Paper 1:

Topic 1 – Atomic Structure and the Periodic Table Retrieval Starters

5.1.1.1 Atoms, Elements and Compounds

1. What is an atom?
2. What is an element?
3. How are atoms of different elements represented?
4. How many different elements are there approximately?
5. What is a compound?
6. Explain why compounds can only be separated into elements by chemical reactions.

5.1.1.2 Mixtures

1. What is a mixture?
2. How are the properties of substances in a mixture affected when they are mixed?
3. What is the difference between a mixture and a compound?
4. Which separation technique is used to separate an insoluble solid from a liquid?
5. Which separation technique is used to separate substances based on differences in boiling points?
6. Explain why physical separation methods do not produce new substances.

5.1.1.3 The Development of the Model of the Atom

1. What did scientists originally believe atoms were like before the discovery of electrons?
2. What discovery led to the development of the plum pudding model?
3. Describe the plum pudding model of the atom.
4. What did the alpha particle scattering experiment show about the atom?
5. Why was the nuclear model developed to replace the plum pudding model?
6. Explain how scientific evidence can lead to changes in scientific models.

5.1.1.4 Relative Electrical Charges of Subatomic Particles

1. What is the relative charge of a proton?
2. What is the relative charge of a neutron?
3. What is the relative charge of an electron?
4. Why do atoms have no overall electrical charge?
5. What is the atomic number of an element?
6. Explain why all atoms of the same element have the same number of protons.

5.1.1.5 Size and Mass of Atoms

1. What is the approximate radius of an atom?
2. Where is almost all of the mass of an atom found?
3. What particles are found in the nucleus of an atom?
4. What is the mass number of an atom?
5. How are isotopes of an element different?
6. An atom has an atomic number of 12 and a mass number of 24. Calculate the number of protons, neutrons and electrons in the atom.

5.1.1.6 Relative Atomic Mass

1. What is meant by relative atomic mass?
2. Why is relative atomic mass usually not a whole number?
3. What information is needed to calculate relative atomic mass?
4. Why does relative atomic mass take account of isotopes?
5. Calculate the relative atomic mass of an element with 75% isotope A of mass 20 and 25% isotope B of mass 22.
6. Explain why the relative atomic mass of chlorine is approximately 35.5.

5.1.1.7 Electronic Structure

1. What are electrons arranged into around the nucleus?
2. Which energy level do electrons fill first?
3. How many electrons can the first shell hold?
4. Write the electronic structure of sodium.
5. Write the electronic structure of oxygen.
6. Explain why the outer shell of an atom affects its chemical properties.

5.1.2.1 The Periodic Table

1. How are elements arranged in the periodic table?
2. What is the atomic number of an element?
3. Why do elements in the same group have similar chemical properties?
4. What does the group number tell you about the electrons in an atom?
5. How is the position of an element in the periodic table related to its electronic structure?
6. Predict the reactivity of an element from its position in the periodic table.

5.1.2.2 Development of the Periodic Table

1. How did early scientists arrange elements in the periodic table?
2. What problem occurred when elements were arranged only by atomic weight?
3. Who developed a periodic table that left gaps for undiscovered elements?
4. Why did Mendeleev leave gaps in his periodic table?
5. How did the discovery of new elements support Mendeleev's predictions?
6. Explain why knowledge of isotopes showed that atomic weight was not always the best way to arrange elements.

5.1.2.3 Metals and Non-metals

1. Where are metals generally found in the periodic table?
2. Where are non-metals generally found in the periodic table?
3. What type of ions do metals form?
4. What type of ions do non-metals form?
5. State one physical property of metals.
6. Explain how the electronic structure of metals and non-metals affects their reactions.

5.1.2.4 Group 0

1. What are the elements in Group 0 called?
2. Why are noble gases unreactive?
3. How many electrons do noble gases usually have in their outer shell?
4. Why is helium different from other noble gases?
5. How does boiling point change down Group 0?
6. Explain why the properties of noble gases are related to their outer electrons.

5.1.2.5 Group 1

1. What are Group 1 elements called?
2. How many electrons do Group 1 elements have in their outer shell?
3. How does the reactivity of Group 1 metals change down the group?
4. What gas is produced when Group 1 metals react with water?
5. What type of ions do Group 1 metals form?
6. Explain why Group 1 metals become more reactive down the group.

5.1.2.6 Group 7

1. What are Group 7 elements called?
2. How many electrons do halogens have in their outer shell?
3. Are halogens metals or non-metals?
4. How does reactivity change down Group 7?
5. What happens when a more reactive halogen reacts with a salt of a less reactive halogen?
6. Explain why iodine has a higher boiling point than chlorine.

Topic 1 Review

1. Explain how the atomic model changed as new evidence was discovered.
2. Describe the structure of an atom using protons, neutrons and electrons.
3. Explain how electronic structure determines the position of an element in the periodic table.
4. Compare the properties and reactions of Group 1 metals and Group 7 halogens.
5. Explain how the periodic table allows scientists to predict the properties of elements.
6. Explain the difference between atoms, elements, compounds and mixtures

Topic 2 – Bonding, Structure and the Properties of Matter Retrieval Starters

5.2.1.1 Chemical Bonds

1. What are the three types of strong chemical bonds?
2. In ionic bonding, what particles are held together by electrostatic forces?

