Scheme of work

Combined Science: Synergy
Building blocks for understanding

This resource provides guidance for teaching the Building blocks for understanding topic from our new GCSE in Combined Science: Synergy (8465) . It has been updated from the draft version to reflect the changes made in the accredited specification. There have been no changes to the required practical. However, there have been minor changes in the specification content in sections 4.5.1.1 Atomic number and the periodic table, 4.5.1.4 Group 1, 4.5.1.5 Group 7, 4.5.2.1 Chemical equations, 4.5.2.3 Relative formula mass.

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.

4.5 Building blocks for understanding

4.5.1 The periodic table

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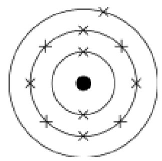
4.5.1.1	The elements in the periodic table are arranged in order of atomic (proton) number and so that elements with similar properties are in columns, known as groups. The table is called a periodic table because similar properties occur at regular intervals. Electrons occupy particular energy levels. Each electron in an atom is at a particular energy level (in a particular shell). The electrons in an atom occupy the lowest available energy levels	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. Show how scientific methods and theories have changed over time. Links to 4.1.2 Atomic structure.	1	Identify link between electron configuration and the structure of the periodic table for elements 1 to 20. Identify anomalies. Discussion questions: • Why isn't the periodic table a regular rectangular shape? • In what ways are elements like letters of the alphabet? WS 1.2 Represent the electronic structure of the first 20 elements of the periodic table in the following forms:  sodium 2,8,1		Video clip: BBC Bitesize – Groups and periods in the periodic table YouTube: How the elements are laid out in the periodic table Teachit Science resource (19411) 'Electron configuration' YouTube: Mendeleev and the Periodic Table Exampro user guide PowerPoint Dynamic Periodic Table

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	(innermost available shells). 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. Following Mendeleev, the elements in the periodic table were arranged in order of relative atomic mass. In this order some elements, such as iodine, appeared to be in the wrong group. These problems were solved once it was realised that most elements occur as mixtures of isotopes and that elements should be arranged in the table in order of atomic number.			WS 1.2 Predict possible reactions and probable reactivity of elements from their positions in the periodic table.		or Royal Society of Chemistry – Periodic Table (interactive) University of Nottingham – The Periodic Table of Videos

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4.5.1.2	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. Elements that react by losing their outer electrons to form positive ions are metals. Elements that do not form positive ions are non-metals. The more reactive non-metals, such as the halogens, react with metals by gaining electrons to form negative ions.	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.	0.5		WS 1.2 Describe metals and non-metals and explain the differences between them in terms of their characteristic physical and chemical properties (see 4.6.2 Structure and bonding and the sections about groups 1, 7 and 0 in this topic).	YouTube: Noble gases – the gases in group 18
4.5.1.3	The elements in Group 0 of the periodic table are called the noble gases. They are unreactive and do not	Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms.	1	Extended writing: Describe the trends in properties in Group 0.	WS 1.2 Predict properties from given trends down Group 0.	Teachit Science resource (24279) 'Group 0 research'

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	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).	Predict properties from given trends down the group.		Explain how properties of the elements in Group 0 depend on the outer shell of electrons of the atoms. High demand: Explain the trends in Group 0.		
4.5.1.4	The elements in Group 1 of the periodic table are known as the alkali metals. They: •are soft metals with low density •react with non-metals, including chlorine and oxygen, to form colourless ionic compounds •react with 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	Discussion question: What makes an element reactive? Extended writing: 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.	WS 1.2 Demo reactivity of Na, Li and K in water with universal indicator. Predict reactions for Rb, Cs and Fr.	Teachit Science resource (20043) 'Alkali metals'

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	•form hydroxides that give alkaline solutions in water. In Group 1, the further down the group an element is, the more reactive the element.			High demand: Explain the trends in Group 1.		
4.5.1.5	The elements in Group 7 of the periodic table are known as the halogens. They: • are non-metals • consist of molecules • react with metals to form ionic compounds • form molecular compounds with other non-metallic elements. In Group 7, the further down the group an element is, the higher its relative molecular	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	Discussion question: Why do some elements pair up? Pupils design a chart which enables them to collate similarities and differences between three linked groups or factors eg Group 0, Group 1 and Group 7 of periodic table Extended writing: 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. High demand: Explain the trends in Group 7.	WS 1.2 Demonstrate the reactions of chlorine, bromine and iodine with iron wool. Carry out displacement reactions using KCl, KBr, KI with waters of the corresponding halogens. Write word and balanced symbol equations for all reactions in the displacement practical.	Video clip: BBC Bitesize – Reactivity of group 1 and 7 elements YouTube: Halogens Using agreed criteria charts are peer assessed.

