Trigonometry

Simple Harmonic Motion
(Independent Learning Project 1)

Due: Monday October 12th at 12:30 pm

Instructions:
1. This assignment is ultimately an independent activity; however, if you wish to discuss the problems with peers or tutors, that is acceptable. All of the final answers (including any work) should be completed individually. DO NOT COPY!

2. The questions below are to be answered in as much detail as possible. Put your answers on a DIFFERENT sheet of paper than this one. Typed (or at least well organized) solutions are much preferred to sloppy garbage 😊

3. The point of this assignment is for you to discover and learn about an application of trig functions known as Simple Harmonic Motion. There are two main ways for you to learn this material:
   a. You can read about this topic in the Ebook in MyMathLab (Section 8.5, p541-543),
   b. You can watch my video lecture at: https://www.youtube.com/watch?v=cheOim_qQdY (skip to 31:50).
In addition, Kahn academy, Youtube, Google… all of these websites will give you plenty of information on the topic if you search “simple harmonic motion and trigonometry.”

Questions:
1. Describe in conversational terms (no math) what it means for an object to be in simple harmonic motion.

2. An object in simple harmonic motion must obey one of the two equations: $d = A \sin \omega t$ or $d = A \cos \omega t$.
   a. What are the variables in these equations? What do they represent?
   b. What are the constants in these equations? What do they represent, more specifically, what do they tell you about the motion of the object?
   c. When would you use the equation $d = A \sin \omega t$ and when would you use $d = A \cos \omega t$?

3. An object is oscillating up and down, in simple harmonic motion.
   a. If the period ($T$) of motion is 12 seconds, what does that mean?
   b. If the frequency ($f$) of motion is 12 cycles/sec, what does that mean?
   c. If the object oscillates at a frequency of 5 cycles/sec, what is the period of the motion?
   d. In general, what is the relationship between period ($T$) and frequency ($f$)?

4. List three examples of simple harmonic motion.

5. An object in simple harmonic motion obeys the equation $d = -3 \sin \frac{\pi}{2} t$
   a. What is the maximum displacement of the object from its rest position?
   b. What is the time required for the object to complete one cycle?
   c. What is the frequency?
   d. Sketch two cycles of the object’s motion, starting at $t = 0$.

6. You have a mass hanging at rest on a spring. You pull the mass down 5 inches, hold it there, and at time $t = 0$ let go. You time the oscillation and record that the mass completes 3 cycles every 7 seconds. Find an equation for the simple harmonic motion of the mass.

7. The A4 note is the A note just above middle C. The frequency of an A4 note is 440 Hz (cycles per second).
   a. You play an A4 note on a guitar. The force from your pluck displaces the guitar string by 0.1 cm. Write an equation for the simple harmonic motion of the string. (Assume the string starts from rest and moves downward first.)
   b. You play the same note, but this time the force from your pluck displaces the string by 0.2 cm. Write an equation of simple harmonic motion of the string. (Again, assume the string starts from rest and moves downward first.)
   c. The pitch of the sound heard in part a will be the same as the pitch heard in part b because the frequency of the string is the same. However, the two sounds produced will be different. What is the difference between the sound heard in part a and the sound heard in part b?