#1611908
Topic: Special Cases of Relative Motion

A man can swim in still water at $4m/s$. River is flowing at $2m/s$. The angle with downstream at which he should swim wo cross the river with minimum drift is:

A 120^o (marked)

B 150^o

C 30^o

D 60^o

Solution

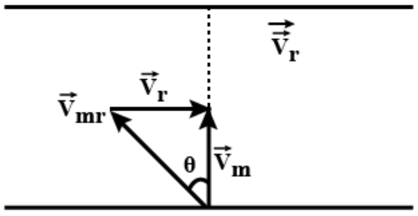
$\vec{V}_{mr} = \vec{V}_m - \vec{V}_r$

$\vec{V}_m = \vec{V}_{mr} + \vec{V}_r$

$\sin\theta = \frac{|\vec{V}_r|}{|\vec{V}_{mr}|} = \frac{2}{4} = \frac{1}{2}$

$\theta = 30^o$

Angle with downstream is 120^o



#1611910
Topic: Elastic Collisions in One-Dimension

An object A of mass m with initial velocity u collides with a stationary object B. After elastic collision A moves with $\frac{u}{4}$. Calculate mass of B.

A $\frac{7m}{5}$

B $\frac{3m}{5}$ (marked)

C $\frac{9m}{5}$

D $\frac{4m}{5}$

Solution

$v - \frac{u}{4} = u$

$\Rightarrow v = \frac{5u}{4}$

$mu = \frac{mu}{4} + Mv$

$\Rightarrow \frac{3mu}{4} = M\frac{5u}{4}$

$\Rightarrow M = \frac{3m}{5}$

#1611913
Topic: Moment of Inertia of Common Bodies

A disc of moment of inertia I is rotating due to external torque. Its kinetic energy is equal to $K\theta^2$, where K is the positive constant. Its angular acceleration at an angle θ will be:

A $\frac{7K\theta}{I}$

B $\frac{6K\theta}{I}$

C $\frac{2K\theta}{I}$ (marked)

D $\frac{4K\theta}{I}$

Solution

$K.E. = K\theta^2$

$\frac{1}{2}I\omega^2 = K\theta^2$

$\omega^2 = \frac{2K\theta^2}{I}$

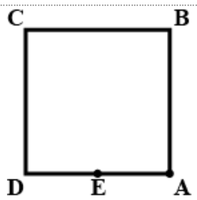
$2\omega\frac{d\omega}{d\theta} = \frac{4K\theta}{I}$

$\omega\frac{d\omega}{d\theta} = \frac{2K\theta}{I}$

$\alpha = \frac{2K\theta}{I}$

#1611918

Topic: Resistance and Resistivity



A wire of length ℓ and resistance R is bent in form of square as shown in figure. If E is a mid point of side DA, then equivalent resistance between points E & A is:

A $\frac{7R}{64}$

B $\frac{7R}{32}$

C $\frac{7R}{16}$

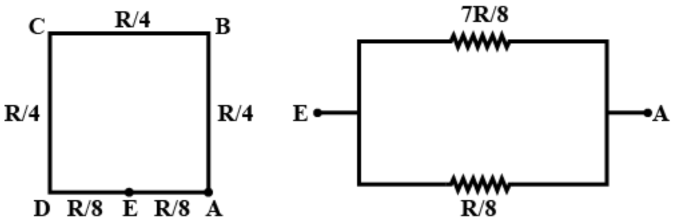
D $\frac{7R}{8}$

Solution

$\Rightarrow \frac{1}{R_{eq}} = \frac{8}{7R} + \frac{8}{R}$

$\Rightarrow \frac{1}{R_{eq}} = \frac{64}{7R}$

$\Rightarrow R_{eq} = \frac{7R}{64}$



Equivalent circuit

#1611928

Topic: Amplitude Modulation

In amplitude modulation equation of messenger wave is $x_1 = A_0 \sin \omega m t$ and that of carrier wave is $x_2 = A C \cos \omega c t$. The equation of amplitude modulated wave is:

A $x = Accos\omega ct + \frac{A_0}{2}[\sin(\omega m + \omega c)t + \sin(\omega c - \omega m)t]$

