PHYSICS
JEE-MAIN (July-Attempt)
26 July (Shift-2) Paper Solution

SECTION - A

1. Two projectiles are thrown with same initial velocity making an angle of 45^0 and 30^0 with the horizontal respectively. The ratio of their ranges will be :

(A) $1:\sqrt{2}$ (B) $\sqrt{2}:1$ (C) $2:\sqrt{3}$ (D) $\sqrt{3}:2$

Sol. **C**

Let initial velocity of both the projectiles be u.

Then for ground-to-ground projectile, horizontal range is given by $R = \frac{u^2 \sin 2\theta}{g}$.

Now, according to question,

$$\frac{R_A}{R_B} = \frac{\frac{u^2 \sin 2\theta_A}{g}}{\frac{u^2 \sin 2\theta_B}{g}} = \frac{\sin 90^\circ}{\sin 60^\circ} = \frac{2}{\sqrt{3}}$$

2. In a vernier callipers, 10 divisions of vernier scale is equal to the 9 divisions of main scale. When both jaws of vernier calliper touch each other, the zero of the vernier scale is shifted to the left of zero of the main scale and 4^{th} vernier scale division exactly coincides with the main scale reading. One main scale division is equal to 1mm. while measuring diameter of a spherical body, the body held between two jaws. It is now observed that zero of vernier scale lies between 30 and 31 divisions of main scale reading and 6^{th} vernier scale division exactly coincides with the main scale reading. The diameter of the spherical body will be :

(A) 3.02 cm (B) 3.06 cm (C) 3.10 cm (D) 3.20 cm

Sol. **C**

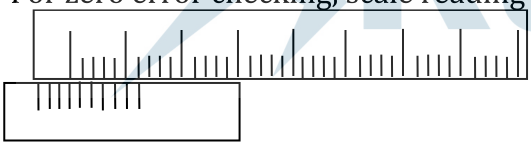
Least count of the scale = 0.01 cm

And 9 MSD = 10 VSD

or,1 VSD = 0.9 MSD = 0.9 x 0.1 cm = 0.09 cm

i.e., length of 1 VSD = 0.09 cm.

For zero error checking, scale reading will be like this-



i.e., Zero error(e) = - 0.06 cm

Main scale reading = 3.00 cm

Final Reading = 3.00 + 0.06 + 0.04 = 3.10 cm

3. A ball of mass 0.15 kg hits the wall with its initial speed of 12 ms^{-1} and bounces back without changing its initial speed. If the force applied by the wall on the ball during the contact is 100 N, calculate the time duration of contact of ball with the wall.

(A) 0.018 s (B) 0.036 s (C) 0.009 s (D) 0.072 s

Sol. **B**

according to Newton's second law of motion: $F = \frac{dp}{dt}$

And average force is $F = \frac{\Delta p}{\Delta t}$

Here $\Delta p = 2 \times 0.15 \times 12 = 3.6 kgm/s$

$F = 100N$

$\therefore \Delta t = \frac{\Delta p}{F} = \frac{3.6}{100} = 0.036$ s

4. A body of mass 8 kg and another of mass 2 kg are moving with equal kinetic energy. The ration of their momenta will be:

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

Sol. **B**

K= $\frac{1}{2}mv^2$

$P = mv$

Using these two relations, we get $P = \sqrt{2mK}$

Therefore: $\frac{P_1}{P_2} = \frac{\sqrt{2m_1K_1}}{\sqrt{2m_2K_2}}$

And Both have same Kinetic energies.

$\therefore \frac{P_1}{P_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{8}{2}} = \sqrt{4} = 2$

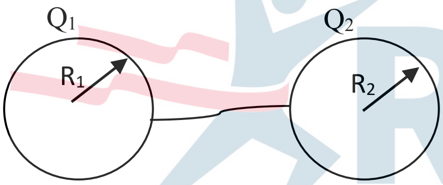
$\frac{P_1}{P_2} = \frac{2}{1}$

5. Two uniformly charged spherical conductors A and B of radii 5 mm and 10 mm are separated by a distance of 2 cm. If the spheres are connected by a conducting wire, then in equilibrium condition, the ratio of the magnitudes of the electric fields at the surface of the sphere A and B will be:

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

Sol. **B**

At equilibrium, their potential will be same as they are connected by a conducting wire.



Given: R_1 = 5 mm and R_2 = 10 mm.

