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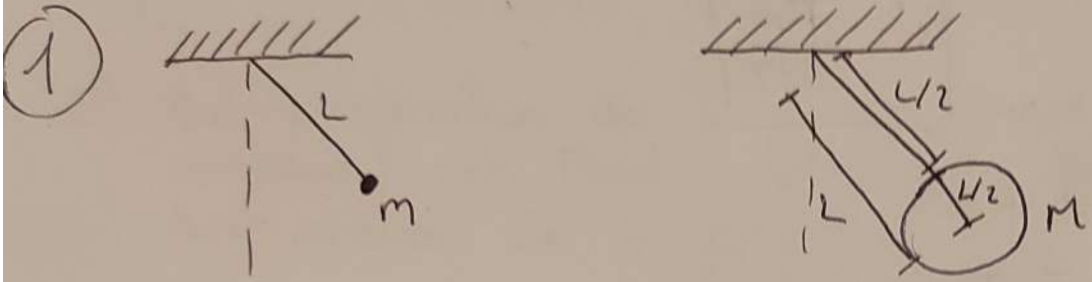
PHY250
HW-3

(1)



$$T = 2\pi\sqrt{\frac{l}{g}} \cdot \sqrt{\frac{I}{ml^2}}$$

I: Moment of inertia about axis of rotation
l: Distance of center of mass and axis.

$$\boxed{T_1 = 2\pi\sqrt{\frac{L}{g}}} \cdot \sqrt{\cancel{\frac{mL^2}{mL^2}}}$$

$I = mL^2$ for point with mass m.

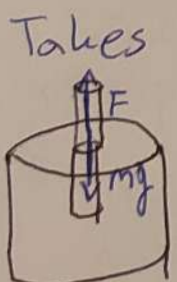
$$T_2 = 2\pi\sqrt{\frac{l}{g}} \cdot \sqrt{\frac{I}{ml^2}}$$

$l = L$ $\quad I = \frac{2}{5}MA^2 + Mr_1^2$
$= \frac{2}{5}M\left(\frac{L}{2}\right)^2 + ML^2 = \frac{11}{10}ML^2$

$$T_2 = 2\pi\sqrt{\frac{L}{g}} \cdot \sqrt{\frac{\frac{11}{10}\cancel{ML^2}}{\cancel{ML^2}}} \Rightarrow \boxed{2\pi\sqrt{\frac{11L}{10g}} = T_2}$$

T_2 is greater than T_1. Hence, The large sphere Takes longer to complete a swing.

(2)



a) Here buoyancy force is given by

$F = \rho V g$ $\quad F = mg$ (force upwards)

$m\cancel{g} = \rho V \cancel{g}$

$m = \rho V$ $\quad V = A \cdot l$

$m = \rho A l$

$$l = \frac{m}{\rho A} \Rightarrow l = \frac{\rho_0 \cancel{A} h}{\rho \cancel{A}} \Rightarrow \boxed{l = \frac{\rho_0 h}{\rho}}$$

b) consider x' to be distance which is further displacement downwards force F, we can write:

$$F = A x' \rho g$$

$$\boxed{x' = \frac{F}{A \rho g}}$$

c) Time period T?

Force constant is given by:

$$\boxed{k = \frac{F}{x} = \frac{A \cancel{x} \rho g}{\cancel{x}}}$$

Now angular frequency is: $\omega = \sqrt{\frac{K}{m}}$

$$\boxed{\omega = \sqrt{\frac{A \rho g}{M}}}$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{A\rho g}{M}}} = \boxed{2\pi \sqrt{\frac{M}{A \rho g}}}$$

3) a) $v = \sqrt{\frac{F}{\mu}}$

$$V = \sqrt{\frac{5\,N}{50 \cdot 10^{-3}\,kg/m}} = \boxed{10\,m/s}$$

V: velocity
F: force
M: mass density

b) $\lambda = \frac{v}{f}$

$$\lambda = \frac{10\,m/s}{40\,Hz} = \boxed{0{,}25\,m}$$

λ: wavelength
v: velocity
f: frequency

c) $T = \frac{1}{f}$ $\quad T = \frac{1}{40\,Hz} = \boxed{0{,}025\,s}$

T: period
A: amplitude

Now, substitute all the values in the equation:

$$Y(x,t) = A \cos 2\pi \left(\frac{x}{\lambda} - \frac{t}{T}\right)$$

$$\boxed{Y(x,t) = 0{,}03\,m \cos 2\pi \left(\frac{x}{0{,}25\,m} - \frac{t}{0{,}025\,s}\right)}$$

d) $a_{max} = 4\pi^2 f^2 A$

$a_{max} = 4\pi^2 (40 Hz)^2 (0{,}03 m)^2$

$\boxed{a_{max} = 1893\ m/s^2}$

e) The acceleration due To gravity always have a vertical component only That is: $\boxed{a_y = -g}$. Here, "g" is The acceleration due To gravity.

The acceleration due To gravity don't have any horizontal component only, that is: $\boxed{a_x = 0}$.

Therefore, The Transverse wave is nearly horizontal, because, The effect of force of gravity is ignored.

Hence, the answer is **yes.**

4) Given That a string That lies along The +X-axis has a free end at x=0.

a) We can derive a wave function for The standing wave by adding wave functions.

$y_1(x,t) = A\cos(kx+\omega t)$ and $y_2(x,t) = A\cos(kx-\omega t)$

$\Rightarrow y(x,t) = y_1(x,t) + y_2(x,t)$

$= A\cos(kx+\omega t) + A\cos(kx-\omega t)$

$= A[\cos(kx+\omega t) + \cos(kx-\omega t)]$

$= A[\cos(kx)\cos(\omega t) - \sin(kx)\sin(\omega t) + \cos(kx)\cos(\omega t) + \sin(kx)\sin(\omega t)]$

$= 2A\cos(kx)\cos(\omega t)$

b) If x=0, the antinode for The standing wave at its fee end is : $y(0,t) = 2A\cancel{\cos(k\cdot 0)}\cos(\omega t)$

$y(0,t) = 2A\cos(\omega t)$

so, x=0 is an antinode

c). • the maximum displacement from the above standing wave is,

$y(0,t) = 2A\cos(\omega t)$

$\boxed{A_{sw} = 2A}$ when $t=0$

• Maximum velocity is;

$y(0,t) = 2A\cos(\omega t)$

$V_y = \frac{\partial y}{\partial t} \Rightarrow -2A\omega\sin(\omega t) = 2A\omega\sin(\omega t) = \omega A_{sw}\sin(\omega t)$

$\cancel{V_y\ V_{ymax} = \omega A_{sw}}$ $\boxed{V_{ymax} = \omega A_{sw}}$ when The object reaches The maximum amplitude.

• ~~Maximum acceleration is;~~

$\cancel{a_y = \frac{\partial^2 y}{\partial t^2}}$

$\cancel{a_y = \partial}$

• Maximum acceleration is:

$a_y = \frac{\partial}{\partial t}(-2A\omega\sin(\omega t))$

$a_y = -2A\omega^2\cos(\omega t) = 2A\omega^2\cos(\omega t)$

$\boxed{a_{ymax} = 2A\omega^2}$ when $t=0$