Units? Units?

Name

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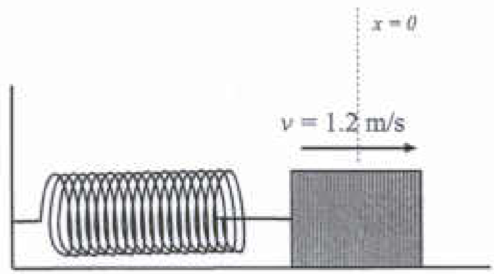
Phys 2010, Section 2
Quiz #5 — Fall 2003

1. A 0.300 kg mass is attached to a spring of force constant 600 N/m. while it moves through the equilibrium position it has a speed of $1.20 \frac{m}{s}$.



a) What is the total mechanical energy of the system?

Speed at the equil. pt. is V_{max}, so

$$E_{Tot} = \frac{1}{2} m v_{max}^2 = \frac{1}{2}(0.300 \text{ kg})(1.20 \tfrac{m}{s})^2 = \boxed{0.216 \text{ J}}$$

b) What is the amplitude of the motion?

Since $E_{Tot} = \frac{1}{2} m v_{max}^2 = \frac{1}{2} k A^2$, then:

$$A^2 = \frac{m v_{max}^2}{k} = \frac{(0.300 \text{ kg})(1.20 \tfrac{m}{s})^2}{(600 \text{ N/m})} = 7.2 \times 10^{-4} \text{ m}^2$$

$$\longrightarrow A = 2.68 \times 10^{-2} \text{ m} = \boxed{2.68 \text{ cm}}$$

c) Find the frequency of the vibrations of the mass.

$$f = \frac{\omega}{2\pi} = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}\sqrt{\frac{600 \text{ N/m}}{0.300 \text{ kg}}} = \boxed{7.12 \text{ Hz}}$$

2. The speed of sound in water is $1480 \frac{m}{s}$. What is the wavelength of a 500 Hz sound wave passing through water?

Use $\lambda f = v$, then:

$$\lambda = \frac{v}{f} = \frac{1480 \tfrac{m}{s}}{500 \tfrac{1}{s}} = \boxed{2.96 \text{ m}}$$

3. A piece of string of mass density 0.020 g/cm is under a tension of 160 N.

Find the speed of waves on the string.

Density is $0.020 \frac{g}{cm} \left(\frac{1 \text{ kg}}{10^3 \text{ g}}\right)\left(\frac{100 \text{ cm}}{1 \text{ m}}\right) = 2.0 \times 10^{-3} \text{ kg/m}$

Then the speed of waves on the string is

$$v = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{160 \text{ N}}{2.0 \times 10^{-3} \text{ kg/m}}} = \boxed{283 \tfrac{m}{s}}$$

4. A source of sound of frequency 520 Hz is moving toward you at a speed of $30.0\frac{\text{m}}{\text{s}}$. (You are not moving.)

What is the frequency which you hear?

Here, $v_s = 30 \frac{m}{s}$ and $v_o = 0$. Making the proper choice of sign (frequency must be raised) the Doppler formula gives the "observed" frequency:

$$f_o = \left(\frac{1}{1 - \frac{30 \, m/s}{343 \, m/s}}\right)(520 \text{ Hz}) = \boxed{570. \text{ Hz}}$$

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

$$f = \frac{\omega}{2\pi} \qquad T = \frac{1}{f} \qquad \omega = \sqrt{\frac{k}{m}} \qquad T = 2\pi\sqrt{\frac{m}{k}} \qquad v_{\text{max}} = \omega A \qquad a_{\text{max}} = \omega^2 A$$

Use $343 \frac{m}{s}$ for speed of sound.

$$E_{\text{tot}} = \tfrac{1}{2}kx^2 + \tfrac{1}{2}mv^2 = \tfrac{1}{2}kA^2 = \tfrac{1}{2}mv_{\text{max}}^2 \qquad T = 2\pi\sqrt{\frac{L}{g}} \qquad \omega = \sqrt{\frac{MgL}{I}}$$

$$g = 9.80\tfrac{\text{m}}{\text{s}^2} \qquad \lambda f = v \qquad v = \sqrt{\frac{F}{\mu}} \qquad \mu = \frac{m}{L} \qquad I = \frac{P}{4\pi r^2}$$

$$\beta = 10\log_{10}\left(\frac{I}{I_0}\right) \qquad I_0 = 1 \times 10^{-12}\,\tfrac{\text{W}}{\text{m}^2} \qquad f_o = \left(\frac{1 \pm \frac{v_o}{v}}{1 \mp \frac{v_s}{v}}\right) f_s = \left(\frac{v \pm v_o}{v \mp v_s}\right) f_s$$