5.1 Atomic structure and the periodic table

5.1.1 A simple model of the atom, symbols, relative atomic mass, electric charge and isotopes

5.1.1.1 Atoms, elements and compounds

1. What are all substance made from?
2. What is an atom?
3. Approximately how many elements are there?
4. What is the periodic table?
5. How are compounds formed?
6. What do chemical reactions involve.
7. What is a compound?
8. How can the elements in a compound be separated?

5.1.1.2 Mixtures

1. What is a mixture?
2. Name five physical processes which can be used to separate mixtures.
3. What physical process would be used to separate a mixture of liquids with different boiling points?
4. What physical process would be used to separate an insoluble salt from a solution?
5. What physical process would be used to separate a solvent from a solution?
6. What physical processes would be used to separate copper sulfate crystals from a mixture of copper sulfate solution and copper oxide?

5.1.1.3 The development of the model of the atom

1. Why might a scientific model be changed or replaced?
2. How did Democritus describe the atom?
3. What did J.J. Thomson discover and what model did he suggest as a result?
4. Describe Thomson's model.
5. Describe the alpha particle scattering experiment.
6. What were the results of the alpha particle scattering experiment.
7. What conclusion did Rutherford make from the results of the alpha particle scattering experiment.
8. How did Bohr adapt Rutherford's model.
9. What sub-atomic particle did Rutherford discover in 1920 to explain the positive charge in an atom?
10. What sub-atomic particle did James Chadwick discover which explained isotopes?

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. In all atoms how many electrons are there compared to protons?
5. What electrical charge do atoms have?
6. What is the atomic number of an element?

5.1.1.5 Size and mass of atoms

1. What is the radius of an atom in m?
2. What is the radius of a nucleus of an atom in m?
3. How is the mass of an atom distributed in the atom?
4. What is the relative mass of a proton?
5. What is the relative mass of a neutron?
6. What is the relative mass of an electron?
7. What is the mass number of an element?
8. What is an isotope?
9. Calculate the number of protons, electrons and neutrons for the following atoms:

	$^{1}_{1}H$	$^{7}_{3}Li$	$^{12}_{6}C$	$^{39}_{19}K$	$^{238}_{92}U$
Protons					
Neutrons					
Electrons					

5.1.1.6 Relative atomic mass

1. What is the relative atomic mass of an element?
2. How would you calculate the relative atomic mass of an atom?

5.1.1.7 Electronic structure

1. What is the maximum number of electrons that can fit in the first shell?
2. What is the maximum number of electrons that can fit in the second shell?
3. What is the maximum number of electrons that can fit in the third shell?
4. Which electron shell has the lowest energy level?
5. In what order are the electron shells filled with electrons?
6. What is the electronic structure of sodium?
7. What is the electronic structure of fluorine?
8. What is the electronic structure of sulfur?
9. What is the electronic structure of hydrogen?
10. What is the electronic structure of neon?
11. Describe how the position of an element on a periodic table can be found from the electronic structure. Use chlorine as an example.

5.1.2 The periodic table

5.1.2.1 The periodic table

1. How are the elements in the periodic table arranged?
2. How are elements with similar properties arranged?
3. Why is it called a "periodic" table?
4. Explain why elements in the same group have similar chemical properties?

5.1.2.2 Development of the periodic table

1. Before the discovery of sub-atomic particles, how did scientists arrange elements in the periodic table?
2. How did Mendeleev organise the elements in his periodic table?
3. Why did Mendeleev leave gaps in his periodic table?
4. What discovery showed why the order based on atomic weight was not always correct?

5.1.2.3 Metals and non-metals

1. Which elements react to form positive ions?
2. Which elements do not form positive ions when they react?
3. What are the majority of elements in the periodic table?
4. Where are metals found in the periodic table
5. Where are non-metals found in the periodic table?
6. What does malleable mean?
7. Malleable is a property of metals. Name four other properties of metals.
8. What does brittle mean?
9. Brittle is a property of non-metals. Name four other properties of non-metals.
10. Explain why metals form positive ions in reactions?
11. Explain why non metals do not form positive ions in reactions.

5.1.2.4 Group 0

1. What is another name for group 0
2. Describe the reactivity of group 0 elements
3. How many electrons do elements of group 0 have in their outer shell?
4. Describe the change in boiling point as you go down (increase relative atomic mass) group 0.

5.1.2.5 Group 1

1. What is another name for group 1?
2. How many electrons do elements in group 1 have in their outer shell?
3. What are the products of the reaction between lithium and water?
4. What are the products of the reaction between sodium and chlorine?
5. What are the products of the reaction between potassium and oxygen?
6. How does the reactivity of elements in group 1 change as you go down the group?
7. Explain, in terms of electrons, why reactivity changes as you go down the group.

