

Level	Atomic structure and the Periodic Table	Structure, Bonding and the properties of matter	Chemical changes	Energy changes in chemistry	The rate and extent of chemical changes	Chemical analysis	Chemicals and industry	Earth and Atmosphere
9	<p>a) Explain that quarks, leptons and their antiparticles make up all matter in the universe.</p> <p>b) Describe the four interactions that occur between fundamental particles</p>			<p>a) Calculate the energy released by nuclear and chemical reactions</p>	<p>a) recall that dynamic equilibrium occurs when the rates of forward and reverse reactions are equal</p>	<p>a) deduce the stoichiometry of an equation from the masses of reactants and products and explain the effect of a limiting quantity of a reactant</p>		<p>a) Analyse the interactions between and compositions of gases and fluids in the atmosphere and beneath the lithosphere in shaping the Earth in the past, present and future</p>
8	<p>a) Explain that protons, neutrons and electrons make up atoms, they are sub-atomic particles. Electrons are fundamental, protons and neutrons are made of quarks</p> <ul style="list-style-type: none"> • 	<p>a) explain how the properties of materials are related to the different types of bonds they contain, their bond strengths in relation to intermolecular forces and the ways in which their bonds are arranged.</p>	<p>a) describe neutrality and relative acidity and alkalinity in terms of the effect of the concentration of hydrogen ions on the numerical value of pH</p> <p>b) explain reduction and oxidation in terms of gain or loss of electrons, identifying which species are oxidised and which are reduced</p>	<p>a) Explain the relationship between mass and energy in nuclear reactions</p>	<p>a) predict the effect of changing reaction conditions (concentration, temperature and pressure) on equilibrium position and suggest appropriate conditions to produce a particular product.</p>	<p>a) explain how the mass of a solute and the volume of the solution is related to the concentration of the solution.</p>	<p>a) evaluate factors that affect decisions on recycling.</p> <p>b) evaluate alternative biological methods of metal extraction (bacterial and phytoextraction).</p>	<p>a) Explain that materials and compounds on Earth are formed mainly from the recycling of atoms present at the time of its formation through chemical reactions.</p> <p>b) describe the potential effects of increased levels of carbon dioxide and methane on the Earth's climate and how these effects may be mitigated, including consideration of scale, risk and environmental implications</p>
7	<p>a) Compare different models of the atom and explain the evidence for the structure they suggest</p> <p>b) Describe how and why the atomic model has changed over time.</p>	<p>a) use ideas about energy transfers and the relative strength of chemical bonds and intermolecular forces to explain the different temperatures at which changes of state occur</p> <p>b) explain that natural and synthetic organic compounds occur due to the ability of carbon to form families of</p>	<p>a) explain reduction and oxidation in terms of loss or gain of oxygen, identifying which species are oxidised and which are reduced</p>	<p>a) Explain that nuclear reactions release energy in the form of heat by converting mass into energy while chemical reactions release energy making and breaking bonds.</p>	<p>a) calculate energy changes in a chemical reaction by considering bond making and bond breaking energies.</p>	<p>a) calculate relative formula masses of species separately and in a balanced chemical equation.</p> <p>b) recall and use the definitions of the Avogadro constant (in standard form) and of the mole</p>	<p>a) describe a process where a material or product is recycled for a different use, and explain why this is viable</p> <p>b) explain why and how electrolysis is used to extract some metals from their ores</p>	<p>a) Explain hypotheses and evidence about the long term impact of human activity on the climate.</p> <p>b) evaluate the evidence for additional anthropogenic causes of climate change, including the correlation between change in atmospheric carbon dioxide concentration and</p>

