1 - FORMULAE

If you are serious about doing A level Chemistry, you **MUST** be able to write a formula without a second thought. It is the single most essential skill for an A level chemist.

You have to know and be able to use the information on this page – you should not be looking it up. There is no data sheet with ion charges at A level.

Elements

Monatomic	Simple molecular	Ionic	Metallic	Giant covalent
helium neon argon krypton xenon radon	hydrogen nitrogen oxygen fluorine chlorine bromine iodine phosphorus sulfur	There are no ionic elements!!	The formula is just the symbol, e.g. magnesium iron sodium nickel	The formula is just the symbol diamond graphite silicon

Compounds

Monatomic	Simple molecular	Ionic	Metallic	Giant covalent
There are no monatomic compounds!!	Some common molecular compounds: carbon dioxide carbon monoxide nitrogen monoxide nitrogen dioxide sulfur dioxide sulfur trioxide ammonia methane hydrogen sulfide	These have to be worked out using ion charges – you have to know these at AS/A level! LEARN them ASAP. Note these acids: hydrochloric acid sulfuric acid nitric acid phosphoric acid	There are no metallic compounds!!	silicon dioxide

Positive ions		Negative ions	
Group 1 ions: lithium sodium potassium Group 2 ions: magnesium calcium barium	Group 3 ions: aluminium Other common ions silver zinc ammonium hydrogen	Group 7 ions: fluoride chloride bromide iodide Group 6 ions: oxide sulfide	Other common ions nitrate sulfate carbonate hydrogencarbonate hydroxide hydride phosphate

TASK 1 – WRITING FORMULAS OF IONIC COMPOUNDS

1) silver bromide .....
2) sodium carbonate .....
3) potassium oxide .....
4) iron (III) oxide .....
5) chromium (III) chloride .....
6) calcium hydroxide .....
7) aluminium nitrate .....
8) sodium sulfate .....
9) lead (II) oxide .....
10) sodium phosphate .....
11) zinc hydrogencarbonate .....
12) ammonium sulphate .....
13) gallium hydroxide .....
14) strontium selenide .....
15) radium sulfate .....
16) sodium nitride .....

TASK 2 – WRITING FORMULAS 1

1) lead (IV) oxide .....
2) copper .....
3) sodium .....
4) ammonium chloride .....
5) ammonia .....
6) sulfur .....
7) sulfuric acid .....
8) neon .....
9) silica .....
10) silicon .....
11) barium hydroxide .....
12) tin (IV) chloride .....
13) silver nitrate .....
14) iodine .....
15) nickel .....
16) hydrogen sulfide .....
17) titanium (IV) oxide .....
18) lead .....
19) strontium sulfate .....
20) lithium .....

TASK 3 – WRITING FORMULAS 2

1) silver carbonate .....
2) gold .....
3) platinum (II) fluoride .....
4) nitric acid .....
5) ammonia .....
6) silicon (IV) hydride .....
7) phosphorus .....
8) diamond .....
9) vanadium (V) oxide .....
10) cobalt (II) hydroxide .....
11) barium hydroxide .....
12) ammonia .....
13) hydrochloric acid .....
14) fluorine .....
15) silicon .....
16) calcium phosphate .....
17) rubidium .....
18) germanium (IV) oxide .....
19) magnesium astatide .....
20) nitrogen monoxide .....

2 - EQUATIONS

From an early age you should have been able to balance chemical equations. However, at A level, you will often need to:

- work out the formulas yourselves
- work out what is made (so you need to know some basic general equations)
- for reactions involving ions in solution, write ionic equations

Some general reactions you should know:

