Discuss the properties of image formed by a mirror shown below:

- Real object
- Place beyond centre of curvature

Options:
1. Real, erect, diminished
2. Real, inverted, diminished
3. Virtual, inverted, diminished
4. Real, erect, magnified

Solution:

\[ h_2 < h_1 \]
The parabola lies in a vertical plane and is rotating about y-axis with angular velocity \( \omega \).

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

\[
\omega = \frac{2}{a} \sqrt{\frac{b}{2a}}
\]

\[
\omega = \frac{2}{a} \sqrt{\frac{2}{b}}
\]

\[
\omega = \frac{2}{a} \sqrt{\frac{1}{2}}
\]

\[
\omega = \frac{2}{a} \sqrt{2}
\]

\[
\omega = \frac{2}{a} \sqrt{2}
\]

Solution:

\[
y = 4cn^2
\]

\[
fibre\ balance\ along\ tangent
\]

\[
(m + b) \cos \theta = \text{constant}
\]

\[
\tan \theta = \frac{m}{b}
\]

Now, \( y = 4cn^2 \)

\[
\frac{dy}{dx} = 8cn \tan \theta
\]

At \((a, b)\),

\[
\tan \theta = \frac{8cn}{b}
\]

\[
\tan \theta = \frac{8cn}{b}
\]

\[
\omega = \frac{2}{a} \sqrt{\frac{8cn}{b}}
\]

\[
\omega = \frac{2}{a} \sqrt{\frac{2}{b}}
\]
If \( F \) is the force, \( V \) is the velocity, \( A \) and \( A' \) is the area. Find the dimension of Young's Modulus, \( Y \), in terms of force, velocity, and area?

\[ \text{a) } F^1 A^0 V^1 \quad \text{b) } F^2 A^0 V^{-1} \quad \text{c) } F^1 A^1 V^0 \]

\text{Solution:}

Consider

\[ [Y] = [F/E] [V/A] [T/A] \]

From definition of Young's Modulus

\[ Y = \frac{\text{Stress}}{\text{Strain}} = \frac{F/A}{\Delta L/L} \]

\[ \therefore [Y] = [F/A] \]

\[ \Delta L \text{ Dimensionless} \]

\[ \therefore [Y] = F^1 A^{-1} \]
Ball (M, R)

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.

\[
F = \frac{Mg}{\sqrt{2ar - a^2}}
\]

\[
F = \frac{Mg}{\sqrt{2ar - a^2}}
\]

**Solution**

To lift ball, torque of force \( F \) should be greater than torque of gravity about \( O' \).

\[
CF > Cmg
\]

\[
F \cdot R > Mg \cdot R
\]

\[
F > \frac{Mg}{R}
\]

From:

\[
\frac{Mg}{R} = \frac{M^2 g}{R^2 - (R - a)^2}
\]

\[
\text{From: } \frac{Mg}{R} = \frac{M^2}{R^2 - 2Rr - a^2}
\]
A coil of radius 'R' rotating about a diametrical axis with angular velocity 'ω' is in a uniform magnetic field 'B'.

Find the value of maximum voltage developed.

Relevance: B = 5x10^-5 T

For half rotation it takes a time of 0.2 second.

\[ \Delta \Phi = B \times 2.5 \times 10^{-5} \text{ m}^2 \]

\[ v = 3 \times 10^{-5} \text{ V} \]

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Solution:

\[ \phi = B \times A = B \times \pi R^2 \cos(\omega t) \]

\[ E_{\text{induced}} = -\frac{\Delta \phi}{\Delta t} = AB \omega \sin(\omega t) \]

Max value of \( E_{\text{induced}} = AB \omega \)

\[ = \pi R^2 B \omega \]

\[ = 3.14 \times 0.01 \times 0.1 \times 5 \times 10^{-5} \text{ m}^2 \text{ T} \]

\[ = 2.5 \times 10^{-5} \text{ V} \]
There is a rod AB of mass m, hanging horizontally with the support of two light strings as shown.

Length of rod is 100 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.

\[ T = 2mg \]

Solution

Torque balance about B:

\[ T \times 100 = mg \times 50 + 2mg \times 25 \]

\[ T = mg \]
8) Fluid is placed in a mixer and rotated with uniform angular velocity \( \omega \). The radius of the cylindrical mixer jar is \( R \). Find the height difference between minimum and maximum fluid level.

\[
\begin{align*}
A & : \frac{\omega^2 R^2}{2g} \\
B & : \frac{\omega^2 R^2}{2gR^2} \\
C & : \frac{\omega R^2}{2g} \\
D & : \frac{\omega^3 R}{2g}
\end{align*}
\]

Solution: The equation of a parabolic curve is

\[
y = \frac{\omega^2}{2g} x^2
\]

\[
h = \frac{\omega^2}{2g} R^2
\]
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'.

