Year: 12
Subject: Chemistry AS

Preparing for year 12

Formulae and equations:
https://www.chemguide.co.uk/14to16/equationmenu.html#top
Formulae (video): https://www.youtube.com/watch?v=crk43-yJlww
Ionic equations (video):
https://www.youtube.com/watch?v=hJAc2sdxKRg
Limiting reagent and atom economy:
https://www.chemguide.co.uk/14to16/calculations/othermole.html#top
Bond energies:
https://www.chemguide.co.uk/14to16/calculations/thermobonds.html#top
Equilibria/Le Chatelier's Principle :
https://www.chemguide.co.uk/14to16/reversiblemenu.html#top

General extras:

Catalyst magazine - https://catalyst-magazine.org/
Future Learn - search for short courses of interest, most can be completed for free www.futurelearn.com
Chemistry Word - https://www.chemistryworld.com/
Nature - https://www.nature.com/
Careers in chemistry -
https://edu.rsc.org/future-in-chemistry/career-options/job-profiles/careers-in-chemistry-a-to-z
Careers in the pharmaceutical industry -
https://www.abpi.org.uk/careers/
Careers in biochemistry -
https://www.biochemistry.org/careers-and-education/careers/career-options/
Careers in physics -
https://www.iop.org/careers-physics/your-future-with-physics/career-paths

Recommended books:

Chemistry

The disappearing spoon by Sam Kean
Uncle Tungsten – memories of a chemical boyhood by Oliver Sacks
Periodic tales: The curious lives of the elements by Hugh Aldersey-Williams
The Science of Everyday Life: Why Teapots Dribble, Toast Burns and Light Bulbs Shine (Hardback) Marty Jopson
The Disappearing Spoon...and other true tales from the Periodic Table by Sam Kean
Stuff Matters: Exploring the Marvellous Materials That Shape Our Man-Made World by Mark Miodownik

General science

A short history of nearly everything by Bill Bryson
8000 metres climbing the world's highest mountains by Alan Hinkes
Bad Science by Ben Goldacre

Medicine

Brave new world by Aldous Huxley
The man who mistook his wife for a hat by Oliver Sacks
The ghost map by Steven Berlin Johnson
Happy accidents: Serendipity in modern medical breakthroughs by Morton A. Meyers

On screen practicals

https://www.open.edu/openlearncreate/course/index.php?categoryid=420
https://edu.rsc.org/resources/collections/screen-experiments

Unit Title	Assessment
Unit 1 Structure, Bonding and Introduction to Organic Chemistry	40% of IAS, 20% of IAL; 1 hour and 30 minutes, total marks 80
Unit 2 Energetics, Group Chemistry, Halogenoalkanes and Alcohols	40% of IAS, 20% of IAL; 1 hour and 30 minutes, total marks 80
Unit 3 Practical Skills in Chemistry I	20% of IA2, 10% of IAL; 1 hour and 20 minutes, total marks 50
Unit 4 Rates, Equilibria and Further Organic Chemistry	40% of IA2, 20% of IAL; 1 hour and 45 minutes, total marks 90
Unit 5 Transition Metals and Organic Nitrogen Chemistry	40% of IA2, 20% of IAL; 1 hour and 45 minutes, total marks 90
Unit 6 Practical Skills in Chemistry II	20% of IA2, 10% of IAL; 1 hour and 20 minutes, total marks 50

Exams

Take place in January, October and May/June

Term	Topic	Focus	Learning Outcomes	Independent learning
1A	1			
	2	**Amount of substance**	• Know the terms atom, element, ion, molecule, compound, empirical formula and molecular formula • Know that the mole (mol) is the unit for amount of a substance and be able to perform calculations using the Avogadro constant	• The Mole https://www.youtube.com/watch?v=YP6Ewyc41zA&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=1&pp=iAQB • Moles and Avogadro's number https://www.youtube.com/watch?v=6KR4KXMHcYM&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=2&pp=iAQB

			• Be able to write balanced full and ionic equations, including state symbols, for chemical reactions • Understand the terms: relative atomic mass, relative molecular mass, relative formula ,mass, molar mass, parts per million • Be able to use experimental data to calculate empirical and molecular formulae	• Reacting masses https://www.youtube.com/watch?v=mA9GF_ued1k&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=3&pp=iAQB • Moles and gases https://www.youtube.com/watch?v=j06HB39V1YM&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=4&pp=iAQB • Reacting volumes of gases https://www.youtube.com/watch?v=9NG6DUBC8sM&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=5&pp=iAQB • Ideal gas equation https://www.youtube.com/watch?v=2W51hKhWdPU&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=6&pp=iAQB • Ideal gas equation https://www.youtube.com/watch?v=FnuBqsmBXXc&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=7&pp=iAQB • Moles and solutions https://www.youtube.com/watch?v=r61dnnGqFYI&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=8&pp=iAQB • Moles and solutions 2 https://www.youtube.com/watch?v=sCRgyhNLITE&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=9&pp=iAQB • Solution calculations https://www.youtube.com/watch?v=YBbgHIJPyYY&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=10&pp=iAQB • Reacting amount calculations https://www.youtube.com/watch?v=wxXQCgmTmmA&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=11&pp=iAQB

				• Making a standard solution https://www.youtube.com/watch?v=QeIFPzs_xOs&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=12&pp=iAQB • Percentage yield and limiting reagents https://www.youtube.com/watch?v=iamXnr_UGIA&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=13&pp=iAQB • Atom economy https://www.youtube.com/watch?v=SYBJLPaA1lw&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=14&pp=iAQB • Empirical and molecular formula https://www.youtube.com/watch?v=crk43-yJIww&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=15&pp=iAQB • Hydrated salts and water of crystallisation https://www.youtube.com/watch?v=hmdbKHq28HI&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=16&pp=iAQB • Mr by titration https://www.youtube.com/watch?v=hpHE6eVLQRE&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=17&pp=iAQB • Acid concentration by titration https://www.youtube.com/watch?v=Nr2WRMcO8X4&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=18&pp=iAQB • Stock solutions and dilution https://www.youtube.com/watch?v=rsK--m_Lr4k&list=PLi6oabjl6coy-P2WxG8FeS5pvfBrBUiyb&index=19&pp=iAQB
	3 - 4	**Calculating amounts of substance in**	• Be able to use chemical equations to calculate reacting masses and vice versa using the concept of amount of substance and molar mass	

		equations using moles	• Be able to calculate volumes of gases and vice versa using: i the concepts of amount of substance ii molar volume of gases iii the expression $pV = nRT$ for gases and volatile liquids • Be able to determine a formula or confirm an equation by experiment, including evaluation of the data **CORE PRACTICAL 1:** • Measure the molar volume of a gas	
	5	**Structure of atoms and mass spectrometry**	• Know the structure of an atom in terms of electrons, protons and neutrons • Know the relative mass and charge of protons, neutrons and electrons • Know what is meant by the terms 'atomic (proton) number' and 'mass number' • Understand the term 'isotope' • Understand the basic principles of a mass spectrometer and be able to analyse and interpret mass spectra to: i deduce the isotopic composition of a sample of an element ii calculate the relative atomic mass of an element from relative abundances of isotopes and vice versa iii determine the relative molecular mass of a molecule, and hence identify molecules in a sample iv understand that ions in a mass spectrometer may have a 2+ charge • Be able to predict the mass spectra, including relative peak heights, for diatomic molecules, including chlorine, given the isotopic abundances	Revise work from IGCSE on Atomic structure. Carry out research to produce a timeline of events in the development of our current understanding of the structure of the atom. Build a model to represent Geiger and Muller's experiment to confirm most of an atom is empty space. Annotate a Periodic Table with key information, showing how to determine numbers of sub-atomic particles. Notes on mass spectrometer. e.g. https://www.chemguide.co.uk/analysis/masspec/howitworks.html Video on mass spectrometer. e.g. https://www.youtube.com/watch?v=J-wao0O0_qM
	5	**Ionisation energy and electron orbitals**	• Be able to define first, second and third ionisation energies and understand that all ionisation energies are endothermic	Periodicity https://www.youtube.com/watch?v=w121xB75toc&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=1&pp=iAQB Ionisation energy

			• Know that an orbital is a region within an atom that can hold up to two electrons with opposite spins. • Understand how ionisation energies are influenced by the number of protons in the nucleus, the electron shielding and the sub-shell from which the electron is removed • Be able to represent data, in a graphical form (including the use of logarithms of first ionisation energy on a graph) for elements 1 to 36 • Know that ideas about electronic configuration developed from: • i an understanding that successive ionisation energies provide evidence for the existence of quantum shells and the group to which the element belongs • ii an understanding that the first ionisation energy of successive elements provides evidence for electron sub-shells • Be able to describe the shape of *s* and *p* orbitals • Know that orbitals in sub-shells: • i each take a single electron before pairing up • ii pair up with two electrons of opposite spin	https://www.youtube.com/watch?v=ntex3wPueyk&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=2&pp=iAQB Successive ionisation energies https://www.youtube.com/watch?v=RDsCWqckESA&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=3&pp=iAQB Patterns in first ionisation energy https://www.youtube.com/watch?v=QaJY3hpDGjw&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=4&pp=iAQB Patterns in first ionisation energy 2 https://www.youtube.com/watch?v=rM1CVh5nYLQ&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=5&pp=iAQB
	6	**Electron configuration and the Periodic Table**	• Be able to predict the electronic configurations, using 1s notation and electrons-in-boxes notation, of: • i atoms, given the atomic number, *Z*, up to *Z* = 36 • ii ions, given the atomic number, *Z*, and the ionic charge, for s and p block ions only, up to Z = 36	Annotate a Periodic Table with key information, showing group and period numbers; how to determine numbers of sub-atomic particles; s, p and d blocks; relationship between electronic configuration and group and period numbers etc. Revision https://www.chemguide.co.uk/atoms/properties/gcse.html#top Atomic orbitals https://www.chemguide.co.uk/atoms/properties/atomorbs.html#top Electronic structures

