Chemistry: Elements and Chemical reactions

Periodic table recap

The arrangement of the periodic table has changed.

Early 1800s

- Arranged by **relative atomic mass**.
- Scientists had not yet discovered protons, neutrons or electrons.
- There were gaps for missing elements that had not been found yet.

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- Ordered mainly by **atomic mass**.
- Elements with similar properties in the same **group**.
- Gaps left for **elements** that hadn't been found yet.

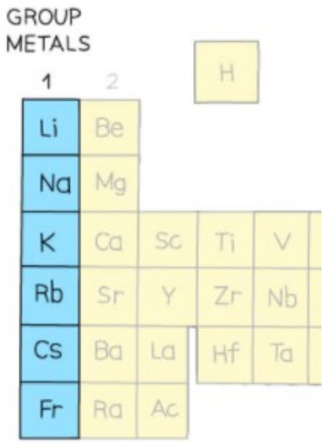
Modern Day

- In order of increasing **atomic mass**.
- Repeating patterns in the properties of the elements.
- **Metals** are on the left and **non-metals** are on the right.

Properties of metals - **Ductile** - **Malleable**
- High **melting** and **boiling** point
- **Conduct heat** - **Conduct electricity**

Properties of non-metals - **Brittle**
- **Insulators** of heat and electricity
- **Not always solids** - **lower density**

Group 1: Alkali Metals



- The group 1 metals are known as the alkali metals
  - They form **alkaline solutions** when they react with water
- The group 1 metals are lithium, sodium, potassium, rubidium, caesium and francium and they are found in the first column of the periodic table
- The alkali metals share similar characteristic chemical properties because they each have one electron in their outermost shell
- Some of these properties are:
  - They are all **soft** metals which can easily be cut with a knife
  - They have relatively **low** densities and **low** melting points
  - They are **very reactive** (they only need to lose one electron to become highly stable)

Physical Trends

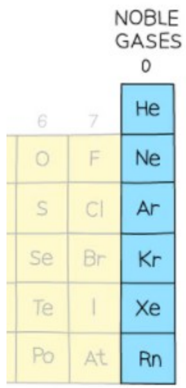
- Apart from the chemical trends there are also patterns to be seen in the physical properties
- The alkali metals are **soft** and easy to cut, getting softer as you move down the group
- The first three alkali metals are less dense than water

Group 1 reactions with water

Element	Reaction	Observations
Li	Lithium + Water $\longrightarrow$ Lithium hydroxide + Hydrogen $2Li(s) + 2H_2O(l) \longrightarrow 2LiOH(aq) + H_2(g)$	◦ Relatively slow reaction ◦ Lithium doesn't melt ◦ Fizzing can be seen and heard as the lithium reacts
Na	Sodium + Water $\longrightarrow$ Sodium hydroxide + Hydrogen $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$	◦ Large amounts of heat released causes the sodium to melt ◦ Hydrogen released catches fire and causes the ball of sodium to dash across the surface
K	Potassium + Water $\longrightarrow$ Potassium hydroxide + Hydrogen $2K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g)$	◦ Reacts more violently than sodium ◦ Enough heat released so hydrogen burns with a lilac coloured flame ◦ Melts into a shiny ball that dashes around the surface

Group 0: Noble Gases

- The elements in group 0 of the periodic table are called the noble gases
- They are all non-metal, **monatomic** (exist as single atoms), **colourless**, **non-flammable** gases at room temperature
- The group 0 elements all have **full outer shells** of electrons; this electronic configuration is **extremely stable**
- Elements participate in reactions to complete their outer shells by losing, gaining, or sharing **electrons**
  - The Group 0 elements do not need to do this, because of their full outer shells which makes them unreactive and **inert**
- Other than helium which has 2 electrons in its outer shell, the noble gases have eight valence electrons (which is why you may see this group labelled "group 8")
- As with other groups, there are trends in the physical properties of the noble gases
- The noble gases have very **low melting** and **boiling** points
- They show an **increase** in boiling point as we move **down** the group due to an increase in the **relative atomic mass** (the atoms get larger as you move down the group)



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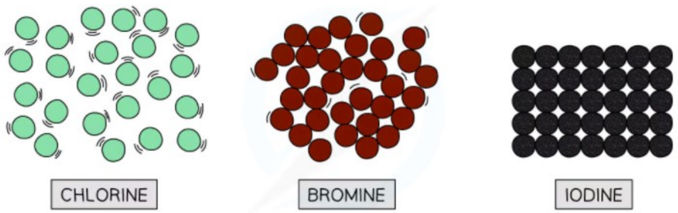
Group 7: Halogens

- The elements in group 7 are known as the halogens
    - These are fluorine, chlorine, bromine, iodine and astatine
- These elements are non-metals that are **poisonous**
- All halogens have similar reactions as they each have seven electrons in their outermost shell
- Halogens are **diatomic**, meaning they form molecules made of pairs of atoms sharing electrons (forming a single covalent bond between the two halogen atoms) such as F_2, Cl_2, etc
- When halogen atoms gain an electron during reactions, they form -1 ions called halide ions
    - The colours of the halogens also change as you descend the group - they become darker



Halogen	State & Appearance at Room Temperature	Characteristics	Colour in solution
Fluorine	Yellow gas	Very reactive, poisonous gas	–
Chlorine	Pale yellow–green gas	Reactive, poisonous and dense gas	Pale green
Bromine	Red–brown liquid	Dense red–brown volatile liquid	Orange
Iodine	Purple–black solid	Shimmery, crystalline solid, sublimes to form a purple vapour	Dark brown

Energy Changes

Energy cannot be **created or destroyed**, you can only move it from place to place or change it to a different form of energy.

Exothermic reactions transfers energy to the surroundings. **The temperature of the surroundings increases**. This means the product molecules must have **LESS energy** than the reactant molecules.
Exothermic reactions include combustion, neutralisation and many oxidation reactions.
Uses: self-heating cans and hand warmers

Endothermic reactions absorb energy from the surroundings. **The temperature of the surroundings decreases.**
This means the product molecules have **MORE energy** than the reactant molecules.
Endothermic reactions include thermal decompositions and the reaction of citric acid with sodium hydrogen carbonate.
Uses: sports injuries cold packs

Exothermic Reaction	Endothermic Reaction
Temp of surroundings INCREASES	Temp of surroundings DECREASES

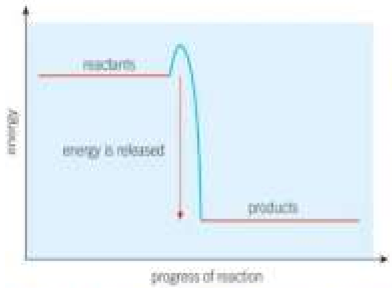


Figure 1 The reaction profile for an exothermic reaction

The reaction profile for exothermic shows the **products** are at a **lower** energy level than the **reactants**. This means when the reactants form the products, energy is **transferred TO the surroundings.** <u>The surroundings get warmer.</u>

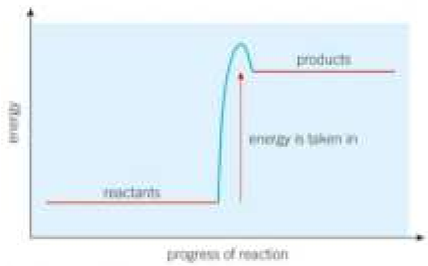


Figure 2 The reaction profile for an endothermic reaction

The reaction profile for endothermic shows the **products** are at a **higher** energy level than the **reactants**. This means when the reactants form the products, energy is **transferred FROM the surroundings.** <u>The surroundings get colder.</u>