Dimensional Analysis – Answer Key

1. A standard incandescent light bulb has power rating of 60W (watts). If you left this bulb on for 8 hours per day, 7 days per week, all year, how much energy would it consume? [1000W = 1 kW and what we call our "power bill" is actually an **energy** bill in that they charge us by the kWhr].

Recall: Joules are a unit of energy. How fast energy is consumed is power. Watt is the unit of power. As an equation: $\left(\frac{J}{s}\right) = (W)$, so another way to express energy is to multiply both sides by a unit of time, so that $\left(\frac{s}{1}\right)\left(\frac{J}{s}\right) = \left(\frac{W}{1}\right)\left(\frac{s}{1}\right) = Ws$ and by simply changing the scale of power and time this can be expressed as **kWhr**, a unit of energy.

$$\left(\frac{60W}{1}\right)\left(\frac{8hr}{day}\right)\left(\frac{365days}{year}\right)\left(\frac{1kW}{1000W}\right) =$$

$$\left(\frac{60\cancel{W}}{1}\right)\left(\frac{8hr}{\cancel{day}}\right)\left(\frac{365\cancel{days}}{year}\right)\left(\frac{1kW}{1000\cancel{W}}\right) = \left(\frac{175.2kWhr}{year}\right)$$

2. Electricity, as of July 2014, costs an average of $0.108 (10.8cents) per kWhr in Oregon. How much does it cost annually to keep this light bulb turned on as described in question 1?

$$\left(\frac{175.2kWhr}{year}\right)\left(\frac{\$0.108}{kWhr}\right) =$$

$$\left(\frac{175.2\cancel{kWhr}}{year}\right)\left(\frac{\$0.108}{\cancel{kWhr}}\right) = \$18.92/year$$

3. If you switched that bulb (Q#1) from a standard incandescent bulb to a compact florescent (CFL) you could get a comparable output of light with only 13W of power. How much energy would you save in a year? How much money would you save in one year?

$$\left(\frac{13W}{1}\right)\left(\frac{8hr}{day}\right)\left(\frac{365days}{year}\right)\left(\frac{1kW}{1000W}\right) =$$

$$\left(\frac{13\cancel{W}}{1}\right)\left(\frac{8hr}{\cancel{day}}\right)\left(\frac{365\cancel{days}}{year}\right)\left(\frac{1kW}{1000\cancel{W}}\right) = \left(\frac{37.96kWhr}{year}\right)$$

or…….

$\left(\frac{13W}{60W}\right) = .216$ meaning that the CFL uses 21.6% of the power that the standard bulb uses, so

$$(.21)\left(\frac{175.2kWhr}{year}\right) = 37.95kWhr/yr$$

But that is just the energy <u>consumption</u> of the CFL bulb. The actual **savings** is the difference between these. Always make sure to answer the questions that was asked!!!!

So… $\left(\frac{175.2kWhr}{year}\right) - \left(\frac{37.95kWhr}{year}\right) = \frac{137.25kWhr}{year}$ in **energy savings!!!**

And…100% - 21% = 79% in savings, applied to the monetary expense would look like this:

$\left(\frac{\$18.92}{year}\right)(.79) = \left(\frac{\$14.95}{year}\right)$ in **monetary savings!!!**

4. According to the US Census there were ≈ 1.5M households in Oregon in 2012. Assuming that still holds true, if each household switched the bulbs in three standard lamps to CFL's, how much energy would be saved in Oregon alone?

$$\left(\frac{37.95kWhr}{year/\cancel{bulb}}\right)\left(\frac{3\ \cancel{bulbs}}{household}\right) = \left(\frac{113.8kwr}{household}\right)$$

$$\left(\frac{113.8kwr}{\cancel{household}}\right)\left(\frac{1.5x10^6\ \cancel{households}}{1}\right) = 1.7\ x\ 10^8 kWhr$$