Scheme of Work 2020 – 2021 (HT1)
Subject: AS Chemistry

Year Group: 12
Specification: AQA 7404

Lesson No	Topic & Objectives	Big Question – What will students learn?	Key Activities & Specialist Terminology (Do Now Task / Starter/Tasks/Plenary	Planned Assessment	Homework or flipped learning resources DODDLE resources	Lit Num SMSC Codes
1	**3.1.1.1 Fundamental particles** The structure of atoms.	**Students should be able to:** • describe the structure of atoms in terms of protons, neutrons and electrons recall the relative mass and relative charge of protons, neutrons and electrons.	• Students research how the model of the atom changed over time (examples of key contributions could include the Ancient Greeks, Dalton, Thompson, Rutherford, Bohr, Chadwick) (AO1 - Knowledge and understanding of atomic structure; AO3 - Evaluate how and why atomic structure model developed over time). • Rich question – How can we tell what is inside an atom if we can't see it?		RSC timeline: http://www.rsc.org/chemsoc/timeline RSC: Chemists in a social & historical context: http://www.rsc.org/learn-chemistry/resource/res00001332/the-atom-detectives?cmpid=CMP00002843 RI Christmas Lecture – section on atomic structure http://www.rsc.org/learn-chemistry/resource/res00001119/ri-christmas-lectures-2012-atomic-structure	C3 Sp3, C3 C3
2	**3.1.1.2 Mass number and isotopes** To define atoms and	**Students should be able to:** • define atoms and ions in terms of numbers of protons, neutrons and electrons, as well as	• Students identify atoms and ions from numbers of protons, neutrons and electrons, and vice versa (AO2 - Apply knowledge and understanding).	• SAM AS Paper 1 (set 1) Q2 • June 2013 Unit 1 Question 1a, 1b,	RSC: Build an atom simulation: http://www.rsc.org/learn-chemistry/resource/res0	C3

	ions in terms of protons, neutrons and electrons. Explain the existence of isotopes. How a TOF mass spectrometer works and some of its simple uses	atomic number and mass number (including isotopes) • describe how a time of flight mass spectrometer works • identify elements and calculate relative atomic mass from mass spectroscopy data • find the relative formula mass of compounds from mass spectroscopy data.	• Students determine the relative atomic mass of elements using isotope abundance data (this could include data for elements found in meteorites to show some difference) quoting answers to a suitable number of significant figures for data provided (AO2 - Apply knowledge and understanding; MS1.1 - Use an appropriate number of significant figures to find relative masses; MS1.2 - Find arithmetic means to find relative masses. • Students look at the mass spectra of compounds to determine the relative formula mass (AO2 - Apply knowledge and understanding). Students investigate the use of mass spectroscopy in drug testing athletes (AO3 - Analyse, interpret and evaluate scientific information).	1c and 1f (QS13.1.01) • January 2012 Unit 1 Question 7a (QW12107) • June 2010 Unit 1 Question 8a (QS10.1.8A)	0001433/build-an-atom-simulation-rsc-funded RSC Spectral School: http://www.rsc.org/learn-chemistry/collections/spectroscopy Isotope data: http://www.chem.ualberta.ca/~massspec/atomic_mass_abund.pdf Data on isotopes in meteorites: 'The Elements: Their Origin, Abundance, and Distribution' by P. A. Cox AQA Time of flight mass spectrometry Teachers' Notes and Student guide http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-TN-MASS-SPECTROMETRY.PDF http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-SG-TOFMS.PDF http://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-SG-TOFMS-QA.PDF	 C3 C3 C3

