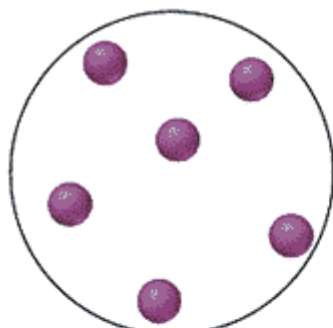
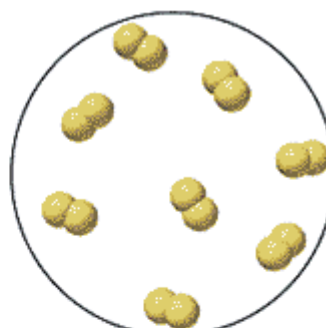

1.0 Basic Chemistry

This is the chemistry you should already know from GCSE:

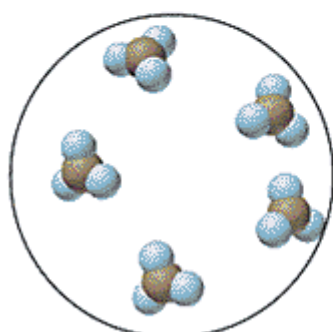
Elements, mixtures and compounds:



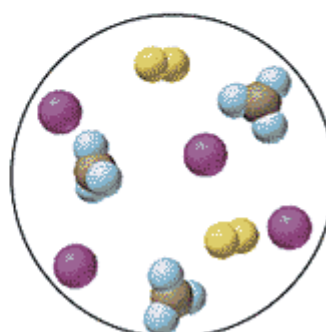
A Atoms of an element



B Molecules of an element



C Molecules of a compound



D Mixture of two elements and a compound

Atom	Simplest building block of matter.
Element	Made up of 1 type of atom.
Mixture	2 or more elements / compounds that are not chemically bonded together. They can be easily separated.
Compound	2 or more elements chemically bonded together.
Molecule	2 or more atoms chemically bonded together

Chemical formulae

1) Common molecules

Name of element	Formula of element	Name compound	Formula of compound	Name of acid	Formula of acid
Hydrogen	H ₂	Water	H ₂ O	Hydrochloric	HCl
Nitrogen	N ₂	Carbon dioxide	CO ₂	Nitric	HNO ₃
Oxygen	O ₂	Carbon monoxide	CO	Sulphuric	H ₂ SO ₄
Halogens	X ₂ Cl ₂	Ammonia	NH ₃	Phosphoric	H ₃ PO ₄

- All gases except Group 0, Noble gases go round in pairs as diatomic molecules.
- All Group VII elements, the Halogens, also go round in pairs as diatomic molecules.

2) Simple ions

Group	1	2	3	4	5	6	7	0
e's in outer shell	1	2	3	4	5	6	7	Full
Gains / loses when reacts to leave a full shell	Loses 1e	Loses 2e	Loses 3e	Loses / gains 4e	Gains 3e	Gains 2e	Gains 1e	
Charge on ion	+1	+2	+3	+/-4	-3	-2	-1	
Example	Li ⁺	Be ²⁺	B ³⁺		N ³⁻	O ²⁻	F ⁻	

3) Compound ions

Charge on ion	Name	Formula
1-	Hydroxide	OH ¹⁻
	Nitrate	NO ₃ ¹⁻
	Hydrogen carbonate	HCO ₃ ¹⁻
2-	Sulphate	SO ₄ ²⁻
	Carbonate	CO ₃ ²⁻
3-	Phosphate	PO ₄ ³⁻
1+	Ammonium	NH ₄ ¹⁺

4) Transition metal ions

- These do not belong to a group so you are told the charge on the ion with a roman numeral

Roman numerals

Charge	1+	2+	3+	4+	5+	6+	7+
Roman numeral	I	II	III	IV	V	VI	VII

Writing formula

- The ions in a chemical formula must **add up to zero**.
- Use subscripts after an ion in a formula to double/triple that ion so the sum = 0. eg. CuCl_2
- If you are double/tripling ions that consist of more than one element brackets must be used. eg. $\text{Ca}(\text{OH})_2$
- In formula – these are the numbers 'on the floor'

Examples:

a) Simple formula:

- Use the Periodic table to look up the chemical symbols and the charges on the ions
- Scale up so the charges cancel out
- Non metal endings change to 'ide'