5.1.2.6 Group 7

1. What is another name for group 7?
2. Describe the general properties of group 7 elements.
3. Name two gases found in group 7.
4. Name a liquid found in group 7.
5. Name two solids found in group 7.
6. Describe the nature of the compounds formed when halogens react with metals.
7. Describe the nature of the compounds formed when halogens react with other non-metals.
8. Describe how the melting points and boiling points change in group 7.
9. Describe how the reactivity of the elements in group 7 change as you go down the group.
10. Explain, in terms of electrons, why does reactivity change as you go down the group.
11. Describe the reaction between a more reactive halogen and a less reactive halogen which is in an aqueous solution of its salt.
12. Complete the following equation and balance: $Cl_2 + 2KI \rightarrow$
13. Complete the following equation and balance: $I_2 + KBr \rightarrow$
14. Complete the following equation and balance: $F_2 + 2KCl \rightarrow$

5.2 Bonding, structure and the properties of matter

5.2.1 Chemical bonds, ionic, covalent and metallic

5.2.1.1 Chemical bonds

1. Name three types of strong chemical bonds.
2. Describe the role of electrons in an ionic bond.
3. Describe the role of electrons in a covalent bond.
4. Describe the role electrons in a metallic bond.
5. Which bonding occurs in compounds formed from non-metals?
6. Which bonding occurs in metallic elements and alloys?
7. Which bonding occurs in compounds formed from metals and non-metals?

5.2.1.2 Ionic bonding

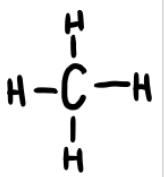
1. What happens when a metal reacts with a non-metal?
2. What type of ions do metals form?
3. What type of ions do non-metals form?
4. What is the charge of ions produce by group 1 elements?
5. What is the charge of ions produce by group 2 elements?
6. What is the charge of ions produce by group 6 elements?
7. What is the charge of ions produce by group 7 elements?
8. What electronic structure do the ions produced have?
9. Draw a dot and cross diagram for sodium chloride
10. Draw a dot and cross diagram for magnesium oxide
11. Draw a dot and cross diagram for lithium oxide
12. Draw a dot and cross diagram for calcium fluoride

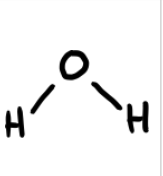
5.2.1.3 Ionic compounds

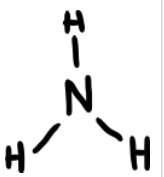
1. Describe the structure of an ionic compound.
2. What are forces of attraction in ionic bonding called?
3. What is the empirical formula for potassium chloride (group 1 + group 7)?
4. What is the empirical formula for beryllium oxide (group 2 + group 6)?
5. What is the empirical formula for sodium oxide? (group 1 + group 6)?
6. What is the empirical formula for magnesium iodide (group 2 + group 7)?

5.2.1.4 Covalent bonding

1. How are covalent bonds formed?
2. Name two covalent compounds which are simple molecules.
3. Name a covalent compound which is a very large molecule.
4. Name two covalently bonded substances which form giant covalent structures.
5. Draw a dot and cross diagram for hydrogen.
6. Draw a dot and cross diagram for chlorine.
7. Draw a dot and cross diagram for oxygen.
8. Draw a dot and cross diagram for nitrogen.
9. Draw a dot and cross diagram for hydrogen chloride.
10. Draw a dot and cross diagram for water.
11. Draw a dot and cross diagram for ammonia.
12. Draw a dot and cross diagram for methane.
13. What is the chemical formula for hydrogen.
14. What is the chemical formula for chlorine.
15. What is the chemical formula for nitrogen.
16. What is the chemical formula for hydrogen chloride.
17. What is the chemical formula for water.
18. What is the chemical formula for ammonia.
19. What is the chemical formula for methane.
20. Draw the structure of poly(ethene).
21. Write the formula of the following structures.







5.2.1.5 Metallic bonding

1. Describe the structure of metals.
2. What are delocalised electrons?
3. How are metallic bonds formed?

5.2.2 How bonding and structure are related to the properties of substances

5.2.2.1 The three states of matter

1. Name the three states of matter.
2. Describe the structure of solids in terms of particles.
3. Describe the structure of liquids in terms of particles.
4. Describe the structure of gases in terms of particles.
5. What term describes solid turning into liquid at a specific temperature.
6. What term describes liquid turning into gas at a specific temperature.
7. What term describes gas turning into liquid at a specific temperature.
8. What term describes liquid turning into solid at a specific temperature.
9. What term describes solid turning into gas at a specific temperature.
10. Bromine has a melting point of -7°C and a boiling point of 59°C. What state is it at 75°C?
11. Why does a single atom not have a state of matter?
12. What are the limitations of particle theory (HT only).
13. Describe the energy required to change states.
14. Describe how the forces between particles affects the melting points and boiling points.

5.2.2.2 State symbols

1. What does the state symbol (aq) represent?
2. What does the state symbol (l) represent?
3. What does the state symbol (g) represent?
4. What does the state symbol (s) represent?

5.2.2.3 Properties of ionic compounds

1. Describe the structure of an ionic compound.
2. Describe the general properties of ionic compounds.
3. What can happen if ionic compounds are melted or dissolved in water?

5.2.2.4 Properties of small molecules

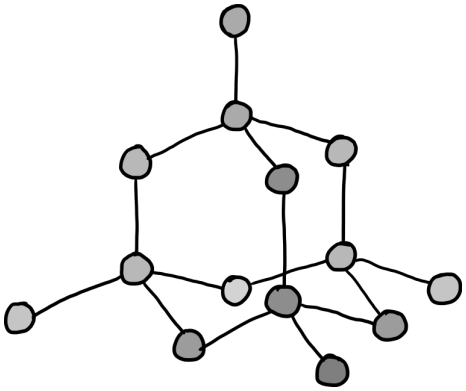
1. What type of bonding is found in small molecules?
2. Describe the general properties of small molecules.
3. What are the forces of interaction between small molecules called?
4. Describe what happens to small molecules when they melt or boil.

