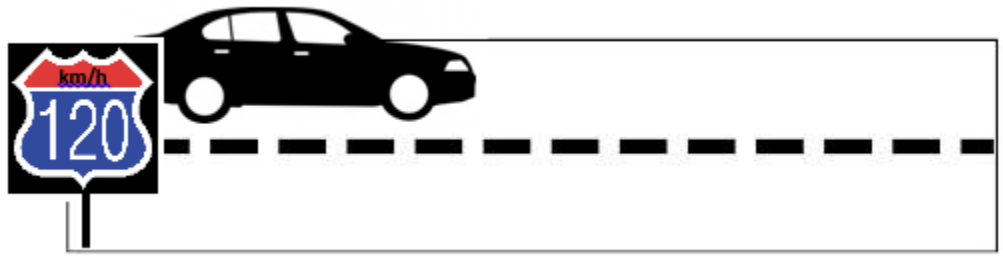
Conversions between Different Systems of Measurement

Multi-UNIT Conversions using DIMENSIONAL ANALYSIS

Dimensional analysis is useful when converting between multiple systems of measurement at the same time.

Example 1:

Given the speed of a car on a highway is 120 **km/h**, how fast is the car travelling in **miles/min**?



Since we are considering both **length** and **time,** we need to find conversion factors for each unit of measure.

km → **miles** AND **h** → **min**

Systems of Measurement Chart

Mass:

1 gram (g) = 1000 milligrams (mg)
1 milligram (mg) = 1000 micrograms (mcg)
1 ounce (oz) = 30 grams (g)
1 pound (lb) = 16 ounces (oz)
1 pound (lb) = 454 grams (g)
2.2 pounds (lb) = 1 kilogram (kg)
1 kilogram (kg) = 1000 grams (g)

1 metric ton = 1000 kilograms (kg)

Volume:

1 teaspoon (tsp) = 5 millilitres (mL)
1 tablespoon (tbsp) = 3 teaspoons (tsp)
2 tablespoons (tbsp) = 1 fluid ounce (oz)
1 cup = 8 ounces
1 cup = 250 millilitres (mL)
1 litre (L) = 1000 millilitres (mL)
1 pint = 2 cups
1 quart = 2 pints
1 gallon = 4 quarts

Length:

1 inch (in)= 2.5 centimeters (cm)
12 inches (in) = 1 foot (ft)
100 centimeters (cm) = 1 meter (m)
1000 meters (m) = 1 kilometer (km)
1 yard = 3 feet (ft)
1 mile = 5280 feet (ft)
1 mile = 1.6 kilometers (km)

Time:

1 hour (h) = 60 minutes (min)
1 minute (min) = 60 seconds (s)
1 day = 24 hours (h)
1 week = 7 days
1 year = 12 months
1 year = 365 days

Step 1:

State the starting measurement as a fraction. Be sure to include the units.

$$\frac{120\ \text{km}}{1\ \text{h}}$$

Step 2:

Find the conversion factors between our starting units and our desired units. From the conversion chart we can see that,

1.6 kilometer (km) = 1 mile and 1 hour (h) = 60 minutes (min).

Step 3:

State the conversion factor for **length** as a fraction (keeping order in mind).
Since km is in the numerator of the starting unit, place km in the denominator of the conversion factor. In Step 5, we will understand why order is important.

$$\frac{1 \text{ mile}}{1.6 \text{ km}}$$

Step 4:

State the conversion factor for **time** as a fraction (keeping order in mind).
Since h is in the denominator of the starting unit, place h in the numerator of the conversion factor.

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

Step 5:

Multiply the starting value with both conversion factors and simplify.

$$\frac{120 \text{ km}}{1 \text{ h}} \times \frac{1 \text{ mile}}{1.6 \text{ km}} \times \frac{1 \text{ h}}{60 \text{ min}} = \frac{120 \text{ miles}}{60 \times 1.6 \text{ min}} = \frac{120 \text{ miles}}{96 \text{ min}} = 1.25 \, miles/min$$

Example 2:

How many feet are there in 1508 cm?

