# Scheme of work

## Combined Science: Trilogy - Foundation

## Chemistry – Atomic structure

This resource provides guidance for teaching the Atomic structure topic from our new GCSE Combined Science: Trilogy specification (8464). It has been updated from the draft version to reflect the changes made in the accredited specification. These changes are also reflected in the learning outcomes with some additions to the resources.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 5.1 Atomic structure and the periodic table

Content linked with Physics Unit 6.7

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

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most students should be able to do* | **Suggested timing (hours)** | **Opportunities to develop scientific communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment**  **Opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 5.1.1.1 | 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. | 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. | 0.5 | Recap Chemistry work in KS3 on defining an atom.  Describe how atoms make up all different substances, including living things.  Draw and label an atom, including the structure of the nucleus. | Examine a range of different organic and non-organic substances. Students can sort them into different categories of elements and compounds.  There are a range of different animations available online which show the relative scales of object, including the size of an atom compared to a cell.  [NHS – Radiation](http://www.nhs.uk/Conditions/Radiation/Pages/Introduction.aspx)  [TEDed – Just how small is an atom](http://ed.ted.com/lessons/just-how-small-is-an-atom)    [Open Culture – Magnifying the Universe: Move from atoms to Galaxies in HD](http://www.openculture.com/2013/03/magnifying_the_universe_move_from_atoms_to_galaxies_in_hd.html)  Students research the uses of an element and make an ID card for it that can go into a class display of the Periodic table. | [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX)  Video clip:  [BBC Bitesize –Structure of an atom](http://www.bbc.co.uk/learningzone/clips/structure-of-the-atom/4409.html)  YouTube:  [What is an atom?](https://www.youtube.com/watch?v=U26h51LN84I&index=4&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV) |
| 5.1.1.1 | There are about 100 different elements.  Elements are shown in the periodic table. | 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. | 0.5 | Recapping from KS3, students colour in different areas of the Periodic table to distinguish metals and non-metals.  Match the names and symbols for the first 20 elements. | Make a game of snap using the names and symbols for the first 20 elements, the Group 0, 1 and 7 elements. | ExamPro  GCSE Chemistry  QSA00F2.09  Video clip:  [BBC Bitesize –Introduction to atoms and elements](http://www.bbc.co.uk/learningzone/clips/introduction-to-atoms-and-elements/1861.html)  [Royal Society of Chemistry –Periodic Table](http://www.rsc.org/periodic-table) (interactive) |
| 5.1.1.1 | 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.  Compounds contain two or more elements chemically 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.  Chemical reactions can be represented by word equations or equations using symbols and formulae. | Name compounds of these elements from given formulae or symbol equations.  Write word equations for the reactions in this specification.  Write formulae and balanced chemical equations for the reactions in this specification. | 0.5 | As a recap from KS3, students should come up with their own definition of a compound.  Write a word equation for the reaction.  Draw a diagram to show how the atoms are chemically bonded in the reaction.  Write the symbol formula for the reaction.  Students can practice converting symbol equations into word equations. | Make a compound of iron sulfate by reacting iron filings and sulfur.  Compare the properties of the reactants and products of the reaction. |  |
| 5.1.1.2 | 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 and no new substances are made. | Describe, explain and give examples of the specified processes of separation.  Suggest suitable separation and purification techniques for mixtures when given appropriate information. | 1 | Define a mixture.  Describe how a magnet can be used to separate magnetic material from non-magnetic.  Describe the processes of distillation, filtration, crystallisation and how they work to separate mixtures.  Give students a range of different mixtures and ask them to suggest suitable separation and purification techniques for them. | Demonstrate various separation techniques from KS3 including distillation, filtration, and evaporation.  Students can separate out various inks using chromatography and relate this to the use of chromatography in forensics.  Students can investigate how to purify dirty salty water and acquire pure salt and pure water.  WS 2.2, 2.3, 4.1 | Video clip:  [BBC Bitesize –Mixtures and compounds](http://www.bbc.co.uk/education/clips/zxwvcdm) |