Let at equilibrium, charges on both the spheres be Q_1 and Q_2 respectively. Then,

$V_1 = V_2$

$\Rightarrow \frac{KQ_1}{R_1} = \frac{KQ_2}{R_2}$

$\Rightarrow \frac{Q_1}{R_1} = \frac{Q_2}{R_2}$

$\Rightarrow \frac{Q_1}{Q_2} = \frac{R_1}{R_2} = \frac{5}{10} = \frac{1}{2}$

Now, electric field on surface of spherical conductor is given by $E = \frac{KQ}{R^2}$.

$\therefore \frac{E_1}{E_2} = \frac{\frac{KQ_1}{R_1^2}}{\frac{KQ_2}{R_2^2}} = \frac{Q_1}{Q_2} \times \frac{R_2^2}{R_1^2}$

$\Rightarrow \frac{E_1}{E_2} = \frac{1}{2} \times \left(\frac{10}{5}\right)^2 = 2$

$\therefore \frac{E_1}{E_2} = \frac{2}{1}$

6. The oscillating magnetic field in a plane electromagnetic wave is given by $B_y = 5 \times 10^{-6} sin 1000\pi(5x - 4 \times 10^8 t)T$. The amplitude of electric field will be:

(A) $15 \times 10^2 Vm^{-1}$ (B) $5 \times 10^{-6} Vm^{-1}$ (C) $16 \times 10^{12} Vm^{-1}$ (D) $4 \times 10^2 Vm^{-1}$

Sol. **D**

From the wave equation, we get $v = \frac{\omega}{k} = \frac{4\times10^8}{5}$

Now, amplitude of electric field is given by $E_0 = vB_0$

$\therefore E_0 = \frac{4\times10^8}{5} \times 5 \times 10^{-6} = 4 \times 10^2 Vm^{-1}$

7. Light travels in two media M_1 and M_2 with speeds 1.5×10^8 ms^{-1} and 2.0×10^8 ms^{-1} respectively. The critical angle between them is:

(A) $\tan^{-1}\left(\frac{3}{\sqrt{7}}\right)$ (B) $\tan^{-1}\left(\frac{2}{3}\right)$ (C) $\cos^{-1}\left(\frac{3}{4}\right)$ (D) $\sin^{-1}\left(\frac{2}{3}\right)$

Sol. **A**

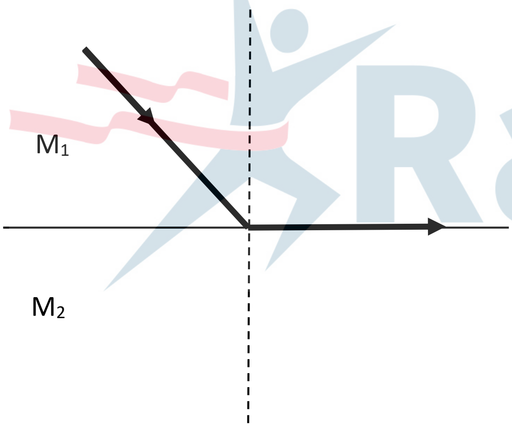
velocity in any medium is inversely proportional to the refractive index.

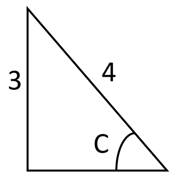
$\therefore \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = \frac{1.5}{2}$

$\frac{\mu_2}{\mu_1} < 1$

$\therefore \mu_2 < \mu_1$

So for critical angle light will go from denser to rarer i.e., Medium 1 to Medium 2. Now,





$\mu_1 \sin C = \mu_2 \sin 90^\circ$

$\Rightarrow \sin C = \frac{\mu_2}{\mu_1} = \frac{1.5}{2} = \frac{15}{20} = \frac{3}{4}$

Using this relation, we get $\tan C = \frac{3}{\sqrt{7}}$

8. A body is projected vertically upward from the surface of earth with a velocity equal to one third of escape velocity. The maximum height attained by the body will be:

(Take radius of earth = 6400 km and g = 10 ms^{-1})

(A) 800 km

(B) 1600 km

(C) 2133 km

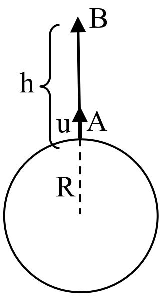
(D) 4800 km

Sol. **A**

Escape velocity of a body on any planet of mass M and radius R is given by following equation -

$V_{esc} = \sqrt{\frac{2GM}{R}}$, where G is universal gravitational constant.

Let projected velocity of body be u.



