PHYSICS

CAPACITOR

1. Two equal capacitors are first connected in series and then in parallel. The ratio of the equivalent capacities in the two cases will be:

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

2. An electron with kinetic energy K_1 enters between parallel plates of a capacitor at an angle 'α' with the plates. It leaves the plates at angle 'β' with kinetic energy K_2. Then the ratio of kinetic energies $K_1 : K_2$ will be :

(1) $\frac{\sin^2\beta}{\cos^2\alpha}$ (2) $\frac{\cos^2\beta}{\cos^2\alpha}$

(3) $\frac{\cos\beta}{\cos\alpha}$ (4) $\frac{\cos\beta}{\sin\alpha}$

3. Consider the combination of 2 capacitors C_1 and C_2, with $C_2 > C_1$, when connected in parallel, the equivalent capacitance is $\frac{15}{4}$ time the equivalent capacitance of the same connected in series. Calculate the ratio of capacitors, $\frac{C_2}{C_1}$.

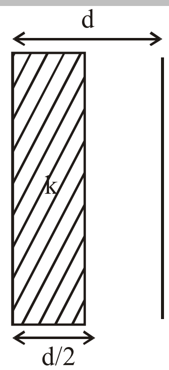
(1) $\frac{15}{11}$ (2) $\frac{111}{80}$ (3) $\frac{29}{15}$ (4) $\frac{15}{4}$

4. For changing the capacitance of a given parallel plate capacitor, a dielectric material of dielectric constant K is used, which has the same area as the plates of the capacitor. The thickness of the dielectric slab is $\frac{3}{4}$d, where 'd' is the separation between the plates of parallel plate capacitor. The new capacitance (C') in terms of original capacitance (C_0) is given by the following relation :

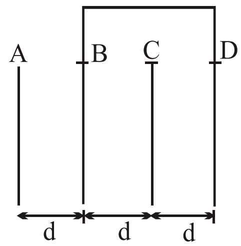
(1) $C' = \frac{3+K}{4K}C_0$ (2) $C' = \frac{4+K}{3}C_0$

(3) $C' = \frac{4K}{K+3}C_0$ (4) $C' = \frac{4}{3+K}C_0$

5. In a parallel plate capacitor set up, the plate area of capacitor is 2 m² and the plates are separated by 1m. If the space between the plates are filled with a dielectric material of thickness 0.5 m and area 2m² (see fig.) the capacitance of the set-up will be ______ ε_0. (Dielectric constant of the material = 3.2) (Round off to the Nearest Integer)

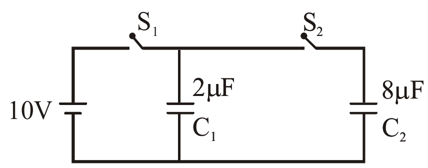


6. Four identical rectangular plates with length, l = 2 cm and breadth, b = $\frac{3}{2}$ cm are arranged as shown in figure. The equivalent capacitance between A and C is $\frac{x\varepsilon_0}{d}$. The value of x is ___. (Round off to the Nearest Integer)

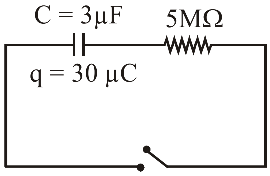


7. A parallel plate capacitor whose capacitance C is 14 pF is charged by a battery to a potential difference V = 12V between its plates. The charging battery is now disconnected and a porcelin plate with k = 7 is inserted between the plates, then the plate would oscillate back and forth between the plates with a constant mechanical energy of______ pJ. (Assume no friction)

8. A 2 μF capacitor C_1 is first charged to a potential difference of 10 V using a battery.Then the battery is removed and the capacitor is connected to an uncharged capacitor C_2 of 8μF. The charge in C_2 on equilibrium condition is_______μC. (Round off to the Nearest Integer)



9. The circuit shown in the figure consists of a charged capacitor of capacity 3 μF and a charge of 30 μC. At time t = 0, when the key is closed, the value of current flowing through the 5 MΩ resistor is 'x' μ-A. The value of 'x to the nearest integer is ________.



10. A parallel plate capacitor has plate area 100 m^2 and plate separation of 10 m. The space between the plates is filled up to a thickness 5 m with a material of dielectric constant of 10. The resultant capacitance of the system is 'x' pF.
The value of $\varepsilon_0 = 8.85 \times 10^{-12}$ F.m^{-1}.
The value of 'x' to the nearest integer is______.

11. A parallel plate capacitor with plate area 'A' and distance of separation 'd' is filled with a dielectric. What is the capacity of the capacitor when permittivity of the dielectric varies as :

$$\varepsilon(x) = \varepsilon_0 + kx, \text{ for } \left(0 < x \le \frac{d}{2}\right)$$

$$\varepsilon(x) = \varepsilon_0 + k(d-x), \text{ for } \left(\frac{d}{2} \le x \le d\right)$$

(1) $\left(\varepsilon_0 + \frac{kd}{2}\right)^{2/kA}$ (2) $\frac{kA}{2\ln\left(\frac{2\varepsilon_0 + kd}{2\varepsilon_0}\right)}$

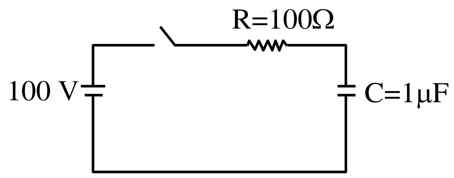
(3) 0 (4) $\frac{kA}{2}\ln\left(\frac{2\varepsilon_0}{2\varepsilon_0 - kd}\right)$

12. If q_f is the free charge on the capacitor plates and q_b is the bound charge on the dielectric slab of dielectric constant k placed between the capacitor plates, then bound charge q_b can be expressed as :

(1) $q_b = q_f\left(1 - \frac{1}{\sqrt{k}}\right)$ (2) $q_b = q_f\left(1 - \frac{1}{k}\right)$

(3) $q_b = q_f\left(1 + \frac{1}{\sqrt{k}}\right)$ (4) $q_b = q_f\left(1 + \frac{1}{k}\right)$

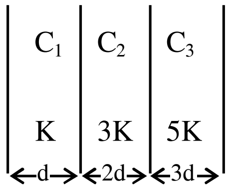
13.



A capacitor of capacitance C=1 μF is suddenly connected to a battery of 100 volt through a resistance R = 100 Ω. The time taken for the capacitor to be charged to get 50 V is :
[Take ln 2 = 0.69]

(1) 1.44×10^{-4} s (2) 3.33×10^{-4} s
(3) 0.69×10^{-4} s (4) 0.30×10^{-4} s

14. In the reported figure, a capacitor is formed by placing a compound dielectric between the plates of parallel plate capacitor. The expression for the capacity of the said capacitor will be :
(Given area of plate = A)



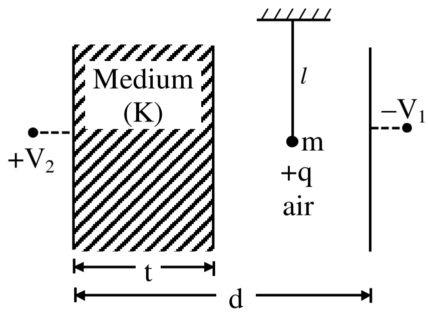
(1) $\frac{15}{34}\frac{K\varepsilon_0 A}{d}$ (2) $\frac{15}{6}\frac{K\varepsilon_0 A}{d}$

(3) $\frac{25}{6}\frac{K\varepsilon_0 A}{d}$ (4) $\frac{9}{6}\frac{K\varepsilon_0 A}{d}$

15. Two capacitors of capacities 2C and C are joined in parallel and charged up to potential V. The battery is removed and the capacitor of capacity C is filled completely with a medium of dielectric constant K. The potential difference across the capacitors will now be :

(1) $\frac{V}{K+2}$ (2) $\frac{V}{K}$ (3) $\frac{3V}{K+2}$ (4) $\frac{3V}{K}$

16. A simple pendulum of mass 'm', length 'l' and charge '+q' suspended in the electric field produced by two conducting parallel plates as shown. The value of deflection of pendulum in equilibrium position will be:



(1) $\tan^{-1}\left[\frac{q}{mg} \times \frac{C_1(V_2 - V_1)}{(C_1 + C_2)(d - t)}\right]$

(2) $\tan^{-1}\left[\frac{q}{mg} \times \frac{C_2(V_2 - V_1)}{(C_1 + C_2)(d - t)}\right]$

(3) $\tan^{-1}\left[\frac{q}{mg} \times \frac{C_2(V_1 + V_2)}{(C_1 + C_2)(d - t)}\right]$

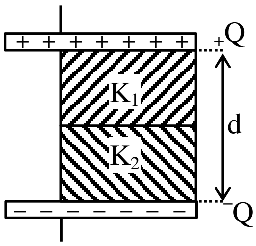
(4) $\tan^{-1}\left[\frac{q}{mg} \times \frac{C_1(V_1 + V_2)}{(C_1 + C_2)(d - t)}\right]$

17. The material filled between the plates of a parallel plate capacitor has resistivity 200 Ωm. The value of capacitance of the capacitor is 2 pF. If a potential difference of 40 V is applied across the plates of the capacitor, then the value of leakage current flowing out of the capacitor is : (given the value of relative permitivity of material is 50)

(1) 9.0 μA (2) 9.0 mA

(3) 0.9 mA (4) 0.9 μA

18. A parallel - plate capacitor with plate area A has separation d between the plates. Two dielectric slabs of dielectric constant K_1 and K_2 of same area A/2 and thickness d/2 are inserted in the space between the plates. The capacitance of the capacitor will be given by :



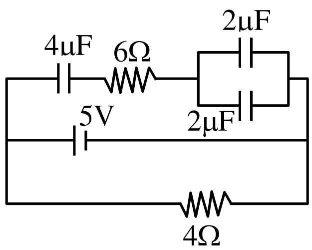
(1) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{K_1+K_2}\right)$

(2) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1K_2}{2(K_1+K_2)}\right)$

(3) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{K_1+K_2}{K_1K_2}\right)$

(4) $\frac{\varepsilon_0 A}{d}\left(\frac{1}{2}+\frac{2(K_1+K_2)}{K_1K_2}\right)$

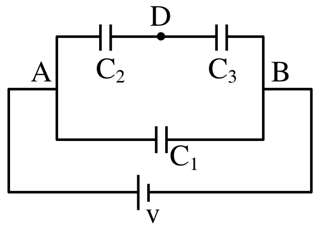
19. Calculate the amount of charge on capacitor of 4 μF. The internal resistance of battery is 1Ω :



(1) 8 μC (2) zero

(3) 16 μC (4) 4 μC

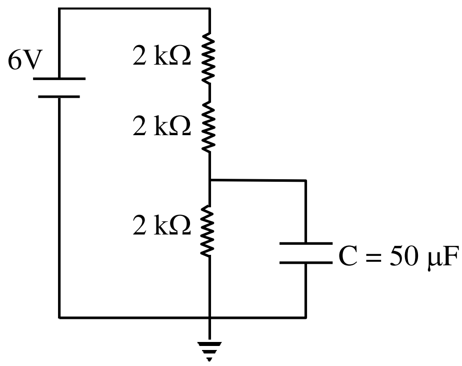
20. Three capacitors $C_1 = 2\mu F$, $C_2 = 6\ \mu F$ and $C_3 = 12\ \mu F$ are connected as shown in figure. Find the ratio of the charges on capacitors C_1, C_2 and C_3 respectively :



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

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

21. A capacitor of 50 μF is connected in a circuit as shown in figure. The charge on the upper plate of the capacitor is__________μC.



22. A parallel plate capacitor of capacitance 200 μF is connected to a battery of 200 V. A dielectric slab of dielectric constant 2 is now inserted into the space between plates of capacitor while the battery remain connected. The change in the electrostatic energy in the capacitor will be_____J.

23. A capacitor is connected to a 20 V battery through a resistance of 10Ω. It is found that the potential difference across the capacitor rises to 2 V in 1 μs. The capacitance of the capacitor is ....μF. Given : $\ln\left(\frac{10}{9}\right)=0.105$

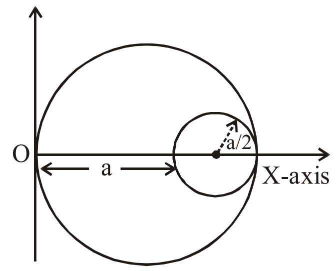
(1) 9.52 (2) 0.95

(3) 0.105 (4) 1.85

COM & COLLISION

1. A ball will a speed of 9 m/s collides with another identical ball at rest. After the collision, the direction of each ball makes an angle of 30° with the original direction. The ratio of velocities of the balls after collision is x : y, where x is ________.

2. A circular hole of radius $\left(\frac{a}{2}\right)$ is cut out of a circular disc of radius 'a' as shown in figure. The centroid of the remaining circular portion with respect to point 'O' will be :



(1) $\frac{1}{6}a$ (2) $\frac{10}{11}a$ (3) $\frac{5}{6}a$ (4) $\frac{2}{3}a$

3. Two solids A and B of mass 1 kg and 2 kg respectively are moving with equal linear momentum. The ratio of their kinetic energies $(K.E.)_A : (K.E.)_B$ will be $\frac{A}{1}$, so the value of A will be ___.

4. Two particles having masses 4 g and 16 g respectively are moving with equal kinetic energies. The ratio of the magnitudes of their linear momentum is n : 2. The value of n will be ___________.

5. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Body 'P' having mass M moving with speed 'u' has head-on collision elastically with another body 'Q' having mass 'm' initially at rest. If m << M, body 'Q' will have a maximum speed equal to '2u' after collision.

Reason R : During elastic collision, the momentum and kinetic energy are both conserved.

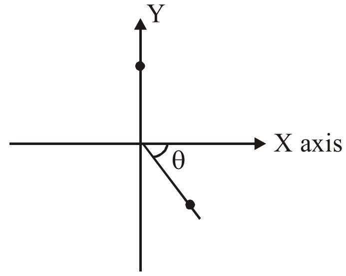
In the light of the above statements, choose the most appropriate answer from the options given below :

(1) A is not correct but R is correct.
(2) Both A and R are correct but R is NOT the correct explanation of A.
(3) Both A and R are correct and R is the correct explanation of A.
(4) A is correct but R is not correct.

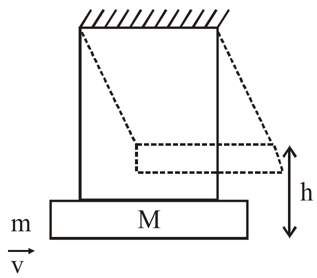
6. A ball of mass 10 kg moving with a velocity $10\sqrt{3}\,ms^{-1}$ along X-axis, hits another ball of mass 20 kg which is at rest. After collision, the first ball comes to rest and the second one disintegrates into two equal pieces. One of the pieces starts moving along Y-axis at a speed of 10 m/s. The second piece starts moving at a speed of 20 m/s at an angle θ (degree) with respect to the X-axis.

The configuration of pieces after collision is shown in the figure. The value of θ to the nearest integer is _______.

After Collision



7. A large block of wood of mass M = 5.99 kg is hanging from two long massless cords. A bullet of mass m = 10g is fired into the block and gets embedded in it. The (block + bullet) then swing upwards, their centre of mass rising a vertical distance h = 9.8 cm before the (block + bullet) pendulum comes momentarily to rest at the end of its arc. The speed of the bullet just before collision is : (Take g = 9.8 ms^{-2})

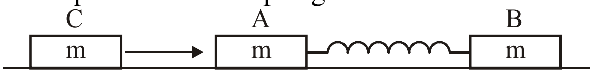


(1) 841.4 m/s (2) 811.4 m/s
(3) 831.4 m/s (4) 821.4 m/s

8. A rubber ball is released from a height of 5 m above the floor. It bounces back repeatedly, always rising to $\frac{81}{100}$ of the height through which it falls. Find the average speed of the ball. (Take g = 10 ms^{-2})

(1) 3.0 ms^{-1} (2) 3.50 ms^{-1}
(3) 2.0 ms^{-1} (4) 2.50 ms^{-1}

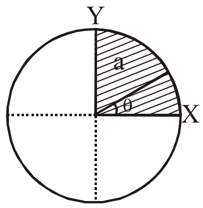
9. Two identical blocks A and B each of mass m resting on the smooth horizontal floor are connected by a light spring of natural length L and spring constant K. A third block C of mass m moving with a speed v along the line joining A and B collides with A.The maximum compression in the spring is



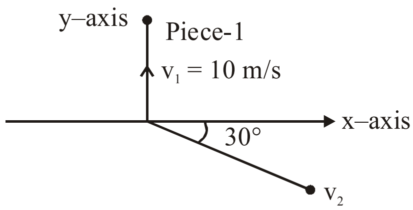
(1) $v\sqrt{\frac{M}{2K}}$ (2) $\sqrt{\frac{mv}{2K}}$

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

10. The disc of mass M with uniform surface mass density σ is shown in the figure. The centre of mass of the quarter disc (the shaded area) is at the position $\frac{x}{3}\frac{a}{\pi}, \frac{x}{3}\frac{a}{\pi}$ where x is ________.
(Round off to the Nearest Integer)
[a is an area as shown in the figure]



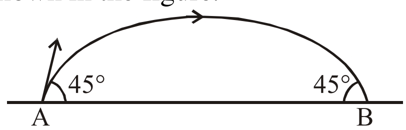
11. A ball of mass 10 kg moving with a velocity $10\sqrt{3}$ m/s along the x-axis, hits another ball of mass 20 kg which is at rest. After the collision, first ball comes to rest while the second ball disintegrates into two equal pieces. One piece starts moving along y-axis with a speed of 10 m/s. The second piece starts moving at an angle of 30° with respect to the x-axis. The velocity of the ball moving at 30° with x-axis is x m/s. The configuration of pieces after collision is shown in the figure below. The value of x to the nearest integer is ______ .



12. An object of mass m_1 collides with another object of mass m_2, which is at rest. After the collision the objects move with equal speeds in opposite direction. The ratio of the masses $m_2 : m_1$ is :

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

13. The projectile motion of a particle of mass 5 g is shown in the figure.

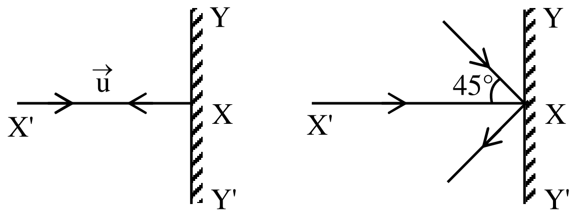


The initial velocity of the particle is $5\sqrt{2}$ ms^{-1} and the air resistance is assumed to be negligible. The magnitude of the change in momentum between the points A and B is x × 10^{-2} $kgms^{-1}$. The value of x, to the nearest integer, is _______.

14. A bullet of '4g' mass is fired from a gun of mass 4 kg. If the bullet moves with the muzzle speed of 50 ms^{-1}, the impulse imparted to the gun and velocity of recoil of gun are :
(1) 0.4 kg ms^{-1}, 0.1 ms^{-1}
(2) 0.2 kg ms^{-1}, 0.05 ms^{-1}
(3) 0.2 kg ms^{-1}, 0.1 ms^{-1}
(4) 0.4 kg ms^{-1}, 0.05 ms^{-1}

15. The position of the centre of mass of a uniform semi-circular wire of radius 'R' placed in x-y plane with its centre at the origin and the line joining its ends as x-axis is given by $\left(0, \frac{xR}{\pi}\right)$.
Then, the value of $|x|$ is __________.

16. Two billiard balls of equal mass 30 g strike a rigid wall with same speed of 108 kmph (as shown) but at different angles. If the balls get reflected with the same speed then the ratio of the magnitude of impulses imparted to ball 'a' and ball 'b' by the wall along 'X' direction is :



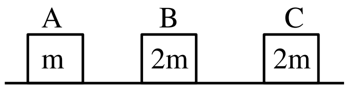
ball (a) ball (b)

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

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

17. A body of mass 2 kg moving with a speed of 4 m/s. makes an elastic collision with another body at rest and continues to move in the original direction but with one fourth of its initial speed. The speed of the two body centre of mass is $\frac{x}{10}$ m/s. Then the value of x is_______.

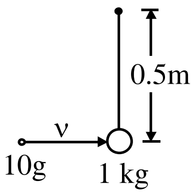
18. Three objects A, B and C are kept in a straight line on a frictionless horizontal surface. The masses of A, B and C are m, 2 m and 2 m respectively. A moves towards B with a speed of 9 m/s and makes an elastic collision with it. Thereafter B makes a completely inelastic collision with C. All motions occur along same straight line. The final speed of C is :



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

19. The initial mass of a rocket is 1000 kg. Calculate at what rate the fuel should be burnt so that the rocket is given an acceleration of 20 ms^{-2}. The gases come out at a relative speed of 500 ms^{-1} with respect to the rocket :[Use g = 10 m/s^2]
(1) 6.0×10^2 kg s^{-1} (2) 500 kg s^{-1}
(3) 10 kg s^{-1} (4) 60 kg s^{-1}

20. A bullet of 10 g, moving with velocity v, collides head-on with the stationary bob of a pendulum and recoils with velocity 100 m/s. The length of the pendulum is 0.5 m and mass of the bob is 1 kg. The minimum value of v = _____ m/s so that the pendulum describes a circle. (Assume the string to be inextensible and g = 10 m/s^2)



21. A body of mass M moving at speed V_0 collides elastically with a mass 'm' at rest. After the collision, the two masses move at angles θ_1 and θ_2 with respect to the initial direction of motion of the body of mass M. The largest possible value of the ratio M/m, for which the angles θ_1 and θ_2 will be equal, is :
(1) 4 (2) 1 (3) 3 (4) 2

22. A block moving horizontally on a smooth surface with a speed of 40 ms^{-1} splits into two equal parts. If one of the parts moves at 60 ms^{-1} in the same direction, then the fractional change in the kinetic energy will be x : 4 where x = ___________.

23. A block moving horizontally on a smooth surface with a speed of 40 m/s splits into two parts with masses in the ratio of 1:2. If the smaller part moves at 60 m/s in the same direction, then the fractional change in kinetic energy is :-
(1) $\frac{1}{3}$ (2) $\frac{2}{3}$ (3) $\frac{1}{8}$ (4) $\frac{1}{4}$

24. A block moving horizontally on a smooth surface with a speed of 40 m/s splits into two parts with masses in the ratio of 1:2. If the smaller part moves at 60 m/s in the same direction, then the fractional change in kinetic energy is :-
(1) $\frac{1}{3}$ (2) $\frac{2}{3}$ (3) $\frac{1}{8}$ (4) $\frac{1}{4}$

CIRCULAR MOTION

1. If $\vec{P} \times \vec{Q} = \vec{Q} \times \vec{P}$, the angle between $\vec{P}$ and $\vec{Q}$ is θ (0° < θ < 360°). The value of 'θ' will be _________°.

2. A particle is moving with uniform speed along the circumference of a circle of radius R under the action of a central fictitious force F which is inversely proportional to R^3. Its time period of revolution will be given by :
(1) $T \propto R^2$ (2) $T \propto R^{\frac{3}{2}}$
(3) $T \propto R^{\frac{5}{2}}$ (4) $T \propto R^{\frac{4}{3}}$

3. A block of 200 g mass moves with a uniform speed in a horizontal circular groove, with vertical side walls of radius 20 cm. If the block takes 40 s to complete one round, the normal force by the side walls of the groove is :
(1) 0.0314 N (2) 9.859×10^{-2} N
(3) 6.28×10^{-3} N (4) 9.859×10^{-4} N

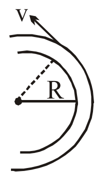
4. **Statement I :** A cyclist is moving on an unbanked road with a speed of 7 kmh^{-1} and takes a sharp circular turn along a path of radius of 2m without reducing the speed. The static friction coefficient is 0.2. The cyclist will not slip and pass the curve (g = 9.8 m/s^2)

Statement II : If the road is banked at an angle of 45°, cyclist can cross the curve of 2m radius with the speed of 18.5 kmh^{-1} without slipping.

In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is incorrect and statement II is correct
(2) Statement I is correct and statement II is incorrect
(3) Both statement I and statement II are false
(4) Both statement I and statement II are true

5. The angular speed of truck wheel is increased from 900 rpm to 2460 rpm in 26 seconds. The number of revolutions by the truck engine during this time is _______.
(Assuming the acceleration to be uniform).

6. A modern grand-prix racing car of mass m is travelling on a flat track in a circular arc of radius R with a speed v. If the coefficient of static friction between the tyres and the track is μ_s, then the magnitude of negative lift F_L acting downwards on the car is : (Assume forces on the four tyres are identical and g = acceleration due to gravity)



(1) $m\left(\frac{v^2}{\mu_s R}+g\right)$ (2) $m\left(\frac{v^2}{\mu_s R}-g\right)$

(3) $m\left(g-\frac{v^2}{\mu_s R}\right)$ (4) $-m\left(g+\frac{v^2}{\mu_s R}\right)$

7. The normal reaction 'N' for a vehicle of 800 kg mass, negotiating a turn on a 30° banked road at maximum possible speed without skidding is _______ $\times 10^3$ kg m/s^2.
[Take : cos 30° = 0.87, μ_s = 0.2]
(1) 10.2 (2) 7.2 (3) 12.4 (4) 6.96

8. A body rotating with an angular speed of 600 rpm is uniformly accelerated to 1800 rpm in 10 sec. The number of rotations made in the process is___.

9. A particle of mass m is suspended from a ceiling through a string of length L. The particle moves in a horizontal circle of radius r such that $r = \frac{L}{\sqrt{2}}$.The speed of particle will be :

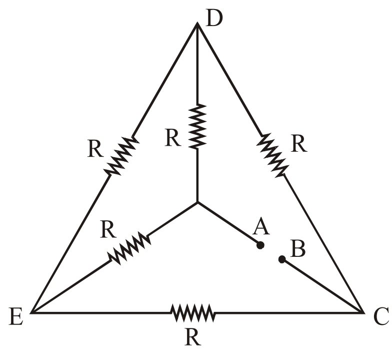
(1) $\sqrt{rg}$ (2) $\sqrt{2rg}$ (3) $2\sqrt{rg}$ (4) $\sqrt{\frac{rg}{2}}$

10. A huge circular arc of length 4.4 ly subtends an angle '4s' at the centre of the circle. How long it would take for a body to complete 4 revolution if its speed is 8 AU per second ?
Given : 1 ly = 9.46×10^{15} m; AU = 1.5×10^{11} m
(1) 4.1×10^8 s (2) 4.5×10^{10} s
(3) 3.5×10^6 s (4) 7.2×10^8 s

11. Two satellites revolve around a planet in coplanar circular orbits in anticlockwise direction. Their period of revolutions are 1 hour and 8 hours respectively. The radius of the orbit of nearer satellite is 2×10^3 km. The angular speed of the farther satellite as observed from the nearer satellite at the instant when both the satellites are closest is $\frac{\pi}{x}$ rad h^{-1} where x is ....

CURRENT ELECTRICITY

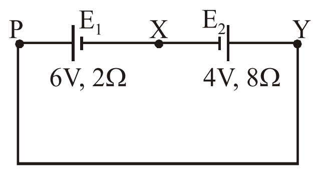
1. Five equal resistances are connected in a network as shown in figure. The net resistance between the points A and B is :



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

2. In an electrical circuit, a battery is connected to pass 20 C of charge through it in a certain given time. The potential difference between two plates of the battery is maintained at 15 V. The work done by the battery is ______J.

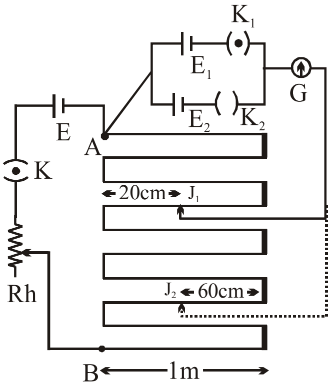
3. A cell E_1 of emf 6V and internal resistance 2Ω is connected with another cell E_2 of emf 4V and internal resistance 8Ω (as shown in the figure). The potential difference across points X and Y is :



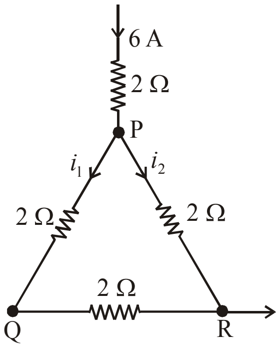
(1) 10.0 V (2) 3.6 V
(3) 5.6V (4) 2.0 V

4. A cylindrical wire of radius 0.5 mm and conductivity 5×10^7 S/m is subjected to an electric field of 10 mV/m. The expected value of current in the wire will be $x^3\pi$ mA. The value of x is ____.

5. In the given circuit of potentiometer, the potential difference E across AB (10m length) is larger than E_1 and E_2 as well. For key K_1 (closed), the jockey is adjusted to touch the wire at point J_1 so that there is no deflection in the galvanometer. Now the first battery (E_1) is replaced by second battery (E_2) for working by making K_1 open and K_2 closed. The galvanometer gives then null deflection at J_2. The value of $\frac{E_1}{E_2}$ is $\frac{a}{b}$, where a = ___.



6. A current of 6 A enters one corner P of an equilateral triangle PQR having 3 wires of resistance 2Ω each and leaves by the corner R. The currents i_1 in ampere is __________.



7. A wire of 1Ω has a length of 1m. It is stetched till its length increases by 25%. The percentage change in resistance to the neartest integer is :-

(1) 56% (2) 25% (3) 12.5% (4) 76%

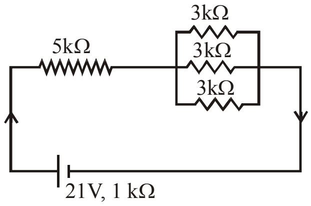
8. A conducting wire of length 'l', area of cross-section A and electric resistivity ρ is connected between the terminals of a battery. A potential difference V is developed between its ends, causing an electric current.

If the length of the wire of the same material is doubled and the area of cross-section is halved, the resultant current would be :

(1) $\frac{1}{4}\frac{VA}{\rho l}$ (2) $\frac{3}{4}\frac{VA}{\rho l}$

(3) $\frac{1}{4}\frac{\rho l}{VA}$ (4) $4\frac{VA}{\rho l}$

9. In the figure given, the electric current flowing through the 5 kΩ resistor is 'x' mA.



The value of x to the nearest integer is _______.

10. A resistor develops 500 J of thermal energy in 20s when a current of 1.5 A is passed through it. If the current is increased from 1.5 A to 3A, what will be the energy developed in 20 s.

(1) 1500 J (2) 1000 J

(3) 500 J (4) 2000 J

11. The energy dissipated by a resistor is 10 mJ in 1s when an electric current of 2 mA flows through it. The resistance is _______ Ω. (Round off to the Nearest Integer)

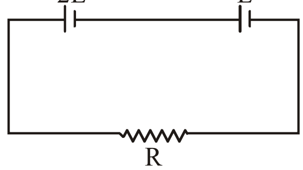
12. A current of 10A exists in a wire of crosssectional area of 5 mm^2 with a drift velocity of 2×10^{-3} ms^{-1}. The number of free electrons in each cubic meter of the wire is ___.

(1) 2×10^6 (2) 625×10^{25}

(3) 2×10^{25} (4) 1×10^{23}

13. The equivalent resistance of series combination of two resistors is 's'. When they are connected in parallel, the equivalent resistance is 'p'. If s = np, then the minimum value for n is ___. (Round off to the Nearest Integer)

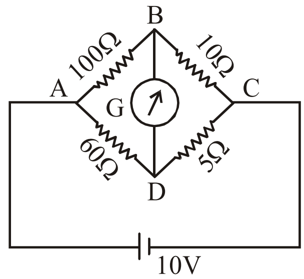
14. Two cells of emf 2E and E with internal resistance r_1 and r_2 respectively are connected in series to an external resistor R (see figure). The value of R, at which the potential difference across the terminals of the first cell becomes zero is :



(1) $r_1 + r_2$ (2) $\frac{r_1}{2} - r_2$

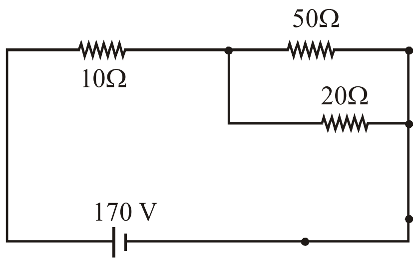
(3) $\frac{r_1}{2} + r_2$ (4) $r_1 - r_2$

15. The four arms of a Wheatstone bridge have resistances as shown in the figure. A galvanometer of 15 Ω resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of 10V is maintained across AC.



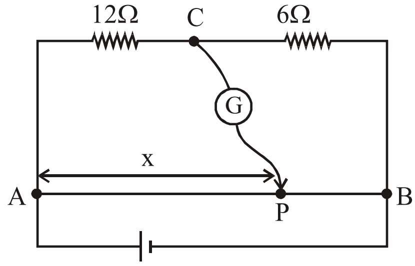
(1) 2.44 μA (2) 2.44 mA
(3) 4.87 mA (4) 4.87 μA

16. The voltage across the 10Ω resistor in the given circuit is x volt.



The value of 'x' to the nearest integer is ______.

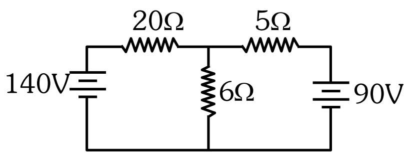
17. Consider a 72 cm long wire AB as shown in the figure. The galvanometer jockey is placed at P on AB at a distance x cm from A. The galvanometer shows zero deflection.



The value of x, to the nearest integer, is

18. Two wires of same length and thickness having specific resistances 6Ω cm and 3Ω cm respectively are connected in parallel. The effective resistivity is ρ Ω cm. The value of ρ, to the nearest integer, is_____.

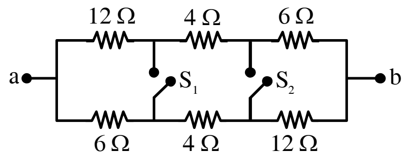
19.



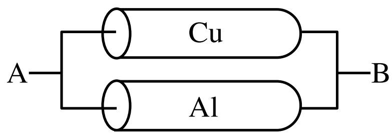
The value of current in the 6Ω resistance is :
(1) 4A (2) 8A
(3) 10A (4) 6A

20. A current of 5 A is passing through a non-linear magnesium wire of cross-section 0.04 m^2. At every point the direction of current density is at an angle of 60° with the unit vector of area of cross-section. The magnitude of electric field at every point of the conductor is : (Resistivity of magnesium $\rho = 44 \times 10^{-8}$ Ωm)
(1) 11×10^{-2} V/m (2) 11×10^{-7} V/m
(3) 11×10^{-5} V/m (4) 11×10^{-3} V/m

21. In the given figure switches S_1 and S_2 are in open condition. The resistance across ab when the switches S_1 and S_2 are closed is _________Ω.



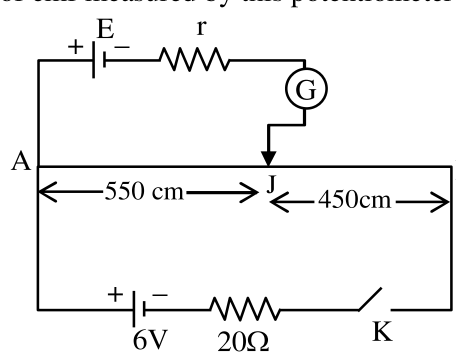
22. A Copper (Cu) rod of length 25 cm and cross-sectional area 3 mm^2 is joined with a similar Aluminium (Al) rod as shown in figure. Find the resistance of the combination between the ends A and B. (Take Resistivity of Copper = 1.7×10^{-8} Ωm Resistivity of Aluminium = 2.6×10^{-8} Ωm)



(1) 2.170 mΩ (2) 1.420 mΩ
(3) 0.0858 mΩ (4) 0.858 mΩ

23. In an electric circuit, a call of certain emf provides a potential difference of 1.25 V across a load resistance of 5 Ω. However, it provides a potential difference of 1 V across a load resistance of 2Ω. The emf of the cell is given by $\frac{x}{10}$ V. Then the value of x is ________.

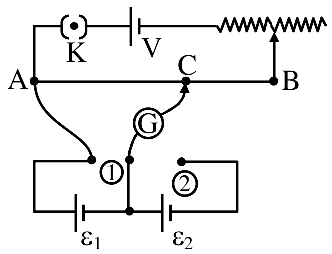
24. In the given figure, there is a circuit of potentiometer of length AB = 10 m. The resistance per unit length is 0.1 Ω per cm. Across AB, a battery of emf E and internal resistance 'r' is connected. The maximum value of emf measured by this potentiometer is :



(1) 5 V (2) 2.25 V (3) 6 V (4) 2.75 V

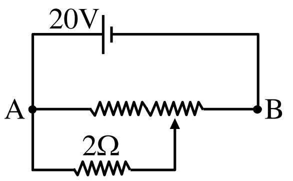
25. An electric bulb rated as 200 W at 100 V is used in a circuit having 200 V supply. The resistance 'R' that must be put in series with the bulb so that the bulb delivers the same power is _____ Ω.

26. In the given potentiometer circuit arrangement, the balancing length AC is measured to be 250 cm. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes 400 cm. The ratio of the emf of two cells, $\frac{\varepsilon_1}{\varepsilon_2}$ is :



(1) $\frac{5}{3}$ (2) $\frac{8}{5}$ (3) $\frac{4}{3}$ (4) $\frac{3}{2}$

27. The given potentiometer has its wire of resistance 10Ω. When the sliding contact is in the middle of the potentiometer wire, the potential drop across 2Ω resistor is :

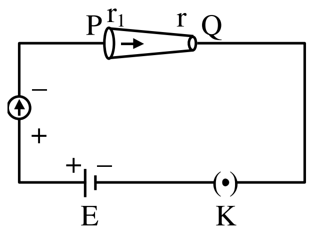


(1) 10 V (2) 5 V

(3) $\frac{40}{9}$ V (4) $\frac{40}{11}$ V

28. A 16 Ω wire is bend to form a square loop. A 9V supply having internal resistance of 1 Ω is connected across one of its sides. The potential drop across the diagonals of the square loop is _________ $\times 10^{-1}$ V

29. In the given figure, a battery of emf E is connected across a conductor PQ of length 'l' and different area of cross-sections having radii r_1 and r_2 ($r_2 < r_1$).



Choose the correct option as one moves from P to Q :

(1) Drift velocity of electron increases.

(2) Electric field decreases.

(3) Electron current decreases.

(4) All of these

30. The resistance of a conductor at 15°C is 16 Ω and at 100°C is 20Ω. What will be the temperature coefficient of resistance of the conductor?

(1) $0.010°C^{-1}$ (2) $0.033°C^{-1}$

(3) $0.003°C^{-1}$ (4) $0.042°C^{-1}$

31. For the circuit shown, the value of current at time t = 3.2 s will be ______ A.

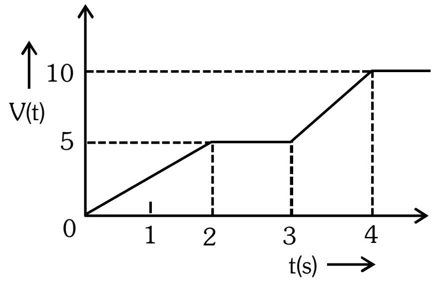


Figure 1

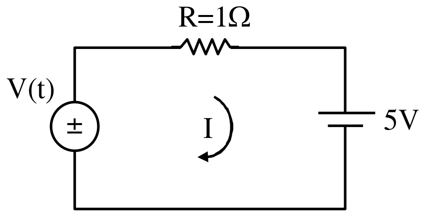
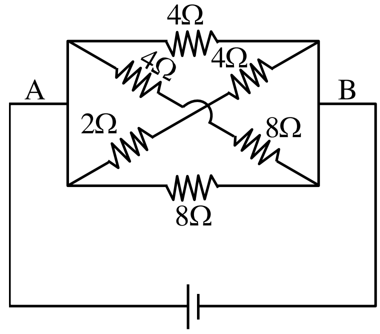


Figure-2

[Voltage distribution V(t) is shown by Fig. (1) and the circuit is shown in Fig. (2)]

32. In the given figure, the emf of the cell is 2.2 V and if internal resistance is 0.6Ω. Calculate the power dissipated in the whole circuit :



2.2 V, r=0.6Ω

(1) 1.32 W (2) 0.65 W

(3) 2.2 W (4) 4.4 W

33. What equal length of an iron wire and a copper-nickel alloy wire, each of 2 mm diameter connected parallel to give an equivalent resistance of 3Ω?
(Given resistivities of iron and copper-nickel alloy wire are 12 μΩ cm and 51 μΩ cm respectively)
(1) 82 m (2) 97 m
(3) 110 m (4) 90 m

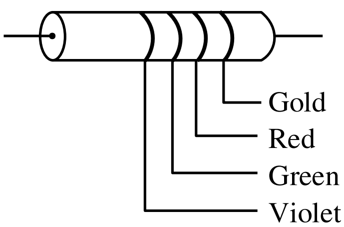
34. If you are provided a set of resistances 2Ω, 4Ω, 6Ω and 8Ω. Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}\Omega$.
(1) 4Ω and 6Ω are in parallel with 2Ω and 8 Ω in series
(2) 6Ω and 8Ω are in parallel with 2Ω and 4Ω in series
(3) 2Ω and 6Ω are in parallel with 4Ω and 8 Ω in series
(4) 2Ω and 4Ω are in parallel with 6Ω and 8Ω in series

35. An electric bulb of 500 watt at 100 volt is used in a circuit having a 200 V supply. Calculate the resistance R to be connected in series with the bulb so that the power delivered by the bulb is 500 W.
(1) 20 Ω (2) 30 Ω
(3) 5 Ω (4) 10 Ω

36. Five identical cells each of internal resistance 1Ω and emf 5V are connected in series and in parallel with an external resistance 'R'. For what value of 'R', current in series and parallel combination will remain the same ?
(1) 1 Ω (2) 25 Ω
(3) 5 Ω (4) 10 Ω

37. First, a set of n equal resistors of 10 Ω each are connected in series to a battery of emf 20V and internal resistance 10 Ω. A current I is observed to flow. Then, the n resistors are connected in parallel to the same battery. It is observed that the current is increased 20 times, then the value of n is ....

