of radius 2R, and to shift from this orbit to an orbit of radius 3R. [Where R is radius of earth and g is acceleration due to gravity on earth surface]

(1) $\frac{3}{4}mgR, \frac{1}{12}mgR$ (2) $\frac{mgR}{4}, \frac{mgR}{12}$

(3) $\frac{3mgR}{4}, \frac{mgR}{6}$ (4) None of these

29. Two point objects of masses m and 4m are at rest at infinite separation. They move towards each other under mutual gravitational attraction. If G is the universal gravitational constant, then at a separation r.

(1) the total mechanical energy of the two objects is zero

(2) their relative velocity is $\sqrt{\frac{10Gm}{r}}$

(3) the total kinetic energy of the objects is $\frac{4Gm^2}{r}$

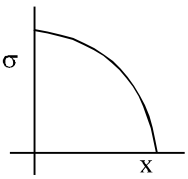
(4) All of these

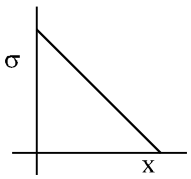
ANSWER KEY

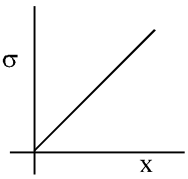
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	4	4	2	2	3	2	2	2	3	2	3	1	3	4	3	1	4	1
Que.	21	22	23	24	25	26	27	28	29											
Ans.	3	3	3	4	4	3	4	1	4											

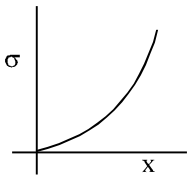
PROPERTIES OF MATTER AND FLUID MECHANICS

1. A uniform rod of mass 'M' and length L is hanging from a ceiling. The variation of tensile stress with distance X from the ceiling is best represented by

(1) 

(2) 

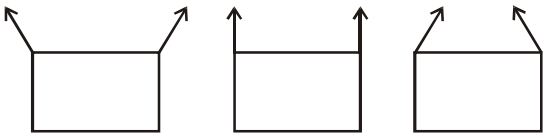
(3) 

(4) 

2. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of :

(1) 81 (2) $\frac{1}{81}$ (3) 9 (4) $\frac{1}{9}$

3. A rectangular frame is to be suspended symmetrically by two strings of equal length on two supports. It can be done in one of the following three ways :-



(a) (b) (c)

The tension in the strings will be

(1) the same in all cases

(2) least in (a)

(3) least in (b)

(4) least in (c)

4. The temperature of a wire is doubled. The young's modulus of elasticity :-

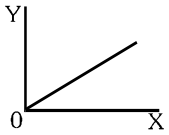
(1) will also double

(2) will increase

(3) will remain same

(4) will decrease

5. A student plots a graph from his readings on the determination of Young's modulus of a metal wire but forgets to put the labels (figure). The quantities on X and Y-axes may be respectively



(1) weight hung and length increased

(2) stress applied and length increased

(3) stress applied and strain developed

(4) All of these

6. A steel cable with a radius of 1.5cm supports a lift. If the maximum stress is not to exceed 10^8 N/m^2, maximum load the cable can support is :-

(1) 9×10^3N (2) 7×10^3N

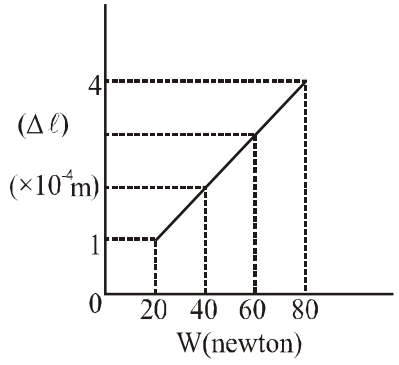
(3) 7.1×10^4N (4) 4×10^6N

7. Two wires of the same material and length but diameter in the ratio 1 : 2 are stretched by the same force. The ratio of potential energy per unit volume for the two wires when stretched will be:

(1) 1 : 1 (2) 2 : 1

(3) 4 : 1 (4) 16 : 1

8. The given graph shows the extension (Δl) of a wire of length 1.0 m suspended from the top of a roof at one end and a load be connected to the other end. If the cross-sectional area of the wire is 10^{-6} m^2, the Young's modulus (Y) of the material of the wire must be :-



(1) 2×10^{11} N/m^2 (2) 2×10^{12} N/m^2

(3) 3×10^{12} N/m^2 (4) 2×10^{7} N/m^2

9. A copper and a steel wire of the same diameter are connected end to end. A deforming force F is applied to this composite wire which causes a total elongation of 1 cm the two wires will have :-

(1) the same stress

(2) different stress

(3) the same strain

(4) slope of stress strain curve will be same

10. How much should the pressure on a litre of water be changed to compress it by 0.10 % ? (Bulk modulus of water is 2.2×10^9 N/m^2)

(1) 2.2×10^5 N/m^2

(2) 2.2×10^4 N/m^2

(3) 2.2×10^6 N/m^2

(4) 2.2×10^8 N/m^2

11. The edge of an aluminium cube is 10cm long. One face of the cube is firmly fixed to a vertical wall. A mass of 100kg is then attached to the opposite face of the cube. The shear modulus of aluminium is 25GPa. What is the vertical deflection of this face ?

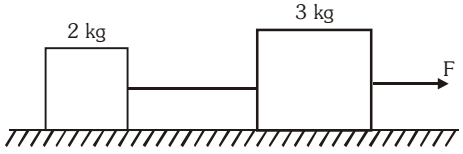
(1) 4.8×10^{-5} m

(2) 6.2×10^{-3} m

(3) 3.92×10^{-7} m

(4) 5×10^{-5} m

12. Two bodies of masses 2 kg and 3 kg are connected by a metal wire of cross section 0.04 mm^2. Breaking stress of metal wire is 2.5 GPa. The maximum force F that can be applied to 3 kg block so that wire does not break is :



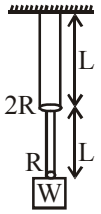
(1) 100 N

(2) 150 N

(3) 200 N

(4) 250 N

13. Two wire of the same material (young's modulus = Y) and same length 'L' but radii R and 2R respectively are joined end to end and a weight W is suspended from the combination as shown in the figure. The elastic potential energy in the system is :-



(1) $\frac{3W^2L}{4\pi R^2Y}$

(2) $\frac{3W^2L}{8\pi R^2Y}$

(3) $\frac{5W^2L}{8\pi R^2Y}$

(4) $\frac{W^2L}{\pi R^2Y}$

14. When an air bubble of radius r rises from the bottom to the surface of a lake, its radius becomes $\frac{5r}{4}$. Taking the atmospheric pressure to be equal to 10 m height of water column, the depth of the lake would approximately be (ignore the suface tension and the effect of temperature) :

(1) 11.2 m

(2) 8.7 m

(3) 9.5 m

(4) 10.5 m

15. The workdone in increasing the length of a one metre long wire of cross-sectional area 1 mm^2 through 1 mm will be (Y = 2 x 10^{11} Nm^{-2}) :

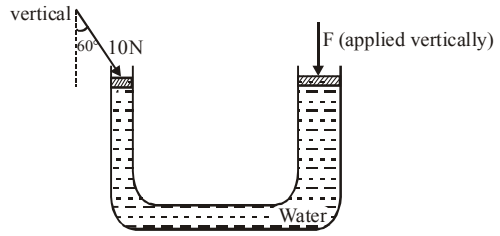
(1) 0.1 J

(2) 5 J

(3) 10 J

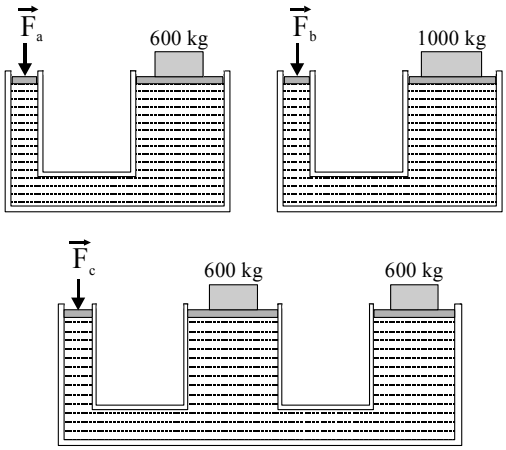
(4) 250 J

16. The area of cross-section of the two vertical arms of a hydraulic press are 1 cm^2 and 10 cm^2 respectively. A force of 10 N applied, as shown in the figure, to a tight fitting light piston in the thinner arm balances a force F applied to the corresponding piston in the thicker arm. Assuming that the levels of water in both the arms are the same, we can conclude :-



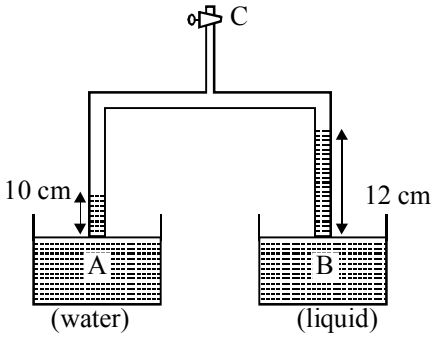
(1) F = 100 N
(2) F = 50 N
(3) F = 25 N
(4) F, as applied, cannot balance the effect of the force on the first piston

17. Rank in order, from largest to smallest, the magnitudes of the forces $\vec{F}_a$, $\vec{F}_b$ and $\vec{F}_c$ required to balance the masses. The masses (on same area) are in kilograms.



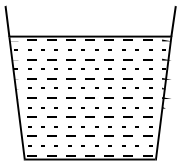
(1) $F_a = F_b = F_c$
(2) $F_a > F_b = F_c$
(3) $F_b > F_a = F_c$
(4) $F_c > F_a > F_b$

18. The limbs of a U-tube glass are lowered into vessels A and B, A containing water. Some air is pumped out through the top of the tube C. The liquids in the left hand limb A and the right hand limb B rise to heights of 10 cm and 12 cm respectively. The density of liquid B is



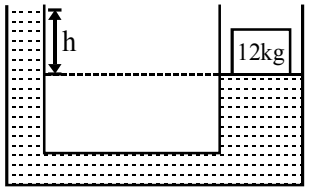
(1) 0.75 g/cm^3 (2) 0.83 g/cm^3
(3) 1.2 g/cm^3 (4) 0.25 g/cm^3

19. A liquid of mass 1 kg is filled in a flask as shown in figure. The force exerted by the flask on the liquid is (g = 10 m/s^2) [Neglect atmospheric pressure]:



(1) 10 N
(2) greater than 10N
(3) less than 10N
(4) zero

20. The area of cross section of the wides tube shown in the figure is 800 cm^2. If a mass of 12 kg is placed on the massless piston, the difference in the heights h in the level of water in two tubes :



(1) 10 m (2) 6 cm (3) 15 cm (4) 2 cm

21. You are holding a bottle of sparking water inside a car moving forward. When the driver applies the brakes :-

(1) Bubbles in the middle of the liquid will start to move forward with respect to the bottle.

(2) Bubbles will start to move backward with respect to the bottle.

(3) Bubbles will stay at the same horizontal location in the water.

(4) Depending on the speed of the car, bubbles might move forward or backward.

22. An object of specific gravity ρ is hung from a massless string. The tension in the string is T. The object is immersed in water so that one half of its volume is submerged. The new tension in the string is-

(1) $\left(\frac{2\rho+1}{2\rho}\right)T$

(2) $\left(\frac{2\rho-1}{2\rho}\right)T$

(3) $\left(\frac{\rho-1}{\rho}\right)T$

(4) $\left(\frac{\rho+1}{\rho}\right)T$

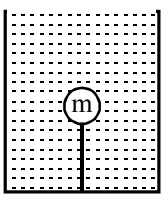
23. A solid sphere of density η (> 1) times lighter than water is suspended in a water tank by a string tied to its base as shown in the figure. If the mass of sphere is m then tension in the string is given by:-

(1) $\left(\frac{\eta-1}{\eta}\right)mg$

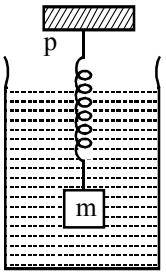
(2) η mg

(3) $\frac{mg}{(\eta-1)}$

(4) (η – 1) mg



24. A cube of mass m and density D is suspended from a point P by a spring of stiffness k. the system is kept inside a beaker filled with a liquid of density d. The elongation in the spring, assuming D > d, is :



(1) $\frac{mg}{k}\left(1-\frac{d}{D}\right)$ (2) $\frac{mg}{k}\left(1-\frac{D}{d}\right)$

(3) $\frac{mg}{k}\left(1+\frac{d}{D}\right)$ (4) $\frac{mg}{k}\left(1+\frac{D}{d}\right)$

25. A solid floats in a liquid in a partially dipped position

(1) The solid exerts a force equal to its weight on the liquid.

(2) The liquid exerts a force of buoyancy on the solid which is equal to the weight of the solid.

(3) The weight of the displaced liquid equals the weight of the solid.

(4) All of these

26. A and B are two metallic pieces. They are fully immersed in water and then weighed. Now they show same loss of weight. The conclusion therefore is

(1) By this information we cannot compare between their weight in air

(2) A and B have equal volume in air

(3) By this information we cannot compare between there density

(4) All of these

27. A wooden block floats in a liquid with 40% of its volume inside the liquid. When the vessel containing the liquid starts rising upwards with acceleration a = g/2, the percentage of volume inside the liquid is

(1) 20% (2) 60% (3) 30% (4) 40%

28. Spheres of iron and lead having same mass are completely immersed in water. Density of lead is more than that of iron. Apparent loss of weight is W_1 for iron sphere and W_2 for lead sphere. Then $\frac{W_1}{W_2}$ is :-

(1) = 1 (2) between 0 and 1

(2) = 0 (4) > 1

29. A little masked girl is holding a helium-filled balloon with a string while riding in a closed elevator going down a very tall building at constant speed. There is vacuum in elevator. Suddenly the elevator cable snaps, sending the elevator into free fall. Being shocked, the girl lets go of the string. She is even more surprised to see

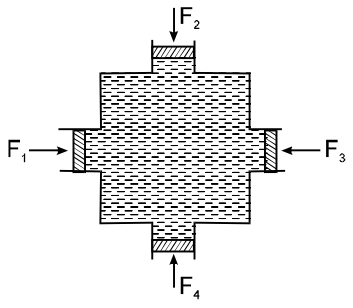
(1) the balloon rising

(2) the balloon floating downward

(3) the balloon remaining stationary

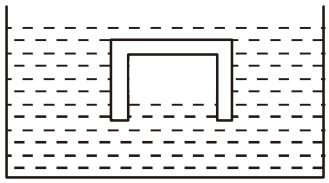
(4) the balloon bouncing slowly between the floor and the ceiling

30. In the figure shown water is filled in a symmetrical container. Four pistons of equal area A are used at the four opening to keep the water in equilibrium. Now an additional force F is applied at each piston. The increase in the pressure at the centre of the container due to this addition is



(1) $\frac{F}{A}$ (2) $\frac{2F}{A}$ (3) $\frac{4F}{A}$ (4) 0

31. An empty glass jar is submerged in tank of water with open mouth of the jar downwards, so that air inside the jar is trapped and cannot get out. As the jar is pushed down slowly, the magnitude of net buoyant force on the system of volume of gas trapped in the jar and on the jar :



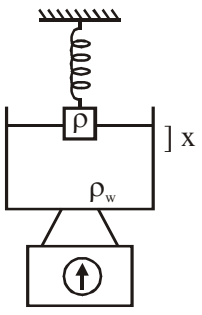
(1) increases

(2) decreases

(3) remains same

(4) Information is insufficient to draw inference.

32. A vessel filled with water is kept on a weighing pan and the scale adjusted to zero. A block of mass m and density ρ is suspended by a massless spring of spring constant K. This block is submerged into the water in the vessel. What is the reading of the scale. (volume submerged is V and density of water is ρ_w)



(1) $V\rho_w g$ (2) $V\rho g$

(3) $m_{vessel} + m_{water}$ (4) None of these

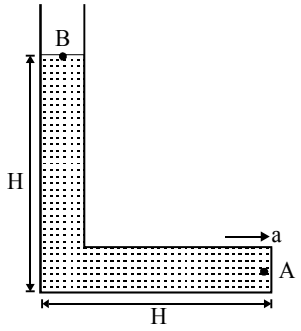
33. A necklace weight 50 g in air but it weights 46 g in water assume that copper is mixed with gold to prepare the necklace. Find how much copper is present in it.(Specific gravity of gold is 20 and that of copper is 10) :-

(1) 20 g (2) 10 g

(3) 30 g (4) 50 g

34. For the L shaped vessel shown in the figure, determine the value of acceleration a so that pressure at point A becomes equal to $\frac{p_0}{2}$.

[p_0 is the atmospheric pressure.]



(1) g

(2) $\frac{g}{2}+\frac{p_0}{2\rho H}$

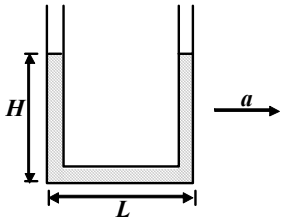
(3) $\frac{p_0}{2\rho H}+g$

(4) $\frac{3p_0}{2\rho H}+g$

35. A liquid stands at the plane level in the U-tube when at rest. If area of cross-section of both the limbs are equal, what will be the difference in heights *h* of the liquid in the two limbs of U-tube, when the system is given an acceleration *a* in horizontal direction towards right as shown?

(L = length of horizontal portion of tube,

H = initial height of liquid in both limbs)



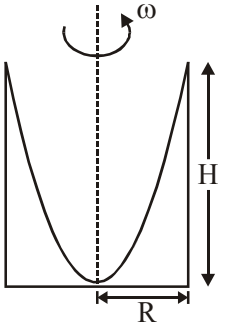
(1) $\frac{g}{a}\frac{L^2}{H}$

(2) $\frac{La}{g}$

(3) $\frac{L^2}{H}\frac{a}{g}$

(4) $\frac{Hg}{a}$

36. A cylinder of radius R and height H is filled with a liquid to an unknown height h when it is rotated at an unknown constant angular velocity ω, the base of the cylinder gets exposed when the liquid just starts spilling out as shown. Find angular speed ω of cylinder :-



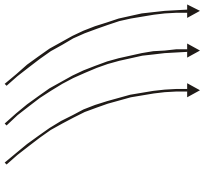
(1) $\frac{\sqrt{gH}}{R}$

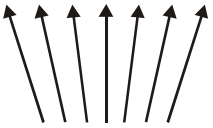
(2) $\frac{\sqrt{2gH}}{R}$

(3) $\frac{2\sqrt{gH}}{R}$

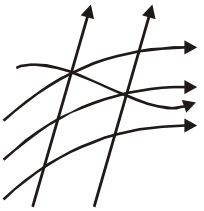
(4) None of these

37. Which of the following diagrams does not represent a streamline flow :-

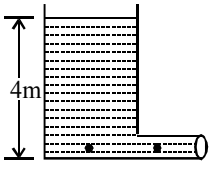
(1) 

(2) 

(3) 

(4) 

38. A vent tank of large cross-sectional area has a horizontal pipe 0.12 m in diameter at the bottom. This holds a liquid whose density is 1500 kg/m^3 to a height of 4.0 m. Assume the liquid is an ideal fluid in laminar flow. In figure, the velocity with which fluid flows out is



(1) $2\sqrt{5}$ m/s

(2) $\sqrt{5}$ m/s

(3) $4\sqrt{5}$ m/s

(4) $\sqrt{10}$ m/s

39. In the widest part of the horizontal pipe oil is flowing at a rate of 2 m/sec. Determine the speed of the flow of oil in the narrow part of the tube if the pressure difference in the broad and narrow parts of the pipe is 0.25 $\rho_{oil}g$.

(1) 9 m/s (2) 6 m/s

(3) 3 m/s (4) 1 m/s

40. A wind with speed 40 m/s blows parallel to the roof of a house. The area of the roof is 250 m^2. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be :

(ρ_{air} = 1.2 kg/m^3)

(1) 4.8×10^5 N, upwards

(2) 2.4×10^5 N, upwards

(3) 2.4×10^5 N, downwards

(4) 4.8×10^5 N, downwards

41. A fully loaded boeing aircraft has a mass of 3.3×10^5kg. It's total wing area is 500m^2. It is in level flight with a speed of 960km/h. Estimate the pressure difference between the lower and upper surfaces of the wings.:-

(1) 6.5×10^3 N/m^2 (2) 12.5×10^3 N/m^2

(3) 3.25×10^3 N/m^2 (4) $2.5 \times 10^3$$N/m^2$

42. Water is being poured into a vessel at a constant rate ϕ m^3/s. There is a small aperture of cross sectional area "a" at the bottom of the vessel. The maximum level of water in the vessel is proportional to :-

(1) ϕ (2) ϕ^2 (3) 1/a (4) a

43. Water flows out of the hole on the side of a bucket and follows a parabolic path. If the bucket falls freely under gravity, ignoring air resistance, the water flow

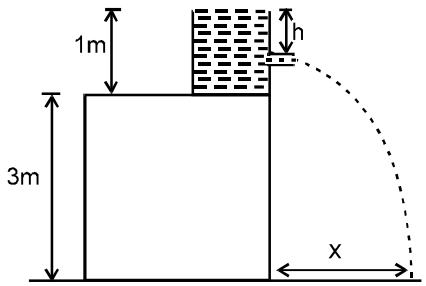
(1) follows a straight line path relative to the falling bucket

(2) follows a parabolic path relative to the falling bucket

(3) decreases but continues to flow

(4) stops

44. A water tank stands on the roof of a building as shown. Then the value of h for which the distance covered by the water 'x' is greatest is



(1) 0.5 m (2) 0.67 m

(3) 1 m (4) none of these

45. The graph between terminal velocity (along y-axis) and square of radius (along x-axis) of spherical body of density ρ allowed to fall through a fluid of density σ is a :-

(1) Straight line with positive slope

(2) Straight line with negative slope

(3) Straight line perpendicular to x-axis

(4) Straight line perpendicular to y-axis

46. A spherical solid ball of volume V is made of a material of density ρ_0. It is falling through a liquid of density ρ' ($\rho' < \rho_0$). Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed v. i.e., $F_{viscous} = -kv^2$, $k > 0$. The terminal speed of the ball is -

(1) $\sqrt{\frac{Vg(\rho_0 - \rho')}{k}}$

(2) $\frac{Vg\rho_0}{k}$

(3) $\sqrt{\frac{Vg\rho_0}{k}}$

(4) $\frac{V(\rho_0 - \rho')}{k}$

47. If two uniform spherical drops of a liquid having same mass, radius, and falling freely with a terminal velocity of $\sqrt[3]{16}$ m/s, coalesce to form a bigger drop, then the terminal velocity with which the bigger drop falls is :-

(1) 8 m/s (2) 4 m/s

(3) 10 m/s (4) None of these

48. Two large vertical parallel plates separated by a gap of d have a highly viscous liquid of density ρ and viscosity coefficient η, flowing steadily under gravity in the gap. The velocity gradient of flow near plates surface is :-

(1) $\frac{2\rho dg}{\eta}$ (2) $\frac{3\rho dg}{\eta}$

(3) $\frac{\rho dg}{3\eta}$ (4) $\frac{\rho dg}{2\eta}$

49. A solid sphere moves at a terminal velocity of 20 m/s in air at a place where g = 10 m/s^2 downwards. The sphere is taken in a hall, where g = 5 m/s^2 downwards having air of same viscosity and sphere is pushed down at a speed of 40 m/s. Then select incorrect statement :- [Neglect buoyancy of air]

(1) Its initial acceleration will be 15 m/s^2 downward.

(2) Its initial acceleration will be 15 m/s^2 upward

(3) The magnitude of acceleration will decrease as time passes and becomes zero after some time

(4) New terminal velocity of the solid sphere will be 10 m/s downwards

50. A solid sphere moves at a terminal velocity of 20 m/s in air at a place where g = 9.8 m/s^2. The sphere is taken in a gravity free hall having air at the same pressure and pushed down at a speed of 20 m/s. Then incorrect statement is :

(1) Its initial acceleration will be 9.8 m/s^2 downward

(2) Its initial acceleration will be 9.8 m/s^2 upward

(3) The magnitude of acceleration will decrease as the time passes

(4) It will eventually stop

51. A small sphere falls from rest in a viscous liquid. Due to friction heat is produced. What is the relation between the rate of production of heat and radius of the sphere at terminal velocity.

(1) $\frac{dQ}{dt} \propto r^2$ (2) $\frac{dQ}{dt} \propto r^5$

(3) $\frac{dQ}{dt} \propto r$ (4) None of these

52. Water flows in a streamline manner through a capillary tube of radius 'a'. The pressure difference being P and the rate of flow is Q. If the radius is reduced to $\frac{a}{2}$ and the pressure is increased to 2P, then the rate of flow becomes-

(1) 4 Q (2) Q/2 (3) Q **(4)** Q/8

53. A U-shaped wire is dipped in a soap solution and removed. The thin soap film formed between the wire and light slider supports a weight of 1.5×10^{-2} N (which includes the small weight of the slider) the length of the slider is 30 cm. What is the surface tension of the film:-

(1) 5×10^{-2} Nm^{-1}

(2) 2.5×10^{-2} Nm^{-1}

(3) 1.5×10^{-2} Nm^{-1}

(4) 3×10^{-2} Nm^{-1}

54. n number of water droplets, each of radius r, coalesce, to form a single drop of radius R. The rise in temperature dθ is (T = surface tension in $\frac{N}{m}$, ρ = density of water in $\frac{kg}{m^3}$, s = specific heat capacity of water in $\frac{cal}{kg/^\circ C}$, J = mechanical equivalent of heat in $\frac{J}{cal}$)

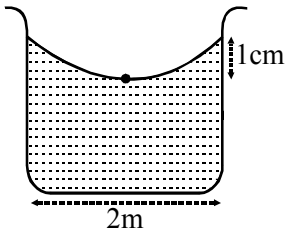
(1) $\frac{3T}{\rho s}\left(\frac{1}{r}-\frac{1}{R}\right)$

(2) $\frac{3T}{J\rho s}\left(\frac{1}{r}-\frac{1}{R}\right)$

(3) $\frac{3T}{\rho s}\left(\frac{1}{r}+\frac{1}{R}\right)$

(4) $\frac{3T}{J\rho s}\left(\frac{1}{r}+\frac{1}{R}\right)$

55. A container of width 2m is filled with a liquid. A thin wire of mass per unit length 10 g/m is gently placed over the liquid surface in the middle of the surface as shown in the figure. As a result, the liquid surface is depressed by a distance 1 cm. Determine the surface tension (in SI unit) of the liquid. Assume suitable approximation.



(1) 5 N/m (2) 8 N/m (3) 6N/m (4) 7 N/m

56. The grease deposited on a glass plate can be easily removed by cleaning the glass with hot water containing detergent powder, because the detergent powder :-

(1) Reduces the angle of contact between the solution and glass

(2) Increases the temperature of the solution

(3) Decrease the density of the solution

(4) Makes the angle of contact between solution and the glass to an obtuse angle

57. The properties of a surface molecules are different from those of the bulk liquid because the surface molecules :-

(i) are smaller than other molecules

(ii) acquire charge due to collision from air molecules

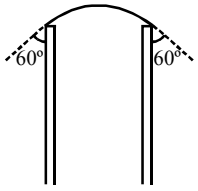
(iii) find different type of molecules in their range of influence

(iv) feel a net force in one direction

(1) (i), (ii) (2) (ii), (iii)

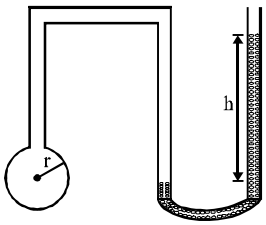
(3) (iii), (iv) (4) (i), (iv)

58. A soap bubble is being blown on a tube of radius 1 cm. The surface tension of the soap solution is 0.05 $\frac{N}{m}$ and the bubble makes an angle of 60^o with the tube as shown. The excess of pressure over the atmospheric pressure in the tube is :



(1) 5 Pa (2) 1 Pa (3) 10 Pa (4) 20 Pa

59. If the radius of the air-bubble on one side of tube is r and difference in height of liquid of density ρ in manometer is h, then surface tension of liquid used to make the bubble is :-



(1) $T = 2r\rho hg$ (2) $T = \frac{rh\rho g}{4}$

(3) $T = \frac{2\pi rh\rho g}{2}$ (4) $T = \frac{rh\rho g}{2}$

60. A capillary tube of radius 0.2 cm is dipped vertically in a beaker containing liquid. If the liquid rises to a height of 5 cm for which the angle of contact is 60°, then surface tension of the liquid is ($d = 1\ gm/cm^3$) :-

(1) 49 dynes/cm (2) 98 dyne/cm

(3) 490 dynes/cm (4) 980 dynes/cm

61. When a capillary tube is dipped into a liquid. The liquid neither rises nor falls in the capillary :-

(i) The surface tension of the liquid must be zero

(ii) The angle of contact must be 90^o

(iii) The surface tension may be zero

(iv) The angle of contact may be 90^o

(1) (i), (ii) (2) (iii), (iv)

(3) (ii), (iii) (4) (ii), (iv)

62. A 20 cm long capillary tube is dipped in water. The water rises up to 8 cm. If the entire arrangement is put in a freely falling elevator the length of water column in the capillary tube will be :-

(1) 8 cm (2) 6 cm

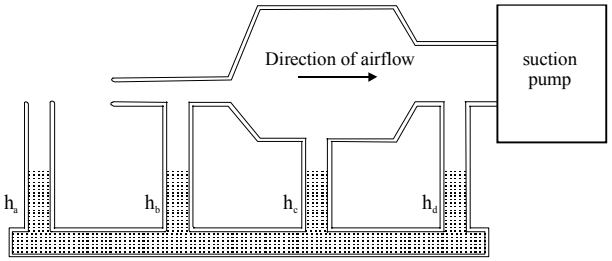
(3) 10 cm (4) 20 cm.

63. The free surface of oil in a tanker at rest is horizontal. If the tanker starts accelerating, the free surface will be tilted by an angle θ. If the acceleration is a ms^{-2} what will be value of θ ?

(1) $\theta = \tan^{-1}\left(\frac{a}{g}\right)$ (2) $\theta = \tan^{-1}\left(\frac{g}{a}\right)$

(3) $\theta = \tan^{-1}(a)$ (4) $\theta = \tan^{-1}(g)$

64. Rank in order, from highest to lowest, the liquid heights h_a to h_d. The air flow is from left to right. The liquid columns are not drawn to scale:-



(1) $h_a > h_b = h_d > h_c$
(2) $h_b = h_d > h_c > h_a$
(3) $h_d > h_c > h_b > h_a$
(4) $h_b > h_d > h_c > h_a$

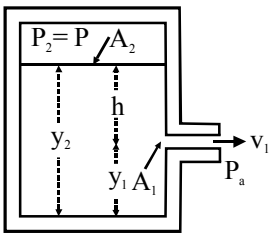
65. Consider a tank containing a liquid of density ρ with a small hole in its side at a height y_1 from the bottom. The air above the liquid, whose surface is at height y_2, is at pressure P. The velocity of fluid at A_1 is :-

(1) $\sqrt{2gh + 2(P - P_a)}$

(2) $\sqrt{2gh + (P - P_a)}$

(3) $\sqrt{2gh + \frac{2(P - P_a)}{\rho}}$

(4) $\sqrt{gh + \frac{(P - P_a)}{\rho}}$



ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	3	4	4	3	4	1	1	3	3	4	3	3	1	2	3	2	1	3
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	2	4	1	4	4	4	4	3	1	2	1	3	3	2	2	4	3	3	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	4	3	1	1	2	4	1	1	2	4	2	2	1	1	3	3	2	4
Que.	61	62	63	64	65															
Ans.	2	4	1	4	3															

THERMAL PHYSICS

1. A gas at the temperature 250 K is contained in a closed vessel. If the gas is heated through 1K, then the percentage increase in its pressure will be–

(1) 0.4% (2) 0.2%

(3) 0.1% (4) 0.8%

2. Two identical rooms in a house are connected by an open doorway. The temperatures in the two rooms are maintained at different values. Which room contains more air?

(1) the room with higher temperature

(2) the room with lower temperature

(3) the room with higher pressure

(4) same, as both have the same pressure & volume

3. Total number of air molecules (inclusive of oxygen, nitrogen, water vapour and other constituents) in a room of capacity 25 m^3 at a temperature of 27° and 1 atm pressure is :-

(1) 6×10^{26} (2) 6×10^{25}

(3) 6×10^{24} (4) 6×10^{27}

4. Three identical closed containers are filled with gases at the same temperature. Container A is filled with 64 g of oxygen, container B is filled with 84 g of nitrogen, and container C is filled with 8 g of hydrogen. Which is the correct ranking of the pressures in the containers ?

(1) $P_A > P_B > P_C$ (2) $P_A > P_C > P_B$

(3) $P_A < P_C < P_B$ (4) $P_A < P_B < P_C$

5. An ideal gas expands in such a way that PV^2 = constant throughout the process. Select correct alternative

(1) This expansion is not possible without heating

(2) This expansion is not possible without cooling

(3) Internal energy remains constant in this expansion

(4) Internal energy increases in this expansion

6. Number of collisions of molecules of a gas on the wall of a container per m^2 will:

(1) Increase if temperature and volume both are doubled

(2) Increase if temperature and volume both are halved

(3) Increase if pressure and temperature both are doubled

(4) Increase if pressure and temperature both are halved

7. Two containers of equal volume contain identical gases at pressures P_1 and P_2 and absolute temperatures, T_1 and T_2 respectively. The vessels are joined and the gas reaches a common pressure P and a common temperature T. Then

(1) $P = \left(\frac{P_1}{T_1} + \frac{P_2}{T_2}\right)T$ (2) $P = \frac{1}{2}\left(\frac{P_1}{T_1} + \frac{P_2}{T_2}\right)T$

(3) $T = \frac{PT_1T_2}{P_1T_2 + P_2T_1}$ (4) $T = \frac{2PT_1T_2}{P_1T_1 + P_2T_2}$

8. You have two closed containers of equal volume. One is full of helium gas. The other holds an equal mass of nitrogen gas. Both gases have the same pressure. How does the temperature of the helium compare to the temperature of nitrogen ? (Assume gases to be have as ideal gas)

(1) $T_{helium} > T_{nitrogen}$

(2) $T_{helium} = T_{nitrogen}$

(3) $T_{helium} < T_{nitrogen}$

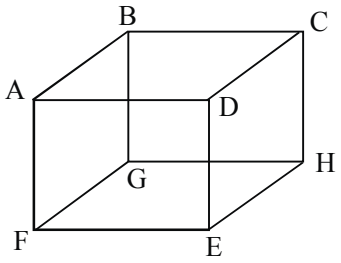
(4) cannot be compared

9. At pressure P and absolute temperature T a mass M of an ideal gas fills a closed container of volume V. An additional mass 2M of the same gas is added into the container and the volume is then reduced to $\frac{V}{3}$ and the temperature to $\frac{T}{3}$. The pressure of the gas will now be:

(1) $\frac{P}{3}$ (2) P

(3) 3 P (4) 9 P

10. 1 mole of an ideal gas is contained in a cubical volume *V*, ABCDEFGH at 300 K. One face of the cube (EFGH) is made up of a material which totally absorbs any gas molecule incident on it. At any given time,

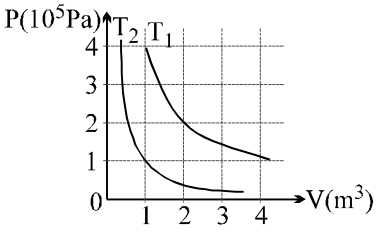


(1) the pressure on EFGH would be zero.
(2) the pressure on all the faces will the equal.
(3) the pressure on EFGH would be double the pressure on ABCD.
(4) the pressure on EFGH would be half that on ABCD

11. When a gas is heated in a vessel of constant volume, the pressure increases because
(1) The average force per impact of a molecule on a wall of the vessel increases
(2) Molecules collide with each other more frequently
(3) The number of molecules per unit volume of the gas increases
(4) All of these

12. A sample of 0.177 g of an ideal gas occupies 1000 cm^3 at STP. Calculate the rms speed of the gas molecules.
(1) 1300 m/s (2) 1500 m/s
(3) 1700 m/s (4) 2000 m/s

13. The following graphs shows two isotherms for a fixed mass of an ideal gas. The ratio of r.m.s. speed of the molecules at temperatures T_1 and T_2 is



(1) $2\sqrt{2}$ (2) $\sqrt{2}$ (3) 2 (4) 4

14. Number of degrees of freedom of molecules of hydrogen in 1 cc of hydrogen at NTP is :-
(1) 1.8×10^{19} (2) 1.5×10^{21}
(3) 1.3×10^{20} (4) 1.6×10^{23}

15. For a gas molecule, its degree of freedom for translation is 3, for rotation is 2 and for vibration is 2. If its rotational K.E is related to total energy by $K.E_R = nE$, then n would be :

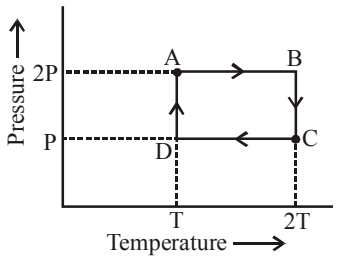
(1) $\frac{3}{2}$ (2) $\frac{7}{2}$

(3) $\frac{3}{7}$ (4) $\frac{2}{7}$

16. In a diatomic molecule, the rotational energy at a given temperature :
(1) does not Obey Maxwell's distribution law
(2) have the same value for all molecules
(3) equal to the translational kinetic energy of each molecule
(4) (2/3)rd of the translational kinetic energy of each molecule

17. A diatomic gas (γ = 1.4) does 2000 J of work when it is expanded isobaricaly. Find the heat given to the gas in the above process (in kJ).
(1) 7000 (2) 7
(3) 5000 (4) 5

18. An ideal monoatomic gas is taken through the thermodynamic states A $\rightarrow$ B $\rightarrow$ C $\rightarrow$ D *via* the paths shown in the figure. If U_A, U_B, U_C and U_D represent the internal energy of the gas in state A, B C and D respectively, then which of the following is not true?



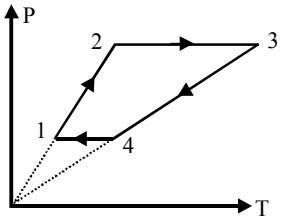
(1) $U_A - U_D = 0$
(2) $U_B - U_C = 0$
(3) $U_C - U_D > 0$
(4) $U_B - U_A < 0$

19. 5n, n and 5n moles of a monoatomic, diatomic and non-linear polyatomic gases (which do not react chemically with each other) are mixed at room temperature. The equivalent degree of freedom for the mixture is-

(1) $\frac{25}{7}$ (2) $\frac{48}{11}$

(3) $\frac{52}{11}$ (4) $\frac{50}{11}$

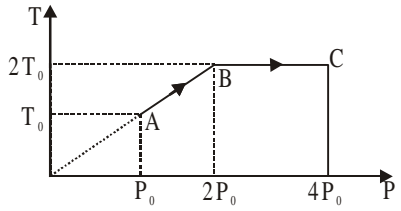
20. Three moles of an ideal monatomic gas performs a cyclic process as shown in the figure. The temperatures in different states are $T_1 = 400$ K, $T_2 = 800$ K, $T_3 = 2400$ K & $T_4 = 1200$ K. Determine the work done by the gas during the cycle [Given R = 8.31 J-mole^{-1}K^{-1})



(1) 19.94 kJ (2) 22.65 kJ

(3) 15.81 kJ (4) 10.37 kJ

21. One mole of an ideal gas is taken through the process ABC as shown in the figure. The total work done on the gas is:



(1) zero (2) $2RT_0\ell n2$

(3) $-2RT_0\ell n2$ (4) $4RT_0\ell n2$

22. C_p and C_v are specific heats at constant pressure and constant volume respectively. It is observed that

$C_p - C_v = a$ for hydrogen gas

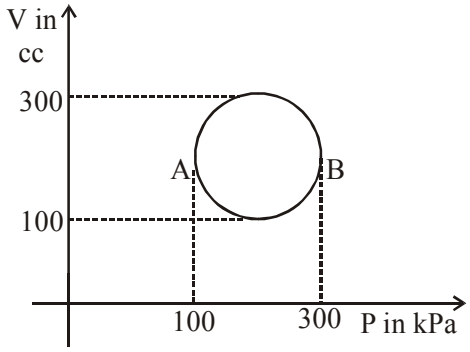
$C_p - C_v = b$ for nitrogen gas

The correct relation between a and b is :

(1) a = 14 b (2) a = 28 b

(3) $a = \frac{1}{14}b$ (4) a = b

23. Calculate heat given to gas during process ABA in figure :-



(1) 3.14 J (2) 314 J

(3) 31.4 J (4) None of these

24. The ratio C_P/C_V for a gas mixture consisting of 8g of helium and 16g of oxygen is :-

(1) 23/15 (2) 15/23

(3) 27/17 (4) 17/27

25. Four moles of carbon monoxide (f = 5) are mixed with four moles of carbon dioxide (f = 7). Assuming the gases to be ideal, the ratio of specific heats is

(1) 15/11 (2) 41/30

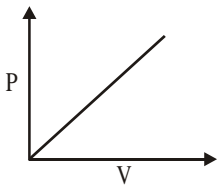
(3) 4/3 (4) 7/4

26. A mixture of n_1 moles of monoatomic gas and n_2 moles of diatomic gas has $\gamma = 1.5$ then :-

(1) $n_1 = n_2$ (2) $2n_1 = n_2$

(3) $2n_2 = n_1$ (4) $2n_1 = 3n_2$

27. 1 mole of monoatomic ideal gas is expanded as per following process. What will be molar heat capacity ?



(1) R (2) 0.303 R (3) 5R (4) 2R

28. P–V diagram of a diatomic gas is a straight line passing through origin. The molar heat capacity of the gas in the process will be :

(1) 4 R (2) 2.5 R (3) 3 R (4) $\frac{4R}{3}$

29. 5.6 litre of helium gas at STP is adiabatically compressed to 0.7 liter. Taking the initial temperature to be T_1, the work done in the process is

(1) $\frac{9}{8}RT_1$ (2) $\frac{3}{2}RT_1$

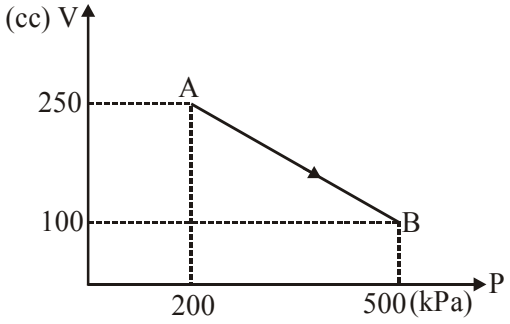
(3) $\frac{15}{8}RT_1$ (4) $\frac{9}{2}RT_1$

30. For a process, relation between temperature and volume is TV^3 = constant. If a monatomic gas follows this process, then find the molar specific heat for this process [R is a gas constant].

(1) $\frac{7R}{6}$ (2) $\frac{R}{3}$

(3) $\frac{11R}{6}$ (4) Zero

31. A monoatomic gas is taken along path AB as shown. Calculate change in internal energy of system :-



(1) 279.8 J (2) 341 J

(3) 241 J (4) Zero

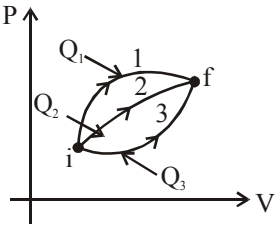
32. Ideal mono-atomic gas is taken through process such that dQ= 3dU. The molar heat capacity for this process is :-

(1) 3 R (2) 4.5 R (3) 4 R (4) 2 R

33. One mole of an ideal monoatomic gas at temperature T_0 expands slowly according to law P= kV (k is constant). If final temperature is $2T_0$ heat supplied to gas is :-

(1) 2 RT_0 (2) 3/2 RT_0 (3) RT_0 (4) $RT_0/2$

34. A diatomic gas undergoes three processes as shown in figure. In process 1, W_1 = 200 J, in process 2, W_2 = 100 J and in process 3, Q_3= 250 J, W_3 = 50 J. Find the ratio of Q_1 and Q_2:



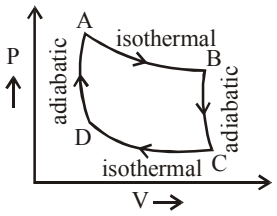
(1) $\frac{4}{3}$ (2) 2

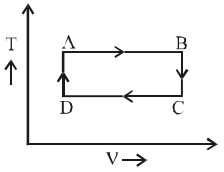
(3) $\frac{5}{2}$ (4) $\frac{4}{5}$

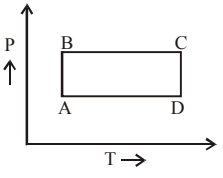
35. In an adiabatic process, pressure is increased by $\frac{2}{3}\%$. If $\frac{C_P}{C_V}=\frac{3}{2}$ then the volume decreased by about :

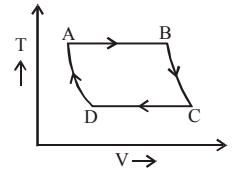
(1) $\frac{4}{9}\%$ (2) $\frac{2}{9}\%$ (3) 4% (4) $\frac{9}{4}\%$

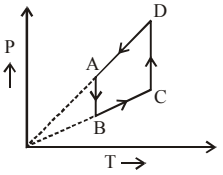
36. The P-V diagram of a certain process (Carnot cycle) is as shown in the figure. The process is represented as:-



(1)


(2)


(3)


(4)


37. Aheat engine is having a source at temperature 527°C and sink at temperature 127°C. If the useful work is required to be done by the engine at the rate of 750 watt, then the amount of heat absorbed per second from the source in calories and the efficiency of heat engine are :-

(1) 482.2 cal/s, 50%

(2) 482.2 cal/s, 25%

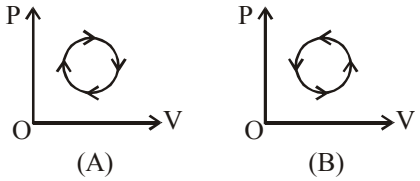
(3) 357.14 cal/s, 50%

(4) 357.14 cal/s, 25%

38. Consider a carnot's cycle operating between T_1 = 500 K and T_2 = 300 K producing 1 kJ of mechanical work per cycle. Find the heat transferred to the engine by the reservoirs.

(1) 2000 J (2) 2500 J (3) 1500 J (4) 1000 J

39. If the P-V diagrams of two thermodynamics devices working in a cyclic process are as shown in the figure, then :-



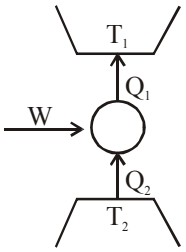
(1) A is a heat engine, B is a heat pump/ refrigerator

(2) B is a heat engine, A is a heat pump/ refrigerator

(3) both A and B are heat engines

(4) both A and B are heat pumps/refrigerator

40. Consider a heat engine as shown in figure. Q_1 and Q_2 are heat added to heat bath T_1 and heat taken from T_2 in one cycle of engine respectively. W is the mechanical work done on the engine. If W > 0, then possibilities are:



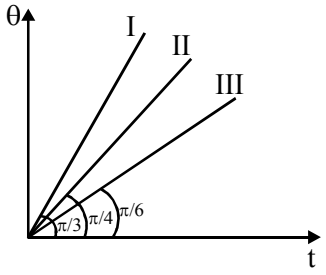
(1) $Q_1 > Q_2 > 0$

(2) $Q_2 > Q_1 > 0$

(3) $Q_2 < Q_1 < 0$

(4) $Q_1 < 0, Q_2 > 0$

41. Three bodies A, B and C of masses m, m and $\sqrt{3}$m respectively are supplied heat at a constant rate. The change in temperature θ versus time t graph for A, B and C are shown by I, II and III respectively. If their specific heat capacities are S_A, S_B and S_C respectively then which of the following relation is correct ? (Initial temperature of body is 0°C) :-



(1) $S_A > S_B > S_C$

(2) $S_B = S_C < S_A$

(3) $S_A = S_B = S_C$

(4) $S_B = S_C > S_A$

42. A copper block of mass 2.5 kg is heated in a furnace to a temperature of 500° C and then placed on a large ice block. What is the maximum amount of ice that can melt. (Specific heat of copper is 0.39 J/gm)

(1) 1.5 kg (2) 2.5 kg

(3) 3.5 kg (4) 4.5 kg

43. During the melting of a slab of ice at 273 K at atmospheric pressure. Consider the following statements

(A) positive work is done by the ice-water system on the atmosphere

(B) positive work is done on the ice-water system by the atmosphere

(C) the internal energy of the ice-water system increases

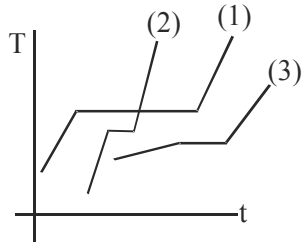
(D) the internal energy of the ice-water system decreases

The correct statements are : -

(1) A & C (2) A & D

(3) B & C (4) B & D

44. Three different materials of identical masses are placed in turn in a special oven where a material absorbs energy at a certain constant rate. During heating process, each material begins in the liquid state and ends in gaseous state. Following figure gives the temperature T verses time t for three materials, C represents specific heats in liquid state & L represent latent heat of vaporization. Then



(1) $C_1 > C_2 > C_3$, $L_1 = L_2 = L_3$
(2) $C_1 > C_2 > C_3$, $L_1 > L_3 > L_2$
(3) $C_3 > C_1 > C_2$, $L_1 > L_3 > L_2$
(4) $C_1 = C_2 = C_3$, $L_1 > L_2 > L_3$

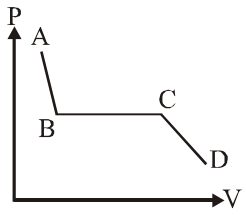
45. When 20 kJ of heat is removed from 1.2 kg of ice originally at –15°C, its new temperature is (approximately) :- (Given : C_{ice} = 2100 J/kg K)

(1) –18°C (2) –26°C
(3) –23°C (4) –35°C

46. Steam at 100°C is more dangerous than the same mass of water at 100°C because the steam:-

(1) moves faster
(2) is less dense
(3) contains more internal energy
(4) has a higher specific heat capacity

47. The portion AB of the indicator diagram representing the state of matter denotes:-

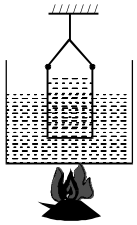


(1) The liquid state of matter
(2) Gaseous state of matter
(3) Change from liquid to gaseous state
(4) Change from gaseous state to liquid state

48. Heat is associated with

(1) Kinetic energy of random motion of molecules
(2) Kinetic energy of orderly motion of molecules
(3) Total kinetic energy of random motion in some cases and kinetic energy of orderly motion in other
(4) Total kinetic energy of random motion and orderly motion of molecules

49. Water is boiling in a large vessel as shown in figure. If another vessel containing water is dipped in the bigger vessel as shown. Choose correct option for water in smaller vessel

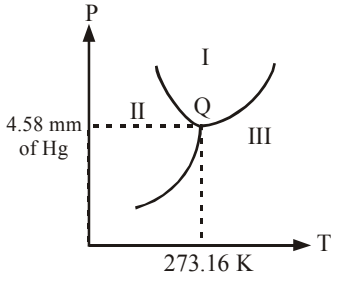


(1) will not boil
(2) will boil below 100°C
(3) will boil above 100°C
(4) will boil at 100°C

50. A small quantity, mass m, of water at a temperature θ (in °C) is poured on to a large mass M of ice which is at its melting point. If c is the specific heat of water and L the latent heat of fusion of ice, then the mass of ice melted is given by :-

(1) $\frac{ML}{mc\theta}$ (2) $\frac{mc\theta}{ML}$ (3) $\frac{Mc\theta}{L}$ (4) $\frac{mc\theta}{L}$

51. In the phase diagram shown, the point Q corresponds to the triple point of water. The regions I, II and III respectively correspond to phases



(1) liquid, solid, vapour
(2) solid, liquid, vapour
(3) liquid, vapour, solid
(4) solid, vapour, liquid

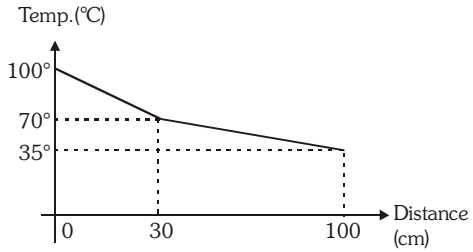
52. An experiment takes 10 minutes to raise the temperature of water in a container from 0°C to 100°C and another 55 minutes to convert it totally into steam by a heater supplying heat at a uniform rate. Neglecting the specific heat of the container and taking specific heat of water to be 1 cal/g °C, the heat of vapourization according to this experiment will come out to be :-

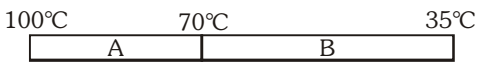
(1) 530 cal/g (2) 540 cal/g
(3) 550 cal/g (4) 460 cal/g

53. 2 kg of metal at 100°C is cooled by 1 kg of water at 0°C. If specific heat capacity of metal is $\frac{1}{2}$ of specific heat capacity of water, final temperature of mixture would be :-

(1) 50°C (2) More than 50°C
(3) Less than 50°C (4) None of the above

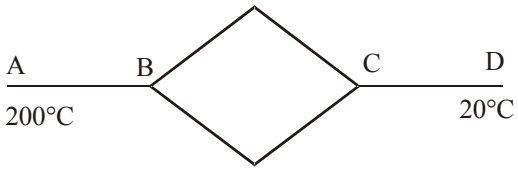
54. Two different rods A and B are kept as shown in figure. The variation of temperature of different cross sections is plotted in a graph shown in figure. The ratio of thermal conductivities of A and B is





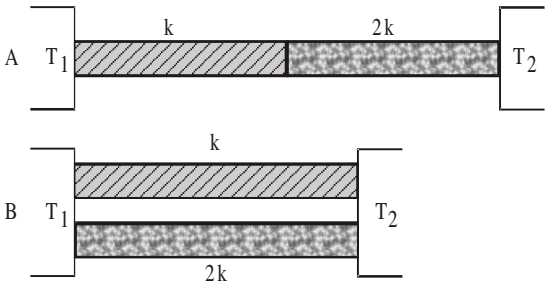
(1) 2 (2) 0.5 (3) 1 (4) 2/3

55. Six identical conducting rods are joined as shown. The ends A and D are maintained at 200° C and 20 °C respectively. No heat is lost to surroundings. The temperature of the junction C will be



(1) 60° C (2) 80°C
(3) 100°C (4) 120°C

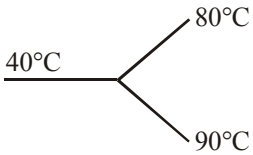
56. Two rods with the same dimensions have thermal conductivities in the ratio 1 : 2. They are arranged between heat reservoirs with the same temperature difference, in two different configurations, A and B. The rates of heat flow in A and B are I_A and I_B respectively. The ratio $\frac{I_A}{I_B}$ is equal to



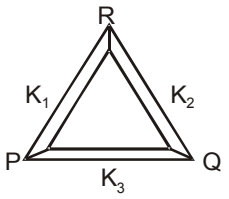
(1) 1 : 2 (2) 1 : 3 (3) 2 : 5 (4) 2 : 9

57. Three rods made of the same material and having the same cross-section have been joined as shown in the figure. Each rod is of the same length. The temperature of the junction of the three rods will be :-

(1) 55° C
(2) 60° C
(3) 75° C
(4) 70° C



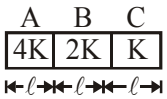
58. Three rods of same dimensions are arranged as shown in figure they have thermal conductivities K_1, K_2 and K_3. The points P and Q are maintained at different temperatures for the heat to flow at the same rate along PRQ and PQ then which of the following option is correct-



(1) $K_3 = \frac{1}{2}(K_1 + K_2)$ (2) $K_3 = K_1 + K_2$

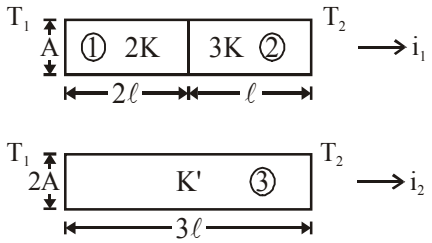
(3) $K_3 = \frac{K_1K_2}{K_1 + K_2}$ (4) $K_3 = 2(K_1 + K_2)$

59. Three rods having same length and cross-section area are joined as shown in figure. Find equivalent thermal conductivity



(1) $\frac{K_A}{7}$ (2) $\frac{6K_B}{7}$ (3) $\frac{7K_B}{3}$ (4) $7K_C$

60.



