#1612995
Topic: Organ Pipes

In resonance tube experiment with a tuning fork of frequency $480\ Hz$ the consecutive resonance lengths are $30\ cm$ and $70\ cm$ then determine speed of sound is

A $200\ m/s$

B $256\ m/s$

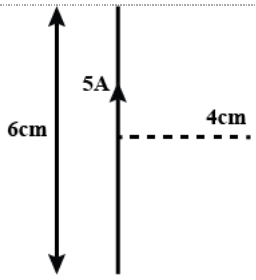
[C] $384\ m/s$

D $240\ m/s$

Solution

$\frac{\lambda}{2} = 40\ cm \Rightarrow \lambda = 0.8\ m$
$f = 480\ Hz \Rightarrow V_{sound} = f\lambda = 480 \times 0.8 = 384\ m/s$

#1613084
Topic: Magnetic field



A conducting wire carries $5A$ current. Its lengths is $6\ cm$. Then the magnetic field intensity at a distance of $4\ cm$ from the wire on the perpendicular bisector of the wire is

[A] $1.5 \times 10^{-5}T$

B $1.3 \times 10^{-5}T$

C $3 \times 10^{-5}T$

D $0.75 \times 10^{-5}T$

Solution

$B = \frac{\mu_0 i}{4\pi r}[\sin\theta_1 + \sin\theta_2]$
$= 10^{-7} \times \frac{5}{4 \times 10^{-2}}\left[\frac{3}{5} + \frac{3}{5}\right]$
$B = 1.5 \times 10^{-5}T.$

#1613087
Topic: Springs

A spring of length $'l'$ has spring constant $'k'$ is cut into two parts of length l_1 and l_2. If their respective spring constants are k_1 and k_2, then $\frac{k_1}{k_2}$ is

[A] $\frac{l_2}{l_1}$

B $\frac{2l_2}{l_1}$

C $\frac{l_1}{l_2}$

D None

Solution

$k_1 l_1 = k_2 l_2 = kl$
$\frac{k_1}{k_2} = \frac{l_2}{l_1}$

#1613089
Topic: Isobaric, Isochoric, Isothermal Processes

In isobaric process of ideal gas $(f = 5)$ work done by gas is equal to $10\ J$. Then heat given to gas during process is

A $25\ J$

B $15\ J$

C $45\ J$

D $35\ J$

Solution

$\triangle Q = \left(\frac{f}{2}+1\right) nR\triangle T = \frac{7}{2} \times 10 = 35\ J$

#1613093

Topic: Basics of Projectile Motion

Two particles are projected obliquely from ground with same speed such that their range $'R'$ are same but they attain different maximum heights h_1 and h_2 then relation between R, h_1 and h_2 is

A $R^2 = 16\ h_1 h_2$

B $R^2 = 8\ h_1 h_2$

C $R^2 = 4\ h_1 h_2$

D $R^2 = h_1 h_2$

Solution

R is same for θ and $(90-\theta)$ angle of projection

$R = \frac{2u^2 \sin\theta\cos\theta}{g}, h_1 = \frac{u^2\sin^2\theta}{2g}; h_2 = \frac{u^2\cos^2\theta}{2g}$

$R^2 = \frac{4u^2\sin^2\theta}{g}\frac{u^2\cos^2\theta}{g}$

$R^2 = 4.2h_1h_2$

$R^2 = 16\ h_1h_2.$

#1613098

Topic: Liquid Drops and Bubbles

A drop of liquid is broken down into 27 identical liquid drops. If the terminal velocity of original liquid drop is V_T, then find the terminal velocity of the new liquid drop thus formed.

