C1 : Atomic structure

Structure of the atom -

- The atomic number of an atom is the number of protons in an atom.
- The mass number is the number of protons plus neutrons in an atom.
- Atoms have no overall electrical charge, as they contain an equal number of protons and electrons.
- An ion is a charged atom, so atoms that gain electrons form negative ions, and atoms that lose electrons form positive ions.
- Isotopes are atoms of the same element but with a different number of neutrons.
- The relative atomic mass equation is :

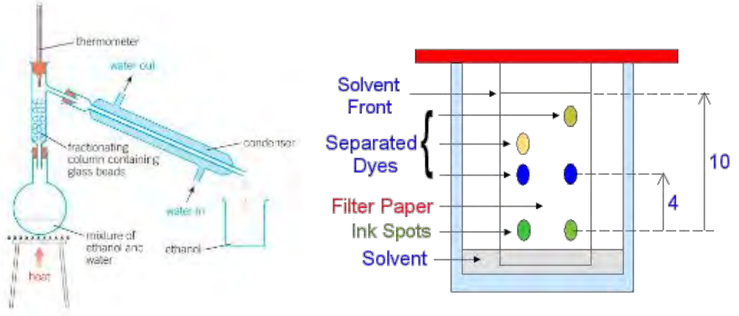
$$A_r = \frac{(\%\ of\ Isotope\ 1 \times mass\ of\ Isotope\ 1) + (\%\ of\ Isotope\ n \times mass\ of\ Isotope\ n)}{100}$$

- The electrons in an atom occupy the energy levels/shells, and each shell can occupy max. 8 electrons, excluding the first shell which can only hold 2.

Particle	Relative Mass	Relative Charge
Proton	1	+1
Neutron	1	0
Electron	1/1860	-1

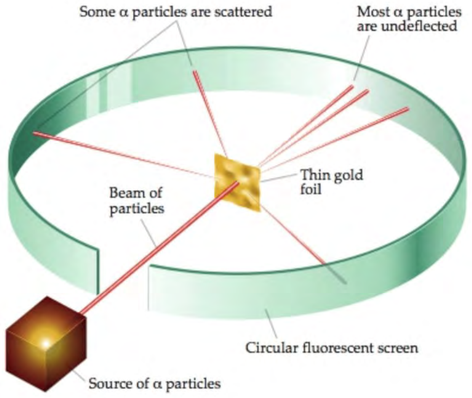
Atoms, elements, and compounds -

- All substances are made of atoms, an atom is the smallest part of an element that can exist, represented by a chemical symbol.
- An element is a substance made up of only one type of atom, many elements are listed in the periodic table.
- Compounds contain two or more elements chemically combined together, formed by chemical reactions, represented by formulae using the symbols.
- The law of conservation of mass is that no new atoms are ever created or destroyed in a chemical reaction, so the total mass of reactants is equal to the total mass of products.



History of the atom -

- Atoms were thought to be tiny spheres that couldn't be divided.
- Then the electron was discovered by JJ Thomson, and he created the plum pudding model that consisted of a sphere of positive charge with electrons embedded, as the charges of the atom must balance out.
- The alpha scattering experiment involved firing positively charged particles at thin pieces of gold foil, and they should pass through because the atom is mostly atom space.
- But some deflected back meaning that they were close to the positive charge and repelled away, so the positive charge must be concentrated.
- So the nuclear model involved the positive charge concentrated in the centre of the atom, and electrons orbiting the nucleus.
- Niels Bohr suggested that the electrons must be orbiting at set distances, in certain shells, as electrons are given out when their energy is reduced.
- Chadwick then researched the existence of neutrons, and where they will be placed in the atom.



