Math Review

Basics

Metric Conversions: Set up your train tracks in order to convert the following problems from one unit to another.

1. 10 cm=_____MM
2. 6 mm = _____ km
3. 1.5 km=_____mm
4. 8 watts=_____ MW
5. 5.4 mm=_____ cm

Scientific Notation: Show all your work. Convert the numbers or multiply/divide using scientific notation

6. One billion=_____
7. Twenty three thousand=_____
8. .0000676=_____
9. Five hundred billion times thirty five thousand=_____
10. 300 billion divided by 6 thousand=_____

Percentages

11. An area of forest is 6000 acres. 45% of the area will be developed. How many acres will be preserved as forest area?
12. A natural gas power plant is 60% efficient. If one cubic meter of natural gas provides 1000 BTUs of usable electricity, how many BTU's of waste heat were produced?
13. If the concentration of mercury in a water supply changes from 70 ppm to 42 ppm in a ten-year period, what is the % change?
14. What is the % change if a the concentration of carbon dioxide increases from 14 ppm to 63 ppm?

Other

15. How many seconds are in 3 years?_____
16. If oil use in the US is 22 barrels per capita, how much oil is used in the United States?_____
17. How much oil would be used applying that same figure to per capita global use? _____

Dimensional Analysis and conversions

Dimensional analysis is simply a fancy name for converting units.

Whenever we measure something, we measure it with units. For example,

15 in (length) 50.0 mL (volume) 1105 mm Hg (pressure)

Often, more than one unit system will be available. Length, for example, can be measured in inches or in centimeters. There will be problems where you have to convert units. You will either be given the conversion (inches to cm) or will be expected to know it (conversions within the metric system-m to km). When doing a conversion, you must show all your work and use "train tracks".

Example: Converting inches to cm. Your conversion factor is 1 inch = 2.54 cm.

How many cm are there in 4.5 inches? To solve this, begin with what you are given (4.5 inches). Set up your "train tracks" and use your conversion. You should line up your units so they cancel each other out and you are left with the unit you are looking for (in this case, cm):

$$\frac{4.5\ \cancel{in} \mid 2.54\ cm}{\mid 1\ \cancel{in}} = 11.43\ cm$$

In this example, the unit of inches cancels out and you are left with cm. You can add steps to your train tracks easily. For example, if you are given a problem to convert feet into cm, you can use the same conversion factor.

Ex: How many cm are there in 3 feet?

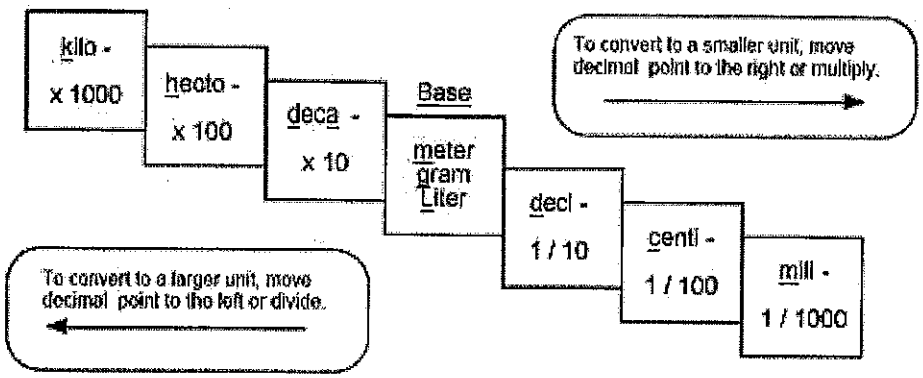
$$\frac{3\ \cancel{ft} \mid 12\ \cancel{in} \mid 2.54\ cm}{\mid 1\ \cancel{ft} \mid 1\ \cancel{in}} = 91.44\ cm$$

Your conversion factors can be placed in any order and can swap places (numerator for denominator) depending on how you can cancel out your units. For example, if you are going from cm to inches:

$$\frac{11.43\ \cancel{cm} \mid 1\ in}{\mid 2.54\ \cancel{cm}} = 4.5\ in$$

The key things to remember are:

