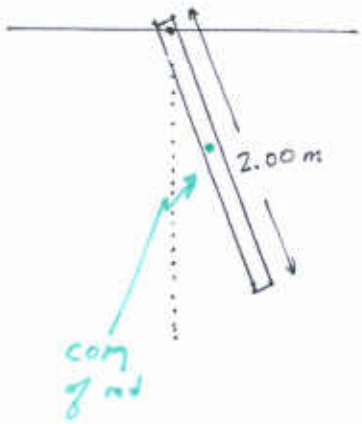
Name_____ Units = Units ?

Phys 2110, Section 5
Quiz #5 — Fall 2001

1. A "physical pendulum" consists of a uniform rod of length 2.00 m pivoted at one end oscillating about the vertical position on some strange planet. (So $g \neq 9.8 \frac{m}{s^2}$ here...)

It is found that the rod makes 10.0 complete oscillations in 29.0 s.



a) What is the frequency of oscillation for this pendulum?

Frequency is:

$$f = \frac{10.0 \text{ osc}}{29.0 \text{ s}} = 0.345 \frac{\text{osc}}{\text{s}} = \boxed{0.345 \text{ Hz}}$$

b) How far is the center of mass from the pivot point?

Center of mass is at the center of the (uniform) rod, so

$$\boxed{h = 1.00 \text{ m}}$$

c) Find the value of g on this planet.

For a "physical" (not simple) pendulum,

$$f = \frac{1}{2\pi}\sqrt{\frac{Mgh}{I}}$$

Here, $I = \frac{1}{3}ML^2$ where $L = 2.00$ m and $h = L/2$. This gives:

$$f = \frac{1}{2\pi}\sqrt{\frac{Mg(L/2)}{\frac{1}{3}ML^2}} = \frac{1}{2\pi}\sqrt{\frac{3}{2}\frac{MgL}{ML^2}} = \frac{1}{2\pi}\sqrt{\frac{3}{2}\frac{g}{L}}$$

Then:

$$f^2 = \frac{1}{4\pi^2}\cdot\frac{3}{2}\frac{g}{L} \longrightarrow g = \frac{8\pi^2}{3}f^2 L$$

$$g = \frac{8\pi^2}{3}(0.345/\text{s})^2(2.00 \text{ m}) = \boxed{6.26 \frac{\text{m}}{\text{s}^2}}$$

2. A travelling wave has the mathematical expression:

$$y(x,t) = \sin((0.600\ \text{m}^{-1})x + (2.00\ \text{s}^{-1})t + 2.55)$$

a) What is the wavelength of the wave? Here, $k = 0.600\ \text{m}^{-1}$ and $k = \frac{2\pi}{\lambda}$, so:

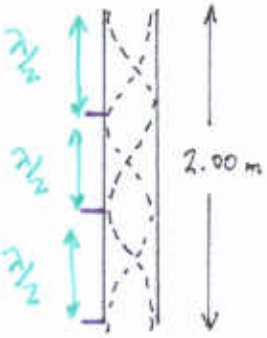
$$\lambda = \frac{2\pi}{k} = \frac{2\pi}{(0.600\ \text{m}^{-1})} = \boxed{10.5\ \text{m}}$$

b) What is the speed of the wave?

Also, $\omega = 2.00\ \text{s}^{-1}$ so

$$v = \frac{\omega}{k} = \frac{(2.00\ \text{s}^{-1})}{(0.600\ \text{m}^{-1})} = \boxed{3.33\ \frac{\text{m}}{\text{s}}}$$

3. In a tube of length 2.00 m with both ends open, the *third* harmonic resonance is produced at a frequency of 263 Hz.



a) What is the wavelength of the standing wave?

Here $L = 2.00\ \text{m} = 3 \cdot \lambda/2$, so

$$\lambda = \frac{2}{3}L = \frac{2}{3}(2.00\ \text{m}) = \boxed{1.33\ \text{m}}$$

b) What is the speed of sound as determined by this measurement?

f and λ satisfy $\lambda f = v$ = speed of sound, so:

$$v = \lambda f = (1.33\ \text{m})(263/\text{s}) = \boxed{351\ \frac{\text{m}}{\text{s}}}$$

You must show all your work and include the right units with your answers!

$$\omega = 2\pi f \qquad f = \frac{1}{T} \qquad k = \frac{2\pi}{\lambda} \qquad \lambda f = \frac{\omega}{k} = v$$

$$x(t) = x_m \cos(\omega t + \phi) \qquad K = \tfrac{1}{2}mv^2 \qquad U_{\text{spr}} = \tfrac{1}{2}kx^2$$

$$I_{\text{rod, end}} = \tfrac{1}{3}ML^2 \qquad f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{g}{L}} \qquad f = \frac{1}{2\pi}\sqrt{\frac{Mgh}{I}}$$

$$y(x,t) = y_m \sin(kx \mp \omega t + \phi) \qquad \text{Wave travels in } \begin{cases} +x \\ -x \end{cases} \text{ direction}$$