Physics

Question: A monoatomic ideal gas expanded isothermally to double its initial volume. It then expanded adiabatically to double the volume again. Find the final pressure if the initial pressure of the gas was $2 \times 10^7 \, Pa$.

Options:

(a) 3.53×10^3

(b) 2.5×10^7

(c) 3.5×10^7

(d) 1.5×10^3

Answer: (a)

Solution:

$V \rightarrow 2V$ (T constant)

$(2V) \rightarrow (4V)$ (Adiabatic)

$p_i \rightarrow \dfrac{p}{2}(p_f)$ (T constant)

$\left(\dfrac{p}{2}\right)(2V)^{1.5} = (p_f)(4V)^{1.5}$

$\left(\dfrac{p}{2p_f}\right) = (2)^{1.5}$

$\Rightarrow p_f = \dfrac{p}{2^{2.5}} = \dfrac{2 \times 10^7}{2^{2.5}} = 3.53 \times 10^3$

Question: Two square loops of length L and ℓ are concentric and co-planar about centre D. Where $L \gg \ell$. Find the mutual inductance.
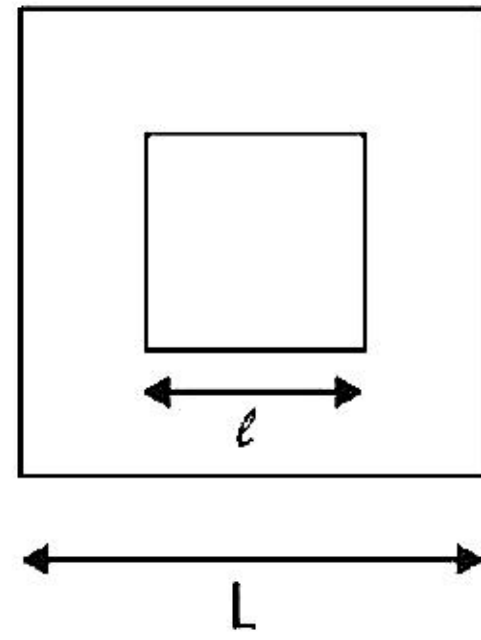
Options:

(a) $\dfrac{\sqrt{2}\mu_0 l^2}{\pi L}$

(b) $\dfrac{2\sqrt{2}\mu_0 l^2}{\pi L}$

(c) $\dfrac{2\mu_0 l^2 L}{L}$

(d) $\dfrac{\mu_0 l^2}{\pi L}$

Answer: (a)

Solution:

Magnetic field due to bigger loop $B = \dfrac{\mu_0 i}{4\pi L}\left(\sin\theta_1 + \sin\theta_2\right)\times 4$

$B = \dfrac{\mu_0 i}{4\pi L}\left(\sin 45° + \sin 45°\right)\times 4$

$B = \dfrac{\mu_0 i}{4\pi L}\,4\sqrt{2}$

Flux linked with the smaller loop $\phi = Bl^2$

$\phi = \dfrac{\sqrt{2}\,\mu_0 i l^2}{\pi L}$

$\phi = Mi$

$M = \dfrac{\sqrt{2}\,\mu_0 i l^2}{\pi L i}$

$$\boxed{M = \dfrac{\sqrt{2}\,\mu_0 l^2}{\pi L}}$$

Question: Find work done in moving a particle of mass 0.5 kg from x = 0 to x = 2. $V = 3x^2 + 4$ m/s

Options:
(a) 20 J
(b) 80 J
(c) 100 J
(d) 60 J

Answer: (d)

Solution:

Work done $= K_f - K_i$

$$= K(2) - K(0)$$

$$= \frac{1}{2} M \left[V(2)^2 \right] - \frac{1}{2} M \left[V(0) \right]^2$$

$$= \frac{1}{2} M \left[\left(3(2)^2 + 4 \right)^2 - (4)^2 \right]$$

$$= \frac{1}{2} \left(\frac{1}{2} \right) [256 - 16]$$

$$= \frac{1}{4} \times 240 = 60 J$$

Question: A car travelling at speed 150 km/h is stopped after covering a distance of 27 m. If the initial velocity is one-third then after how much distance the car would stop?

