KS4 Combined Science Trilogy Scheme of Work - Chemistry

<table>
<tr><th>Lesson Title</th><th>Objectives</th><th>Activities</th><th>Outcomes</th></tr>
<tr>
<td>Topic 1 Atomic Structure and the Periodic Table
Atomic Structure</td>
<td>The relative electrical mass and charge of particles in atoms is:

<table>
<tr><th>Name of particle</th><th>Relative charge</th><th>Relative Mass</th></tr>
<tr><td>Proton</td><td>+1</td><td>1</td></tr>
<tr><td>Neutron</td><td>0</td><td>1</td></tr>
<tr><td>Electron</td><td>-1</td><td>Very small</td></tr>
</table>

In an atom the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge.

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 the same element can have different numbers of neutrons; these atoms are called isotopes of that element.

The electrons in an atom occupy the lowest available energy levels (innermost available shells).

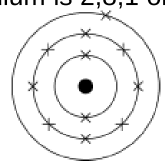
The electronic structure of an atom can be represented by numbers or by a diagram.</td>
<td>Recall structure of atom and the charges of each particle (KS3).

Using examples from the first 20 elements on the periodic table, students read off and work out the number of each charge different elements have.

Describe the relationship between number of positive and negative charges. Apply this relationship to explain why there is no overall charge.

Referring to their table of data students write their rules to state what the atomic number is and why elements are different from each other.

Describe how many electrons there can be in the first, second and third energy shells.

For example, the electronic structure of sodium is 2,8,1 or

showing two electrons in the lowest energy level, eight in the second</td>
<td>Recall the different charges of the particles that make up an atom.

Describe why atoms have no overall charge.

Recall what atomic number represents.

Use the periodic table to identify number of protons in different elements.

Describe the structure of the atom.

Calculate the numbers of protons, neutrons and electrons in an atom or ion, given its atomic number and mass number for the first 20 elements.

Students should be able to represent the electronic structures of the first twenty elements of the periodic table in both forms.

Students may answer questions in terms of either energy levels or shells.</td>
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</table>

		energy level and one in the third energy level.	
Elements. Compounds and Mixtures	All substances are made of atoms. An atom is the smallest part of an element that can exist. There are about 100 different elements. Elements are shown in the periodic table. Compounds are formed from elements by chemical reactions. Chemical reactions always involve the formation of one or more new substances, and often involve a detectable energy change. Compounds contain two or more elements chemically combined in fixed proportions and can be represented by formulae using the symbols of the atoms from which they were formed. Chemical reactions can be represented by word equations or equations using symbols and formulae. A mixture consists of two or more elements or compounds not chemically combined together. The chemical properties of each substance in the mixture are unchanged. Mixtures can be separated by physical processes such as filtration, crystallisation, simple distillation, fractional distillation and chromatography. These physical processes do not involve chemical reactions and no new substances are made.	Define an atom and element. Use scientific conventions to identify elements by chemical symbols. Define a compound. Write word equations for reactions from practical activities stated in the specification. Develop skills to communicate through use of symbol equations. Apply these skills to write balanced symbol equations for equations met in practical activities. Define a mixture. Describe each practical technique of separating mixtures. Explain how chromatography, distillation and filtration practical techniques occur.	Use the names and symbols of the first 20 elements in the periodic table, the elements in Groups 1 and 7, and other elements in this specification. Name compounds of these elements from given formulae or symbol equations. Write word equations for chemical reactions. Write formulae and balanced chemical equations for chemical reactions. Describe, explain and give examples of the specified processes of separation. Suggest suitable separation and purification techniques for mixtures when given appropriate information.

Development of the Model of the Atom	New experimental evidence may lead to a scientific model being changed or replaced. Before the discovery of the electron atoms were thought to be tiny spheres that could not be divided. The discovery of the electron led to the plum-pudding model of the atom. The plum-pudding model suggested that the atom was a ball of positive charge with negative electrons embedded in it. The results from the alpha particle scattering experiment led to the plum-pudding model being replaced by the nuclear model. Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. The experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus. Atoms are very small, having a radius of about 0.1 nm (1 x 10^{-10} m). The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 x 10^{-14} m).	Create a timeline for the history of the atomic model. Describe the differences between the plum-pudding model, nuclear model and atomic model. Describe why changes to the atomic model happened. Describe the experimental techniques involved in the history of the atomic model. Explain how the experimental techniques work.	Describe how and why the atomic model has changed over time. Describe the difference between the plum-pudding model of the atom and the nuclear model of the atom. Describe why the new evidence from the scattering experiment led to a change in the atomic model.
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. 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.	Identify link between electron configuration and the structure of the periodic table for elements 1 to 20. Identify anomalies. BBC Bitesize videos Create a timeline for the history of the periodic table.	Explain how the position of an element in the periodic table is related to the arrangement of electrons in its atoms and hence to its atomic number. Predict possible reactions and probable reactivity of elements from their positions in the periodic table.

