

Chemistry Knowledge Organiser

Topic 1 : Atoms & The Periodic Table

Elements

- An element contains only one type of atom. All elements are given a symbol and are found on the periodic table. You need to learn the symbols for the first 20.
- The Periodic Table is arranged into groups (columns) and periods (rows), as shown below.



Elements in the same group have:

- The same number of electrons in their outer shell
- Similar properties

Elements in the same period have:

- The same number of electron shells

Compounds

- Compounds are 2 or more elements that are chemically bonded
- These are made in chemical reactions.
- Compounds are given a formula for example carbon dioxide is CO_2 means 1 carbon atom and 2 oxygen atoms.
- Another example is calcium hydroxide $\text{Ca}(\text{OH})_2$ which means 1 calcium, 2 oxygen atoms and 2 hydrogen atoms

Chemical Reactions

- In some chemical reactions it may appear that there are less products than there were reactants; however this is often because a gas has been made and this has escaped into the atmosphere.



Key Terms	Definitions
Element	A substance that contains only one type of atoms
Mixture	A mixture is two or more different atoms which are not chemically bonded
Compound	Two or more elements that are chemically bonded
Group	The columns on the Periodic Table
Period	The rows on the Periodic Table
Reactant	What you start with in a chemical reaction
Product	What is made in a chemical reaction

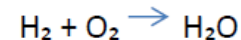
The Conservation of Mass

- In a chemical reaction, chemical bonds are broken the atoms are rearranged and the chemical bonds are made again.
- In a chemical reaction, mass is never lost, you must start and finish with the same mass.

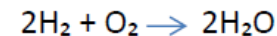


Balancing Equations

- We need to write balanced chemical equations represent chemical reactions and the conservation of mass.
- For example: The equation below shows hydrogen and oxygen making water but there are more oxygen atoms on the right than the left.



- In the equation below there are 4 hydrogen atoms on the left and right of the equation and 2 oxygen atoms on each side



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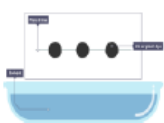
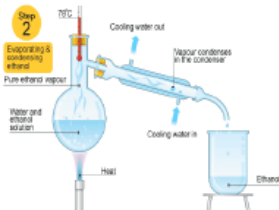

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Pure and Impure Substances

- A pure substance contains only one type of **element** or **compound**.
- An **impure substance** contains more than one type of element or compound in a mixture, for example salt water contains NaCl and H₂O. All mixtures are impure substances.
- Mixtures are much easier to separate than elements or compounds as they are not chemically bonded
- There are a variety of ways that mixtures can be separated and they are outlined below. Remember that these are all physical changes and chemical bonds are not broken during any of these processes.

Key Terms	Definitions
Pure	A substance made of only ONE type of element or compound
Impure	A mixture of elements and/or compounds
Chromatography	A technique where mixtures can be separated based on their solubility.
Distillation	A separation technique which means a mixture of two liquids is heated
Crystallisation	Method of mixture separation where a solvent is evaporated, leaving the solute behind.

Separating Impure Substance

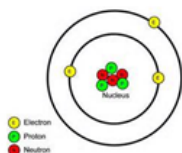
Name	Diagram	Explanation
Chromatography		<ul style="list-style-type: none"> Different substances travel different distances up the paper depending on their solubility in the solvent used (it is often water but not always). The more soluble, the further it moves up the paper Line must be drawn with pencil because pencil will not run. Artificial colours in foods can be identified using chromatography. Additives do not necessarily have a colour and therefore are identified using chemical analysis.
Distillation		<ul style="list-style-type: none"> Distillation is when two liquids with <i>different boiling points</i> are separated For example ethanol (alcohol) boils at 78 °C and water boils at 100 °C If you heat a mixture of water and ethanol to 80°C the ethanol will evaporate but the water will not. You then condense the ethanol and collect the pure ethanol
Crystallisation		<ul style="list-style-type: none"> Crystallisation is when a solvent is evaporated from a solute.

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The structure of the Atom

- All matter is made from atoms. Atoms are very small. The radius of atom is about 1×10^{-10} m (this is also known as 0.1 nanometres).
- The central part of the atom is known as the nucleus. It is only 1×10^{-14} m across, which is 10,000 times smaller than the total atom.
- An atom is made up of three subatomic particles: **protons**, **electrons** and **neutrons**.
- Protons and neutrons are found in the nucleus
- Electrons are found orbiting the nucleus in shells (also known as *energy levels*).

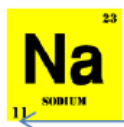


- The mass and charges of the sub atomic particles is shown below:

	Mass	Charge
Proton	1	+1
Neutron	1	0
Electron	0	-1

- Atoms have **no overall charge** because they have the same number of positive protons as negative electrons.