Options:

(a) 5 m

(b) 3 m

(c) 9 m

(d) 27 m

Answer: (b)

Solution:

$$u, s = 27m, v = 0$$

$$v^2 = u^2 + 2as$$

$$0 = u^2 + 2(a)(27)$$

$$\Rightarrow a = \frac{-u^2}{54}$$

If velocity is one-third

$$0^2 = \left(\frac{u}{3} \right)^2 + 2as$$

$$\Rightarrow \frac{u^2}{g} = 2 \left(\frac{u^2}{54} \right)(s)$$

$$s = 3m$$

Question: Dimensions of coefficient of viscosity with respect to momentum, area or time is

Options:

(a) $\left[MLT^{-1} \right]$

(b) $\left[PA^{-1}T^0 \right]$

(c) $P^1 A^{-1} T^0$

(d) $\left[P^1 AT \right]$

Answer: (c)

Solution:

Dimension of momentum $(P) = \left[MLT^{-1} \right]$

Dimension of area $(A) = \left[L^2 \right]$

So, dimension of viscosity $(\eta) = \dfrac{\left[MLT^{-1} \right]}{\left[L \right]^2} = \dfrac{P}{A}$

Hence $\boxed{[\eta] = \left[P^1 A^{-1} T^0 \right]}$

Question: If volume of a system is increased at constant pressure, internal energy of system

Options:

(a) Increases

(b) Decreases

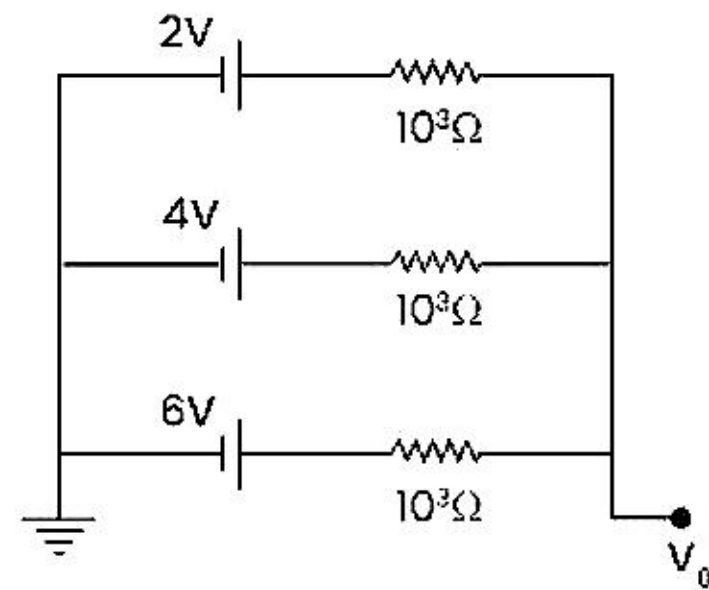(c) Remains same

(d) None of these

Answer: (a)

Solution:

We know $U = f(T)$

By Ideal gas equation at $(P = C)$

$V \propto T$

Hence, if $V \uparrow$ then $T \uparrow$

So, we can say that if $V \uparrow$ then $U \uparrow$

Question: In the shown circuit, find the value of V_0

Options:

(a) 4 volt

(b) 2 volt

(c) 6 volt

(d) 12 volt

Answer: (a)

Solution:

We can method of parallel combinations of cells heel.

