FINAL JEE–MAIN EXAMINATION – SEPTEMBER, 2020

(Held On Sunday 06th SEPTEMBER, 2020) TIME : 3 PM to 6 PM

PHYSICS — TEST PAPER WITH ANSWER & SOLUTION

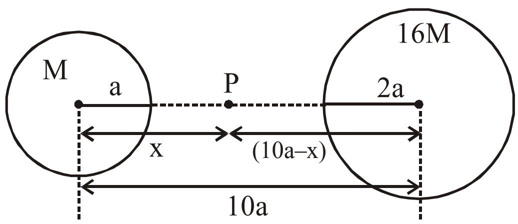
1. Two planets have masses M and 16 M and their radii are a and 2a, respectively. The separation between the centres of the planets is 10a. A body of mass m is fired from the surface of the larger planet towards the smaller planet along the line joining their centres. For the body to be able to reach at the surface of smaller planet, the minimum firing speed needed is :

(1) $\sqrt{\frac{GM^2}{ma}}$ (2) $\frac{3}{2}\sqrt{\frac{5GM}{a}}$

(3) $4\sqrt{\frac{GM}{a}}$ (4) $2\sqrt{\frac{GM}{a}}$

Official Ans. by NTA (2)

Sol.



$$\frac{GM}{x^2} = \frac{G(16M)}{(10a-x)^2}$$

$$\frac{1}{x} = \frac{4}{(10a-x)} \quad \Rightarrow 4x = 10a - x$$

$x = 2a$ ....(i)

COME

$$-\frac{GMm}{8a} - \frac{G(16M)m}{2a} + KE$$

$$= -\frac{GMm}{2a} - \frac{G(16M)m}{8a}$$

$$KE = GMm\left[\frac{1}{8a} + \frac{16}{2a} - \frac{1}{2a} - \frac{16}{8a}\right]$$

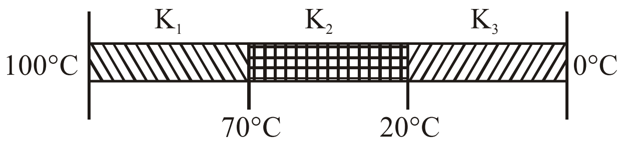
$$KE = GMm\left[\frac{1+64-4-16}{8a}\right]$$

$$\frac{1}{2}mv^2 = GMm\left[\frac{45}{8a}\right]$$

$$V = \sqrt{\frac{90GM}{8a}}$$

$$V = \frac{3}{2}\sqrt{\frac{5GM}{a}}$$

2. Three rods of identical cross-section and lengths are made of three different materials of thermal conductivity K_1, K_2, and K_3, respectively. They are joined together at their ends to make a long rod (see figure). One end of the long rod is maintained at 100°C and the other at 0°C (see figure). If the joints of the rod are at 70°C and 20°C in steady state and there is no loss of energy from the surface of the rod, the correct relationship between K_1, K_2 and K_3 is :



(1) $K_1 : K_3 = 2 : 3$; $K_2 : K_3 = 2 : 5$

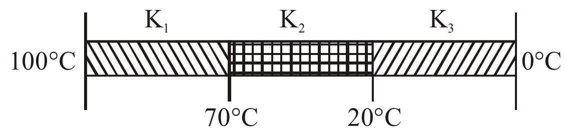
(2) $K_1 < K_2 < K_3$

(3) $K_1 : K_2 = 5 : 2$; $K_1 : K_3 = 3 : 5$

(4) $K_1 > K_2 > K_3$

Official Ans. by NTA (1)

Sol.