			• Understand that electronic configuration determines the chemical properties of an element • Know that the Periodic Table is divided into blocks, such as *s*, *p* and *d* and know the number of electrons that can occupy *s*, *p* and *d* sub-shells in the first four quantum shells • Be able to represent data, in a graphical form (including the use of logarithms of first ionisation energy on a graph) for elements 1 to 36 and hence explain the meaning of the term 'periodic property' • Be able to explain: • i the trends in melting and boiling temperatures of the elements of Periods 2 and 3 of the Periodic Table in terms of the structures of the element and the bonding between its atoms or molecules • ii the general increase and the specific trends in ionisation energy of the elements across Periods 2 and 3 of the Periodic Table • iii the decrease in first ionisation energy down a group	https://www.chemguide.co.uk/atoms/properties/elstructs.html#top Ionisation energy https://www.chemguide.co.uk/atoms/properties/ies.html#top Hydrogen's emission spectra (extra) https://www.chemguide.co.uk/atoms/properties/hspectrum.html#top Electron affinities https://www.chemguide.co.uk/atoms/properties/eas.html#top Atomic and ionic radiihttps://www.chemguide.co.uk/atoms/properties/atradius.html#top
	6	**Ionic bonding**	• Know and be able to interpret evidence for the existence of ions, limited to physical properties of ionic compounds, electron density maps and migration of ions • Be able to describe the formation of ions in terms of loss or gain of electrons • Be able to draw dot-and-cross diagrams to show electrons in cations and anions • Be able to describe ionic crystals as giant lattices of ions	Revise work on ionic bonding from IGCSE. 1. Ionic bonding https://www.chemguide.co.uk/atoms/bonding/ionic.html#top 2. Ionic properties - https://www.chemguide.co.uk/atoms/structures/ionicstruct.html#top

			• Know that ionic bonding is the result of strong electrostatic attraction between ions • Understand the effects of ionic radius and ionic charge on the strength of ionic bonding • Understand reasons for the trends in ionic radii down a group in the Periodic Table, and for a set of isoelectronic ions, e.g. N^{3-} to Al^{3+} • Understand the term polarisation as applied to ions • Understand that the polarising power of a cation depends on its radius and charge, and the polarisability of an anion also depends on its radius and charge	

Term	Week	Focus	Summary	Independent Learning
	1	**Covalent bonding**	• Understand that covalent bonding is the strong electrostatic attraction between two nuclei and the shared pair of electrons between them, based on evidence: • i the physical properties of giant atomic structures • ii electron density maps for simple molecules • Be able to draw dot-and-cross diagrams to show electrons in simple covalent substances, including: • i molecules with single, double and triple bonds • ii species exhibiting dative (coordinate) bonding, including Al_2Cl_6 and the ammonium ion • Be able to discuss the different structures formed by giant lattices of	Revise work on covalent bonding from IGCSE. Carry out research to produce a presentation about the different forms of carbon, including their structures, physical properties and uses. 1. Covalent bonding https://www.chemguide.co.uk/atoms/bonding/covalent.html#top 2. Dative covalent bonding https://www.chemguide.co.uk/atoms/bonding/dative.html#top 3. Giant covalent properties https://www.chemguide.co.uk/atoms/structures/giantcov.html#top 4. Molecular properties https://www.chemguide.co.uk/atoms/structures/molecular.html#top Polarity https://phet.colorado.edu/en/simulations/molecule-polarity

			carbon atoms, including graphite, diamond and graphene, and the application of these • Understand the meaning of the term electronegativity as applied to atoms in a covalent bond • Know that ionic and covalent bonding are the extremes of a continuum of bonding type and be able to explain this is terms of electronegativity differences leading to bond polarity in bonds and molecules, and to ionic bonding if the electronegativity difference is large enough • Be able to distinguish between polar bonds and polar molecules and predict whether or not a given molecule is likely to be polar	
	1	**Shapes of molecules and metallic bonding**	• Understand the principles of the electron-pair repulsion theory, used to interpret and predict the shapes of simple molecules and ions • Understand the terms 'bond length' and 'bond angle' • Know and be able to explain the shapes of, and bond angles in, $BeCl_2$, BCl_3, CH_4, NH_3, NH_4^+, H_2O, CO_2, gaseous PCl_5, SF_6 and C_2H_4 • Be able to apply the electron-pair repulsion theory to predict the shapes of, and bond angles in other molecules and ions • Understand that metals consist of giant lattices of metal ions in a sea of delocalised electrons • Know that metallic bonding is the strong electrostatic attraction between metal ions and the delocalised electrons	Research metallic radii of metallic elements and compare to melting point. Use metallic bonding model to explain any trends. PhET similation - shapes of molecules https://phet.colorado.edu/en/simulations/molecule-shapes https://phet.colorado.edu/en/simulations/molecule-shapes-basics Make the shapes using balloons.

			• Be able to use the models above to interpret simple properties of metals, e.g. electrical conductivity and high melting temperature	
	2	**Introduction to Organic Chemistry and Alkanes**	• Understand the concepts of homologous series and functional group • Be able to apply the rules of IUPAC nomenclature to: i name compounds relevant to this specification ii draw these compounds, as they are encountered in the specification, using structural, displayed and skeletal formulae • Be able to classify reactions as addition, substitution, oxidation, reduction or polymerisation • Understand that bond breaking can be: i homolytic, to produce free radicals ii heterolytic, to produce ions • Know definitions of the terms 'free radical' and electrophile • Know the general formula of alkanes and cycloalkanes and understand that they are hydrocarbons (compounds of carbon and hydrogen only) which are saturated (contain single bonds only) • Understand the term 'structural isomerism' and be able to draw the structural isomers of organic molecules, given their molecular formula • Be able to draw the structural isomers of alkanes and cycloalkanes with up to six carbon atoms	Draw, model and name as many possible isomers of hexane. Repeat with a cyclic isomer 1. Drawing organic compounds https://www.chemguide.co.uk/basicorg/convmenu.html#top 2. Drawing and intro to curly arrows https://www.chemguide.co.uk/basicorg/convmenu.html#top 3. Isomerism https://www.chemguide.co.uk/basicorg/isomermenu.html#top 4. Extra (for now) - acids/bases https://www.chemguide.co.uk/basicorg/acidmenu.html#top 5. All reaction mechanisms to refer to throughout the course: https://www.chemguide.co.uk/mechmenu.html#top
	2	**Alkane fuels and pollution**	• Know that alkanes are used as fuels and obtained from the fractional distillation, cracking and reforming of crude oil	Background https://www.chemguide.co.uk/organicprops/alkanes/background.html#top Combustion https://www.chemguide.co.uk/organicprops/alkanes/oxygen.html#top

			• Know that pollutants, including carbon monoxide, oxides of nitrogen and sulfur, carbon particulates and unburned hydrocarbons, are emitted during the combustion of alkane fuels • Understand the problems that arise from the toxicity of carbon monoxide and the acidity of the oxides of nitrogen and sulfur • Be able to discuss the reasons for developing alternative fuels in terms of sustainability and reducing emissions, including the emission of CO_2 and its relationship to climate change • Be able to apply the concept of carbon neutrality to different fuels, such as petrol, bioethanol and hydrogen	Making halogenoalkanes https://www.chemguide.co.uk/organicprops/alkanes/halogenation.html#top Cracking https://www.chemguide.co.uk/organicprops/alkanes/cracking.html#top Read about: Pollution and climate change
	3	**Reactions of alkanes**	• Understand the reactions of alkanes with: i oxygen in the air (combustion) ii halogens • Understand the mechanism of the free radical substitution reaction between an alkane and a halogen: i using free radicals, which are species with an unpaired electron, represented by a single dot ii showing the initiation step of the mechanism, with curly half-arrows for free radical formation iii showing the propagation and termination steps of the mechanism iv with limited use in synthesis because of further substitution reactions • Understand the difference between hazard and risk • Understand the hazards associated with organic compounds and why it is necessary to carry out risk	Background https://www.chemguide.co.uk/organicprops/haloalkanes/background.html#top Ways to make them https://www.chemguide.co.uk/organicprops/haloalkanes/making.html#top Reactions with hydroxides https://www.chemguide.co.uk/organicprops/haloalkanes/hydroxide.html#top Reaction with cyanides https://www.chemguide.co.uk/organicprops/haloalkanes/cyanide.html#top Reaction with ammonia https://www.chemguide.co.uk/organicprops/haloalkanes/nh3.html#top Testing for halide ions https://www.chemguide.co.uk/organicprops/haloalkanes/agno3.html#top Gringard reagents (extra) https://www.chemguide.co.uk/organicprops/haloalkanes/grignard.html#top Uses of haloalkanes and CFCs https://www.chemguide.co.uk/organicprops/haloalkanes/uses.html#top Read about the ozone layer and uses of CFCs

			assessments when dealing with potentially hazardous materials ● Be able to suggest ways by which risks can be reduced and reactions can be carried out safely, for example: i working on a smaller scale ii taking precautions specific to the hazard iii using an alternative method that involves less hazardous substances	
	4	**Alkenes**	● Know the general formula of alkenes and understand that alkenes and cycloalkenes are hydrocarbons which are unsaturated (have a carbon-carbon double bond which consists of a σ and a π bond) ● Be able to explain geometric isomerism in terms of restricted rotation around a C=C double bond and the nature of the substituents on the carbon atoms ● Understand the E-Z naming system for geometric isomers and why it is necessary to use this when the cis- and trans- naming system breaks down	Background https://www.chemguide.co.uk/organicprops/alkenes/background.html#top Alkenes from alcohol https://www.chemguide.co.uk/organicprops/alkenes/making.html#top Hydrogenation https://www.chemguide.co.uk/organicprops/alkenes/hydrogenation.html#top Reactions with halogens https://www.chemguide.co.uk/organicprops/alkenes/halogenation.html#top Reactions with hydrogen halides https://www.chemguide.co.uk/organicprops/alkenes/hhal.html#top Reactions with sulfuric acid https://www.chemguide.co.uk/organicprops/alkenes/h2so4.html#top Reaction with potassium permanganate (extra) https://www.chemguide.co.uk/organicprops/alkenes/kmno4.html#top Making alcohol https://www.chemguide.co.uk/organicprops/alkenes/hydration.html#top Addition polymerisation https://www.chemguide.co.uk/organicprops/alkenes/polymerisation.html#top Epoxyethane https://www.chemguide.co.uk/organicprops/alkenes/epoxyethane.html#top
	4	**Reactions of alkenes**	● Be able to describe the reactions of alkenes, limited to: i the addition of hydrogen, using a nickel catalyst, to form an alkane ii the addition of halogens to produce a di-substituted halogenoalkane iii the addition of hydrogen halides to produce	Make models to show the addition reactions of ethene.

