BURSCOUGH PRIORY ACADEMY

ENDEAVOUR LEARNING TRUST

Chemistry Paper 1 Knowledge Check List

AQA Chemistry GCSE – Student Progress Sheet

Unit 4.1 - Atomic Structure and the Periodic Table

4.1.1. A Simple Model of the Atom, Symbols, RAM, Electronic Charge and Isotopes

4.1.1.1. Atoms, Elements and Compounds

a	I know that all substances are made of atoms and that an atom is the smallest part of an element that can exist.			
b	I know that atoms of each element are represented by a chemical symbol, e.g. O represents an atom of oxygen, Na represents an atom of sodium.			
c	I know that there are about 100 different elements and that these are shown in the periodic table, and I can use the names and symbols of the first 20 elements and those in Groups 1 (alkali metals) and 7 (halogens).			
d	I know that compounds are formed from elements during chemical reactions and I can name compounds from given formulae or symbol equations.			
e	I can describe how one or more new substances (products) are formed during chemical reactions and that this often involves a detectable energy change.			
f	I know that compounds contain two or more elements chemically combined in fixed proportions and that they can be represented by formulae (using the symbols of the atoms from which they were formed, e.g. H2O).			
g	I know that compounds can only be separated into elements by chemical reactions.			
h	I can represent chemical reactions by word equations and balanced symbol equations (using formulae).			
i	I can write balanced half equations and ionic equations where appropriate. (HT only).			

4.1.1.2. Mixtures

a	I know that a mixture consists of two or more elements or compounds not chemically combined together and that the chemical properties of each substance in the mixture are unchanged.			
b	I can describe how mixtures can be separated by physical processes such as filtration, crystallisation, simple distillation, fractional distillation and chromatography.			

4.1.1.3. The Development of the Model of the Atom

a	I can explain how new experimental evidence may lead to a scientific model being changed or replaced e.g. the nuclear model of the atom replaced the plum pudding model, based on the results of the alpha particle scattering experiment.			
b	I know that, before the discovery of the electron, atoms were thought to be tiny spheres that could not be divided.			
c	I can describe the plum pudding model of the atom: the atom is a ball of positive charge with negative electrons embedded in it.			
d	I can describe the alpha particle scattering experiment and explain how the results from it led to the conclusion that the mass of an atom was concentrated at the centre (nucleus) and that the nucleus was charged.			
e	I know that Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances, and that the theoretical calculations of Bohr agreed with experimental observations.			
f	I can explain how later experiments led to the idea that the positive charge of any nucleus could be subdivided into a whole number of smaller particles (each particle having the same amount of positive charge) and that the name proton was given to these particles.			
g	I know that the experimental work of James Chadwick provided evidence to show the existence of neutrons within the nucleus.			

4.1.1.4. Relative Electrical Charge of Subatomic Particles

a	I know that the relative electrical charge of the subatomic particles in an atom are: • Proton +1 • Neutron 0 • Electron -1			
b	I know that atoms have no overall electrical charge because the number of electrons (negative charge) is equal to the number of protons (positive charge).			
c	I know that the number of protons in an atom of an element is its atomic number (see periodic table) and that all atoms of a particular element have the same number of protons.			
d	I can use the nuclear model to describe atoms.			

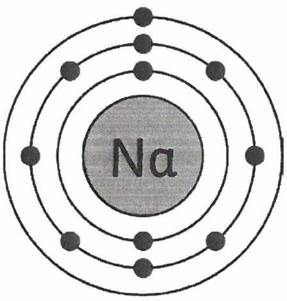
4.1.1.5. Size and Mass of Atoms

a	I know that atoms are very small, having a radius of about 0.1nm (1×10^{-10}m). The radius of a nucleus is less than 1/10 000 of that of the atom (about 1×10^{-14}m).			
b	I know that almost all of the mass of an atom is in the nucleus.			
c	I know that the relative masses of protons, neutrons and electrons are: • Proton 1 • Neutron 1 • Electron very small (almost 0).			
d	I know that the sum of the protons and neutrons in an atom is its mass number (see periodic table).			
e	I know that atoms of the same element can have different numbers of neutrons and that these atoms are called isotopes (of that element) e.g. carbon 12 and carbon 14.			
f	I can use the periodic table to calculate the number of protons, neutrons and electrons in an atom (or ion).			

4.1.1.6. Relative Atomic Mass

a	I know that the relative atomic mass of an element is an average value that takes account of the abundance of the isotopes of the element.			
b	I can calculate the relative atomic mass of an element given the percentage abundance of its isotopes.			

