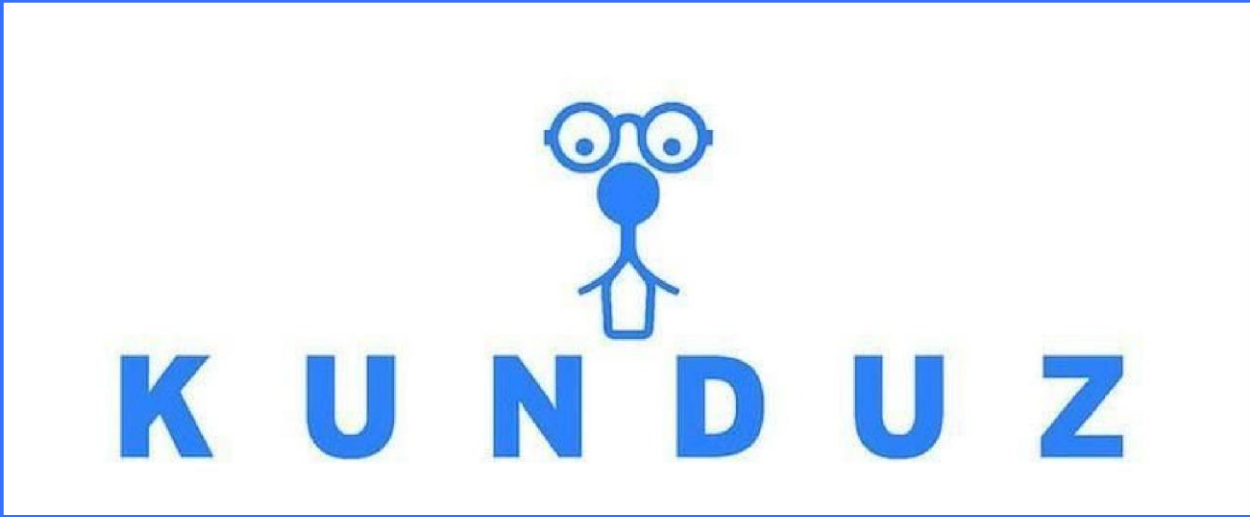


JEE Mains 4th September 2020 shift 1 Physics solutions prepared by KUNDUZ tutors

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Question number

1

Question and Answers

Q1) A small bar magnet is placed with its axis at 30° with the external magnetic field of 0.06 T, experiences a torque of 0.018 N. The minimum work required to rotate it from its stable to unstable position is.

1) 9.3×10^{-3} J
2) 11.7×10^{-3} J
3) 6.4×10^{-2} J
4) 7.2×10^{-2} J

sol)

At stable equilibrium position :

$$\tau = MB\cos(0^\circ), \quad U = -MB\cos(0^\circ)$$

At unstable equilibrium position:

$$\tau = MB\cos(180^\circ), \quad U = -MB\cos(180^\circ)$$

Given $\tau = 0.018 = M \times 0.06 \sin(30^\circ)$

$$\Rightarrow M = \frac{0.018 \times 2}{0.06} = \boxed{0.6\ Am^2}$$

$$\Rightarrow U_{Stable} = -MB = 0.036(-1)\,J$$

$$U_{unstable} = -MB(-1) = 0.036\,J$$

$$\Rightarrow \Delta U = U_{unstable} - U_{Stable} = 0.036 - (-0.036)$$

$$= 2 \times 0.036 = \boxed{0.072\ J}$$

$$\Rightarrow \boxed{\Delta U = 7.2 \times 10^{-2}\ J}$$

Thus, option 4 is correct.

2

Q2) On the x axis and at a distance x from origin, the gravitational field due to mass distribution is given by $\frac{Ax}{(x^2+a^2)^{3/2}}$ in the x direction. The magnitude of gravitational potential on x axis at distance x, taking value to be zero at infinity.

1) $\frac{A}{(x^2+a^2)^{3/2}}$ 2) $A(x^2+a^2)^{3/2}$ 3) $A(x^2+a^2)^{1/2}$

4) $\frac{A}{(x^2+a^2)^{1/2}}$

sol) We know that $E = -\frac{dV}{dx}$

$\Rightarrow dV = -E\,dx$

Integrating both the sides

$\Rightarrow \int_0^V dV = -\int_\infty^x E\,dx$

$\Rightarrow V = -\int_\infty^x \frac{Ax}{(x^2+a^2)^{3/2}}\,dx$

Let $a^2+x^2 = t \Rightarrow 2x\,dx = dt$

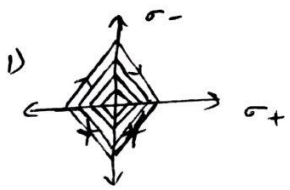
$\Rightarrow V = -\int_\infty^{x^2+a^2} \frac{A}{2} t^{-3/2}\,dt = -\frac{A}{2}(-2)\left[\frac{1}{\sqrt{t}}\right]_\infty^{a^2+x^2}$