Sodium Chloride –



Write the ions with charges

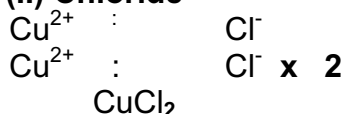
Scale up if necessary to =0

Bring together omitting the charges

b) Complex formula:

- One of the ions will **not** be on the Periodic table, it will be a **compound ion**.
- The formula is worked out the same as before.
- If you scale up compound ions, **you must use brackets**
- If you do not scale up compound ions, **you must NOT use brackets**

Copper (II) Chloride

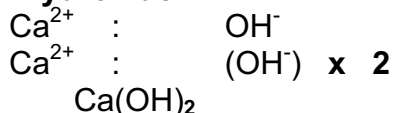


Write the ions with charges

Scale up if necessary to =0

Bring together omitting the charges

Calcium Hydroxide



Write the ions with charges

Scale up if necessary to =0

Bring together omitting the charges

TIP: Once the formulae is written – NEVER CHANGE THE NUMBERS

Examples – have a go at the following:

1 Calcium fluoride

2 Sodium oxide

3 Aluminium chloride

4 Gallium nitride

5 Magnesium hydroxide

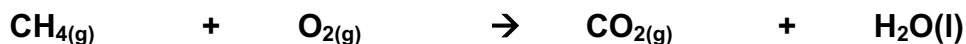
6 Sodium nitrate

7 Sodium sulphate

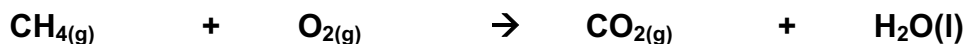
8 Gallium carbonate

Types of reactions

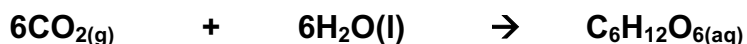
1. **Combustion** – A reaction with oxygen



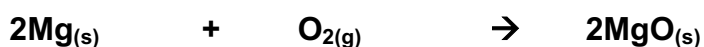
2. **Exothermic** – A reaction that releases heat energy to the surroundings



3. **Endothermic** – A reaction that gains energy from the surroundings



4. **REDOX** – A reaction where REDuction (is gain of electrons) and OXidation (is loss of electrons) takes place



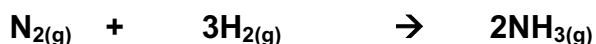
5. **Displacement** – Where a more reactive element 'displaces' a less reactive element



6. **Decomposition** – Where a reactant breaks down into 2 or more products



7. **Reversible** – A reaction where reactants \rightarrow products or products \rightarrow reactants



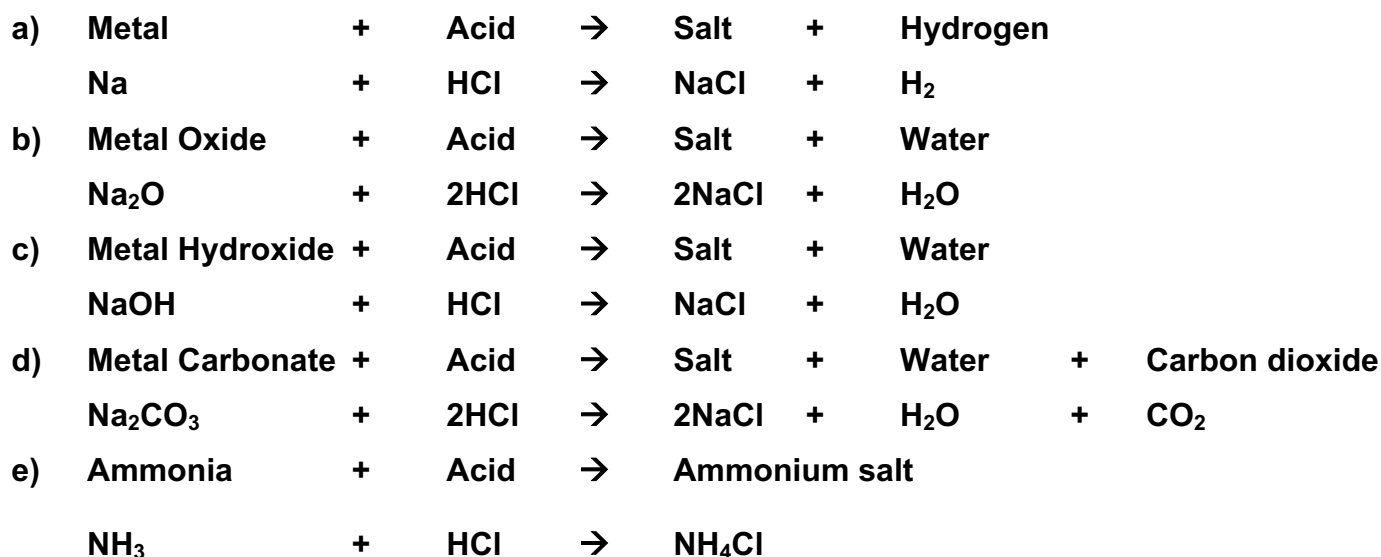
8. **Acid reactions** – A reaction where an acid forms a salt