Find value of $\frac{K'}{K}$ such that slab (3) conduct double thermal current w.r.t. (1) + (2) for same temperature difference :

(1) $\frac{9}{4}$ (2) $\frac{5}{3}$ (3) 5 (4) 2

61. Two spheres of same material are having surfaces blackened and placed in space separately. Their radii are R and 2R respectively and the most dominating wavelengths in their spectrum are observed to be in the ratio 1 : 2. Choose incorrect statement :-

(1) The ratio of their temperatures is 2 : 1

(2) The ratio of their emissive powers is 4 : 1

(3) The ratio of their rates of heat loss is 4 : 1

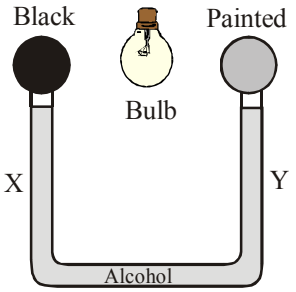
(4) The ratio rates of cooling is 32 : 1

62. A copper sphere is suspended in an evacuated chamber maintained at 300 K. The sphere is maintained at a constant temperature of 500 K by heating it electrically. A total of 300 W of electric power is needed to do it. When **half** of the surface of the copper sphere is completely blackened, 600W is needed to maintain the same temperature of the sphere. Calculate the emissivity of copper.

(1) $e = \frac{1}{3}$ (2) $e = \frac{2}{3}$

(3) $e = \frac{1}{2}$ (4) $e = \frac{1}{6}$

63. The following figure shows two air-filled bulbs connected by a U-tube partly filled with alcohol. What happened to the levels of alcohol in the limbs X and Y when an electric bulb placed midway between the bulbs is lighted?



(1) The level of alcohol in limb X falls while that in limb Y rises

(2) The level of alcohol in limb X rises while that in limb Y falls

(3) The level of alcohol falls in both limbs

(4) The level of alcohol rises in both limbs

64. Assume that the entire surface of a burning log of wood is at the same temperature. Some small spots on the wood appear brighter than the rest of the surface. At such a spot–

(1) there is a small cavity in the wood.

(2) there is a small hump (convex portion) in the wood.

(3) less ash has formed than on the rest of the wood.

(4) more ash has formed than on the rest of the wood.

65. A solid sphere of radius R and a hollow sphere of inner radius r and outer radius R made of copper are heated to the same temperature and are allowed to cool in the same environment. Then, choose the **CORRECT** statement :-

(1) Hollow sphere cools faster

(2) Solid sphere cools faster

(3) Both the spheres attain room temperature at the same time

(4) The rate of loss of heat of the solid sphere is twice that of the hollow sphere

66. Two spheres A and B have the same radii but the heat capacity of A is greater than that of B. The surfaces of both are painted black. They are heated to the same temperature and allowed to cool in vacuum. Then :

(1) A cools faster than B

(2) both A and B cool at the same rate

(3) at any temperature the ratio of their rates of cooling is a constant

(4) B cools faster than A

67. Which of the following statements is/are **CORRECT**:

(i) a body with large reflectivity is a poor emitter

(ii) a brass tumbler feels much colder than a wooden tray on a chilly day

(iii) the earth without its atmosphere would be inhospitably cold

(iv) heating systems based on circulation of steam are more efficient in warming a building than those based on circulation of hot water

Find correct option :-

(1) i & ii only (2) i, ii & iv

(3) i & iv only (4) i, ii, iii & iv

68. The temperature of a body falls from 52°C to 36°C in 10 minutes when placed in a surrounding of constant temperature 20°C. What will be the temperature of the body after another 10 min.

(1) 28°C (2) 20°C

(3) 32°C (4) 24°C

69. A black body emits 10 watt per cm^2 at 427°C. The sun radiates 10^5 watt per cm^2. Then what is the temperature of the sun?

(1) 5000 K (2) 6000 K

(3) 7000 K (4) 8000 K

70. A red star and a green star radiate energy at the same rate which star is bigger in size.

(1) red

(2) green

(3) both have same size

(4) Can't say anything

71. Hot coffee in a mug cools from 90° to 70°C in 4.8 minutes. The room temperature is 20°C. Applying Newton's law of cooling the time needed to cool it further by 10°C should be nearly

(1) 4.2 min (2) 3.8 min

(3) 3.2 min (4) 2.4 min

72. A planet having average surface temperature T_0 is at an average distance d from the sun. Assuming that the planet receives radiant energy from the sun on unit area in unit time is S and it loses radiant energy only from its surface and neglecting all other atmospheric effects we conclude.

(1) $S \propto d^2$ (2) $S \propto d^{-2}$

(3) $S_0 \propto d$ (4) $S_0 \propto d^4$

73. In Newton's law of cooling $\frac{d\theta}{dt} = -k\Delta\theta$, the proportionality constant k is k_1 and k_2 for two substances A and B having mass m_1 and m_2 area A_1 and A_2, specific heat s_1 and s_2, emissivity e_1 and e_2 respectively, it is given that $\frac{e_1}{e_2} = 1$, $\frac{A_1}{A_2} = 1$, $\frac{m_1}{m_2} = 2$, $\frac{s_1}{s_2} = \frac{1}{3}$, while surrounding temperature remains constant.

Then $\frac{k_1}{k_2}$:-

(1) $\frac{1}{3}$ (2) $\frac{2}{9}$ (3) $\frac{3}{2}$ (4) $\frac{3}{4}$

74. In the given table are shown initial lengths, change in temperature and final lengths of there different rods.

Rod	Initial Length	Temperature Change	Change in Length
P	2L	ΔT	ℓ
Q	3L	$2\Delta T$	3ℓ
R	4L	ΔT	ℓ

Which of the following statements is/are true?

(1) All the three rods are of different materials.

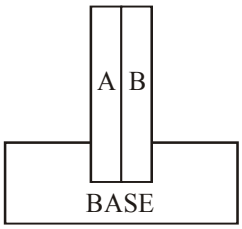
(2) Rods P and Q may be of the same material.

(3) Rods Q and R may be of the same material.

(4) Rods P and R may be of the same material.

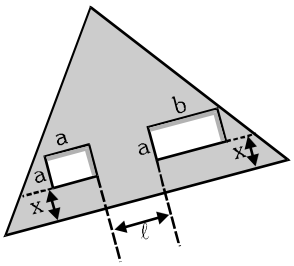
75. When water is heated from 0°C to 4°C and C_p and C_v are its specific heats at constant pressure and constant volume respectively, then :
(1) $C_p > C_v$ (2) $C_p < C_v$
(3) $C_p = C_v$ (4) $C_p - C_v = R$

76. A bimetallic strip consists of metals A and B. It is mounted rigidly at the base as shown. The metal A has a higher coefficient of expansion to that for metal B. When bimetallic strip is placed in a cold bath it will



(1) bend towards the right
(2) bend towards the left
(3) not bend but shrink
(4) neither bend nor shrink

77. A triangular plate has two cavities, one square and one rectangular as shown. The plate is heated.



(1) a increases, b decreases
(2) a and b both increase
(3) a and b increase, x and ℓ decrease
(4) a, b, x and ℓ all increase

78. On a temperature scale Y, water freezes at –160 °Y and boils at – 50 °Y. On this Y scale, a temperature of 340 K would be read as
(1) –106.3°Y (2) –96.3°Y
(3) –86.3°Y (4) –76.3°Y

79. The coefficient of apparent expansion of a liquid when determined using two different vessels A and B are γ_1 and γ_2 respectively. If the coefficient of linear expansion of the vessel A is α_1, the coefficient of linear expansion of the vessel B is

(1) $\frac{\alpha_1\gamma_1\gamma_2}{\gamma_1+\gamma_2}$ (2) $\frac{\gamma_1-\gamma_2}{2\alpha_1}$

(3) $\frac{\gamma_1+\gamma_2+\alpha}{3}$ (4) $\frac{\gamma_1-\gamma_2+3\alpha_1}{3}$

80. For an ideal gas PT^{11} = constant then volume expansion coefficient is equal to-

(1) $\frac{11}{T}$ (2) $\frac{1}{T}$ (3) $\frac{12}{T}$ (4) $\frac{2}{T}$

81. A uniform metallic rod rotates about its perpendicular bisector with constant angular speed. If it is heated uniformaly to raise its temperature slightly :-
(1) Its speed of rotation increases
(2) Its speed of rotation decreases
(3) Its speed of rotation remains same
(4) Its speed of rotation increases because its moment of inertia increases

82. For ideal gas, the coefficient of volume expansion at constant pressure is :-
(1) directly proportional to absolute temp
(2) inversely proportional to absolute temp
(3) Does not depends on temp.
(4) Data is not sufficient

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	2	1	4	2	2,3	2	3	3	4	1	1	3	3	4	4	2	4	4	1
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	3	3	3	1	4	3	1	1	4	2	1	1	1	3	3	2	1	1
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	1	3	3	3	3	1	1	1	4	1	3	1	2	2	4	4	3	2	1
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	1	1	1	1	4	4	1	3	1	3	2	3	2	2	2	4	3	4	3
Que.	81	82																		
Ans.	2	2																		

OSCILLATIONS

1. Which of the following quantities is always non-zero in a simple harmonic motion ?

(1) $\vec{F}\times\vec{a}$ (2) $\vec{a}\times\vec{r}$ (3) $\vec{v}\times\vec{r}$ (4) $\vec{F}.\vec{r}$

2. A particle executes SHM with time period T and amplitude A. Its displacement from mean position after a time T/8 is :-

(1) $\frac{A}{2}$ (2) $\frac{A}{\sqrt{2}}$

(3) $\frac{A}{2\sqrt{2}}$ (4) $\frac{A}{8}$

3. Which of the following relationships between the acceleration a and displacement x of the particle involve simple harmonic motion.

(1) a = 0.7 x (2) a = –200 x^2

(3) a = –10 x (4) a = 100 x^2

4. A particle moves on x-axis according to the equation $x = x_0 \sin^2\omega t$, the motion is simple harmonic :-

(1) with amplitude x_0

(2) with amplitude $2x_0$

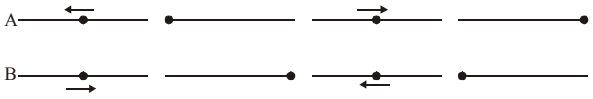
(3) with time period $(2\pi/\omega)$

(4) with time period (π/ω)

5. The displacement time equation of a particle executing SHM is : $x = A \sin(\omega t + \phi)$. At time t = 0 position of the particle is x = A/2 and it is moving along negative x-direction. Then the angle ϕ can be :

(1) $\pi/6$ (2) $\pi/3$ (3) $2\pi/3$ (4) $5\pi/6$

6. Figure represents two simple harmonic motions:



Consider following parameters of SHM.

I. amplitude II. frequency

III. phase IV. maximum velocity

V. time period

VI. maximum acceleration

How many parameter(s) has (have) same value in two SHMs.

(1) 3 (2) 4 (3) 5 (4) 6

7. Two particles P and Q describe SHM of same amplitude a, frequency ν along the same straight line. The maximum distance between the two particles is $a\sqrt{2}$. The initial phase difference between the particles is :-

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

8. Two SHM are represented by equations,

$$y_1 = 6\cos\left(6\pi t + \frac{\pi}{6}\right),\ y_2 = 3\ (\sqrt{3}\sin 3\pi t + \cos 3\pi t)$$

(1) ratio of their amplitudes is 1

(2) ratio of their time periods is 1

(3) ratio of their maximum velocities is 1

(4) ratio of their maximum acceleration is 1

9. Identify, which of the following functions represents simple harmonic motion

(1) $y = ae^{-\omega t}$

(2) $y = a\sin(\omega t)^2$

(3) $y = a\sin\omega t + b\cos\omega t$

(4) $y = \sin\omega t + \cos 2\omega t$

10. Equation of SHM of angular frequency ω and amplitude a, if the particle is situated at $\frac{a}{\sqrt{2}}$ at t=0 and is going towards mean position is

(1) $x = a\sin\left(\omega t + \frac{\pi}{4}\right)$ (2) $x = a\sin\left(\omega t - \frac{\pi}{4}\right)$

(3) $x = a\sin\left(\omega t - \frac{3\pi}{4}\right)$ (4) $x = a\sin\left(\omega t + \frac{3\pi}{4}\right)$

11. The motion of a particle executing SHM is described by

$$x = A\cos(\omega t + \phi)$$

If at t = 0 x = 1 cm and $v = \omega$ cm/s. Its initial phase and amplitude are respectively :-

(1) $\frac{7\pi}{4};\sqrt{2}$ (2) $\frac{\pi}{4};\sqrt{2}$

(3) $\frac{3\pi}{4};\sqrt{2}$ (4) $\frac{\pi}{4};1$

12. A particle is executing simple harmonic motion of amplitude A. At a distance x from the centre, particle moving towards the extreme position receives a blow in the direction of motion which instantaneously doubles the velocity. Its new amplitude will be :-

(1) A (2) $\sqrt{A^2 - x^2}$

(3) $\sqrt{2A^2 - 3x^2}$ (4) $\sqrt{4A^2 - 3x^2}$

13. Maximum speed of a particle in simple harmonic motion is v_{max}. Then average speed of a particle in one complete oscillation is equal to :

(1) $\frac{v_{max}}{2}$ (2) $\frac{v_{max}}{\pi}$ (3) $\frac{\pi v_{max}}{2}$ (4) $\frac{2v_{max}}{\pi}$

14. The equation of simple harmonic motion of a particle oscillating along the x-axis is given by $x = 3\sin(\pi t + \frac{\pi}{6})$ cm. The acceleration of the particle at t = 1 s is :-

(1) $-1.5\ \pi^2$ cm s^{-2} (2) $2.6\ \pi$ cm s^{-2}

(3) $-2.6\ \pi^2$ cm s^{-2} (4) $1.5\ \pi$ cm s^{-2}

15. The average acceleration of a particle performing SHM over one complete oscillation is :-

(1) $\frac{\omega^2 A}{2}$ (2) $\frac{\omega^2 A}{\sqrt{2}}$ (3) Zero (4) $A\omega^2$

16. In simple harmonic motion, let the time period of variation of potential energy be T_1 and time period of variation of position be T_2, then relation between T_1 and T_2 is :-

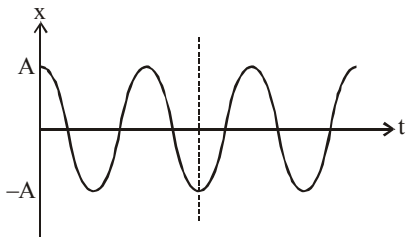
(1) $T_1 = T_2$ (2) $T_1 = 2T_2$

(3) $2T_1 = T_2$ (4) None of these

17. A particle executes SHM along a straight line with mean position at x = 0, period 20 sec and amplitude 5 cm. Find the shortest time taken by the particle to go from x = 4 cm to x = – 3 cm in seconds.

(1) 8s (2) 7s (3) 3s (4) 5s

18. This is the position graph of a mass on spring. What can you say about the velocity and force at the instant indicated by dashed line? (positive direction is to the right).



(1) Velocity is zero, force is to the right

(2) Velocity is positive, force is to the right

(3) Velocity is negative, force is to the right

(4) Velocity is zero, force is to the left

19. A particle is performing simple harmonic motion.

(i) its velocity–displacement graph is parabolic in nature

(ii) its velocity–time graph is sinusoidal in nature

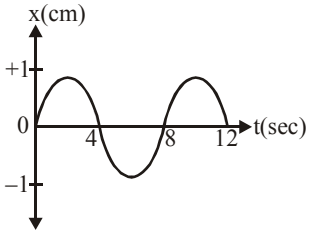
(iii) its velocity–acceleration graph is elliptical in nature

CORRECT answer is

(1) (i), (ii) and (iii) (2) (ii) and (iii)

(3) (i) and (ii) (4) (i) and (iii).

20. The x-t graph of a particle undergoing simple harmonic motion is shown below. The acceleration of the particle at $t = \frac{4}{3}$s is :-



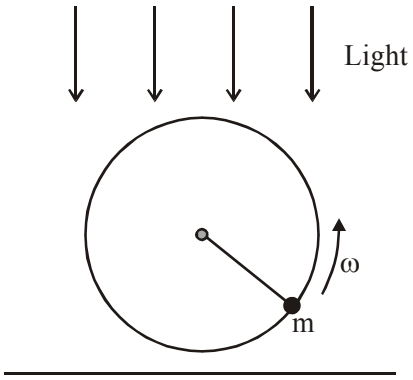
(1) $\frac{\sqrt{3}}{32}\pi^2 \text{cm/s}^2$

(2) $\frac{-\pi^2}{32}\text{cm/s}^2$

(3) $\frac{\pi^2}{32}\text{cm/s}^2$

(4) $-\frac{\sqrt{3}}{32}\pi^2 \text{cm/s}^2$

21. A particle performing uniform circular motion. Shown in figure :-

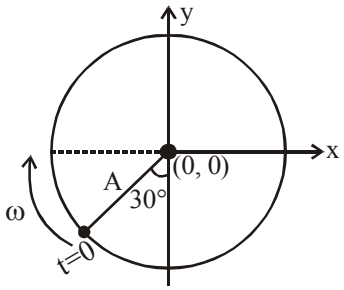


Find out the motion performed by the shadow on horizontal line

(1) Circular (2) Elliptical

(3) SHM (4) parabolic

22. A particle is moving with constant angular velocity ω along a circular path of radius A as shown in figure. Find out x-component of velocity of particle as a function of time.



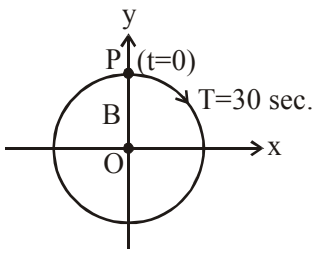
(1) $v = A\omega \cos(\omega t + \pi/6)$

(2) $v = A\omega \cos(\omega t - \pi/6)$

(3) $v = -A\omega \cos(\omega t + \pi/6)$

(4) $v = -A\omega \sin(\omega t + \pi/6)$

23. Given figure shows the circular motion of a particle. The radius of circle, the period sense of revolution and the initial position are indicated on the figure, the simple harmonic motion of the x-projection of the radius vector of the rotation particle p is :



(1) $x(t) = B \sin\left(\frac{\pi}{15}t\right)$

(2) $x(t) = B\cos\left(\frac{\pi}{15}t\right)$

(3) $x(t) = B\sin\left(\frac{\pi t}{15}+\frac{\pi}{2}\right)$

(4) $x(t) = B\cos\left(\frac{\pi t}{15}+\frac{\pi}{2}\right)$

24. Potential energy of a particle of mass 0.1 kg moving along x-axis is given as U = 5x(x–4)J, here x is in meters, then which of the following is correct

(i) particle is acted upon by a constant force.

(ii) speed of particle is maximum at x = 2m.

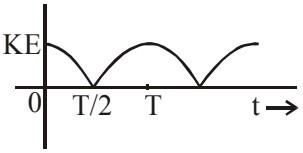
(iii) particle executes SHM

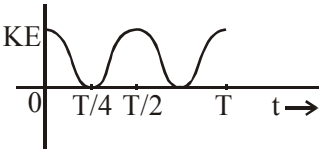
(iv) period is π/5 sec.

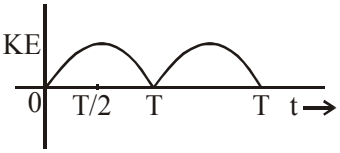
(1) i, ii, iii (2) ii, iii, iv

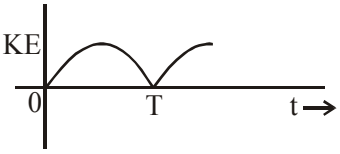
(3) i, ii, iv (4) i, ii, iii & iv

25. A particle is executing simple harmonic motion with a time period T. AT time t = 0, it is at its position of equilibrium. The kinetic energy-time graph of the particle will look like

(1)


(2)


(3)


(4)


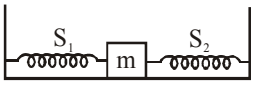
26. The potential energy of a particle executing SHM changes from maximum to minimum in 5 s. Then the time period of SHM is :

(1) 5 s (2) 10 s (3) 15 s (4) 20 s

27. Two identical springs of force constant k are connected (1) in series, (2) in parallel and support a mass m. The ratio of the period of oscillations of the series arrangement with that of the parallel arrangement is :-

(1) 1 : 1 (2) 1 : 2 (3) 1 : 4 (4) 2 : 1

28. When a mass m is connected individually with two springs S_1 and S_2, the oscillation frequencies are n_1 and n_2. If the mass m is attached to the springs as shown in figure, the oscillation frequency would be :-



(1) $n_1 + n_2$ (2) $\sqrt{n_1^2 + n_2^2}$

(3) $\left(\frac{1}{n_1}+\frac{1}{n_2}\right)^{-1}$ (4) $\sqrt{n_1^2 - n_2^2}$

29. In which of the following case frequency of spring-block system will be same as $\frac{1}{2\pi}\sqrt{\frac{K}{m}}$

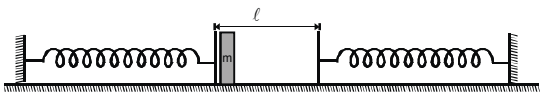
(1) if placed on accelerated elevator

(2) if dipped in non-viscous liquid completely

(3) both (1) and (2)

(4) Neither (1) nor (2)

30. A block of mass m is oscillating on a smooth surface between two light springs of spring constant k separated by a distance ℓ colliding elastically with the springs. If the velocity of the block is increased by an external impulse when it is not touching either of the spring then time period



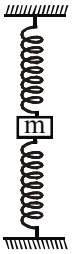
(1) Increases.

(2) Decreases

(3) remains same.

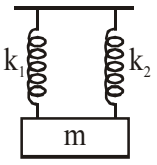
(4) Time period is independent of ℓ

31. One end of a spring is fixed to the ceiling and other end is attached to a block. The block is released when spring is relaxed. The product of time period and amplitude is 8 S.I. units. Spring is cut in two equal parts and the two parts are attached to the block as shown in figure. The block is released when both springs are relaxed. Now find the product of time period and amplitude in S.I. units.



(1) 2 (2) 1 (3) 4 (4) 8

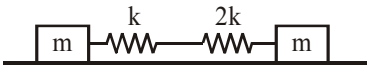
32. A mass is suspended separately by two different springs in successive order then time periods is t_1 and t_2 respectively. If its is connected by both spring as showning figure then time period is t_0, the correct relation is :-



(1) $t_0^2 = t_1^2 + t_2^2$ (2) $t_0^{-2} = t_1^{-2} + t_2^{-2}$

(3) $t_0^{-1} = t_1^{-1} + t_2^{-1}$ (4) $t_0 = t_1 + t_2$

33. A system is shown in the figure. The time period for small oscillations of the two blocks will be.



(1) $2\pi\sqrt{\frac{3m}{k}}$ (2) $2\pi\sqrt{\frac{3m}{2k}}$

(3) $2\pi\sqrt{\frac{3m}{4k}}$ (4) $2\pi\sqrt{\frac{3m}{8k}}$

34. A block of mass 200g executing SHM under the influence of a spring of spring constant $k = 90\ N\ m^{-1}$ and a damping constant $b = 40\ g\ s^{-1}$. The time elapsed for its amplitude to drop to half of its initial value is :- (Given $\log_e 2 = 0.693$)

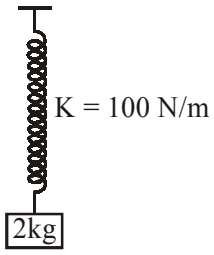
(1) 7s (2) 9s (3) 4s (4) 11s

35. Two masses m_1 and m_2 are suspended together by a massless spring of constant k. When the masses are in equilibrium, m_1 is removed without disturbing the system; the amplitude of vibration is :-

(1) m_1g/k (2) m_2g/k

(3) $\frac{(m_1+m_2)g}{k}$ (4) $\frac{(m_2+m_2)g}{k}$

36. Block is in equilibrium initially. Now we displaced the block by a distance 0.4 m downward and then release. Find time taken by the block to reach the natural length of the spring :-



(1) $\frac{2\pi}{3}\sqrt{\frac{2}{100}}$ (2) $2\pi\sqrt{\frac{2}{100}}$

(3) $\pi\sqrt{\frac{2}{100}}$ (4) $\frac{\pi}{3}\sqrt{\frac{2}{100}}$

37. Pendulum A is a physical pendulum made from a thin rigid and uniform rod whose length is ℓ. One end of this rod is attached to the ceiling by a frictionless hinge so that rod is free to swing back and forth. Pendulum B is a simple pendulum whose length is also ℓ. The ratio $\frac{T_A}{T_B}$ for small angular oscillations-

(1) $\sqrt{\frac{3}{2}}$ (2) $\sqrt{\frac{2}{3}}$ (3) $\frac{2}{3}$ (4) $\frac{3}{2}$

38. A simple pendulum is suspended in a car. The car starts moving on a horizontal road according to equation $x=\frac{g}{2}\sqrt{3}t^2$. Find the time period of oscillation of the pendulum.

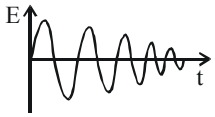
(1) $2\pi\sqrt{\frac{\ell}{g}}$ (2) $\pi\sqrt{\frac{2\ell}{g}}$ (3) $2\pi\sqrt{\frac{\ell}{8g}}$ (4) $2\pi\sqrt{\frac{\ell}{g\sqrt{3}}}$

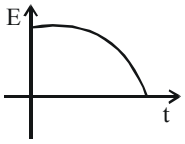
39. The displacement x of a particle at time t is given by x = 5sin2t, where x is in m and t is in s. A simple pendulum has the same period as the particle when the length of the pendulum is (take g = 10 m/s^2):-

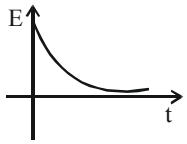
(1) 10.0 m (2) 5.0 m

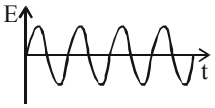
(3) 2.5 m (4) 2.0 m

40. Which of the diagram shown in the figure represents variation of total mechanical energy of a pendulum oscillating in air as function of time:-

(1) 

(2) 

(3) 

(4) 

41. If the differential equation given by

$$\frac{d^2y}{dt^2}+2k\frac{dy}{dt}+\omega^2y=\frac{F_0}{m}\sin\pi t$$

describes the oscillatory motion of a body in a dissipative medium under the influence of a periodic force, then this situation is :-

(1) free vibration (2) damped vibration

(3) forced vibration (4) resonance

42. In damped oscillations, the amplitude after 50 oscillations is 0.8 a_0, where a_0 is the initial amplitude, then the amplitude after 150 oscillations is :-

(1) 0.512 a_0 (2) 0.280 a_0

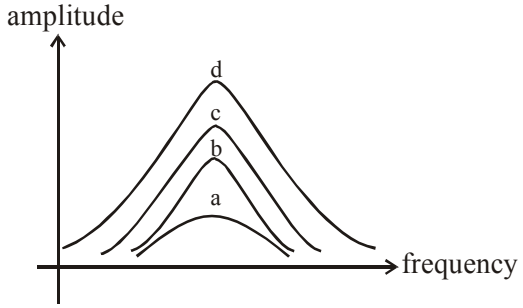
(3) Zero (4) a_0

43. Find out time period of the given periodic function :-

$x = \sin\omega t + \cos 2\omega t + \sin 4\omega t$

(1) $\frac{2\pi}{\omega}$ (2) $\frac{\pi}{\omega}$ (3) $\frac{\pi}{2\omega}$ (4) $\frac{\pi}{4\omega}$

44. Which graph have small damping :-



(1) a (2) b (3) c (4) d

45. The value of amplitude of the forced oscillation when damping is small and ω_d is far away from ω :-

(1) $\frac{F_0}{m\omega^2}$ (2) $\frac{F_0}{m(\omega_d^2-\omega^2)}$

(3) $\frac{F_0}{\omega_d b}$ (4) None

(Where ω_d = driving frequency, ω = natural frequency, F_0 = amplitude of applied force)

46. The value of maximum possible amplitude in the case of forced oscillations when driving frequency is close to natural frequency is :

(1) $\frac{F_0}{m(\omega^2-\omega_d^2)}$ (2) $\frac{F_0}{\omega_d b}$

(3) $\frac{F_0}{m\omega^2}$ (4) None

47. If an external force with angular frequency ω_d acts on an oscillating system with natural frequency ω, the system oscillates :

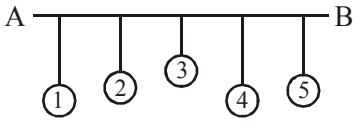
(1) with angular frequency ω

(2) with angular frequency ω_d

(3) with angular frequency $\frac{\omega+\omega_d}{2}$

(4) None of these

48. Five pendulums are suspended from a common rope AB :



Here pendulum 1 and 4 are identical if pendulum-1 is set into oscillatory motion choose the correct option :

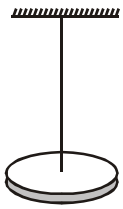
(1) Amplitude of pendulum-4 becomes large

(2) Driving frequency and natural frequency is same for pendulum-4

(3) Finally the frequencies of all the pendulum will be same

(4) All of above

49. The moment of inertia of the disc used in a torsional pendulum about the suspension wire is 0.2 kg-m^2. It oscillated with a period of 2 sec. Another disc is placed over the first one and the time period of system becomes 4 sec, find the moment of inertia of the second disc :-



(1) 0.8 (2) 0.6 (3) 0.4 (4) 0.2

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	3	4	4	3	2	1	3	4	1	4	4	4	3	3	4	1	2	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	1	2	2	4	4	2	3	2	2	2	3	1	1	1	2	2	3	3
Que.	41	42	43	44	45	46	47	48	49											
Ans.	3	1	1	4	2	2	2	4	2											

WAVE MOTION AND DOPPLER'S EFFECT

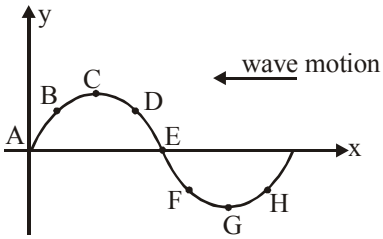
1. When an ultrasonic wave travels from air into water
(1) the wave bends away from the normal
(2) the wave bends towards the normal
(3) wave goes undeviated
(4) concept of bending of wave is only applicable to light waves

2. Transverse mechanical wave are not possible in liquid. Because :-
(1) liquid having bulk modulus
(2) liquid volume is constant
(3) No shearing stress in liquid
(4) liquid density is constant

3. Two mechanical waves, $y_1 = 2\sin 2\pi(50t-2x)$ & $y_2 = 4 \sin 2\pi (ax + 100\, t)$ propagate in a medium with same speed.
(1) The ratio of their intensities is 1: 16
(2) The ratio of their intensities is 1: 4
(3) The value of 'a' is 8 units
(4) The value of 'a' is 2 units

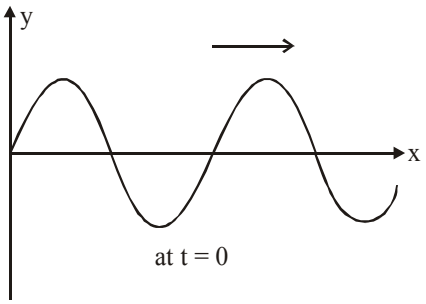
4. A transverse harmonic wave on a string is described by $y = 3\sin[36t + 0.018x + \frac{\pi}{4}]$ where x and y are in cm and t in s. The least distance between two sucessive crests in the wave is :-
(1) 2.5 m (2) 3.5 m (3) 1.5 m (4) 4.5 m

5. A transverse wave is travelling along a stretched string from right to left. The figure shown represents the shape of the string (snap short) at a given instant. At this instant



(1) the particles at A, B and H have downward velocity
(2) the particles at D, E and F have downward velocity
(3) the particles at C, E and G have zero velocity
(4) the particles at A and F have maximum velocity

6. Figure shows a sinusoidal plot which describe the wave. Select the correct equation :-



(1) $y = A \sin(\omega t - kx)$
(2) $y = A \sin(kx - \omega t)$
(3) $y = A \sin(\omega t + kx)$
(4) $y = -A \sin(\omega t + kx)$

7. Two cats in a house mew at each other with sound intensities 5×10^{-9} Wm^{-2} and 9×10^{-6} Wm^{-2}. By how many decibels is the louder sound above the other ?
(1) ~ 13 dB
(2) ~ 23 dB
(3) ~ 33 dB
(4) ~ 43 dB

8. A sound wave is passing through air column in the form of compression and rarefaction. In successive compression and rarefaction :-
(1) pressure is constant
(2) density is constant
(3) position of the particles remains same
(4) No heat transfer

9. A wire of density 9×10^3 kg/m^3 is stretched between two clamps one meter apart and is subjected to an extension of 4.9×10^{-4}m. What will be the lowest frequency of the transverse vibrations in the wire [$Y = 9 \times 10^{10}$ N/m^2] ?
(1) 38 Hz (2) 36 Hz (3) 35 Hz (4) 32 Hz

10. A heavy rope is suspended from a rigid support. A transverse wave pulse is set up at the lower end, then :
(1) the pulse will travel with uniform speed
(2) the pulse will travel with increasing speed
(3) the pulse will travel with decreasing speed
(4) the pulse cannot travel through the rope

11. If the actual frequency of source is f and actual wavelength is λ and velocity of sound in given medium is v then we can calculate f_{app} for stationary observer by :-

(1) $f_{app} = \frac{v_{app}}{\lambda_{app}}$ (2) $f_{app} = \frac{v}{\lambda_{app}}$

(3) $f_{app} = \frac{v_{app}}{\lambda}$ (4) $f_{app} = f$

12. A 43 m long rope of mass 5.0 kg joins two rock climbers. One climber strikes the rope and the second one feels the effect 1.4 s later. What is the tension in the rope ?

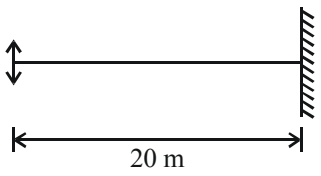
(1) 110 N (2) 301N

(3) 215 N (4) 154 N

13. A wire is 4 m long and has a mass 0.2 kg. The wire is kept horizontally. A transverse pulse is generated by plucking one end of the taut (tight) wire. The pulse makes four trips back and forth along the cord in 0.4 sec. The tension is the cord will be :-

(1) 80 N (2) 160 N (3) 240 N (4) 320 N

14. A string of mass 2.5 kg under some tension. The length of the stretched string is 20 m. If the transverse jerk produced at one end of the string takes 0.5 s to reach the other end, tension in the string is :-



(1) 100 N (2) 200 N (3) 300 N (4) 400 N

15. The transverse displacement of a string (clamped at its both ends) is given by

$$y = 0.06\sin\left(\frac{2\pi}{3}x\right)\cos(120\pi t),$$

where x and y are in m and t is in s. The length of the string is 1.5 m and its mass is 3.0×10^{-2} kg, then tension in string is :-

(1) 648 N (2) 650 N

(3) 649 N (4) 651 N

16. Two radio station that are 250m apart emit radio waves of wavelength 100m. Point A is 400m from both station. Point B is 450m from both station. Point C is 400m from one station and 450 m from the other. The radio station emit radio waves in phase. Which of the following statement is true ?

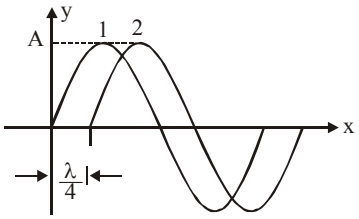
(1) There will constructive interference at A and B, and destructive interference at C.

(2) There will be destructive interference at A and B, and constructive interference at C.

(3) There will be constructive interference at B and C, and destructive interference at A.

(4) There will be destructive interference at A, B and C.

17. In the given figure two identical waves each of intensity I_0; 1 and 2 are superimposed. The resulting intensity is :



(1) I_0 (2) $2\sqrt{2}I_0$ (3) $4I_0$ (4) $2I_0$

18. Two open organ pipes of fundamental frequencies n_1 and n_2 are joined in series. The fundamental frequency of the new pipe so obtained will be :

(1) $n_1 + n_2$ (2) $n_1n_2 / (n_1 + n_2)$

(3) $\sqrt{n_1n_2}$ (4) $\sqrt{\left(n_1^2 + n_2^2\right)}$

19. A tuning fork of frequency 480 Hz is used to vibrate a sonometer wire having natural frequency 410 Hz. The wire will vibrate with a frequency :-

(1) 410 Hz (2) 480 Hz

(3) 820 Hz (4) 960 Hz

20. Two sitar strings, A and B, playing the note 'Dha' are slightly out of tune and produce beats of frequency 5 Hz. The tension of the string B is slightly increased and the beat frequency is found to decrease by 3 Hz. If the frequency of A is 425 Hz, the original frequency of B is :-

(1) 430 Hz (2) 420Hz

(3) 428 Hz (4) 422 Hz

21. Two vibrating tuning forks produce progressive waves given by $y_1 = 4\sin(500\pi t)$ and $y_2 = 2\sin(506\pi t)$. These tuning forks are held near the ear of a person. The person will hear
(1) 3 beats/s with intensity ratio between maxima and minima equal to 4.
(2) 3 beats/s with intensity ratio between maxima and minima equal to 9.
(3) 6 beats/s with intensity ratio between maxima and minima equal to 4.
(4) 6 beats/s with intensity ratio between maxima and minima equal to 9.

22.

	Column I	**Column II**
(A)	Tuning fork A of frequency 256 produces 4 beats/sec with fork B. Frequency of B may be	(P) 128 Hz
(B)	A is loaded slightly. Beats frequency decreases. Frequency of B is	(Q) 260 Hz
(C)	A is filed slightly. Beats frequency decreases. Frequency of B is	(R) 252 Hz
(D)	If A were octave of B, frequency of B is	(S) 264 Hz

(1) A-QR, B-R, C-Q, D-P (2) A-Q, B-P, C-R, D-S
(3) A-Q, B-S, C-P, D-R (4) A-P, B-Q, C-S, D-R

23. An organ pipe closed at one end has fundamental frequency of 1400 Hz. The number of overtones a normal person can hear, is :-
(1) 6 (2) 7 (3) 13 (4) 14

24. Two pipes are each 2 m long. One is closed at one end and the other is open at both ends. The speed of sound in air is 340 m/s. The frequency at which both can resonate is :
(1) 340 Hz (2) 510 Hz
(3) 42.5 Hz (4) none of these

25. An organ pipe P_1 closed at one end vibrating in its first overtone. Another pipe P_2 open at both ends is vibrating in its third overtone. They are in a resonance with a given tuning fork. The ratio of the length of P_1 to that of P_2 is :
(1) $\frac{8}{3}$ (2) $\frac{3}{8}$ (3) $\frac{1}{2}$ (4) $\frac{3}{4}$

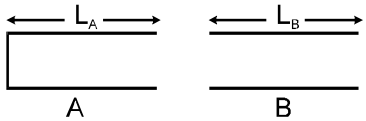
26. An open pipe of length 33 cm resonates to a frequency of 1000Hz. The mode of vibration is: (velocity of sound = 330 m/s)
(1) Fundamental
(2) The 2nd harmonic
(3) The 3rd harmonic
(4) The 4th harmonic

27. In a Resonance–Coulmn lab experiment to measure the velocity of sound, the first resonance is obtained at a length ℓ_1 and the second resonance at a length ℓ_2. Then–
(1) $\ell_2 > 3\ell_1$
(2) $\ell_2 = 3\ell_1$
(3) $\ell_2 < 3\ell_1$
(4) may be any of the above, depending on the frequency of the tuning fork used.

28. A student is experimenting with resonance tube apparatus in Physics lab to find the speed of sound at room temperature. He got 1st two resonating lengths of air column as 17 cm and 51 cm, using tuning fork of frequency 512 Hz. Find speed of sound at room temperature :-
(1) 348 m/s (2) 358 m/s
(3) 332 m/s (4) 322 m/s

29. For a certain organ pipe three successive resonance frequencies are observed at 425 Hz, 595 Hz and 765 Hz respectively. If the speed of sound in air is 340 m/s, then the length of the pipe is:
(1) 2.0 m (2) 0.4 m
(3) 1.0 m (4) 0.2 m

30. The two pipes are submerged in sea water, arranged as shown in figure. Pipe A with length $L_A = 1.5$ m and one open end, contains a small sound source that sets up the standing wave with the second lowest resonant frequency of that pipe. Sound from pipe A sets up resonance in pipe B, which has both ends open. The resonance is at the second lowest resonant frequency of pipe B. The length of the pipe B is :



(1) 1 m (2) 1.5 m (3) 2 m (4) 3 m

31. The equation for the vibration of a string fixed at both ends vibrating in its third harmonic is given by

$y = 2 \text{ cm} \sin [(0.6 \text{ cm}^{-1}) x] \cos [(500 \pi s^{-1})t]$

The length of the string is-

(1) 24.6 cm (2) 12.5 cm

(3) 20.6 cm **(4)** 15.7 cm

32. The transverse displacement of a string (clamped at its both end) is given by :

$$y(x, t) = 0.06 \sin\left(\frac{2\pi}{3}x\right)\cos(120\pi t)$$

where x and y in 'm' and t in second. The length of the string is 1.5 m and its mass is 3.0×10^{-2} kg then :

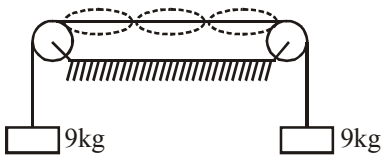
(1) all the points on the string oscillate with the same phase

(2) all the points on the string oscillate with the different frequency

(3) all the points on the string oscillate with the same amplitude

(4) all the points on the string oscillate different phase

33. The length of the wire shown in figure between the pulleys is 1.5 m and its mass is 12.0g. The frequency of vibration with which the wire vibrates in three loops forming antinode at the mid point of the wire is :- (Taken $g = 9.8 \text{ m/s}^2$)



(1) 210 Hz (2) 140 Hz

(3) 70 Hz (4) None of these

34. A sonometer wire resonates with a given tuning fork forming standing waves with five antinodes between the two bridges when a mass of 9 kg is suspended from the wire. When this mass is replaced by a mass M, the wire resonates with the same tuning fork forming three antinodes for the same positions of the bridges. The value of M is:

(1) 25 kg (2) 5 kg

(3) 12.5 kg (4) 1/25 kg

35. In a standing wave on a string rigidly fixed at both ends:

(1) all the particles must be at their positive extremes simultaneously once in half of the time period.

(2) all the particles must be at their positive extremes simultaneously once in a time period.

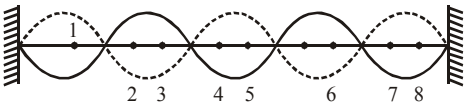
(3) in one time period all the particles are simultaneously at rest twice.

(4) all the particle are never at rest simultaneously.

36. A sonometer wire carries a metal block at the other end, when the block is in air, the resonant length with a tuning fork is found to be 90 cm. When the block is wholly immersed in water the resonant length with same tuning fork decreases to 80 cm. The relative density of the block is :-

(1) $\frac{81}{17}$ (2) $\frac{17}{81}$ (3) $\left(\frac{9}{8}\right)^2$ (4) $\left(\frac{8}{9}\right)^2$

37. A stretched string is vibrating in its 5th harmonic as shown. Consider a particle 1 (figure). At an instant this particle is at mean positions and is moving towards its negative extreme. Which of the following set of particles, are in same phase with particle 1.



(1) 2, 4, 7 (2) 3, 5, 6 (3) 5, 7, 8 (4) 2, 4, 6

38. In case of a transverse wave in a string

(1) if $\frac{\lambda}{2\pi} > A_0$, maximum particle speed is more than the wave speed

(2) if $\frac{\lambda}{2\pi} = A_0$, maximum particle speed is equal to the wave speed

(3) In harmonic wave, wave velocity is variable

(4) In harmonic wave, particle speed is constant

39. A string of length 3 m and linear mass density 0.0025 kg/m is fixed at both ends. One of its resonance frequency is 252 Hz. The next higher resonance frequency is 336 Hz. Then the fundamental frequency will be

(1) 84 Hz (2) 63 Hz

(3) 126 Hz (4) 168 Hz

40. Two trains proceeding in opposite directions with the same speed of 35 m/s cross the station master standing on the plateform. The frequency of the whistles of both the engines is 550 Hz. If the speed of sound is 350 m/s, the number of beats heard by the station master is

(1) 50 (2) 55 (3) Zero (4) 105

41. A train is moving with a constant speed along a large circular track. The engine of the train emits a sound of frequency f. The frequency heard by the guard at rear end of the train :

(1) is less than f

(2) is greater than f

(3) is equal to f

(4) may be greater than, less than or equal to f depending on the factors like speed of train, length of train and radius of circular track

42. A car blowing a horn of frequency 350 Hz is moving normally towards a wall with a speed of 5 m/s. The beat frequency heard by a person standing between the car and the wall is (speed of sound in air = 350 m/s)

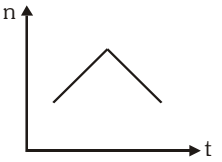
(1) zero (2) 3.5 Hz (3) 5 Hz (4) 10 Hz

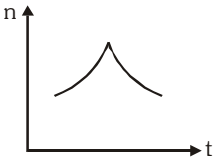
43. A listener is at rest with respect to the source of sound. A wind starts blowing along the line joining the source and the observer. Which of the following quantities do not change as observed by observer ?

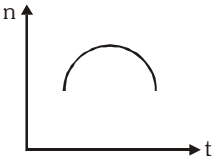
(1) Frequency (2) Velocity of sound

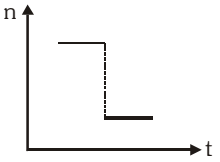
(3) Wavelength (4) All of these

44. A railway engine whistling at a constant frequency moves with a constant speed. It goes past a stationary observer standing beside the railway track. The frequency (n) of the sound heard by the observer is plotted against time (t). Which of the following best represents the resulting curve?

(1) 

(2) 

(3) 

(4) 

45. A car has two horns having a difference in frequency of 180 Hz. The car is approaching a stationary observer with a speed of 60 ms^{-1}. Calculate the difference in frequencies of the notes as heard by the observer, if velocity of sound in air is 330 ms^{-1}.

(1) 220 (2) 110 (3) 100 (4) 300

46. A source of sound producing wavelength 50cm is moving away from a stationary observer with $\left(\frac{1}{5}\right)^{th}$ speed of sound. Then what is the wavelength of sound received by the observer ?

(1) 55 cm (2) 40 cm

(3) 60 cm (4) 70 cm

47. If the bulk modulus of rigidity of water is 2100 MPa, the speed of sound in water is :-

(1) 1450 ms^{-1} (2) 2100 ms^{-1}

(3) 1400 ms^{-1} (4) 1200 ms^{-1}

48. Two identical stationary sound sources, emit sound waves of frequency 10 Hz, and speed 300 m/sec as shown. An observer is moving between the sources with a velocity 30 m/sec. Find the beat frequency as recorded by the observer (Hz).

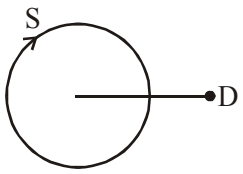
(1) 2 (2) 1 (3) 4 (4) 3

49. A policeman on duty detects a drop of 10% in the pitch of the horn of a moving car as it crosses him. If the velocity of sound is 330 m/s, the speed of the car will be

(1) 20 m/s (2) 17.3 m/s

(3) 25 m/s (4) 27 m/s

50. A source of sound moves along a circle of radius 2 m with constant angular velocity 40 radian/s. Frequency of the source is 300 Hz. A detector is kept of some distance from the circle in the same plane of the circle (as shown in figure). Which of the following is not the possible value of frequency registered by the detector ? (Speed of sound = 320 m/s)



(1) 250 Hz (2) 360 Hz

(3) 396 Hz (4) 220 Hz

51. A racing car moving towards a cliff sounds its horn. The driver observes that the sound reflected from the cliff has a pitch one octave higher than the actual sound of the horn. If v is the velocity of sound then the velocity of the car is

(1) $\frac{v}{\sqrt{2}}$ (2) $\frac{v}{2}$

(3) $\frac{v}{3}$ (4) $\frac{v}{4}$

52. The wavelength of sodium line observed in the spectrum of a star is found to be 598 nm, whereas that from the sodium lamp in the laboratory is found to be 589 nm. Therefore, the star is moving with a speed of about

(1) 2.7×10^6 m/s away from the earth

(2) 5.4×10^6 m/s towards the earth

(3) 1.6×10^6 m/s away from the earth

(4) 4.6×10^6 m/s away from the earth

53. An observer is moving with half the speed of light towards a stationary microwave source emitting waves at frequency 10 GHz. What is the frequency of the microwave measured by the observer?

(speed of light = 3×10^8 ms^{-1})

(1) 17.3 GHz (2) 15.3 GHz

(3) 10.1 GHz (4) 12.1 GHz

ANSWER KEY

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

ELECTROSTATICS

1. Electric charge were named as positive and negative by scientist :-

(1) Faradey (2) Coulomb

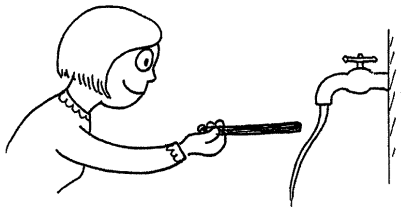
(3) Gilbert (4) Benjamin Franklin

2. Millikan's oil drop experiment attempts to measure the charge on a single electron, e, by measuring the charge on tiny oil drops suspended in an electrostatic field. It is assumed that the charge on the oil drops is due to just a small number of excess electrons. The charges 3.90×10^{-19}C, 6.50×10^{-19}C, and 9.10×10^{-19}C are measured on three drops of oil. The charge of an electron is deduced to be,

(1) 1.3×10^{-19}C (2) 1.6×10^{-19}C

(3) 2.6×10^{-19}C (4) 3.9×10^{-19}C

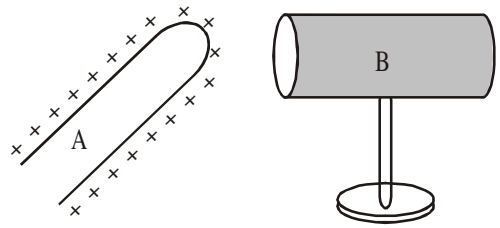
3. In normal cases thin stream of water bends toward a negatively charged rod. When a positively charged rod is placed near the stream, it will bend in the



(1) Opposite direction (2) Same direction.

(3) It won't bend at all (4) Can't be predicted.

4. A positively charged body A has been brought near a brass cylinder B mounted on a glass stand as shown in figure. The potential of B will be :-



(1) zero (2) negative

(3) positive (4) infinite

5. Gold leaves of an electroscope are negatively charged. When X–rays incident on leaves then leaves :-

(1) Converges

(2) Diverges

(3) First diverges and then converges

(4) Remains at their own position

6. In quark model, a proton and a neutron consist of three quarks each. Two types of quarks, the so called 'up' quark (denoted by u) of charge $+\frac{2}{3}e$ and the 'down' quark (denoted by d) of charge $-\frac{1}{3}e$, together with electrons build up ordinary matter. A possible mark composition of a proton and neutron is :-

(1) udd, udd (2) uud, udd

(3) uud, uud (4) ddd, uuu

7. Two identical conducting spheres M and N has charges q_m and q_n respectively. A third identical neutral sphere P is brought in contact with M and then seperated. Now sphere P is brought in contact with N then final charge on sphere P is-

(1) $\frac{q_m + 2q_n}{4}$ (2) $\frac{q_m + q_n}{4}$

(3) $q_m + \frac{q_n}{2}$ (4) $\frac{q_m + 2q_n}{2}$

8. Five balls, numbered 1 to 5 are suspended using separate threads. Pairs (1, 2), (2, 4), (4, 1) show electrostatics attraction, while pairs (2, 3) and (4, 5) show electrostatics repulsion. Therefore, the ball 1 must be

(1) positively charged. (2) negatively charged.

(3) neutral (4) made of metal

9. A positively charged rod is held near a ball suspended by an insulating thread. The ball is seen to start moving toward the charged rod. Which of the following option is most appropriate ?

(1) the ball must have had a charge opposite to that of the rod

(2) the ball must be positively charged

(3) the ball must be metallic

(4) the ball may be neutral

10. A positively charged insulator is brought near (but does not touch) two metallic spheres that are in contact. The metallic spheres are then separated. The sphere, which was initially farthest from the insulator, will have :-

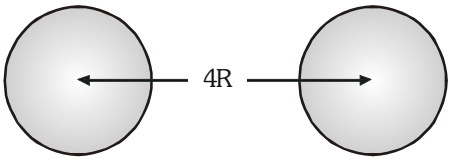
(1) no net charge

(2) a negative charge

(3) a positive charge

(4) either a positive or negative charge

11. Two identical spheres each of radius R are kept at center–to–center spacing 4R as shown in the figure. They are charged and the electrostatic force of interaction between them is first calculated assuming them like point charges at their centers and the force is also measured experimentally. The calculated and measured forces are denoted by F_c and F_m respectively. (F_c and F_m denote magnitude of force)



(1) When they carry charges of the same sign $F_c > F_m$ and when they carry charges of opposite signs $F_c < F_m$ only when they are insulator.

(2) When they carry charges of the same sign $F_c > F_m$ and when they carry charges of opposite signs $F_c < F_m$ only when they are conductor.

(3) When they carry charges of the same sign $F_c < F_m$ and when they carry charges of opposite signs $F_c > F_m$ irrespective of their material.

(4) When they carry charges of the same sign $F_c > F_m$ and when they carry charges of opposite signs $F_c < F_m$ irrespective of their material.

12. Tick the incorrect statement :-

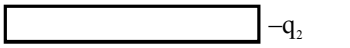
(1) There is a lower limit to the electrostatic force between two particles placed at a separation of 1 m

(2) A gravitational field can be added vectorially to an electric field to get a total field.