Rods are identical have same length (ℓ) and area of cross-section (A)

Combination are in series, so heat current is same for all Rods

$$\left(\frac{\Delta Q}{\Delta t}\right)_{AB} = \left(\frac{\Delta Q}{\Delta t}\right)_{BC} = \left(\frac{\Delta Q}{\Delta t}\right)_{CD} = \text{Heat current}$$

$$\frac{(100-70)K_1A}{\ell} = \frac{(70-20)K_2A}{\ell} = \frac{(20-0)K_3A}{\ell}$$

$30K_1 = 50K_2 = 20K_3$

$3K_1 = 2K_3$

$$\frac{K_1}{K_3} = \frac{2}{3} = 2:3$$

$5K_2 = 2K_3$

$$\frac{K_2}{K_3} = \frac{2}{5} = 2:5$$

3. For a plane electromagnetic wave, the magnetic field at a point x and time t is

$$\vec{B}(x,t) = \left[1.2\times10^{-7}\sin(0.5\times10^3x + 1.5\times10^{11}t)\hat{k}\right]T$$

The instantaneous electric field $\vec{E}$ corresponding to $\vec{B}$ is : (speed of light $c = 3 \times 10^8$ ms^{-1})

(1) $\vec{E}(x,t) = \left[36\sin(0.5\times10^3x + 1.5\times10^{11}t)\hat{k}\right]\frac{V}{m}$

(2) $\vec{E}(x,t) = \left[-36\sin(0.5\times10^3x + 1.5\times10^{11}t)\hat{j}\right]\frac{V}{m}$

(3) $\vec{E}(x,t) = \left[36\sin(1\times10^3x + 0.5\times10^{11}t)\hat{j}\right]\frac{V}{m}$

(4) $\vec{E}(x,t) = \left[36\sin(1\times10^3x + 1.5\times10^{11}t)\hat{j}\right]\frac{V}{m}$

Official Ans. by NTA (2)

Sol. $\vec{E}$ and $\vec{B}$ are perpendicular for EM wave

$E_0 = CB_0$

$= 3 \times 10^8 \times 1.2 \times 10^{-7}$

$= 36$

Having same phase

Propagation is along –x-axis, $\vec{B}$ is along z-axis hence $\vec{E}$ must be along y-axis.

So, option (2) is correct

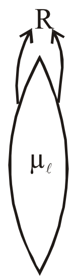
4. A double convex lens has power P and same radii of curvature R of both the surfaces. The radius of curvature of a surface of a plano-convex lens made of the same material with power 1.5 P is:

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

(3) $\frac{3R}{2}$ (4) $\frac{R}{3}$

Official Ans. by NTA (4)

Sol.



$R_1 = R_2 = R$

Power (P)

Refractive index is assume (μ_ℓ)

$$P = \frac{1}{f} = (\mu_\ell - 1)\left(\frac{2}{R}\right) \quad ....(i)$$

$$P' = \frac{1}{f'} = (\mu_\ell - 1)\left(\frac{1}{R'}\right) \quad ....(ii)$$

$$P' = \frac{3}{2}P$$

$$(\mu_\ell - 1)\left(\frac{1}{R'}\right) = \mu\frac{3}{2}(\mu_\ell - 1)\left(\frac{2}{R}\right)$$

$$\therefore \quad R' = \frac{R}{3}$$

5. A circuit to verify Ohm's law uses ammeter and voltmeter in series or parallel connected correctly to the resistor. In the circuit :

(1) ammeter is always connected series and voltmeter in parallel.

(2) Both, ammeter and voltmeter mast be connected in series.

(3) Both ammeter and voltmeter must be connected in parallel.

(4) ammeter is always used in parallel and voltmeter is series.

Official Ans. by NTA (1)

Sol. Conceptual

Option (1) is correct

Ammeter :- In series connection, the same current flows through all the components. It aims at measuring the curent flowing through the circuit and hence, it is connected in series.

Voltmeter :- A voltmeter measures voltage change between two points in a circuit, So we have to place the voltmeter in parallal with the circuit component.

6. A particle moving in the xy plane experiences a velocity dependent force $\vec{F} = k(v_y\hat{i} + v_x\hat{j})$, where v_x and v_y are the x and y components of its velocity $\vec{v}$. If $\vec{a}$ Ls the acceleration of the particle, then which of the following statements is true for the particle ?

(1) quantity $\vec{v}\cdot\vec{a}$ is constant in time.

(2) kinetic energy of particle is constant in time.

(3) quantity $\vec{v}\times\vec{a}$ is constant in lime.

(4) $\vec{F}$ arises due to a magnetic field.

