

Transition from GCSE to A Level

Moving from GCSE Science to A Level can be a daunting leap. You'll be expected to remember a lot more facts, equations, and definitions, and you will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This worksheet aims to give you a head start by helping you:

- to pre-learn some useful knowledge from the first chapter of your A Level course
- understand and practice of some of the maths skills you'll need.

You will also need to watch the video here <https://www.youtube.com/watch?v=t0QoNKFTzFA>

about writing ionic formulae. Make some notes and do the questions following the instructions on the video.

Bring your work with you on the first day at college. There will be a quiz on this work in the first lesson.

Learning objectives

After completing the worksheet and watching the video you should be able to:

- recall the answers to the retrieval questions
- perform maths skills including:
 - converting between units and standard form and decimals
 - balancing chemical equations
 - rearranging equations
- be able to write ionic formulae

Retrieval questions

Atoms, ions, and compounds

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

What does an atom consist of?	a nucleus containing protons and neutrons, surrounded by electrons
What are the relative masses of a proton, neutron, and electron?	1, 1, and $\frac{1}{1836}$ respectively
What are the relative charges of a proton, neutron, and electron?	+1, 0, and -1 respectively
How do the number of protons and electrons differ in an atom?	they are the same because atoms have neutral charge
How does the number of protons differ between atoms of the same element?	it does not differ – all atoms of the same element have the same number of protons
What is the proton number / atomic number of an element?	the number of protons in the atom's nucleus of an element
What is the mass number of an element?	number of protons + number of neutrons
What is an isotope?	an atom with the same number of protons but different number of neutrons
What is the equation for relative isotopic mass?	relative isotopic mass = $\frac{\text{mass of an isotope}}{\frac{1}{12} \text{ mass of 1 atom of } ^{12}\text{C}}$
What is the equation for relative atomic mass (A_r)?	relative atomic mass = $\frac{\text{weighted mean mass of 1 atom}}{\frac{1}{12} \text{ mass of 1 atom of } ^{12}\text{C}}$
What is the equation for relative molecular mass (M_r)?	relative molecular mass = $\frac{\text{average mass of 1 molecule}}{\frac{1}{12} \text{ mass of 1 atom of } ^{12}\text{C}}$
What is an ion?	an atom or group of atoms with a charge (a different number of electrons to protons)
Define the term cation	a positive ion (atom with fewer electrons than protons)
Define the term anion	a negative ion (atom with more electrons than protons)
What is the function of a mass spectrometer?	it accurately determines the mass and abundance of separate atoms or molecules, to help us identify them
What is a mass spectrum?	the output from a mass spectrometer that shows the different isotopes that make up an element

Maths skills

1 Core mathematical skills

A practical chemist must be proficient in standard form, significant figures, decimal places, SI units, and unit conversion.

1.1 Standard form

In science, very large and very small numbers are usually written in standard form. Standard form is writing a number in the format $A \times 10^x$ where A is a number from 1 to 10 and x is the number of places you move the decimal place.

For example, to express a large number such as $50\,000 \text{ mol dm}^{-3}$ in standard form, $A = 5$ and $x = 4$ as there are four numbers after the initial 5.

Therefore, it would be written as $5 \times 10^4 \text{ mol dm}^{-3}$.

To give a small number such as $0.000\,02 \text{ Nm}^2$ in standard form, $A = 2$ and there are five numbers before it so $x = -5$.

So it is written as $2 \times 10^{-5} \text{ Nm}^2$.

Practice questions

- Change the following values to standard form.
 - boiling point of sodium chloride: $1413 \text{ }^\circ\text{C}$
 - largest nanoparticles: $0.0\,001 \times 10^{-3} \text{ m}$
 - number of atoms in 1 mol of water: 1806×10^{21}
- Change the following values to ordinary numbers.
 - 5.5×10^{-6}
 - 2.9×10^2
 - 1.115×10^4
 - 1.412×10^{-3}
 - 7.2×10^1

1.2 Significant figures and decimal places

In chemistry, you are often asked to express numbers to either three or four significant figures. The word significant means to 'have meaning'. A number that is expressed in significant figures will only have digits that are important to the number's precision.

It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

For example, 6.9301 becomes 6.93 if written to three significant figures.

Likewise, 0.000 434 56 is 0.000 435 to three significant figures.