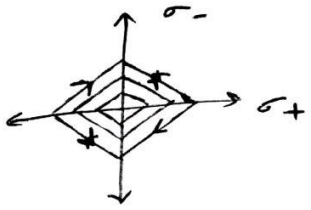
$\Rightarrow \boxed{V = \frac{A}{(x^2+a^2)^{1/2}}}$

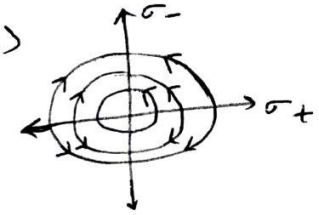
Thus, option 4 is correct.

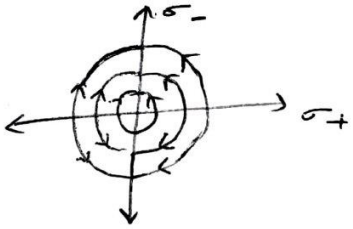
3

Q3> Two charged thin infinite plane sheets of uniform charge density σ_+ and σ_- where $|\sigma_+| > |\sigma_-|$, intersect at right angles. Which of the following best represents the electric field lines for the system.

1) 

2) 

3) 

4) 

Sol> Electric field due to infinite charged plane is constant.

The resultant between the two planes is a linear vector from positive plane to negative plane.

Since $|\sigma_+| > |\sigma_-|$, electric field lines are more towards σ_+ plane.

Thus, option 2 is correct.

4

Q4) A beam of plane polarised light of large cross-sectional area and uniform intensity of $3.3\ W\,m^{-2}$ falls normally on a polarizer (cross-sectional area $3\times10^{-4}\ m^2$) which rotates about its axis with an angular speed of 31.4 rad/s. The energy of light passing through the polariser per revolution is close to:

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

Sol) we know that $I = I_0\cos^2(\theta)$

$\Rightarrow$ energy per second $= E = 3.3\times A\cos^2(\theta)$

$\Rightarrow E = 9.9\times10^{-4}\cos^2(\theta)$

$\Rightarrow E_{avg} = 9.9\times10^{-4}\dfrac{\int_0^{2\pi}\cos^2(\theta)\,d\theta}{\int_0^{2\pi}d\theta}$

$\Rightarrow E_{avg} = \dfrac{9.9\times10^{-4}}{2}$

It takes $t = \dfrac{2\pi}{31.4}$ sec to complete one revolution.

$\Rightarrow E_{Total} = \dfrac{9.9\times10^{-4}}{2}\times\dfrac{2\pi}{31.4} = 9.9\times10^{-5}$

$\Rightarrow E_{Total} \approx 10\times10^{-5} = \boxed{1.0\times10^{-4}\ J}$

5

Q5) Choose the correct option relating wavelengths of different parts of electromagnetic wave spectrum.

1) $\lambda_{radiowaves} > \lambda_{microwaves} > \lambda_{visible} > \lambda_{x\,rays}$

2) $\lambda_{visible} < \lambda_{microwaves} < \lambda_{radiowaves} < \lambda_{x\,rays}$

3) $\lambda_{visible} > \lambda_{x\,rays} > \lambda_{radiowaves} > \lambda_{microwaves}$

4) $\lambda_{x\,rays} < \lambda_{microwaves} < \lambda_{radiowaves} < \lambda_{visible}$.

Sol) Frequency order of electromagnetic waves is as follows:

Gamma > X > Ultraviolet > Visible > IR > microwave > Radio waves.

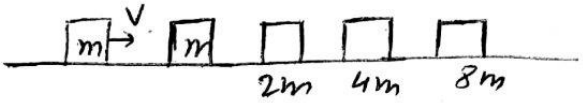
$\Rightarrow$ Wavelength order is:

Radiowaves > microwaves > IR > Visible > UV > Xrays > Gamma rays.

This option 1 is correct.