B $x = Accos\omega ct - \frac{A_0}{2}[\sin(\omega m + \omega c)t + \sin(\omega c - \omega m)t]$

C $x = Accos\omega ct + \frac{A_0}{4}[\sin(\omega m + \omega c)t + \sin(\omega c - \omega m)t]$

D $x = Acsin\omega ct + \frac{A_0}{4}[\sin(\omega m + \omega c)t + \sin(\omega c - \omega m)t]$

Solution

$x = (Ac + A_0 \sin\omega mt)\cos\omega ct$

$x = Ac\cos\omega ct + \frac{A_0}{2}(2\sin\omega mt\cos\omega ct)$

$x = Ac\cos\omega ct + \frac{A_0}{2}[\sin(\omega m + \omega c)t + \sin(\omega c - \omega m)t]$

#1611934

Topic: Transistor

For a common emitter transistor working in active state, following data is given $R_L = 1K\Omega$ $V_{in} = 10mV, \Delta I_B = 15\mu A,\ \Delta I_C = 3mA$. The input resistance r_i & voltage fain A_V for the transistor are:

A 200, 0.67 $K\Omega$

[B] 300, 0.67 $K\Omega$

C 200, 0.1 $K\Omega$

D 300, $1K\Omega$

#1611945

Topic: Capacitance

A capacitor of capacitance $5\mu F$ is charged with $5\mu C$ charge. Its capacitance is changed to $2\mu F$ by some external agent. The work done by external agent is:

A $40.5 \times 10^{-7}J$

B $42.5 \times 10^{-7}J$

[C] $37.5 \times 10^{-7}J$

D $30.5 \times 10^{-7}J$

Solution

$W = U_f - U_i$

$= \frac{Q^2}{2C_f} - \frac{Q^2}{2C_i}$

$= \frac{Q^2}{2}\left(\frac{1}{C_f} - \frac{1}{C_i}\right) = \frac{(5\mu C)^2}{2}\left(\frac{1}{2\mu F} - \frac{1}{5\mu F}\right)$

$= \frac{25 \times 10^{-6}}{2}\left(\frac{3}{10}\right) = \frac{75}{2} \times 10^{-7}J = 37.5 \times 10^{-7}J$

#1611950

Topic: Introduction to Sound Waves

The equation of a sound wave at 0^o is given as $y = A\sin(1000t - 3x)$. The speed at some other temperature T is given $336m/s$. The value of T is

[A] 4.4^oC

B 11^oC

C 12^oC

D 7^oC

Solution

at 0^oC

$y = A\sin(1000t - 3x)$

$v_1 = \frac{w}{k} = \frac{1000}{3}$

at temperature T, $v_2 = 336 m/s$

$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$

$\Rightarrow \frac{\frac{1000}{3}}{336} = \sqrt{\frac{273}{T}}$

$\Rightarrow T = 277.41k$

i.e $T = 4.4^oC$

#1611955

Topic: Gravitational Field

A solid sphere of radius 'a' amd mass 'm' is surrounded by concentric spherical shell of thickness '$2a$' and mass '$2m$'. The gravitational field at a distance $3a$ from their common centers is

A $\frac{Gm}{a^2}$

B $\frac{Gm}{3a^2}$

C $\frac{Gm}{5a^2}$

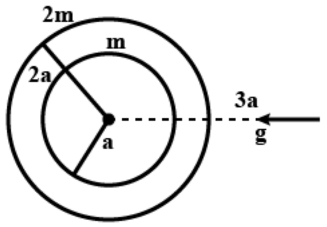
D $\frac{Gm}{4a^2}$

Solution

Gravitational field

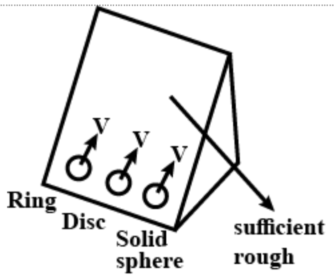
$g = \frac{Gm}{(3a)^2} + \frac{G(2m)}{(3a)^2}$

$g = \frac{G3m}{9a^2} = \frac{Gm}{3a^2}$



#1611959

Topic: Centre of mass



A ring disc and solid sphere are having same speed of their COM at the bottom of incline as shown in the figure. If surface of incline is sufficiently rough. The ratio of height by ring, disc and sphere is.

