Answers & Solutions for

26 JULY EVENING SHIFT JEE (Main)-2022 (Online) Phase-2 (Physics)

$$R = \frac{u^2 \sin 2\theta}{g}$$

$$B = B_0 \sin \frac{2\pi}{\lambda}(vt - x)$$

$$\bar{M} = N I \bar{A}$$

$$c = \frac{E_0}{B_0}, \rho = \frac{3M}{4\pi R_0^3}$$

$$T = 2\pi \sqrt{m/k}$$

IIT JEE PHYSICS PAPER SOLUTION 26 JULY 2022 EVENING SHIFT

QUESTIONS BASED ON VARNIER CALIPERS, AM,WAVE,CAPACITOR AS DIELECTRIC,PRISM TOTAL INTERNAL REFLECTION,EMW ARE TRICKY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE is correct.

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

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

(C) $2:\sqrt{3}$ ✓ (D) $\sqrt{3}:2$

$$\frac{R_1}{R_2} = \frac{\frac{u^2 \sin 2\theta_1}{g}}{\frac{u^2 \sin 2\theta_2}{g}} = \frac{\sin 2\theta_1}{\sin 2\theta_2}$$

$$= \frac{\sin 2(45)}{\sin 2(30^\circ)}$$

$$= \frac{\sin 90}{\sin 60}$$

$$= \frac{1}{\sqrt{3}/2} = 2/\sqrt{3}$$

2. In a Vernier Calipers, 10 divisions of Vernier scale is equal to the 9 divisions of main scale. When both jaws of Vernier calipers touch each other, the zero of the Vernier scale is shifted to the left of zero of the main scale and 4th Vernier scale division exactly coincides with the main scale reading. One main scale division is equal to 1 mm. While measuring diameter of a spherical body, the body is held between two jaws. It is now observed that zero of the Vernier scale lies between 30 and 31 divisions of main scale reading and 6th 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

10 VSD = 9 MSD

$LC = \frac{1}{10}$ MSD $= 0.01$ cm

Negative error $= (0.1 - .04)$ cm

$= .06$ cm

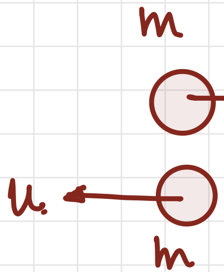
Reading $= 3.0$ cm $+ 6(.01)$ cm $+ .06$ cm

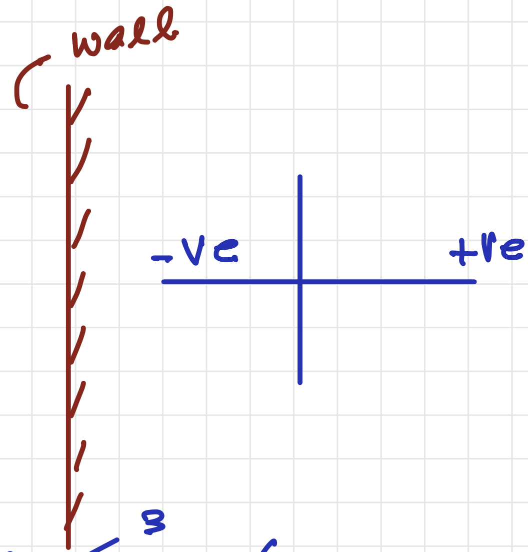
$= 3.12$ cm

$\simeq 3.10$ 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 the contact of ball with the wall.

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





$F \cdot \Delta t = m(V_f - V_i)$

$F \cdot \Delta t = m(-u - u)$

$\Delta t = \frac{-2mu}{F} = \frac{|-2mu|}{|F|} = \frac{2 \times 0.15 \times 12}{100 \times 100} = .036$ sec

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

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

$$KE = \frac{1}{2} m v^2 = \frac{1}{2} \frac{m v^2}{m} \cdot m$$

$$= \frac{1}{2} \frac{m^2 v^2}{m} = \frac{1}{2} \frac{p^2}{m}.$$

$$(KE)_1 = (KE)_2$$

$$\frac{1}{2} \frac{p_1^2}{m_1} = \frac{1}{2} \frac{p_2^2}{m_2}$$

$$\frac{p_1^2}{p_2^2} = \frac{m_1}{m_2} \Rightarrow \frac{p_1}{p_2} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{8}{2}}$$

$$\frac{p_1}{p_2} = \frac{2}{1}$$

5) Two uniformly charged spherical conductors A and B of radii 5mm and 10mm 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 magnitude 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

