

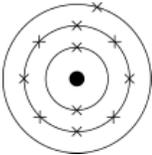
Spec ref.  Chem	Summary of the specification content	Learning outcomes <i>What most candidates should be able to do</i>	Suggested timing (hours)	Opportunities to develop Scientific Communication skills	Opportunities to develop and apply practical and enquiry skills	Self/peer assessment opportunities and resources <i>Reference to past questions that indicate success</i>	Key pieces of assessed work	Key pieces of assessed work
4.1.1.1	<p>All substances are made of atoms. An atom is the smallest part of an element that can exist.</p> <p>Atoms of each element are represented by a chemical symbol, eg 'O' represents an atom of oxygen.</p> <p>There are about 100 different elements.</p> <p>Elements are shown in the periodic table.</p> <p>Compounds are formed from elements by chemical reactions. Chemical reactions always involve the formation of one or more new substances, and often involve a detectable energy change.</p> <p>Compounds contain two or more elements chemically</p>	<p>Use the names and symbols of the first 20 elements in the periodic table, the elements in Groups 1 and 7, and other elements in this specification.</p> <p>Name compounds of these elements from given formulae or symbol equations.</p> <p>Write word equations for the reactions in this specification.</p>	2	<p>Define an atom and element.</p> <p>Use scientific conventions to identify chemical symbols.</p> <p>Use scientific conventions to identify elements by chemical symbols.</p> <p>Define a compound.</p> <p>Write word equations for reactions from practical activities stated in the specification. Develop skills to communicate through use of symbolic</p>				

	<p>combined in fixed proportions and can be represented by formulae using the symbols of the atoms from which they were formed. Compounds can only be separated into elements by chemical reactions.</p> <p>Chemical reactions can be represented by word equations or equations using symbols and formulae.</p>	<p>Write formulae and balanced chemical equations for the reactions in this specification.</p> <p>(HT only) write balanced half equations and ionic equations where appropriate.</p>		<p>equations. Apply these skills to write balanced symbol equations for equations met in practical activities.</p> <p><b>Extended writing</b> Describe word, formulae and balanced chemicals equations.</p>				
4.1.1.2	<p>A mixture consists of two or more elements or compounds not chemically combined together. The chemical properties of each substance in the mixture are unchanged.</p> <p>Mixtures can be separated by physical processes such as filtration, crystallisation, simple distillation, fractional distillation and chromatography. These physical processes do not involve chemical reactions and no new substances are made.</p>	<p>Describe, explain and give examples of the specified processes of separation.</p> <p>Suggest suitable separation and purification techniques for mixtures when given appropriate information.</p>	2	<p>Define a mixture.</p> <p><b>Extended writing</b> Describe each practical technique of separating mixtures. Explain how chromatography, distillation and filtration practical techniques occur.</p> <p><b>High demand</b> Explain why crystallisation happens.</p>	<p>Model mixtures.</p> <p>WS 2.2, 2.3, 4.1</p> <p>Carry out chromatography techniques using sweets or felt tip pens.</p> <p>Demo distillation of citrus peel.</p> <p>Carry out crystallisation using salol. Carry out filtration and evaporation of sea water. Show that mineral waters are not 'pure' in the scientific sense.</p>	<p>Video clip: <a href="#">BBC Bitesize – Mixtures and compounds</a></p>		

4.1.1.3	<p>New experimental evidence may lead to a scientific model being changed or replaced.</p> <p>Before the discovery of the electron, atoms were thought to be tiny spheres that could not be divided.</p> <p>The discovery of the electron led to the plum-pudding model of the atom. The plum-pudding model suggested that the atom was a ball of positive charge with negative electrons embedded in it.</p> <p>The results from the alpha particle scattering experiment led to the plum-pudding model being replaced by the nuclear model.</p> <p>Niels Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations.</p> <p>Later experiments led to the idea that the positive charge of any nucleus could be subdivided into a whole number of smaller particles,</p>						Research the development of the atom.	