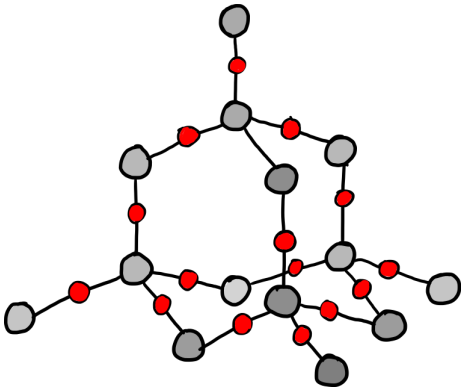
5.2.2.5 Polymers

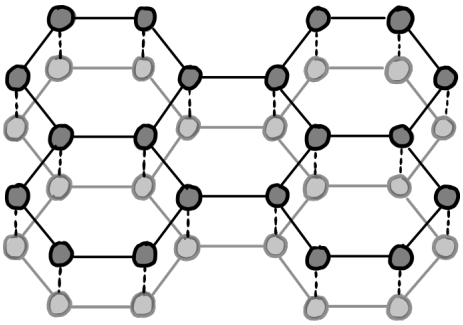
1. What is a monomer?
2. What is a polymer?
3. What is the role of strong covalent bonds in a polymer?
4. How do intermolecular forces affect the properties of polymers?

5.2.2.6 Giant covalent structures

1. Describe the general structure of giant covalent structures.
2. Describe the properties of giant covalent structures.
3. Give three examples of giant covalent structures.
4. Name the following giant covalent structures.







5.2.2.7 Properties of metal and alloys

1. What is an alloy?
2. Describe the general structure of metals and alloys.
3. What are the general properties of metals?
4. How are the atoms arranged in pure metals?
5. What properties of pure metals are a result of the arrangement of atoms?
6. Explain why alloys are harder than pure metals.

5.2.2.8 Metals as conductors

1. Why are metals good conductors of electricity?
2. Why are metals good conductors of thermal energy?

5.2.3 Structure and bonding of carbon

5.2.3.1 Diamond

1. How many covalent bonds does each carbon atom form in diamond?
2. What type of structure is diamond?
3. Describe three properties of diamond.

5.2.3.2 Graphite

1. How many covalent bonds does each carbon atom form in graphite?
2. How many delocalised electrons does each carbon atom in graphite have?
3. Describe the structure of graphite.
4. Why does graphite have similar properties to metals?

5.2.3.3 Graphene and fullerenes

1. Describe the structure of graphene
2. What is graphene useful for?
3. How many delocalised electrons does each carbon atom in graphene have?
4. What is a fullerene?
5. What is the structure of fullerene based on?
6. What was the first fullerene to be discovered?
7. What are cylindrical fullerenes called?
8. What is the ratio between the length and diameter in cylindrical fullerenes.
9. What are cylindrical fullerenes useful for?

5.3 Quantitative chemistry

5.3.1 Chemical measurements, conservation of mass and the quantitative interpretation of chemical reactions

5.3.1.1 Conservation of mass and balanced chemical equations

1. What is the law of conservation of mass?
2. State the numbers of atoms for each element in H_2O.
3. State the number of atoms for each element in NH_3.
4. State the number of atoms in $Ca(OH)_2$.
5. State the number of atoms for each element in $Ca(OH)_2$.
6. Balance $H_2 + O_2 \rightarrow H_2O$
7. Balance $Cl_2 + KI \rightarrow KCl + I_2$

5.3.1.2 Relative formula mass

1. What is the relative formula mass of a compound?
2. What is the relative formula mass of H_2SO_4?
3. What is the relative formula mass of Na_2CO_3?
4. What is the relative formula mass of $Ca(OH)_2$?

5.3.1.3 Mass changes when a reactant or product is a gas

1. Explain why some reactions may seem to involve a change in mass?
2. Describe the mass changes that occur when a metal reacts with oxygen in a non-enclosed system.
3. Describe the mass changes that occur during the thermal decomposition of metal carbonates in a non-enclosed system.

5.3.1.4 Chemical measurements

1. Define uncertainty.
2. How do you calculate the range of a set of measurements?
3. What does a large range of a set of measurements about the mean signify?
4. What is the formula to calculate the uncertainty about the mean.
5. Calculate the uncertainty of the following repeat values.

Experiment	1	2	3	Mean
Volume of CO_2 produced (mL)	20.0	20.1	19.8	20.0

5.3.2 Use of amount of substance in relation to masses of pure substances

5.3.2.1 Moles (HT)

1. What are chemical amounts measured using?
2. What is the symbol for the mole?
3. How is the relative formula mass of a substance linked to the mole?
4. Compare the number of particles in one mole of carbon (C) with the number of particles in one mole of CO_2.
5. What is the value of the Avogadro constant?
6. What is the formula that links the number of moles, relative formula (or atomic) mass and mass in grams?
7. How many moles are there in 44g of H_2O?
8. Calculate the mass of 0.4mol of CO_2.

5.3.2.2 Amounts of substances in equations (HT)

1. Describe the following equation in terms of moles: $Mg + 2HCl \rightarrow MgCl_2 + H_2$
2. What is the formula to calculate the percentage mass of an element in a compound?

5.3.2.3 Using moles to balance equations (HT)

1. Describe how you would balance an equation using the masses of the products and reactants.
2. 24g of magnesium react with 16g of oxygen to produce 40g of magnesium oxide. Write a balanced equation for the reaction.