After connection the potential will remain constant

$$V_1 = V_2$$

$$\frac{1}{4\pi\epsilon_0}\frac{q_1}{r_1} = \frac{1}{4\pi\epsilon_0}\frac{q_2}{r_2} \Rightarrow q_1 r_2 = q_2 r_1$$

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) 15×10^2 Vm^{-1} (B) 5×10^{-6} Vm^{-1}

(C) 16×10^{12}Vm^{-1} (D) 4×10^2Vm^{-1}

$B_y = B_0 \sin \frac{2\pi}{\lambda}(vt - x)$

$B_0 = 5 \times 10^{-6}$ tesla

compare with

$B_y = 5 \times 10^{-6} \sin(5000\pi x - 4000 \times 10^8 \pi t)$

$5000\pi x = \frac{2\pi}{\lambda} x \Rightarrow \lambda = \frac{1}{2500}$ mt

$4000 \times 10^8 \pi t = \frac{2\pi}{\lambda} v t$

$v = 4000 \times 10^8 \times \frac{1}{2500}$

$v = \frac{E_0}{B_0}$

$E_0 = v B_0$

$= \frac{4000 \times 10^8}{2500} \times 5 \times 10^{-6}$

$= \frac{40}{5} \times 10^2$

$= 12 \times 10^2$

7. Light travels in two media M1 and M2 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) $\sin^{-1}\left(\frac{2}{3}\right)$

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

$$\sin C = \frac{\mu_2}{\mu_1} = \frac{v_a / v_{M_2}}{v_a / v_{M_1}}$$

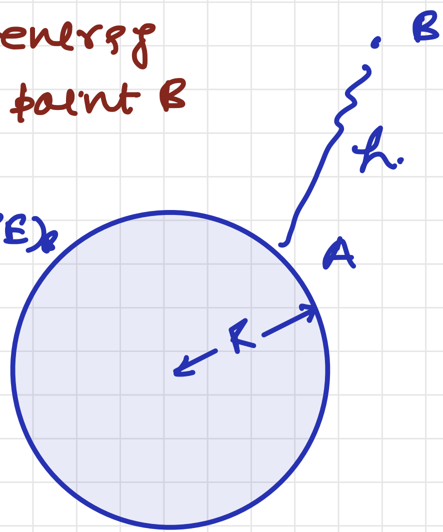
$$= \frac{v_{M_1}}{v_{M_2}} = \frac{1.5 \times 10^8}{2 \times 10^8}$$

$$= \frac{3}{4}$$

$$C = \sin^{-1}(3/4) \text{ or } C = \tan^{-1}\frac{3}{\sqrt{7}}$$

8. A body is projected vertically upwards 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-2)
(A) 800km (B) 1600km
(C) 2133 km (D) 4800 km

Apply conservation of energy between point A and point B



$$(TE)_A = (TE)_B$$

$$(KE)_A + (PE)_A = (KE)_B + (PE)_B$$

$$\frac{1}{2} m \left(\frac{1}{3}\sqrt{\frac{2GM}{R}}\right)^2 - \frac{GMm}{R} = -\frac{GMm}{R+h}$$

$$-\frac{GMm}{R} + \frac{1}{9}\frac{GMm}{R} = -\frac{GMm}{R+h}$$

$$\frac{8}{9R} = \frac{1}{R+h} \Rightarrow h = \frac{R}{8} = \frac{6400}{8} = 800\text{ km}$$

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

$$\% \text{ modulation} = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

$$= \left(\frac{60 - 20}{60 + 20}\right) \times 100$$

$$= 50\%$$

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

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

Linear momentum is conserved

$$0 = \frac{M'}{3}v_1 - \frac{2M'}{3}v_2$$

$$\frac{M'}{3}v_1 = \frac{2M'}{3}v_2$$

since

$$\lambda_1 = \frac{h}{\left(\frac{M'}{3}v_1\right)}$$

$$\lambda_2 = \frac{h}{\left(\frac{2M'}{3}\right)v_2}$$

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

11. A nice cube of dimensions 60cm × 50cm × 20cm is placed in an insulation box of wall thickness 1 cm. The box keeping the ice cube at 0°C of temperature is brought to a room of temperature 40°C. The rate of melting of ice is approximately.