Step 1:

State the starting measurement as a fraction. Be sure to include the units.

$$\frac{1508\ \text{cm}}{1}$$

Step 2:

Find the conversion factors between our starting units and our desired units.
Looking at the conversion chart we notice that there isn't a direct conversion from cm to ft. As a result, we need to break this conversion into two steps. First converting centimeters to inches then secondly converting inches to feet.

Step 3:

State the conversion factor for centimeters to inches as a fraction (keeping order in mind).

Since cm is in the numerator of the starting unit, place cm in the denominator of the conversion factor.

$$\frac{1\ \text{inch}}{2.5\ \text{cm}}$$

Step 4:

State the conversion factor for inches to feet as a fraction (keeping order in mind).
Since inches is in the numerator of the conversion factor above, place inches in the denominator of the conversion factor.

$$\frac{1\text{ft}}{12\ \text{inch}}$$

Step 5:

Multiply the starting value with both conversion factors and simplify.

$$\frac{1508\ \text{cm}}{1} \times \frac{1\ \text{inch}}{2.5\ \text{cm}} \times \frac{1\text{ft}}{12\ \text{inch}} = \frac{1508\ \text{ft}}{2.5 \times 12} = \frac{1508\ \text{ft}}{30} = 50.27\ ft$$

Example 3:

Convert 3 kg/ft into lb/cm?

Step 1:

State the starting unit as a fraction.

$$\frac{3\text{ kg}}{1\text{ ft}}$$

Step 2:

Find the conversion factors between our starting units and our desired units.
For **mass**, the conversion chart tells us that **1 kilogram (kg) = 2.2 pounds (lb)**.
For **length**, there isn't a direct conversion from **ft** to **cm**, we need to break this conversion into two steps. First converting feet to inches then secondly converting inches to centimeters.

Step 3:

State the conversion factor for **kg to lb** as a fraction (keeping order in mind).
Since kg is in the numerator of our starting unit, place kg in the denominator of our conversion factor.

$$\frac{2.2\text{ lb}}{1\text{ kg}}$$

Step 4:

State the conversion factor for **ft** to **inch** as a fraction (keeping order in mind).
Since ft is in the denominator of the starting unit, place ft in the numerator of the conversion factor.

$$\frac{1\text{ft}}{12\text{ inch}}$$

Step 5:

State the conversion factor for **inch** to **cm** as a fraction (keeping order in mind).
Since inches is in the denominator of the conversion factor above, place inches in the numerator of the conversion factor.

$$\frac{1 \text{ inch}}{2.5 \text{ cm}}$$

Step 6:

Multiply the starting value with both conversion factors and simplify.

$$\frac{3 \text{ kg}}{1 \text{ ft}} \times \frac{2.2 \text{ lb}}{1 \text{ kg}} \times \frac{1 \text{ ft}}{12 \text{ inch}} \times \frac{1 \text{ inch}}{2.5 \text{ cm}} = \frac{3 \text{ lb} \times 2.2}{12 \times 2.5 \, cm} = \frac{6.6 \text{ lb}}{30 \text{ cm}} = 0.22 \, lb/cm$$

Exercises:

Convert between the following systems of measurements.

a) 17 in into cm
b) 420 h into weeks
c) 48 oz into lb
d) 7 ft/sec into m/h
e) 50 miles/h into m/s
f) 2.05 kg/inch into lb/cm
g) ¾ h into s
h) 2589 g into lb
i) 135 km/h into ft/s

Solutions:

a) 42.5 cm
b) 2.5 weeks
c) 3 lb
d) 7560 m/h
e) 22.22 m/s
f) 1.80 lb/cm
g) 2700 s
h) 5.70 lb
i) 125 ft/s