Unit 2

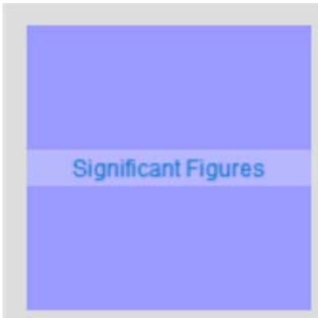
On completion of the unit you should be able to:

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

Today's focus.

Significant Figures Videos:



Download Significant figure videos #1 worksheet under Scanned Lecture Notes.

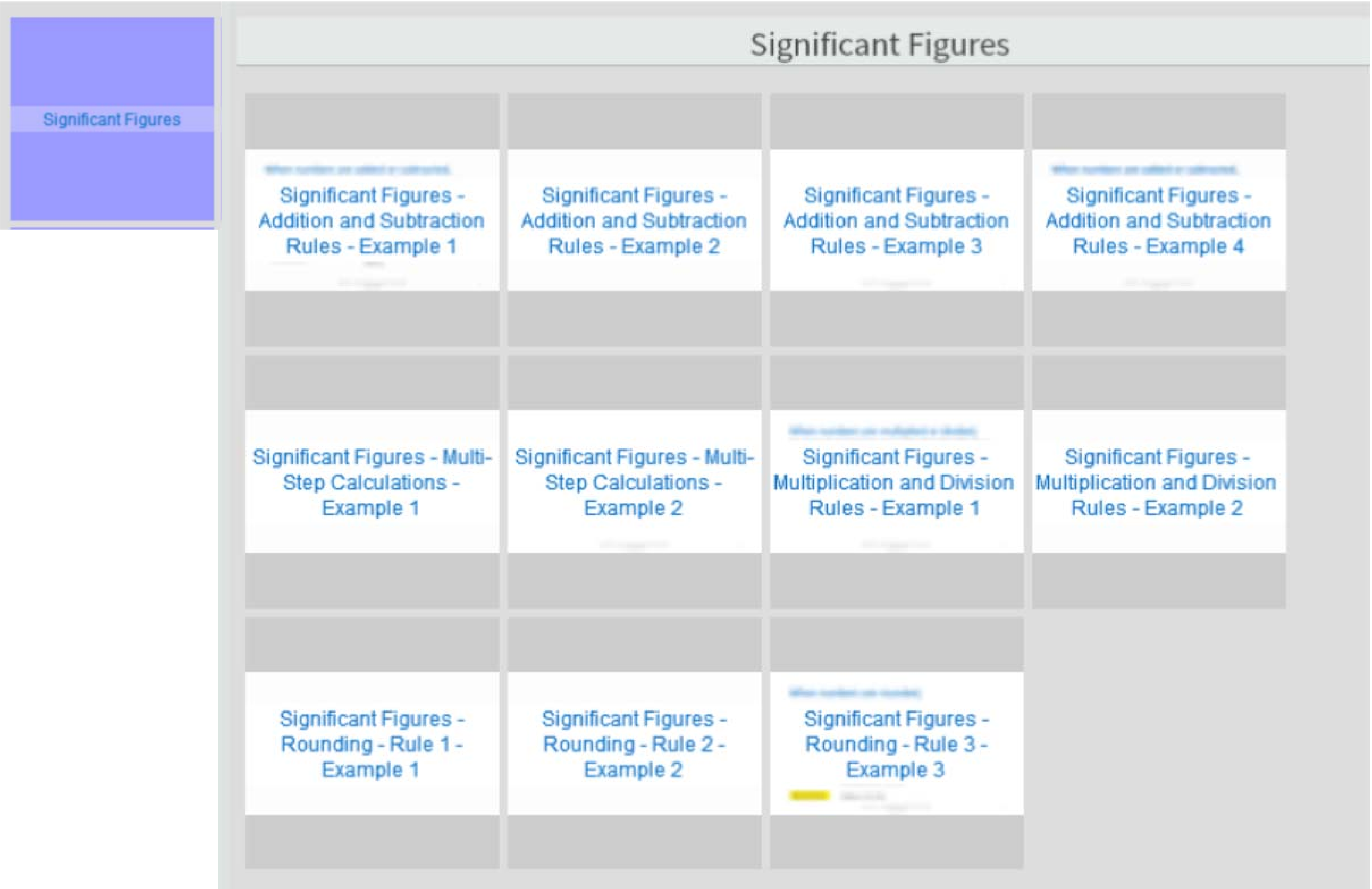
Addition/Subtraction

Multiplication/Division

Rounding

Multi-Step Calculation

Significant Figures Videos:



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 measurment of LENGTH, the base unit is meter.
3. For a measurement of VOLUME** , 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
> Base unit	**mega-**	1,000,000	10^{6}	M
	kilo-	1,000	10^{3}	k
	deci-	0.1	10^{-1}	d
< Base unit	**centi-**	0.01	10^{-2}	c
	milli-	0.001	10^{-3}	m
	micro-	0.000001	10^{-6}	μ
	nano-	0.000000001	10^{-9}	n

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}	µm (micrometer)	1 µm = 0.000001 meter
nano-	0.000000001 or 10^{-9}	nm (nanometer)	1 nm = 0.000000001 meter

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 μL = 0.000001 liter
1 nL = 0.000000001 liter

SI Base Units

1 mL = ________ Liter

(1 mL = 0.001 Liter)

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

1 L = ________ mL

(1 L = 1000 mL)

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

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.