(Latent heat of fusion of ice is 3.4 × 10^5 J kg-1 and thermal conducting of insulation wall is 0.05 Wm-1°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

$$\frac{\Delta Q}{\Delta t} = \frac{KA(T_1 - T_2)}{l}$$

$$\frac{mL}{\Delta t} = \frac{KA(T_1 - T_2)}{l}$$

$$\frac{m}{\Delta t} = \frac{KA(T_1 - T_2)}{L(l)} = \frac{.05 \times 2(0.6 \times 0.5 + 0.5 \times 0.2 + 0.2 \times 0.6)}{3.4 \times 10^5 \times 1 \times 10^{-2}}$$

$$= 61 \times 10^{-5} \text{ kg/sec}$$

12. A gas has n degrees 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) $\frac{n}{n-2}$

$$C_V = \frac{nR}{2}$$

$$C_P = \frac{nR}{2} + R = R\left(\frac{n}{2}+1\right)$$

$$\frac{C_V}{C_P} = \frac{nR/2}{\frac{nR}{2}+R} = \frac{n}{n+2}$$

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 (C) π
(B) 2π (D) 2

$y = 2\sin(\omega t - kx)$

compare with

$y = a\sin\left(\frac{2\pi}{\lambda}v t - \frac{2\pi}{\lambda}x\right)$

$\frac{2\pi}{\lambda}v t = \omega t \Rightarrow v = \frac{\omega\lambda}{2\pi}$ — (1)

Differentiate y w.r.t. (t)

$\frac{dy}{dt} = 2(\omega)\cos(\omega t - kx)$

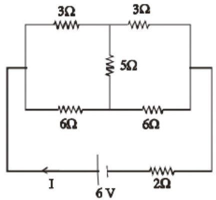
$2(\omega)$ — maximum velocity. — (2)

EQUATE (1) & (2)

$\frac{\omega\lambda}{2\pi} = 2(\omega)$

ANSWER → $\lambda = 4\pi$

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

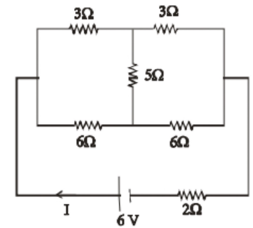


(A) 1A ✓

(B) 2A

(C) $\frac{6}{11}$ A

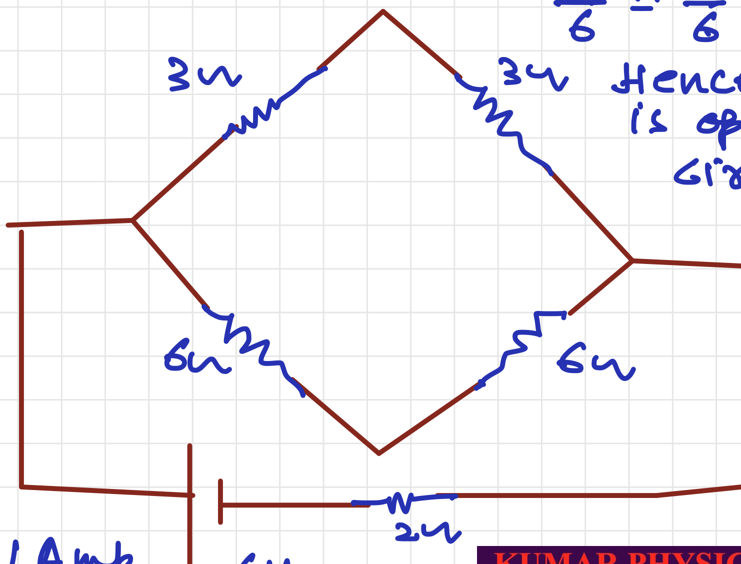
(D) $\frac{4}{3}$ A

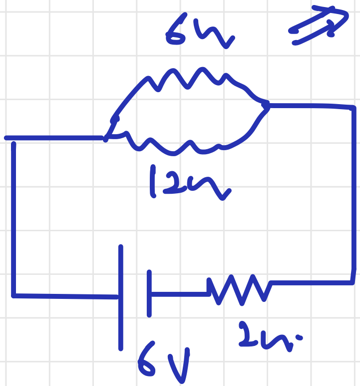


→ This is balanced wheatstone Bridge

$$\frac{3}{6} = \frac{3}{6}$$

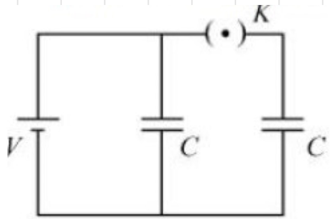
Hence 5-ohm is open circuited





$$I = \frac{6}{2 + \frac{6 \times 12}{6+12}} = \frac{6}{2 + 4} = 1 \text{ Amp}$$

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 E1. 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 E2. The ratio E1/E2 will be