4.1.1.7. Electronic Structure

a	I know that the electrons in an atom occupy the lowest available energy levels (innermost available shells).			
b	I can represent the electronic structure of an atom by numbers or by a diagram, e.g. the electronic structure of sodium is 2,8,1 or: 			

4.1.2. The Periodic Table

4.1.2.1. The Periodic Table

a	I know that the elements in the periodic table are arranged in order of atomic (proton) number, so that elements with similar properties are in columns, known as groups. (it is called a periodic table because similar properties occur at regular intervals).			
b	I know that 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.			
c	I can 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.			
d	I can predict possible reactions and probable reactivity of elements from their positions in the periodic table.			

4.1.2.2. Development of the Periodic Table

a	I know that before the discovery of protons, neutrons and electrons, scientists attempted to classify the elements by arranging them in order of their atomic weights.			
b	I know that the early periodic tables were incomplete and some elements were placed in inappropriate groups if the strict order of atomic weights was followed.			
c	I can describe how Mendeleev overcame some of the problems (by leaving gaps for elements that he thought had not been discovered and in some places changed the order based on atomic weights).			
d	I can describe how elements with properties predicted by Mendeleev were later discovered that filled the gaps.			
e	I can describe how the knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.			

4.1.2.3. Metals and Non-Metals

a	I know that elements that react to form positive ions are metals and that elements that do not form positive ions are non-metals.			
b	I know that the majority of elements are metals and that they are found to the left and towards the bottom of the periodic table.			
c	I know that non-metals are found towards the right and top of the periodic table.			
d	I can explain the differences between metals and non-metals on the basis of their characteristic physical and chemical properties.			
e	I can explain how the atomic structure of metals and non-metals relates to their position in the periodic table.			
f	I can explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number.			

4.1.2.4. Group 0

a	I know that the elements in Group 0 of the periodic table are called the noble gases and that they are unreactive and do not easily form molecules because their atoms have stable arrangements of electrons (full outer shell: eight electrons in their outer shell, except for helium, which has only two electrons).			
b	I know that the boiling points of the noble gases increase with increasing relative atomic mass (going down the group).			
c	I can explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms.			
d	I can predict properties from given trends down the group.			

4.1.2.5. Group 1

a	I know that 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.			
b	I can describe the reactions of the first three alkali metals with oxygen, chlorine and water.			
c	I know that in Group 1, the reactivity of the elements increases going down the group.			
d	I can explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms			
e	I can predict properties from given trends down the group.			

4.1.2.6. Group 7

a	I know that 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.			
b	I know that the halogens are non-metals and consist of molecules made of pairs of atoms.			
c	I can describe the nature of the compounds formed when chlorine, bromine and iodine react with metals and non-metals.			
d	I know that, in Group 7, the further down the group an element is, the higher its relative molecular mass, melting point and boiling point.			
e	I know that, in Group 7, the reactivity of the elements decreases going down the group.			
f	I can describe how a more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.			
g	I can explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms.			
h	I can predict properties from given trends down the group.			

4.1.3. Properties of Transition Metals (Chemistry Only)

4.1.3.1. Comparison with Group 1 Elements (Chemistry Only)

a	I know that Cr, Mn, Fe, Co, Ni and Cu are transition elements.			
b	I know that the transition elements are metals with similar properties which are different from those of the elements in Group 1.			
c	I can describe the difference of transition elements, compared with Group 1, in melting points, densities, strength, hardness and reactivity with oxygen, water and halogens.			

4.1.3.2. Typical Properties (Chemistry Only)

a	I know that many transition elements (Cr, Mn, Fe, Co, Ni and Cu) have ions with different charges, form coloured compounds and are useful as catalysts.			

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Unit 4.2 - Bonding, Structure and the Properties of Matter

4.2.1. Chemical Bonds, Ionic, Covalent and Metallic

4.2.1.1. Chemical Bonds

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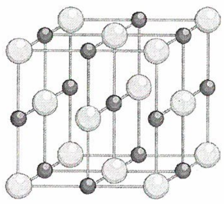
a	I know that there are three types of strong chemical bonds: ionic, covalent and metallic.			
b	I know that for ionic bonding the particles are oppositely charged ions and that it occurs in compounds formed from metals combined with non-metals.			
c	I know that, for covalent bonding, the particles are atoms which share pairs of electrons and that it occurs in most non-metallic elements and in compounds of non-metals.			
d	I know that for metallic bonding the particles are atoms which share delocalised electrons and that it occurs in metallic elements and alloys.			
e	I can explain chemical bonding in terms of electrostatic forces and the transfer or sharing of electrons.			