A $15:14:20$

B $20:15:14$

C $14:20:15$

D $7:5:15$

Solution

$mgh = \frac{1}{2}mv^2(1+k)$

$h_1 : h_2 : h_3 = 1 + k_1 : 1 + k_2 : 1 + k_3$

$h_1 : h_2 : h_3 = 1 + 1 : 1 + 1/2 : 1 + 2/5$

$h_1 : h_2 : h_3 = 2 : 3/2 : 7/5$

$h_1 : h_2 : h_3 = 20 : 15 : 14$

#1611964

Topic: Introduction to Kinetic Theory

Considering all type of degrees of freedom for HCl molecule of mass m having V_{rms} as $\bar{v}$, the temperature of gas will be

A (boxed) $\frac{m\bar{v}^2}{3k}$

B $\frac{m\bar{v}^2}{5k}$

C $\frac{m\bar{v}^2}{7k}$

D $\frac{m\bar{v}^2}{6k}$

Solution

$V_{rms} = \sqrt{\frac{3kT}{m}}$

$V_{rms} = \bar{v}$

$\bar{v}^2 = \frac{3kT}{m}$

$T = \frac{m\bar{v}^2}{3k}$

#1611970

Topic: Measuring Instruments

The time period of a simple pendulum is air is T. Now the pendulum is submerged in a liquid of density $\frac{\rho}{16}$ where ρ is density of the bob of the pendulum. The new time period of oscillation is.

A (boxed) $\frac{4}{\sqrt{15}}T$

B $\sqrt{\frac{4}{15}}T$

C $\sqrt{\frac{15}{4}}T$

D $\frac{\sqrt{15}}{4}T$

Solution

$T = 2\pi\sqrt{\frac{\ell}{g}}$

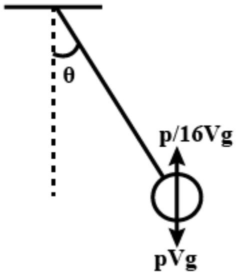
$\tau = I\alpha$

$\left(\rho Vg - \frac{\rho}{16}Vg\right)\ell\sin\theta = (\rho V)\ell^2\alpha$

$\frac{15g}{16\ell}\theta = \alpha$

$\omega = \sqrt{\frac{15g}{16\ell}} \Rightarrow T' = 2\pi\sqrt{\frac{16\ell}{15g}}$

$T' = \frac{4}{\sqrt{15}}T$



#1611975

Topic: Solenoid and Toroid

A solenoid has fixed N number of turns and fixed radius 'a' its length is given by 'ℓ' which can be varied. Its self-inductance is proportional to

A ℓ

B $\frac{1}{\ell}$

C ℓ^2

D $\frac{1}{\ell^2}$

Solution

Self-inductance, L

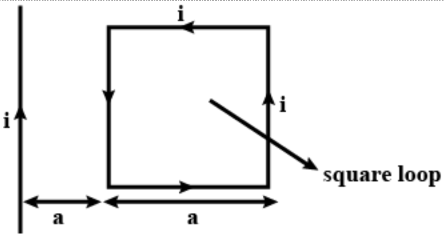
$\frac{L}{\ell} = \mu_0 n^2 \pi r^2 = \mu_0 \frac{N^2}{\ell^2}\pi r^2$

$L = \frac{\mu_0 N^2 \pi r^2}{\ell}$

$L \propto \frac{1}{\ell}$

#1611977

Topic: Magnetic field



The magnetic force between the infinite wire and the square loop is

A $\frac{\mu_0 i^2}{4\pi}$, repulsive

B $\frac{\mu_0 i^2}{2\pi}$, repulsive

C $\frac{\mu_0 i^2}{4\pi}$, attractive

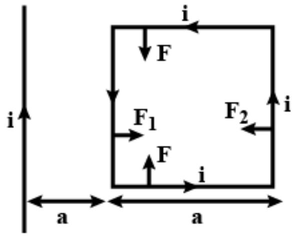
D $\frac{\mu_0 i^2}{2\pi}$, attractive

Solution

$F_1 = \frac{\mu_0 i}{2\pi . 2a} \times ia$

$F_1 = \frac{\mu_0 i^2}{4\pi}$

$\Rightarrow F_{total} = F_1 - F_2 = \frac{\mu_0 i^2}{4\pi}$ to the right.