(A) $\frac{1}{10}$ (B) $\frac{2}{5}$

(C) $\frac{5}{13}$ ✓ (D) $\frac{5}{26}$

Q15: 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 . 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
. The ratio will be :E / E

CASE – I $E_1 = \frac{1}{2}(2C)V^2$

CASE-2 — $E_2 = \frac{1}{2}(KC)V^2 + \frac{1}{2}(KC)\left(\frac{V}{K}\right)^2$

$= \frac{1}{2}V^2\left[KC + \frac{KC}{K^2}\right]$

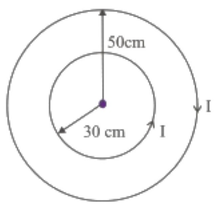
$= \frac{1}{2}V^2\left[KC + \frac{C}{K}\right]$

$= \frac{1}{2}CV^2\left[5 + \frac{1}{5}\right] = \frac{1}{2}CV^2\left(\frac{26}{5}\right)$

$E_1/E_2 = \frac{\frac{1}{2}(2C)V^2}{\frac{1}{2}CV^2\left(\frac{26}{5}\right)} = \frac{10}{26} = \frac{5}{13}$

$= 5/13$

Q16: Two concentric circular loops of radii and are placed in x-y plane as shown in the figure. A current 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) $\frac{7}{2}\hat{k}\mathrm{Am}^2$

(B) $-\frac{7}{2}\hat{k}\mathrm{Am}^2$ ✓

(C) $7\hat{k}\mathrm{Am}^2$

(D) $-7\hat{k}Am^2$

$$M_1 = I\pi(0.5)^2(-\hat{k})$$

$$M_2 = I\pi(0.3)^2(\hat{k})$$

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

$$= \pi I\left(\frac{25}{100} - \frac{9}{100}\right)\hat{k}$$

$$= -\frac{22}{7}(I)\left(\frac{16}{100}\right)\hat{k}$$

$$\vec{M} = -3.52\,\hat{k}\,Am^2$$

$$= -\frac{7}{2}\,\hat{k}\ Amp\,mt^2$$

Q17: 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 E required for an electron of energy $728 eV$ moving along the positive x-axis to pass undeflected is :
(Given, mass of electron $= 9.1 \times 10^{-31}$ kg)

(A) $192 kVm^{-1}$

(B) $192\ mVm^{-1}$

(C) $9600 kVm^{-1}$

(D) $16 kVm^{-1}$

$\vec{E} = E\hat{k}$

$\vec{B} = B\hat{j}$

$B = 12 \times 10^{-3}\ T$

$E = 728 \times 1.6 \times 10^{-19}\ J = \frac{1}{2} m v^2$

$$v = \sqrt{\frac{2 \times 728 \times 1.6 \times 10^{-19}}{9.1 \times 10^{-31}}}$$

$= 16 \times 10^{6}$ mt/sec

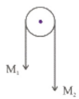
$qvB = qE$

$E = vB = 12 \times 10^{-3} \times 16 \times 10^{6}$

$= 192 \times 10^{3}\ V/m$

$= 192\ kV/m$

Q18: 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:

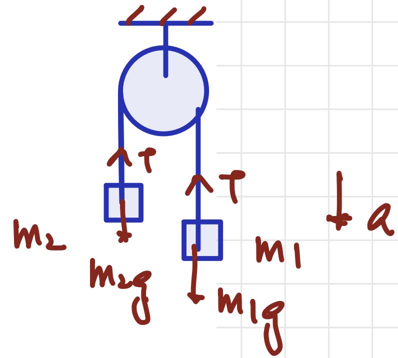


(A) $\frac{1}{3}$

(B) $\frac{2}{3}$ ✓

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

(D) $\frac{1}{2}$



$m_1 g - T = m_1 a$

$T - m_2 g = m_2 a$

ADD

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

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

CASE - I

$$a_1 = \frac{2m_1 g - m_1 g}{3m_1}$$

$a_1 = g/3$

CASE - 2

$$a_2 = \frac{3m_1 g - m_1 g}{4m_1}$$

$a_2 = g/2$

$$\frac{a_1}{a_2} = \frac{g/3}{g/2} = 2/3$$

Q19: 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) $\left(\frac{4}{3}\right)^{\frac{1}{3}}$