Then $u = \frac{1}{3}\sqrt{\frac{2GM}{R}}$

Let the maximum height attained by the body be h.

Then applying law of conservation of energy,

$E_A = E_B$

$$K_A + U_A = K_B + U_B$$

$$\Rightarrow \frac{1}{2}mu^2 - \frac{GMm}{R} = 0 - \frac{GMm}{R+h}$$

$$\Rightarrow \frac{1}{2}m \times \frac{1}{9} \times \frac{2GM}{R} - \frac{GMm}{R} = -\frac{GMm}{R+h}$$

$$\Rightarrow \frac{GMm}{9R} - \frac{GMm}{R} = -\frac{GMm}{R+h}$$

$$\Rightarrow -\frac{8GMm}{9R} = -\frac{GMm}{R+h}$$

$$\Rightarrow 8(R+h) = 9R$$

$$\Rightarrow 8h = R$$

$$\Rightarrow h = \frac{R}{8} = \frac{6400}{8} = 800km$$

9. The maximum and minimum voltage of an amplitude modulated signal are 60 V and 20 V respectively. The percentage modulation index will be:

(A) 0.5% (B) 50% (C) 2% (D) 30%

Sol. **B**

Modulation index, $\mu = \frac{A_{\max} - A_{\min}}{A_{\max} + A_{\min}} \times 100$

$= \frac{60-20}{60+20} \times 100 = \frac{40}{80} \times 100 = 50$

10. A nucleus of mass M at rest splits into two parts having masses $\frac{M'}{3}$ and $\frac{2M'}{3}$ $(M' < M)$. The ratio of de-Broglie wavelength of two parts will be:

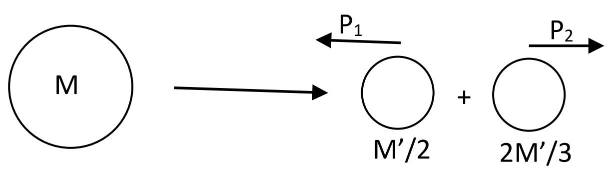
(A) 1:2 (B) 2:1 (C) 1:1 (D) 2:3

Sol. **C**

de-Broglie wavelength is given by $\lambda = \frac{h}{p}$, where h is Plank's constant and p is momentum.

As per question, the particle breaks down due to its internal forces. $i.e., F_{ext} = 0$;

So, the momentum of system will remain conserved. *i.e.,* $P_i = P_f$.



$$|P_1| = |P_2|$$

$$\Rightarrow \frac{h}{\lambda_1} = \frac{h}{\lambda_2}$$

$$\therefore \lambda_1 = \lambda_2$$

$$\frac{\lambda_1}{\lambda_2} = \frac{1}{1}$$

11. An ice cube of dimensions 60 cm x 50 cm x 20 cm is placed in an insulation box of wall thickness 1 cm. the box keeping the ice cube at 0^0C of temperature is brought to a room temperature of 40^0C. The rate of melting of ice is approximately:
(Latent heat of fusion of ice is 3.4×10^5 Jkg^{-1} and thermal conducting of insulation wall is 0.05 $Wm^{-1o}C^{-1}$)
(A) 61×10^{-3} kg s^{-1} (B) 61×10^{-5} kg s^{-1} (C) 208 kg s^{-1} (D) 30×10^{-5} kg s^{-1}

Sol. **B**
Heat will be gained by the container through conducting walls and with that heat the ice will melt.
Heat gained by container = $\frac{dq}{dt} = KA\frac{\Delta T}{x}$
And Total area = $2(60 \times 50 + 50 \times 20 + 20 \times 60) = 10400 cm^2$

$$x = 1cm$$
$$K = 0.05 Wm^{-1}\ {}^oC^{-1}$$
$$Now,$$
$$KA\frac{\Delta T}{x} = \frac{dm}{dt}L$$
$$\Rightarrow \frac{dm}{dt} = \frac{KA}{L}\frac{\Delta T}{x}$$
$$\Rightarrow \frac{dm}{dt} = \frac{0.05 \times 10400 \times 40}{3.4 \times 10^5 \times 1 \times 10^{-2} \times 10000} \simeq 61 \times 10^{-5} kg/\text{sec}$$