3	**3.1.1.3 Electron configuration** Describe the electron structure of atoms and ions. Define and write equations for ionisation energy. Explain how ionisation energy data provides evidence for electron structure.	**Students should be able to:** • give the electron structure of atoms and ions up to *Z*=36 in terms of s, p and d sub-shells • explain how data from ionisation energies provides evidence for electron structure.	• Students write the electron structure of atoms and ions with *Z*=1-36 (AO1 - Demonstrate knowledge and understanding of scientific ideas). • Students research values of first ionisation energies for elements *Z*=1–36 and plot them on a graph and then explain trends (AO2 - Apply knowledge and understanding; MS3.2 - Plot two variables from experimental or other data). • Students write explanations for trends in ionisation energies down a group and across a period (AO1 - Demonstrate knowledge and understanding of scientific ideas). Students determine which Group an element is in using successive ionisation energy data (AO2 - Apply knowledge and understanding).	• January 2012 Unit 1 Question 5a and 5b (QW12.01.05) • June 2013 Unit 1 Question 6b, 6c and 6d (QS13.01.06) • January 2010 Unit 1 Question 2 (QW10.01.02) • June 2009 Unit 1 Question 1a and 1b (QS09.01.01) • January 2002 Unit 1 Question 4d (QW02.01.04)	Orbitron (shows shapes of orbitals): http://winter.group.shef.ac.uk/orbitron/ Ionisation energy data (1st and successive) http://en.wikipedia.org/wiki/Molar_ionization_energies_of_the_elements	C3 C3
4	**3.1.2 Amount of substance** Relative mass of atoms, elements and compounds	**Students should be able to:** • define relative atomic mass (A_r) • define relative molecular mass (M_r) determine relative molecular mass (M_r) of a substance using relative atomic mass (A_r) values.	• The relative mass of different substances is calculated from the formula (AO2 - Apply knowledge and understanding) • The mass of everyday objects could be measured relative to a specific object of known mass (AO2 - Apply knowledge and understanding) Determine the relative formula mass (M_r) of substances using relative atomic mass values (AO2 - Apply knowledge and understanding)	• Students can calculate M_r given the formula of compounds	Suitable resources can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required)	C3

5	**3.1.2.2 The mole and Avogadro constant** Calculations using moles for solids and solutions	**Students should be able to carry out calculations:** • using the Avogadro constant • using mass of substance, M_r, and amount in moles • using concentration, volume and amount of substance in a solution.	• Students calculate the mass (in g) of atoms/ions using the masses sub atomic particles, quoting answers to a suitable number of significant figures for data provided (AO2 - Apply knowledge and understanding). • Practical opportunity: Students measure out 1 mole (and other mole quantities) of different substances (eg sucrose, salt, water) (AO2 - Apply knowledge and understanding). • Students practice doing calculations involving Avogadro constant, involving mass, M_r and moles, and involving concentration, volume and amount of substance and quoting the final results to the appropriate number of significant figures for data provided (AO2 - Apply knowledge and understanding; MS1.1 - Use an appropriate number of significant figures to find relative masses). Students find the concentration of NaCl in intravenous saline (9 g per dm^3), glucose in isotonic sports drinks (17 g in 500 cm^3) and other similar calculations for everyday solutions. (AO2 - Apply knowledge and understanding). Students research how Avogadro determined the value of his constant (AO3 - Analyse, interpret and evaluate scientific information).	• Calculating the mass (in g) of atoms/ions using the masses sub atomic particles to 5 sf • Calculations linking mass, M_r and moles • Calculations linking volume, moles and concentration • Calculations to determine the mass of a substance needed to produce a set volume of a solution with a pre-determined concentration. • Calculations to determine the concentration of a solution when a set mass is dissolved in a set volume. Calculations using Avogadro's number to determine the number of particles in a solution or given	Sports drink data from http://www.lucozadesport.com/products/sport/ Many suitable calculations can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required)	C3 C3
6	**3.1.2.3 The ideal gas equation** Perform calculations	**Students should be able to carry out calculations:** • using the ideal gas equation.	• Students will need to rearrange the ideal gas equation, work in appropriate units and quote answers to an appropriate number of significant figures (AO2 - Apply knowledge and understanding; MS0.0 -	• June 2006 Unit 1 Question 3 (QS06.1.03)	Finding M_r of butane: http://www.nuffieldfoundation.org/practical-chemistry/determining-	C3