General Reaction	Examples
substance + oxygen → oxides	$2\ Mg + O_2 \rightarrow 2\ MgO$ $2\ H_2S + 3\ O_2 \rightarrow 2\ H_2O + 2\ SO_2$ $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$
metal + water → metal hydroxide + hydrogen	$2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$
metal + acid → salt + hydrogen	$Mg + 2\ HCl \rightarrow MgCl_2 + H_2$
oxide + acid → salt + water	$MgO + 2\ HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$
hydroxide + acid → salt + water	$2\ NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$
carbonate + acid → salt + water + carbon dioxide	$CuCO_3 + 2\ HCl \rightarrow CuCl_2 + H_2O + CO_2$
hydrogencarbonate + acid → salt + water + carbon dioxide	$KHCO_3 + HCl \rightarrow KCl + H_2O + CO_2$
ammonia + acid → ammonium salt	$NH_3 + HCl \rightarrow NH_4Cl$
metal carbonate → metal oxide + carbon dioxide (on heating)	$CaCO_3 \rightarrow CaO + CO_2$

TASK 4 – WRITING BALANCED EQUATIONS

1) Balance the following equations.

a) $Mg + HNO_3 \rightarrow Mg(NO_3)_2 + H_2$

b) $CuCl_2 + NaOH \rightarrow Cu(OH)_2 + NaCl$

c) $SO_2 + O_2 \rightarrow SO_3$

d) $C_4H_{10} + O_2 \rightarrow CO_2 + H_2O$

2) Give balanced equations for the following reactions.

a) sodium + oxygen → sodium oxide

b) aluminium + chlorine → aluminium chloride

c) calcium + hydrochloric acid → calcium chloride + hydrogen

d) ammonia + sulphuric acid → ammonium sulphate

TASK 5 – WRITING BALANCED EQUATIONS 2

Write balance equations for the following reactions:

1) burning aluminium

2) burning hexane (C_6H_{14})

3) burning ethanethiol (CH_3CH_2SH)

4) reaction of lithium with water

5) reaction of calcium carbonate with nitric acid

6) thermal decomposition of lithium carbonate

7) reaction of ammonia with nitric acid

8) reaction of potassium oxide with sulfuric acid

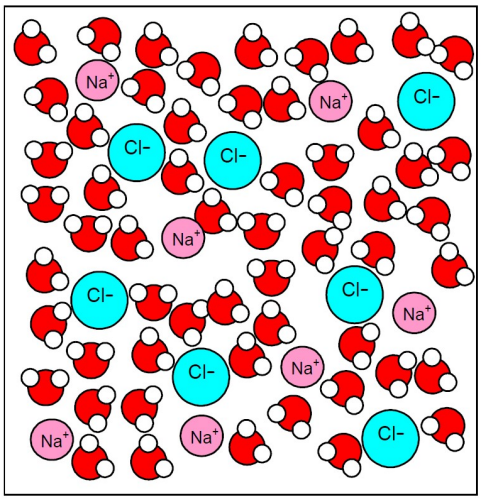
9) reaction of calcium hydroxide with hydrochloric acid

10) reaction of zinc with phosphoric acid

11) reaction of sodium hydrogencarbonate with sulfuric acid

12) reaction of potassium hydroxide with sulfuric acid

Ionic equations



When an ionic substance dissolves in water, the positive and negative ions separate and become hydrated (they interact with water molecules rather than each other). For example, a solution of sodium chloride could also be described as a mixture of hydrated sodium ions and hydrated chloride ions in water.

In reactions involving ionic compounds dissolved in water, some of the ions may not be involved in the reaction. These are called ***spectator ions***. For such reactions, we can write an ***ionic equation*** that only shows the species that are involved in the reaction.

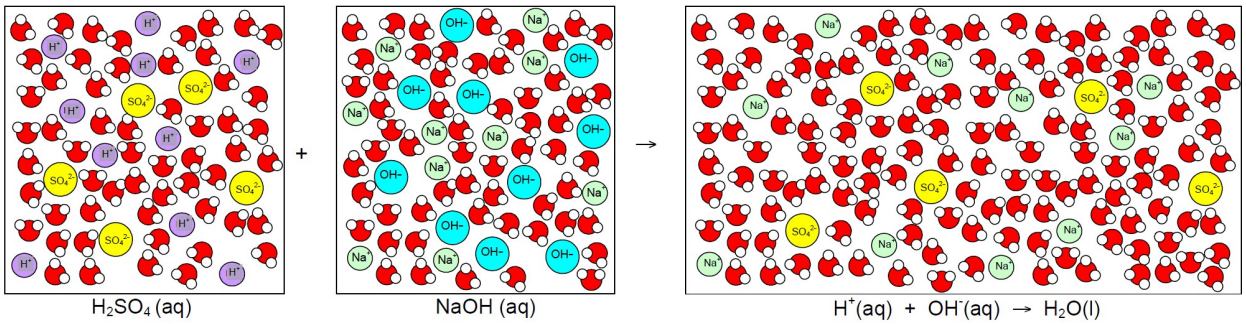
Simple examples are equations for which ionic equations can be written include:

Reactions of acids:

Common ionic equations are:	acid + hydroxide	$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
	acid + carbonate	$2\ H^+(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g)$
	acid + hydrogencarbonate	$H^+(aq) + HCO_3^-(aq) \rightarrow H_2O(l) + CO_2(g)$
	acid + ammonia	$H^+(aq) + NH_3(aq) \rightarrow NH_4^+(aq)$

We can even use these ionic equations to work out the ratio in which acids react without writing any equation.

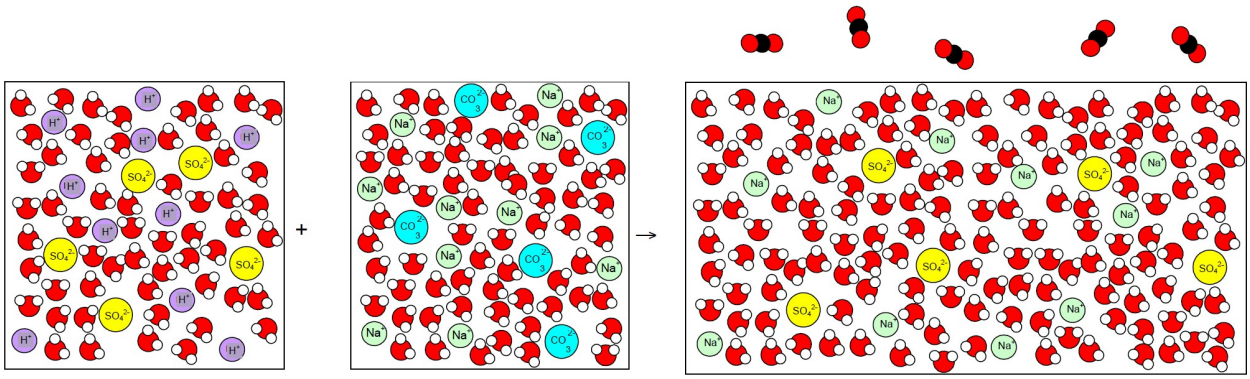
For example, in the reaction of $H_2SO_4(aq)$ with $NaOH(aq)$ we know that one lot of H_2SO_4 contains two lots of H^+ ions. As H^+ ions react with OH^- ions in the ratio 1:1 [$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$] we know that we need two lots of NaOH to provide two lots of OH^- ions to react with the two lots of H^+ ions. Therefore, one lot of H_2SO_4 reacts with two lots of NaOH, i.e. the reacting ratio of H_2SO_4 : NaOH = 1:2



H_2SO_4 (aq)
contains H^+(aq)

NaOH (aq)
0contains OH^-(aq)

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
the Na^+(aq) and SO_4^{2-}(aq) ions are not involved



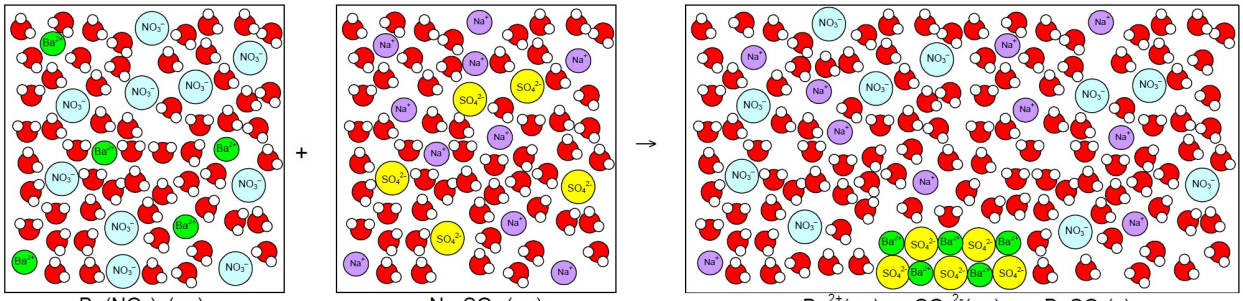
H_2SO_4 (aq)
contains H^+(aq)