So, $\varepsilon_{eq} = \dfrac{\dfrac{2}{10^3} + \dfrac{4}{10^3} + \dfrac{6}{10^3}}{\dfrac{1}{10^3} + \dfrac{1}{10^3} + \dfrac{1}{10^3}} = \dfrac{2+4+6}{1+1+1} = \dfrac{12}{3} = 4V$

Hence $V_0 = 4\,volt$

Question: Two positively charged particles A and B having same kinetic energy move inside a transverse uniform magnetic field. The ratio of radius of path of charge A to that of charge B is $\dfrac{3}{5}$, while mass of particle A is $\dfrac{4}{9}$ times that of particle B. The ratio of charge on particle A to that of B is
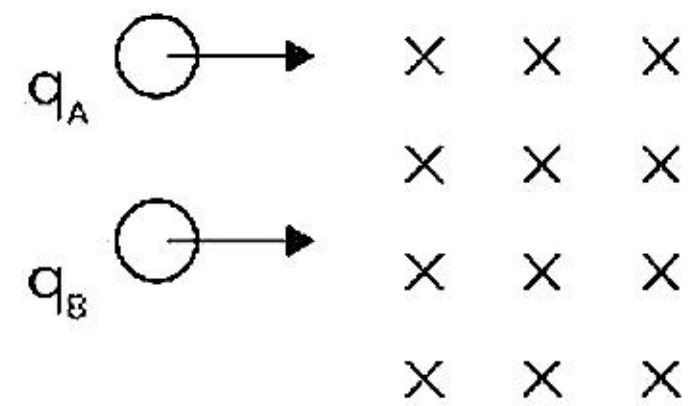
Options:

(a) $\dfrac{9}{10}$

(b) $\dfrac{10}{9}$

(c) $\dfrac{2}{5}$

(d) $\dfrac{5}{3}$

Answer: (b)

Solution:

Given

$KE_A = KE_B$

$\dfrac{1}{2}M_A V_A^2 = \dfrac{1}{2}M_B V_B^2$

$\left(\dfrac{V_A}{V_B}\right)^2 = \dfrac{M_B}{M_A}$

$\left(\dfrac{V_A}{V_B}\right) = \sqrt{\dfrac{9}{4}}$

$\dfrac{V_A}{V_B} = \dfrac{3}{2}$

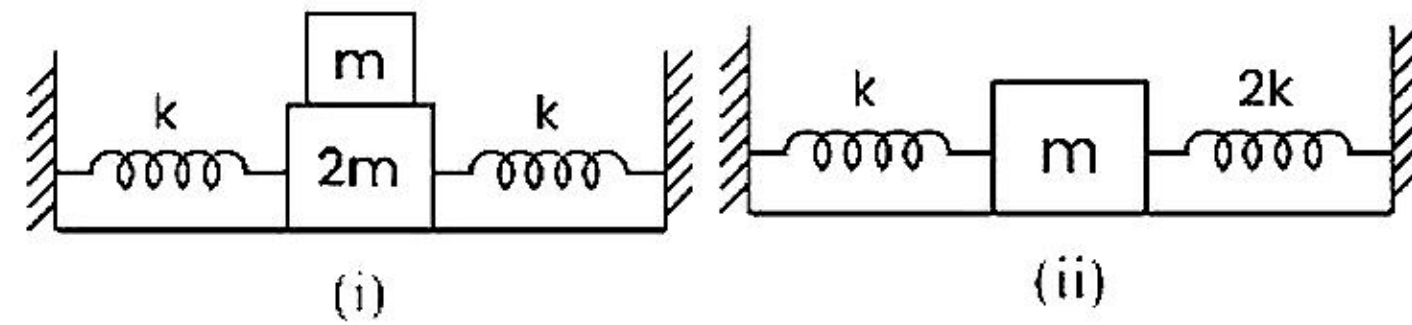We know $r = \dfrac{MV}{qB}$

So,

$$r_A = \frac{M_A V_A}{q_A B}$$

$$r_B = \frac{M_B V_B}{q_B B}$$

$$\left(\frac{r_A}{r_B}\right) = \left(\frac{M_A}{M_B}\right)\left(\frac{V_A}{V_B}\right)\left(\frac{q_B}{q_A}\right)$$

$$\frac{3}{5} = \frac{4}{9} \times \frac{3}{2} \times \left(\frac{q_B}{q_A}\right)$$

$$\left(\frac{q_A}{q_B}\right) = \frac{10}{9}$$

Question: Find the ratio of time period of oscillations in two cases as shown. Assume that there is no slipping between m and 2m blocks in case (1)