5.3.2.4 Limiting reactants (HT)

1. What is a limiting reactant?
2. Why is it common to use an excess of one of the reactants in a chemical reaction?
3. What does the mass of a product formed in a chemical reaction depend upon?
4. What are the steps required to calculate the amount of aluminium oxide formed when 135g of aluminium is reacted with an excess of oxygen.
5. Calculate the mass of potassium chloride when 24g of potassium iodide reacts with an excess of chlorine?

5.3.2.5 Concentration of solutions

1. What is a solution?
2. What is a solute?
3. What is a solvent?
4. What is the formula to calculate the concentration of a solution?
5. How many cm^3 in $1dm^3$?
6. What is the concentration of a salt solution when 20g of salt is dissolved in $500cm^3$ of water?
7. Explain how the concentration of the solution is related to the mass of the solute and the volume of the solvent (HT).

5.4 Chemical changes

5.4.1 Reactivity of metals

5.4.1.1 Metal oxides

1. What are the products when metals react with oxygen?
2. What type of reactions occur when metals react with oxygen?
3. Define oxidation with reference to oxygen.
4. Define reduction with reference to oxygen.

5.4.1.2 The reactivity series

1. What do metals form when they react with other substances?
2. What is the reactivity of a metal related to?
3. Put zinc, lithium, potassium, copper, iron, calcium, sodium and magnesium in order of reactivity (most reactive first).
4. Which two non-metals are often placed in the reactivity series.
5. Write out the reactivity series including the two non-metals.
6. What type of reaction occurs between a reactive metal and a less reactive metal compound?
7. What is the general equation to show the reaction of metal with water.
8. Write out a balanced equation to show the reaction between sodium and water.
9. What is the general equation to show the reaction of metal with acid.
10. Write out a balanced equation to show the reaction between calcium and acid.

5.4.1.3 Extraction of metals and reduction

1. How are most metals found in the Earth?
2. What is a metal ore?
3. Why is gold found as a metal in the Earth?
4. How can iron, zinc and copper be extracted from their oxides?
5. Identify which substances have been oxidised and which substances have been reduced in the following equation: $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$.

5.4.1.4 Oxidation and reduction in terms of electrons (HT)

1. Define oxidation with reference to electrons.
2. Define reduction with reference to electrons.
3. Write out the ionic equation for the following displacement reaction: $Fe + CuSO_4 \rightarrow FeSO_4 + Cu$.
4. Define the term "spectator ion".
5. What are the spectator ions in the following equation: $Mg + FeSO_4 \rightarrow MgSO_4 + Fe$.
6. Write out the half equations for the following reaction $Fe + 2HCl \rightarrow FeCl_2 + H_2$.

5.4.2 Reactions of acids

5.4.2.1 Reactions of acids with metals

1. What are the products of a reaction between some metals and acid?
2. Describe the type of reaction that occurs between metals and acids.
3. Which substances are oxidised in the reaction between metals and acids
4. Which substances are reduced in the reaction between metals and acids?
5. State which species are oxidised and which are reduced in the following reactions:

Reaction	Oxidised	Reduced
magnesium + hydrochloric acid		
zinc + hydrochloric acid		
iron + hydrochloric acid		
magnesium + sulfuric acid		
zinc + sulfuric acid		
iron + sulfuric acid		

5.4.2.2 Neutralisation of acids and salt production

1. Define alkali.
2. Define base.
3. How are acids neutralised?
4. What is the general equation to show the reaction between acids and metal oxides?
5. What is the general equation to show the reaction between acids and metal hydroxides?
6. What is the general equation to show the reaction between acids and metal carbonates?
7. The production of a particular salt depends on which two factors?
8. Predict the products from a reaction between nitric acid and potassium hydroxide.
9. Predict the products from a reaction between hydrochloric acid and calcium carbonate.
10. Predict the products from a reaction between sulfuric acid and copper oxide.
11. Deduce the formula of magnesium chloride using the ions Mg^{2+} and Cl^-.
12. Deduce the formula of zinc sulfate using the ions Zn^{2+} and SO_4^{2-}.

5.4.2.3 Soluble salts

1. Describe how soluble salts can be made.
2. How can salt solutions be used to form solid salts?

5.4.2.4 The pH scale and neutralisation

1. What ions do acids produce in aqueous solution?
2. What ions do alkalis form in aqueous solution.
3. What does pH mean?
4. What is the pH scale a measure of?
5. What numbers on the scale represent acids?
6. What numbers on the pH scale represent alkalis?
7. What does pH 7 represent on the scale?
8. Name two ways the pH of a solution can be measured.
9. What type of reaction occurs between an acid and an alkali.
10. Write an ionic equation for the reaction between an acid and an alkali.

5.4.2.5 Strong and weak acids (HT)

1. What is a strong acid?
2. Give three examples of strong acids.
3. What is a weak acid?
4. Give three examples of weak acids.
5. Explain the difference between the terms concentrated and dilute acids and weak and strong acids.
6. For a given concentration of an aqueous solution, what is the relationship between the strength of acid an the pH.
7. Describe how the pH scale is linked to the hydrogen ion concentration.

5.4.3 Electrolysis

5.4.3.1 The process of electrolysis

1. What type of compounds can be electrolysed?
2. What state must the compound be in for electrolysis to take place?
3. What is an electrolyte?
4. What is the negative electrode called?
5. What is the positive electrode called?
6. What happens when an electric current is passed through an electrolyte?