| 5.1.1.3 | 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 alpha particle scattering experiment led to the plum-pudding model being replaced by the nuclear model.  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.  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.  The experimental work of James Chadwick provided the evidence to show the existence of neutrons within the nucleus. | 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. | 1 | Students can make a timeline of the scientific developments leading to the current model of the atom.  Links to Physics Unit 6.7.  Describe the evidence from the scattering experiment and why it led to a change in the atomic model.  Compare the plum pudding model of the atom and the nuclear model of the atom. | Demonstrate the difference between the plum pudding and the atomic model using a hula hoop with negative electrons hanging in it and a quadrat with gold protons stuck on the corners of the grid (see Physics Unit 6.7 Atoms and isotopes)  WS 1.1, 1.2 | [Nobel Prizes and Laureates](http://www.nobelprize.org/nobel_prizes/)  [Atomic Structure Timeline](http://atomictimeline.net/index.php) |
| 5.1.1.4 | 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. | 0.5 | Draw the subatomic particles and label them with the appropriate charge.  Draw out the numbers of protons in a series of different elements and link to number of electrons. | Make models of different elements to demonstrate the change in number of protons. |  |
| 5.1.1.5 | Atoms are very small, having a radius of about 0.1 nm  (1 x 10-10 m).  The radius of a nucleus is less than 1/10 000 of that of the atom (about 1 x 10-14 m).  Most of the mass of an atom is in the nucleus.  The relative masses of protons, neutrons and electrons are:   |  |  | | --- | --- | | Name of  particle | Relative mass | | Proton | 1 | | Neutron | 1 | | Electron | Very small |   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: | 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.  Be able to relate size and scale of atoms to objects in the physical world. | 0.5 | Describe how the mass of an atom is concentrated in the nucleus.  Define mass number and atomic number.  Define ion and isotope (links to physics).  Draw a series of diagrams for different elements, including the numbers of protons, neutrons and electrons. Describe them as an atom, ion or isotope. | Students describe the distances between nucleus and electrons using Google maps.  Make models of atoms, isotopes and ions using rice krispies, coco pops and ricicles for protons, neutrons and electrons.  Label the structures with their mass, atomic numbers and element symbol.  Show how changing the proton number changes the name of the element.  Decribe what the models show/do not show well. Ask students to come up with their own improved models.  WS 4.3, 4.4  Ma 1b | Video clip:  [BBC Bitesize –Atomic structure](http://www.bbc.co.uk/learningzone/clips/10658.html)  Video clip:  [BBC Bitesize –How mass and atomic numbers explain atomic structure](http://www.bbc.co.uk/education/clips/z8vygk7)  YouTube:  [Atomic Number and Mass Number](https://www.youtube.com/watch?v=gUA8k4gOpbk&index=5&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV) |
| 5.1.1.6 | The relative atomic mass of an element is an average value that takes account of the abundance of the isotopes of the element. | Be able to calculate the relative atomic mass of an element given the percentage abundance of its isotopes. | 0.5 |  |  | YouTube:  [Relative Atomic Mass](https://www.youtube.com/watch?v=PrNVj8i_oDA) |
| 5.1.1.7 | 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. | 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. | 0.5 | Relate the numbers of electrons to the numbers of protons.  Draw the electronic structure of sodium.  Draw out the electronic structure of the atoms used in the previous lesson.  Write out the numerical electronic structure below the shell diagram of each. | Make models of the electronic structure of various elements.  Suspend from string and hang from ceiling in order of numbers of electrons and electron shells.  WS 1.2  Ma 5b | YouTube:  [Energy Levels and Electron Configuration](https://www.youtube.com/watch?v=vfKF6DEhcos&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV&index=6)  YouTube:  [Drawing electron configuration diagrams](https://www.youtube.com/watch?v=hSkJzE2Vz_w&index=23&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV) |