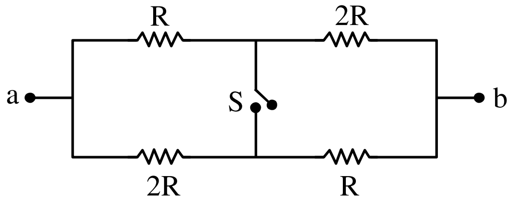
38. The colour coding on a carbon resistor is shown in the given figure. The resistance value of the given resistor is :



(1) (5700 ± 285) Ω (2) (7500 ± 750) Ω
(3) (5700 ± 375) Ω (4) (7500 ± 375) Ω

39. For full scale deflection of total 50 divisions, 50 mV voltage is required in galvanometer. The resistance of galvanometer if its current sensitivity is 2 div/mA will be :
(1) 1 Ω (2) 5 Ω
(3) 4 Ω (4) 2 Ω

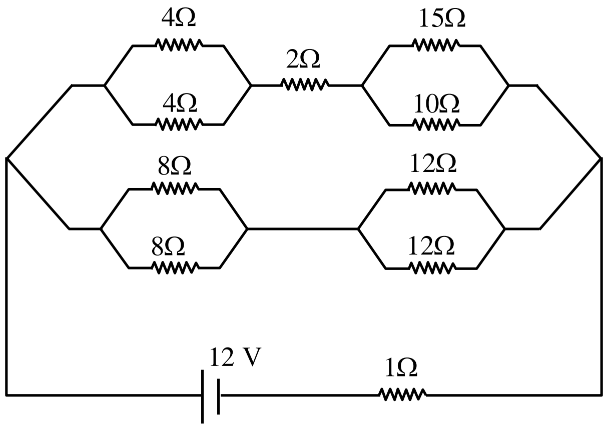
40. The ratio of the equivalent resistance of the network (shown in figure) between the points a and b when switch is open and switch is closed is x : 8. The value of x is _______.



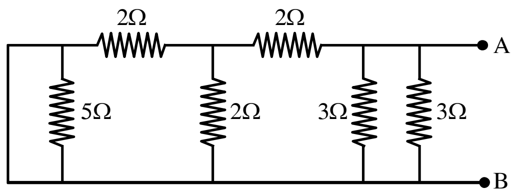
41. Consider a galvanometer shunted with 5Ω resistance and 2% of current passes through it. What is the resistance of the given galvanometer ?
(1) 300 Ω (2) 344 Ω
(3) 245 Ω (4) 226 Ω

42. A square shaped wire with resistance of each side 3Ω is bent to form a complete circle. The resistance between two diametrically opposite points of the circle in unit of Ω will be ______.

43. The voltage drop across 15Ω resistance in the given figure will be______V.



44. The equivalent resistance of the given circuit between the terminals A and B is :



(1) 0 Ω (2) 3Ω
(3) $\frac{9}{2}\Omega$ (4) 1Ω

45. A resistor dissipates 192 J of energy in 1 s when a current of 4A is passed through it. Now, when the current is doubled, the amount of thermal energy dissipated in 5 s in______J.

46. A uniform heating wire of resistance 36 Ω is connected across a potential difference of 240 V. The wire is then cut into half and potential difference of 240 V is applied across each half separately. The ratio of power dissipation in first case to the total power dissipation in the second case would be 1 : x, where x is...........

ELASTICITY

1. If Y, K and η are the values of Young's modulus, bulk modulus and modulus of rigidity of any material respectively. Choose the correct relation for these parameters.

(1) $Y = \dfrac{9K\eta}{3K-\eta} N/m^2$ (2) $\eta = \dfrac{3YK}{9K+Y} N/m^2$

(3) $Y = \dfrac{9K\eta}{2\eta+3K} N/m^2$ (4) $K = \dfrac{Y\eta}{9\eta-3Y} N/m^2$

2. A uniform metallic wire is elongated by 0.04 m when subjected to a linear force F. The elongation, if its length and diameter is doubled and subjected to the same force will be _____ cm.

3. The normal density of a material is ρ and its bulk modulus of elasticity is K. The magnitude of increase in density of material, when a pressure P is applied uniformly on all sides, will be :

(1) $\dfrac{\rho K}{P}$ (2) $\dfrac{\rho P}{K}$ (3) $\dfrac{K}{\rho P}$ (4) $\dfrac{PK}{\rho}$

4. The length of metallic wire is ℓ_1 when tension in it is T_1. It is ℓ_2 when the tension is T_2. The original length of the wire will be –

(1) $\dfrac{\ell_1+\ell_2}{2}$ (2) $\dfrac{T_2\ell_1+T_1\ell_2}{T_1+T_2}$

(3) $\dfrac{T_2\ell_1-T_1\ell_2}{T_2-T_1}$ (4) $\dfrac{T_1\ell_1-T_2\ell_2}{T_2-T_1}$

5. An object is located at 2 km beneath the surface of the water. If the fractional compression $\dfrac{\Delta V}{V}$ is 1.36% , the ratio of hydraulic stress to the corresponding hydraulic strain will be _______. [Given : density of water is 1000 kg m^{-3} and $g = 9.8\ ms^{-2}$.]

(1) $1.96 \times 10^7\ Nm^{-2}$ (2) $1.44 \times 10^7\ Nm^{-2}$

(3) $2.26 \times 10^9\ Nm^{-2}$ (4) $1.44 \times 10^9\ Nm^{-2}$

6. Two separate wires A and B are stretched by 2 mm and 4 mm respectively, when they are subjected to a force of 2 N. Assume that both the wires are made up of same material and the radius of wire B is 4 times that of the radius of wire A. The length of the wires A and B are in the ratio of a : b. Then a/b can be expressed as 1/x where x is _______ .

7. The value of tension in a long thin metal wire has been changed from T_1 to T_2. The lengths of the metal wire at two different values of tension T_1 and T_2 are ℓ_1 and ℓ_2 respectively. The actual length of the metal wire is :

(1) $\dfrac{T_1\ell_2-T_2\ell_1}{T_1-T_2}$ (2) $\dfrac{T_1\ell_1-T_2\ell_2}{T_1-T_2}$

(3) $\dfrac{\ell_1+\ell_2}{2}$ (4) $\sqrt{T_1T_2\ell_1\ell_2}$

8. The length of a metal wire is ℓ_1, when the tension in it is T_1 and is ℓ_2 when the tension is T_2. The natural length of the wire is :

(1) $\sqrt{\ell_1\ell_2}$ (2) $\dfrac{\ell_1T_2-\ell_2T_1}{T_2-T_1}$

(3) $\dfrac{\ell_1T_2+\ell_2T_1}{T_2+T_1}$ (4) $\dfrac{\ell_1+\ell_2}{2}$

9. The area of cross-section of a railway track is 0.01 m^2. The temperature variation is 10°C. Coefficient of linear expansion of material of track is 10^{-5}/°C. The energy stored per meter in the track is _______ J/m.
(Young's modulus of material of track is 10^{11} Nm^{-2})

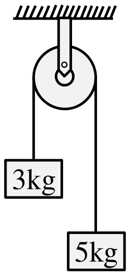
10. Two wires of same length and radius are joined end to end and loaded. The Young's modulii of the materials of the two wires are Y_1 and Y_2. The combination behaves as a single wire then its Young's modulus is :

(1) $Y = \dfrac{2Y_1Y_2}{3(Y_1+Y_2)}$ (2) $Y = \dfrac{2Y_1Y_2}{Y_1+Y_2}$

(3) $Y = \dfrac{Y_1Y_2}{2(Y_1+Y_2)}$ (4) $Y = \dfrac{Y_1Y_2}{Y_1+Y_2}$

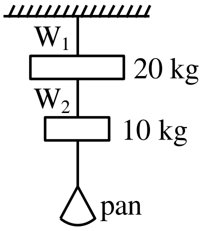
11. A stone of mass 20 g is projected from a rubber catapult of length 0.1 m and area of cross section 10^{-6} m^2 stretched by an amount 0.04 m. The velocity of the projected stone is __________ m/s. (Young's modulus of rubber = 0.5×10^9 N/m^2)

12. Two blocks of masses 3 kg and 5 kg are connected by a metal wire going over a smooth pulley. The breaking stress of the metal is $\frac{24}{\pi} \times 10^2$ Nm^{-2}. What is the minimum radius of the wire? (Take g = 10 ms^{-2})



(1) 125 cm (2) 1250 cm
(3) 12.5 cm (4) 1.25 cm

13. Wires W_1 and W_2 are made of same material having the breaking stress of 1.25×10^9 N/m^2. W_1 and W_2 have cross-sectional area of 8×10^{-7} m^2 and 4×10^{-7} m^2, respectively. Masses of 20 kg and 10 kg hang from them as shown in the figure. The maximum mass that can be placed in the pan without breaking the wires is ____ kg. (Use g = 10 m/s^2)



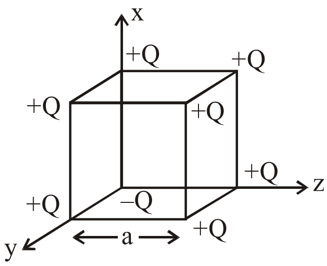
14. A uniform heavy rod of weight 10 kg ms^{-2}, cross-sectional area 100 cm^2 and length 20 cm is hanging from a fixed support. Young modulus of the material of the rod is 2×10^{11} Nm^{-2}. Neglecting the lateral contraction, find the elongation of rod due to its own weight.
(1) 2×10^{-9} m (2) 5×10^{-8} m
(3) 4×10^{-8} m (4) 5×10^{-10} m

15. When a rubber ball is taken to a depth of __________m in deep sea, its volume decreases by 0.5%. (The bulk modulus of rubber = 9.8×10^8 Nm^{-2} Density of sea water = 10^3 kgm^{-3} (g = 9.8 m/s^2)

16. Four identical hollow cylindrical columns of mild steel support a big structure of mass 50×10^3 kg, The inner and outer radii of each column are 50 cm and 100 cm respectively. Assuming uniform local distribution, calculate the compression strain of each column. [Use Y = 2.0×10^{11} Pa, g = 9.8 m/s^2]
(1) 3.60×10^{-8} (2) 2.60×10^{-7}
(3) 1.87×10^{-3} (4) 7.07×10^{-4}

ELECTROSTATICS

1. A cube of side 'a' has point charges +Q located at each of its vertices except at the origin where the charge is –Q. The electric field at the centre of cube is :



(1) $\frac{-Q}{3\sqrt{3}\,\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

(2) $\frac{-2Q}{3\sqrt{3}\,\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

(3) $\frac{2Q}{3\sqrt{3}\,\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

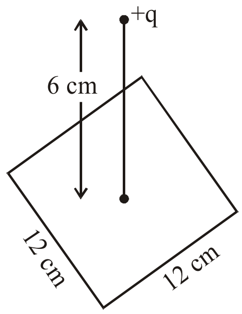
(4) $\frac{Q}{3\sqrt{3}\,\pi\varepsilon_0 a^2}(\hat{x}+\hat{y}+\hat{z})$

2. Two electrons each are fixed at a distance '2d'. A third charge proton placed at the midpoint is displaced slightly by a distance x (x << d) perpendicular to the line joining the two fixed charges. Proton will execute simple harmonic motion having angular frequency : (m = mass of charged particle)

(1) $\left(\frac{2q^2}{\pi\varepsilon_0 md^3}\right)^{\frac{1}{2}}$ (2) $\left(\frac{\pi\varepsilon_0 md^3}{2q^2}\right)^{\frac{1}{2}}$

(3) $\left(\frac{q^2}{2\pi\varepsilon_0 md^3}\right)^{\frac{1}{2}}$ (4) $\left(\frac{2\pi\varepsilon_0 md^3}{q^2}\right)^{\frac{1}{2}}$

3. A point charge of +12 μC is at a distance 6 cm vertically above the centre of a square of side 12 cm as shown in figure. The magnitude of the electric flux through the square will be ______ $\times 10^3$ Nm^2/C.

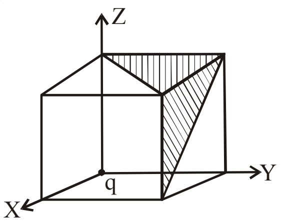


4. The electric field in a region is given $\vec{E}=\left(\frac{3}{5}E_0\hat{i}+\frac{4}{5}E_0\hat{j}\right)\frac{N}{C}$. The ratio of flux of reported field through the rectangular surface of area 0.2 m^2 (parallel to y – z plane) to that of the surface of area 0.3 m^2 (parallel to x – z plane) is a : b, where a = _____.

[Here $\hat{i}, \hat{j}$ and $\hat{k}$ are unit vectors along x, y and z-axes respectively]

5. 512 identical drops of mercury are charged to a potential of 2V each. The drops are joined to form a single drop. The potential of this drop is ____ V.

6. A charge 'q' is placed at one corner of a cube as shown in figure. The flux of electrostatic field $\vec{E}$ through the shaded area is :



(1) $\frac{q}{4\varepsilon_0}$ (2) $\frac{q}{24\varepsilon_0}$

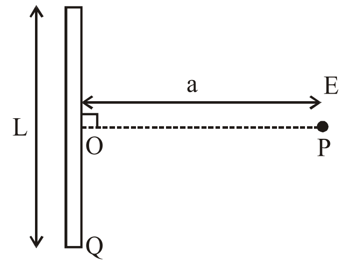
(3) $\frac{q}{48\varepsilon_0}$ (4) $\frac{q}{8\varepsilon_0}$

7. Two small spheres each of mass 10 mg are suspended from a point by threads 0.5 m long. They are equally charged and repel each other to a distance of 0.20 m. The charge on each of the sphere is $\frac{a}{21}\times10^{-8}$ C. The value of 'a' will be ______. [Given g = 10 ms^{-2}]

8. Two identical conducting spheres with negligible volume have 2.1 nC and –0.1 nC charges, respectively. They are brought into contact and then separated by a distance of 0.5 m. The electrostatic force acting between the spheres is__________$\times 10^{-9}$ N.

[Given : $4\pi\varepsilon_0 = \frac{1}{9\times10^9}$ SI unit]

9. Find the electric field at point P (as shown in figure) on the perpendicular bisector of a uniformly charged thin wire of length L carrying a charge Q. The distance of the point P from the centre of the rod is $a=\frac{\sqrt{3}}{2}L$.



(1) $\frac{\sqrt{3}Q}{4\pi\varepsilon_0 L^2}$ (2) $\frac{Q}{3\pi\varepsilon_0 L^2}$

(3) $\frac{Q}{2\sqrt{3}\pi\varepsilon_0 L^2}$ (4) $\frac{Q}{4\pi\varepsilon_0 L^2}$

10. 27 similar drops of mercury are maintained at 10 V each. All these spherical drops combine into a single big drop. The potential energy of the bigger drop is .... times that of a smaller drop.

11. Given below are two statements :

Statement I : An electric dipole is placed at the centre of a hollow sphere. The flux of electric field through the sphere is zero but the electric field is not zero anywhere in the sphere.

Statement II : If R is the radius of a solid metallic sphere and Q be the total charge on it. The electric field at any point on the spherical surface of radius r (< R) is zero but the electric flux passing through this closed spherical surface of radius r is not zero.

In the light of the above statements, choose the correct answer from the options given below :

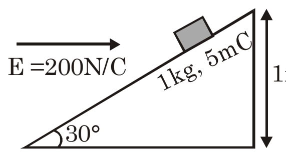
(1) Both Statement I and Statement II are true

(2) Statement I is true but Statement II is false

(3) Both Statement I and Statement II are false

(4) Statement I is false but Statement II is true.

12. An inclined plane making an angle of 30° with the horizontal is placed in a uniform horizontal electric field 200 $\frac{N}{C}$ as shown in the figure. A body of mass 1kg and charge 5 mC is allowed to slide down from rest at a height of 1m. If the coefficient of friction is 0.2, find the time taken by the body to reach the bottom.[g = 9.8 m/s^2, $\sin 30° = \frac{1}{2}$; $\cos 30° = \frac{\sqrt{3}}{2}$]



(1) 0.92 s (2) 0.46 s

(3) 2.3 s (4) 1.3 s

13. Find out the surface charge density at the intersection of point x = 3 m plane and x-axis, in the region of uniform line charge of 8 nC/m lying along the z-axis in free space.

(1) 0.424 nC m^{-2} (2) 47.88 C/m
(3) 0.07 nC m^{-2} (4) 4.0 nC m^{-2}

14. The electric field in a region is given by $\vec{E} = \frac{2}{5}E_0\hat{i} + \frac{3}{5}E_0\hat{j}$ with $E_0 = 4.0 \times 10^3 \frac{N}{C}$. The flux of this field through a rectangular surface area 0.4 m^2 parallel to the Y – Z plane is _________Nm^2C^{-1}.

15. An oil drop of radius 2 mm with a density 3g cm^{-3} is held stationary under a constant electric field 3.55×10^5 V m^{-1} in the Millikan's oil drop experiment. What is the number of excess electrons that the oil drop will possess ? (consider g = 9.81 m/s^2)

(1) 48.8×10^{11} (2) 1.73×10^{10}
(3) 17.3×10^{10} (4) 1.73×10^{12}

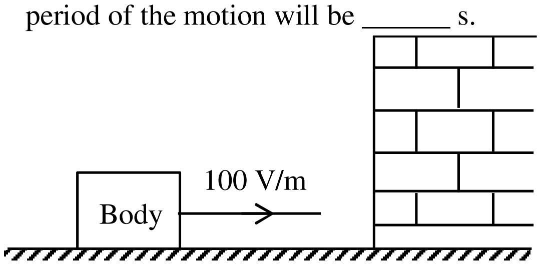
16. An infinite number of point charges, each carrying 1 μC charge, are placed along the y-axis at y = 1 m, 2 m, 4 m, 8 m................. The total force on a 1 C point charge, placed at the origin, is x × 10^3 N. The value of x, to the nearest integer, is________.

[Take $\frac{1}{4\pi \epsilon_0} = 9 \times 10^9\ Nm^2/C^2$]

17. A certain charge Q is divided into two parts q and (Q–q). How should the charges Q and q be divided so that q and (Q–q) placed at a certain distance apart experience maximum electrostatic repulsion ?

(1) $Q = \frac{q}{2}$ (2) Q = 2q
(3) Q = 4q (4) Q = 3q

18. A body having specific charge 8 μC/g is resting on a frictionless plane at a distance 10 cm from the wall (as shown in the figure). It starts moving towards the wall when a uniform electric field of 100 V/m is applied horizontally towards the wall. If the collision of the body with the wall is perfectly elastic, then the time period of the motion will be ______ s.



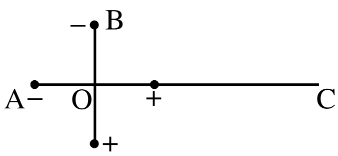
19. An electric dipole is placed on x-axis in proximity to a line charge of linear charge density 3.0×10^{-6} C/m. Line charge is placed on z-axis and positive and negative charge of dipole is at a distance of 10 mm and 12 mm from the origin respectively. If total force of 4 N is exerted on the dipole, find out the amount of positive or negative charge of the dipole.

(1) 815.1 nC (2) 8.8 μC
(3) 0.485 mC (4) 4.44 μC

20. The total charge enclosed in an incremental volume of 2×10^{-9} m^3 located at the origin is ______ nC, if electric flux density of its field is found as $D = e^{-x}\sin y\ \hat{i} - e^{-x}\cos y\ \hat{j} + 2z\hat{k}\ C/m^2$.

21. A particle of mass 1 mg and charge q is lying at the mid-point of two stationary particles kept at a distance '2 m' when each is carrying same charge 'q'. If the free charged particle is displaced from its equilibrium position through distance 'x' (x << 1 m). The particle executes SHM. Its angular frequency of oscillation will be _____ × 10^5 rad/s if $q^2 = 10\ C^2$.

22. Two ideal electric dipoles A and B, having their dipole moment p_1 and p_2 respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of 37° with the axis. The ratio of the dipole moment of A and B, $\frac{p_1}{p_2}$ is : (take sin 37° = $\frac{3}{5}$)



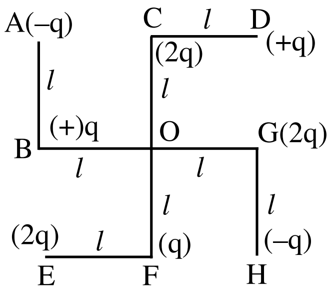
(1) $\frac{3}{8}$ (2) $\frac{3}{2}$ (3) $\frac{2}{3}$ (4) $\frac{4}{3}$

23. Two identical tennis balls each having mass 'm' and charge 'q' are suspended from a fixed point by threads of length 'l'. What is the equilibrium separation when each thread makes a small angle 'θ' with the vertical ?

(1) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{2}}$ (2) $x = \left(\frac{q^2 l}{2\pi\varepsilon_0 mg}\right)^{\frac{1}{3}}$

(3) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g}\right)^{\frac{1}{3}}$ (4) $x = \left(\frac{q^2 l^2}{2\pi\varepsilon_0 m^2 g^2}\right)^{\frac{1}{3}}$

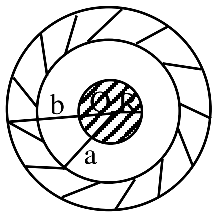
24. What will be the magnitude of electric field at point O as shown in figure? Each side of the figure is l and perpendicular to each other?



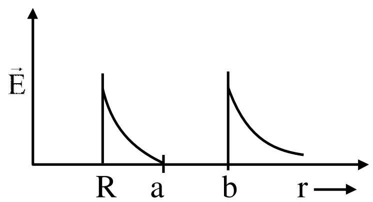
(1) $\frac{1}{4\pi\varepsilon_0}\frac{q}{l^2}$ (2) $\frac{1}{4\pi\varepsilon_0}\frac{q}{(2l^2)}\left(2\sqrt{2}-1\right)$

(3) $\frac{q}{4\pi\varepsilon_0(2l)^2}$ (4) $\frac{1}{4\pi\varepsilon_0}\frac{2q}{2l^2}\left(\sqrt{2}\right)$

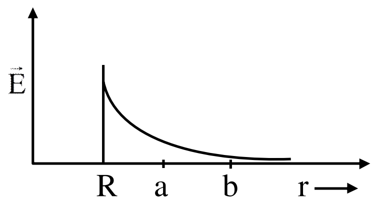
25. A solid metal sphere of radius R having charge q is enclosed inside the concentric spherical shell of inner radius a and outer radius b as shown in figure. The approximate variation electric field $\vec{E}$ as a function of distance r from centre O is given by :



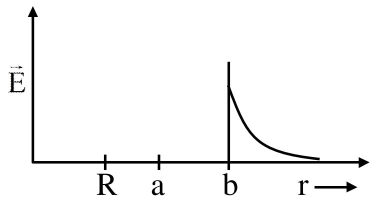
(1)



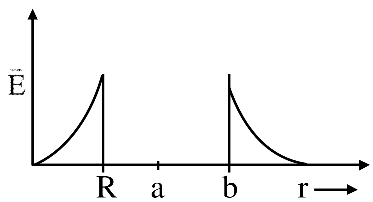
(2)



(3)



(4)



26. The two thin coaxial rings, each of radius 'a' and having charges +Q and –Q respectively are separated by a distance of 's'. The potential difference between the centres of the two rings is :

(1) $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$

(2) $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$

(3) $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

(4) $\frac{Q}{2\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

27. A uniformly charged disc of radius R having surface charge density σ is placed in the xy plane with its center at the origin. Find the electric field intensity along the z-axis at a distance Z from origin :-

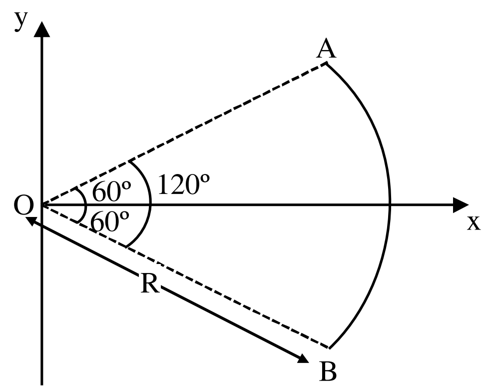
(1) $E=\frac{\sigma}{2\varepsilon_0}\left(1-\frac{Z}{(Z^2+R^2)^{1/2}}\right)$

(2) $E=\frac{\sigma}{2\varepsilon_0}\left(1+\frac{Z}{(Z^2+R^2)^{1/2}}\right)$

(3) $E=\frac{2\varepsilon_0}{\sigma}\left(\frac{1}{(Z^2+R^2)^{1/2}}+Z\right)$

(4) $E=\frac{\sigma}{2\varepsilon_0}\left(\frac{1}{(Z^2+R^2)}+\frac{1}{Z^2}\right)$

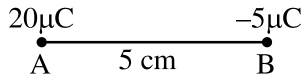
28. Figure shows a rod AB, which is bent in a 120° circular arc of radius R. A charge (–Q) is uniformly distributed over rod AB. What is the electric field $\vec{E}$ at the centre of curvature O ?



(1) $\frac{3\sqrt{3}Q}{8\pi\varepsilon_0R^2}\left(\hat{i}\right)$ (2) $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0R^2}\left(\hat{i}\right)$

(3) $\frac{3\sqrt{3}Q}{16\pi^2\varepsilon_0R^2}\left(\hat{i}\right)$ (4) $\frac{3\sqrt{3}Q}{8\pi^2\varepsilon_0R^2}\left(-\hat{i}\right)$

29. Two particles A and B having charges 20 μC and –5 μC respectively are held fixed with a separation of 5 cm. At what position a third charged particle should be placed so that it does not experience a net electric force?



(1) At 5 cm from 20 μC on the left side of system

(2) At 5 cm from – 5 μC on the right side

(3) At 1.25 cm from – 5 μC between two charges

(4) At midpoint between two charges

30. Choose the **incorrect** statement :

(a) The electric lines of force entering into a Gaussian surface provide negative flux.

(b) A charge 'q' is placed at the centre of a cube. The flux through all the faces will be the same.

(c) In a uniform electric field net flux through a closed Gaussian surface containing no net charge, is zero.

(d) When electric field is parallel to a Gaussian surface, it provides a finite non-zero flux.

Choose the most appropriate answer from the options given below

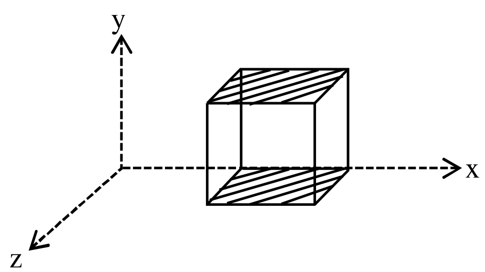
(1) (c) and (d) only

(2) (b) and (d) only

(3) (d) only

(4) (a) and (c) only

31. A cube is placed inside an electric field, $\vec{E} = 150y^2\hat{j}$. The side of the cube is 0.5 m and is placed in the field as shown in the given figure. The charge inside the cube is :



(1) 3.8×10^{-11} C (2) 8.3×10^{-11} C

(3) 3.8×10^{-12} C (4) 8.3×10^{-12} C

EM WAVES

1. An electromagnetic wave of frequency 5 GHz, is travelling in a medium whose relative electric permittivity and relative magnetic permeability both are 2. Its velocity in this medium is ________$\times 10^7$ m/s.

2. Match List - I with List - II.

List - I	List - II
(a) Source of microwave frequency	(i) Radioactive decay on nucleus
(b) Source of infrared frequency	(ii) Magnetron
(c) Source of Gamma Rays	(iii) Inner shell electrons
(d) Source of X-rays	(iv) Vibration of atoms and molecules
	(v) LASER
	(vi) RC circuit

Choose the correct answer from the options given below :

(1) (a)-(vi), (b)-(iv), (c)-(i), (d)-(v)

(2) (a)-(vi), (b)-(v), (c)-(i), (d)-(iv)

(3) (a)-(ii), (b)-(iv), (c)-(vi), (d)-(iii)

(4) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

3. An electromagnetic wave of frequency 3 GHz enters a dielectric medium of relative electric permittivity 2.25 from vacuum. The wavelength of this wave in that medium will be ____ $\times 10^{-2}$ cm.

4. The peak electric field produced by the radiation coming from the 8 W bulb at a distance of 10 m is $\frac{x}{10}\sqrt{\frac{\mu_0 c}{\pi}}\frac{V}{m}$. The efficiency of the bulb is 10% and it is a point source. The value of x is____________.

5. A radiation is emitted by 1000 W bulb and it generates an electric field and magnetic field at P, placed at a distance of 2 m. The efficiency of the bulb is 1.25%. The value of peak electric field at P is x × 10^{-1} V/m. Value of x is_. (Rounded-off to the nearest integer)
[Take $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2N^{-1} m^{-2}, $c = 3 \times 10^8$ ms^{-1}]

6. A plane electromagnetic wave of frequency 500 MHz is travelling in vacuum along y-direction. At a particular point in space and time, $\vec{B} = 8.0 \times 10^{-8}\hat{z}T$. The value of electric field at this point is : (speed of light = 3×10^8 ms^{-1}) $\hat{x}, \hat{y}, \hat{z}$ are unit vectors along x, y and z direction.

(1) $-24\hat{x}$ V / m (2) $2.6\hat{x}$ V / m

(3) $24\hat{x}$ V / m (4) $-2.6\hat{y}$ V / m

7. For an electromagnetic wave travelling in free space, the relation between average energy densities due to electric (U_e) and magnetic (U_m) fields is :

(1) $U_e = U_m$ (2) $U_e > U_m$

(3) $U_e < U_m$ (4) $U_e \neq U_m$

8. The electric field intensity produced by the radiation coming from a 100 W bulb at a distance of 3m is E. The electric field intensity produced by the radiation coming from 60 W at the same distance is $\sqrt{\frac{x}{5}}E$. Where the value of x =_________.

9. A plane electromagnetic wave of frequency 100 MHz is travelling in vacuum along the x direction. At a particular point in space and time, $\vec{B} = 2.0 \times 10^{-8}\hat{k}T$. (where, $\hat{k}$ is unit vector along z-direction) What is $\vec{E}$ at this point ?

(1) $0.6\hat{j}$ V/m (2) $6.0\hat{k}$ V/m

(3) $6.0\hat{j}$ V/m (4) $0.6\hat{k}$ V/m

10. A plane electromagnetic wave propagating along y-direction can have the following pair of electric field $(\vec{E})$ and magnetic field $(\vec{B})$ components.

(1) E_y, B_y or E_z, B_z (2) E_y, B_x or E_x, B_y

(3) E_x, B_z or E_z, B_x (4) E_x, B_y or E_y, B_x

11. In an electromagnetic wave the electric field vector and magnetic field vector are given as $\vec{E} = E_0\,\hat{i}$ and $\vec{B} = B_0\hat{k}$ respectively. The direction of propagation of electromagnetic wave is along :

(1) $(\hat{k})$ (2) $\hat{J}$ (3) $(-\hat{k})$ (4) $(-\hat{j})$

12. Intensity of sunlight is observed as 0.092 Wm^{-2} at a point in free space. What will be the peak value of magnetic field at that point ?

($\varepsilon_0 = 8.85 \times 10^{-12} C^2N^{-1}m^{-2}$)

(1) 2.77×10^{-8} T (2) 1.96×10^{-8} T

(3) 8.31 T (4) 5.88 T

13. A linearly polarized electromagnetic wave in vacuum is

$E = 3.1\cos[(1.8)z - (5.4 \times 10^6)t]\hat{i}$ N/C

is incident normally on a perfectly reflecting wall at z = a. Choose the correct option

(1) The wavelength is 5.4 m

(2) The frequency of electromagnetic wave is 54×10^4 Hz.

(3) The transmitted wave will be $3.1\cos[(1.8)z - (5.4 \times 10^6)t]\hat{i}$ N/C

(4) The reflected wave will be $3.1\cos[(1.8)z + (5.4 \times 10^6)t]\hat{i}$ N/C

14. A light beam is described by E = 800 sin$\omega\left(t - \frac{x}{c}\right)$.An electron is allowed to move normal to the propagation of light beam with a speed of 3×10^7 ms^{-1}. What is the maximum magnetic force exerted on the electron ?

(1) 1.28×10^{-18} N (2) 1.28×10^{-21} N

(3) 12.8×10^{-17} N (4) 12.8×10^{-18} N

15. The magnetic field vector of an electromagnetic wave is given by $B = B_o\frac{\hat{i}+\hat{j}}{\sqrt{2}}\cos(kz - \omega t)$; where $\hat{i}, \hat{j}$ represents unit vector along x and y-axis respectively. At t = 0 s, two electric charges q_1 of 4π coulomb and q_2 of 2π coulomb located at $\left(0,0,\frac{\pi}{k}\right)$ and $\left(0,0,\frac{3\pi}{k}\right)$, respectively, have the same velocity of $0.5\,c\,\hat{i}$, (where c is the velocity of light). The ratio of the force acting on charge q_1 to q_2 is :-

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

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

16. Electric field in a plane electromagnetic wave is given by $E = 50 \sin(500x - 10 \times 10^{10}t)$ V/m

The velocity of electromagnetic wave in this medium is :

(Given C = speed of light in vacuum)

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

17. A plane electromagnetic wave with frequency of 30 MHz travels in free space. At particular point in space and time, electric field is 6 V/m. The magnetic field at this point will be $x \times 10^{-8}$ T. The value of x is _____.

18. The electric field in an electromagnetic wave is given by $E = (50\ NC^{-1})\sin\omega(t - x/c)$
The energy contained in a cylinder of volume V is 5.5×10^{-12} J. The value of V is ________ cm
$\left(\text{given}\ \epsilon_0 = 8.8\times10^{-12}\,C^2N^{-1}m^{-2}\right)$

19. Electric field of plane electromagnetic wave propagating through a non–magnetic medium is given by $E = 20\cos(2 \times 10^{10}\ t - 200x)$ V/m. The dielectric constant of the medium is equal to :
(Take $\mu_r = 1$)
(1) 9 (2) 2 (3) $\frac{1}{3}$ (4) 3

20. The electric field in a plane electromagnetic wave is given by

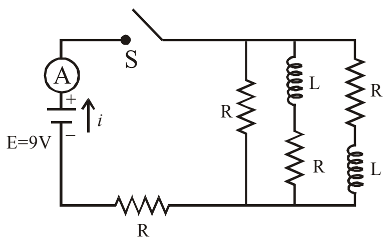
$$\vec{E} = 200\cos\left[\left(\frac{0.5\times10^3}{m}\right)x - \left(1.5\times10^{11}\frac{rad}{s}\times t\right)\right]\frac{V}{m}\hat{j}$$

If this wave falls normally on a perfectly reflecting surface having an area of 100 cm^2. If the radiation pressure exerted by the E.M. wave on the surface during a 10 minute exposure is $\frac{x}{10^9}\frac{N}{m^2}$. Find the value of x.

EMI & AC

1 A resonance circuit having inductance and resistance 2×10^{-4} H and 6.28 Ω respectively oscillates at 10 MHz frequency. The value of quality factor of this resonator is _______. [$\pi = 3.14$]

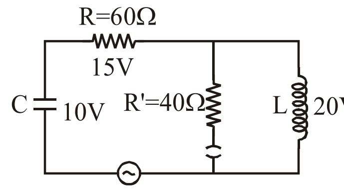
2. Figure shows a circuit that contains four identical resistors with resistance R = 2.0 Ω, two identical inductors with inductance L = 2.0 mH and an ideal battery with *emf* E = 9 V. The current '*i*' just after the switch 'S' is closed will be :



(1) 2.25 A (2) 3.0 A
(3) 3.37 A (4) 9 A

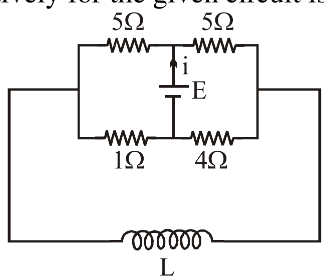
3. A series LCR circuit is designed to resonate at an angular frequency $\omega_0 = 10^5$ rad/s. The circuit draws 16 W power from 120 V source at resonance. The value of resistance 'R' in the circuit is ___Ω.

4. The angular frequency of alternating current in a L-C-R circuit is 100 rad/s. The components connected are shown in the figure. Find the value of inductance of the coil and capacity of condenser.



(1) 0.8 H and 150 μF (2) 0.8 H and 250 μF
(3) 1.33 H and 250 μF (4) 1.33 H and 150 μF

5. The current (i) at time t = 0 and t = ∞ respectively for the given circuit is:



(1) $\frac{18E}{55}, \frac{5E}{18}$ (2) $\frac{10E}{33}, \frac{5E}{18}$
(3) $\frac{5E}{18}, \frac{18E}{55}$ (4) $\frac{5E}{18}, \frac{10E}{33}$

6. A coil of inductance 2H having negligible resistance is connected to a source of supply whose voltage is given by V = 3t volt. (where t is in second). If the voltage is applied when t = 0, then the energy stored in the coil after 4s is _____ J.

7. An LCR circuit contains resistance of 110 Ω and a supply of 220 V at 300 rad/s angular frequency. If only capacitance is removed from the circuit, current lags behind the voltage by 45°. If on the other hand, only inductor is removed the current leads by 45° with the applied voltage. The rms current flowing in the circuit will be :
(1) 1A (2) 2.5 A
(3) 1.5 A (4) 2A

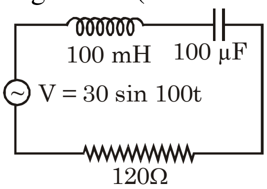
8. An alternating current is given by the equation $i = i_1\sin\omega t + i_2\cos\omega t$. The rms current will be
(1) $\frac{1}{\sqrt{2}}\left(i_1^2 + i_2^2\right)^{\frac{1}{2}}$ (2) $\frac{1}{\sqrt{2}}\left(i_1 + i_2\right)^2$
(3) $\frac{1}{2}\left(i_1^2 + i_2^2\right)^{\frac{1}{2}}$ (4) $\frac{1}{\sqrt{2}}\left(i_1 + i_2\right)$

9. In a series LCR resonant circuit, the quality factor is measured as 100. If the inductance is increased by two fold and resistance is decreased by two fold, then the quality factor after this change will be_____.

10. An aeroplane, with its wings spread 10 m, is flying at a speed of 180 km/h in a horizontal direction. The total intensity of earth's field at that part is 2.5×10^{-4} Wb/m^2 and the angle of dip is 60°. The emf induced between the tips of the plane wings will be :-

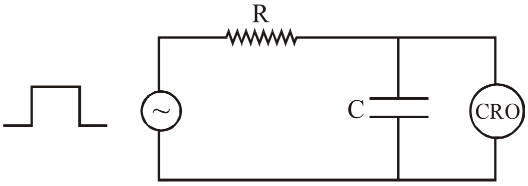
(1) 108.25 mV (2) 54.125 mV
(3) 88.37 mV (4) 62.50 mV

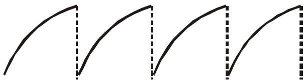
11. Find the peak current and resonant frequency of the following circuit (as shown in figure).

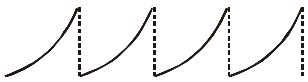


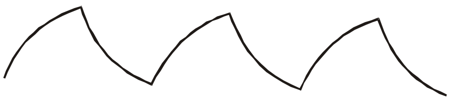
(1) 0.2 A and 50 Hz (2) 0.2 A and 100 Hz
(3) 2 A and 100 Hz (4) 2A and 50 Hz

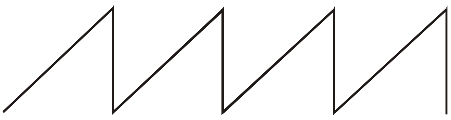
12. An RC circuit as shown in the figure is driven by a AC source generating a square wave. The output wave pattern monitored by CRO would look close to :



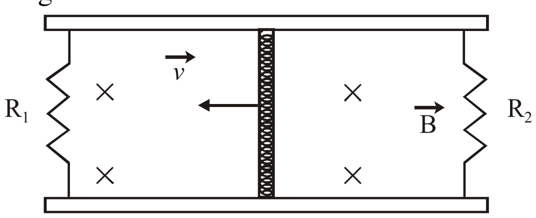
(1) 

(2) 

(3) 

(4) 

13. A conducting bar of length L is free to slide on two parallel conducting rails as shown in the figure



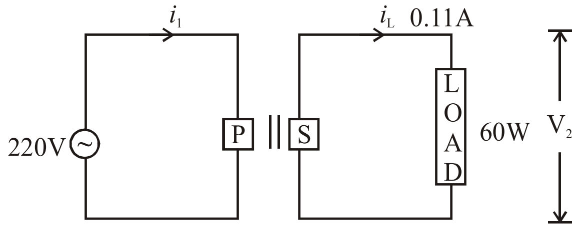
Two resistors R_1 and R_2 are connected across the ends of the rails. There is a uniform magnetic field $\vec{B}$ pointing into the page. An external agent pulls the bar to the left at a constant speed v.

The correct statement about the directions of induced currents I_1 and I_2 flowing through R_1 and R_2 respectively is :

(1) Both I_1 and I_2 are in anticlockwise direction
(2) Both I_1 and I_2 are in clockwise direction
(3) I_1 is in clockwise direction and I_2 is in anticlockwise direction
(4) I_1 is in anticlockwise direction and I_2 is in clockwise direction

14. A sinusoidal voltage of peak value 250 V is applied to a series LCR circuit, in which R = 8Ω, L = 24 mH and C = 60μF. The value of power dissipated at resonant condition is 'x' kW. The value of x to the nearest integer is ________.

