

Dimensional Analysis

Dimensional analysis is the analysis of a relationship by considering its units of measure.

Dimensional analysis offers a method for reducing complex physical problems to the simplest (that is, **most economical**) form prior to obtaining a quantitative answer.

- it is the analysis of the relationships between different physical quantities by identifying their base quantities (such as length, mass, time, and electric charge) and units of measure (such as miles vs. kilometers, or pounds vs. kilograms vs. grams) and tracking these dimensions as calculations or comparisons are performed
- the **factor-label method**, also known as the **unit-factor method**, is a widely used technique for such conversions using the rules of algebra
- the sequential application of conversion factors expressed as **fractions** and arranged so that any dimensional unit appearing in both the numerator and denominator of any of the fractions can be cancelled out until only the desired set of dimensional units is obtained

Conversion Factors

- a ratio which converts one unit of measure into another without changing the quantity is called a conversion factor

1 mile = 1.61 km

Currently 1 Euro = 1.47 CAD

e.g. 1 Ottawa is 176.2 km from Montreal. How far is it in miles?

$$176.2 \text{ km} \times \frac{1 \text{ mile}}{1.61 \text{ km}} = 109.4 \text{ mile}$$

e.g. 2 Ms. O'Neill bought a dress for me in Firenze for 35 euros. How much did the dress cost me in CAD?

$$35 \text{ euros} \times \frac{1.47 \text{ CAD}}{1 \text{ euro}} = 51 \text{ CAD}$$

e.g. 3 How many seconds are there in a year?

$$\cancel{1 \text{ yr}} \times \frac{365 \text{ d}}{\cancel{1 \text{ yr}}} \times \frac{24 \text{ h}}{\cancel{1 \text{ d}}} \times \frac{60 \text{ min}}{\cancel{1 \text{ h}}} \times \frac{60 \text{ s}}{\cancel{1 \text{ min}}} = 31536000 \text{ s}$$
$$3.15 \times 10^7 \text{ s}$$

e.g. 4 I am 5 ft 2 ½ in tall. How tall am I in centimeters?

Necessary info: 1 ft = 12 in and 1 in = 2.54 cm

$$\left(5 \text{ ft} \times \frac{12 \text{ in}}{1 \text{ ft}} + 2.5 \text{ in} \right) \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 158.75 \text{ cm}$$