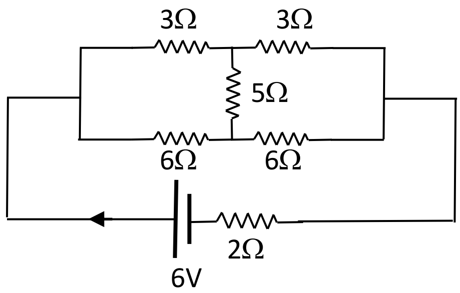
12. A gas has n degree of freedom. The ratio of specific heat of gas at constant volume to the specific heat of gas at constant pressure will be:
(A) $\frac{n}{n+2}$ (B) $\frac{n+2}{n}$ (C) $\frac{n}{2n+2}$ (D) $\frac{n}{n-2}$

Sol. **A**
$$C_v = \frac{nR}{2}$$
$$C_p = \frac{nR}{2} + R = \frac{n+2}{2}R$$
$$\frac{C_v}{C_p} = \frac{n}{n+2}$$

13. A transverse wave is represented by $y = 2\sin(\omega t - kx)$cm. The value of wavelength (in cm) for which the wave velocity becomes equal to the maximum particle velocity, will be:
(A) 4π (B) 2π (C) π (D) 2

Sol. **A**
$$v_{\max} = v_{wave}$$
$$\Rightarrow A\omega = \frac{\omega}{k}$$
$$\Rightarrow A = \frac{1}{k}$$
$$\Rightarrow 2 = \frac{\lambda}{2\pi}$$
$$\Rightarrow \lambda = 4\pi$$

14. A battery of 6 V is connected to the circuit as shown below. The current I drawn from the battery is:



(A) 1A (B) 2A (C) $\frac{6}{11}$A (D) $\frac{4}{3}$A

Sol. **A**

Given circuit is a balance Wheatstone bridge.

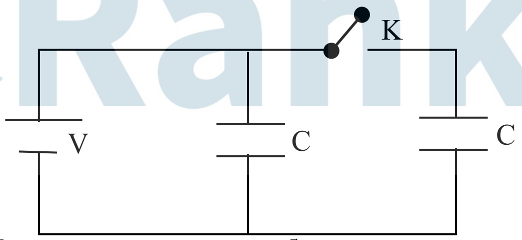
So, there will be no current in 5Ω resistance.

$R_1 = \frac{6\times12}{6+12} = 4\Omega$

$R_{eq} = 4 + 2 = 6\Omega$

$\therefore I = \frac{V}{R_{eq}} = \frac{6}{6} = 1A$

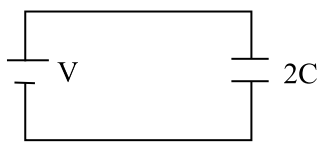
15. A source of potential difference V is connected to the combination of two identical capacitors as shown in the figure. When key 'K' is closed, the total energy stored across the combination is E_1. Now key 'K' is opened and dielectric of dielectric constant 5 is introduced between the plates of the capacitors. The total energy stored across the combination is now E_2. The ratio E_1/E_2 will be:



(A) $\frac{1}{10}$ (B) $\frac{2}{5}$ (C) $\frac{5}{13}$ (D) $\frac{5}{26}$

Sol. **C**

- In case I, when the switch was closed and dielectric was not inserted: -
- $E_1 = \frac{1}{2}(2C)V^2 = CV^2$



In case II, when the switch was open
- and dielectric was inserted: -

$E_2 = \frac{1}{2}(5C)V^2 + \frac{1}{2}\frac{Q^2}{5C}$

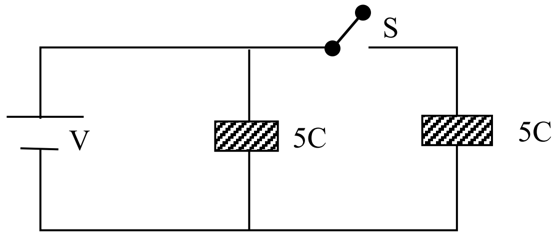
$\Rightarrow E_2 = \frac{1}{2}(5C)V^2 + \frac{1}{2}\frac{(CV)^2}{5C}$

$\Rightarrow E_2 = \frac{1}{2}(5C)V^2 + \frac{1}{10}CV^2$

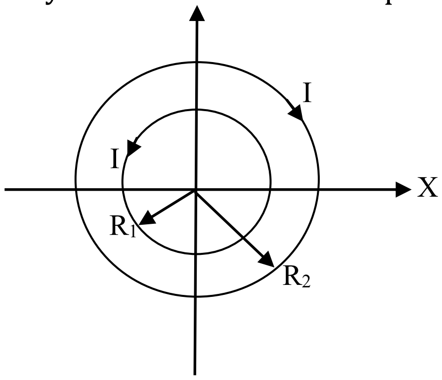
$\Rightarrow E_2 = \left(\frac{5}{2} + \frac{1}{10}\right)CV^2 = \frac{26}{10}CV^2$

