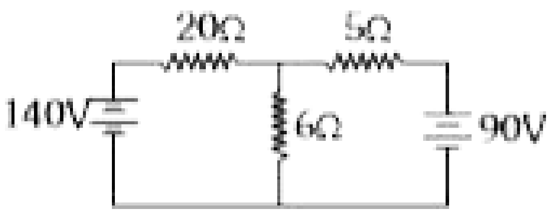
PHYSICS

BOOKS - JEE MAINS PREVIOUS YEAR

JEE MAINS 2021

PHYSICS (SECTION-A)

1. 

The value of current in the 6Ω resistance is :

A. 4A

B. 8A

C. 10A

D. 6A

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2. 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 ______ $\times 10^{3}$ $\mathrm{kg\,m/s^{2}}$.

A. 10.2

B. 7.2

C. 12.4

D. 6.96

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3. 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)

A. 1110 years

B. 700 years

C. 340 years

D. 740 years

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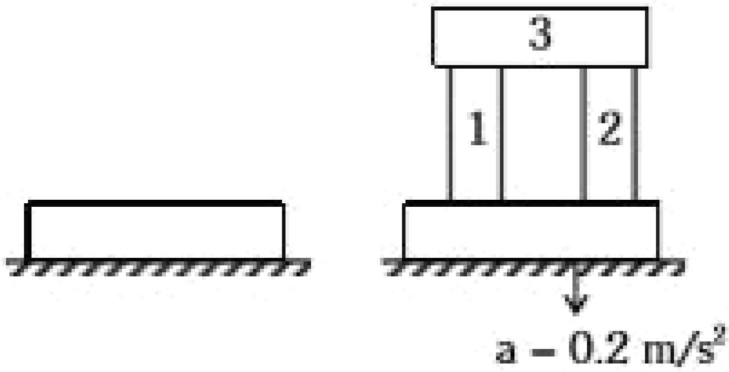
4. A steel block of 10 kg rests on a horizontal floor as shown. When three iron cylinders are placed on it as shown, the block and cylinders go down with an acceleration $0.2m/s^2$. The normal reaction R' by the floor if mass of the iron cylinders are equal and of 20 kg each, is ______ N. [Take $g = 10m / s^2$ and $\mu_s = 0.2$]



A. 716

B. 686

C. 714

D. 684

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5. AC voltage V(t) = 20 sinwt of frequency 50 Hz is applied to a parallel plate capacitor. The separation between the plates is 2 mm and the area is $1m^2$. The amplitude of the oscillating displacement current for the applied AC voltage is _____

[Take $\varepsilon_0 = 8.85 \times 10^{-12} F/m$]

A. $21.14\mu_A$

B. $83.37\mu_A$

C. $27.79\mu_A$

D. $55.58\mu_A$

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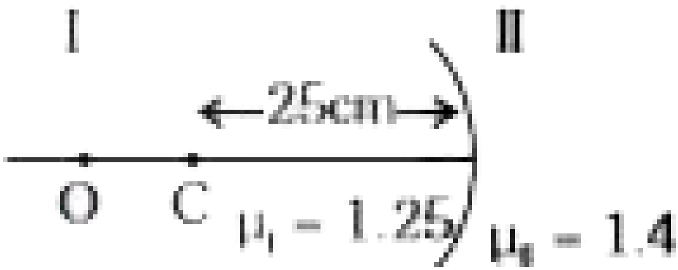
6. Region I and II are separated by a spherical surface of radius 25 cm. An object is kept in region I at a distance of 40 cm from the surface. The distance of the image from the surface is :



A. $55.44 cm$

B. $9.52 cm$

C. $18.23 cm$

D. $37.58 cm$

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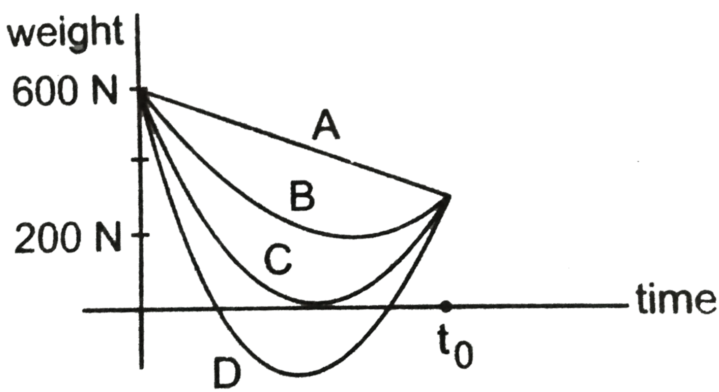
7. Suppose the acceleration due to gravity at earth's surface is $10ms^{-2}$ and at the surface of Mars it is $4.0ms^{-2}$. A passenger goes from the to the mars in a spaceship with a constant velocity. Neglect all other object in sky. Which part of figure best represent the weight (net gravitational force) of the passenger as a function of time?



A. (c)

B. (a)

C. (d)

D. (b)

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8. The amount of heat needed to raise the temperature of 4 moles of a rigid diatomic gas from $0^\circ C$ to $50^\circ C$ when no work is done is ______(R is the universal gas constant)

A. 250 R

B. 750 R

C. 175 R

D. 500 R

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9. If $\overrightarrow{A}$ and $\overrightarrow{B}$ are two vectors satisfying the relation $\overrightarrow{A}\cdot\overrightarrow{B}=\left|\overrightarrow{A}\times\overrightarrow{B}\right|$. Then the value of $\left|\overrightarrow{A}-\overrightarrow{B}\right|$ will be :

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

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

C. $\sqrt{A^2+B^2+2AB}$

D. $\sqrt{A^2 + B^2 - \sqrt{2}AB}$

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10. 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 :

A. $\frac{1}{\sqrt{2}}$

B. $\sqrt{2}$

C. 1

D. 2

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11. A nucleus of mass M emits an X-ray photon of frequency n. Energy lost by the nucleus is given as

A. hv

B. 0

C. $hv\left[1-\frac{hv}{2Mc^2}\right]$

D. $hv\left[1+\frac{hv}{2Mc^2}\right]$

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12. 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 ?

A. $Q = \frac{q}{2}$

B. $Q = 2q$

C. $Q = 4q$

D. $Q = 3q$

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13. 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 $\rho = 44 \times 10^{-8} \Omega m$)

A. $11 \times 10^{-2} V/m$

B. $11 \times 10^{-7} V/m$

C. $11 \times 10^{-5} V/m$

D. $11 \times 10^{-3} V/m$

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14. 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 :

A. $V_A = V_B = V_C = 0$

B. $\frac{1}{V_A} > \frac{1}{V_B} > \frac{1}{V_C}$

C. $V_A = V_B \neq V_C$

D. $\frac{1}{V_A} < \frac{1}{V_B} < \frac{1}{V_C}$

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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 :

A. 3 m

B. 20 m

C. $12\sqrt{2}m$

D. 15 m

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16. 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 :

A. $\frac{T_1 l_2 - T_2 l_1}{T_1 - T_2}$

B. $\frac{T_1 l_1 - T_2 l_2}{T_1 - T_2}$

C. $\frac{l_1 + l_2}{2}$

D. $\sqrt{T_1 T_2 l_1 l_2}$

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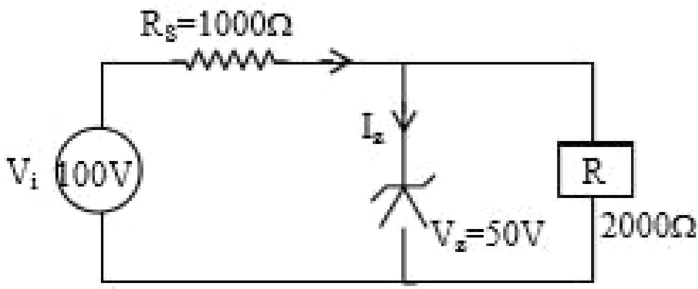
17. For the circuit shown below, calculate the value of I_z

:



A. 25 mA

B. 0.15 A

C. 0.1 A

D. 0.05 A

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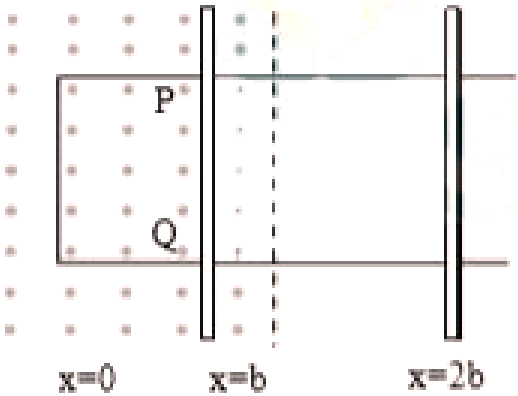
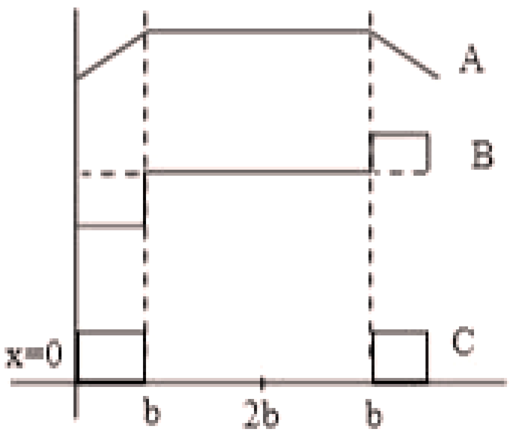
18. The arm PQ of a rectangular conductor is moving from $x = 0$ to $x = 2b$ outwards and then inwards from $x = 2b$ to $x = 0$ as shown in the figure. A uniform magnetic field perpendicular to the plane is acting from $x = 0$ to $x = b$. Identify the graph showing the variation of different quantities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





A. A-Flux, B-Power dissipated, C-EMF

B. A-Power dissipated, B-Flux, C-EMF

C. A-Flux, B-EMF, C-Power dissipated

D. A-EMF, B-Power dissipated, C-Flux

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19. The entropy of any system is given by

$$S = \alpha^2 \beta \;\; \text{In} \;\; \left[\frac{\mu k R}{J \beta^2} + 3\right]$$

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.

[Take $S = \dfrac{dQ}{T}$]

Choose the incorrect option from the following :

A. α and J have the same dimensions.

B. S, β, k and μR have the same dimensions.

C. S and α have different dimensions.

D. α and k have the same dimensions.

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20. The radiation corresponding to $3 \rightarrow 2$ 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 $= 9.1 \times 10^{-31} kg$)

A. 1.36 eV

B. 1.88 eV

C. 0.16 eV

D. 0.82 eV

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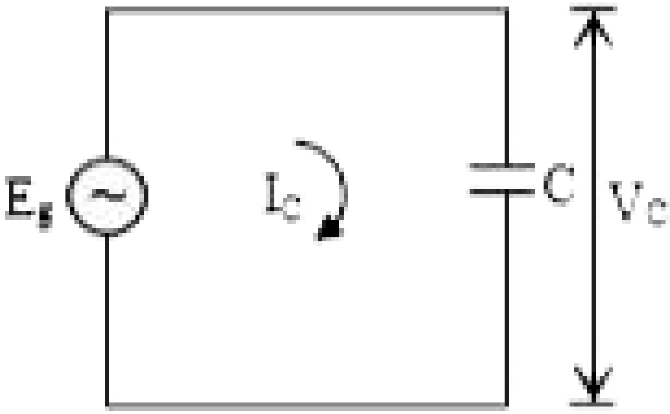
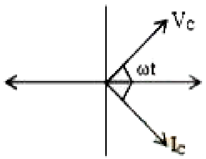
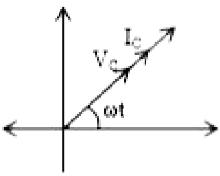
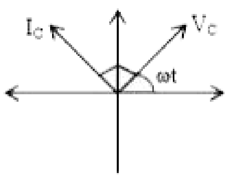
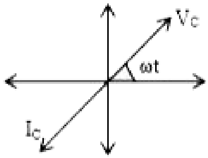
21. In a circuit consisting of a capacitance and a generator with alternating emf $E_g = E_{g_0} \sin \omega t$, V_C and I_C` are the voltage and current. Correct phasor diagram for such circuit is :



A.


B.


C.




D.

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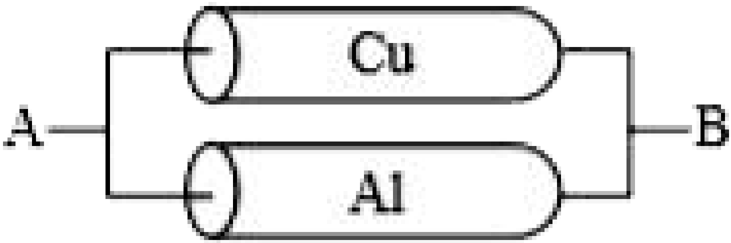
22. A Copper (Cu) rod of length 25 cm and cross sectional area $3mm^2$ is joined with a similar Aluminium (Al) rod as shown in figure. Find the resistance of the combination between the ends A and B.

(Take Resistivity of Copper $= 1.7 \times 10^{-8} \Omega m$ Resistivity of Aluminium $= 2.6 \times 10^{-8} \Omega m$)



A. $2.170 m\Omega$

B. $1.420 m\Omega$

C. $0.0858 m\Omega$

D. $0.858 m\Omega$

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23. What will be the projection of vector $\vec{A} = \hat{i} + \hat{j} + \hat{k}$ on vector $\vec{B} = \hat{i} + \hat{j}$?

A. $\sqrt{2}\left(\hat{i} + \hat{j} + \hat{k}\right)$

B. $2\left(\hat{i} + \hat{j} + \hat{k}\right)$

C. $\sqrt{2}\left(\hat{i} + \hat{j}\right)$

D. $\left(\hat{i} + \hat{j}\right)$

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24. 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 $g = 9.8ms^{-2}$)

A. $-62720.0J$

B. $-627.2J$

C. $+627.2J$

D. $784.0J$

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25. 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 :

A. T_0

B. $8\pi T_0$

C. $4T_0$

D. $\frac{1}{4}T_0$

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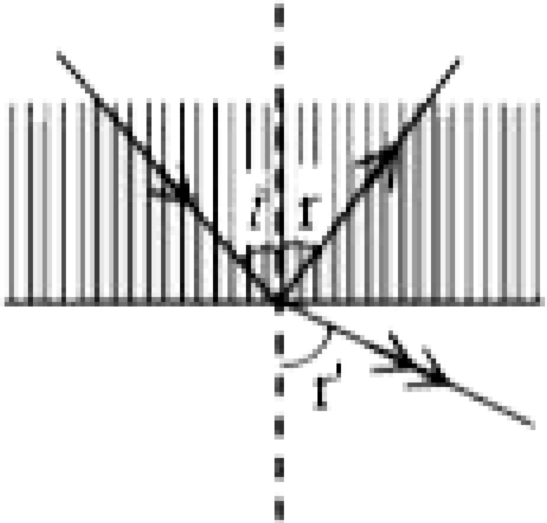
26. A ray of light passes from a denser medium to a rarer medium at an angle of incidence i. The reflected and refracted rays make an angle of 90° with each other. The angle of reflection and refraction are resepectively r and r'. The critical angle is given by :



A. $\sin^{-1}(\cot r)$

B. $\tan^{-1}(\sin i)$

C. $\sin^{-1}(\tan r')$

D. $\sin^{-1}(\tan r)$

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27. 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 :

A. Statement I is true but Statement II is false

B. Both Statement I and Statement II are true

C. Both Statement I and Statement II are false

D. Statement I is false but Statement II is true

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28. A bullet of '4g' mass is fired from a gun of mass 4 kg. If the bullet moves with the muzzle speed of $50ms^{-1}$, the impulse imparted to the gun and velocity of recoil of gun are :

A. $0.4\text{kg ms}^{-1}, 0.1ms^{-1}$

B. $0.2\text{kg ms}^{-1}, 0.05ms^{-1}$

C. $0.2\text{kg ms}^{-1}, 0.1ms^{-1}$

D. $0.4\text{kg ms}^{-1}, 0.05ms^{-1}$

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29. Choose the correct option :

A. True dip is not mathematically related to apparent dip.

B. True dip is less than apparent dip.

C. True dip is always greater than the apparent dip.

D. True dip is always equal to apparent dip.

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30. 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:-

A. The sphere has the greatest and the ring has the least velocity of the centre of mass at the bottom of the inclined plane.

B. The ring has the greatest and the cylinder has the least velocity of the centre of mass at the bottom of the inclined plane.

C. All of them will have same velocity.

D. The cylinder has the greatest and the sphere has the least velocity of the centre of mass at the bottom of the inclined plane.

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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 ≤ 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.

A. 2 eV

B. 4 eV

C. 1 eV

D. 0.5 eV

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32. 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 energy of the α particle

A. 5.0 MeV

B. 5.5 MeV

C. 0.12 MeV

D. 5.38 MeV

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33. 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 an electron to that associated with proton is

A. $\dfrac{m_p}{m_e}$

B. 1

C. $\sqrt{\dfrac{m_p}{m_e}}$

D. $\dfrac{m_e}{m_p}$

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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

A. (a) – (ii) , (b) – (i) , (c) - (iv) , (d) – (iii)

B. (a) – (ii) , (b) – (i) , (c) - (iii) , (d) – (iv)

C. (a) – (iii) , (b) – (i) , (c) - (iv) , (d) – (ii)

D. (a) – (iv) , (b) – (iii) , (c) - (ii) , (d) – (i)

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35. 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.

A. Height = 1731 m

Population Covered = 1413×10^5

B. Height = 1241 m

Population Covered = 7×10^5

C. Height = 1600 m

Population Covered = 2×10^5

D. Height = 1800 m

Population Covered = 1413×10^8

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

A. $\frac{2}{3}k_BT$

B. k_BT

C. $\frac{3}{2}k_BT$

D. $\frac{1}{2}k_BT$

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37. 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 ?

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

A. $2.77 \times 10^{-8} T$

B. $1.96 \times 10^{-8} T$

C. $8.31 T$

D. $5.88 T$

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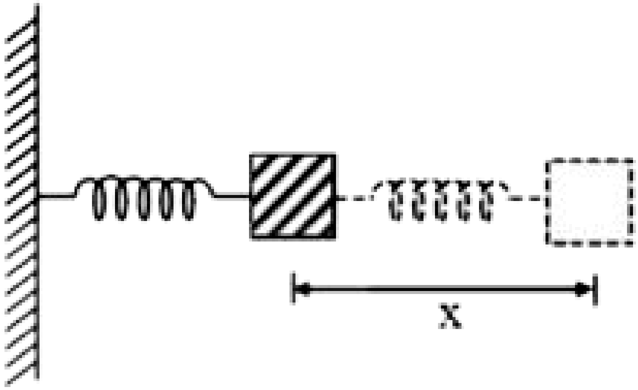
38. The motion of a mass on a spring, with spring constant K is as shown in figure



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 :

A. $C = \sqrt{\frac{2v(0)^2}{\omega^2} + x(0)^2}, \phi = \tan^{-1}\left(\frac{v(0)}{x(0)(\omega)}\right)$

B. $C=\sqrt{\frac{2v(0)^2}{\omega^2}+x(0)^2}, \phi=\tan^{-1}\left(\frac{x(0)\omega}{2v(0)}\right)$

C. $C=\sqrt{\frac{v(0)^2}{\omega^2}+x(0)^2}, \phi=\tan^{-1}\left(\frac{x(0)\omega}{v(0)}\right)$

D. $C=\sqrt{\frac{v(0)^2}{\omega^2}+x(0)^2}, \phi=\tan^{-1}\left(\frac{v(0)}{x(0)\omega}\right)$

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39. 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.

A. $815.1nC$

B. $8.8\mu C$

C. $0.485mC$

D. $4.44\mu C$

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40. A body is projected vertically upward from the surface of earth with a velocity sufficient to carry it to initially. Calculate the time taken by it to reach height h.

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

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

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

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

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41. 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)

A. $2mv^3$

B. $2mnv^3$

C. $2n^3$

D. $2n^2v^3$

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42. 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.

A. $\frac{1}{2}$

B. $\frac{3}{4}$

C. $\frac{1}{3}$

D. $\frac{1}{4}$

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43. A force $\overrightarrow{F} = \left(40\hat{i} + 10\hat{j}\right)$ N acts on body of mass 5 kg. If the body starts from rest, its position vector $\overrightarrow{r}$ at time t = 10 s, will be

A. $\left(100\hat{i} + 400\hat{j}\right)m$

B. $\left(100\hat{i} + 100\hat{j}\right)$ m

C. $\left(400\hat{i} + 100\hat{j}\right)m$

D. $\left(400\hat{i} + 400\hat{j}\right)m$

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44. 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

A. $2\cos^{-1}\left(\frac{\mu}{2}\right)$

B. $\sin^{-1}\left(\frac{\mu}{2}\right)$

C. $\sin^{-1}\left(\sqrt{\frac{\mu-1}{2}}\right)$

D. $\cos^{-1}\left(\frac{\mu}{2}\right)$

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45. An engine has an efficiency of $\frac{1}{6}$. When the temperature of sink is reduced by $62^{\circ}C$, its efficiency is doubled. Temperature of the source is

A. $124^{\circ}C$

B. $37^{\circ}C$

C. $62^{\circ}C$

D. $99^{\circ}C$

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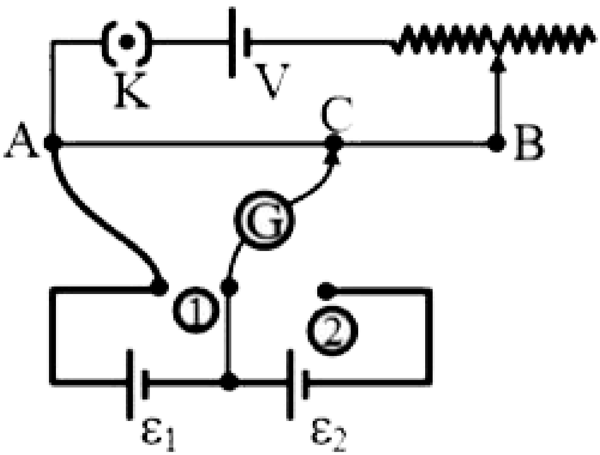
46. In the given potentiometer circuit arrangement, the balancing length AC is measured to be 250 cm. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes 400 cm. The ratio of the emf of two cells , $\frac{\varepsilon_1}{\varepsilon_2}$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



A. $\frac{5}{3}$

B. $\frac{8}{5}$

C. $\frac{4}{3}$

D. $\frac{3}{2}$

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47. Two ions having masses in the ratio $1:1$ and charges $1:2$ are projected into uniform magnetic field perpendicular to the field with speeds in th ratio $2:3$. The ratio of the radius of circular paths along which the two particles move is

A. $1:4$

B. $4:3$

C. $3:1$

D. $2:3$

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48. 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 :

A. 2.5 ms

B. 1.5 ms

C. 3.0 ms

D. 4.5 ms

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49. 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 gas $10m/s^2$)

A. 300 m

B. 200 m

C. 125 m

D. 250 m

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50. 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 :

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

B. $q_b = q_f\left(1 - \frac{1}{k}\right)$

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

D. $q_b = q_f\left(1 + \frac{1}{k}\right)$

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51. Consider a planet in some solar system which has a mass double the mass of the earth and density equal to the average density of the earth. An object weighing W on the earth will weigh

A. 2W

B. W

C. $2^{\frac{1}{3}}W$

D. $\sqrt{2}W$

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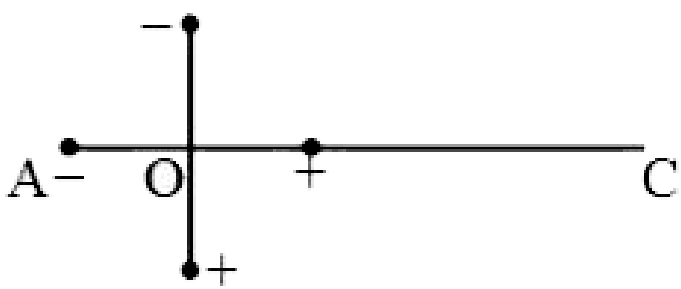
52. Two ideal electric dipoles A and B, having their dipole moment p_1 and p_2 respectively are placed on a plane with their centres at O as shown in the figure. At point C on the axis of dipole A, the resultant electric field is making an angle of 37° with the axis. The ratio of the dipole moment of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



A. $\frac{3}{8}$

B. $\frac{3}{2}$

C. $\frac{2}{3}$

D. $\frac{4}{3}$

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53. Two spherical soap bubbles of radii r_1 and r_2 in vacuume collapse under isothermal condition. The resulting bubble has radius R such that

A. $\frac{r_1 r_2}{r_1 + r_2}$

B. $\sqrt{r_1 r_2}$

C. $\sqrt{r_1^2 + r_2^2}$

D. $\dfrac{r_1 + r_2}{2}$

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54. 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 $\dfrac{AD}{B}$ is :

A. $\left[M^0 LT^{-1}\right]$

B. $\left[ML^2T^{-3}\right]$

C. $\left[M^1L^1T^{-2}\right]$

D. $\left[M^2L^2T^{-3}\right]$

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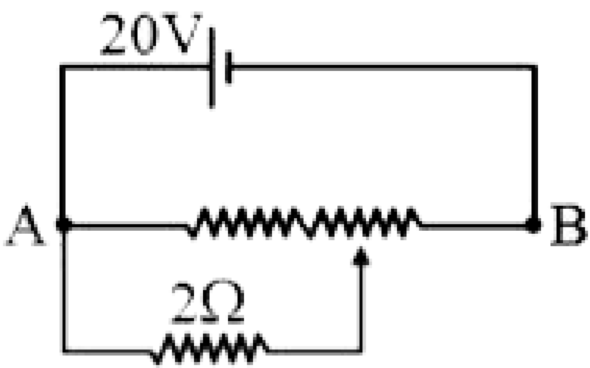
55. The given potentiometer has its wire of resistance 10Ω When the sliding contact is in the middle of the potentiometer wire, the potential drop across 2Ω resistor is :



A. $10V$

B. $5V$

C. $\frac{40}{9}V$

D. $\frac{40}{11}V$

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56. An electron with speed v and a photon with speed c have the same de-Broglic wavelength. If the kinetic energy and momentum of electron is E_e and P_e and that of photon is E_{ph} and P_{ph} respectively, then correct statement is -

A. $\frac{3c}{v}$

B. $\frac{v}{3c}$

C. $\frac{v}{2c}$

D. $\frac{2c}{v}$

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57. 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 :

A. $3\alpha + 7\beta$

B. $\frac{3}{2}\alpha+\frac{7}{3}\beta$

C. $\frac{\alpha}{2}+\frac{\beta}{3}$

D. $\frac{3}{2}\alpha+\frac{7}{2}\beta$

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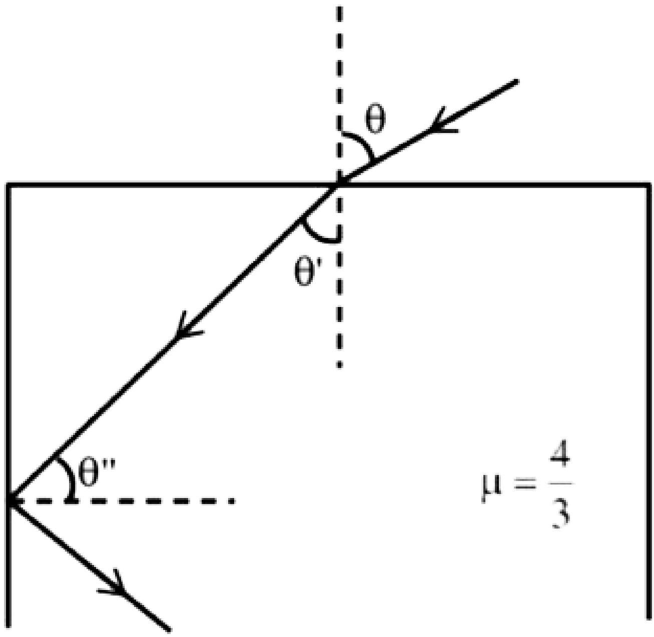
58. A ray of light entering from air into a denser medium of refractive index $\frac{4}{3}$, as shown in figure

The light ray suffers total internal reflection at the adjacent surface as shown. The maximum value of angle

θ should be equal to :



A. $\sin^{-1}\frac{\sqrt{7}}{3}$

B. $\sin^{-1}\frac{\sqrt{5}}{4}$

C. $\sin^{-1}\frac{\sqrt{7}}{4}$

D. $\sin^{-1}\frac{\sqrt{5}}{3}$

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59. When radiation of wavelength λ is incident on a metallic surface , the stopping potential is 4.8volts . If the same surface is illuminated with radiation of double the wavelength , then the stopping potential becomes 1.6volts. Then the threshold wavelength for the surface is

A. 2λ

B. 4λ

C. 8λ

D. 6λ

60. Two vectors $\overrightarrow{A}$ and $\overrightarrow{B}$ have equal magnitudes . If magntiude of $\overrightarrow{A}+\overrightarrow{B}$ is equal to (n) times the magnitude of $\overrightarrow{A}-\overrightarrow{B}$, then angle between $\overrightarrow{A}$ and $\overrightarrow{B}$ is

.