3. In covalent bonding, what do atoms do with their electrons?
4. In metallic bonding, what type of electrons are shared between metal atoms?
5. Which type of bonding occurs between metals and non-metals?
6. Explain how the transfer or sharing of electrons creates chemical bonds.

5.2.1.2 Ionic Bonding

1. What happens to electrons when a metal atom reacts with a non-metal atom?
2. Why does a metal atom become a positive ion when it forms an ionic bond?
3. Why does a non-metal atom become a negative ion when it forms an ionic bond?
4. Why do ions formed from Groups 1, 2, 6 and 7 elements have stable electron arrangements?
5. Draw a dot and cross diagram showing bonding in magnesium chloride
6. How can the charge of an ion be predicted from its group number in the periodic table?

5.2.1.3 Ionic Compounds

1. What type of structure do ionic compounds have?
2. What force holds oppositely charged ions together in an ionic lattice?
3. Why do ionic compounds have high melting points?
4. Why can molten ionic compounds conduct electricity?
5. Why can dissolved ionic compounds conduct electricity?
6. How can the empirical formula of an ionic compound be found from a diagram showing its ions?

5.2.1.4 Covalent Bonding

1. What happens when atoms form covalent bonds?
2. Why are covalent bonds described as strong bonds?
3. How can a substance be identified as a small molecule from its chemical formula?
4. What is the difference between a polymer structure and a small molecule structure?
5. What are examples of giant covalent structures?
6. Draw a dot and cross diagram showing the bonding in carbon dioxide.

5.2.1.5 Metallic Bonding

1. What type of structure do metals have?
2. What happens to the outer electrons of metal atoms in metallic bonding?
3. What are delocalised electrons?
4. What causes the strong attraction in metallic bonding?
5. Show a labelled diagram of metallic bonding in calcium metal.
6. Why can delocalised electrons move through a metal structure?

5.2.2.1 The Three States of Matter

1. What are the three states of matter?
2. What happens to particles when a solid melts into a liquid?
3. What happens to particles when a liquid boils into a gas?
4. Why do substances with stronger forces between particles have higher melting points?
5. How does particle theory explain changes of state?
6. What are the limitations of the simple particle model of matter?

5.2.2.2 State Symbols

1. What state symbol represents a solid substance in a chemical equation?
2. What state symbol represents a liquid substance in a chemical equation?
3. What state symbol represents a gaseous substance in a chemical equation?
4. What state symbol represents a substance dissolved in water?
5. Why are state symbols included in chemical equations?
6. Which state symbol would be used for sodium chloride dissolved in water?

5.2.2.3 Properties of Ionic Compounds

1. Why do ionic compounds have giant ionic lattice structures?
2. Why do ionic compounds have high melting and boiling points?
3. Why are strong electrostatic forces present in ionic compounds?
4. Why can ionic compounds conduct electricity when they are melted?
5. Why can ionic compounds conduct electricity when dissolved in water?
6. Why can solid ionic compounds not conduct electricity?

5.2.2.4 Properties of Small Molecules

1. Why do small molecular substances usually have low melting points?
2. What type of forces exist between molecules in small molecular substances?
3. Why are intermolecular forces weaker than covalent bonds?
4. Why do larger molecules have higher boiling points than smaller molecules?
5. Why do small molecular substances not conduct electricity?
6. What forces are overcome when a small molecular substance melts or boils?

5.2.2.5 Polymers

1. What are polymers made from?
2. Why are polymer molecules described as very large molecules?
3. What type of bonds hold atoms together in polymer molecules?
4. Why are polymers usually solids at room temperature?
5. How can a polymer be identified from a bonding diagram?
6. How are polymers different from substances made of small molecules?

5.2.2.6 Giant Covalent Structures

1. What is a giant covalent structure?
2. Why do giant covalent structures have very high melting points?
3. Why are strong covalent bonds present throughout giant covalent structures?
4. Which three substances are examples of giant covalent structures?
5. Why does diamond have a very high melting point?
6. How can a giant covalent structure be recognised from a diagram?

5.2.2.7 Properties of Metals and Alloys

1. Why do metals usually have high melting and boiling points?
2. How are atoms arranged in a pure metal?
3. Why can pure metals be bent and shaped?
4. Why are alloys harder than pure metals?
5. How does adding other metals affect the layers of atoms in a metal?
6. Why are alloys often used instead of pure metals?

5.2.2.8 Metals as Conductors

1. Why do metals conduct electricity?
2. Which particles carry electrical charge through metals?
3. Why do metals conduct thermal energy?
4. What is the role of delocalised electrons in metallic conduction?
5. Why are metals useful materials for electrical wires?
6. How does metallic bonding explain the conductivity of metals?

5.2.3.1 Diamond

1. How many covalent bonds does each carbon atom form in diamond?
2. What type of structure does diamond have?
3. Why is diamond very hard?
4. Why does diamond have a high melting point?
5. Why does diamond not conduct electricity?
6. How does the structure of diamond explain its properties?

