

# Dimensional Analysis Guide

Dimensional Analysis is a very powerful tool for problem solving. It will help you with unit conversion and later on in Stoichiometry. You should practice hard to become very proficient at this tool. If it seems difficult at first just be patience and keep practicing.

These are some of the common terms used in Dimensional Analysis

**Conversion Factor:** Most conversion factors will be given, or can be found in tables. Conversion factors are fractions whose numerator and denominator are the same quantity expressed in different units. For example: 1 hr = 60 min in order for this to become a conversion factor we must turn it into a fraction:

$$\frac{1 \text{ hr}}{60 \text{ min}} \quad \text{and} \quad \frac{60 \text{ min}}{1 \text{ hr}}$$

**Desired Unit:** These are the units you are looking for. At the end of your operations all other units should cancel out and the desired units will remain.

**Given Units:** These are the units given to you in a conversion factor or in the problem statement. Usually the given units cancel out but they are necessary to reach the desired units.

## Steps for setting up a Dimensional Analysis problem.

1. Read the problem thoroughly. Make sure you KNOW what you need to find
2. Identify the desired units and the given units
3. Locate the conversion factors necessary to solve the problem.
4. Use the conversion factors or given units to set up fractions which will cancel out undesired units and result in desired units only (These must be on their correct place)
5. Multiply all numerators and denominators and then divide them to find the result.

**Example:** If a woman has a mass 135 lbs, what is her mass in grams?

Let's follow the steps one by one.

1. Find the mass in GRAMS
2. Desired unit: Grams Given unit: Pounds
3. From any conversion table we can find that 1 lb = 453.6 g.
4.  $\frac{453.6 \text{ g}}{1 \text{ lb}} \times 135 \text{ lb}$

- Since the “lb” cancel out we are left with grams (g). Since this is the desired unit we can multiply to obtain the answer;

$$\text{Mass in grams} = \frac{453.6 \text{ g}}{1 \text{ lb}} \times 135 \text{ lb} = 61236 \text{ g} \quad \text{or} \quad 6.21 \times 10^4 \text{ g}$$

**Example 2:** What is the mass in grams of 1.00 gal of water? The density of water is 1.00 grams/milliliters.

- We are trying to find mass in GRAMS
- Desired unit: Grams Given unit: Gallons
- The density of water is given, but we also need a factor converting Gallons to milliliters or Gallons to quarts and then quarts to Liters. From a conversion table we find: 1 L = 1000 mL; 1 L = 1.057 qt; 1 gal = 4 qt.

$$4. \text{ Mass in grams} = \frac{1.00 \text{ g } H_2O}{1 \text{ mL } H_2O} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{1 \text{ L}}{1.057 \text{ qt}} \times \frac{4 \text{ qt}}{1 \text{ gal}} \times 1 \text{ gal}$$

$$5. \text{ Mass in grams} = 3.78 \times 10^3 \text{ g } H_2O$$

Practice Problems:

- Perform the following conversions: (a) 0.076 L to mL; (b)  $5.0 \times 10^{-8}$  m to nm; (c)  $6.88 \times 10^5$  ns to s; (d)  $1.55 \text{ kg/m}^3$  to g/L
- Perform the following conversions: (a) 8.60 mi to m; (b) 3.00 days to s; (c) \$1.55/gal to dollars per liter; (d) 5.0 pm/ms to m/s; (e)  $1.55 \text{ kg/m}^3$  to g/L
- The recommended adult dose of Elixophyllin<sup>®</sup>, a drug to treat asthma, is 6 mg/kg of body mass. Calculate the dose in milligrams for a 150-lb person
- A pound of coffee beans yields 50 cups of coffee (4 cups = 1 qt). How many milliliters of coffee can be obtained from 1 g of coffee beans?
- The concentration of carbon monoxide in an urban apartment is  $48 \mu\text{g/m}^3$ . What mass of carbon monoxide in grams is present in a room measuring 8 x 12 x 22 ft?
- The distance from earth to the Moon is approximately 240,000 mi. (a) What is the distance in meters? (b) The *Concorde* SST has an air speed of about 2400 km/hr. If the *Concorde* could fly to the Moon, how many seconds would it take?
- 1000 kg of a certain gold ore contains 10 g. of pure gold. Gold is worth \$400/ounce. How much ore must be mined to obtain gold worth 1 million dollars [28.35 g = 1 ounce]
- You are organizing a party. You want to serve pizza and beer. You estimate that each person will eat 4 slices of pizza and drink 3 beers. Papa John’s pizzas are \$10 a pie which contains 8 slices per pie. Your favorite beer only comes in cases of 24 which cost \$14 per case. If you want to invite 30 people to your party, how much money do you need?