Official Ans. by NTA (3)

Sol. $$\frac{dv_x}{dt} = \frac{k}{m}v_y$$

$$\frac{dv_y}{dt} = \frac{k}{m}v_x$$

$$\frac{dv_y}{dv_x} = \frac{v_x}{v_y} \Rightarrow \int v_y dv_y = \int v_x dv_x$$

$$v_y^2 = v_x^2 + C$$

$$v_y^2 - v_x^2 = \text{constant}$$

Option (3)

$$\vec{v}\times\vec{a} = (v_x\hat{i} + v_y\hat{j})\times\frac{k}{m}(v_y\hat{i} + v_x\hat{j})$$

$$= (v_x^2\hat{k} - v_y^2\hat{k})\frac{k}{m}$$

$$= (v_x^2 - v_y^2)\frac{k}{m}\hat{k}$$

= Constant

7. Consider the force F on a charge 'q' due to a uniformly charged spherical shell of radius R carrying charge Q distributed uniformly over it. Which one of the following statements is true for F, if 'q' is placed at distance r from the centre of the shell ?

(1) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for r > R

(2) $\frac{1}{4\pi\varepsilon_0}\frac{qQ}{R^2} > F > 0$ for r < R

(3) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for all r

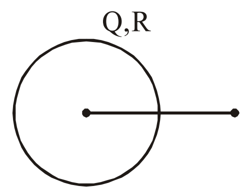
(4) $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{R^2}$ for r < R

Official Ans. by NTA (1)

Sol. Inside the shell

E = 0

hence F = 0



Oustside the sheell

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$

hence $F = \frac{1}{4\pi\varepsilon_0}\frac{Qq}{r^2}$ for r > R

8. Given the masses of various atomic particles $m_p = 1.0072u$, $m_n = 1.0087u$, $m_e = 0.000548u$, $m_{\bar{v}} = 0$, $m_d = 2.0141u$, where p ≡ proton, n ≡ neutron, e ≡ electron, $\bar{v}$ ≡ antineutrino and d ≡ deuteron. Which of the following process is allowed by momentum and energy conservation ?

(1) $n + p \rightarrow d + \gamma$

(2) $e^+ + e^- \rightarrow \gamma$

(3) $n + n \rightarrow$ deuterium atom

(electron bound to the nucleus)

(4) $p \rightarrow n + e^+ + \bar{v}$

Official Ans. by NTA (1)

Sol. Only in case-I, $M_{LHS} > M_{RHS}$ i.e.

total mass on reactant side is greater then that on the product side. Hence it will only be allowed.

9. Two identical electric point dipoles have dipole moments $\vec{p}_1 = p\hat{i}$ and $\vec{p}_2 = -p\hat{i}$ and are held on the x axis at distance 'a' from each other. When released, they move along the x-axis with the direction of their dipole moments remaining unchanged. If the mass of each dipole is'm', their speed when they arc infinitely far apart is:

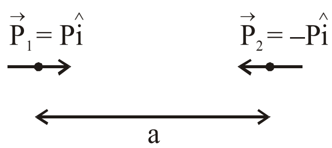
(1) $\frac{p}{a}\sqrt{\frac{1}{\pi\varepsilon_0 ma}}$ (2) $\frac{p}{a}\sqrt{\frac{3}{2\pi\varepsilon_0 ma}}$

(3) $\frac{p}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 ma}}$ (4) $\frac{p}{a}\sqrt{\frac{2}{\pi\varepsilon_0 ma}}$

Official Ans. by NTA (3)

Sol. Using energy conservation:

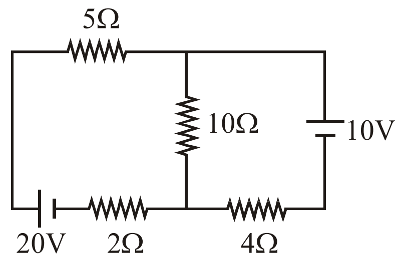
$KE_i + PE_i = KE_f + PE_f$



$$O + \frac{2KP}{a^3} \times P = \frac{1}{2}mv^2 \times 2 + 0$$

$$V = \sqrt{\frac{2P^2}{4\pi\varepsilon_0 a^3 m}} = \frac{P}{a}\sqrt{\frac{1}{2\pi\varepsilon_0 am}}$$

10. In the figure shown, the current in the 10 V battery is close to :



(1) 0.36 A from negative to positive terminal.