(3) The force on a charge due to another charge does not depend on the charges present nearby

(4) A charged particle in uniform circular motion always radiate energy

13. A thin insulator rod is placed between two unlike point charges $+q_1$ and $-q_2$. For this situation tick the wrong alternative.



(1) The total force acting on charge $+q_1$ will increase.

(2) The total force acting on charge $-q_2$ will increase.

(3) The total force acting on charge $-q_2$ will decrease.

(4) The force acting on charge $+q_1$ due to $-q_2$ will remain same.

14. Electrostatic force and gravitational force differ in which respect?

(1) Conservative force

(2) Central force

(3) Principle of superposition

(4) Dependence on the intervening medium

15. Two identical blocks are kept on a frictionless horizontal table and connected by a spring of stiffness 'k' and of natural length ℓ_0. A total charge Q is distributed on the blocks in a way such that in equilibrium spring elongates by maximum value. If this value is equal to x then value of Q is :

(1) $2\ell_0\sqrt{4\pi\varepsilon_0 k(\ell_0 + x)}$

(2) $2x\sqrt{4\pi\varepsilon_0 k(\ell_0 + x)}$

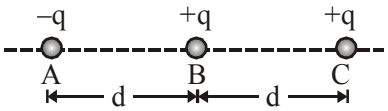
(3) $2(\ell_0 + x)\sqrt{4\pi\varepsilon_0 kx}$

(4) $(\ell_0 + x)\sqrt{4\pi\varepsilon_0 kx}$

16. Let 'e' be charge of an electron. Let point charges be present at vertices of a cube of side 'a' & let 'F' be magnitude of force between two electrons separated by distance 'a'. Which of the following cannot be the force exerted by any of the charge on any other charge present on vertices of the cube ?

(1) $\frac{F}{2}$ (2) $\frac{3F}{4}$ (3) $\frac{F}{3}$ (4) 9F

17. Consider the electric charges A, B, C shown in the figure below, where q is a positive number. Which answer correctly describes the magnitude of the net force experienced by the charges ?



(1) $F_A > F_B > F_C$ (2) $F_A > F_C > F_B$
(3) $F_B > F_A > F_C$ (4) $F_A = F_B = F_C$

18. Which of the following device invented by coulomb to measure quantity of electrostatic force:
(1) Physical balance
(2) Spring balance
(3) Torsion balance
(4) None of these

19.

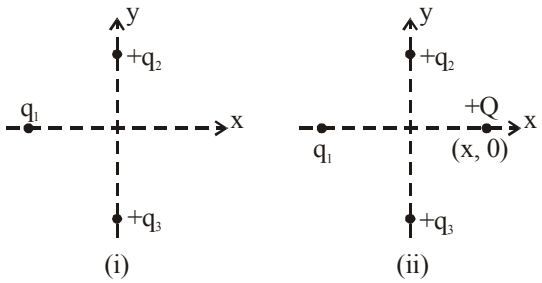


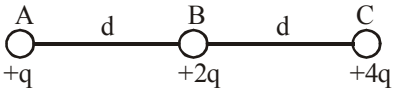
Figure shows two charge + q_2 and $+q_3$ fixed along y axis, exerts a net electric force in the +x direction on a charge q_1 fixed along x axis. If a +Q is added at (x, 0), then force on q_1 :-
(1) Shall increase along +x direction
(2) Shall decrease along +x direction
(3) Shall point along –x direction
(4) None

20. A positive point charge +Q is placed at x = 0 and a negative point charge –Q is placed at x = a. The magnitude of the electrostatic force between the two is F. If another point charge +Q is placed at x = –a, the net force on the charge at the origin (x = 0) is :-
(1) 2F in the negative x-direction
(2) F in the positive x-direction
(3) 5F/4 in the positive x-direction
(4) 2F in the positive x-direction

21. A point charge +Q is placed at the centroid of an equilateral traingle. When a second charge +Q is placed at a vertex of the triangle, the magnitude of the electrostatic force on the central charge is 4N. What is the magnitude of the net force on the central charge when a third charge +Q is placed at another vertex of the triangle ?

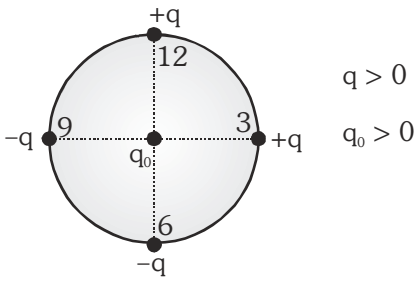
(1) Zero (2) 4N (3) $4\sqrt{2}$N (4) 8N

22. Three charges +q, +2q and +4q are connected by strings as shown in the figure. What is the ratio of tensions in the strings AB and BC.



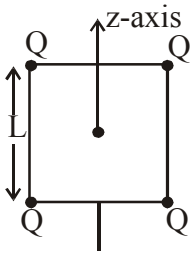
(1) 1 : 2 (2) 1 : 3 (3) 4 :1 (4) 4 : 3

23. Four charges are placed at the circumference of a dial clock as shown in figure.



If the clock has only hour hand then the resultant force on a charge q_0, placed at the centre points in the direction which shows the time as:-
(1) 1 : 30 (2) 7 : 30 (3) 4 : 30 (4) 10 : 30

24. Four point +ve charges of same magnitude (Q) are placed at four corners of a rigid square frame in xy plane as shown in figure. The plane of the frame is perpendicular to z-axis. If a –ve point charges is placed at a distance z away from the above frame (z << L) then:-



(1) –ve charge oscillates along the z-axis
(2) it moves away from the frame
(3) it moves slowly towards the frame and stays in the plane of the frame
(4) it passes through the frame only once

25. Two small spheres with masses m_1 and m_2 hang on weightless, insulating threads with lengths ℓ_1 and ℓ_2. The two spheres carry a charge of q_1 and q_2 respectively. The spheres hang such that they are level with one another and the threads are inclined to the vertical at angle θ_1 and θ_2. Which of the following conditions is required if $\theta_1 = \theta_2$.

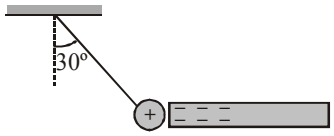
(1) $m_1 = m_2$

(2) $|q_1| = |q_2|$

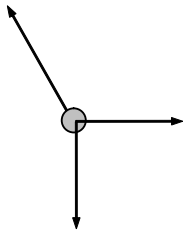
(3) $\ell_1 = \ell_2$

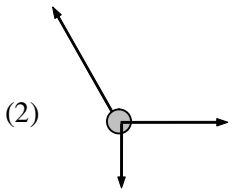
(4) None of the above

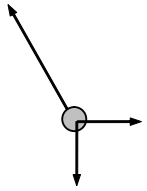
26. A small electrically charged sphere is suspended vertically from a thread. An oppositely charged rod is brought close to the sphere such that the sphere is in equilibrium when displaced from the vertical by an angle of 30°.

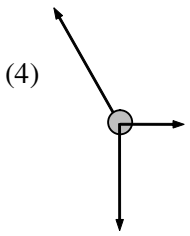


Which one of the following best represents the free body diagram for the sphere?

(1) 

(2) 

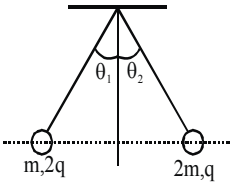
(3) 

(4) 

27. Two point charges –4Q and 9Q are placed at a distance 2 m from each other. The position at which net electric field is zero from the charge –4Q is x (in m). What is the value of x ?

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

28. Two particles which have masses and charges m and 2q and 2m and q respectively are hung by massless threads from a point as shown in equilibrium particles are on same horizontal line what can be the relation in θ_1 & θ_2. (θ_1 & θ_2 are not upto scale in figure)



(1) $\theta_1 > \theta_2$

(2) $\theta_1 < \theta_2$

(3) $\theta_1 = \theta_2$

(4) More information is required.

29. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density 1 g cm^{-3}, the angle remains the same. If density of the material of the sphere is 4/3 g cm^{-3}, the dielectric constant of the liquid is:-

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

30. Pick the incorrect statement :-

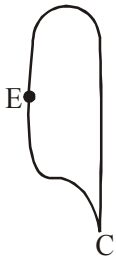
(1) If a point charge is placed off-centre inside an electrically neutral spherical metal shell, then induced charge on its inner surface is uniformly distributed.

(2) If a point charge is placed off-centre inside an electrically neutral, isolated spherical metal shell, then induced charge on its outer surface is uniformly distributed.

(3) A non metal spherical shell of uniform charge attracts or repels a charged particle that is outside the shell such as all the shell's charge were concentrated at the centre of the shell.

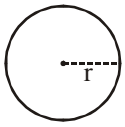
(4) If a charged particle is located inside a non metal spherical shell of uniform charge, there is no electrostatic force on the particle due to the shell.

31. In figure, charge is placed on the piece of copper. How will the charge be distributed on the object?

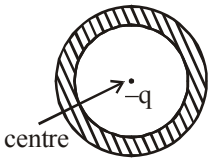


(1) Uniformly throughout the volume
(2) Uniformly over the surface
(3) With greatest density near point C on the surface
(4) With greatest density near point E on the flat surface

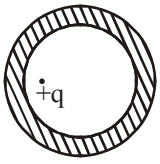
32. In which of the case(s) we will get uniform charge distribution on external spherical surface. Given every object is a conductor.

(A) 

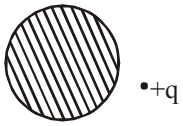
thin shell having net charge +q

(B) 

thick shell having net charge zero

(C) 

thick shell having net charge zero

(D) 

solid sphere having net charge +q

(1) Only A & B (2) Only A, B & C
(3) Only A (4) All

33. A metallic spherical shell has inner radius R_1 and outer radius R_2. A charge +Q is placed at the centre of spherical cavity. The surface charge density on inner and outer surface respectively:-

(1) $\frac{-Q}{4\pi R_1^2}, \frac{+Q}{4\pi R_2^2}$ (2) $\frac{+Q}{4\pi R_1^2}, \frac{-Q}{4\pi R_2^2}$

(3) Zero, Zero (4) $\frac{-Q}{4\pi R_1^2}, \frac{+2Q}{4\pi R_2^2}$

34. Two metal sphere one of radius R and the other of radius 2R, both have same surface charge density σ. They are brought in contact and separated. New surface charge densities on them, respectively :-

(1) $\frac{5\sigma}{3}, \frac{5\sigma}{6}$ (2) $\frac{5\sigma}{6}, \frac{5\sigma}{3}$

(3) $\frac{\sigma}{3}, \frac{2\sigma}{3}$ (4) $\frac{2\sigma}{3}, \frac{\sigma}{3}$

35. Two point charges Q_1 and Q_2 of equal magnitude are placed at a certain distance from each other. Assuming the field strength to be positive in the positive direction of x–axis

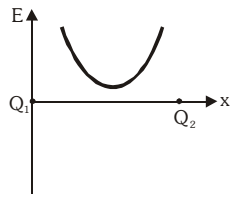


Fig. 1

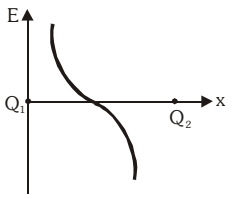


Fig. 2

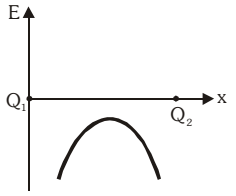


Fig. 3

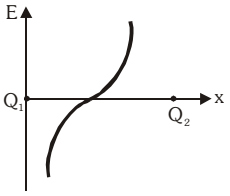


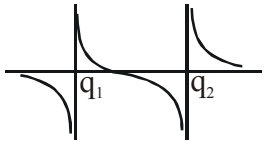
Fig. 4

The signs of the charges Q_1 and Q_2 for given graphs are

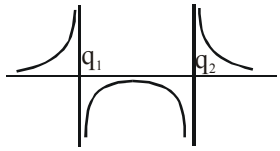
(1) +,+ ; +,– ; –,+ ; –,–
(2) +,– ; +,+ ; –,+ ; –,–
(3) –,+ ; +,– ; +,+ ; –,–
(4) +,+ ; +,– ; –,– ; –,+

36. Variation of electric field along the line joining two charges is given in list-I. Relation between charges is given in list-II. Match the proper variation. Take electric field along right as positive

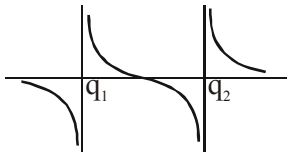
List-I **List-II**

(P) 

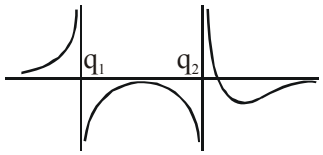
(1) $|q_1| > |q_2|$, $q_1 < 0 ; q_2 > 0$

(Q) 

(2) $|q_1| = |q_2|$, $q_1 > 0 ; q_2 > 0$

(R) 

(3) $|q_1| = |q_2|$, $q_1 < 0 ; q_2 > 0$

(S) 

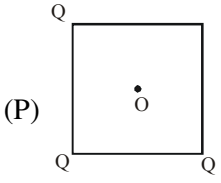
(4) $|q_2| > |q_1|$, $q_1 > 0 \ ; \ q_2 > 0$

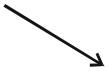
Code:-

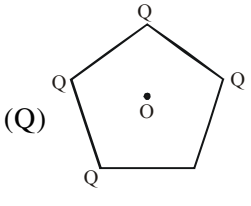
	P	Q	R	S
(1)	3	1	2	4
(2)	1	4	2	3
(3)	4	3	2	1
(4)	2	3	4	1

37. In the given diagrams the direction of electric field at point O is given in list-II (O is circumcenter of the given regular polygon). Charge Q is positive. Match the direction of electric field for the given arrangement:-

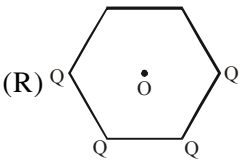
List-I **List-II**

(P) 

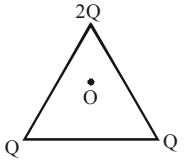
(1) 

(Q) 

(2) 

(R) 

(3) 

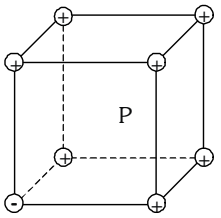
(S) 

(4) 

Code :-

	P	Q	R	S
(1)	2	1	4	3
(2)	3	1	2	4
(3)	3	2	1	4
(4)	1	4	3	2

38. Consider a regular cube with positive point charge +Q in all corners except for one which has a negative point charge –Q. Let the distance from any corner to the center of the cube be r. What is the magnitude of electric field at point P, the center of the cube?



(1) E = 0 (2) $E=1\ kQ/r^2$

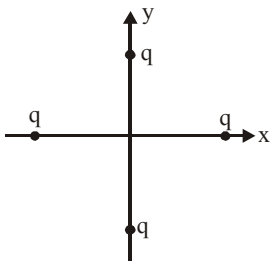
(3) $E=2kQ/r^2$ (4) $E=6kQ/r^2$

39. A point charge of 25 μC is located in the XY plane at the point of position vector $\vec{r}_0 = (\hat{i} + \hat{j})\,m$. What is the magnitude of electric field at the point of position vector $\vec{r}_1 = (4\hat{i} + 5\hat{j})\,m$?

(1) $900\frac{V}{m}$ (2) $\frac{9V}{m}$

(3) $90\frac{V}{m}$ (4) $9000\frac{V}{m}$

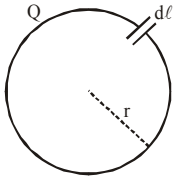
40. Four point charges, each carrying charge q, are at the positions with coordinates of (a,0), (–a,0), (0,a), (0,–a), respectively. The electric field strength at (0, a/2) is



(1) $\frac{1}{4\pi\varepsilon_0}\frac{q}{a^2}$ (2) $\frac{3.84}{4\pi\varepsilon_0}\frac{q}{a^2}$

(3) $\frac{1.84}{4\pi\varepsilon_0}\frac{q}{a^2}$ (4) $\frac{2.84}{4\pi\varepsilon_0}\frac{q}{a^2}$

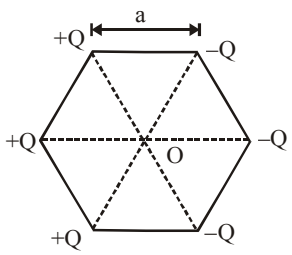
41. A ring of radius "r" has charge Q. It is cut by small length $d\ell$. Find the electric field at the centre :-



(1) Zero (2) $\frac{Qd\ell}{2\pi r^2\varepsilon_0}$

(3) $\frac{Qd\ell}{2\pi r^3\varepsilon_0}$ (4) $\frac{Qd\ell}{8\pi^2\varepsilon_0 r^3}$

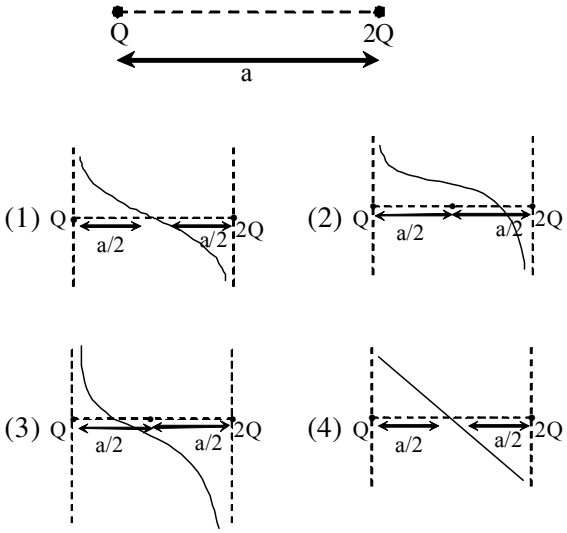
42. Six charges are placed at the vertices of a regular hexagon as shown in the figure. Component of the electric field along the line passing through point O and perpendicular to the plane of the figure at a distance of x (>>a) from O is



(1) $\frac{Qa}{\pi\varepsilon_0 x^3}$ (2) $\frac{2Qa}{\pi\varepsilon_0 x^3}$

(3) $\frac{\sqrt{3}Qa}{\pi\varepsilon_0 x^3}$ (4) zero

43. Find the variation of electric field on the line joining the two charges - [Take +x axis as +ve direction of $\vec{E}$]



44. A ring carries a linear charge density on one half and the linear charge density of same magnitude but opposite sign on the other half.

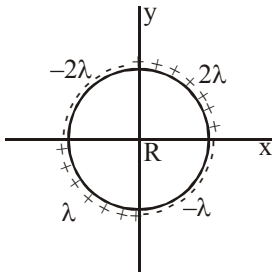
(1) the component of electric field along the axis of ring, at all points on the axis, is non-zero.

(2) the component of electric field along the axis of ring at point on the axis is zero only at the centre.

(3) the resultant field at the centre is zero.

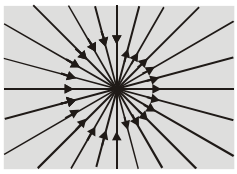
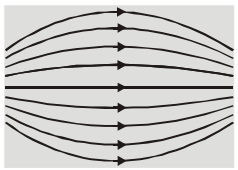
(4) the electric field at all points on the axis of ring is perpendicular to axis.

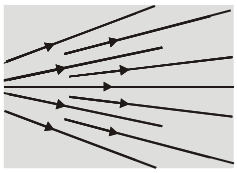
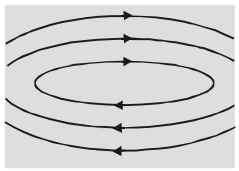
45. The charge per unit length of the four quadrant of the ring is 2λ, -2λ, λ and $-\lambda$ respectively. The magnitude of electric field at the centre is:



(1) $\frac{2K\lambda}{r}$ (2) $\frac{K\lambda}{r}$ (3) $\frac{4K\lambda}{r}$ (4) r

46. Consider the four field patterns shown. Assuming there are no charges in the regions shown, which of the patterns represents a possible electrostatic field:

a  b 

c  d 

(1) a (2) b (3) c (4) d

47. Mark the **CORRECT** statement :-

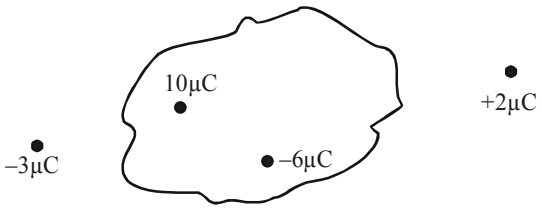
(1) The tangential component of electric field at the surface of a electrostatic conductor is continuous.

(2) The normal component of electric field at the surface of an electrostatic conductor is discontinuous

(3) Work function (which is the minimum work required to remove an electron from inside the conductor) is equal to (–e) ($V_{surface} - V_{inside}$). Thus work function is zero for an electrostatic conductor.

(4) All free electrons reside on the surface of the conductor

48. In a particular system, number of electric field lines associated by 1C charge is 10^9. If net number of electric field lines passing through the given closed surface is $n \times 10^3$ then find n.



(1) 4 (2) 6 (3) 2.5 (4) 3

49. The electric field at a point is :

(1) always continuous

(2) continuous if there is no charge at that point

(3) discontinuous if there is a negative charge at that point.

(4) Both (2) and (3)

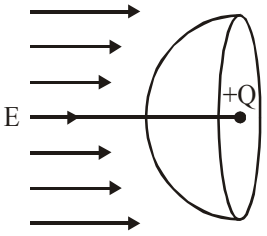
50. The figure shows a point charge +Q placed at the center of an imaginary hemispherical surface of radius R. A uniform electric field E is applied in the horizontal direction. If the net flux passing through the hemispherical surface is zero then what is the magnitude of the electric field E.

(1) $\frac{Q}{2\pi\varepsilon_0 R^2}$

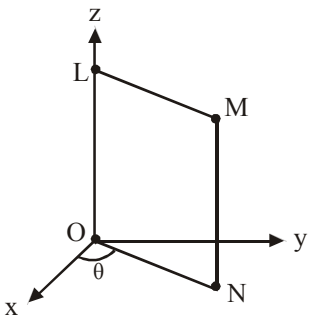
(2) $\frac{Q}{2\varepsilon_0 R^2}$

(3) $\frac{Q}{\pi\varepsilon_0 R^2}$

(4) $\frac{Q}{\varepsilon_0 R^2}$



51. The electric field intensity at all points in space is given by $\vec{E} = \sqrt{3}\hat{i} - \hat{j}$ volts/metre. A square frame LMNO of side 1 metre is shown in figure. The point N lies in x-y plane. The initial angle between line ON and x-axis is $\theta = 60°$.



The magnitude of electric flux through area enclosed in square frame LMNO is -

(1) 0 volt-metre (2) 1 volt-metre

(3) 2 volt-metre (4) 4 volt-metre

52. A body in the form of a right circular cone of dielectric material with base radius R and height h is placed with its base on a horizontal table. A horizontal uniform electric field of magnitude E penetrates the cone. The electric flux that enters the body is

(1) ERh/3 (2) ERh

(3) ERh/6 (4) 2ERh

53. Select incorrect statement :-

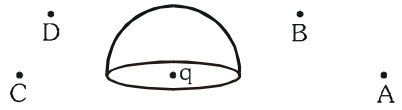
(1) Electrostatics lines of forces cannot be closed

(2) Gauss's law is valid for any arbitrary charge distribution

(3) Electrostatic field is a conservative field

(4) Coulomb's law is valid for cylindrical symmetry of charge

54. Figure shows a charge q placed at the centre of a hollow hemisphere. A second charge Q is placed at one of the positions A, B, C and D. In which position (s) of this second charge, the flux of the electric field through the hemisphere remains unchanged ?



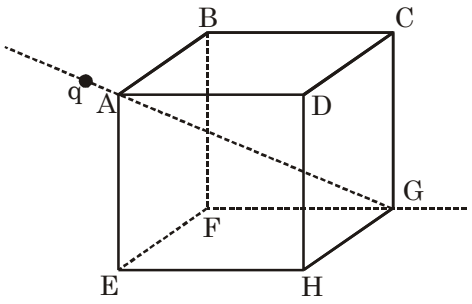
(1) A and C

(2) B and D

(3) A and D

(4) A,B,C and D

55. A charge q is kept just outside a cube on extension of digonal GA. The magnitude of electric flux of face ABCD is :



(1) $\frac{q}{8\epsilon_0}$ (2) $\frac{q}{6\epsilon_0}$

(3) $\frac{q}{24\epsilon_0}$ (4) $\frac{q}{18}\epsilon_0$

56. A point charge +q is kept near infinitely long sheet, the total flux linked with the sheet is :-

(1) $\frac{q}{\epsilon_0}$ (2) $\frac{q}{\sigma\epsilon_0}$ (3) $\frac{q}{2\epsilon_0}$ (4) Zero

57. If $\oint_S \vec{E}.\vec{ds} = 0$ over a surface, then

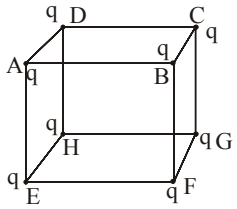
(1) the electric field inside the surface and on it is zero.

(2) the electric field inside the surface is necessarily uniform.

(3) the number of flux lines entering the surface must be equal to the number of flux lines leaving it.

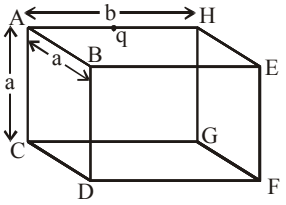
(4) all charges must necessarily be outside the surface.

58. Eight point charges having magnitude q are fixed at vertices of a cube. The electric flux through square surface ABCD of the cube is



(1) $\frac{q}{24\epsilon_0}$ (2) $\frac{q}{12\epsilon_0}$ (3) $\frac{q}{6\epsilon_0}$ (4) $\frac{q}{3\epsilon_0}$

59. A cuboid is of dimension [a × a × b]. Charge q is placed at the centre of edge having length 'b'. If flux through face 'ABCD' is $\frac{q}{32\epsilon_0}$ then select the correct statement(s) :-



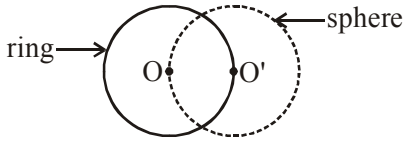
(1) Flux through the entire cuboid is $\frac{q}{4\epsilon_0}$

(2) Flux through the face 'ABEH' is zero.

(3) Flux through the face 'BEFD' is $\frac{3q}{32\epsilon_0}$

(4) All of these

60. A charge Q is distributed uniformly on a ring of radius r. Consider an sphere of equal radius r with its centre at the periphery of the ring. Find the flux of the electric field through the surface of the sphere -

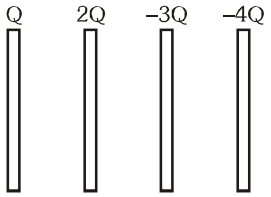


(1) $\frac{Q}{4\epsilon_0}$ (2) $\frac{Q}{6\epsilon_0}$ (3) $\frac{Q}{3\epsilon_0}$ (4) $\frac{Q}{2\epsilon_0}$

61. A hollow charged conductor having surface charge density σ, has a tiny hole cut into its surface. The electric field in the hole is :-

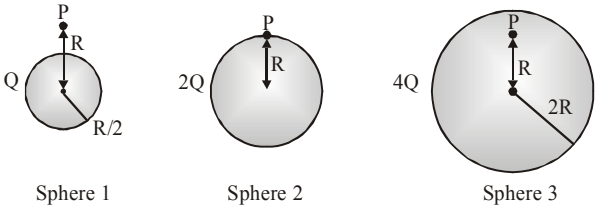
(1) $\frac{\sigma}{\varepsilon_0}$ (2) $\frac{\sigma}{2\varepsilon_0}$ (3) $\frac{\sigma}{4\varepsilon_0}$ (4) Zero

62. Four very large metal plates are given charges as shown. The middle two are then connected through a conducting wire. The charge that will flow through the wire is



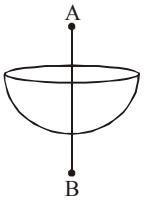
(1) Q (2) 2Q (3) 3Q (4) 5Q

63. Charges Q, 2Q and 4Q are uniformly distributed in three non conducting solid spheres 1, 2 and 3 of radii R/2, R and 2R respectively, as shown in figure. If magnitudes of the electric fields at point P at a distance R from the centre of spheres 1, 2 and 3 are E_1, E_2 and E_3 respectively, then



(1) $E_1 > E_2 > E_3$ (2) $E_3 > E_1 > E_2$
(3) $E_2 > E_1 > E_3$ (4) $E_3 > E_2 > E_1$

64. The diagram shows a uniformly charged hemisphere of radius R. It has volume charge density ρ. If the electric field at a point 2R distance above its centre is E, then what is the electric field at the point which is 2R below its centre?



(1) $\frac{\rho R}{6\varepsilon_0}+E$ (2) $\frac{\rho R}{12\varepsilon_0}-E$

(3) $\frac{-\rho R}{6\varepsilon_0}+E$ (4) $\frac{\rho R}{24\varepsilon_0}+E$

65. A hollow charged spherical conductor has a tiny hole cut into surface. The electric field into hole is (where σ is surface charge density near the hole)

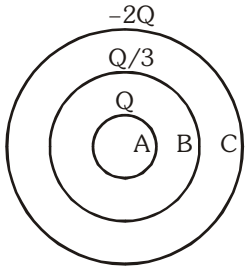
(1) $\frac{\sigma}{2\epsilon_0}$, outward normal direction

(2) $\frac{\sigma}{2\epsilon_0}$, inward normal direction

(3) $\frac{\sigma}{\epsilon_0}$, outward normal direction

(4) $\frac{\sigma}{\epsilon_0}$, inward normal direction

66. Three conducting concentric spherical shells of radius R, 2R and 3R have charges Q, $\frac{Q}{3}$ and – 2Q respectively. The intermediate shell is now grounded. Find the charge flow into the earth.



(1) $\frac{Q}{3}$ (2) $\frac{2Q}{3}$ (3) Q (4) 0

67. An electric charge of 10nC is placed at the point O (4m, 7m, 2m). At the point P (1m, 3m, 2m):–

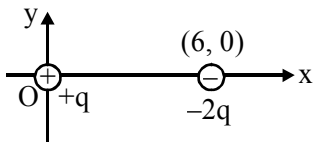
(1) The electric potential is 18 volt.

(2) The electric field has no z–component.

(3) The magnitude of electric field is 3.6 V/m.

(4) All of these

68. The ratio of magnitude of electric field due to +q and –2q at a point between the charges where net potential is zero on x-axis is β : 1, then β will be.



(1) 2 (2) 4 (3) 0.5 (4) 0.25

69. Four charges 2C, –3C, –4C and 5C respectively are placed at all the corners of a square. Which of the following statements is true for the point of intersection of the diagonals:-

(1) Electric field is zero but electric potential is non-zero

(2) Electric field is non-zero but electric potential is zero.

(3) Both electric field and electric potential are zero

(4) Neither electric field nor electric potential is zero

70. Two point-charges, each with a charge of +1μC, lie some finite distance apart. On which of the segments of an infinite line going through the charges is there a point, a finite distance away from the charges, where the electric potential is zero, assuming that it vanishes at infinity ?

(1) Between the charges only

(2) On either side outside the system

(3) Impossible to tell without knowing the distance between the charges.

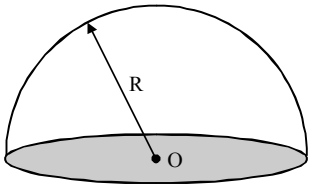
(4) No where

71. Electric potential at the surface of a uniformly charged solid sphere is 4 volt. Find the electric potential (in volt) at the centre of sphere.

(1) 2 volt (2) 6 volt

(3) 4 volt (4) 3 volt

72. Charge Q coulombs is uniformly distributed throughout the volume of a solid hemisphere of radius R metres. Then the potential at centre O of the hemisphere in volts is



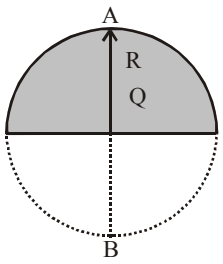
(1) $\frac{1}{4\pi\varepsilon_o}\frac{3Q}{2R}$ (2) $\frac{1}{4\pi\varepsilon_o}\frac{3Q}{4R}$

(3) $\frac{1}{4\pi\varepsilon_o}\frac{Q}{4R}$ (4) $\frac{1}{4\pi\varepsilon_o}\frac{Q}{8R}$

73. A solid sphere of radius R is charged uniformly throughout the volume. At what distance from its surface, is the electric potential 1/4 of the potential at the centre ?

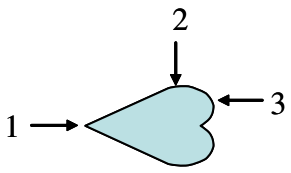
(1) 8R/3 (2) R/3 (3) 5R/3 (4) 2R/3

74. Q charge given to a uniform hemispherical charged distribution of radius 'R'. The potential at two diametrically opposite points are V_A & V_B then $(V_A + V_B)$ is equal to :



(1) $\frac{KQ}{R}$ (2) $\frac{KQ}{2R}$ (3) $\frac{2KQ}{R}$ (4) $\frac{KQ}{3R}$

75. A heart shaped conductor shown below carries net charge Q. Which of the statement, about the electric field E and the surface charge density σ, below is correct?



(1) E strongest and σ smallest at position-1

(2) E strongest and σ highest at position-1

(3) E weakest and σ highest at position-2

(4) E strongest and σ highest at position-3

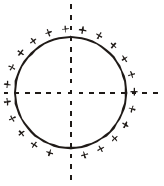
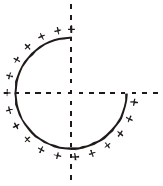
76. The electric potential inside a charged solid spherical conductor in electrostatic condition:-
(1) is always zero
(2) decreases from its value at the surface to a value of zero at the centre
(3) is constant and equal to its value at the surface
(4) increases from its value at the surface to a higher value at the centre

77. The maximum possible electrostatic potential produced by a spherical conductor of radius R is directly proportional to :-

(1) $\frac{1}{R}$ (2) R (3) $\frac{1}{R^2}$ (4) $\frac{1}{R^3}$

78. Consider a finite insulated, uncharged conductor placed near a finite positively charged conductor. The uncharged body must have a potential :
(1) less than the charged conductor and more than at infinity.
(2) more than the charged conductor and less than at infinity.
(3) more than the charged conductor and more than at infinity.
(4) less than the charged conductor and less than at infinity.

79. Charge Q is spread uniformly over a circular ring of radius R, which gives electrical potential V_1 at its centre. If an arc of length $\frac{\pi R}{2}$ is removed from the ring [as shown in figure (ii)] keeping the net charge Q on the remaining part constant.The relation between new potential V_2 at the centre and V_1 is

Fig. (i)  Fig. (ii) 

(1) $V_1 > V_2$
(2) $V_2 > V_1$
(3) $V_1 = V_2$
(4) can't determined

80. Consider two conducting sphere of radius R_1 and R_2 with $R_1 > R_2$. If two are at the same potential, There surface charge densities are σ_1 and σ_2 respectively then :-
(1) $\sigma_1 = \sigma_2$ (2) $\sigma_1 < \sigma_2$
(3) $\sigma_1 > \sigma_2$ (4) None

81. Electric potential in a particular region of space is $V = 12x - 3x^2y + 2yz^2$. The electric field at point P (1m, 0, –2m) is :-
(1) 12 unit (2) 13 unit
(3) 5 unit (4) Zero

82. The electric potential due to an infinite sheet of positive charge density σ at a point located at a perpendicular distance Z from the sheet is (Assume V_0 to be the potential at the surface of sheet) :

(1) V_0 (2) $V_0 - \frac{\sigma Z}{\varepsilon_0}$

(3) $V_0 + \frac{\sigma Z}{2\varepsilon_0}$ (4) $V_0 - \frac{\sigma Z}{2\varepsilon_0}$

83. Consider following statement about the relation between electric field and potential.
(A) Electric field is in the direction in which the potential increases steepest
(B) Electric field is in the direction in which the potential decreases steepest
(C) Magnitude of electric field is given by the change in the magnitude of potential per unit displacement normal to the equipotential surface at that point
(D) Magnitude of electric field is given by the change in the magnitude of potential per unit displacement parallel to the equipotential surface at that point
Select correct alternative :-
(1) A and B (2) B and C
(3) A and C (4) All the above

84. An electric field $\left(-30\hat{i} + 20\hat{j}\right)$ Vm^{-1} exists in the space. If potential at the origin is zero, then find the potential at (5m,3m) in volts.
(1) 110 volt (2) 90 volt
(3) 100 volt (4) 95 volt

85. Let V be electric potential and E the magnitude of the electric field. At a given position, which of the following statements is true ?

(1) E is always zero where V is zero

(2) V is always zero where E is zero

(3) E can be zero where V is non-zero

(4) E is always non-zero where V is non-zero

86. Consider a uniform electric field in the $\hat{k}$ direction. The potential is constant :-

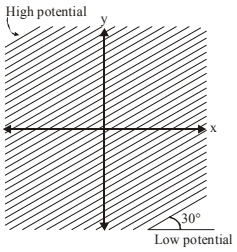
(1) for any x for a given z

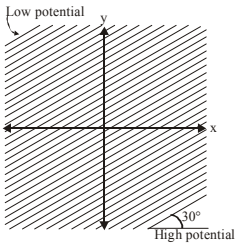
(2) for any y for a given z

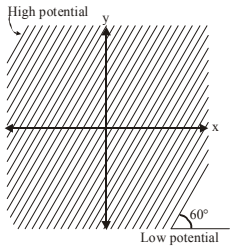
(3) on the x-y plane for a given z

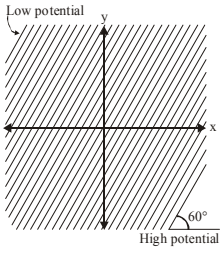
(4) All of these

87. The electric field intensity at all points in space is given by $\vec{E} = \sqrt{3}\hat{i} - \hat{j}$ volts/metre. The nature of equipotential lines in x-y plane is given by

(1) 

(2) 

(3) 

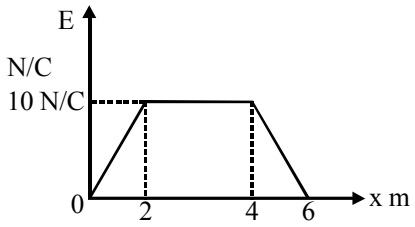
(4) 

88. Uniform electric field of magnitude 100 V/m in space is directed along the line y = 3 + x. Find the potential difference between point A (3, 1) & point B (1, 3)

(1) 100 V (2) $200\sqrt{2}$ V

(3) 200 V (4) zero

89. Figure shows the variation of electric field intensity with distance x. What is the potential difference between the points at x = 2m and x = 6m from origin ?



(1) 30 V (2) 60 V

(3) 40 V (4) 80 V

90. If we have an irregularly shaped conductor as shown and a charge is given to it, choose the correct statement.

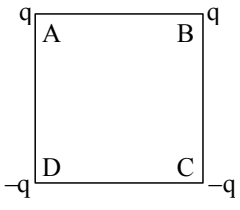
(1) the electric field and electric potential at P is maximum among all points of conductor.

(2) the electric field at P is maximum and electric potential is same at all points of conductor.

(3) the electric field and electric potential at P is same at all points of conductor.

(4) the electric field and electric potential at P is minimum among all points of conductor.

91. Charges are placed on the vertices of a square as shown. Let $\vec{E}$ be the electric field and V the potential at the centre. If the charges on A and B are interchanged with those on D and C respectively, then -



(1) $\vec{E}$ remains unchanged, V changes

(2) Both $\vec{E}$ and V changes

(3) $\vec{E}$ and V remains unchanged

(4) $\vec{E}$ changes, V remains unchanged

92. A spherical conductor A of radius r is placed concentrically inside a conducting shell B of radius R (R > r). A charge Q is given to A, and then A is joined to B by a metal wire. The charge flowing from A to B will be :-

(1) $Q\left(\frac{R}{R+r}\right)$ (2) $Q\left(\frac{r}{R+r}\right)$

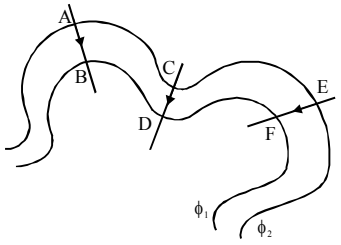
(3) Q (4) 0

93. Potential energy of a system comprising of point charges is U_1.When a charge q is added in the system without disturbing other charges, the potential energy becomes U_2.The potential of the point where the charge q is placed in the system is

(1) $\frac{U_2-U_1}{q}$ (2) $\frac{U_1-U_2}{q}$

(3) $\frac{U_1+U_2}{2q}$ (4) $\frac{U_2-U_1}{2q}$

94. In moving from A to B along an electric field line, the electric field does 1.28×10^{-18} J of work on an electron. If ϕ_1, ϕ_2 are equipotential surfaces, then potential difference $V_E - V_D$ is equal to



(1) –8 volt (2) +8 volt

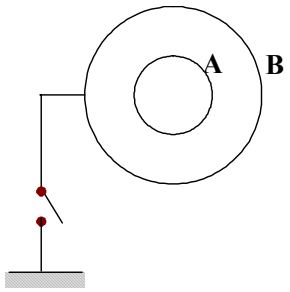
(3) zero (4) 64 volt

95. A spherical shell is uniformly charged by a charge q. A point charge q is at its center. The work of electric force upon the expansion of shell from R to 2R is :-

(1) $\frac{3q^2}{16\pi\varepsilon_0 R}$ (2) $\frac{q^2}{8\pi\varepsilon_0 R}$

(3) $\frac{q^2}{16\pi\varepsilon_0 R}$ (4) $\frac{q^2}{4\pi\varepsilon_0 R}$

96. Initially the spheres A and B are at potentials V_A and V_B respectively. Now sphere B is earthed by closing the switch. The potential of A become



(1) 0 (2) V_A

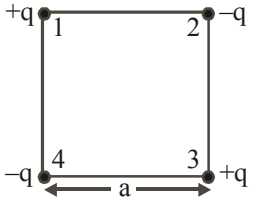
(3) $V_A - V_B$ (4) V_B

97. The work done required to put the four charges together at the corners of a square of side a, as shown in the figure is :-

(1) $\frac{1}{4\pi\varepsilon_0}\frac{q^2}{a}$

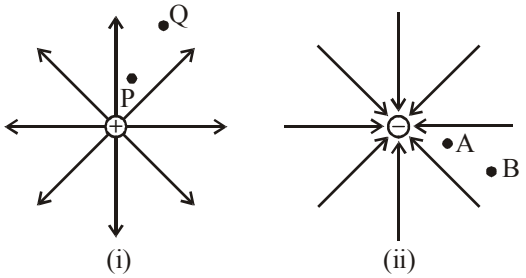
(2) $\frac{-2.6}{4\pi\varepsilon_0}\frac{q^2}{a}$

(3) $+\frac{2.6}{4\pi\varepsilon_0}\frac{q^2}{a}$



(4) none of these

98. Figures show the field lines of a positive and negative point charge respectively

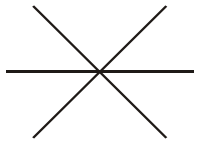


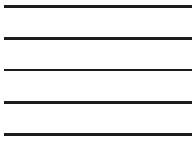
What is the sign of potential energy difference of a small negative charge between points P and Q, B and A :-

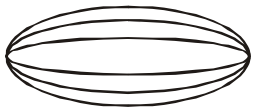
(1) Negative, Negative (2) Positive, Negative

(3) Negative, Positive (4) Positive, Positive

99. Which of the following represents the equipotential lines of a dipole (two equal and opposite charges placed at small separation) ?

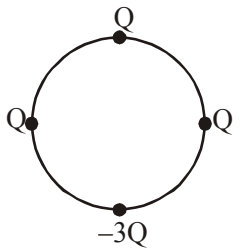
(1) 

(2) 

(3) 

(4) 

100. Find the dipole moment of given configuration if P = QR (where R is the radius of the circle and P is magnitude of dipole moment) :-



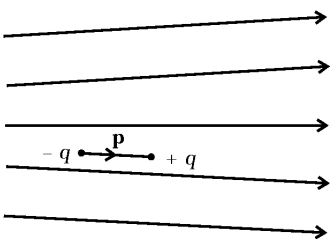
(1) 3P (2) $2\sqrt{2}P$ (3) $3\sqrt{2}P$ (4) 4P

101. An electric dipole is placed at the origin O such that its equator is y-axis. At a point P far away from dipole, the electric field direction is along y-direction. OP makes an angle α with the x-axis such that

(1) $\tan\alpha = \sqrt{3}$ (2) $\tan\alpha = \sqrt{2}$

(3) $\tan\alpha = 1$ (4) $\tan\alpha = \frac{1}{\sqrt{2}}$

102. Figure shows electric field lines in which an electric dipole **p** is placed as shown. Which of the following statements is correct?



(1) The dipole will not experience any force.
(2) The dipole will experience a force towards right.
(3) The dipole will experience a force towards left.
(4) The dipole will experience a force upwards.

103. Two point dipoles of dipole moment $\vec{p}_1$ and $\vec{p}_2$ are at a distance x from each other such that axis of dipoles are same and $\vec{p}_1 \| \vec{p}_2$. The force between the dipoles is :-

(1) $\frac{1}{4\pi\in_0}\frac{4p_1p_2}{x^4}$ (2) $\frac{1}{4\pi\in_0}\frac{3p_1p_2}{x^3}$

(3) $\frac{1}{4\pi\in_0}\frac{6p_1p_2}{x^4}$ (4) $\frac{1}{4\pi\in_0}\frac{8p_1p_2}{x^4}$

104. The electric potential at a point due to an electric dipole will be-

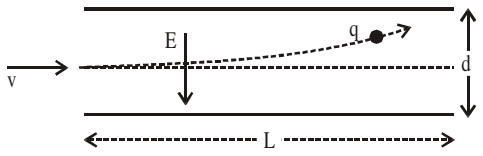
(1) $k\frac{\vec{p}\,.\,\vec{r}}{r^3}$ (2) $k\frac{\vec{p}\,.\,\vec{r}}{r^2}$

(3) $\frac{k(\vec{p}\times\vec{r})}{r}$ (4) $\frac{k(\vec{p}\times\vec{r})}{r^2}$

105. The maximum possible electrostatic potential produced by a spherical conductor of radius R is directly proportional to :-

(1) $\frac{1}{R}$ (2) R (3) $\frac{1}{R^2}$ (4) $\frac{1}{R^3}$

106. In an ink-jet printer, an ink droplet of mass m is given a negative charge q by a computer-controlled charging unit, and then enters at speed v in the region between two deflecting parallel plates of length L separated by distance d (see figure below). All over this region exists a downward electric field which you can assume to be uniform. Neglecting the gravitational force on the droplet, the maximum charge that it can be given so that it will not hit a plate is most closely approximated by :-



(1) $\frac{mv^2E}{dL^2}$ (2) $\frac{mv^2d}{EL^2}$

(3) $\frac{md}{E(vL)^2}$ (4) $\frac{m(vL)^2}{Ed}$

107. The work done to move a charge slowly along an equipotential surface from A to B

(1) cannot be defined as $-\int_A^B \vec{E}\cdot\overrightarrow{d\ell}$

(2) must be defined as $-\int_A^B \vec{E}\cdot\overrightarrow{d\ell}$

(3) is zero

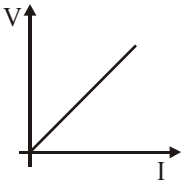
(4) both (2) and (3)

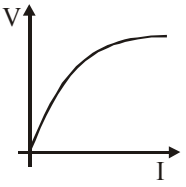
ANSWER KEY

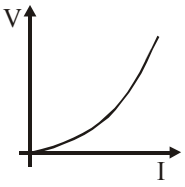
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	1	2	3	1	2	1	3	4	3	4	2	3	4	3	2	3	3	1	4
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	2	2	1	1	4	2	1	1	1	3	3	1	1	2	3	2	3	4	1
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	1	3	4	1	2	2	1	4	1	3	2	4	1	3	3	3	3	4	3
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	2	4	3	2	1	4	4	1	2	4	2	1	3	3	2	3	2	1	3	2
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	2	4	2	2	3	4	4	4	1	2	4	3	1	1	1	3	2	1	4	4
Que.	101	102	103	104	105	106	107													
Ans.	2	3	3	1	2	2	3													

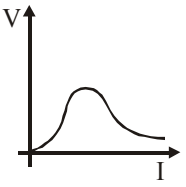
CURRENT ELECTRICITY AND HEATING EFFECTS OF CURRENT

1. Suppose the drift velocity v_d in a material varied with the applied electric field E as $v_d \propto \sqrt{E}$. Then V – I graph for a wire made of such a material is best given by :-

(1) 

(2) 

(3) 

(4) 

2. When you flip a switch to turn on a light, the delay before the light turns on is determined by:

(1) the speed of the electric field moving in the wire.

(2) the drift speed of the electrons in the wire.

(3) the number of electron collisions per second in the wire.

(4) none of these, since the light comes on instantly.

3. An insulating pipe of cross-section area 'A' contains an electrolyte which has two types of ions→ their charges being –e and +2e. A potential difference applied between the ends of the pipe results in the drifting of the two types of ions, having drift speed = v (–ve ion) and v/4 (+ve ion). Both ions have the same number per unit volume = n. The current flowing through the pipe is

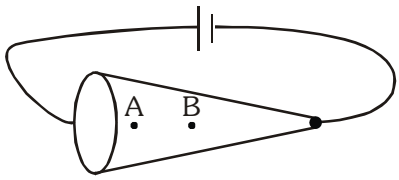
(1) nev A/2

(2) nev A/4

(3) 5nev A/2

(4) 3nev A/2

4. Suppose a current carrying wire has a cross-sectional area that, gradually become smaller along the wire, has the shape of a very long cone as shown in figure. Choose the correct statement:



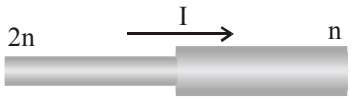
(1) Electric current is different in different portions of wire.

(2) Electric field at point A is same as that of point B.

(3) Drift speed of electrons at point A is lesser than that of at point B.

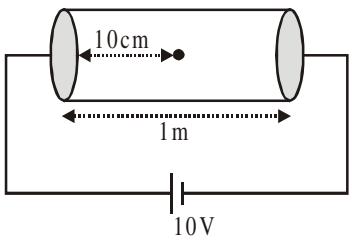
(4) Drift speed of electrons at point A is same as that of at point B.

5. Two cylindrical rods of uniform cross-section area A and 2A, having free electrons per unit volume 2n and n respectively are joined in series. A current I flows through them in steady state. Then the ratio of drift velocity of free electron in left rod to drift velocity of electron in the right rod is $\left(\frac{v_L}{v_R}\right)$



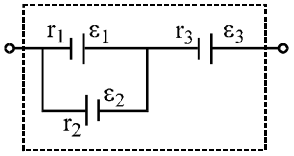
(1) 1 (2) 2 (3) 3 (4) 4

6. A cylindrical solid of length 1m and radius 1m is connected across a source of emf 10V and negligible internal resistance shown in figure. The resistivity of the rod as a function of x (x measured from left end) is given by $\rho = bx$ [where b is a positive constant]. Find the electric field (in SI unit) at point P at a distance 10cm from left end.



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

7 An electric box contains three e.m.f. sources as shown in the figure. Given, $\varepsilon_1=2\varepsilon_2 = 2\varepsilon_3 = 6$ volt, $r_1 = r_2 = r_3 = 1\Omega$.



(1) e.m.f of the electric box is 3/2 Volt.

(2) e.m.f. of the electric box is 1/2 volt.

(3) internal resistance of the electric box is 3/2 Ω.

(4) internal resistance of the electric box is 1 Ω.

8. A constant electric current I is passed through a straight conductor of length ℓ. If S is specific charge of electron then the total momentum of electrons is :-

(1) $\frac{IS}{\ell}$ (2) $\frac{I\ell}{S}$ (3) $\frac{S\ell}{I}$ (4) $\frac{2I\ell}{S}$

9. An electric field travelling in a conductor (connected to a battery) has a speed of the order of :-

(1) ZERO, as electric field inside a conductor is zero

(2) Drift speed

(3) Speed of electromagnetic Waves

(4) None of the above

10. Inside solid conductor, electrons move randomly and keep colliding with fixed ions. If there are N electrons and the velocity of the i^{th} electron (i = 1,2,3....N) at a given time is v_i, then :-

(1) $N\sum_{i=1}^{N} v_i > 0$ (2) $\frac{1}{N}\sum_{i=1}^{N} v_i = 0$

(3) $2N\sum_{i=1}^{N} v_i < 0$ (4) None of these

11. In conductor when electrons move between two collisions, their paths are A and B when external fields are absent and present. Here A and B refer to :-

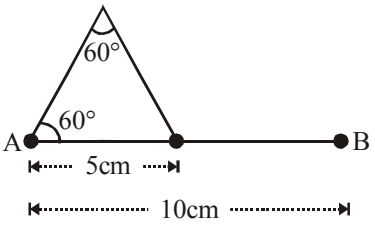
(1) Straight line, straight line

(2) Straight line, curved in general

(3) curved in general, straight lines

(4) curve in general, curved in general

12. A wire has resistance of 24 Ω is bent in the following shape. The effective resistance between A and B is-



(1) 24 Ω (2) 10 Ω

(3) $\frac{16}{3}\Omega$ (4) None of these

13. Carbon resistor has resistance specified by three bands having colours red, yellow and black. If the resistor is remolded to make a resistor twice of previous length, the new colour code will be :-

(1) White, Blue, Black (2) Red, Orange, Black

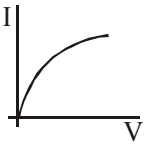
(3) Brown, Red, Black (4) Black, Blue, Black

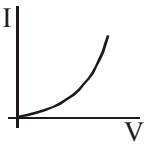
14. A piece of uniform wire, of resistance R is bent into the form of a circle. The resistance between two points on the wire subtending an angle α at the centre is :

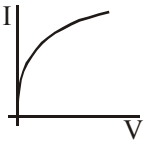
(1) R (2) $R\left(\frac{1}{\alpha}-\frac{1}{2\pi}\right)$

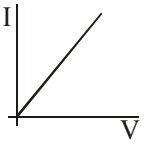
(3) $R\left(\frac{\alpha}{2\pi}\right)$ (4) $R\left(\frac{\alpha}{2\pi}\right)\left[1-\left(\frac{\alpha}{2\pi}\right)\right]$

15. The resistance of the tungsten in a light bulb increases with temperature. Which of the following graphs shows the current as a function of voltage for the light bulb ?