6

Q6) Blocks of masses of m, 2m, 4m and 8m are arranged in a line of a frictionless floor. Another block of mass m, moving with speed v along the same line collides with mass m in perfectly in elastic manner. All the subsequent collisions are also perfectly inelastic. By the time the last block of mass 8m start moving the total energy loss is p% of the original energy. Value of p is close to :



1) 87 2) 37 3) 77 4) 94

Sol) When all the masses are stick together,

$$\text{mass} = m' = m + m + 2m + 4m + 8m$$
$$= 16m$$

By conservation of momentum :

$$mv = 16mv'$$
$$\Rightarrow v' = \frac{v}{16}$$

$$\Rightarrow \Delta KE = \left| \frac{1}{2} \times 16m \left(\frac{v}{16}\right)^2 - \frac{1}{2}mv^2 \right|$$
$$= \frac{1}{2}mv^2 \left(\frac{15}{16}\right)$$

$$\Rightarrow p = \frac{15}{16} \times 100 = \boxed{93.75\%}$$

Thus, option 4 is correct.

7

Q7> A particle of mass $m_A = \frac{m}{2}$ moving along the x axis with velocity v_0 collides elastically with another particle B at rest having mass $m_B = \frac{m}{3}$. If both the particles move along the x axis after the collision, the change $\Delta\lambda$ in the wavelength of particle A, in terms of its de-Broglie wavelength (λ_0) before the collision is.

1> $\Delta\lambda = 2\lambda_0$ 2> $\Delta\lambda = 4\lambda_0$ 3> $\Delta\lambda = \frac{3}{2}\lambda_0$ 4> $\Delta\lambda = \frac{5}{2}\lambda_0$

Sol) Let speed of A and B be v_A and v_B after collision.

By conservation of momentum :

$$\frac{m}{2}v_0 = \frac{m}{2}v_A + \frac{m}{3}v_B \Rightarrow 3v_0 = 3v_A + 2v_B \quad -①$$

$$e = 1 = \frac{v_B - v_A}{v_0} \Rightarrow v_0 = v_B - v_A \quad — ②$$

$① + 3 \times ② \Rightarrow 6v_0 = 5v_B \Rightarrow \boxed{v_B = \frac{6v_0}{5}} \Rightarrow \boxed{v_A = \frac{v_0}{5}}$

$$\lambda_0 = \frac{h}{\frac{m}{2}v_0} = \frac{2h}{mv_0}$$

$$\lambda = \frac{h}{\frac{m}{2}\frac{v_0}{5}} = \frac{10h}{mv_0} \Rightarrow \Delta\lambda = \frac{10h}{mv_0} - \frac{2h}{mv_0} = \frac{8h}{mv_0}$$

$$\Rightarrow \Delta\lambda = 4 \times \frac{2h}{mv_0} \Rightarrow \boxed{\Delta\lambda = 4\lambda_0}$$

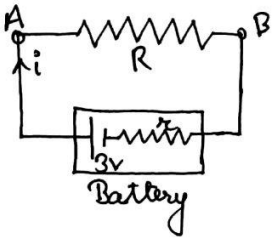
Thus, option 2 is correct.

8

Que 8) A battery of 3.0 V is connected to a resistor dissipating 0.5 W of power. If the terminal voltage of the battery is 2.5 V, the power dissipated within the internal resistance is

(I) 0.125 W (II) 0.5 W (III) 0.10 W (4) 0.072 W

Ans ⇒



Given

Power (R) = 0.5 W

$i^2 R = 0.5 \longrightarrow (1)$

Also $V_{AB} = 2.5\ V$

$iR = 2.5 \longrightarrow (2)$

Dividing (1) by (2)

$$i = \frac{0.5}{2.5} = 0.2\ A \Rightarrow R = \frac{2.5}{2} = 12.5\ \Omega$$

By series law, $i = \frac{3}{R+r} \Rightarrow \frac{1}{5} = \frac{3}{12.5+r}$

$\Rightarrow r = 2.5\ \Omega$

Power dissipated by $r_0 = i^2 R$

$$= \frac{1}{25} \times 2.5 = \frac{1}{10}$$

$= 0.1$ W (option (III))

9

Q 9) The specific heat of water = 4200 J/kg K and the latent heat of ice = 3.4×10^5 J/kg. 100 g of ice is placed in 200 g of water at 25°C. The amount of ice that will melt as the temperature of water reaches 0°C is close to (in gm)

1) 61.7 2) 69.3 3) 64.6 4) 63.8

sol)

Heat given by water to come from 25°C to 0°C = Q

$\Rightarrow Q = 0.2 \times 4200 \times (25-0)$

$= 21000$ J.

This heat melts ice.

Let m be mass of melted ice.

$\Rightarrow m \times 3.4 \times 10^5 = 21000$

$\Rightarrow m = 0.0617$ kg

$\Rightarrow \boxed{m = 61.7 \text{ g}}$

Thus, option 1 is correct.