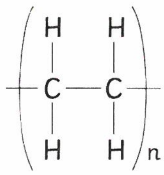
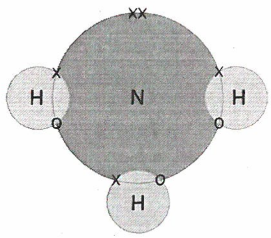
4.2.1.2. Ionic Bonding

a	I know that when a metal atom reacts with a non-metal atom: • electrons in the outer shell of the metal atom are transferred; • metal atoms lose electrons to become positively charged ions; • non-metal atoms gain electrons to become negatively charged ions.			
b	I know that the ions produced by metals in Groups 1 and 2 and by non-metals in Groups 6 and 7 have the electronic structure of a noble gas (Group 0).			
c	I can draw dot and cross diagrams for ionic compounds formed by metals in Groups 1 and 2 with non -metals in Groups 6 and 7, e.g. for sodium chloride.			
d	I can 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).			

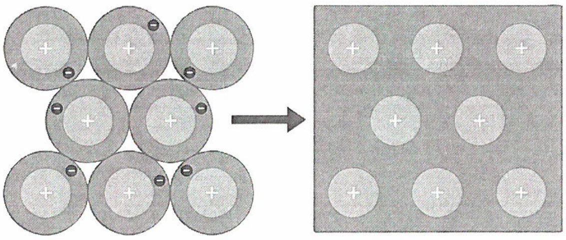
4.2.1.3. Ionic Compounds

a	I know that an ionic compound is a giant structure of ions.			
b	I know that ionic compounds are held together by strong electrostatic forces of attraction between oppositely charged ions, that these forces act in all directions in the lattice, and that this is called ionic bonding.			
c	I know that the structure of sodium chloride can be represented in the following form: 			
d	I can deduce that a compound is ionic from a diagram of its structure.			
e	I can describe the limitations of using dot and cross, ball and stick, two and three-dimensional diagrams to represent a giant ionic structure			
f	I can work out the empirical formula of an ionic compound from a given model or diagram that shows the ions in the structure.			

4.2.1.4. Covalent Bonding

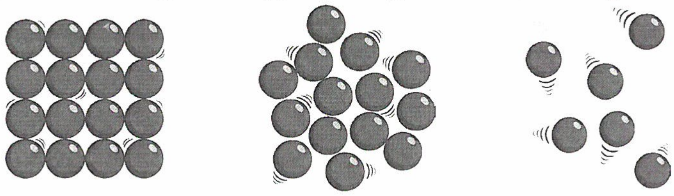
a	I know that atoms form covalent bonds when they share pairs of electrons. These bonds between atoms are strong.			
b	I know that covalently bonded substances may consist of small molecules.			
c	I can recognise common substances that consist of small molecules from their chemical formula.			
d	I know that some covalently bonded substances have very large molecules, such as polymers.			
e	I know that polymers can be represented in the following form where n is a large number:  Poly(ethene)			
f	I know that some covalently bonded substances have giant covalent structures, such as diamond and silicon dioxide.			
g	I know that the covalent bonds in molecules and giant structures can be represented in the following form: 			
h	I can draw dot and cross diagrams for the molecules of hydrogen, chlorine, oxygen, nitrogen, hydrogen chloride, water, ammonia and methane.			
i	I can 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.			
j	I can describe the limitations of using dot and cross, ball and stick, two and three-dimensional diagrams to represent molecules or giant structures.			
k	I can deduce the molecular formula of a substance from a given model or diagram in these forms showing the atoms and bonds in the molecule.			

4.2.1.5. Metallic Bonding

a	I know that metals consist of giant structures of atoms arranged in a regular pattern.			
b	I know that the electrons in the outer shell of metal atoms are delocalised and so are free to move through the whole structure.			
c	I know that the sharing of delocalised electrons gives rise to strong metallic bonds.			
d	I know that the bonding in metals may be represented in the following form: 			
e	I can recognise substances as metallic giant structures from diagrams showing their bonding.			