$\therefore E_2 = \frac{13}{5}CV^2$

$Now, \frac{E_1}{E_2} = \frac{5}{13}$



16. Two concentric circular loops of radii r_1=30 cm and r_2=50 cm are placed in X-Y plane as shown in the figure. A current I=7A is flowing through them in the direction as shown in figure. The net magnetic moment of this system of two circular loops is approximately:



(A) $\frac{7}{2}\hat{k}Am^2$ (B) $-\frac{7}{2}\hat{k}Am^2$ (C) $7\hat{k}Am^2$ (D) $-7\hat{k}Am^2$

Sol. **B**

Given, I = 7 A

R_1 = 30 cm

R_2 = 50 cm

Magnetic Moment (M) = nIA {A is area of coil}

$M_1 = 7 \times \pi \times \left(\frac{30}{100}\right)^2 = 7 \times \frac{22}{7} \times \frac{9}{100} = 1.98A - m^2$

$M_2 = 7 \times \pi \times \left(\frac{50}{100}\right)^2 = 7 \times \frac{22}{7} \times \frac{25}{100} = 5.50A - m^2$

And in vector form these magnetic moments are:

$\overrightarrow{M_1} = 1.98\hat{k}(A - m^2)$

$\overrightarrow{M_1} = -5.50\hat{k}(A - m^2)$

$\Rightarrow \vec{M} = \overrightarrow{M_1} + \overrightarrow{M_2}$

$\Rightarrow \vec{M} = (-5.50 + 1.98)\hat{k}(A - m^2)$

$\Rightarrow \vec{M} = -3.52\hat{k}(A - m^2)$

17. A velocity selector consists of electric field $\vec{E} -= E\hat{k}$ and magnetic field $\vec{B} -= B\hat{j}$ with B = 12 mT. The value of E required for an electron of energy 728 eV moving along the positive x-axis to pass undeflected is –

(Given, mass of electron = 9.1×10^{-31} kg)

(A) 192 kVm^{-1} (B) 192 mVm^{-1} (C) 9600 kVm^{-1} (D) 16 kVm^{-1}

Sol. **A**

K = 728 Ev

$\Rightarrow \frac{1}{2} mv^2 = 728$

$v = \sqrt{\frac{2\times728}{m}}$ ....(i)

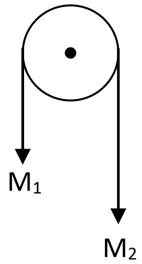
Now, eE = evB

$\Rightarrow$ E = vB

$= \sqrt{\frac{2\times728\times1.6\times10^{-19}}{9.1\times10^{-31}}} \times 12 \times 10^{-3}$

$= 192 \times 10^3$ v/m

18. Two masses M_1 and M_2 are tied together at the two ends of a light inextensible string that passes over a frictionless pulley. When the mass M_2 is twice that of M_1, the acceleration of the system is a_1. When the mass M_2 is thrice that of M_1, the acceleration of the system is a_2. The ratio $\frac{a_1}{a_2}$ will be:



(A) $\frac{1}{3}$ (B) $\frac{2}{3}$ (C) $\frac{3}{2}$ (D) $\frac{1}{2}$

Sol. **B**

Using Newton's law on both blocks: -

$m_1 g - T = m_1 a$ ---(i)

$T - m_2 g = m_2 a$ ---(ii)

adding equation (i) and (ii), we get

$\Rightarrow (m_1 - m_2)g = (m_1 + m_2)a$

$\Rightarrow a = \frac{(m_1 - m_2)}{(m_1 + m_2)} g$

Now, for case (1): $m_1 = 2m_2$

$\therefore a_1 = \frac{(2m_2 - m_2)}{(2m_2 + m_2)} g = \frac{1}{3} g$

And for case (2): $m_1 = 3m_2$

$\therefore a_2 = \frac{(3m_2 - m_2)}{(3m_2 + m_2)} g = \frac{1}{2} g$

Now, according to question ratio of these two accelerations is $\frac{a_1}{a_2} = \frac{g}{3} \times \frac{2}{g} = \frac{2}{3}$

19. Mass numbers of two nuclei are in the ratio of 4:3. Their nuclear densities will be in the ratio of

(A) 4:3 (B) $\left(\frac{3}{4}\right)^{\frac{1}{3}}$ (C) 1:1 (D) $\left(\frac{4}{3}\right)^{\frac{1}{3}}$

Sol. **C**

Radius of nucleus is given by R = (1.3×10^{-15}) $A^{1/3}$ m, where A is mass number.