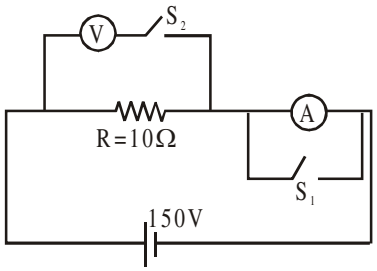
(1) 

(2) 

(3) 

(4) 

16. Voltmeter of resistance 10Ω and ammeter of resistance 10Ω are attached in the following circuit with switches S_1 and S_2



Column I (switch position)	Column II (reading of voltmeter & ammeter)
(P) S_1 open, S_2 closed	(I) 0, 7.5 A
(Q) S_1 closed, S_2 open	(II) 50 V, 10A
(R) S_1 open, S_2 open	(III) 0, 0
(S) S_1 closed, S_2 closed	(IV) 150 V, 0

	P	Q	R	S
(1)	II	III	I	IV
(2)	II	III	IV	I
(3)	III	II	I	IV
(4)	III	II	IV	I

17. The resistance of a thermometer has the following readings at different temperatures

$R_1 = 10\Omega$ $T_1 = 32^oF$

$R_2 = 12\Omega$ $T_2 = 212^oF$

$R_3 = 20\Omega$ $T_3 = ?$

The value of T_3 shall be :-

(1) 625°C (2) 500°C (3) 50°C (4) 100°C

18. A potential difference of 30V is applied across a color coded carbon resistor with first, second and third rings of blue, black and yellow colors. What is the current flowing through the resistor:-

(1) 5×10^{-4} A (2) 5×10^{4} A

(3) 0.5×10^{-4} A (4) 0.5×10^{4} A

19. Three copper rods are subjected to different potential difference. Compare the drift speed (v_i) of electrons through them. Assume that all 3 are at the same temperature.

	Length	Diameter	Potential difference
(1)	L	3d	V
(2)	2L	d	2V
(3)	3L	2d	2V

(1) $v_1 = v_2 > v_3$ (2) $v_1 > v_2 > v_3$

(3) $v_1 < v_2 < v_3$ (4) None of these

20. A piece of conducting wire of resistance R is cut into 2n equal parts. Half the parts are connected in series to form a bundle and remaining half in parallel to form another bundle. These bundles are then connected to give the maximum resistance. The resistance of the combination is

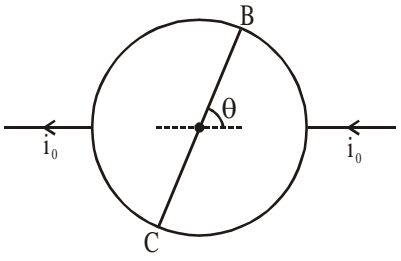
(1) $\frac{R}{2}\left(1+\frac{1}{n^2}\right)$ (2) $\frac{R}{2}\left(1+n^2\right)$

(3) $\frac{R}{2(1+n^2)}$ (4) $R\left(n+\frac{1}{n}\right)$

21. An electric toaster uses nichrome for its heating element. When a negligibly small current passes through it, its resistance at room temperature (27.0°C) is found to be 75.3 Ω. When the toaster is connected to a 230 V supply, the current settles, after a few seconds, to a steady value of 2.68 A. What is the steady temperature of the nichrome element? The linear temperature coefficient of resistance of nichrome averaged over the temperature range involved, is 1.70×10^{-4} °C^{-1}.

(1) 947 °C (2) 424 °C (3) 847 °C (4) 474 °C

22. Consider a circuit made of a wire with uniform resistance in a shape of a circle as shown in the picture. The circle is connected diagonally from point 'C' to point B with the same type of wire. If the current passing through the circuit is i_0, what is the current passing through the wire BC as a function of angle θ?



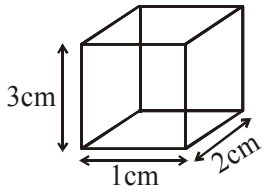
(1) 0 (2) $\frac{\theta}{\pi-\theta}i_0$

(3) $\frac{\pi-2\theta}{\pi+2}i_0$ (4) $\frac{\pi-2\theta}{\pi+4}i_0$

23. Two cylindrical resistors, one of length l and radius r, and the other of length $3l$ and radius 3r, are made of the same materials. If the resistance of the smaller one is R, what is the resistance of the larger one ?

(1) R/3 (2) 3R (3) 9R (4) 27R

24. A cuboid shaped metal structure has following specifications as shown in figure :-



The structure is connected to a battery across opposing faces. The resistance shall be :-

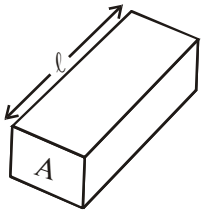
(1) Minimum when battery is connected across (1cm × 2cm) faces

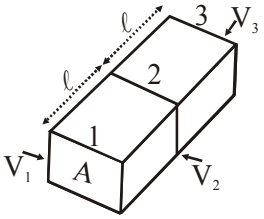
(2) Maximum when battery is connected across (1cm × 3cm) faces

(3) Minimum when battery is connected across (3cm × 2cm) faces

(4) Same in all of above

25. Consider a conductor in the form of a slab of length ℓ and cross–sectional area A which satisfy the equation V = RI. Imagine placing two such identical slabs side by side as shown in the given fig. so that the length of combination is 2ℓ. The current flowing through the combination is (Given $V_1 - V_2 = V_2 - V_3 = V$ and current from 1 to 2 is I) :-





(1) I (2) 2I (3) I/2 (4) I/4

26. Two resistances of equal magnitude R and having temperature coefficient α_1 and α_2 respectively are connected in parallel. The temperature coefficient of the parallel combination is, approximately

(1) $2(\alpha_1 + \alpha_2)$ (2) $\dfrac{\alpha_1\alpha_2}{\alpha_1 + \alpha_2}$

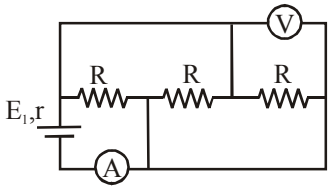
(3) $\dfrac{\alpha_1 - \alpha_2}{2}$ (4) $\dfrac{\alpha_1 + \alpha_2}{2}$

27. A copper wire and an iron wire, each having an area of cross-section A and length L_1 and L_2 are joined end to end. The copper end is maintained at a potential V_1 and the iron end at a lower potential V_2. If σ_1 and σ_2 are the conductivities of copper and iron respectively, the potential of the juction will be :-

(1) $\dfrac{\sigma_1 V_1 + \sigma_2 V_2}{(\sigma_1/L_1) + (\sigma_2/L_2)}$ (2) $\dfrac{\frac{\sigma_1 V_1}{L_1} + \frac{\sigma_2 V_2}{L_2}}{(\sigma_1/L_1) + (\sigma_2/L_2)}$

(3) $\dfrac{(\sigma_1/L_1) + (\sigma_2/L_2)}{\sigma_1 V_1 + \sigma_2 V_2}$ (4) $\dfrac{\sigma_1 V_1 - \sigma_2 V_2}{(\sigma_1/L_1) - (\sigma_2/L_2)}$

28. In the circuit shown in figure, ammeter and voltmeter are ideal. If E = 4V, R = 9Ω and

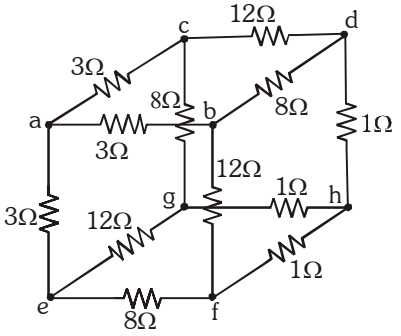


r = 1Ω, then readings of ammeter and voltmeter are

(1) 1A, 3V (2) 2A, 3V

(3) 3A, 4V (4) 4A, 4V

29. A group of 12 resistors is arranged along the edges of a cube as shown in the diagram. The vertices of the cube are labeled a–h. The resistance between each pair of vertices is as follows :



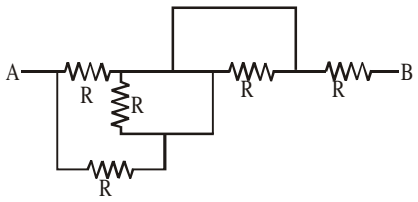
$R_{ab} = R_{ac} = R_{ae} = 3.0\ \Omega$ $R_{cg} = R_{ef} = R_{bd} = 8.0\ \Omega$

$R_{cd} = R_{bf} = R_{eg} = 12.0\ \Omega$ $R_{dh} = R_{fh} = R_{gh} = 1.0\ \Omega$

What is the equivalent resistance between points a and h?

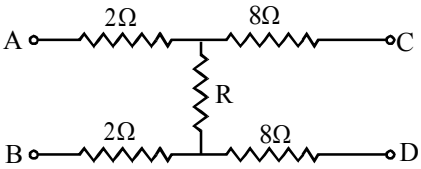
(1) $\frac{22}{7}\Omega$ (2) $\frac{44}{15}\Omega$ (3) 22/15 Ω (4) 44/7 Ω

30. What is the equivalent resistance between A and B ?



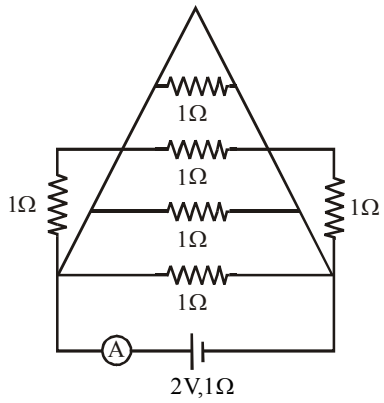
(1) $\frac{3R}{2}$ (2) 2R (3) R (4) $\frac{R}{2}$

31. In the shown circuit, when the voltage between A and B is 16 V the voltage between C and D is 8 V. When the voltage between C and D is 15 V, what is the voltage (in V) between A and B ?



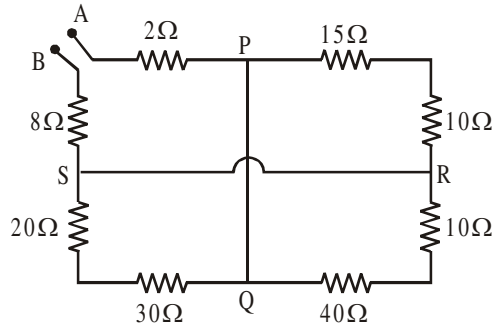
(1) 7.5 (2) 5 (3) 3 (4) 4

32. In the circuit shown in Figure the ammeter reads a current :



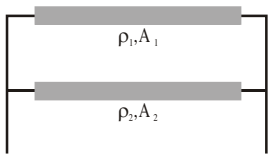
(1) 1A (2) 2A (3) 0.3A (4) 0.2A

33. The equivalent resistance between points A and B is



(1) 32.5Ω (2) 22.5Ω (3) 2.5Ω (4) 42.5 Ω

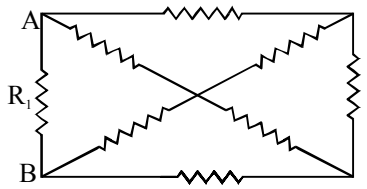
34. Two conductors of same length are connected in parallel as shown in figure. Their cross-sectional areas A_1 and A_2 and their resistivities are ρ_1 and ρ_2 respectively. The equivalent resistivity of this combination is :-



(1) $\frac{\rho_1\rho_2(A_1-A_2)}{A_1\rho_2+A_2\rho_1}$ (2) $\frac{\rho_1\rho_2(A_1+A_2)}{A_1\rho_1+A_2\rho_2}$

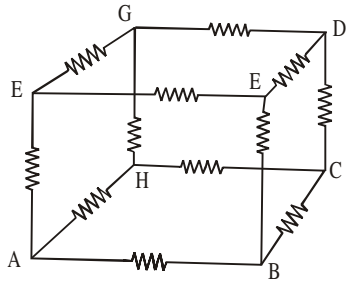
(3) $\frac{\rho_1\rho_2(A_1-A_2)}{A_1\rho_1+A_2\rho_2}$ (4) $\frac{\rho_1\rho_2(A_1+A_2)}{A_1\rho_2+A_2\rho_1}$

35. As shown, the circuit made eight different resistors. It is found that when R_1 =3Ω, the resistance between A and B is 2Ω. Now replaced R_1 by 6Ω resistor, what is the resistance between A and B?



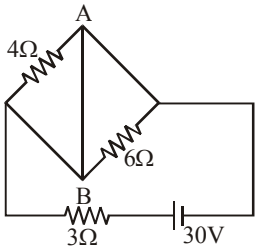
(1) 9Ω (2) 6Ω (3) 3Ω (4) 0Ω

36. Twelve resistors are arranged into a cube as shown in figure. All resistors have a resistance of 6Ω. A 25 V potential difference is applied from point A to point D. Find the total current flowing from A to D.



(1) 1A (2) 2A (3) 5A (4) 10A

37. In the circuit shown in figure :-



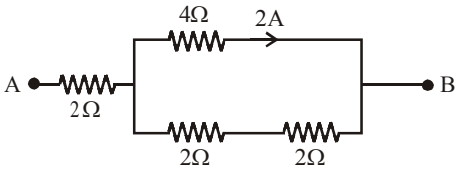
(1) Power supplied by the battery is 300 W

(2) Current flowing in the circuit is 5 A

(3) Potential difference across 4 Ω resistance is not equal to the potential difference across 6 Ω resistance

(4) Current in wire AB is zero

38. If current through 4Ω is 2A then calculate potential difference across A-B :-



(1) 8V (2) 16 V (3) 4 V (4) None

39. Three resistors (2Ω, 4Ω, 4Ω) are combined to achieve R_{max} (maximum resistance) and R_{min} (minimum resistance). Then the average and ratio of R_{max} and R_{min} shall be respectively :-

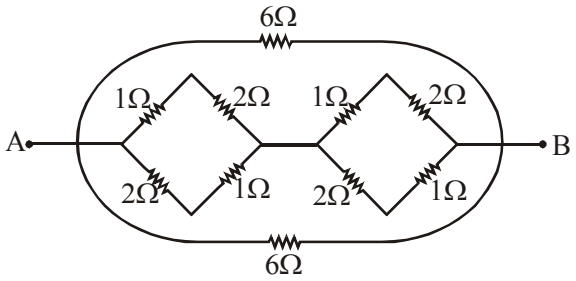
(1) 5.5, 1 : 10

(2) 5.5, 11 : 1

(3) 22/4, 10 : 1

(4) Both 1 and 3 are correct

40.



The value of equivalent resistance between A and B shall be :-

(1) 4.5Ω (2) 3.5Ω

(3) 2.5Ω (4) 1.5Ω

41. Choose the **INCORRECT** statement(s) :

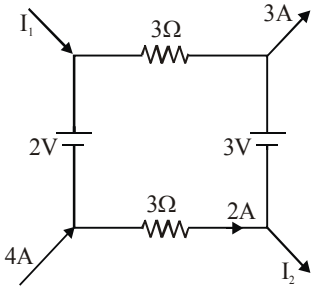
(1) Kirchoff's voltage law is based on conservative nature of electrostatic field.

(2) Kirchoff's current law is based on charge conservation.

(3) Battery can act as load and source both.

(4) Ohm's law is applicable to semiconductor too for whole range of voltage.

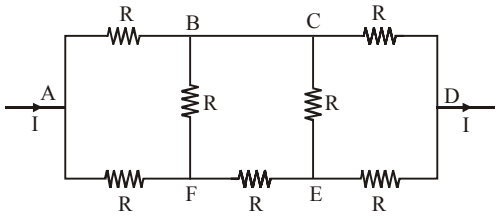
42. A part of circuit is shown in figure. Choose the correct option :-



(1) $I_1/I_2 = 1/2$ (2) $I_1/I_2 = 2$

(3) $I_1/I_2 = -1/2$ (4) $I_1/I_2 = -2$

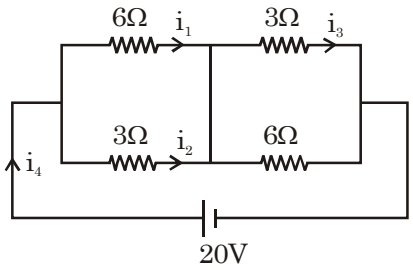
43. In the given circuit, directions of current flow in branches BF and CE are



(1) B to F and C to E (2) F to B and C to E

(3) B to F and E to C (4) F to B and E to C

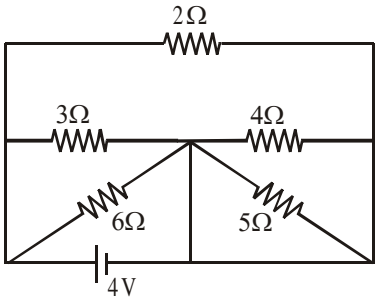
44. Diagram shows a circuit diagram. Choose the **INCORRECT** statements :-



(1) $i_1 = \frac{5}{3}A$ (2) $i_3 = \frac{5}{3}A$

(3) $i_2 = \frac{10}{3}A$ (4) $i_4 = 5A$

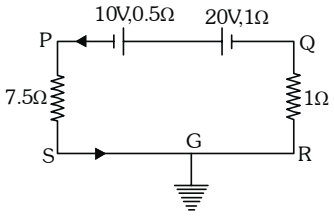
45. In the shown circuit, find the total current through the battery in amperes.



(1) 1 A (2) 2 A

(3) 3 A (4) 4 A

46. In the circuit shown in the figure below, which of the following statement is incorrect ?



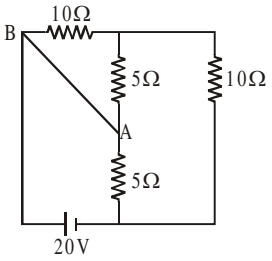
(1) The potential at P is –7.5 V

(2) The potential at Q is –1 V

(3) The potential at R is zero

(4) The potential at S is zero

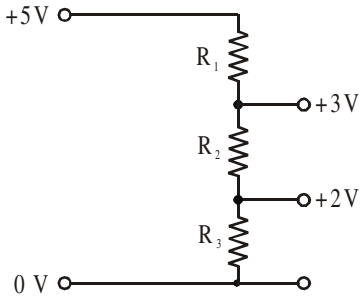
47. In the circuit shown find the current in branch AB of the circuit.



(1) 5 A (2) 0.5A

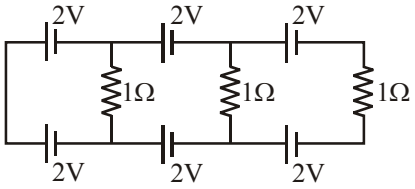
(3) $\frac{11}{3}$A (4) Zero

48. A potential divider is used to give outputs of 2 V and 3 V from a 5 V source, as shown in figure. Which values of resistances, R_1, R_2, and R_3 gives the correct voltages?



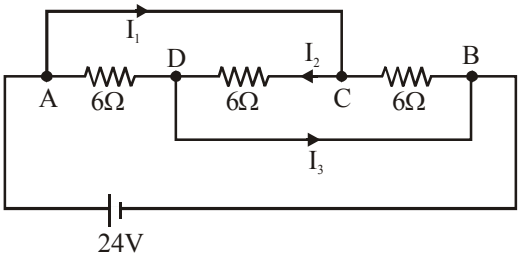
	R_1	R_2	R_3
(1)	1 kΩ	1 kΩ	2 kΩ
(2)	2 kΩ	1 kΩ	2 kΩ
(3)	3 kΩ	2 kΩ	2 kΩ
(4)	3 kΩ	2 kΩ	3 kΩ

49. In the below circuit the current in each resistance is:



(1) 0.5 A (2) 0 A (3) 1 A (4) 0.25 A

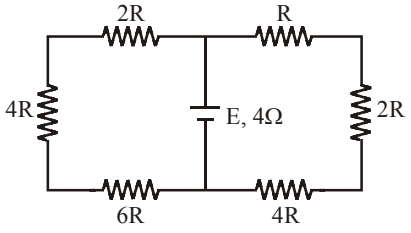
50. Which of the following options is/are **INCORRECT** regarding the below diagram.



(1) I_1 = 8 A (2) I_2 = 4 A

(3) I_1 = 0 (4) I_3 = 8 A

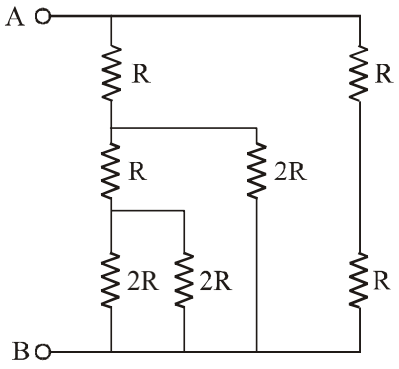
51. A battery of internal resistance 4 Ω is connected to the network of the resistance as shown in figure. If the maximum power can be delivered to the network, the magnitude of R in Ω should be :-



(1) 19/21 Ω (2) 84/19 Ω

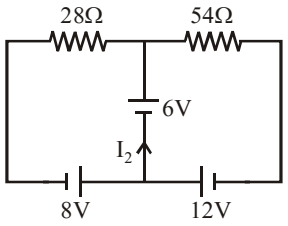
(3) 12 Ω (4) 7 Ω

52. The equivalent resistance between A and B is:-



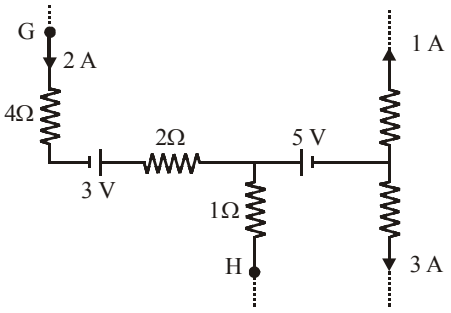
(1) 4R (2) 2R (3) R (4) 0.5R

53. Calculate the value of I_2 in the circuit



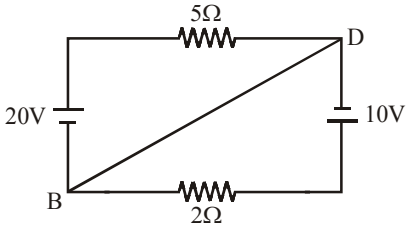
(1) 5 A (2) $\frac{5}{6}$A (3) 6 A (4) None

54. In the part of a circuit shown in Fig., the potential difference $(V_G - V_H)$ between points G and H will be :-



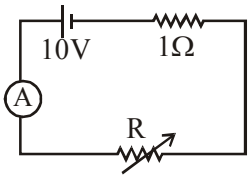
(1) 0 V (2) 15 V (3) 7 V (4) 3 V

55. Calculate the current in wire BD.



(1) 0 (2) 1 A (3) 2 A (4) 5 A

56. The ammeter reading for the following circuit shall be maximum when the value of variable resistance (R) shall be :-



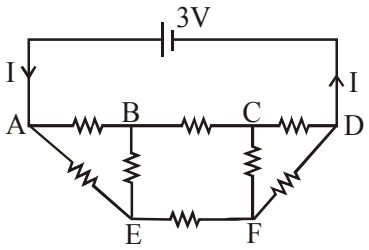
(1) R = 1Ω

(2) R = 0.5Ω

(3) R behaves as connecting wire of negligible resistance

(4) R = 2Ω

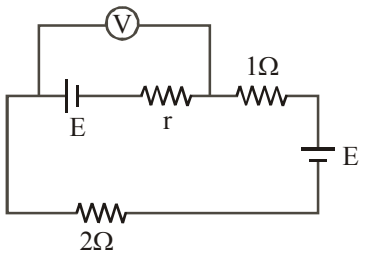
57. Figure shows a network of eight resistors, each equal to 2Ω connected to a 3V battery of negligible internal resistance. The current I in the circuit is :-



(1) 0.25A (2) 0.5A

(3) 0.75A (4) 1.0A

58.



In the given circuit the reading of ideal voltmeter is $\frac{E}{2}$ then internal resistance of battery (r) is:-

(1) 1Ω (2) $\frac{2}{3}\Omega$

(3) $\frac{2}{5}\Omega$ (4) $\frac{5}{2}\Omega$

59. Efficiency of a non ideal cell changes if we vary the external resistance. Suppose, the efficiency was $\frac{2}{3}$ for an external resistor. Now, if we changed the external resistor to $\frac{1}{10}$ th the initial value then the new efficiency will be :-

(1) $\frac{1}{6}$ (2) $\frac{1}{16}$ (3) $\frac{1}{15}$ (4) 1

60. The efficiency of a source of current connected to an external reistance R is n_1 = 60 percent. The efficiency n_2 becomes 90 percent, if the external resistance is :

(1) 6 R (2) 6 R/9 (3) 9 R/6 (4) 9 R

61. A cell of emf 3V and internal resistance 0·75Ω is connected to a non–linear conductor whose I–V relation is $I=\frac{8}{9}V^2$. Obtain the current drawn from the cell :-

(1) 2A (2) 1A (3) 3A (4) None

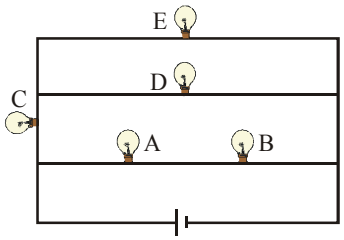
62. Car batteries are often rated in ampere-hours. This information designate the amount of:-

(1) potential that the battery can supply
(2) power
(3) charge
(4) energy

63. When a current of 4 A flows within a battery from its positive to negative terminal, the potential difference across the battery is 12 volts. The potential difference across the battery is 9 volts when a current of 2 A flows within it from its negative to its positive terminal. The internal resistance and the e.m.f. of the battery are :-

(1) 0.1 Ω, 4V (2) 0.2 Ω, 5V
(3) 0.5 Ω, 10V (4) 0.7 Ω, 10V

64. The circuit below is made up using identical light bulbs. The light bulbs of maximum brightness of the following will be :-



(1) A (2) C (3) D (4) E

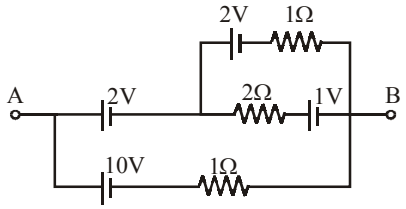
65. In a wire of cross-section radius r, free electrons travel with drift velocity v when a current I flows through the wire. What is the current in another wire of half the radius and of the same material when the drift velocity is 2v ?

(1) 2I (2) I
(3) I/2 (4) I/4

66. An energy source will supply a constant current into the load if its internal resistance is :-

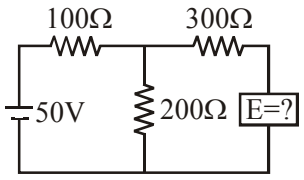
(1) equal to the resistance of load
(2) very large as compared to the load resistance
(3) zero
(4) non-zero but less than the resistance of load

67. The equivalent emf and equivalent resistance between A and B are respectively _ _ _ _,_ _ _



(1) 5.4 V, 1 ohm (2) 5.6 V, 0.75 ohm
(3) 6.2 V, 0.4 ohm (4) 6 V, 2.4 ohm

68. Figure shows a circuit in which a battery of unknown emf and polarity is connected as shown. Battery of unknown emf is such that power dissipated in 200 Ω is zero then E will be :-

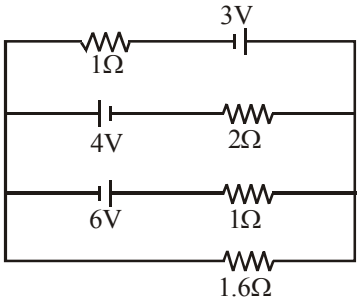


(1) 150 V with negative terminal at top
(2) 300 V with negative terminal at top
(3) 75 V with negative terminal at bottom
(4) 100 V with negative terminal at bottom

69. You are provided with 48 cells, each of emf 2 volt and internal resistance 4 ohms. What maximum current can flow in the circuit having an external resistance of 12Ω ?

(1) 1A (2) 1.2A
(3) 0.96A (4) 1.08A

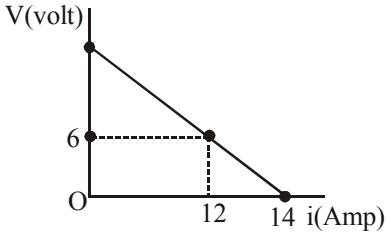
70. Calculate the current flowing through resistance 1.6 Ω :-



(1) 1.4 A (2) 1 A

(3) 2 A (4) none of these

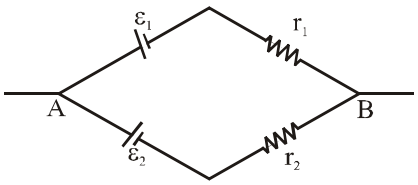
71. 10 Cells, each of emf 'E' and internal resistance 'r', are connected in series to a variable external resistance. Figure shows the variation of terminal potential difference of their combination with the current drawn from the combination.Emf of each cell is



(1) 1.6 V (2) 3.6 V

(3) 1.4 V (4) 4.2 V

72. Two cells of emf ε_1 and $\varepsilon_2(\varepsilon_2 > \varepsilon_1)$ and internal resistances r_1 and r_2 respectively are connected in parallel as shown in figure :-



(1) The equivalent emf ε_{eq} of the two cells is between ε_1 and ε_2, i.e. $\varepsilon_1 < \varepsilon_{eq} < \varepsilon_2$

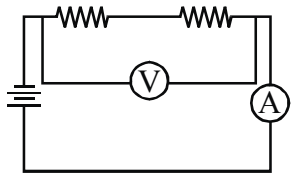
(2) The equivalent emf ε_{eq} is smaller than ε_1

(3) The ε_{eq} is given by $\varepsilon_{eq} = \varepsilon_1 + \varepsilon_2$ always

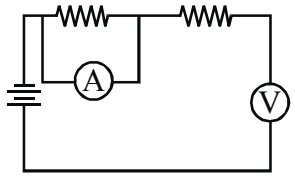
(4) ε_{eq} is independent of internal resistances r_1 and r_2

73. It is required to measure equivalent resistance of circuit with ideal battery, ideal voltmeter & ideal ammeter. Which circuit diagram shows voltmeter V and ammeter A correctly positioned to measure the total resistance of circuit.

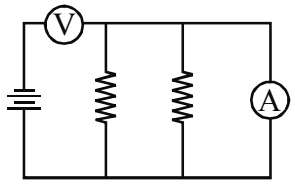
(1)



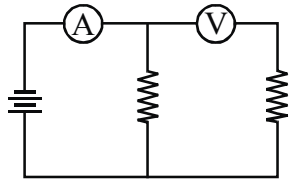
(2)



(3)



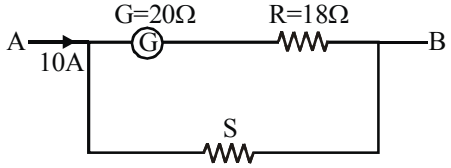
(4)



74. A galvanometer G deflects full scale when a potential difference of 0.50 V is applied. The internal resistance of the galvanometer r_g is 25 ohms. An ammeter is constructed by incorporating the galvanometer and an additional resistance R_S. The ammeter deflects full scale when a measurement of 2.0 A is made. The resistance R_S is closest to :

(1) 0.25 Ω (2) 2.5 Ω (3) 0.45 Ω (4) 0.1 Ω

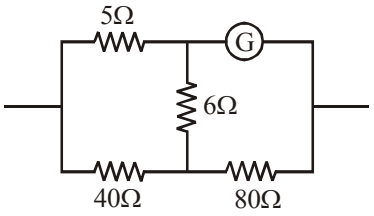
75. Full scale deflection current for galvanometer is 1 Amp. What should be the value of shunt resistance so that galvanometer shows half scale deflection.



(1) 10 Ω (2) 1 Ω

(3) 12 Ω (4) 2 Ω

76. A galvanometer of i_g = 1mA & resistance = 10Ω is connected in a circuit as shown. This combination (circuit) can be used as an ammeter or a voltmeter also. The range of ammeter (R_A) and voltmeter (R_v) are :-



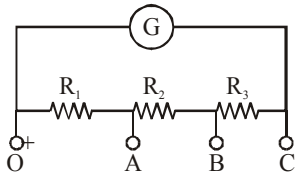
(1) $\frac{9}{8}$mA , 15 mV (2) 1 mA, 12 mV

(3) $\frac{8}{3}$mA , 20 mV (4) $\frac{4}{3}$mA , 10 mV

77. A galvanometer of resistance 40Ω, shunted by a resistance of 50 Ω gives a deflection of 50 divisions when joined in series with a resistance of $\frac{1000}{9}\Omega$ and a 2 volt battery, what is the current sensitivity of galvanometer (in div/mA)?

(1) 6 (2) 10/3 (3) 7.5 (4) None

78. The following figure shows a circuit diagram of an ammeter of three different ranges. The specification of the ammeter is



Range (in amp.)	10	5	1
Terminals taken	O and A	O and B	O and C

The resistance of the galvanometer coil is 99 Ω. The range of the galvanometer is 10 mA. Find the value of $(R_1+R_2+R_3)$.

(1) 1 Ω (2) 10 Ω

(3) 0.1 Ω (4) 0.01 Ω

79. The voltmeter reading after the connection of the resistance is :-

(1) 1V (2) 2V

(3) 3V (4) 4V

80. If resistance of the ammeter is 2Ω, then resistance of the voltmeter is :-

(1) 1Ω (2) 2Ω

(3) 3Ω (4) 4Ω

81. If resistance of the ammeter is 2Ω, then resistance of the resistor which is added in parallel to the voltmeter is :-

(1) $\frac{3}{5}\Omega$ (2) $\frac{2}{7}\Omega$

(3) $\frac{3}{7}\Omega$ (4) None

82. When a current of 5 mA is passed through a galvanometer having a coil of resistance 15 Ω, it shows full scale deflection. The value of the resistance to be put in series with the galvanometer to convert it into to voltmeter of range 0 – 10 Vis:

(1) 2.535×10^3 Ω (2) 4.005×10^3 Ω

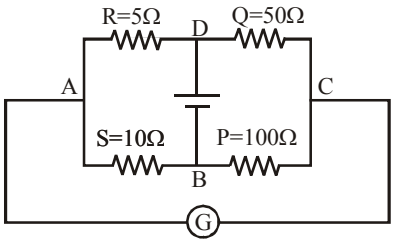
(3) 1.985×10^3 Ω (4) 2.045×10^3 Ω

83. A galvanometer of resistance 50Ω is connected to a battery of 3V alongwith a resistance of 2950Ω in series. A full scale deflection of 30 divisions is obtained in the galvanometer. In order to reduce this deflection to 20 division, the resistance in series should be:-

(1) 6050 Ω (2) 4450 Ω

(3) 5050 Ω (4) 5550 Ω

84. Figure shows a balanced Wheatstone's bridge



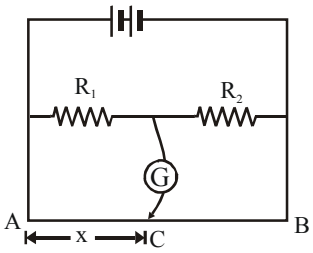
(1) If P is slightly increased, the current in the galvanometer flows from C to A

(2) If P is slightly increased, the current in the galvanometer flows from A to C

(3) If Q is slightly increased, the current in the galvanometer flows from A to C

(4) Both (1) & (3)

85. In the shown arrangement of the experiment of the metre bridge if AC corresponding to null deflection of galvanometer is x, what would be its value if the radius of the wire AB is doubled?



(1) x (2) x/4 (3) 4x (4) 2x

86. Which of the following statements is false ?

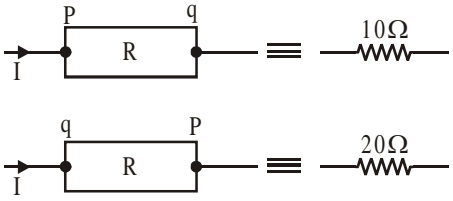
(1) A rheostat can be used as a potential divider

(2) Kirchhoff's second law represents energy conservation

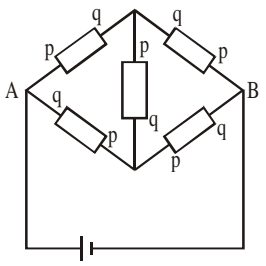
(3) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude.

(4) In a balanced wheatstone bridge if the cell and the galvanometer are exchanged, the null point is disturbed.

87. There is a directional resistor having value according to direction of current and

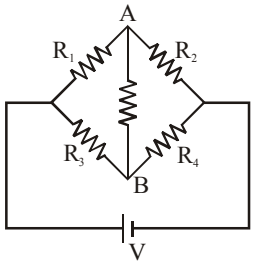


then find the equivalent resistance between AB given as in circuit ?



(1) 16 (2) 14 (3) 12 (4) 18

88. For a circuit shown; $R_1 > R_2$ and $R_3 = R_4$. The direction of current in wire AB is:



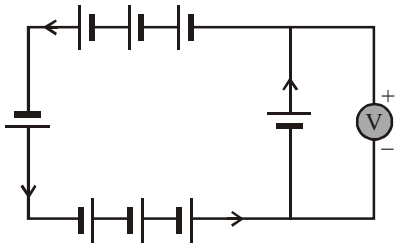
(1) From A to B

(2) No current flows in AB

(3) From B to A

(4) Data is not sufficient

89. In the circuit shown in figure each battery has emf 5 V and has an internal resistance of 0.2 Ω. What is the reading of ideal voltmeter V (in Volt) ?



(1) 0 (2) 1 (3) 2 (4) 3

90. If the current in resistance of uniform cross section is doubled then choose incorrect option (assume temperature to be approximately constant) :-

(1) the current density is doubled

(2) the conduction electron density is doubled

(3) the mean time between collision is constant

(4) the electron drift speed is doubled

91. A 115 V, 1 kW electric oven is mistakenly connected to a 230 V power line that has a 15A fuse. The oven will :

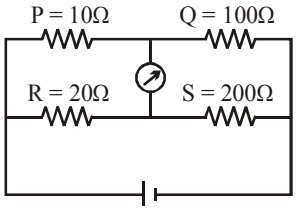
(1) give off less than 1 kW of heat

(2) give off 1 kW of heat

(3) give off more than 1 kW of heat

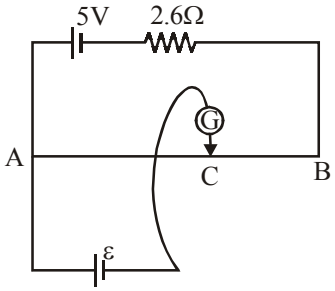
(4) blow the fuse

92. Figure shows a balanced Wheatstone net. Now, it is disturbed by changing P to 11 Ω. Which of the following steps will not bring the bridge to balance again ?



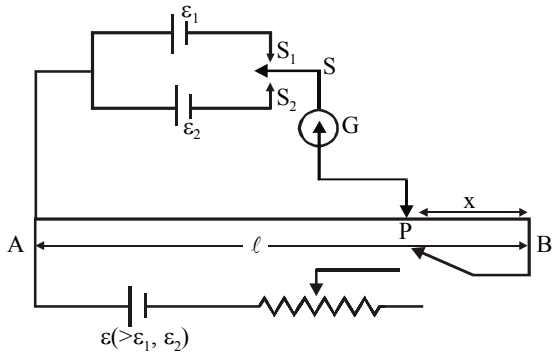
(1) Increasing R by 2 Ω
(2) Increasing S by 20 Ω
(3) Increasing Q by 10 Ω
(4) Making product RQ = 2200 $(\Omega)^2$

93. In the potentiometer circuit shown in the figure, AB is a uniform wire of length 100 cm and resistance 2.4 Ω. The length AC of the wire for which the galvanometer G shows no deflection is 60 cm. The emf of the test cell, ε is



(1) 1.56 V (2) 3 V (3) 2.77 V (4) 1.44 V

94. Two batteries of emf's ε_1 and ε_2 are connected in a circuit as shown in figure. The galvanometer is kept undeflected always. Here AB = ℓ. When the switch S is connected to point S_1, BP = x_1 and when the switch S is connected to point S_2, BP = x_2. Here, the ratio of emf's of the two batteries, i.e. $\varepsilon_1/\varepsilon_2$ equal



(1) x_1/x_2 (2) x_2/x_1

(3) $\frac{(\ell - x_1)}{(\ell - x_2)}$ (4) $\frac{(\ell - x_2)}{(\ell - x_1)}$

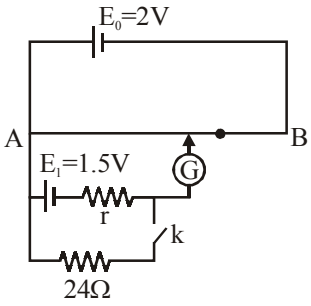
95 In a potentiometer experiment firstly a cell of emf 1V is balanced on 70 cm length. Secondly an unknown emf cell is balanced on 63cm. By replacing 1V cell. The emf of unknown cell shall be :-

(1) 1.9V (2) 0.9V
(3) 3.9V (4) 2.9V

96. If the length of the filament of a heater is reduced by 10%, the power of the heater will

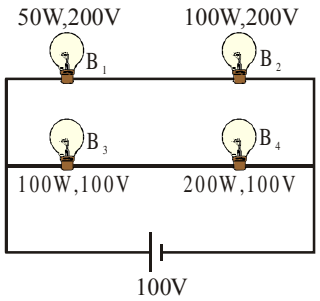
(1) increase by about 9%
(2) increase by about 11%
(3) increase by about 19%
(4) decrease by about 10%

97. For the arrangement of the potentiometer shown in the figure, the balance point is obtained at a distance 75 cm from A when the key k is open. The second balance point is obtained at 60 cm from A when the key k is closed. Find the internal resistance of the battery E_1.



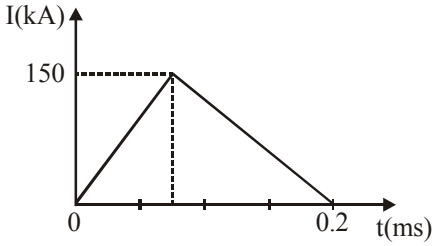
(1) 3 Ω (2) 6 Ω
(3) 9 Ω (4) 12 Ω

98. Which bulb will be glow brightest in the following circuit diagram ?



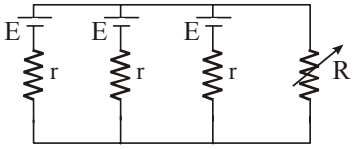
(1) B_1 (2) B_2 (3) B_3 (4) B_4

99. During lighting, a current pulse, shown in figure, flows from the cloud at a height 1.5km to the ground. If the breakdown electric field of humid air is about 400 kVm^{-1}, the energy released during lighting would be (in unit of 10^9 J)



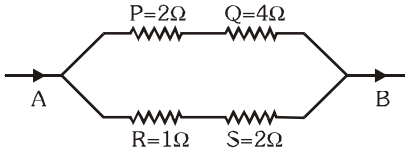
(1) 9 (2) 3.0 (3) 4.5 (4) 6.0

100. In shown circuit there are identical ideal cells of emf E and r = 9 Ω, find the value of R so that the power dissipated in resistance R is maximum.



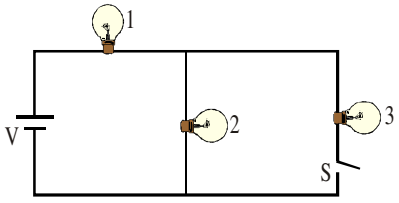
(1) 1 Ω (2) 3 Ω (3) 27 Ω (4) 9 Ω

101. Which of the four resistances generate the greatest amount of heat when a current flows from A to B?



(1) P (2) Q (3) R (4) S

102. Figure shows 3 identical bulbs with switch S closed. The brightness of bulb 1 is B_1, bulb 2 is B_2 and net brightness of system is B_T. If switch is now opened, the brightness of :-



(1) B_1 remains same, B_2 increases and B_T increases.

(2) B_1 remains same, B_2 decreases & B_T decreases

(3) B_1 decreases, B_2 increases & B_T decrease

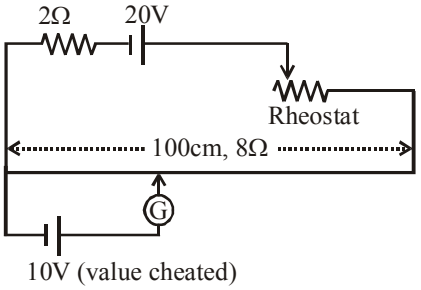
(4) B_1 decrease, B_2 increase & B_T increase

103. The wattage rating of a light bulb indicates the power dissipated by the bulb if it is connected across 110V DC potential difference. If a 50W and 100W bulb are connected in series to a 110V DC source, how much power will be dissipated in the 50W bulb

(1) 50W (2) 100W

(3) 22W (4) 11W

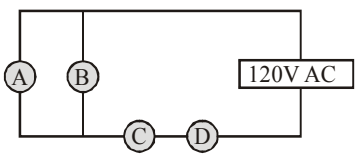
104. A student was given the experiment to measure the emf of a unknown cell using potentiometer. He cheated result and wrote the observation arbitrarily and was caught. Which reading helped the teacher to arrive at the conclusion that he cheated?



S.No.	value of rheostat	Null point
A	R_1	50cm
B	R_2	65cm
C	R_3	70cm
D	R_4	80cm

(1) A (2) B (3) C (4) D

105. The diagram shows a circuit with four identical light bulbs.



When we removed bulb A from the circuit, the light intensity of bulb C :-

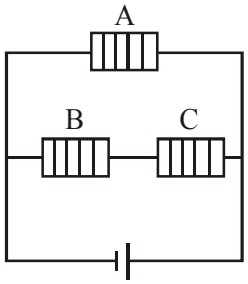
(1) Remains the same

(2) Increases

(3) Decreases

(4) Becomes zero

106. The three electric heaters in the following circuit all have the same resistance. Give that the total heat emitted by a heater is proportional to the power dissipated, the total heat produced by B and C together, compared with the heat produced in A, is :-



(1) A quarter as much

(2) Half as much

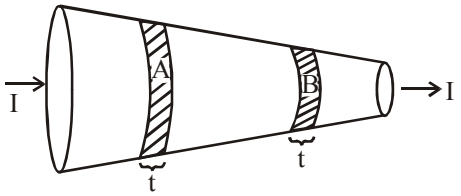
(3) The same

(4) Twice as much

107. A cylindrical copper wire is stretched such that its diameter decreases by 0.01%. The approximate percentage increase in its resistance is :-

(1) 0.02% (2) 0.04% (3) 0.08% (4) 0.16%

108. Figure shows a homogeneous conductor with decreasing cross-sectional area along the flow of current. Consider two elementary disks A and B of same thickness on conductor as shown. Choose the correct option(s) :-



(I) Drift velocity of electrons at B is greater than at A.

(II) No. of electrons per unit volume is same at A and B.

(III) Resistance of segment B is bigger than that of A.

(IV) Electric field, current density and resistivity, all are bigger at B than at A.

(1) I, II & III (2) I & II

(3) I & IV (4) II, III, & IV

109. A galvanometer has a coil of resistance 100 Ω showing a full–scale deflection at 50 μA. Consider following statements.

(A) The resistance needed to use it as a voltmeter of range 50 volt is 10^6 Ω.

(B) The resistance needed to use it as a voltmeter of range 50 volt is 10^5 Ω

(C) The resistance needed to use it as an ammeter of range 10 mA is 0.5 Ω

(D) The resistance needed to use it as an ammeter of range 10 mA is 1.0 Ω

Select correct alternative :-

(1) Only A, D (2) Only A, C

(3) Only B, D (4) Only B, C

110. The connecting wires from the power station to a remote electrical device has high voltage rating because :-

(1) Power loss at connecting wire $\propto$ (voltage)^2

(2) Power loss at connecting wires $\propto$ (voltage)^1

(3) Power loss at connecting wires $\propto$ (voltage)$^{-2}$

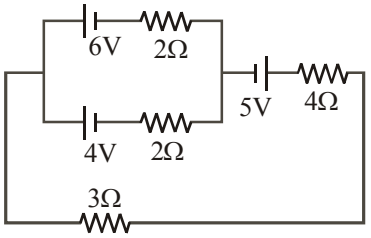
(4) Power loss at connecting wires doesn't depend on voltage

111. Incandescent bulbs are designed by keeping in mind that the resistance of their filament increases with the increase in temperature. If at the room temperature, 100W, 60W and 40W bulbs have filament resistances R_{100}, R_{60} and R_{40} respectively the relation between these resistances is :-

(1) $\frac{1}{R_{100}} > \frac{1}{R_{60}} > \frac{1}{R_{40}}$ (2) $R_{100} = R_{40} + R_{60}$

(3) $R_{100} > R_{60} > R_{40}$ (4) $\frac{1}{R_{100}} = \frac{1}{R_{40}} + \frac{1}{R_{60}}$

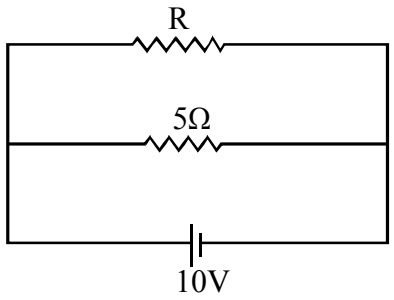
112.



Calculate current in 6V battery :-

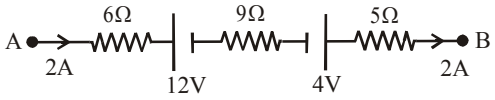
(1) $\frac{1}{4}$A (2) $\frac{1}{8}$A (3) $\frac{1}{2}$A (4) None

113. The power dissipated in the circuit shown in the figure is 30 Watts. The value of R is :-



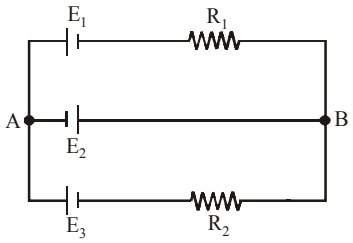
(1) 10Ω (2) 30 Ω (3) 20Ω (4)15Ω

114. The potential difference between A and B in the Figure is :



(1) 24 V (2) 14 V (3) 32 V (4) 48 V

115. In the circuit shown in Fig., $E_1 = E_2 = E_3 = 2V$ and $R_1 = R_2 = 4\Omega$. The current flowing between points A and B through battery E_2 is



(1) zero (2) 2A from A to B
(3) 2A from B to A (4) none of the above

ANSWER KEY

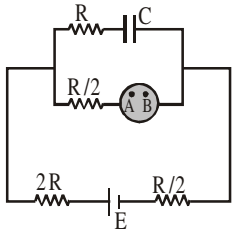
Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	1	4	3	1	2	3	2	3	2	2	2	1	4	1	1	2	3	1	1
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	3	1	3	1	4	2	1	2	1	3	2	2	4	3	3	1	2	3	4
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	3	2	2	4	1	1	2	2	3	1	3	2	3	2	3	4	1	1	1
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	3	3	2	3	2	3	1	1	1	4	1	1	1	4	1	1	1	2	3
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	1	3	2	4	1	4	2	3	1	2	4	2	4	3	2	2	2	3	1	2
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115					
Ans.	4	3	3	1	3	2	2	1	2	3	1	3	1	4	2					

CAPACITANCE & CAPACITOR

1. Capacity of an isolated sphere is increased n times when it is enclosed by an earthed concentric sphere. The ratio of their radii would be:

(1) $\frac{n^2}{n-1}$ (2) $\frac{n}{n-1}$ (3) $\frac{2n}{n+1}$ (4) $\frac{2n+1}{n+1}$

2. A conducting solid sphere is joined in an electrical circuit as shown in figure-

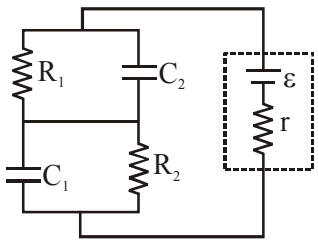


Two imaginary points A and B are taken inside the sphere. For given conditions-

(1) $V_A > V_B$ (2) $V_A < V_B$

(3) $V_A = V_B$ (4) Data insufficient

3. In the given circuit, $R_1 = 2\Omega$, $R_2 = 3\Omega$, $r = 1\Omega$, $\varepsilon = 6V$, $C_1 = 1\mu F$ and $C_2 = 2\ \mu F$. In steady state the ratio of energy stored in the capacitors C_2 and C_1 is

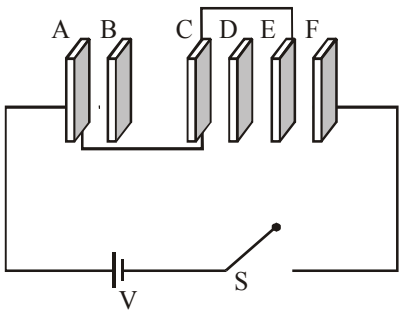


(1) 6/9 (2) 9/6 (3) 8/9 (4) 9/9

4. There are 8 drops of a conducting fluid. Each has radius r and they are charged to potential 1 volt. They are then combined to form a bigger drop. Find potential of big drop.

(1) 1 V (2) 4 V (3) 2 V (4) 8 V

5. A,B,C,D,E and F are conducting plates each of area A, and any two consecutive plates are separated by a distance d. The net energy stored in the system after the switch S is closed is :-



(1) $\frac{3\varepsilon_0 A}{2d}V^2$ (2) $\frac{5\varepsilon_0 A}{12d}V^2$

(3) $\frac{\varepsilon_0 A}{2d}V^2$ (4) $\frac{\varepsilon_0 A}{d}V^2$

6. When an additional charge of 2C is given to a capacitor, energy stored in it is increased by 21%. The original charge of the capacitor is :-

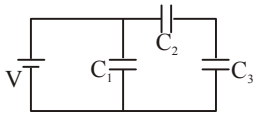
(1) 30 C (2) 40 C (3) 10 C (4) 20 C

7. Three capacitors C_1, C_2 and C_3 are connected to a battery as shown in figure. The three capacitors have equal capacitances. Which capacitor stores the most energy :-

(1) C_1

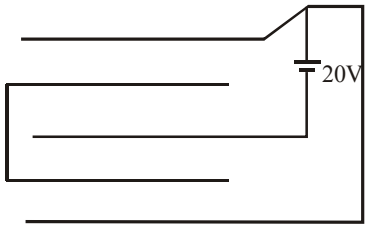
(2) C_2

(3) C_3



(4) All three capacitors store the same amount of energy

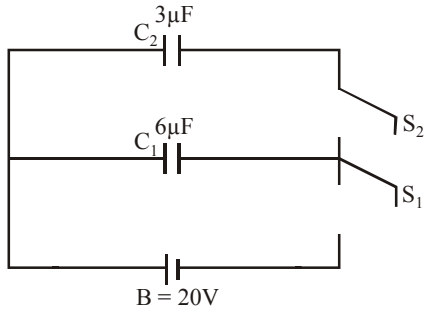
8. Five identical plates of dimension 5 cm × 8 m are placed at separation of 8.85 mm from each other. If they are connected through a battery which provides constant potential difference of 20V as shown, then find the total charge given by battery.



(1) 8×10^{-9} C (2) 16×10^{-9}C

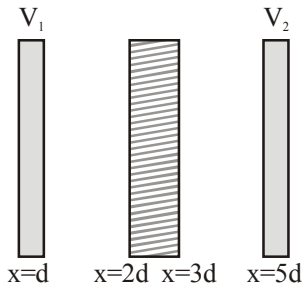
(3) 4×10^{-9} C (4) 12×10^{-9} C

9. In the circuit shown in fig. C_1= 6μF, C_2= 3μF and battery B = 20V. The switch S_1 is first closed. It is opened after long time and S_2 is closed. What is the final charge on C_2?