5.2.3.2 Graphite

1. How many covalent bonds does each carbon atom form in graphite?
2. What structure do carbon atoms form in graphite?
3. Why can graphite conduct electricity?
4. Why is graphite soft?
5. Why can layers in graphite slide over each other?
6. How does the structure of graphite explain its properties?

5.2.3.3 Graphene and Fullerenes

1. What is graphene?
2. How is graphene related to graphite?
3. Why is graphene useful in electronics?
4. What are fullerenes?
5. What is the structure of buckminsterfullerene (C_{60})?
6. What are carbon nanotubes used for?

Topic 2 Review

1. How does bonding determine the properties of a substance?
2. What are the differences between ionic, covalent and metallic bonding?
3. Why do ionic compounds conduct electricity when molten but not when solid?

4. How do the structures of diamond and graphite cause their different properties?
5. Why are metals good conductors of electricity and thermal energy?
6. How do scientists use knowledge of bonding and structure to create new materials?

Topic 3 – Quantitative Chemistry Retrieval Starters

5.3.1.1 Conservation of Mass and Balanced Chemical Equations

1. What does the law of conservation of mass state?
2. Why is the mass of products equal to the mass of reactants in a chemical reaction?
3. Why must chemical equations be balanced?
4. What do the numbers in front of chemical formulas in a balanced equation represent?
5. What is the difference between a multiplier and a subscript in a chemical equation?
6. Balance the equation: $H_2 + O_2 \rightarrow H_2O$.

5.3.1.2 Relative Formula Mass

1. What is meant by relative formula mass (Mr)?
2. How is the relative formula mass of a compound calculated?
3. Which values from the periodic table are needed to calculate Mr?
4. Calculate the Mr of H_2O.
5. Why does the total Mr of reactants equal the total Mr of products in a balanced equation?
6. How can relative formula mass be used to calculate the percentage by mass of an element in a compound?

5.3.1.3 Mass Changes When a Reactant or Product is a Gas

1. Why can a chemical reaction appear to have a change in mass?
2. Why does a metal gain mass when it reacts with oxygen?
3. What happens to carbon dioxide gas produced during thermal decomposition of a metal carbonate?
4. Why can an open system give an inaccurate measurement of mass during a reaction?
5. Explain why the mass of a metal oxide is greater than the mass of the original metal.
6. How can the particle model explain changes in mass during reactions involving gases?

5.3.1.4 Chemical Measurements

1. What is meant by uncertainty in a measurement?
2. Why does every measurement have some uncertainty?
3. How can the range of measurements be used to estimate uncertainty?
4. What does the spread of results show about an experiment?
5. How can repeated measurements improve confidence in a result?
6. What does a smaller range of results suggest about the reliability of measurements?

5.3.2.1 Moles (HT Only)

1. What is the unit used to measure chemical amounts?
2. What is the mass of one mole of a substance equal to?
3. What is the Avogadro constant?
4. How many particles are present in one mole of a substance?
5. Calculate the number of moles in 18 g of water (Mr = 18).
6. Calculate the mass of 0.5 moles of chlorine gas.

5.3.2.2 Amounts of Substances in Equations (HT Only)

1. What information does a balanced symbol equation show about reacting substances?
2. How can a balanced chemical equation be interpreted in terms of moles?
3. In the equation $Mg + 2HCl \rightarrow MgCl_2 + H_2$, how many moles of hydrochloric acid react with one mole of magnesium?

4. How can you calculate the mass of a product from a balanced equation?
5. Why are mole ratios important when calculating reacting masses?
6. Calculate the mass of aluminium oxide produced when 135g of aluminium is burned in air.

5.3.2.3 Using Moles to Balance Equations (HT Only)

1. Why are moles used to balance chemical equations?
2. What must masses be converted into before balancing by calculation?
3. What type of ratio is used to balance equations?
4. Balance the chemical equation for photosynthesis using the following masses: 264 g carbon dioxide reacts with 108 g water to produce 180 g glucose and 192 g oxygen.
5. Balance the chemical equation for the complete combustion of methane using the following masses: 16 g methane reacts with 64 g oxygen to produce 44 g carbon dioxide and 36 g water.
6. Balance a chemical equation between magnesium and oxygen using the following masses: 24 g magnesium reacts with 16 g oxygen to produce 40 g magnesium oxide.

5.3.2.4 Limiting Reactants (HT Only)

1. What is meant by a limiting reactant?
2. Why is one reactant often used in excess during a chemical reaction?
3. How does a limiting reactant affect the amount of product formed?
4. What happens to the excess reactant after the limiting reactant is used up?
5. How can moles be used to identify the limiting reactant?
6. Explain why increasing the amount of the limiting reactant increases the amount of product made.

5.3.2.5 Concentration of Solutions

1. What is meant by the concentration of a solution?
2. What units can be used to measure concentration?
3. How is concentration calculated using mass and volume?
4. Calculate the concentration of a solution containing 20 g of solute in 2 dm^3 of solution.
5. How does increasing the mass of solute affect concentration?
6. How does increasing the volume of solution affect concentration?

Topic 3 Review

1. Explain how the law of conservation of mass applies to chemical reactions.
2. Describe how balanced equations represent the quantities of substances in reactions.
3. Explain how relative formula mass is calculated and used.
4. Explain how moles allow chemists to measure amounts of substances.
5. Describe how limiting reactants affect the amount of product formed.
6. Explain how concentration calculations are used in chemical reactions.