So, we can say that radius of nucleus is directly proportional to $A^{1/3}$.

i.e.,

$R \,\alpha\, A^{\frac{1}{3}}$

$\therefore \frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{\frac{1}{3}}$

$\Rightarrow \frac{R_1}{R_2} = \left(\frac{4}{3}\right)^{\frac{1}{3}}$

$\left(\frac{R_1}{R_2}\right)^3 = \left(\frac{4}{3}\right)$

$\therefore \frac{\rho_1}{\rho_2} = \frac{1}{1}$

20. The area of cross section of rope used to lift a load by a crane is 2.5 x $10^{-4}m^2$. The maximum lifting capacity of the crane is 10 metric tons. To increase the lifting capacity of the crane to 25 metric tons, the required are of the cross section of the rope should be:
(Take g=$10ms^{-2}$)
(A) 6.5 x $10^{-4}m^2$ (B) 10 x $10^{-4}m^2$ (C) 1 x $10^{-4}m^2$ (D) 1.67 x $10^{-4}m^2$

Sol. **A**
Force per unit area must remain same.
$\Rightarrow \frac{10}{2.5\times10^{-4}} = \frac{25}{A}$
$\Rightarrow A = \frac{25\times2.5\times10^{-4}}{10} = 6.25\times10^{-4}$

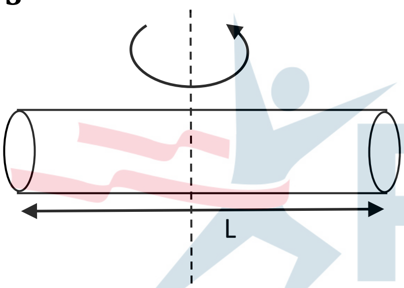
SECTION - B

1. If $\vec{A} = (2\hat{i} + 3\hat{j} - \hat{k})m$ and $\vec{B} = (\hat{i} + 2\hat{j} + 2\hat{k})m$. The magnitude of component of vector $\vec{A}$ along vector $\vec{B}$ will be _________ m.

Sol. **2**
magnitude of component of $\vec{A}$ along $\vec{B} = \frac{\vec{A}.\vec{B}}{B} = \frac{6}{3} = 2$

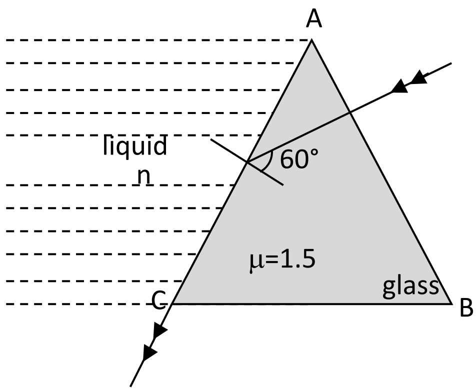
2. The radius of gyration of a cylindrical rod about an axis of rotation perpendicular to its length and passing through the center will be ________m. Given, the length of the rod is $10\sqrt{3}$m.

Sol. **5**

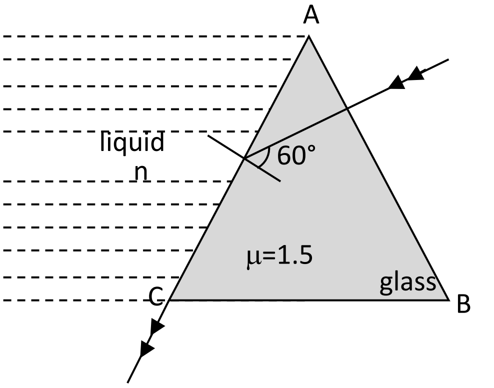


$$I = \frac{ML^2}{12} = MK^2$$
$$K = \frac{L}{\sqrt{12}} = \frac{10\sqrt{3}}{\sqrt{4}\times\sqrt{3}} = 5$$

3. In the given figure, the face AC of the equilateral prism is immersed in a liquid of refractive index 'n'. For incident angle 60^0 at the side AC, the refracted light beam just grazes along the face AC. The refractive index of the liquid $n = \frac{\sqrt{x}}{4}$. The value of x is __________.