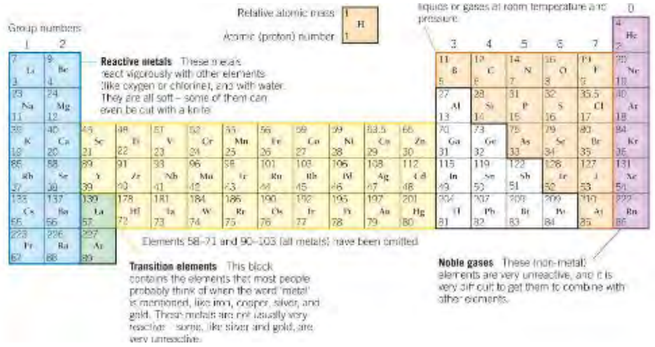
Mixtures/separating mixtures -

- A mixture is made up of two or more elements or compounds that are not chemically combined together, and can be separated by physical means
- These physical means include : filtration, crystallisation, simple distillation, fractional distillation, and chromatography.
- Filtration is used to separate an insoluble solid from a liquid, eg. separating silver chloride and water using a funnel to separate the two substances.
- Crystallisation is used to separate a soluble solid from a liquid, eg. obtaining sodium chloride from water by evaporating or heating the mixture to form crystals.
- Simple distillation is used to separate a liquid from a solid in order to keep the liquid, eg. separating a salt solution, done by heating the solution to evaporate the solvent and the vapour produced is condensed through cooling.
- Fractional distillation is used to separate a mixture of liquids with different boiling points, involves heating and evaporating the liquids before being placed into a condenser to restore the liquid state, eg. ethanol from a fermented mixture.
- Paper chromatography is used to separate substances based on their different solubilities, so a pure compound will only produce one spot while a mixture separates into several spots.

C2 : Periodic table

Transition elements -

- A transition element can create ions with different charges, form many coloured compounds and are useful as industrial catalysts.
- Compared to the alkali metals, they have a higher melting point, stronger, harder, less reactive, don't react as vigorously



Development of the periodic table -

- Elements in the periodic table are arranged in order of atomic number, and elements in the same group have the same number of electrons on the outer shell, giving them similar chemical properties
- John Dalton first arranged the elements in order of their atomic weights
- Then Newlands arranged them in the same way, but noticed the properties of every eighth element is similar so created the law of octaves, but this didn't work for all the elements and some weren't even similar, so his ideas were ridiculed.
- Mendeleev again arranged them in atomic weights, but made sure a periodic pattern in the properties would be seen, and then left gaps for elements that were not discovered and predicted some of their properties.
- The existence of isotopes also accounted for why the order of atomic weights may not be correct at times.
- Metals are elements that form positive ions, and nonmetals are elements that do not form positive ions

Group 7 (halogens) -

- The elements in group 7 are called the halogens, and are a group of toxic non-metals that consists of molecules made of pairs of atoms.
- The melting and boiling point increase as you go down the group, and the reactivity decreases as you go down as it's harder to gain an electron
- They form ions with a negative charge
- When they react with a metal, they form ionic compounds where the ion has a -1 charge
- When they react with non-metals, they share electrons forming a covalent compound
- Since the reactivity decreases, a more reactive halogen can can displace a less reactive halogen from solutions of its salts, eg. chlorine and potassium bromide would become potassium chloride and bromine.

Group 0 (noble gases) -

- The elements in group 0 have full outer electron shells, except from helium with two, making them very stable, completely unreactive, and unable to easily form molecules.
- They are monatomic (single-atom) gases, and the boiling point increases as you go down group 0.

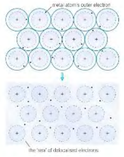
Group 1 (alkali metals) -

- The elements in group 1 are called the alkali metals as they have one electron in their outer shell, meaning they are very reactive.
- The melting and boiling point decreases as you go down the group, and the reactivity increases as you go down because the electrons becomes easier to lose
- They form 1+ ions in reactions to form ionic compounds
- They react with oxygen to make an oxide, burns vigorously and forms white smoke
- They react with chlorine to form a white precipitate
- They react with water to create an alkaline solution and hydrogen, that fizzes and bubbles rapidly.

C3 : Structure and bonding

Bonding in metals/giant metallic structures-

- Metals consist of giant structures arranged in a regular pattern
- The outer electrons are delocalised and free to move, forming a sea of electrons that give rise to metallic bonds



Most metals have high mpt and bpt due to the strong metallic bonding, and are soft, easily bent and shaped due to the layer arrangement in metals, meaning they can slide over one another

- Pure metals can be too soft so alloys are created which are a mixture of metals, atoms here are different sizes, making it difficult for layers to slide over each other, so are harder than pure metals
- Metals have high mpt because the electrostatic forces of attraction make it difficult to separate the metals, so requires energy
- Good conductors of electricity because the delocalised electrons carry electric charge, good conductors of thermal energy because energy is transferred through delocalised electrons