			mono-substituted halogenoalkanes iv the addition of steam, in the presence of an acid catalyst, to produce alcohols v oxidation of the double bond by acidified potassium manganate(VII) to produce a diol • Know the qualitative test for a C=C double bond using bromine or bromine water • Be able to describe the mechanism (including diagrams), giving evidence where possible of: i the electrophilic addition of bromine and hydrogen bromide to ethane ii the electrophilic addition of hydrogen bromide to propene • Be able to describe the addition polymerisation of alkenes and draw the repeat unit given the monomer, and vice versa • Understand how chemists limit the problems caused by polymer disposal by: i developing biodegradable polymers ii removing toxic waste gases produced by the incineration of polymers	
	5	Revision/practicals		
	6	Mocks		
	7	Feedback		

Term	Week	Focus	Summary	Independent Learning
2A	1	**Enthalpy changes**	• Know that the enthalpy change, ΔH, is the heat energy change measured at constant pressure and that standard conditions are 100 kPa and a specified temperature, usually 298 K	• Background - kinetic theory https://www.chemguide.co.uk/physical/kt/basic.html#top • Background - ideal gases https://www.chemguide.co.uk/physical/kt/idealgases.html#top • Background - real gases

			• Know that, by convention, exothermic reactions have a negative enthalpy change and endothermic reactions have a positive enthalpy change • Be able to construct and interpret enthalpy level diagrams showing exothermic and endothermic enthalpy changes • Know the definition of standard enthalpy change of: • i reaction, ΔrH • ii formation, ΔfH • iii combustion, ΔtH • iv neutralisation, $\Delta_{neut}H$ • v atomisation, ΔatH • Be able to use experimental data to calculate: • i energy transferred in a reaction using the expression: • energy transferred (J) = • mass (g) × specific heat capacity ($J\ g^{-1}\ °C^{-1}$)× temperature change (°C) • ii enthalpy change of the reaction in kJ mol-1 • *This will be limited to experiments where substances are mixed in an insulated container, and combustion experiments using a suitable calorimeter*	https://www.chemguide.co.uk/physical/kt/realgases.html#top • Gas laws https://www.chemguide.co.uk/physical/kt/otherlaws.html#top • Enthalpy - background https://www.chemguide.co.uk/physical/energetics/basic.html#top • Definitions https://www.chemguide.co.uk/physical/energetics/definitions.html#top • Hess' Law https://www.chemguide.co.uk/physical/energetics/sums.html#top • Bond enthalpies https://www.chemguide.co.uk/physical/energetics/bondenthalpies.html#top
	1	**Hess's Law**	• Know Hess's Law and be able to apply it to: • i constructing enthalpy cycles • ii calculating enthalpy changes of reaction using data provided, or data selected from a table or obtained from experiments • Be able to evaluate the results obtained from experiments and comment on sources of error and uncertainty and any assumptions made in the experiments. • *Students will need to consider experiments where substances are mixed*	

			in an insulated container, and combustion experiments using e.g. a spirit burner • **CORE PRACTICAL 2** • Determination of the enthalpy change of a reaction using Hess's Law	
	2	**Bond enthalpies**	• Understand the terms 'bond enthalpy' and 'mean bond enthalpy', and be able to use bond enthalpies to calculate enthalpy changes, understanding the limitations of this method • Be able to calculate mean bond enthalpies from enthalpy changes of reaction • Understand that bond enthalpy data gives some indication about which bond will break first in a reaction, how easy or difficult it is and therefore how rapidly a reaction will take place at room temperature	Research bond enthalpy data and use it to produce spreadsheet that will calculate the enthalpy changes for reactions
	2	**Intermolecular forces**	• Understand the nature of the following intermolecular forces: • i London forces (instantaneous dipole-induced dipole) • ii permanent dipole-permanent dipole interactions • iii hydrogen bonds • Understand the interactions in molecules, such as H_2O, liquid NH_3 and liquid HF, which give rise to hydrogen bonding • Understand the following anomalous properties of water resulting from hydrogen bonding: • i its high melting and boiling temperature when compared with molecules of a similar molar mass • ii the density of ice compared to that of water • Be able to predict the presence of hydrogen bonding in molecules analogous to those mentioned above	• Molecular properties https://www.chemguide.co.uk/atoms/structures/molecular.html#top

			• Understand, in terms of intermolecular forces, physical properties shown by substances, including: • i the trends in boiling temperatures of alkanes with increasing chain length • ii the effect of branching in the carbon chain on the boiling temperatures of alkanes • iii the relatively low volatility (higher boiling temperatures) of alcohols compared to alkanes with a similar number of electrons • iv the trends in boiling temperatures of the hydrogen halides HF to HI • Understand factors that influence the choice of solvents, including: • i water, to dissolve some ionic compounds, in terms of the hydration of the ions • ii water, to dissolve simple alcohols, in terms of hydrogen bonding • iii water, as a poor solvent for compounds (to include polar molecules such as halogenoalkane), in terms of inability to form hydrogen bonds • iv non-aqueous solvents, for compounds that have similar intermolecular forces to those in the solvent	
	3	**Redox reactions**	• Know what is meant by the term 'oxidation number' and understand the rules for assigning oxidation numbers • Be able to calculate the oxidation number of elements in compounds and ions, including in peroxides and metal hydrides • Be able to indicate the oxidation number of an element in a compound or an ion, using a Roman numeral • Be able to write formulae given oxidation numbers	• Redox basics https://www.chemguide.co.uk/inorganic/redox/definitions.html#top • Redox equations https://www.chemguide.co.uk/inorganic/redox/equations.html#top • Oxidation states https://www.chemguide.co.uk/inorganic/redox/oxidnstates.html#top

			• Understand oxidation and reduction in terms of electron transfer and changes in oxidation number, and the application of these ideas to reactions of s-block and p-block elements • Know that oxidising agents gain electrons and reducing agents lose electrons • Understand that a disproportionation reaction involves an element in a single species being simultaneously oxidised and reduced • Know that oxidation number is a useful concept in terms of the classification of reactions as redox and as disproportionation • Understand that metals, in general, form positive ions by loss of electrons with an increase in oxidation number whereas non-metals, in general, form negative ions by gain of electrons with a decrease in oxidation number • Be able to write ionic half-equations and use them to construct full ionic equations	
	4	**Chemistry of Groups 1 and 2**	• Understand reasons for the trend in ionisation energy down Groups 1 and 2 • Understand reasons for the trend in reactivity of the elements down Group 1 (Li to K) and Group 2 (Mg to Ba) • Know the reactions of the elements of Group 1 (Li to K) and Group 2 (Mg to Ba) with oxygen, chlorine and water • Know the reactions of: • i oxides of Group 1 and 2 elements with water and dilute acid • ii hydroxides of Group 1 and 2 elements with dilute acid • Know the trends in solubility of the hydroxides and sulfates of Group 2 elements	• Properties https://www.chemguide.co.uk/inorganic/group2/properties.html#top • Reaction with water https://www.chemguide.co.uk/inorganic/group2/reacth2o.html#top • Reaction with oxygen https://www.chemguide.co.uk/inorganic/group2/reacto2.html#top • Reaction with acids https://www.chemguide.co.uk/inorganic/group2/reactacids.html#top • Solubility of hydroxides, sulfates and carbonates https://www.chemguide.co.uk/inorganic/group2/solubility.html#top • Thermal stability of nitrates and carbonates (extra) https://www.chemguide.co.uk/inorganic/group2/thermstab.html#top • Atypical beryllium properties (extra) https://www.chemguide.co.uk/inorganic/group2/beryllium.html#top Redox group 2

			• Understand the reasons for the trends in thermal stability of the nitrates and the carbonates of the elements in Groups 1 and 2 in terms of the size and charge of the cations involved • Understand the formation of characteristic flame colours by Group 1 and 2 compounds in terms of electron transitions • Know experimental procedures to show: • i patterns in the thermal decomposition of Group 1 and 2 nitrates and carbonates • ii flame colours in compounds of Group 1 and 2 elements	https://www.youtube.com/watch?v=amFpqZUvsnY&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=7&pp=iAQB Reactions of group 2 https://www.youtube.com/watch?v=BbhO70aS7zw&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=8&pp=iAQB Testing for sulfate ions https://www.youtube.com/watch?v=Av1pgI6tuUM&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=16&pp=iAQB
	5	**Analysis**	• Know reactions, including ionic equations where appropriate, for identifying: • i carbonate ions, CO_3^{2-}, and hydrogencarbonate ions, HCO_3^-, using an aqueous acid to form carbon dioxide (and testing the gas with lime water) • ii sulfate ions, SO_4^{2-}, using acidified barium chloride solution • iii ammonium ions, NH_4^+, using sodium hydroxide solution and warming to form ammonia (and testing with litmus and HCl fumes) • Be able to calculate solution concentrations, in mol dm^{-3} and g dm^{-3}, including simple acid-base titrations using the indicators methyl orange and phenolphthalein • **CORE PRACTICAL 3** • Finding the concentration of a solution of hydrochloric acid • Understand how to minimise the sources of measurement uncertainty in volumetric analysis and estimate the overall uncertainty in the calculated result. • **CORE PRACTICAL 4**	Testing for halide ions https://www.youtube.com/watch?v=dM3KilsnPY4&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=13&pp=iAQB Solubility of hydroxides, sulfates and carbonates https://www.chemguide.co.uk/inorganic/group2/solubility.html#top Testing for sulfate ions https://www.youtube.com/watch?v=Av1pgI6tuUM&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=16&pp=iAQB Testing for ammonium ions https://www.youtube.com/watch?v=bfwuMvqVepI&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=14&pp=iAQB Testing for carbonate ions https://www.youtube.com/watch?v=eUr-uojBvY0&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=15&pp=iAQB

