College Bound Math Problem Set #2
for the week of October 13, 2014

Find and do one or two problems at the right level for you.

Problems #1 and #2 are designed to show the usefulness of having a good system of notation for very large and very small numbers. They follow up on last week's problem #1, which asked you to translate phrases like "ten thousand" into ordinary numbers (10,000) and exponential form (10^4). Please review that topic with your mentor if necessary. Do as many as you can. If you find #1 easy, do #2 as well.

1. **Extreme numbers, real uses:** Express each of these numbers in words, referring, as needed, to http://en.wikipedia.org/wiki/Names_of_large_numbers. For example,

   - dollars in the 2013 US GDP: 1.68×10^{13} = 16.8 trillion or sixteen trillion eight hundred billion
   - 1-meter steps to finish a 10K race: 10^4 _____
   - human beings on Earth in Sept., 2014: 7.2×10^9 _____
   - neuronal connections in a human brain: 10^{14} _____
   - meters across an atomic nucleus: 10^{-14} _____
   - meters across an atom: 10^{-10} _____

2. **Wave motion:** Sound, light and ripples on the surface of a liquid are all forms of wave motion. You can actually see a water wave by putting some water in a large, plain plate and tapping the water's edge. Three key aspects of a wave are: the *speed* at which the crests (high points) move along; the *frequency*, or how many crests pass an observation point per unit of time; and the *wavelength*, that is, the distance from crest to crest. These are related by the simple formula

$$speed = frequency \times wavelength.$$

   The speed of light is about 3x10^8 meters per second. The wavelength of a yellow light ray is about 600 nanometers. A nanometer is a billionth of a meter

   (a) Express the *wavelength* in meters, so all units are in meters and seconds.
   (b) Find the *frequency*, that is the number of wave crests per second.
   (c) (Optional) Look up the unit known as the "hertz."
   (d) (Optional) Find the speed of light in miles per second.

3. Find the area of a square inscribed in a circle of radius r as shown. *Hint*: Draw one or both diagonals of the square, breaking it into triangles. Find the areas of the triangles using $A = \frac{1}{2}bh$. The base of a triangle does not have to be horizontal. Add up the areas of the pieces of the square to find the whole area.