(2) 0.71 A from positive to negative terminal.

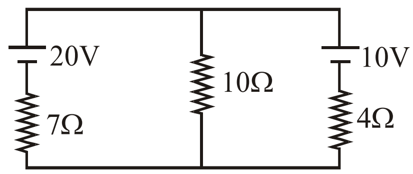
(3) 0.21 A from positive to negative terminal.

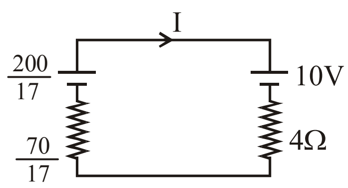
(4) 0.42 A from positive to negative terminal.

Official Ans. by NTA (3)

Sol. $E_{eq} = \frac{20 \times 10}{17} = \frac{200}{17}$

and $R_{eq} = \frac{7 \times 10}{17} = \frac{70}{17}$





$$\therefore \quad I = \frac{\frac{20}{17} - 10}{4 + \frac{70}{17}} = 0.21 \text{ A}$$

from +ve to –ve terminal

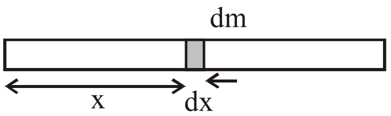
11. The linear mass density of a thin rod AB of length L varies from A to B as $\lambda(x) = \lambda_0\left(1+\frac{x}{L}\right)$, where x is the distance from A. If M is the mass of the rod then its moment of inertia about an axis passing through A and perpendicular to the rod is:

(1) $\frac{5}{12}ML^2$ (2) $\frac{3}{7}ML^2$

(3) $\frac{2}{5}ML^2$ (4) $\frac{7}{18}ML^2$

Official Ans. by NTA (4)

Sol.



$$I = \int r^2 dm = \int x^2 \lambda dx$$

$$I = \int_0^L x^2 \lambda_0\left(1+\frac{x}{L}\right)dx$$

$$I = \lambda_0 \int_0^L \left(x^2 + \frac{x^3}{L}\right)dx$$

$$I = \lambda\left[\frac{L^3}{3} + \frac{L^3}{4}\right]$$

$$I = \frac{7L^3\lambda_0}{12} \qquad ....(i)$$

$$M = \int_0^L \lambda dx = \int_0^L \lambda_0\left(1+\frac{x}{L}\right)dx$$

$$M = \lambda_0\left(L+\frac{L}{2}\right) = \lambda_0\frac{3L}{2}$$

$$\frac{2}{3}M = (\lambda_0 L) \qquad ....(ii)$$

From (i) & (ii)

$$I = \frac{7}{12}\left(\frac{2}{3}M\right)L^2 = \frac{7ML^2}{18}$$

Ans. (4)

12. A student measuring the diameter of a pencil of circular cross-section with the help of a vernier scale records the following four readings 5.50 mm, 5.55 mm, 5.45 mm; 5.65 mm. The average of these four readings is 5.5375 mm and the standard deviation of the data is 0.07395 mm. The average diameter of the pencil should therefore be recorded as :

(1) (5.5375 ± 0.0739) mm

(2) (5.538 ± 0.074) mm

(3) (5.54 ± 0.07) mm

(4) (5.5375 ± 0.0740) mm

Official Ans. by NTA (3)

Sol. Use significant figures. Answer must be upto three significant figures.

Ans. (3)

13. When a particle of mass m is attached to a vertical spring of spring constant k and released, its motion is described by $y(t) = y_0 \sin^2\omega t$, where 'y' is measured from the lower end of unstretched spring. Then ω is :

(1) $\sqrt{\frac{g}{y_0}}$ (2) $\sqrt{\frac{g}{2y_0}}$

(3) $\frac{1}{2}\sqrt{\frac{g}{y_0}}$ (4) $\sqrt{\frac{2g}{y_0}}$

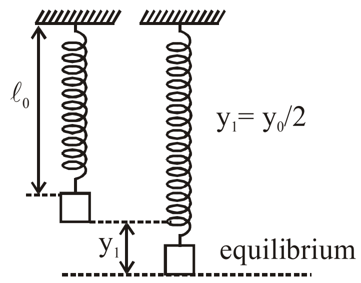
Official Ans. by NTA (2)

