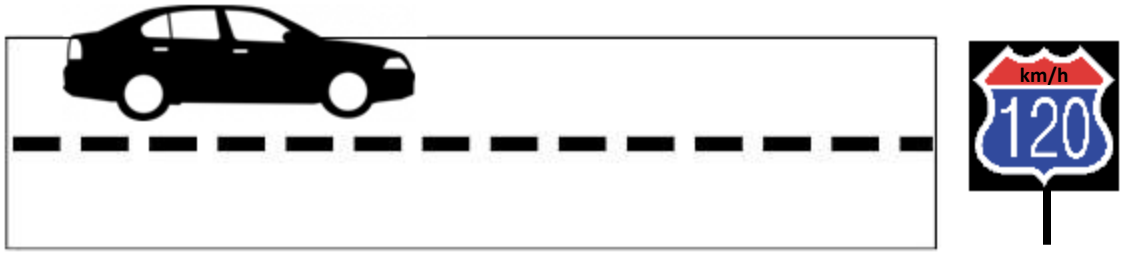
# Conversions between Different Systems of Measurement

## 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 | Volume | Length | Time |
|---|---|---|---|
| 1 g = 1000 mg | 1 tsp = 5 mL | 1 inch = 2.5 cm | 1 h = 60 min |
| 1 mg = 1000 mcg | 1 tbsp = 3 tsp (15 mL) | 12 inches = 1 foot | 1 minute = 60 seconds |
| 1 oz = 30 g | 2 tbsp = 1 fluid oz | 100 cm = 1 meter* | 1 day = 24 hours |
| 1 lb = 16 oz | 1 cup = 8 oz | 1000 m = 1 km* | 1 week = 7 days |
| 1 lb= 454 g | 1 cup = 250 mL | 1 yard = 3 feet | 1 year = 12 months |
| 2.2 lb = 1 kg | 1 L = 1000 mL | 1 mile = 5280 ft | 1 year = 365 days |
| 1 kg = 1000 g* | 1 pint = 2 cups | 1 mile = 1.6 km | |
| 1 metric ton = 1000 kg | 1 quart = 2 pints | | |
| | 1 gallon = 4 quarts | | |

**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 km = 1 mile** and **1 h = 60 min**.

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**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.

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

Notice that the starting units divide out and we are left with our desired units.

**Example 2:** How many feet are there in 1508 cm?

**Step 1:** State the starting measurement as a fraction.

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

**Step 2:** Find the conversion factor between our starting unit and our desired unit.

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.

**cm → in** AND **in → ft**

**Step 3:** State the conversion factor for **cm → in** as a fraction (keeping order in mind).

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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 **in** ➡ **ft** 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.

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

Notice that the starting unit divides out and only the desired unit remains.

**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 kg = 2.2 lb** .

For **length**, there isn't a direct conversion from **ft** to **cm**, we need to break this conversion into two steps.

**ft** ➡ **in** AND **in** ➡ **cm**

**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.

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

**Step 4:** State the conversion factor for **ft** ➡ **in** 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 **in** ➡ **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.

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

Notice that the starting units divide out and only the desired units remain.

**Exercises:** Convert between the following systems of measurements.

1) 17 in into cm
2) 420 h into weeks
3) 48 oz into lb
4) 7 ft/sec into m/h
5) 50 miles/h into m/s
6) 2.05 kg/inch into lb/cm
7) ¾ h into s
8) 2589 g into lb
9) 135 km/h into ft/s

**Solutions:**

1) 42. 5 cm
2) 2.5 weeks
3) 3 lb
4) 7560 m/h
5) 22.22 m/s
6) 1.80 lb/cm
7) 2700 s
8) 5.70 lb
9) 125 ft/s