Sol. **27**



Hence the prism is equilateral, so angle of prism = 60^0.
Therefore on 1st surface angle of refraction $r_1=0^0$.

$$r_1 + i_2 = A$$
$$\Rightarrow 0 + i_2 = 60^0$$
$$\Rightarrow i_2 = 60^0$$

On second surface, i_2 will be critical angle. Applying snell's law on second surface, we get

$$\mu_1 \sin\theta_1 = \mu_2 \sin\theta_2$$
$$\Rightarrow \frac{3}{2}\sin i_2 = \mu \sin 90°$$
$$\Rightarrow \mu = \frac{3}{2} \times \frac{\sqrt{3}}{2} = \frac{3\sqrt{3}}{4} = \frac{\sqrt{27}}{4}$$

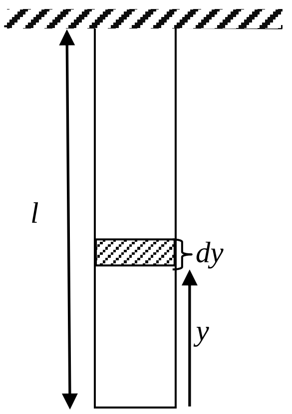
4. Two lighter nuclei combine to form a comparatively heavier nucleus by the relation given below:
$${}_1^2X + {}_1^2X = {}_2^4Y$$
The binding energies per nucleon for ${}_1^2X$ and ${}_2^4Y$ are 1.1 MeV and 7.6 MeV respectively. The energy released in this process is __________MeV.

Sol. **26**

$$E = -(2 \times 1.1 + 2 \times 1.1) - (-(4 \times 7.6)) = -4.4 + 30.4 = 26\text{MeV}$$

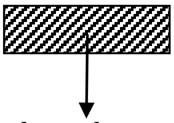
5. A uniform heavy rod of mass 20kg, cross sectional area 0.4 m^2 and length 20 m is hanging from a fixed support. Neglecting the lateral contraction, the elongation in the rod due to its own weight is $x \times 10^{-9}$m. The value of x is__________.
(Given, young's modulus $Y=2x10^{11}$ Nm^{-2} and $g=ms^{-2}$)

Sol. **25**



According to Hook's law, $\frac{F}{A} = Y\frac{\Delta l}{l}$

Net pulling force on the elemental mass will be due the mass lower to it.



F (*force due to lower weight*)

$F = \frac{m}{l}yg$

Let elongation in this elemental mass be $d(\Delta l)$.

Then,

$$\frac{F}{A} = Y\frac{d(\Delta l)}{l}$$

$$\Rightarrow \frac{mgy}{lA} = Y\frac{\Delta l}{dy}$$

$$\Rightarrow \Delta l = \frac{mgy}{lAY}dy$$

$$\Rightarrow l = \int_0^l \frac{mgy}{lAY}dy$$

$$= \frac{mg}{lAY}\int_0^l ydy$$

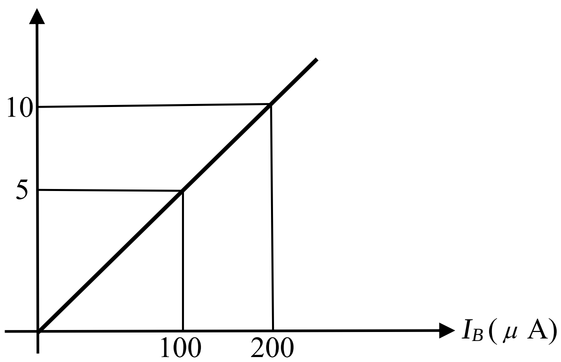
$$= \frac{mg}{lAY}[\frac{y^2}{2}]_0^l$$

$$= \frac{mgl}{2AY}$$

$$= \frac{20 \times 10 \times 20}{2 \times 0.4 \times 2 \times 10^{11}}$$

$$= 25 \times 10^{-9}$$

6. The typical transfer characteristics of a transistor in CE configuration is shown in figure. A load resistor of 2KΩ is connected in the collector branch of the circuit used. The input resistance of the transistor is 0.50KΩ. The voltage gain of the transistor is ________________.