4.2.2. How Bonding and Structure Are Related to the Properties of Structures

4.2.2.1. The Three States of Matter

a	I know that the three states of matter are: solid, liquid and gas.			
b	I know that melting and freezing take place at the melting point, while boiling and condensing take place at the boiling point.			
c	I know that the three states of matter can be represented by a simple model. In this model, particles are represented by small solid spheres. Particle theory can help to explain melting, boiling, freezing and condensing. 			
d	I can discuss the limitations of the simple particle model above including; that in the model there are no forces, that all particles are represented as spheres and that the spheres are solid (HT only).			
e	I know that the amount of energy needed to change state from solid to liquid, and from liquid to gas, depends on the strength of the forces between the particles of the substance. The stronger the forces between the particles the higher the melting point and boiling point of the substance.			
f	I can predict the states of substances at different temperatures given appropriate data.			
g	I can explain the different temperatures at which changes of state occur in terms of energy transfers and types of bonding.			
h	I can recognise that atoms themselves do not have the bulk properties of materials.			
i	I can explain the limitations of the particle theory in relation to changes of state when particles are represented by solid inelastic spheres which have no forces between them (HT only).			

4.2.2.2. State Symbols

a	I know that, in chemical equations, the three states of matter are shown as (s), (l) and (g), with (aq) for aqueous solutions.			

4.2.2.3. Properties of Ionic Compounds

a	I know that ionic compounds have regular structures (giant ionic lattices) in which there are strong electrostatic forces of attraction in all directions between oppositely charged ions.			
b	I know that ionic compounds have high melting points and high boiling points because of the large amounts of energy needed to break the many strong bonds.			
c	I know that, when melted or dissolved in water, ionic compounds conduct electricity because the ions are free to move and so charge can flow.			

4.2.2.4. Properties of Small Molecules

a	I know that substances consisting of small molecules are usually gases or liquids that have relatively low melting points and boiling points.			
b	I know that substances consisting of small molecules have only weak forces between the molecules (intermolecular forces) and that it is these intermolecular forces that are overcome, not the covalent bonds, when the substance melts or boils.			
c	I know that intermolecular forces increase with the size of the molecules, so substances that consist of larger molecules have higher melting and boiling points.			
d	I know that substances consisting of small molecules do not conduct electricity because the molecules do not have an overall electric charge.			
e	I can explain the bulk properties of molecular substances using the idea that intermolecular forces are weak compared with covalent bonds.			

4.2.2.5. Polymers

a	I know that polymers have very large molecules and that the atoms in the polymer molecules are linked to other atoms by strong covalent bonds.			
b	I know that the intermolecular forces between polymer molecules are relatively strong and so these substances are solids at room temperature.			
c	I can recognise polymers from diagrams showing their bonding and structure.			

4.2.2.6. Giant Covalent Structures

a	I know that substances consisting of giant covalent structures are solids with very high melting points.			
b	I know that all of the atoms in giant covalent structures are linked to other atoms by strong covalent bonds and that these bonds must be overcome to melt or boil these substances.			
c	I know that diamond and graphite (forms of carbon) and silicon dioxide (silica) are examples of giant covalent structures.			
d	I can recognise giant covalent structures from diagrams showing their bonding and structure.			

4.2.2.7. Properties of Metals and Alloys

a	I know that metals have giant structures of atoms with strong metallic bonding, which means that most metals have high melting and boiling points.			
b	I know that, in pure metals, atoms are arranged in layers which allows metals to be bent and shaped.			
c	I know that pure metals are too soft for many uses and so are mixed with other metals to make alloys which are harder.			
d	I can explain why alloys are harder than pure metals in terms of distortion of the layers of atoms in the structure of a pure metal.			

4.2.2.8. Metals as Conductors

a	I know that metals are good conductors of electricity because the delocalised electrons in the metal carry electrical charge through the metal.			
b	I know that metals are good conductors of thermal energy because energy is transferred by the delocalised electrons.			

4.2.3. Structure and Bonding of Carbon

4.2.3.1. Diamond

a	I know that, in diamond, each carbon atom forms four covalent bonds with other carbon atoms in a giant covalent structure, so diamond is very hard, has a very high melting point and does not conduct electricity.			
b	I can explain the properties of diamond in terms of its structure and bonding.			

4.2.3.2. Graphite

a	I know that, in graphite, each carbon atom forms three covalent bonds with three other carbon atoms, forming layers of hexagonal rings which have no covalent bonds between the layers.			
b	I know that, in graphite, one electron from each carbon atom is delocalised.			
c	I know that graphite is similar to metals in that it has delocalised electrons.			
d	I can explain the properties of graphite in terms of its structure and bonding.			

4.2.3.3. Graphene and Fullerenes

a	I know that graphene is a single layer of graphite and has properties that make it useful in electronics and composites.			
b	I can explain the properties of graphene in terms of its structure and bonding.			
c	I know that fullerenes are molecules of carbon atoms with hollow shapes. The structure of fullerenes is based on hexagonal rings of carbon atoms but they may also contain rings with five or seven carbon atoms.			
d	I know that the first fullerene to be discovered was Buckminsterfullerene (C_{60}), which has a spherical shape.			
e	I know that carbon nanotubes are cylindrical fullerenes with very high length to diameter ratios and that their properties make them useful for nanotechnology, electronics and materials.			
f	I can recognise graphene and fullerenes from diagrams and descriptions of their bonding and structure.			
g	I can give examples of the uses of fullerenes, including carbon nanotubes.			

