Units Summary Sheet

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1 SI Units

Almost all physical quantities have units, which tell us what type of physical quantity we are talking about. There are seven "base units" or "SI units", which provide the starting point for every other possible physical quantity we could think of. In Chemistry, we usually use six of these SI base units:

Symbol	s	m	kg	A	K	mol
Name	second	metre	kilogram	ampere	kelvin	mole
Quantity	time	length	mass	electric current	temperature	amount of substance

Table 1: The six SI units which are commonly used in chemistry

2 Combining Units

We can combine units by multiplying them together or dividing by them. The result is called a compound unit. For example, we can create a compound unit for speed: m s^{-1}.

$$\text{Speed} = \text{Distance} \,/\, \text{Time}$$
$$\text{Speed} = 5\,\text{m}/10\,\text{s} = 0.5\,\text{m s}^{-1}$$

Sometimes compound units have specific names, which makes them simpler to write. For example, one unit of force is defined as the force required to make one kilogram move one meter per second faster in one second, or in other words to accelerate one kilogram by one meter per second squared.

$$\text{Force} = \text{Mass} \times \text{Acceleration}$$
$$\text{Force} = 1\,\text{kg} \times 1\,\text{m s}^{-2} = 1\,\text{kg m s}^{-2} = 1\text{N}$$

We call one unit of force one Newton (symbol N), mostly because that's faster than writing the SI unit of force (kg m s^{-2}) every time.

In more complex equations, we might find that we can cancel out units to simplify them, just like we might cancel out numbers in a fraction. For example, the equation for the electrostatic energy between two charged particles is:

$$E = \frac{q_1 q_2}{4\pi\epsilon_0 r} \tag{1}$$

In this equation, q_1 and q_2 are the charges of the two particles and have units of Coulombs (C), which in SI units is equal to A s. r is the distance between the two particles, and so has units m, and ϵ_0 is a physical constant called the vacuum permittivity with units C^2 m^{-2} N^{-1}. Combining all of these units:

$$\text{Units of } E = \frac{\text{C}^2}{\text{C}^2\text{m}^{-2}\text{N}^{-1}\text{m}} = \frac{1}{\text{m}^{-1}\text{N}^{-1}} = \text{N m} = \text{kgm}^2\text{s}^{-2} \tag{2}$$

The units of energy should always be the same, regardless of the type of energy: as a practice exercise, check that you get the same units for kinetic energy.

3 Metric Prefixes

In order to make our lives easier, we often use metric prefixes to multiply quantities by certain factors of 10. For example, instead of writing 0.001 mol, to indicate one thousandth of a mole of substance, we can write that as 1 mmol, where the prefix m means one thousandth. For very small or very large numbers, we use these prefixes instead of powers of 10: 5×10^{-15} s = 5 fs. We can also apply these prefixes to compound units: 1 kN is equal to 1000 N. Common metric prefixes are given in the table below.

Symbol	f	p	n	μ	m	c	d	k	M
Prefix	femto	pico	nano	micro	milli	centi	deci	kilo	mega
Factor	10^{-15}	10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^{3}	10^{6}

Table 2: Commonly used metric prefixes