GCSE AQA chemistry higher atomic structure Cheat Sheet

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atom,symbols,electronic charge and isotopes

All substances are made of atoms.An atom is the smallest part of an element that can exist.

Compounds- are formed from elements by chemical reactions.Compounds contain two or more elements chemically combined in fixed proportions

Word equations- display chemical reactions, denoting reactants and products with their full chemical names.**Example-** Sodium hydroxide + hydrochloric acid ⟶ sodium chloride + water

Symbol equations- utilize the formulae of reactants and products to illustrate chemical reactions.**Example-** $S + O_2 \rightarrow SO_2$

Half equations- specifically illustrate electron behavior during reactions where entities gain or lose electrons.**Examples of Half Equations-** $Pb^{2+} + 2e^- \rightarrow Pb$ $2Br^- \rightarrow Br_2 + 2e^-$

Ionic equations- elucidate ion behavior during reactions.Example of Ionic Equation **Initial equation:** $HCl + NaOH \rightarrow NaCl + H_2O$ **Ionic equation:** $H^+ + OH^- \rightarrow H_2O$

A **mixture** consists of two or more elements or compounds not chemically combined together.

Filtration- Separates undissolved solid from a liquid/solution mixture (e.g., sand from water). Utilizes a filter funnel equipped with filter paper placed over a beaker. The filter paper permits only liquid particles to pass, retaining solid particles as residue.

atom,symbols,electronic charge and isotopes (cont)

Crystallisation- Employed for separating a dissolved solid from a solution (e.g., copper sulphate from its aqueous solution). The solution is heated to create a saturated solution, followed by slow cooling to facilitate crystal growth. Crystals are harvested by filtering, washing with cold distilled water, and drying.

Simple Distillation- Separates a liquid and a soluble solid from a solution or pure liquid from a liquid mixture. The heating process initiates evaporation, producing vapor that condenses into pure liquid in a condenser. The remaining solid solute is left behind post complete liquid evaporation.

Fractional Distillation- Separates miscible liquids based on their boiling points (e.g., ethanol and water). The solution is heated to the boiling point of the lower boiling substance, which is then evaporated and collected separately. Example: In a water--ethanol mixture, ethanol (boiling point 78 °C) is evaporated first, followed by water (boiling point 100 °C).

Paper Chromatography- Separates substances with varying solubilities in a solvent (e.g., different dyes in black ink). A pencil-drawn line on chromatography paper holds sample spots for analysis. The solvent ascends the paper via capillary action, carrying colored substances at different rates based on their solubility. Results in separation of components and indicates purity or mixture status of a substance based on the number of spots developed.

atom,symbols,electronic charge and isotopes (cont)

The discovery of the electron led to the **plum pudding model** of the atom. The plum pudding model suggested that the atom is a ball of positive charge with negative electrons embedded in it.

The results from the **alpha particle scattering experiment** led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged. This nuclear model replaced the plum pudding model.

proton-+1 charge **electron-**-1 **neutron-** 0

The number of protons in an atom of an element is its atomic number. All atoms of a particular element have the same number of protons. Atoms of different elements have different numbers of protons.

mass number, symbolized as A, is the sum of protons and neutrons in an atom's nucleus.

Isotopes- are atoms of the same element but with different numbers of neutrons.**Number of neutrons (n) = mass number - atomic number**

Relative atomic mass equation-∑ isotope mass x isotope abundance / 100

The electrons in an atom occupy the lowest available energy levels (innermost available shells). The electronic structure of an atom can be represented by numbers or by a diagram.

The Periodic Table

The elements in the periodic table are arranged in order of **atomic (proton) number** and so that elements with similar properties are in columns, known as groups. The table is called a periodic table because similar properties occur at regular intervals.

The Periodic Table (cont)

Elements in the same group in the periodic table have the same number of electrons in their outer shell (outer electrons) and this gives them similar chemical properties.

Initial Ordering Methods- Before subatomic particles were discovered, elements were arranged by atomic weight, not atomic number. Patterns began to emerge when elements were organized by mass, leading to the term 'periodic'. Some elements were forced into positions to fill gaps, while others were incorrectly placed based on atomic weight only.

Mendeleev's Contribution- First Draft in 1869 Russian chemist Dmitri Mendeleev made the first draft of the periodic table in 1869. Elements were organized in vertical columns based on their properties and compound characteristics. Horizontal Arrangements and Patterns As Mendeleev arranged elements by increasing atomic weight, chemically similar elements naturally fell into the same columns. There were some exceptions where elements didn't follow this pattern. Innovation and Predictions Mendeleev did not force elements into specific positions, he left gaps for undiscovered elements. He even switched the positions of elements to maintain property consistency. Mendeleev used existing element properties to predict the characteristics of undiscovered elements, like "eka-silicon" now known as germanium.