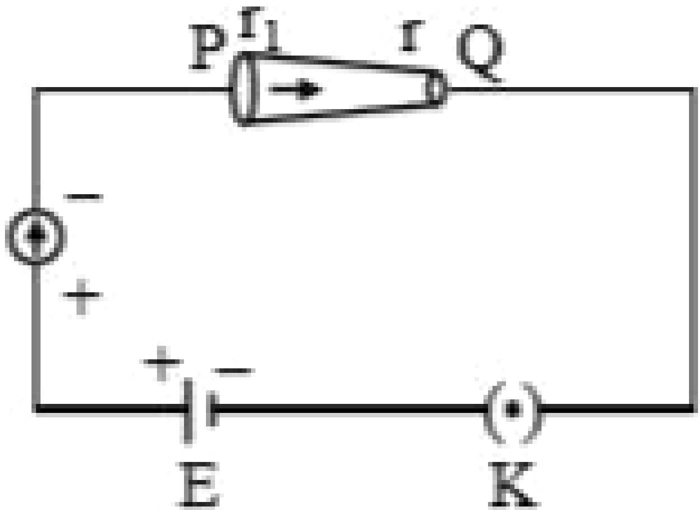
A. $\cos^{-1}\left(\dfrac{-n^2-1}{n^2-1}\right)$

B. $\cos^{-1}\left(\dfrac{n^2-1}{-n^2-1}\right)$

C. $\cos^{-1}\left(\dfrac{n^2+1}{-n^2+1}\right)$

D. $\cos^{-1}\left(\dfrac{n^2+1}{n^2-1}\right)$

61. 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 :

A. Drift velocity of electron increases.

B. Electric field decreases.

C. Electron current decreases.

D. All of these

Answer: A

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62. 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 :

A. 0.75×10^{11}

B. 3×10^{11}

C. 1.5×10^{11}

D. 6×10^{11}

Answer: C

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63. The relative permittivity of distilled water is 81. The velocity of light in it will be :

(Given $\mu_r = 1$)

A. $4.33 \times 10^7 m/s$

B. $2.33 \times 10^7 m/s$

C. $3.33 \times 10^7 m/s$

D. $5.33 \times 10^7 m/s$

Answer: C

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64.

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 :

A. $(a)-(ii), (b)-(iii), (c)-(i), (d)-(iv)$

B. $(a)-(ii)$, $(b)-(i)$, $(c)-(iii)$, $(d)-(iv)$

C. $(a)-(iii)$, $(b)-(iv)$, $(c)-(ii)$, $(d)-(i)$

D. $(a)-(iii)$, $(b)-(iv)$, $(c)-(i)$, $(d)-(ii)$

Answer: C

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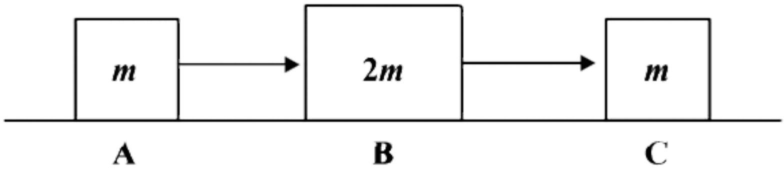
65. There object A, B and C are kept is a straing line a fritionlas horizental surface . These have masses have increase on $2m$ and m repectively . The object A move toward B with a speed 9 m//s and makes as electic collision with a there after B makes complately inclesis with C . All motion over on the same strength line . Find the first speed of the object C



A. $6m/s$

B. $9m/s$

C. $4m/s$

D. $3m/s$

Answer: D

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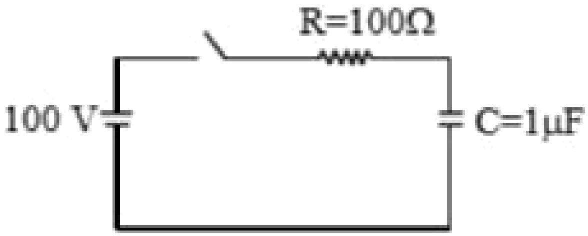
66.



A capacitor of capacitance C=1 μF is suddenly connected to a battery of 100 volt through a resistance $R = 100\Omega$. The time taken for the capacitor to be charged to get 50 V is :

[Take ln 2 = 0.69]

A. $1.44 \times 10^{-4} s$

B. $3.33 \times 10^{-4} s$

C. $0.69 \times 10^{-4} s$

D. $0.30 \times 10^{-4} s$

Answer: C

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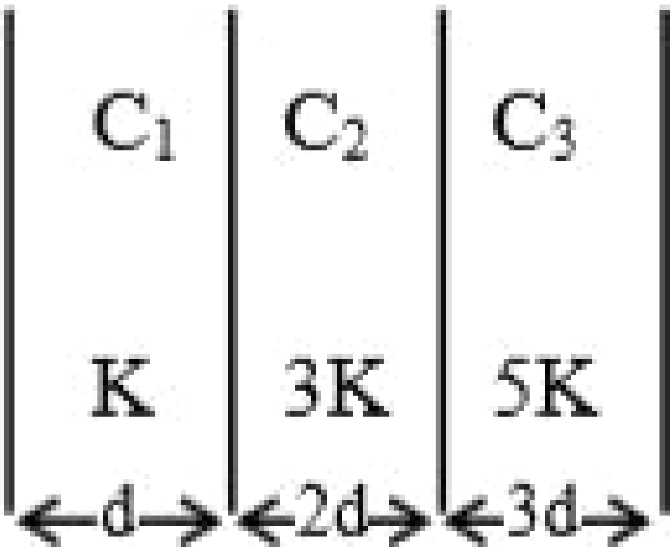
67. In the reported figure, a capacitor is formed by placing a compound dielectric between the plates of parallel plate capacitor. The expression for the capacity of the said capacitor will be :

(Given area of plate = A)



A. $\frac{15}{34}\frac{K\varepsilon_0 A}{d}$

B. $\frac{15}{6}\frac{K\varepsilon_0 A}{d}$

C. $\frac{25}{6}\frac{K\varepsilon_0 A}{6}$

D. $\frac{9}{6}\frac{K\varepsilon_0 A}{d}$

Answer: A

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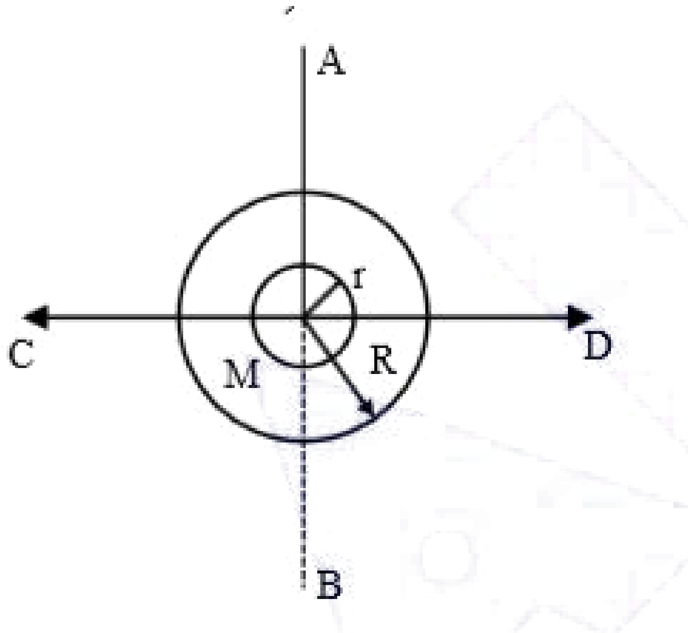
68. The figure shows two solid discs with radius R and r respectively. If mass per unit area is same for both, what is the ratio of MI of bigger disc around axis AB (Which is $\perp$ to the plane of the disc and passing through its centre) of MI of smaller disc around one of its diameters lying on its plane? Given 'M' is the mass of the larger disc. (MI stands for moment of inertia)



A. $R^2 : r^2$

B. $2r^4 : R^4$

C. $2R^2 : r^2$

D. $2R^4 : r^4$

Answer: D

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69. In Young's double slit experiment, if the source of light changes from orange to blue then :

A. the central bright fringe will become a dark fringe.

B. the distance between consecutive fringes will decrease.

C. the distance between consecutive fringes will increase.

D. the intensity of the minima will increase

Answer: B

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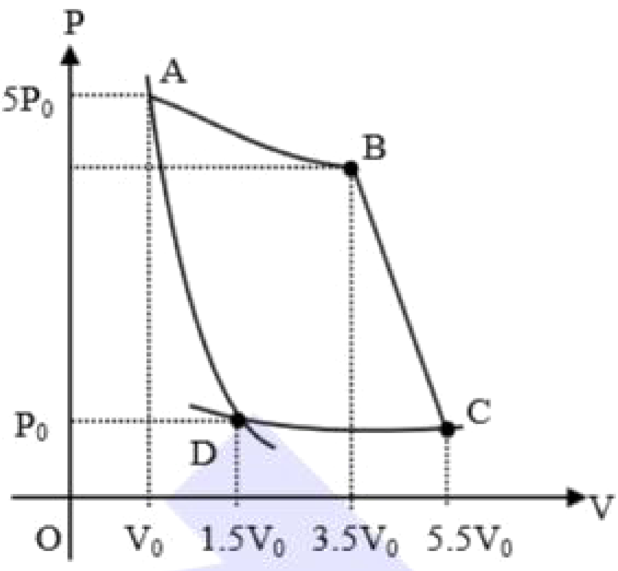
70. In the reported figure, there is a cyclic process ABCDA on a sample of 1 mol of a diatomic gas. The temperature of the gas during the process $A \rightarrow B$ and $C \rightarrow D$ are T_1 and $T_2 (T_1 > T_2)$ respectively.



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

A. $W_{AB} = W_{DC}$

B. $W_{AD} = W_{BC}$

C. $W_{BC} + W_{DA} > 0$

D. $W_{AB} > W_{CD}$

Answer: B

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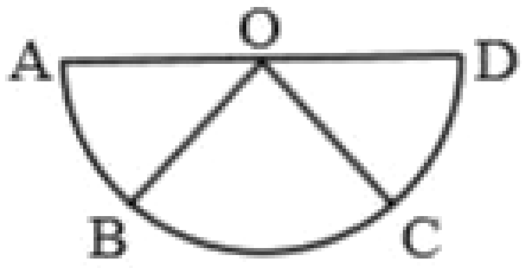
71. Assertion A : If A, B, C, D are four points on a semi-circular arc with centre at 'O' such that

$\left|\overrightarrow{AB}\right| = \left|\overrightarrow{BC}\right| = \left|\overrightarrow{CD}\right|$, 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 :

A. A is correct but R is not correct.

B. A is not correct but R is correct.

C. Both A and R are correct and R is the correct explanation of A.

D. Both A and R are correct but R is not the correct explanation of A.

Answer: D

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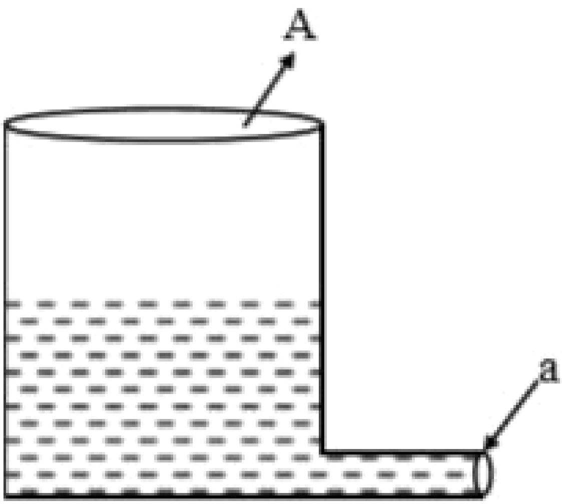
72. A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of crosssectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the emerging liquid is

$(a < < A)$:



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73. A particle starts simple harmonic motion from the mean position. Its amplitude is a and total energy E . At one instant its kinetic energy is 3E/4 . Its displacement at that instant is

A. $y = a$

B. $y = \frac{a}{\sqrt{2}}$

C. $y = \frac{a\sqrt{3}}{2}$

D. $y = \frac{a}{2}$

Answer: D

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74. 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]

A. $-\lambda\left(1-e^{-\lambda t}\right)$

B. $\lambda\left(1-e^{-\lambda t}\right)$

C. $\lambda e^{-\lambda t}$

D. $-\lambda e^{-\lambda t}$

Answer: C

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75. Two parallel plate capacitors of capacitances C and 2C are connected in parallel and charged to a potential difference V. The battery is then disconnected and the region between the plates of the capacitor C is completely filled with a material of dielectric constant K.

The potential differences across the capacitors now becomes..........

A. $\frac{V}{K+2}$

B. $\frac{V}{K}$

C. $\frac{3V}{K+2}$

D. $\frac{3V}{K}$

Answer: C

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76. 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.

A. $\frac{\sqrt{2}-1}{\sqrt{2}+1}$

B. $\frac{1}{3}$

C. $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$

D. $\frac{\sqrt{3}-1}{\sqrt{3}+1}$

Answer: C

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77. A 0.07 H inductor and a 12Ω 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 $\frac{22}{7}$]

A. $8.8A$ and $\tan^{-1}\left(\frac{11}{6}\right)$

B. $88A$ and $\tan^{-1}\left(\frac{11}{6}\right)$

C. $0.88A$ and $\tan^{-1}\left(\frac{11}{6}\right)$

D. $8.8A$ and $\tan^{-1}\left(\frac{6}{11}\right)$

Answer: A

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78. 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 $'\theta'$ with the vertical ?

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

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

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

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

Answer: B

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79. 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

$$= \frac{\text{Pitch}}{\text{Total divisionson circular scale}}$$

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

A. A is not correct but R is correct.

B. Both A and R are correct and R is the correct explanation of A.

C. A is correct but R is not correct.

D. Both A and R are correct and R is NOT the correct explanation of A.

Answer: A

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80. A body in laboratory takes 4 minutes to cool from 61 $^{\circ}C$ to 59 $^{\circ}C$. If the laboratory temperature is 30° C, then the time taken by it to cool from 51 $^{\circ}C$ to 49 $^{\circ}C$ will be

A. 4 min

B. 3 min

C. 8 min

D. 6 min

Answer: D

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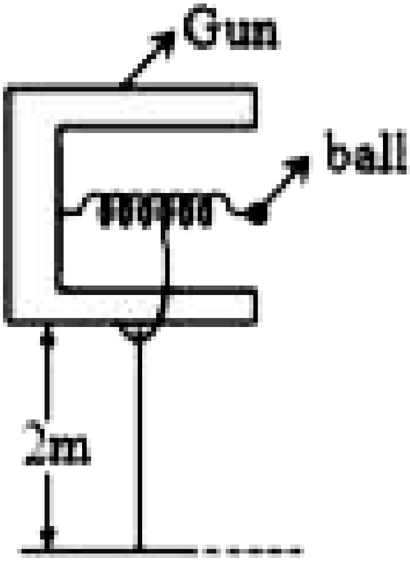
PHYSICS (SECTION-B)

1. 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. $\left(g = 10 \ \ \mathrm{m/s^2}\right)$



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2. In an LCR series circuit, an inductor 30 mH and a resistor 1Ω 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____

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3. 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 metres. The shape of wave does not change during the propagation. The velocity of the wave will be ____m/s.

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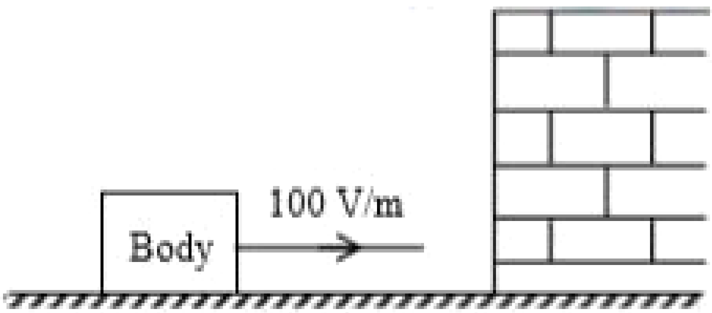
4. A body having specific charge $8\mu C / g$ is resting on a frictionless plane at a distance 10 cm from the wall (as shown in the figure). It starts moving towards the wall when a uniform electric field of 100 V/m is applied horizontally towards the wall. If the collision of the body with the wall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



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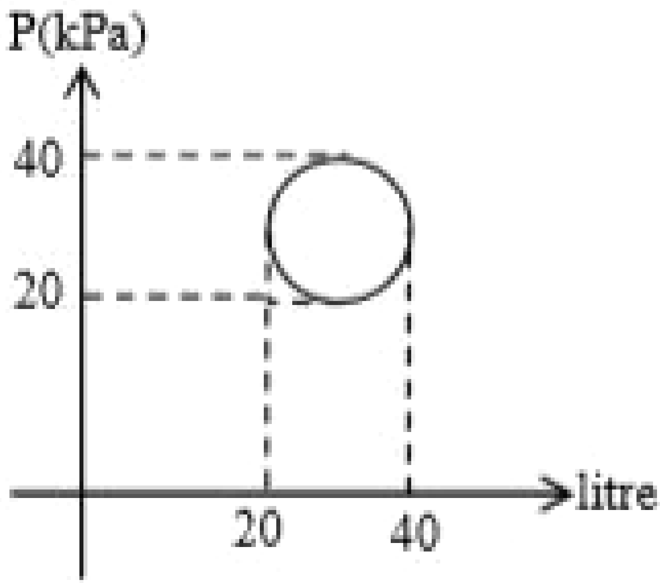
5. In the reported figure, heat energy absorbed by a system in going through a cyclic process is____πJ.



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6. 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____.

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7. 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_____.

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8. 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.

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9. 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.

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10. A carrier wave $V_c(t) = 160\sin\left(2\pi \times 10^6 t\right)$ volts is made to vary between $V_{\max} = 200V$ and $V_{\min} = 120V$ by a message signal $V_m(t) = A_m \sin\left(2\pi \times 10^3 t\right)$ volts. The peak voltage A_m of the modulating signal is_____.

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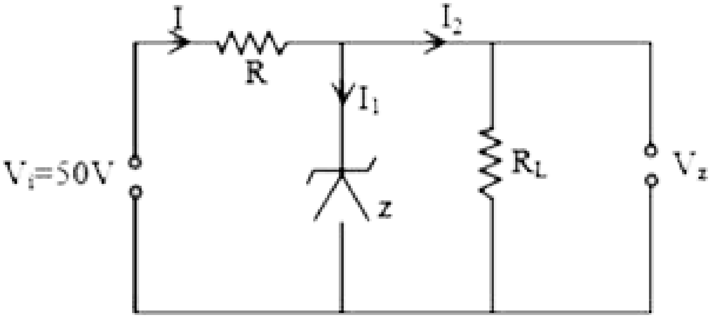
11. In a given circuit diagram, a 5 V zener diode along with a series resistance is connected across a 50 V power supply. The minimum value of the resistance required, if the maximum zener current is 90 mA will be ___ Ω.



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12. 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 itsends as x-axis is given by $\left(0, \frac{xR}{\pi}\right)$. Then the value of |x| is _____.

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13. In an electric circuit, a call of certain emf provides a potential difference of 1.25 V across a load resistance of 5Ω 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 ____.

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

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15. Three particce 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 $\vec{C}$. Theangle between the direction of motion of P and Q is $\cos^{-1}\left(\frac{1}{\sqrt{x}}\right)$ .Then the value of x is ____.

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16. 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 ______ .

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17. 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)

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18. The area of cross-section of a railway track is $0.01m^2$. The temperature variation is $10^\circ C$. Coefficient of linear expansion of material of track is $10^{-5} / ^\circ C$. The energy stored per meter in the track is ______ J/m.

(Young's modulus of material of track is $10^{11} Nm^{-2}$)

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19. 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.____.

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20. In 5 minutes, a body cools from $75^{\circ} C$ to $65^{\circ} C$ at room temperature of $25^{\circ} C$. The temperature of body at the end of next 5 minutes is ______ $^{\circ} C$.

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21. A system consists of two types of gas molecules A and B having same number density $2 \times 10^{25} / m^3$.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 ________ $\times 10^{-2}$

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22. 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 $hc = 20 \times 10^{-26}$ J-m , mass of electron $= 9 \times 10^{-31}$ kg

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23. 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 :

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

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25. 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.

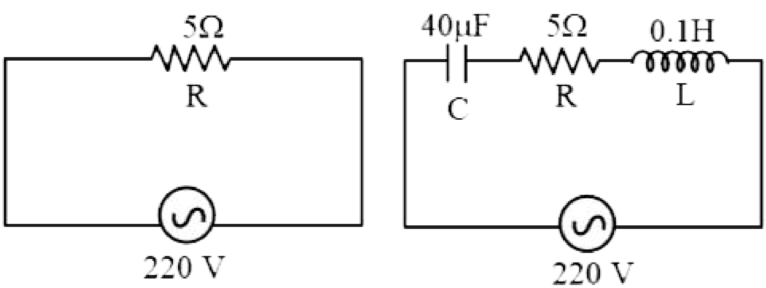

figure (a) figure (b)

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26. 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)

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27. A force of $F = (5y + 20)\hat{j}$ N 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.

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28. 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.

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29. In a semiconductor, the number density of intrinsic charge carriers at $27^{\circ} C$ is $1.5 \times 10^{16} / m^{3}$. If the semiconductor is doped with impurity atom, the hole density increase to $4.5 \times 10^{22} / m^{3}$. The electron density in the doped semiconductor is ________ $\times 10^{9} / m^{3}$.

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30. 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.