$$R = R_0 A^{1/3}$$

Density of nucleus = $\dfrac{\text{mass of nucleus}}{\text{volume of nucleus}}$

$$\rho = \frac{mA}{\frac{4}{3}\pi R^3} = \frac{m(A)}{\frac{4}{3}\pi R_0^3 A} = \frac{3m}{4\pi R_0^3}$$

$\rho \rightarrow$ independent of mass number

Q20: The area of cross section of the rope used to lift a load by a crane is $2.5 \times 10^{-4}\ \mathrm{m}^2$. 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 area of cross section of the rope should be : (take $g = 10\ \mathrm{ms}^{-2}$

(A) $6.25 \times 10^{-4}\ \mathrm{m}^2$

(B) $10 \times 10^{-4}\ \mathrm{m}^2$

(C) $1 \times 10^{-4}\ \mathrm{m}^2$

(D) $1.67 \times 10^{-4}\ \mathrm{m}^2$

$$\text{BREAKING STRESS} = \frac{\text{MAX LIFTING CAPACITY}}{\text{Area of cross-section of rope}}$$

$$\frac{10}{2.5 \times 10^{-4}} = \frac{25}{A}$$

$$A = 625 \times 10^{-6}\ \mathrm{m}^2$$

$$= 6.25 \times 10^{-4}\ \mathrm{m}^2$$

SECTION - B

Numerical Value Type Questions: This section contains 10 questions. In Section B, attempt any five questions out of 10. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the second decimal place; e.g. 06.25, 07.00, -00.33, -00.30, 30.27, -27.30) using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer.

Q21: If $2\hat{i}+3\hat{j}-\hat{k}$ and $\hat{i}+2\hat{j}+2\hat{k}$. The magnitude of component of vector A along vector B will be __2__

$\bar{A}\cdot\bar{B} = AB\cos\theta$

component of $\bar{A}$ along B

$= \vec{A}\cdot\hat{B} = \vec{A}\cdot\dfrac{\bar{B}}{|B|}$

$= \dfrac{\vec{A}\cdot\bar{B}}{|B|} = \dfrac{(2)(1)+(3)(2)+(-1)(2)}{\sqrt{1^2+2^2+2^2}}$

$= \dfrac{2+6-2}{3} = \dfrac{6}{3}$

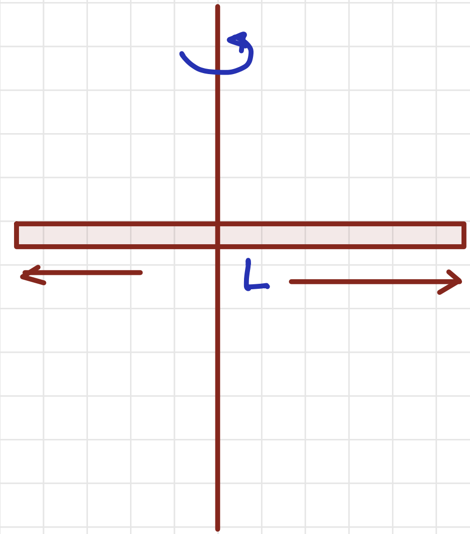
$= 2$

Q22: The radius of gyration of a cylindrical rod about an axis of rotation perpendicular to its length and passing through the center will be __5___. Given, the length of the rod is $10\sqrt{3}$ m.