The Periodic Table (cont)

Mendeleev's Limitations- Mendeleev had no knowledge of isotopes, leading to some inaccuracies. He did consider both atomic mass and chemical properties when sorting, but inaccuracies remained. Impact of Subatomic Particles Once subatomic particles were discovered, atomic numbers were calculated for each element. The modern Periodic Table uses atomic numbers, aligning with Mendeleev's original patterns.

Elements that react to form **positive ions are metals**. Elements that **do not** form positive ions are non-metals

The elements in **Group 0**of the periodic table are called the noble gases. They are unreactive and do not easily form molecules because their atoms have stable arrangements of electrons. The noble gases have eight electrons in their outer shell, except for helium, which has only two electrons. The boiling points of the noble gases increase with increasing relative atomic mass (going down the group)

The elements in **Group 1** of the periodic table are known as the alkali metals and have characteristic properties because of the single electron in their outer shell. Students should be able to describe the reactions of the first three alkali metals with oxygen, chlorine and water. In Group 1, the reactivity of the elements increases going down the group.

The Periodic Table (cont)

The elements in **Group 7** of the periodic table are known as the **halogens** and have similar reactions because they all have seven electrons in their outer shell. The halogens are non-metals and consist of molecules made of pairs of atoms. Students should be able to describe the nature of the compounds formed when chlorine, bromine and iodine react with metals and non-metals. In Group 7, the further down the group an element is the higher its relative molecular mass, melting point and boiling point. In Group 7, the reactivity of the elements decreases going down the group. A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt

Reactions of Group 1+Trends and Properties

Reactions with Water- Alkali metals react more vigorously with water as you move down the group. They are generally stored in oil to prevent reactions with air and water vapor.

Reactions with Oxygen- Alkali metals react with oxygen to form metal oxides that cause tarnishing.

Reactions with Chlorine- All alkali metals react intensely when heated with chlorine gas, forming metal chlorides. The reaction gets more vigorous as you move down the group.

Softness and Density- The metals get softer as you move down the group, with potassium being the exception which has lower density than sodium. The first three metals in this group are less dense than water.

Melting Points- Melting points for these metals decrease as you move down the group.

Reactions of Group 1+Trends and Properties (cont)

Reactivity- Reactivity increases down the group, with atoms needing to lose just one outer electron to attain noble gas configuration. As the number of shells increases down the group, the outer electron is farther from the nucleus and thus more easily lost, increasing reactivity.

Comparing Transition Metals and Group 1 Elements

Position in Periodic Table- Transition elements are found between Groups 2 and 3 in the center of the periodic table. They exhibit the typical metallic properties but have key differences compared to Group 1 metals.

Charge on Ions- All Group 1 metals form ions with a +1 charge. Transition metals can form ions with variable charges, like Fe^{2+} and Fe^{3+} ions in the case of iron.

Physical Properties- Transition metals are much harder, stronger, and denser compared to the soft and light Group 1 metals. They have significantly higher melting points. For example, titanium melts at 1,688 ºC, while potassium melts at 63.5 ºC.

Reactivity- Transition metals are less reactive than Group 1 metals. Alkali metals (Group 1) react rapidly with water, oxygen, and halogens. Transition metals react more slowly or may not react at all.

Reactivity with Oxygen- Group 1 metals tarnish quickly in the presence of oxygen, forming metal oxides. Iron, as a transition metal, takes several weeks to react with oxygen to form iron oxide (rust), and it needs water for this reaction.

Transition Metals: Properties and Applications

Properties of Transition Metals- Most known metals are transition metals, exhibiting typical metallic properties. These metals are lustrous, hard, strong, and good conductors of heat and electricity. Transition metals are dense and have high melting points. They can have multiple oxidation states, allowing them to lose different numbers of electrons based on their chemical environment. Variability in Compounds Compounds with transition elements in different oxidation states have varying properties and colors when dissolved in water.

Applications of Transition Metals

Catalysis Transition metals are widely used as catalysts, substances that speed up chemical reactions without being consumed. Their catalytic properties are due to their ability to switch between multiple oxidation states. They form complexes with reagents, facilitating electron donation and acceptance within a chemical reaction.

Common Catalysts Iron is utilized in the Haber Process. Vanadium pentoxide (V_2O_5) is used in the Contact Process for sulfuric acid production. Nickel is used for hydrogenating alkenes.

Medicine- Transition metals find applications in medicine, especially in limb and joint replacements. Titanium is significant here, as it can bond with bones due to its high biocompatibility.

Other Industrial Applications- These metals are used in the creation of colored compounds for dyes, paints, and other applications. Additional uses include making stained glass, crafting jewelry, and in anti-corrosive materials.