Topic 4 – Chemical Changes Retrieval Starters

5.4.1.1 Metal Oxides

1. What are formed when metals react with oxygen?
2. Why are reactions between metals and oxygen classed as oxidation reactions?
3. In terms of oxygen, what is oxidation?
4. In terms of oxygen, what is reduction?
5. What happens to a metal atom when it reacts with oxygen?
6. Explain why the formation of a metal oxide is an oxidation reaction.

5.4.1.2 The Reactivity Series

1. What is meant by the reactivity of a metal?
2. Why do metals form positive ions when they react?
3. What is the reactivity series used to show?
4. Which metal is more reactive: a metal that displaces another metal from its compound or the metal being displaced?
5. How can reactions with water and dilute acids be used to compare metal reactivity?
6. Explain why a more reactive metal can displace a less reactive metal from its compound.

5.4.1.3 Extraction of Metals and Reduction

1. Why are some metals found as compounds in the Earth rather than as pure metals?

2. Which type of metals are found naturally as the metal itself?
3. Why can metals below carbon in the reactivity series be extracted using carbon?
4. What does reduction mean in terms of oxygen?
5. In the extraction of a metal oxide using carbon, which substance is reduced?
6. Explain why more reactive metals need different extraction methods.

5.4.1.4 Oxidation and Reduction in Terms of Electrons (HT Only)

1. What is oxidation in terms of electrons?
2. What is reduction in terms of electrons?
3. What happens to electrons during oxidation?
4. What happens to electrons during reduction?
5. How can half equations show oxidation and reduction?
6. Identify which substance is oxidised and which is reduced in a given redox reaction.

5.4.2.1 Reactions of Acids with Metals

1. What products are formed when acids react with metals?
2. How can you measure the rate of reaction of a metal and acid reaction?
3. What gas is produced when a metal reacts with an acid?
4. Why are reactions between acids and metals considered redox reactions?
5. Which substance is oxidised when a metal reacts with an acid?
6. Explain how electrons are transferred during a reaction between magnesium and hydrochloric acid.

5.4.2.2 Neutralisation of Acids and Salt Production

1. What is produced when an acid reacts with an alkali?
2. What are the products when an acid reacts with a metal carbonate?
3. Which acid produces chloride salts?
4. Which acid produces nitrate salts?
5. Which acid produces sulfate salts?
6. Explain how the reactants determine the salt produced in a neutralisation reaction.

5.4.2.3 Soluble Salts

1. How can soluble salts be made from acids?
2. Why is excess insoluble solid added during salt preparation?
3. Why is the excess solid filtered off after reacting with an acid?
4. How are salt crystals produced from a salt solution?
5. What is the purpose of evaporating water from a salt solution?
6. Describe how to prepare a pure, dry sample of a soluble salt from an insoluble oxide or carbonate.

5.4.2.4 The pH Scale and Neutralisation

1. What ion do acids produce in aqueous solutions?
2. What ion do alkalis produce in aqueous solutions?
3. What does the pH scale measure?
4. What pH value represents a neutral solution?
5. What pH values do acidic and alkaline solutions have?
6. Explain what happens when hydrogen ions react with hydroxide ions.

5.4.2.5 Strong and Weak Acids (HT Only)

1. What is a strong acid?
2. What is a weak acid?
3. What happens to strong acids when dissolved in water?
4. What happens to weak acids when dissolved in water?
5. If the pH of a solution decreases from pH 5 to pH 2, how does the hydrogen ion concentration change?
6. Explain the difference between a strong acid and a concentrated acid.

5.4.3.1 The Process of Electrolysis

1. What is electrolysis?
2. What is an electrolyte?
3. Why can molten ionic compounds conduct electricity?
4. Which electrode do positive ions move towards during electrolysis?
5. Which electrode do negative ions move towards during electrolysis?
6. Explain how electrolysis causes ions to form elements.

5.4.3.2 Electrolysis of Molten Ionic Compounds

1. What products are formed when molten ionic compounds are electrolysed?
2. What is produced at the cathode during electrolysis of molten lead bromide?
3. What is produced at the anode during electrolysis of molten lead bromide?
4. Why must molten ionic compounds contain free-moving ions?
5. Why are inert electrodes used in electrolysis?
6. Predict the products formed when a binary ionic compound is electrolysed in the molten state.

5.4.3.3 Using Electrolysis to Extract Metals

1. When is electrolysis used to extract metals?
2. Why cannot very reactive metals be extracted using carbon?
3. Why is a mixture of aluminium oxide and cryolite used in aluminium extraction?
4. What metal is extracted by electrolysis of aluminium oxide?
5. Why does electrolysis require large amounts of energy?
6. Explain why the positive electrode in aluminium extraction must be replaced regularly.

5.4.3.4 Electrolysis of Aqueous Solutions

1. What determines which ions are discharged during electrolysis of an aqueous solution?
2. What gas is produced at the cathode if the metal is more reactive than hydrogen?
3. What gas is usually produced at the anode during electrolysis?
4. What happens at the anode if halide ions are present?
5. Why can water molecules affect the products formed during electrolysis?
6. Predict the products formed when an aqueous ionic solution is electrolysed.