	<p>each particle having the same amount of positive charge. The name proton was given to these particles.</p> <p>The experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus.</p>															
4.1.1.4	<p>The relative electrical charge of particles in atoms is:</p> <table border="1" data-bbox="147 587 434 756"> <thead> <tr> <th>Name of particle</th> <th>Relative charge</th> </tr> </thead> <tbody> <tr> <td>Proton</td> <td>+1</td> </tr> <tr> <td>Neutron</td> <td>0</td> </tr> <tr> <td>Electron</td> <td>-1</td> </tr> </tbody> </table> <p>In an atom, the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge.</p> <p>The number of protons in an atom of an element is its atomic number. All atoms of a particular element have the same number of protons. Atoms of different elements have different numbers of protons.</p>	Name of particle	Relative charge	Proton	+1	Neutron	0	Electron	-1	<p>Recall the different charges of the particles that make up an atom.</p> <p>Describe why atoms have no overall charge.</p> <p>Recall what atomic number represents.</p> <p>Use the periodic table to identify the number of protons in different elements.</p>	0.5	<p>Recall structure of atom and the charges of each particle (KS3).</p> <p>Using examples from the first 20 elements on the periodic table, students read off and work out the number of each charge different elements have.</p> <p>Describe the relationship between number of positive and negative charges. Apply this relationship to explain why there is no overall charge.</p> <p>Referring to their table of data, students write their rules to state what the atomic number is and why elements are different from each other.</p>	<p>Designing an appropriate table to display data on atomic numbers and number of atomic particles in different elements.</p>	<p>Explain to each other what atomic structure means, and why atoms have no overall charge.</p>	<p>Atomic Structure questions 1</p> <p>Extension; Atomic Structure questions 2</p> <p>Atomic Structure questions 3</p>	
Name of particle	Relative charge															
Proton	+1															
Neutron	0															
Electron	-1															

<p>4.1.1.5</p>	<p>Atoms are very small, having a radius of about 0.1 nm (<math>1 \times 10^{-10}</math> m).</p> <p>The radius of a nucleus is less than 1/10 000 of that of the atom (about <math>1 \times 10^{-14}</math> m).</p> <p>Most of the mass of an atom is in the nucleus.</p> <p>The relative masses of protons, neutrons and electrons are:</p> <table border="1" data-bbox="147 619 490 790"> <thead> <tr> <th>Name of particle</th> <th>Relative mass</th> </tr> </thead> <tbody> <tr> <td>Proton</td> <td>1</td> </tr> <tr> <td>Neutron</td> <td>1</td> </tr> <tr> <td>Electron</td> <td>Very small</td> </tr> </tbody> </table> <p>The sum of the protons and neutrons in an atom is its mass number.</p> <p>Atoms of the same element can have different numbers of neutrons; these atoms are called isotopes of that element.</p> <p>Atoms can be represented as shown in this example:</p> <p>(Mass no.) 23  <math>\text{Na}</math>  (Atomic no.) 11</p>	Name of particle	Relative mass	Proton	1	Neutron	1	Electron	Very small	<p>Describe the structure of the atom.</p> <p>Details of energy levels and line spectra are <b>not</b> required.</p> <p>Calculate the numbers of protons, neutrons and electrons in an atom or ion, given its atomic number and mass number for the first 20 elements.</p> <p>Be able to relate size and scale of atoms to objects in the physical world.</p>	<p>0.5</p>	<p><b>Extended writing</b>  Describe the structure of atoms.</p>	<p>Model atoms (using physical models or computer simulations).</p> <p>WS 4.3, 4.4  Ma 1b</p>	<p>Video clip:  <a href="#">BBC Bitesize – Atomic structure</a></p> <p>Video clip:  <a href="#">BBC Bitesize –How mass and atomic numbers explain atomic structure</a></p> <p>YouTube:  <a href="#">Atomic Number and Mass Number</a></p>	
Name of particle	Relative mass														
Proton	1														
Neutron	1														
Electron	Very small														