5.4.3.2 Electrolysis of molten ionic compounds.

1. What ions do lead bromide form when melted?
2. What type of electrodes are used during the electrolysis of lead bromide?
3. What happens when a molten ionic compound is electrolysed?
4. What is formed at the positive electrode (anode) during the electrolysis of lead bromide?
5. What is the ionic equation for the positive electrode (anode)?
6. What is formed at the negative electrode (cathode) during the electrolysis of lead bromide?
7. What is the ionic equation for the negative electrode (cathode)?
8. What ions do zinc chloride form when melted?
9. Predict the products of the electrolysis of zinc chloride.

5.4.3.3 Using electrolysis to extract metals.

1. How can metals be extracted by electrolysis?
2. Which type of metals are extracted by electrolysis?
3. Why is aluminium sometimes called "solid electricity"?
4. Describe how aluminium is manufactured.
5. What is formed at the negative electrode (cathode) during the electrolysis of aluminium oxide?
6. What is the ionic equation for the negative electrode (cathode) during the electrolysis of aluminium oxide?
7. What is formed at the positive electrode (anode) during the electrolysis of aluminium oxide?
8. What is the ionic equation for the positive electrode (anode) during the electrolysis of aluminium oxide?
9. Why is cryolite used in this process?
10. Why does the positive electrode (anode) have to be constantly replaced?

5.4.3.4 Electrolysis of aqueous solutions

1. What ions are present in all aqueous solutions?
2. What affects the ions discharged when an aqueous solution is electrolysed?
3. Explain what will be discharged from a negative electrode (cathode) during the electrolysis of an aqueous solution.
4. Explain what will be discharged from a positive electrode (anode) during the electrolysis of an aqueous solution.
5. What are the ions found in a solution of copper sulfate ($CuSO_4$)?
6. Explain what will happen when an aqueous solution of copper sulfate is electrolysed.
7. What are the ions found in a solution of sodium chloride $(NaCl)_{(aq)}$?
8. Explain what will happen when an aqueous solution of sodium chloride is electrolysed.

5.4.3.5 Representation of reactions at electrodes as half equations (HT).

1. What happens at the cathode (negative electrode) during electrolysis?
2. What type of reaction occurs at the cathode (negative electrode)?
3. What happens at the anode (positive electrode) during electrolysis?
4. What type of reaction occurs at the anode (positive electrode)?
5. What happens at the cathode (negative electrode) during electrolysis?
6. What type of reaction occurs at the cathode (negative electrode)?
7. What happens at the anode (positive electrode) during electrolysis?
8. What type of reaction occurs at the anode (positive electrode)?
9. Write out the half equations for the electrolysis of copper sulfate solution.
10. Write out the half equations for the electrolysis of sodium chloride solution.

5.5 Energy changes

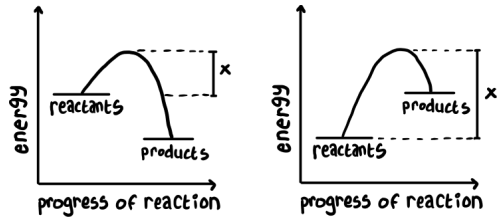
5.5.1 Exothermic and endothermic reactions

5.5.1.1 Energy transfer during exothermic and endothermic reactions.

1. What happens to energy in chemical reactions?
2. Compare the energy in the reactants and the products if energy is transferred to the surroundings during the reaction.
3. Compare the energy in the reactants and the products if energy is transferred from the surroundings during the reaction.
4. What is an exothermic reaction?
5. Give three examples of exothermic reactions.
6. What is an endothermic reaction?
7. Give three examples of endothermic reactions.
8. Describe an experiment to measure the energy released by a neutralisation reaction.

5.5.1.2 Reaction profiles

1. Describe how chemical reactions can occur between particles.
2. What is activation energy?
3. What is a reaction profile?
4. What is represented by X in the following diagrams?



5.5.1.3 The energy changes of reactions (HT)

1. Describe a chemical reaction in terms of energy and bonds.
2. What is the bond energy of a molecule?
3. What reaction occurs when bonds are broken?
4. What reaction occurs when bonds are made?
5. How do you calculate the overall energy change for a reaction?
6. What is the overall energy change for an exothermic reaction?
7. What is the overall energy change for an endothermic reaction?
8. Calculate the overall energy change for the following reaction: $H_2 + Cl_2 \rightarrow 2HCl$. Bond energies: H-H = 436 kj/mol, Cl-Cl = 243 kJ/mol and H-Cl = 432 kJ/mol. State if the reaction is endothermic or exothermic.
9. Calculate the overall energy change for the following reaction: $2HBr \rightarrow H_2 + Br_2$. Bond energies: H-H = 436 kJ/mol, Br-Br = 193 kJ/mol and H-Br = 366 kJ/mol. State if the reaction is endothermic or exothermic.

5.6 The rate and extent of chemical change

5.6.1 Rate of reaction

5.6.1.1 Calculating rates of reaction

1. How do you measure the rate of a chemical reaction?
2. What is the formula to calculate measure the mean rate of reaction from the reactants?
3. What is the formula to calculate the mean rate of reaction from the products?
4. What three quantities can be used to measure the the quantity of the product or reactant?
5. What are the units for rate of reaction?
8. What is a tangent?
9. What is the slope of a tangent used to calculate?