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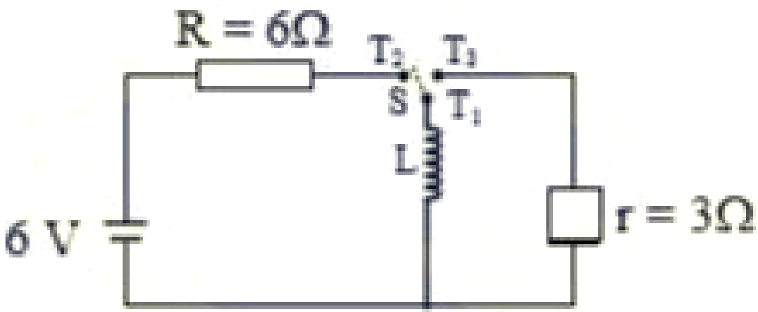
31. Consider an electrical circuit containing a two way switch 'S'. Initially S is open and then T_1 is connected to T_2. As the current in $R = 6\Omega$ attains a maximum value of steady state level, T_1 is disconnected from T_2 and immediately connected to T_3. Potential drop across $r = 3\Omega$ resistor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



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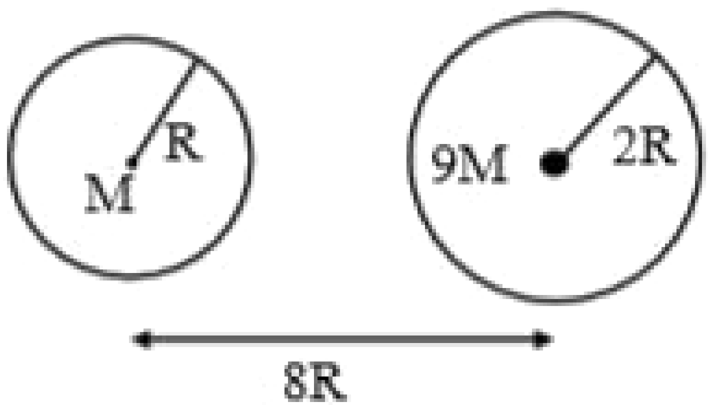
32. Suppose two planets (spherical in shape) of radii R and 2R, but mass M and 9 M respectively have a centre to centre separation 8 R as shown in the figure. A satellite of mass 'm' is projected from the surface of the planet of mass 'M' directly towards the centre of the second planet. The minimum 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]



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33. 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 $\frac{22}{7}$]

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34. 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.

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35. 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.

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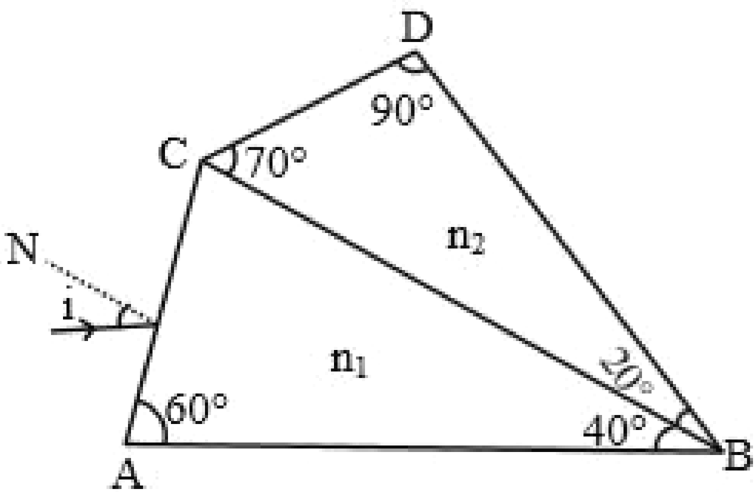
36. A prism of refractive index n_1 and another prism of refractive index n_2 are stuck together (as shown in the figure). n_1 and n_2 depend on λ, the wavelength of light, according to the relation

$$n_1 = 1.2 + \frac{10.8 \times 10^{-14}}{\lambda^2} \text{ and } n_2 = 1.45 + \frac{1.8 \times 10^{-14}}{\lambda^2}$$

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



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37. 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 $= 0.5 \times 10^9 N / m^2$)

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38. 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)

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39. 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 __________.

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40. In a uniform magnetic field, the magnetic needle has a magnetic moment $9.85 \times 10^{-2} A / m^2$ and moment of inertia $5 \times 10^{-6} \text{kg m}^2$. If it performs 10 complete oscillations in 5 seconds then the magnitude of the magnetic field is _______ mT.

[Take π^2 as 9.85]

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PHYSICS (SECTION - A)

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

A. $T_P = T_Q$

B. $T_P < T_Q$

C. $T_P = 0.9 T_Q$

D. $T_P > T_Q$

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2. 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 :

A. Both A and R are correct but R is NOT the correct explanation of A.

B. A is not correct but R is correct.

C. A is correct but R is not correct.

D. Both A and R are correct and R is the correct explanation of A.

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3. What should be the order of arrangement of de-Broglie wavelength of electron (λ_e), an $\alpha-$ particle (λ_α) and proton (λ_p) given that all have the same kinetic energy ?

A. $\lambda_e = \lambda_p = \lambda_\alpha$

B. $\lambda_e < \lambda_p < \lambda_\alpha$

C. $\lambda_e > \lambda_p > \lambda_\alpha$

D. $\lambda_e = \lambda_p > \lambda_\alpha$

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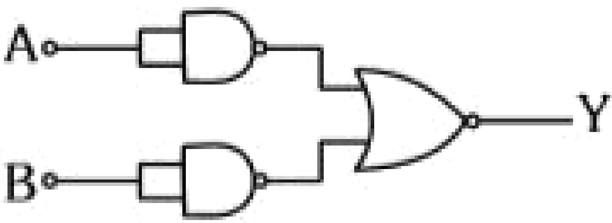
4. Identify the logic operation carried out.



A. OR

B. AND

C. NOR

D. NAND

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5. A particle of mass 4m at rest decays into two particles of masses m and 3m having non-zero velocities. The ratio of the de Broglie wavelengths of the particles 1 and 2 is

A. $1:3$

B. $3:1$

C. $1:\sqrt{3}$

D. $1:1$

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6. 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)

A. $\frac{1}{2}\frac{ln2}{\lambda}$

B. $\frac{\ln 2}{\lambda}$

C. $\frac{2\ln 2}{\lambda}$

D. $\frac{\ln\frac{3}{2}}{\lambda}$

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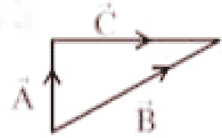
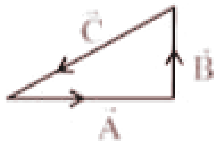
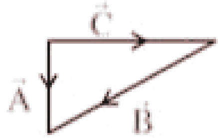
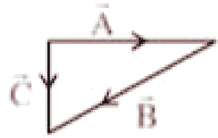
7. Match List I with List II.

	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 :

A. (a) $\rightarrow$ (iv), (b) $\rightarrow$ (i), (c) $\rightarrow$ (iii), (d) $\rightarrow$ (ii)

B. (a) $\rightarrow$ (iv), (b) $\rightarrow$ (iii), (c) $\rightarrow$ (i), (d) $\rightarrow$ (ii)

C. (a) $\rightarrow$ (iii), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (i)

D. (a) $\rightarrow$ (i), (b) $\rightarrow$ (iv), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (iii)

Answer: B

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8. 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 : $\varepsilon(x) = \varepsilon_0 + kx,$ for $\left(0 < x \leq \frac{d}{2}\right)$

$\varepsilon(x) = e_0 + k(d - x)$, for $\left(\frac{d}{2} \leq x \leq d\right)$

A. $\left(\varepsilon_0 + \frac{\mathrm{kd}}{2}\right)^{2/\mathrm{kA}}$

B. $\frac{\mathrm{kA}}{2\ln\left(\frac{2\varepsilon_0 + \mathrm{kd}}{2\varepsilon_0}\right)}$

C. 0

D. $\frac{\mathrm{kA}}{2}\ln\left(\frac{2\varepsilon_0}{2\varepsilon_0 - \mathrm{kd}}\right)$

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9. A monoatomic ideal gas, initially at temperature T_1, is enclosed in a cylinder fitted with a friction less 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 length of the gas column before expansion respectively, then $\frac{T_1}{T_2}$ is given by

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

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

C. $\frac{l_2}{l_1}$

D. $\frac{l_1}{l_2}$

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10. 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

A. angle of refraction is 24.41°

B. angle of refraction is 30°

C. refraction is not possible

D. angle of refraction is 53.4°

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11. Two wires of the same length l and radius are joined end to end and loaded. If the Young's moduli of the materials of the wires are Y_1 and Y_2, the combination behaves as a single wire of Young's modulus will be

A. $Y = \frac{2Y_1Y_2}{3(Y_1 + Y_2)}$

B. $Y = \frac{2Y_1Y_2}{Y_1 + Y_2}$

C. $Y = \frac{Y_1Y_2}{2(Y_1 + Y_2)}$

D. $Y = \frac{Y_1Y_2}{Y_1 + Y_2}$

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12. 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] :

A. 2.67×10^{12}

B. 6.06×10^{18}

C. 32.36×10^{12}

D. 16.18×10^{12}

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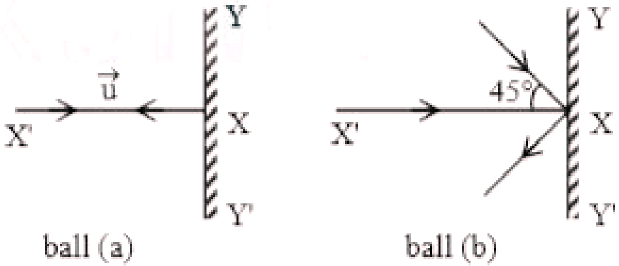
13. Two billiard balls of equal mass 30 g strike a rigid wall with same speed of 108 kmph (as shown) but at different angles. If the balls get reflected with the same speed then the ratio of the magnitude of impulses imparted to ball 'a' and ball 'b' by the wall along 'X' direction is



A. $1:1$

B. $\sqrt{2}:1$

C. $2:1$

D. $1:\sqrt{2}$

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14. 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 :

A. $\dfrac{2\lambda D(d_0)}{(d_0^2 - a_0^2)}$

B. $\dfrac{2\lambda D a_0}{(d_0^2 - a_0^2)}$

C. $\dfrac{\lambda D}{d_0^2} a_0$

D. $\dfrac{\lambda D}{d_0 + a_0}$

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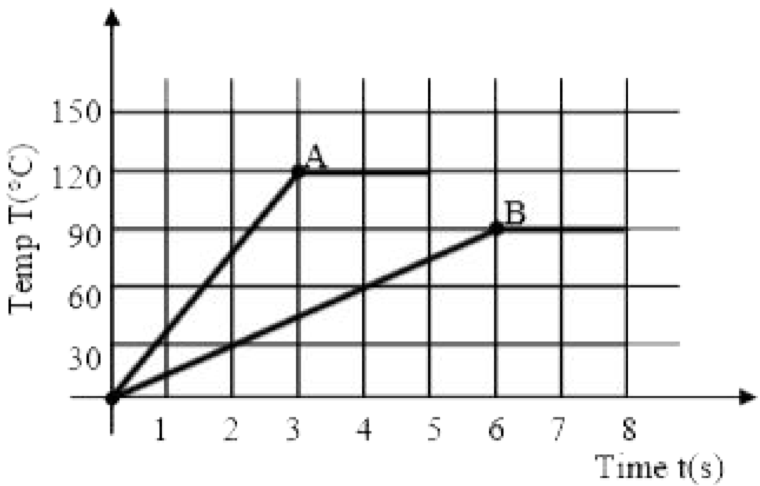
15. Two different metal bodies A and B of equal mass are heated at a uniform rate under similar conditions. The variation of temperature of the bodies is graphically represented as shown in the figure. The ratio of specific heat capacities is :



A. $\frac{8}{3}$

B. $\frac{3}{8}$

C. $\frac{3}{4}$

D. $\frac{4}{3}$

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16. A linearly polarized electromagnetic wave in vacuum is $E = 3.1 \cos\left[(1.8)z - \left(5.4 \times 10^{6}\right)t\right]\hat{i}\ \ \mathrm{N/C}$ is incident normally on a perfectly reflecting wall at z = a. Choose the correct option

A. The wavelength is 5.4 m

B. The frequency of electromagnetic wave is 54×10^{4} Hz

C. The transmitted wave will be

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

D. The reflected wave will be

$$3.1 \cos\left[(1.8)z + \left(5.4 \times 10^{6}\right)t\right]\hat{i} \ \ \mathrm{N/C}$$

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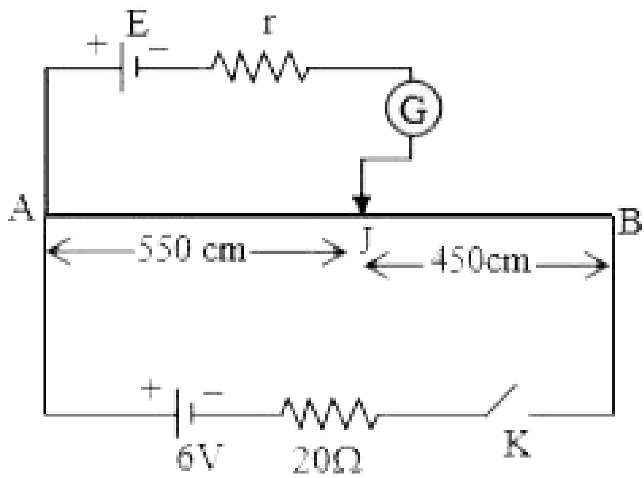
17. In the given figure, there is a circuit of potentiometer of length AB = 10 m. The resistance per unit length is 0.1Ω per cm. Across AB, a battery of emf E and internal resistance 'r' is connected. The maximum value of emf measured by this potentiometer is :



A. 5V

B. 2.25 V

C. 6 V

D. 2.75 V

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18. 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

A. 200 kHz

B. 50 kHz

C. 100 kHz

D. 0

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19. 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 $g = 9.8 \text{ m/s}^2$)

A. 3 drops / 2 seconds

B. 2 drops / second

C. 1 drop / second

D. 1 drop / 7 seconds

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20. 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 :

A. $\frac{v_0 x_1^2}{x_2^2}$

B. $\frac{v_0 x_2^2}{x_1^2}$

C. $\frac{v_0 x_1}{x_2}$

D. $\frac{v_0 x_2}{x_1}$

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21. 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 4000Å What is the maximum kinetic energy of the emitted photoelectron?

A. 7.61 eV

B. 1.41 eV

C. 3.3 eV

D. No photoelectron would be emitted

Answer: B

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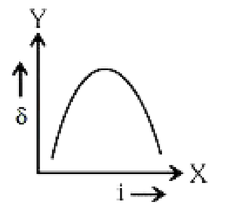
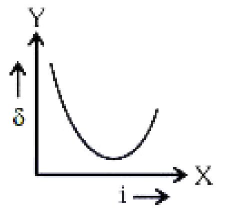
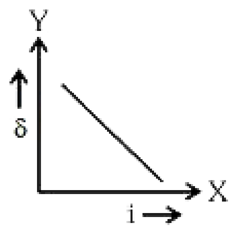
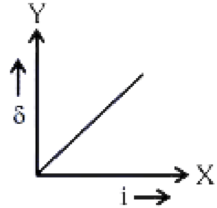
22. The expected graphical representation of the variation of angle of deviation $'\delta'$ with angle of incidence 'i' in a prism is :

A. 

B. 

C. 

D. 

Answer: B

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23. Calculate the terminal velocity of a water drop of radius 0.002 mm falling in air. Density of air $= 1.3 \text{ kg/m}^3$.

Density of water $= 10^3 \text{kg/m}^3$. Coefficient of viscosity of air is 1.7×10^{-5} decapoise.

A. 250.6 ms^{-1}

B. $43.56 \quad ms^{-1}$

C. $4.94 \quad ms^{-1}$

D. $14.4 \quad ms^{-1}$

Answer: C

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24. One mole of an ideal gas is taken through an adiabatic process where the temperature rises from $27^\circ C$ to $37^\circ C$. If the ideal gas is composed of polyatomic molecule that has 4 vibrational modes, which of the following is true ?

$\left[R = 8.314 \text{ J mol}^{-1} k^{-1}\right]$

A. work done by the gas is close to 332 J

B. work done on the gas is close to 582 J

C. Work done by the gas is close to 582 J

D. work done on the gas close to 332 J

Answer: B

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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.

A. $0.62J$

B. $6.2 \times 10^{-3}J$

C. $1.2 \times 10^{3}J$

D. $6.2 \times 10^{3}J$

Answer: A

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26. Match List I with List II.

List-I	List-II
(a) Capacitance, C	(i) $M^{1}L^{1}T^{-3}A^{-1}$
(b) Permittivity of free space, ε_0	(ii) $M^{-1}L^{-3}T^{4}A^{2}$
(c) Permeability of free space, μ_0	(iii) $M^{-1}L^{-2}T^{4}A^{2}$
(d) Electric field, E	(iv) $M^{1}L^{1}T^{-2}A^{-2}$

Choose the correct answer from the options given below

A. (a) $\rightarrow$ (iii), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (i)

B. (a) $\rightarrow$ (iii), (b) $\rightarrow$ (iv), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (i)

C. (a) $\rightarrow$ (iv), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iii), (d) $\rightarrow$ (i)

D. (a) $\rightarrow$ (iv), (b) $\rightarrow$ (iii), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (i)

Answer: A

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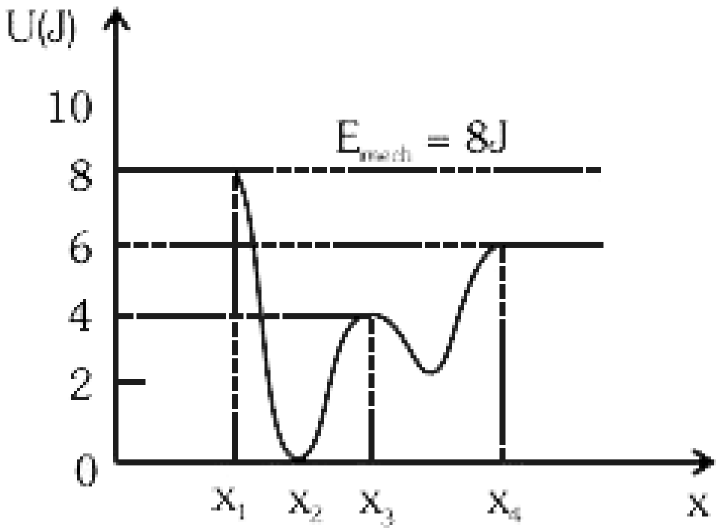
27. Given below is the plot of a potential energy function U(x) for a system, in which a particle is in one dimensional motion, while a conservative force F(x) acts on it. Suppose tha $E_{\text{mech}} = 8$ J, the incorrect statement for this system is :



[where K.E. = kinetic energy]

A. at $x > x_4$, K.E. is constant throughout the region.

B. at $x < x_1$ K.E. is smallest and the particle is moving at the slowest speed.

C. at $x = x_2$, K.E is greatest and the particle is moving at the fastest speed.

D. at $x = x_3$, K.E. = 4 J

Answer: B

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28. A 100Ω resistance, a $0.1\mu F$ 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 the resonant frequency is 60 Hz.

A. 0.70 H

B. 70.3 mH

C. 7.03×10^{-5} H

D. 70.9 H

Answer: D

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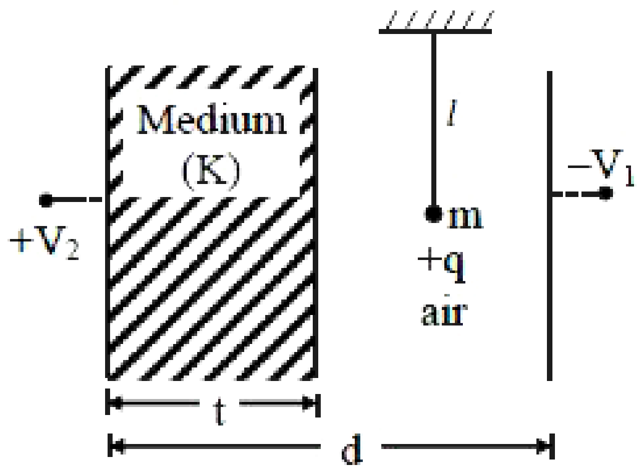
29. A simple pendulum of mass 'm', length 'l' and charge '+q' suspended in the electric field produced by two conducting parallel plates as shown. The value of deflection of pendulum in equilibrium position will be



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

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

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

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

Answer: C

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30. Two Carnot engines A and B operate in series such hat 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 :

A. $\frac{2}{3}T_1 + \frac{3}{2}T_3$

B. $\frac{1}{3}T_1 + \frac{2}{3}T_3$

C. $\frac{3}{2}T_1 + \frac{1}{3}T_3$

D. $\frac{2}{3}T_1 + \frac{1}{3}T_3$

Answer: D

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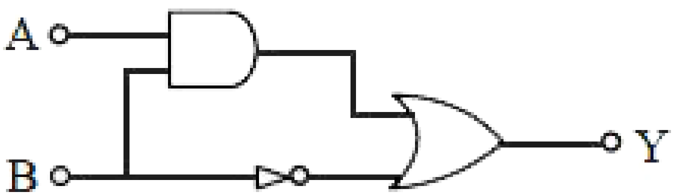
31. Find the truth table for the function Y of A and B represented in the following figure.



A.

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	0

B.

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	1

C.

A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

D.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Answer: B

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32. 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 :

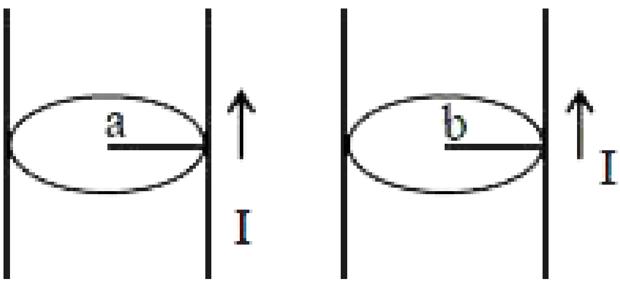
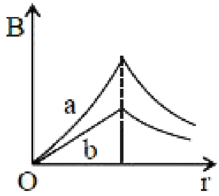
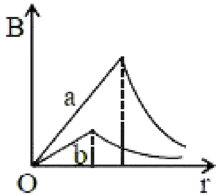
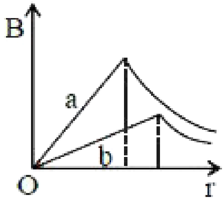
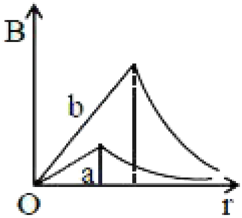


Fig. A Fig. B

A. 

B. 

C. 

D. 

Answer: C

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33. 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 :

A. $\sqrt{\frac{G}{2R^3}}$

B. $\frac{1}{2}\sqrt{\frac{G}{R^3}}$

C. $\frac{1}{2R}\sqrt{\frac{1}{G}}$

D. $\sqrt{\frac{2G}{R^3}}$

Answer: B

Watch Video Solution

34. 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 :

A. A, B, C, D and E

B. A, B and E only

C. B and D only

D. A, C and E only

Answer: B

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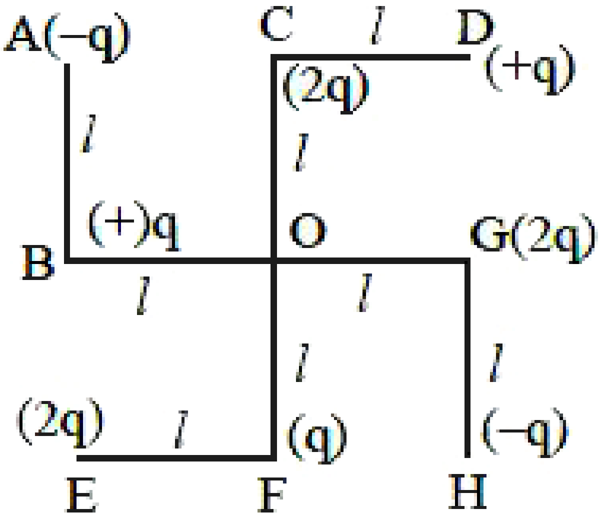
35. What will be the magnitude of electric field at point O as shown in figure ? Each side of the figure is l and perpendicular to each other ?



A. $\dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{l^2}$

B. $\dfrac{1}{4\pi\varepsilon_0}\dfrac{q}{(2l^2)}(2\sqrt{2}-1)$

C. $\dfrac{q}{4\pi\varepsilon_0(2l)^2}$

D. $\dfrac{1}{4\pi\varepsilon_0}\dfrac{2q}{2l^2}(\sqrt{2})$

Answer: B

36. A physical quantity 'y' is represented by the formula

$y = m^2 r^{-4} g^x l^{-\frac{3}{2}}$

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.

A. 5 and ± 2

B. 4 and ± 3

C. $\frac{16}{3}$ and $\pm\frac{3}{2}$

D. 8 and ± 2

Answer: C

37. 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 :

A. $\left(\frac{9P}{8m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

B. $\left(\frac{8P}{9m}\right)^{\frac{1}{2}} t^{\frac{2}{3}}$

C. $\left(\frac{9m}{8P}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

D. $\left(\frac{8P}{9m}\right)^{\frac{1}{2}} t^{\frac{3}{2}}$

Answer: D

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38. 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.

$$\left\{\text{Given } \frac{4\pi^2}{G} = 6 \times 10^{11} N^{-1} m^{-2} kg^2\right\}$$

A. 5.96×10^{19} kg

B. 3.25×10^{21} kg

C. 7.02×10^{25} kg

D. 6.00×10^{23} kg

Answer: D

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39. 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 :

A. $2F_0T\,/\,\mathrm{M}$

B. $F_0T\,/\,2\mathrm{M}$

C. $4F_0T\,/\,3\mathrm{M}$

D. $F_0T\,/\,3\mathrm{M}$

Answer: C

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40. The resistance of a conductor at $15^{\circ} C$ is 16Ω and at $100^{\circ} C$ is 20Ω. What will be the temperature coefficient of resistance of the conductor ?