4.1.1.6	<p>The relative atomic mass of an element is an average value that takes account of the abundance of the isotopes of the element.</p>	<p>Students should be able to calculate the relative atomic mass of an element given the percentage abundance of its isotopes.</p>	0.5			<p>YouTube: <a href="#">Relative Atomic Mass</a></p>	<p>Past paper question 4 specimen paper 1 set 2</p>
4.1.1.7	<p>The electrons in an atom occupy the lowest available energy levels (innermost available shells).</p> <p>The electronic structure of an atom can be represented by numbers or by a diagram.</p> <p>For example, the electronic structure of sodium is 2,8,1 or</p>  <p>showing two electrons in the lowest energy level, eight in the second energy level and one in the third energy level.</p>	<p>Students should be able to represent the electronic structures of the first twenty elements of the periodic table in both forms.</p> <p>Students may answer questions in terms of either energy levels or shells.</p>	0.5	<p>Describe how many electrons there can be in the first, second and third energy shells.</p>	<p>Role play – using students to represent protons, neutrons and electrons, build up the idea of full and complete energy shells with 2 in the first, 8 in the second and 8 in the third energy shell.</p> <p>WS 1.2 Ma 5b</p>	<p>YouTube: <a href="#">Energy Levels and Electron Configuration</a></p> <p>YouTube: <a href="#">Drawing electron configuration diagrams</a></p>	
4.1.2.1	<p>The elements in the periodic table are arranged in order of atomic (proton) number and so that elements with similar properties are in columns, known as groups. The table is called a periodic table because</p>	<p>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.</p> <p>Predict possible reactions and probable reactivity of</p>	0.5	<p>Identify link between electron configuration and the structure of the periodic table for elements 1 to 20. Identify anomalies.</p>		<p>Video clip: <a href="#">BBC Bitesize – Groups and periods in the periodic table</a></p> <p>YouTube:</p>	

	<p>similar properties occur at regular intervals.</p> <p>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.</p>	<p>elements from their positions in the periodic table.</p>				<p><a href="#">How the elements are laid out in the periodic table</a></p> <p>YouTube: <a href="#">Mendeleev and the Periodic Table</a></p>	
4.1.2.2	<p>Before the discovery of protons, neutrons and electrons scientists attempted to classify the elements by arranging them in order of their atomic weights.</p> <p>The early periodic tables were incomplete and some elements were placed in inappropriate groups if the strict order of atomic weights was followed.</p> <p>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.</p> <p>Elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the</p>	<p>Describe these steps in the development of the periodic table.</p> <p>Describe and explain how testing a prediction can support or refute a new scientific idea.</p>	0.5	<p>Create a timeline for the history of the periodic table.</p> <p><b>Extended writing</b> Describe the differences between the early Periodic tables and our current Periodic table. Explain why the Periodic table has changed throughout the years.</p>	WS1.1	<p><a href="#">Dynamic Periodic Table</a></p> <p>or</p> <p><a href="#">Royal Society of Chemistry – Periodic Table (interactive)</a></p> <p>University of Nottingham – <a href="#">The Periodic Table of Videos</a></p>	<p><a href="#">Question 1 specimen paper 1 set 2</a></p>

	order based on atomic weights was not always correct.						
4.1.2.3	<p>Elements that react to form positive ions are metals.</p> <p>Elements that do not form positive ions are non-metals.</p> <p>The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table.</p> <p>Non-metals are found towards the right and top of the periodic table.</p>	<p>Explain the differences between metals and non-metals on the basis of their characteristic physical and chemical properties.</p> <p>Explain how the atomic structure of metals and non-metals relates to their position in the periodic table.</p> <p>Explain how the reactions of elements are related to the arrangement of electrons in their atoms and hence to their atomic number.</p>	0.5				
4.1.2.4	The elements in Group 0 of the periodic table are called the noble gases. They are unreactive and do not easily form molecules because their	Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms.	0.5	<b>Extended writing</b> Describe the trends in properties in Group 0. Explain how properties of the elements in Group		YouTube: <a href="#">Noble gases – the gases in group 18</a>	