#1611981

Topic: Work and Energy

A uniform chain of mass m & length L is kept on a smooth horizontal table such that $\frac{L}{n}$ portion of the chain hangs from the table. The work done required to slowly bring the chain completely on the table is

A $\frac{mgL}{n}$

B $\frac{mgL}{2}$

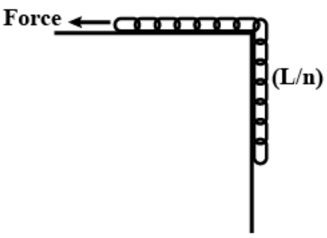
C $\frac{mgL}{n^2}$

D (marked) $\frac{mgL}{2n^2}$

Solution

$U_i = \frac{m}{n}\left(\frac{L}{n}\right)\frac{1}{2}g$

$\Rightarrow U_r = \left(\frac{m}{n}\right)g\left(\frac{L}{n}\right) \Rightarrow W = U_f - U_i = \frac{mgL}{2n^2}$



#1611989

Topic: Interference

In $YDSE$, slab of thickness t and refractive index μ is placed in front of any slit. Then displacement of central maximum in terms of fringe width when light of wavelength λ is incident on system is

A $\frac{\beta(\mu - 1)t}{2\lambda}$

B (marked) $\frac{\beta(\mu - 1)t}{\lambda}$

C $\frac{\beta(\mu - 1)t}{3\lambda}$

D $\frac{\beta(\mu - 1)t}{4\lambda}$

Solution

toppr

Displacement of central maximum (y)

$= (\mu - 1)t = \frac{dy}{D}$

$y = \frac{\lambda D(\mu - 1)t}{\lambda d}$ $\left(\beta = \frac{\lambda D}{d}\right)$

$sy = \frac{\beta(\mu - 1)t}{\lambda}$

#1611991
Topic: Atomic Spectra and Spectral Series

In H-atm spectrum V is the wave number

$V_1 = V_{min} + V_{max}$ for Lyman series

$V_1 = V_{min} + V_{max}$ for Balmer series then $V_1 : V_2$

A 9 : 2

B 3 : 2

C 5 : 2

D 7 : 2

Solution

$V_1 = R(1)^2\left[\frac{1}{1^2} - \frac{1}{2^2}\right] + R(1)^2\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) = RZ^2\left(\frac{7}{4}\right)$

$V_2 = R(1)^2\left[\frac{1}{2^2} - \frac{1}{3^2}\right] + R(1)^2\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = R(1)^2\left(\frac{7}{18}\right)$

$V_1 : V_2 = 9 : 2$

#1611995
Topic: Spherical Mirrors

At what distance from his face a person should concave mirrors of focal length $0.4m$ so that magnification in 5 times for a virtual image

A 32

B 24

C 16

D 50

Solution

$m = \frac{f}{f - 4} = 5$

$\Rightarrow \frac{-40cm}{-40cm - u} = 5$

$\Rightarrow 8 = 40 + u$

$u = -32cm$

#1611999
Topic: Errors, Accuracy and Precision

The mass and sides of a cube given as $(10kg \pm 0.1)$ and $(0.1m \pm 0.01)$, the relative error in density is:

A 0.31

B 0.5

C 0.62

D 0.29

Solution

$\frac{d\delta}{\delta} = \frac{dm}{m} + \frac{3da}{a} \Rightarrow \frac{d\delta}{\delta} = \frac{0.1}{10} + 3\left[\frac{0.01}{0.1}\right]$

$\Rightarrow \frac{d\delta}{\delta} = 0.01 + 0.3$

$\frac{d\delta}{\delta} = 0.31$

#1612003

Topic: Displacement in SHM

A string fixed at both ends, oscillate in 4^{th} harmonic. The displacement of a particle of string is given as:

$Y = 2A\sin(5\pi x)\cos(100\pi t)$. Then find the length of the string?

