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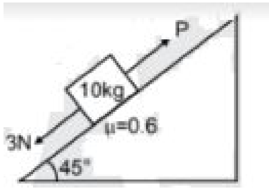
1. A block of mass 10 kg is kept on a rough inclined ash shown in figure. The coefficient of friction between the block and the surface is 0.6. Two forces of magnitudes 3N & P Newton are acting of the block as shown figure. If friction on the block is acting upwards then minimum value of P for which the block remains at rest is :



(1) 64 N (2) 32 N (3) 12 N (4) 3 N

Answer:

(2)

Solution:

Upward force = Downward force

mg $\sin\theta + 3 = p + 1$

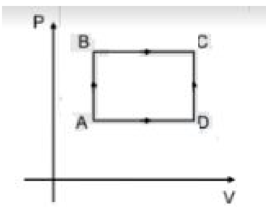
mg $\sin\theta + 3 = P + \mu(N)$

substituting

$$\frac{10\times10}{\sqrt{2}} + 3 = P + \frac{0.6\times10\times10}{\sqrt{2}}$$

Simplifying P = 32N

2.



For path ABC, Heat given to the system is 60 J and work done by the system is 30 J.

For path ADC, work done by the system is 10J. The heat given to the system for path ADC is

(1) 100 J (2) 80 J (3) 40 J (4) 60 J

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Answer:

(3)

Solution:

Change in Int energy should be same

In process ADC

$\Delta U = 60 - 30 = 30$

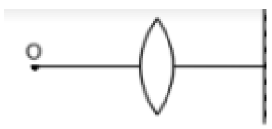
In process ABC

$\Delta Q = \Delta U + \Delta w$

$= 30 + 10$

$= 40$ J

3.



Initially an object is kept at a distance of 10 cm from the convex lens and a sharp image is formed at 10 cm ahead of lens on the screen. Now a glass plate of μ = 1.5 cm and thickness 1.5 cm is placed between object and lens. The distance by which the screen be shifted to get sharp image on the screen will be

(1) $\frac{9}{5}cm$ (2) $\frac{5}{9}cm$ (3) 1 cm (4) 5 cm

Answer:

(2)

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Solution:

$$\vartheta = u = 2f \Rightarrow f = 5cm$$

$$s = t\left(1 - \frac{1}{\mu}\right) = 1.5\left(1 - \frac{1}{312}\right) = 5$$

S is positive $\Rightarrow$ along incident ray

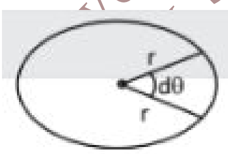
$U' = 9.5cm$ $\vartheta = ?$ $f = 5cm$

$$\frac{1}{\vartheta} = \frac{1}{f} + \frac{1}{u}$$

$$\Rightarrow \vartheta' = \frac{Uf}{U + f} = \frac{-(9.5)(5)}{-9.5 + 5} = \frac{47.5}{4.5}$$

Shift = $\vartheta^1 - \vartheta = 5/9$

4. A planet of mass m having angular momentum L is revolving around the sun. The aerial velocity fo the planet will be



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

Answer:

(2)

Solution:

For small $d\theta$ $dA = \frac{1}{2} r^2 d\theta$

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$$\frac{dA}{dt} = \frac{1}{2}r^2\frac{d\theta}{dt} = \frac{1}{2}r^2 w = \frac{L}{2m} = \{\because L = mr^2 w\}$$

5. The velocity of a particle $\vec{v}$ at any instant is $\vec{v} = y\hat{i} + x\hat{j}$. The equation of trajectory of the particle is:

(1) $x^2 + y^2$ = constant (2) $y^2 = x^2$ + constant

(3) xy = constant (4) None of these

Answer:

(2)

Solution:

$$\vartheta = yi + x\hat{j}$$

$$\frac{dx}{dt} = y \qquad xdx = ydy$$

$$\frac{dy}{dt} = x \qquad \frac{x^2}{2} + \frac{y^2}{2} = C$$

$$x^2 - y^2 = K$$

6. Initially block of mass M is at rest on a frictionless floor and the spring is in relaxed condition A constant force is applied on the block as shown in figure. The maximum velocity of block is :

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

Answer:

(1)

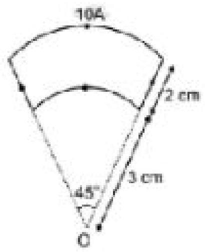
Solution:

$$\vartheta_{max} = Aw$$

$$= \frac{F}{K}\sqrt{\frac{K}{m}}$$

$$= \sqrt{\frac{F}{Km}}$$

7. Magnetic field at point O is



(1) 1.5×10^{-5} (2) 10^{-5} (3) 2×10^{-5} (4) 10^{-4}

Answer:

(2)

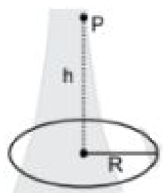
Solution:

$$B_O = B_{AB} + B_{BC} + B_{CD} + B_{OA}$$

$$= O + \frac{\mu o I \vartheta}{4\pi r_{BC}} + O + \frac{\mu o I \vartheta}{4\pi r_{OA}}$$

Substituting values we get $B_O = 10^{-5}$

8. Charge Q is uniformly distributed over a ring of radius R. The height h, on the axis of the ring at which electric field is maximum



(1) $\frac{R}{\sqrt{2}}$ (2) $\frac{R}{2}$ (3) R (4) None of these

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Answer:

(1)

Solution:

E (along) axis of circular coil $= \dfrac{kQh}{(h^2+R^2)^{3/2}}$

for max value of E $\dfrac{dE}{dh}=O$

Differentiating E w.r.t.h and equating it to O

we get $h=\dfrac{\pm R}{\sqrt{2}}$

9. Two radioactive elements A & B have initially activity 10 curie & 20 curie respectively. If A has twice the no. of moles as that of B. The decay constant λ_A & λ_B can be

(a) (10, 5) (b) (5, 20) (c) (20, 10) (d) (50, 100)

Answer:

(2)

Solution:

Conceptual; $\lambda N = A$ $\dfrac{\lambda_A}{\lambda_B}\dfrac{N_A}{N_B}=\dfrac{A_A}{A_B}$

$N_A/N_B=2 \quad \Rightarrow \quad \lambda_A/\lambda_B=\lambda/4$

10. A conducting loop of resistance 10Ω and area $3.5\times10^{-3}\ m^2$ is placed in uniform and time varying magnetic field B = 0.4 sin (50πt). The Charge passing through the loop in t = 0 to t = 10 ms is :

(1) 140 μC (2) 70 μC (3) 280 μC (4) 100 μC

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Answer:

(1)

Solution:

$$Q = \frac{\Delta\varphi}{R} \qquad \varepsilon = \frac{d\varphi}{dt}$$

$$iR = \frac{d\varphi}{dt}$$

$$\frac{dQ}{dt}R = \frac{d\varphi}{dt}$$

$$\int dQ = \int R d\varphi$$

$$Q = \frac{1}{R}\int dQ$$

$$= \frac{1}{R}A\int_0^{10ms} B\,dt$$

$$= \frac{1}{R}3.5\times10^{-3}\int_0^{10ms} 0.4\sin(50\pi t)dt$$

=140 μc

11. If current in a current carrying wire is 1.5A, number of free electrons per unit volume is $8\times10^{28} m^3$ and area of cross section is 5 mm². Drift velocity of electrons will be

(1) 0.2 mm/s (2) 2 mm/s (3) 0.2 mm/s (4) None of these

Answer:

(1)

Solution:

i = e n A V_d (relation between i and v_d)

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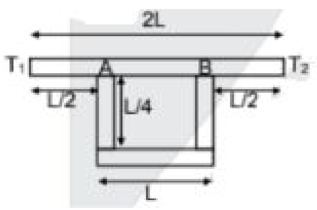
$$V_d = \frac{i}{enA} = \frac{1.5}{1.6\times10^{-19}\times5\times10^{-6}\times8\times10^{28}} = 0.02$$

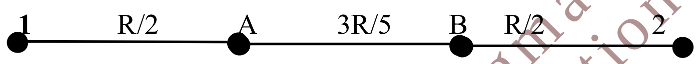
12.



If temperature difference $T_1 - T_2$ is 120°C. The temperature difference between points A & B is

(1) 30 (2) 45 (3) 60 (4) 75

Answer:



(2)

Solution: effective resistence between A and B is

$$\frac{\frac{3R.1^2}{\cancel{2}}}{\frac{3R+2R}{\cancel{2}}} = \frac{3R^{\cancel{2}}}{5\cancel{R}}$$

effective resistence between 1 and 2 is

$$\frac{R}{2}+\frac{R}{2}+\frac{3R}{5}$$

$$R+\frac{3R}{5}=\frac{8R}{5}$$

$$\frac{T_A - T_B}{3R/5} = \frac{T_1 - T_2}{8R/5}$$

$$T_A - T_B = (\cancel{120})15\times\frac{3}{\cancel{8}} = 45^\circ$$

13.