15. For the given circuit, comment on the type of transformer used :



(1) Auxilliary transformer
(2) Auto transformer
(3) Step-up transformer
(4) Step down transformer

16. Amplitude of a mass-spring system, which is executing simple harmonic motion decreases with time. If mass = 500g, Decay constant = 20 g/s then how much time is required for the amplitude of the system to drop to half of its initial value ? (ln 2 = 0.693)

(1) 34.65 s (2) 17.32 s
(3) 0.034 s (4) 15.01 s

17. An AC current is given by $I = I_1 \sin\omega t + I_2 \cos\omega t$. A hot wire ammeter will give a reading :

(1) $\sqrt{\frac{I_1^2 - I_2^2}{2}}$ (2) $\sqrt{\frac{I_1^2 + I_2^2}{2}}$

(3) $\frac{I_1 + I_2}{\sqrt{2}}$ (4) $\frac{I_1 + I_2}{2\sqrt{2}}$

18. A solenoid of 1000 turns per metre has a core with relative permeability 500. Insulated windings of the solenoid carry an electric current of 5A. The magnetic flux density produced by the solenoid is :

(permeability of free space = $4\pi \times 10^{-7}$ H/m)

(1) πT (2) $2 \times 10^{-3}\,\pi$T

(3) $\frac{\pi}{5}$T (4) $10^{-4}\pi$T

19. A block of mass 1 kg attached to a spring is made to oscillate with an initial amplitude of 12 cm. After 2 minutes the amplitude decreases to 6 cm. Determine the value of the damping constant for this motion. (take In 2 = 0.693)

(1) 0.69×10^2 kg s^{-1} (2) 3.3×10^2 kg s^{-1}
(3) 1.16×10^2 kg s^{-1} (4) 5.7×10^{-3} kg s^{-1}

20. Match List-I with List-II

List-I	**List-II**
(a) Phase difference between current and voltage in a purely resistive AC circuit	(i) $\frac{\pi}{2}$; current leads voltage
(b) Phase difference between current and voltage in a pure inductive AC circuit	(ii) zero
(c) Phase difference between current and voltage in a pure capacitive AC circuit	(iii) $\frac{\pi}{2}$; current lags voltage
(d) Phase difference between current and voltage in an LCR series circuit	(iv) $\tan^{-1}\left(\frac{X_C - X_L}{R}\right)$

Choose the most appropriate answer from the options given below :

(1) (a)–(i),(b)–(iii),(c)–(iv),(d)–(ii)
(2) (a)–(ii),(b)–(iv),(c)–(iii),(d)–(i)
(3) (a)–(ii),(b)–(iii),(c)–(iv),(d)–(i)
(4) (a)–(ii),(b)–(iii),(c)–(i),(d)–(iv)

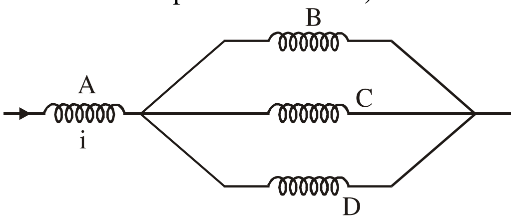
21. What happens to the inductive reactance and the current in a purely inductive circuit if the frequency is halved ?

(1) Both, inductive reactance and current will be halved.
(2) Inductive reactance will be halved and current will be doubled.
(3) Inductive reactance will be doubled and current will be halved.
(4) Both, inducting reactance and current will be doubled.

22. Seawater at a frequency f = 9×10^2 Hz, has permittivity $\varepsilon = 80\varepsilon_0$ and resistivity $\rho = 0.25\ \Omega$m. Imagine a parallel plate capacitor is immersed in seawater and is driven by an alternating voltage source $V(t)=V_0 \sin(2\pi ft)$. Then the conduction current density becomes 10^x times the displacement current density after time $t = \frac{1}{800}$ s. The value of x is ________

$\left(\text{Given} : \frac{1}{4\pi\varepsilon_0} = 9\times10^9\,\text{Nm}^2\text{C}^{-2}\right)$

23. Four identical long solenoids A, B, C and D are connected to each other as shown in the figure. If the magnetic field at the center of A is 3T, the field at the center of C would be : (Assume that the magnetic field is confined with in the volume of respective solenoid).



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

24. In a series LCR resonance circuit, if we change the resistance only, from a lower to higher value :

(1) The bandwidth of resonance circuit will increase.
(2) The resonance frequency will increase.
(3) The quality factor will increase.
(4) The quality factor and the resonance frequency will remain constant.

25. An AC source rated 220 V, 50 Hz is connected to a resistor. The time taken by the current to change from its maximum to the rms value is :

(1) 2.5 ms (2) 25 ms
(3) 2.5 s (4) 0.25 ms

26. In a series LCR circuit, the inductive reactance (X_L) is 10 Ω and the capacitive reactance (X_C) is 4 Ω. The resistance (R) in the circuit is 6 Ω. The power factor of the circuit is :

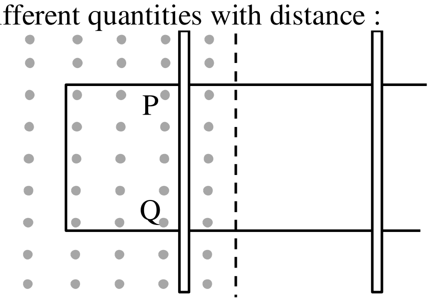
(1) $\frac{1}{2}$ (2) $\frac{1}{2\sqrt{2}}$ (3) $\frac{1}{\sqrt{2}}$ (4) $\frac{\sqrt{3}}{2}$

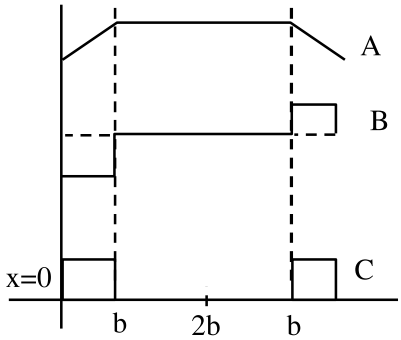
27. The time taken for the magnetic energy to reach 25% of its maximum value, when a solenoid of resistance R, inductance L is connected to a battery, is :

(1) $\frac{L}{R}\ell n5$ (2) infinite
(3) $\frac{L}{R}\ell n2$ (4) $\frac{L}{R}\ell n10$

28. AC voltage V(t) = 20 sinωt of frequency 50 Hz is applied to a parallel plate capacitor. The separation between the plates is 2 mm and the area is 1 m^2. The amplitude of the oscillating displacement current for the applied AC voltage is _______. [Take $\varepsilon_0 = 8.85 \times 10^{-12}$ F/m]
(1) 21.14 μA (2) 83.37 μA
(3) 27.79 μA (4) 55.58 μA

29. The arm PQ of a rectangular conductor is moving from x = 0 to x = 2b outwards and then inwards from x = 2b to x = 0 as shown in the figure. A uniform magnetic field perpendicular to the plane is acting from x = 0 to x = b. Identify the graph showing the variation of different quantities with distance :





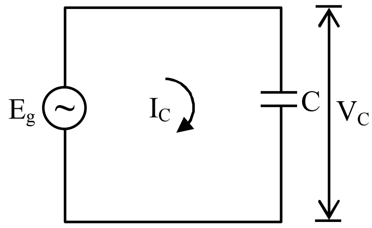
(1) A-Flux, B-Power dissipated, C-EMF
(2) A-Power dissipated, B-Flux, C-EMF
(3) A-Flux, B-EMF, C-Power dissipated
(4) A-EMF, B-Power dissipated, C-Flux

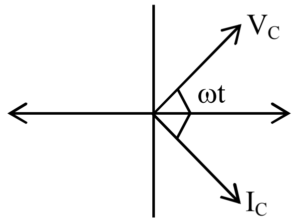
30. In an LCR series circuit, an inductor 30 mH and a resistor 1 Ω are connected to an AC source of angular frequency 300 rad/s. The value of capacitance for which, the current leads the voltage by 45° is $\frac{1}{x} \times 10^{-3}$ F. Then the value of x is ____.

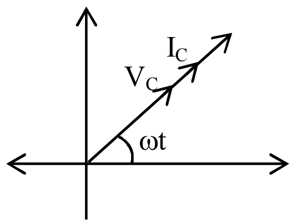
31. For a series LCR circuit with R = 100 Ω, L = 0.5 mH and C = 0.1 pF connected across 220 V–50 Hz AC supply, the phase angle between current and supplied voltage and the nature of the circuit is :
(1) 0°, resistive circuit
(2) ≈ 90°, predominantly inductive circuit
(3) 0°, resonance circuit
(4) ≈ 90°, predominantly capacitive circuit

32. A series LCR circuit of R = 5Ω, L = 20 mH and C = 0.5 μF is connected across an AC supply of 250 V, having variable frequency. The power dissipated at resonance condition is_____$\times 10^2$ W.

33. In a circuit consisting of a capacitance and a generator with alternating emf $E_g = E_{g_0} \sin\omega t$, V_C and I_C are the voltage and current. Correct phasor diagram for such circuit is :



(1)


(2)


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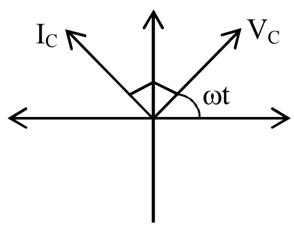

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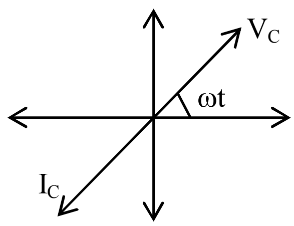


34. Match **List-I** with **List-II** :

	List–I		List–II
(a)	$\omega L > \frac{1}{\omega C}$	(i)	Current is in phase with emf
(b)	$\omega L = \frac{1}{\omega C}$	(ii)	Current lags behind the applied emf
(c)	$\omega L < \frac{1}{\omega C}$	(iii)	Maximum current occurs
(d)	Resonant frequency	(iv)	Current leads the emf

Choose the **correct** answer from the options given below :

(1) (a) – (ii) ; (b) – (i) ; (c) - (iv) ; (d) – (iii)
(2) (a) – (ii) ; (b) – (i) ; (c) - (iii) ; (d) – (iv)
(3) (a) – (iii) ; (b) – (i) ; (c) - (iv) ; (d) – (ii)
(4) (a) – (iv) ; (b) – (iii) ; (c) - (ii) ; (d) – (i)

35. An inductor of 10 mH is connected to a 20 V battery through a resistor of 10 kΩ and a switch. After a long time, when maximum current is set up in the circuit, the current is switched off. The current in the circuit after 1 μs is $\frac{x}{100}$ mA. Then x is equal to ______. (Take $e^{-1} = 0.37$)

36. A circular conducting coil of radius 1 m is being heated by the change of magnetic field $\vec{B}$ passing perpendicular to the plane in which the coil is laid. The resistance of the coil is 2 μΩ. The magnetic field is slowly switched off such that its magnitude changes in time as:

$$B = \frac{4}{\pi}\times 10^{-3}\,T\left(1-\frac{t}{100}\right)$$

The energy dissipated by the coil before the magnetic field is switched off completely is E = _____ mJ.

37. A 10Ω resistance is connected across 220V – 50Hz AC supply. The time taken by the current to change from its maximum value to the rms value is:

(1) 2.5 ms (2) 1.5 ms
(3) 3.0 ms (4) 4.5 ms

38. Two circuits are shown in the figure (a) & (b). At a frequency of _______ rad/s the average power dissipated in one cycle will be same in both the circuits.

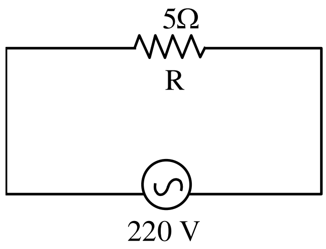


figure (a)

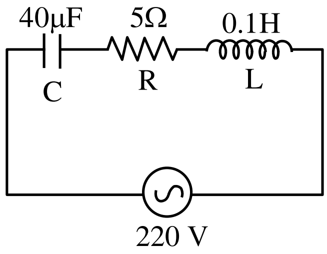
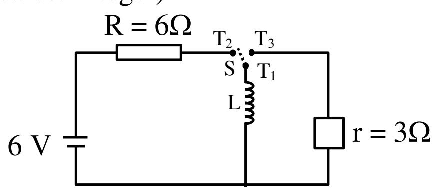


figure (b)

39. A 0.07 H inductor and a 12 Ω resistor are connected in series to a 220 V, 50 Hz ac source. The approximate current in the circuit and the phase angle between current and source voltage are respectively. [Take π as $\frac{22}{7}$]

(1) 8.8 A and $\tan^{-1}\left(\frac{11}{6}\right)$
(2) 88 A and $\tan^{-1}\left(\frac{11}{6}\right)$
(3) 0.88 A and $\tan^{-1}\left(\frac{11}{6}\right)$
(4) 8.8 A and $\tan^{-1}\left(\frac{6}{11}\right)$

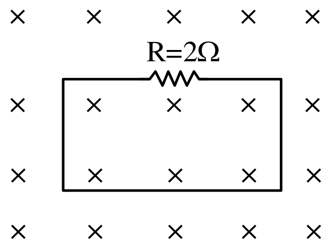
40. Consider an electrical circuit containing a two way switch 'S'. Initially S is open and then T_1 is connected to T_2. As the current in R = 6 Ω attains a maximum value of steady state level, T_1 is disconnected from T_2 and immediately connected to T_3. Potential drop across r = 3 Ω resistor immediately after T_1 is connected to T_3 is______V. (Round off to the Nearest Integer)



41. A 100 Ω resistance, a 0.1 μF capacitor and an inductor are connected in series across a 250 V supply at variable frequency. Calculate the value of inductance of inductor at which resonance will occur. Given that the resonant frequency is 60 Hz.

(1) 0.70 H (2) 70.3 mH
(3) 7.03×10^{-5} H (4) 70.3 H

42. In the given figure the magnetic flux through the loop increases according to the relation $\phi_B(t) = 10t^2 + 20t$, where ϕ_B is in milliwebers and t is in seconds. The magnitude of current through $R = 2\Omega$ resistor at t = 5 s is ______ mA.



43. An inductor coil stores 64 J of magnetic field energy and dissipates energy at the rate of 640 W when a current of 8A is passed through it. If this coil is joined across an ideal battery, find the time constant of the circuit in seconds :

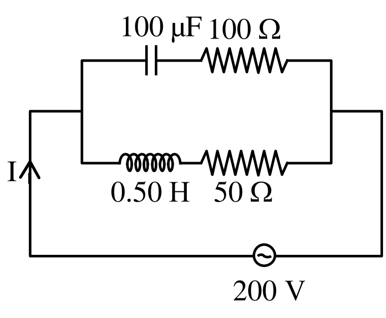
(1) 0.4 (2) 0.8 (3) 0.125 (4) 0.2

44. A series LCR circuit driven by 300 V at a frequency of 50 Hz contains a resistance R = 3 kΩ, an inductor of inductive reactance $X_L = 250\pi\Omega$ and an unknown capacitor. The value of capacitance to maximize the average power should be : (Take $\pi^2 = 10$)

(1) 4 μF (2) 25 μF

(3) 400 μF (4) 40 μF

45. In the given circuit the AC source has $\omega = 100$ rad s^{-1}. Considering the inductor and capacitor to be ideal, what will be the current I flowing through the circuit?

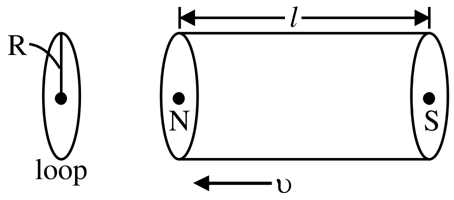


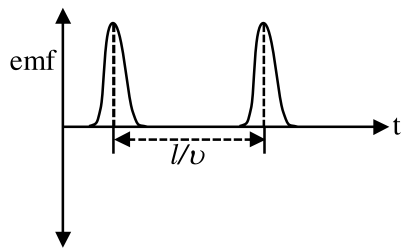
(1) 5.9 A (2) 4.24 A

(3) 0.94 A (4) 6 A

46. A circular coil of radius 8.0 cm and 20 turns is rotated about its vertical diameter with an angular speed of 50 rad s^{-1} in a uniform horizontal magnetic field of 3.0×10^{-2} T. The maximum emf induced the coil will be .... $\times 10^{-2}$ volt (rounded off to the nearest integer)

47. A bar magnet is passing through a conducting loop of radius R with velocity υ. The radius of the bar magnet is such that it just passes through the loop. The induced e.m.f. in the loop can be represented by the approximate curve :



(1)


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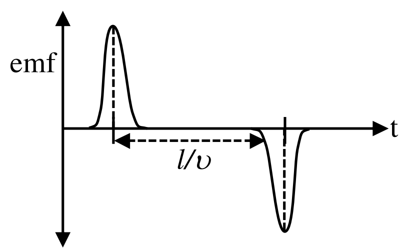

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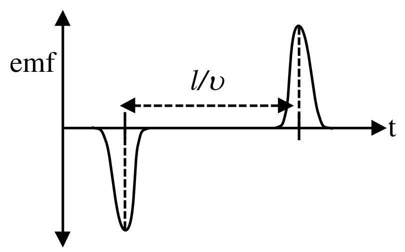
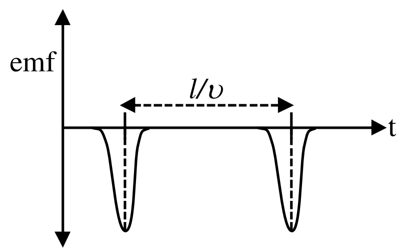


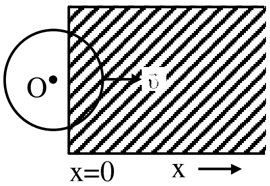
(4)


48. The alternating current is given by

$$i = \left\{\sqrt{42}\sin\left(\frac{2\pi}{T}t\right) + 10\right\}A$$

The r.m.s. value of this current is .... A.

49. A constant magnetic field of 1 T is applied in the x > 0 region. A metallic circular ring of radius 1m is moving with a constant velocity of 1 m/s along the x-axis. At t = 0s, the centre of O of the ring is at x = – 1m. What will be the value of the induced emf in the ring at t = 1s? (Assume the velocity of the ring does not change.)



(1) 1 V (2) 2π V

(3) 2 V (4) 0 V

50. An ac circuit has an inductor and a resistor of resistance R in series, such that $X_L = 3R$. Now, a capacitor is added in series such that $X_C = 2R$. The ratio of new power factor with the old power factor of the circuit is $\sqrt{5}:x$. The value of x is _____.

51. A small square loop of side 'a' and one turn is placed inside a larger square loop of side b and one turn (b >> a). The two loops are coplanar with their centres coinciding. If a current I is passed in the square loop of side 'b', then the coefficient of mutual inductance between the two loops is :

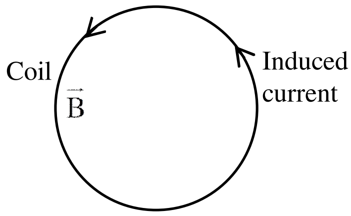
(1) $\frac{\mu_0}{4\pi}8\sqrt{2}\frac{a^2}{b}$ (2) $\frac{\mu_0}{4\pi}\frac{8\sqrt{2}}{a}$

(3) $\frac{\mu_0}{4\pi}8\sqrt{2}\frac{b^2}{a}$ (4) $\frac{\mu_0}{4\pi}\frac{8\sqrt{2}}{b}$

52. In an ac circuit, an inductor, a capacitor and a resistor are connected in series with $X_L = R = X_C$. Impedance of this circuit is :

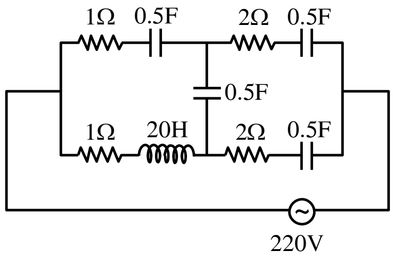
(1) $2R^2$ (2) Zero (3) R (4) $R\sqrt{2}$

53. A coil is placed in a magnetic field $\vec{B}$ as shown below :

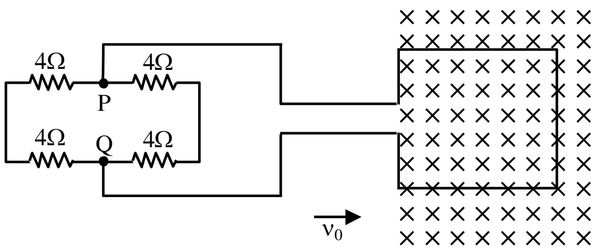


A current is induced in the coil because $\vec{B}$ is :
(1) Outward and decreasing with time
(2) Parallel to the plane of coil and decreasing with time
(3) Outward and increasing with time
(4) Parallel to the plane of coil and increasing with time

54. At very high frequencies, the effective impendance of the given circuit will be ____ Ω.

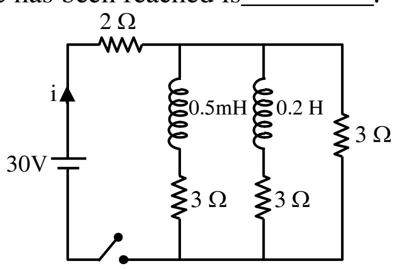


55. A square loop of side 20 cm and resistance 1Ω is moved towards right with a constant speed v_0. The right arm of the loop is in a uniform magnetic field of 5T. The field is perpendicular to the plane of the loop and is going into it. The loop is connected to a network of resistors each of value 4Ω. What should be the value of v_0 so that a steady current of 2 mA flows in the loop ?



(1) 1 m/s (2) 1 cm/s
(3) 10^2 m/s (4) 10^{-2} cm/s

56. For the given circuit the current *i* through the battery when the key in closed and the steady state has been reached is_________.



(1) 6 A (2) 25 A
(3) 10 A (4) 0 A

ERROR & PRACTICAL PHYSICS

1. The period of oscillation of a simple pendulum is $T = 2\pi\sqrt{\frac{L}{g}}$. Measured value of 'L' is 1.0 m from meter scale having a minimum division of 1 mm and time of one complete oscillation is 1.95 s measured from stopwatch of 0.01 s resolution. The percentage error in the determination of 'g' will be :

(1) 1.13% (2) 1.03%
(3) 1.33% (4) 1.30%

2. The pitch of the screw gauge is 1mm and there are 100 divisions on the circular scale. When nothing is put in between the jaws, the zero of the circular scale lies 8 divisions below the reference line. When a wire is placed between the jaws, the first linear scale division is clearly visible while 72^{nd} division on circular scale coincides with the reference line. The radius of the wire is:

(1) 1.64 mm (2) 0.82 mm
(3) 1.80 mm (4) 0.90 mm

3. One main scale division of a vernier callipers is 'a' cm and n^{th} division of the vernier scale coincide with $(n - 1)^{th}$ division of the main scale. The least count of the callipers in mm is :

(1) $\frac{10na}{(n-1)}$ (2) $\frac{10a}{(n-1)}$
(3) $\left(\frac{n-1}{10n}\right)a$ (4) $\frac{10a}{n}$

4. The resistance $R = \frac{V}{I}$, where V = (50 ± 2)V and I = (20 ± 0.2)A. The percentage error in R is 'x' %. The value of 'x' to the nearest integer is _________.

5. In order to determine the Young's Modulus of a wire of radius 0.2 cm (measured using a scale of least count = 0.001 cm) and length 1m (measured using a scale of least count = 1 mm), a weight of mass 1kg (measured using a scale of least count = 1g) was hanged to get the elongation of 0.5 cm (measured using a scale of least count 0.001 cm). What will be the fractional error in the value of Young's Modulus determined by this experiment ?

(1) 0.14% (2) 0.9%
(3) 9% (4) 1.4%

6. The vernier scale used for measurement has a positive zero error of 0.2 mm. If while taking a measurement it was noted that '0' on the vernier scale lies between 8.5 cm and 8.6 cm, vernier coincidence is 6, then the correct value of measurement is_____ cm.
(least count = 0.01 cm)

(1) 8.36 cm (2) 8.54 cm
(3) 8.58 cm (4) 8.56 cm

7. The time period of a simple pendulum is given by $T = 2\pi\sqrt{\frac{\ell}{g}}$. The measured value of the length of pendulum is 10 cm known to a 1mm accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of 1s resolution. The percentage accuracy in the determination of 'g' using this pendulum is 'x'. The value of 'x' to the nearest integer is:-

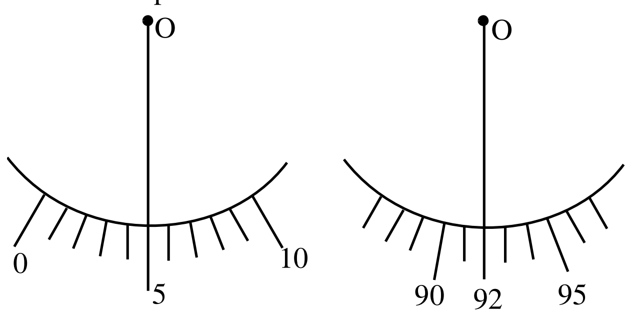
(1) 2% (2) 3% (3) 5% (4) 4%

8. In the experiment of Ohm's law, a potential difference of 5.0 V is applied across the end of a conductor of length 10.0 cm and diameter of 5.00 mm. The measured current in the conductor is 2.00 A. The maximum permissible percentage error in the resistivity of the conductor is :-

(1) 3.9 (2) 8.4 (3) 7.5 (4) 3.0

9. The radius of a sphere is measured to be (7.50 ± 0.85) cm. Suppose the percentage error in its volume is x. The value of x, to the nearest x, is_______.

10. Student A and Student B used two screw gauges of equal pitch and 100 equal circular divisions to measure the radius of a given wire. The actual value of the radius of the wire is 0.322 cm. The absolute value of the difference between the final circular scale readings observed by the students A and B is ________.
[Figure shows position of reference 'O' when jaws of screw gauge are closed]
Given pitch = 0.1 cm.



Screw gauge (A) Screw gauge (B)

11. **Assertion A :** If in five complete rotations of the circular scale, the distance travelled on main scale of the screw gauge is 5 mm and there are 50 total divisions on circular scale, then least count is 0.001 cm.

Reason R :

Least Count = $\dfrac{\text{Pitch}}{\text{Total divisions on circular scale}}$

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) **A** is not correct but **R** is correct.
(2) Both **A** and **R** are correct and **R** is the correct explanation of **A**.
(3) **A** is correct but **R** is not correct.
(4) Both **A** and **R** are correct and **R** is NOT the correct explanation of **A**.

12. A physical quantity 'y' is represented by the formula $y = m^2r^{-4}g^x l^{-\frac{3}{2}}$

If the percentage errors found in y, m, r, l and g are 18, 1, 0.5, 4 and p respectively, then find the value of x and p.

(1) 5 and ± 2 (2) 4 and ± 3
(3) $\frac{16}{3}$ and $\pm\frac{3}{2}$ (4) 8 and ± 2

13. Three students S_1, S_2 and S_3 perform an experiment for determining the acceleration due to gravity (g) using a simple pendulum. They use different lengths of pendulum and record time for different number of oscillations. The observations are as shown in the table.

Student No.	Length of pendulum (cm)	No. of oscillations (n)	Total time for n oscillations	Time period (s)
1.	64.0	8	128.0	16.0
2.	64.0	4	64.0	16.0
3.	20.0	4	36.0	9.0

(Least count of length = 0.1 m
least count for time = 0.1 s)

If E_1, E_2 and E_3 are the percentage errors in 'g' for students 1, 2 and 3 respectively, then the minimum percentage error is obtained by student no._____.

14. In a Screw Gauge, fifth division of the circular scale coincides with the reference line when the ratchet is closed. There are 50 divisions on the circular scale, and the main scale moves by 0.5 mm on a complete rotation. For a particular observation the reading on the main scale is 5 mm and the 20^{th} division of the circular scale coincides with reference line. Calculate the true reading.

(1) 5.00 mm (2) 5.25 mm
(3) 5.15 mm (4) 5.20 mm

15. If the length of the pendulum in pendulum clock increases by 0.1%, then the error in time per day is:

(1) 86.4 s (2) 4.32 s
(3) 43.2 s (4) 8.64 s

16. The acceleration due to gravity is found upto an accuracy of 4% on a planet. The energy supplied to a simple pendulum to known mass 'm' to undertake oscillations of time period T is being estimated. If time period is measured to an accuracy of 3%, the accuracy to which E is known as ....%

17. The diameter of a spherical bob is measured using a vernier callipers. 9 divisions of the main scale, in the vernier callipers, are equal to 10 divisions of vernier scale. One main scale division is 1 mm. The main scale reading is 10 mm and 8^{th} division of vernier scale was found to coincide exactly with one of the main scale division. If the given vernier callipers has positive zero error of 0.04 cm, then the radius of the bob is_____ $\times 10^{-2}$ cm.

18. A student determined Young's Modulus of elasticity using the formula $Y = \dfrac{MgL^3}{4bd^3\delta}$. The value of g is taken to be 9.8 m/s^2, without any significant error, his observation are as following.

Physical Quantity	**Least count of the Equipment used for measurement**	**Observed value**
Mass (M)	1 g	2 kg
Length of bar (L)	1 mm	1 m
Breadth of bar (b)	0.1 mm	4 cm
Thickness of bar (d)	0.01 mm	0.4 cm
Depression (δ)	0.01 mm	5 mm

Then the fractional error in the measurement of Y is :

(1) 0.0083 (2) 0.0155
(3) 0.155 (4) 0.083

19. Two resistors $R_1 = (4 \pm 0.8)\ \Omega$ and $R_2 = (4 \pm 0.4)\ \Omega$ are connected in parallel. The equivalent resistance of their parallel combination will be :

(1) $(4 \pm 0.4)\ \Omega$ (2) $(2 \pm 0.4)\ \Omega$
(3) $(2 \pm 0.3)\ \Omega$ (4) $(4 \pm 0.3)\ \Omega$

FLUID

1. A hydraulic press can lift 100 kg when a mass 'm' is placed on the smaller piston. It can lift _______kg when the diameter of the larger piston is increased by 4 times and that of the smaller piston is decreased by 4 times keeping the same mass 'm' on the smaller piston.

2. A large number of water drops, each of radius r, combine to have a drop of radius R. If the surface tension is T and mechanical equivalent of heat is J, the rise in heat energy per unit volume will be:

(1) $\frac{2T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$ (2) $\frac{2T}{rJ}$

(3) $\frac{3T}{rJ}$ (4) $\frac{3T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$

3. The pressure acting on a submarine is 3×10^5 Pa at a certain depth. If the depth is doubled, the percentage increase in the pressure acting on the submarine would be : (Assume that atmospheric pressure is 1×10^5 Pa density of water is 10^3 kg m^{-3}, g = 10 ms^{-2})

(1) $\frac{200}{3}\%$ (2) $\frac{200}{5}\%$

(3) $\frac{5}{200}\%$ (4) $\frac{3}{200}\%$

4. What will be the nature of flow of water from a circular tap, when its flow rate increased from 0.18 L/min to 0.48 L/min ? The radius of the tap and viscosity of water are 0.5 cm and 10^{-3} Pa s, respectively.
(Density of water : 10^3 kg/m^3)
(1) Unsteady to steady flow
(2) Remains steady flow
(3) Remains turbulent flow
(4) Steady flow to unsteady flow

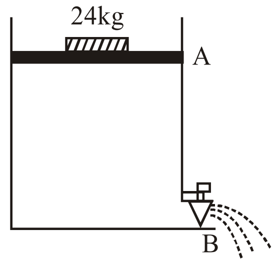
5. When two soap bubbles of radii a and b (b > a) coalesce, the radius of curvature of common surface is :

(1) $\frac{ab}{b-a}$ (2) $\frac{a+b}{ab}$

(3) $\frac{b-a}{ab}$ (4) $\frac{ab}{a+b}$

6. Suppose you have taken a dilute solution of oleic acid in such a way that its concentration becomes 0.01 cm^3 of oleic acid per cm^3 of the solution. Then you make a thin film of this solution (monomolecular thickness) of area 4 cm^2 by considering 100 spherical drops of radius $\left(\frac{3}{40\pi}\right)^{\frac{1}{3}} \times 10^{-3}$ cm. Then the thickness of oleic acid layer will be x × 10^{-14} m.
Where x is__________.

7. Consider a water tank as shown in the figure. It's cross-sectional area is 0.4 m^2. The tank has an opening B near the bottom whose cross-section area is 1 cm^2. A load of 24 kg is applied on the water at the top when the height of the water level is 40 cm above the bottom, the velocity of water coming out the opening B is v ms^{-1}. The value of v, to the nearest integer, is___. [Take value of g to be 10 ms^{-2}]



8. Two small drops of mercury each of radius R coalesce to form a single large drop. The ratio of total surface energy before and after the change is :

(1) $2^{\frac{1}{3}}:1$ (2) $1:2^{\frac{1}{3}}$

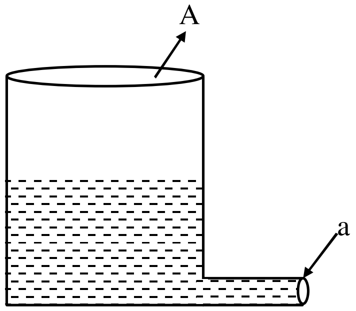
(3) 2 : 1 (4) 1 : 2

9. Two spherical soap bubbles of radii r_1 and r_2 in vacuum combine under isothermal conditions. The resulting bubble has a radius equal to :

(1) $\frac{r_1 r_2}{r_1 + r_2}$ (2) $\sqrt{r_1 r_2}$

(3) $\sqrt{r_1^2 + r_2^2}$ (4) $\frac{r_1 + r_2}{2}$

10. A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the emerging liquid is (a < < A) :



(1) $\frac{A}{2a}$ (2) None of these

(3) $\frac{2a}{A}$ (4) $\frac{a}{A}$

11. A raindrop with radius R = 0.2 mm falls from a cloud at a height h = 2000 m above the ground. Assume that the drop is spherical throughout its fall and the force of buoyance may be neglected, then the terminal speed attained by the raindrop is :

[Density of water $f_w = 1000$ kg m^{-3} and Density of air $f_a = 1.2$ kg m^{-3}, g = 10 m/s^2

Coefficient of viscosity of air = 1.8×10^{-5} Nsm^{-2}]

(1) 250.6 ms^{-1} (2) 43.56 ms^{-1}

(3) 4.94 ms^{-1} (4) 14.4 ms^{-1}

12. The water is filled upto height of 12 m in a tank having vertical sidewalls. A hole is made in one of the walls at a depth 'h' below the water level. The value of 'h' for which the emerging stream of water strikes the ground at the maximum range is ___ m.

13. Two narrow bores of diameter 5.0 mm and 8.0 mm are joined together to form a U-shaped tube open at both ends. If this U-tube contains water, what is the difference in the level of two limbs of the tube.

[Take surface tension of water T = 7.3×10^{-2} Nm^{-1}, angle of contact = 0, g = 10 ms^{-2} and density of water = 1.0×10^3 kg m^{-3}]

(1) 3.62 mm (2) 2.19 mm

(3) 5.34 mm (4) 4.97 mm

14. A soap bubble of radius 3 cm is formed inside the another soap bubble of radius 6 cm. The radius of an equivalent soap bubble which has the same excess pressure as inside the smaller bubble with respect to the atmospheric pressure is .... cm.

15. In Millikan's oil drop experiment, what is viscous force acting on an uncharged drop of radius 2.0×10^{-5} m and density 1.2×10^3 kgm^{-3} ? Take viscosity of liquid = 1.8×10^{-5} Nsm^{-2}. (Neglect buoyancy due to air).

(1) 3.8×10^{-11} N (2) 3.9×10^{-10} N

(3) 1.8×10^{-10} N (4) 5.8×10^{-10} N

GEOMETRICAL OPTICS

1. The focal length f is related to the radius of curvature r of the spherical convex mirror by:

(1) $f = +\frac{1}{2}r$ (2) f = –r

(3) $f = -\frac{1}{2}r$ (4) f = r

2. The same size images are formed by a convex lens when the object is placed at 20cm or at 10cm from the lens. The focal length of convex lens is _____ cm.

3. A short straight object of height 100 cm lies before the central axis of a spherical mirror whose focal length has absolute value |f| = 40cm. The image of object produced by the mirror is of height 25 cm and has the same orientation of the object. One may conclude from the information :

(1) Image is real, same side of concave mirror.

(2) Image is virtual, opposite side of concave mirror.

(3) Image is real, same side of convex mirror.

(4) Image is virtual, opposite side of convex mirror.

4. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : For a simple microscope, the angular size of the object equals the angular size of the image.

Reason R : Magnification is achieved as the small object can be kept much closer to the eye than 25 cm and hence it subtends a large angle.

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) A is true but R is false

(2) Both A and R are true but R is NOT the correct explanation of A.

(3) Both A and R are true and R is the correct explanation of A

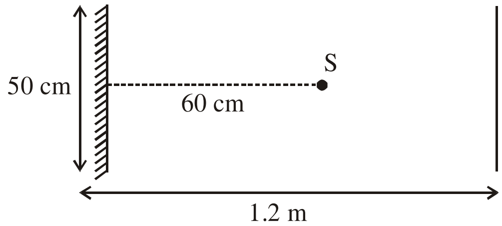
(4) A is false but R is true

5. The incident ray, reflected ray and the outward drawn normal are denoted by the unit vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ respectively. Then choose the correct relation for these vectors.

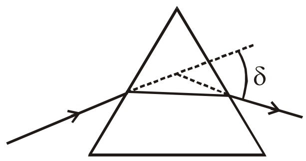
(1) $\vec{b}=\vec{a}+2\vec{c}$ (2) $\vec{b}=2\vec{a}+\vec{c}$

(3) $\vec{b}=\vec{a}-2(\vec{a}.\vec{c})\vec{c}$ (4) $\vec{b}=\vec{a}-\vec{c}$

6. A point source of light S, placed at a distance 60 cm infront of the centre of a plane mirror of width 50 cm, hangs vertically on a wall. A man walks infront of the mirror along a line parallel to the mirror at a distance 1.2 m from it (see the figure). The distance between the extreme points where he can see the image of the light source in the mirror is .... cm.



7. The angle of deviation through a prism is minimum when



(A) Incident ray and emergent ray are symmetric to the prism

(B) The refracted ray inside the prism becomes parallel to its base

(C) Angle of incidence is equal to that of the angle of emergence

(D) When angle of emergence is double the angle of incidence

Choose the correct answer from the options given below :

(1) Statements (A), (B) and (C) are true

(2) Only statement (D) is true

(3) Only statements (A) and (B) are true

(4) Statements (B) and (C) are true

8. The refractive index of a converging lens is 1.4. What will be the focal length of this lens if it is placed in a medium of same refractive index ? (Assume the radii of curvature of the faces of lens are R_1 and R_2 respectively)

(1) 1 (2) Infinite

(3) $\frac{R_1R_2}{R_1-R_2}$ (4) Zero

9. Red light differs from blue light as they have :

(1) Different frequencies and different wavelengths

(2) Different frequencies and same wavelengths

(3) Same frequencies and same wavelengths

(4) Same frequencies and different wavelengths

10. A deviation of 2° is produced in the yellow ray when prism of crown and flint glass are achromatically combined. Taking dispersive powers of crown and flint glass are 0.02 and 0.03 respectively and refractive index for yellow light for these glasses are 1.5 and 1.6 respectively. The refracting angles for crown glass prism will be ________° (in degree) (Round off to the Nearest Integer)

11. The thickness at the centre of a plano convex lens is 3 mm and the diameter is 6 cm. If the speed of light in the material of the lens is 2×10^8 ms^{-1}. The focal length of the lens is _____.

(1) 0.30 cm (2) 15 cm

(3) 1.5 cm (4) 30 cm

12. The radius in kilometer to which the present radius of earth (R = 6400 km) to be compressed so that the escape velocity is increased 10 time is _______.

13. The image of an object placed in air formed by a convex refracting surface is at a distance of 10 m behind the surface. The image is real and is at of the distance of the object from the surface $\frac{2^{rd}}{3}$.The wavelength of light inside the surface is $\frac{2}{3}$ times the wavelength in air. The radius of the curved surface is $\frac{x}{13}$m. the value of 'x' is__________.

14. Your friend is having eye sight problem. She is not able to see clearly a distant uniform window mesh and it appears to her as non-uniform and distorted. The doctor diagnosed the problem as :

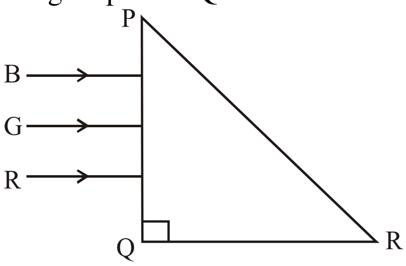
(1) Astigmatism

(2) Myopia with Astigmatism

(3) Presbyopia with Astigmatism

(4) Myopia and hypermetropia

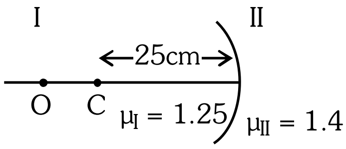
15. Three rays of light, namely red (R), green (G) and blue (B) are incident on the face PQ of a right angled prism PQR as shown in figure.



The refractive indices of the material of the prism for red, green and blue wavelength are 1.27, 1.42 and 1.49 respectively. The colour of the ray(s) emerging out of the face PR is :

(1) green (2) red
(3) blue and green (4) blue

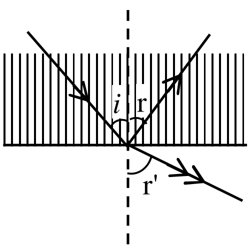
16. Region I and II are separated by a spherical surface of radius 25 cm. An object is kept in region I at a distance of 40 cm from the surface. The distance of the image from the surface is :



(1) 55.44 cm (2) 9.52 cm
(3) 18.23 cm (4) 37.58 cm

17. An object viewed from a near point distance of 25 cm, using a microscopic lens with magnification '6', gives an unresolved image. A resolved image is observed at infinite distance with a total magnification double the earlier using an eyepiece along with the given lens and a tube of length 0.6 m, if the focal length of the eyepiece is equal to ______ cm.

18. A ray of light passes from a denser medium to a rarer medium at an angle of incidence *i*. The reflected and refracted rays make an angle of 90° with each other. The angle of reflection and refraction are respectively r and r'. The critical angle is given by :



(1) $\sin^{-1}(\cot r)$ (2) $\tan^{-1}(\sin i)$
(3) $\sin^{-1}(\tan r')$ (4) $\sin^{-1}(\tan r)$

19. A ray of light passing through a prism ($\mu = \sqrt{3}$) suffers minimum deviation. It is found that the angle of incidence is double the angle of refraction within the prism. Then, the angle of prism is ________ (in degrees)

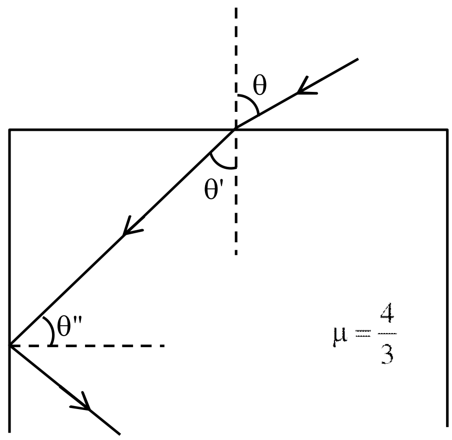
20. A ray of laser of a wavelength 630 nm is incident at an angle of 30° at the diamond-air interface. It is going from diamond to air. The refractive index of diamond is 2.42 and that of air is 1. Choose the correct option.