	Mendeleev overcame some of the problems of earlier periodic tables by leaving gaps for elements that he thought had not been discovered and in some places changed the order based on atomic weights. Elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.	Describe the differences between the early Periodic tables and our current Periodic table. Explain why the Periodic table has changed throughout the years.	Describe these steps in the development of the periodic table. Describe and explain how testing a prediction can support or refute a new scientific idea.
Metals and Non-Metals Group 0	Elements that react to form positive ions are metals. Elements that do not form positive ions are non-metals. The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table. Non-metals are found towards the right and top of the periodic table. 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 boiling points of the noble gases increase with increasing relative atomic mass (going down the group).	Table to show the different properties of metals and non-metals. Describe the trends in properties in Group 0. Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms.	Explain the differences between metals and non-metals on the basis of their characteristic physical and chemical properties. Explain how the atomic structure of metals and non-metals relates to their position in the periodic table. Explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number. Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms. Predict properties from given trends down the group.
Groups 1 and 7	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.:	Describe the trends in properties in Group 1. Explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms. Explain the trends in Group 1.	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 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. 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.	Show video of reactivity of Na, Li and K in water with universal indicator. Predict reactions for Rb, Cs and Fr. Describe the trends in properties in Group 7. Explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms. Show video of Group 7 reactions. Write word and balanced symbol equations for all reactions showing displacement reactions.	Explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms. Predict properties from given trends down the group. Describe the nature of the compounds formed when chlorine, bromine and iodine react with metals and non-metals. Explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms. Predict properties from given trends down the group.
States of Matter and Changing State	Know that • The three states of matter are solid, liquid and gas. • Melting and freezing take place at the melting point, boiling and condensing take place at the boiling point. • The three states of matter can be represented by a simple model.	Describe and draw diagrams showing the properties of matter in a solid, liquid and gas. Define melting point and boiling point. Grade 9: explain the differences in changes of state in terms of intermolecular forces of attraction between a short molecule ie methane and a longer molecule ie pentane	Students should be able to: • predict the states of substances at different temperatures given appropriate data • explain the different temperatures at which changes of state occur in terms of energy transfers and types of bonding • recognise that atoms themselves do not have the bulk properties of materials Include appropriate state symbols in chemical equations for the reactions in this specification.

Topic 2 Structure, Bonding and Properties of Matter Ionic Bonding (2 lessons)	Describe the formation of ions. Metal atoms lose electrons to become positively charged ions. Non-metal atoms gain electrons to become negatively charged ions. The electron transfer during the formation of an ionic compound can be represented by a dot and cross diagram. The charge on the ions produced by metals in Groups 1 and 2 and by non-metals in Groups 6 and 7 relates to the group number of the element in the periodic table. An ionic compound is a giant structure of ions. Ionic compounds are held together by strong electrostatic forces of attraction between oppositely charged ions. These forces act in all directions in the lattice and this is called ionic bonding Properties of ionic compounds, why they have high melting points, how they conduct electricity.	Dot and cross diagrams to show ions and transfer of electrons. Tabulate common atoms and state the charges of the ions formed. Grade 9: explain an example of ionic bonding including detail on electron transfer, group numbers of the atoms involved and the use of correct terms, eg cation and anion. Describe the bonding in the sodium chloride lattice using the correct terms, eg electrostatic forces of attraction.	Students should be able to: • draw dot and cross diagrams for ionic compounds formed by metals in Groups 1 and 2 with non-metals in Groups 6 and 7 • work out the charge on the ions of metals and non-metals from the group number of the element, limited to the metals in Groups 1 and 2, and non-metals in Groups 6 and 7. Students should be able to: • deduce that a compound is ionic from a diagram of its structure • describe the limitations of using dot and cross, ball and stick, two and three dimensional diagrams to represent a giant ionic structure • work out the empirical formula of an ionic compound from a given model or diagram that shows the ions in the structure. These compounds have high melting points and high boiling points because of the large amounts of energy needed to break the many strong bonds. When melted or dissolved in water, ionic compounds conduct electricity because the ions are free to move and so charge can flow.
Covalent Bonding	When atoms share pairs of electrons, they form covalent bonds. These bonds between atoms are strong. Covalently bonded substances may consist of small molecules.	Model simple covalent substance using molecular model kits. Demo giant covalent structures using molecular model kits.	Students should be able to: • recognise substances as small molecules, polymers or giant structures from diagrams showing their bonding