A $\frac{V_T}{3}$

B $\frac{V_T}{9}$

C $\frac{V_T}{27}$

D $\frac{9V_T}{9}$

Solution

$M = \rho \times \frac{4}{3}\pi R^3$

$\frac{M}{27} = \rho \times \frac{4}{3}\pi r^3$

$r \to \frac{R}{3}$

$V_T \propto (Radius)^2$

$\frac{V_T}{V_{new}} = \frac{R^2}{(R/3)^2} = 9\ V_{new} = \frac{V_T}{9}.$

#1613101

Topic: Energy and Power

$1\ kg$ of water is at $20^\circ C$. A resistor of 20Ω is connected across $200\ V$ battery and the heat dissipated is supplied to water then the time taken by the water to evaporate is: (Specific heat $= 4200\ J/kg^\circ C$; Latent heat $= 2260\ Kj/Kg$).

A $44\ minutes$

B $33\ minutes$

C $22\ minutes$

D $11\ minutes$

Solution

$mS\triangle T + mL = \frac{V^2}{R}t$

$1\times 4200\times 80 + 1\times 2.26\times 10^6 = \frac{(200)^2}{20}t$

$t = 21.6\ m \sim 22\ minutes$

#1613103

Topic: Amplitude Modulation

In amplitude modulation carrier wave is $C = 4\sin 2000t$ and message wave $M = 2\sin 200t$ Find out modulation index.

A 9

B 3

C $\frac{1}{9}$

D $\frac{1}{3}$

Solution

$m = \left(\frac{V_{max} - V_{min}}{V_{max} + V_{min}}\right) = \frac{4-2}{4+2} = \frac{2}{6} = \frac{1}{3}$

#1613106

Topic: Engines and Cycles

A Carnot engine has efficiency $\frac{1}{6}$. If temperature of sink is decreased by $62^\circ C$ then its efficiency becomes $\frac{1}{3}$ then the temperature of source and sink.

A $T_H = 98^\circ, T_C = 36^\circ C$

B $T_H = 99^\circ, T_C = 37^\circ C$

C $T_H = 100^\circ, T_C = 38^\circ C$

D $T_H = 102^\circ, T_C = 40^\circ C$

Solution

$\frac{1}{6} = 1 - \frac{T_C}{T_H}$

$\frac{T_C}{T_H} = 1 - \frac{T_C - (62)}{T_H} = 1 - \frac{T_C}{T_H} + \frac{(62)}{T_H}$

$\frac{1}{3} = \frac{1}{6} + \frac{62}{T_H}$

$\frac{62}{T_H} = \frac{1}{6}\ T_H = 372\ K$

$\frac{1}{6} = 1 - \frac{T_C}{372}$

$\frac{T_C}{372} = \frac{5}{6}$

$T_C = \frac{5\times 372}{6} = 310\ K.$

#1613107

Topic: Moving Coil Galvanometer

If a galvanometer has full scale deflection current I_G and resistance G. A shunt resistance R_A is used to convert it into an ammeter of range I_0 and a resistance R_V is connected in series to convert it into a voltmeter of range V_0 such that $V_0 = I_0 G$ then $R_A R_V$ and $\frac{R_A}{R_V}$ respectively are

A G^2 and $\frac{I_G^2}{(I_0 - I_G)^2}$

B G^2 and $\frac{I_0^2}{(I_0 - I_G)^2}$

C G^2 and $\frac{I_G}{(I_0 - I_G)^2}$

D G^2 and $\frac{I_G^2}{(I_0 + I_G)^2}$

Solution

$(I_0 - I_G)R_A = I_G G$ and $V_0 = I_G(G + R_V)$

$I_0 = \frac{I_G(G+R_A)}{R_A}$ $V_0 = I_G(G + R_V)$

$V_0 = I_G G \Rightarrow I_G(G + R_V) = I_G \frac{(G+R_A)G}{R_A}$

$R_A G + R_V R_A = G^2 + R_A G$

$R_V R_A = G^2$

$R_A = \frac{I_G G}{I_0 - I_G}; R_V = \frac{(I_0 - I_G)G}{I_G}$

$\frac{R_A}{R_V} = \frac{I_G^2}{(I_0 - I_G)^2}$.

