1. A mass $m$ at the end of a spring vibrates with a frequency of 0.88 Hz. When an additional 600 g mass is added to $m$, the frequency is 0.60 Hz. What is the value of $m$?

$$\omega = \sqrt{\frac{k}{m}} \rightarrow f = \frac{1}{2\pi} \sqrt{\frac{k}{m}}$$

$$\frac{f_2}{f_1} = \sqrt{\frac{m_2}{m_1}} \rightarrow \frac{(0.6 \text{ Hz})}{(0.88 \text{ Hz})} = \sqrt{\frac{m}{m+0.600 \text{ kg}}}$$

$$\rightarrow m = 0.52 \text{ kg}.$$ 

2. It takes a force of 80.0 N to compress the spring of a popgun 0.20 m to load a 0.15 kg ball. With what speed will the ball leave the gun?

$$k = \frac{F}{\Delta x} = \frac{80.0 \text{ N}}{0.20 \text{ m}} = 400 \text{ N/m}$$

The ball will leave at the equilibrium position, where the kinetic energy is maximum. The maximum potential energy equals the maximum kinetic energy, therefore we have:

$$KE_{\text{Max}} = \frac{1}{2} m v_0^2 = PE_{\text{Max}} = \frac{1}{2} k A^2;$$

$$\frac{1}{2} (0.150 \text{ kg}) v_0^2 = \frac{1}{2} (400 \text{ N/m})(0.20 \text{ m})^2$$

$$\rightarrow v_0 = 10.3 \text{ m/s}.$$

3. A 0.5 kg mass vibrates according to the equation $x=0.45\cos(8.4t)$, where $x$ is in meters and $t$ is in seconds. Determine

a) the amplitude $A = 0.45 \text{ m}$

b) the frequency $2\pi f = 8.4 \text{ s}^{-1} \rightarrow f = 1.34 \text{ Hz}$

c) total energy $v_0 = \omega A = (8.4 \text{ s}^{-1})(0.45 \text{ m}) = 3.78 \text{ m/s}$

$$E = KE_{\text{Max}} = \frac{1}{2} m v_0^2 = \frac{1}{2} (0.5 \text{ kg})(3.78 \text{ m/s})^2 = 3.6 \text{ J}.$$ 

d) potential energy when $x=0.3 \text{ m}.$

$$PE = \frac{1}{2} k x^2 = \frac{1}{2} (m \omega^2) x^2 = \frac{1}{2} (0.5 \text{ kg})(8.4 \text{ s}^{-1})^2(0.3 \text{ m})^2 = 1.6 \text{ J}.$$