5.4.3.5 Representation of Reactions at Electrodes as Half Equations (HT Only)

1. What happens to positive ions at the cathode?
2. Why are reactions at the cathode reductions?
3. What happens to negative ions at the anode?
4. Why are reactions at the anode oxidations?
5. What information does a half equation show?

6. Write a half equation to represent the reaction at an electrode during electrolysis.

Topic 4 Review

1. Explain how the reactivity series allows scientists to predict metal reactions.
2. Describe the difference between oxidation and reduction.
3. Explain how metals can be extracted from their compounds.
4. Describe how acids react with metals, bases and carbonates.
5. Explain how electrolysis separates ionic compounds into elements.
6. Compare extraction of metals using carbon reduction and electrolysis.

Topic 5 – Energy Changes Retrieval Starters

5.5.1.1 Energy Transfer During Exothermic and Endothermic Reactions

1. What happens to energy in a chemical reaction according to the law of conservation of energy?
2. What is an exothermic reaction?
3. What happens to the temperature of the surroundings during an exothermic reaction?
4. Give two examples of exothermic reactions.
5. What is an endothermic reaction?
6. What happens to the temperature of the surroundings during an endothermic reaction?

5.5.1.2 Reaction Profiles

1. What must happen between reacting particles for a chemical reaction to occur?
2. What is activation energy?
3. What does a reaction profile show?
4. How can you identify an exothermic reaction from a reaction profile?

5. Draw a labelled reaction profile for the endothermic reaction A + B → C + D, showing the reactants, products, activation energy and overall energy change.
6. Draw a labelled reaction profile for the exothermic reaction A + B → C + D, showing the reactants, products, activation energy and overall energy change.

5.5.1.3 The Energy Change of Reactions (HT Only)

1. Why is energy needed during a chemical reaction?
2. Is energy absorbed or released when chemical bonds are broken?
3. Is energy absorbed or released when new chemical bonds are formed?
4. In an exothermic reaction, is more energy released forming bonds or absorbed breaking bonds?
5. In an endothermic reaction, is more energy absorbed breaking bonds or released forming bonds?
6. How can bond energies be used to calculate the overall energy change of a reaction?

Topic 5 Review

1. Explain the difference between exothermic and endothermic reactions.
2. Explain how energy changes occur when bonds are broken and formed.
3. Describe how reaction profiles can be used to identify exothermic and endothermic reactions.
4. Explain why activation energy is needed for chemical reactions.
5. Compare the energy changes in exothermic and endothermic reactions.
6. Explain how energy changes in chemical reactions are used in everyday applications.

Paper 2:

Topic 6 – The Rate and Extent of Chemical Change Retrieval Starters

5.6.1.1 Calculating rates of reactions

1. How is the mean rate of a reaction calculated using the quantity of reactant used?
2. How is the mean rate of a reaction calculated using the quantity of product formed?
3. What units can be used for the rate of reaction when measuring mass change?
4. What units can be used for the rate of reaction when measuring gas volume produced?
5. How can a graph showing the amount of product formed over time be used to determine the rate of reaction?
6. How is the gradient of a tangent to a reaction graph used to calculate the rate of reaction at a specific time?

5.6.1.2 Factors which affect the rates of chemical reactions

1. What five factors can affect the rate of a chemical reaction?
2. How does increasing the concentration of reactants in solution affect the rate of reaction?
3. How does decreasing the pressure of reacting gases affect the rate of reaction?
4. How does increasing the surface area of a solid reactant affect the rate of reaction?
5. How does increasing the temperature affect the rate of reaction?
6. How do catalysts affect the rate of chemical reactions?

5.6.1.3 Collision theory and activation energy

1. What does collision theory state about when chemical reactions can occur?
2. What is activation energy?
3. Why does increasing the concentration of reactants increase the rate of reaction?
4. Why does increasing the temperature increase the rate of reaction?
5. Why does increasing the surface area of a solid reactant increase the rate of reaction?
6. Explain how pressure affects the rate of reaction between reacting gases using collision theory.

5.6.1.4 Catalysts

1. What is a catalyst?
2. Why are catalysts not included in chemical equations?
3. How do catalysts increase the rate of a reaction?
4. What happens to the activation energy when a catalyst is used?
5. Why do different chemical reactions require different catalysts?
6. How do enzymes act as catalysts in biological systems?

5.6.2.1 Reversible reactions

1. What is a reversible reaction?
2. How are reversible reactions represented using a symbol equation?
3. What happens to the products in a reversible reaction?
4. How can the direction of a reversible reaction be changed?
5. Give an example of a condition that can affect the direction of a reversible reaction.
6. Why can reversible reactions produce both reactants and products?

5.6.2.2 Energy changes and reversible reactions

1. If a reaction is exothermic in one direction, what type of reaction is it in the opposite direction?
2. How does the energy change compare in the forward and reverse reactions?
3. What happens to energy during an exothermic reaction?
4. What happens to energy during an endothermic reaction?
5. Why does reversing a reaction reverse the energy change?
6. A forward reaction releases energy. Is the reverse reaction exothermic or endothermic?

