(3)

Discuss the properties of image formed by ~~a mirror~~ shown mirror of a real object place beyond centre of curvature?

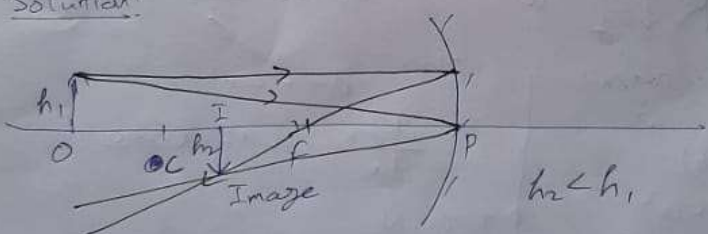
A) Real, Erect, Diminished.

B) ~~Reto~~ Real, Inverted, Diminished ✓

C) Virtual, Inverted, Diminished

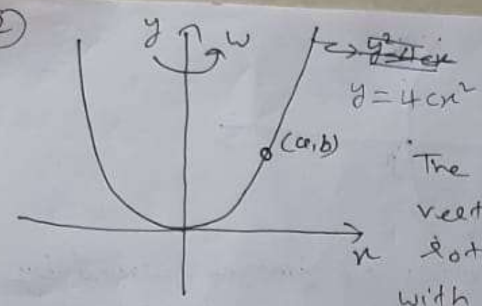
D) Real, Erect, Magnified.

Solution:



$h_2 < h_1$

(2)

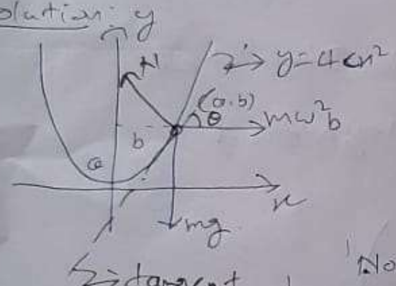


The parabola lies in vertical plane and rotating about y-axis with angular velocity 'ω'.

The particle pivoted in parabolic wire is at rest at (a,b). Find 'ω'.

~~A)~~ $\sqrt{\frac{2g}{a}}$ B) $\sqrt{\frac{g}{2a}}$ C) $2\sqrt{\frac{g}{a}}$ D) $\frac{1}{2}\sqrt{\frac{g}{a}}$

Solution:



Force balance along tangent

$(m\omega^2 b)\cos\theta = mg\sin\theta$

$\tan\theta = \frac{\omega^2 b}{g}$

Now, $y = 4cx^2$

$\frac{dy}{dx} = 8 \cdot cx = \tan\theta$

At (a,b),

~~$\tan\theta = 8cb = \omega$~~

$\tan\theta = 8ca = \frac{\omega^2 b}{g}$

$$\boxed{\omega = \sqrt{\frac{8cag}{b}}} = 2\sqrt{\frac{2cag}{b}}$$

$y = 4cx^2$
(a,b)

$b = 4ca^2$

$\Rightarrow 2ca = \frac{b}{2a}$

Now,

$\omega = 2\sqrt{\frac{b}{2a} \times \frac{g}{b}}$

$$\boxed{\omega = \sqrt{\frac{2g}{a}}}$$

(1) If 'F' is the force, 'V' is the velocity, and 'A' is the area. Find the dimensions of Young's Modulus 'Y' in terms of force, velocity and area?

A) $F^1 A^0 V^{-1}$

B) $F^2 A^0 V^{-1}$

C) $F^1 A^2 V^2$

D) $F^1 A^{-1} V^0$ ✓

Solution:-

Consider

~~$[Y] = [F]^a [V]^b [A]^c$~~

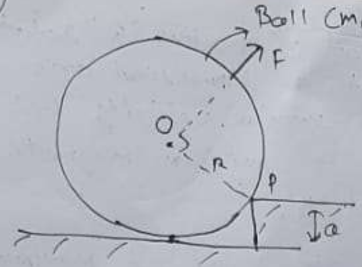
From Definition of Young's Modulus

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta L/L}$$

$$\therefore [Y] = \frac{[F]}{[A]} \quad , \quad \frac{\Delta L}{L} = \text{Dimensionless}$$

$$\therefore \boxed{[Y] = F^1 A^{-1}}$$

(4)



Force applied on the spherical ball of mass 'M' and radius 'R' perpendicular to line ~~'OP'~~ 'OP'.

Find min. value of 'F' to lift the ball.