			• Preparation of a standard solution from a solid acid and use it to find the concentration of a solution of sodium hydroxide	
	6	**Chemistry of Group 7**	• Understand reasons for the trends for Group 7 elements in: • i melting and boiling temperatures and physical state at room temperature • ii electronegativity • iii reactivity down the group • Understand the trend in reactivity of Group 7 elements in terms of the redox reactions of Cl_2, Br_2 and I_2 with halide ions in aqueous solution • Understand the following reactions: • precipitation reactions of the aqueous anions Cl^-, Br^- and I^- with aqueous silver nitrate solution, and the solubility of the precipitates in aqueous ammonia solutions • Be able to make predictions about fluorine and astatine and their compounds, in terms of knowledge of trends in halogen chemistry	• Properties https://www.chemguide.co.uk/inorganic/group7/properties.html#top • Oxidising power https://www.chemguide.co.uk/inorganic/group7/halogensasoas.html#top • Reactions of halogens https://www.chemguide.co.uk/inorganic/group7/otherreactions.html#top • Hydrogen halides https://www.chemguide.co.uk/inorganic/group7/acidityhx.html#top • Reducing power of halides https://www.chemguide.co.uk/inorganic/group7/halideions.html#top • Testing for halide ions https://www.chemguide.co.uk/inorganic/group7/testing.html#top • Making chlorine (extra) https://www.chemguide.co.uk/inorganic/group7/diaphragmcell.html#top The halogens https://www.youtube.com/watch?v=WQWC4adcnBA&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=9&pp=iAQB Oxidising power of halogens https://www.youtube.com/watch?v=iRlA-HB1B84&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=10&pp=iAQB Group 7 displacement reactions https://www.youtube.com/watch?v=y-YKSgfbenM&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=11&pp=iAQB Group 7 displacement reactions 2 https://www.youtube.com/watch?v=yH-HVxFoZzw&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=12&pp=iAQB

				Testing for halide ions https://www.youtube.com/watch?v=dM3KilsnPY4&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=13&pp=iAQB
	7	**Explaining redox reactions of Group 7**	• Understand, in terms of changes in oxidation number, the following reactions of the halogens: • i oxidation reactions with Group 1 and 2 metals • ii the disproportionation reaction of chlorine with water and the use of chlorine in water treatment • iii the disproportionation reaction of chlorine with cold, dilute aqueous sodium hydroxide to form bleach • iv the disproportionation reaction of chlorine with hot alkali • v reactions analogous to those specified above • Understand the following reactions: • i solid Group 1 halides with concentrated sulfuric acid, to illustrate the trend in reducing ability of the hydrogen halides • iii hydrogen halides with ammonia gas (to produce ammonium halides) and with water (to produce acids)	

Term	Week	Focus	Summary	Independent Learning
2B	1	**Kinetics**	• Understand, in terms of the collision theory, the effect of changes in concentration, temperature, pressure and surface area on the rate of a chemical reaction • Understand that reactions only take place when collisions have sufficient energy, known as the activation energy • Be able to calculate the rate of a reaction from:	Collision theory https://www.chemguide.co.uk/physical/basicrates/introduction.html#top Surface area https://www.chemguide.co.uk/physical/basicrates/surfacearea.html#top Concentration https://www.chemguide.co.uk/physical/basicrates/concentration.html#top Pressure https://www.chemguide.co.uk/physical/basicrates/pressure.html#top Temperature

			• i the time taken for a reaction, using rate = 1/time • ii the gradient of suitable graph, by drawing a tangent, either for initial rate, or at a time, t • Understand qualitatively in terms of, the Maxwell-Boltzmann distribution of molecular energies how changes in temperature affect the rate of a reaction • Understand the role of catalysts in providing alternative reaction routes of lower activation energy • Be able to draw the reaction profiles for uncatalysed and catalysed reactions including the energy level of the intermediate formed with the catalyst • Understand the use of catalysts in industry to make processes more sustainable by using less energy and/or higher atom economy • Be able to interpret the action of a catalyst in terms of a qualitative understanding of the Maxwell-Boltzmann distribution of molecular energies	https://www.chemguide.co.uk/physical/basicrates/temperature.html#top Catalyst https://www.chemguide.co.uk/physical/basicrates/catalyst.html#top Catalysts (extra) https://www.chemguide.co.uk/physical/catalysismenu.html#top Read about thermal runaway reactions and the danger of explosions in bread factories
	2	**Equilibria**	• Know that many reactions are readily reversible and that they can reach a state of dynamic equilibrium in which: • i the rate of the forward reaction is equal to the rate of the backward reaction • ii the concentrations of the reactants and the products remain constant • Be able to predict and justify the qualitative effects of changes of temperature, pressure and concentration on the position of equilibrium in a homogeneous system • Evaluate data to explain the necessity, for many industrial processes, to reach a	Introduction to equilibria https://www.chemguide.co.uk/physical/equilibria/introduction.html#top Le Chatelier's Principle https://www.chemguide.co.uk/physical/equilibria/lechatelier.html#top Example - Haber Process https://www.chemguide.co.uk/physical/equilibria/haber.html#top Example - Contact Process https://www.chemguide.co.uk/physical/equilibria/contact.html#top Example - ethanol https://www.chemguide.co.uk/physical/equilibria/ethanol.html#top Kc https://www.chemguide.co.uk/physical/equilibria/kc.html#top

			compromise between the yield and the rate of reaction	Read about the history of the Haber Process and how it relates to warfare.
	3	**Introduction to halogenoalkanes**	• Be able to classify reactions (including those in Unit 1) as addition, elimination, substitution, oxidation, reduction, hydrolysis or polymerisation • Understand the concept of a reaction mechanism • Understand that heterolytic bond breaking results in species that are electrophiles or nucleophiles • Know the definition of the term 'nucleophile' • Understand the link between bond polarity and the type of reaction mechanism a compound will undergo • Understand the nomenclature of halogenoalkanes and be able to draw their structural, displayed and skeletal formulae • Understand the distinction between primary, secondary and tertiary halogenoalkanes • Understand the reactions of halogenoalkanes with: • i aqueous alkali, e.g. KOH(aq) to produce alcohols (where the hydroxide ion acts as a nucleophile) • ii ethanolic potassium hydroxide to produce alkenes by an elimination reaction (where the hydroxide ion acts as a base) • iii aqueous silver nitrate in ethanol (where water acts as a nucleophile) • iv alcoholic ammonia under pressure to produce amines (where the ammonia acts as a nucleophile) • v alcoholic potassium cyanide to produce nitriles (where the cyanide ion acts as a nucleophile	Knowledge of the concepts introduced in Unit 1, Topics 5 and 6 will be assumed and extended in this topic. Revise these. Background https://www.chemguide.co.uk/organicprops/haloalkanes/background.html#top Ways to make them https://www.chemguide.co.uk/organicprops/haloalkanes/making.html#top Reactions with hydroxides https://www.chemguide.co.uk/organicprops/haloalkanes/hydroxide.html#top Reaction with cyanides https://www.chemguide.co.uk/organicprops/haloalkanes/cyanide.html#top Reaction with ammonia https://www.chemguide.co.uk/organicprops/haloalkanes/nh3.html#top Testing for halide ions https://www.chemguide.co.uk/organicprops/haloalkanes/agno3.html#top Gringard reagents (extra) https://www.chemguide.co.uk/organicprops/haloalkanes/grignard.html#top Uses of haloalkanes and CFCs https://www.chemguide.co.uk/organicprops/haloalkanes/uses.html#top Read about the ozone layer and uses of CFCs

			• Understand the mechanisms of the nucleophilic substitution reactions between primary halogenoalkanes and: • i aqueous potassium hydroxide • ii ammonia	
	3	**Trends in Reactivity of Nucleophilic Substitution Reactions**	• Understand that experimental observations and data can be used to compare the relative rates of hydrolysis of: • i primary, secondary and tertiary structural isomers of a halogenoalkane • ii primary chloro-, bromo- and iodoalkanes using aqueous silver nitrate in ethanol • **CORE PRACTICAL 5** • Investigation of the rates of hydrolysis of some halogenoalkanes • Know the trend in reactivity of primary, secondary and tertiary halogenoalkanes • Understand, in terms of bond enthalpy, the trend in reactivity of chloro-, bromo- and iodoalkanes • **CORE PRACTICAL 6** • Chlorination of 2-methylpropan-2-ol with concentrated hydrochloric acid	
	4	**Alcohols**	• Understand the nomenclature of alcohols and be able to draw their structural, displayed and skeletal formulae • Understand the reactions of alcohols with: • i oxygen in air (combustion) • ii halogenating agents: • PCl5 to produce chloroalkanes (including its use as a qualitative test for the presence of the –OH group) • 50% concentrated sulfuric acid and potassium bromide to produce bromoalkanes	Background https://www.chemguide.co.uk/organicprops/alcohols/background.html#top Making alcohols https://www.chemguide.co.uk/organicprops/alcohols/manufacture.html#top Dehydrating alcohols https://www.chemguide.co.uk/organicprops/alcohols/dehydration.html#top Testing for alcohols https://www.chemguide.co.uk/organicprops/alcohols/sodium.html#top Reaction with halogens https://www.chemguide.co.uk/organicprops/alcohols/halogen.html#top Oxidation https://www.chemguide.co.uk/organicprops/alcohols/oxidation.html#top Making esters (extra for now) https://www.chemguide.co.uk/organicprops/alcohols/esterification.html#top