### 5.1.2 The periodic table

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most students should be able to do* | **Suggested timing (hours)** | **Opportunities to develop scientific communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment**  **Opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 5.1.2.1 | 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. | 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. | 0.5 | Describe the position of an element in the periodic table and how it is related to the arrangement of electrons in its atoms and the atomic number. | Give students collections of different elements from one group and ask them to put it in an order.  Students can then join up with other groups and continue to arrange cards in order. | Video clip: [BBC Bitesize – Groups and periods in the periodic table](http://www.bbc.co.uk/education/clips/z4snvcw)  YouTube:  [How the elements are laid out in the periodic table](https://www.youtube.com/watch?v=DoQy9hmIEvo&index=2&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV)    YouTube:  [Mendeleev and the Periodic Table](https://www.youtube.com/watch?v=L4M2VKASI1Q&index=9&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV) |
| 5.1.2.2 | 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. | 0.5 | Put a timeline of the steps that Mendeleev went through into the correct order. | Give students cards with the properties and atomic weights of the elements Mendeleev knew about. Ask them to place the cards into a order would classify the properties.  Compare this to an order using atomic weights.  Students can sketch how Mendeleev came up with a solution for the organisation of the periodic table.  Give students details of the reactions of some elements, then ask them to predict what the reactions of different elements might be.  WS1.1 | [Dynamic Periodic Table](http://www.ptable.com/)  or  [Royal Society of Chemistry –Periodic Table](http://www.rsc.org/periodic-table) (interactive)  University of Nottingham – [The Periodic Table of Videos](http://www.periodicvideos.com/) |
| 5.1.2.3 | 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. | 1 | As a recap from KS3, ask students to describe the differences between metals and non-metals on the basis of their characteristic physical and chemical properties.  Draw electronic diagrams for metals and non-metals.  Describe the electronic structure of magnesium and copper and relate them to how reactive they are. | Give students a range of resources and ask them to come up with methods to investigate the properties and uses of metals and non- metals, including, strength, malleability and flexibility (using copper and carbon).  Compare the reaction between magnesium and hydrochloric acid with the reaction of copper and acid |  |
| 5.1.2.4 | 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. | 1 | Define the Group 0 elements.  Describe the elements in Group 0 including their properties, symbols and electronic structure.  Predict properties from given trends down the group. | Ask students to research the colours of different noble gases and then design a neon sign, identifying which noble gas produces each colour. | [The noble gases video](https://www.youtube.com/watch?v=Lid8BsbqTDQ)  YouTube:  [Noble gases - the gases in group 18](https://www.youtube.com/watch?v=qNaBMvJXdJ4&index=70&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV) |
| 5.1.2.5 | 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.:  In Group 1, the reactivity of the elements increases going down the group. | Describe the reactions of the first three alkali metals with oxygen, chlorine and water.  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. | 1 | Define the Group 1 metals.  Describe the properties and describe how the reactivity changes as you move down the group.  Draw the electronic shells of the Group 1 metals and link to the reactivity.  Describe how properties of the elements in Group 1 depend on the outer shell of electrons of the atoms.  Predict the properties of caesium and rubidium based on their electronic structure. | Demonstrate the reactivity of the Group 1 metal in water.  Demonstrate that alkali metals form alkaline solutions in water using UI.  Students can investigate the flame colours of compounds of alkali metals using flame tests. | Video clip:  [BBC Bitesize –Alkali metals and their reactions to air and water](http://www.bbc.co.uk/learningzone/clips/alkali-metals/4407.html)  YouTube:  [Group 1 as an example of Groups in the periodic table](https://www.youtube.com/watch?v=87eG6WimRSw&index=11&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV)  YouTube:  [Alkali metals in water, accurate!](https://www.youtube.com/watch?v=uixxJtJPVXk) |
| 5.1.2.6 | 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.  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 reactivity of the elements decreases going down the group.  A more reactive halogen can displace a less reactive halogen from an aqueous solution of its salt. | Describe the nature of the compounds formed when chlorine, bromine and iodine react with metals and non-metals.  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. | 1 | Define the elements of Group 7.  Describe the properties of the elements in Group 7 including the electron shell configuration.  Predict properties from given trends down the group. | Demonstrate the relative reactivities of the halogens by reacting potassium halogens solution (eg iodide) with bromine or chlorine.  Model the electronic structure of halogens using plasticine electrons on diagrams of orbits. | Video clip:  [BBC Bitesize –Reactivity of group 1 and 7 elements](http://www.bbc.co.uk/education/clips/zm94d2p)  YouTube:  [Halogens](https://www.youtube.com/watch?v=yW_C10cEzMk&index=45&list=PLW0gavSzhMlReKGMVfUt6YuNQsO0bqSMV) |