(1) 120 μC (2) 80 μC (3) 40 μC (4) 20 μC

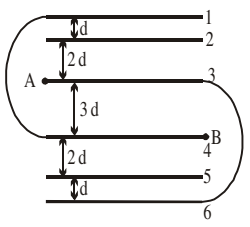
10. Two identical thin metal plates has potential V_1 and V_2 ($V_1 > V_2$). A neutral metal slab is placed between these two plates. Find potential of right surface of metal slab



(1) $\frac{V_1 + V_2}{2}$ (2) $\frac{2V_1 + V_2}{3}$

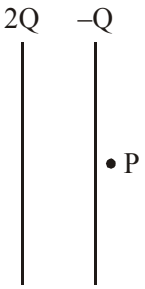
(3) $\frac{V_1 - V_2}{3}$ (4) $\frac{V_1 + 2V_2}{3}$

11. There are six plates of equal area A and the plates are arranged as shown in figure. The equivalent capacitance between points A and B is $\frac{\alpha \in_0 A}{d}$. Find value of α.



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

12. In figure, the plates of a parallel plate capacitor have unequal charges. Its capacitance is C. P is a point outside the capacitor and close to the plate of charge –Q. The distance between the plates is d. Then which of following is incorrect:-



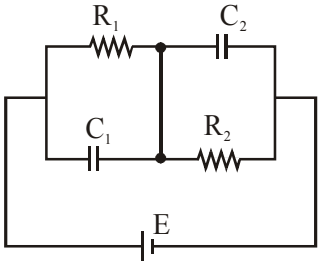
(1) a point charge at point P will experience electric force due to the capacitor

(2) the potential difference between the plates will be 3Q/2C

(3) the energy stored in the electric field in the region between the plates is $9Q^2/8C$

(4) the force on one plate due to the other plate is $Q^2/2\pi\varepsilon_0 d^2$

13. For the circuit shown in figure the ratio of energy stored in capacitor (1) to that of in capacitor (2) is



(1) $\frac{R_1C_1}{R_2C_2}$ (2) $\frac{R_1C_2}{R_2C_1}$ (3) $\frac{R_1^2C_1}{R_2^2C_2}$ (4) $\frac{R_1C_1^2}{R_2C_2^2}$

14. A proton, deutron and α-particle are accelerated by same potential difference. They enter between parallel plates of a capacitors in direction perpendicular to electric field, then deflection of:-

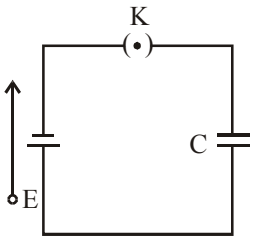
(1) Proton is maximum

(2) Deutron is maximum

(3) α-particle is maximum

(4) All particle will be same

15. A parallel plate capacitor is connected to a battery as shown in figure. Consider two situations:



A: Key K is kept closed and plates of capacitors are moved apart using insulating handle.

B: Key K is opened and plates of capacitors are moved apart using insulating handle.

Choose the **CORRECT** option :-

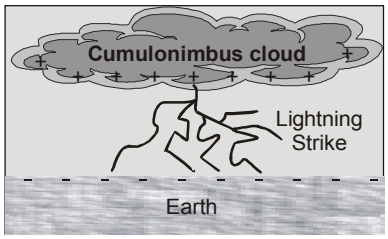
(1) In A : Q remains same but C changes.

(2) In B : V remains same but C changes.

(3) In A : V remains same and hence Q changes.

(4) In B : Q remains same and hence V remains constant.

16. A cumulonimbus cloud is 5 km long and 2 km wide and has its base 1 km above the surface of the earth as shown here. Consider the cloud and earth to be a parallel plate capacitor with air as the dielectric. Then the capacitance of the cloud-earth combination is-



(1) 8.8 μF (2) 8.08 μF

(3) 0.088 μF (4) 0.88 μF

17. A parallel plate capacitor is connected to a battery which builds up an electric field of 60 V/cm between the plates as shown in figure-I. Now two initially neutral plates that are connected are positioned as shown in figure-II. The plates are at equal distances from each other. Find the electric field strength between the plates B and D.

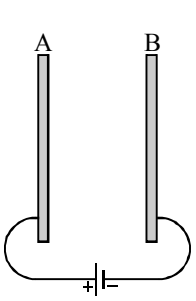


Figure-I

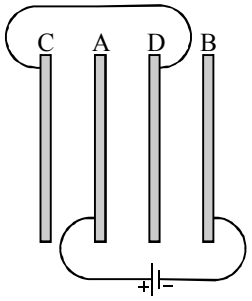


Figure-II

(1) 8 kV/m (2) 6 kV/m (3) 4 kV/m (4) 3 kV/m

18. A parallel plate capacitor of plate area 0.2 m^2 and spacing 10^{-2} m is charged to 10^3 volt and then disconnected from the battery, and pull apart to double the plate spacing

(1) Final charge on the capacitor becomes two times of initial

(2) Final charge becomes half of initial value.

(3) Final voltage on the capacitor will remain 10^3 Volts.

(4) Final voltage on the capacitor is 2×10^3 Volts.

19. An electron is in equilibrium between two horizontal plates of a charged capacitor. If the plates are interchanged in position. It means electric field is reversed then the acceleration of the electron will be :-

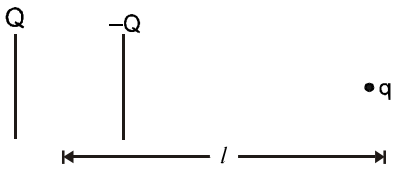
(1) Details are not complete

(2) g

(3) 2g

(4) 5 m/sec^2

20. The plates of small size of a parallel plate capacitor are charged as shown . The force on the charged particle of 'q' at a distance 'l' from the capacitor is : (Assume that the distance between the plates is d << l)



(1) zero (2) $\frac{Qqd}{2\pi \in_0 \ell^3}$

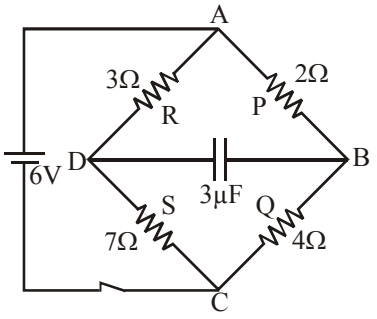
(3) $\frac{Qqd}{\pi \in_0 \ell^3}$ (4) $\frac{Qqd}{4\pi \in_0 \ell^3}$

21. A parallel plate capacitor is to be designed with a voltage rating 1 kV using a material of dielectric constant 3 and dielectric strength about 10^7 V/m. What minimum area of plates is required to have a capacitance 50 pF :-

(1) 1.9 cm^2 (2) 40 cm^2

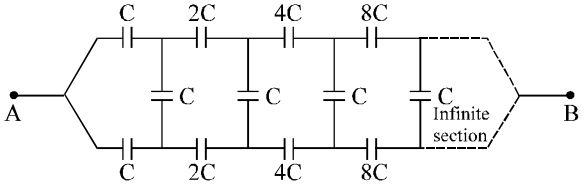
(3) 62 cm^2 (4) 35 cm^2

22. In steady state, the energy stored in the capacitor as shown in figure is :-



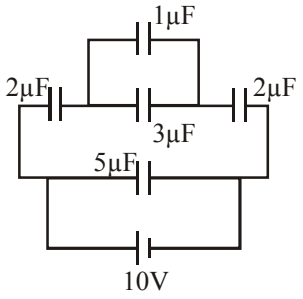
(1) 80 nJ (2) 20 nJ (3) 100 nJ (4) 60 nJ

23. Find the equivalent capacitance of the circuit between point A and B.



(1) $\frac{C}{3}$ (20) $\frac{C}{8}$ (3) C (4) $\frac{C}{32}$

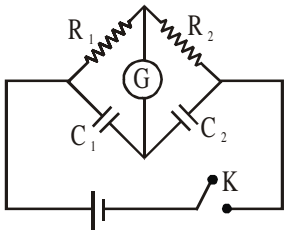
24. The ratio of potential difference between 1 μF and 5 μF capacitors -



(1) 1 : 2 (2) 4 : 5

(3) 1 : 5 (4) 1 : 4

25. In the circuit, if no current flows through the galvanometer when the key K is closed, the bridge is balanced. The balancing condition for bridge is



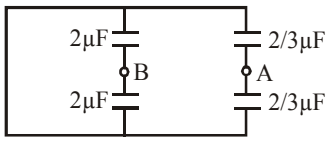
(1) $\frac{C_1}{C_2}=\frac{R_1}{R_2}$ (2) $\frac{C_1}{C_2}=\frac{R_2}{R_1}$

(3) $\frac{C_1^2}{C_2^2}=\frac{R_1^2}{R_2^2}$ (4) $\frac{C_1^2}{C_2^2}=\frac{R_2}{R_1}$

26. A parallel plate capacitor of capacitance C is connected to a battery and is charged to a potential difference V. Another capacitor of capacitance 2C is connected to another battery and is charged to potential difference 2V. The charging batteries are now disconnected and the capacitors are connected in parallel to each other in such a way that the positive terminal of one is connected to the negative terminal of the other. The final energy of the configuration is–

(1) Zero (2) $\frac{25CV^2}{6}$ (3) $\frac{3CV^2}{2}$ (4) $\frac{9CV^2}{2}$

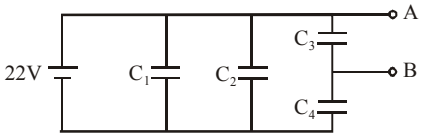
27. The equivalent capacitance of the circuit across the terminals A and B is equal to :-



(1) 0.5 μF (2) 2 μF

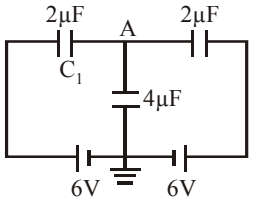
(3) 1 μF (4) none of these

28. In fig. given C_1= 3μF, C_2= 5μF, C_3= 9μF, and C_4= 13μF. What is the potential difference between points A and B?



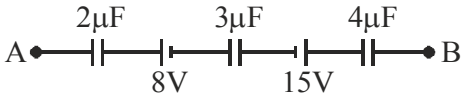
(1) 13 V (2) 9 V (3) 0 V (4) 11 V

29. Three capacitors are connected as shown in fig. Then the charge on capacitor C_1 is :-



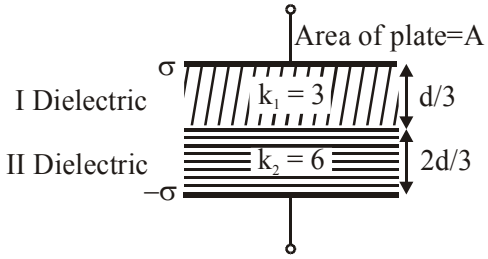
(1) 6μC (2) 12μC (3) 18μC (4) 24μC

30. The potential of the point A is greater than that of B by 19 volt. What is the potential difference in volts across the 3μF capacitor ?



(1) 7 (2) 8 (3) 23 (4) 4

31. In the figure shown σ is the surface charge density on the upper metallic plate



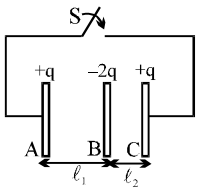
(1) The ratio of energy density in I dielectric to II dielectric is 2

(2) The ratio of energy density in I dielectric to II dielectric is 4

(3) The ratio of energy density in I dielectric to II dielectric is 1

(4) None of these

32. Three long conducting plate A, B & C having charges +q, –2q & +q as shown in figure. Here plate A and C are fixed. If the switch S is closed the middle plate (B) will start moving in



(here $\ell_1 > \ell_2$)

(1) Left direction

(2) Right direction

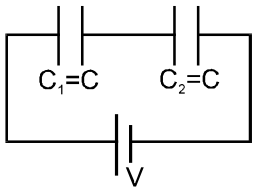
(3) will not move

(4) First move leftward & then rightward

33. Two parallel plate capacitors of capacitance C_0 and $2C_0$ are connected in parallel and charged to a potential difference V_0. Now the battery is disconnected and the region between the capacitor plates of capacitance C_0 is completely filled with a dielectric of dielectric constant K. The potential difference across the capacitors, now becomes :

(1) $\frac{V_0}{(3K+1)}$ (2) $\frac{3V_0}{(K+2)}$ (3) $\frac{2V_0}{K}$ (4) $\frac{V_0}{(2K+1)}$

34. Two identical capacitor C_1 and C_2 are connected in series with a battery. They are fully charged. Now a dielectric slab is inserted between the plates of C_2. The potential difference across C_1 will :



(1) increase

(2) decrease

(3) remain same

(4) depend on internal resistance of the cell

35. Two identical plates of a parallel plate capacitor are given charges +q and –3q. If σ_1 and σ_2 are the charge densities on outer and inner faces of the first plate then,

(1) $\sigma_1 = \sigma_2$ (2) $\sigma_1 = \frac{-\sigma_2}{2}$

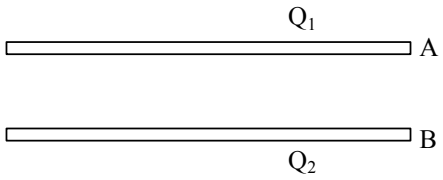
(3) $\sigma_1 = \frac{\sigma_2}{2}$ (4) $\sigma_2 = \frac{\sigma_1}{2}$

36. If dielectric constant and dielectric strength be denoted by K and X respectively, then a material suitable for use as a dielectric in a capacitor must have

(1) high K and high X (2) high K and low X

(3) low K and high X (4) low K and low X

37. Two conducting plates A and B are parallel. A is given a charge Q_1 and B is given a charge Q_2. The charge on inner side of B is -



(1) $\frac{Q_1 - Q_2}{2}$

(2) $\frac{Q_2 - Q_1}{2}$

(3) $\frac{(Q_1 + Q_2)}{2}$

(4) $\frac{-(Q_1 + Q_2)}{2}$

38. A capacitor has some dielectric between its plates, and the capacitor is connected to a dc source. The battery is now disconnected and then the dielectric is removed, then :-

(1) capacitance will increase

(2) energy stored will decrease

(3) electric field will increase

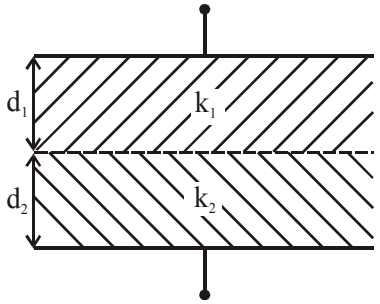
(4) voltage will decrease

39. In a parallel plate capacitor with air between the plates each plate has an area of 6×10^{-3} m^2 and the distance between the plates is 3 mm. Now this capacitor is connected to a 100 V supply. Now supply is disconnected and a mica sheet (of dielectric constant = 6) is inserted between the plates. Find the voltage across capacitor :-

(1) 100 V (2) 600 V

(3) $\frac{50}{3}$ V (4) $\frac{100}{3}$ V

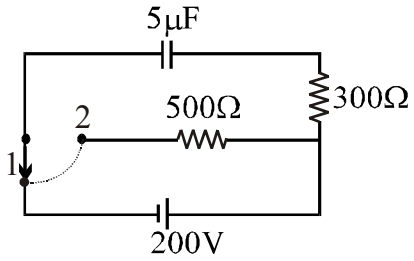
40. A parallel plate capacitor is made of two dielectric blocks in series. One of the block has thickness d_1 and dielectric constant k_1 and the other has thickness d_2 and dielectric constant k_2 as shown in figure. This arrangement can be thought as a dielectric slab of thickness $d = (d_1 + d_2)$ and effective dielectric constant k. The value of k is :-



(1) $\frac{k_1d_1 + k_2d_2}{d_1 + d_2}$ (2) $\frac{k_1d_1 + k_2d_2}{k_1 + k_2}$

(3) $\frac{k_1k_2(d_1 + d_2)}{k_1d_2 + k_2d_1}$ (4) $\frac{2k_1k_2}{k_1 + k_2}$

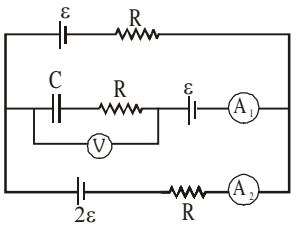
41. A capacitor of capacitance 5μF is connected to a source of constant emf of 200V for a long time, then the switch was shifted to contact 2 from contact 1. The total amount of heat generated in the 500Ω resistance, thereafter is:-



(1) 1/32 J (2) 3/32 J

(3) 2/32 J (4) 5/32 J

42. In the given circuit, ammeters A_1 and A_2 are ideal and the voltmeter (V) is having very large resistance. In the steady state reading of ammeters A_1, A_2 and voltmeter (V) will be respectively



(1) 0, $\frac{\varepsilon}{2R}$ and $\frac{\varepsilon}{2}$ (2) 0, $\frac{\varepsilon}{R}$ and $\frac{\varepsilon}{2}$

(3) 0, $\frac{\varepsilon}{2R}$ and $\frac{5\varepsilon}{2}$ (4) 0, $\frac{\varepsilon}{2R}$ and $\frac{3\varepsilon}{2}$

43. The capacitor shown in figure 1 is charged by connecting switch S to contact 'a' for a long time. If switch S is thrown to contact 'b' at time t = 0, which of the curves in figure 2 represents the magnitude of the current through the resistor R as a function of time?

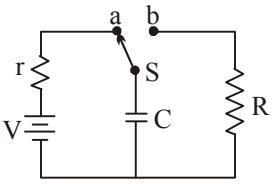


Figure 1

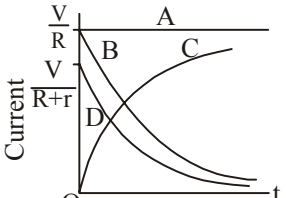
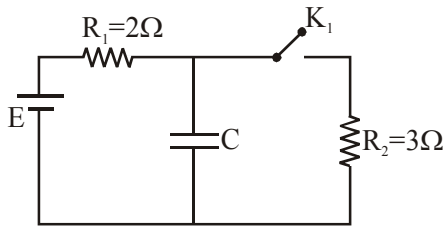


Figure 2

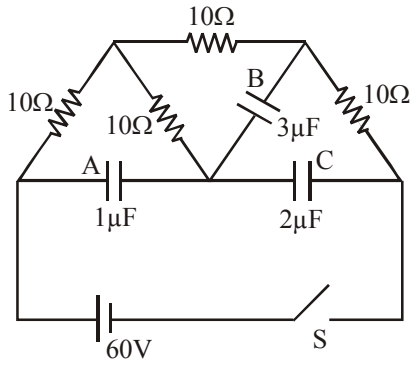
(1) A (2) B (3) C (4) D

44. In the circuit shown in the figure K_1 is open. The charge on capacitor C in steady state is q_1. Now key is closed and at steady state charge on C is q_2. The ratio of charges q_1/q_2 is



(1) 5/3 (2) 3/5 (3) 1 (4) 2/3

45. In the given figure, the switch S is closed at time t = 0. Q_A, Q_B and Q_C are charges on the capacitor A, capacitor B and capacitor C in the steady state respectively. Choose the correct statement :-



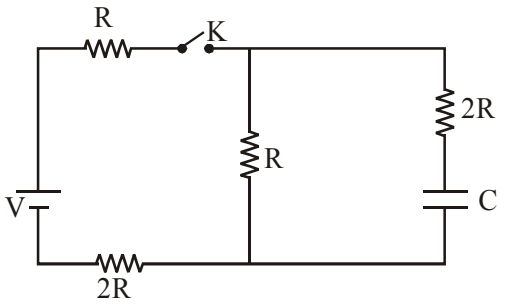
(1) $Q_A < Q_B < Q_C$

(2) $Q_A < Q_C < Q_B$

(3) $Q_C < Q_A < Q_B$

(4) $Q_C < Q_B < Q_A$

46.



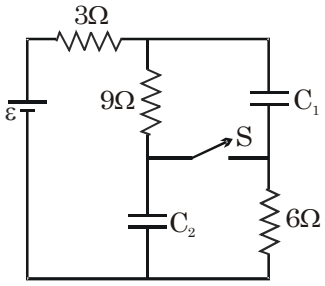
Find time constant for given circuit :-

(1) $\frac{11RC}{4}$ (2) $\frac{8RC}{3}$ (3) $\frac{7RC}{3}$ (4) $\frac{9RC}{4}$

47. In above question, find time constant when key is open :

(1) $\frac{8RC}{3}$ (2) $\frac{7RC}{3}$ (3) 3 RC (4) $\frac{3RC}{2}$

48. In the circuit shown there is steady state with the switch closed. The switch is opened at t = 0. Choose the incorrect option.
(Given : $\varepsilon = 24V$, $C_1 = 3F$ and $C_2 = 2F$)



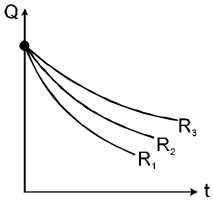
(1) The voltage across C_1 before the switch is open is 12V.

(2) The voltage across C_1 after a long time after the switch is open is 12V.

(3) The voltage across C_2 after a long time after the switch is open is 24V.

(4) The voltage across C_2 before the switch is open is 8V.

49. Three identical capacitors are given a charge Q each and they are then allowed to discharge through resistance R_1, R_2 and R_3 separately. Their charges, as a function of time are shown in the graph below. The smallest of the three resistances is



(1) R_3 (2) R_2

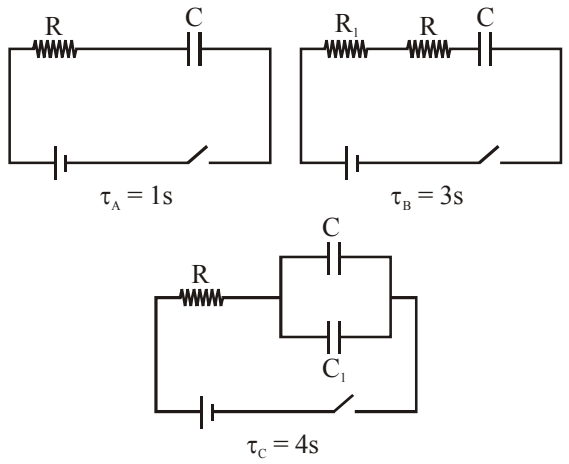
(3) R_1 (4) cannot be predicted

50. A parallel combination of 0.1 M Ω resistor and a 10 μF capacitor is connected across a 1.5 volt source of negligible resistance. The time required for the capacitor to set charged upto 0.75 volt is approximately (in seconds) :

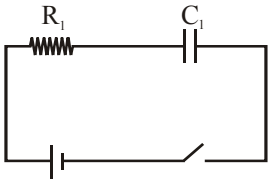
(1) ∞ (2) $\log_e 2$

(3) $\log_{10} 2$ (4) Zero

51. Given below are three circuits with their time constants,



then find time constant (in second) of circuit shown below.



(1) 2 sec (2) 4 sec

(3) 6 sec (4) 1 sec

52. A 600 pF capacitor is connected to a battery of 200 V, Now we remove battery and connect a similar capacitor to that charged capacitor. How much energy is lost in this whole process :-

(1) 3×10^{-6} J (2) 6×10^{-6} J

(3) 4×10^{-6} J (4) 18×10^{-6} J

53. In a Van-de-Graaff generator a spherical metal shell is to be a 15×10^6 V electrode. The dielectric strength of the gas surrounding the electrode is 5×10^7 V/m. The minimum radius of shell must be:-

(1) 30 cm (2) 20 cm

(3) 10 cm (4) 15 cm

ANSWER KEY

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

MAGNETIC EFFECT OF CURRENT AND MAGNETISM

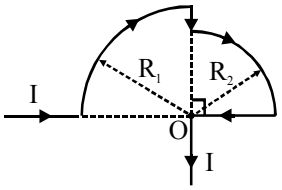
1. A point charge moving with constant velocity:-
(1) May produce radial magnetic field
(2) Always produces radial magnetic field
(3) Can not produce electric field
(4) Produces both electric and magnetic field

2. A circular coil of wire consisting of 100 turns, each of radius 8.0 cm carries a current of 0.40 A. What is the magnitude of the magnetic field B at the centre of the coil ?
(1) $2\pi \times 10^{-4}$ T (2) $\pi \times 10^{-4}$ T
(3) $4\pi \times 10^{-4}$ T (4) 10^{-7} T

3. A long straight wire carries a current of 35 A. What is the magnitude of the field B at a point 20 cm from the wire ?
(1) 3.5×10^{-5} T
(2) 7×10^{-5} T
(3) 10^{-5} T
(4) 2×10^{-5} T

4. A long straight wire in the horizontal plane carries a current of 50 A in north to south direction. Give the magnitude and direction of B at a point 2.5m east of the wire :-
(1) 4×10^{-6} T upwards
(2) 6×10^{-6} T down
(3) 4×10^{-6} T east
(4) Both (1) and (3)

5. In the loop shown, the magnetic induction at the point 'O' is



(1) $\frac{\mu_0 I}{8}\left(\frac{R_1 - R_2}{R_1 R_2}\right)$ (2) $\frac{\mu_0 I}{8}\left(\frac{R_1 + R_2}{R_1 R_2}\right)$

(3) $\frac{\mu_0 I}{8}\left(\frac{R_1 R_2}{R_1 + R_2}\right)$ (4) Zero

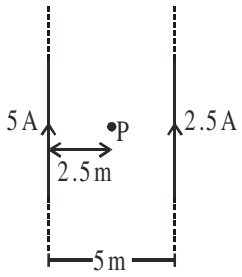
6. For adjoining figure, The magnetic field at point 'P' will be:-

(1) $\frac{\mu_0}{4\pi} \odot$

(2) $\frac{\mu 0}{\pi} \otimes$

(3) $\frac{\mu_0}{2\pi} \otimes$

(4) $\frac{\mu_0}{2\pi} \odot$



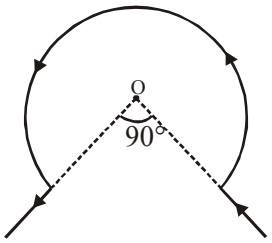
7. A current i is flowing in a straight conductor of length L. The magnetic induction at a point on its axis at a distance $\frac{L}{4}$ from its centre will be :

(1) 0 (2) $\frac{\mu_0 i}{2\pi L}$

(3) $\frac{\mu_0 i}{\sqrt{2}L}$ (4) $\frac{4\mu_0 i}{\sqrt{5}\pi L}$

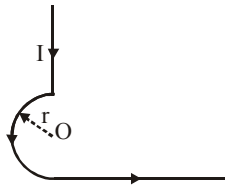
8. The magnetic field B_0 due to current carrying circular loop of radius 12 cm at its centre is 0.50×10^{-4} T. The magnetic field due to this loop at a point on the axis at a distance of 5 cm from the centre is -
(1) 3.5×10^{-9} T (2) 5.3×10^{-9} T
(3) 1.3×10^{-5} T (4) 3.9×10^{-5} T

9. The wire shown in the figure carries a current of 40A. The magnetic field at O is 0.94 mT. What is the radius (in cm) of arc ?



(1) 1 cm (2) 2 cm
(3) 3 cm (4) 4 cm

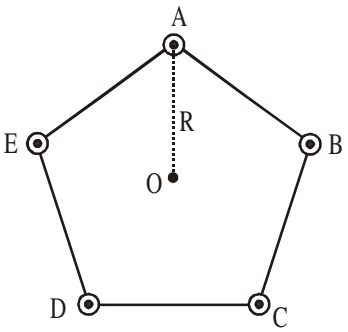
10. In the figure, the magnetic induction at point O is:-



(1) $\frac{\mu_0 I}{4\pi r}$ (2) $\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{2\pi r}$

(3) $\frac{\mu_0 I}{4r} + \frac{\mu_0 I}{4\pi r}$ (4) $\frac{\mu_0 I}{4r} - \frac{\mu_0 I}{4\pi r}$

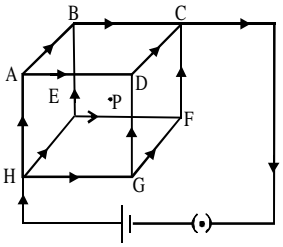
11. Five long wire A,B,C,D and E each carrying current I are arranged to form edges of a pentagonal prism as shown in figure. Each wire carries current out of the plane of paper. The magnetic induction at a point on the axis O is (axis O is at a distance R from each wire) is :-



(1) equal to zero (2) less than zero

(3) more than zero (4) infinite

12. A steady current is set up in a cubic network composed of wires of equal resistance and length d as shown in figure. What is the magnetic field at the centre P due to the cubic network ?



(1) $\frac{\mu_0}{4\pi}\cdot\frac{2I}{d}$ (2) $\frac{\mu_0}{4\pi}\cdot\frac{3I}{\sqrt{2}d}$

(3) Zero (4) $\frac{\mu_0}{4\pi}\cdot\frac{8\pi I}{d}$

13. Biot savart law indicates that the moving electron (velocity v) produces a magnetic field B such that:-

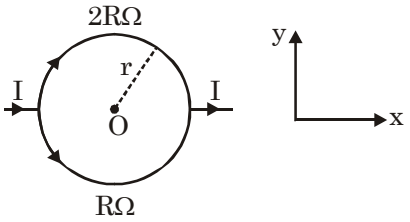
(1) B is perpendicular to v

(2) B is parallel to v

(3) it obeys inverse cube law

(4) it is along the line joining the electron and point of observation.

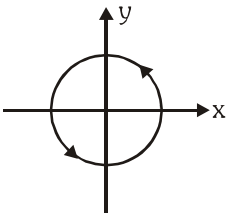
14. Two wires are bent (shown as joint-circle) with radius r (in xy plane). The upper half has resistance of 2R Ω and the lower half of R Ω. A current I is passed into circle as shown. The magnetic field at centre is :



(1) $\frac{\mu_0 I}{r}\left(\hat{k}\right)$ (2) $\frac{\mu_0 I}{2r}\left(\hat{k}\right)$

(3) zero (4) $\frac{\mu_0 I}{12r}\left(\hat{k}\right)$

15. Current i = 2.5 A flows along the circle $x^2 + y^2 = 9\ cm^2$ (here x & y in cm) as shown



Magnetic field at point (0, 0, 4 cm) is

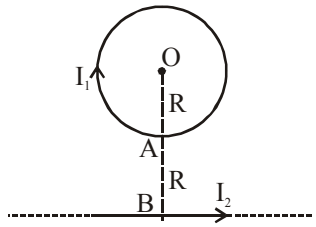
(1) $(36\pi \times 10^{-7} T)\hat{k}$

(2) $(36\pi \times 10^{-7} T)(-\hat{k})$

(3) $\left(\frac{9\pi}{5} \times 10^{-7} T\right)\hat{k}$

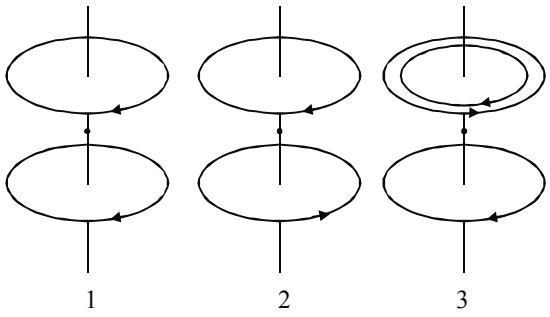
(4) $\left(\frac{9\pi}{5} \times 10^{-7} T\right)(-\hat{k})$

16. In the diagram, I_1, I_2 are the strengths of the currents in the loop and infinite long straight conductor respectively. OA = AB = R. The net magnetic field at the centre O is zero. The ratio of the currents in the loop and the straight conductor is :



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

17. The diagram shows three arrangements of circular loops, centered on vertical axes and carrying identical currents in the directions indicated. Rank the arrangements according to the magnitude of the magnetic field at the midpoints between the loops on the central axes. (from minimum to maximum)



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

18. A current I flows along the length of an infinitely long, straight, solid pipe. The current is uniformly distributed on the cross section. Then incorrect statement –

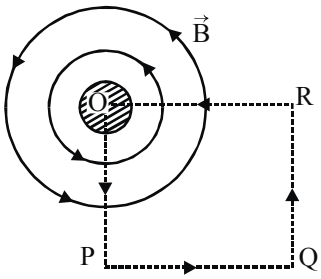
(1) The magnetic field is zero only on the axis of the pipe

(2) The magnetic field is different at different points on the same cross section inside the pipe

(3) The magnetic field is maximum on surface

(4) The magnetic field at all points inside the pipe is the same, but not zero

19. A current carrying thick wire (current = i) perpendicular to the plane of the paper produces a magnetic field, as shown in the figure. A square of side a is drawn with one of its vertices on the centre of the wire. The integral $\int \vec{B}.d\vec{r}$ along $OPQRO$ has the value



(1) $+\mu_0 i$ (2) $\frac{\mu_0 i}{8}$

(3) $\frac{\mu_0 i}{4}$ (4) $\frac{\mu_0 i}{2}$

20. Two identical current carrying co-axial loops, carry Current I in an opposite sense. A simple amperian loop C passes through both of them once. Then which is correct :-

(1) $\oint \vec{B}.\vec{dl} = +\mu_0 I$

(2) $\oint \vec{B}.\vec{dl} = 0$, independent of sense of C

(3) B vanishes every where on C

(4) None of these

21. A toroid of n turns, mean radius R and cross sectional radius 'a' carries current I. It is placed on a horizontal table taken as XY - Plane. Its magnetic moment M :-

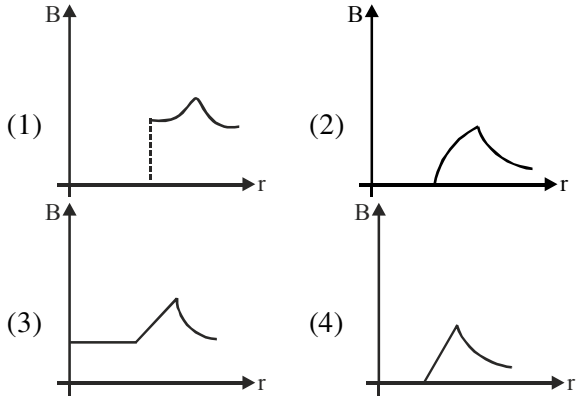
(1) is non-zero and points in the Z-direction by symmetry

(2) Points along the axis of the toroid

(3) is zero otherwise there would a field falling as $\frac{1}{r^3}$ at large distances out side the toroid

(4) is pointing radially outwards

22. A current i is uniformly distributed over the cross section of a long hollow cylindrical wire of inner radius R_1 and outer radius R_2. Magnetic field B varies with distance r from the axis of the cylinder as :-



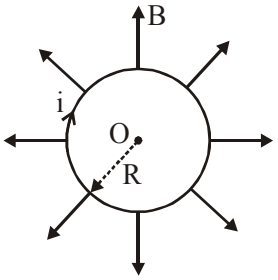
23. If magnetic field in space is $1T\,\hat{i}$, electric field is $10\,N/C\,\hat{i}$, no gravitational field is present and a charged particle is released from rest from origin, it will

(1) not move at all
(2) move in circular path
(3) move in a helical path
(4) move on a straight line

24. An electron is projected with uniform velocity along the axis of a current carrying long solenoid. Which of the following is true?

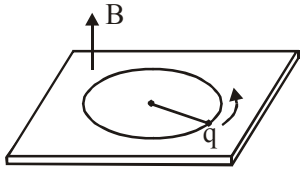
(1) The electron will be accelerated along the axis.
(2) The electron path will be circular about the axis.
(3) The electron will experience a force at 45° to the axis and hence executed a helical path.
(4) The electron will continue to move with uniform velocity along the axis of the solenoid.

25. A current carrying circular loop of radius R placed in radial magnetic field B according to figure, magnetic force on loop is :-



(1) $Bi(2\pi R)$ (2) $Bi(\pi R)$
(3) $Bi(4\pi R)$ (4) zero

26. A charge particle is whirled in a horizontal circle on a frictionless table by attaching it to a string fixed at one point. If a magnetic field is switched on in vertical direction, the tension in string :-



(1) will increase
(2) will decrease
(3) will remaining same
(4) may increase or decrease.

27. A particle of charge +q and mass m at t = 0, enters in a uniform magnetic field $\vec{B} = B_0\hat{k}$, while moving with velocity $\vec{v}=v_0(\hat{i}+\hat{k})$ then:-

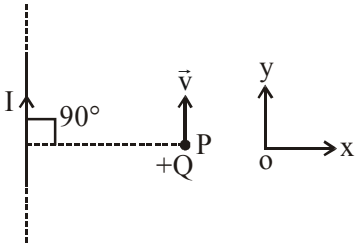
(1) it moves along a circular path of radius $\frac{mv_0}{qB_0}$

(2) it moves along a helical path of pitch $\frac{2\pi m}{qB_0}v_0$

(3) it moves along a helical path of pitch $\frac{2\sqrt{2}\pi m}{qB_0}v_0$

(4) it moves along straight line path along z axis.

28. A long straight wire carries a current I. At the instant, when a charge +Q at point P has velocity v as shown in figure. The direction of magnetic force on charge is :-

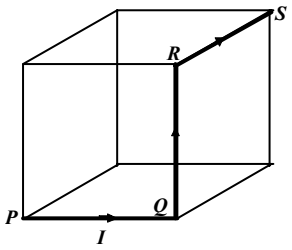


(1) along ox (2) along oy
(3) opposite to ox (4) opposite to oy

29. A magnetic field :-

(1) Always exerts a force on a charged particle
(2) Never exerts a force on a charged particle
(3) Exerts a force, if the charged particle is moving across the magnetic field lines
(4) Exerts a force, if the charged particle is moving along the magnetic field lines

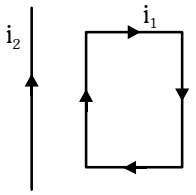
30. A wire *PQRS* carrying a current *I* runs along three edges of a cube of side *l* as shown. There exists a uniform magnetic field of magnitude *B* along one of the sides of the cube. The magnitude of the force acting on the wire is



(1) 0 (2) IlB

(3) $\sqrt{2}\,I\,lB$ (4) $2\,I\,lB$

31. A rectangular loop carrying a current i_1, is situated near a long straight wire carrying a steady current i_2. The wire is parallel to one of the sides of the loop and is in the plane of the loop as shown in the figure. Then the current loop will:–



(1) move away from the wire.

(2) move towards the wire.

(3) remain stationary.

(4) rotate about an axis parallel to the wire.

32. A charged particle moves through a uniform magnetic field in a direction perpendicular to it. Then the

(1) speed of the particle remains unchanged

(2) direction of the particle remains unchanged

(3) acceleration remains unchanged

(4) velocity remains unchanged

33. A charged particle can continue to move with a constant velocity in a region wherein,

(A) $E = 0, B \neq 0$ (B) $E \neq 0, B \neq 0$

(C) $E \neq 0, B = 0$ (D) $E = 0, B = 0$

Select correct alternative :-

(1) Only A, B, D (2) Only A, D

(3) Only A, C, D (4) Only B, D

34. Two long and parallel straight wires A and B carrying currents of 8.0 A and 5.0 A in the same direction are separated by a distance of 4.0 cm. Estimate the force on a 10 cm section of wire A:-

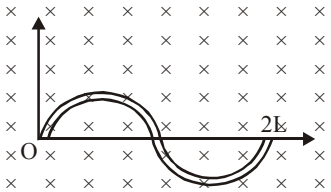
(1) 2×10^{-5} Attractive

(2) 4×10^{-5} Attractive

(3) 2×10^{-5} Repulsive

(4) 4×10^{-5} Repulsive

35. A wire carrying a current *i* is placed in a magnetic field in the form of the curve $y = a \sin\left(\frac{\pi x}{L}\right)$ $0 \le x \le 2L$. Force acting on the wire is :-



(1) $\frac{iBL}{\pi}$ (2) $iBL\pi$

(3) $2iBL$ (4) Zero

36. A charge having q/m equal to 10^8 C/kg and moving with velocity 3×10^5 m/s enters into a uniform magnetic field B = 0.3 tesla at an angle 30^0 with direction of field. Then radius of curvature will be:-

(1) 0.01 cm (2) 0.5 cm

(3) 1 cm (4) 2 cm

37. Two particles x and y having equal charges after being accelerated through the same PD enter a region of uniform magnetic field and describe circular paths of radii R_1 and R_2 respectively. The ratio of the mass of x and y is :-

(1) $(R_1/R_2)^{1/2}$ (2) (R_2/R_1)

(3) $(R_1/R_2)^2$ (4) (R_1/R_2)

38. A wire of mass 100 g, length 1m and current 5A is balanced in mid air by a uniform transverse magnetic field B, then find the value of 'B' :-

(1) 0.2T (2) 0.1 T

(3) 0.5 T (4) 0.6 T

39. A particle of mass m and charge q moving with velocity v enters a region of uniform magnetic field B. Then :-

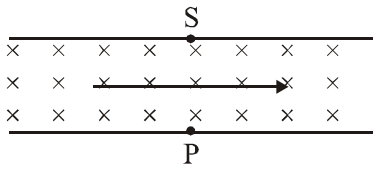
(1) Its path in the region of field is always circular.

(2) Its path in the region of field is circular if $\vec{v}\times\vec{B}=\vec{0}$

(3) Its path in the region is helical if $\vec{v}\times\vec{B}=\vec{0}$

(4) Time period T does not depend on the angle between $\vec{v}$ and $\vec{B}$. (Provided $\theta \neq 0$ & 180^o)

40. The charge carriers are moving from left to right in the magnetic field which is into the page and point S is at higher potential then the charge carrier are:-



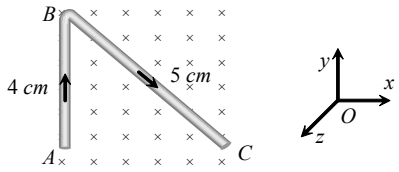
(1) negative

(2) positive

(3) neutral

(4) All of the above

41. A uniform conducting wire ABC has a mass of 10g. A current of 2A flows through it. The wire is kept in a uniform magnetic field B=2T. The acceleration of the wire will be:-



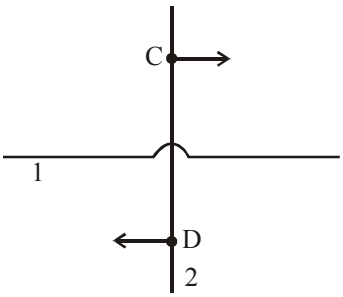
(1) Zero

(2) 12 ms^{-2} along y-axis

(3) $1.2\times10^{-3}\,ms^{-2}$ along y-axis

(4) $0.6\times10^{-3}\,ms^{-2}$ along y-axis

42. Two crossed wires each carrying current I are shown in the figure. The direction of the force exerted on wire 2 by wire 1 at the point C & D are shown by arrow :-



(1) Current in wire 1 flows from left to right and current in wire 2 flows from bottom to top.

(2) Current in wire 1 flows from left to right and current in wire 2 flows from top to bottom

(3) Current in wire 1 flows from right to left & current in wire 2 flows from bottom to top.

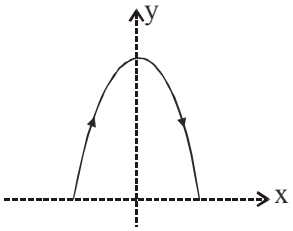
(4) It is impossible to have given force directions at point C & D

43. A 1.5 m diameter cyclotron is used to accelerate protons to an energy of 8 MeV. The required magnetic field strength for this cyclotron is (Given mass of proton = 1.6×10^{-27} kg)

(1) $\frac{2}{15}$T (2) $\frac{4}{15}$T

(3) $\frac{8}{15}$T (4) $\frac{14}{15}$T

44. A wire carrying a current of 4A is bent in the form of a parabola $x^2 + y = 16$ as shown in figure, where x and y are in meter. The wire is placed in a uniform magnetic field $\vec{B}=5\hat{k}$ tesla. The force acting on the wire is



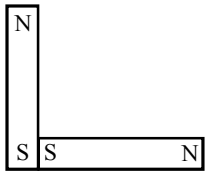
(1) $80\,\hat{j}$ N

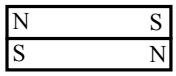
(2) $-\,80\,\hat{j}$ N

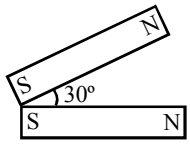
(3) $-160\,\hat{j}$ N

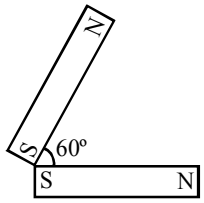
(4) $160\,\hat{j}$ N

45. Following figures show the arrangement of bar magnets in different configurations. Each magnet has magnetic dipole $\vec{M}$. Which configuration has highest net magnetic dipole moment :-

(1) 

(2) 

(3) 

(4) 

46. A solid conducting sphere of radius R is rotating with constant angular velocity ω about its diameter. If charge Q is uniformly distributed on its surface then its magnetic dipole moment is

(1) $\frac{1}{3}QR^2\omega$ (2) $\frac{2}{3}QR^2\omega$

(3) $\frac{1}{5}QR^2\omega$ (4) $\frac{2}{5}QR^2\omega$

47. The length of magnet is 31.4 cm and its pole strength is 0.8 A-m. The magnetic moment, if it is bent in the form of a semicircle is :-

(1) 1.2 (2) 1.6 (3) 0.16 (4) 0.12

48. A circular current loop of magnetic moment M is in an arbitrary orientation in an external magnetic field B. The work done to rotate the loop by 30° about an axis perpendicular to its plane is :-

(1) MB (2) $\sqrt{3}\frac{MB}{2}$

(3) $\frac{MB}{2}$ (4) Zero

49. If a magnet is held vertically on a horizontal paper, the numbers of neutral points which can be obtained on the paper is :-

(1) 1 (2) 2

(3) Zero (4) Infinite

50. The gyro–magnetic ratio of an electron in an H–atom, according to Bohr model is :-

(1) independent of orbit of electron

(2) increases with quantum number n

(3) decreases with quantum number n

(4) None of these

51. To increase the current sensitivity of a moving coil galvanometer, we should :–

(1) decrease number of turns in coil

(2) decrease area of cross section of the coil

(3) increase torsional constant of spiral springs

(4) None of the above

52. The magnetic needle of an oscillation magnetometer, executes 45 oscillations per minute at a place where the dip is 37°. The oscillation frequency at a place where the dip is 60° will be.: (the ratio of the magnetic fields at the two places is 405 : 512).

(1) 35 per minute

(2) 40 per minute

(3) 50 per minute

(4) 55 per minute

53. Force experienced by a particle having charge q and velocity $\vec{v}$ in a magnetic field B is given by $\vec{F} = q(\vec{v} \times \vec{B})$. What is the direction of force acting on electrons (negatively charged particles) falling vertically, at a place where the Earth's magnetic field is horizontal pointing towards North?

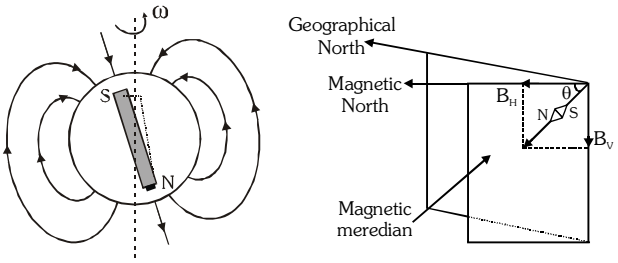
(1) East

(2) West

(3) Vertically up

(4) Vertically down

54. Our earth behaves as it has a powerful magnet within it. The value of magnetic field on the surface of earth is a few tenth of gauss ($1G = 10^{-4}$ T) There are three elements of Earth's magnetism



(i) Angle of declination

(ii) Angle of dip

(iii) Horizontal component of Earth's magnetic field.

In the magnetic meridian of a certain place, the horizontal component of Earth's magnetic field is 0.6 G and the dip angle is 53°. The value of net magnetic field at this place is

(1) 0.8 G (2) 0.6 G (3) 1.0 G (4) 2.0 G

55. A magnetic needle of magnetic moment 6.7×10^{-2} Am^2 and moment of inertia 7.5×10^{-6} kg m^2 is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is :

(1) 6.98 s (2) 8.76 s

(3) 6.65 s (4) 8.89 s

56. A short bar magnet is placed with its north pole pointing north. The neutral point is 10 cm away from the centre of magnet. If B_H = 0.4 G, calcualte the magnetic moment of the magnet

(1) 0.6 A-m^2 (2) 0.4 Am^2

(3) 0.8 A-m^2 (4) None of these

57. A Ship is to reach a place 10° south of west. In which direction should it be steered if the declination at the place is 18° west of north :-

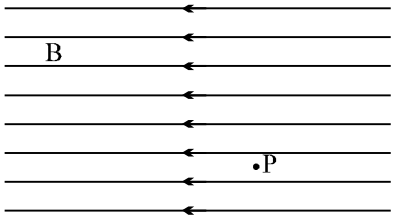
(1) W of magnetic north at 82°

(2) E of magnetic north at 82°

(3) W of magnetic north at 18°

(4) E of magnetic north at 10°

58. Consider the uniform magnetic field shown :



Starting from point P and without leaving the region of magnetic field, is it possible to choose a closed path (that is, a path that returns to P) for which the line integral of the magnetic field is nonzero ?

(1) Yes, but only positive

(2) Yes, but only negative

(3) Yes, both positive and negative

(4) No.

59. Which of the following is universal magnetic property?

(1) Ferromagnetism (2) Diamagnetism

(3) Paramagnetism

(4) Anti-ferromagnetism

60. A ferromagnetic material is placed in an external magnetic field. The magnetic domains

(1) may increase in size

(2) decrease in size

(3) aligns antiparallel to external magnetic field

(4) aligns perpendicular to external magnetic field

61. Susceptibility of a material is 100 then material will be :-

(1) Ferromagnetic (2) Paramagnetic

(3) Diamagnetic (4) All of the above

62. The magnetic materials having negative magnetic susceptibility are :-

(1) Non magnetic (2) Para magnetic

(3) Diamagnetic (4) Ferromagnetic

63. In a permanent magnet at room temperature

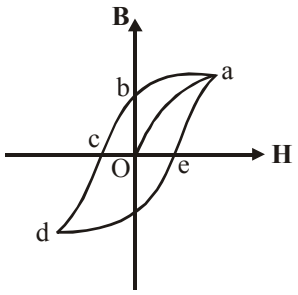
(1) magnetic moment of each molecule is zero.

(2) the individual molecules have non-zero magnetic moment which are all perfectly aligned.

(3) domains are partially aligned.

(4) domains are all perfectly aligned.

64. Figure shows the magnetic hysteresis loop that is the B-H curve for ferromagnetic materials. Mark the **INCORRECT** statement :-



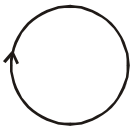
(1) The value of B at H = 0 is called remanence

(2) The value of H at c is called coercivity

(3) A permanent magnet has low remanence and low coercivity

(4) An electromagnet has low remanence and low coercivity

65. A field line is shown in figure. This field can not represent



(a) Magnetostatic field

(b) Electrostatic field

(c) Induced electric field

(d) Gravitational field

(1) (a), (b) (2) (b), (c)

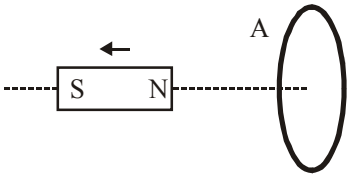
(3) (b), (d) (4) (c), (d)

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	1	1	2	3	1	4	2	3	1	3	1	4	1	4	2	4	3	2
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	3	2	4	4	1	1	2	3	3	3	2	1	1	1	3	2	3	1	4	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	1	3	3	3	1	3	4	1	1	4	2	2	3	3	2	1	4	2	1
Que.	61	62	63	64	65															
Ans.	1	3	3	3	3															

ELECTROMAGNETIC INDUCTION

1. A bar magnet with its north (N) and south (S) poles as shown below is initially moving to the left, along the axis of, and away from a circular conducting loop A current I is induced in the loop, with "a" the acceleration of the magnet due to this current. As seen from the magnet looking in the direction of the loop.



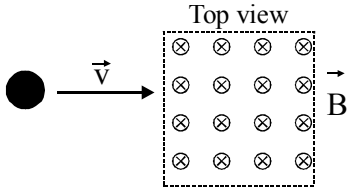
(1) I runs clockwise and "a" points to the left

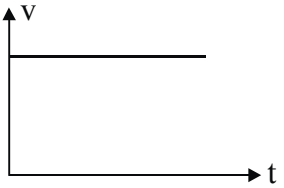
(2) I runs counterclockwise and "a" points to the right

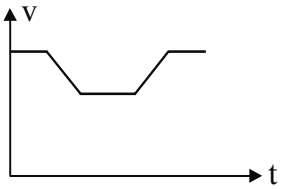
(3) I runs clockwise and "a" points to the right;

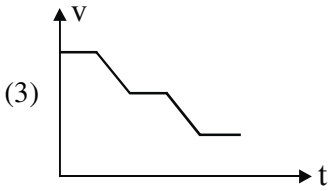
(4) I runs counterclokwise and "a" point to the left

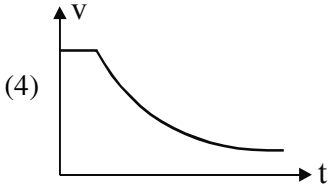
2. A copper disc slides on a horizontal frictionless table. There is a square region of constant uniform magnetic field perpendicular to the table, as shown. Which graph correctly shows the speed 'v' of the penny as a function of time t ?



(1)


(2)


(3)


(4)


3. The magnetic flux through a coil perpendicular to its plane and directed into paper is varying according to the relation $\phi = (5t^2 + 10t + 5)$ miliweber. The emf induced in the loop at t = 5s is:

(1) 0.02 V (2) 0.04 V

(3) 0.06 V (4) 0.08 V

4. A square of side ℓ meters lies in the x-y plane in a region, where the magnetic field is given by $B = \left(a\hat{i} + b\hat{j} + c\hat{k}\right)$T. Where a,b,c are constant.

The magnitude of flux in Wb passing through the square is.

(1) $\ell^2 b$ (2) $\ell^2\sqrt{a^2 + b^2 + c^2}$

(3) $\ell^2 a$ (4) $\ell^2 c$

5. A bar magnet is moved along the axis of copper ring placed far away from the magnet. Looking from the side of the magnet, an anticlockwise current is found to be induced in the ring. Which of the following may be true?

(1) The south pole faces the ring and the magnet moves towards it.

(2) The south pole faces the ring and the magnet moves away from it.

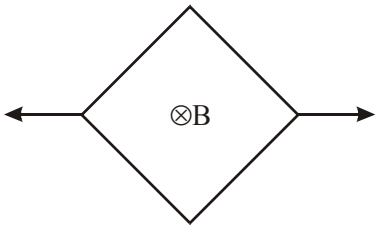
(3) The north pole faces the ring and the magnet moves away from it.