		similar compounds, chains and rings						the consumption of fossil fuels, and describe the uncertainties in the evidence base c) describe the principal methods for increasing the availability of potable water in terms of the separation techniques used, including ease of treatment of waste, ground and salt water.
6	<p>a) Explain the properties of isotopes and the processes that they are involved in</p> <p>b) Explain, in terms of Isotopes, how this changes the arrangement proposed by Mendeleev.</p>	<p>a) Explain the limitations of the particle model in relation to changes of state.</p> <p>b) explain the properties of diamond, graphite, fullerenes and graphene in terms of their structures and bonding</p>	<p>a) use the names and symbols of common elements and compounds and the principle of conservation of mass to write formulae and balanced chemical equations and half equations</p> <p>b) Explain that hydrogen ion concentration increases by a factor of ten the pH value of a solution decreases by a factor of one</p> <p>c) describe competing reactions in the electrolysis of aqueous solutions of ionic compounds in terms of the different species present</p>	<p>a) draw and label a reaction profile for an exothermic and an endothermic reaction, identifying activation energy</p>	<p>a) explain catalytic action in terms of activation energy</p> <p>b) recall that some reactions may be reversed by altering the reaction conditions</p>	<p>a) explain any observed changes in mass in non-enclosed systems during a chemical reaction and explain them using the particle model</p> <p>b) explain how the mass of a given substance is related to the amount of that substance in moles</p> <p>c) use a balanced equation to calculate masses of reactants or products</p>	<p>a) interpret data from a life-cycle assessment of a material or product</p> <p>b) describe the production of materials that are more useful by cracking.</p>	<p>a) Explain the processes involved in the formation of the Earth's atmosphere allowing it to support life since the Pre-Cambrian epoch.</p> <p>b) describe the greenhouse effect in terms of the interaction of radiation with matter</p> <p>c) describe the major sources of carbon monoxide, sulphur dioxide, oxides of nitrogen and particulates in the atmosphere and explain the problems caused by increased amounts of these substances</p>
5	<p>a) Describe the structure of the atom including the size, relative charges and relative masses of its constituent parts</p> <p>b) Describe how the atomic model was created.</p>	<p>c) describe and compare the nature and arrangement of chemical bonds in ionic compounds, simple molecules, giant covalent structures, polymers and metals</p> <p>d) Explain processes of energy transfer</p>	<p>a) Calculate the empirical formula of a compound from the relative numbers of atoms present</p> <p>b) recall that acids react with some metals and with carbonates and write equations</p>	<p>a) explain activation energy as the energy needed for a reaction to occur</p>	<p>a) interpret rate of reaction graphs</p> <p>b) explain the effects on rates of reaction of changes in temperature, concentration and pressure in terms of frequency and energy of collision between particles</p>	<p>a) describe and explain the processes of filtration, crystallisation, simple distillation, and fractional distillation</p> <p>b) recall and use the law of conservation of mass</p>	<p>a) describe the basic principles in carrying out a life-cycle assessment of a material or product</p> <p>b) describe the fractions as largely a mixture of compounds of formula C_nH_{2n+2}</p>	<p>a) Explain how the composition and properties of the Earth and its atmosphere changes from the core to the height of 100km, and how materials are cycled within them.</p> <p>b) describe how it is</p>

		by heating and cooling in terms of the motion and arrangement of molecules	<p>predicting products from given reactants</p> <p>c) explain how the reactivity of metals with water or dilute acids is related to the tendency of the metal to form its positive ion</p> <p>d) describe electrolysis in terms of the ions present and reactions at the electrodes</p>				<p>which are members of the alkane homologous series</p> <p>c) explain, using the position of carbon in the reactivity series, the principles of industrial processes used to extract metals, including extraction of a non-ferrous metal</p>	thought an oxygen-rich atmosphere developed over time.
4	<p>a) Explain the different ways in which atoms can be bonded to form chemical compounds</p> <p>b) Explain how reactions of elements are related to the arrangement of electrons.</p>	<p>a) Explain the processes and conditions involved in the formation of natural and synthetic materials relating their structure to their properties and applications</p> <p>b) construct dot and cross diagrams for simple ionic and covalent substances</p>	<p>a) use the formulae of common ions to deduce the formula of a compound and write balanced ionic equations</p> <p>b) describe the physical states of products and reactants using state symbols (s, l, g and aq).</p>	a) distinguish between endothermic and exothermic reactions on the basis of the temperature change of the surroundings	<p>a) describe the effect of changes in temperature, concentration, pressure, and surface area on rate of reaction</p> <p>b) describe the characteristics of catalysts and their effect on rates of reaction</p>	<p>a) explain what is meant by the purity of a substance, distinguishing between the scientific and everyday use of the term 'pure'</p> <p>b) use melting point data to distinguish pure from impure substances</p>	a) describe and explain the separation of crude oil by fractional distillation	a) Explain the processes and conditions involved in the formation of different Earth materials
3	<p>a) compare the trends in Group 0 with those of Group 1 and Group 7 elements</p> <p>b) Recall relative charges and relative mass of protons, neutrons and electrons</p> <p>c) Complete the electronic configuration</p> <p>d) Explain how simple properties related to the outside the shell.</p>	<p>a) Explain how chromatography can be used in different scenarios.</p> <p>b) Compare different separation techniques and explain which is best and why.</p> <p>c) recall that carbon can form four covalent bonds</p>	<p>a) Explain the composition of common chemical molecules and how different molecules react</p> <p>b) use chemical symbols to write the formulae of elements and simple covalent and ionic compounds</p> <p>c) describe tests to identify selected gases including oxygen, hydrogen, carbon dioxide and chlorine.</p>	a) describe the characteristics of exothermic and endothermic changes	a) recall that enzymes act as catalysts in biological systems.			<p>a) Classify different Earth materials and describe the conditions and processes that produced them</p> <p>b) interpret evidence for how it is thought the atmosphere was originally formed</p>
2	<p>a) calculate formula masses for compounds</p> <p>b) write word equations to represent</p>	<p>a) Explain how chromatography separates mixtures.</p> <p>b) Compare evaporation and distillation</p>	a) Explain chemical reactions as processes where atoms in compounds are rearranged to form	a) state simply what happens in endothermic and exothermic changes		a) Analyse chromatograms to identify substances in mixtures – including R _f values.	<p>a) explain why properties of ceramics make them suitable for their uses.</p> <p>b) explain how</p>	a) Describe the composition of the atmosphere at the Earth's surface and explain how it supports life