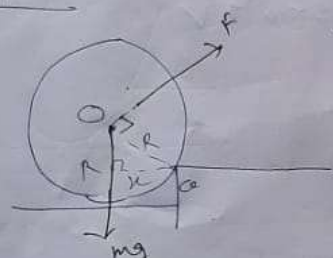
A) $\frac{mg}{a}\sqrt{2aR-R^2}$

B) $\frac{mg}{R}\sqrt{2aR+a^2}$

C) $\frac{mg}{a}\sqrt{2aR+R^2}$

D) $\frac{mg}{R}\sqrt{2aR-a^2}$ ✓

Solution



To lift ball, torque of force 'F' should be greater than torque of gravity about 'P'.

$\tau_F > \tau_{mg}$

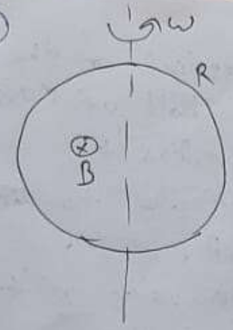
$F \cdot R > mg \cdot x$

$F > \frac{mg}{R}x$

$F_{min} = \frac{mg}{R}x = \frac{mg}{R}\sqrt{R^2-(R-a)^2}$

$$\boxed{F_{min} = \frac{mg}{R}\sqrt{2aR-a^2}}$$

(5)



A coil of radius 'R' rotating about a diametrical axis with angular velocity 'ω' in a uniform magnetic field 'B'.

Find the value of maximum voltage developed.

$R = 10\text{ cm}$, $B = 5\times10^{-5}\text{ T}$

For half rotation it takes a time of 0.2 second.

A) 3×10^{-5} V

B) 2.5×10^{-5} V ✓

C) 5×10^{-6} V

D) 5×10^{-5} V

Solution:

Flux as a function of time

$\phi = \vec{B}\cdot\vec{A} = AB\cos(\omega t)$

Emf induced,

$\varepsilon = \frac{-d\phi}{dt} = AB\omega\sin(\omega t)$

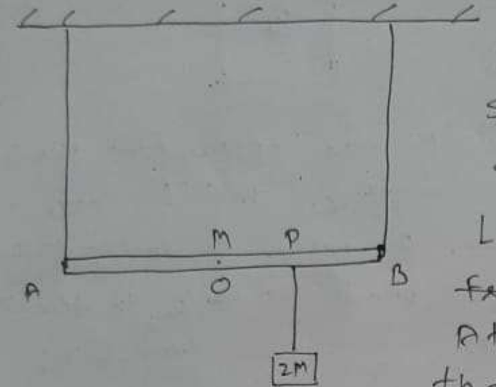
Max value of Emf $= AB\omega$

$= \pi R^2 B\omega$

$= 3.14\times0.1\times0.1\times5\times10^{-5}\times\frac{\pi}{0.2}$

$= 2.5\times10^{-5}$ V

(6)



There is a uniform rod AB of mass 'm' hanging horizontally with the support of two light strings as shown.

Length of rod is 100cm.

~~from 75 cm~~

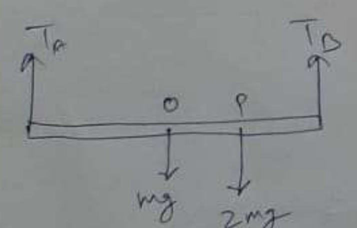
At point 'P' on the rod, a block of mass '2m' is hanged

Distance AP = 75 cm

Find Tension in string 'A' if rod is in equilibrium.

A) 2mg B) 3mg C) $\frac{mg}{3}$ ✓D) mg

Solution



Torque Balance about 'B':

$T_A \times 100 = mg \times 50 + 2mg \times 25$

$$\boxed{T_A = mg}$$

(8) Fluid is placed in a mixer and rotated with uniform angular velocity 'w'. Radius of the cylindrical mixer jar is 'R'. Find the height difference between minimum and maximum fluid level.

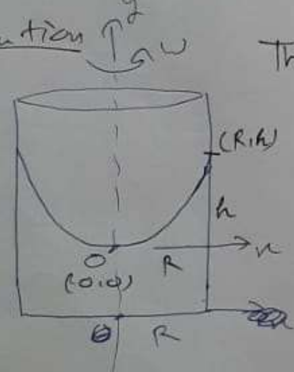
A) $\frac{w^2R^2}{2g}$ ✓

C) $\frac{wR^2}{2g}$

B) $\frac{w^2}{2gR^2}$

D) $\frac{w^2R}{2g}$

Solution



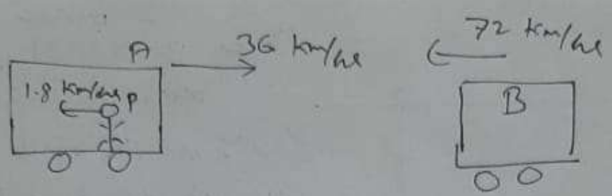
The equition of parabolic curve is

$$y = \frac{w^2}{2g} x^2$$

(R,h)

$$h = \frac{w^2}{2g} R^2$$

(7)



Two trains 'A' and 'B' are approaching each other with speed 36 km/hr and 72 km/hr respectively as shown. A person 'P' inside train 'A' is walking with speed 1.8 km/hr in direction opposite to train 'A'. wrt to 'A'.

