

## Unit 2

On completion of the unit you should be able to:

1. define the following terms: mass, volume, temperature, significant figures, density and specific gravity.
2. identify the number of significant figures in a measurement.
3. round off the results of calculations to the correct number of significant figures.
4. express measurements in scientific notation with the correct number of significant figures.
5. identify the SI units commonly used to measure mass, volume, length and temperature.
6. define the commonly used metric prefixes.
7. perform conversions using conversion factors.
8. given any of the following (mass, volume and density), calculate the unknown.
9. given any two of the following (mass, volume and specific gravity), calculate the unknown.

### MEASUREMENT

#### 2.1 Metric system

- **SI system**
- **British System**

Reading: Hebden – page 9 – 16

#### 2.2 Temperature measurements

2.3 **Scientific notation** – to be covered by Physics. Apply the concepts when carrying out calculations in this course.

#### 2.4 Dimensional analysis

Reading: Hebden – page 19 – 23

# SI Base Units

There are many SI base units of measurements. For this course, we will concentrate on the 5 base units listed below:

1. For a measurement of MASS, the base unit is kilogram.
2. For a measurement of LENGTH, the base unit is meter.
3. For a measurement of VOLUME<sup>\*\*</sup>, the base unit is liter.
4. For a measurement of TIME, the base unit is second.
5. For a measurement of TEMPERATURE, the base unit is Kelvin.

## SI system

In the SI system, prefixes are used to represent multiples of 10 or fractions of 10 of the base units. The following table summarizes the basic prefixes that you should know.

PREFIX	MULTIPLE	SCIENTIFIC NOTATION	ABBREVIATION
mega-	1,000,000	$10^6$	M
kilo-	1,000	$10^3$	k
deci-	0.1	$10^{-1}$	d
centi-	0.01	$10^{-2}$	c
milli-	0.001	$10^{-3}$	m
micro-	0.000001	$10^{-6}$	$\mu$
nano-	0.000000001	$10^{-9}$	n

> Base unit

< Base unit

Apply to:

Mass (g)

Length (m)

Volume (L)

# SI Base Units

Conversion  
factors



Length - base unit of meter

[\[edit\]](#)

PREFIX	MULTIPLE / SCIENTIFIC NOTATION	MASS	METER EQUIVALENT (conversion factor)
mega-	1,000,000 or $10^6$	Mm (megameter)	1 Mm = 1,000,000 meter
kilo-	1,000 or $10^3$	km (kilometer)	1 km = 1,000 meter
deci-	0.1 or $10^{-1}$	dm (decimeter)	1 dm = 0.1meter
centi-	0.01 or $10^{-2}$	cm (centimeter)	1 cm = 0.01 meter
milli-	0.001 or $10^{-3}$	mm (millimeter)	1 mm = 0.001 meter
micro-	0.000001 or $10^{-6}$	$\mu\text{m}$ (micrometer)	1 $\mu\text{m}$ = 0.000001 meter
nano-	0.000000001 or $10^{-9}$	nm (nanometer)	1 nm = 0.000000001 meter

# SI Base Units

$$1 \text{ mL} = \underline{\hspace{2cm}} \text{ Liter}$$

$$(1 \text{ mL} = 0.001 \text{ Liter})$$

$$\frac{1 \text{ mL}}{0.001 \text{ L}} \quad \text{or} \quad \frac{0.001 \text{ L}}{1 \text{ mL}}$$

$$1 \text{ L} = \underline{\hspace{2cm}} \text{ mL}$$

$$(1 \text{ L} = 1000 \text{ mL})$$

$$\frac{1000 \text{ mL}}{1 \text{ L}} \quad \text{or} \quad \frac{1 \text{ L}}{1000 \text{ mL}}$$

# SI Base Units

Do the  
Same for  
everyone  
Of these  
without  
mistakes!