5.6.2.3 Equilibrium

1. What is meant by equilibrium in a reversible reaction?
2. What conditions are needed for equilibrium to be reached?
3. Why must reactants and products be prevented from escaping for equilibrium to occur?
4. At equilibrium, how do the rates of the forward and reverse reactions compare?
5. Why is equilibrium called dynamic?

6. What happens to the amounts of reactants and products once equilibrium is reached?

5.6.2.4 The effect of changing conditions on equilibrium (HT only)

1. What happens to an equilibrium system when a change is made to its conditions?
2. What principle is used to predict the effect of changes on equilibrium?
3. What does Le Chatelier's Principle state?
4. How does changing conditions affect the position of equilibrium?
5. Why does a system at equilibrium respond to changes in conditions?
6. How can equilibrium be shifted to increase the amount of a desired product?

5.6.2.5 The effect of changing concentration (HT only)

1. What happens when the concentration of a reactant is increased in an equilibrium system?
2. Why does increasing the concentration of a reactant produce more products?
3. What happens when the concentration of a product is decreased in an equilibrium system?
4. Why do concentrations of all substances change after the concentration of one substance is altered?
5. How can changing concentration affect the position of equilibrium?
6. For the equilibrium reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, explain what happens to the position of equilibrium when the concentration of hydrogen is increased.

5.6.2.6 The effect of temperature changes on equilibrium (HT only)

1. What happens to the amount of products at equilibrium when the temperature is increased for an endothermic reaction?
2. What happens to the amount of products at equilibrium when the temperature is increased for an exothermic reaction?
3. What happens to the amount of products at equilibrium when the temperature is decreased for an endothermic reaction?

4. What happens to the amount of products at equilibrium when the temperature is decreased for an exothermic reaction?
5. Why does increasing temperature affect the position of equilibrium?
6. For the (exothermic) equilibrium reaction $N_2(g) + 3H_2(g) \leftrightharpoons 2NH_3(g)$, predict how increasing the temperature affects the equilibrium position and explain why.

5.6.2.7 The effect of pressure changes on equilibrium (HT only)

1. How does increasing pressure affect the equilibrium position of a gaseous reaction?
2. Why does increasing pressure shift equilibrium towards the side with fewer gas molecules?
3. How does decreasing pressure affect the equilibrium position of a gaseous reaction?
4. Why does decreasing pressure shift equilibrium towards the side with more gas molecules?
5. How can the symbol equation be used to predict the effect of pressure changes on equilibrium?
6. For the equilibrium reaction $N_2(g) + 3H_2(g) \leftrightharpoons 2NH_3(g)$, predict how increasing the pressure affects the equilibrium position and explain why.

Topic 6 Review

1. Explain how changing concentration, pressure, temperature and surface area affects the rate of a chemical reaction.
2. Explain how collision theory can be used to explain why increasing temperature increases the rate of reaction.
3. Explain how catalysts increase the rate of reaction and why they are not used up during a reaction.
4. Describe the conditions needed for dynamic equilibrium and explain what happens when conditions are changed.
5. For the reaction $N_2 + 3H_2 \leftrightharpoons 2NH_3$, explain how changing temperature, pressure and concentration affects the equilibrium position.
6. Explain the difference between reversible reactions, equilibrium and irreversible reactions.

Topic 7 – Organic Chemistry Retrieval Starters

5.7.1.1 Crude oil, hydrocarbons and alkanes

1. What is crude oil?
2. Why is crude oil described as a finite resource?
3. What are hydrocarbons?
4. What elements are found in hydrocarbon molecules?
5. What is the general formula for alkanes?
6. An alkane has the formula C_4H_{10}. Explain how this shows that it is an alkane.

5.7.1.2 Fractional distillation and petrochemicals

1. What process is used to separate crude oil into fractions?
2. Explain how fractional distillation separates hydrocarbons in crude oil.
3. Why do different fractions condense at different temperatures?
4. What are fractions from crude oil used to produce?
5. Give two examples of fuels produced from crude oil.
6. Explain why crude oil is useful as a feedstock for the petrochemical industry.

5.7.1.3 Properties of hydrocarbons

1. How does boiling point change as the size of hydrocarbon molecules increases?
2. How does viscosity change as the size of hydrocarbon molecules increases?
3. How does flammability change as the size of hydrocarbon molecules increases?
4. Why are small hydrocarbons useful as fuels?
5. What are the products of complete combustion of a hydrocarbon?
6. Write the balanced symbol equation for the complete combustion of methane (CH_4).

5.7.1.4 Cracking and alkenes

1. What is cracking?

2. Why are hydrocarbons cracked?
3. What two types of hydrocarbons are produced during cracking?
4. What test is used to identify an alkene?
5. What colour change occurs when bromine water reacts with an alkene?
6. Explain why cracking is important for producing useful chemicals and fuels.

Topic 7 Review

1. Explain how crude oil is separated into useful fractions by fractional distillation.
2. Explain how the properties of hydrocarbons change as their molecules become larger.
3. Describe the difference between alkanes and alkenes.
4. Explain how cracking produces more useful hydrocarbons from larger molecules.
5. Write and explain the equation for the complete combustion of a hydrocarbon.
6. Explain why hydrocarbons are important in modern life.

