Solutions & Comments for Mentors, #2
week of October 13, 2014

1.

10^4	**<u>ten thousand</u>**	10^{-14}	**<u>one hundred-trillion*th*</u>**
7.2×10^9	**<u>7 billion 200 million</u>**	10^{-10}	**<u>one ten-billionth</u>**
10^{14}	**<u>one hundred trillion</u>**		

Powers and *prefixes* (**m**onopoly, **bi**cycle, **tri**ple, **quadr**angle, **quint**et, …) are the keys to these number names. The crucial role is played by powers of one thousand, but remember to *subtract 1*.

1000^1 = 1,000 = one thousand
1000^2 = 1,000,000 = one **m**llion
1000^3 = 1,000,000,000 = one **bi**llion
1000^4 = 1,000,000,000,000 = one **tri**llion
1000^5 = 1,000,000,000,000,000 = one **quadr**illion

2. (a) $600 nanometers = 6\times10^2\times10^{-9} meters = 6\times10^{-7} meters$

(b) $frequency = \dfrac{speed}{wavelength} = \dfrac{3\times10^8}{6\times10^{-7}} = \dfrac{30\times10^7}{6\times10^{-7}} = 5\times10^{14}/\text{sec}$

(d) One can (i) web-search for the "speed of light" (in) "miles per second" or (ii) web-search for "conversion" of "speed units" (and use a converter on the speed that's provided in the problem), or (iii) use only what we know ... if "we" know the handy fact that a kilometer is about 62% of a mile. Thus, $3\times10^8 m/\text{sec} =$

$$3\times10^5 km/\text{sec} \approx (0.62)\times3\times10^5 mi/\text{sec} = 1.86\times10^5 mi/\text{sec} = 186{,}000 mi/\text{sec}.$$

3. Draw the line segment $\overline{BD}$ and consider it to be the *base* of the triangle ΔBDA. If your student likes bases to be horizontal, just rotate the figure... or tilt your heads to the left! Since B and D are opposite corners of a square, $\overline{BD}$ goes through the center, O, so it's a diameter*. Its length is therefore $2r$.

The *height* of any triangle is measured in a direction perpendicular to its base. The radius $\overline{OA}$ meets that requirement* and, since it's a radius, its length is r.

The area of any triangle is half its base times its height. In the case of ΔBDA, that's $\frac{1}{2}(2r)(r) = r^2$. Since *two* such triangles make up the square, its area is $2r^2$.

* The two starred claims in #3 can be proved using the definition of a square, but I wouldn't recommend going into proofs. They're both visually plausible and if your student raises the issue, they can be argued on symmetry grounds. For example: If not through the center, on *which side* of the center would the line go?! Looking at the figure in a mirror - or drawing it on a glass plate that we then flip - we get the same figure but with the line passing on the *other side* of the center, an outcome that contradicts the assumption that the line could possibly miss the center!