	Some covalently bonded substances have very large molecules, such as polymers. Some covalently bonded substances have giant covalent structures, such as diamond and silicon dioxide. Properties of small covalent compounds and the strength of intermolecular forces. These substances do not conduct electricity because the molecules do not have an overall electric charge.	Describe the difference between simple covalent substances and giant covalent substances.	• recognise common substances that consist of small molecules from their chemical formula. • draw dot and cross diagrams for the molecules of hydrogen, chlorine, oxygen, nitrogen, hydrogen chloride, water, ammonia and methane • represent the covalent bonds in small molecules, in the repeating units of polymers and in part of giant covalent structures, using a line to represent a single bond Students should be able to use the idea that intermolecular forces are weak compared with covalent bonds to explain the bulk properties of molecular substances.
Giant Covalent Structures	Substances that consist of giant covalent structures are solids with very high melting points. Diamond and graphite (forms of carbon) and silicon dioxide (silica) are examples of giant covalent structures.	Research the properties of diamond, graphite, graphene and fullerenes.	Explain the properties of diamond, graphite, graphene and fullerenes in terms of its structure and bonding. Give examples of the uses of fullerenes, including carbon nanotubes.
Metallic Bonding and Polymers	Metals have giant structures of atoms with strong metallic bonding. This means that most metals have high melting and boiling points. In pure metals, atoms are arranged in layers, which allows metals to be bent and shaped. Pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder.	Draw diagrams to explain the structure of pure metals and alloys. Draw the structure of polymers and explain why they have certain properties.	Explain why alloys are harder than pure metals in terms of distortion of the layers of atoms in the structure of a pure metal. Students should be able to recognise polymers from diagrams showing their bonding.

	Metals are good conductors of electricity because the delocalised electrons in the metal carry electrical charge through the metal. Metals are good conductors of thermal energy because energy is transferred by the delocalised electrons. Polymers have very large molecules. The atoms in the polymer molecules are linked to other atoms by strong covalent bonds.		
Topic 4 Chemical Changes Acids and Alkalis	Acids produce hydrogen ions (H^+) in aqueous solutions. Aqueous solutions of alkalis contain hydroxide ions (OH^-). The pH scale, from 0 to 14, is a measure of the acidity or alkalinity of a solution, and can be measured using universal indicator or a pH probe. In neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water. A strong acid is completely ionised in aqueous solution. Examples of strong acids are hydrochloric, nitric and sulfuric acids. A weak acid is only partially ionised in aqueous solution. Examples of weak acids are ethanoic, citric and carbonic acids.	Measure the pH of a variety of the following solutions: • acidic • alkaline • neutral. Practical: measure the pH change when a strong acid neutralises a strong alkali. Define the following terms: • acid • base • alkali • neutral. Recall the pH numbers for the following solutions: • acidic • alkaline • neutral. Write the symbol equation for the neutralisation of an acid and an alkali. Explain the meaning of the following terms: • dilute • concentrated	Describe the use of universal indicator or a wide range indicator to measure the approximate pH of a solution. Use the pH scale to identify acidic or alkaline solutions. Use and explain the terms dilute and concentrated (in terms of amount of substance), and weak and strong (in terms of the degree of ionisation) in relation to acids. Use and explain the terms dilute and concentrated (in terms of amount of substance), and weak and strong (in terms of the degree of ionisation) in relation to acids.