#1613127

Topic: Dual Nature

The De-Broglie wave length of electron in second exited state of hydrogen atom is

A $5A^\circ$

B $10A^\circ$

C $100A^\circ$

D $6.6A^\circ$

Solution

$\lambda = \sqrt{\frac{150}{1.5}} = 10\mathring{A}$

#1613134

Topic: Beats

An observer moves on the same line on which two sources of sound of frequency $660\ Hz$ are present. The observer observes beat frequency of $10\ Hz$. If speed of sound is $330\ m/s$ then speed of the observer is

A $5\ m/s$

B $3\ m/s$

C $2.5\ m/s$

D $4\ m/s$

Solution

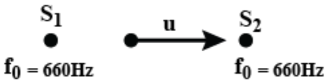
$f_1 =$ apparent frequency received from $S_1 = \frac{c-u}{c} f_0$

$f_2 =$ apparent frequency received from $S_2 = \frac{c+u}{c} f_0$ beat frequency $= f_2 - f_1 = \left[\frac{c+u}{c} - \frac{c-u}{c}\right] f_0$

$= \frac{2u}{c} f_0 = 10$

$= \frac{2u \times 660}{330} = 10$

$= u = 2.5\ m/s.$



#1613139

Topic: Speed and Velocity

Velocity of a particle as function of displacement x is given by $v = bx^{1/2}$. Then the displacement as function of time is

A bt

B $\frac{b^2t^2}{4}$

C $\frac{bt}{4}$

D $\frac{b^2t^3}{4}$

Solution

$v = bx^{1/2}$

$\frac{dx}{dt} = bx^{1/2}$

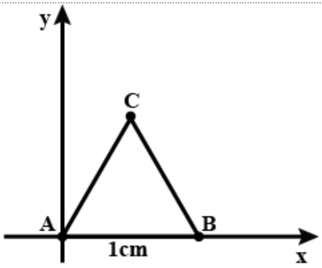
$\int_0^x \frac{dx}{x^{1/2}} = \int_0^t bd\,t$

$2\sqrt{x} = bt$

$x = \frac{b^2t^2}{4}.$

#1613141

Topic: Centre of mass



Three particles $A(50\ g)$, $B(100\ g)$ and $C(150\ g)$ are placed at vertices of an equilateral triangle as shown in figure. Then the coordinates of centre of mass of system is

A $\left(\frac{7}{12}, \frac{\sqrt{3}}{4}\right) cm$

B $\left(\frac{\sqrt{3}}{4}, \frac{7}{12}\right) cm$

C $\left(\frac{7}{16}, \frac{\sqrt{3}}{8}\right) cm$

D $\left(\frac{\sqrt{3}}{8}, \frac{7}{16}\right) cm$

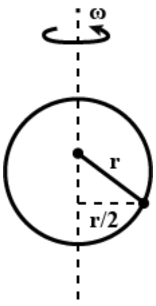
Solution

$x_{cm} = \frac{50 \times 0 + 100 \times 1 + 150 \times 1/2}{50 + 100 + 50} = \frac{175}{300} = \frac{7}{12} cm$

$y_{cm} = \frac{50 \times 0 + 100 \times 0 + 150\sqrt{3}/2}{300} = \frac{\sqrt{3}}{4} cm$

#1613145

Topic: Angular velocity



A ring a radius r is rotating about a vertical axis along its diameter with constant angular velocity ω. A read of mass m remains at rest w.r.t. ring at the position shown in figure. Then w^2 is

A $\frac{g}{\sqrt{3}r}$

B $\frac{2g}{\sqrt{3}r}$

C $\frac{\sqrt{3}g}{r}$

D $\frac{g}{r}$

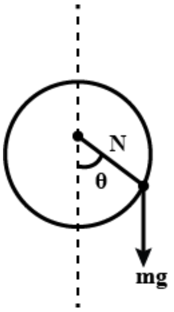
Solution

$\theta = 30^\circ$

$N \sin 30^\circ = m\omega^2 r$

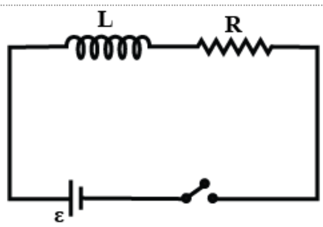
$N \cos 30^\circ = mg$

$\tan 30^\circ = \frac{\omega^2 r}{g}$, $\omega^2 = \frac{g}{\sqrt{3}r}$,



#1613149

Topic: LCR circuits



The switch shown in figure is closed at $t = 0$ find the charge through battery till time $t = \frac{L}{R}$.