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	mass, melting point and boiling point. In Group 7, 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.					

4.5.2 Chemical quantities

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4.5.2.1	Atoms of each element are represented by a chemical symbol, eg O represents an atom of oxygen, Na represents an atom of sodium. There are about 100 different elements. Elements are shown in the periodic table. 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 from which they were formed. Compounds can only be separated	Use the names and symbols of the first 20 elements, Groups 1, 7 and 0 and other common elements from a supplied periodic table to write formulae and balanced chemical equations where appropriate. (HT only) Write balanced half equations. 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.	1	Discussion question: Can a compound be pure?		Teachit Science resource (19581) 'Elements and their symbols' TED Ed – The science of macaroni salad RSC resource 'Chemical misconceptions II – Word equations' Teachit Science resource (19431) 'Balancing equations'

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	into elements by chemical reactions. Chemical reactions always involve the formation of one or more new substances, and often involve a detachable energy change. Chemical reactions can be represented by word equations or equations using symbols and formulae. In chemical equations, the three states of matter are shown as (s), (l) and (g), with (aq) for aqueous solutions.					
4.5.2.2	The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals	WS 1.2 Pupils should understand the use of the multipliers in equations in normal script before a formula and in subscript within a formula.	3	Use the following quotes to relate to and discuss the law of conservation of mass: Nasir al-Din al-Tusi, 1201–1274. Persian Muslim scholar said 'A body of matter cannot	Model the law of conservation of mass using molecular model kits. Lego or Duplo bricks can be used to good effect.	Video clips: BBC Bitesize Conservation of mass in chemical reactions YouTube:

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	the mass of the reactants. This means that chemical reactions can be represented by symbol equations that are balanced in terms of the numbers of atoms of each element involved on both sides of the equation. Some reactions may appear to involve a change in mass but this can usually be explained because a reactant or product is a gas and its mass has not been taken into account.	WS 1.2 Pupils should be able to explain any observed changes in mass in non-enclosed systems during a chemical reaction given the balanced symbol equation for the reaction and explain these changes in terms of the particle model.		disappear. It only changes into a different form ...' Empedocles, 490–430 BC. Greek philosopher 'nothing comes from nothing.' Explain the meaning of the law of conservation of mass. Write simple word equations. Write simple symbol equations. Balance symbol equations. Extended writing: Describe the equations given in terms of number of moles, reactants and products. Higher demand: Balance complex equations and add state symbols.	Teacher demonstration. The precipitation reaction: lead nitrate + potassium iodide can be performed on a balance. No change in total mass but obvious yellow precipitate observed. Use magnesium ribbon to produce magnesium oxide. Measure the mass of the ribbon at the start of the experiment, burn the ribbon in a strong Bunsen flame (safety required) and measure the mass of the ribbon at the end of the experiment. Use HCl acid in a conical flask with $CaCO_3$. Measure the mass of the reaction on	The law of conservation of mass Law of Conservation of Mass Experiment YouTube: BBC Chemical reactions (burning iron wool experiment at 7 minutes in) RSC and Nuffield Foundation resource 'The change in mass when magnesium burns'

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					a top pan balance as the reaction proceeds over two minutes. Demonstrate combustion of paper in a large beaker to show mass may decrease because products are released to the air as gases. Try balancing iron wool on a pair of scales (a makeshift one can be set up using a carefully balanced metre rule). Heat the iron wool strongly to observe the increase in mass of the oxide.	
4.5.2.3	The relative atomic mass of an element compares the mass of atoms of the element with the ^{12}C isotope. It is an average value for the isotopes of the element.	Pupils are expected to use relative atomic masses in the calculations specified in the subject content. MS 1a, 3a Calculate the relative formula mass (M_r) of a compound	1	Review the definition of relative atomic mass. Recall how to find the relative atomic mass from the periodic table. Define the relative molecular mass.		RSC resource – AfL Chemistry: Calculations in chemistry Teachit Science resource (23867)

