

Key Concepts essential for A Level Chemistry

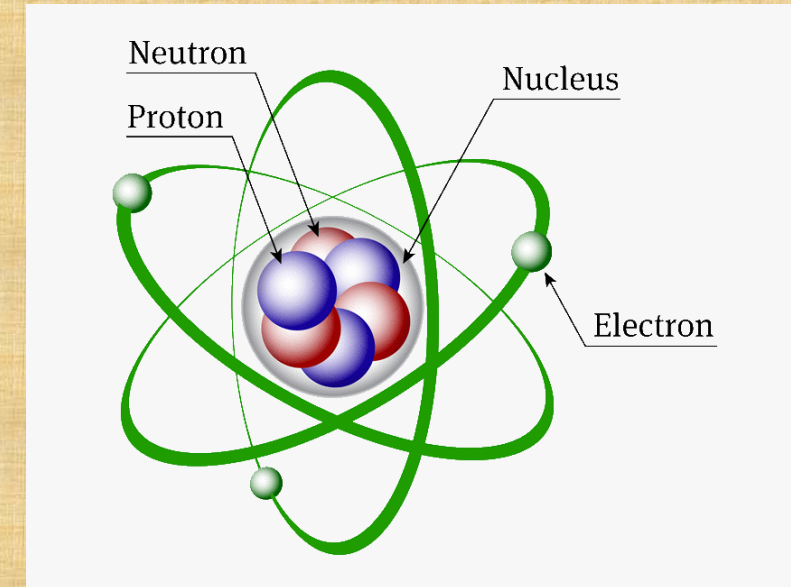
**Atoms, Formulae, Molecules
and Naming Compounds**

Atoms

- All matter is made of particles. At one time, it was thought that the tiniest particle was the *atom*;
- We now know that atoms can be split and that there are smaller particles than atoms, the so-called sub-atomic particles, electrons, protons and neutrons.
- Chemistry is all about rearrangements of atoms *that do not themselves* change.

Structure of the Atom

| Particle | Relative mass (Carbon -12 scale) | Relative charge (on scale electron charge = -1 unit) |
|----------|-------------------------------------|---|
| Proton | 1 | +1 |
| Electron | 1/1840 | -1 |
| Neutron | 1 | 0 |



The atom is mostly empty space. It has a solid core or *nucleus*, the centre that contains the protons and neutrons. The electrons circulate round the nucleus in specific *orbits* or *shells*.

Atoms

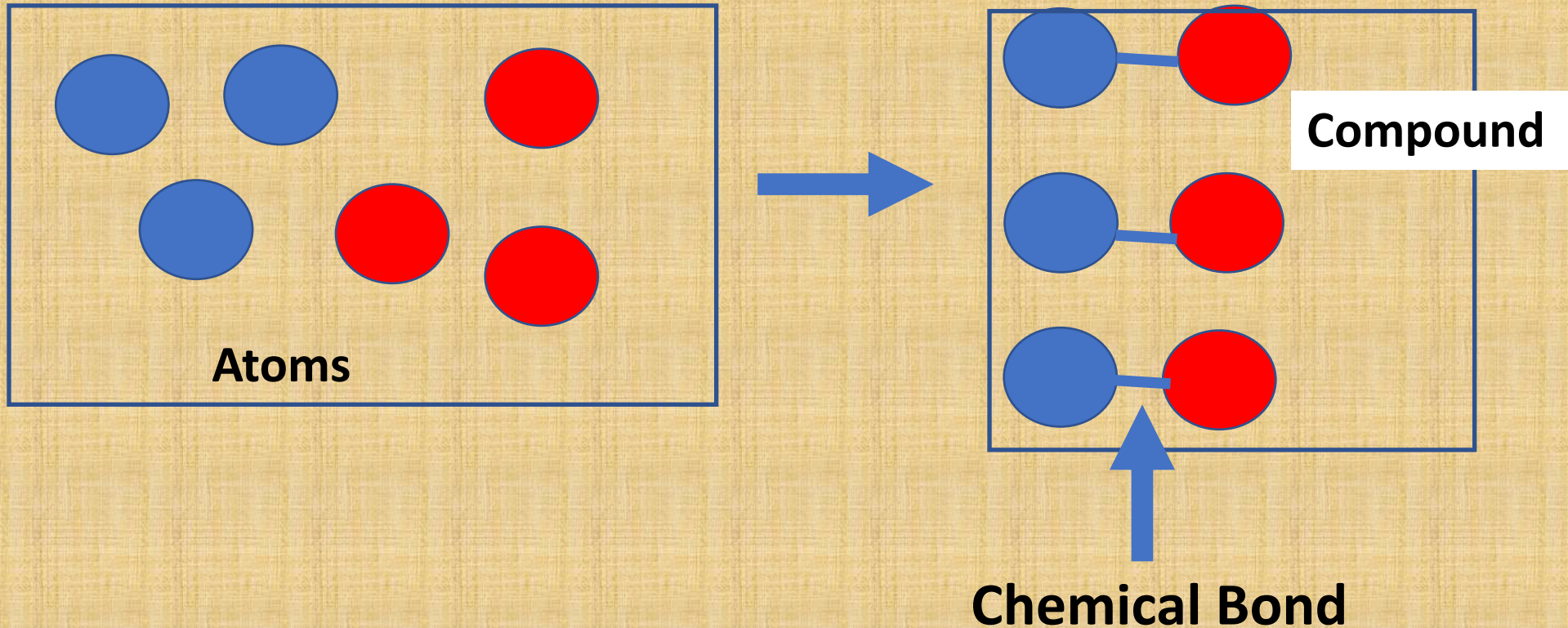
- Atoms are the particles whose symbols are found in the periodic table. There are only about 100 of them.
- There are more substances in the world than the 100 or so different kinds of atom. The other substances are made by combining atoms in various ways to make compounds.
- **An *atom* is the smallest, electrically neutral, particle of an element that can take part in a chemical change.**