LITER EQUIVALENT (conversion factor)
1 ML = 1,000,000 liter
1 kL = 1,000 liter
1 dL = 0.1 liter
1 cL = 0.01 liter
1 mL = 0.001 Liter
1 $\mu$ L = 0.000001 liter
1 nL = 0.000000001 liter

# SI Base Units

## Meter

Some approximate sizes:

- a penny is approximately 2 centimeters in diameter
- an average adult is approximately 1.7 meters
- the thickness of hair is approximately 60 micrometer
- a piece of paper is approximately 0.1 millimeter
- one full twist of the DNA molecule is 3-4 nanometer

## Liter

Some approximate sizes:

- a soft drink can holds approximately 350 milliliters of pop
- 20 drops from a medicine dropper is approximately 1 milliliters
- a cup holds approximately 250 milliliters
- a teaspoon holds approximately 5 milliliters of liquid

# Angstrom

In addition to the SI unit of base unit of length, meter, a unit of length that is commonly used Chemistry is the angstrom. The abbreviation for **angstrom** is Å.

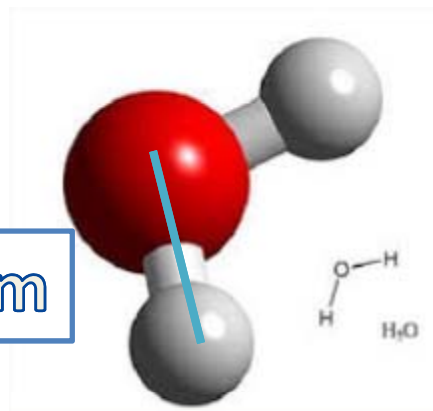
**Conversion factor:**  $1\text{Å} = 10^{-10}$  meter

**1 Angstrom is one ten-billionth of a meter**

It is used to express sizes of atoms.

Example: Water,  $\text{H}_2\text{O}$

1 Angstrom





# British System

Although the metric system is widely used in the scientific community, it is important to know the common units of the British system. Listed below is the metric equivalent to British units.

- $2.54 \text{ cm} = 1 \text{ inch}$
- $30 \text{ cm} = 1 \text{ foot}$
- $1 \text{ meter} = 39.37 \text{ inches}$
- $1 \text{ pound} = 454 \text{ grams}$
- $2.2 \text{ pounds} = 1 \text{ kilogram}$
- $1 \text{ quart} = 0.946 \text{ liters}$

# Dimensional Analysis

*Unit given  $\times$  conversion factor(s) = unit sought*

All about unit  
cancellation

# Dimensional Analysis

$$2.7 \text{ cm} = \underline{\hspace{2cm}} \mu\text{m}$$

*Unit given  $\times$  conversion factor(s) = unit sought*

$$2.7 \text{ cm} \times \boxed{\hspace{2cm} ? \hspace{2cm}} = \underline{\hspace{2cm}} \mu\text{m}$$

$$\begin{array}{l} 10^6 \mu\text{m} = 1 \text{ m} \\ 10^2 \text{ cm} = 1 \text{ m} \end{array} \left. \vphantom{\begin{array}{l} 10^6 \mu\text{m} = 1 \text{ m} \\ 10^2 \text{ cm} = 1 \text{ m} \end{array}} \right\} 10^6 \mu\text{m} = 10^2 \text{ cm} \quad \frac{10^6 \mu\text{m}}{10^2 \text{ cm}}$$

$$2.7 \cancel{\text{cm}} \times \frac{10^6 \mu\text{m}}{\cancel{10^2 \text{cm}}} = \underline{2.7 \times 10^4} \mu\text{m}$$

(In Maple TA: 27000 or 2.7E4)

# Dimensional Analysis

$$55 \mu\text{g} = \underline{\hspace{2cm}} \text{ng}$$

*Unit given  $\times$  conversion factor(s) = unit sought*

$$55 \mu\text{g} \times \boxed{\hspace{2cm} ? \hspace{2cm}} = \underline{\hspace{2cm}} \text{ng}$$

$$10^6 \mu\text{g} = 1 \text{ g}$$

$$10^9 \text{ ng} = 1 \text{ g}$$

$$\left. \begin{array}{l} 10^6 \mu\text{g} = 1 \text{ g} \\ 10^9 \text{ ng} = 1 \text{ g} \end{array} \right\} 10^6 \mu\text{g} = 10^9 \text{ ng}$$

$$\frac{10^9 \text{ ng}}{10^6 \mu\text{g}}$$

$$55 \cancel{\mu\text{g}} \times \frac{10^9 \text{ ng}}{10^6 \cancel{\mu\text{g}}} = \underline{5.5 \times 10^4} \text{ ng}$$