		• weak • strong. Explain why strong acids are completely ionised in aqueous solutions but a weak acid is only partially ionised. Recall examples of strong and weak acids.	
Reactions of Acids (2 lessons)	Acids are neutralised by alkalis (eg soluble metal hydroxides) and bases (eg insoluble metal hydroxides and metal oxides) to produce salts and water, and by metal carbonates to produce salts, water and carbon dioxide. The particular salt produced in any reaction between an acid and a base or alkali depends on: • the acid used (hydrochloric acid produces chlorides, nitric acid produces nitrates, sulfuric acid produces sulfates) Soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates.	Investigate the following reactions: • acids + soluble metal hydroxide • acid + insoluble metal hydroxide • acids + metal carbonates. Write word and balanced symbol equations for these reactions. Define the term neutralisation. Using common reactants, predict the products. Describe how to make a pure, dry sample of a soluble salt. Define the terms: • soluble • insoluble. Explain what is meant by a soluble salt. Explain why reactants are often used in excess. Preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath	Predict products from given reactants. Use the formulae of common ions to deduce the formulae of salts. Describe how to make pure, dry samples of named soluble salts from information provided.

		or electric heater to evaporate the solution.	
Reactions of Metals and the Reactivity Series	Metals react with oxygen to produce metal oxides. The reactions are oxidation reactions because the metals gain oxygen. Metals can be arranged in order of their reactivity in a reactivity series. The non-metals hydrogen and carbon are often included in the reactivity series. A more reactive metal can displace a less reactive metal from a compound. Acids react with some metals to produce salts and hydrogen.	Define the following terms: • oxidation • reduction. Write word and balanced symbol equations for the reactions of metals with oxygen to produce metal oxides. Use these to identify where reduction and oxidation has taken place. Explain why displacement occurs. Compare the year of discovery of a metallic element with its position in the reactivity series. Investigate the reactions of the following metals with sulfuric acid: • magnesium • zinc • iron. Write word and balanced symbol equations for these reactions.	Explain reduction and oxidation in terms of loss or gain of oxygen. Recall and describe the reactions, if any, of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids, where appropriate, to place these metals in order of reactivity. Explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion. Knowledge of reactions of magnesium, zinc and iron with hydrochloric and sulfuric acids.
Extraction of Metals	Unreactive metals such as gold are found in the Earth as the metal itself but most metals are found as compounds that require chemical reactions to extract the metal. Describe how carbon is used to reduce metal oxides. Explain how this takes place in terms of movement of electrons.	Video on the discovery of metals. Video on extraction of Iron. Word and symbol equations showing the process of carbon reducing the iron oxide.	Knowledge of the extraction of metals with reduction of oxides using carbon. Interpret or evaluate specific metal extraction processes when given appropriate information. Identify the substances which are oxidised or reduced in terms of gain or loss of oxygen.

	Identify which products have been oxidised in extraction examples. Explain how this takes place in terms of movement of electrons.		
Electrolysis (2 lessons)	Explain why solid ionic compounds cannot conduct electricity but ionic compounds can conduct electricity when melted or dissolved in water. Define the term electrolyte. Describe how an electric current can pass through an ionic compound. Explain what happens to positive and negative ions during electrolysis and how elements form from their ions. Describe how aluminium is extracted from its ore. Be able to predict the products of the electrolysis of aqueous solutions containing a single ionic compound.	Watch a video of the electrolysis of lead bromide. Draw and label a diagram showing the ions produced at each electrode. Label a diagram showing the process of extracting aluminium. Investigate what happens when aqueous solutions such as sodium chloride are electrolysed using inert electrodes.	Students should be able to predict the products of the electrolysis of binary ionic compounds in the molten state. Give reasons why some metals have to be extracted by electrolysis Explain why a mixture is used as the electrolyte in the extraction of aluminium and explain why the positive electrode must be continually replaced. describe how an aqueous solution is electrolysed. Explain why the following atoms could be produced: • hydrogen oxygen.
Topic 3 Quantitative Chemistry Chemistry Calculations	Know that • the relative formula mass (M_r) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula. • Chemical amounts are measured in moles. The symbol for the unit mole is mol. • The mass of one mole of a substance in grams is numerically equal to its relative formula mass.	Calculate relative formula masses of familiar compounds. Calculate the number of moles in a substance using the relative formula mass.	Be able to calculate the relative formula mass (M_r) of a compound from its formula, given the relative atomic masses. Understand that the measurement of amounts in moles can apply to atoms, molecules, ions, electrons, formulae and equations, for example that in one mole of carbon (C) the number of atoms is the same as the number of molecules in one mole of carbon dioxide (CO_2).