5.6.1.2 Factors which affect the rate of chemical reaction

1. Name five factors which affect the rate of chemical reaction?
2. Describe the effect of changing these factors on the rate of chemical reaction.
3. What is turbidity?
4. Describe an experiment involving colour change or turbidity to measure the effect of concentration on the rate of reaction.
5. Describe an experiment involving the collection of gas to measure the effect of concentration on the rate of reaction.

5.6.1.3 Collision theory and activation energy

1. Explain collision theory.
2. What is activation energy.
3. Describe the effect of increasing the concentration of reactants on the reaction rate using collision theory.
4. Describe the effect of increasing the pressure of reactants on the reaction rate using collision theory.
5. Describe the effect of increasing the surface area of reactants on the reaction rate using collision theory.
6. How does the surface area to volume ratio affect the rate of reaction?
7. Describe the effect of increasing the temperature of reactants on the reaction rate using collision theory.

5.6.1.4 Catalysts

1. What is a catalyst?
2. How do catalysts work?
3. What are enzymes?
4. What is a reaction profile?

5.6.2 Reversible reactions and dynamic equilibrium

5.6.2.1 Reversible reactions

1. What is a reversible reaction?
2. Represent a reversible reaction with the reactants A and B and the products C and D.
3. How can the direction of a reversible reaction be changed?
4. How can the direction of the decomposition of ammonium chloride into ammonia and hydrogen chloride be changed?

5.6.2.2 Energy changes and reversible reactions

1. If a reaction is exothermic in one direction what will it be in the opposite direction?
2. What does hydrated mean?
3. What does anhydrous mean?
4. What are energy changes associated with the reversible reaction of hydrated copper sulfate changing into anhydrous copper sulfate and water.

5.6.2.3 Equilibrium

1. What is equilibrium?
2. What is a closed system?

5.6.2.4 The effect of changing conditions on equilibrium (HT)

1. What do the relative amounts of reactants and products at equilibrium depend upon?
2. Describe what happens to a system at equilibrium when a change is made to one of the conditions.
3. What is Le Chatelier's principle?
4. Where will the position of equilibrium be when ammonium chloride is heated?
5. Where will the position of equilibrium be when ammonia and hydrogen chloride are cooled?
6. Where will the position of equilibrium be when hydrated copper sulfate is heated?

5.6.2.5 The effect of changing concentration (HT)

1. Describe what happens if the concentration of a reactant or product in a reversible reaction is changed.
2. Describe the effect of increasing the concentration of a reactant in a reversible reaction.
3. Describe the effect of decreasing the concentration of a product in a reversible reaction.
4. What happens is more nitrogen is added in the following reaction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$?
5. What happens is more hydrogen is added in the following reaction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$?
6. What happens if the concentration of ammonia is decreased in the following reaction? $N_2 + 3H_2 \rightleftharpoons 2NH_3$?

5.6.2.6 The effect of temperature changes on equilibrium (HT)

1. Describe the effect of increasing the temperature of a system at equilibrium on the relative amount of products for an exothermic reaction.
2. Describe the effect of increasing the temperature of a system at equilibrium on the relative amount of products for an endothermic reaction.
3. Describe the effect of decreasing the temperature of a system at equilibrium on the relative amount of products for an exothermic reaction.
4. Describe the effect of decreasing the temperature of a system at equilibrium on the relative amount of products for an endothermic reaction.
5. The following reaction is exothermic in the forward direction and endothermic in the opposite direction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$. Describe what happens if the temperature is decreased.
6. The following reaction is exothermic in the forward direction and endothermic in the opposite direction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$. Describe what happens if the temperature is increased.

5.6.2.7 The effect of pressure changes on equilibrium (HT)

1. Describe the effect of decreasing the pressure of a gaseous reaction at equilibrium.
2. Describe the effect of increasing the pressure of a gaseous reaction at equilibrium.
3. Describe what will happen to the equilibrium position if the pressure is increased for the following reaction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$.
4. Describe what will happen to the equilibrium position if the pressure is decreased for the following reaction: $N_2 + 3H_2 \rightleftharpoons 2NH_3$.

5.7 Organic chemistry

5.7.1 Carbon compounds as fuels and feedstock

5.7.1.1 Crude oil, hydrocarbons and alkanes

1. What is crude oil made from?
2. What is crude oil?
3. What are hydrocarbons?
4. What type of molecules are most of the hydrocarbons found in crude oil?
5. What is the general formula for alkanes?
6. Name the first four members of the alkanes.
7. What is the formula of methane?
8. Draw the structure of ethane.
9. What is the formula of propane?
10. Draw the structure of butane.

5.7.1.2 Fractional distillation and petrochemicals

1. What is a crude oil fraction?
2. How can crude oil be separated into fractions?
3. How does the petrochemical industry use different fractions?
4. What are the five main crude oil fractions?
5. Name four useful materials produced by the petrochemical industry?
6. Why are there are vast array of natural and synthetic carbon compounds?
7. Explain how fractional distillation works.

5.7.1.3 Properties of hydrocarbons

1. Name three properties of hydrocarbons which depend on the size of the molecule.
2. What is viscosity?
3. Describe how these properties change with increasing molecular size.
4. What is released by the combustion of fuels?
5. What two substances are oxidised during combustion?
6. Write a word equation for the complete combustion of a hydrocarbon.
7. Write a balanced chemical equation for the complete combustion of methane.
8. Write a balanced chemical equation for the complete combustion of butane.