10

Q10> Match C_P/C_V ratio for ideal gases with different type of molecules:

Molecule Type	C_P/C_V
A> Monoatomic	I> 7/5
B> Diatomic rigid	II> 9/7
C> Diatomic non-rigid	III> 4/3
D> Triatomic rigid.	IV> 5/3

1> A - III, B - IV, C - II, D - I

2> A - IV, B - I, C - II, D - III

3> A - IV, B - II, C - I, D - III

4> A - II, B - III, C - I, D - IV

Sol> $C_P/C_V = 1 + 2/f = \gamma$

A → For monoatomic gas

$f = 3 \Rightarrow \gamma = 1 + \frac{2}{3} = \boxed{\frac{5}{3}}$

B> For Diatomic rigid gas.

$f = 5, \Rightarrow \gamma = 1 + \frac{2}{5} = \boxed{\frac{7}{5}}$

C → For diatomic non rigid gas:

$f = 7 \Rightarrow \gamma = 1 + \frac{2}{7} = \boxed{9/7}$

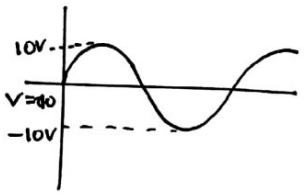
D → For triatomic rigid molecule

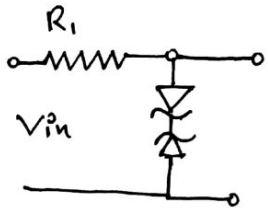
$f = 6 \Rightarrow \gamma = 1 + \frac{2}{6} = \boxed{4/3}$

Thus, option 2 is correct.

11

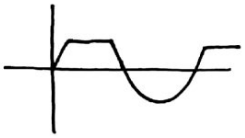
Que 11) Take the breakdown voltage of the zener diode used in the given circuit as 6V. For the input voltage shown in the figure below, the time variation of the output voltage is:



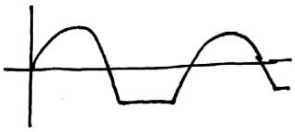


(Graph not to scale)

(1)



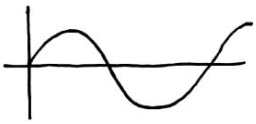
(2)



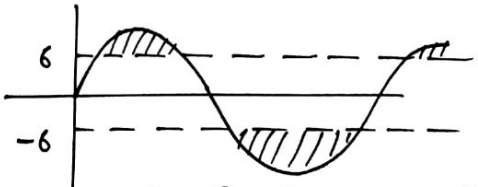
(3)



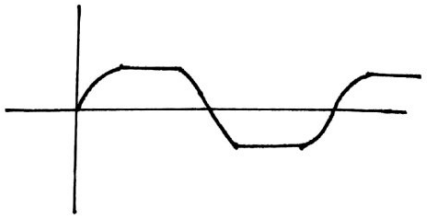
(4)



Ans) By the property of zener diodes, the circuit is short and the ~~current~~ output voltage will be 6 V for any $V_{in} > 6$. So, in the input voltage



The output voltage in shaded region will be constant 6V. ie.



option (3)

12

Q12) An air bubble of radius 1 cm in water has an upward acceleration of $9.8\ cm/s^2$. The density of water is $1\ gm\ cm^{-3}$ and water offers negligible drag force on the bubble. The mass of the bubble is? ($g = 980\ cm/s^2$) 1) 4.15 g 2) 1.52 g 3) 4.51 g 4) 3.15 g

Sol) Let mass of bubble be m.

Volume $= V = \frac{4}{3}\pi r^3 = \frac{4\pi}{3} \times 1^3 = \frac{4\pi}{3}\ cm^3$

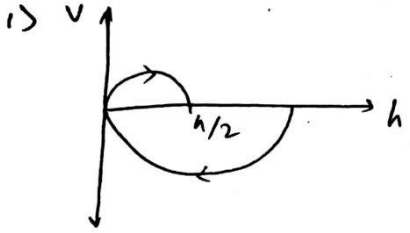
$\Rightarrow -mg + F_B = ma \Rightarrow -mg + \rho V g = ma$

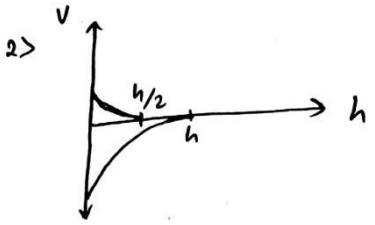
$\Rightarrow m = \frac{\rho V g}{a+g} = 1 \times \frac{4\pi}{3} \times \frac{980}{(980+9.8)} = \boxed{4.15\ g}$

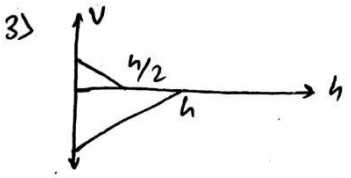
Thus, option 1 is correct.