A. $0.010^{\circ} C^{-1}$

B. $0.033^{\circ} C^{-1}$

C. $0.003^{\circ} C^{-1}$

D. $0.042^{\circ} C^{-1}$

Answer: C

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PHYSICS (SECTION - B)

1. 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

____

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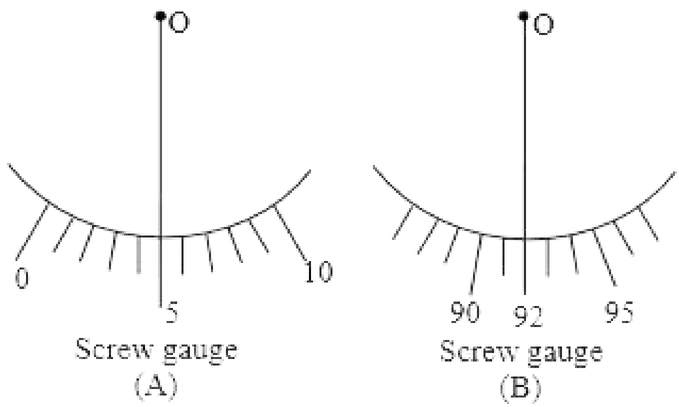
2. Student A and Student B used two screw gauges of equal pitch and 100 equal circular divisions to measure the radius of a given wire. The actual value of the radius of the wire is 0.322 cm. The absolute value of the difference between the final circular scale readings observed by the students A and B is __________

[Figure shows position of reference 'O' when jaws of screw gauge are closed]

Given pitch = 0.1 cm.



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3. An inductor of 10 mH is connected to a 20 V battery through a resistor of $10\ \text{k}\Omega$ 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 μs is $\frac{x}{100}$ mA Then x is equal to ________. (Take $e^{-1} = 0.37$)

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4. 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 $2\mu\Omega$ 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.

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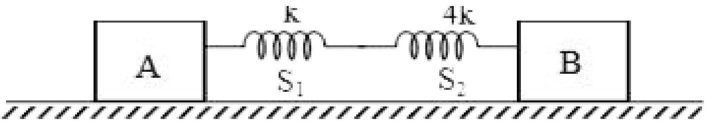
5. In the reported figure, two bodies A and B of masses 200 g and 800 g are attached with the system of springs. Springs are kept in a stretched position with some extension when the system is released. The horizontal surface is assumed to be frictionless. The angular frequency will be _________ rad/s when k = 20

N/m.



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6. 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 values of x is ________.

Watch Video Solution

7. 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' $(x < < 1 \text{ m})$. The particle executes SHM. Its angular frequency of oscillation will be ________ $\times 10^5$ rad/s if $q^2 = 10C^2$

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8. 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.

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9. A pendulum bob has a speed of $3ms^{-1}$ at its lowest position. The pendulum is 0.5 m long. The speed of the bob, when string makes an angle of 60° to the vertical is $\left(\text{take, g} = 10ms^{-1}\right)$

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10. A particle of mass 'm' is moving in time 't' on a trajectory given by

$$\overrightarrow{r} = 10\alpha t^2 \hat{i} + 5\beta(t-5)\hat{j}$$

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.

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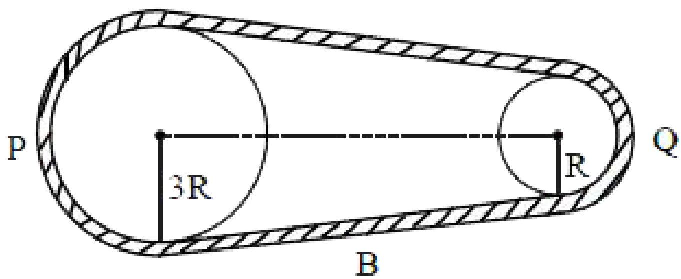
11. In the given figure, two wheels P and Q are connected by a belt B. The radius of P is three times as that of Q. In case of same rotational kinetic energy, the ratio of rotational inertias $\left(\frac{I_1}{I_2}\right)$ will be $x:1$ The value of x will be _______



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12. The wavelength of yellow light in vacuum is 6000 Å. If the absolute refractive index of air is 1.0002, then calculate the thickness of air column which will have one more wavelength of yellow light than in the same thickness of vacuum.

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13. 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 ____________

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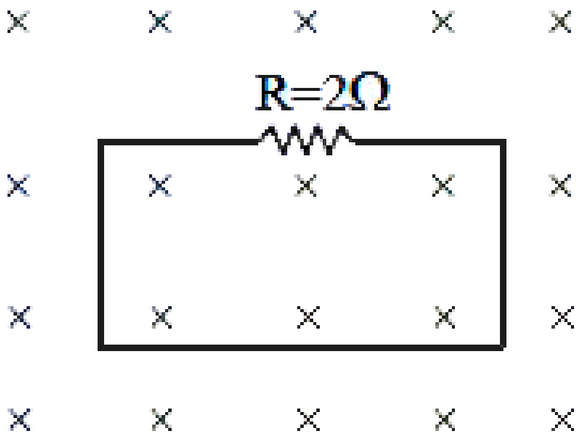
14. In the given figure the magnetic flux through the loop increases according to the relation $\phi_B(t) = 10t^2 + 20t$, where ϕ_B is in milliwebers and t is in seconds.

The magnitude of current throught $R = 2\Omega$ resistor at $t = 5$ s is ______ mA.



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15. 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 $2\omega\ \text{cm s}^{-1}$ respectively, then its amplitude is $x\sqrt{2}$ cm where the value of x is ________.

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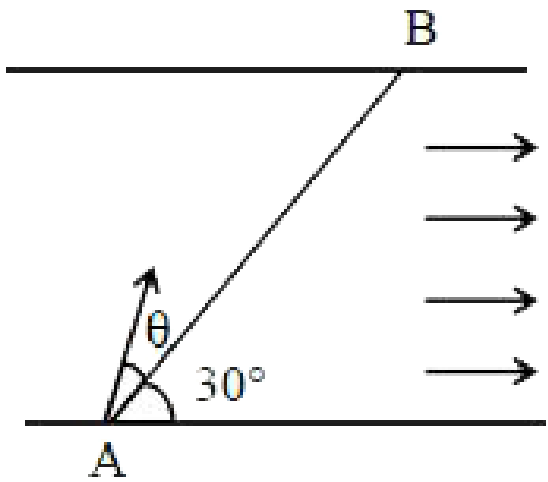
16. A swimmer wants to cross a river from point A to point B. Line AB makes an angle of 30° with the flow of river. Magnitude of velocity of the swimmer is same as that of the river. The angle θ with the line AB should be

________ $^\circ$, so that the swimmer reaches point B.



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

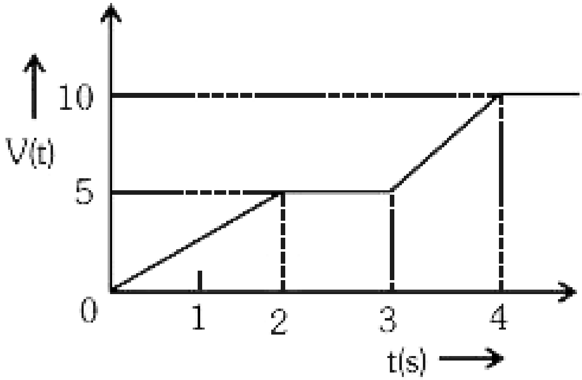

Figure 1

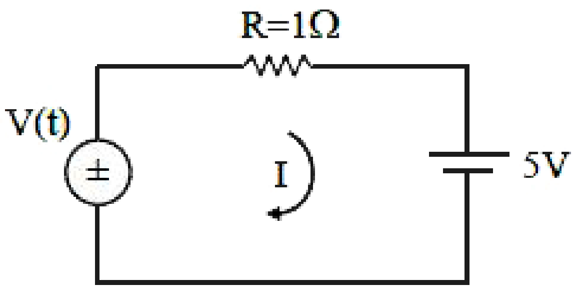

Figure-2

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

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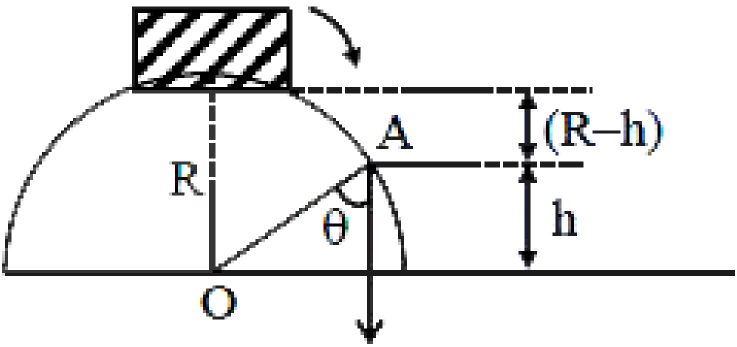
18. A small block slides down from the top of hemisphere of radius R = 3 m as shown in the figure. The height 'h' at which the block will lose contact with the surface of the sphere is ________ m.

(Assume there is no friction between the block and the hemisphere)



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19. 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)

$\left[\mathrm{h}=4.14\times 10^{-15}\ \mathrm{eVs}, c=3\times 10^{8}\ \mathrm{ms}^{-1}\right]$

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20. 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.

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PHYSICS

1. A particle is executing SHM along a straight line. Its velocities at distances x_1 and x_2 from the mean position are v_1 and v_2, respectively. Its time period is

A. $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 + v_2^2}}$

B. $T = 2\pi\sqrt{\frac{x_2^2 - x_1^2}{v_1^2 - v_2^2}}$

C. $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 + v_2^2}}$

D. $T = 2\pi\sqrt{\frac{x_2^2 + x_1^2}{v_1^2 - v_2^2}}$

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2. A system of binary stars of mass m_A and m_B are moving in circular orbits of radii r_A and r_B respectively. If T_A and T_B are at the time periods of masses m_A and m_B respectively then

A. $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$

B. $T_A > T_B(\text{if } \ r_A > r_B)$

C. $T_A = T_B$

D. $T_A > T_B(\text{if } \ m_A > m_B)$

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

A. $(\hat{k})$

B. $(-\hat{j})$

C. $(-\hat{k})$

D. $\hat{j}$

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4. If the kinetic energy of a moving body becomes four times its initial kinetic energy, then the percentage change in its momentum will be:

A. 100%

B. 200%

C. 400%

D. 300%

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5. 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. Then natural length of the wire is

A. $\dfrac{I_1 + I_2}{2}$

B. $\dfrac{I_1 T_2 - I_2 T}{T_2 - T_1}$

C. $\dfrac{I_1 T_2 + I_2 T_1}{T_2 + T_1}$

D. $\sqrt{I_1 I_2}$

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6. For a series LCR circuit with $R = 100\Omega, L = 0.5mH$ and $C = 0.1pF$ connected across 200V - 50 Hz AC supply, the phase between current and supplied voltage and the nature of the circuit is:

A. 0°, resonance circuit

B. 0°, resistive circuit

C. $\approx 90^{\circ}$, predominantly inductive circuit

D. $\approx 90^{\circ}$, predominantly capacitive circuit

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7. A satellite is launched into a circular orbit of radius 'R' around earth while a second satellite is launched into an orbit or radius 1.02 R. The percentage difference in the time periods of the two satellites is

A. 1.5

B. 3.0

C. 0.7

D. 2.0

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

A. $1 : 2^{\frac{1}{3}}$

B. $2 : 1$

C. $2^{\frac{1}{3}} : 1$

D. $1 : 2$

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9. 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:

A. $t^{\frac{3}{2}}$

B. $t^{\frac{1}{2}}$

C. $t^{\frac{3}{4}}$

D. $t^{\frac{1}{4}}$

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10. Electrons with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength of the emitted X-ray is

A. 0

B. $\dfrac{hc}{mc}$

C. $\dfrac{2m^2c^2\lambda^2}{h^2}$

D. $\dfrac{2m\lambda^2}{h}$

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11. At an angle of 30° to the magnetic meridian, the apparent dip is 45°. Find the true dip:

A. $\tan^{-1}\frac{1}{\sqrt{3}}$

B. $\tan^{-1}\sqrt{3}$

C. $\tan^{-1}\frac{2}{\sqrt{3}}$

D. $\tan^{-1}\frac{2}{\sqrt{3}}$

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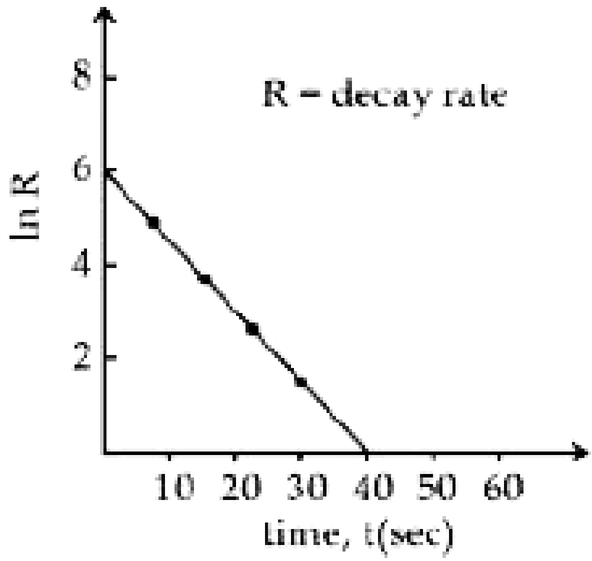
12. For a certain radioactive process the graph between In R and t(sec) is obtained as shown in the figure. The

the value of half life for the unknown radioactive material is approximately:



A. 6.93 sec

B. 4.62 sec

C. 9.15 sec

D. 2.62 sec

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13. A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time t_1. If the 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 :

A. $t_2 + t_1$

B. $t_1 + t_2$

C. $\frac{t_1 t_2}{t_2 - t_1}$

D. $\frac{t_1 t_2}{t_2 + t_1}$

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14. A body rolls down an inclined plane without slipping. The kinetic energy of rotation is 50% of its translational kinetic energy. The body is:

A. Solid sphere

B. Hollow cylinder

C. Ring

D. Solid cylinder

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15. The magnetic susceptibility of a rod is 499. The absolute permeability of vacuum is $4\pi \times 10^{-7} H/m$. The absolute permeability of the material of the rod is

A. $\pi \times 10^{-4} H/m$

B. $2\pi \times 10^{-4} H/m$

C. $3\pi \times 10^{-4} H/m$

D. $4\pi \times 10^{-4} H/m$

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

A. $f=\dfrac{2}{\gamma+1}$

B. $f=\dfrac{1}{\gamma+1}$

C. $f=\dfrac{2}{\gamma-1}$

D. $f=\dfrac{\gamma+1}{2}$

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17. 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 ?

A. 296 km/sec

B. 322 km/sec

C. 336 km/sec

D. 306 km/sec

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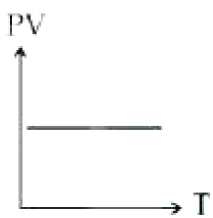
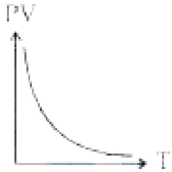
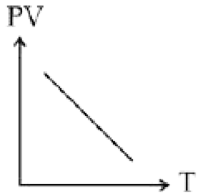
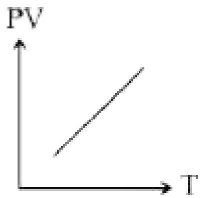
18. Which of the following graphs represent the behavior of an ideal gas? Symbols have their usual meaning.

A. 

B. 

C. 

D. 

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19. 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:

A. $\left[t^{-2}v^{-1}l^{1}\right]$

B. $\left[t^{-1}v^{1}l^{-2}\right]$

C. $\left[t^{1}v^{2}l^{-1}\right]$

D. $\left[t^{-1}v^{-2}l^{1}\right]$

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20. The vectors $\overrightarrow{P}$ and $\overrightarrow{Q}$ have equal magnitudes of $\overrightarrow{P}+\overrightarrow{Q}$ is n times the magnitude of $\overrightarrow{P}-\overrightarrow{Q}$, then angle between $\overrightarrow{P}$ and $\overrightarrow{Q}$ is:

A. $\cos^{-1}\left(\frac{n-1}{n+1}\right)$

B. $\sin^{-1}\left(\frac{n-1}{n+1}\right)$

C. $\cos^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

D. $\sin^{-1}\left(\frac{n^2-1}{n^2+1}\right)$

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21. 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 ....

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

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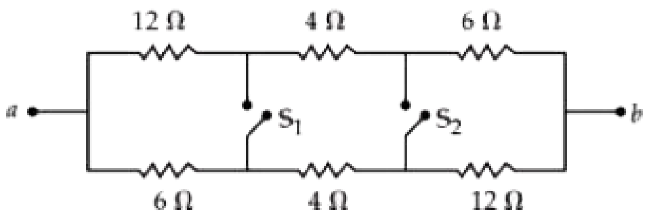
23. In the given figure switches S_1 and S_2 are in open condition. The resistance across ab when the switches S_1 and S_2 are closed is .... Ω.



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24. When a certain metallic surface is illuminated with mono chromatic light of wavelength λ, the stopping potential for photoelectric current is $3V_0$. When the same surface is illuminated with light of wavelength 2λ the stopping potential is V_0. The threshold wavelength for this surface for photoelectric effect is.

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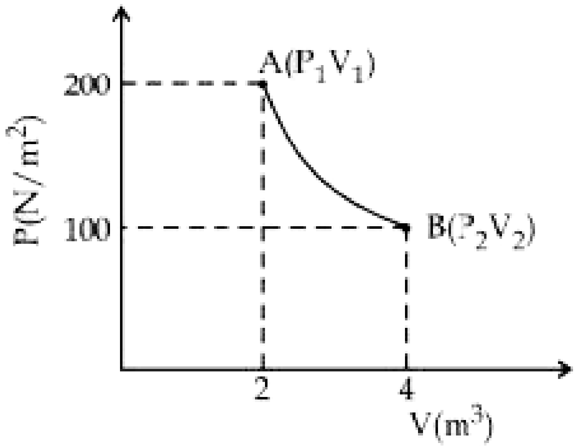
25. One mole of an ideal gas at $27^\circ C$ is taken from A to B as shown in the given PV indicator diagram. The work done by the system be .... $\times 10^{-1} J$.

[Given : R = 8.3 J/mole K, In2 = 0.6931] (Round off to the nearest integer)



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26. 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

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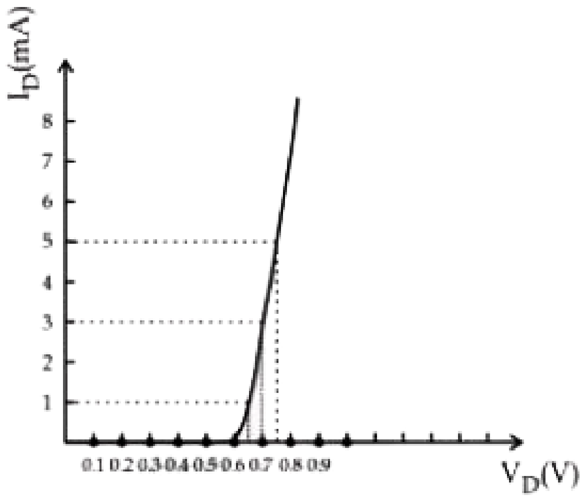
27. For the forward biased diode characteristics shown in the figure, the dynamic resistance at $I_D = 3mA$ will be ....Ω.



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28. 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 __________.

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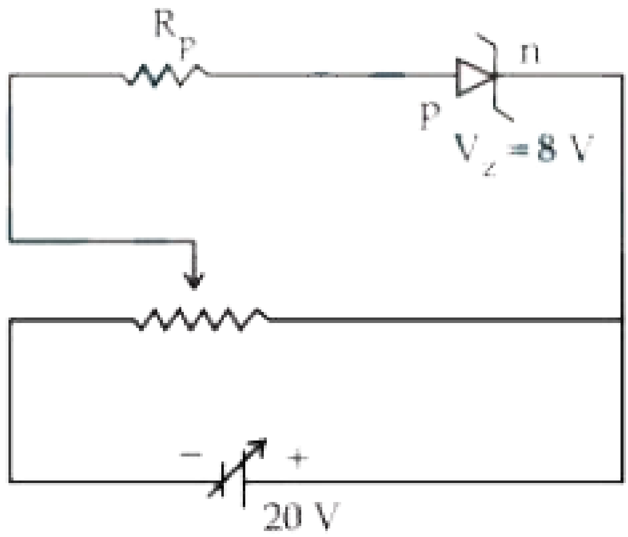
29. A zener diode having zener voltage 8V and power dissipation rating of 0.5W is connected across a potential divider arranged with maximum potential drop across zener diode is as shown in the diagram. The value of protective resistance R_P is .... Ω.



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30. 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 of 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 ....

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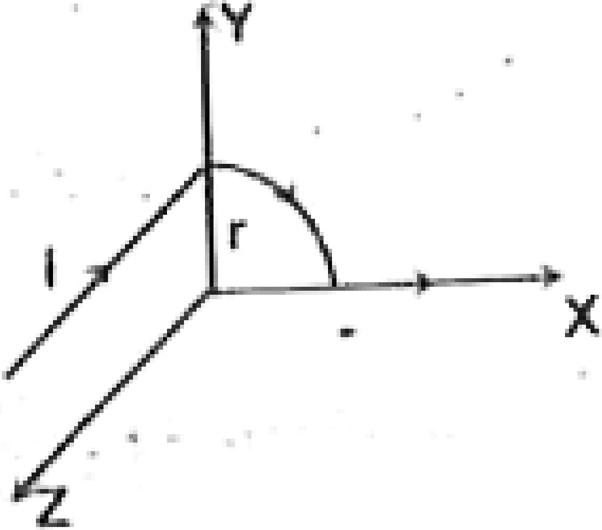
Physics Section A

1. Shown in the figure is a conductor carrying a current

i. the magnetic field at the origin is :



A. $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$

B. $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}-(x-y)\right]$

C. $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

D. $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$

Watch Video Solution

2. Electri field of a 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 $\mu_r = -1$)

A. $\dfrac{1}{3}$

B. 2

C. 3

D. 9

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3. The half-life period of a radio-active element X is same as the mean life time of another radio-active element Y. Initially they have the same number of atoms. Then:

A. y- will decay faste than x.

B. x - will decay faster than y.

C. x and y decay at the same rate always.

D. x and y have same decay rate initially and later on different decay rate.

Watch Video Solution

4. A capacitor is connected to a 20 V battery through a resistance of 10Ω. If is found that the potential difference across the capacitor rises to 2V in$1\mu s$. The capacitance of the capacitor is ________ μF.

A. 9.52

B. 1.85

C. 0.95

D. 2.00

Watch Video Solution

5. The temperature of an ideal gas in 3- deimensions is 300 K. The corresponding de - Broglie wavelength of the electron approximately at 300 K , is :

[m_e = mass of electron $= 9 \times 10^{-31} kg$

h = Planck constant $= 6.6 \times 10^{-34} Js$

k_B = Boltzmann constant $= 1.38 \times 10^{-33} JK^{-1}$]

A. 2.26 nm

B. 3.25 nm

C. 8.46 nm

D. 6.26 nm

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6. A body of mass 'm' drpped from a height 'h' reaches the ground with a speed of 0.8$\sqrt{gh}$. The value of warkdone by the air-friction is ,

A. 1.64 mgh

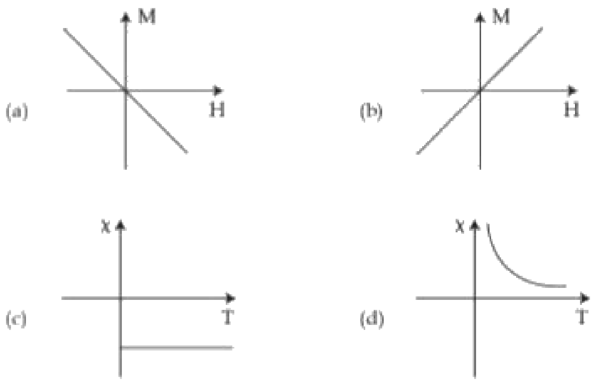
B. mgh

C. 0.64 mgh

D. $-0.68mgh$

Watch Video Solution

7. Following plots show Magnetization (M) vs Magnetising field (H) and Megnetic susceptibility (x) vs Temperature (T) graph :



Which of the following combination wioll be represented by a diamagnetioc material ?