4.2.4. Bulk and Surface Properties of Matter including Nanoparticles (Chemistry Only)

4.2.4.1. Sizes of Particles and their Properties (Chemistry Only)

a	I know that nanoscience refers to structures that are 1–100 nm in size, of the order of a few hundred atoms.			
b	I know that nanoparticles, are smaller than fine particles (PM2.5), which have diameters between 100 and 2500 nm (1 x 10-7 m and 2.5 x 10-6 m).			
c	I know that coarse particles (PM10) have diameters between 1 x 10-5 m and 2.5 x 10-6 m and that they are often referred to as dust.			
d	I know that as the side of cube decreases by a factor of 10 the surface area to volume ratio increases by a factor of 10.			
e	I know that nanoparticles may have properties different from those for the same materials in bulk because of their high surface area to volume ratio.			
f	I know that smaller quantities of nanoparticles may be needed to be effective, than for materials with normal particle sizes.			
g	I can compare 'nano' dimensions to typical dimensions of atoms and molecules.			

4.2.4.2. Uses of Nanoparticles (Chemistry Only)

a	I know that nanoparticles have many applications in medicine, in electronics, in cosmetics and sun creams, as deodorants, and as catalysts.			
b	I know that new applications for nanoparticulate materials are an important area of research.			
c	I can describe the advantages and disadvantages of the applications of nanoparticulate materials.			
d	I can evaluate the use of nanoparticles for a specified purpose.			
e	I can explain that there are possible risks associated with the use of nanoparticles.			

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Unit 4.3 - Quantitative Chemistry

4.3.1. Chemical Measurements, Conservation of Mass and the Quantitative Interpretation of Chemical Equations

4.3.1.1. Conservation of Mass and Balanced Chemical Equations

a	I know that the law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants.			
b	I know that chemical reactions can be represented by symbol equations which are balanced in terms of the numbers of atoms of each element involved on both sides of the equation.			
c	I can use multipliers in equations in normal script before a formula and in subscript within a formula.			

4.3.1.2. Relative Formula Mass

a	I know that the relative formula mass (Mr) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula.			
b	I know that, in a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown.			

4.3.1.3. Mass Changes when a Reactant or Product is a Gas

a	I know that some reactions may appear to involve a change in mass but this can usually be explained because a reactant or product is a gas and its mass has not been taken into account.			
b	I can explain any observed changes in mass in non-enclosed systems during a chemical reaction given the balanced symbol equation for the reaction and explain these changes in terms of the particle model.			

4.3.1.4. Chemical Measurements

a	I can explain why, whenever a measurement is made, there is always some uncertainty about the result obtained.			
b	I can represent the distribution of results and make estimations of uncertainty and use the range of a set of measurements about the mean as a measure of uncertainty (e.g. range bars on graphs).			

4.3.2. Use of Amount of Substance in Relation to Masses of Pure Substances

4.3.2.1. Moles (HT Only)

a	I know that chemical amounts are measured in moles and that the symbol for the unit mole is mol.			
b	I know that the mass of one mole of a substance in grams is numerically equal to its relative formula mass.			
c	I know that the number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant. The value of the Avogadro constant is 6.02 x 1023 per mole.			
d	I know that one mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance.			
e	I can use the relative formula mass of a substance to calculate the number of moles in a given mass of that substance and vice versa.			

4.3.2.2. Amounts of Substances in Equations (HT Only)

a	I know that the masses of reactants and products can be calculated from balanced symbol equations.			
b	I know that chemical equations can be interpreted in terms of moles. For example: $Mg + 2HCI \longrightarrow MgCI_2 + H_2$ shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas.			
c	I can calculate the masses of reactants and products from the balanced symbol equation and the mass of a given reactant or product.			

4.3.2.3. Using Moles to Balance Equations (HT Only)

a	I know that the balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles to simple whole number ratios.			
b	I can balance an equation given the masses of reactants and products.			

4.3.2.4. Limiting Reactants (HT Only)

a	I know that, in a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used, and that the reactant that is completely used up is called the limiting reactant because it limits the amount of products.			
b	I can explain the effect of a limiting quantity of a reactant on the amount of products it is possible to obtain in terms of amounts in moles or masses in grams.			