	• One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance.		Be able to use the relative formula mass of a substance to calculate the number of moles in a given mass of that substance and vice versa.
Topic 5 Energy Changes	Know that: • Energy is conserved in chemical reactions. • An exothermic reaction is one that transfers energy to the surroundings so the temperature of the surroundings increases. • Exothermic reactions include combustion, many oxidation reactions and neutralisation. • An endothermic reaction is one that takes in energy from the surroundings so the temperature of the surroundings decreases. • Endothermic reactions include thermal decompositions and the reaction of citric acid and sodium hydrogencarbonate. Define the term activation energy. Draw reaction profiles for exothermic and endothermic. Explain what the diagrams display.	Define the terms: • exothermic • endothermic. Investigate the variables that affect temperature changes in reacting solutions such as, eg acid plus metals, acid plus carbonates, neutralisations, displacement of metals. Draw reaction profiles for exothermic and endothermic. Explain what the diagrams display.	Distinguish between exothermic and endothermic reactions on the basis of the temperature change of the surroundings. Evaluate uses and applications of exothermic and endothermic reactions given appropriate information. Draw simple reaction profiles (energy level diagrams) for exothermic and endothermic reactions showing the relative energies of reactants and products, the activation energy and the overall energy change, with a curved arrow to show the energy as the reaction proceeds. Use reaction profiles to identify reactions as exothermic or endothermic. Explain that the activation energy is the energy needed for a reaction to occur.
Topic 6 The Rate and Extent of Chemical change	To learn about the factors which affect the rates of chemical reactions which include: the concentrations of reactants in solution, the pressure of reacting gases, the surface area	Draw diagrams of particles to explain how each of the factors affect the rate of a reaction.	Explain the effect on the rate of reaction of the following factors: • concentration

Factors that affect a rate of reaction and Collision Theory	of solid reactants, the temperature and the presence of catalysts. Collision theory explains how various factors affect rates of reactions. Identify advantages of using catalysts in industrial reactions eg reducing costs. Explain the effect of using a catalyst on the activation energy.	Draw and describe the energy profile diagram for a catalyst and label the activation energy change.	• pressure • surface area • temperature • catalyst. using collision theory. Be able to identify catalysts in reactions from their effect on the rate of reaction and because they are not included in the chemical equation for the reaction. Be able to explain catalytic action in terms of activation energy
How to investigate the rate of a reaction.	Investigate how the rate of a chemical reaction can be found by measuring the quantity of a reactant used or the quantity of product formed over time. Investigate how changes in concentration affect the rates of reactions by a method involving measuring the volume of a gas produced **and** a method involving a change in colour.	React $CaCO_3$ with dilute HCl and measure the volume of CO_2 evolved against time. Record the results and plot a graph of results of volume of gas against time. Use the results and graph to determine the mean rate of reaction. A similar reaction can be done with magnesium and hydrochloric acid. Use graphical data to explain each part of the graph ie: • initially rate is fast • slows down reaction completes.	Calculate the mean rate of a reaction from given information about the quantity of a reactant used or the quantity of a product formed and the time taken. Draw and interpret graphs showing the quantity of product formed or quantity of reactant used up against time. Draw tangents to the curves on these graphs and use the slope of the tangent as a measure of the rate of reaction.
Reversible Reactions	Know that • In some chemical reactions, the products of the reaction can react to produce the original reactants. Such reactions are called reversible reactions	Practical: hydrate or dehydrate copper sulfate. Write a balanced equation for the reaction and describe the full process.	Explain what is meant by a reversible reaction. Explain the difference between: $\rightleftharpoons$ reactions