The Periodic Table

- https://www.rsc.org/periodic-table/?gclid=EAlalQobChMIzdOn6Nnf6QIVhvhRCh3HqAnrEAAYASAAEgLqjfD_BwE

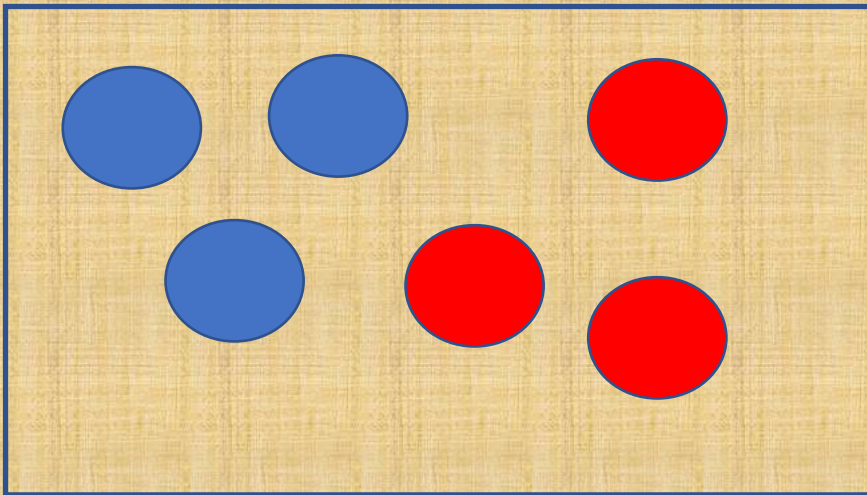
Compounds

A compound is a substance formed when two or more chemical elements are chemically bonded together.