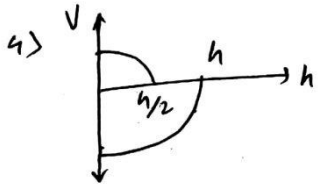
13

Q13> A tennis ball is released from a height h and after falling on a wooden floor it rebounds and reaches height h/2. The velocity verses height of the ball during its motion may be represented graphically by :

1> 

2> 

3> 

4> 

sol> Let us take downward direction -ve.

$$V^2 = u^2 \pm 2gh$$

=> V and h has parabolic relation.

when ball is dropped its speed increases but in negative direction, and reaches maximum magnitude when h = 0.

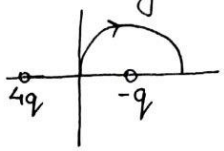
when ball hits wooden floor its speed decrease due to collision.

Again its speed decrease and becomes zero at height = h/2. This time velocity is positive.

Thus, option 4 is correct.

14

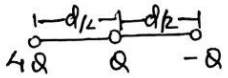
Que 14) A 2 point charges $4Q$ and $-Q$ are fixed on the x-axis at $x = d/2$ and $x = -d/2$, respectively. If the third point charge 'q' is taken from the origin to $x = d$ in a semicircular path, the change in energy will be



(1) Increase by $\frac{2Q^2}{3\pi\varepsilon_0 d}$ (2) Increase by $\frac{2Q^2}{4\pi\varepsilon_0 d}$

(3) Decrease by $\frac{Q^2}{4\pi\varepsilon_0 d}$ (4) Decrease by $\frac{4Q^2}{3\pi\varepsilon_0 d}$

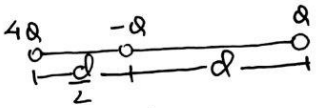
Ans ⇒ Initial energy



$$E_i = \frac{K(4Q)(Q)}{\left(\frac{d}{2}\right)} + \frac{K(Q)(-Q)}{\left(\frac{d}{2}\right)}$$

$$= \frac{8KQ^2}{d} - \frac{2KQ^2}{d} = \frac{6KQ^2}{d}$$

Final energy



$$E_f = \frac{K(4Q)(Q)}{\left(\frac{3d}{2}\right)} + \frac{K(4Q)(-Q)}{\left(\frac{d}{2}\right)}$$

$$= \frac{8KQ^2}{3d} - \frac{2KQ^2}{d} = \frac{2KQ^2}{3d}$$

Energy difference, $\Delta E = \frac{6KQ^2}{d} - \frac{2KQ^2}{3d}$ ($E_i - E_f > 0$ so energy ↓)

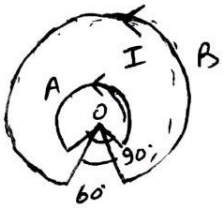
$$= \frac{16KQ^2}{3d} \quad \left(\text{since } K = \frac{1}{4\pi\varepsilon_0}\right)$$

$$= \frac{16}{3} \times \frac{1}{4\pi\varepsilon_0} \times \frac{Q^2}{d}$$

$$= \frac{4Q^2}{3\pi\varepsilon_0 d}$$ option (4)

15

Q15) A wire A, bent in a shape of an arc of a circle, carrying a current of 2A and having radius 2 cm and another wire B also bent in the shape of an arc of a circle, carrying a current of 3A and having radius of 4 cm, are placed as shown in the figure. The ratio of the magnetic fields due to the wires A and B at common centre O is :



1) 6 : 5 2) 6 : 4
3) 2 : 5 4) 4 : 6

Sol) The straight wires pass through O, so magnetic field is zero.