	using the ideal gas equation.		Recognise and make use of appropriate units in ideal gas calculations MS2.2 - Change the subject of the ideal gas equation; MS2.3 - Substitute numerical values into the ideal gas equation using appropriate units for physical quantities). • Practical opportunity: Students find the M_r of a volatile liquid (AO2 - Apply knowledge and understanding; MS0.0 - Recognise and make use of appropriate units in ideal gas calculations ; MS2.2 - Change the subject of the ideal gas equation; MS2.3 - Substitute numerical values into the ideal gas equation using appropriate units for physical quantities; PS 3.2 - Process and analyse data; PS 4.1 - Know and understand how to use a wide range of experimental and practical instruments, equipment and techniques). Students find the mass of argon inside a gas cylinder (23 MPa pressure, 146 × 23 cm dimensions) (AO2 - Apply knowledge and understanding; MS0.0 - Recognise and make use of appropriate units in ideal gas calculations MS2.2 - Change the subject of the ideal gas equation; MS2.3 - Substitute numerical values into the ideal gas equation using appropriate units for physical quantities). Students investigate the link between the gas laws and the ideal gas equation; (they could also research how the behaviour of real gases deviates from ideal gas behaviour although this is beyond the specification) (AO3 - Analyse, interpret and evaluate scientific information)	• June 2005 Unit 1 Question 2b (QS05.1.02) • January 2005 Unit 1 Question 2b (QW05.1.02) • January 2004 Unit 1 Question 4a (QW04.1.04)	relative-molecular-mass-butane Data on gas cylinders: http://www.boconline.co.uk/en/index.html Many suitable calculations can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required)	C3
Students should be able to:						

7	**3.1.2.4 Empirical and molecular formula** Calculate empirical and molecular formulae from data.	**Students should be able to:** • explain the difference between empirical and molecular formulae • carry out calculations: • to find empirical formula from data giving composition by mass or percentage by mass • to find molecular formula from the empirical formula and relative molecular mass.	• Practical opportunity: Students find the empirical formula of a metal oxide (eg magnesium oxide or copper oxide) (AO2 - Apply knowledge and understanding; PS 3.2 – process & analyse data using appropriate mathematical skills). • Students find empirical formulae (and molecular formulae where relevant) from data (AO2 - Apply knowledge and understanding; MS0.2 - Use ratios, fractions and percentages). Students look at some further information about elemental microanalysis using the RSC resource (this is beyond the specification but relevant) (AO3 - Analyse, interpret and evaluate scientific information)	• June 2010 Unit 1 Question 4a (QS10.1.04) • June 2009 Unit 1 Question 2c (QS09.1.02)	Finding empirical formula of copper oxide http://www.nuffieldfoundation.org/practical-chemistry/finding-formula-copper-oxide Many suitable calculations can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required) RSC resource on elemental microanalysis: http://www.nationalstemcentre.org.uk/elibrary/resource/9890/elemental-microanalysis	C3 C3
8	**3.1.2.5 Balanced equations and associated calculations** To write balanced full and ionic equations. To use equations to calculate masses, percentage yields, atom economies,	**Students should be able to:** • write balanced equations • write ionic equations • carry out calculations for reactions involving: • masses, • percentage yields, • atom economies, • volumes of gases, • concentrations & volumes of solutions, • give economic, ethical and environmental advantages for society and industry of processes with a high atom economy.	• Students balance equations, including ones where formulae are given and some where they are not (AO2 - Apply knowledge and understanding). • Students write ionic equations from given equations (AO2 - Apply knowledge and understanding). • Students practise calculations to find masses, percentage yields, atom economies, volumes of gases, concentrations & volumes of solutions (AO2 - Apply knowledge and understanding; MS1.1 - Use an appropriate number of significant figures; MS2.3 - Substitute numerical values into algebraic equations using appropriate units for physical quantities).	• January 2011 Unit 1 Question 3 (QW11.1.03) • June 2010 Unit 1 Question 3 (QS10.1.03) • January 2009 Unit 1 Question 5 (QW09.1.05) • June 2004 Unit 1 Question 2 (QS04.1.02) • January 2004 Unit 1 Question 3 (QW04.1.03)	Finding the M_r of a hydrated salt: http://www.nuffieldfoundation.org/practical-chemistry/finding-formula-hydrated-copperii-sulfate Many suitable calculations and practical activities can be found at http://www.docbrown.info/ and http://www.chemsheets.co.uk/ (subscription required)	C3

	volumes of gases, concentrations & volumes of solutions.
	