A. a,d

B. a,c

C. b,d

D. b,c

Watch Video Solution

8. 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 :

A. $(4 \pm 0.3)\Omega$

B. $(4 \pm 0.4)\Omega$

C. $(2 \pm 0.4)\Omega$

D. $(2 \pm 0.3)\Omega$

Watch Video Solution

9. Four particles each of mass M move along a circle of radius R under the action of their mutula gravitational attraction the speed of each paritcles is

A. $\frac{1}{2}\sqrt{\frac{GM}{R\left(2\sqrt{2}+1\right)}}$

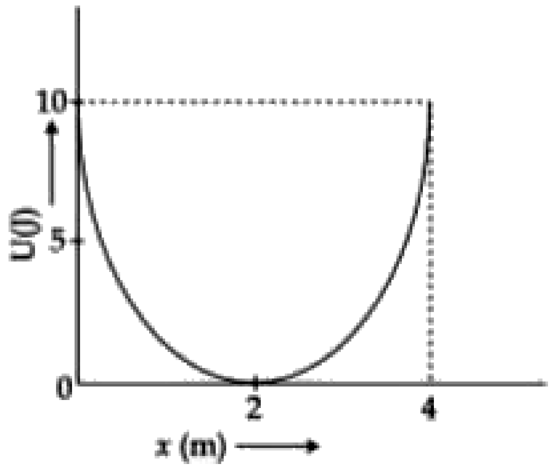
B. $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}-1)}$

C. $\frac{\sqrt{GM}}{R}$

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

Watch Video Solution

10. 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 ?



A. $10 m / s^2$

B. $9.8m/s^2$

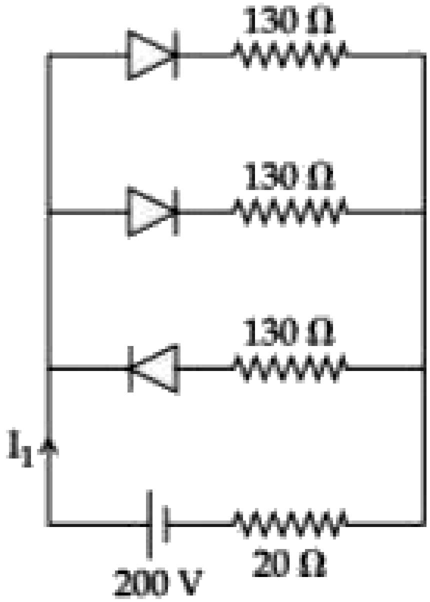
C. $4m/s^2$

D. $5m/s^2$

Watch Video Solution

11. 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 :



A. 3.75A

B. 2A

C. 2.35A

D. 2.73A

Watch Video Solution

12. The ranges and heights fo r 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 :

A. $R_1 > R_2$ and $H_2 = H_2$

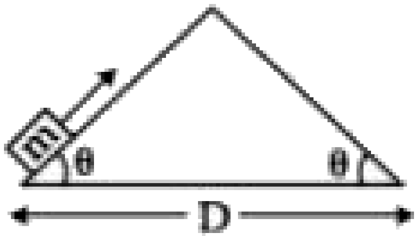
B. $R_1 = R_2$ and $H_1 = H_2$

C. $R_1 = R_2$ and $H_1 < H_2$

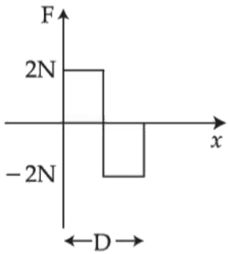
D. $R_1 < R_2$ and $H_1 < H_2$

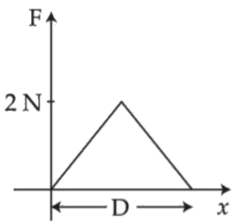
Watch Video Solution

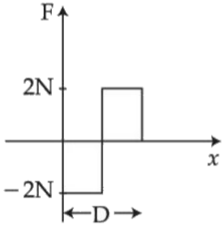
13. An object of mass 'm' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile.

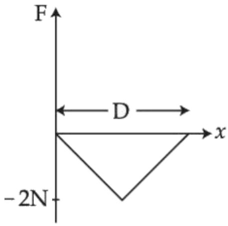


The correct applied force vs distance graph will be :

A. 

B. 

C. 

D. 

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14. A glass tumbler having irmer 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 ?

A. 10 cm

B. 11.7 cm

C. 7.5 cm

D. 8.75 cm

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15. A square loop of side 10 cm and resistance 1 Omega is moved towards right with a constant velocity V_0 as shown in . The left arm of the loop is in a uniform magnetic field of 2 T. the field is perpendicular ot the plane of the drawing and is going into it. the loop is connected to a network of resistors each of value 3 Omega with what speed should the loop be moved so that a steady curfrent of 1 mA flows in the loop.

(##HCV_VOL2_C38_S01_024_Q01##)

A. $1cm / s$

B. $1m / s$

C. $10^2 m / s$

D. $10^{-2} cm / s$

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16. 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 $9.8m/s^2$, 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 :

A. 0.0155

B. 0.0083

C. 0.083

D. 0.155

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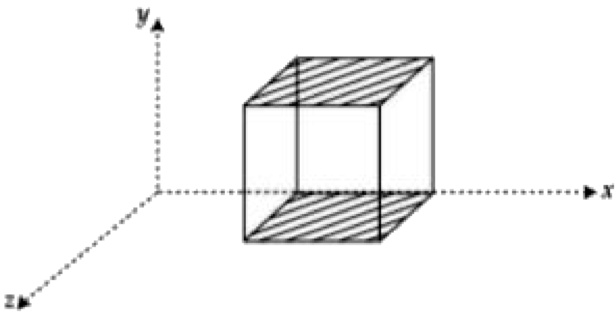
17. A cube is placed inside an electric field, $\overrightarrow{E} = 150y^2\hat{j}$. The side of the cube is 0.5 m and is placed in the field as shown in the given figure. The charge inside the cube is :



A. $3.8 \times 10^{-11}C$

B. $8.3 \times 10^{-11}C$

C. $8.3 \times 10^{-12}C$

D. $3.8 \times 10^{-12} C$

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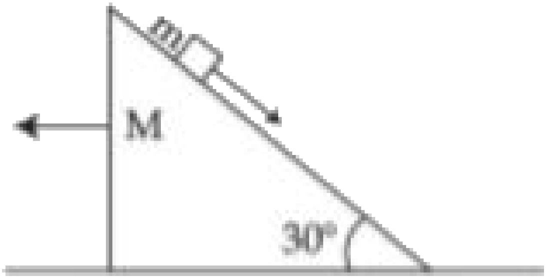
18. A block of mass m slides on the wooden wedge, which in turn slides backward on the horizontal surface. The acceleration of the block with respect to the wedge is :

Given $m = 8kg, M = 16mg$

Assume all the surfaces shown in the figure to be frictionless.



A. $\frac{3}{5}g$

B. $\frac{6}{5}g$

C. $\frac{4}{3}g$

D. $\frac{2}{3}g$

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19. Due to cold weather a 1 m water pipe of cross-sectional area $1cm^2$ is filled with ice at $-10^\circ C$. Resistive heating is used to melt the ice. Current of 0.5 A is passed through $4k\Omega$ 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

$= 3.33 \times 10^5 Jkg^{-1}$,

specific heat of ice $= 2 \times 10^3 Jkg^{-1}$ and

density of ice $= 10^3 kg/m^3$)

A. 0..353s

B. 3.53s

C. 35.3s

D. 70.6s

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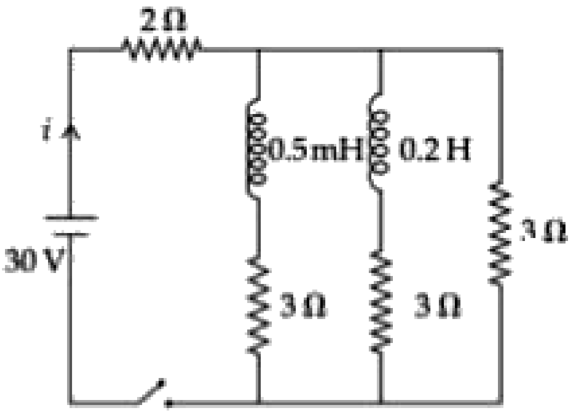
20. For the given circuit the current i through the battery when the key in closed and the steady state has been reached is ______ .



A. $0A$

B. $6A$

C. $10A$

D. $25A$

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21. 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 $: r < R_E$)

A. $1 - \frac{r}{R_E} - \frac{r^2}{R_E^2} - \frac{r^3}{R_E^3}$

B. $1 + \frac{r}{R_E} - \frac{r^2}{R_E^2} - \frac{r^3}{R_E^3}$

C. $1 + \frac{r}{R_E} - \frac{r^2}{R_E^2} + \frac{r^3}{R_E^3}$

D. $1+\frac{r}{R_E}+\frac{r^2}{R_E^2}+\frac{r^3}{R_E^3}$

Answer: 3

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22. A bob of mass 'm' suspended by a thread of length l undergoes simple harmonic osillations with time peroid T. If the bob is immersed in a liquiod tha has density $\frac{1}{4}$ times that of the bob and the length of the thread is increased by $1/3^{rd}$ of the original length ,then the time period of the simple harmonic oscilltions will be :

A. T

B. $\frac{3}{2}T$

C. $\frac{4}{3}T$

D. $\frac{3}{4}$T

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23. Choose the incorrect statement :

(a) The electric lines of force entering into A Gaussian surface provide nagative 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 uniform electric field net 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 :

A. (a) and (b) Only

B. (b) and (c) Only

C. (c) only

D. (d) Only

Answer: D

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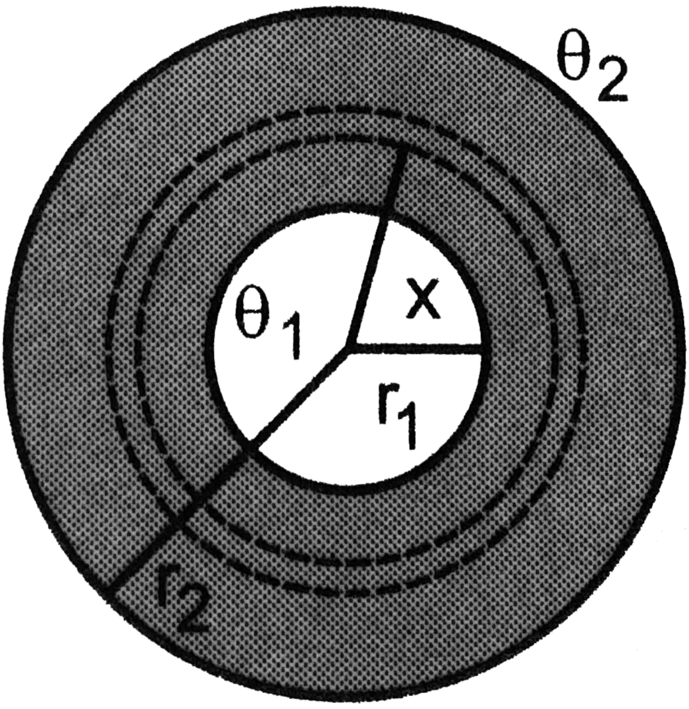
24. Two thin metallic spherical shells of radii r_1 and r_2 $(r_1 < r_2)$ are placed with their centres coinciding. A material of thermal conductivity K is filled in the space between the shells. The inner shells is maintained at temperature θ_1 and the outer shell at temperature θ_2 $(\theta_1 < \theta_2)$. Calculate the rate at which heat flows radially through the material.



A. $\dfrac{K(\theta_2 - \theta_1)(r_2 - r_1)}{4\pi r_1 r_2}$

B. $\dfrac{K(\theta_2 - \theta_1)}{r_2 - r_1}$

C. $\dfrac{\pi r_1 r_2(\theta_2 - \theta_1)}{r_2 - r_1}$

D. $\dfrac{4\pi K r_1 r_2(\theta_2 - \theta_1)}{r_2 - r_1}$

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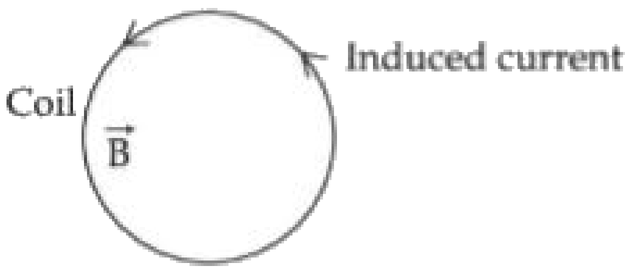
25. A coil is placed in a magnetic field $\overrightarrow{B}$ as shown below :



A current is induced in the coil because $\overrightarrow{B}$ is :

A. parallel to the plane of coil and increasing with time

B. outward and incresing with time

C. outward and decreasing with time

D. parallel to the plane of coil and decreasing with time

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

A. $3:16$

B. $3:8$

C. $16:3$

D. $8:3$

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27. 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_1 . Statement II : To get a steady de output from the pulsating voltage received from a full wave rectifier we can connect an inductor in series with R_1 In the light of the above statements ,choose the most appropriate answer from the options given below :

A. Both Statement I and Statement II are true

B. Both Statement I and Statement II are false

C. Statement I is true but Statement II is false

D. Statement I is false but Statement II is true

Answer: C

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28. 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 .)

A. $2\sqrt{3} \times 10^{-5} T$, inside the plane of triangle

B. $2\sqrt{3} \times 10^{-7} T$, outside the plane of triangle

C. $3 \times 10^{-7} T$,outside the plane of triangle

D. $3 \times 10^{-5} T$, inside the plane of triangle

Answer: 4

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29. 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 inteval 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 approprate ooption from the options given below :

A. only (c)

B. only (b)

C. (b) and (c)

D. (c) and (d)

Answer: D

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30. Four identical hollow cylindrical columns of mild steel support a big structure of mass 50×10^3kg .The inner and outer radii of each column are are 50 cm and 100 cm respectively. Assuming uniform local distribution ,calculate the compression strain of each column. [use $Y = 2.0 \times 10^{11} Pa, g = 9.8 m/s^2$]

A. $7.07 \times 10(-4)$

B. 3.60×10^{-8}

C. 1.87×10^{-3}

D. 2.60×10^{-7}

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31. A system consists of two identical sphers each of mass 1.5 kg and radius 50 cm at the ends of a light rod .The distane between the centres of the 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 .

A. $18.75 kgm^2$

B. $1.905 \times 10^5 kgm^2$

C. $1.875 \times 10^5 kgm^2$

D. $19.05 kgm^2$

Answer: 4

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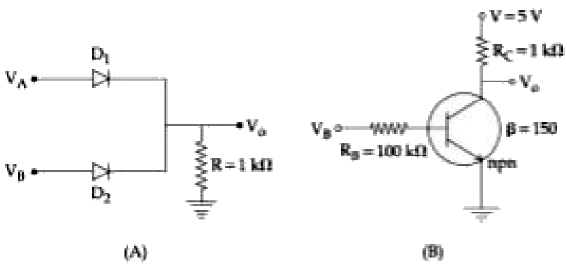
32. IF V_A and V_B are the input voltages (either 5 V or 0 V) and V_o is the output voltage then the two gates represented in the following circuits (A) and (B) are :



A. AND and OR Gate

B. NAND and NOR Gate

C. AND and NOT Gate

D. OR and NOT Gate

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33. 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 :

A. $\sqrt{\frac{m_e}{m_p}}$

B. $\sqrt{\frac{m_p}{m_e}}$

C. $\frac{m_p}{m_e}$

D. $\left(\frac{m_p}{m_e}\right)^{3/2}$

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34. If velocity,time and force were chosen as basic quantities, find the dimensions of mass.

A. $\left[FT^{-1}V^{-1}\right]$

B. $\left[FVT^{-1}\right]$

C. $\left[FTV^{-1}\right]$

D. $[FT^2V]$

Answer: 3

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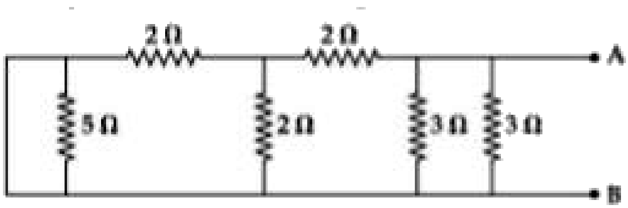
35. The equivalent resistane of the given circuit between the terminals A and B is :



A. 1Ω

B. $\frac{9}{2}\Omega$

C. 3Ω

D. 0Ω

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36. 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 photon is relased .Find the frequency of the emitted photon $\left(h = 6.6 \times 10^{-34}\right)$Js

A. $1.45 \times 10^{16} MHz$

B. $1.45 \times 10^{9} MHz$

C. $0.19 \times 10^{15} MHz$

D. $9.0 \times 10^{27} MHz$

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37. If three forces $\overrightarrow{F_1}, + \overrightarrow{F_2}$ and $\overrightarrow{F_3}$ are represented by three sides of a triangle and $\overrightarrow{F_1} + \overrightarrow{F_2} = -\overrightarrow{F_3}$, then these three forces are concurrent forces and satisfy the condition for equilibrium .

Statement II : A triangle made up of three forces $\overrightarrow{F}_1, \overrightarrow{F}_2$ and $\overrightarrow{F}_3$ as 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 :

A. Both Statement I and Statement II are false

B. Statement I is true but Satement II is false.

C. Both Statement I and Statement II are true.

D. Statement I is false but Statement II is true

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38. Two forces $\left(\vec{P}+\vec{Q}\right)$ and $\left(\vec{P}-\vec{Q}\right)$ where $\vec{P}\perp\vec{Q}$,when act at an angle θ_1 to each other. the magnitude of their resultant is $\sqrt{3\left(p^2+Q^2\right)}$, when they act at an angle θ_2 ,the magnitude of their resultant bocomes $\sqrt{2\left(P^2+Q^2\right)}$ .The possible only when $\theta_1<\theta_2$.

Statement II : In the situation given above .

$\theta_1 = 60^\circ$ and $\theta_2 = 90^\circ$

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

A. Both Statement I and Statement II are false

B. Statement I is false but Statement II is true .

C. Both Statement I and Statement II are true.

D. Statement I is true but Statement II is false .

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39. The magnetic field vector of an electromagnetic wave is given by $B = B_0 \frac{\hat{i} + \hat{j}}{\sqrt{2}} \cos(kz - \omega t)$, where $\hat{i}$, $\hat{j}$

represents unit vector along x and y - axis repectively .At t=0 s , two electric charges q_1 of 4π coulomb and q_2 of 2π coulmb located at $\left(0, 0, \frac{\pi}{k}\right)$ and $\left(0, 0, \frac{3\pi}{k}\right)$, repectively ,have the same velocity of $0.5c\hat{i}$,(where c is the velocity of light).The ratio of the force actig on charge q_1 to q_2 is :

A. $2:1$

B. $2\sqrt{2}:1$

C. $1:\sqrt{2}$

D. $\sqrt{2}:1$

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Physics Section B

1. 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 aT, where a is a constant greater than 1. The co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{a^2-1}{a^2}\right)$ where x = _______.

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2. A uniform heating wire of resistance 36 $ohms$ is connected across a potential difference of 240 V. The wire is then cut into half and a 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 ________ .

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3. 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 $72kmh^1$ when the brakes tare 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 _______ $\times 10^5$ N/m.

Watch Video Solution

4. The temperature of 3.00 mo! of an ideal diatomic gas is increased by $40.0^\circ C$ 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 $R = 8.31 J mol^{-1} K^{-1}$)

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5. 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 $\frac{\pi}{3}$ red h^{-1} where x is ________.

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6. 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 ________ .

Watch Video Solution

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

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8. A 2 kg steel rod of length 0.6 mis 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 $g = 10ms^{-2}$)

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9. 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________.

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10. The average translational kinetic energy of N_2 gas molecules at ________ $^{\circ}C$ 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).

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11. In a Young's double slit experiment the slits separated by 0.3 mm and screen is 1.5 m awavy from the plane of slits .Distance between fourth bright fringes on both sides of central bright fringe is 2.4 cm .The frequency of light used is _____ $\times 10^{14} Hz$.

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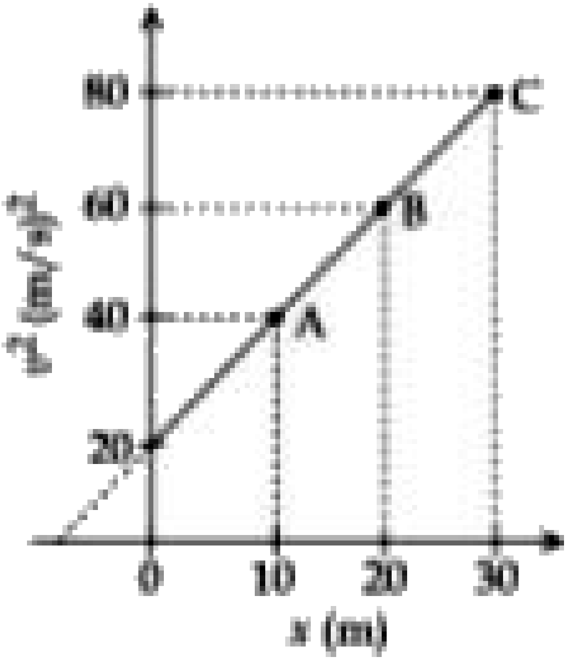
12. A particle is moving with constant acceleration 'a' Following graph shown v^2 versus x(displacement)plot .The acceleration plot .The acceleration of the particle is

_____ m/s^2 .



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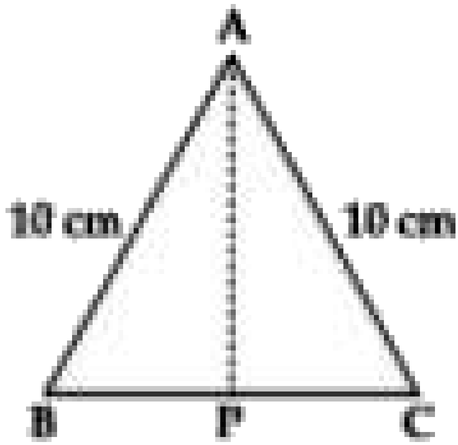
13. Cross -section view of a prism is the equilateral triangle ABC shown in the figure .The minimum deviation is oberved using this prism when the angle of incidence is equal to prism angle .The time taken by

light to travel from P (midpoint of BC) to A is ______ x 10^{-10}s . (Given ,speed of light in vacuum $= 3 \times 10^8 \frac{m}{s}$ and $\cos^{30^\circ} = \frac{\sqrt{3}}{2}$)



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14. 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 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 magne tic moment of the core would be approimately $\left(\frac{x}{499}\right)$ Find the value of x.

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15. 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 Pa. the absolute value of the workdone by the gas in the process = __________ J.

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16. A bandwidth of 6 MHz is available for A.M transmission .If the maximum audio signal frequency used form modulating the carrier wave is not to exceed 6 kHz .The nnumber of stations that can be broadcasted within this band simultaneously without interfering with each other will be ______.

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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 10mm and 8th 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.

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18. A parallel plate capacitor of capacitance $200\mu F$ is connected to a battery of 200 V. A dielectric slab of dielectric 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.

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

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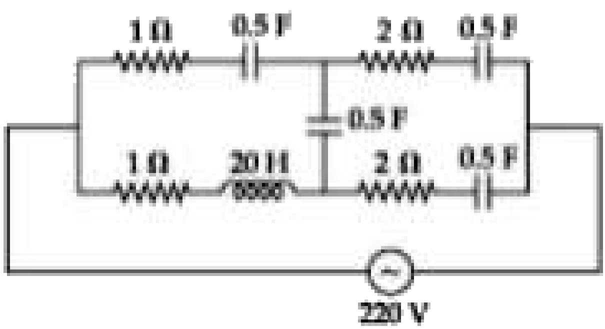
20. At very high frequencies ,the effective impedence of the given circuit will be ______Ω.



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Physics (Section A)

1. A huge circular arc of length 4.4 ly subtends an anlge '4s' at the centre of the circle. How long it would take for a body to complete 4 revoluation if its speed is 8AU per second ?

Given : $1ly = 9.46 \times 10^{15}m$

$1AU = 1.5 \times 10^{11}m$

A. $7.2 \times 10^{8}s$

B. $4.1 \times 10^{8}s$

C. $3.5 \times 10^{6}s$

D. $4.5 \times 10^{10} s$

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2. In a photoelectric experiment increasing the intensity of incident light

A. increases the frequency of photons incident and increases the K.E.of the ejected electrons

B. increases the number of photons incident and also increases the K.E.of the ejected electrons

C. increases the number of photons incident and the K.E.of the ejected electrons remains unchanged

D. increases the frequency of photons incident and the K.E.of the ejected electrons remains unchanged

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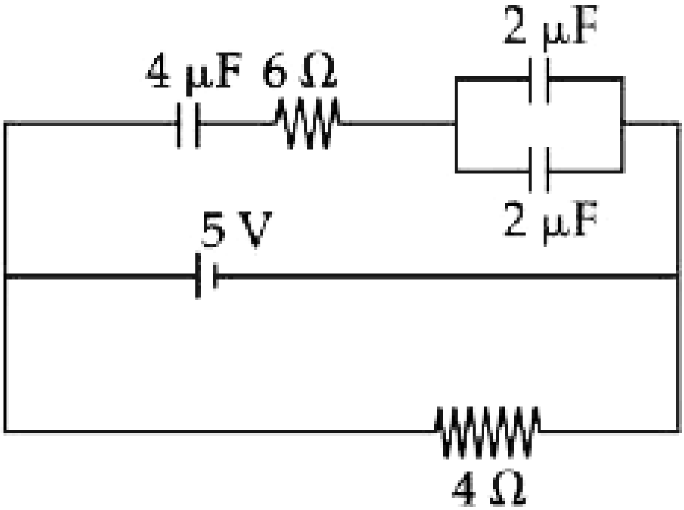
3. Calculate the amount of charge on capcitor of $4\mu F$. The internal resistance of battery is 1Ω :



A. zero

B. $4\mu C$

C. $16\mu C$

D. $8\mu C$

Answer: D

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

The velocity of electromagnetic wave in this medium is :

(Given C= speed of light in vacuum)

A. C

B. $\frac{2}{3} C$

C. $\frac{3}{2} C$

D. $\frac{C}{2}$

Watch Video Solution

5. An ideal gas is expanding such that $PT^3 =$ constant . The coeffficent of volume expansion of the gas is :

A. $\frac{4}{T}$

B. $\frac{2}{T}$

C. $\frac{3}{T}$

D. $\frac{1}{T}$

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6. 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 ?