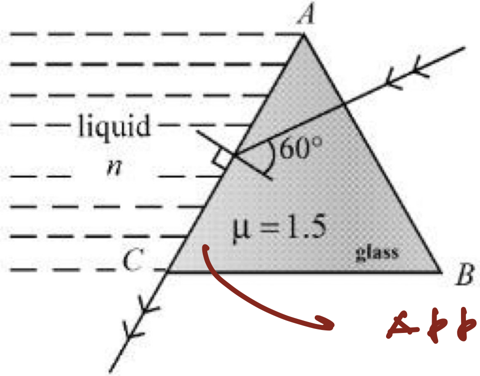
$$\frac{M l^2}{12} = M k^2$$

$$k = \frac{l}{\sqrt{12}}$$

$$= \frac{l}{2\sqrt{3}} = \frac{10\sqrt{3}}{2\sqrt{3}} = 5$$



Q23: In the given figure, the face AC of the equilateral prism is immersed in a liquid of refractive index 'n'. For incident angle at the side AC, the refracted light beam just grazes along face AC. The refractive index of the liquid $\sqrt{x}/4$. The value of x is ______. (Given refractive index of glass = 1.5)



Apply snail's law at surface AC

$$1.5 \sin 60 = \mu \sin 90$$

$$\mu = 1.5\left(\frac{\sqrt{3}}{2}\right) = \frac{3\sqrt{3}}{4} = \frac{\sqrt{27}}{4} \Rightarrow \frac{\sqrt{x}}{4}$$

$$x = 27$$

24. Two lighter nuclei combine to from a comparatively heavier nucleus by the relation given below:
${}^{2}_{1}X + {}^{2}_{1}X = {}^{4}_{2}Y$ The binding energies per nucleon for ${}^{2}_{1}X$ and ${}^{4}_{2}Y$ are 1.1 MeV and 7.6 MeV respectively. The energy released in the process is __26__ MeV

$${}^{2}_{1}X + {}^{2}_{1}X = {}^{4}_{2}Y$$

Energy released = change in BE

$$= (7.6 \times 4) - (4 \times 1.1)$$

$$= 26 \text{ MeV}$$

25. A uniform heavy rod of mass 20 kg, 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 25

(Given Young's modulus $Y = 2 \times 10^{11}$ Nm-2 and $g = 10\ ms^{-2}$)

$$Y = \frac{F/A}{\Delta L/L} = \frac{T_{AVG}(L)}{AY}$$

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

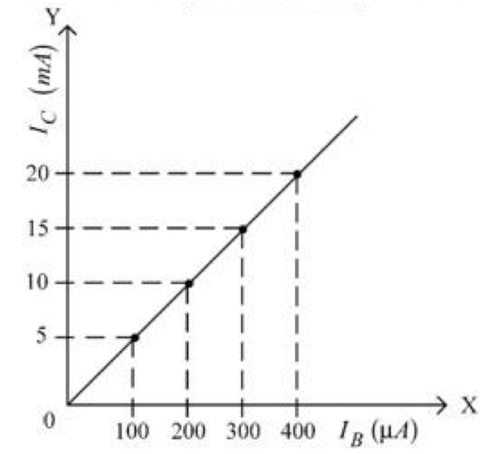
$$= \frac{4 \times 10^{3} \times 10^{-11}}{4 \times 0.4}$$

$$= 2.5 \times 10^{-8}$$

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

$$x = 25$$

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



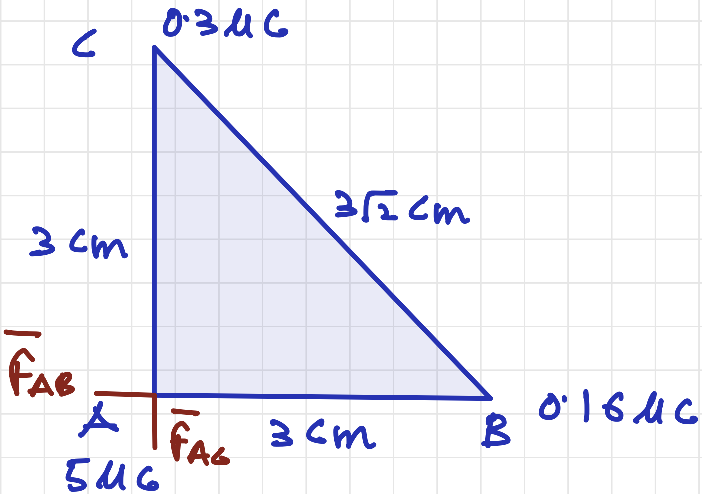
$$V_{gain} = \text{current gain} \times \frac{R_L}{R_i}$$

$$= \left(\frac{\Delta I_c}{\Delta I_b}\right)\left(\frac{R_L}{R_i}\right)$$

$$= \left(\frac{5\times 10^{-3}}{100\times 10^{-6}}\right)\left(\frac{2\times 10^{3}}{0.5\times 10^{3}}\right)$$

$$= \frac{(10)(10)}{(0.5)} = 200$$

27) Three point charges of magnitude 5 μC, 0.16 μC and 0.3 μC 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 = 3cm and point A Is the right angle corner. Charge at point A, experiences __17__ N of electrostatic force due to the other two charges.



