

Chemistry Lecture #5: Dimensional Analysis

Dimensional Analysis (sometimes called the Factor-Label Method) is a way to convert one unit of measurement into another unit of measurement. For example, let's convert 72 cm into meters. We know that $100 \text{ cm} = 1 \text{ m}$. Keep this equality in the back of your mind - we'll use this little fact later.

If you multiply a measurement by one, you get the same measurement.

$$72 \text{ cm} \times 1 = \text{same measurement.}$$

If you divide 72 cm by "1", you still get the same measurement.

$$\frac{72 \text{ cm}}{1} \times 1 = \text{same measurement}$$

If, instead of multiplying by "1" you multiply by a fraction equal to "1," you get the same measurement. $3/3 = 1$, so you're still multiplying by "1."

$$\frac{72 \text{ cm}}{1} \times \frac{3}{3} = \text{same measurement}$$

Any fraction where the object on top is the same as the object on the bottom will be equal to "1." Thus, $3/3 = 1$, $R/R = 1$, and $\$/\$ = 1$.

$$\frac{72 \text{ cm}}{1} \times \frac{\cancel{\$}}{\cancel{\$}} = \text{Same measurement}$$

Since $100 \text{ cm} = 1 \text{ m}$, the fraction $(1 \text{ m}/100 \text{ cm}) = 1$. 1 m and 100 cm are the same thing, so if we multiply 72 cm by $(1 \text{ m}/100 \text{ cm})$, we've multiplied it by "1."

$$\frac{72 \text{ cm}}{1} \times \frac{1 \text{ m}}{100 \text{ cm}} = \text{Same measurement}$$

We can then cancel the cm on the top and bottom of the fractions, leaving our answer in meters (m).

$$\frac{72 \text{ cm}}{1} \times \frac{1 \text{ m}}{100 \cancel{\text{cm}}} = \frac{72 \text{ m}}{100} = \boxed{0.72 \text{ m}}$$

Steps for converting measurements.

1. Write the equality you need to use.
2. Write the measurement you want to convert as a fraction.
3. Write the equality as a fraction with the units you want to cancel at the appropriate location (either top or bottom).
4. Cancel units on the top and bottom. Multiply and divide the numbers.

Convert 2.5 days to hours. $1 \text{ d} = 24 \text{ h}$

$$\frac{2.5 \cancel{\text{d}}}{1} \times \frac{24 \text{ h}}{\cancel{\text{d}}} = \frac{60 \text{ h}}{1} = 60 \text{ h}$$

Convert 7 days to minutes.

$\text{d} \rightarrow \text{h} \rightarrow \text{min}$

$$1 \text{ d} = 24 \text{ h}$$

$$1 \text{ h} = 60 \text{ min}$$

$$\frac{7 \cancel{\text{d}}}{1} \times \frac{24 \cancel{\text{h}}}{\cancel{\text{d}}} \times \frac{60 \text{ min}}{\cancel{\text{h}}} = 10080 \text{ min}$$

Convert 90 km/h into m/min, given that 1000 m = 1 km | h = 60 min
km \rightarrow m, h \rightarrow min

$$\frac{90 \text{ km}}{\text{h}} \times \frac{1000 \text{ m}}{\text{km}} \times \frac{\text{h}}{60 \text{ min}} = \frac{90,000 \text{ m}}{60 \text{ min}}$$
$$= 1500 \frac{\text{m}}{\text{min}}$$

Convert 12 L/h to gal/min, given that 1 L = 0.264 gal

L \rightarrow gal h \rightarrow min 1 h = 60 min.

$$\frac{12 \cancel{\text{L}}}{\cancel{\text{h}}} \times \frac{0.264 \text{ gal}}{\cancel{\text{L}}} \times \frac{\cancel{\text{h}}}{60 \text{ min}} = 0.0528 \frac{\text{gal}}{\text{min}}$$

$$5.28 \times 10^{-2} \frac{\text{gal}}{\text{min}}$$