$(\sqrt{2} = 1.414)$

A. 2×10^{10}

B. 4×10^{10}

C. 10^{5}

D. 7×10^{9}

Answer: D

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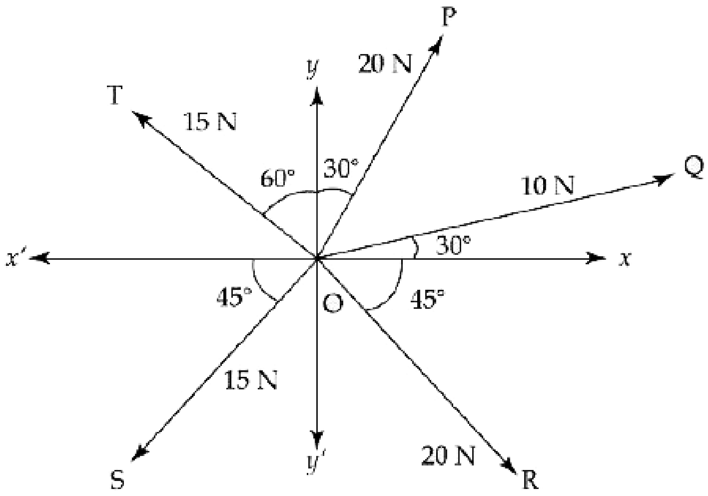
7. The resultant of these forces $\overrightarrow{O}P, \overrightarrow{O}Q, \overrightarrow{O}R, \overrightarrow{O}S$ and $\overrightarrow{O}T$ is approximately __________ N.

[Take $\sqrt{3} = 1.7$, $\sqrt{2} = 1.4$, Given $\hat{i}$ and $\hat{j}$ unit vectors along x, y axis]



A. $2.5\hat{i} - 14.5\hat{j}$

B. $3\hat{i} + 15\hat{j}$

C. $-1.5\hat{i} - 15.5\hat{j}$

D. $9.25\hat{i} + 5\hat{j}$

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

A. $3.8 \times 10^{-11} N$

B. $1.8 \times 10^{-10} N$

C. $3.9 \times 10^{-10} N$

D. $5.8 \times 10^{-10} N$

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9. 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 ?

A. 5Ω

B. 10Ω

C. 25Ω

D. 1Ω

Answer: D

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10. Which of the following is not a dimensionless quantity ?

A. Quality factor

B. Relative magnetic permeability (μ_r)

C. Permeability of free space (μ_0)

D. Power factor

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11. For a transistor in CE mode to be used as an amplifier, it must be operated in :

A. Saturation region only

B. Both cut-off and Saturation

C. The active region only

D. Cut-off region only

Answer: C

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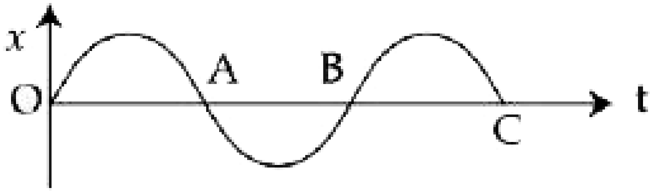
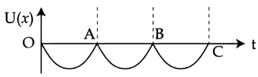
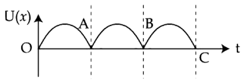
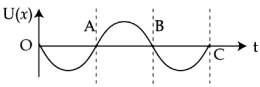
12. The variation of displacement with time of a particle executing free simple harmonic motion is shown in the figure.

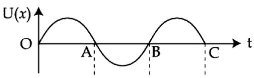


The potential energy U(x) versus time (t) plot of the particle is correctly shown in figure :

A. 

B. 

C. 

D. 

Answer: B

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13. If E and H represents the intensity of electric field and magnetising field respectively, then the unit of E/H will be :

A. newton

B. joule

C. mho

D. ohm

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14. 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 :

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

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

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

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

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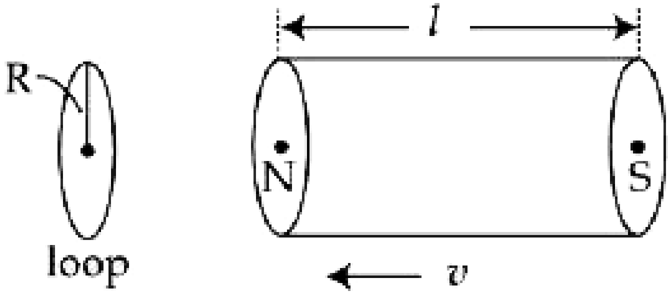
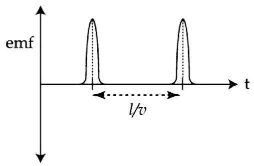
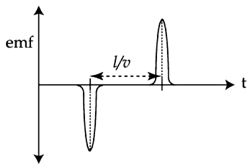
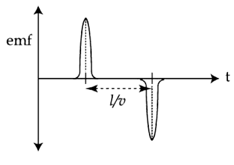
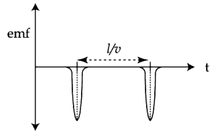
15. A bar magnet is passing through a conducting loop of radius R with velocity v. The radius of the bar magnet is such that it just passes through the loop. The induced e.m.f. in the loop can be represented by the approximate curve :



A. 

B. 

C. 

D. 

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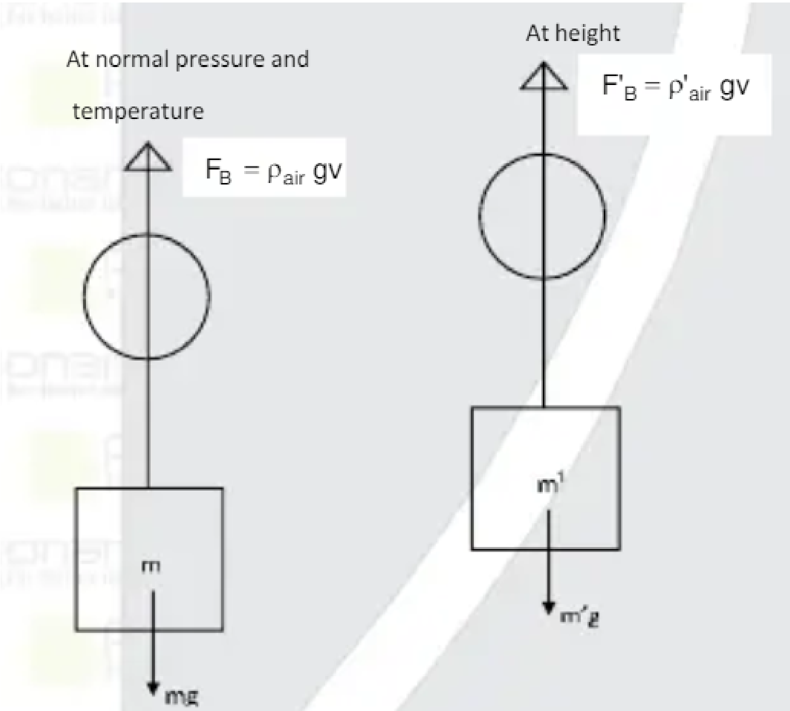
16. A balloon carries a total load of 185kg at normal pressure and temperature at 27 dec C. What load with the balloon carry on rising to a height at which the barometer pressure is 45cm of Hg and the temperature is -7 deg C. Assuming volume constant.



A. $181.46kg$

B. $123.54kg$

C. $214.15kg$

D. $219.07kg$

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17. 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 :

A. $\frac{2}{3}Ml^2$

B. $\frac{Ml^2}{12}$

C. $\frac{Ml^2}{6}$

D. Ml^2

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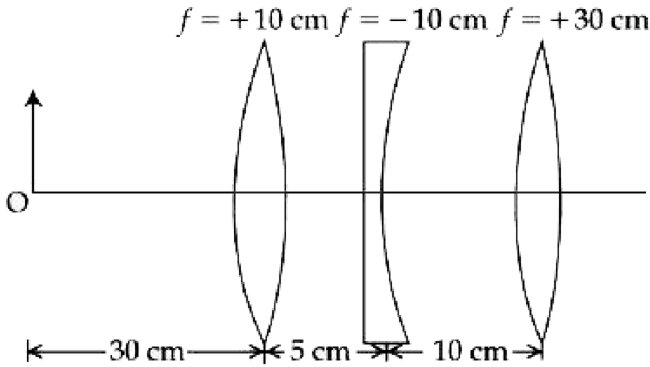
18. Find the distance of the image from object O, formed by the combination of lenses in the figure :

$f = +10cm f = -10cn f = +30cm$



A. $10cm$

B. infinity

C. 20cm

D. 75cm

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19. 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

A. $\dfrac{d_1 d_2}{d_1 + d_2}$

B. $\dfrac{d_1 d_2}{d_1 - d_2}$

C. $\dfrac{2 d_1 d_2}{d_1 - d_2}$

D. $\dfrac{2 d_1 d_2}{d_1 + d_2}$

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20. 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 :

A. lighter ion will be deflected more than heavier ion

B. no ion will be deflecled

C. lighter ion will be deflected less than heavier ion

D. both ions will be deflected equally

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21. A block moving horizontally on a smooth surface with a speed of 40 m/s splits into two parts with messes in the ratio of 1:2 If the smaller part moves at 60 m/s in the same direction , then fractional change in kinetic energy is :

A. $\frac{2}{3}$

B. $\frac{1}{8}$

C. $\frac{1}{2}$

D. $\frac{1}{4}$

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22. 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, W_1 and W_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 :

A. $\dfrac{(I_1 - I_2)^2 \omega_1 \omega_2}{2I_1 + I_2}$

B. $\dfrac{I_1 I_2}{(I_1 + I_2)}(\omega_1 - \omega_2)^2$

C. $\dfrac{I_1 I_2}{2(I_1 + I_2)}(\omega_1 - \omega_2)^2$

D. $\dfrac{(\omega_1 - \omega_2)^2}{2(I_1 + I_2)}$

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23. A player kicks a football with an initial speed of $25ms^{-1}$ 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 $g = 10ms^{-2}$)

A. $h_{\max} = 3.54mT = 9.125s$

B. $h_{\max} = 15.625mT = 3.54s$

C. $h_{\max} = 15.625mT = 1.77s$

D. $h_{\max} = 10mT = 2.5s$

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24. 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:

A. $-60G$

B. $-4G$

C. $+2G$

D. $-20G$

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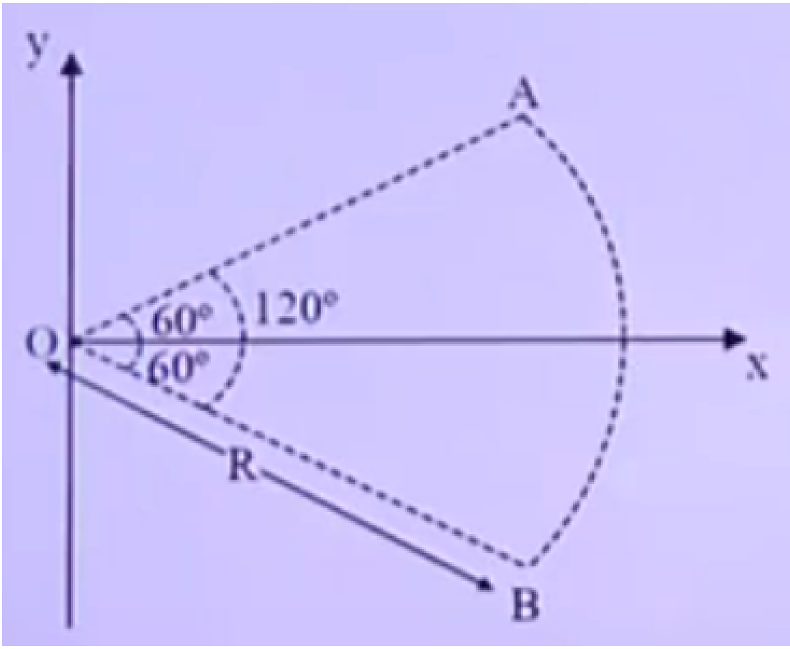
25. Figure shows a rod AB, which is bent in a 120° circular arc of radius R. A charge (-Q) is uniformly distributed over rod AB. What is the electric field $\overrightarrow{E}$ at the centre of curvature O ?



A. $\dfrac{3\sqrt{3}Q}{8\pi^{2}\varepsilon_{0}R^{2}}\left(\hat{i}\right)$

B. $\dfrac{3\sqrt{3}Q}{8\pi^{2}\varepsilon_{0}R^{3}}\left(\hat{i}\right)$

C. $\dfrac{3\sqrt{3}Q}{8\pi^2\varepsilon_0 R^2}\left(-\hat{i}\right)$

D. $\dfrac{3\sqrt{3}Q}{16\pi^2\varepsilon_0 R^2}\left(\hat{i}\right)$

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26. If the rms speed of oxygen molecules at$0^\circ C$ is 160 m/s, find the rms speed of hydrogen molecules at $0^\circ C$.

A. 332 m/s

B. 80 m/s

C. 40 m/s

D. 640 m/s

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27. 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 ?

A. $5I_0$

B. $2I_0$

C. $4I_0$

D. I_0

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28. 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 :

A. $(a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)$

B. $(a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)$

C. $(a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)$

D. $(a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)$

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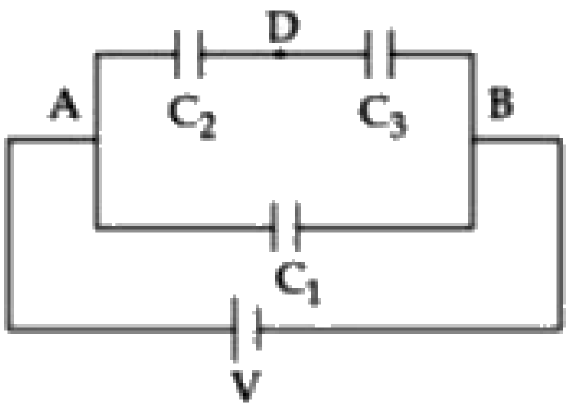
29. Three capacitors $C_1 = 2\mu F, C_2 6\mu F$ and $C_3 = 12\mu F$ are connected as shown in figure. Find the ratio of the charges on capacitors C_1, C_2 and C_3 respectively :



A. $2:3:3$

B. $3:4:4$

C. $2:1:1$

D. $1:2:2$

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30. 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 ?

A. $1.5V$

B. $1.25V$

C. $0.96V$

D. $0.24V$

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31. For a transistor a 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 :

A. $\alpha=\frac{\beta}{1-\beta}$

B. $\alpha=\frac{1-\beta}{\beta}$

C. $\alpha\beta=1$

D. $\beta=\frac{\alpha}{1-\alpha}$

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32. An antenna is mounted on a 400 m tall building. What will be the wavelength of signal that can be radiated effectively by the transmission tower upto a range of 44 km ?

A. 302 m

B. 37.8 m

C. 605 m

D. 75.6 m

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33. 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.

A. 2.45 m

B. 2.94 m

C. 4.18 m

D. 7.35 m

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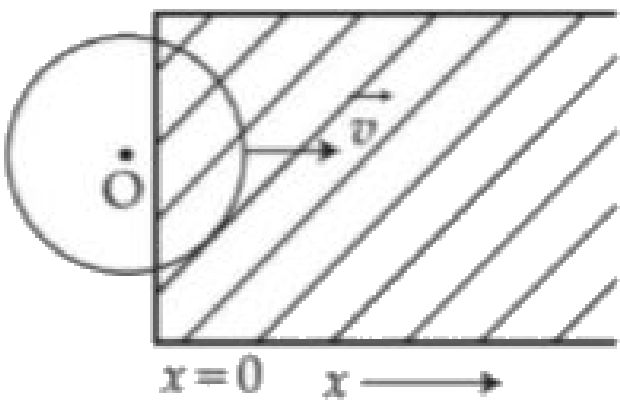
34. A constant magnetic field of 1 T is applied in the $x > 0$ region. A metallic circular ring of radius 1 m is moving with a constant velocity of 1 m/s along the x-axis. At t=0 s, the centre O of the ring is at x=-1 m. What will be the value of the induced emf in the ring at t=1s? (Assume the velocity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



A. 1 V

B. 0 V

C. $2\pi V$

D. 2 V

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35. 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:

A. 5Ω

B. 4Ω

C. 1Ω

D. 2Ω

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36. 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 $= 1 cal g^{-1} {}^{\circ} C^{-1}$]

A. $14.76^{\circ} C$

B. $1.476^{\circ} C$

C. $0.014^{\circ} C$

D. $0.147^{\circ} C$

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37. If force (F), length(L) and time (T) as chosen as the fundamental quantities, then what would be the dimensional formula for the density?

A. $[FL^{-5}T^{2}]$

B. $[FL^{-3}T^{2}]$

C. $[FL^{-3}T^{3}]$

D. $[FL^{-4}T^{2}]$

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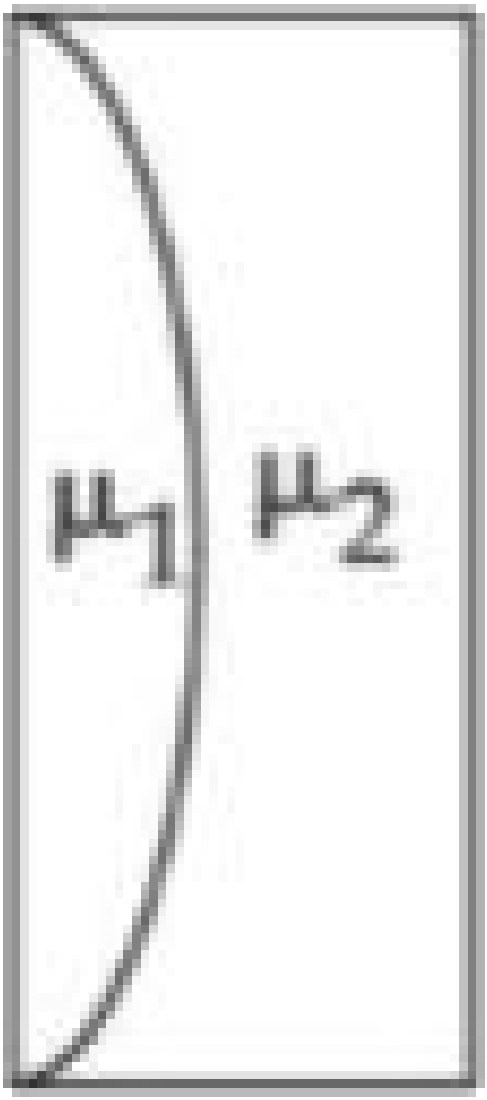
38. Curved surfaces of a plano-convex lens of refractive index μ_1 and a plano-concave lens of refractive index μ_2 have equal radius of curvature as shown in figure. Find the ratio of radius of curvature to the focal length of the combined lenses.



A. $\mu_1 - \mu_2$

B. $\mu_2 - \mu_1$

C. $\dfrac{1}{\mu_1 - \mu_2}$

D. $\dfrac{1}{\mu_2 - \mu_1}$

Answer: option 3

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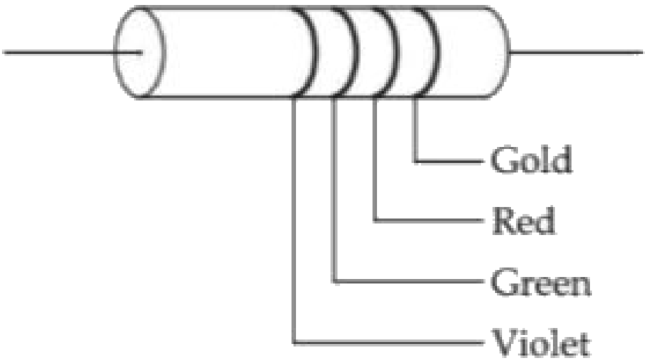
39. The colour coding on a carbon resistor is shown in the given figure. The resistance value of the given resistor is :



A. $(7500 \pm 375)\Omega$

B. $(7500 \pm 750)\Omega$

C. $(5700 \pm 285)\Omega$

D. $(5700 \pm 375)\Omega$

Answer: option 1

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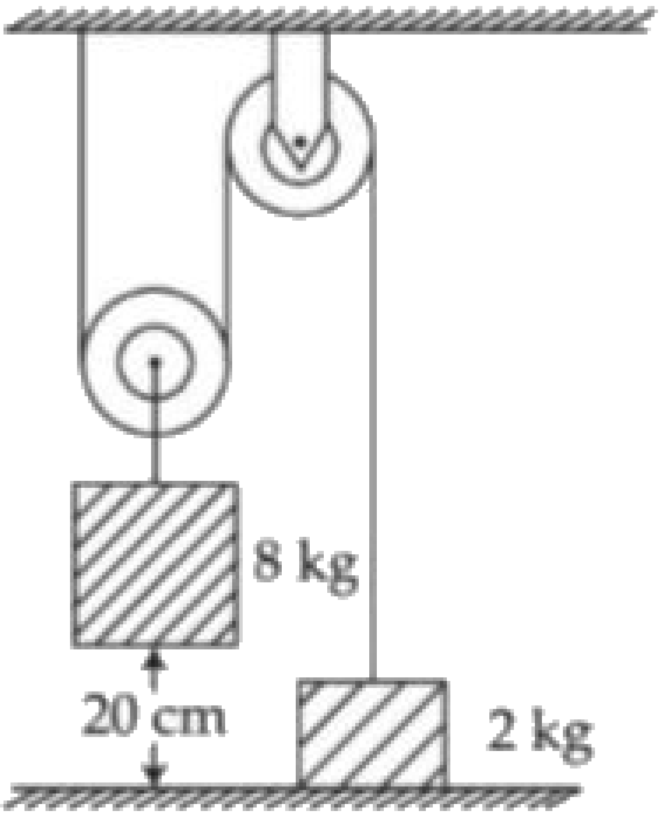
40. The boxes of masses 2 kg and 8 kg are connected by a massless string passing over smooth pulleys. Calculate the time taken by box of mass 8 kg to strike the ground starting from rest. (use g=10 m/s^2):



A. $0.2s$

B. $0.25s$

C. $0.4s$

D. $0.34s$

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41. 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 $(ii) a < x < b$?

A. $\dfrac{b^2 - a^2}{x^2}$

B. $\dfrac{a^2}{x^2}$

C. $\dfrac{x^2}{a^2}$

D. $\dfrac{x^2}{b^2 - a^2}$

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42. Angular momentum of a single particle moving with constant speed along circular path :

A. remains same in magnitude but changes in the direction

B. is zero

C. changes in magnitude but remains same in the direction

D. remains same in magnitude and direction

Answer: D

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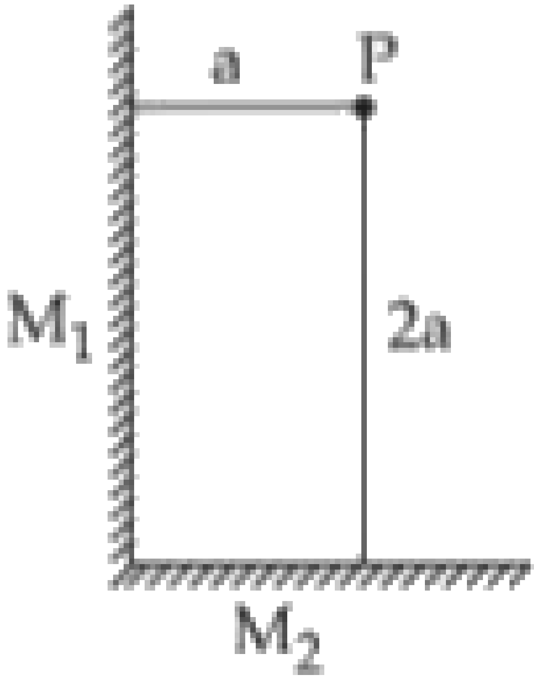
43. Two Placed at M_1 and M_2 meter away from M_1 and M_2 respectively. The shortest distance between the images thus formed is : (Take $\sqrt{5} = 2.3$)



A. $2\sqrt{10}$ a

B. $2.3a$

C. $3a$

D. $4.6a$

Answer: D

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44. 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 :

A. 280° C

B. 382° C

C. 174° C

D. 180.4° C

Answer: C

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45. 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 :

A. zero

B. $2R^2$

C. $R\sqrt{2}$

D. R

Answer: D

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46. A helicopter is flying horizontally with a speed 'v' at an altitude V 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 ?

A. $\frac{\sqrt{2v^2h}}{g}+h^2\Bigg)$

B. $\Bigg(\frac{\sqrt{2ghv^2+1}}{h^2}$

C. $\sqrt{\frac{2hv^2}{g}+h^2}$

D. $\frac{\sqrt{2gh}}{v^2}+h^2$

Answer: C

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47. 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)

A. 0° C

B. $\frac{ap_0}{eR}$

C. $\frac{P_0}{aR}$

D. infinity

Answer: option 3

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48. 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 ,

A. 4

B. 3

C. 1

D. 2

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49. Which of the following equations is dimensionally incorrect ?