	<p>atoms have stable arrangements of electrons.</p> <p>The noble gases have eight electrons in their outer energy level, except for helium, which has only two electrons.</p> <p>The boiling points of the noble gases increase with increasing relative atomic mass (going down the group).</p>	<p>Predict properties from given trends down the group.</p>		<p>0 depend on the outer shell of electrons of the atoms.</p> <p><b>High demand</b> Explain the trends in Group 0.</p>			
4.1.2.5	<p>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.:</p> <p>In Group 1, the reactivity of the elements increases going down the group.</p>	<p>Describe the reactions of the first three alkali metals with oxygen, chlorine and water.</p> <p>Explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms.</p> <p>Predict properties from given trends down the group.</p>	0.5	<p><b>Extended writing</b> Describe the trends in properties in Group 1. Explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms.</p> <p><b>High demand</b> Explain the trends in Group 1.</p>	<p>Demo reactivity of Na, Li and K in water with universal indicator. Predict reactions for Rb, Cs and Fr.</p>	<p>Video clip: <a href="#">BBC Bitesize –Alkali metals and their reactions to air and water</a></p> <p>YouTube: <a href="#">Group 1 as an example of Groups in the periodic table</a></p>	

						YouTube: <a href="#">Alkali metals in water, accurate!</a>	
4.1.2.6	<p>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. The halogens are non-metals and consist of molecules made of pairs of atoms.</p> <p>In Group 7, the further down the group an element is, the higher its relative molecular mass, melting point and boiling point.</p> <p>In Group 7, the reactivity of the elements decreases going down the group.</p> <p>A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.</p>	<p>Describe the nature of the compounds formed when chlorine, bromine and iodine react with metals and non-metals.</p> <p>Explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms.</p> <p>Predict properties from given trends down the group.</p>	0.5	<p><b>Extended writing</b> Describe the trends in properties in Group 7. Explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms.</p> <p><b>High demand</b> Explain the trends in Group 7.</p>	<p>Demonstrate the reactions of chlorine, bromine and iodine with iron wool.</p> <p>Carry out displacement reactions using KCl, KBr, KI with waters of the corresponding halogens.</p> <p>Write word and balanced symbol equations for all reactions in the displacement practical.</p>	<p>Video clip: <a href="#">BBC Bitesize – Reactivity of group 1 and 7 elements</a></p> <p>YouTube: <a href="#">Halogens</a></p>	<p>Question booklet Periodic Table 2</p> <p>Extension; Question booklet Periodic Table 1 Question booklet Periodic Table 3 Question booklet Periodic Table 4</p>
4.1.3.1	The transition elements are metals with similar properties which are different from	Describe the difference compared with Group 1 in melting points, densities, strength, hardness and	0.5	<p><b>Extended writing</b> Describe the properties of Cr, Mn, Fe, Co, Ni, Cu.</p>	Research the properties and uses of Cr, Mn, Fe, Co, Ni and Cu.	YouTube: <a href="#">GCSE Science Revision</a>	Past paper question 2 specimen paper 1 set 1

	those of the elements in Group 1.	<p>reactivity with oxygen, water and halogens.</p> <p>Exemplify these general properties by reference to Cr, Mn, Fe, Co, Ni, Cu.</p>		Explain the links between properties of transition metals with their common uses.		<p>YouTube:  <a href="#">The Transition Metals Song</a></p>	
4.1.3.2	Many transition elements have ions with different charges form coloured compounds and are useful as catalysts.	Exemplify these general properties by reference to compounds of Cr, Mn, Fe, Co, Ni, Cu.	0.5	<p>Describe the properties of Cr, Mn, Fe, Co, Ni and Cu.</p> <p><b>High demand</b>  Give reasons why transition metals have ions with different charges.</p>	<p>Carry out flame tests for common metals.</p> <p>This topic can be used in the development of the following mathematical skills:  1b Recognise expressions in standard form.  5b Visualise and represent 2D and 3D forms including two dimensional representations of 3D objects.</p>		TEST
4.10.1.1	<p>Humans use the Earth's resources to provide warmth, shelter, food and transport.</p> <p>Natural resources, supplemented by agriculture, provide food, timber, clothing and fuels.</p>	State examples of natural products that are supplemented or replaced by agricultural and synthetic products.	1	<p>Define the terms:</p> <ul style="list-style-type: none"> <li>• finite</li> <li>• renewable.</li> </ul> <p>Explain the differences between the two terms using suitable examples.</p>	Research examples of natural products that are supplemented or replaced by agricultural and synthetic products.		Past paper question 2 specimen paper 2 set 2