A $\frac{L_\epsilon}{eR^2}$

B $\frac{L_\epsilon}{2eR^2}$

C $\frac{2L_\epsilon}{eR^2}$

D None

Solution

$i = \frac{\epsilon}{R}(1 - e^{-t/\tau})$ where $\tau = L/R$

$\frac{dq}{dt} = \frac{\epsilon}{R}(1 - e^{-t/\tau})$

$\int_0^q dq = \int_0^\tau \frac{\epsilon}{R}(1 - e^{-t/\tau})dt$

$q = \frac{\epsilon}{R}\left[t - \frac{e^{-t/\tau}}{-1/\tau}\right]_0^\tau$

$q = \frac{\epsilon}{R}\left[\tau + \frac{\tau}{e} - \tau\right]$

$q = \frac{\epsilon}{R}\frac{\tau}{e} = \frac{L\epsilon}{eR^2}$.

#1613154

Topic: Photons and Photoelectric Effect

The ratio of wavelengths of photons emitted when hydrogen atom de-excites from third excited state to second excited state an then de-excites form seconds excited state to first excited state is

A $\frac{7}{20}$

B $\frac{20}{7}$

C 5

D 20

Solution

$\frac{1}{\lambda_1} = R\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = \frac{7R}{144} \ldots\ldots (1)$
$\frac{1}{\lambda_2} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = \frac{5R}{136} \ldots\ldots (2)$
$(2)/(1) \frac{\lambda_1}{\lambda_2} = \frac{5R}{36} \times \frac{144}{7R} = \frac{20}{7}.$

#1613158

Topic: Acceleration due to Gravity

Two planets of radii R_1 and R_2 have masses M_1 and M_2 such that $\frac{M_1}{M_2} = \frac{1}{9}$. The weight of an object on these planets is w_1 and w_2 such that $\frac{w_1}{w_2} = \frac{4}{9}$. The ratio R_1/R_2.

A 2

B $\frac{1}{2}$

C 4

D $\frac{1}{4}$

Solution

$w_1 = \frac{GM_1 m}{R_1^2}; w_2 = \frac{GM_2 m}{R_2^2}$
$\frac{w_1}{w_2} = \frac{M_1}{M_2}\left(\frac{R_2}{R_1}\right)^2$
$\frac{4}{9} = \frac{1}{9}\left(\frac{R_2}{R_1}\right)^2 \Rightarrow \frac{R_1}{R_2} = \frac{1}{2}.$

#1613160

Topic: Motion of Centre of Mass

A solid sphere of radius R has total charge $2Q$ and volume charge density $\rho = kr$ where r is distance from centre. Now charges Q and $-Q$ are placed diametrically opposite distance $2a$ where a is distance form centre of sphere such that net force on charge Q is zero then relation between a and R is

A $a = R/2$

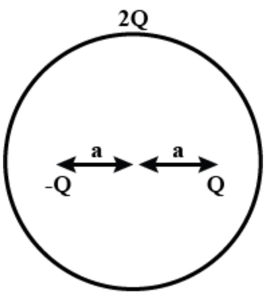
B $a = R$

C $a = 2R$

D $a = 3R/4$

Solution

$\int_0^R kr4\pi r^2 dr = 2Q$
$k\pi R^4 = 2Q \ldots\ldots (1)$
$\frac{KQ^2}{4a^2} = Q\int_0^a \frac{Kkr4\pi r^2 dr}{r^2}$
$\frac{KQ^2}{4a^2} = QKk4\pi\frac{a^2}{2} \Rightarrow \frac{KQ^2}{4a^2} = Q.K.\frac{2Q}{\pi R^4}4\pi\frac{a^2}{2}$
$\frac{1}{4a^2} = \frac{4a^2}{R^2} \Rightarrow R^4 = 16a^4$
$R = 2a \Rightarrow a = \frac{R}{2}.$



#1613167

Topic: Volume Expansion

A cylinder of length l and radius r is heated to temperature T. A longitudinal compressive force F is applied on cylinder to keep its length same. Find coefficient of volume expansion.