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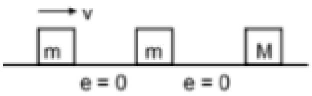


Three blocks m, m and M are kept on a frictionless floor as shown in figure. The left most block is given velocity v towards right. All the collisions between the blocks are perfectly inelastic. The loss in kinetic energy after all the collisions is 5/6th of initial kinetic energy. The ratio of M/m will be:

(1) 1/8 (2) 1/4 (3) 4 (4) 2

Answer:

(3)

Solution:

$$\frac{mu}{2m+M} = V_f \qquad K_f = \frac{1}{6}K_1$$

$$\frac{1}{2}\frac{P^2}{2m+M} = \frac{1}{6}\frac{1}{2}\frac{P^2}{m}$$

$$6m = 2m + M = 4m = M$$

14. In mixture 2 mole of He and 1 mole of Ar is present. Find $\frac{(V_{RMS})_{He}}{(V_{RMS})_{Ar}}$ $at\, 300\, k$.

(1) 6.32 (2) 1.58 (3) 3.16 (4) 10

Answer:

(3)

Solution:

$$V_{RMS} \;\; \alpha \sqrt{m} \qquad V_{RMS}{}^{2} \sqrt{\frac{3RT}{M}}$$

15. Light of wavelength λ_1 = 340 nm and λ_2 = 540 nm are incident on a metallic surface. If the ratio of the speed of the electrons ejected is 2. The work function of the metal is

(1) 1 eV (2) 1.85 eV (3) 1.5 eV (4) 2 eV

Answer:

(2)

Solution:

$$\frac{hc}{\lambda_1} = \phi + \frac{1}{2} m (\text{mv})^2 \qquad 1$$

$$\frac{hc}{\lambda_2} = \phi + \frac{1}{2} m V^2 \qquad 2$$

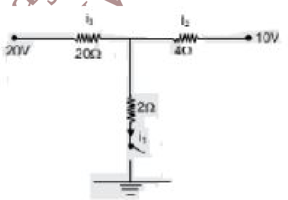
$$sub \quad 2 \quad in \quad 1$$

$$\frac{hc}{\lambda_1} = \phi + 4\left(\frac{hc}{\lambda_2} - 4\right)$$

$$3\phi = 4\left(\frac{12375}{5400}\right) - \frac{12375}{3400}$$

$$\phi = 1.838 \quad \sim \quad 1.85$$

16. Value of i_1 (Ampere) when switch is closed is.



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

Answer:

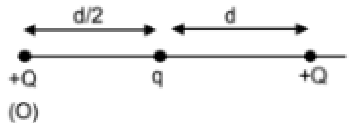
(2)

Solution:

$$\frac{v_0 - 20}{2} = \frac{v - 10}{4} = \frac{v - 0}{2}$$

$\Rightarrow V = 10 \qquad i = \frac{10}{2} = 5A$

17. If net force on charge kept at O is zero. The value of charge q is :



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

Answer:

(4)

Solution:

Net force of $q = 0 \Rightarrow \frac{KQq}{(d/2)_2} + \frac{KQq}{d^2} = 0$

$\therefore q = -\frac{Q}{4}$

18. If value of electric field $E = 6.3 \times 10^{27}\ volt/m$ for a electromagnetic wave. The value of magnetic field B will be:

(1) $5 \times 10^{-19} T$ (2) $2.1 \times 10^{19} T$ (3) $5 \times 10^{-20} T$ (4) $2.1 \times 10^{20} T$

Answer:

(2)

Solution:

$\frac{E}{B} = C \qquad \Rightarrow \qquad B = \frac{E}{C}$

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19. Two coherent light sources having intensity I1 and I2. If ratio of $\frac{I_{max}}{I_{min}}$ is 6 : 1. Find $\frac{I_1}{I_2}$?

(1) $\frac{16}{9}$ (2) $\frac{9}{16}$ (3) $\frac{4}{1}$ (4) $\frac{25}{9}$

Answer:

(4)

Solution:

$$\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_1}+\sqrt{I_2}\right)^2}{\left(\sqrt{I_1}-\sqrt{I_2}\right)^2} \qquad \textit{simplify we get } \frac{I_1}{I_2} = \frac{25}{9}$$

20. If length of resistance wire is increased by 0.5 % keeping the volume constant then change in resistance will be

(1) 0 % (2) 1% (3) 0.5% (4) 2%

Answer:

(2)

Solution:

$$R = \frac{\rho l \times l}{a \times l} = \frac{\rho l^2}{V}$$

$$R \, \alpha \, l^2$$

$$1\omega \times \frac{\Delta R}{l^2} = 2\left(\frac{\Delta l}{l} \times 100\right)$$

$$= 2(0.5)$$

$$100 \times \frac{\Delta R}{l^2} = 1\%$$

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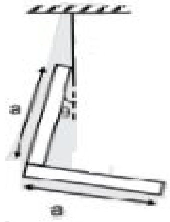
21. A uniform L shaped rod each of side A is held as shown in the figure. The angle θ such that rod remain stable will be.