A (correct) $80cm$

B $100cm$

C $60cm$

D $120cm$

Solution

$\frac{2\pi}{\lambda} = 5\pi$

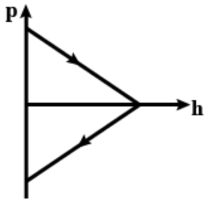
$4\left(\frac{\lambda}{2}\right) = \ell \Rightarrow 2\lambda = \ell \Rightarrow 2 \times \frac{2}{5} = \ell$

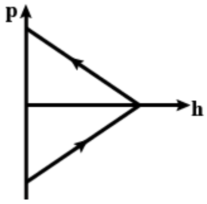
$\Rightarrow \ell = 80cm$

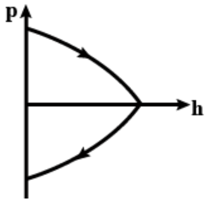
#1612040

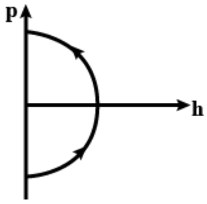
Topic: Basics of Projectile Motion

Particle is projected vertically upward from ground. Which of the following plots best describe the momentum vs height from the ground?

A


B


C (correct)


D


Solution

$v^2 = u^2 - 2gh$

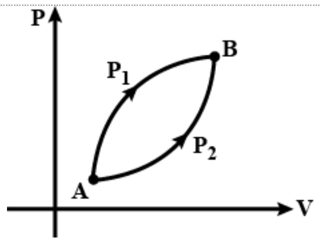
$v = \sqrt{u^2 - 2gh}$

$|p| = mv = m\sqrt{u^2 - 2gh} \Rightarrow p^2 = m^2u^2 - 2mgh$

toppr

#1612042

Topic: Adiabatic Processes



A thermodynamic system undergoes two processed P_1 and P_2 from $A \to B$ as shown in $P - V$ diagram. Choose the correct option.

A $\Delta U_{P1} = \Delta U_{P2}, Q_{P1} = Q_{P2}$

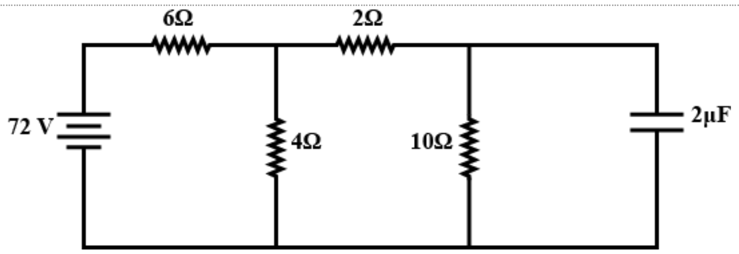
B $\Delta U_{P1} = \Delta U_{P2}, Q_{P1} > Q_{P2}$

C $\Delta U_{P1} > \Delta U_{P2}, Q_{P1} < Q_{P2}$

D $\Delta U_{P1} < \Delta U_{P2}, Q_{P1} = Q_{P2}$

#1612043

Topic: Resistance and Resistivity



Determine the charge on capacitor in steady state:

A $40\mu C$

B $20\mu C$

C $15\mu C$

D $80\mu C$

#1612053

Topic: Electric Charge

A charged particle ($Q = 10^{-4}C$) is released from rest at $z = 0$ in magnetic field given as $\vec{B} = B_0\cos(\omega t - kz)\hat{i} + B_1\cos(\omega t + kz)\hat{j}$ where $B_0 = 3 \times 10^{-5}T$ and $B_1 = 2 \times 10^{-6}T$. Then th rms value of force acting on particle is?

A 3×10^{-2}

B 0.6

C 0.9

D 0.1

Solution

The electric field in the region is:

$\vec{E} = -cB_0\cos(\omega t - kz)\hat{j} - cB_1\cos(\omega t + kz)\hat{i}$

so for charge released from rest at $z = 0$, the rms value of force is:

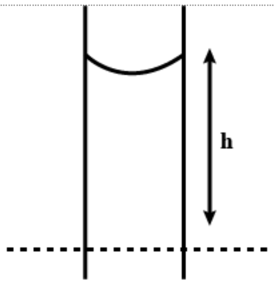
$$F_{rms} = g\sqrt{\left(\frac{cB_0}{\sqrt{2}}\right)^2 + \left(\frac{cB_1}{\sqrt{2}}\right)^2}$$

$$= 10^{-4} \times \frac{3 \times 10^8}{\sqrt{2}}\sqrt{(30 \times 10^{-6})^2 + (2 \times 10^{-6})^2}$$

$$= 10^{-4} \times \frac{3 \times 10^8}{\sqrt{2}}\sqrt{904} \times 10^{-6} = 0.63$$

