$$T_p = 2\pi\sqrt{\frac{l}{g}} \qquad T_{SHO} = 2\pi\sqrt{\frac{m}{K}} \qquad F = Kx \qquad T = \frac{1}{f} \qquad f = \frac{1}{T}$$

Harmonic Motion Problems:

1. What is the period of a pendulum with a length of 1.8m?

$T = 2\pi\sqrt{l/g} = 2\pi\sqrt{\frac{1.8}{9.8}} = 2.69$ sec

2. A student sets up a pendulum in the classroom with a period of 1.0 seconds and wants to use it as a timer. What length is required in order to obtain the period of 1 second?

$T = 2\pi\sqrt{l/g}$ $\quad \left(\frac{1}{2\pi}\right)^2 = l/9.8$ $\quad l = 9.8(.0253)$

$1 = 2\pi\sqrt{l/9.8}$ $\quad 0.0253 = l/9.8$ $\quad l = 0.248$ m

3. What would the period be if the student takes the pendulum to the moon where the gravitational constant is approximately 1/6 of the earth's gravitational constant?

$T = 2\pi\sqrt{l/g}$ $\quad g = 9.8/6 =$ $\quad g = 1.63$ $\quad T = 2\pi\sqrt{\frac{.248}{1.63}} = 2.4$ sec

4. By what factor must you increase the length of the string of a pendulum in order to double the period?

$T \approx \sqrt{l/g}$ $\quad$ T increases 2x

$l \uparrow 4x$

5. A student sets up a simple harmonic oscillator (SHO) with a mass of 0.25 kg and a spring constant of 65 N/m. What is the period of this oscillator?

$T = 2\pi\sqrt{m/k} = 2\pi\sqrt{.25/65} = 0.39$ sec

What is the frequency?

$f = 1/T = 1/0.39 = 2.6$ Hz

6. What force is required to displace a spring with a spring constant "k" of 98 N/m by 0.28m?

$F = kx = 98(.28) = 27.4$ N

7. A spring is displaced 15 cm by a force of 12.8 N, what is the spring constant "k"?

$F = kx$ $\quad 12.8 = k(.15)$ $\quad k = \frac{12.8}{0.15} = 85.3$ N/m

Bonus: A student displaces a SHO by a distance of 25 cm with a force of 18N. The mass of the oscillator is 1.5 kg. What is the oscillator's frequency of vibration?

$k = \frac{F}{x} = \frac{18}{.25} = 72$ N/m $\quad f = \frac{1}{T} = \frac{1}{.907} = 1.1$ Hz

$T = 2\pi\sqrt{m/k} = 2\pi\sqrt{\frac{1.5}{72}} = 0.907$