5.7.1.4 Cracking and alkenes

1. What is cracking?
2. Name two methods of cracking.
3. Describe the the two methods of cracking hydrocarbons.
4. What are the products of cracking?
5. Compare the reactivity of alkanes and alkenes.
6. Describe the test for alkenes.
7. Why is cracking required?
8. What are alkenes used for?
9. Write a balanced equation for hexane (C_6H_{14}) being cracked into butane (C_4H_{10}).

5.8 Chemical analysis

5.8.1 Purity, formulations and chromatography

5.8.1.1 Pure substances

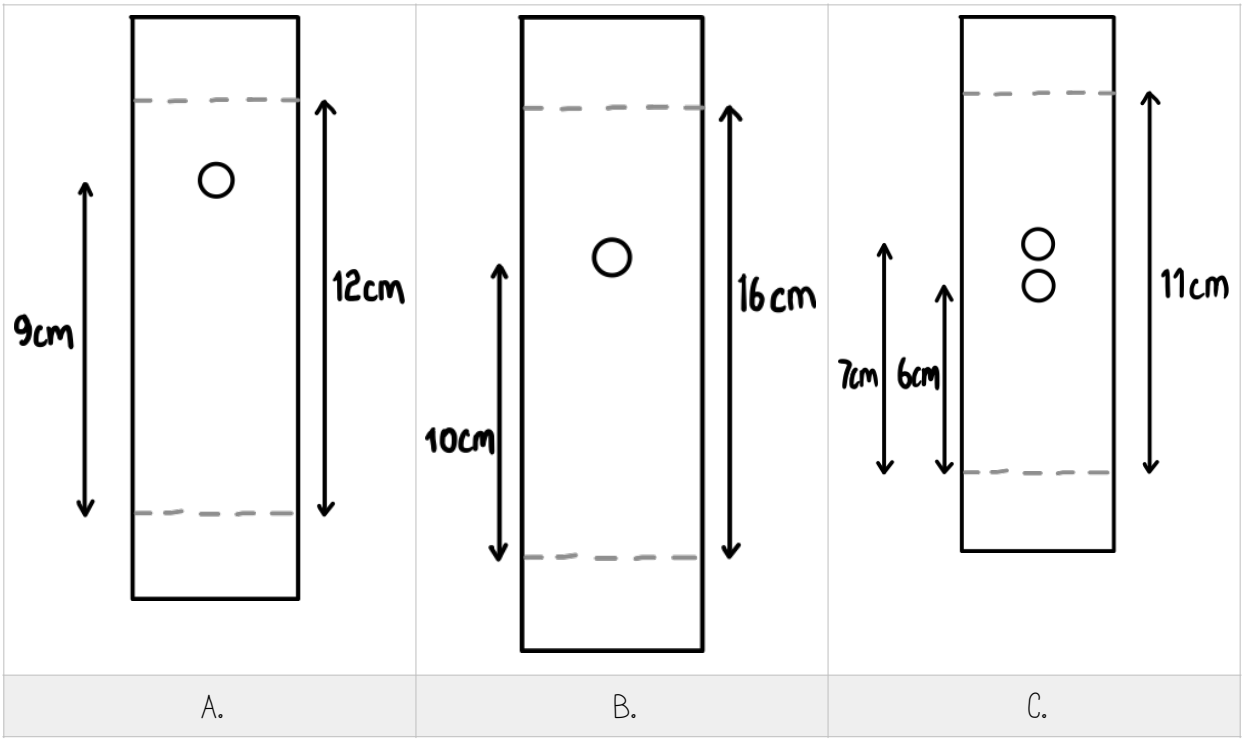
1. What is a pure substance?
2. How can pure substances be distinguished from mixtures?

5.8.1.2 Formulations

1. What is a formulation?
2. How are formulations made?
3. Name seven examples of formulations.

5.8.1.3 Chromatography

1. What is chromatography?
2. What is the mobile phase?
3. What is the stationary phase?
4. Explain how chromatography works.
5. What is the origin?
6. What is the solvent front?
7. What does Rf mean?
8. What is the formula to calculate the Rf of a substance?
9. What is the Rf value of a sample which has travelled half the distance of the solvent front?
10. What is the Rf value of a sample which has travelled a quarter of the distance of the solvent front?
11. How can chromatography be used to determine if a substance is pure?
12. Calculate the Rf value for each sample from the following chromatograms.



A. B. C.

13. Which of the chromatograms above shows a mixture?
14. Describe an experiment to see if the colouring in sweets is pure or a mixture.

5.8.2 Identification of common gases

1. What is the test for hydrogen?
2. What Is the test for oxygen?
3. What Is the test for carbon dioxide?
4. What Is the test for chlorine?

5.9 Chemistry of the atmosphere

5.9.1 The composition and evolution of the Earth's atmosphere

5.9.1.1 The proportions of different gases in the atmosphere

1. For approximately how long have the proportions of the gases in the atmosphere today been this way?
2. What is the proportion of nitrogen in the atmosphere?
3. What is the proportion of oxygen in the atmosphere?
4. Name three other components that are found in small proportions in the atmosphere?