(1) angle of refraction is 24.41°
(2) angle of refraction is 30°
(3) refraction is not possible
(4) angle of refraction is 53.4°

21. A prism of refractive index μ and angle of prism A is placed in the position of minimum angle of deviation. If minimum angle of deviation is also A, then in terms of refractive index :

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

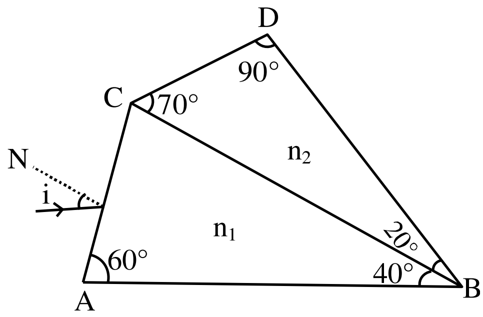
22. A ray of light entering from air into a denser medium of refractive index $\frac{4}{3}$, as shown in figure. The light ray suffers total internal reflection at the adjacent surface as shown. The maximum value of angle θ should be equal to :



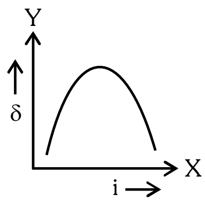
(1) $\sin^{-1}\frac{\sqrt{7}}{3}$ (2) $\sin^{-1}\frac{\sqrt{5}}{4}$
(3) $\sin^{-1}\frac{\sqrt{7}}{4}$ (4) $\sin^{-1}\frac{\sqrt{5}}{3}$

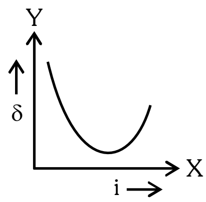
23. A prism of refractive index n_1 and another prism of refractive index n_2 are stuck together (as shown in the figure). n_1 and n_2 depend on λ, the wavelength of light, according to the relation $n_1 = 1.2 + \frac{10.8\times10^{-14}}{\lambda^2}$ and $n_2 = 1.45 + \frac{1.8\times10^{-14}}{\lambda^2}$

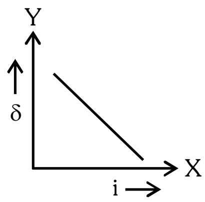
The wavelength for which rays incident at any angle on the interface BC pass through without bending at that interface will be _________ nm.

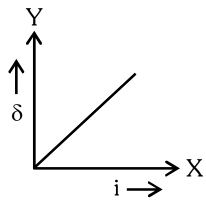


24. The expected graphical representation of the variation of angle of deviation 'δ' with angle of incidence 'i' in a prism is :

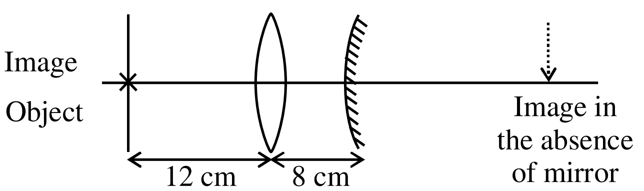
(1) 

(2) 

(3) 

(4) 

25. An object is placed at a distance of 12 cm from a convex lens. A convex mirror of focal length 15 cm is placed on other side of lens at 8 cm as shown in the figure. Image of object coincides with the object. When the convex mirror is removed, a real and inverted image is formed at a position. The distance of the image from the object will be ....(cm)

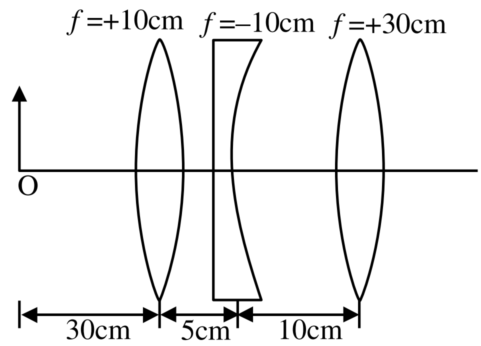


26. An object is placed beyond the centre of curvature C of the given concave mirror. If the distance of the object is d_1 from C and the distance of the image formed is d_2 from C, the radius of curvature of this mirror is :

(1) $\frac{2d_1d_2}{d_1 - d_2}$ (2) $\frac{2d_1d_2}{d_1 + d_2}$

(3) $\frac{d_1d_2}{d_1 + d_2}$ (4) $\frac{d_1d_2}{d_1 - d_2}$

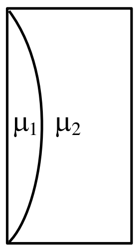
27. Find the distance of the image from object O, formed by the combination of lenses in the figure :



(1) 75 cm (2) 10 cm

(3) 20 cm (4) infinity

28. Curved surfaces of a plano-convex lens of refractive index μ_1 and a plano-concave lens of refractive index μ_2 have equal radius of curvature as shown in figure. Find the ratio of radius of curvature to the focal length of the combined lenses.



(1) $\frac{1}{\mu_2 - \mu_1}$ (2) $\mu_1 - \mu_2$

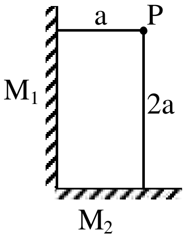
(3) $\frac{1}{\mu_1 - \mu_2}$ (4) $\mu_2 - \mu_1$

29. An object is placed at the focus of concave lens having focal length f. What is the magnification and distance of the image from the optical centre of the lens?

(1) 1, ∞ (2) Very high, ∞

(3) $\frac{1}{2}, \frac{f}{2}$ (4) $\frac{1}{4}, \frac{f}{4}$

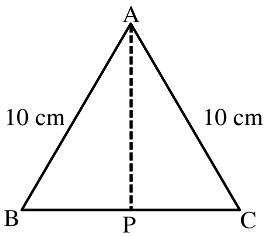
30. Two plane mirrors M_1 and M_2 are at right angle to each other shown. A point source 'P' is placed at 'a' and '2a' meter away from M_1 and M_2 respectively. The shortest distance between the images thus formed is : (Take $\sqrt{5}$ = 2.3)



(1) 3a (2) 4.6 a

(3) 2.3 a (4) $2\sqrt{10}$ a

31. Cross–section view of a prism is the equilateral triangle ABC in the figure. The minimum deviation is observed using this prism when the angle of incidence is equal to the prism angle. The time taken by light to travel from P (midpoint of BC) to A is______ $\times 10^{-10}$ s. (Given, speed of light in vacuum = 3×10^8 m/s and cos30° = $\frac{\sqrt{3}}{2}$)



32. Car B overtakes another car A at a relative speed of 40 ms^{-1}. How fast will the image of car B appear to move in the mirror of focal length 10 cm fitted in car A, when the car B is 1.9 m away from the car A?

(1) 4 ms^{-1} (2) 0.2 ms^{-1}

(3) 40 ms^{-1} (4) 0.1 ms^{-1}

33. A glass tumbler having inner depth of 17.5 cm is kept on a table. A student starts pouring water (μ = 4/3) into it while looking at the surface of water from the above. When he feels that the tumbler is half filled, he stops pouring water. Up to what height, the tumbler is actually filled ?

(1) 11.7 cm (2) 10 cm

(3) 7.5 cm (4) 8.75 cm

GRAVITATION

1. Two stars of masses m and 2m at a distance d rotate about their common centre of mass in free space. The period of revolution is :

(1) $\frac{1}{2\pi}\sqrt{\frac{d^3}{3Gm}}$ (2) $2\pi\sqrt{\frac{d^3}{3Gm}}$

(3) $\frac{1}{2\pi}\sqrt{\frac{3Gm}{d^3}}$ (4) $2\pi\sqrt{\frac{3Gm}{d^3}}$

2. Four identical particles of equal masses 1kg made to move along the circumference of a circle of radius 1 m under the action of their own mutual gravitational attraction. The speed of each particle will be :

(1) $\sqrt{\frac{G}{2}(1+2\sqrt{2})}$ (2) $\sqrt{G(1+2\sqrt{2})}$

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

3. Consider two satellites S_1 and S_2 with periods of revolution 1 hr. and 8hr. respectively revolving around a planet in circular orbits. The ratio of angular velocity of satellite S_1 to the angular velocity of satellites S_2 is :

(1) 8 : 1 (2) 1 : 4

(3) 2 : 1 (4) 1 : 8

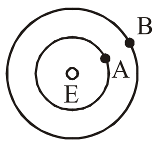
4. A body weighs 49 N on a spring balance at the north pole. What will be its weight recorded on the same weighing machine, if it is shifted to the equator ?

(Use g = $\frac{GM}{R^2}$ = 9.8 ms^{-2} and radius of earth, R = 6400 km.]

(1) 49 N (2) 48.83 N

(3) 49.83 N (4) 49.17 N

5. Two satellites A and B of masses 200kg and 400kg are revolving round the earth at height of 600 km and 1600 km respectively. If T_A and T_B are the time periods of A and B respectively then the value of $T_B - T_A$:

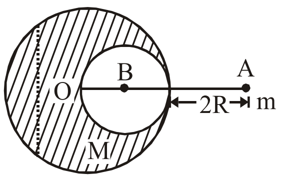


[Given : radius of earth = 6400km, mass of earth = 6×10^{24} kg]

(1) 1.33×10^3 s (2) 3.33×10^2 s

(3) 4.24×10^3 s (4) 4.24×10^2 s

6. A solid sphere of radius R gravitationally attracts a particle placed at 3R form its centre with a force F_1. Now a spherical cavity of radius $\left(\frac{R}{2}\right)$ is made in the sphere (as shown in figure) and the force becomes F_2. The value of $F_1 : F_2$ is :



(1) 25 : 36 (2) 36 : 25
(3) 50 : 41 (4) 41 : 50

7. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : The escape velocities of planet A and B are same. But A and B are of unequal mass.

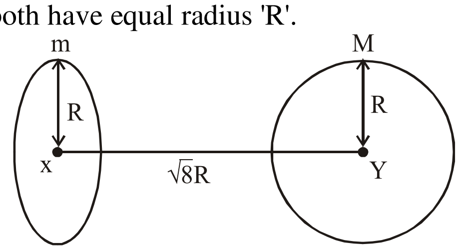
Reason R : The product of their mass and radius must be same, $M_1R_1 = M_2R_2$

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both A and R are correct but R is NOT the correct explanation of A
(2) A is correct but R is not correct
(3) Both A and R are correct and R is the correct explanation of A
(4) A is not correct but R is correct

8. The initial velocity v_i required to project a body vertically upward from the surface of the earth to reach a height of 10R, where R is the radius of the earth, may be described in terms of escape velocity v_e such that $v_i = \sqrt{\frac{x}{y}} \times v_e$. The value of x will be ________.

9. Find the gravitational force of attraction between the ring and sphere as shown in the diagram, where the plane of the ring is perpendicular to the line joining the centres. If $\sqrt{8}R$ is the distance between the centres of a ring (of mass 'm') and a sphere (mass 'M') where both have equal radius 'R'.



(1) $\frac{\sqrt{8}}{9} \cdot \frac{GmM}{R}$ (2) $\frac{2\sqrt{2}}{3} \cdot \frac{GMm}{R^2}$
(3) $\frac{1}{3\sqrt{8}} \cdot \frac{GMm}{R^2}$ (4) $\frac{\sqrt{8}}{27} \cdot \frac{GmM}{R^2}$

10. Assume that a tunnel is dug along a chord of the earth, at a perpendicular distance (R/2) from the earth's centre, where 'R' is the radius of the Earth. The wall of the tunnel is frictionless. If a particle is released in this tunnel, it will execute a simple harmonic motion with a time period :

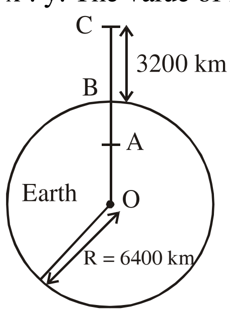
(1) $\frac{2\pi R}{g}$ (2) $\frac{g}{2\pi R}$
(3) $\frac{1}{2\pi}\sqrt{\frac{g}{R}}$ (4) $2\pi\sqrt{\frac{R}{g}}$

11. A planet revolving in elliptical orbit has :
(A) a constant velocity of revolution.
(B) has the least velocity when it is nearest to the sun.
(C) its areal velocity is directly proportional to its velocity.
(D) areal velocity is inversely proportional to its velocity.
(E) to follow a trajectory such that the areal velocity is constant.

Choose the correct answer from the options given below :

(1) A only (2) D only
(3) C only (4) E only

12. In the reported figure of earth, the value of acceleration due to gravity is same at point A and C but it is smaller than that of its value at point B (surface of the earth). The value of OA : AB will be x : y. The value of x is ....



13. The maximum and minimum distances of a comet from the Sun are 1.6×10^{12} m and 8.0×10^{10} m respectively. If the speed of the comet at the nearest point is 6×10^4 ms^{-1}, the speed at the farthest point is :

(1) 1.5×10^3 m/s (2) 6.0×10^3 m/s
(3) 3.0×10^3 m/s (4) 4.5×10^3 m/s

14. If one wants to remove all the mass of the earth to infinity in order to break it up completely. The amount of energy that needs to be supplied will be $\frac{x}{5}\frac{GM^2}{R}$ where x is ____ (Round off to the Nearest Integer)
(M is the mass of earth, R is the radius of earth, G is the gravitational constant)

15. A geostationary satellite is orbiting around an arbitary planet 'P' at a height of 11R above the surface of 'P', R being the radius of 'P'. The time period of another satellite in hours at a height of 2R from the surface of 'P' is _________. 'P' has the time period of 24 hours.

(1) $6\sqrt{2}$ (2) $\frac{6}{\sqrt{2}}$ (3) 3 (4) 5

16. The time period of a satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of radius 9R is :

(1) 9 T (2) 27 T
(3) 12 T (4) 3 T

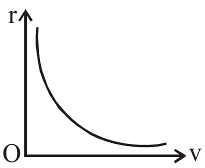
17. If the angular velocity of earth's spin is increased such that the bodies at the equator start floating, the duration of the day would be approximately :
(Take : g = 10 ms^{-2}, the radius of earth, R = 6400×10^3 m, Take π = 3.14)

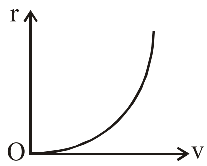
(1) 60 minutes (2) does not change
(3) 1200 minutes (4) 84 minutes

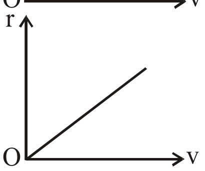
18. The angular momentum of a planet of mass M moving around the sun in an elliptical orbit is $\vec{L}$. The magnitude of the areal velocity of the planet is :

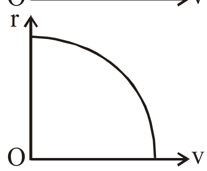
(1) $\frac{4L}{M}$ (2) $\frac{L}{M}$
(3) $\frac{2L}{M}$ (4) $\frac{L}{2M}$

19. A particle of mass m moves in a circular orbit under the central potential field, $U(r)=\frac{-C}{r}$, where C is a positive constant.
The correct radius – velocity graph of the particle's motion is :

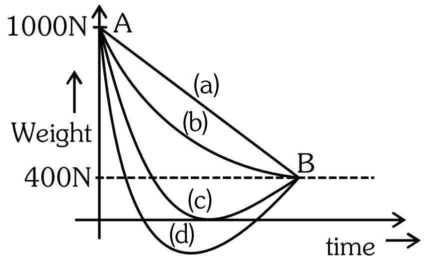
(1)


(2)


(3)


(4)


20. A person whose mass is 100 kg travels from Earth to Mars in a spaceship. Neglect all other objects in sky and take acceleration due to gravity on the surface of the Earth and Mars as 10 m/s^2 and 4 m/s^2 respectively. Identify from the below figures, the curve that fits best for the weight of the passenger as a function of time.



(1) (c) (2) (a) (3) (d) (4) (b)

21. A satellite is launched into a circular orbit of radius R around earth, while a second satellite is launched into a circular orbit of radius 1.02 R. The percentage difference in the time periods of the two satellites is :

(1) 1.5 (2) 2.0 (3) 0.7 (4) 3.0

22. Consider a binary star system of star A and star B with masses m_A and m_B revolving in a circular orbit of radii r_A and r_B, respectively. If T_A and T_B are the time period of star A and star B, respectively, then :

(1) $\frac{T_A}{T_B}=\left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$ (2) $T_A = T_B$
(3) $T_A > T_B$ (if $m_A > m_B$)
(4) $T_A > T_B$ (if $r_A > r_B$)

23. A body is projected vertically upwards from the surface of earth with a velocity sufficient enough to carry it to infinity. The time taken by it to reach height h is ______ S.

(1) $\sqrt{\frac{R_e}{2g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

(2) $\sqrt{\frac{2R_e}{g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

(3) $\frac{1}{3}\sqrt{\frac{R_e}{2g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

(4) $\frac{1}{3}\sqrt{\frac{2R_e}{g}}\left[\left(1+\frac{h}{R_e}\right)^{3/2}-1\right]$

24. The minimum and maximum distances of a planet revolving around the Sun are x_1 and x_2. If the minimum speed of the planet on its trajectory is v_0 then its maximum speed will be :

(1) $\frac{v_0 x_1^2}{x_2^2}$ (2) $\frac{v_0 x_2^2}{x_1^2}$

(3) $\frac{v_0 x_1}{x_2}$ (4) $\frac{v_0 x_2}{x_1}$

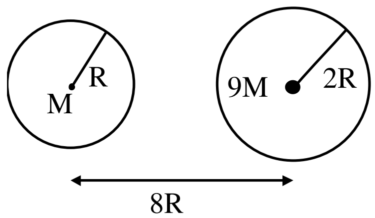
25. Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is W, the weight of the same object on that planet will be :

(1) 2W (2) W

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

26. Suppose two planets (spherical in shape) of radii R and 2R, but mass M and 9 M respectively have a centre to centre separation 8 R as shown in the figure. A satellite of mass 'm' is projected from the surface of the planet of mass 'M' directly towards the centre of the second planet. The minimum speed 'v' required for the satellite to reach the surface of the second planet is $\sqrt{\frac{a}{7}\frac{GM}{R}}$ then the value of 'a' is ________.

[Given : The two planets are fixed in their position]



27. Two identical particles of mass 1 kg each go round a circle of radius R, under the action of their mutual gravitational attraction. The angular speed of each particle is :

(1) $\sqrt{\frac{G}{2R^3}}$ (2) $\frac{1}{2}\sqrt{\frac{G}{R^3}}$

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

28. The planet Mars has two moons, if one of them has a period 7 hours, 30 minutes and an orbital radius of 9.0×10^3 km. Find the mass of Mars.

$\left\{\text{Given } \frac{4\pi^2}{G} = 6\times10^{11}\ N^{-1}\ m^{-2}\ kg^2\right\}$

(1) 5.96×10^{19} kg (2) 3.25×10^{21} kg
(3) 7.02×10^{25} kg (4) 6.00×10^{23} kg

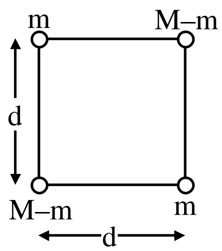
29. Inside a uniform spherical shell :

(a) the gravitational field is zero
(b) the gravitational potential is zero
(c) the gravitational field is same everywhere
(d) the gravitation potential is same everywhere
(e) all of the above

Choose the most appropriate answer from the options given below :

(1) (a), (c) and (d) only
(2) (e) only
(3) (a), (b) and (c) only
(4) (b), (c) and (d) only

30. A body of mass (2M) splits into four masses {m, M – m, m, M – m}, which are rearranged to form a square as shown in the figure. The ratio of $\frac{M}{m}$ for which, the gravitational potential energy of the system becomes maximum is x : 1. The value of x is ....



31. A mass of 50 kg is placed at the centre of a uniform spherical shell of mass 100 kg and radius 50 m. If the gravitational potential at a point, 25 m from the centre is V kg/m. The value of V is :

(1) – 60 G (2) + 2 G
(3) – 20 G (4) – 4 G

32. The masses and radii of the earth and moon are (M_1, R_1) and (M_2, R_2) respectively. Their centres are at a distance 'r' apart. Find the minimum escape velocity for a particle of mass 'm' to be projected from the middle of these two masses:

(1) $V = \frac{1}{2}\sqrt{\frac{4G(M_1+M_2)}{r}}$

(2) $V = \sqrt{\frac{4G(M_1+M_2)}{r}}$

(3) $V = \frac{1}{2}\sqrt{\frac{2G(M_1+M_2)}{r}}$

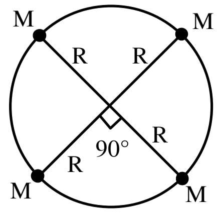
(4) $V = \frac{\sqrt{2G}(M_1+M_2)}{r}$

33. If R_E be the radius of Earth, then the ratio between the acceleration due to gravity at a depth 'r' below and a height 'r' above the earth surface is : (Given : $r < R_E$)

(1) $1-\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$ (2) $1+\frac{r}{R_E}+\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$

(3) $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$ (4) $1+\frac{r}{R_E}-\frac{r^2}{R_E^2}-\frac{r^3}{R_E^3}$

34. Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is :



(1) $\frac{1}{2}\sqrt{\frac{GM}{R(2\sqrt{2}+1)}}$ (2) $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}+1)}$

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

HEAT & THERMODYNAMICS

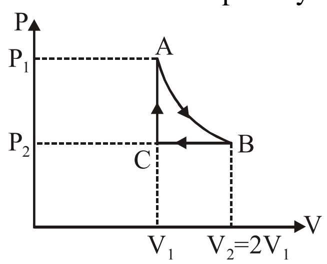
1. n mole a perfect gas undergoes a cyclic process ABCA (see figure) consisting of the following processes.

$A \rightarrow B$: Isothermal expansion at temperature T so that the volume is doubled from V_1 to $V_2 = 2V_1$ and pressure changes from P_1 to P_2.

$B \rightarrow C$: Isobaric compression at pressure P_2 to initial volume V_1.

$C \rightarrow A$: Isochoric change leading to change of pressure from P_2 to P_1.

Total workdone in the complete cycle ABCA is :



(1) 0 (2) $nRT\left(\ln 2+\frac{1}{2}\right)$

(3) nRTln2 (4) $nRT\left(\ln 2-\frac{1}{2}\right)$

2. Match List-I with List-II :

List-I	List-II
(a) Isothermal	(i) Pressure constant
(b) Isochoric	(ii) Temperature constant
(c) Adiabatic	(iii) Volume constant
(d) Isobaric	(iv) Heat content is constant

Choose the correct answer from the options given below :

(1) (a) → (i), (b) → (iii), (c) → (ii), (d) → (iv)
(2) (a) → (ii), (b) → (iii), (c) → (iv), (d) → (i)
(3) (a) → (ii), (b) → (iv), (c) → (iii), (d) → (i)
(4) (a) → (iii), (b) → (ii), (c) → (i), (d) → (iv)

3. Each side of a box made of metal sheet in cubic shape is 'a' at room temperature 'T', the coefficient of linear expansion of the metal sheet is 'α'. The metal sheet is heated uniformly, by a small temperature ΔT, so that its new temperature is T + ΔT. Calculate the increase in the volume of the metal box.

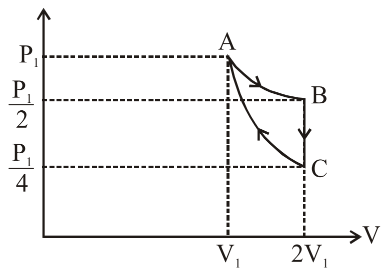
(1) $3a^3\alpha\Delta T$ (2) $4a^3\alpha\Delta T$

(3) $4\pi a^3\alpha\Delta T$ (4) $\frac{4}{3}\pi a^3\alpha\Delta T$

4. On the basis of kinetic theory of gases, the gas exerts pressure because its molecules :

(1) continuously lose their energy till it reaches wall.
(2) are attracted by the walls of container.
(3) continuously stick to the walls of container.
(4) suffer change in momentum when impinge on the walls of container.

5. If one mole of an ideal gas at (P_1, V_1) is allowed to expand reversibly and isothermally (A to B) its pressure is reduced to one-half of the original pressure (see figure). This is followed by a constant volume cooling till its pressure is reduced to one-fourth of the initial value (B→C). Then it is restored to its initial state by a reversible adiabatic compression (C to A). The net workdone by the gas is equal to :



(1) $RT\left(\ln 2-\frac{1}{2(\gamma-1)}\right)$ (2) $-\frac{RT}{2(\gamma-1)}$

(3) 0 (4) RT ln 2

6. The root mean square speed of molecules of a given mass of a gas at 27°C and 1 atmosphere pressure is 200 ms^{-1}. The root mean square speed of molecules of the gas at 127°C and 2 atmosphere pressure is $\frac{x}{\sqrt{3}} ms^{-1}$. The value of x will be _____.

7. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : When a rod lying freely is heated, no thermal stress is developed in it.

Reason R : On heating the length of the rod increases.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both A and R are true but R is NOT the correct explanation of A
(2) A is false but R is true
(3) A is true but R is false
(4) Both A and R are true and R is the correct explanation of A

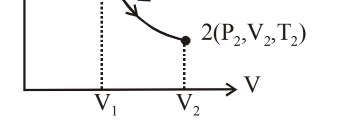
8. A diatomic gas, having $C_p = \frac{7}{2}R$ and $C_v = \frac{5}{2}R$, is heated at constant pressure. The ratio dU : dQ : dW :

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

9. In a certain thermodynamical process, the pressure of a gas depends on its volume as kV^3. The work done when the temperature changes from 100°C to 300°C will be ___ nR, where n denotes number of moles of a gas.

10. A monoatomic gas of mass 4.0 u is kept in an insulated container. Container is moving with velocity 30 m/s. If container is suddenly stopped then change in temperature of the gas (R = gas constant) is $\frac{x}{3R}$. Value of x is ___.

11. Thermodynamic process is shown below on a P-V diagram for one mole of an ideal gas. If $V_2 = 2V_1$ then the ratio of temperature T_2/T_1 is :



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

12. Given below are two statements :

Statement I : In a diatomic molecule, the rotational energy at a given temperature obeys Maxwell's distribution.

Statement II : In a diatomic molecule, the rotational energy at a given temperature equals the translational kinetic energy for each molecule.

In the light of the above statements, choose the correct answer from the options given below :

(1) Statement I is false but Statement II is true.
(2) Both Statement I and Statement II are false.
(3) Both Statement I and Statement II are true.
(4) Statement I is true but Statement II is false.

13. A reversible heat engine converts one-fourth of the heat input into work. When the temperature of the sink is reduced by 52 K, its efficiency is doubled. The temperature in Kelvin of the source will be _________.

14. A container is divided into two chambers by a partition. The volume of first chamber is 4.5 litre and second chamber is 5.5 litre. The first chamber contain 3.0 moles of gas at pressure 2.0 atm and second chamber contain 4.0 moles of gas at pressure 3.0 atm. After the partition is removed and the mixture attains equilibrium, then, the common equilibrium pressure existing in the mixture is $x \times 10^{-1}$ atm. Value of x is_.

15. The internal energy (U), pressure (P) and volume (V) of an ideal gas are related as U = 3PV + 4. The gas is :

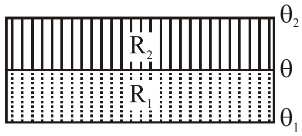
(1) Diatomic only
(2) Polyatomic only
(3) Either monoatomic or diatomic
(4) Monoatomic only

16. The volume V of a given mass of monoatomic gas changes with temperature T according to the relation $V = KT^{2/3}$. The workdone when temperature changes by 90 K will be xR. The value of x is [R = universal gas constant]

17. 1 mole of rigid diatomic gas performs a work of Q/5 when heat Q is supplied to it. The molar heat capacity of the gas during this transformation is $\frac{xR}{8}$, The value of x is ....

[K = universal gas constant]

18. The temperature θ at the junction of two insulating sheets, having thermal resistances R_1 and R_2 as well as top and bottom temperatures θ_1 and θ_2 (as shown in figure) is given by :



(1) $\dfrac{\theta_2 R_2 - \theta_1 R_1}{R_2 - R_1}$ (2) $\dfrac{\theta_1 R_2 - \theta_2 R_1}{R_2 - R_1}$

(3) $\dfrac{\theta_1 R_2 + \theta_2 R_1}{R_1 + R_2}$ (4) $\dfrac{\theta_1 R_1 + \theta_2 R_2}{R_1 + R_2}$

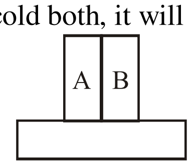
19. The volume V of an enclosure contains a mixture of three gases, 16 g of oxygen, 28 g of nitrogen and 44 g of carbon dioxide at absolute temperature T. Consider R as universal gas constant. The pressure of the mixture of gases is:

(1) $\dfrac{88RT}{V}$ (2) $\dfrac{3RT}{V}$ (3) $\dfrac{5}{2}\dfrac{RT}{V}$ (4) $\dfrac{4RT}{V}$

20. In thermodynamics, heat and work are :
(1) Path functions
(2) Intensive thermodynamic state variables
(3) Extensive thermodynamic state variables
(4) Point functions

21. Calculate the value of mean free path (λ) for oxygen molecules at temperature 27°C and pressure 1.01×10^5 Pa. Assume the molecular diameter 0.3 nm and the gas is ideal. ($k = 1.38 \times 10^{-23}$ JK^{-1})
(1) 58 nm (2) 32 nm
(3) 86 nm (4) 102 nm

22. A bimetallic strip consists of metals A and B. It is mounted rigidly as shown. The metal A has higher coefficient of expansion compared to that of metal B. When the bimetallic strip is placed in a cold both, it will :



(1) Bend towards the right
(2) Not bend but shrink
(3) Neither bend nor shrink
(4) Bend towards the left

23. For an ideal heat engine, the temperature of the source is 127°C. In order to have 60% efficiency the temperature of the sink should be _______°C. (Round off to the Nearest Integer)

24. A polyatomic ideal gas has 24 vibrational modes. What is the value of γ ?
(1) 1.03 (2) 1.30
(3) 1.37 (4) 10.3

25. A Carnot's engine working between 400 K and 800 K has a work output of 1200 J per cycle. The amount of heat energy supplied to the engine from the source in each cycle is :
(1) 3200 J (2) 1800 J
(3) 1600 J (4) 2400 J

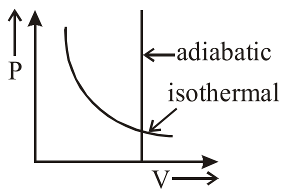
26. Two ideal polyatomic gases at temperatures T_1 and T_2 are mixed so that there is no loss of energy. If F_1 and F_2, m_1 and m_2, n_1 and n_2 be the degrees of freedom, masses, number of molecules of the first and second gas respectively, the temperature of mixture of these two gases is :

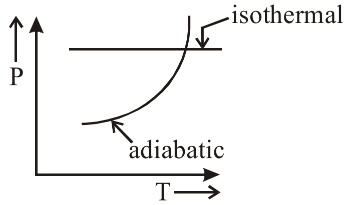
(1) $\dfrac{n_1T_1 + n_2T_2}{n_1 + n_2}$ (2) $\dfrac{n_1F_1T_1 + n_2F_2T_2}{n_1F_1 + n_2F_2}$

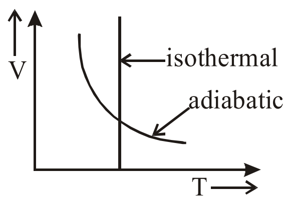
(3) $\dfrac{n_1F_1T_1 + n_2F_2T_2}{F_1 + F_2}$ (4) $\dfrac{n_1F_1T_1 + n_2F_2T_2}{n_1 + n_2}$

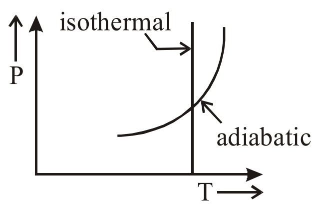
27. If one mole of the polyatomic gas is having two vibrational modes and β is the ratio of molar specific heats for polyatomic gas $\left(\beta = \dfrac{C_P}{C_V}\right)$ then the value of β is :
(1) 1.02 (2) 1.2 (3) 1.25 (4) 1.35

28. Which one is the correct option for the two different thermodynamic processes ?

(a)


(b)


(c)


(d)


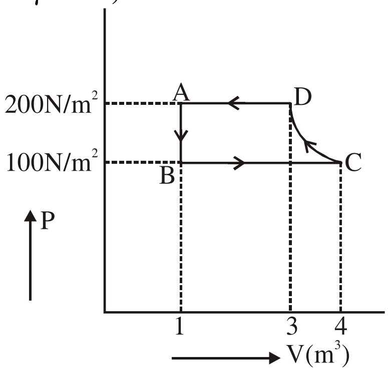
(1) (c) and (a) (2) (c) and (d)
(3) (a) only (4) (b) and (c)

29. What will be the average value of energy along one degree of freedom for an ideal gas in thermal equilibrium at a temperature T ? (k_B is Boltzmann constant)

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

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

30. The P-V diagram of a diatomic ideal gas system going under cyclic process as shown in figure. The work done during an adiabatic process CD is (use $\gamma = 1.4$) :



(1) –500 J (2) –400 J

(3) 400 J (4) 200 J

31. An ideal gas in a cylinder is separated by a piston in such a way that the entropy of one part is S_1 and that of the other part is S_2. Given that $S_1 > S_2$. If the piston is removed then the total entropy of the system will be :

(1) $S_1 \times S_2$ (2) $S_1 - S_2$

(3) $\frac{S_1}{S_2}$ (4) $S_1 + S_2$

32. Consider a sample of oxygen behaving like an ideal gas. At 300 K, the ratio of root mean square (rms) velocity to the average velocity of gas molecule would be :
(Molecular weight of oxygen is 32 g/mol; $R = 8.3\ J\ K^{-1}\ mol^{-1}$)

(1) $\sqrt{\frac{3}{3}}$ (2) $\sqrt{\frac{8}{3}}$

(3) $\sqrt{\frac{3\pi}{8}}$ (4) $\sqrt{\frac{8\pi}{3}}$

33. Two identical metal wires of thermal conductivities K_1 and K_2 respectively are connected in series. The effective thermal conductivity of the combination is :

(1) $\frac{2K_1K_2}{K_1+K_2}$ (2) $\frac{K_1+K_2}{2K_1K_2}$

(3) $\frac{K_1+K_2}{K_1K_2}$ (4) $\frac{K_1K_2}{K_1+K_2}$

34. For an adiabatic expansion of an ideal gas, the fractional change in its pressure is equal to (where γ is the ratio of specific heats):

(1) $-\gamma\frac{dV}{V}$ (2) $-\gamma\frac{V}{dV}$

(3) $-\frac{1}{\gamma}\frac{dV}{V}$ (4) $\frac{dV}{V}$

35. The amount of heat needed to raise the temperature of 4 moles of a rigid diatomic gas from 0°C to 50°C when no work is done is _______. (R is the universal gas constant)

(1) 250 R (2) 750 R

(3) 175 R (4) 500 R

36. Consider a mixture of gas molecule of types A, B and C having masses $m_A < m_B < m_C$. The ratio of their root mean square speeds at normal temperature and pressure is :

(1) $v_A = v_B = v_C = 0$ (2) $\frac{1}{v_A} > \frac{1}{v_B} > \frac{1}{v_C}$

(3) $v_A = v_B \neq v_C$ (4) $\frac{1}{v_A} < \frac{1}{v_B} < \frac{1}{v_C}$

37. The entropy of any system is given by

$$S = \alpha^2\beta \ln\left[\frac{\mu kR}{J\beta^2} + 3\right]$$

where α and β are the constants. μ, J, k and R are no. of moles, mechanical equivalent of heat, Boltzmann constant and gas constant respectively.

$$\left[\text{Take } S = \frac{dQ}{T}\right]$$

Choose the incorrect option from the following :

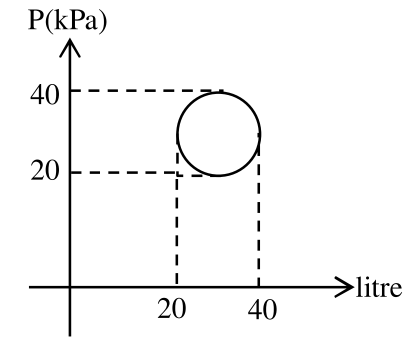
(1) α and J have the same dimensions.

(2) S, β, k and μR have the same dimensions.

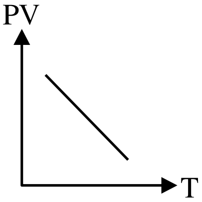
(3) S and α have different dimensions.

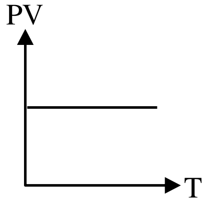
(4) α and k have the same dimensions.

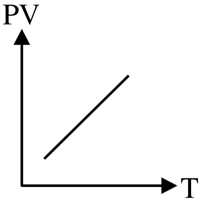
38. In the reported figure, heat energy absorbed by a system in going through a cyclic process is ______ πJ.

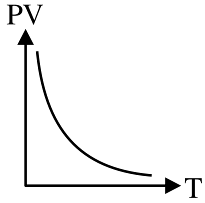


39. Which of the following graphs represent the behavior of an ideal gas ? Symbols have their usual meaning.

(1) 

(2) 

(3) 

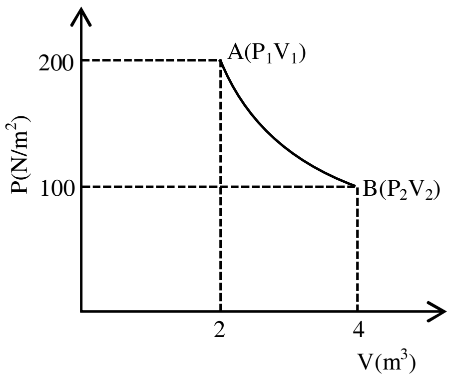
(4) 

40. The correct relation between the degrees of freedom f and the ratio of specific heat γ is :

(1) $f=\frac{2}{\gamma-1}$ (2) $f=\frac{2}{\gamma+1}$

(3) $f=\frac{\gamma+1}{2}$ (4) $f=\frac{1}{\gamma+1}$

41. One mole of an ideal gas at 27ºC is taken from A to B as shown in the given PV indicator diagram. The work done by the system will be____ $\times 10^{-1}$ J. [Given : R = 8.3 J / mole K, ln2 = 0.6931] (Round off to the nearest integer)



42. What will be the average value of energy for a monoatomic gas in thermal equilibrium at temperature T ?

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

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

43. In 5 minutes, a body cools from 75°C to 65°C at room temperature of 25°C. The temperature of body at the end of next 5 minutes is _______°C.

44. For a gas $C_P - C_V = R$ in a state P and $C_P - C_V = 1.10\ R$ in a state Q, T_P and T_Q are the temperatures in two different states P and Q respectively. Then

(1) $T_P = T_Q$ (2) $T_P < T_Q$

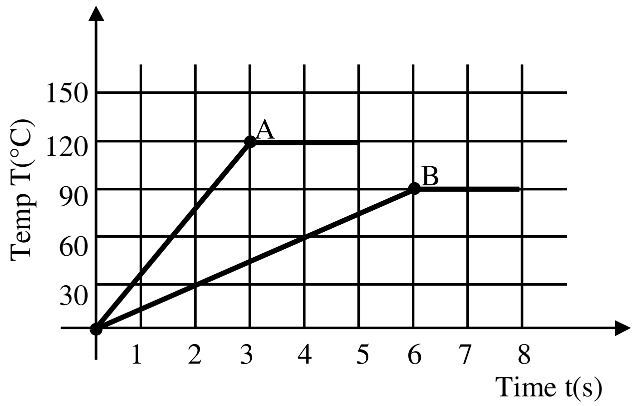
(3) $T_P = 0.9\ T_Q$ (4) $T_P > T_Q$

45. A monoatomic ideal gas, initially at temperature T_1 is enclosed in a cylinder fitted with a frictionless piston. The gas is allowed to expand adiabatically to a temperature T_2 by releasing the piston suddenly. If l_1 and l_2 are the lengths of the gas column, before and after the expansion respectively, then the value of $\frac{T_1}{T_2}$ will be :

(1) $\left(\frac{l_1}{l_2}\right)^{\frac{2}{3}}$ (2) $\left(\frac{l_2}{l_1}\right)^{\frac{2}{3}}$

(3) $\frac{l_2}{l_1}$ (4) $\frac{l_1}{l_2}$

46. Two different metal bodies A and B of equal mass are heated at a uniform rate under similar conditions. The variation of temperature of the bodies is graphically represented as shown in the figure. The ratio of specific heat capacities is :



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

47. A heat engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by 62°C, its efficiency get doubled. The temperature of the source is :

(1) 124°C (2) 37°C

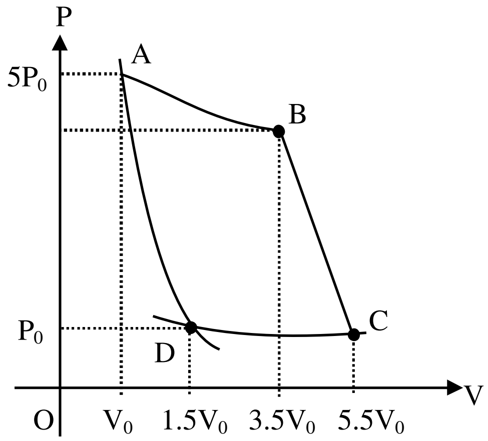
(3) 62°C (4) 99°C

48. A system consists of two types of gas molecules A and B having same number density 2×10^{25} / m^3. The diameter of A and B are 10 Å and 5 Å respectively. They suffer collision at room temperature. The ratio of average distance covered by the molecule A to that of B between two successive collision is ______ $\times 10^{-2}$

49 The number of molecules in one litre of an ideal gas at 300 K and 2 atmospheric pressure with mean kinetic energy 2×10^{-9} J per molecules is :

(1) 0.75×10^{11} (2) 3×10^{11}
(3) 1.5×10^{11} (4) 6×10^{11}

50. In the reported figure, there is a cyclic process ABCDA on a sample of 1 mol of a diatomic gas. The temperature of the gas during the process $A \to B$ and $C \to D$ are T_1 and T_2 ($T_1 > T_2$) respectively.



