Units

Other Handouts:

- Scientific notation •Ratio and Proportion
- Significant Figures •Logarithms
- Review of Number •Graphing

In the decimal system we work with powers of ten:

10^5	10^4	10^3	10^2	10^1	10^0	$\frac{1}{10}$	$\frac{1}{100}$	$\frac{1}{1000}$	$\frac{1}{10000}$
10^5	10^4	10^3	10^2	10^1	10^0	10^{-1}	10^{-2}	10^{-3}	10^{-4}
100000	10000	1000	100	10	1	0.1	0.01	0.001	0.0001

From the table you can see that $0.1 = \frac{1}{10} = 10^{-1}$ $0.01 = \frac{1}{100} = 10^{-2}$

Dividing by 100 is equivalent to multiplying by 10^{-2}

Metric Units The metric system is an international standard of measurement based on decimals. It is used to measure weight, liquids, and length. The modern metric system, introduced in Australia in 1970, is called the International System of Units (SI).

Quantity	Unit	Symbol
Length (dimensions)	metre	m
Mass (weight)	gram	g
Volume (liquids)	litre	L (or l or ℓ)
Time	second	s

Examples of other units are the Joule (J) , byte (B) and Watt (W).

Variations to the basic unit The basic unit of time, the second, may vary in quantity to include hours (1 minute = 60 s) or hours, days, months, etc. The other basic units may vary in quantities also. Large and small quantities of these units often have a prefix to make writing quantities more compact. To indicate these variations, a prefix is added to the basic unit. Note the symbols for each prefix. For example 0.000 001g may be written as 1 mcg or 1µg.

Prefix	Symbol	Example	Multiplication Factor	Order of Magnitude
giga	G	GL for gigalitre = 1,000,000,000 L	1,000,000,000 = 10^9	9
mega	M	ML for megalitre = 1,000,000 L	1,000,000 = 10^6	6
kilo	k	kg for kilogram = 1,000 g	1,000= 10^3	3
hecto	h		100= 10^2	2
deka	da		10= 10^1	1
Unit	e.g. m ,g, L or s		1= 10^0	0
deci	d	dL for decilitre = 0.1 L	0.1= 10^{-1}	-1
centi	c	cm for centimetre = 0.01 m	0.01= 10^{-2}	-2
milli	m	ms for millisecond = 0.001 s	0.001= 10^{-3}	-3
micro	mc or µ	mcg or µg for microgram = 0.000 000 1 g	0.000 001= 10^{-6}	-6

nano	n	nm for nanometre = 0.000 000 001 m	0.000 000 001= 10^{-9}	-9

10^{-9}	nano	n
10^{-8}		
10^{-7}		
10^{-6}	micro	μ
10^{-5}		
10^{-4}		
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^{0} = 1	unit	
10^{1}	deka	da
10^{2}	hecto	h
10^{3}	kilo	k
10^{4}		
10^{5}		
10^{6}	Mega	M
10^{7}		
10^{8}		
10^{9}	Giga	G

To convert from one metric unit to another: You need to know common metric equivalents and how to write one quantity of a unit in terms of another.

Some common metric equivalents :

Units of weight
10^3 millilitres = 1 litre
10^1 decilitres = 1 litre
10^3 litres = 1 kilolitre

Units of length / height
10^3 millimetres = 1 metre
10^2 centimetres = 1 metre
10^3 metres = 1 kilometre

Units of volume
10^6 micrograms = 1 gram
10^3 milligrams = 1 gram
10^3 grams = 1 kilogram

Examples

- A mass of 1.8 kg is equivalent to how many grams?

Since 1 kg is 10^3 g, rewrite the kg as 10^3 g. This gives us
1.8 kg = 1.8 x 10^3 g = 1.8 x 1000 g = 1800 g.

- How many g is 540 mg?

Recall that 10^3 mg = 1 g, so dividing by 10^3 gives 1 mg = 10^{-3} g, so rewrite the mg as 10^{-3} g. This gives
540 mg = 540 x 10^{-3} g = 540 x 0.001 g = 0.54 g.

The **order of magnitude of a number** is, intuitively speaking, the number of powers of 10 contained in the number. The order of magnitude of 86,000 is 4 since the highest power of 10 in this number is 10,000 = 10^4. The order of magnitude of 0.0045 is -3 , since the highest power of 10 in this number is 0.001 = 10^{-3}
The diameter of the DNA helix is approximately 2 nm, so is of the order of magnitude of -9 (equivalent to 10^{-9} m). It is the **same order of magnitude** as the thickness of a cell membrane (between 6 and 9 nm).

The **difference** in the **order of magnitude** between two values is a power of 10. For example, the estimated speed of a 'fast' neutron is 10,000,000 m/s (order of magnitude = 7). This is 4 orders of magnitude (10^4) faster than the estimated speed of a 'thermal' neutron which is 2000 m/s (order of magnitude = 3). And a centimetre (10^{-2} m) is 5 orders of magnitude smaller than a kilometre (10^3 m).

Practice Problems – Conversions and Order of Magnitude

1. Complete the table with as much information as you can.

Prefix	Symbol	In decimal notation	Order of magnitude
milli			
	μ		
		100	
mega			
		0.1	
			-2
	k		
giga			9

2. Work out the following metric conversions:

(a) 6 km in metres (d) 1.002 g in micrograms (g) 0.725 kg in grams

(b) 3.2 kL in millilitres (e) 8.214 L in decilitres (h) 52 mm in centimetres

(c) 44 mm in metres (f) 120 g in kilograms (i) 40000 ng in micrograms

3. The diameter of Jupiter is 142.984 km and the diameter of the Sun is 1.39 Gm. Express both diameters in metres. How many orders of magnitude is the Sun's diameter larger than that of Jupiter?

4. Given that 1 m^3 = 1 000 000 cm^3, convert

(a) 3.5 m^3 to cm^3 (b) 5240 cm^3 to m^3

Solutions to Practice Problems

1.

Prefix	Symbol	In decimal notation	Order of magnitude
milli	m	0.001	-3
micro	μ	0.000 001	-6
hecto	h	100	2
mega	M	1,000,000	6
deci	d	0.1	-1
centi	c	0.01	-2
kilo	k	1000	3
giga	G	1 000 000 000	9

2. (a) 600 metres (d) 0.000 001 002 micrograms (g) 725 grams
(b) 3,200,000 millilitres (e) 82.14 decilitres (h) 5.2 centimetres
(c) 0.044 metres (f) 0.12 kilograms (i) 40 micrograms

3. Larger by 4 orders of magnitude. 4. (a) 3.5 x10^6 cm^3 (b) 0.00524 m^3