1. Start with the value you are given and put that in the first slot on your tracks
2. Create a list of your conversion factors
3. Be sure to include all your units in your work
4. Cancel your units as you go-this will help you decide which conversion factor to use and which number goes on the top of the tracks and which goes on the bottom.
5. Check yourself-did you end up with the unit that you wanted to?
6. Use scientific notation when you can!
7. Review your metric conversions-you will be expected to know what the prefixes mean (ex: 1000 m=1 km)



Dimensional Analysis Worksheet

1. 261 g → kg

2. 3 days → seconds

3. 9,474 mm → cm

4. 1 year → minutes

5. 175 lbs → kg
   (Note: 2.2 lb = 1 kg)

6. 4.65 km → m

7. 22.4 kg/L to kg/mL

8. 25 m/s to miles/hr

9. How many cm are there in 6 feet? (1 inch=2.54 cm)

10. Traveling at 65 miles/hour, how many feet can you travel in 22 minutes? (1 mile = 5280 feet)

Energy and Power for APES

The Basics:
The basic unit of energy is the joule (J).

- 1000 J = 1 kJ
- Other units of energy include:
  - 1 calorie (cal) = 4.184 J
  - 1 BTU = 1.05 kJ
  - 1 therm = 100,000 BTU

Power is the rate at which energy is used.

- Formula: P = E/t (where P = power, E = energy, and t = time)
- The unit for power is the watt.
  - 1 W = 1 J/s (1 watt = 1 joule per second)
- Therefore a 100 watt light bulb uses 100 J/s of electrical energy. If it is 20% efficient, then the bulb converts 20% of the electrical energy into light and 80% is lost as waste heat.
- Notice that in the above example we can see the operation of both the First and Second Laws of Thermodynamics. The First Law says that energy can be converted from one form to another but none is lost. We have accounted for all of the energy, but most of the electrical energy (high quality) was converted to low quality energy (heat). Therefore, we also see the Second Law, which states that in any energy conversion some energy is converted into lower quality energy (usually heat) and is unable to perform useful work.

Knowing the relationship between energy and power allows us to find the energy used when an appliance of known power (in watts) operates for a known amount of time (in seconds).

- Example: How much energy (in kJ) does a 75 watt light bulb use when it is turned on for 25 minutes?
- Equation: E = P x t (rearranging P = E/t)
- Solution: E = 75 J/s x 60s/min x 25 min = 110,000 J or 110 kJ

If the wattage is not given, then some information about the current can usually be found. To find the power (in watts) of any electrical appliance in your home that does not give the wattage, use the equation P = V x I, where V is the voltage, and I is the current in amps (A). American household voltage is 100 V (AC, electrical stoves and driers are 220 V).

The Kilowatt Hour (or kwh) is not a unit of power but a unit of energy. Notice that kilowatt is a unit of power and hour is a unit of time. Therefore, E = P x t. A kilowatt-hour is equal to 1 kw (or 1000 watts) delivered continuously for one hour (3600 seconds).

- 1 kwh = 1000 J/s x 3600 s = 3,600,000 J or 3600 kJ

The Problems:

1. Dr. Nick's Nov-Dec power bill shows that his home used 1355 kwh over a 30 day period.

   (a) Find the energy used (in kJ) for the 30-day period.

   (b) Find the energy used in J/day.

   (c) At the rate of $.0749/kwh, what is Dr. Nick's power bill (w/out tax)?

2. The current through a toaster (110 V) is 8 A.

   (a) What is the power (in watts) of the toaster?

   (b) How much energy (in J) will the toaster use in 5 minutes of operation?

3. A 100 watt light bulb is 20% efficient.

   (a) How much energy does it use in 12 hours of operation?

   (b) How much energy does the bulb convert into light over the 12-hour period?

   (c) How much energy does the bulb convert into heat over the 12-hour period?

   (d) Convert the total energy use into kwh.

4. An electric clothes dryer has a power rating of 4000 W. Assume that a family does 5 loads of laundry each week for 4 weeks. Further assume that each load takes 1 hour.

   (a) Find the energy used in both J and kwh.

   (b) If the cost of electricity is $.0758/kwh, find the cost of operating the dryer for 1 month.

5. Dr. Nick's natural gas bill states that his household used 110 therms of energy for a 30-day period.

   (a) Convert 110 therms to kwh.

   (b) His charge for the energy was $88.78. Find the cost of this natural gas in $/kwh.