			• red phosphorus and iodine to produce iodoalkanes • iii concentrated phosphoric acid to form alkenes by elimination • Understand that potassium dichromate(VI) in dilute sulfuric acid can oxidise: • i primary alcohols to produce aldehydes (which give a positive result with Benedict’s or Fehling’s solution) if the product is distilled as it forms • ii primary alcohols to produce carboxylic acids (which give a positive result with sodium carbonate or sodium hydrogencarbonate) if the reagents are heated under reflux • iii secondary alcohols to produce ketones • Understand, the following techniques in the preparation and purification of a liquid organic compound: • i heating under reflux • ii extraction with a solvent using a separating funnel • iii distillation • iv drying with an anhydrous salt • v boiling temperature determination • **CORE PRACTICAL 7** • The oxidation of propan-1-ol to produce propanal and propanoic acid	Iodoform reaction (extra) https://www.chemguide.co.uk/organicprops/alcohols/iodoform.html#top Uses of alcohol (extra) https://www.chemguide.co.uk/organicprops/alcohols/uses.html#top
	5	**Mass spectra and IR**	• Be able to interpret data from mass spectra to suggest possible structures of simple organic compounds using the m / z of the molecular ion and fragmentation patterns • Be able to use infrared spectra, or data from infrared spectra, to deduce functional groups present in organic compounds, and predict infrared absorptions, due to familiar functional	Infrared spectroscopy https://www.chemguide.co.uk/analysis/ir/background.html#top Fingerprint region https://www.chemguide.co.uk/analysis/ir/fingerprint.html#top Key groups https://www.chemguide.co.uk/analysis/ir/interpret.html#top

			groups including given wavenumber data: • i C–H stretching absorptions in alkanes, alkenes and aldehydes • ii C=C stretching absorption in alkenes • iii O–H stretching absorptions in alcohols and carboxylic acids • iv C=O stretching absorptions in aldehydes, ketones and carboxylic acids • v C–X stretching absorption in halogenoalkanes • vi N-H stretching absorption in amines • **CORE PRACTICAL 8** • Analysis of some inorganic and organic unknowns	Testing for ammonium ions https://www.youtube.com/watch?v=bfwuMvqVepI&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=14&pp=iAQB Testing for carbonate ions https://www.youtube.com/watch?v=eUr-uojBvY0&list=PLi6oabjl6cox58UGRofHwF4C_Tb7906FK&index=15&pp=iAQB
	6	Revision		
	7	Revision		

Term	Week	Focus	Summary	Independent Learning
3A	1	**A2 content** **The Rate Law**	• Understand the terms: • i rate of reaction • ii rate equation, rate=k[A]$_m$[B]$_n$ where m and n are 0, 1 or 2 • iii order with respect to a substance in a rate equation • iv overall order of a reaction • v rate constant • vi half-life • vii rate-determining step • viii activation energy • ix heterogeneous and homogeneous catalyst • Be able to calculate the half-life of a reaction using data from a suitable graph and identify a reaction with a constant half-life as being first order • Be able to select and justify a suitable experimental technique to obtain rate data for a given reaction, including:	• Orders of reaction https://www.chemguide.co.uk/physical/basicrates/orders.html#top • Orders of reaction https://www.chemguide.co.uk/physical/basicrates/ordermech.html#top • Practicals https://www.chemguide.co.uk/physical/basicrates/experimental.html#top • Arrhenius equation https://www.chemguide.co.uk/physical/basicrates/arrhenius.html#top

			- i titration - ii colorimetry - iii mass change - iv volume of gas evolved - v other suitable technique(s) for a given reaction - Understand experiments that can be used to investigate reaction rates by an initial-rate method, carrying out separate experiments where different initial concentrations of one reagent are used **CORE PRACTICAL 13b**: Rates of reaction Following the rate of a reaction using a 'clock reaction' (Harcourt-Esson, iodine clock)	
	2	**Studying the Kinetics of Reactions**	- Understand experiments that can be used to investigate reaction rates by a continuous monitoring method to generate data to enable concentration-time or volume-time graphs to be plotted - Be able to deduce the order (0, 1 or 2) with respect to a substance in a rate equation using data from: - i a concentration-time graph - ii a rate-concentration graph - iii an initial-rate method **CORE PRACTICAL 13a**: Rates of reaction Following the rate of the iodine-propanone reaction by a titrimetric method	Practicals https://www.chemguide.co.uk/physical/basicrates/experimental.html#top
	3	**Using Kinetics to Investigate Mechanisms**	- Understand how to: - i obtain data to calculate the order with respect to the reactants (and the hydrogen ion) in the acid-catalysed iodination of propanone - ii use these data to make predictions about species involved in the rate-determining step	

			• iii deduce a possible mechanism for the reaction • Be able to deduce the rate-determining step from a rate equation and vice versa • Be able to deduce a reaction mechanism, using knowledge of the rate equation and the stoichiometric equation for a reaction • Understand that knowledge of the rate equations for the hydrolysis of halogenoalkanes can be used to provide evidence for SN1 and SN2 mechanisms for tertiary and primary halogenoalkane hydrolysis	
	4	**Activation energy and catalysts**	• Be able to use calculations and graphical methods to find the activation energy for a reaction from experimental data • **CORE PRACTICAL 10** • Finding the activation energy of a reaction • Understand the use of a solid (heterogeneous) catalyst for industrial reactions, in the gas phase, in terms of providing a surface for the reaction	
	5	**Entropy**	• Understand that, since endothermic reactions can occur spontaneously at room temperature, enthalpy changes alone do not control whether reactions occur • Understand entropy as a measure of disorder of a system in terms of the random dispersal of molecules and of energy quanta between molecules • Understand that the entropy of a substance increases with temperature, that entropy increases as solid → liquid → gas and that perfect crystals at zero kelvin have zero entropy	• Entropy https://www.chemguide.co.uk/physical/entropy/introduction.html#top • Calculating entropy https://www.chemguide.co.uk/physical/entropy/entropychange.html#top

			• Be able to interpret the natural direction of change as being in the direction of increasing total entropy (positive entropy change), e.g. gases spread spontaneously through a room • Understand why entropy changes occur during: • i changes of state • ii dissolving of a solid ionic lattice • iii reactions in which there is a change in the number of moles from reactants to products • Understand that the total entropy change of any reaction is the sum of the entropy change of the system and the entropy change of the surroundings, summarised by the expression: • $\Delta S_{total} = \Delta S_{system} + \Delta S_{surroundings}$ • Be able to calculate the entropy change of the system for a reaction, ΔS_{system}, given the entropies of the reactants and products • Be able to calculate the entropy change in the surroundings, and hence ΔS_{total}, using the expression • ΔSsurroundings = $-\Delta H$ • T • Understand that the feasibility of a reaction depends on: • i the balance between ΔS_{system} and $\Delta S_{surroundings}$, so that even endothermic reactions can occur spontaneously at room temperature • ii temperature, as higher temperatures decreases the magnitude of $\Delta S_{surroundings}$ so its contribution to ΔS_{total} is less • Understand that reactions can occur as long as ΔS_{total} is positive even if one of the other entropy changes is negative	

			• Understand and distinguish between the concepts of thermodynamic stability and kinetic stability	
	6	**Lattice Energy**	• Be able to define the terms: • i standard enthalpy change of atomisation, ΔatH • ii electron affinity • iii lattice energy (as the exothermic process for the formation of one mole of an ionic solid from its gaseous ions) • Be able to construct Born-Haber cycles and carry out related calculations • Understand that a comparison of the experimental lattice energy value (from a Born-Haber cycle) with the theoretical value (obtained from electrostatic theory) in a particular compound indicates the degree of covalent bonding • understand that polarisation of anions by cations leads to some covalency in an ionic bond, based on evidence from the Born-Haber cycle • Be able to define the terms 'enthalpy change of solution, $\Delta_{sol}H$' and 'enthalpy change of hydration, $\Delta_{hyd}H$ *of* an ion' • Be able to use energy cycles and energy level diagrams to calculate the enthalpy change of solution of an ionic compound, using enthalpy change of hydration and lattice energy • Understand the effect of ionic charge and ionic radius on the values of enthalpy change of hydration and the lattice energy of an ionic compound • Be able to use entropy and enthalpy changes of solution values to predict the solubility of ionic compounds and discuss trends in the solubility of ionic compounds covered in Unit 2	• Lattice enthalpy https://www.chemguide.co.uk/physical/energetics/lattice.html#top • Enthalpy of solution https://www.chemguide.co.uk/physical/energetics/solution.html#top

Term	Week	Focus	Summary	Independent Learning
3B	1	**Chemical Equilibria**	• Be able to deduce an expression for Kc , for homogeneous and heterogeneous systems, in terms of equilibrium concentrations • Be able to deduce an expression for Kp for homogeneous and heterogeneous systems, in terms of equilibrium partial pressures in atm • Be able to calculate a value, with units where appropriate, for the equilibrium constants (K_c and K_p) for homogeneous and heterogeneous reactions, from experimental data • Understand how, if at all, a change in temperature, pressure or the presence of a catalyst affects the equilibrium composition in a homogeneous or heterogeneous system • Understand that the value of the equilibrium constant is not affected by changes in concentration or pressure or by the addition of a catalyst • Know the effect of changing the temperature on the equilibrium constant (K_c and K_p) for both exothermic and endothermic reactions • Understand that the effect of temperature on the position of equilibrium is explained using a change in the value of the equilibrium constant • Understand the effect of a change in temperature on: • i the value of ΔS_{total} • ii the magnitude of the equilibrium constant, since $\Delta S_{total} = R \ln K$	Kc https://www.chemguide.co.uk/physical/equilibria/kc.html#top Kp https://www.chemguide.co.uk/physical/equilibria/kp.html#top

			• Be able to apply knowledge of the value of equilibrium constants to predict the extent to which a reaction takes place	
	2	**Acid-base equilibria**	• Understand that a Brønsted–Lowry acid is a proton donor and a base a proton acceptor and that acid-base equilibria involve proton transfer • Be able to identify Brønsted–Lowry conjugate acid-base pairs • Be able to define the term ‘pH’ • Be able to calculate pH from hydrogen ion concentration • Be able to calculate the concentration of hydrogen ions in a solution, in mol dm^{-3}, from its pH, using the expression $[H^+] = 10^{-pH}$ • Understand the difference between a strong acid and a weak acid in terms of the degree of dissociation • Be able to calculate the pH of a strong acid	Complete the RSC on-screen titration experiment 1. Theory/definitions https://www.chemguide.co.uk/physical/acidbaseeqia/theories.html#top 2. Strong and weak acids https://www.chemguide.co.uk/physical/acidbaseeqia/acids.html#top 3. Kw https://www.chemguide.co.uk/physical/acidbaseeqia/kw.html#top 4. Strong and weak bases https://www.chemguide.co.uk/physical/acidbaseeqia/bases.html#top 5. pH curves https://www.chemguide.co.uk/physical/acidbaseeqia/phcurves.html#top 6. Indicators https://www.chemguide.co.uk/physical/acidbaseeqia/indicators.html#top 7. Buffer solutions https://www.chemguide.co.uk/physical/acidbaseeqia/buffers.html#top
	3	**Weak acids, water and bases**	• Be able to deduce the expression for the acid dissociation constant, K_a for a weak acid • Be able to calculate the pH of a weak acid from K_a or pK_a values, making relevant assumptions • *Students will not be expected to solve quadratic equations* • Be able to define the ionic product of water, Kw	

