

4.1.1 A simple model of the atom, symbols, relative atomic mass, electronic charge and isotopes

The historical development of atomic structure provides a good example of how scientific ideas and explanations have developed over time as new evidence emerges. The arrangement of elements in the modern periodic table can be explained in terms of atomic structure, which provides evidence for the model of a nuclear atom with electrons in energy levels.

Topic	Student Checklist	R	A	G
4.1.1 A simple model of the atom, symbols, relative atomic mass, electronic charge and isotopes	State that everything is made of atoms and recall what they are			
	Describe what elements and compounds are			
	State that elements and compounds are represented by symbols; and use chemical symbols and formulae to represent elements and compounds			
	Write word equations and balanced symbol equations for chemical reactions, including using appropriate state symbols			
	HT ONLY: Write balanced half equations and ionic equations			
	Describe what a mixture is			
	Name and describe the physical processes used to separate mixtures and suggest suitable separation techniques			
	Describe how the atomic model has changed over time due to new experimental evidence, inc discovery of the atom and scattering experiments (inc the work of James Chadwick)			
	Describe the difference between the plum pudding model of the atom and the nuclear model of the atom			
	State the relative charge of protons, neutrons and electrons and describe the overall charge of an atom			
	State the relative masses of protons, neutrons and electrons and describe the distribution of mass in an atom			
	Calculate the number of protons, neutrons and electrons in an atom when given its atomic number and mass number			
	Describe isotopes as atoms of the same element with different numbers of neutrons			
	Define the term relative atomic mass and why it takes into account the abundance of isotopes of the element			
	Calculate the relative atomic mass of an element given the percentage abundance of its isotopes			
Describe how electrons fill energy levels in atoms, and represent the electron structure of elements using diagrams and numbers				

Topic 2 - Bonding, structure and properties of matter

Chemists use theories of structure and bonding to explain the physical and chemical properties of materials. Analysis of structures shows that atoms can be arranged in a variety of ways, some of which are molecular while others are giant structures. Theories of bonding explain how atoms are held together in these structures. Scientists use this knowledge of structure and bonding to engineer new materials with desirable properties. The properties of these materials may offer new applications in a range of different technologies.

Topic	Student Checklist	R	A	G
4.2.1 Chemical bonds, ionic, covalent and metallic	Describe the three main types of bonds: ionic bonds, covalent bonds and metallic bonds in terms of electrostatic forces and the transfer or sharing of electrons			
	Describe how the ions produced by elements in some groups have the electronic structure of a noble gas and explain how the charge of an ion relates to its group number			
	Describe the structure of ionic compounds, including the electrostatic forces of attraction, and represent ionic compounds using dot and cross diagrams			
	Describe the limitations of using dot and cross, ball and stick, two and three-dimensional diagrams to represent a giant ionic structure			
	Work out the empirical formula of an ionic compound from a given model or diagram that shows the ions in the structure			
	Describe covalent bonds and identify different types of covalently bonded substances, such as small molecules, large molecules and substances with giant covalent structures			
	Represent covalent bonds between small molecules, repeating units of polymers and parts of giant covalent structures using diagrams			
	Draw dot and cross diagrams for the molecules of hydrogen, chlorine, oxygen, nitrogen, hydrogen chloride, water, ammonia and methane			
	Deduce the molecular formula of a substance from a given model or diagram in these forms showing the atoms and bonds in the molecule			
	Describe the arrangement of atoms and electrons in metallic bonds and draw diagrams the bonding in metals			
	4.2.2 How bonding and structure are related to the properties of substances	Name the three States of matter, identify them from a simple model and state which changes of state happen at melting and boiling points		
Explain changes of state using particle theory and describe factors that affect the melting and boiling point of a substance				
HT ONLY: Discuss the limitations of particle theory				
Recall what (s), (l), (g) and (aq) mean when used in chemical equations and be able to use them appropriately				
Explain how the structure of ionic compounds affects their properties, including melting and boiling points and conduction of electricity (sodium chloride structure only)				
Explain how the structure of small molecules affects their properties				
Explain how the structure of polymers affects their properties				
Explain how the structure of giant covalent structures affects their properties				
Explain how the structure of metals and alloys affects their properties, including explaining why they are good conductors				
Explain why alloys are harder than pure metals in terms of the layers of atoms				
Explain the properties of graphite, diamond and graphene in terms of their structure and bonding				
Describe the structure of fullerenes, and their uses, including Buckminsterfullerene and carbon nanotubes				
Compare the dimensions of nanoparticles to other particles and explain the effect of their surface area to volume ratio on their properties				
Discuss the applications of nanoparticles and their advantages and disadvantages, including uses in medicine, cosmetics, fabrics and the development of catalysts				