Magnetic field due to A $= \frac{\mu_0}{4\pi} \frac{I_A}{\ell_A} \theta_A = B_A$

$\ell_A = 2\text{cm}, \quad \theta_A = 270^\circ = 3\pi/2$

$\Rightarrow B_A = \frac{\mu_0}{4\pi} \frac{I_A}{2} \times \frac{3\pi}{2}$

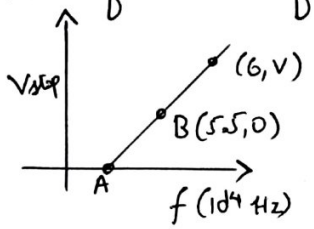
Similarly $B_B = \frac{\mu_0}{4\pi} \frac{I_B}{\ell_B} \theta_B = \frac{\mu_0}{4\pi} \frac{I_B}{4} \times \frac{5\pi}{3}$

$\Rightarrow \frac{B_A}{B_B} = \frac{I_A}{2} \times \frac{3\pi}{2} \times \frac{4}{I_B} \times \frac{3}{5\pi} = \frac{2 \times 3\pi}{4} \times \frac{12}{3 \times 5\pi}$

$\Rightarrow \boxed{B_A : B_B = 6 : 5}$ Thus, option 1 is correct.

16

Que 16) Given figure shows few data points in a photo-electric effect experiment for a certain metal. The min^m energy for ejection of electrons from its surface is



(1) 2.10 eV (2) 2.59 eV (3) 1.93 eV (4) 2.27 eV

Ans) By Einstein's photoelectric equation

$h(f) = \phi + KE$ → Energy of $e^{\ominus}$ on ejecting

(ϕ ↓ Work funcⁿ)

Also $KE = eV$, where V is stopping potential

According to the graph

At $f = 5.5 \times 10^{14}$ Hz, $V = 0$

so, $\phi = hf$

$= 5.5 \times 10^{14} \times 6.62 \times 10^{-34}$ J

$= \left(\frac{36.3 \times 10^{-20}}{1.6 \times 10^{-19}}\right)$ eV

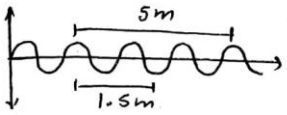
$= 2.27$ eV

17

Q17) For a transverse wave travelling, along a straight line. The distance between two peaks is 5 m, while the distance between one crest and one trough 1.5 m. The possible wavelengths (in m) of waves are :

1) 1, 3, 5 2) $\frac{1}{2}, \frac{1}{4}, \frac{1}{6}$ .... 3) $\frac{1}{1}, \frac{1}{3}, \frac{1}{5}$ .... 4) 1, 2, 3 ....

Sol)



Distance between crest = 5m

$\Rightarrow 5 = n\lambda$ — (1)

Distance between crest and trough =

$= \left(\frac{2m+1}{2}\right)\lambda = 1.5$ — (2)

$\frac{(1)}{(2)} \Rightarrow \frac{5}{1.5} = \frac{2n}{2m+1} \Rightarrow 10m + 5 = 3n$ — (3)

n and m are integers $\Rightarrow$

1) $m = 1, n = 5, \lambda = 1\,m$
2) $m = 4, n = 15, \lambda = 1/3\,m$
3) $m = 7, n = 25, \lambda = 1/5\,m$. Thus, option 3 is correct.

18

Q18) Standing from the origin, at time $t=0$, with initial velocity $5\hat{j}$ m/s, a particle moves in the x-y plane with a constant acceleration of $(10\hat{i}+4\hat{j})$ m/s^2. At time t its coordinates are $(20m, y_0 m)$. The values of t and y_0 are respectively.

1) 4, 52 2) 2, 24 3) 2, 18 4) 5, 25

Sol) Given $v = 5\hat{j}$ m/s $\Rightarrow v_x = 0$, $v_y = 5$ m/s

$a = 4\hat{j} + 10\hat{i} \Rightarrow a_x = 10$ m/s^2, $a_y = 4$ m/s^2

we know that

$S_x = u_x t + \frac{1}{2} a_x t^2 \Rightarrow 20 = 0 + \frac{1}{2} \times 10 \times t^2$

$\Rightarrow \boxed{t = 2 \text{ sec}}$

Also $S_y = u_y t + a_y t^2 \Rightarrow y_0 = (5 \times 2) + \left(\frac{1}{2} \times 4 \times 2^2\right)$

$\Rightarrow y_0 = 10 + 8$

$\Rightarrow \boxed{y_0 = 18 \text{ m}}$

Thus, option 3 is correct.