4.3.2.5. Concentration of Solutions

a	I know that many chemical reactions take place in solutions and that the concentration of a solution can be measured in mass per given volume of solution, e.g. grams per dm^3 (g/dm^3).			
b	I can calculate the mass of solute in a given volume of solution of known concentration in terms of mass per given volume of solution.			
c	I can explain how the mass of a solute and the volume of a solution is related to the concentration of the solution (HT only)			

4.3.3. Yield and Atom Economy of Chemical Reactions (Chemistry Only)

4.3.3.1. Percentage Yield (Chemistry Only)

a	I know that, even though no atoms are gained or lost in a chemical reaction, it is not always possible to obtain the calculated amount of a product because: • the reaction may not go to completion because it is reversible; • some of the product may be lost when it is separated from the reaction mixture; • some of the reactants may react in ways different to the expected reaction.			
b	I know that the amount of a product obtained from a chemical reaction is known as the yield.			
c	I know that, when compared with the maximum theoretical amount as a percentage, it is called the percentage yield.			
d	I can calculate the percentage yield of a product from the actual yield of a reaction, using the equation: % Yield = (Mass of product actually made / Maximum theoretical mass of product) x100			
e	I can calculate the theoretical mass of a product from a given mass of reactant and the balanced equation for the reaction (HT Only).			

4.3.3.2. Atom Economy (Chemistry Only)

a	I know that atom economy (atom utilisation) is a measure of the amount of starting materials that end up as useful products.			
b	I know that atom economy is important for sustainable development and for economic reasons to use reactions with high atom economy.			
c	I can calculate the percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows: $\text{Atom economy} = \dfrac{\text{Relative formula mass of desired product from equation} \times 100}{\text{Sum of relative formula masses of all reactants from equation}}$			
d	I can explain why a particular reaction pathway is chosen to produce a specified product given appropriate data such as atom economy (if not calculated), yield, rate, equilibrium position and usefulness of by-products (HT Only).			

4.3.4. Using Concentration of Solutions in mol/dm³ (Chemistry Only) (HT Only)

a	I know that the concentration of a solution can be measured in mol/dm^3.			
b	I know that the amount in moles of solute (or the mass in grams of solute) in a given volume of solution can be calculated from its concentration in mol/dm^3.			
c	I know that if the volumes of two solutions that react completely are known and the concentration of one solution is known, the concentration of the other solution can be calculated.			
d	I can explain how the concentration of a solution in mol/dm^3 is related to the mass of the solute and the volume of the solution.			

4.3.5. Use of Amount of Substance in Relation to Volumes of Gases (Chemistry Only) (HT Only)

a	I know that equal amounts in moles of gases occupy the same volume under the same conditions of temperature and pressure.			
b	I know that the volume of one mole of any gas at room temperature and pressure (20^oC and 1 atmosphere pressure) is 24 dm^3.			
c	I can calculate the volume of a gas at room temperature and pressure from its mass and relative formula mass.			
d	I can calculate volumes of gaseous reactants and products from a balanced equation and a given volume of a gaseous reactant or product.			

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Unit 4.4 - Chemical Changes

4.4.1. Reactivity of Metals

4.4.1.1. Metal Oxides

a	I know that metals react with oxygen to produce metal oxides and that the reactions are called oxidation reactions because the metals gain oxygen.			
b	I can explain reduction and oxidation in terms of loss or gain of oxygen.			

4.4.1.2. Reactivity Series

a	I know that when metals react with other substances the metal atoms form positive ions and that the reactivity of a metal is related to its tendency to form positive ions.			
b	I know that metals can be arranged in order of their reactivity in a reactivity series.			
c	I know that the non-metals hydrogen and carbon are often included in the reactivity series.			
d	I can recall and describe the reactions, if any, of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids and where appropriate, place these metals in order of reactivity.			
e	I can explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion.			
f	I know that a more reactive metal can displace a less reactive metal from a compound.			
g	I can deduce an order of reactivity of metals based on experimental results.			

4.4.1.3. Extraction of Metals and Reduction

a	I know that 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.			
b	I know that metals less reactive than carbon can be extracted from their oxides by reduction with carbon and that reduction involves the loss of oxygen.			
c	I can identify the substances which are oxidised or reduced in terms of gain or loss of oxygen.			
d	I can interpret and evaluate specific metal extraction processes when given appropriate information.			