			• Be able to calculate the pH of a strong base from its concentration, using K_w or pK_w • Be able to define the terms 'pK_a' and 'pK_w' • Be able to analyse data from the following experiments: • i measuring the pH of a variety of substances, e.g. equimolar solutions of strong and weak acids, strong and weak bases, and salts • ii comparing the pH of a strong and weak acid after dilution 10, 100, and 1000 times • Be able to calculate K_a for a weak acid from experimental data given the pH of a solution containing a known mass of acid • **CORE PRACTICAL 11** • Finding the Ka value for a weak acid	
	4	**Titration curves and buffer solutions**	• Be able to draw and interpret titration curves using all combinations of strong and weak acids and bases • Be able to select a suitable indicator for a titration, using a titration curve and appropriate data • Know what is meant by the term 'buffer solution' • Understand the action of a buffer solution • Be able to calculate the pH of a buffer solution given appropriate data • Be able to calculate the concentrations of solutions required to prepare a buffer solution of a given pH • Understand how to use a weak acid-strong base or strong acid-weak base titration curves to: • i demonstrate buffer action	

			• ii determine Ka from the pH at the point where half the acid is neutralised • Understand the importance of buffer solutions in biological environments: • i buffers in cells and in blood (H2CO3/HCO3) • ii in foods to prevent deterioration due to pH change (caused by bacterial or fungal activity)	
	5	**Chirality and mechanisms**	• Know that optical isomerism is a result of chirality in molecules with a single chiral centre • Understand that optical isomerism results from chiral centre(s) in a molecule with asymmetric carbon atom(s) and that optical isomers are object and non-superimposable mirror images • Know that optical activity is the ability of a single optical isomer to rotate the plane of polarisation of plane-polarised monochromatic light in molecules containing a single chiral centre • Know what is meant by the term 'racemic mixture' • Be able to use data on optical activity of reactants and products as evidence for SN1 and SN2 mechanisms and addition to carbonyl compounds	Revise structural isomerism and geometric isomerism from Unit 1, Topic 4B: Alkanes and Topic 5: Alkenes. 1. Addition-elimination reactions https://www.chemguide.co.uk/organicprops/carbonyls/addelim.html#top 2. Optical isomerism https://www.chemguide.co.uk/basicorg/isomerism/optical.html
	6			

Year 13: A2 chemistry continued

Term	Week	Focus	Summary	Independent Learning
1A	1		•	
	2	**Chemistry of carbonyl compounds**	• Understand the nomenclature of aldehydes and ketones and be able to draw their structural, displayed and skeletal formulae • Understand that aldehydes and ketones: • i do not form intermolecular hydrogen bonds and this affects their physical properties • ii can form hydrogen bonds with water and this affects their solubility • Understand the reactions of carbonyl compounds with: • i Fehling's or Benedict's solution, Tollens' reagent and acidified dichromate(VI) ions • *In equations, the oxidising agent can be represented as [O]* • ii lithium tetrahydridoaluminate(III) (lithium aluminium hydride) in dry ether (ethoxyethane) • *In equations, the reducing agent can be represented by [H]* • iii HCN, in the presence of KCN, as a nucleophilic addition reaction, using curly arrows, relevant lone pairs, dipoles and evidence of optical activity to show the mechanism • iv 2,4-dinitrophenylhydrazine (2,4-DNPH), as a qualitative test for the presence of a carbonyl group and to identify a carbonyl compound given data of the melting temperatures of derivatives • *The equation for this reaction is not required* • v iodine in the presence of alkali (the iodoform test)	Revise preparation of carbonyl compounds from alcohols in Unit 2, Topic 10C: Alcohols Make models of carbonyl compounds and water and use these to visualise solubility. Use 'Read-write-cover-check' technique to embed knowledge of mechanism. 1. Introduction https://www.chemguide.co.uk/organicprops/acids/background.html#top 2. Making carboxylic acids https://www.chemguide.co.uk/organicprops/acids/preparation.html#top 3. Acidic properties https://www.chemguide.co.uk/organicprops/acids/acidity.html#top 4. Esterification https://www.chemguide.co.uk/organicprops/acids/esterification.html#top 5. Reduction https://www.chemguide.co.uk/organicprops/acids/reduction.html#top 6. Acyl chlorides https://www.chemguide.co.uk/organicprops/acids/pcl5.html#top 7. https://www.chemguide.co.uk/organicprops/acids/decarbox.html#top Videos 1. Introduction https://www.youtube.com/watch?v=d9X5T5NXkbA 2. Naming carboxylic acids https://www.youtube.com/watch?v=EyrYj4jRjRs 3. Reactions https://www.youtube.com/watch?v=dEIEZ6TYdi0 4. Esters https://www.youtube.com/watch?v=LUmBK_Cu9RA 5. Esterification https://www.youtube.com/watch?v=H51yz8s5lkY 6. Hydrolysis of esters

				7. https://www.youtube.com/watch?v=iMHRf83TZTo 8. Triglycerides https://www.youtube.com/watch?v=GdTn23h7Sek 9. Acyl chlorides intro https://www.youtube.com/watch?v=Sur_cc86rXc 10. Reactions of acyl chlorides https://www.youtube.com/watch?v=sOpFD1rHtZ4
	3	**Chemistry of carboxylic acids and their derivatives**	• Understand the nomenclature of carboxylic acids and be able to draw their structural, displayed and skeletal formulae • Understand that hydrogen bonding affects the physical properties of carboxylic acids, in relation to their boiling temperatures and solubility • Understand that carboxylic acids can be prepared by the oxidation of alcohols or aldehydes and the hydrolysis of nitriles • Understand the reactions of carboxylic acids with: • i lithium tetrahydridoaluminate(III) (lithium aluminium hydride) in dry ether (ethoxyethane) • ii bases to produce salts • iii phosphorus(V) chloride (phosphorus pentachloride) • iv alcohols in the presence of an acid catalyst • Understand the nomenclature of acyl chlorides and esters and be able to draw their structural, displayed and skeletal formulae • Understand the reactions of acyl chlorides with: • i water • ii alcohols • iii concentrated ammonia • iv amines • Understand the hydrolysis reactions of esters, in acidic and alkaline solution • Understand how polyesters are formed by condensation polymerisation reactions	Produce summary mind map of reactions involving carboxylic acids from year 1, including appropriate reagents and conditions.

	4	**Spectroscopy**	• Be able to use data from mass spectra to: • i suggest possible structures of a simple organic compound given accurate relative molecular masses • ii calculate the accurate relative molecular mass of a compound, given accurate relative atomic masses to four decimal places • Understand that ^{13}C NMR spectroscopy provides information about the positions of ^{13}C atoms in a molecule • Be able to use data from ^{13}C NMR spectroscopy to: • i predict the different environments for carbon atoms present in a molecule, given values of chemical shift, δ • ii justify the number of peaks present in a ^{13}C NMR spectrum in terms of the number of carbon atoms in different environments • Be able to use both low and high resolution proton NMR spectroscopy to: • i predict the different types of proton present in a molecule, given values of chemical shift, δ • ii relate relative peak areas, or ratio number of protons, to the relative numbers of ^{1}H atoms in different environments • iii deduce the splitting patterns of adjacent, non-equivalent protons using the (n+1) rule and hence suggest the possible structures for a molecule • iv predict the chemical shifts and splitting patterns of the 1H atoms in a given molecule	Knowledge of the concepts introduced in Unit 2, Topic 10D: Mass Spectra and IR will be assumed and extended in this topic. Revise this. Research the key principles of NMR using 'Spectra School' 1. Carbon 13 https://www.chemguide.co.uk/analysis/nmr/backgroundc13.html#top 2. https://www.chemguide.co.uk/analysis/nmr/interpretc13.html#top 3. Proton https://www.chemguide.co.uk/analysis/nmr/background.html#top 4. https://www.chemguide.co.uk/analysis/nmr/lowres.html#top 5. https://www.chemguide.co.uk/analysis/nmr/highres.html#top 6. https://www.chemguide.co.uk/analysis/nmr/integration.html#top # Videos 1. Introduction https://www.youtube.com/watch?v=EVyN5pZbzDA 2. Carbon 13 https://www.youtube.com/watch?v=IaHSYjDhGCM 3. Carbon 13 examples https://www.youtube.com/watch?v=YlcH9aK9ZVw 4. Proton NMR https://www.youtube.com/watch?v=xZRA1Qh_QtM 5. Proton NMR 2 https://www.youtube.com/watch?v=yN-mPlLyf4I 6. Proton NMR 3 https://www.youtube.com/watch?v=9btbezNOI68
	5	**Chromatography**	• Know that chromatography separates components of a mixture using a mobile phase and a stationary phase • Be able to calculate R_f values from one-way chromatograms	• Introduction https://www.chemguide.co.uk/analysis/chromatography/thinlayer.html#top

			• Know that high performance liquid chromatography, HPLC, and gas chromatography, GC, are types of column chromatography which separate substances because of different retention times in the column and may be used in conjunction with mass spectrometry, in applications such as forensics or drug testing in sport	• Column https://www.chemguide.co.uk/analysis/chromatography/column.html#top • Gas https://www.chemguide.co.uk/analysis/chromatography/gas.html#top • HPLC https://www.chemguide.co.uk/analysis/chromatography/hplc.html#top • Paper https://www.chemguide.co.uk/analysis/chromatography/paper.html#top Video 1. https://www.youtube.com/watch?v=mBz6U67g14Q 2. https://www.youtube.com/watch?v=kFiAcipDRng
	6	**Redox Equilibria – Electrode Potentials**	• Understand the terms 'oxidation' and 'reduction' in terms of electron transfer and changes in oxidation number, applied to *s*-, *p*- and *d*-block elements • Know what is meant by the term 'standard electrode potential', E_0 • Know that the standard electrode potential, E_0, to is measured in conditions of: • i 298 K temperature • ii 100 kPa pressure of gases • iii 1.00 mol dm^{-3} concentration of ions • Know the features of the standard hydrogen electrode and understand why a reference electrode is necessary • Understand that different methods are used to measure standard electrode potentials of: • i metals or non-metals in contact with their ions in aqueous solution • ii ions of the same element with different oxidation numbers • **CORE PRACTICAL 12** • Investigating some electrochemical cells	Revise redox. 1. Electrode potential https://www.chemguide.co.uk/physical/redoxeqia/introduction.html#top 2. Electrochemical series https://www.chemguide.co.uk/physical/redoxeqia/ecs.html#top 3. Non-metals https://www.chemguide.co.uk/physical/redoxeqia/nonmetal.html#top 4. Combining half cells https://www.chemguide.co.uk/physical/redoxeqia/combinations.html#top 5. Predicting feasibility https://www.chemguide.co.uk/physical/redoxeqia/predict.html#top Videos 1. Electrode potentials https://www.youtube.com/watch?v=Y7WRsaFJM8I 2. Standard hydrogen electrode https://www.youtube.com/watch?v=Ip1K_jV262A