5.9.1.2 The Earth's early atmosphere

1. How old is the Earth thought to be?
2. What was the atmosphere of Earth initially thought to be like?
3. Describe how the atmosphere is thought to have developed in the first billion years.
4. What caused the build up of nitrogen in the atmosphere?
5. As well as nitrogen which two other gases may have formed in small proportions?
6. Describe how carbon dioxide concentrations in the atmosphere were reduced.

5.9.1.3 How oxygen increased

1. When was oxygen first produced?
2. What was responsible for the production of oxygen?
3. What process produced oxygen?
4. Write a word equation to show the production of oxygen.
5. Write a balanced equation to show the production of oxygen.
6. Describe what happened to oxygen levels over the next billion years and the effect this had on life on Earth.

5.9.1.4 How carbon dioxide decreased

1. Name three ways by which carbon dioxide levels were decreased in the atmosphere

5.9.2 Carbon dioxide and methane as greenhouse gases

5.9.2.1 Greenhouse gases

1. What is the effect of greenhouse gases on the Earth?
2. Name three greenhouse gases?
3. Describe the greenhouse effect.

5.9.2.2 Human activities which contribute to an increase in greenhouse gases in the atmosphere

1. Name two greenhouse gases which have increased as a result of human activities.
2. Name two human activities which have increased the amount of carbon dioxide in the atmosphere.
3. Name two human activities which have increased the amount of methane in the atmosphere.
4. Describe what the effect of human activities will be on the Earth's atmosphere?
5. How can scientists trust the data that has been collected about effect of greenhouse gases?
6. Explain why differing opinions are presented in the media about climate change?

1. What is a major cause of global climate change?
2. List four potential effects of global climate change?
3. Discuss the environmental implications of global climate change?

5.9.2.4 The carbon footprint and its reduction

1. Define the term "carbon footprint".
2. Describe how the carbon footprint can be reduced?
3. Describe actions which can be taken to reduce carbon dioxide and methane emissions.
4. Suggest why the actions may have a limited effect.

5.9.3 Common atmospheric pollutants and their sources

5.9.3.1 Atmospheric pollutants from fuels

1. What is the major source of atmospheric pollutants?
2. What elements do most fuels contain?
3. Name five gases released into the atmosphere when fuel is burned.
4. Name two substances which form particulates in the atmosphere.
5. What is a particulate.
6. What happens if there is not enough oxygen for the fuel to burn?
7. What are the products formed as a result of incomplete combustion?
8. Why is sulfur dioxide formed from the burning of fossil fuels?
9. How are oxides of nitrogen formed?

5.9.3.2 Properties and effects of atmospheric pollutants

1. What are the properties of carbon monoxide?
2. What is the effect of carbon monoxide on the body?
3. What is the effect of sulfur dioxide on the atmosphere?
4. What is the effect of oxides of nitrogen on the atmosphere?
5. What are the effects of particulates on the body?
6. What is the effect of particulates on the atmosphere?

5.10 Using resources

5.10.1 Using the Earth's resources and obtaining potable water

5.10.1.1 Using the Earth's resources and sustainable development

1. What do humans use the Earth's resources for?
2. What do natural resources, supplemented by agriculture provide?
3. What are processed finite resources from the earth, oceans and atmosphere used to provide?
4. What is sustainable development?
5. Give three examples of natural products and their synthetic replacements.
6. What is a finite resource?
7. Give three examples of finite resources.
8. What is a renewable resource?
9. Give three examples of renewable resources.

5.10.1.2 Potable water

1. What is potable water?
2. What properties should drinking water have.
3. Explain whether potable water is a pure substance or a mixture.
4. What is the source of most of the potable water used in the UK.
5. How is most of the potable water produced in the UK?
6. Name three sterilising agents used to produce potable water.
7. What is the source of potable water, when fresh water supplies are limited?
8. Name two methods of desalination.
9. What is a drawback to using either of these methods?
10. Describe a method to analyse and purify water samples from different sources.

5.10.1.3 Waste water treatment

1. What are the main sources of waste water?
2. Why does agricultural and sewage waste water require treatment?
3. Why does industrial waste water require treatment?
4. Describe the four stages of sewage treatment.
5. Compare the relative ease of obtaining water from waste water, ground water and salt water.

5.10.1.4 Alternative methods of extracting metals (HT)

1. Why are alternative methods required for extracting metals from ores?
2. Name two methods of extracting copper from low grade ores.
3. Describe how these new methods are different to traditional mining methods.
4. Describe the process of phytomining.
5. Describe the process of bioleaching.
6. What is a leachate?
7. How can the metal compounds extracted by alternative methods be processed to produce metal.

5.10.2.1 Life cycle assessment

1. What are life cycle assessments (LCAs).
2. What are the four stages assessed by LCAs.
3. What are easy to quantify when carrying out LCAs?
4. What is difficult to quantify when carrying out LCAs?
5. How can LCAs be misused.
6. Carry out an LCA for shopping bags made from plastic and paper

LCA stage	Plastic bag	Paper bag
Raw materials		
Manufacturing		
Use		
Disposal		

5.10.2.2 Ways of reducing the use of resources

1. List three ways end users can sustainably use resources.
2. Name four effects of reduction in the use of materials.
3. Name five materials which are produced from limited resources.
4. Name two methods of obtaining raw materials from the earth.
5. What is the effect of obtaining materials by these methods?
6. Explain how glass products can be reused.
7. What happens to other products which cannot be reused?
8. Describe how metals can be recycled.
9. What does the amount of separation required for recycling depend upon?
10. How can scrap steel be recycled?