

Name: _____
A.P. Environmental Science

Date _____
Mr. Romano

Dimensional Analysis
(a.k.a. the Factor-Label Method a.k.a. the Unit Cancellation Method)
(calculator-free math!)

Temporarily, we are going to take an aside and work on some problem solving that will not (at first) seem like it falls in the realms of environmental science. We need to do a little math. Actually, we need to do a lot of math. Free response questions on the AP are notorious for making you do mathematical conversions in the context of environmental science. Maybe you may have to figure out the gas efficiency of your car, the gas usage in your weekly commute, or even your possible savings for trading in your gas-guzzler for a more fuel-efficient model. You could possibly have to compare the cost difference of heating a home using oil or natural gas. Maybe you might have to calculate number of BTU's of heat needed to generate the electricity produced by a coal-fired power plant. The possibilities are almost endless... So how are you going to accomplish such tasks? Think of yourself, sans calculator, trying to figure out the problem first, and then you'll have to deal with the actual math. For some people, this is rote and approached without fear. Some of you are going to tell me you have your own way of doing things, but for now I ask that you do it the organized way I'm about to show you. For others, this will be a more difficult task and a lot of focused effort will have to be exerted to understand the process. Now I'm not going to assume it has occurred, but I have to tell you that you should already have the acquired knowledge of basic addition, subtraction, multiplication, & division, **and** converting to and from scientific notation, **and** metric prefix conversions, **and** (believe it or not, you should have learned in chemistry and/or physics) the factor-label method that I am about to review with you (or possibly teach to you for the first time).

Be open-minded. Be attentive. Be organized. And if you just hate doing math caveman-style... um... pray?

Example 1:

Convert 1 day into minutes. Be sure to show all labels and numbers in your work.

Example 2:

Convert 10 gallons of water into pounds of water.

Given: 1 gallon of water = 8 pounds of water

Example 3:

Convert one year into minutes. Be sure to show all labels and numbers in your work. (no quick use of song lyrics allowed!)

Example 4:

Convert 2 days into seconds. Be sure to show all labels and numbers in your work.

Example 5:

Convert 0.500 kWh into BTUs (British Thermal Units).

Given: 3,400 BTU's = 1 kWh

Example 6:

Convert 2,000 ft³ of natural gas into dollars (\$)

Given: Natural gas is available at a cost of \$5.00 per 1000 ft³

Example 7:

Determine the average fuel consumption in gallons (per year) of the average American car given the following:

Given: The average car is driven 10,000 miles per year. The mileage rate for the average car is 25 miles per gallon of gasoline.

Example 8:

The new kid in school has been heard bragging that he can bench press 145,000 grams.

If 1kg = 2.2 pounds, should you be impressed? Convert to pounds to find out.

Example 9:

Determine the amount of BTU's needed to heat 1,000 square feet of space in a home.

Given: 80,000 BTUs of heat are needed to heat one square foot

Example 10:

You find 1×10^3 pennies in the cushions of your couch. If each penny weighs 4 grams, how much did all that loot weigh in lbs.? (2.2 lbs = 1 Kilogram)

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Sample AP Problem: The Dishwasher!

The environmental impact of washing a load of dirty dishes in an electric dishwasher differs from that of washing them in a sink by hand. A comparison of the two methods may allow consumers to spend their money more wisely. Use the assumptions in the table below to perform the calculations that follow.

| |
|---|
| All the dishes fit into a single load. |
| The water entering both the water heater and the sink is at 50 °F. |
| The water heater and the dishwasher are both 100% efficient. |
| Washing the dishes by hand requires 20 gallons of water heated to 110 °F. |
| In one complete cycle, the electric dishwasher uses 10 gallons of water heated to 140 °F and the dishwasher also uses 0.500 kilowatt-hour of electrical energy for its mechanical operations. |

(a) Calculate the total energy, in BTUs, used to wash a load of dishes using the dishwasher.

Other important information:

1 British thermal unit (BTU) the amount of energy needed to raise the temperature of one pound of water 1.0 °F.

1 gallon of water = 8.0 pounds of water.

1 kilowatt-hour = 3400BTU

(b) Calculate the energy in BTUs used to heat the water for washing a load of dishes by hand.