				3. Electrochemical cells https://www.youtube.com/watch?v=jncyjigULRo 4. Summary https://www.youtube.com/watch?v=cS_SY4m45-w 5. Cells GCSE https://www.youtube.com/watch?v=8T4cEZD32qg 6. Fuel cells https://www.youtube.com/watch?v=sVF9pSB_STA 7. Advantages and disadvantages of fuel cells https://www.youtube.com/watch?v=8oL45kfadss 8. Storage cells https://www.youtube.com/watch?v=flUA9K6IdLQ 9. Redox titrations https://www.youtube.com/watch?v=Mv0o1sfltM8&list=PLi6oabjl6coxbrrG7w2tD7I5lTjlq8atT&index=17&pp=iAQB 10. Redox titrations https://www.youtube.com/watch?v=wLgMnaGH1Yc&list=PLi6oabjl6coxbrrG7w2tD7I5lTjlq8atT&index=18&pp=iAQB 11. Thiosulfate titrations https://www.youtube.com/watch?v=ddHzpKdfF0c&list=PLi6oabjl6coxbrrG7w2tD7I5lTjlq8atT&index=20&pp=iAQB 12. Half equations https://www.youtube.com/watch?v=gENXsGxMCfI&list=PLi6oabjl6coxbrrG7w2tD7I5lTjlq8atT&index=14&pp=iAQB Combining half equations https://www.youtube.com/watch?v=zjfxN-9tuQA&list=PLi6oabjl6coxbrrG7w2tD7I5lTjlq8atT&index=26&pp=iAQB
	7		•	
			•	

Term	Week	Focus	Summary	Independent Learning
1B	1	**Redox Equilibria – Uses of E^0_{cell}**	• Be able to calculate a standard emf, E^0_{cell}, by combining two standard electrode potentials • Be able to write cell diagrams using the conventional representation of half-cells • Understand the importance of the	

			conditions when measuring an electrode potential, *E* • Be able to use standard electrode potentials to predict the thermodynamic feasibility of a reaction • Understand that E0 cell is directly proportional to the total entropy change and to lnK for a reaction	
	2	**Redox Equilibria – More uses of E^{o}_{cell}**	• Understand the limitations of predictions made using standard electrode potentials, in terms of kinetic stability of systems and departure from standard conditions • Know that standard electrode potentials are sometimes referred to as standard reduction potentials and can be listed as an electrochemical series • Understand how standard electrode potentials can be used to predict the thermodynamic feasibility of disproportionation reactions • Understand that fuel cells use the energy released on the reaction of a fuel with oxygen to generate a voltage • *Knowledge that methanol and other hydrogen-rich fuels are used in fuel cells is expected.*	

			- Know the electrode reactions that occur in a hydrogen-oxygen fuel cell *Knowledge of hydrogen-oxygen fuel cells with both acidic and alkaline electrolyte is expected*	
	3	**Redox Equilibria – Redox Titrations**	- Be able to carry out both structured and unstructured titration calculations involving redox reactions, including iron(II) ions and potassium manganate(VII) and sodium thiosulfate and iodine - Be able to discuss the uncertainty of measurements and their implications for the validity of the final results **CORE PRACTICAL 13a and b** - Be able to carry out redox titrations with both - i iron(II) ions and potassium manganate(VII) - ii sodium thiosulfate and iodine	
	4	Revision for January exams		
	5	Revision for January exams		
	6	Revision for January exams		

	7	Revision for January exams		

Term	Week	Focus	Summary	Independent Learning
2A	1	**Properties of Transition Metals and their Compounds**	• Know that transition metals are d-block elements that form one or more stable ions with incompletely-filled *d*-orbitals • Be able to deduce the electronic configurations of atoms and ions of the d-block elements of period 4 Sc-Zn) given their atomic number and charge (if any) • Understand why transition metals show variable oxidation number • Know what is meant by the term 'ligand' • Understand that dative (coordinate) covalent bonding is involved in the formation of complex ions • Know that a complex ion is a central metal ion surrounded by ligands • Know that aqueous solutions of transition metal ions are usually coloured • Understand that the colour of aqueous ions, and other complex ions, is a	Revise KS3 light – why do objects look coloured? Revise electron configuration. Videos 1. Introduction https://www.youtube.com/watch?v=0xmOdqKzB1Q&list=PLi6oabjl6coxmdJCSAEjg4IE3ocM911Ag&index=1&pp=iAQB 2. General properties https://www.youtube.com/watch?v=m8OTnORw6og&list=PLi6oabjl6coxmdJCSAEjg4IE3ocM911Ag&index=2&pp=iAQB 3. Precipitation reactions https://www.youtube.com/watch?v=VKsKxqGjkOU&list=PLi6oabjl6coxmdJCSAEjg4IE3ocM911Ag&index=3&pp=iAQB 4. Complex ions https://www.youtube.com/watch?v=WqANuNfCc90&list=PLi6oabjl6coxmdJCSAEjg4IE3ocM911Ag&index=4&pp=iAQB 5. Ligand substitution https://www.youtube.com/watch?v=LAnOtBr4VKU&list=PLi6oabjl6coxmdJCSAEjg4IE3ocM911Ag&index=6&pp=iAQB 6. Stereoisomerism https://www.youtube.com/watch?v=jcBiPOOimlo&list=PLi6oabjl6coxmdJCSAEjg4IE3ocM911Ag&index=5&pp=iAQB

			consequence of the splitting of the energy levels of the *d*-orbitals by ligands • Understand why there is a lack of colour in some aqueous ions and other complex ions • Understand the meaning of the term 'coordination number' • Understand that colour changes in transition metal ions may arise as a result of changes in: • i oxidation number of the ion • ii ligand	
	2	**Transition Metal Complexes and Ligands**	• Understand that H_2O, OH^- and NH_3 act as monodentate ligands • Understand why complexes with six-fold coordination have an octahedral shape, such as those formed by metal ions with H_2O, OH^- and NH_3 as ligands • Know that transition metal ions may form tetrahedral complexes with relatively large ions such as Cl^- • Know that square planar complexes are also formed by transition metal ions and that *cis*-platin is an example of such a complex which is used in cancer treatment where it is supplied as a single isomer	Research role of cis-platin in cancer treatments. Listen to podcast about cis-platin and produce summary notes. 1. Introduction https://www.chemguide.co.uk/inorganic/transition/features.html#top 2. Complex ions https://www.chemguide.co.uk/inorganic/complexions/whatis.html#top 3. Naming https://www.chemguide.co.uk/inorganic/complexions/names.html#top 4. Shapes https://www.chemguide.co.uk/inorganic/complexions/shapes.html#top 5. Ligand exchange https://www.chemguide.co.uk/inorganic/complexions/ligandexch.html#top 6. More ligand exchange https://www.chemguide.co.uk/inorganic/complexions/stabconst.html#top

			and not in a mixture with the *trans* form • Understand the terms bidentate and hexadentate in relation to ligands, and be able to identify examples such as $NH_2CH_2CH_2NH_2$ and $EDTA^{4-}$ • Know that haemoglobin is an iron(II) complex containing a polydentate ligand and that ligand exchange occurs when an oxygen molecule bound to haemoglobin is replaced by a carbon monoxide molecule • *The structure of the haem group will not be assessed*	7. Colour https://www.chemguide.co.uk/inorganic/complexions/colour.html#top 8. Vanadium https://www.chemguide.co.uk/inorganic/transition/vanadium.html#top 9. Manganese https://www.chemguide.co.uk/inorganic/transition/manganese.html#top 10. Iron https://www.chemguide.co.uk/inorganic/transition/iron.html#top 11. Copper https://www.chemguide.co.uk/inorganic/transition/copper.html#top 12. 13. Extra - chromium https://www.chemguide.co.uk/inorganic/transition/chromium.html#top 14. Extra cobalt https://www.chemguide.co.uk/inorganic/transition/cobalt.html#top
	3	**Reactions of Transition Metal ions in solution**	• Know the colours of the oxidation states of vanadium (+5, +4, +3 and +2) in its compounds • Understand redox reactions for the interconversion of the oxidation states of vanadium (+5, +4, +3 and +2), in terms of the relevant E_0 values • Understand, in terms of the relevant E_o values, that the dichromate(VI) ion, $Cr_2O_7^{2-}$: • i can be reduced to Cr^{3+} and Cr^{2+} ions using zinc in acidic conditions • ii can be produced by the oxidation of Cr^{3+} ions using hydrogen peroxide in	

			alkaline conditions (followed by acidification) • Know that the dichromate(VI) ion, $Cr_2O_7^{2-}$ can be converted into chromate(VI) ions as a result of the equilibrium • $Cr_2O_7^{2-} + H_2O \rightleftharpoons 2CrO_4^{2-} + 2H^+$ • Be able to record observations and write suitable equations for the reactions of Cr^{3+}(aq), Mn^{2+}(aq), Fe^{2+}(aq), Fe^{3+}(aq), Co^{2+}(aq) Ni^{2+}(aq), Cu^{2+}(aq) and Zn^{2+}(aq) with aqueous sodium hydroxide and aqueous ammonia, including in excess • Be able to write ionic equations to show the meaning of amphoteric behaviour, deprotonation and ligand exchange in the reactions in 17.22 • Understand that ligand exchange, and an accompanying colour change, occurs in the formation of: • i $[Cu(NH_3)_4(H_2O)_2]^{2+}$ from $[Cu(H_2O)_6]^{2+}$ via $Cu(OH)_2(H_2O)_4$ • ii $[CuCl_4]^{2-}$ from $[Cu(H_2O)_6]^{2+}$ • iii $[CoCl_4]^{2-}$ from $[Co(H_2O)_6]^{2+}$ • Understand, in terms of the positive increase in ΔSsystem, that the	

			substitution of a monodentate ligand by a bidentate or hexadentate ligand leads to a more stable complex ion	
	4	**Catalysis**	• Know that transition metals and their compounds can act as heterogeneous and homogeneous catalysts • Know that a heterogeneous catalyst is in a different phase from the reactants and that the reaction occurs at the surface of the catalyst • Understand, in terms of oxidation number, how v_2o_5 acts as a catalyst in the contact process • Understand how a catalytic converter decreases carbon monoxide and nitrogen monoxide emissions from internal combustion engines by: • i adsorption of co and no molecules onto the surface of the catalyst, resulting in the weakening of bonds and chemical reaction • ii desorption of co_2 and n_2 product molecules from the surface of the catalyst • Know that a homogeneous catalyst is in the same phase as the reactants and appreciate that the catalysed reaction will proceed via an intermediate species	Build a model of a catalytic converter to illustrate how catalyst reduces harmful emissions from road vehicles. Annotate your model to clearly show the processes involved.