#1612055

Topic: Capillarity



Mass'm' of a liquid rises inside a capillary of radius 'r'. The mass of fluid that rises when a capillary of radius "$2r$" is used is

A m

B $2m$

C $\frac{m}{2}$

D $4m$

Solution

$m = \rho Ah$

$m = \rho \pi r^2 \frac{2T\cos\theta}{\rho g r} \Rightarrow m \propto r$

#1612060

Topic: Gas Laws

r.m.s. speed of ideal gas at 127^oC is $200m/s$, the r.m.s. speed of same ideal gas at temperature 227^oC is:

A $100\sqrt{5}$

B $200\sqrt{5}$

C $100\sqrt{15}$

D $100\sqrt{10}$

Solution

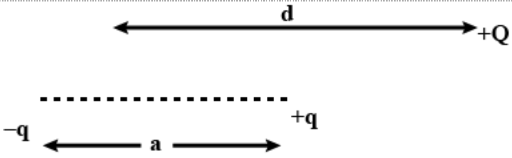
$v = \sqrt{\frac{3RT}{M}}$

$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} = \frac{200}{v_2} = \sqrt{\frac{400}{500}}$

$v_2 = 100\sqrt{5}$

#1612074

Topic: Electric Charge



Three point charges $-q$, q and Q are arranged as given in figure:

If d is distance from centre of $-q$ and $+q$ to Q and $d >>> a$, then the potential energy of given system is:

A $\left(\frac{kqQa}{d^2}\right)$

B $\left(\frac{+kq^2}{a} + \frac{kqQa}{d^2}\right)$

C $\left(\frac{-kq^2}{a} + \frac{kqQa}{2d^2}\right)$

D $\left(\frac{-kq^2}{a} + \frac{kqQa}{d^2}\right)$

Solution

$$U = -\frac{kq^2}{a} + \frac{kqQ}{d - \frac{a}{2}} - \frac{kqQ}{\left(d + \frac{a}{2}\right)}$$

$$U = \left(\frac{-kq^2}{a} + \frac{kqQa}{d^2 - \frac{a^2}{4}}\right)$$

$d >>> a$

$$U = \left(\frac{-kq^2}{a} + \frac{kqQa}{d^2}\right)$$

#1612080

Topic: Stopping Potential and Einstein's Photoelectric Equation

Light is incident on a metal plate whose work function is $2eV$. Electric field associated with light is given by $E = E_0 \sin\left(\omega t - \frac{2\pi}{5 \times 10^{-7}} x\right)$ [S.I. unit]. If energy of photon is given by $\frac{12375}{\lambda(in \mathring{A}}eV$ then stopping potential is.

A $2.48eV$

B $0.48eV$

C $0.78eV$

D $1.24eV$

Solution

$K = \frac{2\pi}{5 \times 10^{-7}} m$

$\lambda = 5 \times 10^{-7} m = 5000\mathring{A}$

Energy of photon $= \frac{12375}{5000} = 2.475eV$

stopping potential $= \frac{\frac{hc}{\lambda} - \phi}{} = \left[\frac{2.475eV - 2eV}{e}\right]$

$= 0.475V$

#1612088

Topic: Atomic Spectra and Spectral Series

Wavelength of the first line of Balmer series is $600nm$. The wavelength of second line of the Balmer series will be:

A $444nm$

B $800nm$

C $388nm$

D $632nm$

Solution

$\frac{1}{\lambda_1} = R\left[\frac{1}{2^2} - \frac{1}{3^2}\right] = \frac{5}{36}R$

$\frac{1}{\lambda_2} = R\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = R\left[\frac{3}{16}\right]$

$\frac{\lambda_2}{\lambda_1} = \frac{5R/36}{3R/16} = \frac{5}{36} \times \frac{16}{3}$

$\lambda_2 = \frac{5}{36} \times \frac{16}{3} \times 660 = 444.44nm$