

Dimensional analysis

Unit analysis is a method for converting one measurement into an equivalent measurement with different units.

A conversion factor is a way of writing "1":  $\frac{1 \text{ hour}}{60 \text{ minutes}}$  or  $\frac{60 \text{ minutes}}{1 \text{ hour}}$

If you multiply by a conversion factor so the same unit is on top and bottom, you can cancel that unit.

**Example 1:** A reaction is known to take 5600.0 seconds, how many minutes will this be?

$$5600.0 \text{ sec} \times \frac{1 \text{ min}}{60 \text{ sec}} = 93.3333\dots$$

93.333 min

**Example 2**

Convert 2.58 yards into feet (1 yard = 3 ft):

$$2.58 \text{ yds} \times \frac{3 \text{ ft}}{1 \text{ yd}} = \text{7.74 ft}$$

**Example 3**

Chickpeas cost \$1.60 per hundred grams; how much chickpeas can you get for \$5?

$$5 \text{ \$} \times \frac{100 \text{ g}}{1.60 \text{ \$}} = \frac{5 \times 100}{1.60} = 312.5 \text{ grams chickpeas}$$

≈ 300 grams chickpeas

**Example 4**

\* sometimes you need to do several steps

How many feet is 1.00 meter? (there are exactly 12 inches in a foot, and approximately 39.37 inches in a meter)

$$1.00 \text{ m} \times \frac{39.37 \text{ in}}{1 \text{ m}} \times \frac{1 \text{ ft}}{12 \text{ in}} = 3.28083 \text{ ft}$$

≈ 3.28 ft

We can multiply units together. Consider the unit "worker-hours" which is the amount of work one person working for one hour can achieve.

**Example 5:** If 12 people work together for 8 hours, how many "worker-hours" of work were done?

$$12 \text{ workers} \times 8 \text{ hours} = 96 \text{ worker}\cdot\text{hours}$$

$$\approx 100 \text{ worker}\cdot\text{hours}$$

We can also divide units. When we do, we have a rate. For example  $95 \frac{\text{km}}{\text{hr}}$  means 95 kilometers per hour. That is, in one hour a person with this speed travels 95 km.

**Example 6**

What is 5.52 metres per second in km per hour?

$$\frac{5.52 \cancel{\text{m}}}{1 \cancel{\text{sec}}} \times \frac{60 \cancel{\text{sec}}}{1 \cancel{\text{min}}} \times \frac{60 \cancel{\text{min}}}{1 \text{ hr}} \times \frac{1 \text{ km}}{1000 \cancel{\text{m}}} = 19.872 \frac{\text{km}}{\text{hr}}$$

$$\approx 19.9 \text{ km/hr}$$

**Example 7**

What is 25 grams per minute in kg per hour?

$$\frac{25 \cancel{\text{g}}}{\cancel{\text{min}}} \times \frac{1 \text{ kg}}{1000 \cancel{\text{g}}} \times \frac{60 \cancel{\text{min}}}{1 \text{ hr}} = 1.5 \text{ kg/hr}$$

**Example 8**

What is 5900 square inches in square feet?

$$5900 \text{ sq in} = 5900 \cancel{\text{in}^2} \times \frac{1 \cancel{\text{ft}}}{12 \cancel{\text{in}}} \times \frac{1 \cancel{\text{ft}}}{12 \cancel{\text{in}}} = 40.9722 \text{ ft}^2$$

$$\approx 41 \text{ sq ft}$$

**Example 9**

What is 4.6 cubic metres in mL? \*\* Note that 1mL = 1 cubic cm

$$4.6 \text{ m}^3 \times \left( \frac{100 \cancel{\text{cm}}}{1 \cancel{\text{m}}} \right)^3 = 4.6 \times 100^3 \div 1^3$$

$$= 4600000 \text{ cm}^3$$

$$= 4.6 \times 10^6 \text{ mL}$$