	• The direction of reversible reactions can be changed by changing the conditions. • If a reversible reaction is exothermic in one direction, it is endothermic in the opposite direction. Introduce Le Chatelier's Principle for HT		and → reactions. Describe the effects of temperature on the reversible reaction.
Topic 7 Organic Chemistry Crude Oil and Alkanes	Describe the formation of crude oil. Describe the composition of crude oil. Define a hydrocarbon. Describe the structure and bonding in Alkanes. Describe the process of fractional distillation. Grade 9: explain the process of fractional distillation in terms of intermolecular forces of attraction.	Make molecular models and work out general formula for the alkanes. Draw the covalent bonding in: • methane • ethane • propane • butane. Define the term saturated. Research uses of the fractions of crude oil.	Be able to recognise and draw alkanes given their formulae. Explain what is meant by the formula C_nH_{2n+2} Explain how fractional distillation works in terms of evaporation and condensation.
Properties of Hydrocarbons and Alkenes	Explain the properties of hydrocarbons in relation to intermolecular forces. Write balanced symbol equations for the combustion of hydrocarbon fuels. Know that • Hydrocarbons can be broken down (cracked) to produce smaller, more useful molecules.	Investigate the properties of different hydrocarbons in terms of boiling point, viscosity and flammability with increasing molecular size. Identify the products of combustion of alkanes. Use bromine water to identify alkenes.	Recall how boiling point, viscosity and flammability change with increasing molecular size. Write balanced equations for the complete combustion of hydrocarbons with a given formula. Describe in general terms the conditions used for catalytic cracking and steam cracking.

	• Cracking can be done by various methods including catalytic cracking and steam cracking. • The products of cracking include alkanes and another type of hydrocarbon called alkenes. • Alkenes are more reactive than alkanes and react with bromine water, which is used as a test for alkenes. • There is a high demand for fuels with small molecules and so some of the products of cracking are useful as fuels.		Recall the colour change when bromine water reacts with an alkene. Balance chemical equations as examples of cracking given the formulae of the reactants and products. Give examples to illustrate the usefulness of cracking. Be able to explain how modern life depends on the uses of hydrocarbons.
Topic 8 Chemical Analysis Formulations Chromatography	Define the terms: • pure substance • compound. Explain, in terms of intermolecular forces, the terms: • melting point • boiling point. Define the terms: • mixture formulation.	Research the melting and boiling points of common pure substances and compounds. Suggest reasons for differences in data available on the internet. Research the composition of the following formulations: • fuel • cleaning agents • paints • medicines • alloys • fertilisers • foods. Identify the purpose of each chemical in the formulation.	Be able to use melting point data to distinguish pure from impure substances. Identify formulations given appropriate information.

<table>
<tr><td>Chromatography</td><td>Describe a method for paper chromatography.

Explain what happens to substances during the process of chromatography.

Describe what the R_f value is and how to calculate the R_f value.</td><td>Investigate how paper chromatography can be used to separate and tell the difference between coloured substances. Students should calculate Rf values.</td><td>Explain how paper chromatography separates mixtures.

Suggest how chromatographic methods can be used for distinguishing pure substances from impure substances.

Interpret chromatograms and determine R_f values from chromatograms.</td></tr>
<tr><td>Test for Gases</td><td>Describe the tests for the following gases
Oxygen
Hydrogen
Carbon Dioxide
Chlorine</td><td>Carry out the tests for Hydrogen and Carbon Dioxide.

Watch videos on the tests for Oxygen and Chlorine.</td><td></td></tr>
<tr><td>Topic 9 Chemistry of the Atmosphere

Evolution of the Atmosphere</td><td>Know that
There are theories about what was in the Earth’s early atmosphere and how the atmosphere was formed have changed and developed over time.
The role of volcanoes in the development of the early atmosphere
The level of carbon dioxide changed as plants evolved
How the oceans formed
The composition of the atmosphere today and how oxygen formed.</td><td>Draw accurate pie charts for the composition of the atmosphere both in the past and today.

Explain why the composition of the atmosphere has changed over billions of years.
Compare the Earth’s atmosphere to that of Mars and Venus.

Explain how algae and plants have caused the concentrations of oxygen in the atmosphere to increase.</td><td>Describe the composition of the atmosphere and how it has changed over time..

Draw accurate pie charts for the composition of the atmosphere both in the past and today.