Find velocity of person wrt train 'B'. in m/s.

A) 28.5 B) 29.5 C) 30.5 D) 31.5

Solution

$V_A = 36$ km/hr $= 10$ m/s

$V_B = -72$ km/hr $= -20$ m/s

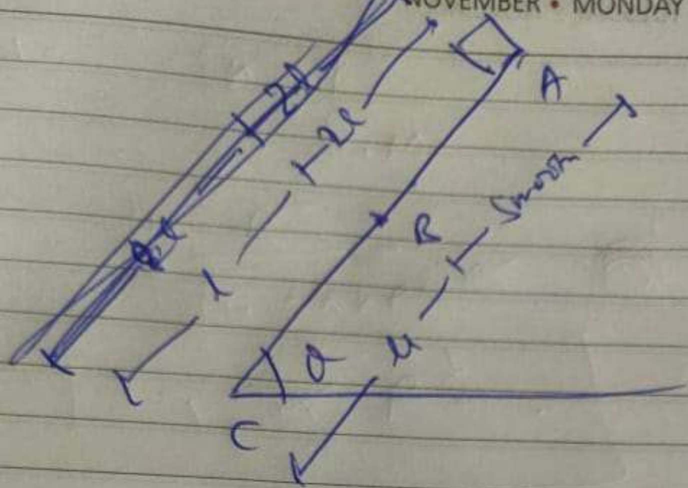
$V_{PA} = -1.8$ km/hr $= -0.5$ m/s

$\Rightarrow V_{PA} = V_P - V_A$

$V_P = V_{PA} + V_A = -0.5 + 10 = 9.5$ m/s

$V_{PB} = V_P - V_B = +9.5 - (-20) = 29.5$ m/s

(5)



$\mu = R \tan\theta$. Block starts from A & stops at C. find the R.

Sol^n: Work = ΔK

$$\Rightarrow W_N^{\,0} + W_g + W_f = K_2^{\,0} - K_1^{\,0}$$

$$\Rightarrow mg(3l\sin\theta) - (\mu mg\cos\theta)\,l = 0$$

$$\Rightarrow \mu = 3\tan\theta .$$

$\therefore R = 3$.

(3) Which is correct option for resistance for Tungsten, Copper, aluminium & mercury.

a) $R_{Cu} < R_W$ b) $R_{Al} > R_{Hg}$

c) $R_{Cu} > R_{Hg}$ d) $R_{Al} > R_W$

Sol. $\rho_{Hg} > \rho_W > \rho_{Al} > \rho_{Cu}$

$\therefore R_{Hg} > R_W > R_{Al} > R_{Cu}$

$R_{Cu} < R_W$

17 THURSDAY • NOVEMBER

(2) Density of a ~~star~~ galaxy varies as

$\rho = \frac{k}{r}$ where r is the distance

& k is constant. A ~~planet~~ star of

mass m revolves around around it

then time period is directly ~~proportional~~

proportional to

i) $R^{3/2}$ b) R c) $R^{7/2}$

d) $R^{1/2}$.

Soln: Mass of star

$M = \int \rho \, dV =$

$= \int_0^R \frac{k}{r} \cdot 4\pi r^2 \, dr$

$= \frac{4\pi k R^2}{2}$

~~T = 2πR~~

$\therefore T = \frac{2\pi R}{V_0} = \frac{2\pi R}{\sqrt{\frac{GM}{R}}}$

18 NOVEMBER • FRIDAY

$\Rightarrow T = 2\pi \frac{R^{3/2}}{\sqrt{GM}}$

$\Rightarrow T = 2\pi \frac{R^{3/2}}{\sqrt{G \, 4\pi k R^2}}$ ~~∝~~

$$\boxed{T \propto R^{1/2}.}$$

(7) A particle of mass m moving with speed $u\hat{i}$ collides elastically with a particle at rest of mass 3m and then find velocity of particle of mass m becomes $v\hat{j}$ find the relation between v & u

a) $u = 2v$ b) $u = v/2$ c) $u = \frac{v}{\sqrt{2}}$

d) $\sqrt{2}v$.