Choose the correct option out of the following for work done if processes BC and DA are adiabatic.

(1) $W_{AB} = W_{DC}$ (2) $W_{AD} = W_{BC}$
(3) $W_{BC} + W_{DA} > 0$ (4) $W_{AB} < W_{CD}$

51. A body takes 4 min. to cool from 61° C to 59°C. If the temperature of the surroundings is 30°C, the time taken by the body to cool from 51°C to 49° C is :

(1) 4 min. (2) 3 min.
(3) 8 min. (4) 6 min.

52. One mole of an ideal gas is taken through an adiabatic process where the temperature rises from 27°C to 37°C. If the ideal gas is composed of polyatomic molecule that has 4 vibrational modes, which of the following is true?
[$R = 8.314$ J mol^{-1} k^{-1}]

(1) work done by the gas is close to 332 J
(2) work done on the gas is close to 582 J
(3) work done by the gas is close to 582 J
(4) work done on the gas is close to 332 J

53. Two Carnot engines A and B operate in series such that engine A absorbs heat at T_1 and rejects heat to a sink at temperature T. Engine B absorbs half of the heat rejected by Engine A and rejects heat to the sink at T_3. When workdone in both the cases is equal, to value of T is :

(1) $\frac{2}{3}T_1 + \frac{3}{2}T_3$ (2) $\frac{1}{3}T_1 + \frac{2}{3}T_3$
(3) $\frac{3}{2}T_1 + \frac{1}{3}T_3$ (4) $\frac{2}{3}T_1 + \frac{1}{3}T_3$

54. An electric appliance supplies 6000 J/min heat to the system. If the system delivers a power of 90W. How long it would take to increase the internal energy by 2.5×10^3 J ?

(1) 2.5×10^2 s (2) 4.1×10^1s
(3) 2.4×10^3 s (4) 2.5×10^1s

55. The rms speeds of the molecules of Hydrogen, Oxygen and Carbondioxide at the same temperature are V_H, V_O and V_C respectively then :

(1) $V_H > V_O > V_C$ (2) $V_C > V_O > V_H$
(3) $V_H = V_O > V_C$ (4) $V_H = V_O = V_C$

56. The temperature of equal masses of three different liquids x,y and z are 10ºC, 20ºC and 30ºC respectively. The temperature of mixture when x is mixed with y is 16ºC and that when y is mixed with z is 26ºC. The temperature of mixture when x and z are mixed will be :

(1) 28.32º C (2) 25.62º C
(3) 23.84ºC (4) 20.28ºC

57. A cylindrical container of volume 4.0×10^{-3} m^3 contains one mole of hydrogen and two moles of carbon dioxide. Assume the temperature of the mixture is 400 K. The pressure of the mixture of gases is : [Take gas constant as 8.3 J mol^{-1} K^{-1}]

(1) 249×10^1 Pa (2) 24.9×10^3 Pa
(3) 24.9×10^5 Pa (4) 24.9 Pa

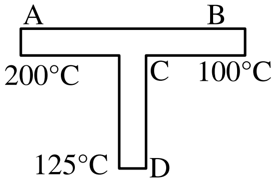
58. A refrigerator consumes an average 35 W power to operate between temperature –10°C to 25°C. If there is no loss of energy then how much average heat per second does it transfer ?

(1) 263 J/s (2) 298 J/s
(3) 350 J/s (4) 35 J/s

59. A balloon carries a total load of 185 kg at normal pressure and temperature of 27°C. What load will the balloon carry on rising to a height at which the barometric pressure is 45 cm of Hg and the temperature is –7°C. Assuming the volume constant ?

(1) 181.46 kg (2) 214.15 kg.
(3) 219.07 kg (4) 123.54 kg

60. A rod CD of thermal resistance 10.0 KW^{-1} is joined at the middle of an identical rod AB as shown in figure, The end A, B and D are maintained at 200°C, 100°C and 125°C respectively. The heat current in CD is P watt. The value of P is ....



61. If the rms speed of oxygen molecules at 0°C is 160 m/s, find the rms speed of hydrogen molecules at 0°C.

(1) 640 m/s (2) 40 m/s
(3) 80 m/s (4) 332 m/s

62. The height of victoria falls is 63 m. What is the difference in temperature of water at the top and at the bottom of fall ?
[Given 1 cal = 4.2 J and specific heat of water = 1 cal g^{-1} °C^{-1}]

(1) 0.147° C (2) 14.76° C
(3) 1.476° (4) 0.014° C

63. A heat engine operates between a cold reservoir at temperature T_2 = 400 K and a hot reservoir at temperature T_1. It takes 300 J of heat from the hot reservoir and delivers 240 J of heat to the cold reservoir in a cycle. The minimum temperature of the hot reservoir has to be _________K.

64. A reversible engine has an efficiency of $\frac{1}{4}$. If the temperature of the sink is reduced by 58°C, its efficiency becomes double. Calculate the temperature of the sink :

(1) 174°C (2) 280°C
(3) 180.4°C (4) 382°C

65. For an ideal gas the instantaneous change in pressure 'p' with volume 'v' is given by the equation $\frac{dp}{dv} = -ap$. If $p = p_0$ at $v = 0$ is the given boundary condition, then the maximum temperature one mole of gas can attain is :
(Here R is the gas constant)

(1) $\frac{p_0}{aeR}$ (2) $\frac{ap_0}{eR}$
(3) infinity (4) 0°C

66. Two thin metallic spherical shells of radii r_1 and r_2 ($r_1 < r_2$) are placed with their centres coinciding.
A material of thermal conductivity K is filled in the space between the shells. The inner shell is maintained at temperature θ_1 and the outer shell at temperature $\theta_2(\theta_1<\theta_2)$. The rate at which heat flows radially through the material is :-

(1) $\frac{4\pi K r_1 r_2(\theta_2-\theta_1)}{r_2-r_1}$ (2) $\frac{\pi r_1 r_2(\theta_2-\theta_1)}{r_2-r_1}$
(3) $\frac{K(\theta_2-\theta_1)}{r_2-r_1}$ (4) $\frac{K(\theta_2-\theta_1)(r_2-r_1)}{4\pi r_1 r_2}$

67. A mixture of hydrogen and oxygen has volume 500 cm^3, temperature 300 K, pressure 400 kPa and mass 0.76 g. The ratio of masses of oxygen to hydrogen will be :-

(1) 3 : 8 (2) 3 : 16 (3) 16 : 3 (4) 8 : 3

68. A sample of gas with $\gamma = 1.5$ is taken through an adiabatic process in which the volume is compressed from 1200 cm^3 to 300 cm^3. If the initial pressure is 200 kPa. The absolute value of the workdone by the gas in the process = _____ J.

69. Due to cold weather a 1 m water pipe of cross–sectional area 1 cm^2 is filled with ice at –10°C. Resistive heating is used to melt the ice. Current of 0.5 A is passed through 4 kΩ resistance. Assuming that all the heat produced is used for melting, what is the minimum time required ? (Given latent heat of fusion for water/ice = 3.33×10^5 J kg^{-1}, specific heat of ice = 2×10^3 J kg^{-1} and density of ice = 10^3 kg / m^3

(1) 0.353 s (2) 35.3 s
(3) 3.53 s (4) 70.6 s

70. An ideal gas is expanding such that PT^3 = constant. The coefficient of volume expansion of the gas is :

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

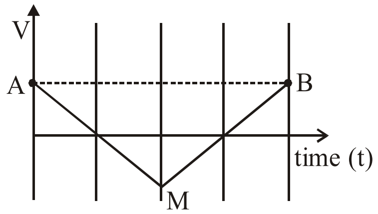
71. The temperature of 3.00 mol of an ideal diatomic gas is increased by 40.0 °C without changing the pressure of the gas. The molecules in the gas rotate but do not oscillate. If the ratio of change in internal energy of the gas to the amount of workdone by the gas is $\frac{x}{10}$. Then the value of x (round off to the nearest integer) is _______. (Given R = 8.31 J mol^{-1} K^{-1})

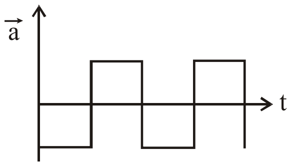
72. The average translational kinetic energy of N_2 gas molecules at ....°C becomes equal to the K.E. of an electron accelerated from rest through a potential difference of 0.1 volt.
(Given $k_B = 1.38 \times 10^{-23}$ J/K)
(Fill the nearest integer).

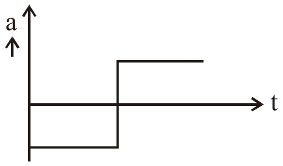
73. A steel rod with $y = 2.0 \times 10^{11}$ Nm^{-2} and $\alpha = 10^{-5}$ °C^{-1} of length 4 m and area of cross-section 10 cm^2 is heated from 0° C to 400°C without being allowed to extend. The tension produced in the rod is $x \times 10^5$ N where the value of x is ....

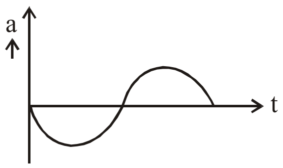
KINEMATICS

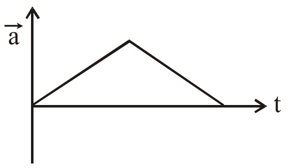
1. If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph ?



(1) 

(2) 

(3) 

(4) 

2. A particle is projected with velocity v_0 along x-axis. A damping force is acting on the particle which is proportional to the square of the distance from the origin i.e., $ma = -\alpha x^2$. The distance at which the particle stops :

(1) $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{2}}$ (2) $\left(\frac{2v_0}{3\alpha}\right)^{\frac{1}{3}}$

(3) $\left(\frac{2v_0^2}{3\alpha}\right)^{\frac{1}{2}}$ (4) $\left(\frac{3v_0^2}{2\alpha}\right)^{\frac{1}{3}}$

3. An engine of a train, moving with uniform acceleration, passes the signal-post with velocity u and the last compartment with velocity v. The velocity with which middle point of the train passes the signal post is:

(1) $\sqrt{\frac{v^2+u^2}{2}}$ (2) $\frac{v-u}{2}$

(3) $\frac{u+v}{2}$ (4) $\sqrt{\frac{v^2-u^2}{2}}$

4. A stone is dropped from the top of a building. When it crosses a point 5 m below the top, another stone starts to fall from a point 25 m below the top. Both stones reach the bottom of building simultaneously. The height of the building is :

(1) 35 m (2) 45m (3) 50 m (4) 25m

5. The trajectory of a projectile in a vertical plane is $y = \alpha x - \beta x^2$, where α and β are constants and x & y are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection θ and the maximum height attained H are respectively given by :-

(1) $\tan^{-1}\alpha, \frac{\alpha^2}{4\beta}$ (2) $\tan^{-1}\beta, \frac{\alpha^2}{2\beta}$

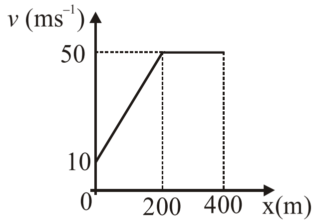
(3) $\tan^{-1}\alpha, \frac{4\alpha^2}{\beta}$ (4) $\tan^{-1}\left(\frac{\beta}{\alpha}\right), \frac{\alpha^2}{\beta}$

6. A scooter accelerates from rest for time t_1 at constant rate a_1 and then retards at constant rate a_2 for time t_2 and comes to rest. The correct value of $\frac{t_1}{t_2}$ will be :-

(1) $\frac{a_1+a_2}{a_2}$ (2) $\frac{a_2}{a_1}$

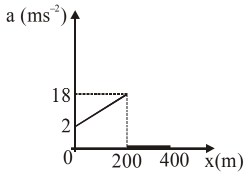
(3) $\frac{a_1}{a_2}$ (4) $\frac{a_1+a_2}{a_1}$

7. The velocity-displacement graph describing the motion of a bicycle is shown in the figure.

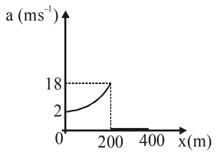


The acceleration-displacement graph of the bicycle's motion is best described by :

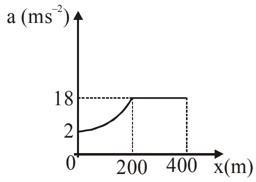
(1)



(2)



(3)



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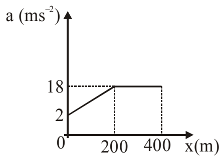


8. A mosquito is moving with a velocity $\vec{v} = 0.5t^2\,\hat{i} + 3t\,\hat{j} + 9\hat{k}$ m/s and accelerating in uniform conditions. What will be the direction of mosquito after 2s ?

(1) $\tan^{-1}\left(\frac{2}{3}\right)$ from x-axis

(2) $\tan^{-1}\left(\frac{2}{3}\right)$ from y-axis

(3) $\tan^{-1}\left(\frac{5}{2}\right)$ from y-axis

(4) $\tan^{-1}\left(\frac{5}{2}\right)$ from x-axis

9. A swimmer can swim with velocity of 12 km/h in still water. Water flowing in a river has velocity 6 km/h. The direction with respect to the direction of flow of river water he should swim in order to reach the point on the other bank just opposite to his starting point is _________°. (Round off to the Nearest Integer) (find the angle in degree)

10. A car accelerates from rest at a constant rate α for some time after which it decelerates at a constant rate β to come to rest. If the total time elapsed is t seconds, the total distance travelled is :

(1) $\frac{4\alpha\beta}{(\alpha+\beta)}t^2$ (2) $\frac{2\alpha\beta}{(\alpha+\beta)}t^2$

(3) $\frac{\alpha\beta}{2(\alpha+\beta)}t^2$ (4) $\frac{\alpha\beta}{4(\alpha+\beta)}t^2$

11. The velocity of a particle is $v = v_0 + gt + Ft^2$. Its position is x = 0 at t = 0 ; then its displacement after time (t = 1) is :

(1) $v_0 + g + F$

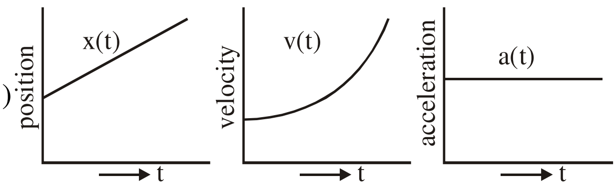
(2) $v_0 + \frac{g}{2} + \frac{F}{3}$

(3) $v_0 + \frac{g}{2} + F$

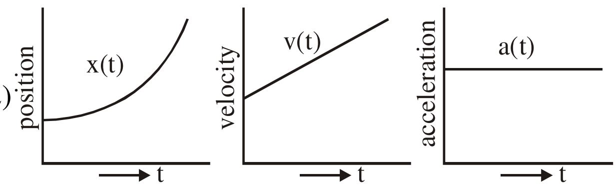
(4) $v_0 + 2g + 3F$

12. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by :

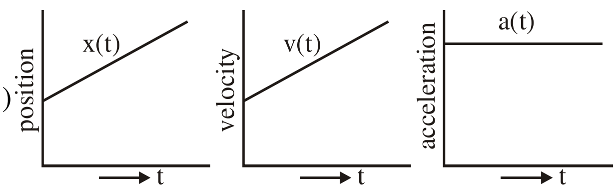
(1)



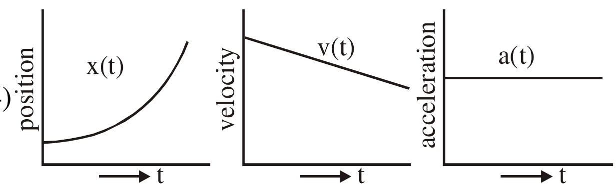
(2)



(3)

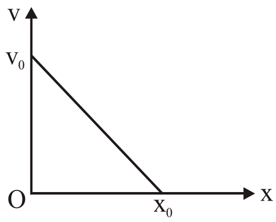


(4)

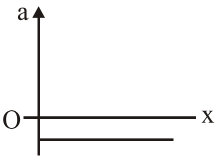


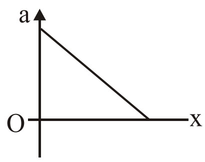
13. A person is swimming with a speed of 10 m/s at an angle of 120° with the flow and reaches to a point directly opposite on the other side of the river. The speed of the flow is 'x' m/s. The value of 'x' to the nearest integer is ______.

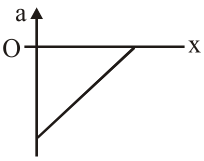
14. The velocity-displacement graph of a particle is shown in the figure.

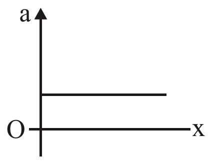


The acceleration-displacement graph of the same particle is represented by :

(1) 

(2) 

(3) 

(4) 

15. A butterfly is flying with a velocity $4\sqrt{2}$ m/s in North-East direction. Wind is slowly blowing at 1 m/s from North to South. The resultant displacement of the butterfly in 3 seconds is :

(1) 3 m (2) 20 m

(3) $12\sqrt{2}$ m (4) 15 m

16. A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time t_1. If he remains stationary on a moving escalator then the escalator takes him up in time t_2. The time taken by him to walk up on the moving escalator will be :

(1) $\frac{t_1t_2}{t_2-t_1}$ (2) $\frac{t_1+t_2}{2}$

(3) $\frac{t_1t_2}{t_2+t_1}$ (4) t_2-t_1

17. Water droplets are coming from an open tap at a particular rate. The spacing between a droplet observed at 4^{th} second after its fall to the next droplet is 34.3 m. At what rate the droplets are coming from the tap ? (Take g = 9.8 m/s^2)

(1) 3 drops / 2 seconds

(2) 2 drops / second

(3) 1 drop / second

(4) 1 drop / 7 seconds

18. The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is : (When v stands for velocity)

(1) 2 mv^3 (2) 2 mnv^3

(3) $2nv^3$ (4) $2n^2v^3$

19. A force $\vec{F}=\left(40\hat{i}+10\hat{j}\right)N$ acts on a body of mass 5 kg. If the body starts from rest, its position vector $\vec{r}$ at time t = 10 s, will be :

(1) $\left(100\hat{i}+400\hat{j}\right)m$ (2) $\left(100\hat{i}+100\hat{j}\right)m$

(3) $\left(400\hat{i}+100\hat{j}\right)m$ (4) $\left(400\hat{i}+400\hat{j}\right)m$

20. A balloon was moving upwards with a uniform velocity of 10 m/s. An object of finite mass is dropped from the balloon when it was at a height of 75 m from the ground level. The height of the balloon from the ground when object strikes the ground was around :
(takes the value of g as 10 m/s^2)

(1) 300 m (2) 200 m

(3) 125 m (4) 250 m

21. The instantaneous velocity of a particle moving in a straight line is given as $v = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is :

(1) $3\alpha + 7\beta$ (2) $\frac{3}{2}\alpha+\frac{7}{3}\beta$

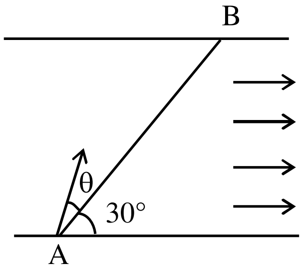
(3) $\frac{\alpha}{2}+\frac{\beta}{3}$ (4) $\frac{3}{2}\alpha+\frac{7}{2}\beta$

22. A ball is thrown up with a certain velocity so that it reaches a height 'h'. Find the ratio of the two different times of the ball reaching $\frac{h}{3}$ in both the directions.

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

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

23. A swimmer wants to cross a river from point A to point B. Line AB makes an angle of 30° with the flow of river. Magnitude of velocity of the swimmer is same as that of the river. The angle θ with the line AB should be ____°, so that the swimmer reaches point B.



24. Two spherical balls having equal masses with radius of 5 cm each are thrown upwards along the same vertical direction at an interval of 3s with the same initial velocity of 35 m/s, then these balls collide at a height of .... m. (Take $g = 10\ m/s^2$)

25. A bomb is dropped by fighter plane flying horizontally. To an observer sitting in the plane, the trajectory of the bomb is a :
(1) hyperbola
(2) parabola in the direction of motion of plane
(3) straight line vertically down the plane
(4) parabola in a direction opposite to the motion of plane

26. If the velocity of a body related to displacement x is given by $\upsilon = \sqrt{5000 + 24x}\ m/s$, then the acceleration of the body is ...... m/s^2.

27. Water drops are falling from a nozzle of a shower onto the floor, from a height of 9.8 m. The drops fall at a regular interval of time. When the first drop strikes the floor, at that instant, the third drop begins to fall. Locate the position of second drop from the floor when the first drop strikes the floor.
(1) 4.18 m (2) 2.94 m
(3) 2.45 m (4) 7.35 m

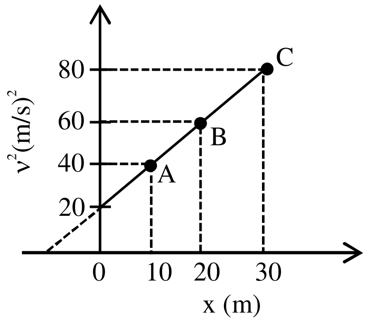
28. A player kicks a football with an initial speed of $25\ ms^{-1}$ at an angle of 45° from the ground. What are the maximum height and the time taken by the football to reach at the highest point during motion ? (Take $g = 10\ ms^{-2}$)
(1) $h_{max} = 10$ m T = 2.5 s
(2) $h_{max} = 15.625$ m T = 3.54 s
(3) $h_{max} = 15.625$ m T = 1.77 s
(4) $h_{max} = 3.54$ m T = 0.125 s

29. A helicopter is flying horizontally with a speed 'v' at an altitude 'h' has to drop a food packet for a man on the ground. What is the distance of helicopter from the man when the food packet is dropped?

(1) $\sqrt{\dfrac{2ghv^2+1}{h^2}}$ (2) $\sqrt{2ghv^2+h^2}$

(3) $\sqrt{\dfrac{2v^2h}{g}+h^2}$ (4) $\sqrt{\dfrac{2gh}{v^2}+h^2}$

30. A particle is moving with constant acceleration 'a'. Following graph shows v^2 versus x(displacement) plot. The acceleration of the particle is___m/s^2.



31. The ranges and heights for two projectiles projected with the same initial velocity at angles 42° and 48° with the horizontal are R_1, R_2 and H_1, H_2 respectively. Choose the correct option :
(1) $R_1 > R_2$ and $H_1 = H_2$
(2) $R_1 = R_2$ and $H_1 < H_2$
(3) $R_1 < R_2$ and $H_1 < H_2$
(4) $R_1 = R_2$ and $H_1 = H_2$

MAGNETISM

1. A soft ferromagnetic material is placed in an external magnetic field. The magnetic domains :
(1) increase in size but no change in orientation.
(2) have no relation with external magnetic field.
(3) decrease in size and changes orientation.
(4) may increase or decrease in size and change its orientation.

2. A proton, a deuteron and an α particle are moving with same momentum in a uniform magnetic field. The ratio of magnetic forces acting on them is ____ and their speed is ____ in the ratio.

(1) 1 : 2 : 4 and 2 : 1 : 1

(2) 2 : 1 : 1 and 4 : 2 : 1

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

(4) 1 : 2 : 4 and 1 : 1 : 2

3. Magnetic fields at two points on the axis of a circular coil at a distance of 0.05m and 0.2 m from the centre are in the ratio 8 : 1. The radius of coil is ____.

(1) 0.2 m (2) 0.1 m

(3) 0.15 m (4) 1.0 m

4. In a ferromagnetic material, below the curie temperature, a domain is defined as :

(1) a macroscopic region with zero magnetization.

(2) a macroscopic region with consecutive magnetic dipoles oriented in opposite direction.

(3) a macroscopic region with randomly oriented magnetic dipoles.

(4) a macroscopic region with saturation magnetization.

5. A bar magnet of length 14 cm is placed in the magnetic meridian with its north pole pointing towards the geographic north pole. A neutral point is obtained at a distance of 18 cm from the center of the magnet. If $B_H = 0.4$ G, the magnetic moment of the magnet is (1 G = 10^{-4}T)

(1) 2.880×10^3 J T^{-1}

(2) 2.880×10^2 J T^{-1}

(3) 2.880 J T^{-1}

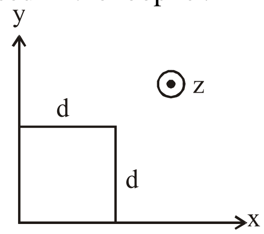
(4) 28.80 J T^{-1}

6. A charge Q is moving $\overrightarrow{dl}$ distance in the magnetic field $\vec{B}$. Find the value of work done by $\vec{B}$.

(1) 1 (2) Infinite

(3) Zero (4) –1

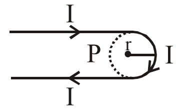
7. The magnetic field in a region is given by $\vec{B} = B_0\left(\frac{x}{a}\right)\hat{k}$. A square loop of side d is placed with its edges along the x and y axes. The loop is moved with a constant velocity $\vec{v} = v_0\hat{i}$. The emf induced in the loop is :



(1) $\frac{B_0 v_0^2 d}{2a}$ (2) $\frac{B_0 v_0 d}{2a}$

(3) $\frac{B_0 v_0 d^2}{a}$ (4) $\frac{B_0 v_0 d^2}{2a}$

8. A hairpin like shape as shown in figure is made by bending a long current carrying wire. What is the magnitude of a magnetic field at point P which lies on the centre of the semicircle ?



(1) $\frac{\mu_0 I}{4\pi r}(2-\pi)$ (2) $\frac{\mu_0 I}{4\pi r}(2+\pi)$

(3) $\frac{\mu_0 I}{2\pi r}(2+\pi)$ (4) $\frac{\mu_0 I}{2\pi r}(2-\pi)$

9. A loop of flexible wire of irregular shape carrying current is placed in an external magnetic field. Identify the effect of the field on the wire.

(1) Loop assumes circular shape with its plane normal to the field.

(2) Loop assumes circular shape with its plane parallel to the field.

(3) Wire gets stretched to become straight.

(4) Shape of the loop remains unchanged.

10. Which of the following statements are correct?

(A) Electric monopoles do not exist whereas magnetic monopoles exist.

(B) Magnetic field lines due to a solenoid at its ends and outside cannot be completely straight and confined.

(C) Magnetic field lines are completely confined within a toroid.

(D) Magnetic field lines inside a bar magnet are not parallel.

(E) $\chi = -1$ is the condition for a perfect diamagnetic material, where χ is its magnetic susceptibility.

Choose the correct answer from the options given below :

(1) (C) and (E) only (2) (B) and (D) only
(3) (A) and (B) only (4) (B) and (C) only

11. A deuteron and an alpha particle having equal kinetic energy enter perpendicular into a magnetic field. Let r_d and r_α be their respective radii of circular path. The value of $\frac{r_d}{r_\alpha}$ is equal to :

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

12. At an angle of 30° to the magnetic meridian, the apparent dip is 45°. Find the true dip :

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

13. The magnetic susceptibility of a material of a rod is 499. Permeability in vacuum is $4\pi \times 10^{-7}$ H/m. Absolute permeability of the material of the rod is :

(1) $4\pi \times 10^{-4}$ H/m (2) $2\pi \times 10^{-4}$ H/m
(3) $3\pi \times 10^{-4}$ H/m (4) $\pi \times 10^{-4}$ H/m

14. **Statement I :** The ferromagnetic property depends on temperature. At high temperature, ferromagnet becomes paramagnet.

Statement II : At high temperature, the domain wall area of a ferromagnetic substance increases.

In the light of the above statements, choose the **most appropriate** answer from the options given below :

(1) **Statement I** is true but **Statement II** is false
(2) Both **Statement I** and **Statement II** are true
(3) Both **Statement I** and **Statement II** are false
(4) **Statement I** is false but **Statement II** is true

15. Choose the correct option :

(1) True dip is not mathematically related to apparent dip.
(2) True dip is less than apparent dip.
(3) True dip is always greater than the apparent dip.
(4) True dip is always equal to apparent dip.

16. The value of aluminium susceptibility is 2.2×10^{-5}. The percentage increase in the magnetic field if space within a current carrying toroid is filled with aluminium is $\frac{x}{10^4}$. Then the value of x is ______.

17. Two ions having same mass have charges in the ratio 1 : 2. They are projected normally in a uniform magnetic field with their speeds in the ratio 2 : 3. The ratio of the radii of their circular trajectories is :

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

18. The relative permittivity of distilled water is 81. The velocity of light in it will be : (Given μ_r = 1)

(1) 4.33×10^7 m/s (2) 2.33×10^7 m/s
(3) 3.33×10^7 m/s (4) 5.33×10^7 m/s

19. In a uniform magnetic field, the magnetic needle has a magnetic moment 9.85×10^{-2} A/m^2 and moment of inertia 5×10^{-6} kg m^2. If it performs 10 complete oscillations in 5 seconds then the magnitude of the magnetic field is ________ mT. [Take π^2 as 9.85]

20. Match **List I** with **List II**.

List-I	List-II
(a) Capacitance, C	(i) $M^1L^1T^{-3}A^{-1}$
(b) Permittivity of free space, ε_0	(ii) $M^{-1}L^{-3}T^4A^2$
(c) Permeability of free space, μ_0	(iii) $M^{-1}L^{-2}T^4A^2$
(d) Electric field, E	(iv) $M^1L^1T^{-2}A^{-2}$

Choose the correct answer from the options given below

(1) (a) → (iii), (b) → (ii), (c) → (iv), (d) → (i)
(2) (a) → (iii), (b) → (iv), (c) → (ii), (d) → (i)
(3) (a) → (iv), (b) → (ii), (c) → (iii), (d) → (i)
(4) (a) → (iv), (b) → (iii), (c) → (ii), (d) → (i)

21. Figure A and B shown two long straight wires of circular cross-section (a and b with a < b), carrying current I which is uniformly distributed across the cross-section. The magnitude of magnetic field B varies with radius r and can be represented as :

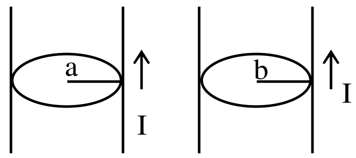
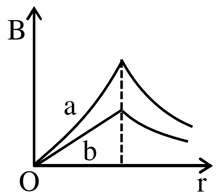
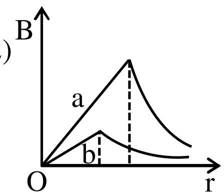
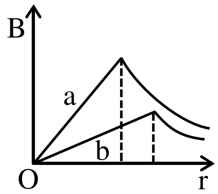
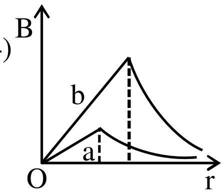


Fig. A Fig. B

(1)


(2)


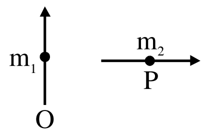
(3)


(4)


22. The fractional change in the magnetic field intensity at a distance 'r' from centre on the axis of current carrying coil of radius 'a' to the magnetic field intensity at the centre of the same coil is : (Take r < a)

(1) $\frac{3}{2}\frac{a^2}{r^2}$ (2) $\frac{2}{3}\frac{a^2}{r^2}$ (3) $\frac{2}{3}\frac{r^2}{a^2}$ (4) $\frac{3}{2}\frac{r^2}{a^2}$

23. Two short magnetic dipoles m_1 and m_2 each having magnetic moment of 1 Am^2 are placed at point O and P respectively. The distance between OP is 1 meter. The torque experienced by the magnetic dipole m_2 due to the presence of m_1 is ...... $\times 10^{-7}$ Nm.



24. If the maximum value of accelerating potential provided by a ratio frequency oscillator is 12 kV. The number of revolution made by a proton in a cyclotron to achieve one sixth of the speed of light is ....
[$m_p = 1.67 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$ C, Speed of light = 3×10^8 m/s]

25. A coil in the shape of an equilateral triangle of side 10 cm lies in a vertical plane between the pole pieces of permanent magnet producing a horizontal magnetic field 20 mT. The torque acting on the coil when a current of 0.2 A is passed through it and its plane becomes parallel to the magnetic field will be $\sqrt{x} \times 10^{-5}$ Nm. The value of x is..........

26. Two ions of masses 4 amu and 16 amu have charges +2e and +3e respectively. These ions pass through the region of constant perpendicular magnetic field. The kinetic energy of both ions is same. Then :

(1) lighter ion will be deflected less than heavier ion
(2) lighter ion will be deflected more than heavier ion
(3) both ions will be deflected equally
(4) no ion will be deflected.

27. A uniform conducting wire of length is 24a, and resistance R is wound up as a current carrying coil in the shape of an equilateral triangle of side 'a' and then in the form of a square of side 'a'. The coil is connected to a voltage source V_0. The ratio of magnetic moment of the coils in case of equilateral triangle to that for square is $1:\sqrt{y}$ where y is ....

28. A coaxial cable consists of an inner wire of radius 'a' surrounded by an outer shell of inner and outer radii 'b' and 'c' respectively. The inner wire carries an electric current i_0, which is distributed uniformly across cross-sectional area. The outer shell carries an equal current in opposite direction and distributed uniformly. What will be the ratio of the magnetic field at a distance x from the axis when (i) x < a and (ii) a < x < b ?

(1) $\frac{x^2}{a^2}$
(2) $\frac{a^2}{x^2}$
(3) $\frac{x^2}{b^2 - a^2}$
(4) $\frac{b^2 - a^2}{x^2}$

29. A coil having N turns is wound tightly in the form of a spiral with inner and outer radii 'a' and 'b' respectively. Find the magnetic field at centre, when a current I passes through coil :

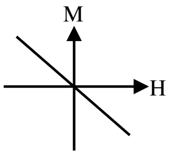
(1) $\frac{\mu_0 IN}{2(b-a)} \log_e\left(\frac{b}{a}\right)$
(2) $\frac{\mu_0 I}{8}\left[\frac{a+b}{a-b}\right]$
(3) $\frac{\mu_0 I}{4(a-b)}\left[\frac{1}{a}-\frac{1}{b}\right]$
(4) $\frac{\mu_0 I}{8}\left(\frac{a-b}{a+b}\right)$

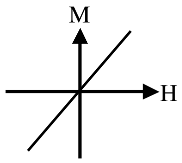
30. A current of 1.5 A is flowing through a triangle, of side 9 cm each. The magnetic field at the centroid of the triangle is :
(Assume that the current is flowing in the clockwise direction.)

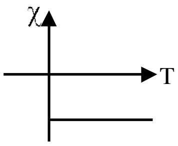
(1) 3×10^{-7} T, outside the plane of triangle
(2) $2\sqrt{3} \times 10^{-7}$ T, outside the plane of triangle
(3) $2\sqrt{3} \times 10^{-5}$ T, inside the plane of triangle
(4) 3×10^{-5} T, inside the plane of triangle

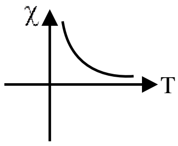
31. A long solenoid with 1000 turns/m has a core material with relative permeability 500 and volume 10^3 cm^3. If the core material is replaced by another material having relative permeability of 750 with same volume maintaining same current of 0.75 A in the solenoid, the fractional change in the magnetic moment of the core would be approximately $\left(\frac{x}{499}\right)$. Find the value of x.

32. Following plots show Magnetization (M) vs Magnetising field (H) and Magnetic susceptibility (χ) vs temperature (T) graph :

(a) 

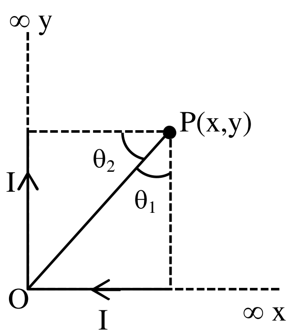
(b) 

(c) 

(d) 

Which of the following combination will be represented by a diamagnetic material?

33. There are two infinitely long straight current carrying conductors and they are held at right angles to each other so that their common ends meet at the origin as shown in the figure given below. The ratio of current in both conductor is 1 : 1. The magnetic field at point P is ____.



(1) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$

(2) $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(3) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}-(x+y)\right]$

(4) $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$

MODERN PHYSICS

1. Given below are two statements :

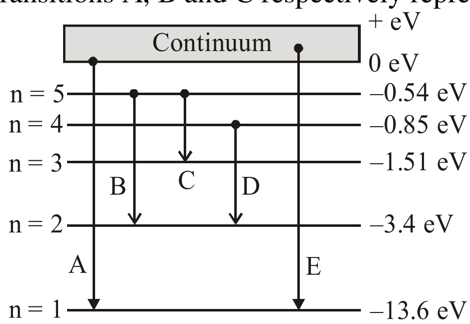
Statement-I : Two photons having equal linear momenta have equal wavelengths.

Statement-II : If the wavelength of photon is decreased, then the momentum and energy of a photon will also decrease.

In the light of the above statements, choose the correct answer from the options given below.

(1) Both Statement I and Statement II are true
(2) Statement I is false but Statement II is true
(3) Both Statement I and Statement II are false
(4) Statement I is true but Statement II is false

2. In the given figure, the energy levels of hydrogen atom have been shown along with some transitions marked A, B, C, D and E. The transitions A, B and C respectively represent :



(1) The ionization potential of hydrogen, second member of Balmer series and third member of Paschen series.
(2) The first member of the Lyman series, third member of Balmer series and second member of Paschen series.
(3) The series limit of Lyman series, third member of Balmer series and second member of Paschen series.
(4) The series limit of Lyman series, second member of Balmer series and second member of Paschen series.

3. The de Broglie wavelength of a proton and α-particle are equal. The ratio of their velocities is :

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

4. An X-ray tube is operated at 1.24 million volt. The shortest wavelength of the produced photon will be :

(1) 10^{-3} nm (2) 10^{-1} nm
(3) 10^{-2} nm (4) 10^{-4} nm

5. According to Bohr atom model, in which of the following transitions will the frequency be maximum ?

(1) n = 4 to n = 3
(2) n = 2 to n = 1
(3) n = 5 to n = 4
(4) n = 3 to n = 2

6. An α particle and a proton are accelerated from rest by a potential difference of 200 V. After this, their de Broglie wavelengths are λ_α and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_\alpha}$ is :

(1) 3.8 (2) 8 (3) 7.8 (4) 2.8

7. Two radioactive substances X and Y originally have N_1 and N_2 nuclei respectively. Half life of X is half of the half life of Y. After three half lives of Y, number of nuclei of both are equal. The ratio $\frac{N_1}{N_2}$ will be equal to :

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

8. The wavelength of the photon emitted by a hydrogen atom when an electron makes a transition from n = 2 to n = 1 state is :

(1) 194.8 nm
(2) 913.3 nm
(3) 490.7 nm
(4) 121.8 nm

9. An electron of mass m_e and a proton of mass m_p = 1836 m_e are moving with the same speed. The ratio of their de Broglie wavelength $\frac{\lambda_{electron}}{\lambda_{proton}}$ will be :

(1) 1836 (2) 1
(3) 918 (4) $\frac{1}{1836}$

10. The stopping potential for electrons emitted from a photosensitive surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. The new wavelength is :

(1) 329 nm (2) 309 nm
(3) 382 nm (4) 400 nm

11. The wavelength of an X-ray beam is 10Å. The mass of a fictitious particle having the same energy as that of the X-ray photons is $\frac{x}{3}$h kg. The value of *x* is_________. (h = Planck's constant)

12. If λ_1 and λ_2 are the wavelengths of the third member of Lyman and first member of the Paschen series respectively, then the value of $\lambda_1 : \lambda_2$ is :

(1) 1 : 9
(2) 7 : 108
(3) 7 : 135
(4) 1 : 3

13. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : An electron microscope can achieve better resolving power than an optical microscope.

Reason R : The de Broglie's wavelength of the electrons emitted from an electron gun is much less than wavelength of visible light.

In the light of the above statements, choose the correct answer from the options given below:

(1) A is true but R is false.
(2) Both A and R are true and R is the correct explanation of A.
(3) Both A and R are true but R is NOT the correct explanation of A.
(4) A is false but R is true.

14. The recoil speed of a hydrogen atom after it emits a photon in going from n = 5 state to n = 1 state will be :

(1) 4.17 m/s (2) 2.19 m/s
(3) 3.25 m/s (4) 4.34 m/s

15. A radioactive sample is undergoing α decay. At any time t_1, its activity is A and another time t_2, the activity is $\frac{A}{5}$. What is the average life time for the sample ?

(1) $\frac{\ell n5}{t_2 - t_1}$ (2) $\frac{t_1 - t_2}{\ell n5}$
(3) $\frac{t_2 - t_1}{\ell n5}$ (4) $\frac{\ell n(t_2 + t_1)}{2}$

16. Two stream of photons, possessing energies equal to twice and ten times the work function of metal are incident on the metal surface successively. The value of ratio of maximum velocities of the photoelectrons emitted in the two respective cases is x : y. The value of x is ....

17. The stopping potential in the context of photoelectric effect depends on the following property of incident electromagnetic radiation :

(1) Phase (2) Intensity
(3) Amplitude (4) Frequency

18. The first three spectral lines of H-atom in the Balmer series are given λ_1, λ_2, λ_3 considering the Bohr atomic model, the wave lengths of first and third spectral lines $\left(\frac{\lambda_1}{\lambda_3}\right)$ are related by a factor of approximately 'x' × 10^{-1}. The value of x, to the nearest integer, is ________.