Topic 8 – Chemical Analysis Retrieval Starters

5.8.1.1 Pure substances

1. What is meant by a pure substance in chemistry?
2. What is the difference between a pure substance and a mixture?
3. How can melting point data be used to identify a pure substance?
4. How can boiling point data be used to identify a pure substance?
5. Why do pure substances have fixed melting points and boiling points?
6. A substance melts over a range of temperatures rather than at one temperature. Explain what this suggests about the substance.

5.8.1.2 Formulations

1. What is a formulation?

2. Why are the components of a formulation mixed in carefully measured quantities?
3. Give two examples of products that are formulations.
4. Explain why a medicine is an example of a formulation.
5. How do formulations differ from simple mixtures?
6. A paint contains pigments, solvents and other chemicals. Explain why paint is a formulation.

5.8.1.3 Chromatography

1. What is chromatography used for?
2. What are the stationary phase and mobile phase in paper chromatography?
3. Explain how paper chromatography separates substances in a mixture.
4. What does an Rf value show in chromatography?
5. Calculate the Rf value of a substance that moves 4 cm when the solvent moves 8 cm.
6. A pure compound produces one spot on a chromatogram. Explain what this shows.

5.8.2.1 Test for hydrogen

1. How is hydrogen gas tested for?
2. What happens when a burning splint is placed into hydrogen gas?
3. What observation confirms the presence of hydrogen?
4. Why must the burning splint be held at the open end of the test tube when testing hydrogen?
5. Which gas produces a squeaky pop sound when tested with a burning splint?
6. A gas burns with a pop sound when tested with a burning splint. Identify the gas.

5.8.2.2 Test for oxygen

1. How is oxygen gas tested for?
2. What happens when a glowing splint is placed into oxygen?
3. What observation confirms the presence of oxygen?
4. Why does oxygen relight a glowing splint?
5. Which gas relights a glowing splint?
6. A gas causes a glowing splint to relight. Identify the gas.

5.8.2.3 Test for carbon dioxide

1. How is carbon dioxide gas tested for?
2. What solution is used to test for carbon dioxide?
3. What happens to limewater when carbon dioxide is bubbled through it?
4. What observation confirms the presence of carbon dioxide?
5. Which gas turns limewater milky?
6. A gas turns limewater cloudy. Identify the gas.

5.8.2.4 Test for chlorine

1. How is chlorine gas tested for?
2. What happens when damp litmus paper is placed into chlorine gas?
3. What observation confirms the presence of chlorine?
4. Why must the litmus paper be damp when testing chlorine?
5. Which gas bleaches damp litmus paper?
6. A gas turns damp litmus paper white. Identify the gas.

Topic 8 Review

1. Explain how melting point and boiling point data can be used to identify pure substances.
2. Explain how chromatography can be used to separate and identify substances in a mixture.
3. Describe how to calculate an Rf value from a chromatogram.
4. Explain how a formulation differs from a pure substance.
5. Describe the tests used to identify hydrogen, oxygen, carbon dioxide and chlorine.
6. Explain why chemical analysis is useful in areas such as forensic science and medicine.

Topic 9 – Chemistry of the Atmosphere Retrieval Starters

5.9.1.1 The proportions of different gases in the atmosphere

1. What percentage of the Earth's atmosphere is nitrogen?
2. What percentage of the Earth's atmosphere is oxygen?

3. Name two other gases found in small proportions in the atmosphere.
4. What is the approximate ratio of nitrogen to oxygen in the atmosphere?
5. How have the proportions of gases in the atmosphere changed over the last 200 million years?
6. A sample of air contains 80% nitrogen and 20% oxygen. Explain why this represents the composition of the Earth's atmosphere.

5.9.1.2 The Earth's early atmosphere

1. What gas was thought to make up most of the Earth's early atmosphere?
2. How did volcanic activity contribute to the formation of the early atmosphere?
3. What happened to water vapour released by volcanoes as the Earth cooled?
4. Why is there limited evidence about the Earth's early atmosphere?
5. Explain how carbon dioxide levels decreased when oceans formed.
6. Explain how the Earth's early atmosphere was different from the atmosphere today.

5.9.1.3 How oxygen increased

1. Which organisms first produced oxygen in the atmosphere?
2. What process produces oxygen during photosynthesis?
3. Write the word equation for photosynthesis.
4. How did photosynthesis change the amount of oxygen in the atmosphere?
5. Why did an increase in oxygen allow animals to evolve?
6. Explain why plants and algae are important in maintaining oxygen levels in the atmosphere.

5.9.1.4 How carbon dioxide decreased

1. How did plants and algae reduce the amount of carbon dioxide in the atmosphere?
2. What process removes carbon dioxide from the atmosphere?
3. How were sedimentary rocks formed using carbon dioxide?
4. How did the formation of fossil fuels reduce atmospheric carbon dioxide?
5. Describe how limestone, coal, crude oil and natural gas formed.
6. Explain why carbon dioxide levels decreased as the Earth developed.

