ADDITIONAL SCIENCE C3: CHEMISTRY **Higher content bold & labeled as HT** **Key words in bold**	Video	Exam Q	☺ 😐 ☹
Newlands & **Mendeleev** classified the elements by arranging them in order of their atomic weights.			
The early **periodic tables** were incomplete & some elements were put in inappropriate groups. Mendeleev overcame the problems by leaving gaps for undiscovered elements.			
The modern periodic table is arranged by electronic structures. Elements in the same group have the same number of electrons in their highest occupied energy level (outer shell)			
Group 1 (alkali metals) are metals with low density, react with non-metals to form ionic compounds. In water they release hydrogen & form hydroxides that give alkaline solutions			
In Group 1, the further down the group an element is the more reactive the element & the lower its melting point & boiling point			
Compared with Group 1, **transition elements** have higher melting points (except for mercury), higher densities, are stronger & harder, are much less reactive & form coloured compounds & are used as catalysts			
Group 7 (halogens) react with metals to form **ionic compounds**. The halide ion has a -1 charge. Further down the group the less reactive & the higher its melting & boiling point. More reactive halogens displace less reactive halogens from an aqueous solution of its salt			
HT: The higher the energy level of the outer electrons the more easily electrons are lost & the less easily electrons are gained			
Soft water readily forms lather with soap. **Hard water** reacts with soap to form **scum** & so more soap is needed to form lather. Soapless detergents do not form scum			
Hard water contains dissolved compounds, usually of **calcium or magnesium**. The compounds are dissolved when water comes into contact with rocks			
There are two types of hard water. **Permanent hard water** remains hard when it is boiled. **Temporary hard water** is softened by boiling			
HT: Temporary hard water contains hydrogen carbonate ions (HCO_3^-) that decompose on heating to produce carbonate ions which react with calcium & magnesium ions to form precipitates			
Using hard water can increase costs because more soap is needed. When temporary hard water is heated it can produce **scale** that reduces the efficiency of heating systems & kettles			
Hard water has some benefits because calcium compounds are good for the development & maintenance of bones & teeth & also help to reduce heart disease			
Hard water is softened by adding **sodium carbonate**, which reacts with the calcium & magnesium ions to form a **precipitate** of **calcium carbonate & magnesium carbonate**. **Ion exchange columns** containing hydrogen ions or sodium ions, replace the calcium & magnesium ions when hard water passes			
Water filters containing carbon, silver & ion exchange resins can remove some dissolved substances from tap water to improve the taste & quality			
Chlorine is added to drinking water to reduce microbes & fluoride may be added to improve dental health			
Pure water can be produced by **distillation**			
The relative amounts of energy released when substances burn can be measured by simple **calorimetry**, eg by heating water in a glass or metal container			
The amount of energy released or absorbed by a chemical reaction in solution can be calculated from the temperature change in an **insulated container**. Can be used for reactions of solids with water or for neutralisation reactions			
Simple energy level diagrams can be used to show the relative energies of reactants & products, the **activation energy** & the overall energy change of a reaction			
During a chemical reaction energy must be **supplied to break bonds** & **energy is released when bonds are formed**			
HT: In an exothermic reaction, the energy released from forming new bonds is greater than the energy needed to break existing bonds			
HT: In an endothermic reaction, the energy needed to break existing bonds is greater than the energy			

released from forming new bonds			
Catalysts provide a different pathway for a chemical reaction that has a lower activation energy			
Hydrogen can be burned as a fuel in combustion engines. It can also be used in fuel cells that produce electricity to power vehicles. **Hydrogen + Oxygen → Water**			
Flame tests identify **metal ions**. lithium → crimson, sodium compounds → yellow, potassium compounds → lilac, calcium compounds → red, barium compounds→ green			
Aluminium, calcium & magnesium ions form white precipitates with sodium hydroxide solution but only the aluminium hydroxide precipitate dissolves in excess sodium hydroxide solution			
Copper(II), iron(II) & iron(III) ions form coloured precipitates with sodium hydroxide solution. Copper forms a blue precipitate, iron(II) a green precipitate & iron(III) a brown precipitate			
Carbonates react with dilute acids to form carbon dioxide. Carbon dioxide produces a white precipitate with limewater. This turns limewater cloudy			
Halide ions in solution produce precipitates with silver nitrate solution in the presence of dilute nitric acid. Silver chloride is white, silver bromide is cream & silver iodide is yellow			
Sulfate ions in solution produce a white precipitate with barium chloride solution in the presence of dilute hydrochloric acid			
The volumes of acid & alkali solutions that react with each other can be measured by **titration** using a suitable indicator			
HT: If the concentration of one of the reactants is known, the results of a titration can be used to find the concentration of the other reactant			
The raw materials for the **Haber process** are nitrogen & hydrogen. Nitrogen is obtained from the air & hydrogen may be obtained from natural gas or other sources			
The purified gases are passed over a catalyst of iron at a high temperature & a high pressure Some hydrogen & nitrogen reacts to form **ammonia**. The reaction is **reversible**. Remaining hydrogen & nitrogen are recycled			
HT: When a reversible reaction occurs in a closed system, equilibrium is reached when the reactions occur at exactly the same rate in each direction. Relative amounts of reacting substances at equilibrium depend on the conditions of the reaction			
HT: If the temperature is raised, the yield from the endothermic reaction increases & the yield from the exothermic reaction decreases			
HT: If the temperature is lowered, the yield from the endothermic reaction decreases & the yield from the exothermic reaction increases			
HT: In gaseous reactions, an increase in pressure will favour the reaction that produces the least number of molecules as shown by the symbol equation for that reaction			
HT: These factors, together with reaction rates are important when determining the optimum conditions in industrial processes, including the Haber process			
Alcohols contain the functional group –OH. **Methanol, ethanol & propanol** are the first three members of a homologous series of alcohols			
Methanol, ethanol & propanol dissolve in water to form a neutral solution, react with sodium to produce hydrogen, burn in air, are used as a fuels & solvents, & ethanol is the main alcohol in alcoholic drinks			
Ethanol can be oxidised to ethanoic acid, either by chemical oxidising agents or by microbial action. Ethanoic acid is the main acid in vinegar			
Ethanoic acid is a member of the carboxylic acids, which have the functional group **–COOH**			
HT: It does not ionise completely when dissolved in water & so is a weak acid. Aqueous solutions of weak acids have a higher pH value than aqueous solutions of strong acids with the same concentration			
Ethyl ethanoate is the **ester** produced from ethanol & ethanoic acid. Esters have the functional group **–COO–.** They are volatile compounds with distinctive smells & are used as flavourings & perfumes			