			• Understand the role of Fe^{2+} ions in catalysing the reaction between i^- and $S_2O_8^{2-}$ ions • Know the role of Mn^{2+} ions in autocatalysing the reaction between MnO_4^- and $C_2O_4^{2-}$ ions • **Core practical 14** • The preparation of a transition metal complex	
	5	**Chemistry of Arenes – Structure of Benzene**	• Be able to use thermochemical, X-ray diffraction and infrared data as evidence for the structure and stability of the benzene ring • Understand that the delocalised model for the structure of benzene involves overlap of *p*-orbitals to form π-bonds • Understand why benzene is resistant to bromination, compared to alkenes, in terms of delocalisation of π-bonds in benzene compared to the localised electron density of the π-bond in alkenes	Make models of benzene and ethene and use them to help compare the bonding in both and explain why benzene does not give a positive result for unsaturation. Draw and annotate energy level diagrams for hydrogenation of benzene and cyclohexene and use these as evidence for the delocalised model.
	6	**Chemistry of Arenes – Electrophilic Substitution Reactions**	• Know the following reactions of benzene, limited to: • i oxygen in air (combustion to form a smoky flame) • ii bromine, in the presence of a catalyst	• Introduction https://www.chemguide.co.uk/organicprops/arenes/background.html#top • https://www.chemguide.co.uk/organicprops/arenes/manufacture.html#top • Nitration of benzene https://www.chemguide.co.uk/organicprops/arenes/nitration.html#top

			• iii a mixture of concentrated nitric and sulfuric acids • iv fuming sulfuric acid • v halogenoalkanes and acyl chlorides with aluminium chloride as catalyst (Friedel Crafts reaction) • Understand the mechanism of the electrophilic substitution reactions of benzene in halogenation, nitration and Friedel-Crafts reactions including the generation of the electrophile • Understand the reaction of phenol with bromine water and the reasons for the relative ease of this reaction compared to benzene	• Halogenation of benzene https://www.chemguide.co.uk/organicprops/arenes/halogenation.html#top • Friedel-Crafts Acylation https://www.chemguide.co.uk/organicprops/arenes/fc.html#top • Other reactions https://www.chemguide.co.uk/organicprops/arenes/other.html#top Videos 1. Naming aromatic compounds https://www.youtube.com/watch?v=wu3hJeb5Jr0 2. Structure and bonding in benzene https://www.youtube.com/watch?v=g6eLwkYne0g 3. Explaining bonding in benzene https://www.youtube.com/watch?v=UEuW3xM_slY 4. Evidence for benzene's structure and bonding https://www.youtube.com/watch?v=lMsS5RsGmW0 5. Reactions of benzene https://www.youtube.com/watch?v=Ph73widRSpw 6. Nitration of benzene https://www.youtube.com/watch?v=elLU43JqJDE Friedel crafts reaction https://www.youtube.com/watch?v=K6SNxePSIKE
	7	**Organic compounds containing nitrogen**	• Understand the nomenclature of amides, amines and amino acids and be able to draw their structural, displayed and skeletal formulae • Understand the reactions of primary aliphatic amines (using butylamine as an example) and aromatic amines (using phenylamine as an example) with: • i water to form an alkaline solution • ii acids to form salts • iii halogenoalkanes	Research pK_a of a number of amines and use the data to list amines in order of basic strength. Justify order in terms of structure of amines. Revisit esterification reactions Revisit the reactions of halogenoalkanes and nitration of aromatic rings

			• iv ethanoyl chloride • v complex ion formation with copper(ii) ions • Understand that amines are miscible with water as a result of hydrogen bonding, and the reasons for the difference in basicity between ammonia, primary aliphatic amines and primary aromatic amines • Understand, in terms of reagents and general reaction conditions the preparation of primary aliphatic amines: • i from halogenoalkanes • ii by the reduction of nitriles • Know the preparation of aromatic amines by the reduction of aromatic nitro-compounds using tin and concentrated hydrochloric acid • Be able to describe the reaction of aromatic amines with nitrous acid to form benzenediazonium ions followed by a coupling reaction with phenol to form a dye • Understand that amides can be prepared from acyl chlorides	

Term	Week	Focus	Summary	Independent Learning

2B	1	**Condensation polymers and amino acids**	• Be able to describe: • i condensation polymerisation for the formation of polyesters such as terylene and polyamides such as nylon and proteins • ii addition polymerisation including poly(propenamide) and poly(ethenol) • Be able to draw the structural formulae of the repeat units of the polymers in 19.8 • Be able to comment on the physical properties of polyamides and the solubility in water of the addition polymer poly(ethenol) in terms of hydrogen bonding, e.g. soluble laundry bags or liquid detergent capsules (liquitabs) • Be able to describe experiments to investigate the characteristic behaviour of amino acids limited to: • i acidity and basicity and the formation of zwitterions • ii effect of aqueous solutions on plane-polarised monochromatic light • iii formation of peptide bonds by condensation polymerisation • **CORE PRACTICAL 15**	Draw or model the structures of a range of polymers including proteins. 1. Background https://www.chemguide.co.uk/organicprops/aminoacids/background.html#top 2. Acid-base behaviour of amino acids https://www.chemguide.co.uk/organicprops/aminoacids/acidbase.html#top 3. Protein structure https://www.chemguide.co.uk/organicprops/aminoacids/proteinstruct.html#top 4. Hydrolysis of proteins https://www.chemguide.co.uk/organicprops/aminoacids/proteinhydrolysis.html#top 5. Proteins as enzymes https://www.chemguide.co.uk/organicprops/aminoacids/enzymes.html#top 6. Effect of changing conditions on enzyme catalysis https://www.chemguide.co.uk/organicprops/aminoacids/enzymes2.html#top 7. Enzyme inhibitors https://www.chemguide.co.uk/organicprops/aminoacids/enzymes3.html#top 8. DNA structure https://www.chemguide.co.uk/organicprops/aminoacids/dna1.html#top 9. Extra: DNA replication/protein synthesis https://www.chemguide.co.uk/organicprops/aminoacids/dna2.html#top 10. https://www.chemguide.co.uk/organicprops/aminoacids/dna3.html#top Videos 1. Introduction https://www.youtube.com/watch?v=IVUcazxo4FQ 2. Zwitterions https://www.youtube.com/watch?v=zL3PGlWAb5U 3. Reactions of amino acids https://www.youtube.com/watch?v=--jNIrCMoic

			• Analysis of some inorganic and organic unknowns	4. Condensation reactions https://www.youtube.com/watch?v=FLJEYL356-c 5. Proteins https://www.youtube.com/watch?v=1uGq0qKE3aM&list=PLcqmJIl16GiAlMIZUngr2z-3mbFBOW3hC&index=6&pp=iAQB 6. Protein structure https://www.youtube.com/watch?v=gTCSXPumt8s&list=PLcqmJIl16GiAlMIZUngr2z-3mbFBOW3hC&index=7&pp=iAQB 7. Nucleotide structure https://www.youtube.com/watch?v=zEHIbvS_-eA&list=PLcqmJIl16GiAlMIZUngr2z-3mbFBOW3hC&index=14&pp=iAQB 8. Drawing DNA/Cisplatin https://www.youtube.com/watch?v=D3mIRevWzc8
	2	**Identifying Organic Structures**	• Be able to deduce the empirical formulae, molecular formulae and structural formulae from data drawn from combustion analysis, element percentage composition, characteristic reactions of functional groups, infrared spectra, mass spectra and nuclear magnetic resonance spectra (both ^{13}C and proton) • Understand methods of increasing the length of the carbon chain in a molecule by the use of magnesium to form Grignard reagents and the reactions of the latter with carbon dioxide and with carbonyl compounds in dry ether	

	3	**Planning how to Synthesise Compounds**	• Be able to use knowledge of organic chemistry contained in this specifications to solve problems such as: • i predicting the properties of unfamiliar compounds containing one or more of the functional groups included in the specification, and explain these predictions • ii planning reaction schemes of up to four steps, recalling familiar reactions and using unfamiliar reactions given sufficient information • iii selecting suitable practical procedures for carrying out reactions involving compounds with functional groups included in the specification • iv identifying appropriate control measures to reduce risk based on data of hazards	Produce your own large-scale summary of the organic reactions covered in the specification, including appropriate reagents and conditions.
	4	**Carrying out Preparations of Organic Compounds**	• Understand the following techniques used in the preparation and purification of organic compounds: • i refluxing • ii purification by washing, e.g. with water and sodium carbonate solution • iii solvent extraction • iv recrystallisation • v drying	Complete the RSC Screen experiment

			• vi distillation • vii steam distillation • viii melting temperature determination • ix boiling temperature determination • **CORE PRACTICAL 16** • The preparation of aspirin	
	5	Revision for May/June exams		
	6	Revision for May/June exams		
	7	Revision for May/June exams		