Na_2CO_3 (aq)
contains CO_3^{2-}(aq)

$2\ H^+(aq) + CO_3^{2-}(aq) \rightarrow H_2O(l) + CO_2(g)$
the Na^+(aq) and SO_4^{2-}(aq) ions are not involved

Precipitation reactions

Some salts are insoluble in water. If solutions containing those ions are mixed, the insoluble salt forms as a solid as the solutions are mixed. This solid is known as a precipitate, and the reaction as precipitation.

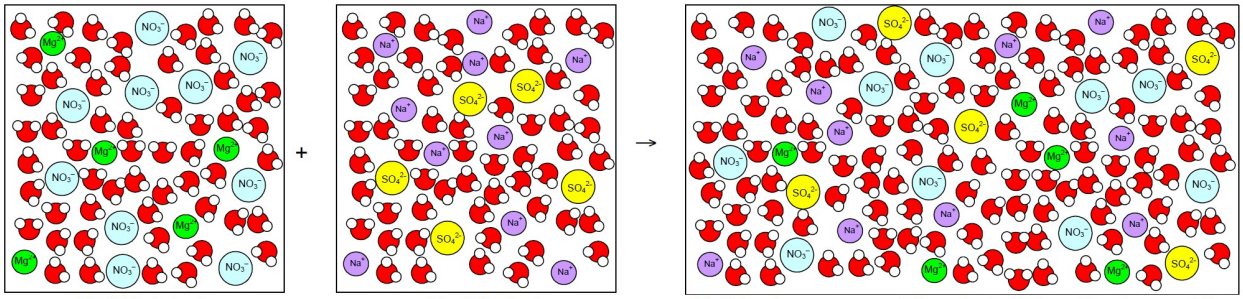


$Ba(NO_3)_2$ (aq)
contains Ba^{2+}(aq)

Na_2SO_4 (aq)
contains SO_4^{2-}(aq)

$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$

Most salts are soluble in water. Often when solutions of two salts are mixed, no such precipitation reaction will take place and the ions will remain dissolved in water.



$Mg(NO_3)_2$ (aq)

Na_2SO_4 (aq)

Nothing happens – solutions just mix together (none of the combinations of ions give an insoluble compound)

TASK 6 – IONIC EQUATIONS

1) Use your knowledge of ionic equations to give the molar ratio in which the following acids react with bases. Complete the table to show your answers.

Acid	Formula of acid	Base	Formula of base	Molar ratio of acid:base
hydrochloric acid		lithium hydroxide		
sulphuric acid		sodium hydrogencarbonate		
nitric acid		ammonia		
sulphuric acid		potassium carbonate		
nitric acid		strontium hydroxide		

2) Write ionic equations for each of the following reactions.

a) reaction of hydrochloric acid (aq) with potassium hydroxide (aq)

b) precipitation of silver iodide from reaction between silver nitrate (aq) and potassium iodide (aq)

c) reaction of potassium carbonate (aq) with nitric acid (aq)

d) precipitation of calcium hydroxide from reaction between sodium hydroxide (aq) and calcium chloride (aq)

e) reaction of ammonia (aq) with hydrochloric acid (aq)

f) reaction of sodium hydrogencarbonate (aq) with sulfuric acid (aq)

g) precipitation of calcium sulfate from reaction between calcium chloride (aq) and sulfuric acid (aq)

h) precipitation of lead (II) chloride from reaction between lead nitrate (aq) and sodium chloride (aq)

i) reaction of barium hydroxide (aq) with nitric acid (aq)

3 – SIGNIFICANT FIGURES & STANDARD FORM

Standard Form

- Standard form is very useful for writing very large or small numbers.
- They are written in the form A x 10^n where A is a number between 1 and 10.
- n represents the number of places the decimal point is moved (for +n values the decimal point has been moved to the left, for -n values the decimal point has been moved to the right).