19. The de-Broglie wavelength associated with an electron and a proton were calculated by accelerating them through same potential of 100 V. What should nearly be the ratio of their wavelengths ? ($m_P = 1.00727$ u, $m_e = 0.00055$u)

(1) 1860 : 1 (2) $(1860)^2 : 1$

(3) 41.4 : 1 (4) 43 : 1

20. The half-life of Au^{198} is 2.7 days. The activity of 1.50 mg of Au^{198} if its atomic weight is 198 g mol^{-1} is, ($N_A = 6 \times 10^{23}$/mol)

(1) 240 Ci (2) 357 Ci

(3) 535 Ci (4) 252 Ci

21. Calculate the time interval between 33% decay and 67% decay if half-life of a substance is 20 minutes.

(1) 60 minutes (2) 20 minutes

(3) 40 minutes (4) 13 minutes

22. If an electron is moving in the n^{th} orbit of the hydrogen atom, then its velocity (v_n) for the n^{th} orbit is given as :

(1) $v_n \propto n$

(2) $v_n \propto \frac{1}{n}$

(3) $v_n \propto n^2$

(4) $v_n \propto \frac{1}{n^2}$

23. An electron of mass m and a photon have same energy E. The ratio of wavelength of electron to that of photon is : (c being the velocity of light)

(1) $\frac{1}{c}\left(\frac{2m}{E}\right)^{1/2}$ (2) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$

(3) $\left(\frac{E}{2m}\right)^{1/2}$ (4) $c\,(2mE)^{1/2}$

24. Which level of the single ionized carbon has the same energy as the ground state energy of hydrogen atom?

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

25. If 2.5×10^{-6} N average force is exerted by a light wave on a non-reflecting surface of 30 cm^2 area during 40 minutes of time span, the energy flux of light just before it falls on the surface is _____ W/cm^2. (Round off to the Nearest Integer)

(Assume complete absorption and normal incidence conditions are there)

26. The atomic hydrogen emits a line spectrum consisting of various series.Which series of hydrogen atomic spectra is lying in the visible region ?

(1) Brackett series

(2) Paschen series

(3) Lyman series

(4) Balmer series

27. Two identical photocathodes receive the light of frequencies f_1 and f_2 respectively. If the velocities of the photo-electrons coming out are v_1 and v_2 respectively, then

(1) $v_1^2 - v_2^2 = \frac{2h}{m}[f_1 - f_2]$

(2) $v_1^2 + v_2^2 = \frac{2h}{m}[f_1 + f_2]$

(3) $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{\frac{1}{2}}$

(4) $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{1/2}$

28. A particle of mass m moves in a circular orbit in a central potential field $U(r) = U_0 r^4$. If Bohr's quantization conditions are applied, radii of possible orbitals r_n vary with $n^{1/\alpha}$, where α is____________.

29. Imagine that the electron in a hydrogen atom is replaced by a muon (μ). The mass of muon particle is 207 times that of an electron and charge is equal to the charge of an electron. The ionization potential of this hydrogen atom will be :-

(1) 13.6 eV

(2) 2815.2 eV

(3) 331.2 eV

(4) 27.2 eV

30. A particle is travelling 4 times as fast as an electron. Assuming the ratio of de-Broglie wavelength of a particle to that of electron is 2 : 1, the mass of the particle is :-

(1) $\frac{1}{16}$ times the mass of e^-

(2) 8 times the mass of e^-

(3) 16 times the mass of e^-

(4) $\frac{1}{8}$ times the mass of e^-

31. A proton and an α-particle, having kinetic energies K_p and K_α, respectively, enter into a magnetic field at right angles.

The ratio of the radii of trajectory of proton to that of α-particle is 2 : 1. The ratio of $K_p : K_\alpha$ is :

(1) 1 : 8 (2) 8 : 1

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

32. The decay of a proton to neutron is :

(1) not possible as proton mass is less than the neutron mass

(2) possible only inside the nucleus

(3) not possible but neutron to proton conversion is possible

(4) always possible as it is associated only with β^+ decay

33. The speed of electrons in a scanning electron microscope is 1×10^7 ms^{-1}. If the protons having the same speed are used instead of electrons, then the resolving power of scanning proton microscope will be changed by a factor of:

(1) 1837

(2) $\frac{1}{1837}$

(3) $\sqrt{1837}$

(4) $\frac{1}{\sqrt{1837}}$

34. A radioactive material decays by simultaneous emissions of two particles with half lives of 1400 years and 700 years respectively. What will be the time after the which one third of the material remains ? (Take ln 3 = 1.1)

(1) 1110 years (2) 700 years

(3) 340 years (4) 740 years

35. A nucleus of mass M emits γ-ray photon of frequency 'ν'. The loss of internal energy by the nucleus is :

[Take 'c' as the speed of electromagnetic wave]

(1) $h\nu$ (2) 0

(3) $h\nu\left[1-\frac{h\nu}{2Mc^2}\right]$ (4) $h\nu\left[1+\frac{h\nu}{2Mc^2}\right]$

36. The radiation corresponding to $3 \to 2$ transition of a hydrogen atom falls on a gold surface to generate photoelectrons. These electrons are passed through a magnetic field of 5×10^{-4} T. Assume that the radius of the largest circular path followed by these electrons is 7 mm, the work function of the metal is : (Mass of electron $= 9.1 \times 10^{-31}$ kg)

(1) 1.36 eV

(2) 1.88 eV

(3) 0.16 eV

(4) 0.82 eV

37. An electron having de-Broglie wavelength λ is incident on a target in a X-ray tube. Cut-off wavelength of emitted X-ray is :

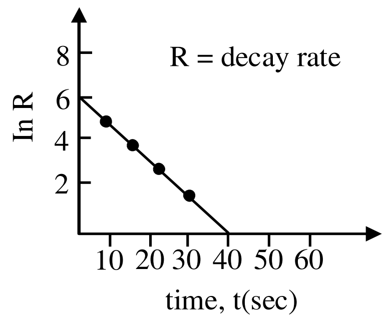
(1) 0

(2) $\frac{2m^2c^2\lambda^2}{h^2}$

(3) $\frac{2mc\lambda^2}{h}$

(4) $\frac{hc}{mc}$

38. For a certain radioactive process the graph between In R and t(sec) is obtained as shown in the figure. Then the value of half life for the unknown radioactive material is approximately :



(1) 9.15 sec (2) 6.93 sec

(3) 2.62 sec (4) 4.62 sec

39. A certain metallic surface is illuminated by monochromatic radiation of wavelength λ. The stopping potential for photoelectric current for this radiation is $3V_0$. If the same surface is illuminated with a radiation of wavelength 2λ, the stopping potential is V_0. The threshold wavelength of this surface for photoelectric effect is______λ.

40. A radioactive substance decays to $\left(\frac{1}{16}\right)^{th}$ of its initial activity in 80 days. The half life of the radioactive substance expressed in days is____.

41. A nucleus with mass number 184 initially at rest emits an α-particle. If the Q value of the reaction is 5.5 MeV, calculate the kinetic energy of the α-particle.

(1) 5.0 MeV (2) 5.5 MeV

(3) 0.12 MeV (4) 5.38 MeV

42. An electron of mass m_e and a proton of mass m_P are accelerated through the same potential difference. The ratio of the de-Broglie wavelength associated with the electron to that with the proton is :-

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

(3) $\sqrt{\frac{m_P}{m_e}}$ (4) $\frac{m_e}{m_p}$

43. What should be the order of arrangement of de-Broglie wavelength of electron (λ_e), an α-particle (λ_α) and proton (λ_p) given that all have the same kinetic energy ?

(1) $\lambda_e = \lambda_p = \lambda_\alpha$ (2) $\lambda_e < \lambda_p < \lambda_\alpha$

(3) $\lambda_e > \lambda_p > \lambda_\alpha$ (4) $\lambda_e = \lambda_p > \lambda_\alpha$

44. A particle of mass 4M at rest disintegrates into two particles of mass M and 3M respectively having non zero velocities. The ratio of de-Broglie wavelength of particle of mass M to that of mass 3M will be :

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

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

45. Some nuclei of a radioactive material are undergoing radioactive decay. The time gap between the instances when a quarter of the nuclei have decayed and when half of the nuclei have decayed is given as :

(where λ is the decay constant)

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

(3) $\frac{2\ln 2}{\lambda}$ (4) $\frac{\ln\frac{3}{2}}{\lambda}$

46. The half-life of ^{198}Au is 3 days. If atomic weight of ^{198}Au is 198 g/mol then the activity of 2 mg of ^{198}Au is [in disintegration/second] :

(1) 2.67×10^{12} (2) 6.06×10^{18}

(3) 32.36×10^{12} (4) 16.18×10^{12}

47. When radiation of wavelength λ is incident on a metallic surface, the stopping potential of ejected photoelectrons is 4.8 V. If the same surface is illuminated by radiation of double the previous wavelength, then the stopping potential becomes 1.6 V. The threshold wavelength of the metal is :

(1) 2 λ (2) 4 λ (3) 8 λ (4) 6 λ

48. A light beam of wavelength 500 nm is incident on a metal having work function of 1.25 eV, placed in a magnetic field of intensity B. The electrons emitted perpendicular to the magnetic field B, with maximum kinetic energy are bent into circular arc of radius 30 cm. The value of B is _______ $\times 10^{-7}$ T.

Given hc = 20×10^{-26} J-m, mass of electron = 9×10^{-31} kg

49. From the given data, the amount of energy required to break the nucleus of aluminium $^{27}_{13}$Al is _____ x $\times 10^{-3}$ J.

Mass of neutron = 1.00866 u
Mass of proton = 1.00726 u
Mass of Aluminium nucleus = 27.18846 u
(Assume 1 u corresponds to x J of energy)
(Round off to the nearest integer)

50. The nuclear activity of a radioactive element becomes $\left(\frac{1}{8}\right)^{th}$ of its initial value in 30 years. The half-life of radioactive element is ______ years.

51. If 'f' denotes the ratio of the number of nuclei decayed (N_d) to the number of nuclei at t = 0 (N_0) then for a collection of radioactive nuclei, the rate of change of 'f' with respect to time is given as : [λ is the radioactive decay constant]

(1) $-\lambda (1 - e^{-\lambda t})$
(2) $\lambda (1 - e^{-\lambda t})$
(3) $\lambda e^{-\lambda t}$
(4) $-\lambda e^{-\lambda t}$

52. In Bohr's atomic model, the electron is assumed to revolve in a circular orbit of radius 0.5 Å. If the speed of electron is 2.2×16^6 m/s, then the current associated with the electron will be ___________ $\times 10^{-2}$ mA. [Take π as $\frac{22}{7}$]

53. A radioactive sample has an average life of 30 ms and is decaying. A capacitor of capacitance 200 µF is first charged and later connected with resistor 'R'. If the ratio of charge on capacitor to the activity of radioactive sample is fixed with respect to time then the value of 'R' should be ______Ω.

54. A particle of mass 9.1×10^{-31} kg travels in a medium with a speed of 10^6 m/s and a photon of a radiation of linear momentum 10^{-27} kg m/s travels in vacuum. The wavelength of photon is _______ times the wavelength of the particle.

55. An electron and proton are separated by a large distance. The electron starts approaching the proton with energy 3 eV. The proton captures the electrons and forms a hydrogen atom in second excited state. The resulting photon is incident on a photosensitive metal of threshold wavelength 4000 Å. What is the maximum kinetic energy of the emitted photoelectron?

(1) 7.61 eV

(2) 1.41 eV

(3) 3.3 eV

(4) No photoelectron would be emitted

56. Consider the following statements :

A. Atoms of each element emit characteristics spectrum.

B. According to Bohr's Postulate, an electron in a hydrogen atom, revolves in a certain stationary orbit.

C. The density of nuclear matter depends on the size of the nucleus.

D. A free neutron is stable but a free proton decay is possible.

E. Radioactivity is an indication of the instability of nuclei.

Choose the correct answer from the options given below :

(1) A, B, C, D and E (2) A, B and E only

(3) B and D only (4) A, C and E only

57. The K_α X-ray of molybdenum has wavelength 0.071 nm. If the energy of a molybdenum atoms with a K electron knocked out is 27.5 keV, the energy of this atom when an L electron is knocked out will be ______ keV. (Round off to the nearest integer) [$h = 4.14 \times 10^{-15}$ eVs, $c = 3 \times 10^8\ ms^{-1}$]

58. A particular hydrogen like ion emits radiation of frequency 2.92×10^{15} Hz when it makes transition from n = 3 to n = 1. The frequency in Hz of radiation emitted in transition from n = 2 to n = 1 will be :

(1) 0.44×10^{15} (2) 6.57×10^{15}

(3) 4.38×10^{15} (4) 2.46×10^{15}

59. In a photoelectric experiment ultraviolet light of wavelength 280 nm is used with lithium cathode having work function $\phi = 2.5$ eV. If the wavelength of incident light is switched to 400 nm, find out the change in the stopping potential. ($h = 6.63 \times 10^{-34}$ Js, $c = 3 \times 10^8\ ms^{-1}$)

(1) 1.3 V (2) 1.1 V

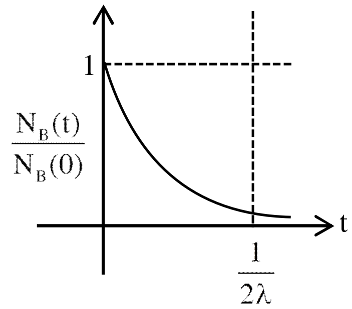
(3) 1.9 V (4) 0.6 V

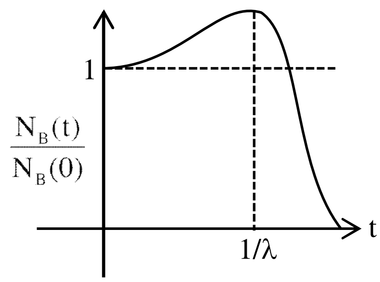
60. The de-Broglie wavelength of a particle having kinetic energy E is λ. How much extra energy must be given to this particle so that the de-Broglie wavelength reduces to 75% of the initial value ?

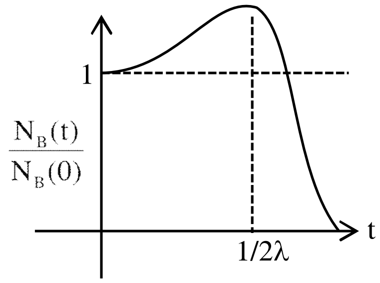
(1) $\frac{1}{9}E$ (2) $\frac{7}{9}E$ (3) E (4) $\frac{16}{9}E$

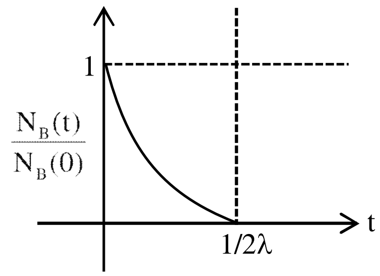
61. At time t = 0, a material is composed of two radioactive atoms A and B, where $N_A(0) = 2N_B(0)$. The decay constant of both kind of radioactive atoms is λ. However, A disintegrates to B and B disintegrates to C. Which of the following figures represents the evolution of $N_B(t) / N_B(0)$ with respect to time t ?

$$\begin{bmatrix} N_A(0) = \text{No. of A atoms at } t = 0 \\ N_B(0) = \text{No. of B atoms at } t = 0 \end{bmatrix}$$

(1) 

(2) 

(3) 

(4) 

62. There are 10^{10} radioactive nuclei in a given radioactive element, Its half-life time is 1 minute. How many nuclei will remain after 30 seconds ? $\left(\sqrt{2} = 1.414\right)$

(1) 2×10^{10} (2) 7×10^9

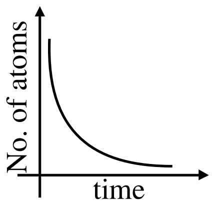
(3) 10^5 (4) 4×10^{10}

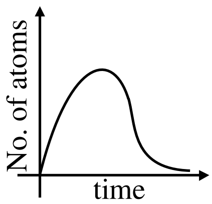
63. In a photoelectric experiment, increasing the intensity of incident light :
(1) increases the number of photons incident and also increases the K.E. of the ejected electrons
(2) increases the frequency of photons incident and increases the K.E. of the ejected electrons.
(3) increases the frequency of photons incident and the K.E. of the ejected electrons remains unchanged
(4) increases the number of photons incident and the K.E. of the ejected electrons remains unchanged

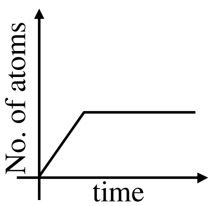
64. A monochromatic neon lamp with wavelength of 670.5 nm illuminates a photo-sensitive material which has a stopping voltage of 0.48 V. What will be the stopping voltage if the source light is changed with another source of wavelength of 474.6 nm?
(1) 0.96 V (2) 1.25 V
(3) 0.24 V (4) 1.5 V

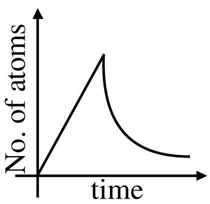
65. X different wavelengths may be observed in the spectrum from a hydrogen sample if the atoms are exited to states with principal quantum number n = 6 ? The value of X is ________.

66. A sample of a radioactive nucleus A disintegrates to another radioactive nucleus B, which in turn disintegrates to some other stable nucleus C. Plot of a graph showing the variation of number of atoms of nucleus B vesus time is :
(Assume that at t = 0, there are no B atoms in the sample)

(1)


(2)


(3)


(4)


67. A moving proton and electron have the same de-Broglie wavelength. If K and P denote the K.E. and momentum respectively. Then choose the correct option :
(1) $K_p < K_e$ and $P_p = P_e$
(2) $K_p = K_e$ and $P_p = P_e$
(3) $K_p < K_e$ and $P_p < P_e$
(4) $K_p > K_e$ and $P_p = P_e$

68. A free electron of 2.6 eV energy collides with a H^+ ion. This results in the formation of a hydrogen atom in the first excited state and a photon is released. Find the frequency of the emitted photon. (h = 6.6×10^{-34} Js)
(1) 1.45×10^{16} MHz (2) 0.19×10^{15} MHz
(3) 1.45×10^{9} MHz (4) 9.0×10^{27} MHz

69. Consider two separate ideal gases of electrons and protons having same number of particles. The temperature of both the gases are same. The ratio of the uncertainty in determining the position of an electron to that of a proton is proportional to :-
(1) $\left(\frac{m_p}{m_e}\right)^{3/2}$ (2) $\sqrt{\frac{m_e}{m_p}}$ (3) $\sqrt{\frac{m_p}{m_e}}$ (4) $\frac{m_p}{m_e}$

70. The temperature of an ideal gas in 3-dimensions is 300 K. The corresponding de-Broglie wavelength of the electron approximately at 300 K, is :
[m_e = mass of electron = 9×10^{-31} kg
h = Planck constant = 6.6×10^{-34} Js
k_B = Boltzmann constant = 1.38×10^{-23} JK^{-1}]
(1) 6.26 nm (2) 8.46 nm
(3) 2.26 nm (4) 3.25 nm

71. The half life period of radioactive element x is same as the mean life time of another radioactive element y. Initially they have the same number of atoms. Then :
(1) x–will decay faster than y.
(2) y– will decay faster than x.
(3) x and y have same decay rate initially and later on different decay rate.
(4) x and y decay at the same rate always.

NLM & FRICTION

1. The coefficient of static friction between a wooden block of mass 0.5 kg and a vertical rough wall is 0.2. The magnitude of horizontal force that should be applied on the block to keep it adhere to the wall will be ______N.
[g = 10 ms^{-2}]

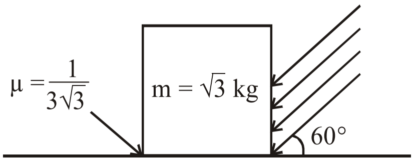
2. An inclined plane is bent in such a way that the vertical cross-section is given by $y = \frac{x^2}{4}$ where y is in vertical and x in horizontal direction. If the upper surface of this curved plane is rough with coefficient of friction μ = 0.5, the maximum height in cm at which a stationary block will not slip downward is ________ cm.

3. A person standing on a spring balance inside a stationary lift measures 60 kg. The weight of that person if the lift descends with uniform downward acceleration of 1.8 m/s^2 will be_ N.
[g = 10 m/s^2]

4. A boy pushes a box of mass 2 kg with a force $\vec{F} = \left(20\hat{i} + 10\hat{j}\right)N$ on a frictionless surface. If the box was initially at rest, then ______ m is displacement along the x-axis after 10 s.

5. As shown in the figure, a block of mass $\sqrt{3}$ kg is kept on a horizontal rough surface of coefficient of friction $\frac{1}{3\sqrt{3}}$. The critical force to be applied on the vertical surface as shown at an angle 60° with horizontal such that it does not move, will be 3x. The value of x will be

[g = 10 m/s^2; sin 60° = $\frac{\sqrt{3}}{2}$; cos 60° = $\frac{1}{2}$]

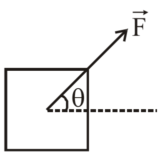


6. Two masses A and B, each of mass M are fixed together by a massless spring. A force acts on the mass B as shown in figure. If the mass A starts moving away from mass B with acceleration 'a', then the acceleration of mass B wil be :-

(1) $\frac{Ma - F}{M}$ (2) $\frac{MF}{F + Ma}$

(3) $\frac{F + Ma}{M}$ (4) $\frac{F - Ma}{M}$

7. A block of mass m slides along a floor while a force of magnitude F is applied to it at an angle θ as shown in figure. The coefficient of kinetic friction is μ_K. Then, the block's acceleration 'a' is given by : (g is acceleration due to gravity)



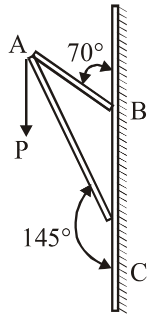
(1) $-\frac{F}{m}\cos\theta - \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

(2) $\frac{F}{m}\cos\theta - \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

(3) $\frac{F}{m}\cos\theta - \mu_K\left(g + \frac{F}{m}\sin\theta\right)$

(4) $\frac{F}{m}\cos\theta + \mu_K\left(g - \frac{F}{m}\sin\theta\right)$

8. Consider a frame that is made up of two thin massless rods AB and AC as shown in the figure. A vertical force $\vec{P}$ of magnitude 100 N is applied at point A of the frame.

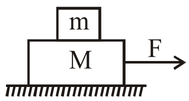


Suppose the force is $\vec{P}$ resolved parallel to the arms AB and AC of the frame. The magnitude of the resolved component along the arm AC is xN. The value of x, to the nearest integer, is ________.

[Given : sin(35°) = 0.573, cos(35°) = 0.819
sin(110°) = 0.939, cos(110°) = –0.342]

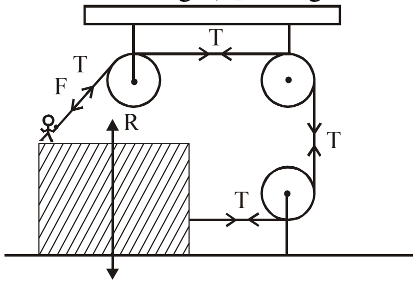
9. A body of mass 2kg moves under a force of $(2\hat{i} + 3\hat{j} + 5\hat{k})N$. It starts from rest and was at the origin initially. After 4s, its new coordinates are (8, b, 20). The value of b is __________.
(Round off to the Nearest Integer)

10. Two blocks (m = 0.5 kg and M = 4.5 kg) are arranged on a horizontal frictionless table as shown in figure. The coefficient of static friction between the two blocks is $\frac{3}{7}$. Then the maximum horizontal force that can be applied on the larger block so that the blocks move together is ______ N. (Round off to the Nearest Integer) [Take g as 9.8 ms^{-2}]



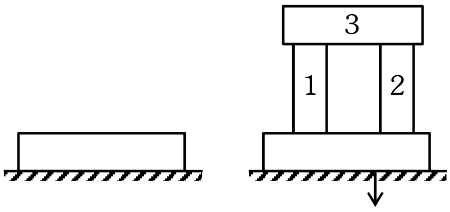
11. A body of mass 1 kg rests on a horizontal floor with which it has a coefficient of static friction $\frac{1}{\sqrt{3}}$. It is desired to make the body move by applying the minimum possible force F N. The value of F will be __________. (Round off to the Nearest Integer) [Take g = 10 ms^{-2}]

12. A boy of mass 4 kg is standing on a piece of wood having mass 5kg . If the coefficient of friction between the wood and the floor is 0.5, the maximum force that the boy can exert on the rope so that the piece of wood does not move from its place is ________N.(Round off to the Nearest Integer) [Take $g = 10\ ms^{-2}$]



13. A bullet of mass 0.1 kg is fired on a wooden block to pierce through it, but it stops after moving a distance of 50 cm into it. If the velocity of bullet before hitting the wood is 10 m/s and it slows down with uniform deceleration, then the magnitude of effective retarding force on the bullet is 'x' N. The value of 'x' to the nearest integer is ______ .

14. A steel block of 10 kg rests on a horizontal floor as shown. When three iron cylinders are placed on it as shown, the block and cylinders go down with an acceleration 0.2 m/s^2. The normal reaction R' by the floor if mass of the iron cylinders are equal and of 20 kg each, is ______ N. [Take $g = 10\ m/s^2$ and $\mu_s = 0.2$]



(1) 716 (2) 686 (3) 714 (4) 684

15. A particle of mass M originally at rest is subjected to a force whose direction is constant but magnitude varies with time according to the relation

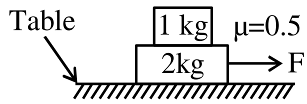
$$F = F_0\left[1-\left(\frac{t-T}{T}\right)^2\right]$$

Where F_0 and T are constants. The force acts only for the time interval 2T. The velocity v of the particle after time 2T is :

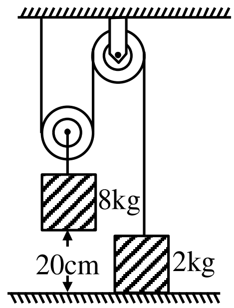
(1) $2F_0T / M$ (2) $F_0T / 2M$
(3) $4F_0T / 3M$ (4) $F_0T / 3M$

16. A body of mass '*m*' is launched up on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of friction between the body and plane is $\frac{\sqrt{x}}{5}$ if the time of ascent is half of the time of descent. The value of x is _____.

17. The coefficient of static friction between two blocks is 0.5 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is ....N.(Take: $g = 10\ ms^{-2}$)



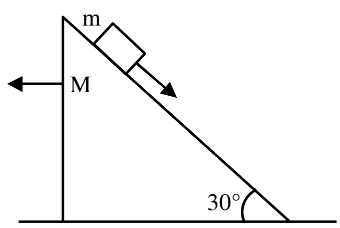
18. The boxes of masses 2 kg and 8 kg are connected by a massless string passing over smooth pulleys. Calculate the time taken by box of mass 8 kg to strike the ground starting from rest. (use $g = 10\ m/s^2$)



(1) 0.34 s (2) 0.2 s
(3) 0.25 s (4) 0.4 s

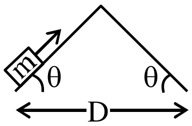
19. A car is moving on a plane inclined at 30º to the horizontal with an acceleration of 10 ms^{-2} parallel to the plane upward. A bob is suspended by a string from the roof of the car.The angle in degrees which the string makes with the vertical is______. (Take $g = 10\ ms^{-2}$)

20. A block of mass m slides on the wooden wedge, which in turn slides backward on the horizontal surface. The acceleration of the block with respect to the wedge is : Given m = 8 kg, M = 16 kg. Assume all the surfaces shown in the figure to be frictionless.

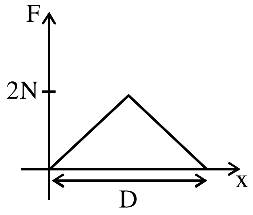


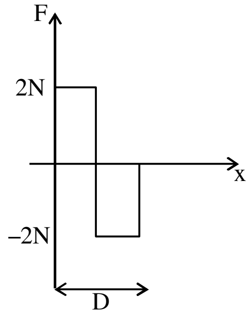
(1) $\frac{4}{3}g$ (2) $\frac{6}{5}g$ (3) $\frac{3}{5}g$ (4) $\frac{2}{3}g$

21. An object of mass 'm' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile.



The correct applied force vs distance graph will be:

(1)


(2)


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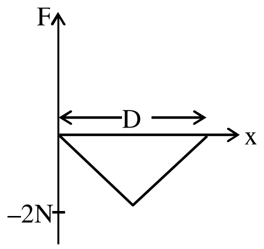

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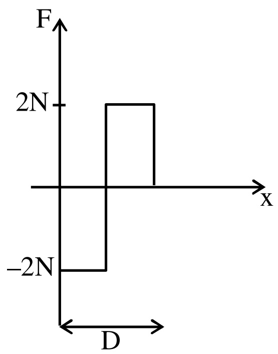


22. When a body slides down from rest along a smooth inclined plane making an angle of 30° with the horizontal, it takes time T. When the same body slides down from the rest along a rough inclined plane making the same angle and through the same distance, it takes time αT, where α is a constant greater than 1. The co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{\alpha^2-1}{\alpha^2}\right)$ where x = ...

POC

1. An audio signal $\nu_m = 20 \sin 2\pi\,(1500\,t)$ amplitude modulates a carrier

$\nu_C = 80 \sin 2\pi\,(100{,}000\,t)$.

The value of percent modulation is _______.

2. A signal of 0.1 kW is transmitted in a cable. The attenuation of cable is –5 dB per km and cable length is 20 km. The power received at receiver is 10^{-x} W. The value of x is ______.

[Gain in dB = $10 \log_{10}\left(\frac{P_0}{P_i}\right)$]

3. Given below are two statement :

Statement-I: A speech signal of 2 kHz is used to modulate a carrier signal of 1 MHz. The band width requirement for the signal is 4 kHz.

Statement-II : The side band frequencies are 1002 kHz. and 998 kHz.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is true but Statement II is false
(2) Statement I is false but Statement II is true
(3) Both Statement I and Statement II are true
(4) Both Statement I and Statement II are false

4. A transmitting station releases waves of wavelength 960 m. A capacitor of 2.56 μF is used in the resonant circuit. The self inductance of coil necessary for resonance is ____ $\times 10^{-8}$ H.

5. If a message signal of frequency 'f_m' is amplitude modulated with a carrier signal of frequency 'f_c' and radiated through an antenna, the wavelength of the corresponding signal in air is :

(1) $\frac{c}{f_c - f_m}$ (2) $\frac{c}{f_m}$

(3) $\frac{c}{f_c + f_m}$ (4) $\frac{c}{f_c}$

6. The maximum and minimum amplitude of an amplitude modulated wave is 16V and 8V respectively. The modulation index for this amplitude modulated wave is x × 10^{-2}. The value of x is______.

7. If the highest frequency modulating a carrier is 5 kHz, then the number of AM broadcast stations accommodated in a 90 kHz bandwidth are ....

8. A 25 m long antenna is mounted on an antenna tower. The height of the antenna tower is 75 m. The wavelength (in meter) of the signal transmitted by this antenna would be :
(1) 300 (2) 400 (3) 200 (4) 100

9. Two identical antennas mounted on identical towers are separated from each other by a distance of 45 km. What should nearly be the minimum height of receiving antenna to receive the signals in line of sight ? (Assume radius of earth is 6400 km)
(1) 19.77 m (2) 39.55 m
(3) 79.1 m (4) 158.2 m

10. For VHF signal broadcasting, ____ km^2 of maximum service area will be covered by an antenna tower of height 30m, if the receiving antenna is placed at ground. Let radius of the earth be 6400 km. (Round off to the Nearest Integer) (Take π as 3.14)

11. A carrier signal $C(t) = 25 \sin (2.512 \times 10^{10} t)$ is amplitude modulated by a message signal $m(t) = 5 \sin (1.57 \times 10^{8} t)$ and transmitted through an antenna.What will be the bandwidth of the modulated signal ?
(1) 8 GHz (2) 2.01 GHz
(3) 1987.5 MHz (4) 50 MHz

12. Match List–I with List–II.

List–I
(a) 10 km height over earth's surface
(b) 70 km height over earth's surface
(c) 180 km height over earth's surface
(d) 270 km height over earth's surface

List–II
(i) Thermosphere
(ii) Mesosphere
(iii) Stratosphere
(iv) Troposphere

(1) (a)–(iv), (b)–(iii), (c)–(ii), (d)–(i)
(2) (a)–(i), (b)–(iv), (c)–(iii), (d)–(ii)
(3) (a)–(iii), (b)–(ii), (c)–(i), (d)–(iv)
(4) (a)–(ii), (b)–(i), (c)–(iv), (d)–(iii)

13. A TV transmission tower antenna is at a height of 20 m. Suppose that the receiving antenna is at.
(i) ground level
(ii) a height of 5 m.
The increase in antenna range in case (ii) relative to case (i) is n%.
The value of n, to the nearest integer, is .

14. A carrier wave $V_C(t) = 160 \sin (2\pi \times 10^6 t)$ volts is made to vary between $V_{max} = 200$ V and $V_{min} = 120$ V by a message signal $V_m(t) = A_m \sin(2\pi \times 10^3 t)$ volts. The peak voltage A_m of the modulating signal is _______.

15. What should be the height of transmitting antenna and the population covered if the television telecast is to cover a radius of 150 km ? The average population density around the tower is $2000/km^2$ and the value of $R_e = 6.5 \times 10^6$ m.
(1) Height = 1731 m
Population Covered = 1413×10^5
(2) Height = 1241 m
Population Covered = 7×10^5
(3) Height = 1600 m
Population Covered = 2×10^5
(4) Height = 1800 m
Population Covered = 1413×10^8

16. In amplitude modulation, the message signal
$V_m(t) = 10 \sin (2\pi \times 10^5 t)$ volts and
Carrier signal
$V_C(t) = 20 \sin (2\pi \times 10^7 t)$ volts
The modulated signal now contains the message signal with lower side band and upper side band frequency, therefore the bandwidth of modulated signal is α kHz. The value of α is :
(1) 200 kHz (2) 50 kHz
(3) 100 kHz (4) 0

17. A message signal of frequency 20 kHz and peak voltage of 20 volt is used to modulate a carrier wave of frequency 1 MHz and peak voltage of 20 volt. The modulation index will be :

18. The amplitude of upper and lower side bands of A.M. wave where a carrier signal with frequency 11.21 MHz, peak voltage 15 V is amplitude modulated by a 7.7 kHz sine wave of 5V amplitude are $\frac{a}{10}$ V and $\frac{b}{10}$ V respectively. Then the value of $\frac{a}{b}$ is ___________.

19. The maximum amplitude for an amplitude modulated wave is found to be 12V while the minimum amplitude is found to be 3V. The modulation index is 0.6x where x is ______.

20. An amplitude modulated wave is represented by $C_m(t) = 10(1 + 0.2 \cos 12560t) \sin(111 \times 10^4 t)$ volts.
The modulating frequency in kHz will be ....

21. A transmitting antenna at top of a tower has a height of 50 m and the height of receiving antenna is 80 m. What is range of communication for Line of Sight (LoS) mode ? [use radius of earth = 6400 km]
(1) 45.5 km (2) 80.2 km
(3) 144.1 km (4) 57.28 km

22. A transmitting antenna has a height of 320 m and that of receiving antenna is 2000 m. The maximum distance between them for satisfactory communication in line of sight mode is 'd'. The value of 'd' is .... km.

23. An antenna is mounted on a 400 m tall building. What will be the wavelength of signal of signal that can be radiated effectively by the transmission tower upto a range of 44 km?
(1) 37.8 m (2) 605 m
(3) 75.6 m (4) 302 m

24. If the sum of the heights of transmitting and receiving antennas in the line of sight of communication is fixed at 160 m, then the maximum range of LOS communication is _____km. (Take radius of Earth = 6400 km)

25. A bandwidth of 6 MHz is available for A.M. transmission. If the maximum audio signal frequency used for modulating the carrier wave is not to exceed 6 kHz. The number of stations that can be broadcasted within this band simultaneously without interfering with each other will be______.

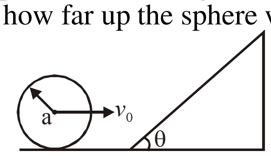
26. A carrier wave with amplitude of 250 V is amplitude modulated by a sinusoidal base band signal of amplitude 150 V. The ratio of minimum amplitude to maximum amplitude for the amplitude modulated wave is 50 : x, then value of x is ....

ROTATIONAL MOTION

1. Moment of inertia (M.I.) of four bodies, having same mass and radius, are reported as ;
I_1 = M.I. of thin circular ring about its diameter.
I_2 = M.I. of circular disc about an axis perpendicular to the disc and going through the centre,
I_3 = M.I. of solid cylinder about its axis and
I_4 = M.I. of solid sphere about its diameter.
Then :
(1) $I_1 + I_3 < I_2 + I_4$ (2) $I_1 + I_2 = I_3 + \frac{5}{2} I_4$
(3) $I_1 = I_2 = I_3 > I_4$ (4) $I_1 = I_2 = I_3 < I_4$

2. A uniform thin bar of mass 6 kg and length 2.4 meter is bent to make an equilateral hexagon. The moment of inertia about an axis passing through the centre of mass and perpendicular to the plane of hexagon is ____ $\times 10^{-1}$ kg m^2.

3. A sphere of radius 'a' and mass 'm' rolls along a horizontal plane with constant speed v_0. It encounters an inclined plane at angle θ and climbs upward. Assuming that it rolls without slipping, how far up the sphere will travel ?

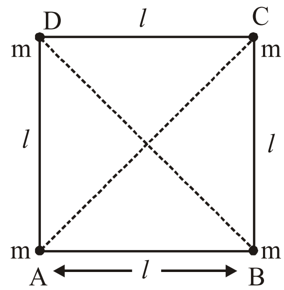


(1) $\frac{10v_0^2}{7g\sin\theta}$ (2) $\frac{v_0^2}{5g\sin\theta}$
(3) $\frac{2}{5}\frac{v_0^2}{g\sin\theta}$ (4) $\frac{v_0^2}{2g\sin\theta}$

4. Four identical solid spheres each of mass 'm' and radius 'a' are placed with their centres on the four corners of a square of side 'b'. The moment of inertia of the system about one side of square where the axis of rotation is parallel to the plane of the square is :
(1) $\frac{4}{5}ma^2 + 2mb^2$ (2) $\frac{8}{5}ma^2 + mb^2$
(3) $\frac{8}{5}ma^2 + 2mb^2$ (4) $\frac{4}{5}ma^2$

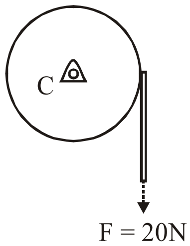
5. A cord is wound round the circumference of wheel of radius r. The axis of the wheel is horizontal and the moment of inertia about it is I. A weight mg is attached to the cord at the end. The weight falls from rest. After falling through a distance 'h', the square of angular velocity of wheel will be :-
(1) $\frac{2mgh}{I+2mr^2}$ (2) $\frac{2mgh}{I+mr^2}$
(3) $2gh$ (4) $\frac{2gh}{I+mr^2}$

6. Four equal masses, m each are placed at the corners of a square of length (l) as shown in the figure. The moment of inertia of the system about an axis passing through A and parallel to DB would be :



(1) ml^2 (2) $2\,ml^2$
(3) $3\,ml^2$ (4) $\sqrt{3}\,ml^2$

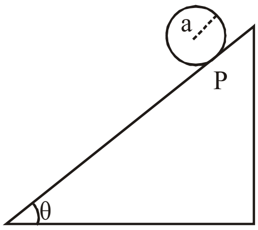
7. Consider a 20 kg uniform circular disk of radius 0.2 m. It is pin supported at its center and is at rest initially. The disk is acted upon by a constant force F = 20 N through a massless string wrapped around its periphery as shown in the figure.



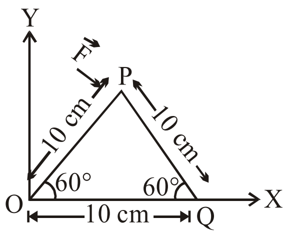
Suppose the disk makes n number of revolutions to attain an angular speed of 50 rad s^{-1}. The value of n, to the nearest integer, is _______. [Given : In one complete revolution, the disk rotates by 6.28 rad]

8. A force $\vec{F} = 4\hat{i} + 3\hat{j} + 4\hat{k}$ is applied on an intersection point of x = 2 plane and x-axis. The magnitude of torque of this force about a point (2, 3, 4) is ________. (Round off to the Nearest Integer)

9. A solid disc of radius 'a' and mass 'm' rolls down without slipping on an inclined plane making an angle θ with the horizontal. The acceleration of the disc will be $\frac{2}{b} g \sin\theta$ where b is ______. (Round off to the Nearest Integer)
(g = acceleration due to gravity)
(θ = angle as shown in figure)



10. A triangular plate is shown. A force $\vec{F} = 4\hat{i} - 3\hat{j}$ is applied at point P. The torque at point P with respect to point 'O' and 'Q' are :



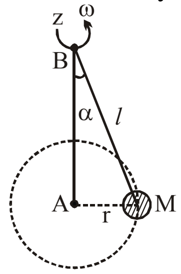
(1) $-15 - 20\sqrt{3}$, $15 - 20\sqrt{3}$

(2) $15 + 20\sqrt{3}$, $15 - 20\sqrt{3}$

(3) $15 - 20\sqrt{3}$, $15 + 20\sqrt{3}$

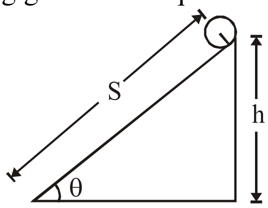
(4) $-15 + 20\sqrt{3}$, $15 + 20\sqrt{3}$

11. A mass M hangs on a massless rod of length l which rotates at a constant angular frequency. The mass M moves with steady speed in a circular path of constant radius. Assume that the system is in steady circular motion with constant angular velocity ω. The angular momentum of M about point A is L_A which lies in the positive z direction and the angular momentum of M about B is L_B. The correct statement for this system is :

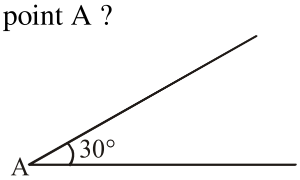


(1) L_A and L_B are both constant in magnitude and direction
(2) L_B is constant in direction with varying magnitude
(3) L_B is constant, both in magnitude and direction
(4) L_A is constant, both in magnitude and direction

12. The following bodies,
(1) a ring (2) a disc
(3) a solid cylinder (4) a solid sphere,
of same mass 'm' and radius 'R' are allowed to roll down without slipping simultaneously from the top of the inclined plane. The body which will reach first at the bottom of the inclined plane is ______.
[Mark the body as per their respective numbering given in the question]



13. A sphere of mass 2kg and radius 0.5 m is rolling with an initial speed of 1 ms^{-1} goes up an inclined plane which makes an angle of 30° with the horizontal plane, without slipping. How low will the sphere take to return to the starting point A ?