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	The relative formula mass (M_r) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula. In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown.	from its formula, given the relative atomic masses.		Extended writing: Write instructions to another student how to calculate the relative formula mass.		'Working out chemical formulae'
4.5.2.4 (HT only)	Chemical amounts are measured in moles. The symbol for the unit mole is mol. The mass of one mole of a substance in grams is numerically	Pupils should understand that the measurement of amounts in moles can apply to atoms, molecules, ions, electrons, formulae and equations, for example that in one mole of carbon (C) the number of atoms is the same as the number of molecules	1	Define one mole in terms of M_r and A_r Calculate the number of moles in a substance using the relative formula mass. Extended writing: Write instructions to another student how to calculate the	Measure out and compare one mole of elements like iron, sulfur, magnesium, copper, aluminium and so on. Measure out and compare one mole of common compounds,	Video clips YouTube: What is a mole? Avogadro's number – The mole

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	equal to its relative formula mass. One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance. The number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant. The value of the Avogadro constant is 6.02×10^{23} per mole.	in one mole of carbon dioxide (CO_2). Pupils should be able to use the relative formula mass of a substance to calculate the number of moles in a given mass of that substance and vice versa. WS 4.1, 4.2, 4.3, 4.5, 4.6 MS 1a, 1b, 2a, 3b, 3c		number of moles using the relative formula mass.	water, sodium chloride, calcium carbonate.	Teachit Science resource (23866) 'Mole calculations'
4.5.2.5 (HT only)	The balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles	MS 3c, 3d Pupils should be able to balance an equation given the masses of reactants and products. WS 4.1 Pupils should be able to explain the effect of a limiting quantity of a reactant on the	2.5	Use the masses of substances present in a reaction to write a balanced equation. Define the term limiting reactant. Link the limiting reactant to the number of moles.	Use a small strip of magnesium ribbon in 20 ml HCl acid. Identify which reactant is the limiting reactant and state the reason for this choice.	Video clip YouTube: Calculating Masses in Reactions

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	to simple whole number ratios. In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used. The reactant that is completely used up is called the limiting reactant because it limits the amount of products. The masses of reactants and products can be calculated from balanced symbol equations. Chemical equations can be interpreted in terms of moles. For example: $Mg + 2HCl \longrightarrow$	amount of products it is possible to obtain in terms of amounts in moles or masses in grams. MS 1a, 1c, 3c, 3d Pupils should be able to: • calculate the masses of substances shown in a balanced symbol equation • calculate the masses of reactants and products from the balanced symbol equation and the mass of a given reactant or product.		Link the limiting reactant to the masses in grams. Balance chemical equations and use these to calculate the masses of substances present. Extended writing: Write instructions to another student how to use balanced chemical equations to calculate the masses of substances present.		

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	$MgCl_2 + H_2$ shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas.					
4.5.2.6 (HT only)	Many chemical reactions take place in solutions. The concentration of a solution can be measured in mass per given volume of solution, eg grams per dm^3 (g/dm^3).	MS 1c, 3c Pupils should be able to: • explain how the mass of a solute and the volume of a solution is related to the concentration of the solution • calculate the mass of solute in a given volume of solution of known concentration in terms of mass per given volume of solution.	0.5	Explain the meaning of concentration and the unit grams per dm^3 . Be able to convert cm^3 into dm^3 . Use the equation: $C = m / v$ to calculate the concentration of a solution. Rearrange the equation: $C = m / v$ to make mass the subject. Extended writing:	To demonstrate the idea of concentration pupils could make different concentrations of tea, coffee or a dark squash like blackcurrant. Pupils often confuse the concept of 'concentration' with 'strength'.	Video clip YouTube: Concentration formula and calculations

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				Write instructions to another student on how to calculate the concentration, or how to rearrange the equation to calculate mass. Discuss the differences of the word ‘concentration’ and ‘strength’ in science and everyday language.		