4.4.1.4. Oxidation and Reduction in Terms of Electrons (HT only)

a	I know that oxidation is the loss of electrons and reduction is the gain of electrons (OILRIG).			
b	I can write ionic equations for displacement reactions.			
c	I can identify in a given reaction, symbol equation or half equation which species are oxidised and which are reduced.			

4.4.2. Reactions of Acids

4.4.2.1. Reactions of Acids with Metals

a	I know that acids react with some metals to produce salts and hydrogen.			
b	I can explain in terms of gain or loss of electrons, that these are redox reactions (HT only).			
c	I can identify which species are oxidised and which are reduced in given chemical equations (HT only).			

4.4.2.2. Neutralisation of Acids and Salt Production

a	I know that acids are neutralised by alkalis (e.g., soluble metal hydroxides) and bases (e.g., insoluble metal hydroxides and metal oxides) to produce salts and water, and by metal carbonates to produce salts, water and carbon dioxide.			
b	I know that 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) and the positive ions in the base, alkali or carbonate.			
c	I can use the formulae of common ions to deduce the formulae of salts.			

4.4.2.3. Soluble Salts

a	I can describe how soluble salts can be made from acids by reacting them with solid insoluble substances, such as metals, metal oxides, hydroxides or carbonates (the solid is added to the acid until no more reacts and the excess solid is filtered off to produce a solution of the salt).			
b	I can describe how salt solutions can be crystallised to produce solid salts.			
c	I can describe how to make pure, dry samples of named soluble salts from information provided.			

4.3.2.4. Limiting Reactants (HT Only)

a	I know that acids produce hydrogen ions (H^+) in aqueous solutions whilst aqueous solutions of alkalis contain hydroxide ions ($OH-$).			
b	I know that 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.			
c	I can describe the use of universal indicator or a wide range indicator to measure the approximate pH of a solution and use the pH scale to identify acidic or alkaline solutions.			
d	I know that a solution with pH 7 is neutral, aqueous solutions of acids have pH values of less than 7 and aqueous solutions of alkalis have pH values greater than 7.			
e	I know that, in neutralisation reactions between an acid and an alkali, hydrogen ions react with hydroxide ions to produce water. This reaction can be represented by the equation: $H+(aq) + OH^-(aq) \rightarrow H_2O(I)$			

4.4.2.5. Titrations (Chemistry Only)

a	I know that the volumes of acid and alkali solutions that react with each other can be measured by titration using a suitable indicator.			
b	I can describe how to carry out titrations using strong acids and strong alkalis only (sulfuric, hydrochloric and nitric acids only) to find the reacting volumes accurately.			
c	I can calculate the chemical quantities in titrations involving concentrations in mol/dm^3 and in g/dm^3 (HT Only).			

4.4.2.6. Strong and Weak Acids (HT Only)

a	I know that a strong acid is completely ionised in aqueous solution. Examples of strong acids are: hydrochloric, nitric and sulfuric acids.			
b	I know that a weak acid is only partially ionised in aqueous solution. Examples of weak acids are: ethanoic, citric and carbonic acids.			
c	I know that, for a given concentration of aqueous solutions, the stronger an acid, the lower the pH.			
d	I can 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.			
e	I know that as the pH decreases by one unit, the hydrogen ion concentration of the solution increases by a factor of 10.			
f	I can describe neutrality and relative acidity in terms of the effect on hydrogen ion concentration and the numerical value of pH (whole numbers only).			

4.4.3. Electrolysis

4.4.3.1. The Process of Electrolysis

a	I know that when an ionic compound is melted or dissolved in water, the ions are free to move about within the liquid or solution. These liquids and solutions are able to conduct electricity and are called electrolytes.			
b	I know that passing an electric current through electrolytes causes the ions to move to the electrodes. Positively charged ions move to the negative electrode (the cathode), and negatively charged ions move to the positive electrode (the anode). Ions are discharged at the electrodes producing elements. This process is called electrolysis.			
c	I can write and balance half equations for the reactions occurring at the electrodes during electrolysis (HT only).			

4.4.3.2. The Electrolysis of Molten Ionic Compounds

a	I know that when a simple ionic compound (eg lead bromide) is electrolysed in the molten state using inert electrodes, the metal (lead) is produced at the cathode and the non-metal (bromine) is produced at the anode.			
b	I can predict the products of the electrolysis of binary ionic compounds in the molten state.			

4.4.3.3. Using Electrolysis to Extract Metals

a	I know that metals can be extracted from molten compounds using electrolysis.			
b	I know that electrolysis is used if the metal is too reactive to be extracted by reduction with carbon or if the metal reacts with carbon and that large amounts of energy are used in the extraction process to melt the compounds and to produce the electrical current.			
c	I can describe how aluminium is manufactured by the electrolysis of a molten mixture of aluminium oxide and cryolite using carbon as the positive electrode (anode).			
d	I can explain why a mixture is used as the electrolyte and why the positive electrode must be continually replaced.			