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

Answer:

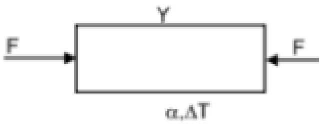
(2)

Solution:

Clockwise torque = anti clockwise torque

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

22. A rod of acted by two equal forces as shown in the figure. The coefficient of thermal expansion of the rod is α and area of cross section is A. When the temperature the rod increased by Δ t. The length of the rod does not change. The young's modulus Y will be.



(1) $\frac{F}{2A\alpha\Delta T}$ (2) $\frac{F}{A\alpha\Delta T}$ (3) $\frac{2F}{A\alpha\Delta T}$ (4) $\frac{F}{3A\alpha\Delta T}$

Answer:

(2)

Question:

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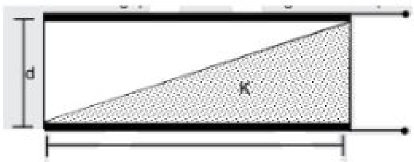
$$\Delta l = l\alpha \qquad ......1$$

$$\Delta l = \frac{Fl}{Ay} \qquad ......2$$

$$From\ 1\ and\ 2 \qquad l\,\alpha\,\Delta T = \frac{F\,l}{Ay}$$

$$Y = \frac{F}{A\alpha\Delta T}$$

23. A capacitor is formed by two square metal-plates of edge a, separated by a distance d. Dielectric of dielectric constants K is filled in the gap as shown in the figure. The equivalent capacitance is



(1) $\frac{k\varepsilon_0 a^2 \ln k}{d(k-1)}$ (2) $\frac{k\varepsilon_0 a^2 \ln k}{d(k-2)}$ (3) $\frac{k\varepsilon_0 a^2 \ln k}{2d(k-1)}$ (4) $\frac{2k\varepsilon_0 a^2 \ln k}{d(k-1)}$

Answer:

(1)

Solution:

$$\left\{\frac{y}{d} = \frac{x}{a}\right\} \qquad ....1$$

$$d\,C_2 = \frac{\varepsilon_0\ adx}{(d-y)}$$

$$d\,C_1 = \frac{K\varepsilon_0\ adx}{y}$$

$$d\,C_{eq} = \left(\frac{dC_1\ \ dC_2}{da + dC_2}\right) = \frac{\varepsilon_0\,a\,dx}{\left(\frac{C_1}{K}\right) + \left(\frac{d-y}{1}\right)} \qquad ....2$$

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$$C_{eq} = \int_0^a \frac{\varepsilon_0 a\, dx}{\frac{y}{k} + \frac{(d-y)}{1}}$$

Integrating we get option 1

24. In a semiconductor mobility of electron, i.e. drift velocity per unit applied electric field is 1.6 (S.I unit). Density of electron is $10^{19}/m^3$. (Neglect holes concentration). Resistivity of semi conductor is :-

(1) 0.4 Ωm (2) 2 Ωm (3) 4 Ωm (4) 0.2 Ωm

Answer:

(1)

Solution:

$$\sigma = ne\mu \;\Rightarrow\; \rho = \frac{1}{ne\mu}$$

$$\frac{1}{10^{19} \times 1.6 \times 10^{-19} \times 1.6} = 0.4\Omega m$$

25. A block of mass M is hanging by a string of negligible mass in a car. The speed of wave in the string 60 m/s. Now car is accelerated horizontally by an acceleration a the speed of wave in the string is 60.5 m/s. What is a in terms of g?

(1) $\frac{g}{5}$ (2) $\frac{g}{10}$ (3) $\frac{g}{\sqrt{30}}$ (4) $\frac{g}{30}$

Answer:

(3)

Solution:

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$$v=\sqrt{\frac{ma}{M}} \qquad V\,\alpha\,\sqrt{a_{eft}}$$

$$\frac{\sqrt{g^2+u^2}}{g}=\left(\frac{60.5}{60}\right)$$

$$\frac{g\sqrt{1+\left(\frac{a}{g}\right)^2}}{g}=\left(\frac{60.5}{60}\right)$$

$$\left(1+\frac{1}{2}\frac{a}{g}\right)=\left(\frac{60.5}{60}\right)=\left(\frac{60+\frac{1}{2}}{60}\right)$$

$$\text{Simplifying } a={g}/{\sqrt{30}}$$

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