$$F_{AC} = \frac{1}{4\pi\epsilon_0}\frac{(5\times0.3)\times10^{-12}}{9\times10^{-4}}$$

$$F_{AB} = \frac{1}{4\pi\epsilon_0}\frac{(5\times0.16)\times10^{-12}}{9\times10^{-4}}$$

$$F_{NET} = \sqrt{(F_{AB})^2 + (F_{AC})^2}$$

$$= \frac{9\times10^{9}\times10^{-12}}{9\times10^{-4}}\sqrt{(1.5)^2+(0.8)^2}$$

$$= 17\text{ N}$$

28. In a coil of resistance 8 Ω, 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 __2__ J.

$R = 8\ \text{ohm}$

$\phi = \frac{2}{3}(9-t^2)$

$|e| = \left|-\frac{d\phi}{dt}\right| = \frac{2}{3}\left[\frac{d}{dt}(9-t^2)\right]$

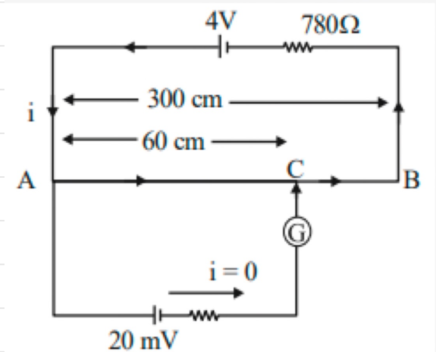
$= \left|\frac{2}{3}[0-2t]\right| = \left|-\frac{4t}{3}\right|$

$|e| = \frac{4t}{3}$

$H = \int_0^3 \frac{V^2}{R}\,dt = \int_0^3 \frac{1}{8}\,\frac{16}{9}\,t^2\,dt$

$= \frac{2}{9}\left[\frac{t^3}{3}\right]_0^3 = \frac{2}{9}\left[\frac{27}{3}\right] = 2\,J$

Q29: 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 20 Ω



R – Resistance of potentiometer wire

$$i = \frac{4}{R+780}$$

300 cm is having a resistance R

60 cm " " " " $= \frac{R \times 60}{300}$

Under balance condition

$$20 \times 10^{-3} = \left(\frac{4}{R+780}\right) \times \frac{R \times 60}{(300)}$$

$$\frac{20}{1000} = \frac{240 R}{(300)(R+780)}$$

$$40R = R + 780$$

$$39R = 780 \Rightarrow R = \frac{780}{39} = 20 \text{ ohm}$$

Q30: 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 $\sqrt{x}$. The value of x is _2_.

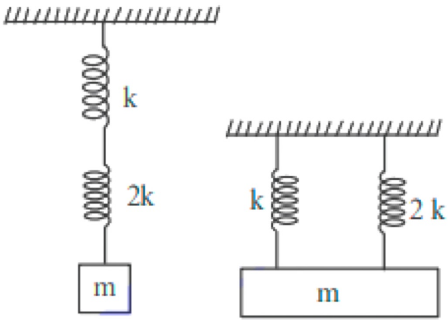


figure (a) figure (b)

2.00

CASE-1

$$K_{eq} = \frac{(K)(2K)}{3K} = \frac{2K}{3}$$

$$T_1 = 2\pi\sqrt{\frac{m}{2K/3}} = 2\pi\sqrt{\frac{3m}{2K}}$$

CASE-2

$$K_{eq} = 3K$$

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

$$\frac{T_1}{T_2} = \sqrt{\frac{3m}{2K}\cdot\frac{3K}{m}} = \frac{3}{\sqrt{2}}$$

$$\frac{3}{T_2} = \frac{3}{\sqrt{2}} \qquad T_2 = \sqrt{2} = \sqrt{x}$$

$$x = 2.0$$

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QUESTIONS BASED ON

VARNIER CALIPERS, AM,WAVE,CAPACITOR AS DIELECTRIC,PRISM TOTAL INTERNAL REFLECTION,EMW ARE TRICKY