Sol: COLM

$$mu\hat{i} + 3m(\vec{0}) = mv\hat{j} + 3m\vec{v_1}$$

$$\Rightarrow \vec{v_1} = \frac{u\hat{i} - v\hat{j}}{3}$$

$$\Rightarrow v_1^2 = \frac{u^2 + v^2}{9} \quad (i)$$

COKE

$$\frac{1}{2}mu^2 + 0 = \frac{1}{2}mv^2 + \frac{1}{2}3m(v_1)^2$$

$$\Rightarrow u^2 = v^2 + 3v_1^2$$

$$\Rightarrow v_1^2 = \frac{u^2 - v^2}{3} \quad (ii)$$

From (i) & (ii), $\frac{u^2 + v^2}{9} = \frac{u^2 - v^2}{3}$

$$\Rightarrow u^2 + v^2 = 3u^2 - 3v^2$$

~~$\Rightarrow$ ... $2u^2 = 3v^2$~~

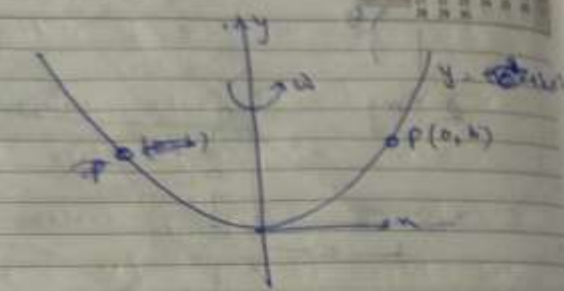
$\Rightarrow v^2 = \frac{u^2}{2}$

$$\Rightarrow 4v^2 = 2u^2$$

$$\Rightarrow u = \sqrt{2}v.$$

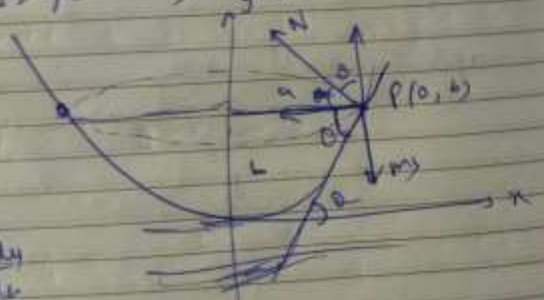
$\Rightarrow$

(6)



A bead of mass m is at rest w.r.t. a wire frame whose equation is $y = 4kx^2$. Find angular speed of the frame.

a) $2\sqrt{2gk}$ b) $\sqrt{2gk}$ c) $\sqrt{gk}$ d) $\sqrt{\frac{g}{2k}}$



$\tan\theta = \frac{dy}{dx}$

$= 8kx$

$\therefore \tan\theta \big|_{x=a} = 8ka$

$N\sin\theta = m\omega^2 a$ — (i)

$N\cos\theta = mg$ — (ii)

(i) ÷ (ii) $\tan\theta = \frac{\omega^2 a}{g}$

$\frac{\omega^2 a}{g} = 8ka$

$\Rightarrow \omega = \sqrt{8gk}$

$\Rightarrow \omega = 2\sqrt{2gk}$

(15) Two magnets are used for the following applications:

Magnet 'P' is used as Permanent Magnet

Magnet 'T' is used in transformers.

Discuss their properties:-

A) P has low retentivity and high coercivity.

B) P has higher retentivity and low ~~coercivity~~ coerctivity

C) 'T' has high coercitivity and low retentivity.

D) 'T' has low coercivity and ~~high~~ low retentivity

Solution:

The magnets used in transformers should have low coercivity and low retentivity.
Similarly, permanent magnets should have high retentivity and high coercitivity.

Morning
2^{nd} September.

(17) 'A' and 'B' are two identical strings of same length have fundamental frequencies 450 Hz and 300 Hz respectively. Find the ratio of tensions in string A & B?

A) $\frac{9}{4}$ B) $\sqrt{\frac{9}{4}}$ C) $\frac{4}{9}$ D) $\sqrt{\frac{4}{9}}$

Solution: The expressions of fundamental frequency

$$f \propto \frac{v}{L} \quad , \quad v = \sqrt{\frac{T}{\mu}}$$

$$\propto \frac{1}{L}\sqrt{\frac{T}{\mu}}$$

Since, strings are identical.

$$f \propto \sqrt{T}$$

$$\frac{T_A}{T_B} = \left(\frac{450}{300}\right)^2 = \left(\frac{3}{2}\right)^2 = \frac{9}{4}$$

Morning
2nd Sep.