(1) 0.60 s (2) 0.52 s
(3) 0.57 s (4) 0.80 s

14. A thin circular ring of mass M and radius r is rotating about its axis with an angular speed ω. Two particles having mass m each are now attached at diametrically opposite points. The angular speed of the ring will become :

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

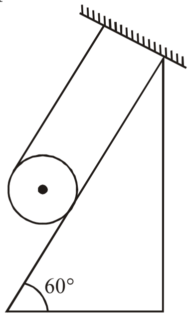
(3) $\omega\frac{M}{M+2m}$ (4) $\omega\frac{M-2m}{M+2m}$

15. Consider a uniform wire of mass M and length L. It is bent into a semicircle. Its moment of inertia about a line perpendicular to the plane of the wire passing through the centre is :

(1) $\frac{1}{4}\frac{ML^2}{\pi^2}$ (2) $\frac{2}{5}\frac{ML^2}{\pi^2}$

(3) $\frac{ML^2}{\pi^2}$ (4) $\frac{1}{2}\frac{ML^2}{\pi^2}$

16. A solid cylinder of mass m is wrapped with an inextensible light string and, is placed on a rough inclined plane as shown in the figure. The frictional force acting between the cylinder and the inclined plane is :



[The coefficient of static friction, μ_s, is 0.4]

(1) $\frac{7}{2}$mg (2) 5 mg (3) $\frac{mg}{5}$ (4) 0

17. A circular disc reaches from top to bottom of an inclined plane of length 'L'. When it slips down the plane, it takes time 't_1'. When it rolls down the plane, it takes time t_2. The value of $\frac{t_2}{t_1}$ is $\sqrt{\frac{3}{x}}$. The value of x will be ______.

18. A rod of mass M and length L is lying on a horizontal frictionless surface. A particle of mass 'm' travelling along the surface hits at one end of the rod with a velocity 'u' in a direction perpendicular to the rod. The collision is completely elastic. After collision, particle comes to rest. The ratio of masses $\left(\frac{m}{M}\right)$ is $\frac{1}{x}$. The value of 'x' will be ______.

19. A body rolls down an inclined plane without slipping. The kinetic energy of rotation is 50% of its translational kinetic energy. The body is :

(1) Solid sphere (2) Solid cylinder

(3) Hollow cylinder (4) Ring

20. Two bodies, a ring and a solid cylinder of same material are rolling down without slipping an inclined plane. The radii of the bodies are same. The ratio of velocity of the centre of mass at the bottom of the inclined plane of the ring to that of the cylinder is $\frac{\sqrt{x}}{2}$. Then, the value of x is _.

21. Consider a situation in which a ring, a solid cylinder and a solid sphere roll down on the same inclined plane without slipping. Assume that they start rolling from rest and having identical diameter.

The **correct** statement for this situation is:-

(1) The sphere has the greatest and the ring has the least velocity of the centre of mass at the bottom of the inclined plane.

(2) The ring has the greatest and the cylinder has the least velocity of the centre of mass at the bottom of the inclined plane.

(3) All of them will have same velocity.

(4) The cylinder has the greatest and the sphere has the least velocity of the centre of mass at the bottom of the inclined plane.

22. The centre of a wheel rolling on a plane surface moves with a speed v_0. A particle on the rim of the wheel at the same level as the centre will be moving at a speed $\sqrt{x}\, v_0$. Then the value of x is _______.

23. Given below are two statements : one is labelled as **Assertion A** and the other is labelled as **Reason R**.

Assertion A : Moment of inertia of a circular disc of mass 'M' and radius 'R' about X, Y axes (passing through its plane) and Z-axis which is perpendicular to its plane were found to be I_x, I_y and I_z respectively. The respective radii of gyration about all the three axes will be the same.

Reason R : A rigid body making rotational motion has fixed mass and shape. In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Both **A** and **R** are correct but **R** is NOT the correct explanation of **A**.

(2) **A** is not correct but **R** is correct.

(3) **A** is correct but **R** is not correct.

(4) Both **A** and **R** are correct and **R** is the correct explanation of **A**.

24. A particle of mass 'm' is moving in time 't' on a trajectory given by

$$\vec{r} = 10\,\alpha t^2 \hat{i} + 5\beta(t-5)\hat{j}$$

Where α and β are dimensional constants.
The angular momentum of the particle becomes the same as it was for t = 0 at time t = ______seconds.

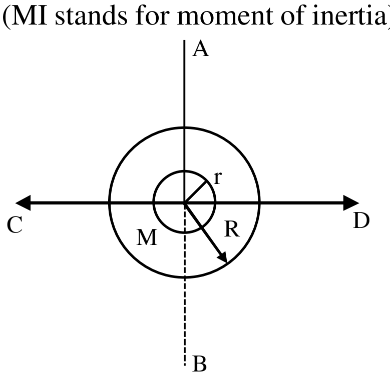
25. A solid disc of radius 20 cm and mass 10 kg is rotating with an angular velocity of 600 rpm, about an axis normal to its circular plane and passing through its centre of mass. The retarding torque required to bring the disc at rest in 10 s is _____ $\pi \times 10^{-1}$ Nm.

26.

List-I	List-II
(a) MI of the rod (length L, Mass M, about an axis $\perp$ to the rod passing through the midpoint)	(i) 8 $ML^2/3$
(b) MI of the rod (length L, Mass 2M, about an axis $\perp$ to the rod passing through one of its end)	(ii) $ML^2/3$
(c) MI of the rod (length 2L, Mass M, about an axis $\perp$ to the rod passing through its midpoint)	(iii) $ML^2/12$
(d) MI of the rod (Length 2L, Mass 2M, about an axis $\perp$ to the rod passing through one of its end)	(iv) 2 $ML^2/3$

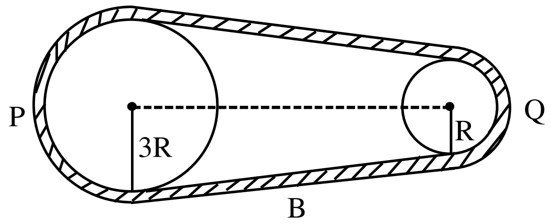
Choose the **correct** answer from the options given below :
(1) (a)–(ii), (b)–(iii), (c)– (i), (d)–(iv)
(2) (a)–(ii), (b)–(i), (c)– (iii), (d)–(iv)
(3) (a)–(iii), (b)–(iv), (c)– (ii), (d)–(i)
(4) (a)–(iii), (b)–(iv), (c)– (i), (d)–(ii)

27. The figure shows two solid discs with radius R and r respectively. If mass per unit area is same for both, what is the ratio of MI of bigger disc around axis AB (Which is $\perp$ to the plane of the disc and passing through its centre) of MI of smaller disc around one of its diameters lying on its plane? Given 'M' is the mass of the larger disc. (MI stands for moment of inertia)

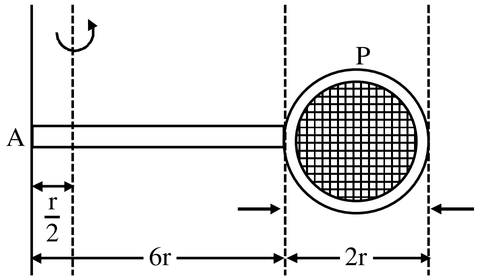


(1) $R^2 : r^2$ (2) $2r^4 : R^4$
(3) $2R^2 : r^2$ (4) $2R^4 : r^4$

28. In the given figure, two wheels P and Q are connected by a belt B. The radius of P is three times as that of Q. In case of same rotational kinetic energy, the ratio of rotational inertias $\left(\frac{I_1}{I_2}\right)$ will be x : 1. The value of x will be _____.

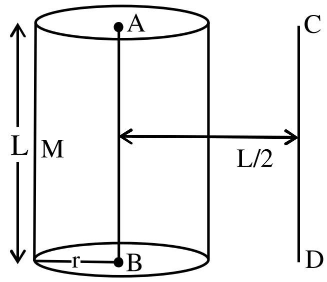


29. Consider a badminton racket with length scales as shown in the figure.



If the mass of the linear and circular portions of the badminton racket are same (M) and the mass of the threads are negligible, the moment of inertia of the racket about an axis perpendicular to the handle and in the plane of the ring at, $\frac{r}{2}$ distance from the end A of the handle will be .... Mr^2.

30. The solid cylinder of length 80 cm and mass M has a radius of 20 cm. Calculate the density of the material used if the moment of inertia of the cylinder about an axis CD parallel to AB as shown in figure is 2.7 kg m^2.



(1) 14.9 kg / m^3
(2) 7.5×10^1 kg / m^3
(3) 7.5×10^2 kg/m^3
(4) 1.49×10^2 kg / m^3

31. Moment of inertia of a square plate of side l about the axis passing through one of the corner and perpendicular to the plane of square plate is given by :

(1) $\frac{Ml^2}{6}$ (2) Ml^2 (3) $\frac{Ml^2}{12}$ (4) $\frac{2}{3}Ml^2$

32. Two discs have moments of intertia I_1 and I_2 about their respective axes perpendicular to the plane and passing through the centre. They are rotating with angular speeds, ω_1 and ω_2 respectively and are brought into contact face to face with their axes of rotation coaxial. The loss in kinetic energy of the system in the process is given by :

(1) $\frac{I_1I_2}{(I_1+I_2)}(\omega_1-\omega_2)^2$ (2) $\frac{(I_1-I_2)^2\omega_1\omega_2}{2(I_1+I_2)}$

(3) $\frac{I_1I_2}{2(I_1+I_2)}(\omega_1-\omega_2)^2$ (4) $\frac{(\omega_1-\omega_2)^2}{2(I_1+I_2)}$

33. Angular momentum of a single particle moving with constant speed along circular path :

(1) changes in magnitude but remains same in the direction

(2) remains same in magnitude and direction

(3) remains same in magnitude but changes in the direction

(4) is zero

34. A system consists of two identical spheres each of mass 1.5 kg and radius 50 cm at the end of light rod. The distance between the centres of the two spheres is 5 m. What will be the moment of inertia of the system about an axis perpendicular to the rod passing through its midpoint ?

(1) 18.75 kgm^2 (2) 1.905×10^5 kgm^2

(3) 19.05 kgm^2 (4) 1.875×10^5 kgm^2

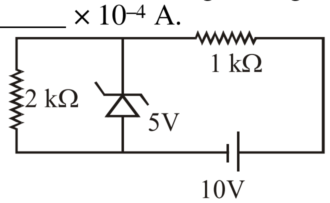
35. A 2 kg steel rod of length 0.6 m is clamped on a table vertically at its lower end and is free to rotate in vertical plane. The upper end is pushed so that the rod falls under gravity, Ignoring the friction due to clamping at its lower end, the speed of the free end of rod when it passes through its lowest position is ....ms^{-1}. (Take g = 10 ms^{-2})

SEMICONDUCTORS

1. If an emitter current is changed by 4 mA, the collector current changes by 3.5 mA. The value of β will be :

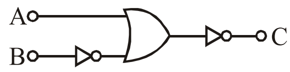
(1) 7 (2) 0.5 (3) 0.875 (4) 3.5

2. In connection with the circuit drawn below, the value of current flowing through 2 kΩ resistor is ________ × 10^{-4} A.

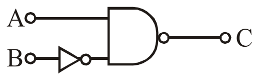


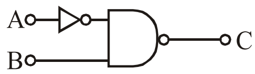
3. A common transistor radio set requires 12V (D.C.) for its operation. The D.C. source is constructed by using a transformer and a rectifier circuit, which are operated at 220 V (A.C.) on standard domestic A.C. supply. The number of turns of secondary coil are 24, then the number of turns of primary are _______.

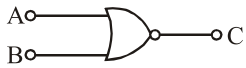
4.

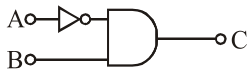


The logic circuit shown above is equivalent to :

(1)


(2)


(3)


(4)


5. Given below are two statements :

Statement I : PN junction diodes can be used to function as transistor, simply by connecting two diodes, back to back, which acts as the base terminal.

Statement II : In the study of transistor, the amplification factor β indicates ratio of the collector current to the base current.

In the light of the above statements, choose the correct answer from the options given below :

(1) Statement I is false but Statement II is true

(2) Both Statement I and Statement II are true

(3) Both Statement I and Statement II are false

(4) Statement I is true but Statement II is false

6. Zener breakdown occurs in a *p-n* junction having p and n both :

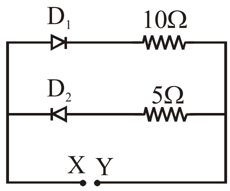
(1) lightly doped and have wide depletion layer.

(2) heavily doped and have narrow depletion layer.

(3) lightly doped and have narrow depletion layer.

(4) heavily doped and have wide depletion layer.

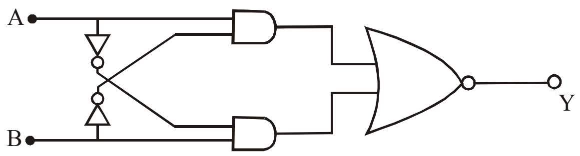
7. A 5V battery is connected across the points X and Y. Assume D_1 and D_2 to be normal silicon diodes. Find the current supplied by the battery if the +ve terminal of the battery is connected to point X.



(1) ~ 0.5 A (2) ~ 1.5 A
(3) ~ 0.86 A (4) ~ 0.43 A

8. For extrinsic semiconductors; when doping level is increased:
(1) Fermi-level of p-type semiconductor will go upward and Fermi-level of n-type semiconductors will go downward.
(2) Fermi-level of p-type semiconductors will go downward and Fermi-level of n-type semiconductor will go upward.
(3) Fermi-level of both p-type and n-type semiconductros will go upward for $T > T_F$ K and downward for $T < T_F$ K, where T_F is Fermi temperature.
(4) Fermi-level of p and n-type semiconductors will not be affected.

9. The truth table for the followng logic circuit is :



(1)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(2)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

(3)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

(4)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

10. Match List I with List II.

List I	List II
(a) Rectifier	(i) Used either for stepping up or stepping down the a.c. voltage
(b) Stabilizer	(ii) Used to convert a.c. voltage into d.c. voltage
(c) Transformer	(iii)Used to remove any ripple in the rectified output voltage
(d) Filter	(iv) Used for constant output voltage even when the input voltage or load current change

Choose the correct answer from the options given below :
(1) (a)–(ii), (b)–(iv), (c)–(i), (d)–(iii)
(2) (a)–(iii), (b)–(iv), (c)–(i), (d)–(ii)
(3) (a)–(ii), (b)–(i), (c)–(iv), (d)–(iii)
(4) (a)–(ii), (b)–(i), (c)–(iii), (d)–(iv)

11. LED is constructed from Ga-As-P semiconducting material. The energy gap of this LED is 1.9 eV. Calculate the wavelength of light emitted and its colour.

[$h = 6.63 \times 10^{-34}$ Js and $c = 3 \times 10^{8}$ ms^{-1}]

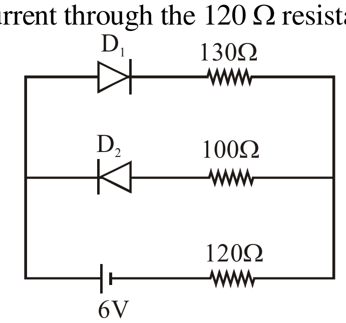
(1) 1046 nm and red colour

(2) 654 nm and orange colour

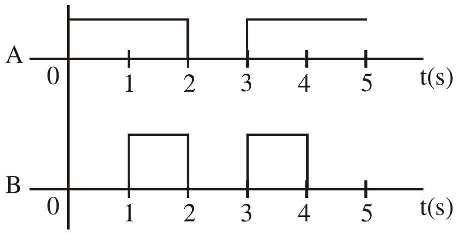
(3) 1046 nm and blue colour

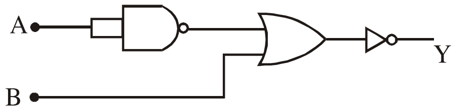
(4) 654 nm and red colour

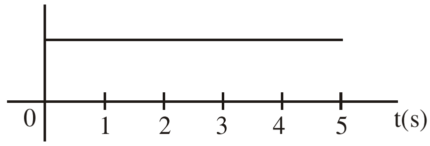
12. The circuit contains two diodes each with a forward resistance of 50 Ω and with infinite reverse resistance. If the battery voltage is 6 V, the current through the 120 Ω resistance is_ mA.

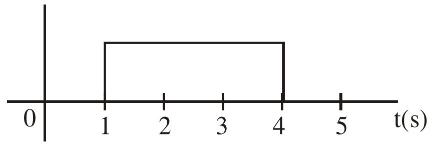


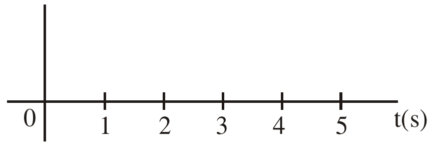
13. Draw the output signal Y in the given combination of gates :-

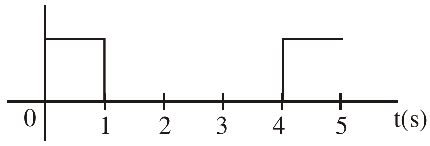




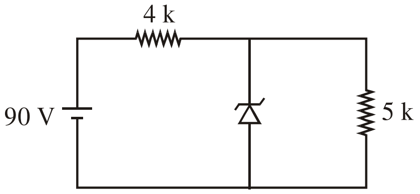
(1)


(2)


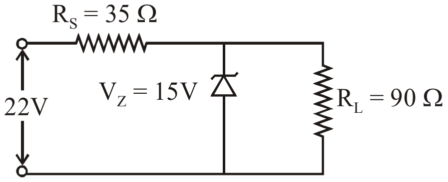
(3)


(4)


14. The zener diode has a V_z = 30 V. The current passing through the diode for the following circuit is .... mA.

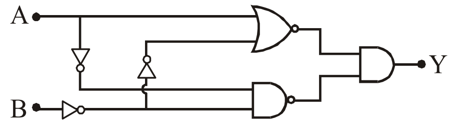


15. The value of power dissipated across the zener diode (V_z = 15 V) connected in the circuit as shown in the figure is x × 10^{-1} watt.

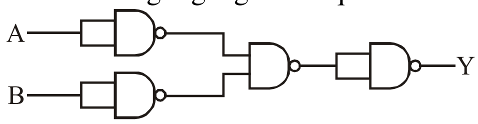


The value of x, to the nearest integer, is ______.

16. In the logic circuit shown in the figure, if input A and B are 0 to 1 respectively, the output at Y would be 'x'. The value of x is _______.

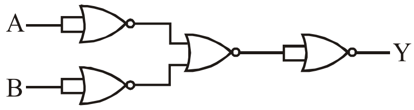


17. The following logic gate is equivalent to :



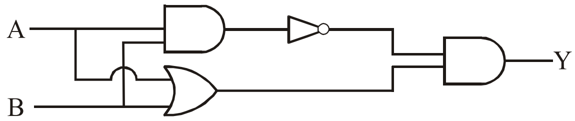
(1) NOR Gate (2) OR Gate
(3) AND Gate (4) NAND Gate

18. The output of the given combination gates represents :



(1) XOR Gate (2) NAND Gate
(3) AND Gate (4) NOR Gate

19. Which one of the following will be the output of the given circuit ?



(1) NOR Gate (2) NAND Gate
(3) AND Gate (4) XOR Gate

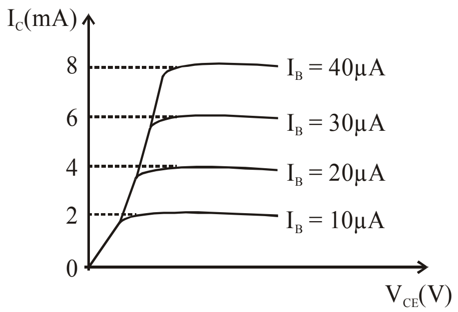
20. An npn transistor operates as a common emitter amplifier with a power gain of 10^6. The input circuit resistance is 100Ω and the output load resistance is 10 KΩ. The common emitter current gain 'β' will be ______. (Round off to the Nearest Integer)

21. The correct relation between α (ratio of collector current to emitter current) and β (ratio of collector current to base current) of a transistor is:

(1) $\beta = \dfrac{\alpha}{1+\alpha}$ (2) $\alpha = \dfrac{\beta}{1-\alpha}$

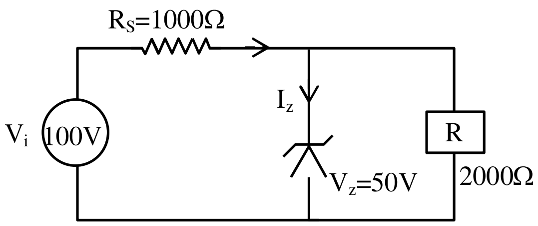
(3) $\beta = \dfrac{1}{1-\alpha}$ (4) $\alpha = \dfrac{\beta}{1+\beta}$

22. The typical output characteristics curve for a transistor working in the common-emitter configuration is shown in the figure.



The estimated current gain from the figure is

23. For the circuit shown below, calculate the value of I_z :



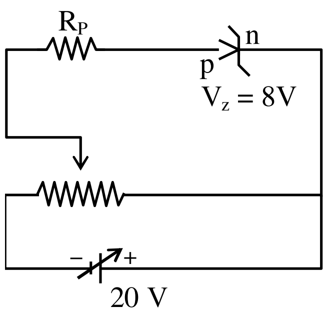
(1) 25 mA

(2) 0.15 A

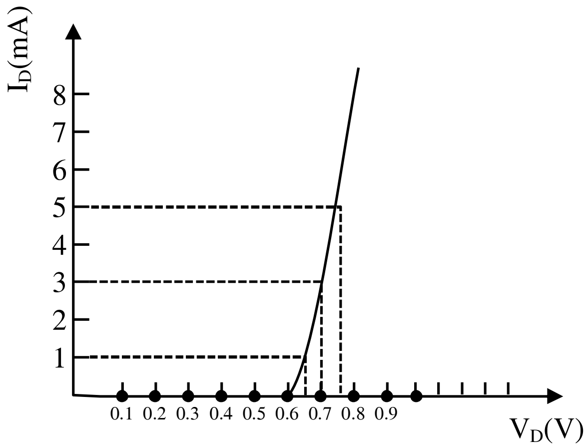
(3) 0.1 A

(4) 0.05 A

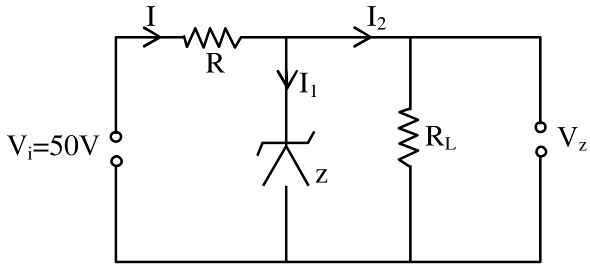
24. A zener diode having zener voltage 8 V and power dissipation rating of 0.5 W is connected across a potential divider arranged with maximum potential drop across zener diode is as shown in the diagram. The value of protective resistance R_p is ....Ω.



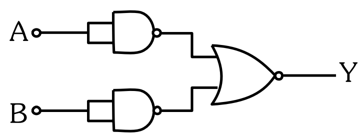
25. For the forward biased diode characteristics shown in the figure, the dynamic resistance at I_D = 3 mA will be_______Ω.



26. In a given circuit diagram, a 5 V zener diode along with a series resistance is connected across a 50 V power supply. The minimum value of the resistance required, if the maximum zener current is 90 mA will be _____ Ω.



27. Identify the logic operation carried out.



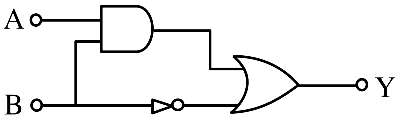
(1) OR (2) AND

(3) NOR (4) NAND

28. In a semiconductor, the number density of intrinsic charge carriers at 27°C is 1.5×10^{16} / m^3. If the semiconductor is doped with impurity atom, the hole density increases to 4.5×10^{22} / m^3. The electron density in the doped semiconductor is _______ $\times 10^9/m^3$.

29. A transistor is connected in common emitter circuit configuration, the collector supply voltage is 10 V and the voltage drop across a resistor of 1000 Ω in the collector circuit is 0.6 V. If the current gain factor (β) is 24, then the base current is _______ μA. (Round off to the Nearest Integer)

30. Find the truth table for the function Y of A and B represented in the following figure.



(1)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	0

(2)

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

(3)

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

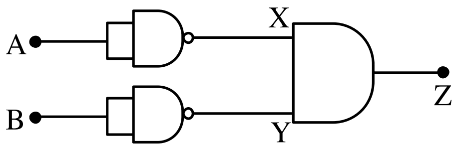
(4)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

31. Consider a situation in which reverse biased current of a particular P-N junction increases when it is exposed to a light of wavelength $\leq$ 621 nm. During this process, enhancement in carrier concentration takes place due to generation of hole-electron pairs. The value of band gap is nearly.

(1) 2 eV (2) 4 eV
(3) 1 eV (4) 0.5 eV

32. Identify the logic operation carried out by the given circuit :-



(1) OR (2) AND
(3) NOR (4) NAND

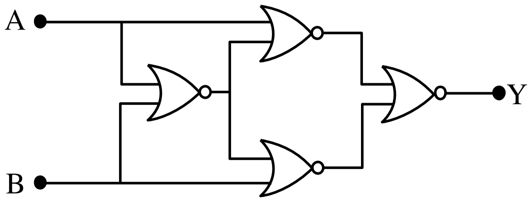
33. **Statement-I :** By doping silicon semiconductor with pentavalent material, the electrons density increases.

Statement-II : The n-type semiconductor has net negative charge.

In the light of the above statements, choose the most appropriate answer from the options given below :

(1) Statement-I is true but Statement-II is false.
(2) Statement-I is false but Statement-II is true.
(3) Both Statement-I and Statement-II are true.
(4) Both Statement-I and Statement-II are false.

34. Four NOR gates are connected as shown in figure. The truth table for the given figure 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	1
1	0	1
1	1	0

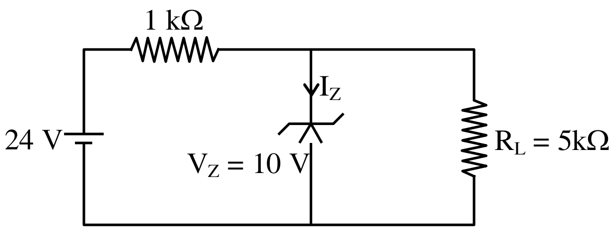
(3)

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

(4)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

35. For the given circuit, the power across zener diode is .... mW.



36. For a transistor in CE mode to be used as an amplifier, it must be operated in :

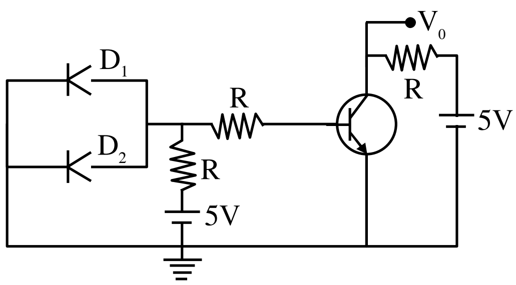
(1) Both cut-off and Saturation

(2) Saturation region only

(3) Cut-off region only

(4) The active region only

37. A circuit is arranged as shown in figure. The output voltage V_0 is equal to .... V.



38. For a transistor α and β are given as $\alpha = \frac{I_C}{I_E}$

and $\beta = \frac{I_C}{I_B}$. Then the correct relation between

α and β will be :

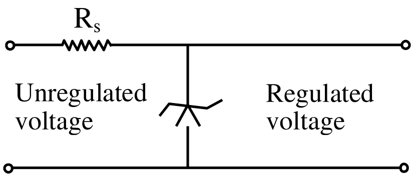
(1) $\alpha = \frac{1-\beta}{\beta}$

(2) $\beta = \frac{\alpha}{1-\alpha}$

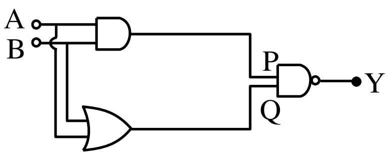
(3) $\alpha\beta = 1$

(4) $\alpha = \frac{\beta}{1-\beta}$

39. A zener diode of power rating 2W is to be used as a voltage regulator. If the zener diode has a breakdown of 10 V and it has to regulate voltage fluctuated between 6 V and 14 V, the value of R_s for safe operation should be ________ Ω.



40. In the following logic circuit the sequence of the inputs A, B are (0, 0), (0,1), (1, 0) and (1, 1). The output Y for this sequence will be :



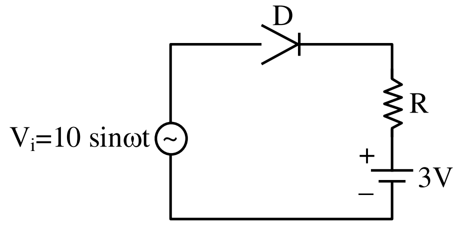
(1) 1, 0, 1, 0

(2) 0, 1, 0, 1

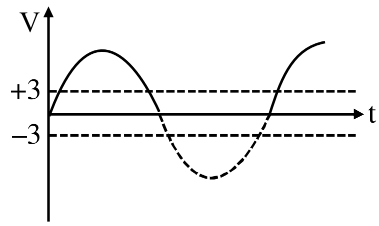
(3) 1, 1, 1, 0

(4) 0, 0, 1, 1

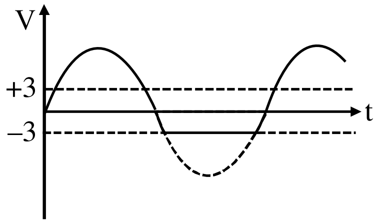
41. Choose the correct waveform that can represent the voltage across R of the following circuit, assuming the diode is ideal one:



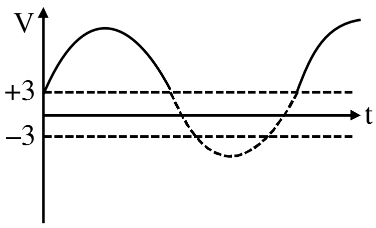
(1)



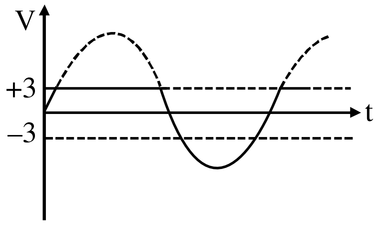
(2)



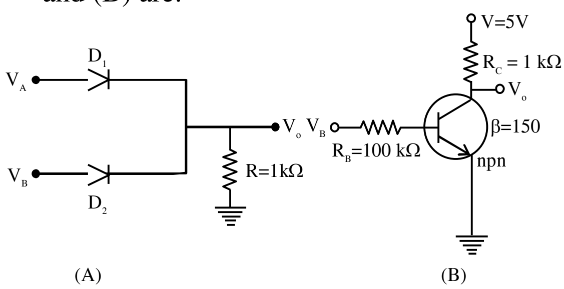
(3)



(4)



42. If V_A and V_B are the input voltages (either 5V or 0V) and V_o is the output voltage then the two gates represented in the following circuit (A) and (B) are:-



(1) AND and OR Gate

(2) OR a

(3) NAND and NOR Gate

(4) AND and NOT Gate

43. **Statement–I :**

To get a steady dc output from the pulsating voltage received from a full wave rectifier we can connect a capacitor across the output parallel to the load R_L.

Statement–II :

To get a steady dc output from the pulsating voltage received from a full wave rectifier we can connect an inductor in series with R_L.

In the light of the above statements, choose the most appropriate answer from the options given below :

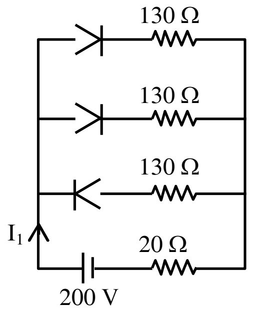
(1) **Statement I** is true but **Statement II** is false

(2) **Statement I** is false but **Statement II** is true

(3) Both **Statement I** and **Statement II** are false

(4) Both **Statement I** and **Statement II** are true

44. In the given figure, each diode has a forward bias resistance of 30Ω and infinite resistance in reverse bias. The current I_1 will be :

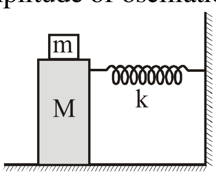


(1) 3.75 A (2) 2.35 A

(3) 2 A (4) 2.73 A

SIMPLE HARMONIC MOTION

1. In the given figure, a mass M is attached to a horizontal spring which is fixed on one side to a rigid support. The spring constant of the spring is k. The mass oscillates on a frictionless surface with time period T and amplitude A. When the mass is in equilibrium position, as shown in the figure, another mass m is gently fixed upon it. The new amplitude of oscillation will be :



(1) $A\sqrt{\frac{M-m}{M}}$ (2) $A\sqrt{\frac{M}{M+m}}$

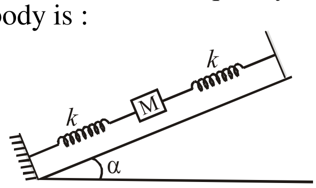
(3) $A\sqrt{\frac{M+m}{M}}$ (4) $A\sqrt{\frac{M}{M-m}}$

2. When a particle executes SHM, the nature of graphical representation of velocity as a function of displacement is :

(1) circular (2) elliptical

(3) parabolic (4) straight line

3. In the given figure, a body of mass M is held between two massless springs, on a smooth inclined plane. The free ends of the springs are attached to firm supports. If each spring has spring constant *k*, the frequency of oscillation of given body is :



(1) $\frac{1}{2\pi}\sqrt{\frac{k}{2M}}$ (2) $\frac{1}{2\pi}\sqrt{\frac{2k}{Mg\sin\alpha}}$

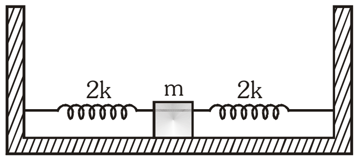
(3) $\frac{1}{2\pi}\sqrt{\frac{2k}{M}}$ (4) $\frac{1}{2\pi}\sqrt{\frac{k}{Mg\sin\alpha}}$

4. If the time period of a two meter long simple pendulum is 2s, the acceleration due to gravity at the place where pendulum is executing S.H.M. is:

(1) $\pi^2 ms^{-2}$ (2) $9.8\ ms^{-2}$

(3) $2\pi^2 ms^{-2}$ (4) $16\ m/s^2$

5. Two identical springs of spring constant '2k' are attached to a block of mass m and to fixed support (see figure).When the mass is displaced from equilibrium position on either side, it executes simple harmonic motion. The time period of oscillations of this system is :



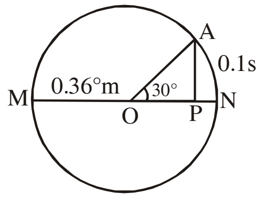
(1) $2\pi\sqrt{\frac{m}{k}}$ (2) $\pi\sqrt{\frac{m}{2k}}$

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

6. $Y = A\sin(\omega t + \phi_0)$ is the time-displacement equation of a SHM. At t = 0 the displacement of the particle is $Y = \frac{A}{2}$ and it is moving along negative *x*-direction. Then the initial phase angle ϕ_0 will be :

(1) $\frac{\pi}{6}$ (2) $\frac{\pi}{3}$ (3) $\frac{5\pi}{6}$ (4) $\frac{2\pi}{3}$

7. The point A moves with a uniform speed along the circumference of a circle of radius 0.36 m and covers 30° in 0.1 s. The perpendicular projection 'P' from 'A' on the diameter MN represents the simple harmonic motion of 'P'. The restoration force per unit mass when P touches M will be :



(1) 100 N (2) 0.49 N

(3) 50 N (4) 9.87 N

8. If two similar springs each of spring constant K_1 are joined in series, the new spring constant and time period would be changed by a factor:

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

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

9. A particle executes S.H.M., the graph of velocity as a function of displacement is :-

(1) A circle (2) A parabola

(3) An ellipse (4) A helix

10. Given below are two statements :

Statement I : A second's pendulum has a time period of 1 second.

Statement II : It takes precisely one second to move between the two extreme positions.

In the light of the above statements, choose the correct answer from the options given below :

(1) Both Statement I and Statement II are false.

(2) Statement I is false but Statement II is true

(3) Statement I is true but Statement II is false

(4) Both Statement I and Statement II are true.

11. A particle executes S.H.M. with amplitude 'a' and time period V. The displacement of the particle when its speed is half of maximum speed is $\frac{\sqrt{x}a}{2}$. The value of x is ....

12. Time period of a simple pendulum is T. The time taken to complete 5/8 oscillations starting from mean position is $\frac{\alpha}{\beta}T$. The value of α is ....

13. Time period of a simple pendulum is T inside a lift when the lift is stationary. If the lift moves upwards with an acceleration g/2, the time period of pendulum will be :

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

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

14. For what value of displacement the kinetic energy and potential energy of a simple harmonic oscillation become equal ?

(1) x = 0 (2) x = ± A

(3) $x = \pm\frac{A}{\sqrt{2}}$ (4) $x = \frac{A}{2}$

15. Consider two identical springs each of spring constant k and negligible mass compared to the mass M as shown. Fig.1 shows one of them and Fig.2 shows their series combination. The ratios of time period of oscillation of the two SHM is $\frac{T_b}{T_a} = \sqrt{x}$, where value of x is ______.

(Round off to the Nearest Integer)

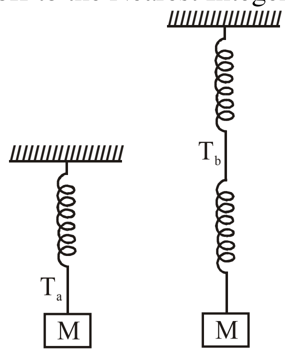


Fig.1 Fig.2

16. Two particles A and B of equal masses are suspended from two massless springs of spring constants K_1 and K_2 respectively.If the maximum velocities during oscillations are equal, the ratio of the amplitude of A and B is

(1) $\frac{K_2}{K_1}$ (2) $\frac{K_1}{K_2}$

(3) $\sqrt{\frac{K_1}{K_2}}$ (4) $\sqrt{\frac{K_2}{K_1}}$

17. A particle performs simple harmonic motion with a period of 2 second. The time taken by the particle to cover a displacement equal to half of its amplitude from the mean position is $\frac{1}{a}$s. The value of 'a' to the nearest integer is ______ .

18. The function of time representing a simple harmonic motion with a period of $\frac{\pi}{\omega}$ is :

(1) $\sin(\omega t) + \cos(\omega t)$

(2) $\cos(\omega t) + \cos(2\omega t) + \cos(3\omega t)$

(3) $\sin^2(\omega t)$

(4) $3\cos\left(\frac{\pi}{4} - 2\omega t\right)$

19. A particle is making simple harmonic motion along the X-axis. If at a distances x_1 and x_2 from the mean position the velocities of the particle are v_1 and v_2 respectively. The time period of its oscillation is given as :

(1) $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 - v_2^2}}$

(2) $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}$

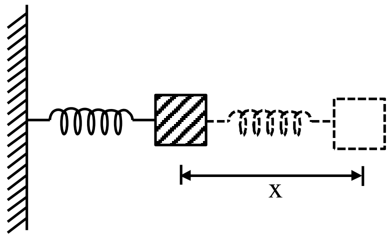
(3) $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 + v_2^2}}$

(4) $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

20. T_0 is the time period of a simple pendulum at a place. If the length of the pendulum is reduced to $\frac{1}{16}$ times of its initial value, the modified time period is :

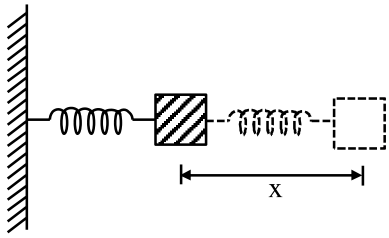
(1) T_0
(2) $8\pi T_0$
(3) $4T_0$
(4) $\frac{1}{4}T_0$

21. The motion of a mass on a spring, with spring constant K is as shown in figure.



The equation of motion is given by $x(t) = A\sin\omega t + B\cos\omega t$ with $\omega = \sqrt{\frac{K}{m}}$

Suppose that at time t = 0, the position of mass is x(0) and velocity v (0), then its displacement can also be represented as $x(t) = C\cos(\omega t - \phi)$, where C and ϕ are :



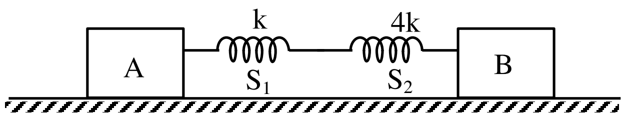
(1)
$C = \sqrt{\frac{2v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$

(2)
$C = \sqrt{\frac{2v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{x(0)\omega}{2v(0)}\right)$

(3) $C = \sqrt{\frac{v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{x(0)\omega}{v(0)}\right)$

(4) $C = \sqrt{\frac{v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$

22. In the reported figure, two bodies A and B of masses 200 g and 800 g are attached with the system of springs. Springs are kept in a stretched position with some extension when the system is released. The horizontal surface is assumed to be frictionless. The angular frequency will be _______ rad/s when k = 20 N/m.



23. In a simple harmonic oscillation, what fraction of total mechanical energy is in the form of kinetic energy, when the particle is midway between mean and extreme position.

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

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

24. A particle starts executing simple harmonic motion (SHM) of amplitude 'a' and total energy E. At any instant, its kinetic energy is $\frac{3E}{4}$ then its displacement 'y' is given by :

(1) $y = a$

(2) $y = \frac{a}{\sqrt{2}}$

(3) $y = \frac{a\sqrt{3}}{2}$

(4) $y = \frac{a}{2}$

25. An object of mass 0.5 kg is executing simple harmonic motion. It amplitude is 5 cm and time period (T) is 0.2 s. What will be the potential energy of the object at an instant $t = \frac{T}{4}s$ starting from mean position. Assume that the initial phase of the oscillation is zero.

(1) 0.62 J (2) 6.2×10^{-3} J

(3) 1.2×10^{3} J (4) 6.2×10^{3} J

26. A particle executes simple harmonic motion represented by displacement function as

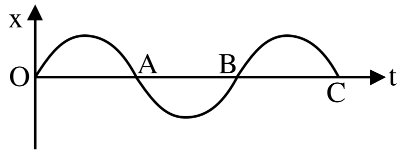
$$x(t) = A \sin(\omega t + \phi)$$

If the position and velocity of the particle at t = 0 s are 2 cm and 2ω cm s^{-1} respectively, then its amplitude is $x\sqrt{2}$ cm where the value of x is ____.

