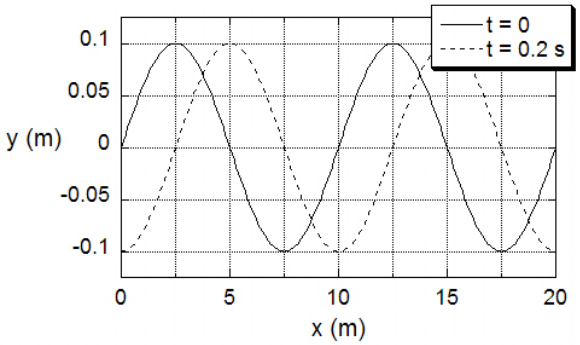
Name _____

PH105-001 **Exam 3b** **Nov. 21, 2008**

1. A transverse wave on a rope is shown below as a plot of y versus x at two different times. Write down an explicit expression for the transverse displacement of the wave as a function of x and t; i.e., y(x,t). Include all known numerical values in the equation.



$$y(x,t) = A\sin(kx - \omega t + \varphi) = A\sin(\frac{2\pi x}{\lambda} - \frac{2\pi t}{T} + \varphi)$$

$$A = 0.1m,\ \lambda = 10\,m,\ T = 4(0.2s) = 0.8\,s,\ \varphi = 0$$

$$y(x,t) = (0.1m)\sin(\frac{2\pi x}{10\,m} - \frac{2\pi t}{0.8s}) = (0.1m)\sin(0.628x - 7.85t)$$

2. A block of copper with dimensions 0.1 m x 0.1 m x 0.1 m is submerged in water. The density of the copper is 8,900 kg/m^3 and the density of water is 1,000 kg/m^2.

   (a) What is the buoyant force on the block?

$$B = m_w g = \rho_w V g = (1000)(9.8)(0.1)^3 = 9.8\ N$$

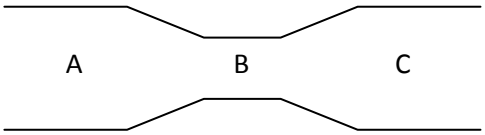
   (b) What is the apparent weight of the block in the water?

$$W = m_{Cu} g = \rho_{Cu} V g = (8900)(9.8)(0.1)^3 = 87.2\ N$$
$$W_{app} = W - B = 87.2 - 9.8 = 77.4\,N$$

3. A tire has a volume of 15 liters and is inflated with nitrogen gas to a *gauge* pressure of 3 atmospheres at a temperature of 25^{o}C. The molecular mass of nitrogen (N_2) is 28 g. What is the total mass of the nitrogen in the tire?

$$n = \frac{PV}{RT} = \frac{(4*1.013x10^5)(15x10^{-3})}{(8.31)(273+25)} = 2.45\,moles$$
$$m = nM = (2.45)(28) = 68.6\,g$$

4. Water flows through a pipe which has a constriction, as shown below.



(a) At which point is the speed of the flow the greatest? Explain.

$Av = constant \rightarrow v_B$ *greatest*

(b) At which point is the water pressure the greatest? Explain.

$P + \frac{1}{2}\rho v^2 + \rho g y = constant \rightarrow P_B$ *smallest*

5. A simple pendulum and a mass-spring system each have a period of 1 sec on earth. What will be their periods on Mars? The acceleration of gravity on Mars is 3.7 m/s^2.

(a) Period of simple pendulum?

$$T_{Mars} = 2\pi\sqrt{\frac{L}{g_m}} = 2\pi\sqrt{\frac{L}{3.7 g_E / 9.8}} = \sqrt{\frac{9.8}{3.7}} T_E = 1.63 \text{ sec}$$

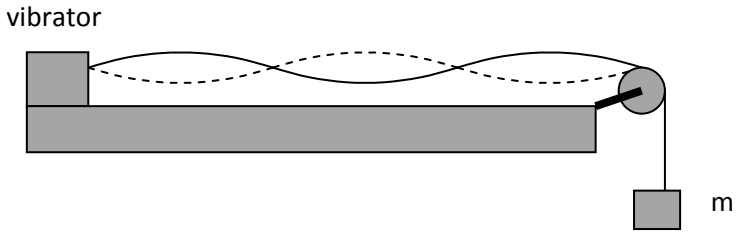
(b) Period of mass-spring system?

$T = 2\pi\sqrt{\frac{m}{k}}$ *Doesn't depend on g, so* T_{Mars} *= 1 sec*

6. A train approaches a station with a speed of 40 m/s. A person standing at rest on the station platform blows a whistle with a frequency of 3,000 Hz. What frequency do the passengers in the train hear? Assume speed of sound in air = 343 m/s.

$$f = f_0\left(\frac{v + v_0}{v - v_s}\right) = 3000\left(\frac{343 + 40}{343 - 0}\right) = 3350\, Hz$$

7. In a physics lab experiment a string is held in tension by a mass hanging from one end of the string over a pulley. A vibrator at the other end of the string produces the standing wave pattern shown in the figure. The length of the string from the vibrator to the pulley is 3 m, the hanging mass is 1 kg, and the mass density of the string is 0.02 kg/m. What is the frequency of the vibration?



$$f = \frac{v}{\lambda} = \frac{1}{\lambda}\sqrt{\frac{F}{\mu}} = \frac{1}{\lambda}\sqrt{\frac{mg}{\mu}} = \frac{1}{(2m)}\sqrt{\frac{(1kg)(9.8m/s^2)}{(0.02kg/m)}} = \frac{22.1m/s}{2m} = 11.1Hz$$

8. What is the intensity in W/m^2 of a 77 dB sound?

$$\beta = 10\log(I/I_0)$$

$$I = I_0 10^{\beta/10} = 10^{-12}10^{7.7} = 10^{-4.3} = 5.0x10^{-5}\ W/m^2$$

9. A 1-m simple pendulum and a meter stick pivoted at the end oscillate side by side. Which has the greatest frequency of oscillation? Explain.

$$T_{sp} = 2\pi\sqrt{\frac{L}{g}},\ T_{ms} = 2\pi\sqrt{\frac{I}{mgd}} = 2\pi\sqrt{\frac{\frac{1}{3}mL^2}{mg\frac{1}{2}L}} = \sqrt{\frac{2}{3}}T_{sp}$$

So, $T_{ms} < T_{sp}$, or $f_{ms} > f_{sp}$

R = 8.31 J/mole·K

$0^oC = 273$ K.

1 atmosphere = 1.013 x 10^5 Pa

$I_0 = 1 \times 10^{-12}$ W/m^2 (corresponds to 0 dB)

1 liter = 10^{-3} m^3

Speed of sound in air = 343 m/s at 20^o C