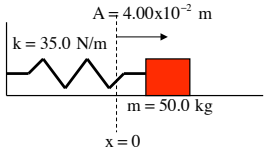
Problem 15.19

A 50.0 kg mass oscillates in the horizontal. The spring constant is 35.0 N/m and the amplitude is .04 meters.



a.) What is the *total energy* in the system?

The *total energy* in the system is "E = KE + U," where the "KE" and "U" are determined by where in the cycle the body happens to be. If we look at an extreme where x = A and the body is not moving, all of the energy is wrapped up in *potential energy*. In that case, we can write:

$$E = \cancel{KE}^{0} + U_{spring}$$
$$= \frac{1}{2}kA^2$$
$$= \frac{1}{2}(35.0\ \text{N/m})(.0400\ \text{m})^2$$
$$= 2.80\text{x}10^{-2}\ \text{J}$$

b.) What is the *speed* of the body when its position is as x = .0100 meters?

This is a good problem as it is a bit obscure and makes you think. In this case, energy is still the key. Specifically:

$$E_{total} = KE + U_{spring}$$
$$= \frac{1}{2}mv^2 + \frac{1}{2}kx^2$$
$$\Rightarrow v = \left[\frac{E_{total} - \frac{1}{2}kx^2}{\frac{1}{2}m}\right]^{1/2}$$
$$\Rightarrow v = \left[\frac{(2.80\text{x}10^{-2}\ \text{J}) - \frac{1}{2}(35.0\ \text{N/m})(.0100\ \text{m})^2}{\frac{1}{2}(50.0\text{x}10^{-3}\ \text{kg})}\right]^{1/2}$$
$$= 1.02\ \text{m/s}$$

c.) What is the *KE* of the body when its position is at x = .0300 meters?

Again, the energy relationship:

$$E_{total} = KE + U_{spring}$$
$$= KE + \frac{1}{2}kx^2$$
$$\Rightarrow KE = E_{total} - \frac{1}{2}kx^2$$
$$= (2.80\text{x}10^{-2}\ \text{J}) - \frac{1}{2}(35.0\ \text{N/m})(3.00\text{x}10^{-2}\ \text{m})^2$$
$$= 1.23\text{x}10^{-2}\ \text{J}$$

d.) What is the *potential energy* of the body when its position is x= .0300 meters?

Using what we determined in *Part c,* we can write:

$$E_{total} = KE + U_{spring}$$
$$(2.80\text{x}10^{-2}\ \text{J}) = (1.23\text{x}10^{-2}\ \text{J}) + U_{spring}$$
$$\Rightarrow U = 1.57\text{x}10^{-2}\ \text{J}$$