Acid – Is a substance that donates protons, H^+ ions: HCl

Base – Is a substance that accepts protons, H^+ ions: NH_3

Alkali – Is a substance that releases hydroxide ions, OH^- in aqueous solution: NaOH

Salt – Is formed when the hydrogen ions in an acid is replaced by a positive metal or ammonium ion



Balancing chemical equations

- The acid reactions will be used as examples, a few connections first.

Acid reactions – A reaction where an acid forms a salt

- a) **Metal** + **Acid** → **Salt** + **Hydrogen**
b) **Metal Oxide** + **Acid** → **Salt** + **Water**
c) **Metal Hydroxide** + **Acid** → **Salt** + **Water**
d) **Metal Carbonate** + **Acid** → **Salt** + **Water** + **Carbon dioxide**
e) **Ammonia** + **Acid** → **Ammonium salt**

- a) $\text{Na} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2$
b) $\text{Na}_2\text{O} + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O}$
c) $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
d) $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$
e) $\text{NH}_3 + \text{HCl} \rightarrow \text{NH}_3\text{Cl}$

Chemical connections:

Water or Hydrogen

- If you look at the reactants in (a), you'll notice that the metal has **no oxygen present**.
- This means that water, H_2O **cannot be formed, therefore H_2 is the product**
- If you look at the reactants in (a) – (d), you'll notice that the metal **has oxygen present**.
- This means that water, H_2O **can be formed, therefore H_2O is the product**

Carbon dioxide or not

- If you look at the reactants in (d), you'll notice that the metal has **3 oxygen's and 1 carbon present**.
- This means that water, H_2O **can be formed, therefore H_2O is the product**
- What is left is **1 carbon and 2 oxygen's, so CO_2 is also formed**

All salts contain the following

- A positive cation - usually a metal or ammonium (NH_4^+)
- A negative anion derived from an acid

Salt – where the hydrogen ion in an acid is replaced with a metal or ammonium ion

Acid	Sulphuric	Nitric	Hydrochloric	Phosphoric
Formula of acid	H_2SO_4	HNO_3	HCl	H_3PO_4
Salt	...sulphate	...nitrate	...chloride	...phosphate
Formula ...salt	... SO_4^{2-}	... NO_3^{1-}	... Cl^{1-}	... PO_4^{3-}

Note – The number of acidic hydrogen's in the acid = the size of the negative charge on the anion formed:

Balancing chemical reactions:

- Balance using **Big numbers Before** the species with that elements in to scale up the number of moles of reactants → products.
- A rule of thumb to help you balance is to balance the elements in this order - **MACHO**:
Metal
Any other element
Carbon
Hydrogen
Oxxygen

A table helps.

Iron + Hydrochloric acid → Iron (II) chloride + Hydrogen



Fe	1		1	
Cl		1 x 2 = 2	2	
H		2		2

- Put the **2** that you have multiplied up by before the molecule with the element you are scaling up.
- You now have the same number of atoms on each side.

State symbols

- All that remains is to add state symbols to the balanced chemical reaction

Solid	(s)
Liquid	(l)
Gas	(g)
Aqueous (dissolved in water)	(aq)



- All metal elements are solids, (s).
- All acids are dissolved in water, (aq)
- All ionic compounds are either solids or dissolved in water, (s) or (aq)

A rule of thumb:

- Ionic compounds dissolve in water.
- If there is water as a product or water as (aq) in the reactants then the ionic compound's state symbol will be (aq)

- Water is the solvent that (aq) chemistry takes place in. You cannot dissolve water in water so water is a liquid, (l)

Summary:

Step 1

Write out the word equation

Step 2

Write the correct chemical formula

Step 3

Balance using **MACHO**

Step 4

Add the state symbols

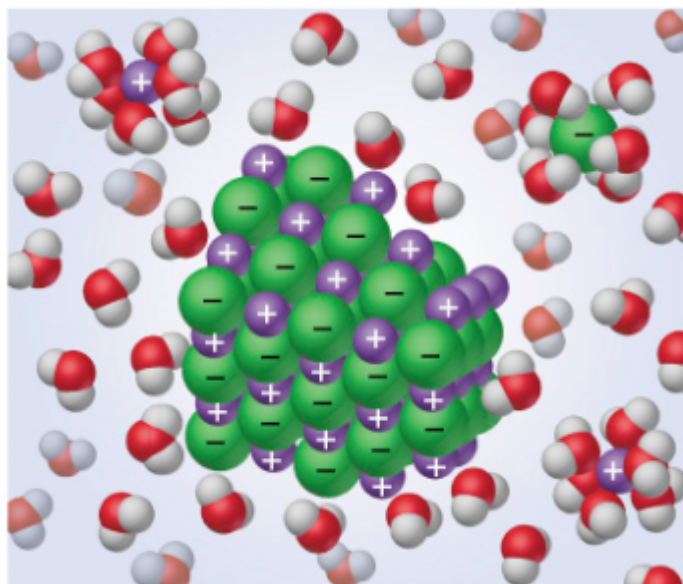
Examples – have a go at the following:



9. **Ionic equations** – Where the spectator ions are removed revealing the species involved in the reaction



- Ionic compounds when dissolved in water separate out into their constituent ions
- For example – aqueous NaCl is actually a solution of Na^+ ions and Cl^- ions as shown below: [Click image for animation](#)



- This allows us to look at the actual aqueous ions involved in the reaction.
- Ions that are not involved in reactions are called **spectator ions** as they do little more than 'watch' the reaction.

Rules:

1. All acids are (aq) therefore can be written with their acidic hydrogens dissociated:



2. All soluble ionic compounds, (aq) ions dissociated:



3. All insoluble ionic compounds, (s) ions will NOT dissociated:

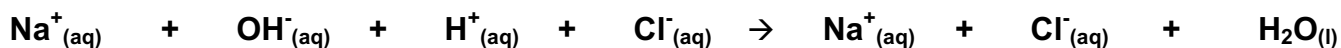


Example 1:

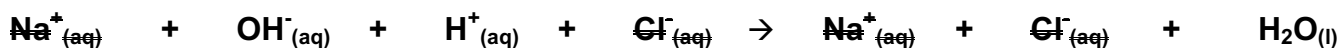
- 1) Write the full balanced chemical equation



- 2) Separate any ionic or acids species found with an aqueous state symbols



- 3) Identify and cross out the spectator ions



- 1) Rewrite the **balanced ionic equation** without the spectator ions

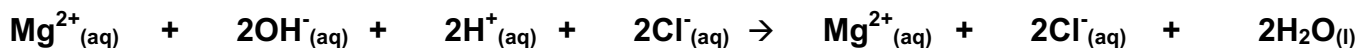


Example 2:

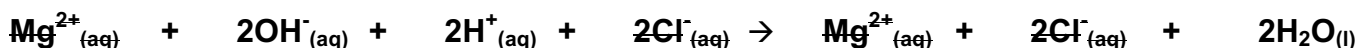
- 1) Write the full balanced chemical equation



- 2) Separate any ionic or acids species found with an aqueous state symbols



- 3) Identify and cross out the spectator ions



- 2) Rewrite the **balanced ionic equation** without the spectator ions

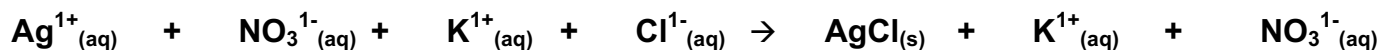


Example 3: A precipitation reaction

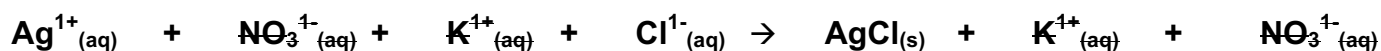
3) Write the full balanced chemical equation



4) Separate any ionic or acids species found with an aqueous state symbols



5) Identify and cross out the spectator ions



- $\text{AgCl}_{(\text{s})}$ is in an ionic lattice structure.
- $\text{Ag}^{1+}_{(\text{aq})}$ and $\text{NO}_3^{1-}_{(\text{aq})}$ are dissociated ions
- As they are different, they are **not spectator ions and cannot be cancelled out**

6) Rewrite the **balanced ionic equation** without the spectator ions