	<p>displacement reactions</p> <p>c) link information about Group 0 elements to their properties</p>	<p>c) Explain changes of state in terms of particle models</p>	<p>new compounds</p> <p>b) explain, using particle models, the differences between evaporation and boiling</p> <p>c) describe in detail what happens to particles in a chemical reaction</p>				<p>polymer properties make them suitable for their uses</p> <p>c) explain why composite properties make them suitable for their uses</p>	<p>b) Describe how the structure of the Earth leads to dynamic conditions at the surface.</p>
1	<p>a) write and interpret formulae</p> <p>b) calculate the percentage of a given element within a compound</p> <p>c) Explain why a compound has different properties to the elements in it.</p> <p>d) describe patterns in the properties of Group 1 elements using data given</p> <p>e) describe displacement reactions</p>	<p>a) Explain how particles diffuse in liquids and gases</p> <p>b) State what happens to mixtures when they undergo different separation techniques.</p> <p>c) Explain how to identify pure and impure substances</p>	<p>a) use a particle model to explain evaporating, condensing, and subliming</p> <p>b) explain the differences in physical and chemical changes</p> <p>c) describe what happens to atoms in chemical reactions</p>	<p>a) identify a reaction as endothermic and exothermic</p>		<p>a) explain how chromatography separates mixtures</p>	<p>a) Explain how distillation works</p> <p>b) state some properties of composite materials</p>	<p>a) Describe the different layers of the Earth</p> <p>b) Describe different Earth materials using their physical properties</p>
E3	<p>a) Describe how particles are arranged in elements, mixtures and compounds, and how they behave.</p> <p>b) identify substances that are elements, giving a simple reason for my answer</p> <p>c) write the chemical names for some simple compounds</p> <p>d) compare patterns in properties in the groups and periods of the Periodic Table.</p> <p>e) describe the reactivity of Group 0</p>	<p>a) Describe what happens during dissolving.</p> <p>b) State that particles spread by diffusion</p>	<p>a) describe what happens to atoms in chemical reactions</p> <p>b) compare chemical reactions to physical changes</p> <p>c) identify reactants and products in word equations</p> <p>d) predict products of combustion reactions</p>			<p>a) Describe what a Chromatogram looks like</p>	<p>a) state the definition of a polymer and some uses.</p> <p>b) State some uses of ceramics</p>	

	elements f) Explain the patterns and trends seen in periods and groups of the periodic table							
E2	a) list the properties of some elements b) state what a compound is c) explain how elements are classified as metals and non-metals	a) Describe observations of physical and chemical changes when things are heated and cooled. b) State that different substances in mixtures have their own melting points	a) state some signs of a chemical reaction b) state what happens to the reactants in a chemical reaction					
E1	a) Place materials into groups by their physical properties based on observations	a) Place materials into groups by their physical properties based on observations b) Place materials into groups based on solid, liquids and gases						