19

Q19) Dimensional formula of thermal conductivity is. (K denotes temperature)

1) $MLT^{-2}K$ 2) $MLT^{-3}K^{-1}$ 3) $MLT^{-3}K$ 4) $MLT^{-2}K^{-2}$

Sol) we know that $\dot{Q} = kA\frac{\Delta T}{x}$

Dimension of $\dot{Q} = ML^2T^{-3}$, $A = L^2$, $x = L$

$\Delta T = K$

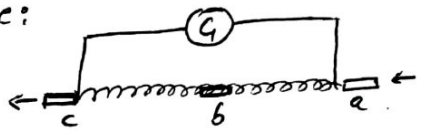
$\Rightarrow k = \frac{\dot{Q}x}{A\Delta T} = \frac{ML^2T^{-3} \times L}{L^2 K} = \boxed{MLT^{-3}K^{-1}}$

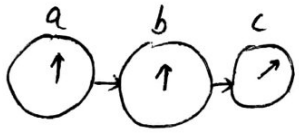
Thus, option 2 is correct

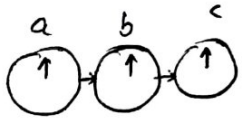
20

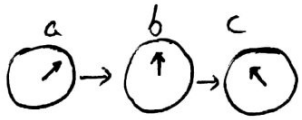
Q20> A small bar magnet moves through a coil at constant speed from one end to the other. Which of the following series of observations will be seen on the galvanometer G attached across the coil?

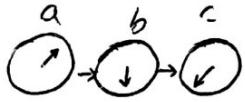
Three positions shown describe:
a) The magnets entry
b) Magnet is completely inside
c) Magnets exit.



1) 

2) 

3) 

4) 

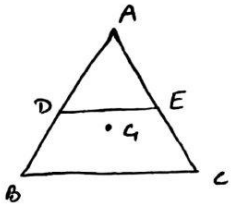
Sol> When magnet is completely inside the coil then there is no deflection in galvanometer.

while entering and exiting the change in flux is same but negative of one another. So, if needed deflects θ right while entring then it deflect θ left wile exit and vice versa.

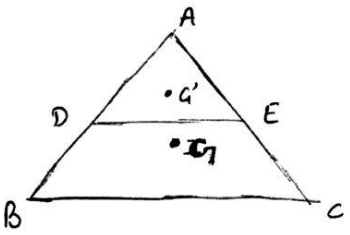
Thus, option 3 is correct.

21

Q21) ABC is a plane lamina of the shape of equilateral Δ. D, E are mid points of AB and AC and G is the centroid of lamina. Moment of inertia of the lamina about the axis passing through G and perpendicular to the plane ABC is I_0. If part ADE is removed, the moment of inertia of the remaining part about the same axis is $\frac{NI_0}{16}$, where N is an integer. Value of N is:



Sol)



Let G' be the centroid of ΔADE.

Let moment of inertia about centroid be Kma^2, where a is length of side, where $K = 1/12$

$\Rightarrow$ length between A and G $= \frac{2}{3} \times \sqrt{a^2 - \left(\frac{a}{2}\right)^2} = \frac{a}{\sqrt{3}}$

$\Rightarrow$ distance between A and G' $= \frac{2}{3} \times \sqrt{\left(\frac{a}{2}\right)^2 - \left(\frac{a}{4}\right)^2} = \frac{a}{2\sqrt{3}}$

MOI of ABC about axis passing through G $= I_{cm}$ (say)

$\Rightarrow I_{cm} = Kma^2 = \boxed{I_0}$

Mass of ADE $= \frac{m}{a^2} \times \left(\frac{a}{2}\right)^2 = \frac{m}{4}$

Let MOI of ADE about axis through G' $= I'_{cm}$ (say)

$\Rightarrow I'_{cm} = K\frac{m}{4} \times \left(\frac{a}{2}\right)^2 = \frac{Kma^2}{16}$

Let MOI of ADE about axis passing through G $= I$

$\Rightarrow I = K\frac{ma^2}{16} + \frac{m}{4}\left(\frac{a}{\sqrt{3}} - \frac{a}{2\sqrt{3}}\right)^2 = \frac{ma^2}{16}\left(K + \frac{1}{3}\right) = \frac{5}{12}\frac{ma^2}{16}$

$\Rightarrow NI_0/16 = ma^2/12 - \frac{5}{16}ma^2/12 = 11I_0/16 \Rightarrow \boxed{N = 11}$

22

(Q22) In a compound microscope, the magnified, virtual image is formed at 25 cm from eyepiece. The focal length of its objective lens is 1 cm. If the magnification is 100 and the tube length of the microscope is 20 cm, then the focal length of eye piece lens is (in cm):

Sol) We know that in case of least distance of distinct vision, $M = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right)$, where $D = 25$ cm

Given, $M = 100$

$\Rightarrow 100 = \frac{v_o}{u_o}\left(1 + \frac{25}{f_e}\right)$

Also $\frac{v_o}{u_o} = \frac{L}{f_o}$ { L is length of microscope }

$\Rightarrow 100 = \frac{L}{f_o}\left(1 + \frac{25}{f_e}\right) \Rightarrow 100 = \frac{20}{1}\left(1 + \frac{25}{f_e}\right)$

$\Rightarrow 4 = \frac{25}{f_e} \Rightarrow f_e = \frac{25}{4}$

$\Rightarrow \boxed{f_e = 6.25 \text{ cm}}$

23

Q 23> A circular disc of mass M and radius R is rotating with angular speed ω. If another stationary disc having radius R/2 and same mass M is dropped co-axially on the rotating disc. Gradually both discs attain constant angular speed ω_2. The energy lost in the process is p% of the initial value of energy. Value of p is ____.