(In Maple TA: 55000 or 5.5E4)

# Dimensional Analysis

$$37 \text{ mm}^3 = \underline{\hspace{2cm}} \text{ cm}^3$$

*Unit given  $\times$  conversion factor(s) = unit sought*

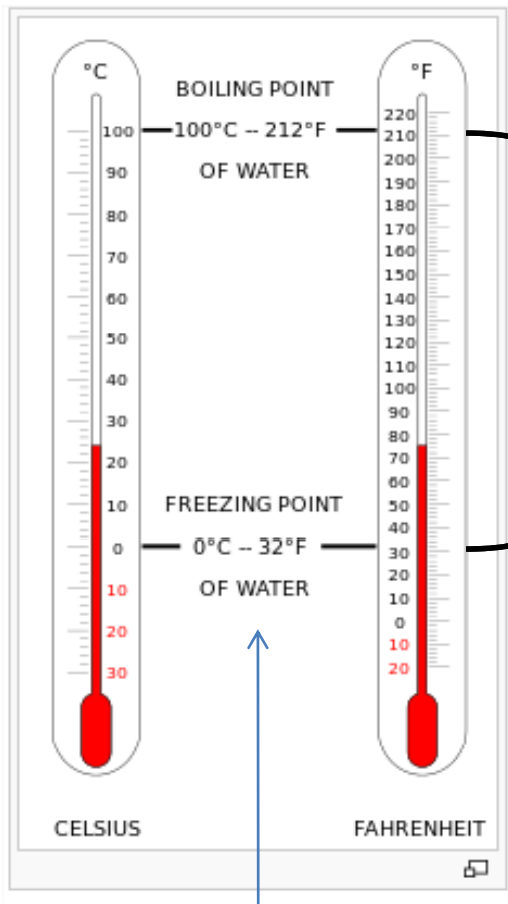
$$37 \text{ mm}^3 \times \boxed{\hspace{2cm} ? \hspace{2cm}} = \underline{\hspace{2cm}} \text{ cm}^3$$

$$10 \text{ mm} = 1 \text{ cm} \quad \frac{1 \text{ cm}}{10 \text{ mm}}$$

$$37 \cancel{\text{ mm}}^3 \times \frac{1 \text{ cm}}{10 \cancel{\text{ mm}}} \times \frac{1 \text{ cm}}{10 \cancel{\text{ mm}}} \times \frac{1 \text{ cm}}{10 \cancel{\text{ mm}}} = \underline{3.7 \times 10^{-2}} \text{ cm}^3$$

(In Maple TA: 0.037 or 3.7E-2)

# Temperature – Conversion from °F and °C



32 degrees offset

212-32 = 180 degrees in Fahrenheit

100-0 = 100 degrees in Celsius

$$24^{\circ}\text{C} = ?^{\circ}\text{F}$$

**Answer: 75°F**

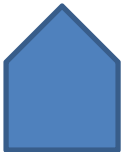
$$180^{\circ}\text{F} = 100^{\circ}\text{C}$$

$$\downarrow$$
$$9^{\circ}\text{F} = 5^{\circ}\text{C}$$

$$\frac{9^{\circ}\text{F}}{5^{\circ}\text{C}}$$

$$^{\circ}\text{F} = ^{\circ}\text{C} \times \left( \frac{9^{\circ}\text{F}}{5^{\circ}\text{C}} \right) + 32$$

Temperature offset  
between the two scales



# Kelvin

[\[edit\]](#)

Of the three scales, the Kelvin scale is used in the [SI system](#). This scale is based on the lowest theoretical temperature known as absolute zero. Lord William Kelvin proposed this scale such that a degree in the Celsius scale is the same size as a degree in the Kelvin scale. The conversion to the Kelvin scale from the Celsius scale is

$$K = {}^{\circ}\text{C} + 273.15$$

Approximate temperatures:

- room temperature is approximately 298K (approximately 25°C)
- when helium gas becomes a liquid, it is approximately 4K (approximately -269°C)
- when nitrogen gas becomes a liquid, it is approximately 77K (approximately -196°C)