(4) Both (1) & (3)

6. A conducting circular loop is placed in a uniform magnetic field, B = 0.025 T with its direction perpendicular to the plane of loop. The radius of the loop is made to shrink at a constant rate of 1 mm/s. The induced e.m.f. when the radius is 2 cm, is :-

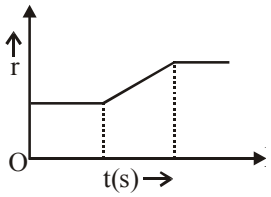
(1) 2 μV (2) 2π μV (3) π μV (4) $\frac{\pi}{2}$ μV

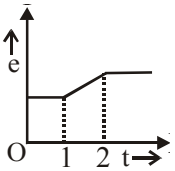
7. A conducting square loop of edge length a and resistance R is in a uniform magnetic field of induction B, perpendicularly. Two opposite corners of the loop are pulled apart as shown in the figure, till it becomes straight. The charge flown through the loop is :

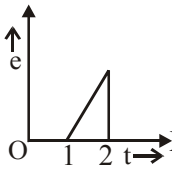


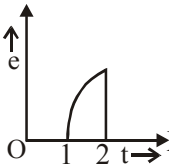
(1) $\frac{Ba^2}{2R}$ (2) $\frac{1}{2}Ba^2R$ (3) $\frac{Ba^2}{R}$ (4) zero

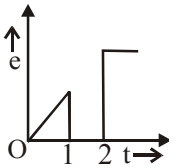
8. A flexible wire bent in the form of a circle is placed in a uniform magnetic field perpendicular to the plane of the coil. The radius of the coil changes as shown in figure. The graph of induced emf in the coil is respresented by :-



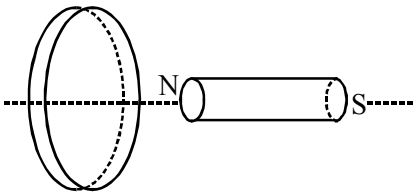
(1)


(2)


(3)


(4)


9. A magnet is placed co-axially with the conducting loop. Mark **INCORRECT** statement :-



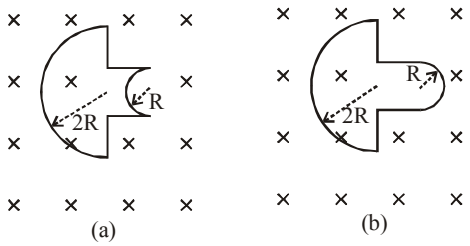
(1) when the magnet is pushed towards right, a clockwise current is observed if observed from magnet side

(2) if the flux passing initially through the loop is ϕ and its resistance is R, the total charge flown after the magnet is thrown to infinity is $\frac{\phi}{R}$

(3) if the loop's resistance is non zero and inductance is assumed to be L, the flux passing through the loop is remain conserved.

(4) if we bring the resistanceless loop from infinity, it must carry a current i = $\frac{\phi}{L}$, where L = inductance of the loop and ϕ = flux passing through the coil by the magnet.

10. A conducting loop with shape (a) is placed in uniform magnetic field B. Its one curved portion is turned so that the shape becomes (b). Find the correct statements(s). Given Ω be the resistance.



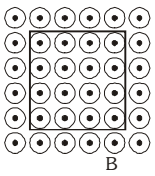
(1) Change in flux is given by $2B\pi R^2$.

(2) Change in flux is given by $\frac{B\pi R^2}{2}$.

(3) Total charge crossing any point of loop is $\frac{B\pi R^2}{2\Omega}$.

(4) Total charge crossing any point of loop is $\frac{B\pi R^2}{\Omega}$.

11. A uniform magnetic field B is directed out of the page. A metallic wire has the shape of a square frame and is placed in the field as shown. While the shape of the wire is steadily transformed into a circle in the same plane, the current in the frame



(1) is directed clockwise

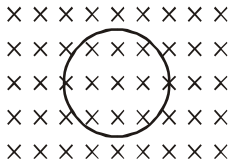
(2) does not appear

(3) is directed counterclockwise

(4) is alternating

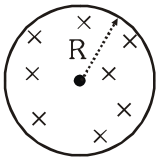
Paragraph for Question 12 and 13

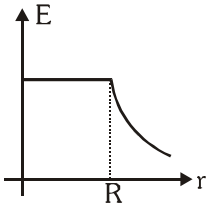
Consider a conducting circular loop placed in a magnetic field as shown in figure. When magnetic field changes with time, magnetic flux also changes and emf $e = -\frac{d\phi}{dt}$ is induced.

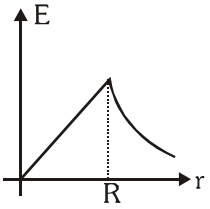


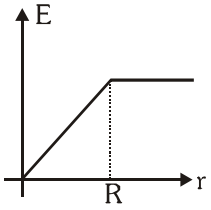
If resistance of loop is R then induced current is $i = \frac{e}{R}$. For current, charges must have non–zero average velocity. Magnetic force cannot make the stationary charges to move. Actually there is an induced electric field in the conductor caused by changing magnetic flux, which makes the charges to move, $\oint \vec{E} \cdot \vec{d\ell} = -\frac{d\phi}{dt}$. This induced electric field is non conservative by nature.

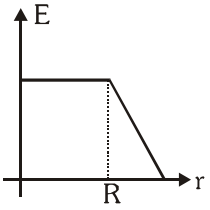
12. A cylindrical space of radius R is filled with a uniform magnetic induction B parallel to the axis of the cylinder. If $\frac{dB}{dt}$ = constant, the graph, showing the variation of induced electric field with distance r from the axis of cylinder, is



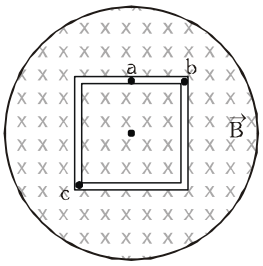
(1) 

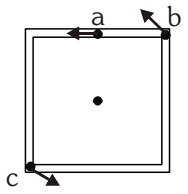
(2) 

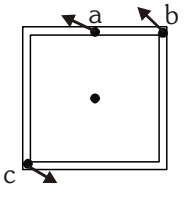
(3) 

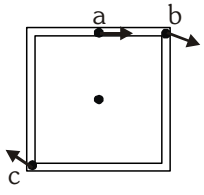
(4) 

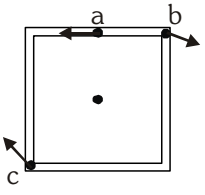
13. A square conducting loop is placed in the time varying magnetic field $\left(\frac{dB}{dt} = +\text{ve constant}\right)$. The centre of square coincides with axis of cylindrical region of magnetic field. The directions of induced electric field at point a, b & c.



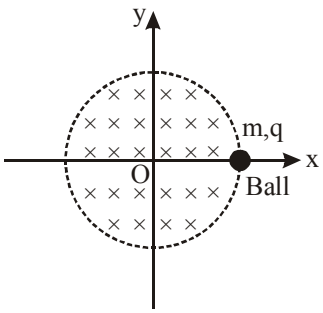
(1) 

(2) 

(3) 

(4) 

14. A small ball having positive charge q and mass m lies on a horizontal smooth surface (take it as xy-plane) at distance b from origin. A magnetic field exists within the region enclosed by the circle $x^2 + y^2 = b^2$ and directed towards negative z-axis as shown. If magnetic field starts increasing with time as $B = B_0(10 + t)$, then :-



(1) The ball will start to move towards +ve x-axis with acceleration $\frac{bqB_0}{2m}$

(2) The ball will start to move towards –ve x-axis with acceleration $\frac{bqB_0}{2m}$

(3) The ball will start to move towards +ve y-axis with acceleration $\frac{bqB_0}{2m}$

(4) The ball will start to move towards –ve y-axis with acceleration $\frac{bqB_0}{2m}$

15. Current in a circuit falls from 5.0 A to 0.0 A in 0.1 s. If an average emf of 200 V induced, give an estimate of the self-inductance of the circuit:-

(1) 2H (2) 4H (3) 6H (4) 8H

16. The self inductance L of a solenoid of length l and area of cross-section A, with a fixed number of turns N, L increases as :-

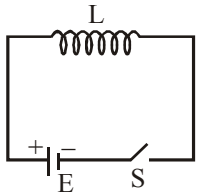
(1) l and A increase

(2) l decreases and A increase

(3) l increases and A decreases

(4) both l and A decrease

17. A coil of self inductance L is connected to a battery of emf E through a switch S as shown in figure. After the switch is closed, charges leave the battery and move through the coil. Find the total work done on the charges if final current is I_0:-



(1) $\frac{1}{4}LI_0^2$ (2) $\frac{1}{2}LI_0^2$

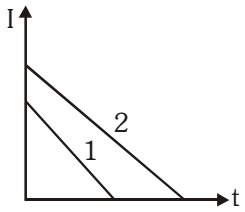
(3) $\frac{3}{4}LI_0^2$ (4) LI_0^2

18. The magnetic energy stored in a solenoid is terms of magnetic field B, area A and length ℓ of the solenoids

(1) $\frac{B^2A\ell}{2\mu_0}$ (2) $\frac{B^2A\ell}{\mu_0}$

(3) $\frac{2B^2A\ell}{\mu_0}$ (4) $\frac{B^2A\ell}{4\mu_0}$

19. Two identical inductance carry currents that vary with time according to linear laws (as shown in figure). In which of two inductances the self induced emf is greater ?



(1) 1

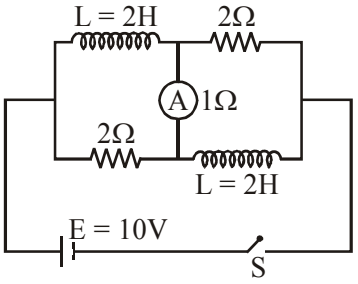
(2) 2

(3) same

(4) data are insufficient to decide

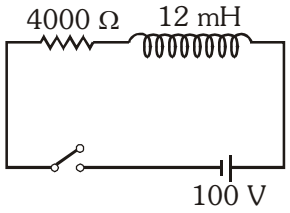
20. Initially all the inductors have zero current. At t = 0 switch S is closed. If at t = 0 current through ammeter is I_1 and after long time current through ammeter is I_2 then find out $\frac{I_2}{I_1}$.

{Neglect mutual inductance between coils. Battery is ideal} :-



(1) 5 (2) 2 (3) 2.5 (4) 10

21. In the inductive circuit given in fig. the current rises after the switch is closed. At instant, when the current is 15 mA. Then potential difference across the inductor is :–



(1) 40 V (2) 80 V (3) 160 V (4) 0

22. The time constant of an inductive coil is 2.0×10^{-3} s. When 90Ω resistance is added in series, the time constant reduces to 0.5×10^{-3} s. The inductance of the coill will be :-

(1) 60 mH

(2) 120 mH

(3) 50 mH

(4) 20 mH

23. A coil of having inductance 2 H and resistance 20 Ω is connected to a battery of emf 4V. When current flowing through the circuit is 0.1 A, the rate of increase of current is :

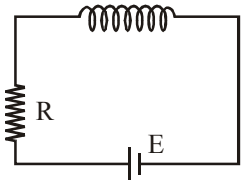
(1) 1 A/s

(2) 2 A/s

(3) 4 A/s

(4) 0.2 A/s

24. The circuit shown in figure is allowed to reach steady state and then a soft iron core is inserted in the coil such that its coefficient of self inductance changes from L to nL. The steady current in the circuit after complete insertion is:

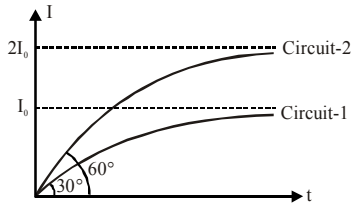


(1) $\frac{E}{R}$ (2) $\frac{nE}{R}$

(3) $\frac{E}{nR}$ (4) Zero

25. Growth of current in two different L-R circuits are depicted by the I-t graphs shown. Angle subtended by the curves with time axis at time t = 0 are also shown in the graph. τ_1 and τ_2 are time constants for the circuits 1 and 2 respectively. Choose the **CORRECT** alternative

(1) $\frac{\tau_1}{\tau_2} = \frac{2}{3}$

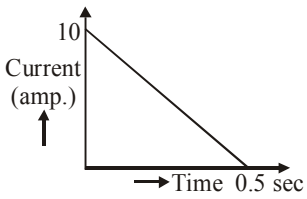


(2) $\frac{\tau_1}{\tau_2} = \frac{3}{2}$

(3) Initial rate of change of current for circuit-2 is 2 times that of circuit-1

(4) Initial rate of change of current for circuit-2 is 6 times that of circuit-1

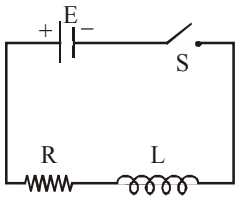
26. In a coil of resistance 100 Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is :

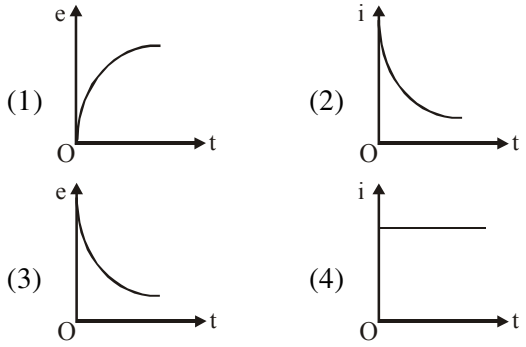


(1) 250 Wb (2) 275 Wb

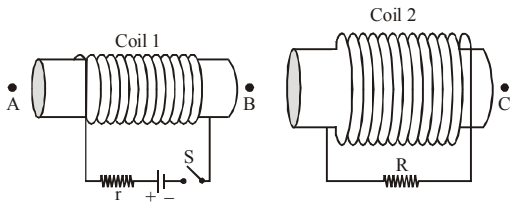
(3) 200 Wb (4) 225 Wb

27. Switch S of the circuit shown in figure is closed at t = 0. If e denotes the induced emf in L and i the current flowing through the circuit at time t, which of the following graphs is correct :-



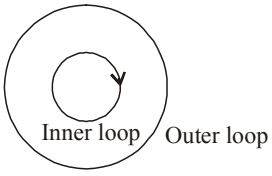


28. Two coils, 1 and 2, with iron cores are positioned as shown in figure. Coil 1 is part of a circuit with a battery and a switch. Assume that S has been closed for a long time. Which one of the following changes will not result in an induced magnetic field in coil 2 that points towards C ?



(1) Immediately after switch S is closed
(2) Coil 2 and its core are moved toward A
(3) Coil 1 and its core are moved toward B
(4) Coil 2 and its core are moved toward C

29. The current in the inner loop is clockwise and increases linearly with time.



The induced current in the outer loop is :-
(1) Constant in the anticlockwise direction
(2) Constant in the clockwise direction
(3) Increases linearly in the anticlockwise direction
(4) Increases linearly in the clockwise direction

30. A coil of 100 turns and 1 cm radius is kept coaxially within a long solenoid of 10 turns per cm and 5 cm radius. The mutual inductance of the system is :
(1) $4\pi^2 \times 10^{-6}$ H (2) $4\pi^2 \times 10^{-5}$ H
(3) $4\pi^2 \times 10^{-4}$ H (4) $4\pi^2 \times 10^{-3}$ H

31. A solenoid of length 50 cm with 20 turns per cm and area of cross-section 40cm^2 completely surrounds another co-axial solenoid of same length, area of cross-section 25 cm^2 with 25 turns per cm.The mutual inductance of the system.
(1) 7.85mH (2) 15.7mH
(3) 3.68 mH (4) 9.62mH

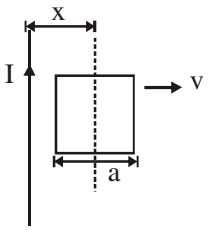
32. A long solenoid with 15 turns per cm has a small loop of area 2.0 cm^2 placed inside the solenoid such that plane of loop makes an angle 60° with axis of solenoid. If the current in solenoid changes from 2.0 A to 4.0 A in 0.1 sec. Find induced emf in the loop.
(1) 3.8 μV (2) 6.5 μV
(3) 65 μV (4) 380 μV

33. Two concentric circular coils, one of small radius r_1 and other of large radius r_2 ($r_2 >> r_1$) are placed co-axially with centeres coinciding. The mutual inductance for the arrangement is:-

(1) $\frac{\mu_0 \pi r_2^2}{2r_1}$ (2) $\frac{\mu_0 \pi r_1^2}{r_2}$

(3) $\frac{\mu_0 \pi r_1^2}{2r_2}$ (4) $\frac{\mu_0 \pi r_2^2}{r_1}$

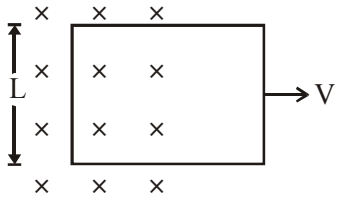
34. A conducting square frame of side *a* and a long straight wire carrying current I are located in the same plane as shown in the figure. The frame moves to the right with a constant velocity v. The emf induced in the frame will be proportional to



(1) $\frac{1}{x^2}$ (2) $\frac{1}{(2x-a)^2}$

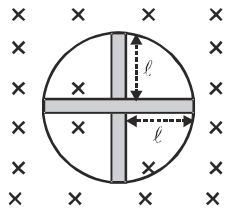
(3) $\frac{1}{(2x+a)^2}$ (4) $\frac{1}{(2x-a)(2x+a)}$

35. A conducting square loop of side L and resistance R moves in its plane with a uniform velocity v perpendicular to one of its sides. A magnetic induction B constant in time and space, pointing perpendicular and into the plane at the loop exists everywhere with half the loop outside the field, as shown in figure. The induced emf is:



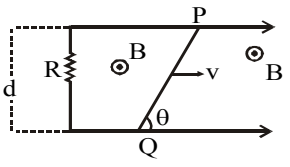
(1) zero (2) RvB (3) $\frac{vBL}{R}$ (4) vBL

36. A conducting wheel in which there are four rods of length 25 cm as shown in figure is rotating with constant angular velocity 20 rad/sec in a uniform magnetic field 8T. The induced potential difference between its centre and rim will be



(1) 4 V (2) 3 V (3) 6 V (4) 5 V

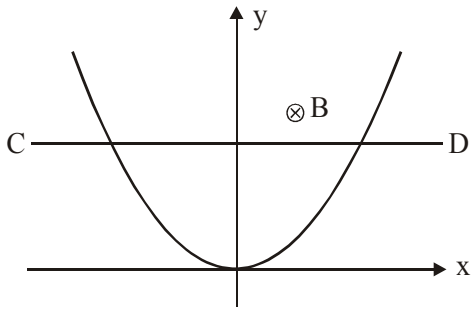
37. In the given configuration, wire PQ has negligible resistance.B is magnetic field coming out of paper θ is a fixed angle of made by PQ travelling smoothly over two conducting is parallel wire separated by d. The current in wire is :-



(1) $\frac{dvB}{R}$ (2) $\frac{dvB}{R\cos\theta}$

(3) $\frac{Bvd\cos\theta}{R}$ (4) $\frac{Bvd\cos^2\theta}{R}$

38. A wire bent as a parabola $y = 4x^2$ is located in a uniform magnetic field of 2T, perpendicular to xy plane. At t = 0, a connecting bar CD starts sliding from origin with constant accelerationof 2 m/s^2 along +ve y-axis. Find the emf (in volts) induced in the loop thus formed at y = 2m.



(1) 8 V (2) 9 V (3) 10 V (4) 11 V

39. The primary and secondary coils of a transformer have 50 and 1500 turns respectively. If the magnetic flux ϕ linked with the primary coil is given by $\phi = \phi_0 + 4t$, where ϕ is in webers, t is time in seconds and ϕ_0 is a constant, the output voltage across the secondary coil is :

(1) 30 volts (2) 90 volts
(3) 120 volts (4) 220 volts

40. For a transformer, the turns ratio is 3 and its efficiency is 0.75. The current flowing in the primary coil is 2A and the voltage applied to it is 100 V. Then the voltage and the current flowing in the secondary coil are respectively

(1) 150 V, 1.5 A (2) 300 V, 0.5 A
(3) 300 V, 1.5 A (4) 150 V, 0.5 A

41. An alternating current of peak value 1 A and of frequency 50 Hz flows through the primary of a transformer. If the mutual inductance between the primary and secondary be 0.5 H, the peak value of voltage induced in the secondary is :

(1) 50 V (2) 100 V
(3) 50 π V (4) 100 π V

42. A 220-volt input is supplied to a Transformer. The output circuit draws a current of 2.0 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is :-

(1) 5.0 ampere (2) 3.6 ampere
(3) 2.8 ampere (4) 2.5 ampere

43. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns, giving the output power at 230 V. If the current in the primary of the transformer is 5A, and its efficiency is 90%, the output current would be:-

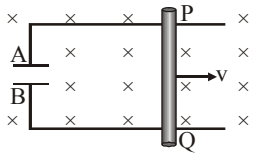
(1) 50 A (2) 45 A (3) 25 A (4) 20 A

44. An air cored solenoid with length 30 cm, area of cross section 25 cm^2 and number of turns 500 carries a current of 2.5 A. The current is suddenly switched off in a brief time of 10^{-3} s. How much is the average back emf induced across the ends of the open switch in the circuit. (ignore the variation in magnetic field near the ends of the solenoid) .

(1) 3.27V (2) 6.54V

(3) 13.08 V (4) 9.53V

45. A conducting rod PQ of length L = 1.0 m is moving with a uniform speed v = 2 m/s in a uniform magnetic field B = 4.0T directed into the paper. A capacitor of capacity C = 10 μF is connected as shown in figure. Then.



(1) $q_A = +\ 80\ \mu C$ and $q_B = -\ 80\ \mu C$

(2) $q_A = -\ 80\ \mu C$ and $q_B = +\ 80\ \mu C$

(3) $q_A = 0 = q_B$

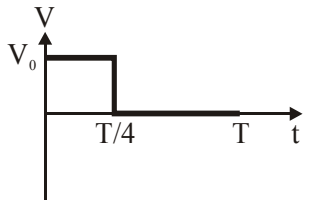
(4) Charage stored in the capacitor increases exponentially with time.

ANSWER KEY

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

ALTERNATING CURRENT

1. A periodic voltage V varies with time t as shown in the figure. T is the time period. The r.m.s. value of the voltage is :-



(1) $\frac{V_0}{8}$ (2) $\frac{V_0}{2}$

(3) V_0 (4) $\frac{V_0}{4}$

2. The voltage of an AC source varies with time according to the relation

$E = 200 \sin(100\pi t) \cos(100\pi t)$

Select correct statement.

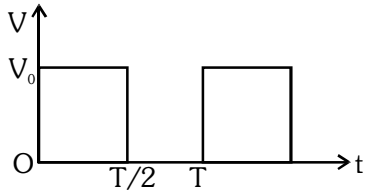
(1) the peak voltage of source is 200 V

(2) the peak voltage of source is 400 V

(3) the frequency of source voltage is 50 Hz

(4) the frequency of source voltage is 100 Hz

3. The r.m.s. value of potential difference V shown in the figure is :-

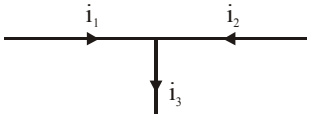


(1) $\frac{V_0}{\sqrt{3}}$ (2) V_0 (3) $\frac{V_0}{\sqrt{2}}$ (4) $\frac{V_0}{2}$

4. A resistor of 500 Ω and an inductor of 0.5 H are in series with an AC voltage source which is given by $V = 100\sqrt{2}$ sin (1000 t). The power factor of the combination is :-

(1) $\frac{1}{\sqrt{2}}$ (2) $\frac{1}{\sqrt{3}}$ (3) 0.5 (4) 0.6

5. In the given figure if $i_1 = 3 \sin \omega t$ and $i_2 = 4 \cos \omega t$, then i_3 is



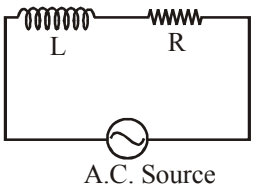
(1) 5 sin (ωt +53°)

(2) 5 sin (ωt + 37°)

(3) 5 sin (ωt + 45°)

(4) 5 cos (ωt + 53°)

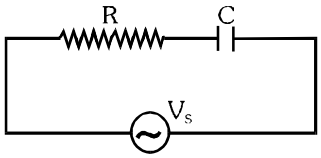
6. In a simple L-R circuit with A.C. source the potential difference at any instant across inductor and resistance are V_L and V_R respectively and A.C. source has potential difference V_{AC} at the same instant. Then :



(1) $V_L^2 + V_R^2 = V_{AC}^2$ (2) $V_L + V_R = V_{AC}$

(3) $V_L^2 - V_R^2 = V_{AC}^2$ (4) $V_L^3 + V_R^3 = V_{AC}^3$

7. A 50 Hz a.c. source of 20 volts is connected across R and C as shown in figure below. The voltage across R is 12 volts. The voltage across C is –



(1) 8 V

(2) 16V

(3) 10 V

(4) not possible to determine unless values of R and C are given

8. The Magnetic energy in an inductor changes from maximum value to minimum value in 5.0 ms, when connected to an AC source. Frequency of the source is :-

(1) 20 Hz (2) 50 Hz (3) 200 Hz (4) 500 Hz

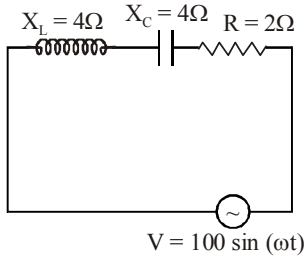
9. A coil of 0.01 H inductance and 1Ω resistance is connected to 200 volt, 50 Hz AC supply. The time lag between maximum alternating voltage and maximum alternating current is

(tan 72° = 3.14) :-

(1) 40 ms (2) 250 ms

(3) 4 ms (4) 2.5 ms

10. Which of the following statement is correct regarding the AC circuit shown in the adjacent figure ?



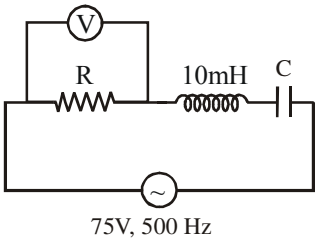
(1) The rms value of current through the circuit is $i_{rms} = 5\sqrt{2}$ A

(2) The phase difference between source emf and current is $\phi = \cos^{-1}\left(\frac{1}{3}\right)$

(3) Average power dissipated in the circuit is 2500W

(4) The rms value of current through the circuit is i_{rms} = 50 A

11. In the circuit of Figure, the volmeter reads 75 V.Value of C is :



(1) 4 μF (2) 2 μF

(3) 6 μF (4) 10μF

12. An LCR series circuit with 100Ω resistance is connected to an ac source of 400 V and angular frequency 300 rad/s. When only the capacitance is removed, the current lags behind the voltage by 60°. When only the inductance is removed, the current leads the voltage by 60°. The current and power dissipated in the LCR circuit is

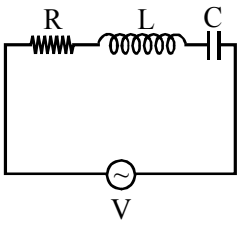
(1) 400 W, 2 A

(2) 800 W, 4 A

(3) 800 W, 2 A

(4) 1600 W, 4 A

13. For the RLC series circuit shown, which of these statements is true :-



(1) The source does no net work : Energy lost in R is compensated by energy stored in C and L

(2) The current through C leads current through L by 90°

(3) The current through C is 180° out of phase with the current through L

(4) All energy is dissipated in R

14. In R-L-C series AC circuit, the potential differences across each element is 20 V. Now the value of the resistance alone is doubled then potential differences, across R, L and C respectively become :-

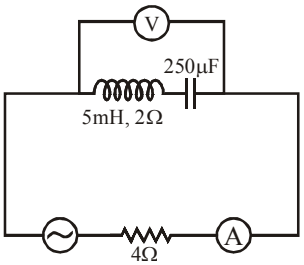
(1) 20 V, 10 V, 10 V

(2) 20 V, 20 V, 20 V

(3) 20 V, 40 V, 40 V

(4) 10 V, 20 V, 20 V

15. In the circuit shown in the figure, the A.C. source gives a voltage V = 10 cos (2000 t) volt. Neglecting source resistance, select correct alternative(s).



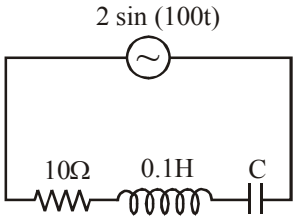
(1) The reading of voltmeter is 0 V
(2) The reading of voltmeter is 6.5 V
(3) The reading of ammeter is 1 A
(4) The reading of ammeter is 0.7 A

16. Consider following in AC circuits and their characteristics :

	List-I	**List-II**
(P)	Purely resistive circuit	(1) Current leads source voltage
(Q)	L-R series circuit	(2) Current lags source voltage
(R)	R-C series circuit	(3) Current may lead or lag voltage
(S)	L-C series circuit	(4) Current & source voltage are in same phase.

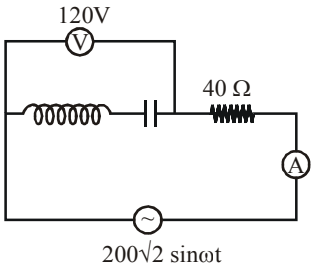
Codes	**P**	**Q**	**R**	**S**
(1)	1	2	3	4
(2)	1	4	2	3
(3)	4	2	1	3
(4)	3	4	2	1

17. The power factor of circuit is $1/\sqrt{2}$. The capacitance of the circuit is equal to :-



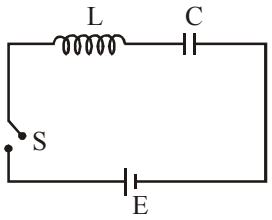
(1) 400 μF (2) 300 μF
(3) 500 μF (4) 200 μF

18. In the given LCR series circuit find the reading of the hot wire ammeter.



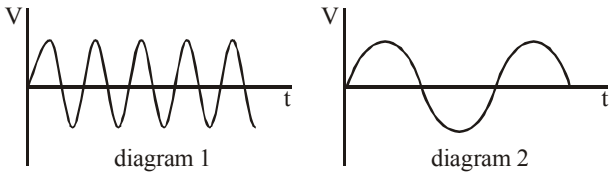
(1) 2 A (2) 4 A (3) 5 A (4) 9 A

19. An ideal DC source of emf E is connected with an uncharged capacitor and inductor. If switch is closed at t = 0, what is the maximum charge on the capacitor in subsequent flow of charge?



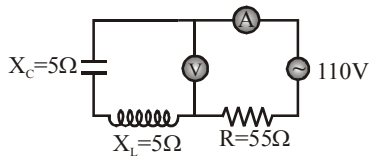
(1) 2CE (2) CE
(3) 1.5 CE (4) 4CE

20. An series LCR circuit is resonating with a source whose emf varies with time as described in diagram-1. If we replace source by another source whose emf varies with time according to diagram-2, then :



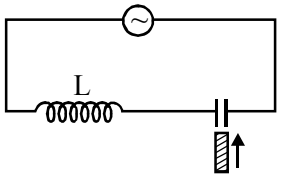
(1) for getting resonance again, decrease R
(2) current will remain in phase with source voltage
(3) for getting resonance again, decrease C
(4) current will lead source voltage after replacing the source

21. The reading of ammeter in the circuit shown will be



(1) 2A (2) 2.4A (3) Zero (4) 1.7A

22. The resonant frequency of the L-C circuit is f_0 before insertion of the dielectric of $\varepsilon_r = 4$. After inserting the dielectric, the resonant frequency will be :-

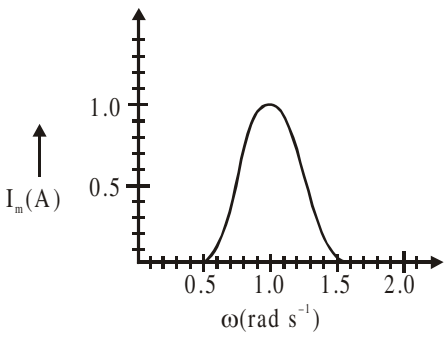


(1) $\frac{f_0}{2}$ (2) $2f_0$ (3) $\frac{f_0}{4}$ (4) 4f

23. An inductor coil, a capacitor and an alternating source of virtual value 36 V are connected in series. When the frequency of the source is varied, a maximum virtual current 4 A is observed. If this iductor coil is connected to a battery of emf 18V and internal resistance 9 Ω, the current in the circuit will be:

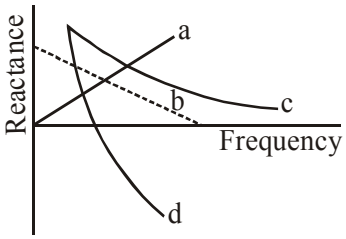
(1) 1 A (2) 2 A
(3) 3 A (4) none of these

24. In a series LCR circuit, the plot of I_m vs ω is shown in the figure. The bandwidth of this plot will be :-



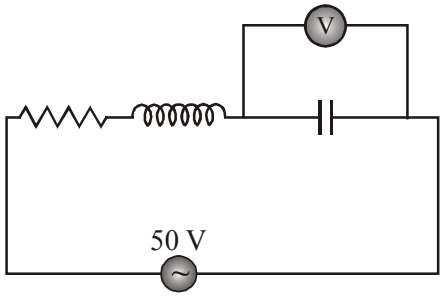
(1) zero (2) 0.1 rad s^{-1}
(3) 0.2 rad s^{-1} (4) 0.4 rad s^{-1}

25. Which of the following plots may represent the reactance of a series LC combination ?



(1) a (2) b (3) c (4) d

26. If reading of voltmeter V shown in the figure at resonance is 200 V, then quality factor of the circuit is :-

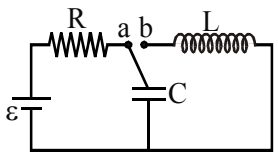


(1) 2 (2) 4 (3) 1 (4) 3

27. An inductance L, a capacitance C and a resistance R may be connected to an AC source of angular frequency ω, in three different combination of RC, RL or RLC in series. Assume that $\omega L = \frac{1}{\omega C}$. The power drawn by the three combinations are P_1, P_2 & P_3 respectively. Then,

(1) $P_1 > P_2 > P_3$ (2) $P_1 = P_2 < P_3$
(3) $P_1 = P_2 > P_3$ (4) $P_1 = P_2 = P_3$

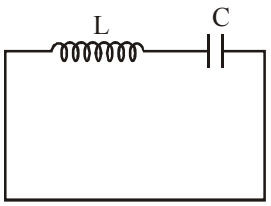
28. The switch in the circuit pictured is in position a for a long time. At t = 0 the switch is moved from a to b. The current through the inductor will reach its first maximum after moving the switch in a time:-



(1) $2\pi\sqrt{LC}$ (2) $\frac{1}{4}\sqrt{LC}$

(3) $\frac{\pi}{2}\sqrt{LC}$ (4) $\pi\sqrt{LC}$

29. In an LC circuit the capacitor has maximum charge q_0. The value of $\left(\frac{dI}{dt}\right)_{max}$ is :-



(1) $\frac{q_0}{LC}$ (2) $\frac{q_0}{\sqrt{LC}}$

(3) $\frac{q_0}{2LC}$ (4) $\frac{2q_0}{LC}$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	3	1	1	2	2	2	3	3	4	4	4	1	4	3	3	2	1	4
Que.	21	22	23	24	25	26	27	28	29											
Ans.	1	1	1	4	4	2	2	3	1											

EM WAVES

1. In an electromagnetic wave,
$E = 1.2 \sin(2 \times 10^6 t - kx)$ N/C.
Find peak value of intensity of magnetic field.
(1) 4×10^{-8}A/m
(2) $\frac{10^{-3}}{\pi}$ A/m
(3) 4×10^{-9} A/m
(4) $\frac{10^{-2}}{\pi}$ A/m

2. Intensity of an unpolarised wave is 53.1 W/m^2. It is passed through polariser. Find magnitude of electric field of the transmitted wave ?
(1) 50 N/C (2) 86 N/C
(3) 100 N/C (4) 121 N/C

3. Electromagnetic wave of intensity 1400 W/m^2 falls normally on metal surface of area 1.5 m^2 and is completely reflected by it. Find out force exerted by beam.
(1) 14×10^{-5} N
(2) 14×10^{-6} N
(3) 7×10^{-5} N
(4) 7×10^{-6} N

4. The relation between electric field E and magnetic field intensity H in an electromagnetic wave is-
(1) $E = \frac{H}{\sqrt{\mu_0 \varepsilon_0}}$
(2) $E = H\sqrt{\mu_0 \varepsilon_0}$
(3) $E = \sqrt{\frac{\mu_0}{\varepsilon_0}}\ H$
(4) $E = \sqrt{\frac{\varepsilon_0}{\mu_0}}\ H$

5. The frequency order for γ-rays(a), X-rays (b) and UV-rays (c) is given as :-
(1) b > a > c (2) a > b > c
(3) c > b > a (4) a > c > b

6. For a plane electromagnetic wave propagating in the +Z direction, which one of the following combination gives the correct possible direction for $\vec{E}$ and $\vec{B}$ field respectively ?
(1) $\left(\hat{i}+2\hat{j}\right)\text{and}\left(2\hat{i}-\hat{j}\right)$
(2) $\left(-2\hat{i}-3\hat{j}\right)\text{and}\left(3\hat{i}-2\hat{j}\right)$
(3) $\left(2\hat{i}+3\hat{j}\right)\text{and}\left(\hat{i}+2\hat{j}\right)$
(4) $\left(3\hat{i}+4\hat{j}\right)\text{and}\left(4\hat{i}-3\hat{j}\right)$

7. A plane wave $\Psi = a \sin(bx + ct)$ is incident on a surface. Equation of the reflected wave is $\Psi' = a'\sin(-bx+ct)$. Select incorrect statement.
(1) Reflecting surface is YZ plane.
(2) The wave is incident normally on the surface.
(3) medium of incident wave is denser than medium of reflecting surface.
(4) a' can be greater than a.

8. What is the phase difference between electric field & magnetic field in an electromagnetic wave -
(1) zero (2) $\frac{\pi}{2}$
(3) π (4) $\frac{\pi}{4}$

9. The amplitude of the electric field in a plane electromagnetic wave in vaccum is 9×10^{-3} V/m. The amplitude of the magnetic field will be :
(1) 3×10^{-11} T
(2) 3×10^{5} T
(3) $\frac{1}{3} \times 10^{-11}$ T
(4) $\frac{1}{2.7} \times 10^{5}$ T

10. The potential difference between the plates of a parallel plate capacitor is changing at the rate of 10^6 V/s. If the capacitance is 2μF, the displacement current in the dielectric of the capacitor will be

(1) 1 A (2) 2 A

(3) 3 A (4) 4 A

11. A point source of e.m. radiation has an average power output of 800 W. The maximum value of electric field at a distance 4.0 m from the source is

(1) 68.20 V/m (2) 54.77 V/m

(3) 50.32 V/m (4) 48.10 V/m

12. Displacement current is same as :

(1) conduction current due to flow of free electron

(2) conduction current due to flow of positive ions

(3) conduction current due to flow of both positive and negative free charge carriers

(4) is not a conduction current but is caused by time varying electric field

ANSWER KEY

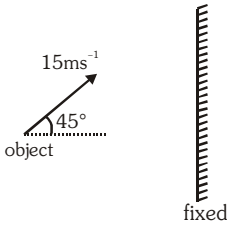
Que.	1	2	3	4	5	6	7	8	9	10	11	12
Ans.	4	3	2	3	2	2	4	1	1	2	2	4

RAY OPTICS AND OPTICAL INSTRUMENTS

1. A ray of light travelling in the direction $\frac{1}{2}\left(\hat{i}+\sqrt{3}\hat{j}\right)$ is incident on a plane mirror. After reflection, it travels along the direction $\frac{1}{2}\left(\hat{i}-\sqrt{3}\hat{j}\right)$. The angle of incidence is :-

(1) 30° (2) 45° (3) 60° (4) 75°

2. An object is approaching a fixed plane mirror with speed 15 ms^{-1} making an angle of 135° with the normal to the mirror. The speed of image w.r.t. mirror is :–



(1) 15 ms^{-1} (2) $\frac{15}{\sqrt{2}}$ ms^{-1}

(3) $15\sqrt{2}$ ms^{-1} (4) 30 ms^{-1}

3. An object is placed at 100 cm from plane mirror. It approaches towards mirror with a velocity 8 cm/s. Calculate magnitude of displacement of image with respect to object in 5 sec :-

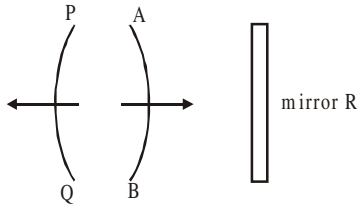
(1) 60 cm (2) 40 cm

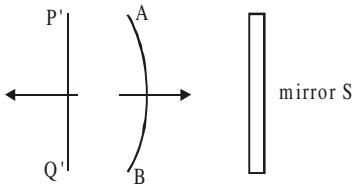
(3) 120 cm (4) 80 cm

4. If two mirrors are kept at 60° to each other, then the number of images formed by them is

(1) 4 (2) 3 (3) 5 (4) 6

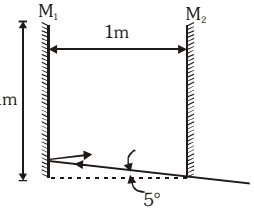
5. AB is incident wavefront on mirror R and mirror S whereas PQ and P'Q' is reflected wavefront from mirror R and mirror S respectively. Choose the **CORRECT** statement





(1) mirror R is concave and mirror S is convex.
(2) mirror R is plane and mirror S is convex.
(3) mirror R is plane and mirror S is concave.
(4) mirror R is convex and mirror S is plane.

6. Refer to the figure. The number of reflections from mirrors M_1 and M_2 are



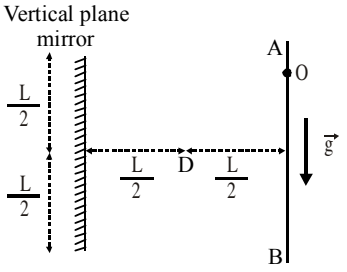
(1) 5 and 5
(2) 6 and 5
(3) 10 and 10
(4) 6 and 6

7. Plane mirror and an object has speeds of 5 ms^{-1} and 10 ms^{-1} respectively. If the motion of mirror and object is along the normal of the mirror then the speed of image may be :–

(1) 0 ms^{-1} (2) 10 ms^{-1}

(3) 20ms^{-1} (4) Both (1) and (3)

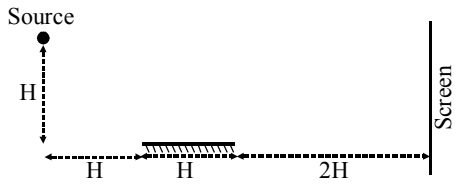
8. A point object O can move along vertical line AB as shown in figure. When image of the object is first visible to D then it is released at t = 0 from rest. The time for which image of object is visible to D is :-



(1) $\sqrt{\frac{6L}{g}}$ (2) $\sqrt{\frac{2L}{g}}$

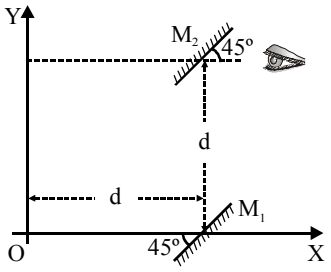
(3) $\sqrt{\frac{3L}{g}}$ (4) $t \to \infty$

9. A point source has been placed as shown in the figure. What is the length on the screen that will receive reflected light from the mirror ?



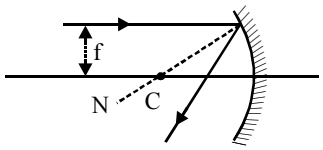
(1) 2 H (2) 3H (3) H (4) None

10. The co-ordinates of the image formed of an object placed at origin, which the eye will observe in mirror M_2 is -



(1) (0, d) (2) (d, – d)
(3) (– d, d) (4) (d, d)

11. A light ray is coming parallel to principal axis, the distance between ray and axis is equal to focal length (as shown). Find the angle of deviation after reflection :-



(1) 60° (2) 90°
(3) 120° (4) $180°-2\tan^{-1}(0.5)$

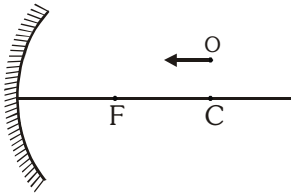
12. The image produced by a concave mirror is one quarter the size of object when the object is 12.5 cm from mirror. If the object is moved 5 cm closer to the mirror, the image will only be half the size of the object. The focal length of mirror is

(1) f = 5.0 cm (2) f = 2.5 cm
(3) f = 7.5 cm (4) f = 10 cm

13. A boy is 1.8m tall and can see his image in a plane mirror fixed on a wall. His eyes are 1.6m from the floor level. The minimum length of the mirror to see his full image is

(1) 0.9 m (2) 0.85 m
(3) 0.8 m
(4) Can't be determined

14. A point object O is going towards concave mirror as shown in the figure. Choose the correct option representing direction of velocity of the image (F is the focus and C is the centre of curvature)



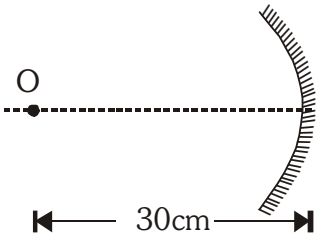
(1) 
(2)
(3)
(4) 

15. A particle approaches from very large distance towards concave mirror along the principal axis. By the time the particle reaches the mirror the distance between the particle and its image

(1) first decreases then increases
(2) first increases then decreases
(3) first increases then decreases and then again increases
(4) first decreases then increases and then again decreases

Paragraph for Question 16to 17

An object is present on the principal axis of a concave mirror at a distance 30 cm from it. Focal length of mirror is 20 cm.



16. Image formed by mirror is

(1) At a distance 60 cm in front of mirror
(2) At a distance 60 cm behind the mirror
(3) At a distance 12 cm in front of mirror
(4) At a distance 12 cm behind the mirror.

17. If object starts moving with 2 cms^{-1} along principal axis towards the mirror then,

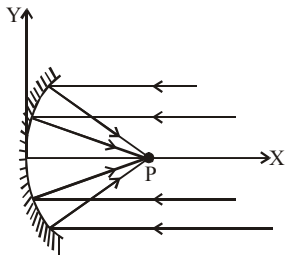
(1) Image starts moving with 8 cms^{-1} away from the mirror

(2) Image starts moving with 8 cms^{-1} towards the mirror

(3) Image starts moving with 4 cms^{-1} towards the mirror

(4) Image starts moving with 4 cms^{-1} away from the mirror

18. A broad beam of light is incident on a reflecting surface. If entire beam focuses at a single point P, then nature of reflecting surface is



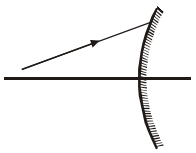
(1) Parabolic

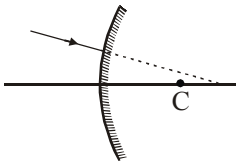
(2) Spherical

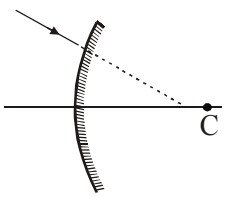
(3) elliptical

(4) hyperbolic

19. In which of the following diagrams the image formed is virtual and inverted and diminished? (Object is on principle Axis)

(1) 

(2) 

(3) 

(4) All of these

20. Assume that you are sitting in a car. You see a person in the rear view mirror of radius of curvature 2m running towards you at t = 0. If person is running with velocity 5m/s, and it is at 9m distance from mirror at this instant. The average velocity of the image of man in first second is :-

(1) 20 cm/s (2) 25 cm/s

(3) 10 cm/s (4) 30 cm/s

21. The image of a real object formed by a concave mirror is twice the size of the object. The focal length of the mirror is 20 cm. The distance of the object from the mirror may be :-

(1) 10 cm (2) 20 cm

(3) 25 cm (4) 15 cm

22. A particle is moving towards a fixed spherical mirror. The image.

(1) must move away from the mirror

(2) must move towards the mirror

(3) may move towards the mirror

(4) will move towards the mirror, only if the mirror is convex

23. A point object on the principal axis at a distance 15 cm in front of a concave mirror of radius of curvature 20 cm has velocity 2 mm/s perpendicular to the principal axis. The velocity of image at that instant will be

(1) 2 mm/s

(2) 4 mm/s

(3) 8 mm/s

(4) 16 mm/s

24. If object starts moving with 2 cms^{-1} perpendicular to principal axis above the principal axis having real image two times magnified then,

(1) Image moves with velocity 4 cms^{-1} below the principal axis

(2) Image moves with velocity 4 cms^{-1} above the principal axis

(3) Image moves with velocity 8 cms^{-1} below the principal axis

(4) Image moves with velocity 8 cms^{-1} above the principal axis

25. Find the incorrect statement for a concave mirror producing a virtual image of the object.

(1) The linear magnification is always greater than one, except at the pole

(2) The linear magnification is always less than one.

(3) The magnification tends to one as the object moves nearer to the pole of the mirror.

(4) The distance of the object from the pole of the mirror is less than the focal length of mirror.

26. A concave mirror of focal length f is separated by a plane mirror facing the former by a distance of 3.6f. Find where should a point source be kept on their common axis, so that the real image after two reflections (first from spherical mirror and then plane mirror) coincides with the object.

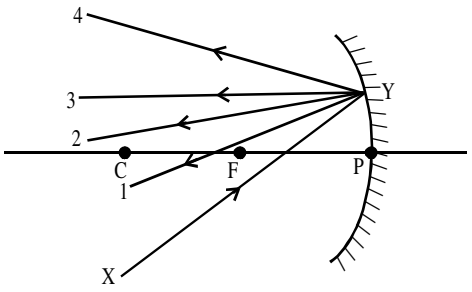
(1) 1.2 f from plane mirror

(2) 2.4 f from plane mirror

(3) 1.8 f from plane mirror

(4) none of these

27. Figure shows a small concave mirror with CP as its principal axis. A ray XY is incident on the mirror. Which of the four rays can be the reflected ray :-



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

28. A convex mirror gives an image three times as large as the object placed at a distance of 20 cm from it. For the image to be real, the focal length should be :-

(1) 15 cm (2) 10 cm

(3) 30 cm (4) 20 cm

29. Paraxial ray is that incident ray which is :-

(1) Any ray parallel to principle axis

(2) Any ray making small angle with principle axis

(3) Ray incident close to pole and making small angle with principle axis

(4) Ray incident at pole at any angle

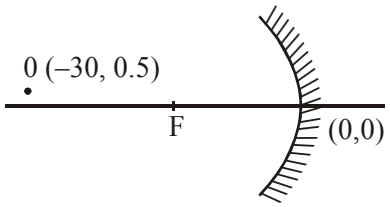
30. A mirror of radius of curvature 30 cm, forms image of size three times that of object. The position(s) of the object may be at a distance from mirror equal to :-

(i) 10 cm (ii) 20 cm (iii) 40 cm

(1) only (ii) (2) only (i)

(3) (i), (iii) (4) (i), (ii)

31. An object is placed in front of concave mirror of focal length 10 cm.



As shown in figure as if pole of mirror is at (0,0) and principle axis is along x-axis. If coordinates of object are (–30 cm, 0.5 cm) find coordinates of image in cm :-

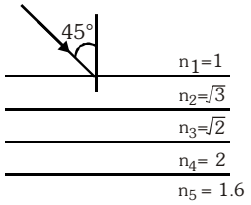
(1) (–15, –0.25)

(2) (–7.5, –0.125)

(3) (–60, –1)

(4) (30, – 0.5)

32. In the figure shown the angle made by the light ray with the normal in the medium of refractive index $\sqrt{2}$ is:

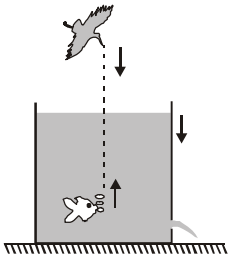


(1) 30° (2) 60°

(3) 90° (4) None of these

33. A bird in air is diving vertically over a tank with speed 5 cm/s, base of tank is silvered. A fish in the tank is rising upward along the same line with speed 2 cm/s. Water level is falling at rate of 2 cm/s. Find the speed of birds image formed in mirror as obserbed by fish.

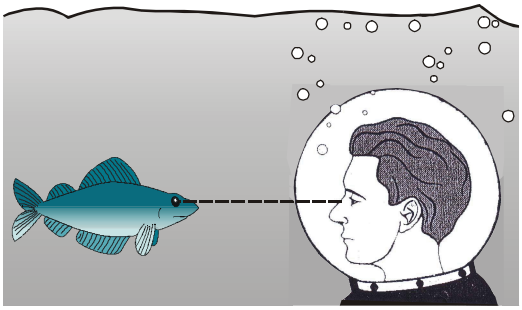
$[\mu_{water} = 4/3]$



(1) 4 cm/s (2) 5 cm/s

(3) 2 cm/s (4) 8 cm/s

34. A diver in a glass bubble helmet looks at a fish as shown. Where is the image of the fish relative to its true location ?



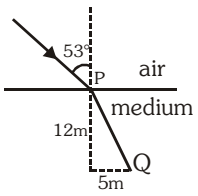
(1) Closer to the diver

(2) Farther from the diver

(3) The real distance from the diver

(4) The answer depends on the location of the fish

35. A light ray passes from air into another medium at point P. How long does it take the light ray to travel from P to Q :-



(1) 9×10^{-10} s (2) 9×10^{-7} s

(3) 9×10^{-8} s (4) 9×10^{-6}s

36. A bird in air looks at a fish directly below it inside in a transparent liquid in a tank. If the distance of the fish as estimated by the bird is h_1 and that of the bird as estimated by the fish is h_2, then the refractive index of liquid is :-

(1) $\frac{h_2}{h_1}$

(2) $\frac{h_1}{h_2}$

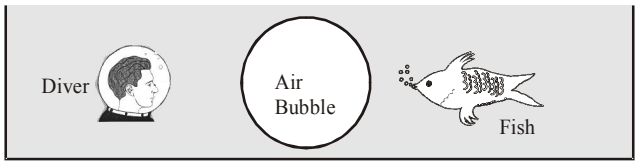
(3) $\frac{h_1 + h_2}{h_1 - h_2}$

(4) $\frac{h_1 - h_2}{h_1 + h_2}$

37. A vessel is quarter filled with a liquid of refractive index μ. The remaining part of the vessel is filled with an immiscible liquid of refractive index 1.5 μ. The apparent depth of the vessel is 50% of the actual depth. The value of μ is

(1) 1 (2) $\frac{3}{2}$ (3) $\frac{2}{3}$ (4) $\frac{4}{3}$

38. A fish sees the smiling face of a scuba diver through a bubble of air between them, as shown. Compared to the face of the diver, the image seen by the fish will be



(1) smaller and erect

(2) smaller and inverted

(3) larger and erect

(4) larger and inverted

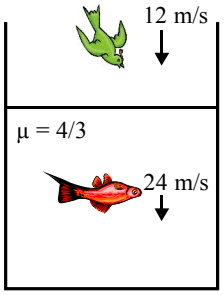
39. Deviation for a ray at the interface of two media from denser (1) to rarer (2) with angle of incidence 30° is 15°. What maximum deviation a ray of same wavelength can undergo at the interface of two media when entering from medium (2)

(1) 90° (2) 45° (3) 0° (4) 60°

40. A cylindrical bucket of depth 60 cm is partially filled with a liquid of refractive index 1.5 and with oil (on top of liquid) of refractive index 2. It appears that the volume of air, volume of liquid and volume of oil are equal, to an observer who views from top of the bucket. The apparent depth of the bucket as seen by the observer is given as α cm. Then $\left(\frac{\alpha}{5}\right)$ is :

(1) 1 (2) 8 (3) 4 (4) 10

41. A fish and a bird are moving as shown in figure. Find the velocity of bird as observed by fish.

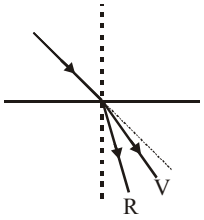


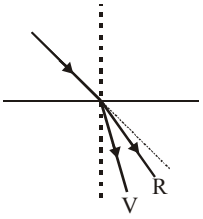
(1) 8 m/s upwards
(2) 8 m/s downwards
(3) 9 m/s upwards
(4) 9 m/s downwards

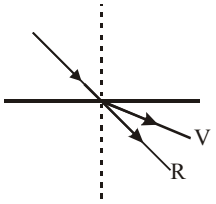
42. A person spear-fishing from a boat sees a stationary fish a few meters away in a direction about 30º below the horizontal. The index of refraction of the water is 1.34. Assume the dense spear does not change direction when it enters the water. To spear the fish, the person should :-

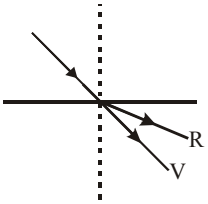
(1) aim above where he sees the fish
(2) aim precisely at the fish; or
(3) aim below the fish
(4) Can't be determined

43. A ray of light is going from air to water. Which of the following figure shows dispersion of light?

(1) 

(2) 

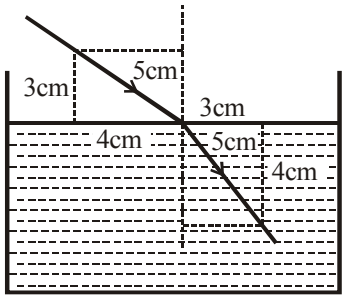
(3) 

(4) 

44. If f_1 and f_2 represent the first and second focal lengths of a single refracting surface, separating μ_1 & μ_2 then (assuming cartesian sign convention)-

(1) $\mu_2 f_2 + \mu_1 f_1 = 0$ (2) $\mu_1 f_2 + \mu_2 f_1 = 0$
(3) $\mu_1 f_1 - \mu_2 f_2 = 0$ (4) $\mu_2 f_1 - \mu_1 f_2 = 0$

45. In shown figure, a ray of light enters a liquid and is bent towards the normal. The speed of light in the liquid is :-



(1) 3×10^8 m/s (2) 2.75×10^8 m/s
(3) 2.50×10^8 m/s (4) 2.25×10^8 m/s

46. A light ray incident on interface of two media, a to b. If angle of incidence in a is $\theta_a = 45°$ & angle of refraction in medium b is $\theta_b = 60°$. If velocity of light in medium b is $\frac{c}{3}$ then find velocity of light in medium a :-

(1) $c\sqrt{\frac{2}{3}}$ (2) $\frac{c\sqrt{2}}{3}$

(3) $\frac{c}{\sqrt{3}}$ (4) $\frac{c}{3}\sqrt{\frac{2}{3}}$

47. An object is just below a combination of two slabs, one is of refractive index 1.5 & thickenss 30cm, other is of refractive index 1.2 and thickness 24cm. Find apparent depth of the object from upper surface of combination :-

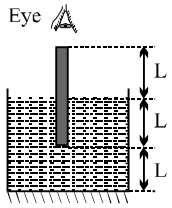
(1) 54 cm (2) 40 cm
(3) 73.8 cm (4) 14 cm

48. If thickness of a slab is $5\sqrt{3}$ cm and refractive index $\sqrt{3}$. If light incident on it at angle of incidence 60° then find lateral shift between direction of incident ray and emergent ray produced by it :-

(1) $\frac{5\sqrt{3}}{2}$cm (2) $\frac{5}{2}$cm

(3) $\frac{5}{\sqrt{3}}$cm (4) 5cm

49. What is the length of the image of the rod in mirror, according to the observer in air? (The refractive index of liquid is μ.)