Giant covalent structures/fullerenes and graphenes-

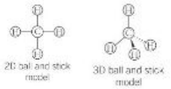
- Giant covalent structures are huge networks of atoms held together by strong covalent bonds
- They are solids with high mpt and bpt, insoluble in water, hard and don't conduct electricity (except from graphite)
- In diamond, each carbon atom forms four covalent bonds with other carbon atoms, arranged in a giant lattice
- They are very hard due to the rigid giant covalent structure, high mpt and bpt due to strong intermolecular forces, does not conduct electricity as there are no free electrons due to the full outer shell
- In graphite, each carbon atom forms three covalent bonds with three other carbon atoms, but no covalent bonds between the layers
- This means it has 1 free electron (electrons behave more like metallic structures) and weak intermolecular forces, so layers can slide over each other, can conduct electricity and thermal energy
- Fullerenes are molecules of carbon atoms with hollow shapes, based on hexagonal rings of carbon atoms
- Carbon nanotubes (cyclical fullerenes) can be produced which have a high length to diameter ratios, useful because of the high tensile strength, high electrical and thermal conductivity (delocalised)
- Graphene is a single layer of graphite and used for electronics and composites, as it's a good conductor of thermal energy and electricity, very reactive

Nanoparticles/uses of nanoparticles-

- Nanoscience refers structures that are about 1-100 nm in size
- Nanoparticles are smaller than fine particles, with diameters between 100 and 2500 nm (1 x 10-7 m and 2.5 x 10-6 m), and these are smaller than coarse particles with diameters between 1 x 10-5 m and 2.5 x 10-6 m.
- Nanoparticles are highly reactive compared to other powdered reactants because of the high SA to V ratio and high percentage of atoms exposed
- This also means smaller quantities are needed to be effective compared to the same materials in bulk
- Can be used in sun creams by coating them with silica (blocks sun rays), deodorants and cosmetics as are absorbed deeper into the skin, in medicine to deliver drugs where they need to go, silver nanoparticles kill bacteria, good catalysts due to high SA to V ratios
- The risks of nanoparticles is that they could cause a violent explosion, has an unpredictable effect on our cells

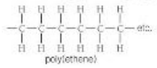
Covalent bonding/simple molecules-

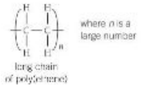
- Covalent bonds are formed when non-metal atoms share pairs of electrons, forming strong bonds
- Substances made up of simple/small molecules are gases or liquids, low mpt and bpt, weak intermolecular forces, don't conduct electricity because there is no overall electric charge



Limitations: 2D ball and stick don't show the true Shape or angles, dot and cross show fixed position of Electrons when they are moving in covalent bonds

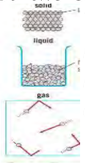
- Polymers are made of small molecules bonded to form long chains, linked by strong covalent bonds
- They contain strong intermolecular forces, so solid at rtp





States of matter/atoms into ions-

- Solids have a fixed shape and cannot be compressed, liquids have a fixed volume but can flow, gases have no fixed shape and can be compressed
- Melting & freezing happen at mpt, condensing & boiling at bpt
- At melting and boiling point, energy is transferred from the surroundings to the solid for the forces between the particles to break, and melt
- At freezing and condensing point, energy is transferred from the substance to the surroundings as stronger forces form between particles
- So the stronger the forces, the higher the boiling and melting point



The limitations of this model is that it assumes particles are made up of solid spheres with no forces operating between them, but some atoms are not spherical and are made up of mostly empty space, so are not solid at all.

- Elements react to form compounds by gaining, losing or sharing electrons
- Covalent bonding is sharing electrons, ionic bonding is transferring electron

Ionic bonding/giant ionic structures-

- In ionic bonding, atoms lose or gain electrons to form charged particles called ions, metal atoms lose electrons to become positively charged, and non-metal atoms gain electrons to become negatively charged
- Can be represented through a dot and cross diagram:

- Group 1 form 1+ ions, 2 form 2+ ions, 3 form 3+ ions, 4 don't, 5 form 3- ions, 6 form 2- ions, 7 form 1- ions, 0 never form ions
- An ionic compound is a giant structure of ions, and are held together by strong electrostatic forces of attraction between oppositely charged ions
- They have a high mpt and bpt (large energy needed to break bonds), solid at room temperature, conduct electricity when molten or dissolved in water as ions can carry charge through the liquid easily