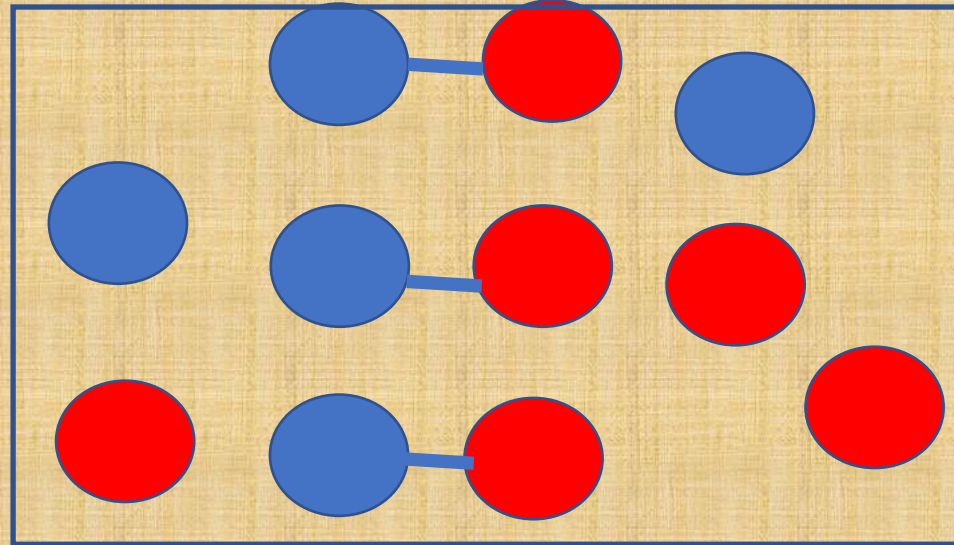


Mixtures

In mixtures, the substances present are not chemically bonded together.



**Mixture of two
different atoms**



**Mixture of two types of atoms
and a compound.**

Chemical Formulae

- A chemical formula is a useful shorthand method for describing the atoms in a chemical
- The chemical formula of an element or compound tells you:
 - Which elements it contains: eg FeSO_4 contains iron, sulphur and oxygen
 - How many atoms of each kind are in each molecule: eg H_2SO_4 contains two atoms of hydrogen, one atom of sulphur and four atoms of oxygen in each molecule

Polyatomic Ions

A **polyatomic ion** is an **ion** composed of more than one atom.

| Name | Symbol | Charge |
|-----------------|-----------------|--------|
| Ammonium | NH ₄ | +1 |
| Carbonate | CO ₃ | -2 |
| Hydroxide | OH | -1 |
| Nitrate | NO ₃ | -1 |
| Nitrite | NO ₂ | -1 |
| Sulphate | SO ₄ | -2 |
| Sulphite | SO ₃ | -2 |
| Cyanide | CN | -1 |

| Name | Symbol | Charge |
|--------------------|--------------------------------|--------|
| Hydrogen-carbonate | HCO ₃ | -1 |
| Hydrogen-sulphate | HSO ₄ | -1 |
| Chlorate(I) | ClO | -1 |
| Chlorate(V) | ClO ₃ | -1 |
| Vanadate(V) | VO ₃ | -1 |
| Manganate(VII) | MnO ₄ | -1 |
| Chromate(VI) | CrO ₄ | -2 |
| Dichromate(VI) | Cr ₂ O ₇ | -2 |

Naming Inorganic Compounds

1) If there are only two elements present then the name will end in **-ide**

Thus, **oxides** contain an element and oxygen eg

Na_2O is **Sodium Oxide**

CaO is **Calcium Oxide**

Chlorides contain an element and chlorine eg

MgCl_2 is **Magnesium Chloride**

AlCl_3 is **Aluminium Chloride**

Bromides and **Iodides** have an element and either bromine or iodine eg

KBr is **Potassium Bromide**

ZnI is **Zinc Iodide**

Hydrides contain an element and hydrogen and **Nitrides** an element and nitrogen. eg

LiH is **Lithium Hydride**

Mg₃N₂ is **Magnesium Nitride**

Other elements also form these types of compounds and the name always ends in **-ide**. The exceptions to this are **hydroxides** that have the -OH group and **cyanides**, which have the **-CN** group. eg

NaOH is **Sodium Hydroxide**

Ca(OH)₂ is **Calcium Hydroxide**

KCN is **Potassium Cyanide**

2) If the elements concerned have more than one charge then this must be shown.

- Thus as iron has charge of **+2** and **+3**, the name **Iron Chloride** would not tell you which of the two possible compounds **FeCl₂** or **FeCl₃** is being considered.
- In this case the valency of the iron is indicated by the use of a Roman II or III in brackets after the name of the metal. In this case **Iron(II) Chloride** for **FeCl₂** or **Iron(III) Chloride** for **FeCl₃**.

3) For compounds containing two **non-metal** atoms the actual number of atoms of the element present are stated.