Sol. $y = y_0 \sin^2\omega t$

$$y = \frac{y_0}{2}(1-\cos 2\omega t)$$

$$y - \frac{y_0}{2} = -\frac{y_0}{2}\cos 2\omega t$$

Amplitude : $\frac{y_0}{2}$



$$\frac{y_0}{2} = \frac{mg}{K}$$

$$2\omega = \sqrt{\frac{K}{m}} = \sqrt{\frac{2g}{y_0}}$$

$$\omega = \sqrt{\frac{g}{2y_0}}$$

Ans. (2)

14. In a dilute gas at pressure P and temperature T, the mean time between successive collisions of a molecule varies with T as :

(1) $\sqrt{T}$ (2) $\frac{1}{T}$

(3) $\frac{1}{\sqrt{T}}$ (4) T

Official Ans. by NTA (3)

Sol. $v_{avg} \propto \sqrt{T}$

t_0 : mean time

λ : mean free path

$$t_0 = \frac{\lambda}{v_{avg}} \propto \frac{1}{\sqrt{T}}$$

15. A fluid is flowing through a horizontal pipe of varying cross-section, with speed v ms^{-1} at a point where the pressure is P Pascal. P At another point where pressure is $\frac{P}{2}$ Pascal its speed is V ms^{-1}. If the density of the fluid is ρ kg m^{-3} and the flow is streamline, then V is equal to :

(1) $\sqrt{\frac{P}{2\rho}+v^2}$ (2) $\sqrt{\frac{P}{\rho}+v^2}$

(3) $\sqrt{\frac{2P}{\rho}+v^2}$ (4) $\sqrt{\frac{P}{\rho}+v}$

Official Ans. by NTA (2)

Sol. Applying Bernoulli's Equation

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$$P + \frac{1}{2}\rho v^2 = \frac{P}{2} + \frac{1}{2}\rho V^2$$

$$\frac{2P}{2\rho} + \frac{1}{2}\frac{\rho v^2}{\rho} \times 2 = V^2$$

$$\sqrt{\frac{P}{\rho}+v^2} = V$$

Ans. (2)

16. Assuming the nitrogen molecule is moving with r.m.s. velocity at 400 K, the de-Broglie wavelength of nitrogen molecule is close to :

(Given : nitrogen molecule weight : 4.64×10^{-26}kg, Boltzman constant : 1.38×10^{-23} J/K, Planck constant: 6.63×10^{-34} J.s)

(1) 0.34 Å (2) 0.24 Å

(3) 0.20 Å (4) 0.44 Å

Official Ans. by NTA (2)

Sol. $v_{rms} = \sqrt{\frac{3KT}{m}}$

m → mass of one molecule (in kg) = $\frac{\text{molar mass}}{NA}$

de-Broglie wavelenth,

$$\lambda = \frac{h}{mv}$$

given, v = v_{rms}

$$\lambda = \frac{h}{m\sqrt{\frac{3KT}{m}}}$$

$$\lambda = \frac{h}{\sqrt{3KTm}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{3 \times 1.38 \times 10^{-23} \times 400 \times \left(\frac{28 \times 10^{-3}}{6.023 \times 10^{-23}}\right)}}$$

$$\lambda = \frac{6.63 \times 10^{-11}}{2.77} = 2.39 \times 10^{-11} m$$

λ = 0.24 Å

17. Particle A of mass m_1 moving with velocity $(\sqrt{3}\hat{i} + \hat{j})ms^{-1}$ collides with another particle B of mass m_2 which is at rest initially. Let $\vec{V}_1$ and $\vec{V}_2$ be the velocities of particles A and B after collision respectively. If $m_1 = 2m_2$ and after collision $\vec{V}_1 = (\hat{i} + \sqrt{3}\hat{j})ms^{-1}$, the angle between $\vec{V}_1$ and $\vec{V}_2$ is :