Where t=time, h = height, s = surface tension, θ = angle, p= density, a, r = radius, g = acceleration due to gravity, v = volume, p = pressure, W = work done, T = torque, ε =permittivity, E = electric field, J = current density, L = length.

A. $W = \tau\theta$

B. $h = \dfrac{2s\cos\theta}{prg}$

C. $j = \varepsilon\dfrac{\partial E}{\partial t}$

D. $v = \dfrac{\pi pa^4}{8\eta L}$

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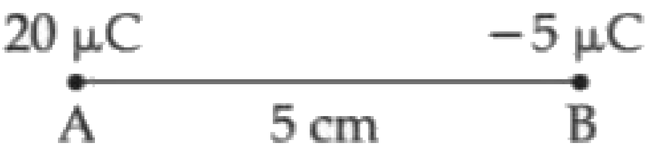
50. Two particles A and B having charges 20 μC and -5 μ C respectively are held fixed with a separation of 5 cm. At what position a third charged particle should be placed so that it does not experience a net electric force ?



A. At 1.25 cm from a-5 μC between two charges

B. At 5 cm from 20 μ C on the left side of system

C. At midpoint between two charges

D. At 5 cm from -5 μ c on the right side

Answer: D

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51. Consider a galvanometer shunted with 5 Ω resistance and 2% of current passes through it. What is the resistance of the given galvanometer ?

A. 245 Ω

B. 344 Ω

C. 226 Ω

D. 300 Ω

Answer: A

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52. 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 $2 \times 10^{11} Nm^{-2}$ Neglecting the lateral contraction, find the elongation of rod due to its own weight:

A. 2×10^{-9} m

B. 5×10^{-10} m

C. 4×10^{-8} m

D. 8×10^{-8} m

Answer: B

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53. 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 :

A. $\frac{\mu_0}{4\pi} 8\sqrt{2}\frac{b^2}{a}$

B. $\frac{\mu_0}{4\pi}\frac{8\sqrt{2}}{a}$

C. $\frac{\mu_0}{4\pi}\frac{8\sqrt{2}}{b}$

D. $\frac{\mu_0}{4\pi}8\sqrt{2}\frac{a^2}{b}$

Answer: D

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54. 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 :

A. $k_p = k_e$ and $P_p = P_e$

B. $k_p > k_e$ and $P_p = P_e$

C. $k_p < k_e$ and $P_p = P_e$

D. $k_p < k_e$ and $P_p < P_e$

Answer: C

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55. 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 Tenion	(iv) MLT^{-2}

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

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

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

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

Answer: C

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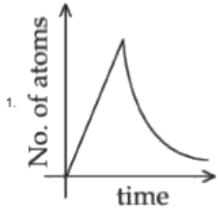
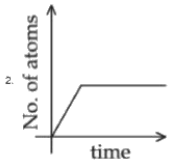
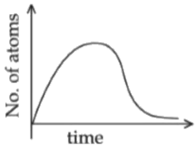
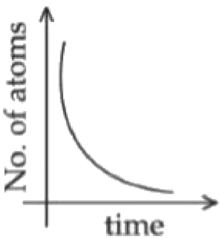
56. A sample of a radioactive nucleus A disintegrates to another radioactive nucleus B, which in turn disintegrates to some other stable nucleus C. Plot of a graph showing the variation of number of atoms of nucleus B vesus time is : (Assume that at $t = 0$, there are no B atoms in the sample)

A. 

B. 

C. 

D. 

Answer: C

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

A. $\frac{1}{2}, \frac{f}{2}$

B. $1, \infty$

C. very high ∞

D. $\frac{1}{4}, \frac{f}{4}$

Answer: A

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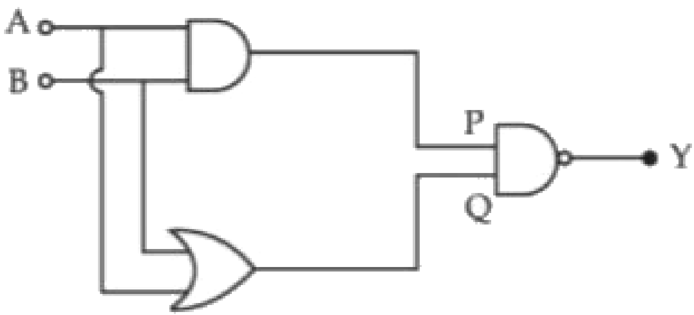
58. In the following logic circuit the sequence of the inputs A, B are (0, 0), (0,1), (1, 0) and 1, 1). The output Y for this sequence will be :



A. 0, 1, 0, 1

B. 0, 01, 1

C. 1, 0, 1, 0

D. 1, 1, 1, 0

Answer: D

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59. 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:

A. $\dfrac{\mu_0 I}{4(a-b)}\left[\dfrac{1}{a}-\dfrac{1}{b}\right]$

B. $\dfrac{\mu_0 I}{8}\left[\dfrac{a+b}{a-b}\right]$

C. $\dfrac{\mu_0 IN}{2(b-a)}\dfrac{\log_e(b)}{a}$

D. $\dfrac{\mu_0 I}{8}\dfrac{a-b}{a+b}$

Answer: C

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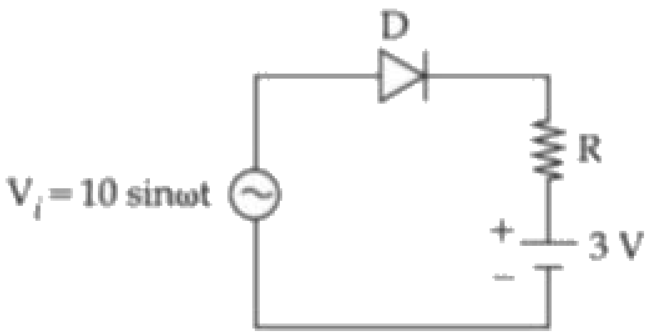
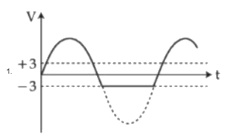
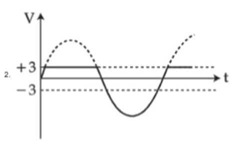
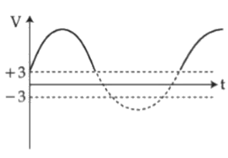
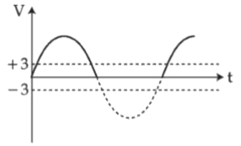
60. Choose the correct waveform that can represent the voltage across R of the following circuit, assuming the diode is ideal one :



A. 

B. 

C. 

D. 

Answer: B

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61. 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 :

A. $V = \sqrt{4G\frac{M_1 + M_2}{r}}$

B. $V = \frac{1}{2}\sqrt{2G\frac{M_1 + M_2}{r}}$

C. $V = \sqrt{2G}\frac{M_1 + M_2}{r}$

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

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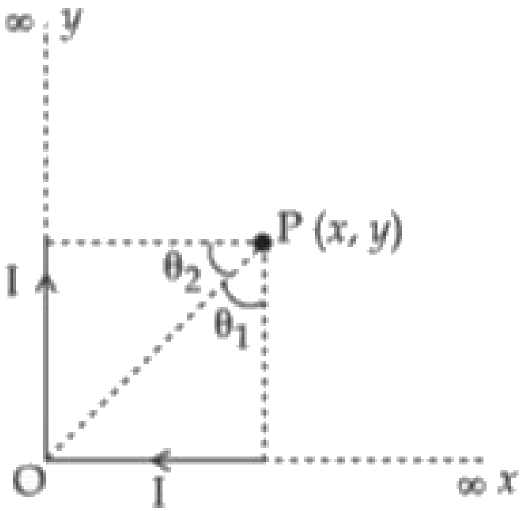
62. There are two infinitely long straight current caarrying conductors and they are held at right angles to each other so that their common ends meet at the origin as shown in the figure given below. The ratio of current in both conductors is 1 : 1. The magnetic field at point P is ________.



A. $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}+(x+y)\right]$

B. $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2}+y^2-(x-y)\right]$

C. $\frac{\mu_0 I}{4\pi xy}\left[\sqrt{x^2+y^2}-(x+y)\right]$

D. $\frac{\mu_0 Ixy}{4\pi}\left[\sqrt{x^2+y^2}+(x+y)\right]$

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63. Electri field of a 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 $\mu_r = 1$)

A. $\frac{1}{3}$

B. 2

C. 3

D. 9

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64. The half life period of a radioactive element x is same as the mean life time of another radioactive element y. Initially they have the same number of atoms.Then :

A. y- will decay faste than x.

B. x - will decay faster than y.

C. x and y decay at the same rate always.

D. x and y have same decay rate initially and later on different decay rate.

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65. A capacitor is connected to a 20 V battery through a resistance of 10Ω. If is found that the potential difference across the capacitor rises to 2V in$1\mu s$. The capacitance of the capacitor is ________μF.

A. 9.52

B. 1.85

C. 0.95

D. 0.105

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66. The temperature of an ideal gas in 3- deimensions is 300 K. The corresponding de - Broglie wavelength of the electron approximately at 300 K , is :

[m_e = mass of electron $= 9 \times 10^{-31} kg$

h = Planck constant $= 6.6 \times 10^{-34} Js$

k_B = Boltzmann constant $= 1.38 \times 10^{-33} JK^{-1}$]

A. 2.26 nm

B. 3.25 nm

C. 8.46 nm

D. 6.26 nm

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67. A body of mass 'm' drpped from a height 'h' reaches the ground with a speed of 0.8$\sqrt{gh}$. The value of warkdone by the air-friction is ,

A. 1.64 mgh

B. mgh

C. 0.64 mgh

D. $-0.68mgh$

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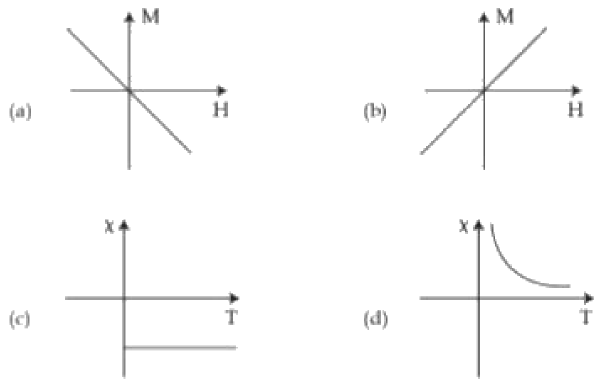
68. Following plots show Magnetization (M) vs Magnetising field (H) and Megnetic susceptibility (x) vs Temperature (T) graph :



Which of the following combination wioll be represented by a diamagnetioc material ?

A. a,d

B. a,c

C. b,d

D. b,c

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69. 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 :

A. $(4 \pm 0.3)\Omega$

B. $(4 \pm 0.4)\Omega$

C. $(2 \pm 0.4)\Omega$

D. $(2 \pm 0.3)\Omega$

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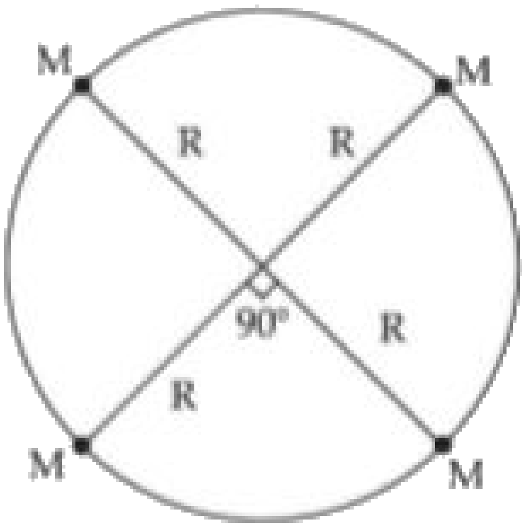
70. Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is :



A. $\frac{1}{2}\sqrt{\frac{GM}{R\left(2\sqrt{2}+1\right)}}$

B. $\frac{1}{2}\sqrt{\frac{GM}{R}(2\sqrt{2}-1)}$

C. $\frac{\sqrt{GM}}{R}$

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

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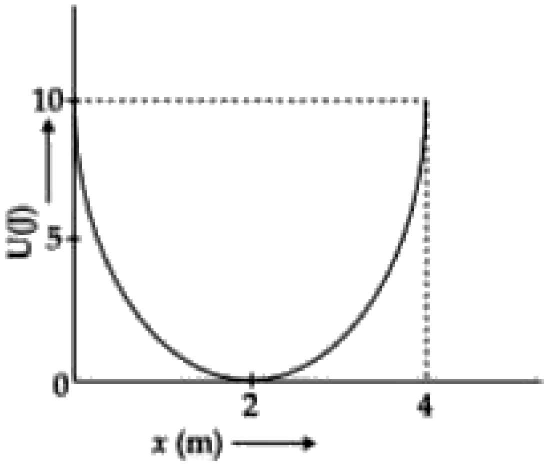
71. A mass of 5 kg is connected to a spring. The potential energy curve of the simple harmonic motion executed by the system is shown in the figure. A simple pendulum of length 4 m has the same period of oscillation as the spring system. What is the value of acceleration due to gravity on the planet where these experiments are performed ?



A. $10m / s^2$

B. $9.8m / s^2$

C. $4m / s^2$

D. $5m / s^2$

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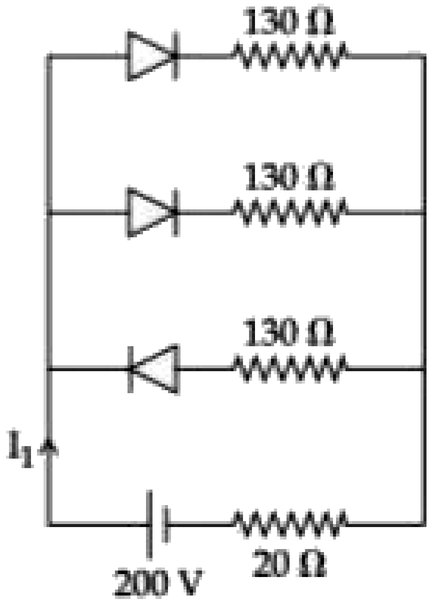
72. In the given figure, each diode has a forward bias resistance of 30Ω and infinite resistance in reverse bias. The current I_1 will be :



A. 3.75A

B. 2A

C. 2.35A

D. 2.73A

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73. The ranges and heights fo r 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. Then

A. $R_1 > R_2$ and $H_2 = H_2$

B. $R_1 = R_2$ and $H_1 = H_2$

C. $R_1 = R_2$ and $H_1 < H_2$

D. $R_1 < R_2$ and $H_1 < H_2$

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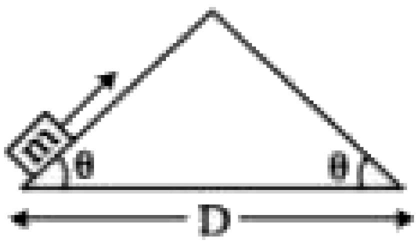
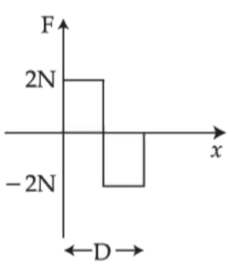
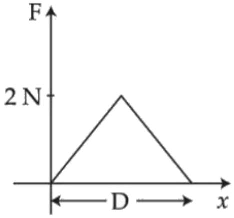
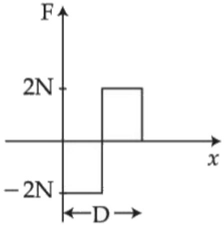
74. An object of mass 'm' is being moved with a constant velocity under the action of an applied force of 2N along a frictionless surface with following surface profile.

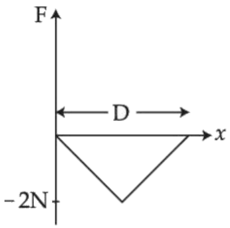


The correct applied force vs distance graph will be :

A. 

B. 

C. 

D. 

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75. A glass tumbler having irmer 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 ?

A. 10 cm

B. 11.7 cm

C. 7.5 cm

D. 8.75 cm

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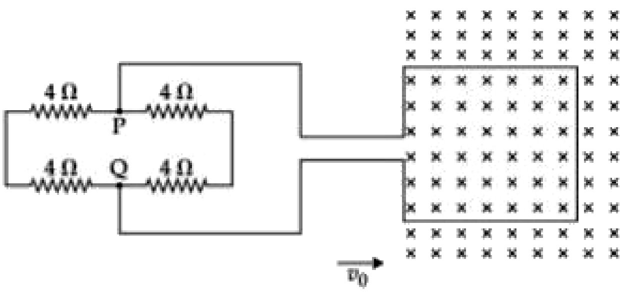
76. A square loop of side 20 cm and resistance 1Ω is moved towards right with a constant speed v_0. The right arm of the loop is in a uniform magnetic field of 5 T. The field is perpendicular to the plane of the loop and is going into it. The loop is connected to a network of resistors each of value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



A. $1cm / s$

B. $1m / s$

C. $10^2 m / s$

D. $10^{-2} cm / s$

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77. A student determined Young's Modulus of elasticity using the formula $Y = \frac{MgL^3}{4bd^3\delta}$. 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 :

A. 0.0155

B. 0.0083

C. 0.083

D. 0.155

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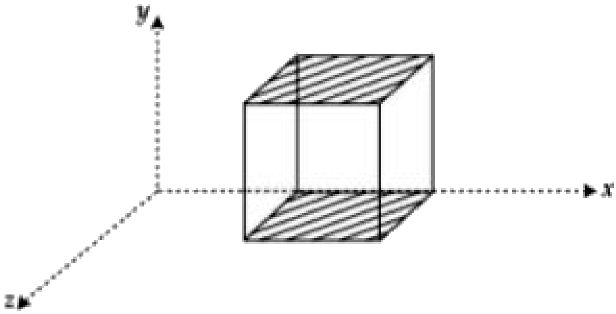
78. A cube is placed inside an electric field, $\overrightarrow{E} = 150y^2\hat{j}$. The side of the cube is 0.5 m and is placed in the field as shown in the given figure. The charge inside the cube is

:



A. $3.8 \times 10^{-11} C$

B. $8.3 \times 10^{-11} C$

C. $8.3 \times 10^{-12} C$

D. $3.8 \times 10^{-12} C$

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79. 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 $m = 8kg, M = 16mg$

Assume all the surfaces shown in the figure to be frictionless.

A. $\frac{3}{5}g$

B. $\frac{6}{5}g$

C. $\frac{4}{3}g$

D. $\frac{2}{3}g$

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80. Due to cold weather a 1 m water pipe of cross-sectional area $1cm^2$ is filled with ice at $-10^{\circ}C$. Resistive heating is used to melt the ice. Current of 0.5 A is passed through $4k\Omega$ 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 $= 3.33 \times 10^5 Jkg^{-1}$, specific heat of ice $= 2 \times 10^3 Jkg^{-1}$ and

density of ice $= 10^3 kg/m^3$)

A. 0..353s

B. 3.53s

C. 35.3s

D. 70.6s

Answer: C

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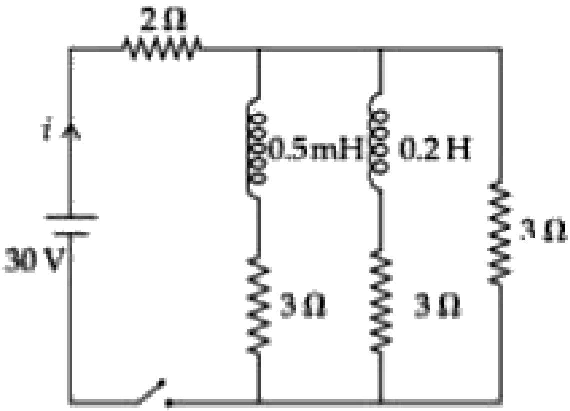
81. For the given circuit the current i through the battery when the key in closed and the steady state has been reached is ______ .



A. $0A$

B. $6A$

C. $10A$

D. $25A$

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Physics (Section B)

1. If the velocity of a body related to displacement x is given by $v = \sqrt{5000 + 24x}$ m/s, then the acceleration of the body is ______m / s^2.

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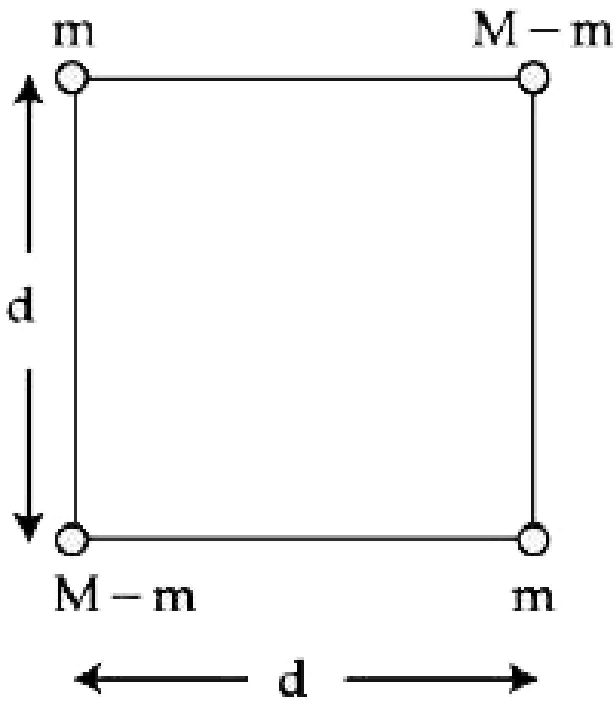
2. A body of mass (2M) splits into four masses $\{m, M - m, m, M - m\}$, which are rearranged to form a square as shown in the figure. The ratio of $\frac{M}{m}$ for which, the gravitational potential energy of the system becomes maximum is x : 1 . The value of x is

________.



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3. A transmitting antenna has a height of 320m and that of receiving antenna is 2000m. The maximum distance between them for satisfactory communication in line of sight mode is 'd'. The value of 'd' is __________km.

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4. A uniform conducting wire of length $12a$ and resistance R is wound up as a current carrying coil in the shape of (i) an equilateral triangle of side a, (ii) a square of sides a and, (iii) a regular hexagon of sides a. The coil is connected to a voltage source V_0. Find the magnetic moment of the coils in each case.

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5. Two cars X and Y are approaching each other with velocities 36km/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.

Watch Video Solution

6. 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 angles 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 ________.

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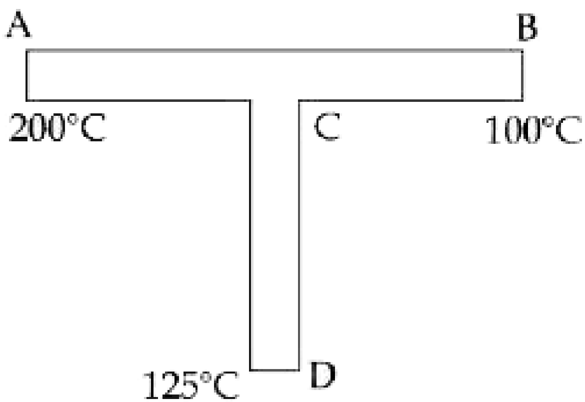
7. A rod CD of thermal resistance $10.0 KW^{-1}$ is joined at the middle of an identical rod AB as shown in figure. The ends A, B and D are maintained at $200^{\circ} C$, $100^{\circ} C$ and $125^{\circ} C$ respectively. The heat current in CD is P watt. The value of P is ________.



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8. 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.

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9. First , a set of n equal resistors of 10Ω each are connected in series to a battery of emf 20V and internal resistance 10Ω. 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 ___________.

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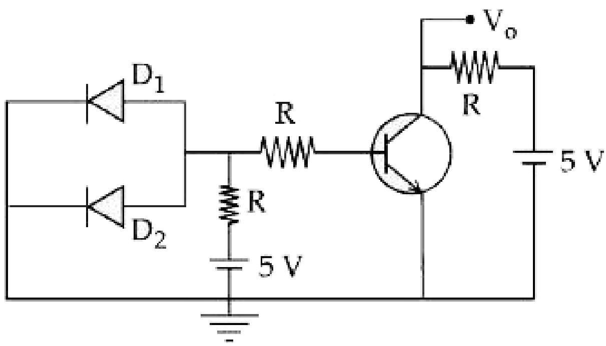
10. A circuit is arranged as shown in figure. The output voltage V_0 is equal to ___________V.