A $\frac{F}{YT\pi r^2}$

B $\frac{3F}{YT\pi r^2}$

C $\frac{2F}{YT\pi r^2}$

D None of these

Solution

$\sigma = \frac{F}{A}$

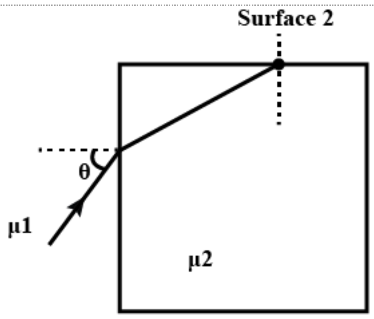
$Y \propto T = \frac{F}{\pi r^2}$

$\alpha = \frac{F}{YT\pi r^2}$

$\gamma = 3\alpha = \frac{3F}{YT\pi r^2}$.

#1613174

Topic: Reflection at Plane Surface



Find condition for TIR at surface 2.

A $\theta < \sin^{-1}\sqrt{\left(\frac{\mu_2}{\mu_1}\right)^2 - 1}$

B $\theta > \sin^{-1}\sqrt{\left(\frac{\mu_2}{\mu_1}\right) - 1}$

C $\theta < \sin^{-1}\frac{\mu_2}{\mu_1}$

D $\theta > \sin^{-1}\frac{\mu_2}{\mu_1}$

Solution

$\mu_1 \sin\theta = \mu_2 \sin r_1$

$90 - r_1 > C$

$\sin(90 - r_1) > \sin c$

$\cos r_1 > \sin c$

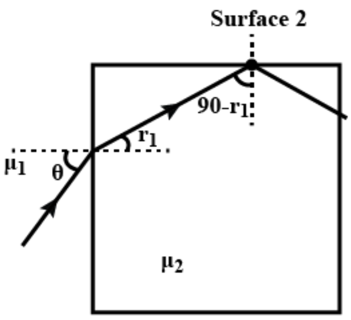
$\cos r_1 > \frac{\mu_1}{\mu_2}$

$\sqrt{1 - \left(\frac{\mu_1 \sin\theta}{\mu_2}\right)^2} > \frac{\mu_1}{\mu_2}$

$1 - \frac{\mu_1^2}{\mu_2^2}\sin^2\theta > \frac{\mu_1^2}{\mu_2^2}$

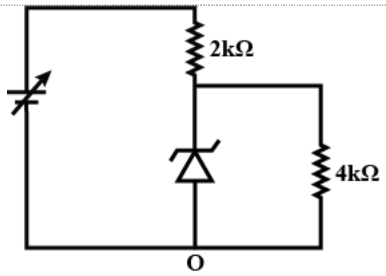
$\frac{\mu_2^2 - \mu_1^2}{\mu_1^2} > \sin^2\theta$

$\theta < \sin^{-1}\sqrt{\left(\frac{\mu_2}{\mu_1}\right)^2 - 1}$.



#1613181

Topic: Zener Diode



For the given circuit shown in figure, the potential of the battery is varied from $10V$ to $16V$. If by zener diode breakdown voltage is $6V$, find maximum current through zener diode.