5.9.2.1 Greenhouse gases

1. What are greenhouse gases?
2. Name three greenhouse gases.
3. Explain how greenhouse gases keep the Earth warm.
4. What happens when greenhouse gases absorb long wavelength radiation?
5. Why is the greenhouse effect necessary for life on Earth?
6. Explain the difference between short wavelength radiation and long wavelength radiation in the greenhouse effect.

5.9.2.2 Human activities which contribute to an increase in greenhouse gases

1. Name two human activities that increase carbon dioxide levels.
2. Name two human activities that increase methane levels.
3. How does burning fossil fuels increase carbon dioxide in the atmosphere?
4. How does farming increase methane levels in the atmosphere?
5. Why do scientists use peer-reviewed evidence when studying climate change?
6. Explain why some climate change predictions have uncertainty.

5.9.2.3 Global climate change

1. What is meant by global climate change?
2. What is the main cause of the recent increase in average global temperature?
3. State four possible effects of global climate change.
4. How could rising temperatures affect sea levels?
5. Explain why predicting climate change is difficult.
6. Discuss why global climate change has environmental and social impacts.

5.9.2.4 The carbon footprint and its reduction

1. What is a carbon footprint?
2. What gases are included when calculating a carbon footprint?
3. Give two ways of reducing carbon dioxide emissions.
4. Give two ways of reducing methane emissions.
5. Why can reducing greenhouse gas emissions be difficult?
6. Explain how using renewable energy can reduce a carbon footprint.

5.9.3.1 Atmospheric pollutants from fuels

1. What pollutants can be produced when fuels are burned?
2. How is carbon monoxide produced during combustion?
3. How are particulates produced when fuels are burned?
4. What pollutant is produced when sulfur impurities in fuels are burned?
5. What conditions cause carbon monoxide to form instead of carbon dioxide?
6. Explain why burning fuels can release several different pollutants.

5.9.3.2 Properties and effects of atmospheric pollutants

1. Why is carbon monoxide dangerous to humans?
2. Why is carbon monoxide difficult to detect?
3. What problems are caused by sulfur dioxide?
4. What problems are caused by oxides of nitrogen?
5. How do particulates affect human health?
6. Explain how atmospheric pollutants can cause environmental problems such as acid rain and global dimming.

Topic 9 Review

1. Explain how the composition of the Earth's atmosphere has changed over time.
2. Explain how photosynthesis increased oxygen levels and decreased carbon dioxide levels.
3. Describe how greenhouse gases affect the temperature of the Earth.
4. Explain how human activities increase greenhouse gas levels and contribute to climate change.
5. Describe the sources and effects of major atmospheric pollutants.
6. Evaluate actions that could reduce the impact of human activities on the atmosphere.

Topic 10 – Using Resources Retrieval Starters

5.10.1.1 Using the Earth's resources and sustainable development

1. What are natural resources?

2. Give two examples of products obtained from the Earth's resources.
3. What is the difference between a finite resource and a renewable resource?
4. Give one example of a natural product that can be replaced by an agricultural or synthetic product.
5. What is meant by sustainable development?
6. Explain why reducing the use of finite resources is important for future generations.

5.10.1.2 Potable water

1. What is meant by potable water?
2. Why is potable water not considered chemically pure water?
3. What are the two main requirements for drinking water to be safe?
4. Describe the steps used to produce potable water from fresh water supplies.
5. Name three substances or methods that can be used to sterilise water.
6. Explain why desalination is used and why it requires large amounts of energy.

5.10.1.3 Waste water treatment

1. Why does waste water need to be treated before being released into the environment?
2. What types of waste are removed during sewage treatment?
3. What happens during the screening and grit removal stage of sewage treatment?
4. What is produced during sedimentation of sewage?
5. What happens during anaerobic digestion of sewage sludge?
6. Explain why aerobic biological treatment is used during waste water treatment.

5.10.1.4 Alternative methods of extracting metals (HT only)

1. Why are alternative methods of extracting metals needed?
2. What is phytomining?
3. How does phytomining extract metal compounds from the ground?
4. What is bioleaching?
5. How can copper be extracted from a solution of copper compounds after bioleaching?

6. Evaluate one advantage and one disadvantage of using biological methods to extract metals.

5.10.2.1 Life cycle assessment

1. What is a life cycle assessment (LCA)?
2. What stages of a product's life are considered in a life cycle assessment?
3. Why are energy use and resource use easier to quantify than pollution effects?
4. Why are life cycle assessments not completely objective?
5. How could a life cycle assessment be misused?
6. Explain how a life cycle assessment could be used to compare plastic and paper shopping bags.

5.10.2.2 Ways of reducing the use of resources

1. What are the three main ways of reducing the use of resources?
2. Why does recycling reduce the use of limited resources?
3. How can glass bottles be reused?
4. How are metals recycled?
5. Why does recycling metals reduce the need for mining?
6. Explain why reducing, reusing and recycling materials helps protect the environment.

Topic 10 Review

1. Explain why sustainable development is important when using Earth's resources.
2. Describe how fresh water can be treated to make it potable.
3. Explain the processes involved in waste water treatment.
4. Compare traditional metal extraction methods with phytomining and bioleaching.
5. Explain how life cycle assessments are used to compare the environmental impact of products.
6. Evaluate different ways of reducing the use of Earth's limited resources.