(i)   (ii)

Options:

(a) $\dfrac{3}{2}$

(b) $\dfrac{3}{\sqrt{2}}$

(c) $\dfrac{1}{2}$

(d) $\dfrac{2}{3}$

Answer: (b)
Solution:

For Case Ist: $T = 2\pi \sqrt{\dfrac{m_{eq}}{k_{eq}}}$

$$T_1 = 2\pi \sqrt{\frac{3m}{2k}} \quad ...(1)$$

For case 2nd :

$$T_2 = 2\pi \sqrt{\frac{m_{eq}}{k_{eq}}}$$

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

$$\frac{T_1}{T_2} = \frac{\sqrt{\dfrac{3m}{2k}}}{\sqrt{\dfrac{m}{3k}}}$$

$$\boxed{\frac{T_1}{T_2} = \frac{3}{\sqrt{2}}}$$

Question: Rod is clamped to wall at one end on other end force is applied radius r, length l, force F, increase in length is 5 cm. Then radius 4r, length 4l, force 4F, increase in length is
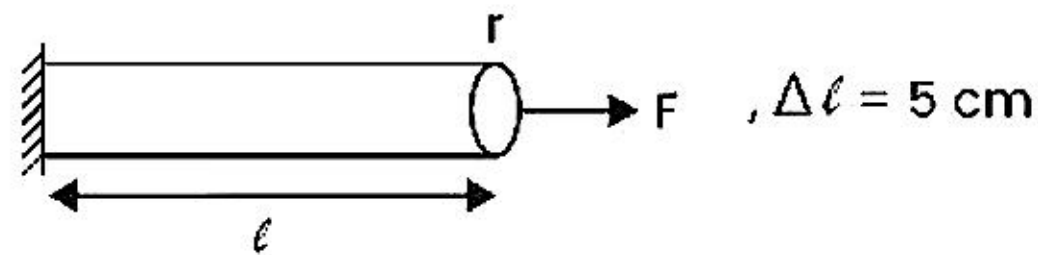
Options:

(a) 15 cm

(b) 2 cm

(c) 5 cm

(d) 10 cm

Answer: (c)
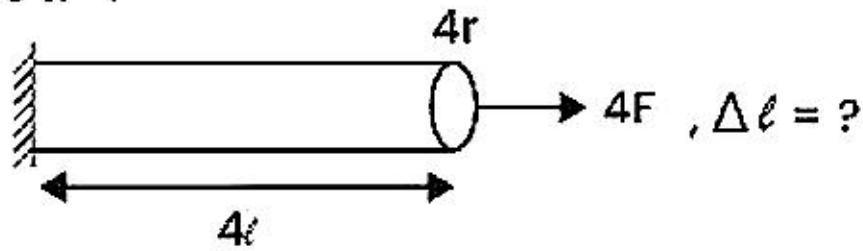
Solution:

Case Ist:

Case Ist :

Case IInd :

We know $\Delta l = \dfrac{Fl}{AY}$

So $\dfrac{5}{\Delta l} = \dfrac{\dfrac{Fl}{\pi r^2 \gamma}}{\dfrac{4F4l}{16\pi r^2 \gamma}}$

$\Rightarrow \Delta l = 5cm$

Question: Particles a, b, c of mass 100 kg are in a straight line where distance between a,b and b,c is 13 m. A fourth particle p is placed on the perpendicular bisector of AC when BP = 13m. If net force on P is F. Find F in terms of G (Gravitational constant)

Options:

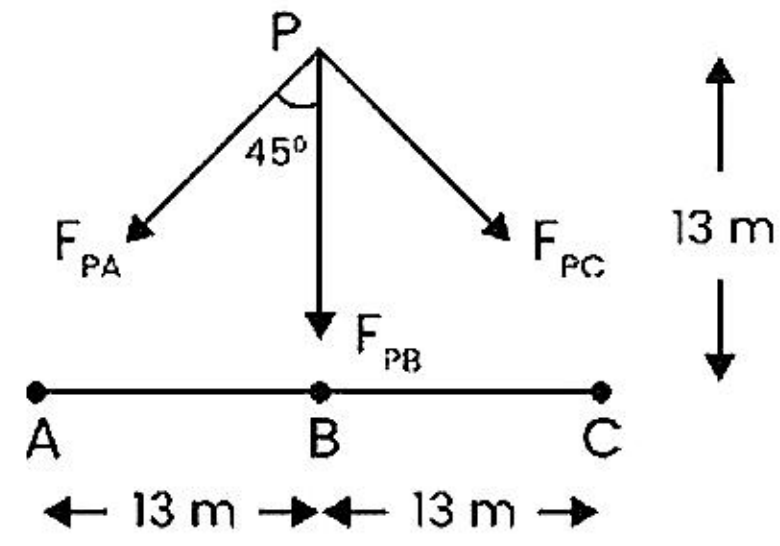(a) $\dfrac{G \times 10^4}{13^2}\left(\dfrac{1}{\sqrt{4}} + 2\right)$

(b) $\dfrac{G \times 10^4}{13^2}\left(\dfrac{1}{\sqrt{2}} + 1\right)$

(c) $\dfrac{G\times10^{4}}{13^{2}}\left(\dfrac{1}{\sqrt{5}}+3\right)$

(d) $\dfrac{G\times10^{4}}{13^{2}}\left(\dfrac{1}{\sqrt{6}}+1\right)$

Answer: (b)

Solution:

$$\left|F_{net}\right|=\left|\vec{F}_{PA}+\vec{F}_{PB}+\vec{F}_{PC}\right|$$

$$=2\left(\dfrac{G(100)(100)}{\left(13\sqrt{2}\right)^{2}}\cos45°\right)+\left(\dfrac{G(100)(100)}{13^{2}}\right)$$

$$=\dfrac{G\times10^{4}}{13^{2}}\left(\dfrac{1}{\sqrt{2}}+1\right)$$

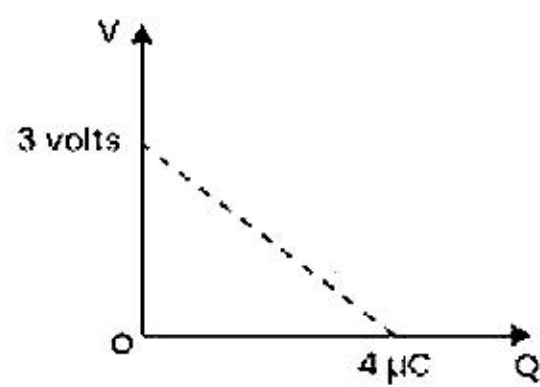**Question:** A capacitor having capacity 2μF is charged steadily and charge of 5μc is given to it. Then the graph of potential with charge given is
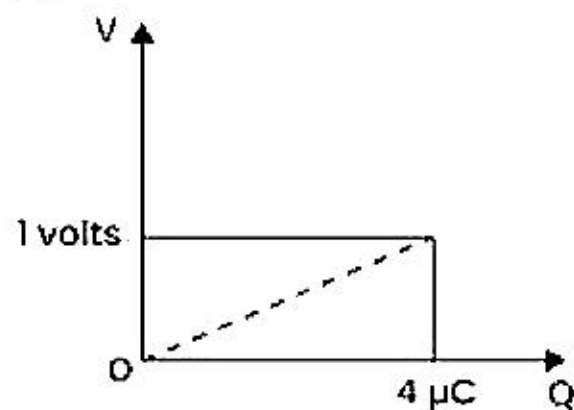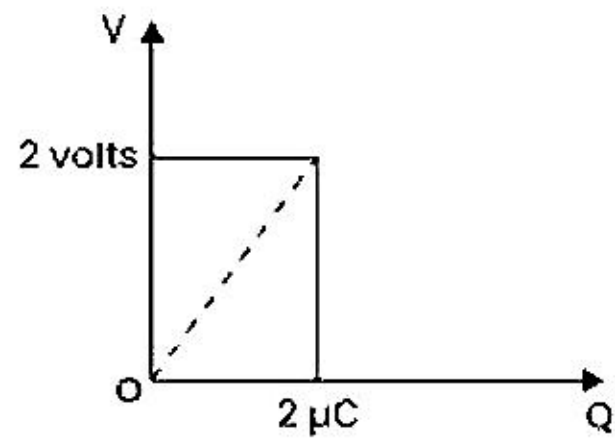
Options:

(a)
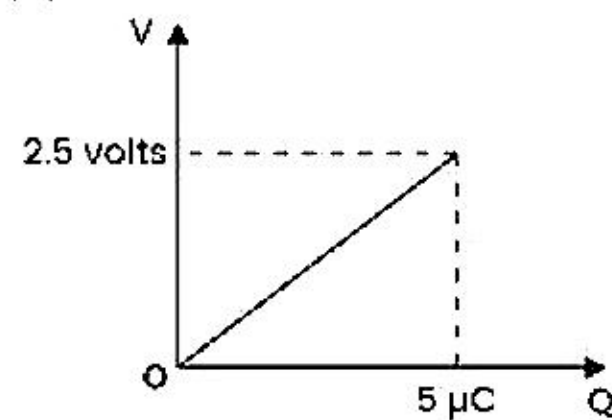
(b)

(c)

(d)

Answer: (a)

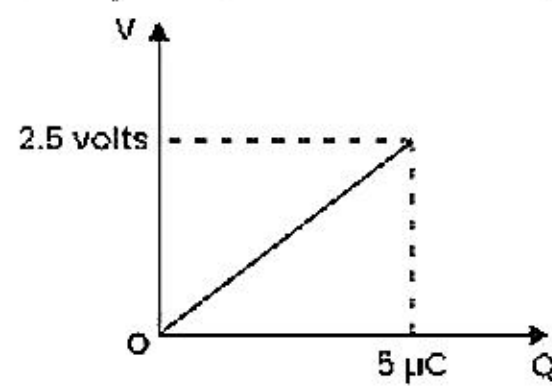**Solution:**

We know Q = CV

$$\therefore V = \frac{Q}{C} = \frac{1}{C}(Q) = \frac{5\mu C}{2\mu F}$$

= 2.5 V

Graph will be a straight line as C is constant.

Question: A solid cylinder and solid sphere of same mass are rolled down from the same point on an inclined plane of inclination Q. Find the ratio of their velocity of centre of mass when they reach the bottom of incline.

Options:

(a) $\sqrt{\dfrac{10}{15}}$

(b) $\sqrt{\dfrac{18}{15}}$

(c) $\sqrt{\dfrac{12}{15}}$
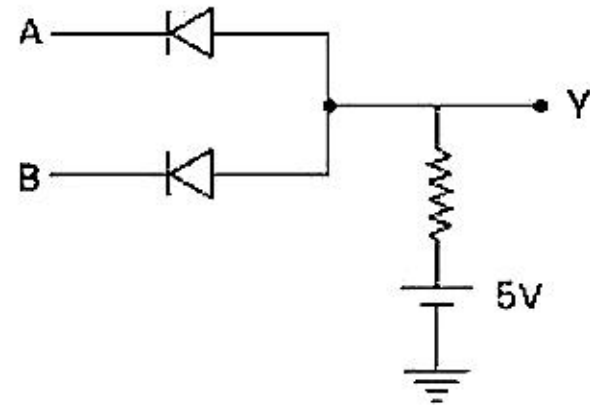
(d) $\sqrt{\dfrac{14}{15}}$