A $1.5\ mA$

B $3.5\ mA$

C $5\ mA$

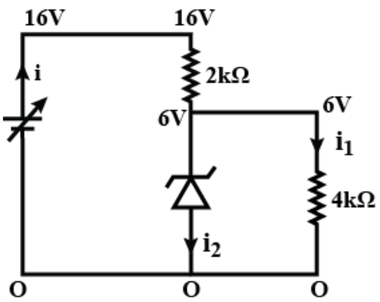
D $6.5\ mA$

Solution

$i_i = \frac{6}{4} = 1.5\ mA$

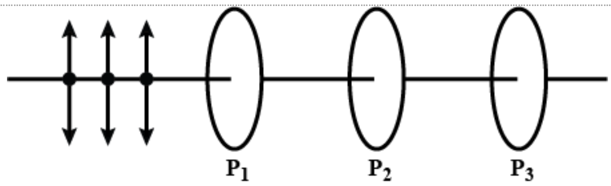
Maximum current will be obtained for battery voltage $16\ V$

$i = \frac{16-6}{2} = 5mA\ i_z(max) = 5 - 1.5 = 3.5\ mA$



#1613187

Topic: Polarisation



Unpolarised light beam of intensity I_0 is incident on polaroid P_1. The three polaroids are arranged in such a way that transmission axis of P_1 and P_3 are perpendicular to each other. Angle between the transmission axis of P_2 and P_3 is 60°. The intensity of the beam coming out from P_3 will be

A $\frac{I_0}{2}$

B $\frac{3I_0}{8}$

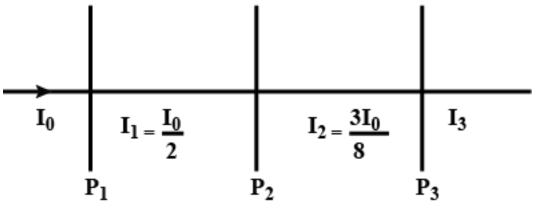
C $\frac{3I_0}{32}$

D $\frac{3I_0}{64}$

Solution

$I_2 = I_1 \cos^2 30^\circ = \frac{I_0}{2} \times \frac{3}{4} = \frac{3I_0}{8}$

$\therefore I_3 = I_2 \cos^2 60^\circ = \frac{3I_0}{8} \times \frac{1}{4} = \frac{3I_0}{32}$



#1613190

Topic: Nuclear Structure

Two radioactive samples 1 and 2 have equal number of nuclei initially. They have half-lives of 10 seconds and 20 $seconds$. The ratio of number of nuclei of 1 and 2 at $t = 60$ $seconds$ is

A $8:1$

B $1:8$

C $3:8$

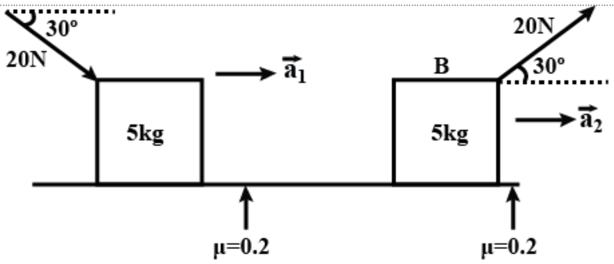
D $1:9$

Solution

$N_1 = N_0\left(\frac{1}{2}\right)^6$ $N_2 = N_0\left(\frac{1}{2}\right)^3$ $\frac{N_1}{N_2} = \frac{1}{8}$

#1613194

Topic: Acceleration



Two blocks A and B are being accelerated by forces shown in figure with acceleration $\vec{a}_1$ and $\vec{a}_2$ respectively. The value of $|\vec{a}_1 - \vec{a}_2|$.

A $\frac{4}{5}$

B $\frac{8}{5}$

C $\frac{5}{4}$

D $\frac{5}{8}$

Solution

$N_1 = 50 + 10 = 60N$

$F_{Lim} = 0.2 \times 60 = 12N$

$F_{applied} > 12N$

$\therefore f_1 = 12N$

$\therefore a_1 = \dfrac{17.32 - 12}{5}$

$N_2 = 50 - 10 = 40N$

$F_{Lim} = 0.2 \times 40 = 8N$

$F_{applied} > 8N$

$\therefore f_1 = 8N$

$a_2 = \dfrac{17.32 - 8}{5}$

$= \dfrac{5.32}{5}$

$\therefore a_1 - a_2 = -\dfrac{4}{5}$

$\therefore |a_1 - a_2| = \dfrac{4}{5}.$