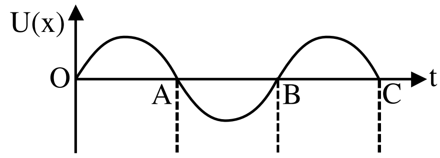
27. Two simple harmonic motions are represented by the equations

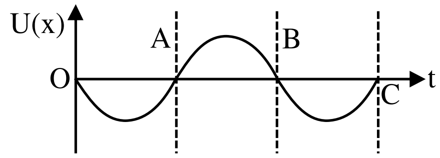
$x_1 = 5 \sin\left(2\pi t + \frac{\pi}{4}\right)$ and $x_2 = 5\sqrt{2}(\sin 2\pi t + \cos 2\pi t)$. The amplitude of second motion is .... times the amplitude in first motion.

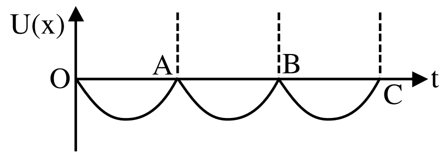
28. The variation of displacement with time of a particle executing free simple harmonic motion is shown in the figure.

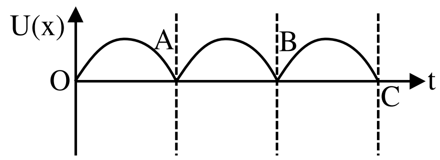


The potential energy U(x) versus time (t) plot of the particle is correctly shown in figure :

(1)


(2)


(3)


(4)


29. Two simple harmonic motion, are represented by the equations $y_1 = 10 \sin\left(3\pi t + \frac{\pi}{3}\right)$

$y_2 = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$

Ratio of amplitude of y_1 to y_2 = x : 1. The value of x is ________.

30. A particle of mass 1 kg is hanging from a spring of force constant 100 Nm^{-1}. The mass is pulled slightly downward and released so that it executes free simple harmonic motion with time period T. The time when the kinetic energy and potential energy of the system will become equal, is $\frac{T}{x}$. The value of x is ________.

31. A bob of mass 'm' suspended by a thread of length l undergoes simple harmonic oscillations with time period T. If the bob is immersed in a liquid that has density $\frac{1}{4}$ times that of the bob and the length of the thread is increased by 1/3rd of the original length, then the time period of the simple harmonic oscillations will be :-

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

32. For a body executing S.H.M. :

(a) Potential energy is always equal to its K.E.

(b) Average potential and kinetic energy over any given time interval are always equal.

(c) Sum of the kinetic and potential energy at any point of time is constant.

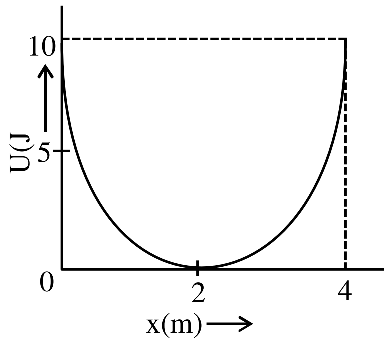
(d) Average K.E. in one time period is equal to average potential energy in one time period.

Choose the most appropriate option from the options given below :

(1) (c) and (d) (2) only (c)

(3) (b) and (c) (4) only (b)

33. A mass of 5 kg is connected to a spring. The potential energy curve of the simple harmonic motion executed by the system is shown in the figure. A simple pendulum of length 4 m has the same period of oscillation as the spring system. What is the value of acceleration due to gravity on the planet where these experiments are performed?



(1) 10 m/s^2 (2) 5 m/s^2

(3) 4 m/s^2 (4) 9.8 m/s^2

UNIT & DIMENSION

1. The workdone by a gas molecule in an isolated system is given by, $W = \alpha\beta^2 e^{-\frac{x^2}{\alpha kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature, α and β are constants. Then the dimension of β will be :

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

(3) $[M^2 L T^2]$ (4) $[M^0 L T^0]$

2. Match List-I with List-II :

List-I	List-II
(a) h (Planck's constant)	(i) $[M L T^{-1}]$
(b) E (kinetic energy)	(ii) $[M L^2 T^{-1}]$
(c) V (electric potential)	(iii) $[M L^2 T^{-2}]$
(d) P (linear momentum)	(iv) $[M L^2 I^{-1} T^{-3}]$

Choose the correct answer from the options given below :

(1) (a)$\rightarrow$(iii), (b)$\rightarrow$(iv), (c)$\rightarrow$(ii), (d)$\rightarrow$(i)

(2) (a)$\rightarrow$(ii), (b)$\rightarrow$(iii), (c)$\rightarrow$(iv), (d)$\rightarrow$(i)

(3) (a)$\rightarrow$(i), (b)$\rightarrow$(ii), (c)$\rightarrow$(iv), (d)$\rightarrow$(iii)

(4) (a)$\rightarrow$(iii), (b)$\rightarrow$(ii), (c)$\rightarrow$(iv), (d)$\rightarrow$(i)

3. If e is the electronic charge, c is the speed of light in free space and h is Planck's constant, the quantity $\frac{1}{4\pi\varepsilon_0}\frac{|e|^2}{hc}$ has dimensions of :

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

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

4. In a typical combustion engine the work done by a gas molecule is given $W = \alpha^2\beta e^{\frac{-\beta x^2}{kT}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. If α and β are constants, dimensions of α will be :

(1) $[MLT^{-2}]$ (2) $[M^0LT^0]$

(3) $[M^2LT^{-2}]$ (4) $[MLT^{-1}]$

5. If 'C' and 'V' represent capacity and voltage respectively then what are the dimensions of λ, where $\frac{C}{V} = \lambda$?

(1) $[M^{-2}L^{-3}I^2T^6]$ (2) $[M^{-3}L^{-4}I^3T^7]$

(3) $[M^{-1}L^{-3}I^{-2}T^{-7}]$ (4) $[M^{-2}L^{-4}I^3T^7]$

6. If time (t), velocity (v), and angular momentum (l) are taken as the fundamental units. Then the dimension of mass (m) in terms of t, v and l is :

(1) $[t^{-1} v^1 l^{-2}]$ (2) $[t^1 v^2 l^{-1}]$

(3) $[t^{-2} v^{-1} l^1]$ (4) $[t^{-1} v^{-2} l^1]$

7. The force is given in terms of time t and displacement x by the equation

F = A cos Bx + C sin Dt

The dimensional formula of $\frac{AD}{B}$ is :

(1) $[M^0 L T^{-1}]$ (2) $[M L^2 T^{-3}]$

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

8. If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of P in the formula $P = EL^2M^{-5}G^{-2}$ are :-

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

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

9. Match List–I with List–II.

List-I		List-II	
(a)	Magnetic Induction	(i)	$ML^2T^{-2}A^{-1}$
(b)	Magnetic Flux	(ii)	$M^0L^{-1}A$
(c)	Magnetic Permeability	(iii)	$MT^{-2}A^{-1}$
(d)	Magnetization	(iv)	$MLT^{-2}A^{-2}$

Choose the most appropriate answer from the options given below :

(1) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)

(2) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)

(3) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)

(4) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

10. Which of the following is not a dimensionless quantity ?
(1) Relative magnetic permeability (μ_r)
(2) Power factor
(3) Permeability of free space (μ_0)
(4) Quality factor

11. If E and H represents the intensity of electric field and magnetising field respectively, then the unit of E/H will be :
(1) ohm (2) mho
(3) joule (4) newton

12. Match List-I with List-II.

List-I	List-II
(a) R_H (Rydberg constant)	(i) $kg\ m^{-1}\ s^{-1}$
(b) h(Planck's constant)	(ii) $kg\ m^2\ s^{-1}$
(c) μ_B (Magnetic field energy density)	(iii) m^{-1}
(d) η(coefficient of viscocity)	(iv) $kg\ m^{-1}\ s^{-2}$

Choose the most appropriate answer from the options given below :
(1) (a)–(ii), (b)–(iii), (c)–(iv), (d)–(i)
(2) (a)–(iii), (b)–(ii), (c)–(iv), (d)–(i)
(3) (a)–(iv), (b)–(ii), (c)–(i), (d)–(iii)
(4) (a)–(iii), (b)–(ii), (c)–(i), (d)–(iv)

13. If force (F), length (L) and time (T) are taken as the fundamental quantities. Then what will be the dimension of density :
(1)$[FL^{-4}T^2]$ (2) $[FL^{-3}T^2]$
(3) $[FL^{-5}T^2]$ (4) $[FL^{-3}T^3]$

14. Match **List-I** with **List-II**.

List-I	List-II
(a) Torque	(i) MLT^{-1}
(b) Impulse	(ii) MT^{-2}
(c) Tension	(iii) ML^2T^{-2}
(d) Surface Tension	(iv) MLT^{-2}

Choose the **most appropriate** answer from the option given below :
(1) (a)–(iii), (b)–(i), (c)–(iv), (d)–(ii)
(2) (a)–(ii), (b)–(i), (c)–(iv), (d)–(iii)
(3) (a)–(i), (b)–(iii), (c)–(iv), (d)–(ii)
(4) (a)–(iii), (b)–(iv), (c)–(i), (d)–(ii)

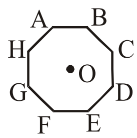
15. Which of the following equations is dimensionally incorrect ?
Where t = time, h = height, s = surface tension, θ = angle, ρ = density, a, r = radius, g = acceleration due to gravity, v = volume , p = pressure, W = work done, Γ = torque, $\in$= permittivity, E = electric field, J = current density, L = length.
(1) $v = \dfrac{\pi p a^4}{8\eta L}$ (2) $h = \dfrac{2s\cos\theta}{\rho r g}$
(3) $J = \in\dfrac{\partial E}{\partial t}$ (4) $W = \Gamma\theta$

16. If velocity [V], time [T] and force [F] are chosen as the base quantities, the dimensions of the mass will be :
(1) $[FT^{-1}V^{-1}]$ (2) $[FTV^{-1}]$
(3) $[FT^2V]$ (4) $[FVT^{-1}]$

VECTORS, BASIC MATHS & CALCULUS

1. A current through a wire depends on time as $i = \alpha_0 t + \beta t^2$ where $\alpha_0 = 20$ A/s and $\beta = 8\ As^{-2}$. Find the charge crossed through a section of the wire in 15 s.
(1) 2250 C (2) 11250 C
(3) 2100 C (4) 260 C

2. In an octagon ABCDEFGH of equal side, what is the sum of
$\overrightarrow{AB}+\overrightarrow{AC}+\overrightarrow{AD}+\overrightarrow{AE}+\overrightarrow{AF}+\overrightarrow{AG}+\overrightarrow{AH}'$
if, $\overrightarrow{AO}=2\hat{i}+3\hat{j}-4\hat{k}$



(1) $-16\hat{i}-24\hat{j}+32\hat{k}$ (2) $16\hat{i}+24\hat{j}-32\hat{k}$
(3) $16\hat{i}+24\hat{j}+32\hat{k}$ (4) $16\hat{i}-24\hat{j}+32\hat{k}$

3. If $\vec{A}$ and $\vec{B}$ are two vectors satisfying the relation $\vec{A}\cdot\vec{B}=\left|\vec{A}\times\vec{B}\right|$. Then the value of $\left|\vec{A}-\vec{B}\right|$ will be :
(1) $\sqrt{A^2+B^2}$ (2) $\sqrt{A^2+B^2+\sqrt{2}AB}$
(3) $\sqrt{A^2+B^2+2AB}$ (4) $\sqrt{A^2+B^2-\sqrt{2}AB}$

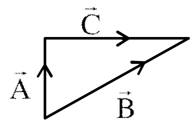
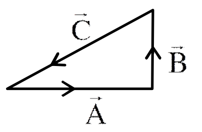
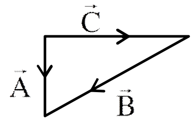
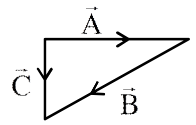
4. Two vectors $\vec{P}$ and $\vec{Q}$ have equal magnitudes. If the magnitude of $\vec{P}+\vec{Q}$ is *n* times the magnitude of $\vec{P}-\vec{Q}$, then angle between $\vec{P}$ and $\vec{Q}$ is :
(1) $\sin^{-1}\left(\dfrac{n-1}{n+1}\right)$ (2) $\cos^{-1}\left(\dfrac{n-1}{n+1}\right)$
(3) $\sin^{-1}\left(\dfrac{n^2-1}{n^2+1}\right)$ (4) $\cos^{-1}\left(\dfrac{n^2-1}{n^2+1}\right)$

5. What will be the projection of vector $\vec{A}=\hat{i}+\hat{j}+\hat{k}$ on vector $\vec{B}=\hat{i}+\hat{j}$?
(1) $\sqrt{2}\left(\hat{i}+\hat{j}+\hat{k}\right)$ (2) $2\left(\hat{i}+\hat{j}+\hat{k}\right)$
(3) $\sqrt{2}\left(\hat{i}+\hat{j}\right)$ (4) $\left(\hat{i}+\hat{j}\right)$

6. Three particles P, Q and R are moving along the vectors $\vec{A} = \hat{i} + \hat{j}$, $\vec{B} = \hat{j} + \hat{k}$ and $\vec{C} = -\hat{i} + \hat{j}$ respectively. They strike on a point and start to move in different directions. Now particle P is moving normal to the plane which contains vector $\vec{A}$ and $\vec{B}$. Similarly particle Q is moving normal to the plane which contains vector $\vec{A}$ and $\vec{C}$. The angle between the direction of motion of P and Q is $\cos^{-1}\left(\frac{1}{\sqrt{x}}\right)$.

Then the value of x is ________.

7. Match **List I** with **List II**.

List I		List II	
(a)	$\vec{C} - \vec{A} - \vec{B} = 0$	(i)	
(b)	$\vec{A} - \vec{C} - \vec{B} = 0$	(ii)	
(c)	$\vec{B} - \vec{A} - \vec{C} = 0$	(iii)	
(d)	$\vec{A} + \vec{B} = -\vec{C}$	(iv)	

Choose the correct answer from the options given below :

(1) (a) → (iv), (b) → (i) , (c) → (iii), (d) → (ii)

(2) (a) → (iv), (b) → (iii) , (c) → (i), (d) → (ii)

(3) (a) → (iii), (b) → (ii) , (c) → (iv), (d) → (i)

(4) (a) → (i), (b) → (iv) , (c) → (ii), (d) → (iii)

8. Two vectors $\vec{X}$ and $\vec{Y}$ have equal magnitude. The magnitude of $(\vec{X} - \vec{Y})$ is n times the magnitude of $(\vec{X} + \vec{Y})$. The angle between $\vec{X}$ and $\vec{Y}$ is :

(1) $\cos^{-1}\left(\frac{-n^2-1}{n^2-1}\right)$ (2) $\cos^{-1}\left(\frac{n^2-1}{-n^2-1}\right)$

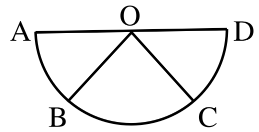
(3) $\cos^{-1}\left(\frac{n^2+1}{-n^2-1}\right)$ (4) $\cos^{-1}\left(\frac{n^2+1}{n^2-1}\right)$

9. **Assertion A :** If A, B, C, D are four points on a semi-circular arc with centre at 'O' such that $|\overrightarrow{AB}| = |\overrightarrow{BC}| = |\overrightarrow{CD}|$, then

$\overrightarrow{AB} + \overrightarrow{AC} + \overrightarrow{AD} = 4\overrightarrow{AO} + \overrightarrow{OB} + \overrightarrow{OC}$

Reason R : Polygon law of vector addition yields

$\overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CD} + \overrightarrow{AD} = 2\overrightarrow{AO}$



In the light of the above statements, choose the **most appropriate** answer from the options given below :

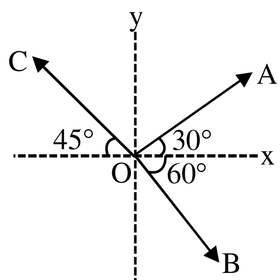
(1) **A** is correct but **R** is not correct.

(2) **A** is not correct but **R** is correct.

(3) Both **A** and **R** are correct and **R** is the correct explanation of **A**.

(4) Both **A** and **R** are correct but **R** is not the correct explanation of **A**.

10. The magnitude of vectors $\overrightarrow{OA}$, $\overrightarrow{OB}$ and $\overrightarrow{OC}$ in the given figure are equal. The direction of $\overrightarrow{OA} + \overrightarrow{OB} - \overrightarrow{OC}$ with x-axis will be :-



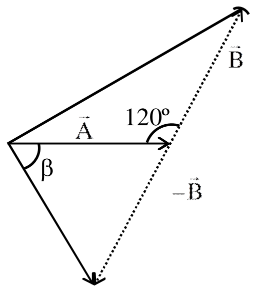
(1) $\tan^{-1}\frac{(1-\sqrt{3}-\sqrt{2})}{(1+\sqrt{3}+\sqrt{2})}$

(2) $\tan^{-1}\frac{(\sqrt{3}-1+\sqrt{2})}{(1+\sqrt{3}-\sqrt{2})}$

(3) $\tan^{-1}\frac{(\sqrt{3}-1+\sqrt{2})}{(1-\sqrt{3}+\sqrt{2})}$

(4) $\tan^{-1}\frac{(1+\sqrt{3}-\sqrt{2})}{(1-\sqrt{3}-\sqrt{2})}$

11. The angle between vector $(\vec{A})$ and $(\vec{A}-\vec{B})$ is :

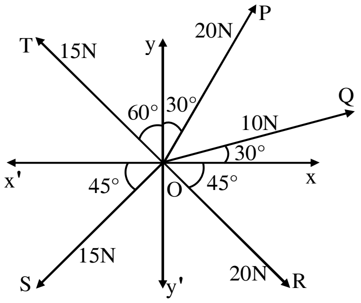


(1) $\tan^{-1}\left(\frac{-\frac{B}{2}}{A-B\frac{\sqrt{3}}{2}}\right)$ (2) $\tan^{-1}\left(\frac{A}{0.7B}\right)$

(3) $\tan^{-1}\left(\frac{\sqrt{3}B}{2A-B}\right)$ (4) $\tan^{-1}\left(\frac{B\cos\theta}{A-B\sin\theta}\right)$

12. The resultant of these forces $\overrightarrow{OP}, \overrightarrow{OQ}, \overrightarrow{OR}, \overrightarrow{OS}$ and $\overrightarrow{OT}$ is approximately ...... N.

[Take $\sqrt{3}=1.7, \sqrt{2}=1.4$ Given $\hat{i}$ and $\hat{j}$ unit vectors along x, y axis]



(1) $9.25\hat{i}+5\hat{j}$ (2) $3\hat{i}+15\hat{j}$

(3) $2.5\hat{i}-14.5\hat{j}$ (4) $-1.5\hat{i}-15.5\hat{j}$

13. **Statement I :**

Two forces $(\vec{P}+\vec{Q})$ and $(\vec{P}-\vec{Q})$ where $\vec{P}\perp\vec{Q}$, when act at an angle θ_1 to each other, the magnitude of their resultant is $\sqrt{3(P^2+Q^2)}$, when they act at an angle θ_2, the magnitude of their resultant becomes $\sqrt{2(P^2+Q^2)}$. This is possible only when $\theta_1 < \theta_2$.

Statement II :

In the situation given above.

$\theta_1 = 60°$ and $\theta_2 = 90°$

In the light of the above statements, choose the most appropriate answer from the options given below :-

(1) Statement-I is false but Statement-II is true
(2) Both Statement-I and Statement-II are true
(3) Statement-I is true but Statement-II is false
(4) Both Statement-I and Statement-II are false.

14. **Statement : I**

If three forces $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$ are represented by three sides of a triangle and $\vec{F}_1+\vec{F}_2=-\vec{F}_3$, then these three forces are concurrent forces and satisfy the condition for equilibrium.

Statement : II

A triangle made up of three forces $\vec{F}_1, \vec{F}_2$ and $\vec{F}_3$ as its sides taken in the same order, satisfy the condition for translatory equilibrium.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement-I is false but Statement-II is true
(2) Statement-I is true but Statement-II is false
(3) Both Statement-I and Statement-II are false
(4) Both Statement-I and Statement-II are true.

WORK POWER ENERGY

1. A small bob tied at one end of a thin string of length 1m is describing a vertical circle so that the maximum and minimum tension in the string are in the ratio 5 : 1. The velocity of the bob at the height position is _____ m/s. (Take g = 10 m/s^2)

2. The potential energy (U) of a diatomic molecule is a function dependent on r (interatomic distance) as : $U=\frac{\alpha}{r^{10}}-\frac{\beta}{r^5}-3$

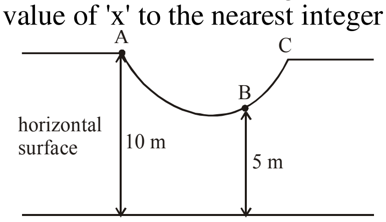
where, α and β are positive constants. The equilibrium distance between two atoms will be $\left(\frac{2\alpha}{\beta}\right)^{\frac{a}{b}}$, where a = ____.

3. A constant power delivering machine has towed a box, which was initially at rest, along a horizontal straight line. The distance moved by the box in time 't' is proportional to :-

(1) $t^{2/3}$ (2) $t^{3/2}$ (3) t (4) $t^{1/2}$

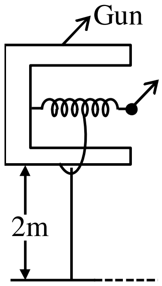
4. As shown in the figure, a particle of mass 10 kg is placed at a point A. When the particle is slightly displaced to its right, it starts moving and reaches the point B. The speed of the particle at B is x m/s. (Take g = 10 m/s^2)

The value of 'x' to the nearest integer is_____.



5. A ball of mass 4 kg, moving with a velocity of 10 ms^{-1}, collides with a spring of length 8 m and force constant 100 Nm^{-1}. The length of the compressed spring is x m. The value of x, to the nearest integer, is_____.

6. In a spring gun having spring constant 100 N/m a small ball 'B' of mass 100 g is put in its barrel (as shown in figure) by compressing the spring through 0.05 m. There should be a box placed at a distance 'd' on the ground so that the ball falls in it. If the ball leaves the gun horizontally at a height of 2 m above the ground. The value of d is ____ m. ($g = 10\ m/s^2$)



7. If the Kinetic energy of a moving body becomes four times its initial Kinetic energy, then the percentage change in its momentum will be :

(1) 100% (2) 200%

(3) 300% (4) 400%

8. A body at rest is moved along a horizontal straight line by a machine delivering a constant power. The distance moved by the body in time '*t*' is proportional to :

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

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

9. A porter lifts a heavy suitcase of mass 80 kg and at the destination lowers it down by a distance of 80 cm with a constant velocity. Calculate the workdone by the porter in lowering the suitcase. (take $g = 9.8\ ms^{-2}$)

(1) –62720.0 J

(2) –627.2 J

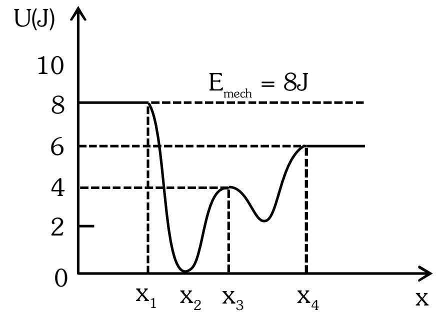
(3) +627.2 J

(4) 784.0 J

10. A pendulum bob has a speed of 3 m/s at its lowest position. The pendulum is 50 cm long. The speed of bob, when the length makes an angle of 60° to the vertical will be ($g = 10\ m/s^2$) ______ m/s.

11. A force of $F = (5y + 20)\ \hat{j}$ N acts on a particle. The workdone by this force when the particle is moved from y = 0 m to y = 10 m is ______ J.

12. Given below is the plot of a potential energy function U(x) for a system, in which a particle is in one dimensional motion, while a conservative force F(x) acts on it. Suppose that $E_{mech} = 8$ J, the incorrect statement for this system is :



[where K.E. = kinetic energy]

(1) at $x > x_4$, K.E. is constant throughout the region.

(2) at $x < x_1$, K.E. is smallest and the particle is moving at the slowest speed.

(3) at $x = x_2$, K.E. is greatest and the particle is moving at the fastest speed.

(4) at $x = x_3$, K.E. = 4 J.

13. An automobile of mass 'm' accelerates starting from origin and initially at rest, while the engine supplies constant power P. The position is given as a function of time by :

(1) $\left(\frac{9P}{8m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$ (2) $\left(\frac{8P}{9m}\right)^{\frac{1}{2}} t^{\frac{2}{3}}$

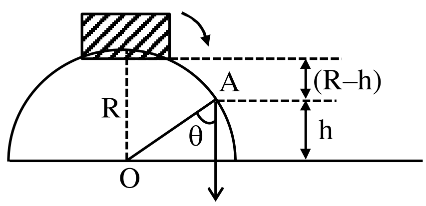
(3) $\left(\frac{9m}{8P}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$ (4) $\left(\frac{8P}{9m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

14. A boy is rolling a 0.5 kg ball on the frictionless floor with the speed of 20 ms^{-1}. The ball gets deflected by an obstacle on the way. After deflection it moves with 5% of its initial kinetic energy. What is the speed of the ball now ?

(1) 19.0 ms^{-1} (2) 4.47 ms^{-1}

(3) 14.41 ms^{-1} (4) 1.00 ms^{-1}

15. A small block slides down from the top of hemisphere of radius R = 3 m as shown in the figure. The height 'h' at which the block will lose contact with the surface of the sphere is ____m. (Assume there is no friction between the block and the hemisphere)



16. A uniform chain of length 3 meter and mass 3 kg overhangs a smooth table with 2 meter laying on the table. If k is the kinetic energy of the chain in joule as it completely slips off the table, then the value of k is .... (Take g = 10 m/s^2)

17. Two persons A and B perform same amount of work in moving a body through a certain distance d with application of forces acting at angle 45° and 60° with the direction of displacement respectively. The ratio of force applied by person A to the force applied by person B is $\frac{1}{\sqrt{x}}$. The value of x is ....

18. A body of mass 'm' dropped from a height 'h' reaches the ground with a speed of $0.8\sqrt{gh}$. The value of workdone by the air-friction is :

(1) –0.68 mgh (2) mgh

(3) 1.64 mgh (4) 0.64 mgh

19. An engine is attached to a wagon through a shock absorber of length 1.5 m. The system with a total mass of 40,000 kg is moving with a speed of 72 kmh^{-1} when the brakes are applied to bring it to rest. In the process of the system being brought to rest, the spring of the shock absorber gets compressed by 1.0 m. If 90% of energy of the wagon is lost due to friction, the spring constant is .... × 10^5 N/m.

WAVE MOTION

1. Which of the following equations represents a travelling wave ?

(1) $y = A\sin(15x - 2t)$ (2) $y = Ae^{-x^2}(vt + \theta)$

(3) $y = Ae^{x}\cos(\omega t - \theta)$ (4) $y = A\sin x \cos\omega t$

2. Two cars are approaching each other at an equal speed of 7.2 km/hr. When they see each other, both blow horns having frequency of 676 Hz. The beat frequency heard by each driver will be _____ Hz. [Velocity of sound in air is 340 m/s.]

3. A student is performing the experiment of resonance column. The diameter of the column tube is 6 cm. The frequency of the tuning fork is 504 Hz. Speed of the sound at the given temperature is 336 m/s. The zero of the meter scale coincides with the top end of the resonance column tube. The reading of the water level in the column when the first resonance occurs is:

(1) 13 cm (2) 16.6 cm

(3) 18.4 cm (4) 14.8 cm

4. The percentage increase in the speed of transverse waves produced in a stretched string if the tension is increased by 4%, will be __________%.

5. The mass per unit length of a uniform wire is 0.135 g/cm. A transverse wave of the form y = –0.21 sin (x + 30t) is produced in it, where x is in meter and t is in second. Then, the expected value of tension in the wire is x × 10^{-2} N. Value of x is. (Round-off to the nearest integer)

6. A tuning fork A of unknown frequency produces 5 beats/s with a fork of known frequency 340 Hz. When fork A is filed, the beat frequency decreases to 2 beats/s. What is the frequency of fork A ?

(1) 342 Hz (2) 345 Hz

(3) 335 Hz (4) 338 Hz

7. A closed organ pipe of length L and an open organ pipe contain gases of densities ρ_1 and ρ_2 respectively. The compressibility of gases are equal in both the pipes. Both the pipes are vibrating in their first overtone with same frequency. The length of the open pipe is $\frac{x}{3}L\sqrt{\frac{\rho_1}{\rho_2}}$ where x is ________. (Round off to the Nearest Integer)

8. A sound wave of frequency 245 Hz travels with the speed of 300 ms^{-1} along the positive x-axis. Each point of the wave moves to and fro through a total distance of 6 cm. What will be the mathematical expression of this travelling wave ?

(1) Y(x,t) = 0.03 [sin 5.1 x – (0.2 × 10^3)t]

(2) Y(x,t) = 0.06 [sin 5.1 x – (1.5 × 10^3)t]

(3) Y(x,t) = 0.06 [sin 0.8 x – (0.5 × 10^3)t]

(4) Y(x,t) = 0.03 [sin 5.1 x – (1.5 × 10^3)t]

9. The amplitude of wave disturbance propagating in the positive x-direction is given by $y = \frac{1}{(1+x)^2}$ at time t = 0 and $y = \frac{1}{1+(x-2)^2}$ at t = 1s, where x and y are in meres. The shape of wave does not change during the propagation. The velocity of the wave will be ____m/s.

10. The frequency of a car horn encountered a change from 400 Hz to 500 Hz. When the car approaches a vertical wall. If the speed of sound is 330 m/s. Then the speed of car is ______ km/h.

11. With what speed should a galaxy move outward with respect to earth so that the sodium-D line at wavelength 5890 Å is observed at 5896 Å ?

(1) 306 km/sec (2) 322 km/sec

(3) 296 km/sec (4) 336 km/sec

12. A source and a detector move away from each other in absence of wind with a speed of 20 m/s with respect to the ground. If the detector detects a frequency of 1800 Hz of the sound coming from the source, then the original frequency of source considering speed of sound in air 340 m/s will be .... Hz.

13. Two travelling waves produces a standing wave represented by equation,
$y = 1.0 \text{ mm} \cos(1.57 \text{ cm}^{-1}) x \sin(78.5 \text{ s}^{-1})t$.
The node closest to the origin in the region x > 0 will be at x = ... cm.

14. Two waves are simultaneously passing through a string and their equations are :
$y_1 = A_1 \sin k(x-vt)$, $y_2 = A_2 \sin k(x-vt + x_0)$. Given amplitudes A_1 = 12 mm and A_2 = 5 mm, x_0 = 3.5 cm and wave number k = 6.28 cm^{-1}. The amplitude of resulting wave will be .... mm.

15. Two cars X and Y are approaching each other with velocities 36 km/h and 72 km/h respectively. The frequency of a whistle sound as emitted by a passenger in car X, heard by the passenger in car Y is 1320 Hz. If the velocity of sound in air is 340 m/s, the actual frequency of the whistle sound produced is .... Hz.

16. A tuning fork is vibrating at 250 Hz. The length of the shortest closed organ pipe that will resonate with the tuning fork will be ______ cm. (Take speed of sound in air as 340 ms^{-1})

17. A wire having a linear mass density 9.0×10^{-4} kg/m is stretched between two rigid supports with a tension of 900 N. The wire resonates at a frequency of 500 Hz. The next higher frequency at which the same wire resonates is 550 Hz. The length of the wire is _______m.

WAVE OPTICS

1. In a Young's double slit experiment, the width of the one of the slit is three times the other slit. The amplitude of the light coming from a slit is proportional to the slit-width. Find the ratio of the maximum to the minimum intensity in the interference pattern.

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

2. An unpolarized light beam is incident on the polarizer of a polarization experiment and the intensity of light beam emerging from the analyzer is measured as 100 Lumens. Now, if the analyzer is rotated around the horizontal axis (direction of light) by 30° in clockwise direction, the intensity of emerging light will be ________ Lumens.

3. If the source of light used in a Young's double slit experiment is changed from red to violet :
(1) consecutive fringe lines will come closer.
(2) the central bright fringe will become a dark fringe.
(3) the fringes will become brighter.
(4) the intensity of minima will increase.

4. Two coherent light sources having intensity in the ratio 2x produce an interference pattern. The ratio $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ will be :

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

5. Consider the diffraction pattern obtained from the sunlight incident on a pinhole of diameter 0.1μm. If the diameter of the pinhole is slightly increased, it will affect the diffraction pattern such thtat :
(1) its size decreases, and intensity decreases
(2) its size increases, and intensity increases
(3) its size increases, but intensity decreases
(4) its size decreases, but intensity increases

6. In a Young's double slit experiment two slits are separated by 2 mm and the screen is placed one meter away. When a light of wavelength 500 nm is used, the fringe separation will be:
(1) 0.25 mm (2) 0.50 mm
(3) 0.75 mm (4) 1 mm

7. In Young's double slit arrangement, slits are separated by a gap of 0.5 mm, and the screen is placed at a distance of 0.5 m from them. The distance between the first and the third bright fringe formed when the slits are illuminated by a monochromatic light of 5890 Å is :-
(1) 1178×10^{-9} m (2) 1178×10^{-6} m
(3) 1178×10^{-12} m (4) 5890×10^{-7} m

8. A galaxy is moving away from the earth at a speed of 286 kms^{-1}. The shift in the wavelength of a red line at 630 nm is $x \times 10^{-10}$ m. The value of x, to the nearest integer, is______.
[Take the value of speed of light c, as 3×10^8 ms^{-1}]

9. In the Young's double slit experiment, the distance between the slits varies in time as $d(t) = d_0 + a_0 \sin\omega t$; where d_0, ω and a_0 are constants. The difference between the largest fringe width and the smallest fringe width obtained over time is given as :

(1) $\frac{2\lambda D(d_0)}{(d_0^2 - a_0^2)}$ (2) $\frac{2\lambda D a_0}{(d_0^2 - a_0^2)}$
(3) $\frac{\lambda D}{d_0^2} a_0$ (4) $\frac{\lambda D}{d_0 + a_0}$

10. In Young's double slit experiment, if the source of light changes from orange to blue then :
(1) the central bright fringe will become a dark fringe.
(2) the distance between consecutive fringes will decrease.
(3) the distance between consecutive fringes will increase.
(4) the intensity of the minima will increase.

11. The difference in the number of waves when yellow light propagates through air and vacuum columns of the same thickness is one. The thickness of the air column is ______ mm. [Refractive index of air = 1.0003, wavelength of yellow light in vacuum = 6000 Å]

12. White light is passed through a double slit and interference is observed on a screen 1.5 m away. The separation between the slits is 0.3 mm. The first violet and red fringes are formed 2.0 mm and 3.5 mm away from the central white fringes. The difference in wavelengths of red and voilet light is .... nm.

13. A source of light is placed in front of a screen. Intensity of light on the screen is I. Two Polaroids P_1 and P_2 are so placed in between the source of light and screen that the intensity of light on screen is I/2. P_2 should be rotated by an angle of .... (degrees) so that the intensity of light on the screen becomes $\frac{3I}{8}$.

14. The light waves from two coherent sources have same intensity $I_1 = I_2 = I_0$. In interference pattern the intensity of light at minima is zero.What will be the intensity of light at maxima ?
(1) I_0 (2) $2\,I_0$ (3) $5\,I_0$ (4) $4\,I_0$

15. A fringe width of 6 mm was produced for two slits separated by 1 mm apart. The screen is placed 10 m away. The wavelength of light used is 'x' nm. The value of 'x' to the nearest integer is ______.

16. In a Young's double slit experiment, the slits are separated by 0.3 mm and the screen is 1.5 m away from the plane of slits. Distance between fourth bright fringes on both sides of central bright is 2.4 cm. The frequency of light used is_____$\times 10^{14}$ Hz.

17. The width of one of the two slits in a Young's double slit experiment is three times the other slit. If the amplitude of the light coming from a slit is proportional to the slit-width, the ratio of minimum to maximum intensity in the interference pattern is x : 4 where x is _______.

ANSWER KEY

CAPACITOR

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	2	BONUS	3	3	2	864	16	2	161	2	2	3	1	3
Q.No.	16	17	18	19	20	21	22	23							
Ans.	3	3	1	1	3	100	4	2							

COM & COLLISION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	3	2	1	3	30	3	4	1	4	20	1	5	2	2
Q.No.	16	17	18	19	20	21	22	23	24						
Ans.	2	25	4	4	400	3	1	3	3						

CIRCULAR MOTION

Q.No.	1	2	3	4	5	6	7	8	9	10	11
Ans.	180	1	4	4	728	2	1	200	1	2	3

CURRENT ELECTRICITY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	300	3	5	1	2	1	1	3	4	2500	2	4	2	3
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	70	48	4	3	3	10	4	15	1	50	1	3	45	1	3
Q.No.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	1	3	2	4	1	1	20	4	4	9	3	3	6	4	3840
Q.No.	46														
Ans.	4														

ELASTICITY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	2	3	4	32	1	2	5	2	20	3	40	4	500
Q.No.	16														
Ans.	2														

ELECTROSTATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	3	226	1	128	2	20	36	3	243	2	4	1	640	2
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	12	2	1	4	4	6000	3	2	2	1	4	1	2	2	3
Q.No.	31														
Ans.	2														

EM WAVES

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	15	4	667	2	137	1	1	3	3	3	4	1	4	4	3
Q.No.	16	17	18	19	20										
Ans.	3	2	500	1	354										

EMI & AC

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2000	1	900	2	4	144	4	1	283	1	1	3	3	4	3
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	2	1	BONUS	4	2	6	4	1	1	3	3	3	3	3
Q.No.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	125	3	1	74	80	1	500	1	3	4	60	4	1	DROP
Q.No.	46	47	48	49	50	51	52	53	54	55	56				
Ans.	60	3	11	3	1	1	3	1	2	2	3				

ERROR & PRACTICAL PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	2	4	5	4	2	2	1	34	13	1	3	1	3	3
Q.No.	16	17	18	19											
Ans.	14	52	2	3											

FLUID

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	25600	4	1	4	1	25	3	1	3	3	3	6	2	2	2

GEOMETRICAL OPTICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	15	4	NTA : 3 ALLEN: 2	3	150	1	2	1	12	4	64	30	2	2
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	25	4	60	3	1	1	600	2	50	1	1	2	3	2
Q.No.	31	32	33												
Ans.	5	4	2												

GRAVITATION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	4	1	2	1	3	2	10	4	4	4	4	3	3	3
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	2	4	4	1	1	4	2	4	4	3	4	2	4	1	2
Q.No.	31	32	33	34											
Ans.	4	2	4	2											

HEAT & THERMODYNAMICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	1	4	1	400	1	2	50	3600	3	4	208	26	2
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	60	25	3	3	1	4	4	NTA : 113 ALLEN : –113	1	4	2	2	2	1	1
Q.No.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	3	1	1	4	4	4	100	3	1	17258	3	57	4	2
Q.No.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	2	4	25	3	2	4	2	4	1	1	3	3	1	4	2
Q.No.	61	62	63	64	65	66	67	68	69	70	71	72	73		
Ans.	1	1	500	1	1	1	3	480	2	3	25	500	8		

KINEMATICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	4	1	2	1	2	1	NTA : 2 ALLEN : BONUS	120	3	2	2	5	3	4
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	3	1	3	3	2	3	30	50	3	12	4	3	3	1
Q.No.	31														
Ans.	2														

MAGNETISM

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	2	2	4	3	3	3	2	1	1	2	4	2	1	2
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	22	2	3	8	1	3	4	1	543	3	2	3	1	1	4
Q.No.	31	32	33												
Ans.	250	1	1												

MODERN PHYSICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	4	3	2	1	2	4	3	4	1	3	10	3	2	1	3
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	1	4	15	4	2	2	2	2	2	25	4	1	3	2	4
Q.No.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
Ans.	4	2	1	4	4	4	3	4	4	20	4	3	4	4	4
Q.No.	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	4	2	125	27	10	3	112	150	910	2	2	10	4	1	2
Q.No.	61	62	63	64	65	66	67	68	69	70	71				
Ans.	3	2	4	2	15	2	1	3	3	1	2				

NLM & FRICTION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	25	25	492	500	3	4	2	82	12	21	5	30	10	2	3
Q.No.	16	17	18	19	20	21	22								
Ans.	3	15	4	30	4	2	3								

PRINCIPLE OF COMMUNICATION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	25	8	3	10	4	33	9	4	2	1206	4	1	50	40	1
Q.No.	16	17	18	19	20	21	22	23	24	25	26				
Ans.	1	1	1	1	2	4	224	2	64	500	200				

ROTATIONAL MOTION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	8	BONUS	3	2	3	20	20	3	1	4	4	3	3	3
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	3	2	4	2	3	1	2	2	10	4	3	4	9	52	4
Q.No.	1	32	33	34	35										
Ans.	4	3	2	3	6										

SEMICONDUCTOS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	25	440	4	1	2	4	2	2	1	4	20	4	9	5
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	0	1	2	4	100	4	200	1	192	25	500	2	5	25	2
Q.No.	31	32	33	34	35	36	37	38	39	40	41	42	43	44	
Ans.	1	3	1	4	120	4	5	2	20	3	NTA : 3 ALLEN : 1	2	4	3	

SIMPLE HARMONIC MOTION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	3	3	4	3	4	1	3	2	3	7	4	3	2
Q.No.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Ans.	4	6	4	4	4	4	10	2	4	1	2	2	4	1	8
Q.No.	31	32	33												
Ans.	4	1	3												

UNIT & DIMENSION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	2	2	1	2	4	4	2	4	4	3	1	2	1	1	1
Q.No.	16														
Ans.	2														

VECTOR, BASIC MATHS & CALCULUS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ans.	2	2	4	4	4	3	2	2	4	1	3	1	2	4

WORK POWER ENERGY

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	5	1	2	10	6	1	1	1	2	2	450	2	4	2	2
Q.No.	16	17	18	19											
Ans.	40	2	1	16											

WAVE MOTION

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	1	8	4	2	1215	3	4	4	2	132	1	2025	1	7	1210
Q.No.	16	17													
Ans.	34	10													

WAVE OPTICS

Q.No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	3	75	1	4	4	1	2	6	2	2	2	300	30	4	600
Q.No.	16	17													
Ans.	5	1													