Number	3435	1029000	0.025	23.2	0.0000278
Standard form	3.435×10^3	1.029×10^6	2.5×10^{-2}	2.32×10^1	2.78×10^{-5}

- To find the value of n:
  - for numbers greater than 1, n = number of places between first number and decimal place
  - for numbers less than 1, n = number of places from the decimal place to the first number (including that number)

Significant figures

Full number	1 sig fig	2 sig fig	3 sig fig	4 sig fig	5 sig fig
9.378652	9	9.4	9.38	9.379	9.3787
4204274	4000000	4200000	4200000	4204000	4204300
0.903521	0.9	0.90	0.904	0.9035	0.90352
0.00239482	0.002	0.0024	0.00239	0.002395	0.0023948

Significant figures for calculations involving multiplication / division

- Your final answer should be given to the same number of significant figures as the least number of significant figures in the data used.

  e.g. Calculate the average speed of a car that travels 1557 m in 95 seconds.

  average speed = $\frac{1557}{95}$ = 16 m/s (answer given to 2 sig fig as lowest sig figs in data is 2 sig fig for time)

  e.g. Calculate the average speed of a car that travels 1557 m in 95.0 seconds.

  average speed = $\frac{1557}{95}$ = 16.4 m/s (answer given to 3 sig fig as lowest sig figs in data is 3 sig fig for time)

Significant figures for calculations involving addition/subtraction ONLY

- Here the number of significant figures is irrelevant – it is about the place value of the data. For example

  e.g. Calculate the total energy released when 263 kJ and 1282 kJ of energy are released.

  Energy released = 263 + 1282 = 1545 kJ (answer is to nearest unit as both values are to nearest unit)

  e.g. Calculate the total mass of calcium carbonate when 0.154 g and 0.01234 g are mixed.

  Mass = 0.154 + 0.01234 = 0.166 g (answer is to nearest 0.001 g as least precise number is to nearest 0.001 g)

TASK 7 – SIGNIFICANT FIGURES & STANDARD FORM

1) Write the following numbers to the quoted number of significant figures.

a) 345789 4 sig figs ……

b) 297300 3 sig figs ……

c) 0.07896 3 sig figs ……

d) 6.0961 3 sig figs ……

e) 0.001563 3 sig figs ……

f) 0.010398 4 sig figs ……

2) Complete the following sums and give the answers to the appropriate number of significant figures.

a) 6125 x 384 ……

b) 25.00 x 0.010 ……

c) 13.5 + 0.18 ……

d) 7550 ÷ 25 ……

e) 0.000152 x 13.00 ……

f) 0.0125 x 0.025 ……

3) Write the following numbers in non standard form.

a) 1.5×10^{-3} ……

b) 4.6×10^{-4} ……

c) 3.575×10^{5} ……

d) 5.34×10^{2} ……

e) 1.03×10^{6} ……

f) 8.35×10^{-3} ……

4) Write the following numbers in standard form.

a) 0.000167 ……

b) 0.0524 ……

c) 0.000000015 ……

d) 34500 ……

e) 0.62 ……

f) 87000000 ……

5) Complete the following calculations and give the answers to the appropriate number of significant figures.

a) $6.125 \times 10^{-3} \times 3.5$ ……

b) $4.3 \times 10^{-4} \div 7.00$ ……

c) $4.0 \times 10^{8} + 35000$ ……

d) $0.00156 + 2.4 \times 10^{3}$ ……

e) $6.10 \times 10^{-2} - 3.4 \times 10^{-5}$ ……

f) $8.00 \times 10^{-3} \times 0.100 \times 10^{-3}$ ……