Answer: (d)

Solution:

Acceleration $\Rightarrow a = \dfrac{g\sin\theta}{1 + \dfrac{I}{mR^2}}$; also $v = \sqrt{2as}$

$$a_{\text{cylinder}} = \frac{g\sin\theta}{1 + \dfrac{1/2mR^2}{mR^2}} = \frac{2}{3}g\sin\theta$$

$$a_{\text{sphere}} = \frac{g\sin\theta}{1 + \dfrac{2/5mR^2}{mR^2}} = \frac{5}{7}g\sin\theta$$

So ratio of velocity $\dfrac{v_{\text{cylinder}}}{v_{\text{sphere}}} = \sqrt{\dfrac{a_{\text{cylinder}}}{a_{\text{sphere}}}} = \sqrt{\dfrac{2/3}{5/4}} = \sqrt{\dfrac{14}{15}}$
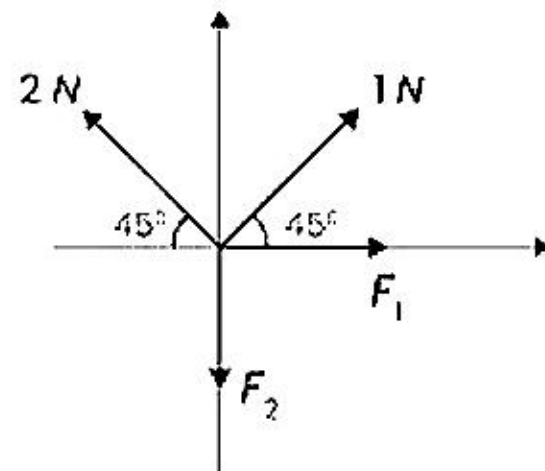
Question: Which logic gate is this?

Options:
(a) NAND gate
(b) OR gate
(c) AND gate
(d) XOR gate
Answer: (c)

    Solution:

In 1	In 2	Out
0	0	0
0	1	0
1	0	0
1	1	1

Question: The ratio of $F_1 : F_2 = 1 : x$. Then find the value of x, when net force is zero

Options:
(a) 3
(b) 2
(c) 1
(d) 4
Answer: (a)
Solution:
F_1 must balance net horizontal force
i.e $F_1 = 2\cos 45° - 1\cos 45°$

$= \sqrt{2} - \dfrac{1}{\sqrt{2}} = \dfrac{2-1}{\sqrt{2}} = \dfrac{1}{\sqrt{2}}$
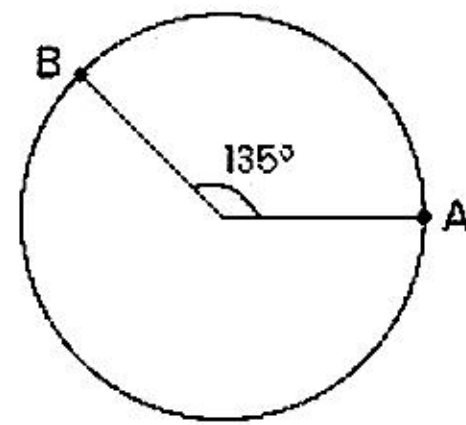
F_2 must balance net vertical force

i.e. $F_2 = 2\sin 45° + 1\sin 45°$

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

$$\therefore \frac{F_1}{F_2} = \frac{1}{3}$$

$$\therefore x = 3$$

Question: When a particle moves on a circular track from point A to B as shown, it covers a distance of 80 m. Find the displacement of the particle. (cos 135° = -0.7)
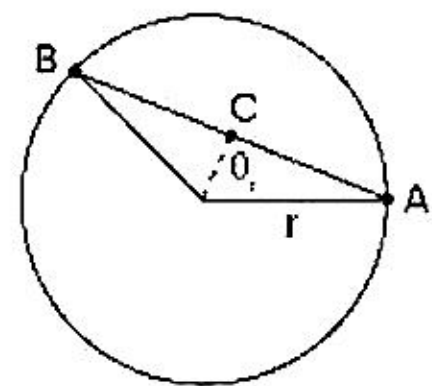