(1) 60° (2) 15° (3) –45° (4) 105°

Official Ans. by NTA (4)

Sol. $\vec{v}_{01} = (\sqrt{3}\hat{i} + \hat{j})$ m / s

$\vec{v}_{02} = \vec{0}$

$m_1 = 2m_2$

After collision, $\vec{v}_1 = (\hat{i} + \sqrt{3}\hat{j})$ m / s

$\vec{v}_2 = ?$

Applying conservation of linear momentum,

$$m_1\vec{v}_{01} + m_2\vec{v}_{02} = m_1\vec{v}_1 + m_2\vec{v}_2$$

$$2m_2(\sqrt{3}\hat{i} + \hat{j}) + 0 = 2m_2(\hat{i} + \sqrt{3}\hat{j}) + m_2\vec{v}_2$$

$$\vec{v}_2 = 2(\sqrt{3}\hat{i} + \hat{j}) - 2(\hat{i} + \sqrt{3}\hat{j})$$

$$= 2(\sqrt{3}\hat{i} - \hat{j}) + 2(\hat{i} - \sqrt{3}\hat{j})$$

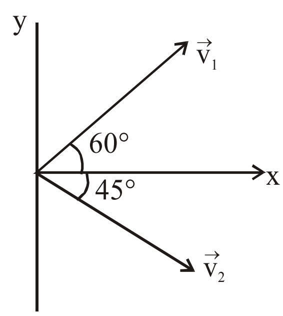
$$\vec{v}_2 = 2(\sqrt{3} - 1)(\hat{i} - \hat{j})$$

for angle between $\vec{v}_1$ & $\vec{v}_2$,

$$\cos\theta = \frac{\vec{v}_1 \cdot \vec{v}_2}{v_1 v_2} = \frac{2(\sqrt{3}-1)(1-\sqrt{3})}{2 \times 2\sqrt{2}(\sqrt{3}-1)}$$

$$\cos\theta = \frac{1-\sqrt{3}}{2\sqrt{2}} \Rightarrow \theta = 105°$$

or



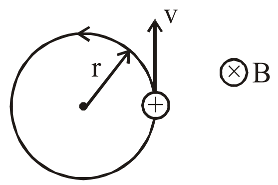
18. A charged particle going around in a circle can be considered to be a current loop. A particle of mass m carrying charge q is moving in a plane with speed v under the influence of magnetic field $\vec{B}$. The magnetic moment of this moving particle :

(1) $-\frac{mv^2\vec{B}}{B^2}$ (2) $-\frac{mv^2\vec{B}}{2\pi B^2}$

(3) $\frac{mv^2\vec{B}}{2B^2}$ (4) $-\frac{mv^2\vec{B}}{2B^2}$

Official Ans. by NTA (4)

Sol.



Magnetic moment

M = iA

$$M = \left(\frac{q}{T}\right) \times \pi r^2 = \frac{q\pi r^2}{\left(\frac{2\pi r}{v}\right)} = \frac{qvr}{2}$$

$$M = \frac{qv}{2} \times \frac{vm}{qB}$$

$$M = \frac{mv^2}{2B}$$

As we can see from the figure, direction of magnetic moment (M) is opposite to magnetic field.

$$\vec{M} = -\frac{mv^2}{2B}\hat{B}$$

$$= -\frac{mv^2}{2B^2}\vec{B}$$

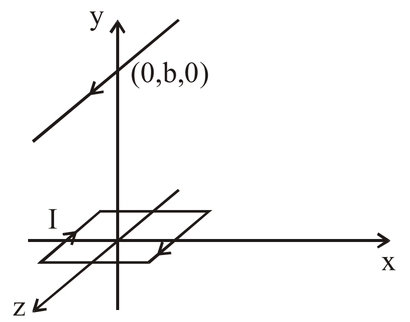
19. A square loop of side 2a and carrying current I is kept in xz plane with its centre at origin. A long wire carrying the same current I is placed parallel to z-axis and passing through point (0, b, 0), (b >> a). The magnitude of torque on the loop about z-ax is will be :