Atomic Number and Mass Number



← Mass number: This is the total of protons+neutrons

← Atomic number: This is the number of protons

Therefore sodium has 11 protons, 11 electrons and $23 - 11 = 12$ neutrons

Key Terms	Definitions
Atom	The particles that make up all substances with mass, they contain protons, neutrons and electrons.
Nucleus	The centre of an atom, it contains protons and neutrons.
Nanometre	A unit of measurement: 1×10^{-9} m
Proton	A sub atomic particle found in the nucleus, it has a charge of +1 and a relative mass of 1.
Electron	A sub atomic particle found in the shells of an atom, it has a charge of -1 and a negligible mass
Subatomic	These are the smaller particles that make up an atom
Neutron	A sub atomic particle found in the nucleus of an atom, it has a charge of 0 and a mass of 1
Atomic Number	The number of protons in an atom.
Mass Number	The total of protons and neutrons in an atom.

Electron Configuration

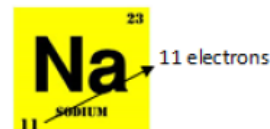
There are very strict rules about how electrons fill up the electron shells, the inner shell is always filled first. Each shell has a maximum number of electrons it can take.

Shell 1: maximum 2 electrons

Shell 2: maximum 8 electrons

Shell 3: maximum 8 electrons

Example:



The electronic configuration of Sodium (Na) can also be written like this 2,8,1. This shows there is 2 electrons in the 1st shell, 8 electrons in the second shell and 1 electron in the 3rd shell.




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The History of the Periodic Table

- Throughout history scientists have tried to classify substances and many scientists attempted to construct a Periodic Table.
- Before the knowledge of protons, neutrons and electrons, scientists arranged the Periodic table by **atomic weight**. This meant the groups were not always correct.
- In 1869 Dimitri **Mendeleev**, a Russian Scientist, published his Periodic Table. It was slightly different to those that had been before. He still arranged elements by atomic weight but he also left gaps for where he predicted elements would be.
- He very accurately predicted the properties of elements that were not discovered until many years later; for example, Gallium.
- Mendeleev's Periodic Table is still different from the modern one as some of his masses were wrong due to the existence of **isotopes**
- Isotopes are elements with same number of protons and electrons but a different number of neutrons and therefore different atomic weights.

Isotopes of Carbon

		
^{12}C	^{13}C	^{14}C
Carbon-12	Carbon-13	Carbon-14
6 protons 6 neutrons	6 protons 7 neutrons	6 protons 8 neutrons

Mendeleev's Periodic Table

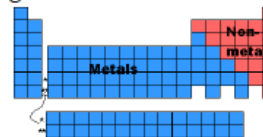


Mendeleev's Periodic Table shows elements arranged by atomic weight. Elements are labeled with their symbol and atomic weight. Gaps are present for elements predicted by Mendeleev. The table includes elements from Hydrogen (H) to Francium (Fr).

Key Terms	Definitions
Dimitri Mendeleev	A Russian Chemist, who in 1869 published a Periodic Table containing gaps.
Periodic Table	The table which organises the 118 elements based on atomic structure
Isotope	Two atoms with the same number of protons and electrons but a different number of neutrons
Metal	An element which loses electrons to form a positive charge
Non Metal	An element which gains electrons to form a negative charge
Ion	An element with a positive or negative charge

Metals and Non-Metals

- Metals are found on the left hand side of the Periodic Table, the majority of elements are metals.
- When metals react, they lose an electrons to form positive ions.
- Non metals gain electrons to form a negative charge.



Groups in the Periodic Table

	Physical properties	Chemical Properties	Equation	Trends/Explanation
Group 1 (Alkali metals)	Soft, low density	React vigorously with water releasing hydrogen	Sodium + Water \rightarrow Sodium Hydroxide + Hydrogen	More reactive as you go down, outermost electron further from the nucleus so it's easier to lose
Group 7 (Halogens)	Low melting point, exist as pair (Cl_2)	React with group 1 metals to form compounds. Can carry out displacement reactions	Sodium + Chlorine \rightarrow Sodium Chloride Sodium Bromide + Chlorine \rightarrow Sodium Chloride + Bromine	Higher melting point as you go down the group (higher molecular mass). Less reactive as you go down the group.
Group 0 (Noble Gases)	Low melting point/boiling point Eight electrons in outer shell (except helium)	Unreactive, as they have a full outer shell	N/A	Higher melting point and boiling point as you go down the group (due to increase in density)