Options:
(a) 46.2 m
(b) 62.6 m
(c) 45.2 m
(d) 58.1 m
Answer: (b)
Solution:

$$\theta = 135° = \frac{3\pi}{4} \text{ radiaus}$$

We know

$$\text{angle} = \frac{\text{arc}}{\text{radius}}$$

$$\Rightarrow r = \frac{\text{arc}}{\text{angle}} = \frac{80}{\dfrac{3\pi}{4}}$$

So disp $AB = 2AC = 2 \times r\sin\dfrac{\theta}{2}$

$$= 2 \times \frac{80}{\dfrac{3\pi}{4}} \left(\sqrt{\frac{1-\cos\theta}{2}} \right)$$

$$= \frac{640}{3\pi}\sqrt{\frac{1.7}{2}} = 62.6\, m$$

Question: Conduction (RMS) current 6.6 μA in a circuit with capacitor connected across 220 V source. Angular frequency is 600 rad/sec. Value of capacitance is?

Options:

(a) 50 pF

(b) 20 pF

(c) 40 pF

(d) 10 pF

Answer: (a)

Solution:

$\omega = 600 \, rad / s$

$I = \dfrac{V}{X_c} = \dfrac{220}{(1/\omega c)}$

$6.6 \times 10^{-6} = 220 \times (600) \times C$

$C = \dfrac{6.6 \times 10^{-6}}{220 \times 600} = 50 \, pF$

Question: Speed of light in two media of refractive index μ_A and μ_b is V_A and V_B respectively. The ratio of μ_A and μ_B is 1 : 2. If the time taken by light to travel same distance in both media is t_1 and t_2 respectively such that $t_2 - t_1 = 5 \times 10^{-10}$s. Calculate the distance travelled by the light.

Options:

(a) $V_B (10^{-9})$

(b) $V_B (15^{-9})$

(c) $V_B (20^{-9})$

(d) $V_B (30^{\,9})$

Answer: (a)

Solution:

Let the distance travelled be 's'

$s = V_A t_1 \qquad s = V_B t_2$

$V_A t_1 = V_B t_2 \Rightarrow \dfrac{V_B}{V_A} = \dfrac{t_1}{t_2}$

Now, $V = \dfrac{c}{\mu} \qquad \dfrac{\mu_A}{\mu_B} = \dfrac{t_1}{t_2}$

$\dfrac{1}{2} = \dfrac{t_1}{t_2} \Rightarrow t_2 = 2t_1$

$t_2 - t_1 = 5 \times 10^{-10} \, sec$

$2t_1 - t_1 = 5 \times 10^{-10} \Rightarrow t_1 = 5 \times 10^{-10} \, sec$

$t_2 = 10^{-9} \, sec$

Now, $s = V_A \left(5 \times 10^{-10} \right) = V_B \left(10^{-9} \right)$

Question: A cyclist is moving with speed 18 km/h towards a hill. A sound source kept behind (at some distance) cyclist produces sound of frequency 640 Hz. speed of sound = 320 m/s. Find the beats heard by cyclist due to source and echo.

Options:

(a) 10 Hz

(b) 30 Hz

(c) 20 Hz

(d) 50 Hz

Answer: (c)

Solution:

Let f' = apparent freq. of the source

$$= f \left(\frac{v - v_0}{v - vs} \right)$$

$$= 640 \left(\frac{320 - 5}{320} \right) = 640 \left(\frac{315}{320} \right)$$

f'' = apparent freq of reflection

$$= 640 \left(\frac{320 + 5}{320} \right) = 640 \left(\frac{325}{320} \right)$$

$$\left| f'' - f' \right| = f_B = 20 \, Hz$$