	Chemistry 4.1 Atomic structure and the periodic table	NEED TO KNOW	REVISION
4.1.1.1	All substances are made of atoms. An atom is the smallest part of an element that can exist. Atoms of each element are represented by a chemical symbol, eg 'O' represents an atom of oxygen. There are about 100 different elements. Elements are shown in the periodic table.	Recognise that elements are made from only one type of particle known as an atom, which is the smallest part of an element. Recall symbols For the first 20 elements in the periodic table, the elements in Groups 1 and 7, and other elements in this specification. Name the first 20 elements in the periodic table, the elements in Groups 1 and 7, and other elements in this specification from their symbols.	
4.1.1.1	Compounds are formed from elements by chemical reactions. Compounds contain two or more elements chemically combined in fixed proportions and can be represented by formulae using the symbols of the atoms.	Name compounds of these elements from given formulae or symbol equations	
4.1.1.1	Chemical reactions can be represented by word equations or equations using symbols and formulae.	Write word, formulae and balance chemical equations for the reactions where appropriate, using the symbols of the first 20 elements in the periodic table, the elements in Groups 1 and 7, and other elements named in this specification.	
4.1.1.2	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. 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.	Describe, explain and give examples of the specified processes of separation. Suggest suitable separation and purification techniques for mixtures when given appropriate information.	
4.1.1.3	New experimental evidence may lead to a scientific model being changed or replaced. Before the discovery of the electron atoms were thought to be tiny spheres that could not be divided. 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. The results from the Rutherford and Marsden's alpha scattering experiments led to the plum-pudding model being replaced by the nuclear model.	Describe how and why the atomic model has changed over time. Describe the difference between the plum-pudding model of the atom and the nuclear model of the atom. Describe why the new evidence from the scattering experiment led to a change in the atomic model.	

	Neils Bohr adapted the nuclear model by suggesting that electrons orbit the nucleus at specific distances. The theoretical calculations of Bohr agreed with experimental observations. 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. The name proton was given to these particles. In 1932 the experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus.		
4.1.1.4	The relative electrical charge of particles in atoms is: Name of particle / Relative charge Proton / +1 Neutron / 0 Electron / -1 In an atom the number of electrons is equal to the number of protons in the nucleus. Atoms have no overall electrical charge. 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.	Recall the different charges of the particles that make up an atom. Describe why atoms have no overall charge. Recall what atomic number represents. Use the periodic table to identify number of protons in different elements.	
4.1.1.5	Atoms are very small, having a radius of about 0.1 nm (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). Most of the mass of an atom is in the nucleus.	Describe the structure of the atom. Details of energy levels and line spectra are **not** required. 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.	

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The relative masses of protons, neutrons and electrons are:
<table>
<tr><th>Name of particle</th><th>Relative mass</th></tr>
<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>
</table>
The sum of the protons and neutrons in an atom is its mass number.

Atoms of the same element can have different numbers of neutrons; these atoms are called isotopes of that element.

Atoms can be represented as shown in this example:

Mass number 23

Na

Atomic number 11
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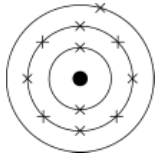
<td>4.1.1.6</td>
<td>The electrons in an atom occupy the lowest available energy levels (innermost available shells). The electronic structure of an atom can be represented by numbers or by a diagram. For example, the electronic structure of sodium is 2,8,1 or
 
showing two electrons in the lowest energy level, eight in the second energy level and one in the third energy level.</td>
<td>Students should be able to represent the electronic structures of the first twenty elements of the periodic table in both forms.

Students may answer questions in terms of either energy levels or shells.</td>
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<td>4.1.2.1</td>
<td>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 similar properties occur at regular intervals.

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.</td>
<td>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.
Predict possible reactions and probable reactivity of elements from their positions in the periodic table.</td>
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4.1.2.2	Before the discovery of protons, neutrons and electrons scientists attempted to classify the elements by arranging them in order of their atomic weights. The early periodic tables were incomplete and some elements were placed in inappropriate groups if the strict order of atomic weights was followed. 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. Elements with properties predicted by Mendeleev were discovered and filled the gaps. Knowledge of isotopes made it possible to explain why the order based on atomic weights was not always correct.	Describe these steps in the development of the periodic table. Describe and explain how testing a prediction can support or refute a new scientific idea.	
4.1.2.3	Elements that react to form positive ions are metals. Elements that do not form positive ions are non-metals. The majority of elements are metals. Metals are found to the left and towards the bottom of the periodic table. Non-metals are found towards the right and top of the periodic table.	Explain the differences between metals and non-metals on the basis of their characteristic physical and chemical properties. Explain how the atomic structure of metals and non-metals relates to their position in the periodic table. 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	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 atoms have stable arrangements of electrons. The noble gases have eight electrons in their outer energy level, except for helium, which has only two electrons. The boiling points of the noble gases increase with increasing relative atomic mass (going down the group).	Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms. Predict properties from given trends down the group.	
4.1.2.5	The elements in Group 1 of the periodic table, known as the alkali metals: • are metals with low density (the first three elements in the group are less dense than water) • react with non-metals to form ionic compounds in which the metal ion carries a charge of +1. The compounds are white solids that dissolve in water to form colourless solutions • react with water, releasing hydrogen • form hydroxides that dissolve in water to give alkaline solutions. In Group 1, the further down the group an element is, the more reactive it is. This is because the further from the nucleus the outer electron is, the more easily the electron is lost.	Explain how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms. Predict properties from given trends down the group.	

4.1.2.6	The elements in Group 7 of the periodic table (known as the halogens): • are non-metals • consist of molecules which are made up of pairs of atoms • react with metals to form ionic compounds in which the halide ion carries a charge of -1 • form molecular compounds with other non-metallic elements. In Group 7, the further down the group an element is, the higher its relative molecular mass, melting point and boiling point. In Group 7, the further down the group an element is, the less reactive the element, because the further from the nucleus the outer electrons are, the less easily electrons are gained. A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt.	Explain how properties of the elements in Group 7 depend on the outer shell of electrons of the atoms. Predict properties from given trends down the group.	