Topic 5 – Energy Changes

Understanding of chemical changes began when people began experimenting with chemical reactions in a systematic way and organising their results logically. Knowing about these different chemical changes meant that scientists could begin to predict exactly what new substances would be formed and use this knowledge to develop a wide range of different materials and processes. It also helped biochemists to understand the complex reactions that take place in living organisms. The extraction of important resources from the Earth makes use of the way that some elements and compounds react with each other and how easily they can be 'pulled apart'.

Topic	Student Checklist	R	A	G
4.4.1 Reactivity of metals	Describe how metals react with oxygen and state the compound they form, define oxidation and reduction			
	Describe the arrangement of metals in the reactivity series, including carbon and hydrogen, and use the reactivity series to predict the outcome of displacement reactions			
	Recall and describe the reactions, if any, of potassium, sodium, lithium, calcium, magnesium, zinc, iron and copper with water or dilute acids			
	Relate the reactivity of metals to its tendency to form positive ions and be able to deduce an order of reactivity of metals based on experimental results			
	Recall what native metals are and explain how metals can be extracted from the compounds in which they are found in nature by reduction with carbon			
	Evaluate specific metal extraction processes when given appropriate information and identify which species are oxidised or reduced			
4.4.2 Reactions of acids	HT ONLY: Describe oxidation and reduction in terms of loss and gain of electrons			
	HT ONLY: Write ionic equations for displacement reactions, and identify which species are oxidised and reduced from a symbol or half equation			
	HT ONLY: Explain in terms of gain or loss of electrons that the reactions between acids and some metals are redox reactions, and identify which species are oxidised and which are reduced (Mg, Zn, Fe + HCl & H₂SO₄)			
	Explain that acids can be neutralised by alkalis, bases and metal carbonates and list the products of each of these reactions			
	Predict the salt produced in a neutralisation reaction based on the acid used and the positive ions in the base, alkali or carbonate and use the formulae of common ions to deduce the formulae of the salt			
	Describe how soluble salts can be made from acids and how pure, dry samples of salts can be obtained			
	<i>Required practical 1: preparation of a pure, dry sample of a soluble salt from an insoluble oxide or carbonate using a Bunsen burner to heat dilute acid and a water bath or electric heater to evaporate the solution</i>			
	Recall what the pH scale measures and describe the scale used to identify acidic, neutral or alkaline solutions			
	Define the terms acid and alkali in terms of production of hydrogen ions or hydroxide ions (in solution), define the term base			
	Describe the use of universal indicator to measure the approximate pH of a solution and use the pH scale to identify acidic or alkaline solutions			
	<i>Describe how to carry out titrations using strong acids and strong alkalis only (sulfuric, hydrochloric and nitric acids to find the reacting volumes accurately</i>			
	HT ONLY: Calculate the chemical quantities in titrations involving concentrations in mol/dm³ and in g/dm³			
	<i>Required practical 2: determination of the reacting volumes of solutions of a strong acid and a strong alkali by titration</i>			
	HT ONLY: 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			

	HT ONLY: Explain how the concentration of an aqueous solution and the strength of an acid affects the pH of the solution and how pH is related to the hydrogen ion concentration of a solution			
4.4.3 Electrolysis	Describe how ionic compounds can conduct electricity when dissolved in water and describe these solutions as electrolytes			
	Describe the process of electrolysis			
	Describe the electrolysis of molten ionic compounds and predict the products at each electrode of the electrolysis of binary ionic compounds			
	Explain how metals are extracted from molten compounds using electrolysis and use the reactivity series to explain why some metals are extracted with electrolysis instead of carbon			
	Describe the electrolysis of aqueous solutions and predict the products of the electrolysis of aqueous solutions containing single ionic compounds			
	<i>Required practical 3: investigate what happens when aqueous solutions are electrolysed using inert electrodes</i>			
	HT ONLY: Describe the reactions at the electrodes during electrolysis as oxidation and reduction reactions and write balanced half equations for these reactions			