Notice that the zeros before the figure are *not* significant – they just show you how large the number is by the position of the decimal point. Here, a 5 follows the last significant digit, so just as with decimals, it must be rounded up.

Any zeros between the other significant figures are significant. For example, 0.003 018 is 0.003 02 to three significant figures.

Sometimes numbers are expressed to a number of decimal places. The decimal point is a place holder and the number of digits afterwards is the number of decimal places.

For example, the mathematical number pi is 3 to zero decimal places, 3.1 to one decimal place, 3.14 to two decimal places, and 3.142 to three decimal places.

Practice questions

- 3 Give the following values in the stated number of significant figures (s.f.).
a 36.937 (3 s.f.) **b** 258 (2 s.f.) **c** 0.043 19 (2 s.f.) **d** 7 999 032 (1 s.f.)

- 4 Use the equation:
 number of molecules = number of moles \times 6.02×10^{23} molecules per mole
 to calculate the number of molecules in 0.5 moles of oxygen. Write your answer in standard form to 3 s.f.

- 5 Give the following values in the stated number of decimal places (d.p.).
a 4.763 (1 d.p.) **b** 0.543 (2 d.p.) **c** 1.005 (2 d.p.) **d** 1.9996 (3 d.p.)

1.3 Converting units

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard units – most are *Système International* (SI) units.

If you convert between units and round numbers properly it allows quoted measurements to be understood within the scale of the observations.

Multiplication factor	Prefix	Symbol
10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

Unit conversions are common. For instance, you could be converting an enthalpy change of $488\,889 \text{ J mol}^{-1}$ into kJ mol^{-1} . A kilo is 10^3 so you need to divide by this number or move the decimal point three places to the left.

$$488\,889 \div 10^3 \text{ kJ mol}^{-1} = 488.889 \text{ kJ mol}^{-1}$$

Converting from mJ mol^{-1} to kJ mol^{-1} , you need to go from 10^3 to 10^{-3} , or move the decimal point six places to the left.

$$333 \text{ mJ mol}^{-1} \text{ is } 0.000\,333 \text{ kJ mol}^{-1}$$

If you want to convert from 333 mJ mol^{-1} to nJ mol^{-1} , you would have to go from 10^{-9} to 10^{-3} , or move the decimal point six places to the right.

$$333 \text{ mJ mol}^{-1} \text{ is } 333\,000\,000 \text{ nJ mol}^{-1}$$

Practice question

- 6 Calculate the following unit conversions.
a $300 \mu\text{m}$ to m
b 5 MJ to mJ
c 10 GW to kW

2 Balancing chemical equations

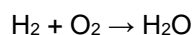
2.1 Conservation of mass

When new substances are made during chemical reactions, atoms are not created or destroyed – they just become rearranged in new ways. So, there is always the same number of each type of atom before and after the reaction, and the total mass before the reaction is the same as the total mass after the reaction. This is known as the conservation of mass.

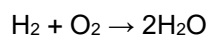
You need to be able to use the principle of conservation of mass to write formulae, and balanced chemical equations and half equations.

2.2 Balancing an equation

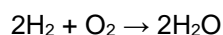
The equation below shows the correct formulae but it is not balanced.



While there are two hydrogen atoms on both sides of the equation, there is only one oxygen atom on the right-hand side of the equation against two oxygen atoms on the left-hand side. Therefore, a two must be placed before the H_2O .



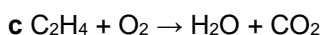
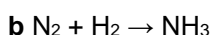
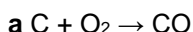
Now the oxygen atoms are balanced but the hydrogen atoms are no longer balanced. A two must be placed in front of the H_2 .



The number of hydrogen and oxygen atoms is the same on both sides, so the equation is balanced.

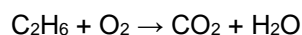
Practice question

1 Balance the following equations.

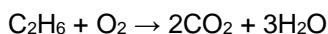


2.3 Balancing an equation with fractions

To balance the equation below:

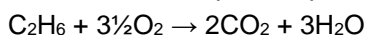


- Place a two before the CO_2 to balance the carbon atoms.
- Place a three in front of the H_2O to balance the hydrogen atoms.

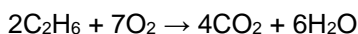


There are now four oxygen atoms in the carbon dioxide molecules plus three oxygen atoms in the water molecules, giving a total of seven oxygen atoms on the product side.

