

Most calculations in chemistry require that all measurements of the same quantity (mass, length, volume, temperature, and so on) be expressed in the same unit. To change the units of a quantity, you can multiply the quantity by a conversion factor. With SI units, such conversions are easy because units of the same quantity are related by multiples of 10, 100, 1000, or 1 million. Suppose you want to convert a given amount in milliliters to liters. You can use the relationship $1 \text{ L} = 1000 \text{ mL}$. From this relationship, you can derive the following conversion factors.

$$\frac{1000 \text{ mL}}{1 \text{ L}} \text{ and } \frac{1 \text{ L}}{1000 \text{ mL}}$$

The correct strategy is to multiply the given amount (in mL) by the conversion factor that allows milliliter units to cancel out and liter units to remain. Using the second conversion factor will give you the units you want.

These conversion factors are based on an exact definition ($1000 \text{ mL} = 1 \text{ L}$ exactly), so significant figures do not apply to these factors. The number of significant figures in a converted measurement depends on the certainty of the measurement you start with.

Sample Problem

A sample of aluminum has a mass of 0.087 g. What is the sample's mass in milligrams?

Based on SI prefixes, you know that $1 \text{ g} = 1000 \text{ mg}$. Therefore, the possible conversion factors are

$$\frac{1000 \text{ mg}}{1 \text{ g}} \text{ and } \frac{1 \text{ g}}{1000 \text{ mg}}$$

The first conversion factor cancels grams, leaving milligrams.

$$0.087 \text{ g} \times \frac{1000 \text{ mg}}{1 \text{ g}} = 87 \text{ mg}$$

Notice that the values 0.087 g and 87 mg each have two significant figures.

A sample of a mineral has $4.08 \times 10^{-5} \text{ mol}$ of vanadium per kilogram of mass. How many micromoles of vanadium per kilogram does the mineral contain?

The prefix *micro-* specifies $\frac{1}{1,000,000}$ or 1×10^{-6} of the base unit. So, $1 \text{ } \mu\text{mol} = 1 \times 10^{-6} \text{ mol}$. The possible conversion factors are

$$\frac{1 \text{ } \mu\text{mol}}{1 \times 10^{-6} \text{ mol}} \text{ and } \frac{1 \times 10^{-6} \text{ mol}}{1 \text{ } \mu\text{mol}}$$

The first conversion factor will allow moles to cancel and micromoles to remain.

$$4.08 \times 10^{-5} \text{ mol} \times \frac{1 \text{ } \mu\text{mol}}{1 \times 10^{-6} \text{ mol}} = 40.8 \text{ } \mu\text{mol}$$

Notice that the values $4.08 \times 10^{-5} \text{ mol}$ and $40.8 \text{ } \mu\text{mol}$ each have three significant figures.

Practice

- Express each of the following measurements in the units indicated.
 - 2250 mg in grams
 - 59.3 kL in liters
- Use scientific notation to express each of the following measurements in the units indicated.
 - 0.000 072 g in micrograms
 - $3.98 \times 10^6 \text{ m}$ in kilometers