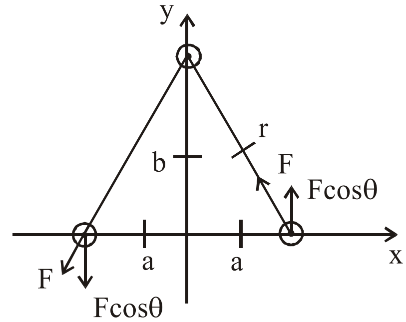
(1) $\frac{2\mu_0 I^2 a^2 b}{\pi(a^2+b^2)}$ (2) $\frac{\mu_0 I^2 a^2 b}{2\pi(a^2+b^2)}$

(3) $\frac{\mu_0 I^2 a^2}{2\pi b}$ (4) $\frac{2\mu_0 I^2 a^2}{\pi b}$

Official Ans. by NTA (1)

Sol.





$r = \sqrt{b^2 + a^2}$

$$F = BI2a = \frac{\mu_0 I}{2\pi r} I \times 2a$$

$$F = \frac{\mu_0 I^2 a}{\pi\sqrt{b^2+a^2}}$$

$$\tau = F\cos\theta \times 2a$$

$$= \frac{\mu_0 I^2 a}{\pi\sqrt{b^2+a^2}} \times \frac{b}{\sqrt{b^2+a^2}} \times 2a$$

$$\tau = \frac{2\mu_0 I^2 a^2 b}{\pi(a^2+b^2)}$$

If b >> a then $\tau = \frac{2\mu_0 I^2 a^2}{\pi b}$

But among the given options (1) is most appropriate

20. When a car is at rest, its driver sees rain drops falling on it vertically. When driving the car with speed v, he sees that rain drops are coming at an angle 60° from the horizontal. On further increasing the speed of the car to (1 + β)v, this angle changes to 45°. The value of β is close to:

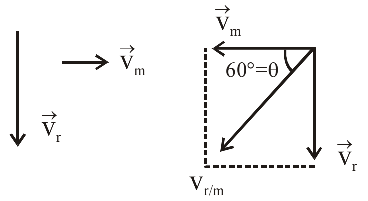
(1) 0.41 (2) 0.50

(3) 0.37 (4) 0.73

Official Ans. by NTA (4)

Sol. Rain is falling vertically downwards.

$\vec{v}_{r/m} = \vec{v}_r - \vec{v}_m$

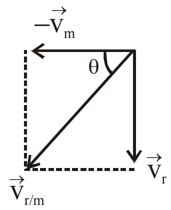


$$\tan 60° = \frac{v_r}{v_m} = \sqrt{3}$$

$$v_r = v_m\sqrt{3} = v\sqrt{3}$$

Now, $v_m = (1 + B)v$

and $\theta = 45°$



$$\tan 45 = \frac{v_r}{v_m} = 1$$

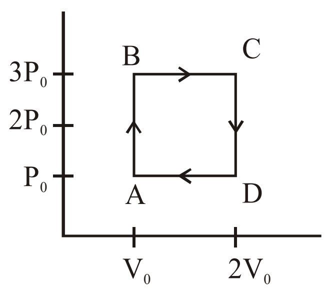
$v_r = v_m$

$$v\sqrt{3} = (1+\beta)v$$

$$\sqrt{3} = 1+\beta$$

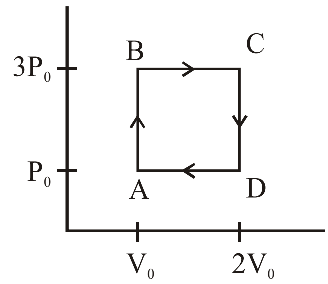
$$\Rightarrow \beta = \sqrt{3} - 1 = 0.73$$

21. An engine operates by taking a monatomic ideal gas through the cycle shown in the figure. The percentage efficiency of the engine is close to ________ .



Official Ans. by NTA (19.00)

Sol.