Given appropriate information, interpret evidence and evaluate different theories about the Earth’s early atmosphere.</td></tr>
<tr><td>Greenhouse gases and climate change</td><td>Greenhouse gases in the atmosphere maintain temperatures on Earth high enough to support life.</td><td>Watch videos on the Greenhouse Effect and global warming.</td><td>Describe the greenhouse effect in terms of the interaction of short and long wavelength radiation with matter.</td></tr>
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	Water vapour, carbon dioxide and methane are greenhouse gases. Some human activities increase the amounts of greenhouse gases in the atmosphere. An increase in average global temperature is a major cause of climate change. There are several potential effects of global climate change.	Describe how greenhouse gases are produced. Evaluate the use of models for predicting climate change. Identify the effects of global warming. Explain the effects of climate change.	Recall two human activities that increase the amounts of each of the greenhouse gases carbon dioxide and methane. Evaluate the quality of evidence in a report about global climate change given appropriate information. Describe briefly four potential effects of global climate change Discuss the scale, risk and environmental implications of global climate change.
Carbon footprints and Air pollution	Describe what a carbon footprint is. Describe how emissions can be reduced. Suggest the consequences of the reductions on the Earth, atmosphere and everyday life. Know that • The combustion of fuels is a major source of atmospheric pollutants. • Most fuels, including coal, contain carbon and/or hydrogen and may also contain some sulfur. • The gases released into the atmosphere when a fuel is burned may include carbon dioxide, water vapour, carbon monoxide, sulfur dioxide and oxides of nitrogen. Solid particles and unburned hydrocarbons may also be released that form particulates in the atmosphere.	Use appropriate websites to calculate your personal carbon footprint. Write word equations for complete and incomplete combustion. Explain why the following can be produced in combustion: • carbon dioxide • carbon monoxide • soot • water vapour • sulfur dioxide oxides of nitrogen Describe the effect of the following products: • Carbon monoxide on the human body. • Sulfur dioxide and oxides of nitrogen on acidity of rain water.	Describe actions to reduce emissions of carbon dioxide and methane. Give reasons why actions may be limited Describe how carbon monoxide, soot (carbon particles), sulfur dioxide and oxides of nitrogen are produced by burning fuels Predict the products of combustion of a fuel given appropriate information about the composition of the fuel and the conditions in which it is used. Describe and explain the problems caused by increased amounts of these pollutants in the air.

		• Sulfur dioxide and oxides of nitrogen on respiratory system. • Particulates on global dimming. Particulates on human health problems.	
Topic 10 Using Resources Finite and Renewable Resources	Know that Natural resources, supplemented by agriculture, provide food, timber, clothing and fuels. Finite resources from the Earth, oceans and atmosphere are processed to provide energy and materials. Chemistry plays an important role in improving agricultural and industrial processes to provide new products The Earth's resources of metal ores are limited. Copper ores are becoming scarce and new ways of extracting copper from low-grade ores include phytomining and bioleaching.	Define the terms: • finite • renewable. Explain the differences between the two terms using suitable examples	State examples of natural products that are supplemented or replaced by agricultural and synthetic products. Distinguish between finite and renewable resources given appropriate information. Extract and interpret information about resources from charts, graphs and tables.
Recycling and Life Cycle Assessments	Describe what a LCA is using a suitable example. Use information to interpret the LCA of a given material or product. Discuss the issues relating to using limited resources to generate energy. Know that obtaining raw materials from the Earth by quarrying and mining causes environmental impacts.	Use the internet to carry out simple comparative LCAs for shopping bags made from plastic and paper. LCAs should be done as a comparison of the impact on the environment of the stages in the life of a product, and only quantified where data is readily available for energy, water, resources and wastes. Research methods of producing/obtaining metal/glass/building materials/clay	Carry out simple comparative LCAs for shopping bags made from plastic and paper Evaluate ways of reducing the use of limited resources, given appropriate information

		ceramics/plastics. Identify in these methods the limited resources that are used to generate the energy. Research how glass is recycled. Research how metal is recycled and alternatives for use of scrap metals ie in obtaining iron in a blast furnace.	
Potable Water and Waste Water Treatment	Define the terms: • potable water • pure water. Explain the differences between the two terms. Know the methods used to produce potable water and how they depend on available supplies of water and local conditions Know that sewage treatment includes: • screening and grit removal • sedimentation to produce sewage sludge and effluent • anaerobic digestion of sewage sludge aerobic biological treatment of effluent.	Watch videos on how water is made safe to drink and how sewage is treated. Label diagrams to show the processes and explain each stage.	Distinguish between potable water and pure water. Describe the differences in treatment of ground water and salty water. Give reasons for the steps used to produce potable water. Give reasons for the stages used to treat sewage.