	To understand the importance of processes having a high atom economy for society and industry.
	
	Required practical 1
	Make up a volumetric solution and carry out a simple acid–base titration
			• Practical opportunity: the yield for the conversion of magnesium to magnesium oxide (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills).
			• Practical opportunity: Students find the M_r of a hydrated salt (eg copper sulfate or magnesium sulfate) by heating to constant mass (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills).
			• Practical opportunity: Students find the percentage conversion of a Group 2 carbonate to its oxide by heat (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills).
			• **Required practical 1** - Make up a volumetric solution and carry out a simple acid–base titration (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills); PS 3.3 - Consider margins of error, accuracy and precision of data; AT d - Use laboratory apparatus for a variety of experimental techniques including titration, using burette and pipette; AT f - Use acid–base indicators in titrations of weak/strong acids with weak/strong alkalis).
			• Practical opportunity: Students perform titration to analyse many substances, including many everyday substances :
			  • the concentration of ethanoic acid in vinegar
			  • the mass of calcium carbonate in an indigestion tablet
			  • the M_r of a group 2 hydrogencarbonate
				• January 2002 Unit 1 Question 7 (QW02.1.07)
				• January 2009 Unit 1 Question 3
					Chemistry Review article: Atom Economy (Volume 19, edition 2)	C3

			• the M_r of succinic acid Analysis of coffee descaler • the mass of aspirin in an aspirin tablet. (AO2 - Apply knowledge and understanding; PS 3.2 - Process and analyse data using appropriate mathematical skills); PS 3.3 - Consider margins of error, accuracy and precision of data; AT d - Use laboratory apparatus for a variety of experimental techniques including titration, using burette and pipette ; AT f - Use acid–base indicators in titrations of weak/strong acids with weak/strong alkalis).			
9	**3.1.3.1 Ionic bonding** Understand ionic bonding. Write formulas of ionic compounds.	**Students should be able to:** • describe the structure of ionic compounds • explain the properties of ionic compounds using an understanding of ionic bonding • predict the formula of simple ions based on the position of the element in the Periodic Table and knowledge of common compound ions write the formula of ionic compounds.	• Students explain the properties of ionic compounds (AO2 - Apply knowledge and understanding). • Students write the formula of ionic compounds, including those with common compound ions (AO2 - Apply knowledge and understanding). • Rich question: Which of the following ionic compounds have the highest and lowest melting points: sodium chloride, potassium chloride; magnesium chloride – explain your reasoning?	• Write the formula of ionic compounds • January 2012 Unit 1 Question 5 (QW12.1.05)	Nuffield Science Data Book (free download): http://www.nationalstemcentre.org.uk/elibrary/resource/3402/nuffield-advanced-science-book-of-data-second-edition Chemistry Data Book (Starck, Wallace, McGlashan) ISBN: 9780719539510	
10	**3.1.3.2 Nature of covalent and dative covalent bonds** Understand covalent bonding, including co-ordinate bonds.	**Students should be able to:** • describe the nature of covalent bonds, including co-ordinate and multiple bonds • represent molecules by diagrams where lines represent each covalent bond, with an arrow to represent a co-ordinate bond	• Students describe differences between ionic and covalent bonding (AO1 - Demonstrate knowledge and understanding of scientific ideas). • Students describe similarities and differences between covalent and co-ordinate bonds (AO1 - Demonstrate knowledge and understanding of scientific ideas). • Students draw diagrams of molecules showing covalent and co-ordinate bonds as lines/arrows respectively ("stick"	Draw "stick" diagrams of molecules	Animation showing covalent bonding http://www.chemit.co.uk/resource/Details/87	C3

