DLI Physics Problem Set 2: Smurfy Oscillations

Name_____

October 13, 2017

Due Tuesday 10 October

1. The motion of a Smurf$^{\text{TM}}$' is described by the following function of time

$$x(t) = (0.30\text{m}) \cos\left(\frac{\pi}{3}t\right)$$

Find

(a) the position of the Smurf$^{\text{TM}}$' at t=0 and t=0.60 s,

(b) the amplitude of the motion,

(c) the period of the motion,

(d) the angular frequency,

(e) the frequency.

(f) If the Smurf is located at x=0, how much time will pass before the Smurf is located at x=0 again? From the time when x=0, how much time will pass before the Smurf is 0.30 meters from the origin?

(g) Use python to plot the motion of this Smurf

2. Gargamel hangs a Smurf$^{\text{TM}}$ of mass 100g from a spring and set in oscillatory motion. At $t = 0$ the displacement is 43.785 cm and the acceleration is -1.7514 cm/s^2.

   (a) What is the spring constant?

   (b) What is the Smurf$^{\text{TM}}$'s angular frequency of oscillation?

3. The top surface of a mushroom is executing simple harmonic motion in a vertical direction with an amplitude of 5 cm and a frequency of $30/\pi$ cycles per second. Smurfette$^{\text{TM}}$ climbs on the mushroom cap at the lowest point of its path.

   (a) At what point (height) will Smurfette$^{\text{TM}}$ leave the platform? (Hint: What would Smurfette's$^{\text{TM}}$ acceleration be if she were freely falling? If the platform accelerates downward faster than this, she will leave contact with the surface.

   (b) How far will she rise above the highest point reached by the mushroom cap's surface?

4. Use a Python program to plot the position, velocity, and acceleration of your mass-spring system from last Friday. In general this should be damped motion. Use Python, with help from Dr. S, to figure out the the spring constant and the damping coefficient for this motion.

   This motion is approximately described by this force relationship:

$$F(x, v) = -kx - bv \tag{1}$$