$W_{ABCDA} = 2P_0V_0$

$Q_{in} = Q_{AB} + Q_{BC}$

$Q_{AB} = nC(T_B - T_A)$

$$= \frac{n3R}{2}(T_B - T_A)$$

$$= \frac{3}{2}(P_BV_B - P_AV_A)$$

$$= \frac{3}{2}(3P_BV_0 = P_0V_0) = 3P_0V_0$$

$Q_{BC} = nC_P(T_C - T_B)$

$$= \frac{n5R}{2}(T_C - T_B)$$

$$= \frac{5}{2}(P_CV_C - P_BV_B)$$

$$= \frac{5}{2}(6P_0V_0 - 3P_0V_0) = \frac{15}{2}P_0V_0$$

$$\eta = \frac{W}{Q_{in}} \times 100 = \frac{2P_0V_0}{3P_0V_0 + \frac{15}{2}P_0V_0} \times 100$$

$$\eta = \frac{400}{21} = 19.04 \approx 19$$

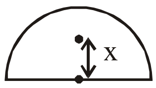
$\eta = 19$

22. The centre of mass of a solid hemisphere of radius 8 cm is X cm from the centre of the flat surface. Then value of x is ________ .

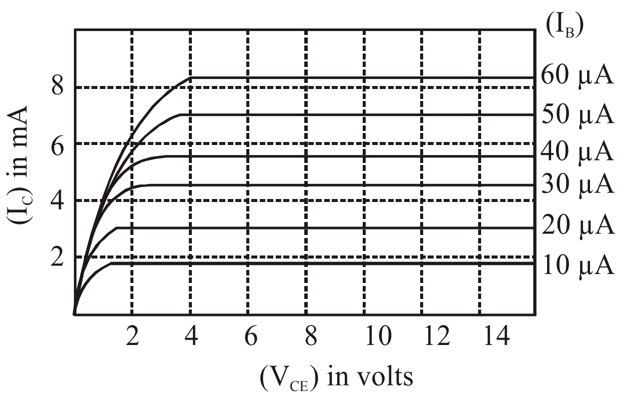
Official Ans. by NTA (3.00)

Sol. $x = \frac{3R}{8} = 3cm$

x = 3



23. The output characteristics of a transistor is shown in the figure. When V_{CE} is 10 V and 1_C = 4.0 mA, then value of β_{ac} is ________ .



Official Ans. by NTA (150.00)

Sol. $\Delta I_B = (30 - 20) = 10\mu A$

$\Delta I_C = (4.5 - 3)\ mA = 1.5mA$

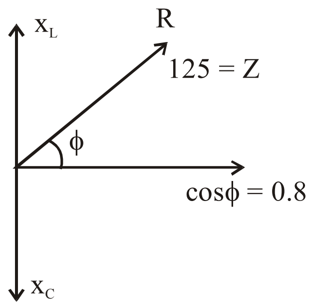
$$\beta_{ac} = \frac{\Delta I_C}{\Delta I_B} = \frac{1.5mA}{10\mu A} = 150$$

$\beta_{ac} = 150$

24. In a scries LR circuit, power of 400 W is dissipated from a source of 250 V, 50 Hz. The power factor of the circuit is 0.8. In order to bring the power factor to unity, a capacitor of value C is added in series to the L and R. Taking the value of C as $\left(\frac{n}{3\pi}\right)\mu F$, then value of n is ________ .

Official Ans. by NTA (400.00)

Sol.



$$P = \frac{E_{rms}^2}{Z}\cos\phi$$

$$400 = \frac{(250)^2 \times 0.8}{Z}$$

Z = 25 × 5 = 125

X_L = 125 sinϕ = 125 × 0.6 = 75

25. A Young's doublc-slit experiment is performed using monochromatic light of wavelength λ. The intensity of light at a point on the screen, where the path difference is λ, is K units. The intensity of light at a point where the path difference is A $\frac{\lambda}{6}$ is given by $\frac{nK}{12}$, where n is an integer. The value of n is ________ .

Official Ans. by NTA (9.00)

Sol. $I_{max} = k$

$I_1 = I_2 = K/4$

$\Delta x = \lambda/6 \quad \Rightarrow \Delta\phi = \pi/3$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

$$I = \frac{K}{4} + \frac{K}{4} + 2 \times \frac{K}{4}\frac{1}{2}$$

$$= \frac{K}{2} + \frac{K}{4} = \frac{3K}{4} = \frac{9K}{12}$$

n = 9