	Draw molecules with lines/arrows showing covalent/co-ordinate bonds.	• describe the structure of molecular substances • explain the properties of molecular substances.	diagrams) (AO2 - Apply knowledge and understanding). • Students explain the properties of molecular substances (AO2 - Apply knowledge and understanding). Rich question: The ammonium ion has three covalent N–H bonds and one co-ordinate N–H bond – how does the strength of the covalent bonds compare to the co-ordinate bond – explain your reasoning?			
11	**3.1.3.3 Metallic bonding** Understand metallic bonding.	**Students should be able to:** • describe the nature of metallic bonding • describe the structure of metals • explain the properties of metals.	• Students describe differences between metallic, ionic and covalent bonding (AO2 - Apply knowledge and understanding). • Students explain the properties of metals (AO2 - Apply knowledge and understanding). • Rich question: Which metals have the highest and lowest melting points – sodium, potassium, magnesium – explain your reasoning?		Nuffield Science Data Book (free download): http://www.nationalstemcentre.org.uk/elibrary/resource/3402/nuffield-advanced-science-book-of-data-second-edition Chemistry Data Book (Starck, Wallace, McGlashan) ISBN: 9780719539510	
12	**3.1.3.4 Bonding and physical properties** Understand the structure of ionic, molecular, giant covalent and metallic substances.	**Students should be able to:** • describe and explain the properties of ionic, molecular, giant covalent and metallic substances, in terms of melting/boiling points and conductivity • describe in detail and draw the structures of diamond, graphite, ice, iodine, magnesium and sodium chloride.	• Practical opportunity: investigate the melting point, solubility and conductivity of substances with different structure types (AO2 - Apply knowledge and understanding; PS 1.1 - Solve problems set in practical contexts). • Students create a summary table to describe and explain the structure and properties of ionic, molecular, giant covalent and metallic substances (AO2 - Apply knowledge and understanding). • Students sketch the structures of diamond, graphite, ice, iodine, magnesium and sodium chloride as solids and label	• June 2013 Unit 1 Question 3 (QS13.1.03) • June 2011 Unit 1 Question 4 (QS11.1.04) • June 2010 Unit 1 Question 7 (QS10.1.07) • June 2006 Unit 1 Question 2 (QS06.1.02)	Nuffield Science Data Book (free download): http://www.nationalstemcentre.org.uk/elibrary/resource/3402/nuffield-advanced-science-book-of-data-second-edition Chemistry Data Book (Starck, Wallace, McGlashan) ISBN: 9780719539510	

	Describe and sketch details of the structures of diamond, graphite, ice, iodine, magnesium and sodium chloride.		the diagrams to explain their melting/boiling points and conductivity (AO2 - Apply knowledge and understanding). Students determine which type of structure a substance has from its properties using data and/or experimentally (eg to test solubility, conductivity and ease of melting (AO2 - Apply knowledge and understanding).	• January 2006 Unit 1 Question 6 (QW06.1.06) • January 2005 Unit 1 Question 5a (QW05.1.05A) • January 2003 Unit 1 Question 1e (QW03.1.01)	*Chemistry Review* article: Graphene (Volume 19, edition 2) *Chemistry Review* article: The disguises of carbon (Volume 18, edition 1)	C3 C3
13	**3.1.3.5 Shapes of simple molecules and ions** Work out, name and sketch the shape of molecules and ions. Explain why molecules and ions have the shapes that they have.	**Students should be able to:** • work out, name and sketch the shape of molecules and ions with up to six electron pairs surrounding the central atom, including bond angles • explain using VSEPR theory why molecules and ions have the shapes that they do, including the effect on the bond angles of the great repulsion by lone (non-bonding) pairs.	• Make models of molecular shapes (AO2 - Apply knowledge and understanding; MS4.3 - Understand the symmetry of 2D and 3D shapes). • Use balloons to represent electron pairs to demonstrate shapes (AO2 - Apply knowledge and understanding). Deduce, sketch and name the shapes of given molecules and ions, including bond angles (AO2 - Apply knowledge and understanding; MS4.1 - Use angles and shapes in regular 2D and 3D structures; MS4.2 - Visualise and represent 2D and 3D forms including two-dimensional representations of 3D objects; MS4.3 - Understand the symmetry of 2D and 3D shapes).	• June 2011 Unit 1 Question 3 (QS11.1.03) • January 2010 Unit 1 Question 6 (QW10.1.06) • June 2006 Unit 1 Question 5b (QS06.1.05B) • June 2005 Unit 1 Question 4 (QS05.1.04) • January 2004 Unit 1 Question 6a (QW04.1.06)	Rotatable shapes https://people.ok.ubc.ca/wsmcneil/vsepr.htm Molymod molecular models RSC exercise on VSEPR theory: http://www.rsc.org/learn-chemistry/resource/res00000648/shapes-of-molecules-and-ions	C3 C3
14	**3.1.3.6 Bond polarity** Definition of electronegativity. How polar covalent bonds	**Students should be able to:** • define and understand the concept of electronegativity • understand why some covalent bonds are polar and deduce whether a bond is polar	• Predict and explain the trend in electronegativity down a group and across a period (AO2 - Apply knowledge and understanding). • Predict whether covalent bonds are polar or not (AO2 - Apply knowledge and understanding). • Predict whether molecules have permanent dipoles or not (AO2 - Apply	• January 2013 Unit 1 Question 3 (QW13.1.03) • June 2004 Unit 1 Question 6a (QS04.1.06A)	Rotatable shapes https://people.ok.ubc.ca/wsmcneil/vsepr.htm Molymod molecular models.	C3