Find velocity of person w/t train 'A' & 'B'.

\[ V_{p} = 28.5 \text{ m/s} \]

Solution:
\[ V_{A} = 36 \text{ km/hr} = 10 \text{ m/s} \]
\[ V_{B} = 72 \text{ km/hr} = -20 \text{ m/s} \]
\[ V_{pA} = 1.8 \text{ km/hr} = -0.5 \text{ m/s} \]
\[ V_{p} = V_{pA} + V_{a} = -0.5 -10 = 9.5 \text{ m/s} \]
\[ V_{pB} = V_{p} - V_{B} = 9.5 - (-20) = 29.5 \text{ m/s} \]
No rotate. Block stands for A & stop on C. Find the $R_y$.

\[
\Sigma F_y = 0: \quad W - 2K = 0
\]

\[
\Rightarrow \quad W + mg + W_f = 2K
\]

\[
\Rightarrow \quad mg (\sin \theta) - (mg \cos \theta) \cdot R = 0
\]

\[
\Rightarrow \quad m = g \tan \theta
\]

\[
\Rightarrow \quad R = 3
\]
Which is correct option for resistance for Tungsten, Copper, Aluminum & Mercury.

(a) \( R_{Cu} < R_{W} \)  
(b) \( R_{Al} > R_{Hg} \)

(c) \( R_{Cu} > R_{Hg} \)  
(d) \( R_{Al} > R_{W} \)

\( R_{Hg} > R_{W} > R_{Al} > R_{Cu} \)

\( R_{Al} > R_{W} > R_{Hg} > R_{Cu} \)
Density of a galaxy varies to
\[ \rho \propto \frac{1}{r^2} \quad \text{where } r \text{ is the distance} \]
& \( t \in \text{ constant} \). A star of mass \( m \) revolves around around it then the period is directly
proportional to \( R \).

\[ T = \frac{2\pi R}{V} \quad \text{or} \quad \frac{2\pi R}{\sqrt{4\pi G\rho}} \]

\[ \rho \propto \frac{1}{r^2} \]

\[ (a) \ R^\frac{3}{2} \quad (b) \ R \quad (c) \ R^\frac{5}{2} \]

\[ (d) \ R \]

\[ \text{Mass of stars} \]
\[ M = \int \rho dv = \frac{4\pi}{3} \]
\[ = \frac{4\pi}{3} R \quad \text{... on inspecting} \]
\[ \frac{4\pi}{3} R \]
\[ \frac{4\pi}{3} k R^2 \]
\[ \frac{4\pi}{3} R \]

\[ \frac{2\pi R}{V} \]

\[ \frac{2\pi R}{\sqrt{4\pi G\rho}} \]
A particle 2 was in motion with speed 
\( u \) at rest. It collided elastically with a particle at rest of mass \( m \), and then

\[ u = \frac{u}{2} \quad \text{and} \quad \frac{1}{2} m v^2 = \frac{1}{2} m u^2 + \frac{1}{2} m v^2 \]

The final velocity of particle 2 is 
\[ v = \frac{u}{2} \]

\[ m v' + 2 m v = m u + 2 m \frac{u}{2} \]

\[ s = \frac{u v}{2} - \frac{v^3}{3} \]

\[ v = \frac{u}{2} \quad \text{and} \quad \frac{v}{u} = \frac{1}{3} \]

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\[ 2 v' + 2 v = 2 u + 2 \frac{u}{2} \]

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A bead $q$ moves on a wire at a constant speed $v$. The wire is smooth and frictionless. The position of the bead is given by the equation $y = mx^2$. Find the angular speed $\omega$.

Given: $\omega = \frac{dy}{dx}$

$\omega = \frac{dy}{dx} = 2\sqrt{x}$

On the diagram, find the point $P(1, 2)$ to determine the direction of motion. The velocity vector $\mathbf{v}$ is along the tangent to the curve at point $P$.
Two magnets are used for the following applications:

- Magnet 'P' is used as permanent magnet.
- Magnet 'T' is used in transformers.

Discuss their properties:

- P has low retentivity and high coercivity.
- P has high retentivity and low coercivity.
- 'T' has high coercivity and low retentivity.
- 'T' has low coercivity and high retentivity.

Solution:

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

Morning
2nd 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?

\[ \frac{F_A}{F_B} = \frac{\frac{9}{4}}{\frac{4}{3}} = \frac{9}{4} \times \frac{3}{4} = \frac{9}{4} \]

Solution: The expressions of fundamental frequency are:

\[ f = \frac{1}{2L} \sqrt{\frac{T}{\mu}} \]

\[ v = \frac{1}{L} \sqrt{\frac{T}{\mu}} \]

Since, strings are identical,

\[ f \propto \sqrt{T} \]

\[ \frac{F_A}{F_B} = \left( \frac{450}{300} \right)^2 = \left( \frac{3}{2} \right)^2 = \frac{9}{4} \]

Morning
8 2nd Sep.