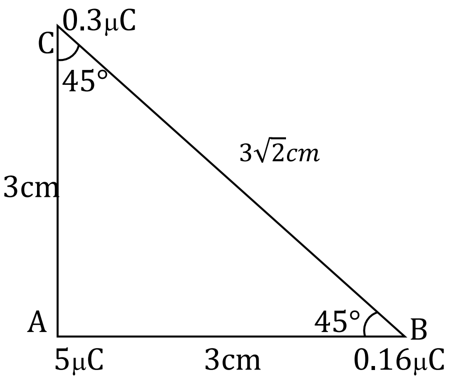
Sol. 200

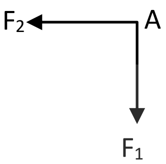
$$\beta_{AC} = \frac{\Delta i_C}{\Delta i_B} = 50$$

$$voltage\ gain = 50 \times \frac{R_{out}}{R_{in}} = 200$$

7. Three-point charges of magnitudes 5μC, 0.16μC and 0.3μC are located at the vertices A, B, C of a right-angled triangle whose sides are AB=3 cm, BC=$3\sqrt{2}$cm and CA=3 cm and point A is the right-angle corner. Charge at point A experiences _______N of electrostatic force due to the other two charges.

Sol. **17**





$F_1 = \frac{k\times0.3\times5\times10^{-12}}{9\times10^{-4}}$

$= \frac{9\times10^{9}\times1.5\times10^{-8}}{9} = 15$

$F_2 = \frac{9\times10^{9}\times0.8\times10^{-8}}{9}$

$F_{net} = \sqrt{225+64} = \sqrt{289} = 17$

8. In a coil of resistance 8Ω, the magnetic flux due to an external magnetic field varies with time as $\phi = \frac{2}{3}(9 - t^2)$. The value of total heat produced in the coil, till the flux becomes zero, will be __________ J.

Sol. **2**

$V = -\frac{d\phi}{dt} = \frac{4}{3}t$

$\phi = 0 \Rightarrow t = 3$

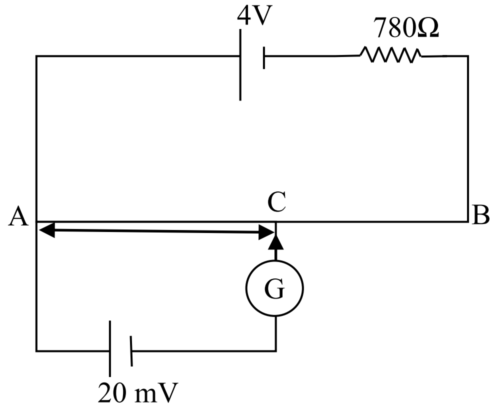
$\therefore V = 4$

Now

$H = \frac{V^2}{R} = \frac{16}{8} = 2$

9. A potentiometer wire of length 300 cm is connected in series with a resistance 780 Ω and a standard cell of emf 4V. A constant current flows through potentiometer wire. The length of the null point for cell of emf 20 mV is found to be 60 cm. The resistance of the potentiometer wire is __________Ω.

Sol. **20**



Given, AB = 3 m = 300 cm
AC = 60 cm
For null deflection,

$\frac{\varepsilon_1}{\varepsilon_2} = \frac{R_1}{R_2}$

$\frac{4}{20\times10^{-3}} = \frac{780+R}{\frac{60}{300}R}$

$\Rightarrow R = 20$

10. As per given figures, two springs of spring constants k and 2k are connected to mass m. If the period of oscillation in figure (a) is 3s, then the period of oscillation in figure (b) will be $\sqrt{x}$ s. The value of x is __________.

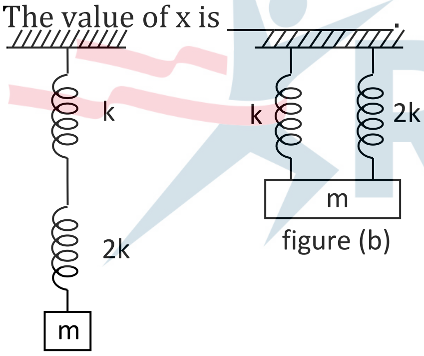


figure (a)

Sol. **2**

Here, $T_1 = 2\pi\sqrt{\frac{3m}{2k}}$

$\Rightarrow 3 = 2\pi\sqrt{\frac{3m}{2k}}$

And for 2nd System,

$K_{eq} = 2k + k = 3k$

$\therefore T_2 = 2\pi\sqrt{\frac{m}{3k}}$

Hence,

$\frac{T_1}{T_2} = \frac{3}{T_2} = \sqrt{\frac{3}{2}\times\frac{3}{1}}$

$\Rightarrow T_2 = \sqrt{2}$

$\Rightarrow x = 2$