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11. 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________

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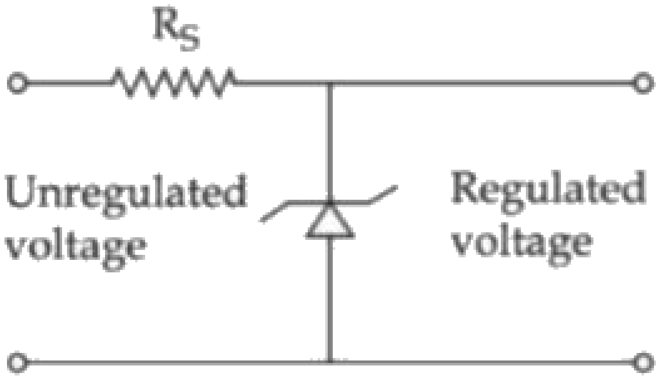
12. A zener diode of power rating 2 W is to be used as a voltage regulator. If the zener diode has a breakdown of 10 V and it has to regulate voltage fluctuated between 6 V and 14 V, the value of R_S for safe operation should be

________Ω.



A. 10 ohm

B. 20 ohm

C. 30 ohm

D. 40 ohm

Answer: option 2

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13. 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 _______

A. 1

B. 2

C. 3

D. 4

Answer: option 2

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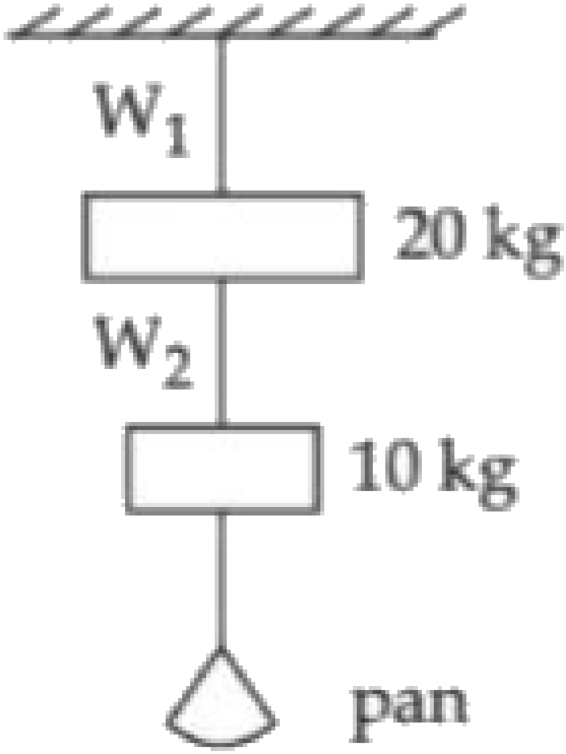
14. Wires W_1 and W_2 are made of same material having the breaking stress of $1.25 \times 10^9 N/m^2$. W_1 and W_2 have cross-sectional area of $8 \times 10^{-7} m^2$ and $4 \times 10^{-7} m^2$, respectively. Masses of 20 kg and 10 kg hang from them as shown in the figure. The maximum mass that can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



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15. 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

(Take speed of sound in air as $340ms^{-1}$)

A. 31 cm

B. 32 cm

C. 33 cm

D. 34 cm

Answer: option 4

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16. A heat engine operates between a cold reservoir at temperature $T_2 = 400K$ and a hot reservoir at temperature T . 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.

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17. 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 ___________.

Watch Video Solution

18. Two simple harmonic motion, are represented by the equations

$$y_1 = 10\sin\left(3\pi t + \frac{\pi}{3}\right)$$

$$y_2 = 5\left(\sin 3\pi t + \sqrt{3}\cos 3\pi t\right)$$

Ratio of amplitude of y_1 to $y_2 = x : 1$. The value of x is

____

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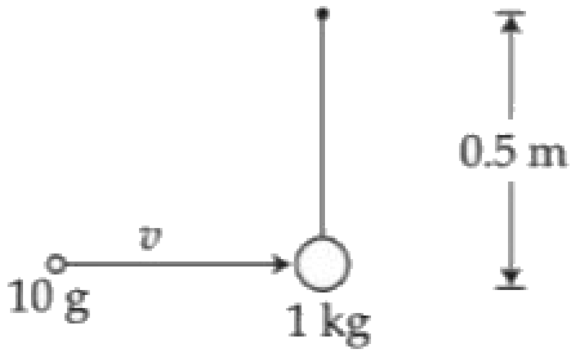
19. A bullet of 10 g, moving with velocity v, collides head-on with the stationary bob of a pendulum and recoils with velocity 100 m/s. The length of the pendulum is 0.5 m and mass of the bob is 1 kg. The minimum value of v= ____________ m/s so that the pendulum describes a circle.

(Assume the string to be inextensible and $g = 10m/s^2$)



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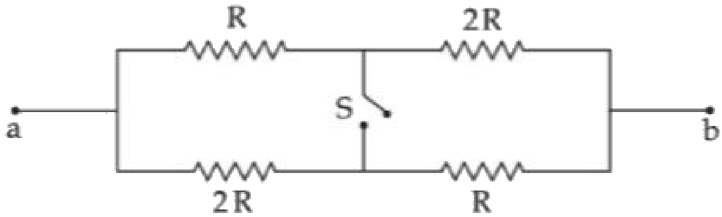
20. The ratio of the equivalent resistance of the network (shown in figure) between the points a and b when switch is open and switch is closed is x: 8. The value of x is__________



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21. 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.

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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 =________

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23. A square loop having resistance of each side as 3 ohm each is bent to form a circle. Then, the resistance across two diametric end points is?

Watch Video Solution

24. 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 = $9.8 \times 10^8 Nm^{-2}$ Density of sea water = $10^3 kgm^{-3}$

g = 9.8 $\frac{m}{s^2}$)

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25. A car is moving on a plane inclined at 30° to the horizontal with an acceleration of $10m/s^2$ parallel to the plane upward. A bob is suspended by a string from the roof. The angle in degrees which the string makes with the vertical is: (Assume that the bob does not move relative to car) $\left[g = 10m/s^2\right]$

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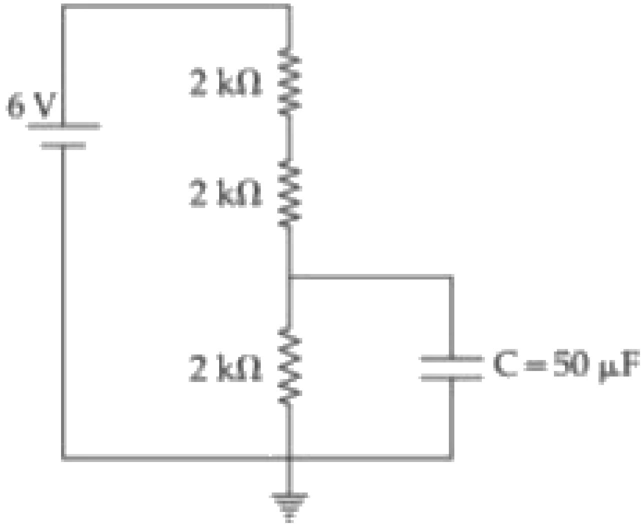
26. The electric field in an electromagnetic wave is given by $E = \left(50NC^{-1}\sin\omega(t - x/c)\right)$ The energy contained in a cylinder of volume V is 5.5×10^{-12} J. The value of V is $\_\_cm^3$. (given $\varepsilon_0 = 8.8 \times 10^{-12}C^2N^{-1}m^{-2}$)

Watch Video Solution

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

capacitor is________μ C



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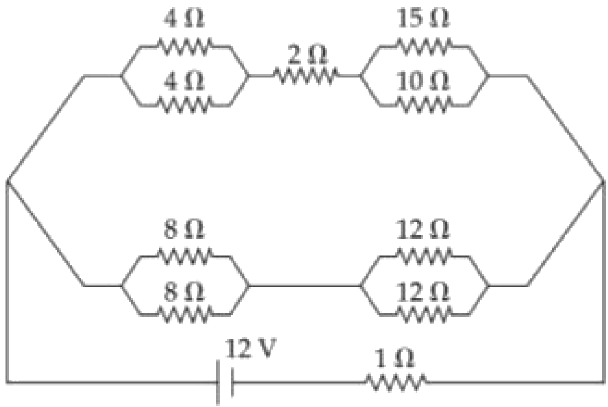
28. A particle of mass 1 kg is hanging from a spring of force constant 100 Nm^{1} . The mass is pulled slightly downward and released so that it executes free simple harmonic motion with time period T. The time when the kinetic energy and potential energy of the system will become equal, is $\frac{T}{x}$ The value of x is______

Watch Video Solution

29. The voltage drop across 15 ω resistance in the given figure will be______________



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30. 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)

Watch Video Solution

31. 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 aT, where a is a constant greater than 1.

The co-efficient of friction between the body and the rough plane is $\frac{1}{\sqrt{x}}\left(\frac{a^2-1}{a^2}\right)$ where x = ________.

Watch Video Solution

32. A uniform heating wire of resistance 36 $ohms$ is connected across a potential difference of 240 V. The wire is then cut into half and a 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 ________ .

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33. 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 $72kmh^{1}$ when the brakes tare 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 _______ $\times 10^{5}$ N/m.

Watch Video Solution

34. The temperature of 3.00 mo! of an ideal diatomic gas is increased by $40.0^{\circ}C$ 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 $R = 8.31 J mol^{-1} K^{-1}$)

Watch Video Solution

35. 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 _______.

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36. 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 ________ .

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

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38. A 2 kg steel rod of length 0.6 mis 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 $g = 10ms^{-2}$)

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39. 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.

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40. The average translational kinetic energy of N_2 gas molecules at ________ $^{\circ}C$ 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).

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Physics (Section A)

1. A fighter jet plane is flying horizontally drops a bomb find the nature of path of bomb as seen by pilot.

A. parabola in the direction of motion of plane

B. straight line vertically down the plane

C. hyperbola

D. parabola in a direction opposite to the motion of plane

2. An electric bulb rated 500 W at 100 V is used in a circuit having a 200 V supply. What resistance R must be put in series with the bulbs so that the bulb delivers 500 W?

A. 20Ω

B. 30Ω

C. 5Ω

D. 10Ω

3. 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 :

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

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

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

D. (a)-(ii), {b)-(iv), (c)-(i), (d)-(iii)

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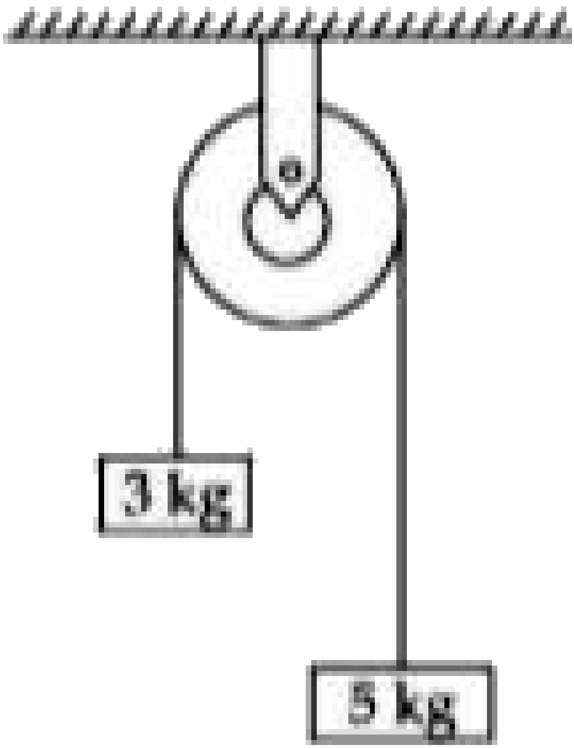
4. Two blocks of masses 3 kg and 5 kg are connected by a metal wire going over a smooth pulley. The breaking stress of the metal is $\frac{24}{\pi} \times 10^2 Nm^{-2}$. What is the minimum radius of the wire ?

(take $g = 10ms^{-2}$)



A. 1.25 Cm

B. 1250 cm

C. 12.5 cm

D. 125 cm

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5. 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 ?

A. $\frac{1}{9}E$

B. $\frac{7}{9}E$

C. E

D. $\frac{16}{9}E$

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6. 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 $3\times10^{7}ms^{-1}$. What is the maximum magnetic force exerted on the electron ?

A. $12.8\times10^{-18}N$

B. $1.28\times10^{-21}N$

C. $1.28 \times 10^{-18} N$

D. $12.8 \times 10^{-17} N$

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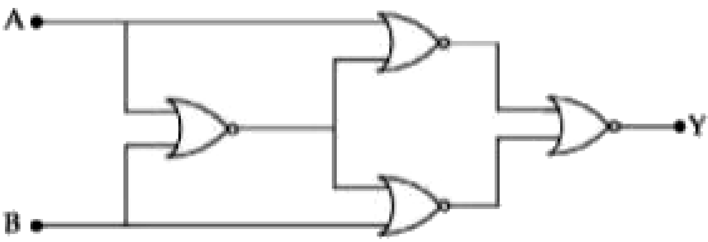
7. Four NOR gates are connected as shown in figure. The truth table for the given figure is :



A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

A.

B.

A	B	Y
0	0	1
0	1	0
1	0	1
1	1	0

C.

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

D.

A	B	Y
0	0	0
0	1	1
1	0	0
1	1	1

Answer: A

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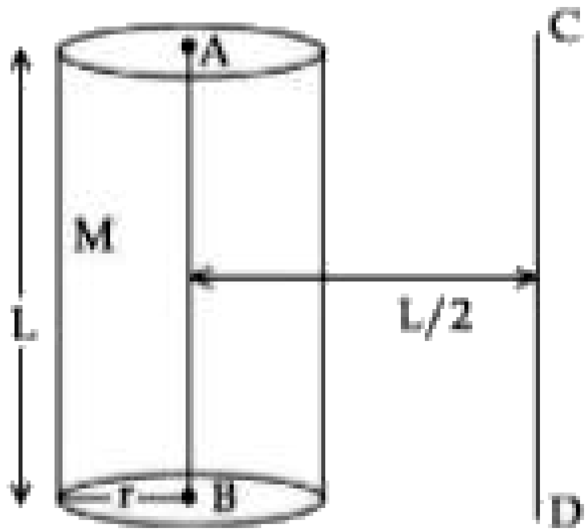
8. The solid cylinder of length 80 cm and mass M has a radius of 20 cm. Calculate the density of the material used if the moment of inertia of the cylinder about an axis CD parallel to AB as shown in figure is 2.7 kg m^2.



A. $1.49 \times 10^2 kg/m^3$

B. $7.5 \times 10^2 kg/m^3$

C. $14.9 kg/m^3$

D. $7.5 \times 10^1 kg/m^3$

Answer: A

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9. If you are provided a set of resistances 2Ω, 4Ω, 6Ω and 8Ω. Connect these resistances so as to obtain an equivalent resistance of $\frac{46}{3}\Omega$

A. 4Ω and 6Ω are in parallel with 2Ω and 8Ω in series

B. 2Ω and 6Ω are in parallel with 4Ω and 8Ω in series

C. 2Ω and 4Ω are in parallel with 6Ω and 8Ω in series

D. 6Ω and 8Ω are in parallel with 2Ω and 4Ω in series

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10. The temperature of equal masses of three different liquids x, y and z are $10^{\circ} C, 20^{\circ} C$ and $30^{\circ} C$ respectively. The temperature of mixture when x is mixed with y is $16^{\circ} C$ and that when y is mixed with z is $26^{\circ} C$. The temperature of mixture when x and z are mixed will be :

A. $25.62^{\circ} C$

B. $20.28^{\circ} C$

C. $28.32^{\circ} C$

D. $23.84^{\circ} C$

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11. 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 :

A. $\sqrt{rg}$

B. $\sqrt{2rg}$

C. $2\sqrt{rg}$

D. $\sqrt{\frac{rg}{2}}$

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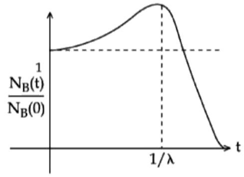
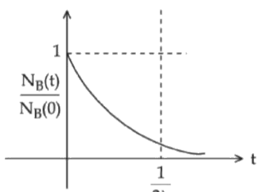
12. At time t = 0, a material is composed of two radioactive atoms A and B, where $N_{A0} = 2N_{B0}$.

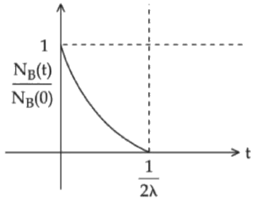
The decay constant of both kind of radioactive atoms is λ. However, A disintegrates to B and B disintegrates to C. Which of the following figures represents the evolution of $N_B(t)\,/\,N_B(0)$ with respect to time t?

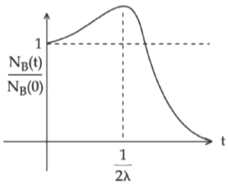
$[N_A(0) =$ No. of A atoms at t = 0]

$[N_B(0) =$ No. of B atoms at t= 0]

A. 

B. 

C. 

D. 

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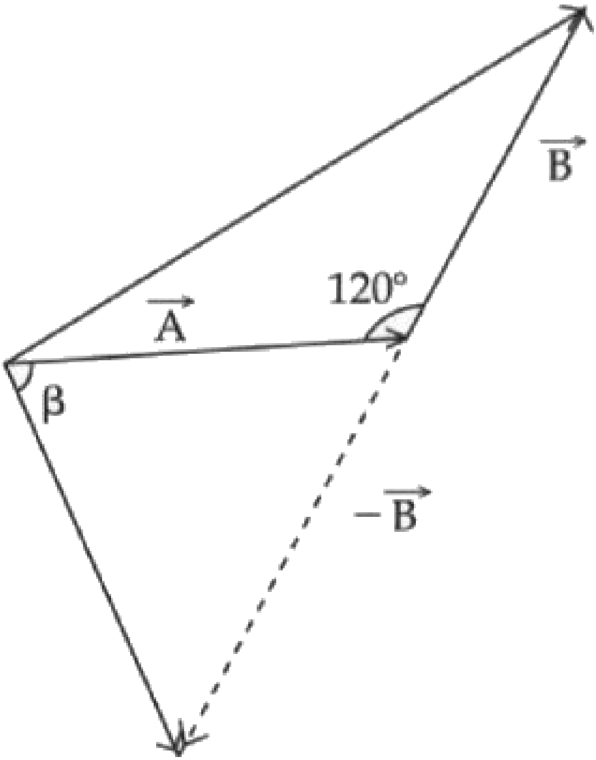
13. The angle between vector $\left(\vec{A}\right)$ and $\left(\vec{A}-\vec{B}\right)$ is :



A. $\tan^{-1}\left(\dfrac{-\frac{B}{2}}{A-B\frac{\sqrt{3}}{2}}\right)$

B. $\tan^{-1}\left(\dfrac{\sqrt{3}B}{2A-B}\right)$

C. $\tan^{-1}\left(\dfrac{A}{0.7B}\right)$

D. $\tan^{-1}\left(\frac{B\cos\theta}{A - B\sin\theta}\right)$

Answer: B

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

A. 86.4 s

B. 43.2 s

C. 4.32 s

D. 8.64 s

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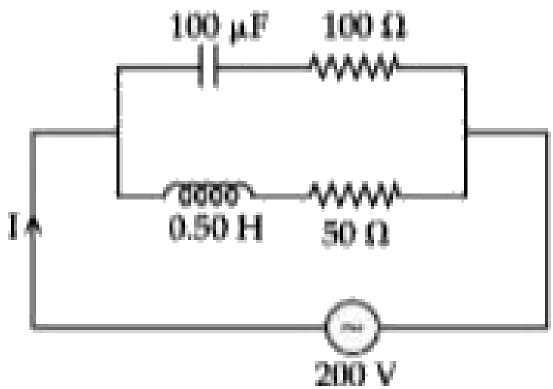
15. In the given circuit the AC source has $\omega = 100 rad s^{-1}$. Considering the inductor and capacitor to be ideal, what will be the current I flowing through the circuit ?



A. 0.94 A

B. 5.9 A

C. 3.16 A

D. 6A

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16. A cylindrical container of volume $4.0 \times 10^{-3} m^3$ 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 $8.3 J mol^{-1} K^{-1}$]

A. $24.\ 9 \times 10^3 Pa$

B. $249 \times 10^1 Pa$

C. $24.9 \times 10^5 Pa$

D. $24.9Pa$

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17. A refrigerator consumes an average 35 W power to operate between temperature - $10^{\circ}C$ to $25^{\circ}C$. If there is no loss of energy then how much average heat per second does it transfer ?

A. 298 J/s

B. 35 J/s

C. 350 J/s

D. 263 J/s

Answer: D

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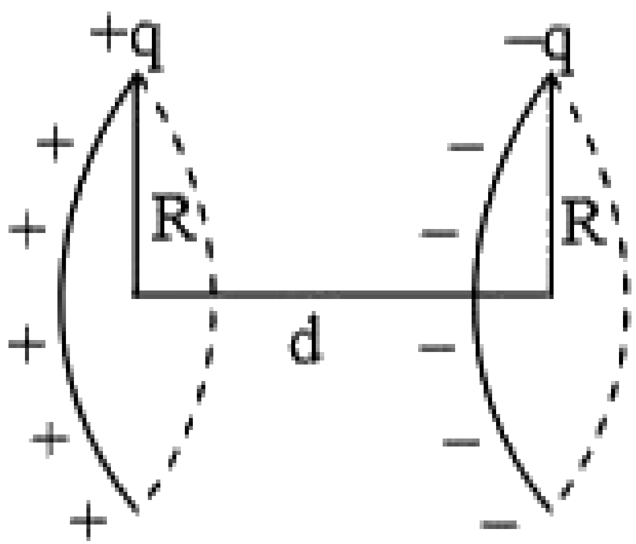
18. Two thin rings each of radius R are placed at a distance 'd' apart. The charges on the rings are +q and -q. The potential difference between their centres will be -



A. $\frac{Q}{2\pi es\pi_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

B. $\frac{Q}{2\pi es\pi_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$

C. $\frac{Q}{4\pi es\pi_0}\left[\frac{1}{a}-\frac{1}{\sqrt{s^2+a^2}}\right]$

D. $\frac{Q}{4\pi es\pi_0}\left[\frac{1}{a}+\frac{1}{\sqrt{s^2+a^2}}\right]$

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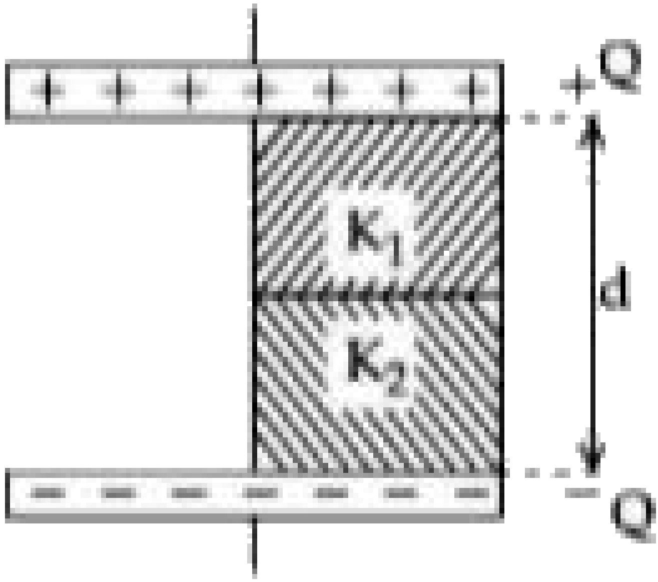
19. A parallel-plate capacitor with plate area A has separation d between the plates. Two dielectric slabs of dielectric constant K_1 and K_2 of same area $A/2$ and thickness $d/2$ are inserted in the space between the plates. The capacitance of the capacitor will be given by

:



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

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

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

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

Answer: B

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20. 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 the range of communication for Line of Sight (LoS) mode?

[use radius of earth = 6400 km]

A. 80.2 km

B. 45.5 km

C. 144.1 km

D. 57.28 km

Answer: D

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Physics (Section B)

1. If the maximum value of accelerating potential provided by a radio 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 ______

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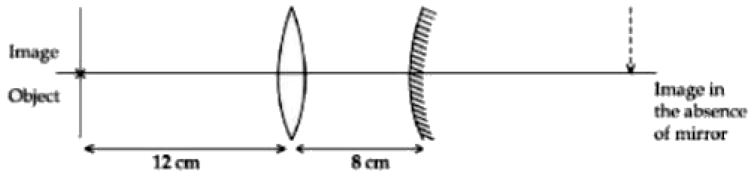
2. An object is placed at a distance of 12 cm from a convex lens. A convex mirror of focal length 15 cm is placed on other side of lens at 8 cm as shown in the figure. Image of object coincides with the object.



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) .

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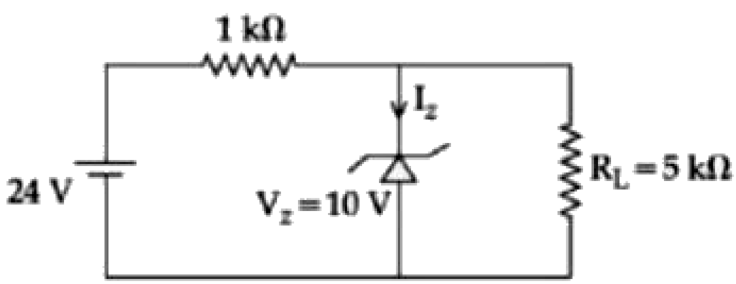
3. For the given circuit, the power across zener diode is _____ mW.



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4. The acceleration due to gravity is found upto an accuracy of 4% on a planet. The energy supplied to a simple pendulum of 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 __________%.

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5. 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).

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6. 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 $\frac{3I}{8}$

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7. 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 ____

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8. 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 $A_1 = 12mm$ and

$A_2 = 5mm, x_0 = 3.5$ cm and wave number $k = 6.28cm^{-1}$. The amplitude of resulting wave will be __________mm.

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9. 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.

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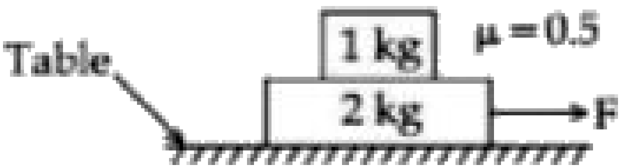
10. The coefficient of static friction between two blocks is 0.5 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is N. (take $g = 10ms^{-2}$)



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