# Converting from one unit to another

We will use the method of dimensional analysis, sometimes called the factor-label method.... or, the "drag and drop" method!

Dimensional analysis uses conversion factors to change between one unit and another

What's a conversion factor? A simple equality.

Example

$12\ \text{in} = 1\ \text{ft}$

# Conversion factors in metric

In the metric system, conversion factors between units may always be made from the metric prefixes!

For example, "kilo-" means $10^3$

$k = 10^3$

so

$kg = 10^3 g$

$km = 10^3 m$

$kL = 10^3 L$

$ks = 10^3 s$

Just apply the prefix to the base unit!

# How do we actually USE a conversion factor?

$1\,cm = 10^{-2}\,m$

Convert 15.75 m to cm

$$15.75\,\cancel{m} \times \frac{cm}{10^{-2}\,\cancel{m}} = 1575\,cm$$

DRAG AND DROP!

Put what you want to cancel on the bottom, then ...

... put what it equals on the top!

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$1\,kg = 10^{3}\,g$

Convert 0.01893 kg to g

$$0.01893\,\cancel{kg} \times \frac{10^{3}\,g}{\cancel{kg}} = 18.93\,g$$

Convert 14500 mg to kg

$mg = 10^{-3} g$ $\quad kg = 10^{3} g$

$$14500\ mg \times \frac{10^{-3}\ g}{mg} \times \frac{kg}{10^{3}\ g} = 0.0145\ kg$$

If you have TWO prefixes in your problem, you will apply TWO conversion factors in your solution!

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Convert 0.147 mm to μm

$mm = 10^{-3} m$ $\quad \mu m = 10^{-6} m$

μ ← micro-

$$0.147\ mm \times \frac{10^{-3}\ m}{mm} \times \frac{\mu m}{10^{-6}\ m} = 147\ \mu m$$

Convert 38.47 in to m, assuming 2.54 cm = 1 in

$2.54\ cm = in$ $\qquad cm = 10^{-2}\ m$

$$38.47\ in \times \frac{2.54\ cm}{in} \times \frac{10^{-2}\ m}{cm} = \boxed{0.9771\ m}$$

Even though English units are involved, we can solve this problem the same way we solved the previous problem where only metric units were used!

Even if you're unfamiliar with the metric units involved in a problem, you can still do conversions easily.

88100 kHz to MHz

$Hz = s^{-1}$ (frequency)

$kHz = 10^3 Hz$ $\quad MHz = 10^6 Hz$

$$88100\ kHz \times \frac{10^3\ Hz}{kHz} \times \frac{MHz}{10^6\ Hz} = \boxed{88.1\ MHz}$$

0.004184 kJ to J

$J$ = joule (energy)

$kJ = 10^3 J$

$$0.004184\ kJ \times \frac{10^3\ J}{kJ} = \boxed{4.184\ J}$$

# A sample application of dimensional analysis: Drug calculations.in the healthcare field.

Example: A patient is ordered 40 mg of codeine phosphate by subcutaneous injection. 50 mg in 1 mL liquid is available. How much of this liquid should be adminstered?

This is a conversion factor. It tells us the volume of liquid that contains a certain amount of the drug. We can use this information exactly the same way we were using the metric prefixes earlier!

Hint: Many statements that give conversion factors contain the words "in" or "per"!

$$50\ \text{mg drug} = 1\ \text{mL}$$

$$40\ \text{mg drug} \times \frac{1\ \text{mL}}{50\ \text{mg drug}} = \boxed{0.8\ \text{mL}}$$

# Mileage

A car (averaging 17.5 miles per gallon) is traveling 50 miles per hour. How many gallons of gas will be used on a trip that lasts 0.75 hours?

$17.5 \text{ mi} = 1 \text{ gal}$ $\quad$ $50 \text{ mi} = 1 \text{ hr}$

$$0.75 \text{ hr} \times \frac{50 \text{ mi}}{1 \text{ hr}} \times \frac{1 \text{ gal}}{17.5 \text{ mi}} = \boxed{2.1 \text{ gal}}$$

If gas is $3.46 per gallon, how much will the trip cost?

$\$3.46 = 1 \text{ gal}$

$$2.1 \text{ gal} \times \frac{\$3.46}{1 \text{ gal}} = \boxed{\$7.41}$$

For a 200 mile trip in a car which averages 15 miles per gallon, if gas costs $3.46 per gallon, what's the cost of the trip?

$15 \text{ mi} = 1 \text{ gal}$ $\$3.46 = 1 \text{ gal}$

$$200 \text{ mi} \times \frac{1 \text{ gal}}{15 \text{ mi}} \times \frac{\$3.46}{1 \text{ gal}} = \boxed{\$46.13}$$