- To balance the equation, place three and a half in front of the O_2 .

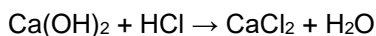


- Finally, multiply the equation by 2 to get whole numbers.



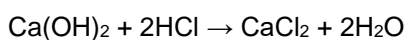
Practice question

- 2 Balance the equations below.
- a $\text{C}_6\text{H}_{14} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
- b $\text{NH}_2\text{CH}_2\text{COOH} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} + \text{N}_2$

2.4 Balancing an equation with brackets

Here the brackets around the hydroxide (OH^-) group show that the $\text{Ca}(\text{OH})_2$ unit contains one calcium atom, two oxygen atoms, and two hydrogen atoms.

To balance the equation, place a two before the HCl and another before the H_2O .

**Practice question**

- 3 Balance the equations below.
- a $\text{Mg}(\text{OH})_2 + \text{HNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + \text{H}_2\text{O}$
- b $\text{Fe}(\text{NO}_3)_2 + \text{Na}_3\text{PO}_4 \rightarrow \text{Fe}_3(\text{PO}_4)_2 + \text{NaNO}_3$

3 Rearranging equations**3.1 Rearranging equations**

In chemistry, you sometimes need to rearrange an equation to find the desired values.

For example, you may know the amount of a substance (n) and the mass of it you have (m), and need to find its molar mass (M).

The amount of substance (n) is equal to the mass you have (m) divided by the molar mass (M):

$$n = \frac{m}{M}$$

You need to rearrange the equation to make the molar mass (M) the subject.

Multiply both sides by the molar mass (M):

$$M \times n = m$$

Then divide both sides by the amount of substance (n):

$$m = \frac{m}{N}$$

Practice questions

- 1 Rearrange the equation $c = \frac{n}{V}$ to make:
- a n the subject of the equation
- b V the subject of the equation.
- 2 Rearrange the equation $PV = nRT$ to make:
- a n the subject of the equation
- b T the subject of the equation.

Maths skills – check your answers

1 Core mathematics

Practice questions

- 1 a 1.413×10^3 °C b 1.0×10^{-7} m
c 1.806×10^{21} atoms
- 2 a 0.000 0055 b 290
c 11150 d 0.001 412
e 72
- 3 a 36.9 b 260
c 0.043 d 8 000 000
- 4 Number of molecules = $0.5 \text{ moles} \times 6.022 \times 10^{23} = 3.011 \times 10^{23} = 3.01 \times 10^{23}$
- 5 a 4.8 b 0.54
c 1.01 d 2.000
- 6 a 0.0003 m b 5×10^9 mJ
c 1×10^7 kW

2 Balancing chemical equations

Practice questions

- 1 a $2\text{C} + \text{O}_2 \rightarrow 2\text{CO}$ b $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$
c $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{H}_2\text{O} + 2\text{CO}_2$
- 2 a $\text{C}_6\text{H}_{14} + 9\frac{1}{2}\text{O}_2 \rightarrow 6\text{CO}_2 + 7\text{H}_2\text{O}$ or $2\text{C}_6\text{H}_{14} + 19\text{O}_2 \rightarrow 12\text{CO}_2 + 14\text{H}_2\text{O}$
b $2\text{NH}_2\text{CH}_2\text{COOH} + 4\frac{1}{2}\text{O}_2 \rightarrow 4\text{CO}_2 + 5\text{H}_2\text{O} + \text{N}_2$
or $4\text{NH}_2\text{CH}_2\text{COOH} + 9\text{O}_2 \rightarrow 8\text{CO}_2 + 10\text{H}_2\text{O} + 2\text{N}_2$
- 3 a $\text{Mg}(\text{OH})_2 + 2\text{HNO}_3 \rightarrow \text{Mg}(\text{NO}_3)_2 + 2\text{H}_2\text{O}$
b $3\text{Fe}(\text{NO}_3)_2 + 2\text{Na}_3\text{PO}_4 \rightarrow \text{Fe}_3(\text{PO}_4)_2 + 6\text{NaNO}_3$

3 Rearranging equations

Practice questions

- 1 a $n = cv$ b $v = \frac{n}{c}$
- 2 a $n = \frac{PV}{RT}$ b $T = \frac{PV}{nR}$