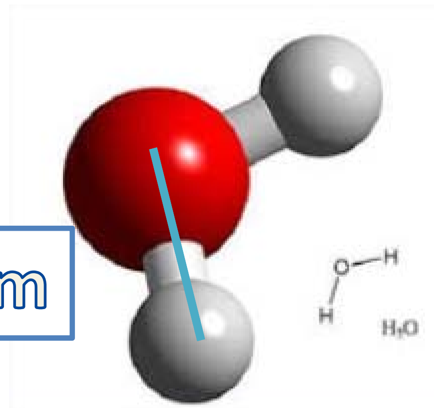
Conversion factor: 1Å = 10^{-10} meter

1 Angstrom is one ten-billionth of a meter

It is used to express sizes of atoms.

Example: Water, H_2O

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 cm = 1 inch
- 30 cm = 1 foot
- 1 meter = 39.37 inches
- 1 pound = 454 grams
- 2.2 pounds = 1 kilogram
- 1 quart = 0.946 liters

Dimensional Analysis

Unit given x *conversion factor(s)* = *unit sought*

All about unit cancellation

Dimensional Analysis

Let's try some practice questions.

Dimensional Analysis

2.7 cm = ________ μm

Unit given x *conversion factor(s)* = *unit sought*

2.7 cm x [?] = ___ μm

10^6 μm = 1 m

10^2 cm = 1 m

10^6 μm = 10^2 cm

$$\frac{10^6\ \mu m}{10^2\ cm}$$

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

(In Maple TA: 27000 or 2.7E4)

Dimensional Analysis

$$55\ \mu g = \underline{\hspace{3cm}}\ ng$$

Unit given x *conversion factor(s)* = *unit sought*

$$55\ \mu g \times \boxed{\quad ? \quad} = \underline{\hspace{1cm}}\ ng$$

$$10^6\ \mu g = 1\ g$$
$$10^9\ ng = 1\ g$$

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

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

(In Maple TA: 55000 or 5.5E4)

Dimensional Analysis

$$37\ mm^3 = \_\_\_\_\_\_\_\_\ cm^3$$

Unit given x *conversion factor(s)* = *unit sought*

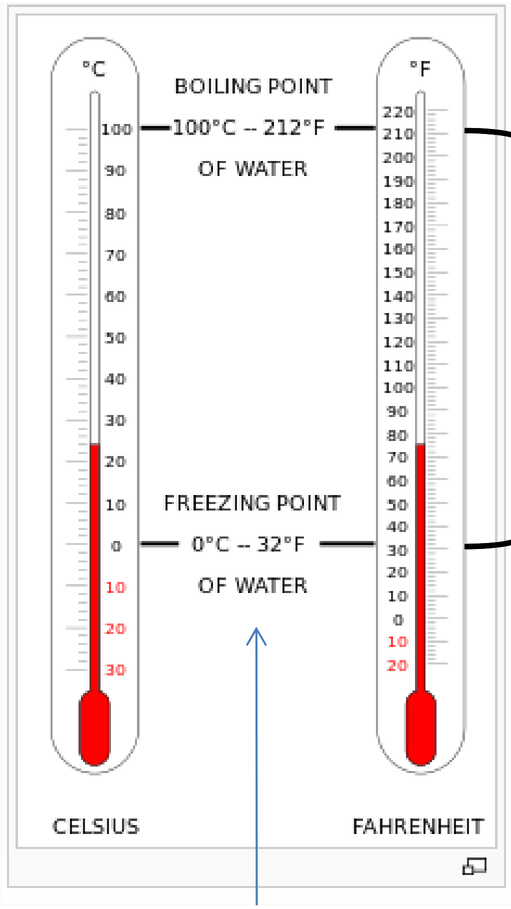
$$37\ mm^3 \quad \times \quad \boxed{\quad ? \quad} = \_\_\_\ cm^3$$

$$10\ mm = 1\ cm \qquad \frac{1\ cm}{10\ mm}$$

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

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

Temperature – Conversion from ^{o}F and ^{o}C



212-32 = 180 degrees in Fahrenheit

100-0 = 100 degrees in Celsius

32 degrees offset

180 ^{o}F = 100 ^{o}C

9 ^{o}F = 5 ^{o}C

$$\frac{9\ ^{o}F}{5\ ^{o}C}$$

^{o}F = ? 24^{o}C

Answer: 75^{o}F

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

Temperature offset between the two scales

Image credit: http://en.wikipedia.org/wiki/Fahrenheit

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

$$K = {}^{o}C + 273.15$$

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)