- CO is Carbon Monoxide where mon- means one
- CO₂ is Carbon Dioxide where di- means two
- SO₂ is Sulphur Dioxide. This could be called Sulphur(IV) Oxide
- SO₃ is Sulphur Trioxide. This could be called Sulphur(VI) Oxide
- PCl₃ is Phosphorus Trichloride or Phosphorus(III) Chloride
- PCl₅ is Phosphorus Pentachloride or Phosphorus(V) Chloride
- CCl₄ is Carbon Tetrachloride
- SiCl₄ is Silicon Tetrachloride.

4) Where a compound contains a metal, a non-metal and oxygen it has a name ending in -ate or -ite. eg

Carbonate $-\text{CO}_3$

Sulphate $-\text{SO}_4$

Nitrate $-\text{NO}_3$

Thus a compound of sodium, carbon and oxygen would be Na_2CO_3 and would be called Sodium Carbonate.

NaNO_3 is Sodium Nitrate

$\text{Mg}(\text{NO}_3)_2$ is Magnesium Nitrate

$\text{Fe}_2(\text{SO}_4)_3$ is Iron(III) Sulphate

FeSO_4 is Iron(II) Sulphate

5) Because most non-metals can have more than one polyatomic ion they can also produce more than one acid upon which these groups are based.

Thus sulphur can form **sulphates** and **sulphites**.

The ending **-ite** is used when an element forms more than one such compound.

In all cases the **-ite** is used for the compound with the lower number of oxygen atoms.

Sulphate can also be referred to as **sulphate(VI)** and **sulphite** can also be referred to as **sulphite(IV)**.

In the case of nitrogen with oxygen the compounds would be **nitrate** and **nitrite** or **nitrate(V)** and **nitrate(III)**.

Polyatomic Ions

| Common name | Systematic name | Formulae |
|--------------|-----------------|-----------------|
| Sulphate | Sulphate(VI) | $-\text{SO}_4$ |
| Sulphite | Sulphate(IV) | $-\text{SO}_3$ |
| Nitrate | Nitrate(V) | $-\text{NO}_3$ |
| Nitrite | Nitrate(III) | $-\text{NO}_2$ |
| Chlorate | Chlorate(V) | $-\text{ClO}_3$ |
| Hypochlorite | Chlorate(I) | $-\text{ClO}$ |

6) When a compound is considered it is usual to put the metal down first both in the name and the formula. The exceptions to this rule are in organic compounds where the name has the metal first but the formula has the metal at the end. eg CH_3COONa is **Sodium Ethanoate**

7) The elements nitrogen and hydrogen can join together to form a group called the ammonium group. This must not be confused with the compound ammonia This ammonium group has the formula NH_4^+ and sits in the place generally taken by a metal in the formula. Eg

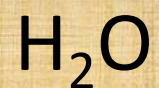
NH_4Cl is Ammonium Chloride

$(\text{NH}_4)_2\text{SO}_4$ is Ammonium Sulphate

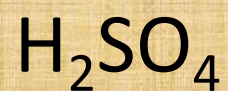
NH_4ClO_3 is Ammonium Chlorate(V)

8) There are a small number of simple molecules that do not follow the above rules. You will need to learn their names and formulae.

Water



Sulphuric Acid



Nitric Acid



Hydrochloric Acid



Ammonia



Organic compounds have their own set of rules for naming but you will need to learn some of the basic rules. The names are generally based on the names of the simple hydrocarbons. These follow a simple pattern after the first four:

| Formula | Name |
|---------------------------|---------|
| CH_4 | Methane |
| C_2H_6 | Ethane |
| C_3H_8 | Propane |
| C_4H_{10} | Butane |

After butane the names are based on the prefix for the number of carbons C_5 -**pent**, C_6 - **hex** and so on.