4.4.3.4. Using Electrolysis of Aqueous Solutions

a	I know that the ions discharged when an aqueous solution is electrolysed using inert electrodes depend on the relative reactivity of the elements involved: • at the negative electrode (cathode), hydrogen is produced if the metal is more reactive than hydrogen; • at the positive electrode (anode), oxygen is produced unless the solution contains halide ions when the halogen is produced. This happens because in the aqueous solution water molecules break down producing hydrogen ions and hydroxide ions that are discharged.			
b	I can predict the products of the electrolysis of aqueous solutions containing a single ionic compound.			

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

a	I know that, during electrolysis, at the cathode (negative electrode), positively charged ions gain electrons and so the reactions are reductions.			
b	I know that, at the anode (positive electrode), negatively charged ions lose electrons and so the reactions are oxidations.			
c	I know that reactions at electrodes can be represented by half equations, for example: $2H^+ + 2e^- \rightarrow H_2$ and $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$ or $4OH^- - 4e^- \rightarrow O_2 + 2H_2O$			

AQA Chemistry GCSE Student Progress

Unit 4.5 - Energy Changes

4.5.1. Exothermic and Endothermic Reactions

4.5.1.1. Energy Transfer During Exothermic and Endothermic Reactions

a	I know that energy is conserved in chemical reactions.			
b	I know that 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.			
c	I can describe some everyday uses of exothermic reactions, including self-heating cans and hand warmers.			
d	I know that 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 hydrogen carbonate.			
e	I can describe some everyday uses of endothermic reactions, including sports injury packs.			
f	I can evaluate uses and applications of exothermic and endothermic reactions given appropriate information.			

4.5.1.2. Reaction Profiles

a	I know that chemical reactions can occur only when reacting particles collide with each other and with sufficient energy. The minimum amount of energy that particles must have to react is called the activation energy.			
b	I know that reaction profiles can be used to show the relative energies of reactants and products, the activation energy and the overall energy change of a reaction.			
c	I can 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 line to show the energy as the reaction proceeds.			
d	I can use reaction profiles to identify reactions as exothermic or endothermic.			
e	I know that the activation energy is the energy needed for a reaction to occur.			

4.5.1.3. The Energy Change of Reactions (HT only)

a	I know that, during a chemical reaction, energy must be supplied to break bonds in the reactants and energy is released when bonds in the products are formed.			
b	I know that the energy needed to break bonds and the energy released when bonds are formed can be calculated from bond energies.			
c	I know that the difference between the sum of the energy needed to break bonds in the reactants and the sum of the energy released when bonds in the products are formed is the overall energy change of the reaction.			
d	I know that in an exothermic reaction, the energy released from forming new bonds is greater than the energy needed to break existing bonds.			
e	I know that, in an endothermic reaction, the energy needed to break existing bonds is greater than the energy released from forming new bonds.			
f	I can calculate the energy transferred in chemical reactions using bond energies supplied.			

4.5.2. Chemical Cells and Fuel Cells (Chemistry Only)

4.5.2.1. Cells and Batteries (Chemistry Only)

a	I know that cells contain chemicals which react to produce electricity.			
b	I know that a simple cell can be made by connecting two different metals in contact with an electrolyte.			
c	I know that the voltage produced by a cell is dependent upon a number of factors including the type of electrode and electrolyte.			
d	I know that batteries consist of two or more cells connected together in series to provide a greater voltage.			
e	I know that in non-rechargeable cells and batteries the chemical reactions stop when one of the reactants has been used up and that alkaline batteries are non-rechargeable.			
f	I know that rechargeable cells and batteries can be recharged because the chemical reactions are reversed when an external electrical current is supplied.			
g	I can interpret data for relative reactivity of different metals and evaluate the use of cells.			
h	I can describe the safe and careful use of liquids.			

4.5.2.2. Fuel Cells (Chemistry Only)

a	I know that fuel cells are supplied by an external source of fuel (e.g. hydrogen) and oxygen or air and that the fuel is oxidised electrochemically within the fuel cell to produce a potential difference.			
b	I know that the overall reaction in a hydrogen fuel cell involves the oxidation of hydrogen to produce water.			
c	I can evaluate the use of hydrogen fuel cells in comparison with rechargeable cells and batteries.			
d	I can write the half equations for the electrode reactions in the hydrogen fuel cell (HT Only).			