(1) μL+ L (2) L+L/μ

(3) L + L (4) mL+L/μ

50. A light ray is incident at an angle 30^0 on a transparent surface separating two media. If the angle of refraction is 60^0 then critical angle is

(1) $\sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

(2) $\sin^{-1}\left(\sqrt{3}\right)$

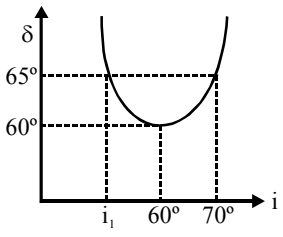
(3) $\sin^{-1}\left(\frac{2}{3}\right)$

(4) 45^0

51. A ray of light is incident normally on one of the faces of a prism of apex angle 30° and refractive index √2. The angle of deviation of the ray is :

(1) 0° (2) 12.5° (3) 15° (4) 22.5°

52. The angle of deviation (δ) vs angle of incidence is plotted for a prism.Pick up the correct statements



(1) The angle of prism is 60°

(2) The refractive index of the prism is n = √3

(3) For deviation to be 65° the angle of incidence i_1 = 55°

(4) All the above

53. The ratio of angle of minimum deviation produced by a thin prism $\left(\mu = \frac{3}{2}\right)$ in air to that in liquid of refractive index $\frac{9}{7}$ is :

(1) $\frac{1}{3}$ (2) 3

(3) $\frac{1}{4}$ (4) 4

54. If refractive index of material except vacuum for different color will be different and variation is given as $\frac{d\mu}{d\lambda} = a\lambda$ (where λ is wavelength and a is a positive constant) and wavelength increases as we go along

$V \to I \to B \to G \to Y \to O \to R$

Choose the incorrect alternative.

(1) deviation will be maximum for red through any prism

(2) white light going from air to matter will disperse in different colours

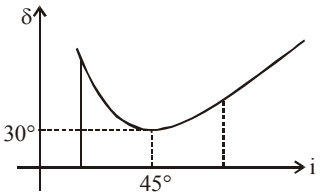
(3) white light going from air to matter then red will be closest to normal in refracted light

(4) Only two options are correct

55. Light travelling in air falls at an incidence angle of 2° on one refracting surface of a prism of refractive index 1.5 and angle of prism 4º. The medium on the other side is water (n = 4/3). The deviation produced by the prism in degree is :

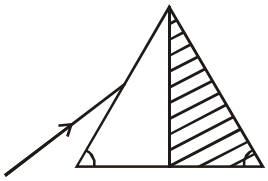
(1) 2 (2) 2.5 (3) 1 (4) 2.3

56. Variation of angle of deviation δ versus angle of incidence for a prism is given the figure. The value of refractive index of prism :-



(1) $\sqrt{3}$ (2) $\sqrt{2}$ (3) $\sqrt{\frac{3}{2}}$ (4) $\frac{2}{\sqrt{3}}$

57. A light ray is incident upon a isosceles prism in minimum deviation position and suffers a deviation of 34°. If the shaded half of the prism is knocked off, the ray will :-



(1) suffer a deviation of 34°
(2) suffer a deviation of 68°
(3) suffer a deviation of 17°
(4) not come out of the prism.

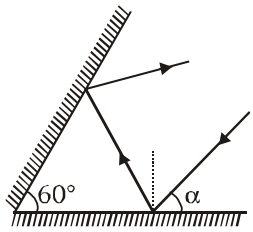
58. A light ray, incident at an angle of incidence of 60° on prism with prism angle 30°, is deviated by 30°. The refractive index of the prism is

(1) $\sqrt{3}$ (2) $\frac{2}{\sqrt{3}}$ (3) $\frac{2\sqrt{3}}{5}$ (4) $\sqrt{2}$

59. A light ray incident normally on one face of an equilateral prism and emerges out grazingly at the other face. The refractive index of the prism is

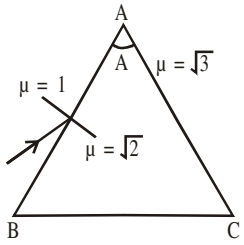
(1) $\sqrt{3}$ (2) $\frac{2}{\sqrt{3}}$ (3) $\frac{2\sqrt{3}}{5}$ (4) $\sqrt{2}$

60. What is the value of α for which there are maximum 2 reflections only



(1) 35° (2) 45°
(3) 55° (4) 65°

61. What will be the angle of prism A so that any ray incident on surface AB will not emerge out from AC ?



(1) 30º (2) 45º
(3) 60º (4) None of these

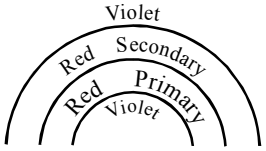
62. A given ray of light suffers minimum deviation in an equilateral prism P. If refractive index increases slightly then the ray will suffer
(1) greater deviation
(2) no deviation
(3) same deviation as before
(4) Lesser deviation

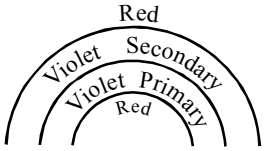
63. A prism of cross section ABC & refractive index $\sqrt{\frac{3}{2}}$ and angle ∠CAB = 8° is given. A ray of light incident on surface AB at angle of incidence 60°. The angle of emergence will be:-

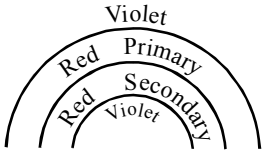
(1) $\sin^{-1}\sqrt{\frac{27}{50}}$ (2) $\sin^{-1}\left(\sqrt{\frac{9}{10}}\right)$

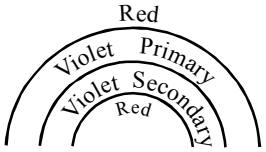
(3) $\sin^{-1}\left(\sqrt{\frac{3}{2}}\right)$ (4) $\sin^{-1}\left(\sqrt{\frac{24}{25}}\right)$

64. In a rainbow, we see two rainbows; primary and secondary. Which of the following figures approximately represent the order of colors in rainbows?

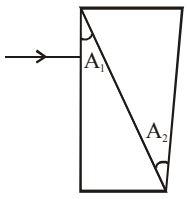
(1) 

(2) 

(3) 

(4) 

65. An achromatic combination is made by combining 2 thin prisms as shown. If $\omega_1 > \omega_2$, then :-



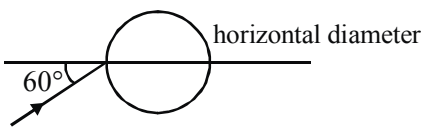
(1) Net deviation would be clockwise

(2) Net deviation would be anticlockwise

(3) Net deviation would be zero.

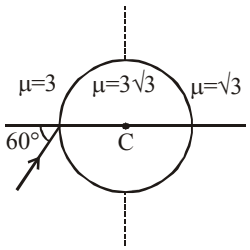
(4) Cannot be predicted on basis of given information.

66. A ray of light falls on a transparent sphere kept in air as shown in figure. If the final ray emerges from the sphere parallel to the horizontal diameter, then the refractive index of the sphere is



(1) $\sqrt{2}$ (2) $\sqrt{3}$ (3) $\frac{3}{\sqrt{2}}$ (4) 2

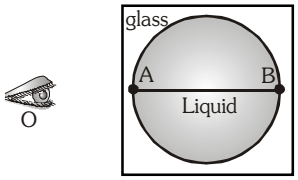
67. Left half of a glass sphere is surrounded with a medium having refractive index 3 and the right half is surrounded with medium having refractive index $\sqrt{3}$ as shown. A ray is incident at an angle of 60° as shown. Find the total deviation as the ray comes out the sphere?



(1) 60° CW (2) 60° ACW

(3) 120° CW (4) 120° ACW

68. The observer 'O' sees the distance AB as infinitely large. If refractive index of liquid is μ_1 and that of glass is μ_2, then $\frac{\mu_1}{\mu_2}$ is :



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

69. A parallel beam of light travelling in water (refractive index = 4/3) is refracted by a spherical air bubble of radius 2cm situated in water. Assuming the light rays to be paraxial, the position of the image due to refraction at the first surface is -

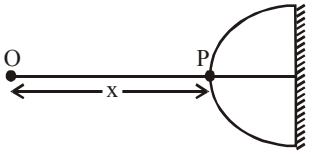
(1) 6 cm from the first surface

(2) 12 cm from the first surface

(3) 3 cm from the first surface

(4) 10 cm from the first surface

70. A hemispherical surface of radius R and refractive index μ = 1.5 is polished as shown. At what distance x from point P. A point object O be placed so that its image coincides with the object itself?



(1) R (2) 1.5 R

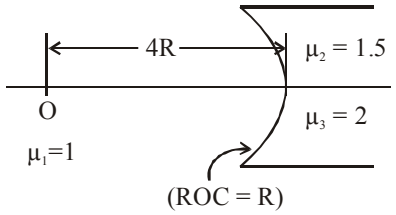
(3) 2 R (4) 3 R

71. Light from a point source in air falls on a spherical glass surface (R.I. of glass = 1.5 and r radius of curvature = 20 cm) The centre of curvature of spherical surface is in air. The distance of light source from the glass surface is 80 cm. At what position the image is formed from glass surface:-

(1) 40 cm (2) –40 cm

(3) 120 cm (4) –120 cm

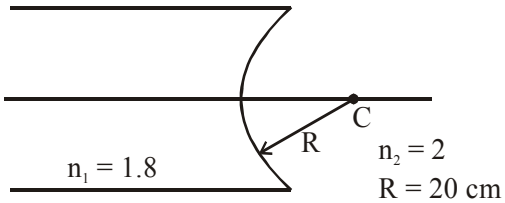
72.



As shown in diagram an object is placecd in medium of refractive index $\mu_1 = 1$ at a distance 4R from spherical surface. On other side of spherical surface there are two medium of refractive index $\mu_2 = 1.5$ & $\mu_3 = 2.0$. Two images are formed find separation between them :-

(1) 0.4 R (2) R (3) 2R (4) None

73.



Find power of the spherical surface if light source is in rarer medium :-

(1) +1D (2) –2D (3) +0.5D (4) +2D

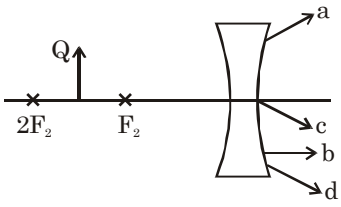
74. A converging beam of rays is incident on a diverging lens. Having passed through the lens the rays intersect at a point 10 cm from the lens. If the lens is removed, the point where the rays meet will move 20/3 cm closer to the mounting that holds. Find the focal length of the lens without sign.

(1) 10 cm (2) 20 cm (3) 5 cm (4) 6 cm

75. A plano convex lens behave as a concave mirror of focal length 30 cm when its plane surface is silvered and as a concave mirror of focal length 10 cm when its curved surface is silvered. The radius of curvature of curved surface is :-

(1) 40 cm (2) 30 cm (3) 50 cm (4) 60 cm

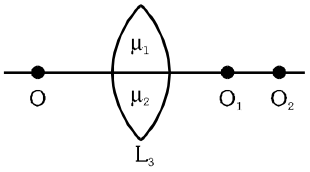
76. A diverging lens and an object are positioned as shown in figure at left. Which of the rays a, b, c and d could emanate from point Q at the top of the object ?



(1) a, b and c (2) a and c

(3) a and b (4) all

77. Consider three converging lenses L_1, L_2 and L_3 having identical geometrical construction. The indices of refraction of L_1 and L_2 are μ_1 and μ_2 respectively. The upper half of the lens L_3 has a refractive index μ_1 and the lower half has μ_2 (Fig.). A point object O forms image at O_1 by the lens L_1 and at O_2 by the lens L_2 placed in same position. If L_3 is placed at the same place,



(1) there will be an image at O_1

(2) there will be an image at O_2

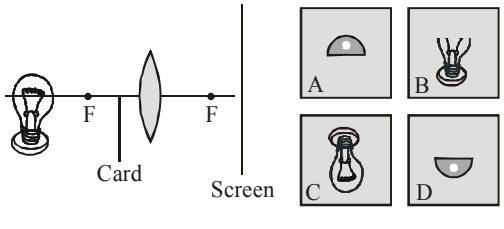
(3) the only image will form somewhere between O_1 and O_2

(4) both (1) and (2)

78. By placing a convex lens of focal length equal to 15.0 cm between an object and a screen separated by a distance of 75.0 cm, the sizes of the images obtained are 6.0 cm and 2/3 cm. The size of the object must be :-

(1) 2.0 cm (2) 4.0 cm (3) 3.0 cm (4) 1.5 cm

79. An opaque card is held over the lower half of a converging lens as shown in figure (a). Which picture in figure (b) best shows the image that appears on the screen ?



(a) (b)

(1) A (2) B (3) C (4) D

80. Optical axis of a thin equiconvex lens is the x-axis. The co-ordinate of a point object and its image are (–20 cm, 1 cm) and (40 cm, – 4 cm) respectively

(A) The lens is located at x = 12 cm

(B) The lens is located at x = – 8 cm

(C) The focal length of the lens is 9.6 cm

(D) The focal length of the lens is 12 cm

Select Correct Options

(1) A & D (2) A & C

(3) B & D (4) B & C

81. A converging lens forms sharp image of an object on a screen. The image is real and has twice the size of the object. If the positions of the screen and the object are interchanged, leaving the lens in its original position, what is the new image size on the screen ?

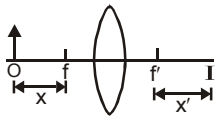
(1) Twice the object size

(2) Same as the object size

(3) Half the object size

(4) Can't say as it depends on the focal length of the lens

82. An object is placed at a point distance x from the focus of a convex lens and its image is formed at I as shown in the figure. The distance x, x' satisfy the relation



(A) $x + x' \le 2f$ (B) $f = \sqrt{xx'}$

(C) $2f \le x + x'$

Select correct alternative(s)

(1) Only B (2) Only A & B

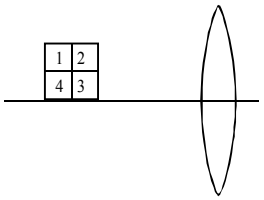
(3) Only B & C (4) Only C

83. If f_1 and f_2 represent the first and second focal lengths of a single refracting surface, then (assuming cartesian sign convention)-

(1) $f_2 + f_1 = 0$ (2) $f_2 + \mu f_1 = 0$

(3) $f_1 + \mu f_2 = 0$ (4) $f_1 f_2 = 1$

84. A convex lens is used to form a real image of the object as shown in the figure. Then the real inverted image is as shown in the following figure:–



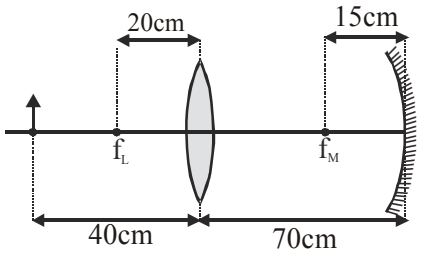
(1) 

(2) 

(3) 

(4) 

85. An upright object is placed at a distance in front of a converging lens equal to twice the focal length 20 cm of the lens. On the other side there is a concave mirror of focal length 15 cm separated from the lens by a distance of 70 cm. Then select the correct statement from the following



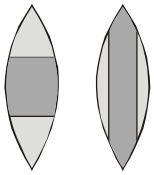
(1) Magnification for the system is $-\frac{1}{2}$

(2) Magnification for the system is –1

(3) Final image by the system will real and at distance of 60 cm from centre of curvature of spherical mirror

(4) Magnification for the system is $+\frac{1}{2}$

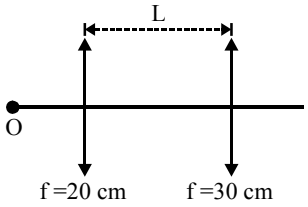
86. Figure shows two convex lenses A and B, each made up of three different transparent materials. The number of images formed, of an object kept on the principal axis of each lens will be



(1) 3 and 3 (2) 3 and 1

(3) 1 and 1 (4) 3 and 2

87. Two converging lens have focal length 20 cm & 30 cm. Optical axis of both lens coincide. This lens system is used to form an image of an object. It turn out that size of the image does not depend on the distance between the lens system & the object. If L is distance between lens & M is magnification after all possible refraction-



(1) L = 10 cm (2) L = 50 cm

(3) $|M| = \frac{2}{3}$ (4) $|M| = \frac{1}{3}$

88. In displacement method, the distance between object and the screen is 96 cm. The ratio of length of two images formed by a converging lens placed between them is 4. Then

(1) Distance between the two positions of the lens is 48 cm

(2) distance between the two positions of the lens is 32 cm.

(3) focal length of the lens is 64/3 cm.

(4) Both (2) and (3) are correct

89. In displacement method, the distance between object and the screen is 96 cm. The ratio of length of two images formed by a converging lens placed between them is 4. Then select wrong option :-

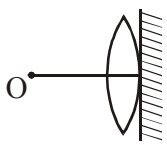
(1) ratio of the length of object to the length of shorter image is 2.

(2) distance between the two positions of the lens is 32 cm.

(3) focal length of the lens is 64/3 cm.

(4) when the shorter image is formed on screen, distance of the lens from the screen is 30 cm.

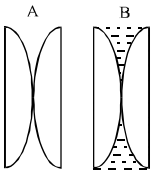
90. Behind a thin converging lens having both the surfaces of the same radius 10 cm, a plane mirror has been placed.



The image of an object at a distance 40 cm from the lens is formed at the same position. What is the refractive index of the lens ?

(1) 1.5 (2) $\frac{5}{3}$ (3) $\frac{9}{8}$ (4) None

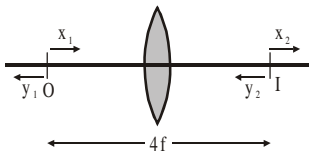
91. Figure A shows two identical plano-convex lenses in contact as shown. The combination has focal length 24 cm. Figure B shows the same with a liquid introduced between them. If refractive index of glass of the lenses is 1.50 and that of the liquid is 1.60, the focal length of the system in figure B will be



(1) –120 cm (2) 120 cm

(3) –24 cm (4) 24 cm

92. In a converging lens of focal length f and the distance between real object and its real image is 4*f*. If the object moves x_1 distance towards lens its image moves x_2 distance away from the lens and when object moves y_1 distance away from the lens its image moves y_2 distance towards the lens, then choose the correct option:-



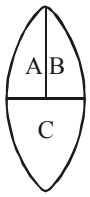
(1) $x_1 > x_2$ and $y_1 > y_2$ (2) $x_1 < x_2$ and $y_1 < y_2$

(3) $x_1 < x_2$ and $y_1 > y_2$ (4) $x_1 > x_2$ and $y_2 > y_1$

93. An object and a screen are fixed on the uprights of an optical bench. The distance between them is 100 cm. A convex lens is placed in between the object and the screen and the position of the lens is so adjusted that the image of the object is formed on the screen at two conjugate positions of the lens. The distance between these conjugate positions of the lens is 40 cm. What is the focal length of the lens :-

(1) 15 cm (2) 18 cm (3) 21 cm (4) 24 cm

94. A thin, symmetrical double-convex lens of focal length 50 cm is cut into three parts A, B and C as shown, then :



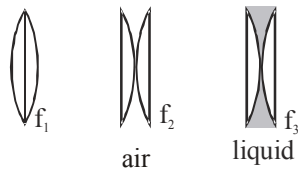
(1) Power of C is 2D

(2) Focal length of A is 100 cm

(3) Power of B is 1D

(4) All of these

95. The figure shows different arrangements of two identical pieces of plano-convex lenses. The refractive index of the liquid used is equal to that of the glass. Then, the effective focal lengths in the three cases are related as



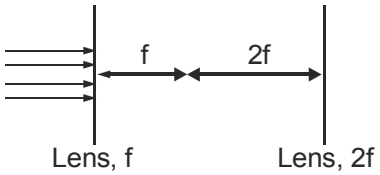
(1) $f_1 = f_2$, $f_3 = 0$

(2) $f_1 \neq f_2 \neq f_3$

(3) $f_1 = f_2 > f_3$

(4) $f_1 = f_2$, $f_3 \to \infty$

96. Two convex lenses of focal lengths f and $2f$ are arranged to have their foci at the same point, as shown in the diagram. A circular beam of parallel light rays having 1 cm cross-section radius is incident on the first lens. The beam exiting the second lens is :



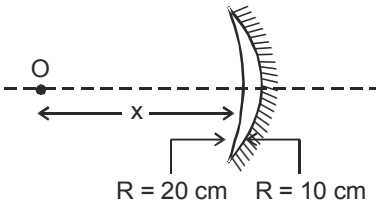
(1) diverging

(2) converging.

(3) Parallel and of 1 cm cross-section radius.

(4) Parallel and of 2 cm cross-section radius.

97. Radii of curvature of a concavo-convex lens (refractive index = 1.5) are 20 cm (concave side) and 10 cm (convex side) as shown. The convex side is silvered. The distance x on the principal axis where an object is placed so that its image is created on the object itself, is equal to :-



(1) 4 cm (2) 8 cm (3) 12 cm (4) 16 cm

98. A parallel beam of white light falls on a combination of a concave and a convex lens, both of same material. Their focal lengths are 15 cm and 30 cm respectively for the mean wavelength in white light. On the other side of the lens system, one sees

(A) a coloured pattern with red at the outer edge

(B) a coloured pattern with violet at the outer edge

(C) white light again

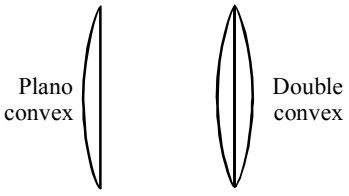
(D) that it is impossible for the lens system to converge the rays at a point

Which of the following is correct ?

(1) Only (A) (2) Only (D)

(3) (B) and (D) (4) Only (C)

99. You are given two thin identical plano-convex lenses, one of which is shown to the right. When you place an object 20 cm to the left of a single plano-convex lens, the image appears 40 cm to the right of the lens. You then arrange the two plano-convex lenses back to back to form a double convex lens. If the object is at 20 cm to the left of this new lens, what is the approximate location of the image :-



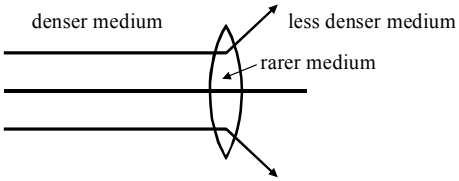
(1) 6.7 cm to the right of the lens.

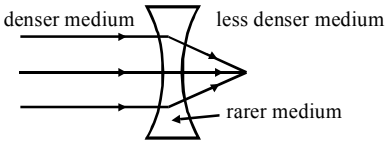
(2) 10 cm to the right of the lens.

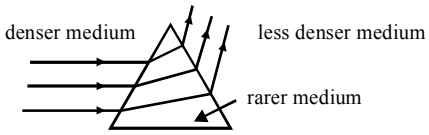
(3) 20 cm to the right of the lens.

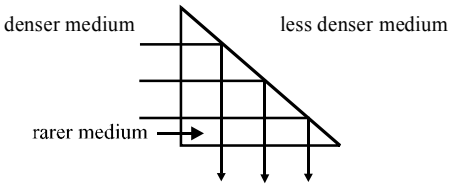
(4) 80 cm to the right of the lens.

100. When light rays pass from an optically denser medium through an optically less denser medium as shown below, which is/are possible?

(I)


(II)


(III)


(IV)


(1) I, II only (2) III, IV only

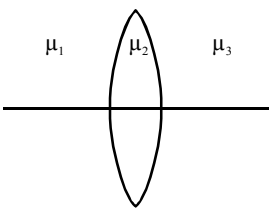
(3) I, II, III only (4) IV only

101. Parallel rays are incident on a thick plano-convex lens having radius of curvature R, refractive index μ and thickness t. When rays are incident on plane surface they converge at a distance x from plane surface. When rays are incident on curved surface then rays converge at y distance from curved surface. Then

(1) x = y (2) x < y

(3) x > y (4) data insufficient

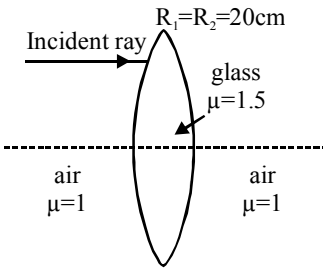
102. The diagram shows an equiconvex lens. What should be the condition on the refractive indices so that the lens becomes diverging ?



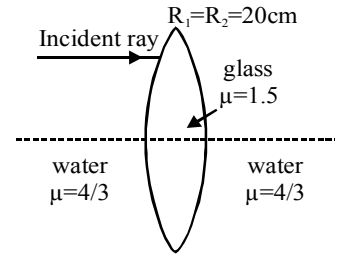
(1) $2\mu_2 > \mu_1 - \mu_3$ (2) $2\mu_2 < \mu_1 + \mu_3$

(3) $2\mu_2 > 2\mu_1 - \mu_3$ (4) $2\mu_2 > \mu_1 + \mu_3$

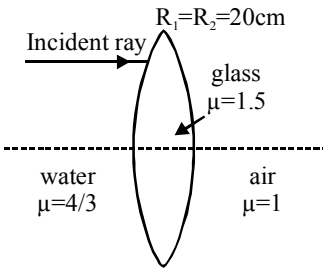
103. **Column I (optical system)** **Column II (focal length)**

(A)


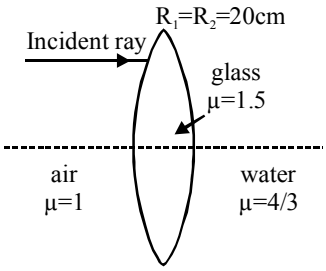
(P) 80 cm

(B)


(Q) 40 cm

(C)


(R) 30 cm

(D)


(S) 20 cm

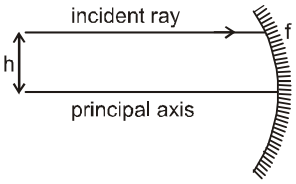
(1) A – S, B – P, C – R, D – Q

(2) A – S, B – P, C – Q, D – R

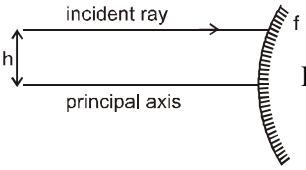
(3) A – P, B – S, C – Q, D – R

(4) A – P, B – S, C – R, D – Q

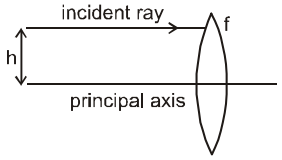
104. A ray is parallel to principal axis and at a distance h from principal axis as shown in each situation. The focal length of mirror or lens in each situation is f (h<<f). Select correct match in each situations with the magnitude of deviation of incident ray produced.

(A) 

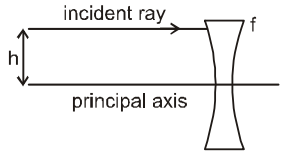
Deviation=$180^\circ-\frac{h}{f}$

(B) 

Deviation=$180^\circ-\frac{2h}{f}$

(C) 

Deviation = $\frac{h}{f}$

(D) 

Deviation = $\frac{2h}{f}$

(1) (A) and (B)

(2) (A) and (C)

(3) (A) and (D)

(4) (B) and (C)

105. A diverging lens with magnitude of focal length 25 cm is placed at a distance of 15 cm from a converging lens of magnitude of focal length 20 cm. A beam of parallel light falls on the diverging lens. The final image formed is :

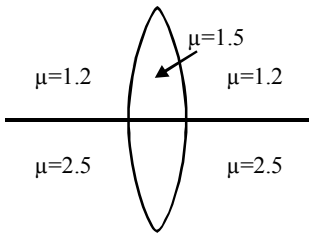
(1) real and at a distance of 40 cm from the divergent lens

(2) real and at a distance of 6 cm from the convergent lens

(3) real and at a distance of 40 cm from convergent lens

(4) virtual and at a distance of 40 cm from convergent lens.

106. A thin lens of material having refractive index $\mu = 1.5$ and focal length of 20 cm in air has two mediums of different refractive indices $\mu_1 = 1.2$ and $\mu_2 = 2.5$ covering upper and lower halves of the lens, respectively as shown in figure. If an object is placed on the principal axis, then its two images will be formed one after refraction from upper part and other after refraction from lower part. Considering the object to be at infinity the separation between two images formed would be :-



(1) 15 cm (2) 40 cm

(3) 25 cm (4) 65 cm

107. An object approaches a convergent lens from the left of the lens with a uniform speed 5 m/s and stops at the focus. The image :

(1) moves away from the lens with an uniform speed 5 m/s

(2) moves away from the lens with an uniform acceleration

(3) moves away from the lens with a non-uniform acceleration

(4) moves towards the lens with a non-uniform acceleration

108. Two point source S_1 and S_2 are 24 cm apart. Where should a convex lens of focal length 9cm be placed in between them so that the images of both sources are formed at the same place ?

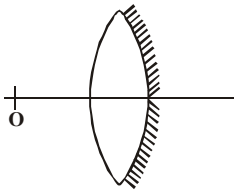
(1) 6 cm from S_1

(2) 15 cm from S_1

(3) 10 cm from S_1

(4) 12 cm from S_1

109. An equiconvex lens of refractive index μ and radius of curvature R has its one surface silvered. A point source O is placed before the silvered lens so that its image is coincident with it, the distance of the object from the lens is :-



(1) $\frac{R}{(\mu-1)}$ (2) $\frac{2R}{(\mu-1)}$

(3) $\frac{R}{(2\mu-1)}$ (4) $\frac{2R}{(2\mu-1)}$

110. Four combinations of two thin lenses are given in List I. The radius of curvature of all curved surfaces is r and the refractive index of all the lenses is 1.5. Match lens combinations in List I with their focal length in List II and select the correct answer using the code given below the lists.

List–I	**List–II**
(P) 	(A) 2r
(Q) 	(B) $\frac{r}{2}$
(R) 	(C) –r
(S) 	(D) r

Code :

(1) P-A, Q-B, R-C, S-D

(2) P-B, Q-D, R-C, S-A

(3) P-D, Q-A, R-B, S-C

(4) P-B, Q-A, R-C, S-D

111. If a convergent beam of light passes through a diverging lens, the result :-

(1) may be a converging beam

(2) may be a diverging beam

(3) may be parallel beam

(4) All of the above

112. A symmetric double convex lens is cut in two equal parts by a plane containing the principal axis. If the power of the original lens was 4 D, the power of a divided lens will be

(1) 2 D (2) 3 D (3) 4 D (4) 5 D

113. When a glass lens (μ_g=3/2) is dipped in a medium then it becomes disappear. Then that medium :-

(1) will be water (μ_w=4/3)

(2) may be water

(3) medium will not be water

(4) nothing can be said

114. A man with normal vision uses a magnifying lens of focal length 10 cm. Then,

(A) Magnification of any value is possible

(B) Maximum magnification possible is 3.5

(C) Minimum magnification possible is 2.5

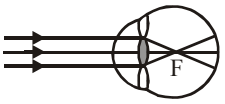
(D) Magnification depends upon the distance of the lens from the eye.

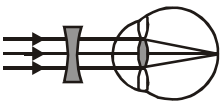
Select correct alternative.

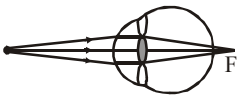
(1) Only A, D (2) Only B, C

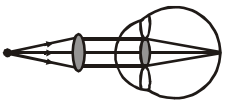
(3) Only B, C, D (4) Only A

115. Identify the wrong description of the given figures:-

(A) 

(B) 

(C) 

(D) 

(1) A represents far-sightedness

(2) B correction for short-sightedness

(3) C represents far-sightedness

(4) D correction for far-sightedness

116. A presbyopic patient has near point as 30 cm and far point as 40 cm. The dioptric power for the corrective lens for seeing distant objects is :-

(1) 40 (2) – 4 (3) –2.5 (4) –0.25

117. A telescope consists of two thin lenses of focal lengths 0.3 m and 3 cm, respectively. It is focussed on Moon which subtends an angle of 0.5° at the objective. Then, the angle subtended at the eye by the final image will be :

(1) 5° (2) 0.25° (3) 0.5° (4) 0.35°

118. An astronomical telescope in normal adjustment receives light from a distant source S. The tube length is now decreased slightly -

(1) A virtual image of S will be formed at a finite distance

(2) No image will be formed

(3) A small, real image of S will be formed behind the eyepiece, close to it

(4) A large, real image of S will be formed behind the eyepiece, far away from it

119. An astronomical telescope has objective and eye-piece lenses of power 0.5D and 20D, respectively. What will be its magnifying power for normal adjustment?

(1) 30 (2) 10

(3) 40 (4) 20

120. The image formed by an objective of a telescope is-

(1) virtual and diminished

(2) real and diminished

(3) real and enlarged

(4) virtual and enlarged

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	1	1	4	3	3	2	4	1	1	3	3	2	1	1	4	1	1	1	2	3
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	3	3	1	2	2	4	3	3	4	1	1	1	1	3	1	2	1	2	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	3	2	2	4	4	2	4	2	1	3	4	2	4	3	2	3	1	2	4
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	4	1	1	1	2	2	2	2	1	3	2	1	1	3	2	2	4	1	3	4
Que.	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
Ans.	3	3	2	3	2	4	2	4	4	3	1	3	3	4	4	4	2	3	2	1
Que.	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Ans.	3	2	1	2	3	4	3	1	3	2	4	3	3	3	1	3	1	1	3	2

WAVE NATURE OF LIGHT & WAVE OPTICS

1. Though quantum-theory of light can explain a number of phenomena observed with light, it is necessary to retain the wave-nature of light to explain the phenomenon of :-

(1) photoelectric effect

(2) diffraction

(3) compton effect

(4) black body radiation

2. If light is incident on the interface of two transparent media then :

(1) Frequency of light in optically denser medium is greater.

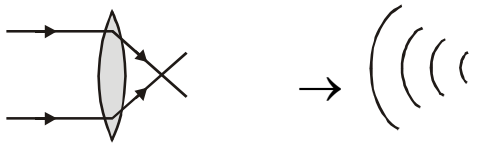
(2) Velocity of light in optically denser medium is greater.

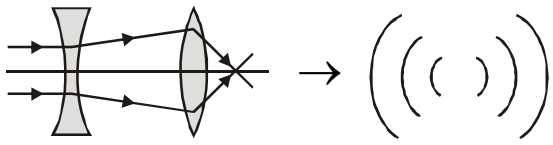
(3) Intensity of light is greater in optically rarer medium.

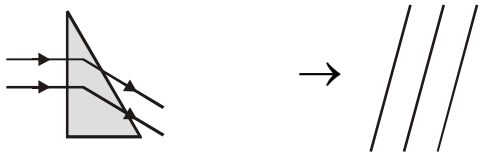
(4) Phase of light wave doesn't change due to refraction

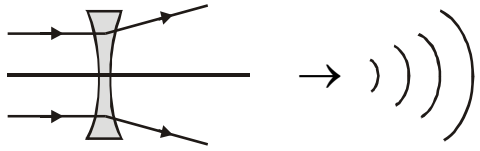
3. In Column I the parallel rays are incident on some optical device and in Column II the shape of emergent wavefronts are shown. Select incorrect match :-

Column - I **Column - II**

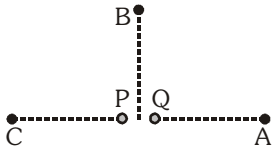
(1) 

(2) 

(3) 

(4) 

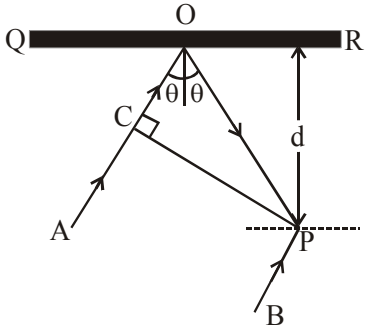
4. Figure here shows P and Q as two equally intense coherent sources emitting radiations of wavelength 20 m. The separation PQ is 5.0 m and phase of P is ahead of the phase of Q by 90°. A,B and C are three distant points of observation equidistant from the mid--point of PQ. The intensity of radiations at A,B,C will be in the ratio-



(1) 0 : 1 : 4 (2) 4 : 1 : 0

(3) 0 : 1 : 2 (4) 2 : 1 : 0

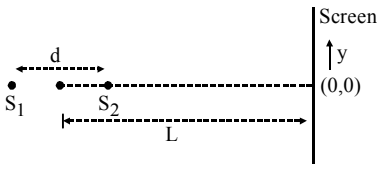
5. In the given diagram, CP represents a wavefront and AO and BP, the corresponding two rays. Find the condition on θ for constructive interference at P between the ray BP and reflected ray OP



(1) $\cos\theta = 3\lambda/2d$ (2) $\cos\theta = \lambda/4d$

(3) $\sec\theta - \cos\theta = \lambda/d$ (4) $\sec\theta - \cos\lambda = 4\lambda/d$

6. The figure shows two point sources which emit light of wavelength λ in phase with each other and are at a distance d = 5.5 λ apart along a line which is perpendicular to a large screen at a distance L from the mid point of the sources. Assume that d is much less than L. Which of the following statement is (are) correct?



(1) Ten bright fringes appear on the screen

(2) Six bright fringes appear on the screen

(3) Point y = 0 corresponds to bright fringe

(4) Point y = 0 corresponds to dark fringe.

7. At some point two waves of intensity I_0 and $2I_0$ interfere with path difference $\lambda/8$ then find resultant intesity at that point Initially they are in phase :

(1) $3I_0$ (2) $3I_0 + 2\sqrt{2}\, I_0$

(3) $3I_0 + \sqrt{2}\, I_0$ (4) $5I_0$

8. In a Young's double slit experiment the intensity at a point is I where the corresponding path difference is one sixth of the wavelength of light used. If I_0 denotes the maximum intensity, the ratio $\frac{I}{I_0}$ is equal to

(1) $\frac{1}{4}$ (2) $\frac{1}{2}$ (3) $\frac{\sqrt{3}}{2}$ (4) $\frac{3}{4}$

9. In a YDSE (Young's double slit experiment) screen is placed 1m from the slits, wavelength of light used is 6000Å. Fringes formed on the screen are observed by a student sitting close to the slits. The student's eye can distinguish two neighbouring fringes, if they subtend an angle more than 1 minute of arc. Calculate the maximum distance between the slits so that fringes are clearly visible?

(1) 2.06 mm (2) 1.63 mm

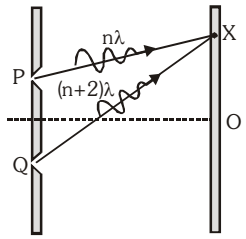
(3) 4.12 mm (4) 3.09 mm

10. In Young's double-slit experiment intensity at a point is $\frac{1}{4}$ of the maximum intensity. Angular position of this point is :

(1) $\sin^{-1}\left(\frac{\lambda}{d}\right)$ (2) $\sin^{-1}\left(\frac{\lambda}{2d}\right)$

(3) $\sin^{-1}\left(\frac{\lambda}{3d}\right)$ (4) $\sin^{-1}\left(\frac{\lambda}{4d}\right)$

11. The figure shows a double slit experiment P and Q are the slits. The path lengths PX and QX are $n\lambda$ and $(n+2)\lambda$ respectively, where n is a whole number and λ is the wavelength. Taking the central fringe at O, what is formed at X



(1) First bright (2) First dark

(3) Second bright (4) Second dark

12. In Young's double slit experiment with light of wavelength λ = 600 nm, intensity of central fringe is I_0. Now one of the slit is covered by glass plate of refractive index 1.4 and thickness t = 5 μm, the new intensity at the same point on screen will be:-

(1) $\frac{I_0}{4}$ (2) $\frac{3I_0}{4}$ (3) I_0 (4) $\frac{I_0}{2}$

13. In Young's double slit experiment the slits are 0.5 mm apart and interference is observed on a screen placed at a distance of 100 cm from the slits. It is found that the 9th bright fringe is at a distance of 9.0 mm from the second dark fringe (Both the fringes are on the same side of central maxima). What is the wavelength of light used :-

(1) 2000 Å (2) 4000 Å

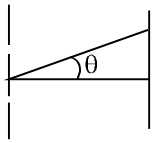
(3) 6000 Å (4) 8000 Å

14. In YDSE with two identical slits, when upper slit is covered with a transparent sheet of mica second order minima is observed above the centre of the screen and second order maxima below it. Which of the following can not be possible value of phase difference caused by the mica sheet

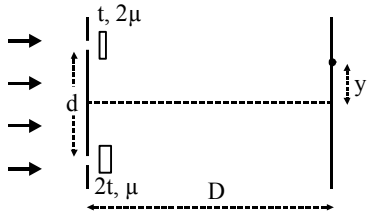
(1) $\frac{\pi}{3}$ (2) $\frac{7\pi}{2}$ (3) $\frac{10\pi}{3}$ (4) $\frac{11\pi}{3}$

15. Two slits are separated by 0.3 mm. A beam of 500 nm light strikes the slits producing an interference pattern. The number of maxima observed in the angular range $-30° < \theta < 30°$ is:-

(1) 300
(2) 150
(3) 599
(4) 601



16. In the YDSE shown the two slits are covered with thin sheets having thickness t & 2t and refractive index 2μ and μ. Find the position (y) of central maxima



(1) zero (2) $\frac{tD}{d}$ (3) $-\frac{tD}{d}$ (4) none

17. In a young's double slit experiment, the slits are illuminated by monochromatic light. The entire set up is immersed in pure water. In order to restore the original fringe width, what can be done?

(1) The slits can be brought closed together.

(2) The screen can be moved away from the slit plane.

(3) The incident light can be replaced by that of a longer wavelength.

(4) All of these

18. Monochromatic light of wavelength 900 nm is used in a young's double slit experiment. One of the slits is covered by a transparent sheet of thickness 1.8×10^{-5} m made of material of refractive index 1.6. How many fringes will shift due to introduction of the sheet :-

(1) 18 (2) 12 (3) 10 (4) 6

19. In the Young's double slit experiment, the intensities at two points P_1 and P_2 on the screen are respectively I_1 and I_2. If P_1 is located at the centre of a bright fringe and P_2 is located at a distance equal to a quarter of fringe width from P_1 then $\frac{I_1}{I_2}$ is

(1) 2 (2) 3

(3) 4 (4) None of these

20. A thin paper of thickness 0.02 mm having refractive index 1.45 is pasted across one of the slits in a Young's double slit experiment. The paper transmits $\frac{4}{9}$ of light falling on it (λ_{light} = 600 nm) :-

(1) Amplitude of light wave transmitted through the paper will be $\frac{4}{9}$ times that of incident wave

(2) The ratio of maximum and minimum intensity in the fringe pattern will be 25

(3) The total number of fringe crossing the centre if an identical paper is pasted on the other slit is 30.

(4) The ratio of maximum and minimum intensity in the pattern will be 5.

21. Two slits are 1 mm apart and the screen is placed one metre away. Source produces blue and yellow light which is placed symmetrically with respect to slits to obtain interference on the screen. Find position on screen from central bright where maxima of both colours coincide, wavelength of blue colour is 480 nm and wavelength of yellow colour is 540 nm.

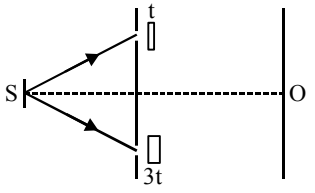
(1) 3.84 mm (2) 4.32 mm

(3) 4.86 mm (4) None

22. Young double slit experiment is performed in air. At certain position 3rd minima is found. If same arrangement is placed in a liquid then 3rd maxima is found at that position. The refractive index of the liquid is :

(1) $\frac{4}{3}$ (2) $\frac{7}{6}$ (3) $\frac{5}{4}$ (4) $\frac{6}{5}$

23. In YDSE set up two thin transparent slabs of same refractive index having thickness t and 3t are introduced in front of slits (as shown in figure). As a result, the first order minimum is formed at central point O, then value of λ is



(1) μt (2) 4(μ – 1)t

(3) 3(μ – 1)t (4) 4μt

24. If one of the slits of a standard YDSE apparatus is covered by a thin parallel sided glass slab so that it transmit only one half of the light intensity of the other, then select incorrect statement :

(1) the fringe pattern will get shifted towards the covered slit.

(2) the fringe pattern will get shifted away from the covered slit.

(3) the bright fringes will be less bright and the dark ones will be less dark.

(4) the fringe width will remain unchanged.

25. In single slit pattern intensities at angular position $\theta_1 = \frac{3\lambda}{a}$, $\theta_2 = \frac{5\lambda}{2a}$, $\theta_3 = \frac{7\lambda}{2a}$ are I_1, I_2 and I_3 respectively then :

(1) $I_1 < I_2 < I_3$ (2) $I_1 > I_2 > I_3$

(3) $I_1 < I_3 < I_2$ (4) $I_2 > I_1 > I_3$

26. A slit of width d is illuminated by red light of wavelength 6500 Å. For what value of d will the first maximum fall at an angle of diffraction of 30° ?

(1) 0.65×10^{-6} m (2) 1.95×10^{-6} m

(3) 1.3×10^{-6} m (4) 2.6×10^{-6} m

27. A screen is placed 50 cm from a single slit, which is illuminated with 6000 Å light. If distance between first and third minima in the diffraction pattern is 3 mm. What is the width of the slit ?

(1) 0.1 mm (2) 0.2 mm (3) 0.3 mm (4) 0.5 mm

28. In single slit diffraction the width of slit is b and wavelength used is λ. Find angular separation between 3rd dark fringes above and below central maxima. The distance of screen from slit is D :

(1) $\frac{3\lambda}{b}$ (2) $\frac{6\lambda}{b}$ (3) $\frac{3\lambda D}{b}$ (4) $\frac{6\lambda D}{b}$

29. Two towers on top of two hills are 40 km apart. The line joining them passes 50 m above a hill halfway between the towers. What is the longest wavelength of radio waves, which can be sent between the towers without appreciable diffraction effects?

(1) 25.0 cm (2) 12.5 cm

(3) 25 m (4) 12.5 m

30. Two point white dots are 1 mm apart on a black paper. They are viewed by eye of pupil of diameter 3 mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye ? [Take wavelength of light = 500 nm]

(1) 1 (2) 3 m (3) 5 m (4) 7 m

31. What changes on polarisation of light :

(1) Frequency (2) Wavelength

(3) Phase (4) Intensity

32. A mixture of plane polarised and unpolarised light falls normally on a polarizing sheet. On rotating the polarizing sheet about the direction of the incident beam, the transmitted intensity varies by a factor of 4. Find the ratio of the intensities I_P and I_0, respectively of the polarized and unpolarized components in the incident beam.

(1) $\frac{3}{2}$ (2) $\frac{5}{2}$ (3) $\frac{1}{2}$ (4) $\frac{3}{4}$

33. A beam of unpolarised light of intensity I_0 is passed through a polaroid A and then through another polaroid B which is oriented so that its principal plane makes an angle of 45° relative to that of A. The intensity of the emergent light is:-

(1) I_0 (2) $\frac{I_0}{2}$ (3) $\frac{I_0}{4}$ (4) $\frac{I_0}{8}$

34. The angle of incidence of light is equal to Brewster's angle.

Consider the following statements :-

(a) reflected ray is perpendicular to refracted ray

(b) refracted ray is parallel to reflected ray

(c) reflected light is polarized having its electric vector perpendicular to the plane of incidence

(d) refracted light is polarized

Select the correct options :-

(1) (a) and (d) are true

(2) (a) and (b) are true

(3) (a) and (c) are true

(4) (b) and (c) are true

35. Two nicole crystal are placed crossed to each other in front of a light source such that their crystallographic axis are perpendicular. Intensity of unpolarised light from source is I_0. What percentage of intensity comes out of system if second crystal is rotated by 60° :-

(1) 25% (2) 12.5 %

(3) 37.5 % (4) 50%

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	4	1	4	2	4	4	4	1	3	3	1	3	1	3	2	4	2	1	2
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35					
Ans.	2	4	2	2	3	2	2	2	2	3	4	1	3	3	3					

MODERN PHYSICS

1. If h is Planck's constant, the momentum of a photon of wavelength 0.01 Å is :-

(1) 10^{-2} h (2) h

(3) 10^{2} h (4) 10^{12}h

2. An experiment is carried out in which light is shone on a photocell whose plate (cathode) has a work function of 1.5 eV. Two series of measurements were performed. For the first measurement, light has a wavelength 414 nm and intensity I and for the second measurement light has a wavelength of 517.5 nm and intensity 3I. The ratio of stopping potential for the wavelength is : (Take : h = 4.14×10^{-15}eVs)

(1) $\frac{4}{5}$ (2) $\frac{5}{3}$ (3) $\frac{5}{4}$ (4) $\frac{3}{5}$

3. Light emitted during the deexcitation of electron from n = 3 to n = 2, when incident on a metal, photoelectrons are just emitted from that metal. In which of the following transition photoelectric effect is not possible?

(1) From n = 2 to n = 1 (2) From n = 3 to n = 1

(3) From n = 5 to n = 2 (4) From n = 4 to n = 3

4. In an experiment on photoelectric effect, the wavelength of the incident radiation is λ. The wavelength of the incident radiation is reduced to $\frac{1}{3}$rd of the initial value and the maximum kinetic energy of the photoelectron is observed to be n times the previous value. The threshold wavelength for the metal plate is :-

(1) $\left(\frac{n-1}{n-3}\right)\lambda$ (2) $\left(\frac{n}{n-3}\right)\lambda$

(3) $\frac{(n+1)\lambda}{(n-3)}$ (4) $\frac{3\lambda}{n}$

5. When monochromatic point source of light is placed at 0.1 m from a photocell, the cut-off voltage and saturation current are 0.8 volt and 24 mA respectively. If the same source is placed at 0.2m away from the photocell, then cut-off voltage and saturation current will be :

(1) 0.4 volt and 12 mA (2) 0.8 volt and 12 mA

(3) 0.8 volt and 6 mA (4) 0.16 volt and 12 mA

6. In a photoelectric effect experiment, if f is the frequency of radiations incident on the metal surface and I is the intensity of the incident radiations, then choose the correct statement(s).

(A) If f is increased keeping I and work function constant then maximum kinetic energy of photoelectron increases.

(B) If distance between cathode and anode is increased stopping potential increases

(C) If I is increased keeping f and work function constant then stopping potential remains same and saturation current increases.

(D) Work function is decreased keeping f and I constant then stopping potential increases

Select correct alternative.

(1) A, B & C

(2) B, C & D

(3) A, C & D

(4) Only A

7. When monochromatic radiation of intensity I falls on a metal surface, the number of photoelectron and their maximum kinetic energy are N and T respectively. If the intensity of radiation is 2I, the number of emitted electrons and their maximum kinetic energy are respectively :

(1) 2N and T

(2) 2N and 2T

(3) N and T

(4) N and 2T

8. The wavelength of light incident on a metal surface is reduced from 300 nm to 200 nm (both are less than threshold wavelength). What is the change in the stopping potential for photoelectrons emitted from the surface

(Take h = 6.6×10^{-34}J-sec)

(1) 4 V (2) 3 V

(3) 2 V (4) 1 V

9. When photons of wavelength λ_1 are incident on an isolated sphere suspended by an insulated thread, the corresponding stopping potential is found to be V. When photons of wavelength λ_2 are used, the corresponding stopping potential was thrice the above value. If light of wavelength λ_3 is used, calculate the stopping potential for this case.