Sol> MOI of disc of radius $R = I_1 = \frac{MR^2}{2}$

MOI of disc of radius $\frac{R}{2} = I_2 = \frac{M}{2}\left(\frac{R}{2}\right)^2 = \frac{MR^2}{8}$

By conservation of angular momentum:

$$I_1\omega = (I_1 + I_2)\omega^2$$

$$\Rightarrow \omega_2 = \frac{MR^2\omega}{2\times\left(\frac{MR^2}{2} + \frac{MR^2}{8}\right)} = \boxed{\frac{4\omega}{5}}$$

$$U_{initial} = \frac{1}{2}I_1\omega^2 = \frac{MR^2}{4}\omega^2$$

$$U_{final} = \frac{1}{2}(I_1+I_2)\omega_2^2 = \frac{MR^2\omega^2}{5}$$

$$\Rightarrow \Delta U = MR^2\omega^2\left(\frac{1}{4} - \frac{1}{5}\right) = \frac{MR^2\omega^2}{20}$$

$$\Rightarrow p = \frac{\Delta U}{U_{initial}} \times 100 = \frac{1}{20}\times 2 \times 100 = \boxed{20\%}$$

24

Q24>

A closed vessel contains 0.1 mole of a monoatomic gas at 200 K. If 0.05 mole of the same gas at 400 K is added to it, the final equilibrium temperature (in K) of the gas in the vessel will be close to ____.

sol> Volume of vessel is constant.

Let it be V.

$\Rightarrow P_1V = n_1RT_1 \Rightarrow P_1V = 0.1R \times 200$

$\Rightarrow P_1V = 20R$ — ①

$P_2V = n_2RT_2 \Rightarrow P_2V = 0.05 \times R \times 400$

$\Rightarrow P_2V = 20R$ — ②

Now $n = n_1 + n_2 = 0.15$ moles

$\Rightarrow PV = nRT \Rightarrow PV = 0.15RT$ — ③

Also $P_1 + P_2 = P$

$\Rightarrow$ ①, ②, ③ $\Rightarrow \frac{20R}{V} + \frac{20R}{V} = \frac{0.15RT}{V}$

$\Rightarrow T = \frac{40}{0.15} = \boxed{266.67\ K}$

25

Q25> In the line spectra of hydrogen atom, difference between the largest and the shortest wavelengths of the Lyman series is 304 Å. The corresponding difference in paschan series in Å is ___.

sol> In Lyman series:

For λ_{min} transition is from $n=\infty$ to $n=1$

$\Rightarrow 1/\lambda_{min} = R\left(1-\frac{1}{\infty}\right) = R$

$\Rightarrow \boxed{\lambda_{min} = R^{-1}}$

For λ_{min} transition is from $n=2$ to $n=1$

$\Rightarrow \frac{1}{\lambda_{max}} = R\left(1-\frac{1}{4}\right) \Rightarrow \boxed{\lambda_{max} = \frac{4}{3R}}$

For paschan series:

For λ_{min} transition is from $n=\infty$ to $n=3$

$\Rightarrow 1/\lambda_{min} = R\left(\frac{1}{3^2}-\frac{1}{\infty}\right) \Rightarrow \boxed{\lambda_{min} = \frac{9}{R}}$

For λ_{max} transition is from $n=4$ to $n=3$

$\Rightarrow \frac{1}{\lambda_{max}} = R\left(\frac{1}{9}-\frac{1}{16}\right)$

$\Rightarrow \lambda_{max} = \left(\frac{7R}{144}\right)^{-1} \Rightarrow \boxed{\lambda_{max} = \frac{144}{7R}}$

Given that $\frac{4}{3R} - R^{-1} = 304\text{ Å} \Rightarrow \frac{1}{R} = 3\times 304\text{ Å}$

$\Rightarrow \Delta\lambda = \frac{144}{7R} - \frac{9}{R} = \frac{81}{7R} = \frac{81}{7}\times 3\times 304\text{ Å}$

$\Rightarrow \boxed{\Delta\lambda = 10553.14\text{ Å}}$

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