	<p>Finite resources from the Earth, oceans and atmosphere are processed to provide energy and materials.</p> <p>Chemistry plays an important role in improving agricultural and industrial processes to provide new products. It's also important in sustainable development, which is development that meets the needs of current generations without compromising the ability of future generations to meet their own needs.</p>	<p>Distinguish between finite and renewable resources given appropriate information.</p> <p>Extract and interpret information about resources from charts, graphs and tables.</p> <p>Use orders of magnitude to evaluate the significance of data.</p> <p>WS 3.2</p> <p>MS 2c, 2h, 4a</p>					
4.10.1.2	<p>Water of appropriate quality is essential for life. For humans, drinking water should have sufficiently low levels of dissolved salts and microbes. Water that is safe to drink is called potable water. Potable water is not pure water in the chemical sense because it contains dissolved substances.</p> <p>The methods used to produce potable water depend on</p>	<p>Distinguish between potable water and pure water.</p> <p>Describe the differences in treatment of ground water and salty water.</p> <p>Give reasons for the steps used to produce potable water.</p> <p>WS 2.3, 2.4, 2.5, 2.6, 2.7</p>	2	<p>Define the terms:</p> <ul style="list-style-type: none"> <li>• potable water</li> <li>• pure water.</li> </ul> <p>Explain the differences between the two terms.</p> <p>Extended writing: describe the process of desalination.</p>	<p><b>Required practical 8:</b></p> <p>Analysis and purification of water samples from different sources, including pH, dissolved solids and distillation.</p>	<p>Video clip</p> <p>YouTube: <a href="#">UTEK – Potable Water Generator</a></p> <p>Resources for schools - <a href="#">Thames Water Tools for Schools</a></p> <p><a href="#">Exampro user guide PowerPoint</a></p>	

	<p>available supplies of water and local conditions.</p> <p>In the UK, rain provides water with low levels of dissolved substances (fresh water) that collects in the ground, in lakes and rivers, and most potable water is produced by:</p> <ul style="list-style-type: none"> <li>• choosing an appropriate source of fresh water</li> <li>• passing the water through filter beds</li> <li>• sterilising.</li> </ul> <p>Sterilising agents used for potable water include chlorine, ozone or ultra-violet light.</p> <p>If supplies of fresh water are limited, desalination of salty water or sea water may be required. Desalination can be done by distillation or by processes that use membranes such as reverse osmosis. These processes require large amounts of energy.</p>			<p>Extended writing: describe the process of distillation</p> <p>Extended writing: explain why distillation separates substances.</p> <p>Grade 9: explain what happens to substances during the process of distillation in terms of intermolecular forces of attraction.</p>	<p>AT skills covered by this practical activity: 2, 3 and 4.</p>	<p>Video clip</p> <p>YouTube: <a href="#">Simple Distillation</a></p>	
4.10.1.3	<p>Urban lifestyles and industrial processes produce large amounts of waste water that require treatment before being released into the environment. Sewage and agricultural waste water require removal of</p>	<p>Comment on the relative ease of obtaining potable water from waste, ground and salt water.</p>	1		<p>Research how water is treated.</p> <p>Extended writing: detail the methods involved.</p>	<p>Several water companies provide resources for schools regarding sewage treatment, for example: <a href="#">Anglian Water</a></p>	<p>Past paper question 2 specimen paper 2 set 1</p>

organic matter and harmful microbes. Industrial waste water may require removal of organic matter and harmful chemicals.

Sewage treatment includes:

- screening and grit removal
- sedimentation to produce sewage sludge and effluent
- anaerobic digestion of sewage sludge
- aerobic biological treatment of effluent.

Video clip  
YouTube:  
[Water and You:  
The Water  
Treatment Process](#)