Naming Compounds p1

<https://tinyurl.com/y8ktpnad>

| | | | | | |
|----|------------------|----|---------------------------------|----|---|
| 1 | H ₂ O | 11 | CH ₄ | 21 | CaCl ₂ |
| 2 | CO ₂ | 12 | H ₂ S | 22 | Ca(NO ₃) ₂ |
| 3 | NH ₃ | 13 | HBr | 23 | Ca(OH) ₂ |
| 4 | O ₂ | 14 | H ₂ SO ₄ | 24 | CaSO ₄ |
| 5 | H ₂ | 15 | HNO ₃ | 25 | BaCl ₂ |
| 6 | SO ₂ | 16 | NaCl | 26 | AlCl ₃ |
| 7 | SO ₃ | 17 | NaNO ₃ | 27 | Al(NO ₃) ₃ |
| 8 | HCl | 18 | Na ₂ CO ₃ | 28 | Al ₂ (SO ₄) ₃ |
| 9 | HI | 19 | NaOH | 29 | FeSO ₄ |
| 10 | HF | 20 | Na ₂ SO ₄ | 30 | FeCl ₂ |

Naming Compounds p2

<https://tinyurl.com/y8ktpnad>

| | | | | | |
|----|------------------------------|----|--|----|------------------------------|
| 31 | FeCl_3 | 41 | CuSO_4 | 51 | C_2H_6 |
| 32 | $\text{Fe}_2(\text{SO}_4)_3$ | 42 | ZnCl_2 | 52 | C_4H_{10} |
| 33 | PbO | 43 | AgNO_3 | 53 | C_8H_{18} |
| 34 | PbO_2 | 44 | NH_4Cl | 54 | $(\text{NH}_4)_2\text{CO}_3$ |
| 35 | $\text{Pb}(\text{NO}_3)_2$ | 45 | $(\text{NH}_4)_2\text{SO}_4$ | 55 | KMnO_4 |
| 36 | PbCl_2 | 46 | NH_4VO_3 (V is Vanadium) | 56 | K_2CrO_4 |
| 37 | PbSO_4 | 47 | KClO_3 | 57 | KHCO_3 |
| 38 | $\text{Cu}(\text{NO}_3)_2$ | 48 | KIO_3 | 58 | KI |
| 39 | CuCl | 49 | NaClO | 59 | $\text{Co}(\text{NO}_3)_2$ |
| 40 | CuCl_2 | 50 | NaNO_2 | 60 | KAt |

Naming Compounds (answers)

| | | |
|---|-----------------------------|------------------------------|
| 1 Water | 11 Methane | 21 Calcium chloride |
| 2 Carbon dioxide | 12 Hydrogen sulphide | 22 Calcium nitrate |
| 3 Ammonia | 13 Hydrogen bromide | 23 Calcium hydroxide |
| 4 Oxygen | 14 Sulphuric acid | 24 Calcium sulphate |
| 5 Hydrogen | 15 Nitric acid | 25 Barium chloride |
| 6 Sulphur dioxide (or IV oxide) | 16 Sodium chloride | 26 Aluminium chloride |
| 7 Sulphur trioxide (or VI oxide) | 17 Sodium nitrate | 27 Aluminium nitrate |
| 8 Hydrogen chloride | 18 Sodium carbonate | 28 Aluminium sulphate |
| 9 Hydrogen iodide | 19 Sodium hydroxide | 29 Iron(II) sulphate |
| 10 Hydrogen fluoride | 20 Sodium sulphate | 30 Iron(II)chloride |

Naming Compounds (answers)

| | | |
|-------------------------------|---------------------------------|---------------------------------------|
| 31 Iron(III) chloride | 41 Copper(II) sulphate | 51 Ethane |
| 32 Iron(III) sulphate | 42 Zinc chloride | 52 Butane |
| 33 Lead(II) oxide | 43 Silver nitrate | 53 Octane |
| 34 Lead(IV) oxide | 44 Ammonium chloride | 54 Ammonium carbonate |
| 35 Lead(II) nitrate | 45 Ammonium sulphate | 55 Potassium manganate(VII) |
| 36 Lead(II) chloride | 46 Ammonium vanadate(V) | 56 Potassium chromate(VI) |
| 37 Lead (II) sulphate | 47 Potassium chlorate(V) | 57 Potassium hydrogencarbonate |
| 38 Copper(II) nitrate | 48 Potassium iodate | 58 Potassium iodide |
| 39 Copper(I) chloride | 49 Sodium chlorate(I) | 59 Cobalt(II) nitrate |
| 40 Copper(II) chloride | 50 Sodium nitrite | 60 Potassium astatide |