	originate and deducing whether a bond is polar. How polar molecules originate and deducing whether a molecule has a permanent dipole.	understand why some molecules are polar and deduce whether a molecule has a permanent dipole.	knowledge and understanding; MS4.3 - Understand the symmetry of 2D and 3D shapes).			
15	**3.1.3.7 Forces between molecules** The three types of intermolecular force: van der Waals' forces, permanent dipole-dipole forces; and hydrogen bonds. How melting and boiling points of molecular substances depend on the relative strength of	**Students should be able to:** • understand that there are three types of intermolecular force • explain how each of the intermolecular forces arise • explain how the melting points are influenced by these intermolecular forces • explain the anomalous nature of ice and how its low density can be explained through a knowledge of hydrogen bonding.	• Students produce a summary to compare the three types of intermolecular force (AO2 - Apply knowledge and understanding). • Students explain trends in Group 4, 5, 6 and 7 hydrides (to show relative strength of the three types of force and the effect of M_r on van der Waals' forces) (AO2 - Apply knowledge and understanding). • Practical opportunity: Students could try to deflect jets of various liquids from burettes to investigate the presence of different types and relative size of intermolecular forces (AO2 - Apply knowledge and understanding; AT k - Safely and carefully handle solids and liquids, including corrosive, irritant, flammable and toxic substances; PS 1.2 - Apply scientific knowledge to practical contexts). • Students explain why ice floats on water by reference to hydrogen bonding (AO2 - Apply knowledge and understanding). Rich question – Why is there no hydrogen bonding between molecules of HCl gas even though Cl	• June 2013 Unit 1 Question 4 (QS13.1.04) • January 2012 Unit 1 Question 1 (QS12.1.01) • June 2011 Unit 1 Question 3 (QS11.1.03) • January 2011 Unit 1 Question 1 (QW11.1.01) • January 2010 Unit 1 Question 3 (QW10.1.01) • June 2005 Unit 1 Question 5 (QS05.1.05) • June 2004 Unit 1 Question 6b (QS04.01.06)	Nuffield Science Data Book (free download): http://www.nationalstemcentre.org.uk/elibrary/resource/3402/nuffield-advanced-science-book-of-data-second-edition Chemistry Data Book (Starck, Wallace, McGlashan) ISBN: 9780719539510 RSC AfL exercise on hydrogen bonding: http://www.rsc.org/learn-chemistry/resource/res00000129/afl-what-are-hydrogen-bonds-and-where-are-they-found	C3

	intermolecular forces. The impact of hydrogen bonding on the density of ice and melting/boiling points.		is more electronegative than N yet NH_3 has hydrogen bonding?		*Chemistry Review* article: All things Ice (Volume 22, edition 3) RSC Kitchen Chemistry The Structure of Ice and Water http://www.rsc.org/learn-chemistry/resource/res00000813/kitchen-chemistry-the-structure-of-ice-and-water *Chemistry Review* article: Gecko glue (Volume 21, edition 1)	C3 C3 C3