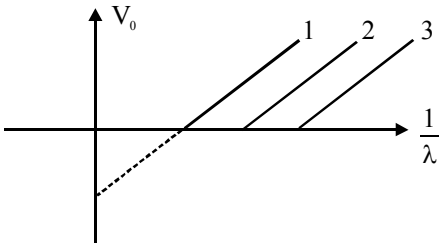
(1) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{1}{\lambda_1}\right]$

(2) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{3}{2\lambda_1}\right]$

(3) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right]$

(4) $\frac{hc}{e}\left[\frac{1}{\lambda_3}-\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right]$

10. Graph shows stopping potential (V_0) v/s $\frac{1}{\text{wavelength}}\left(\frac{1}{\lambda}\right)$ for three metals, then



(1) Planck's constant for metal (1) is greatest
(2) Work function for metal (3) is greatest
(3) Threshold frequency for metal (1) is greatest
(4) Threshold wavelength is maximum for metal 3

11. In the experiment of photon KE_{max} is K_0. If frequency is increased by factor n_1 then KE_{max} is n_2K_0. Find work function :-

(1) $\left(\frac{n_2-n_1}{n_1-1}\right)K_0$ (2) $\left(\frac{n_2-n_1}{n_2+n_1}\right)K_0$

(3) $\left(\frac{n_2+n_1}{n_2-n_1}\right)K_0$ (4) $\left(\frac{n_2+n_1}{n_2-1}\right)K_0$

12. Find the maximum magnitude of the linear momentum of a photoelectron emitted when light of wave length 400 nm falls on a metal having work function 2.5 eV :-

(1) 4×10^{-25} Kg m/s

(2) 8×10^{-25} Kg m/s

(3) 12×10^{-25} Kg m/s

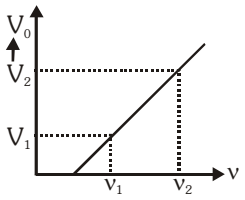
(4) 16×10^{-25} Kg m/s

13. After absorbing a slowly moving neutron of mass m_N (momentum ~0) a nucleus of mass M breaks into two nuclei of masses m_1 and $3m_1(4m_1 = M + m_N)$, respectively. If the de Broglie wavelength of the nucleus with mass m_1 is λ, then de Broglie wavelength of the other nucleus will be :-

(1) 9 λ (2) 3 λ

(3) $\frac{\lambda}{3}$ (4) λ

14. Figure shows the graph of stopping potential versus the frequency of a photosensitive metal. The plank's constant and work function of the metal are :-



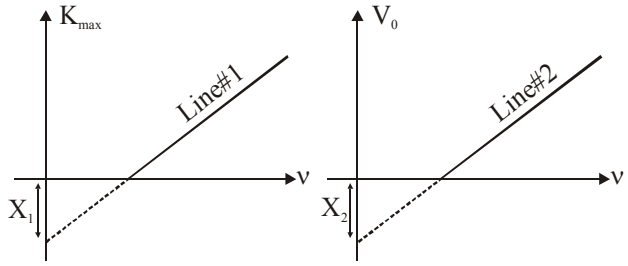
(1) $\left(\frac{V_2+V_1}{\nu_2+\nu_2}\right)e, \left(\frac{V_2\nu_1+V_1\nu_2}{\nu_2+\nu_1}\right)e$

(2) $\left(\frac{V_2+V_1}{\nu_2-\nu_1}\right)e, \left(\frac{V_2\nu_1+V_1\nu_2}{\nu_2-\nu_1}\right)e$

(3) $\left(\frac{V_2-V_1}{\nu_2+\nu_1}\right)e, \left(\frac{V_2\nu_1-V_1\nu_2}{\nu_2+\nu_1}\right)e$

(4) $\left(\frac{V_2-V_1}{\nu_2-\nu_1}\right)e, \left(\frac{V_2\nu_1-V_1\nu_2}{\nu_2-\nu_1}\right)e$

15. For ion of metal match the following columns.



	Column-I	Column-II
(A)	Slope of line #1	(P) ϕ_0
(B)	Slope of line #2	(Q) ϕ_0/e
(C)	Value of X_1	(R) h
(D)	Value of X_2	(S) h/e

(1) A-R, B-S, C-P, D-Q (2) A-R, B-S, C-Q, D-P

(3) A-S, B-R, C-P, D-Q (4) A-S, B-R, C-Q, D-P

16. A monochromatic light source of intensity 5 mW emits 8×10^{15} Photons per second. This light ejects photoelectrons from a metal surface. The stopping potential for this setup is 2.0V. The work function of the metal will be

(1) 3.9eV (2) 7.9 eV (3) 1.9eV (4) 5.9eV

17. A metal surface is illuminated by light of two different wavelength 248 nm and 310 nm. The maximum speeds of the photoelectrons corresponding to these wavelengths are u_1 and u_2, respectively. If the ratio $u_1 : u_2 = 2 : 1$ and hc = 1240 eV nm, the work function of the metal is nearly

(1) 3.7 eV (2) 3.2 eV

(3) 2.8 eV (4) 2.5 eV

18. If stopping potentials corresponding to wavelengths 4000Å and 4500Å are 1.3V and 0.9V respectively, then the work function of the metal is (Consider h is unknown)-

(1) 0.3 eV (2) 1.3 eV (3) 2.3 eV (4) 5 eV

19. A silver sphere (work function 4.6 eV) is suspended in a vacuum chamber by an insulating thread. Ultraviolet light of wavelength 0.2 μ m strikes on the sphere. The maximum electric potential of the sphere will be (hc = 12400 eVÅ):-

(1) 4.6 V (2) 6.2 V (3) 1.6 V (4) 3.2 V

20. Which of the following devices is sometimes called an "electric eye" ?

(1) LED (2) Photocell

(3) Integrated chip (4) Solar cell

21. A photon, an electron and a uranium nucleus all have the same de–Broglie wavelength. The one with the greatest total energy :-

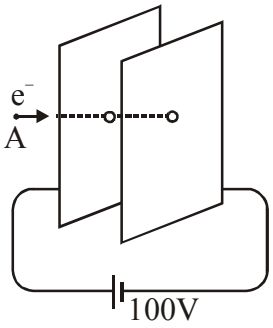
(1) Is the photon

(2) Is the electron

(3) Is the uranium nucleus

(4) Depends upon the wavelength and the properties of the particle

22. Two large parallel plates are connected with a power supply of 100 V. These plates have a fine hole at the centre. An electron (e^-) having kinetic energy 200 eV at A is so directed that it passes through the holes. When it comes out, its de-Broglie wavelength is



(1) 0.71Å (2) 1.23Å

(3) 1.78Å (4) 2.19Å

23. An electron (mass m) with an initial velocity $\vec{v} = v_0\hat{i}$ is in an electric field $\vec{E} = E_0\hat{j}$. If $\lambda_0 = h/mv_0$, it's de Brogile wavelength at time t is given by :-

(1) λ_0 (2) $\lambda_0\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}$

(3) $\frac{\lambda_0}{\sqrt{1+\frac{e^2E_0^2t^2}{m^2v_0^2}}}$ (4) $\frac{\lambda_0}{\left(1+\frac{e^2E_0^2t^2}{m^2v_0^2}\right)}$

24. The activity of a radioactive sample is measured as N_0 counts per minute at t = 0 and N_0/e counts per minute at t = 5 minutes. The time (in minutes) at which the activity reduces to half of its initial value is :-

(1) $5 \log_e 2$ (2) $\log_e 2/5$

(3) $\frac{5}{\log_e 2}$ (4) $5 \log_{10} 2$

25. Wavelength of photon is equal to the wavelength of electron moving with kinetic energy 1.5 eV. What is the value of energy of photon :-

(1) 1.5 eV (2) 12.25 eV

(3) 1.24 KeV (4) 1.24 eV

26. A proton and electron are accelerated by same potential different let λ_e and λ_p denote the de-Broglie wavelengths of the electron and the proton respectively :-

(1) $\lambda_e = \lambda_p$ (2) $\lambda_e < \lambda_p$

(3) $\lambda_e > \lambda_p$ (4) None

27. The radioactive sources A and B of half lives of 2hr and 4hr respectively, initially contain the same number of radioactive atoms. At the end of 2 hours, their rates of disintegration are in the ratio:-

(1) 4 : 1 (2) 2 : 1 (3) $\sqrt{2}:1$ (4) 1 : 1

28. Electrons used in an electron microscope are accelerated by a voltage of 25 kV. If the voltage is increased to 100 kV then the de-Broglie wavelength associated with the electrons would:

(1) increase by 2 times

(2) decrease by 2 times

(3) decrease by 4 times

(4) increase by 4 times

29. An electron is confined to a 1nm wide region, the uncertainty in momentum using Heisenberg uncertainty principle will be :-

(1) 1.05×10^{-25} kg m/s

(2) 2.03×10^{-31} kg m/s

(3) 3.05×10^{-34} kg m/s

(4) 2.49×10^{-32} kg m/s

30. Consider the following nuclear reactions and select the correct statements from the options that follow.

Reaction I : $n \rightarrow p + e^- + \bar{\nu}$

Reaction II : $p \rightarrow n + e^+ + \nu$

(A) Free neutron has higher mass than proton, therefore reaction I is possible

(B) Free proton has less mass than neutron, therefore reaction II is not possible for the free proton

(C) Inside a nucleus, both decays (reaction I and II) are possible

(D) Inside a nucleus, reaction I is not possible but reaction II is possible.

(1) A, B, C are correct (2) A, C, D are correct

(3) A, B, D are correct (4) B, C, D are correct

31. A certain radioactive substance has a half-life of 5 years. Thus for a nucleus in a sample of the element, the probability of decay in 10 years is :-

(1) 50 % (2) 75 % (3) 100 % (4) 60 %

32. A particle of mass 1 μg is dropped from height 20m. Its de Broglie wavelength is :-

(1) 3.3×10^{-24} kg - m/s

(2) 3.3×10^{-26} kg - m/s

(3) 6.6×10^{-34} kg - m/s

(4) 6.6×10^{-24} kg - m/s

33. If M (A ;Z), M_p and M_n denote the masses of the nucleus ${}^{A}_{Z}X$, proton and neutron respectively in units of u (1u = 931.5 MeV/c^2) and BE represents its binding energy in MeV, then :-

(1) $M(A, Z) = ZM_p + (A - Z) M_n - BE$

(2) $M(A, Z) = ZM_p + (A - Z) M_n + BE/c^2$

(3) $M(A, Z) = ZM_p + (A - Z) M_n - BE/c^2$

(4) $M(A, Z) = ZM_p + (A - Z) M_n + BE$

34. A radioactive nucleus undergoes a series of decay according to the scheme

$$A \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\alpha} A_3 \xrightarrow{\gamma} A_4$$

If the mass number and atomic number of A are 180 and 72 respectively. What are these number of A_4:-

(1) ${}_{72}A_4^{172}$ (2) ${}_{69}A_4^{174}$

(3) ${}_{69}A_4^{172}$ (4) ${}_{72}A_4^{176}$

35. Two radioactive substances X and Y emit α and β particles respectively. Their disintegration constants are in the ratio 2:3. To have equal probabilities of getting emission of α and β particles, the ratio of number of atoms of X to that of Y at any time instant is

(1) 2 : 3 (2) 3 : 2 (3) e : 1 (4) (e–1) : 1

36. Mark the incorrect statement :

(1) Following alpha or beta decay a nucleus reaches its ground state after emitting nuclear gamma rays.

(2) A proton can not decay to a neutron in a nuclei because such decay has negative Q value of reaction.

(3) A positron can capture electron resulting in gamma rays photon only.

(4) In positive beta decay the emitted positron shows continuous distribution of kinetic energy.

37. The Th_{90}^{232} atom has successive alpha and beta decays to the end product Pb_{82}^{208}. The numbers of alpha and beta particles emitted in the process respectively are

(1) 4,6 (2) 4, 4 (3) 6, 2 (4) 6,4

38. A radioactive sample at any instant has its disintegration rate 5000 disintegrations per minute. After 5 minutes, the rate is 1250 disintegration per minute. Then, the decay constant (per minute) is :-

(1) 0.8 ln2 (2) 0.4 ln2

(3) 0.2 ln2 (4) 0.1 ln2

39. The activity of a sample reduces from A_0 to $\frac{A_0}{\sqrt{3}}$ in one hour. The activity after 3 hour will be :-

(1) $\frac{A_0}{3\sqrt{3}}$ (2) $\frac{A_0}{9}$ (3) $\frac{A_0}{9\sqrt{3}}$ (4) $\frac{A_0}{27}$

40. A fresh radioactive sample is given at t = 0. Its decay fraction are $\frac{1}{5}$ at t_1 instant and $\frac{4}{5}$ at t_2 instant. Its mean life is :-

(1) $\frac{t_2-t_1}{\ell n2}$ (2) $\frac{t_2-t_1}{\ell n4}$ (3) $\frac{t_2-t_1}{2}$ (4) $\frac{t_2-t_1}{4}$

41. The initial activity of a certain radioactive isotope was measured as 16000 counts min^{-1}. Given that the only activity measured was due to this isotope and that its activity after 12h was 2000 counts min^{-1}, its half life in hours is :-

(1) 9.0 (2) 6.0 (3) 4.0 (4) 3.0

42. The half life of $^{238}_{92}U$ undergoing α-decay is 4.5×10^9 years. What is the activity of 1 gm sample $^{238}_{92}U$.

(1) 5.12×10^{10} Bq (2) 1.23×10^4 Bq

(3) 5.2×10^{12} Bq (4) None of these

43. A nucleus (of nuclear density ρ) disintegrates into two daughter nuclei with masses in the ratio 8 : 27. Density of the smaller nucleus is :-

(1) $\frac{2}{3}\rho$ (2) $\frac{2}{5}\rho$ (3) $\frac{8}{27}\rho$ (4) ρ

44. An α-particle of energy 4 MeV is scattered through 180° by a fixed uranium nucleus. The distance of the closest approach is of the order of:-

(1) 1 Å (2) 10^{-10} cm

(3) 10^{-12} cm (4) 10^{-15} cm

45. When Lithium (^{7}Li) is bombarded by a proton, two alpha particles (^{4}He) are produced. The masses of ^{7}Li, ^{1}H and ^{4}He are 7.016004 u, 1.007825 u and 4.002603 u respectively. The reaction energy is nearly:

(1) 17 eV (2) 17 keV

(3) 17 MeV (4) 170 MeV

46. The half life of a radioactive nucleus is 50 days. The time interval $(t_2 - t_1)$ between the time t_2 when $\frac{2}{3}$ of it has decayed and the time t_1 when $\frac{1}{3}$ of it had decayed is :-

(1) 60 days (2) 15 days

(3) 30 days (4) 50 days

47. Experiments on scattering of α-particle demonstrated that the radius of a nucleus is smaller than the radius of an atom by a factor of about :-

(1) 10^2 (2) 10^4 (3) 10^{12} (4) 10^7

48. Accurate measurement of atomic masses is carried out with :-

(1) mass spectrometer

(2) Milikan oil drop experiment

(3) Cathode rays

(4) None of these

49. An element have two isotopes having masses m_1 and m_2. The relative abundances of these isotopes are x% and (100 – x)%. The average mass of element will be :-

(1) $\frac{m_1(100-x)+m_2x}{100}$

(2) $\frac{m_1x+m_2(100-x)}{100}$

(3) $\frac{(m_1+m_2)x}{100}$

(4) None of these

50. Given the mass of iron nucleus as 55.85 u and A = 56 find the nuclear density :-

(1) 2.3×10^3 kg m^{-3}

(2) 2.3×10^{17} kg m^{-3}

(3) 0.25×10^{12} kg m^{-3}

(4) None of these

51. Express the mass defect of $^{16}_{8}O$ in MeV/c^2.

(Mass defect of $^{16}_{8}O$ in u is = 0.13691 u) :-

(1) 250 MeV/c^2

(2) 127.5 MeV/c^2

(3) 300 MeV/c^2

(4) None of these

52. Find the Q-value of the emitted α-particle in the α-decay of $^{226}_{88}Ra$. m_α = 4.00260u

$m(^{226}_{88}Ra)$ = 226.02540 u

$m(^{222}_{86}Rn)$ = 222.01750 u

(1) 8.93 MeV

(2) 4.93 MeV

(3) 12.3 MeV

(4) None of these

53. M_x and M_y denote the atomic masses of the parent and the daughter nuclei respectively in a radioactive decay. The Q value for a β^--decay is Q_1 and that for β^+ decay is Q_2. If m_e denotes the mass of an electron then which of the following statements is correct ?

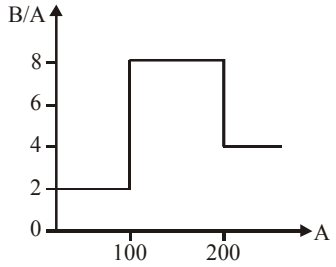
(1) $Q_1 = (M_x - M_y)c^2$ and $Q_2 = (M_x - M_y - 2m_e)c^2$

(2) $Q_1 = (M_x - M_y)c^2$ and $Q_2 = (M_x - M_y)c^2$

(3) $Q_1 = (M_x - M_y - 2m_e)c^2$ & $Q_2 = (M_x - M_y + 2m_e)c^2$

(4) $Q_1 = (M_x - M_y + 2m_e)c^2$ & $Q_2 = (M_x - M_y + 2m_e)c^2$

54. Assume that the nuclear binding energy per nucleon (B/A) versus mass number (A) is as shown in the figure. Use this plot to choose the correct choice(s) given below.



(A) Fusion of two nuclei with mass numbers lying in the range of 1 < A < 50 will release energy

(B) Fusion of two nuclei with mass numbers lying in the range of 51 < A < 100 will release energy

(C) Fission of a nucleus lying in the mass range of 100 < A < 200 will release energy when broken into two equal fragments

(D) Fission of a nucleus lying in the mass range of 200 < A < 260 will release energy when broken into two equal fragments

(1) A & B (2) A & D

(3) B & D (4) C & D

55. Which of the following regarding to neutron is correct :-

(1) free neutron is unstable

(2) mean life of free neutron is 1000 s.

(3) for heavy nuclei more neutrons are required to overcome the effect of repulsion among the protons.

(4) All correct

56. The wavelengths of K_α line of X–rays for isotopes Pb^{208}, Pb^{206} and Pb^{204} are λ_1, λ_2 and λ_3 respectively. Then :

(1) $\lambda_1 > \lambda_2 > \lambda_3$ (2) $\lambda_1 < \lambda_2 < \lambda_3$

(3) $\lambda_1 = (\lambda_1\lambda_3)^{1/2}$ (4) $\lambda_1 = \lambda_2 = \lambda_3$

57. In majority of crystals the value of lattice constant is of the order of 3Å. The proper X-rays with which the crystal structure can be studied are -

(1) 50Å to 100 Å

(2) 10Å to 50 Å

(3) 6Å to 10 Å

(4) 0.1Å to 2.7 Å

58. If λ_{Cu} is the wavelength of K_α X-ray line of copper (atomic number 29) and λ_{Mo} is the wavelength of the K_α X-ray line of molybdenum (atomic number 42), then the ratio $\frac{\lambda_{Cu}}{\lambda_{Mo}}$ is close to

(1) 1.99 (2) 2.14

(3) 0.50 (4) 0.48

59. The wavelength of the characteristic X-ray K_α line emitted by a hydrogen-like element is 0.32Å. The wavelengthy of K_β line emitted by the same element is :-

(1) 0.27 Å (2) 0.64 Å

(3) 13.5 Å (4) 0.54 Å

60. The energy of a photon of characteristic x-ray from a coolidge tube comes from :-

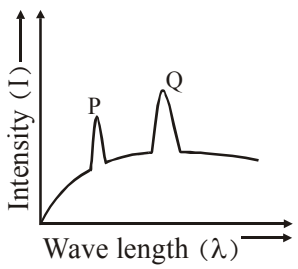
(1) The KE of the striking electron

(2) The KE of the free electron of the target

(3) The KE of the ions of the target

(4) An atomic transition in the target

61. In a characteristic x-ray spectra of some atom superimposed on continuous x-ray spectrum (peaks represents K_α and K_β) :-



(1) P represent K_α line

(2) Q represents K_β line

(3) Q & P represents K_α & K_β lines respectively

(4) Relative positions of K_α & K_β depend on the particular atom

62. Electrons with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut off wavelength of emitted X-ray is :-

(1) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (2) $\lambda_0 = \frac{2h}{mc}$

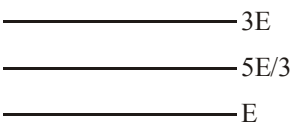
(3) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$ (4) $\lambda_0 = \lambda$

63. Energy levels A, B and C of a certain atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$. If λ_1, λ_2 and λ_3 are wave lengths of radiations corresponding to transitions C to B, B to A and C to A respectively, which of the following relations is correct –

(1) $\lambda_3 = \lambda_1 + \lambda_2$ (2) $\lambda_1 + \lambda_2 + \lambda_3 = 0$

(3) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$ (4) $\lambda_3 = \frac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$

64. The figure shows the energy level of certain atom. When the electron deexcites from 3E to E, an electromagnetic wave of wavelength λ is emitted. What is the wavelength of the electromagnetic wave emitted when the electron deexcites from $\frac{5E}{3}$ to E?



(1) 3 λ (2) 2 λ (3) 5 λ (4) $\frac{3\lambda}{5}$

65. In hydrogen atom, electron excites from ground state to higher energy state and its orbital velocity is reduced to $\frac{1}{3}$rd of its initial value. The radius of the orbit in the ground state is R. The radius of the orbit in that higher energy state is :

(1) 2 R (2) 3 R (3) 27 R (4) 9 R

66. A sample of Hydrogen atoms in their ground state are excited by means of monochromatic radiation of wavelength 970.6 Å. How many different wavelengths are possible in the resulting emission spectrum?

(1) 2 (2) 4 (3) 6 (4) 8

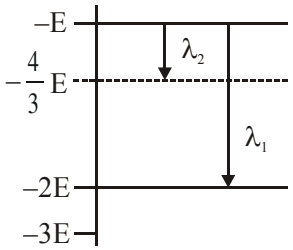
67. Some energy levels of a molecule are shown in the figure. The ratio of the wavelengths $r = \lambda_1/\lambda_2$, is given by :

(1) $r = \frac{3}{4}$

(2) $r = \frac{1}{3}$

(3) $r = \frac{4}{3}$

(4) $r = \frac{2}{3}$



68. In Rutherford's famous gold foil scattering experiment, he found that most alpha particles would pass through the foil undeflected. Which one of the following nuclear properties can be inferred from this observation?

(a) The nucleus must have a positive charge

(b) Most of the mass of an atom is in the nucleus

(c) The nucleus contains both protons neutrons

(d) The diameter of the nucleus is small compared to the diameter of the atom

(1) a, b (2) b, c

(3) b, d (4) a, b, c

69. The transition from the state n = 3 to n = 1 in a hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from :

(1) $4 \rightarrow 2$ (2) $4 \rightarrow 3$

(3) $2 \rightarrow 1$ (4) $3 \rightarrow 2$

70. If wavelength of photon emitted due to transition of an electron third orbit to first orbit in a hydrogen atom is λ, then the wavelength of photon emitted due to transition of electron from fourth orbit to second orbit will be :

(1) $\frac{128}{27}\lambda$ (2) $\frac{25}{9}\lambda$ (3) $\frac{36}{7}\lambda$ (4) $\frac{125}{11}\lambda$

71. When a hydrogen atom emits a photon in going from n = 5 to n = 1, its recoil speed is almost-

(1) 10^{-4} m/s

(2) 2×10^{-2} m/s

(3) 4 m/s

(4) 8×10^{2} m/s

72. The electron in hydrogen atom in a sample is in n^{th} excited state then the number of different spectrum lines obtained in its emission spectrum will be :-

(1) 1 + 2 + 3+ ...+ (n – 1)

(2) 1 + 2 + 3 + ... + n

(3) 1 + 2 + 3 + ... + (n + 1)

(4) 1 × 2 × 3 × ... × (n – 1)

73. The minimum light intensity that can be perceived by the eye is about 10^{-10} watt/m^2. The number of photons of wavelength 5.6×10^{-7} m that must enter the pupil of area 10^{-4} m^2 for vision per second, is approximately equal to

(1) 3×10^{2} photons

(2) 3×10^{4} photons

(3) 3×10^{5} photons

(4) 3×10^{6} photons

74. A neutron collides head on with a stationary hydrogen atom is ground state :-

(1) If KE of the neutron is less than 13.6 eV, collision must be elastic

(2) If KE of the neutron is less than 13.6 eV, collision may be inelastic

(3) inelastic collision must take place when initial KE of neutron is greater than 13.6eV

(4) perfectly inelastic collision can not take place

75. The photon radiated from hydrogen corresponding to 2^{nd} line of Lyman series is absorbed by a hydrogen-like atom 'X' in 2^{nd} excited state. As a result Then, the hydrogen-like atom 'X' makes a transition to n^{th} orbit

(1) X = He^{+}, n = 4

(2) X = Li^{++}, n = 6

(3) X = He^{+}, n = 6

(4) X = Li^{++}, n = 9

76. The activity of a sample reduces from A_0 to $\frac{A_0}{\sqrt{3}}$ in one hour. The activity after 3 hour will be :-

(1) $\frac{A_0}{3\sqrt{3}}$ (2) $\frac{A_0}{9}$

(3) $\frac{A_0}{9\sqrt{3}}$ (4) $\frac{A_0}{27}$

77. A radioactive nucleus A with a half life T, decays into a nucleus B. At t = 0, there is no nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then, t is given by :

(1) $t = T \log (1.3)$ (2) $t = \frac{T}{\log(1.3)}$

(3) $t = \frac{T}{2}\frac{\log 2}{\log 1.3}$ (4) $t = T\frac{\log 1.3}{\log 2}$

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	**4**	**2**	**4**	**1**	**3**	**3**	**1**	**3**	**2**	**2**	**1**	**1**	**4**	**4**	**1**	**3**	**1**	**3**	**3**	**2**
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**2**	**3**	**3**	**2**	**2**	**4**	**2**	**1**	**2**
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	**3**	**2**	**4**	**3**	**3**	**4**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**3**	**4**	**4**	**4**	**2**	**1**	**4**
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77			
Ans.	**3**	**1**	**4**	**1**	**4**	**3**	**2**	**3**	**2**	**1**	**3**	**2**	**2**	**1**	**4**	**1**	**4**			

SEMICONDUCTOR & DIGITAL ELECTRONICS

1. The conductivity of a semiconductor increases with increase in temperature because

(1) number density of free current carriers increases.

(2) relaxation time increases.

(3) both number density of carriers and relaxation time increase.

(4) number density of current carriers increases, relaxation time decreases but effect of decrease in relaxation time is much less than increase in number density.

2. The manifestation of band structure in solids is due to :-

(1) Heisenberg uncertainty principle

(2) Pauli's exclusion principle

(3) Bohr's correspondence principle

(4) Boltzmann law

3. Which of the following statements is **INCORRECT**:-

(1) The resistance of intrinsic semiconductor decrease with increase of temperature

(2) Doping pure Si with trivalent impurities gives P-type semiconductors

(3) The majority carriers in N-type semiconductors are holes

(4) A PN-junction can act as a semiconductor diode

4. An intrinsic semiconductor has a resistivity of 0.5 Ωm at room temperature. Find the intrinsic carrier concentration if the mobilities of electrons and holes are 0.39 $m^2V^{-1}s^{-1}$ and 0.11 $m^2V^{-1}s^{-1}$ respectively :-

(1) 1.2×10^{18} m^{-3}

(2) 2.5×10^{19} m^{-3}

(3) 1.9×10^{20} m^{-3}

(4) 3.1×10^{21} m^{-3}

5. The mobility of electrons and holes in a sample of instrinsic germanium at room temperature are 0.36 and 0.14 m^2/V-s. If electron and holes densities each are equal to $2.5 \times 10^{19}/m^3$ then conductivity of germanium will be (in ohm meter) :

(1) 2 (2) 4 (3) 6 (4) 8

6. The intrinsic carrier density at 300 K for the pure germanium is $2.29 \times 10^{19}/m^3$ and the mobilities of electrons and holes are 0.39 and 0.19 m^2/volt-sec respectively. The conductivity of the intrinsic semiconductor is :-

(1) $\frac{1.6 \times 2.29}{0.58}$/ohm – m

(2) 1.6 × 2.29 × 0.58/ohm-m

(3) $\frac{1.6}{2.29 \times 0.58}$/ohm – m

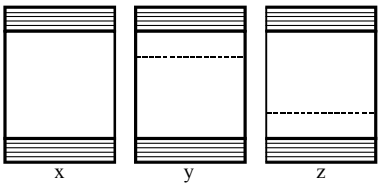
(4) $\frac{0.58}{1.6 \times 2.29}$/ohm – m

7. Resistivity of N-type germanium crystal is 6 Ωm. Velocity of electron per unit electric field is 0.8 (SI unit). Number density of charge carrier is:-

(1) $1.3 \times 10^{18}/m^3$ (2) $2.6 \times 10^{18}/m^3$

(3) $5.2 \times 10^{16}/m^3$ (4) $7.8 \times 10^{18}/m^3$

8. The energy band diagrams for three semiconductor samples of silicon are as shown. We can then assert that :-



(1) Sample X is undoped while samples Y and Z have been doped with a trivalent and a pentavalent impurity respectively

(2) Sample X is undoped while both samples Y and Z have been doped with a pentavalent impurity

(3) Sample X has been doped with equal amounts of trivalent and pentavalent impurities while samples Y and Z are undoped

(4) Sample X is undoped while samples Y and Z have been doped with a pentavalent and a trivalent impurity respectively

9. If a semiconductor has an intrinsic carrier concentration of 1.41×10^{16} m^{-3}, when doped with 10^{21} m^{-3} phosphorus, then the concentraion of holes at room temperature will be

(1) $2 \times 10^{21}/m^3$

(2) $2\times10^{11}/m^3$

(3) $1.41\times10^{10}/m^3$

(4) $1.41\times10^{16}/m^3$

10. Diffusion current in a p-n junction is greater than the drift current in magnitude :-

(1) If the junction is forward-biased

(2) If the junction is reverse-biased

(3) If the junction is unbiased

(4) In no case.

11. In an unbiased p-n junction electrons diffuse from n-region to p-region because :-

(1) Holes in p-region attract them

(2) Electrons travel across the junction due to potential difference

(3) Electron concentration in n-region is more as compared to that in p-region

(4) Electrons only move from n to p region and not the vice-versa (p to n)

12. In an unbiased P-N junction, holes diffuse from the P region to N region because :-

(1) free electron in the N region attract them

(2) they move across the junction by the potential difference

(3) hole concentration in P region is more as compared to N region

(4) All of these

13. In a p-n junction diode not connected to any circuit:

(1) the potential is the same everywhere

(2) the p-type side is at a higher potential than the n-type side

(3) there is an electric field at the junction directed from the n-type side to the p-type side

(4) there is an electric field at the junction directed from the p-type side to the n-type side

14. In a p-n junction,

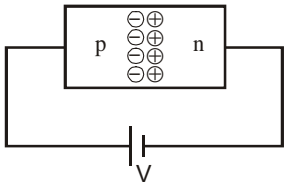
(1) new holes and conduction electrons are produced continuously throughout the material

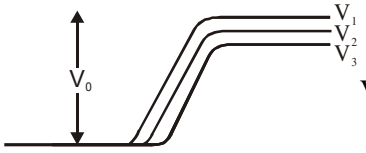
(2) new holes and conduction electrons are produced continuously throughout the material except in the depletion region

(3) holes and conduction electrons recombine continuously throughout the material.

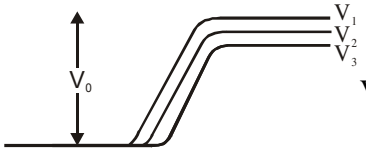
(4) holes and conduction electrons recombine continuously throughout the depletion region.

15. p-n junction diode under forward bias is shown below. Correct diagram for barrier potential is:-



(1) 

$V_1 > V_2 > V_3$

(2) 

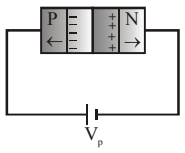
$V_3 > V_2 > V_1$

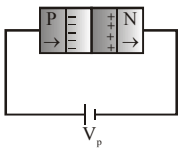
(3) 

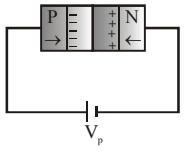
$V_1 > V_2 > V_3$

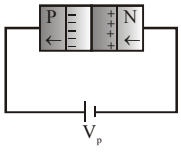
(4) None of these

16. In the case of forward biasing of PN-junction, which one of the following figures correctly depicts the direction of flow of majority carriers

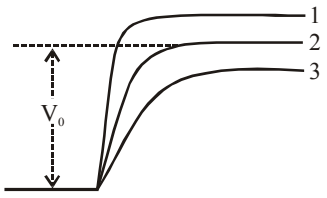
(1) 

(2) 

(3) 

(4) 

17. In figure V_0 is the potential barrier across a p-n junction, when no battery is connected across the junction



(1) 1 and 3 both correspond to forward bias of junction

(2) 3 corresponds to forward bias of junction and 1 corresponds to reverse bias of junction

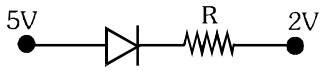
(3) 1 corresponds to forward bias and 3 corresponds to reverse bias of junction.

(4) 3 and 1 both correspond to reverse bias of junction.

18. When the voltage drop across a P-N junction diode is increased from 0.65V to 0.70V the change in the diode current is 5mA. The dynamic resistance of the diode is :-

(1) 5Ω (2) 10Ω (3) 20Ω (4) 25Ω

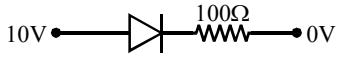
19. If forward resistance of P–N junction is $\frac{R}{2}$ then determine I.



(1) $\frac{14V}{3R}$ (2) $\frac{2V}{R}$

(3) $\frac{V}{R}$ (4) Zero

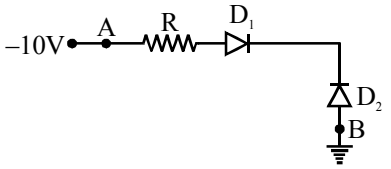
20. A junction diode has resistance of 50 ohm when forward biased and 5000 ohm when reverse biased. The current in the arrangement shown in the figure will be



(1) $\frac{1}{5}$A (2) $\frac{1}{15}$A

(3) $\frac{1}{5}$mA (4) $\frac{1}{15}$mA

21. In given figure, assuming the diodes to be ideal,



(1) D_1 is forward biased and D_2 is reverse biased and hence current flows from A to B

(2) D_2 is forward biased and D_1 is reverse biased and hence no current flows from B to A and vice versa.

(3) D_1 and D_2 are both forward biased and hence current flows from A to B.

(4) D_1 and D_2 are both reverse biased and hence no current flows from A to B and vice versa.

22. A Si and a Ge diode has identical physical dimensions. The band gap in Si is larger than that in Ge. An identical reverse bias is applied across the diodes

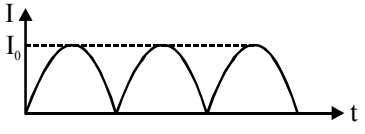
(1) The reverse current in Ge is larger than that in Si

(2) The reverse current in Si is larger than that in Ge

(3) The reverse current is identical in the two diodes

(4) The relative magnitude of the reverse currents cannot be determined from the given data only

23. Figure shows current as a function of time at the output of a full wave rectifier. Average value of this current is :

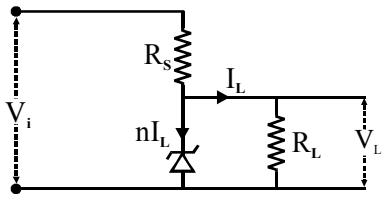


(1) $\frac{I_0}{\sqrt{2}}$ (2) $\frac{I_0}{2}$

(3) $\frac{I_0}{\pi}$ (4) $\frac{2I_0}{\pi}$

24. The breakdown in a reverse biased p-n junction diode is more likely to occur due to :-
(i) large velocity of the minority charge carriers if the doping concentration is small
(ii) large velocity of the minority charge carriers if the doping concentration is large
(iii) strong electric field in a depletion region if the doping concentration is small
(iv) strong electric field in the depletion region if the doping concentratiion is large
(1) (i) and (ii) (2) (ii) and (iii)
(3) (i) and (iii) (4) (i) and (iv)

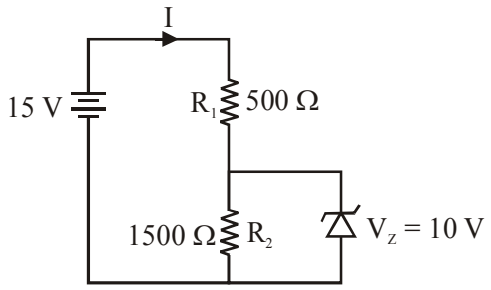
25. The value of the resistor, R_s, needed in the dc voltage regulator circuit shown here, equals :



(1) $\frac{V_i - V_L}{nI_L}$ (2) $\frac{V_i + V_L}{nI_L}$

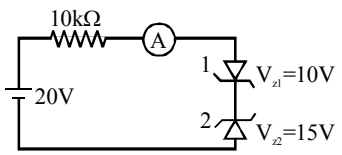
(3) $\frac{V_i - V_L}{(n+1)I_L}$ (4) $\frac{V_i + V_L}{(n+1)I_L}$

26. In the the circuit given, the current through the zener diode is :-



(1) 10 mA (2) 6.67 mA
(3) 5 mA (4) 3.33 mA

27. The reading of ammeter in the following circuit.



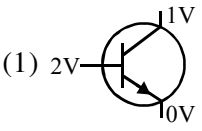
(1) 0.5 mA (2) 1.0 mA
(3) 1.5 mA (4) 2.5 mA

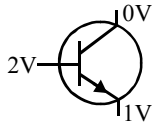
28. A photo diode is fabricated with semiconductor having band gap 2.5 eV. What wavelength can it detect ?
(1) ≥ 4960 Å (2) ≥ 4000 Å
(3) ≤ 4960 Å (4) ≤ 6526 Å

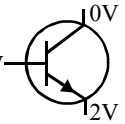
29. Three photo diode D_1, D_2 and D_3 are made of semiconductors having band gap of 2.5 eV, 2 eV and 3 eV respectively. Which one will be able to detect light of wavelength 4800Å :-
(1) D_1
(2) D_2
(3) D_3
(4) D_1 and D_2 both

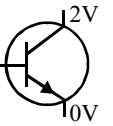
30. In an N-P-N transistor, the collector current is 10 mA, if 80% emitted electrons reach the collector then :-
(1) the emitter current will be 7.5 mA
(2) the emitter current will be 12.5 mA
(3) the base current will be 3.5 mA
(4) the base current will be 1.5 mA

31. In which of the following cases, the transistor is operating in active region :-

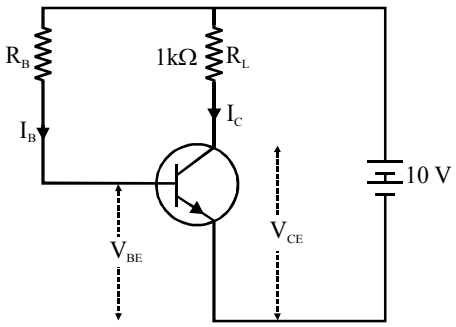
(1) 

(2) 

(3) 

(4) 

32. In the circuit shown in figure, the current gain β = 100 for a npn transistor. what should be the base resistor R_B so that V_{CE} = 5V, (V_{BE} = 0):-



(1) 2×10^3 Ω (2) 10^5 Ω
(3) 2×10^5 Ω (4) 5×10^5 Ω

33. A Transistor is used as an amplifire in CB mode with a load resistance of 5KΩ.The current gain of amplifire is 0.98 and input resistance is 70Ω, the voltage gain and power gain respectively are :-

(1) 70, 68.6

(2) 80, 75.6

(3) 60, 66.6

(4) 90,96.6

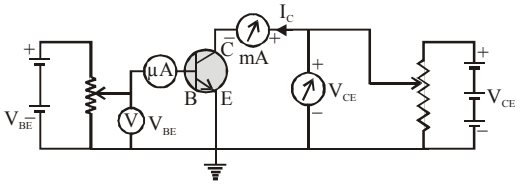
34. A transistor is operated in common emitter configuration at constant collector voltage V_C = 1.5 volt such that a change in the base current from 100μA to 150μA produces a change in the collector current from 5mA to 10 mA. The current gain β is .....

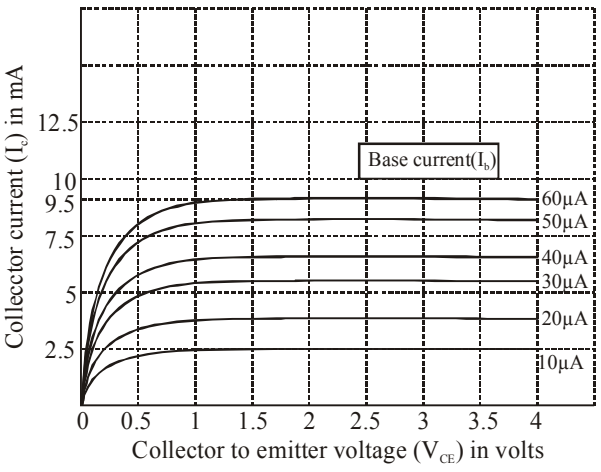
(1) 50 (2) 67 (3) 75 (4) 100

35. A transistor is connected in common emitter (CE) configuration. The collector supply is 8 V and the voltage drop across a resistor of 800 Ω in the collector circuit is 0.8 V. If the current gain factor α is 0.96, find the base current.

(1) 48 μA (2) 42 μA (3) 26 μA (4) 15 μA

36. For the transistor circuit the output characteristics of the transistor, for this biasing configuration are as shown





(a) Type of transistor used

(b) Biasing configur ation employed

(c) Current amplification factor for the transistor for V_{CE} = 3V

Identify the correct alternative.

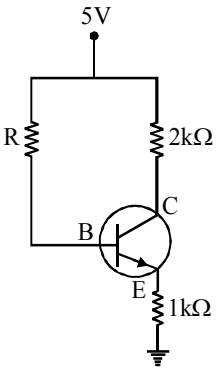
(1) (a) NPN (b) CE (c)140

(2) (a) PNP (b) CB (c) 100

(3) (a) NPN (b) CE (c) 10

(4) (a) PNP (b) CE (c) 14

37.



Find the value of resistance R when

V_{CE} = 2V, V_{BE} = 0.7V, β = 100

(1) 200 kΩ (2) 165.4 kΩ

(3) 215 kΩ (4) 330 kΩ

38. A common emitter amplifier gives an output of 3V for an input of 0.01 V. If β of the transistor is 100 and the input resistance is 1 kΩ then the collector resistance is :-

(1) 3 kΩ (2) 30 kΩ

(3) 1 kΩ (4) 5 kΩ

39. For a common emitter amplifier, the audio signal voltage across the collector resistance 2 kΩ is 2 V. If the current amplification factor of the transistor is 200, and the base resistance is 1.5 Ω, the input signals voltage and base current are respectively

(1) 0.15 V, 10 μA

(2) 1.015 V, 1 A

(3) 1.5 μV, 1 mA

(4) 7.5 μV, 5 μA

40. In a common emitter transistor amplifier, an input signal of 10 mV is applied. Due to this signal, the change in base current is 50 μA and the corresponding change in collector current is 5 mA. If the load resistance in the collector emitter circuit is 5 kΩ, the change in output voltage will be

(1) 5V (2) 10 V (3) 25 V (4) 50 V

41. In a common emitter amplifier circuit using an n-p-n transistor, the phase difference between the input and the output voltages will be :

(1) 135° (2) 180° (3) 45° (4) 90°

42. A common emitter amplifier is designed with NPN transistor ($\alpha = 0.99$). The input impedance is 1KΩ and load is 10 KΩ. The voltage gain will be

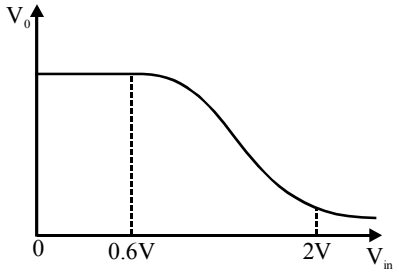
(1) 9.9 (2) 99 (3) 990 (4) 9900

43. In a common amitter transistor amplifier, when signal voltage changes by 0.01 volt, the base current changes by 10 μA and collector current changes by 1 mA. If the collector resistance $R_C = 4$ kΩ and load resistance $R_L = 8$ kΩ, then the current gain is

(1) 1 (2) 10

(3) 100 (4) 1000

44. Figure shows the transfer characteristics of a base biased CE transistor. Which of the following statements is **FALSE** ?



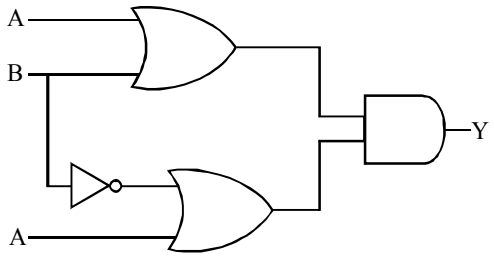
(1) At V_i = 1V , it can be used as an amplifier.

(2) At V_i = 0.5V, it can be used as a switch turned off.

(3) At V_i = 2.5V, it can be used as a switch turned on.

(4) At V_i = 0.4V, transistor is in active state.

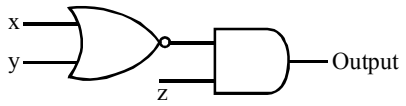
45.



Find out value of Y :-

(1) A (2) B (3) 0 (4) 1

46. In which of the following cases, we would obtain an output of one



(1) x = 1, y = 1, z = 1

(2) x = 1, y = 1, z = 0

(3) x = 0, y = 1, z = 1

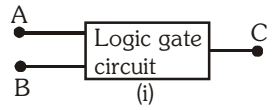
(4) x = 0, y = 0, z = 1

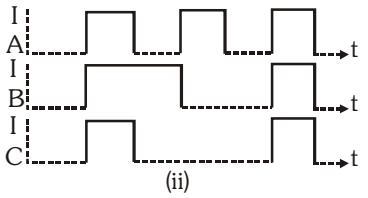
47. What will be input of A and B for the Boolean expression $\overline{(A+B)} \bullet \overline{(A \bullet B)} = 1$

(1) (0, 0) (2) (0, 1)

(3) (1, 0) (4) (1, 1)

48. The following figure (i) shows a logic gate circuit with two inputs A and B and output C. The voltage waveforms of A, B and C are as shown in figure (ii) given below :-





The logic circuit gate is :

(1) OR gate (2) AND gate

(3) NAND gate (4) NOR gate

49. Input waveforms A and B as shown in fig I are applied to the combination of gates as shown in Fig.II. Which of the waveforms shown in Fig. (i) to (iv) correctly represents the output waveform?

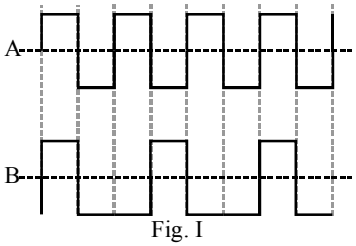


Fig. I

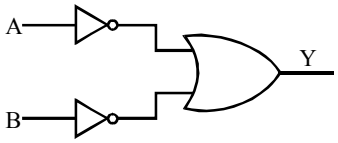


Fig-II

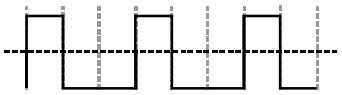


Fig. (i)

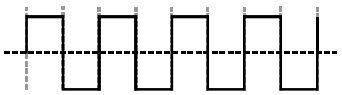


Fig. (ii)

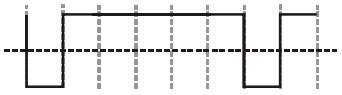


Fig. (iii)

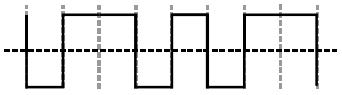


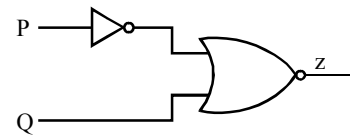
Fig. (iv)

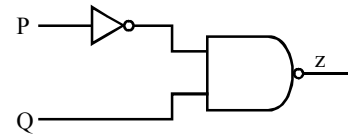
(1) Fig (i) (2) Fig. (ii) (3) Fig. (iii) (4)Fig. (iv)

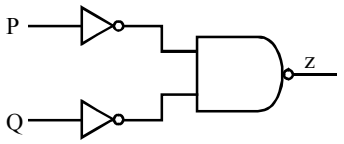
50. A combination of logic gates has the truth table below.

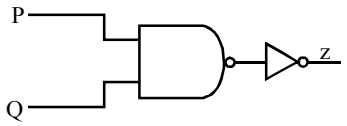
P	Q	Z
0	0	0
0	1	1
1	0	1
1	1	1

Which of the following combinations has this truth table ?

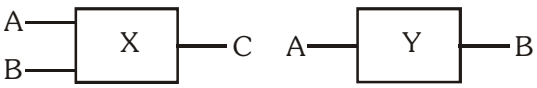
(1)


(2)


(3)


(4)


51. Logic gates X and Y have the following truth tables.



A	B	C
0	0	0
1	0	0
0	1	0
1	1	1

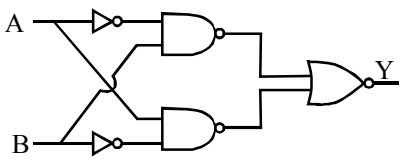
A	B
0	1
1	0

When the output of X is connected to the input Y, the resulting combination is equivalent to:-

(1) NOR gate (2) AND gate

(3) NAND gate (4) OR gate

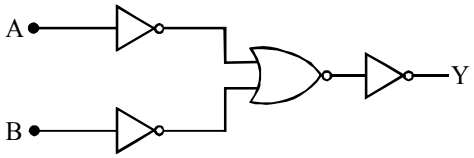
52. Output Y of the given logic gate network is :



(1) $\bar{A}.B + A.\bar{B}$ (2) $A.B + \bar{A}.\bar{B}$

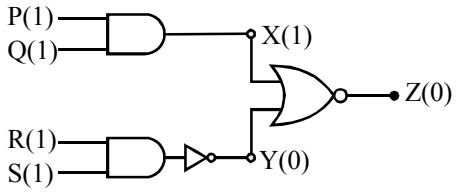
(3) $\left(\overline{A + B}\right) . \bar{A} . \bar{B}$ (4) None

53. The combination of gates below equivalent to:



(1) AND gate (2) XOR gate
(3) NOR gate (4) NAND gate

54. The circuit diagram shows a logic combination with the states of output X, Y and Z given for inputs P, Q, R and S all at state 1. When inputs P and R change to state 0 with inputs Q and S still at 1, the states of outputs X, Y and Z change to

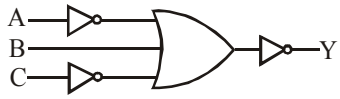


(1) 1, 0, 0 (2) 1, 1, 1
(3) 0, 1, 0 (4) 0, 0, 1

55. In the Boolen algebra $\overline{A}.\overline{B}$ equals :-

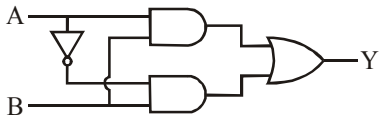
(1) A + B (2) $\overline{A+B}$
(3) A.B (4) $\overline{A}.B$

56. The logic circuit given in diagram performs the logic operation :-



(1) Y = ABC (2) Y = $AB\overline{C}$
(3) Y = $A\overline{B}C$ (4) Y = $\overline{A}B\overline{C}$

57. Truth table for the given circuit is :-



(1)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(2)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	0

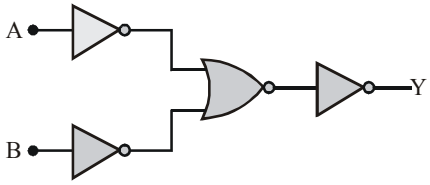
(3)

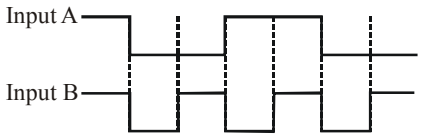
A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

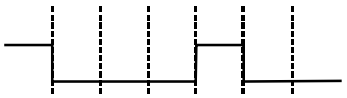
(4)

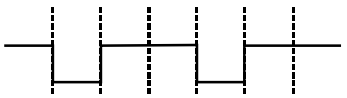
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	1

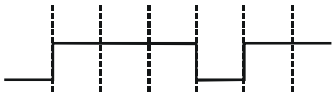
58. The logic circuit shown has the input waveforms 'A' and 'B' as shown. Pick out the CORRECT output waveform :-

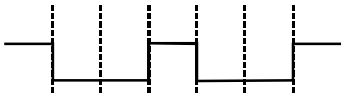




(1) 

(2) 

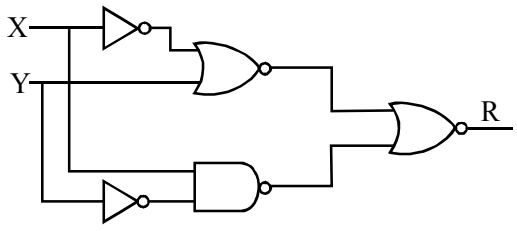
(3) 

(4) 

59. Boolean output for $ABC\left(\overline{A}+\overline{B}+\overline{C}\right)$ is :-

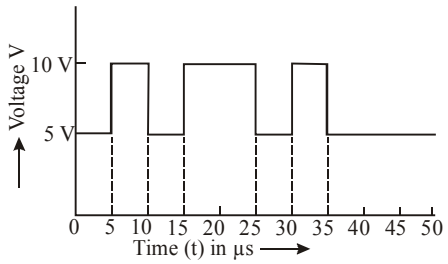
(1) Zero (2) 1
(3) A + B + C (4) ABC

60. Figure gives a system of logic gates. From the study of truth table it can be found that to produce a high output (1) at R, we must have



(1) X = 0, Y = 1
(2) X = 1, Y = 1
(3) X = 1, Y = 0
(4) None of these

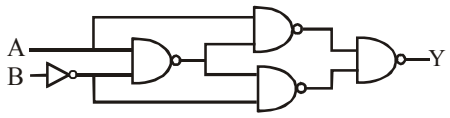
61. In a negative logic the following wave form corresponds to the :



(1) 0000000000 (2) 0101101000

(3) 1111111111 (4) 1010010111

62.

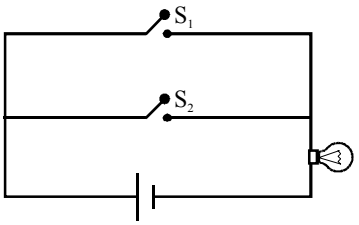


Output Y is :-

(1) $A\overline{B}+\overline{A}B$ (2) $\overline{A}\overline{B}+AB$

(3) $(A+B)\overline{A}$ (4) $(A+B)\overline{B}$

63. Make a truth table corresponding to the circuit shown in figure.



(1)

A	B	C
1	0	0
0	1	0
0	0	0
1	1	1

(2)

A	B	C
1	0	1
0	1	1
0	0	0
1	1	0

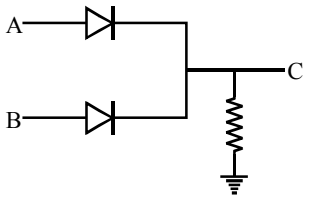
(3)

A	B	C
1	0	1
0	1	1
0	0	0
1	1	1

(4)

A	B	C
1	0	0
0	1	0
0	0	1
1	1	1

64. In the circuit below, A and B represent two inputs and C represents the output The circuit represents



(1) NOR gate (2) AND gate

(3) NAND gate (4) OR gate

ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	4	2	3	2	1	2	1	4	2	1	3	3	3	1	2	3	2	2	2	2
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	1	4	4	3	4	1	3	4	2	4	3	1	4	2	1	4	1	4	3
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	3	3	4	1	4	1	2	3	3	3	4	4	3	2	3	3	3	1	4
Que.	61	62	63	64																
Ans.	4	2	3	4																