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Pearson Edexcel Level 3 Advanced Subsidiary GCE in Chemistry (8CH01)

Pearson Edexcel Level 3 Advanced GCE in Chemistry (9CH01)

Course Planner

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Issue 2

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This document is Issue 2. We will inform centres of any changes to this issue.
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Contents

Introduction

This support document contains two sample course planners for the Edexcel GCE in Chemistry specification.

- **Course planner 1** follows the specification in topic order.
- **Course planner 2** is an alternative route through the specification, focusing on grouped areas of chemistry which naturally fit together at AS and A2 levels. This may suit your particular teaching style.

These are only suggested course planners and do not need to be followed. However, they may be useful when working through the specification for the first time.

Timings

Estimated teaching time available

Unit 1	60 hours	**AS** 120 hours	To include practical assessment
Unit 2	60 hours		
Unit 4	60 hours	**A2** 120 hours	To include practical assessment (plus extra time if you start teaching A2 after the summer AS examinations)
Unit 5	60 hours		

The following table shows the suggested timings for each topic. It is assumed that each lesson is one hour long.

Timings for course planner 1

For course planner 1 each unit is taught separately. This allows for a **modular** teaching approach to the Edexcel GCE in Chemistry.

Unit 1: The Core Principles of Chemistry		
This can be taught in the autumn term of the AS		
Topic		**Time (hours)**
1.3	Formulae, equations and amounts of substance	12
1.4	Energetics	11
1.5	Atomic structure and the periodic table	9
1.6	Bonding	9
1.7	Introductory organic chemistry	14
	Total teaching time (hours)	**55**
Internal assessments		*5*
	Total time (hours)	**60**

Unit 2: Application of Core Principles of Chemistry		
This can be taught in the spring and summer terms of the AS		
Topic		**Time (hours)**
2.3	Shapes of molecules and ions	3
2.4	Intermediate bonding and bond polarity	2
2.5	Intermolecular forces	4
2.6	Redox	2
2.7	The periodic table – groups 2 and 7	16
2.8	Kinetics	4
2.9	Chemical equilibria	2
2.10	Organic chemistry	8
2.11	Mechanisms	4
2.12	Mass spectra and IR	3
2.13	Green chemistry	5
	Total teaching time (hours)	**53**
Internal assessments		*7*
	Total time (hours)	**60**

Unit 4: General Principles of Chemistry I — Rates, Equilibria and Further Organic Chemistry		
This can be taught in the autumn term of the A2		
Topic		**Time (hours)**
4.3	How fast? — rates	10
4.4	How far? — entropy	6
4.5	Equilibria	5
4.6	Application of rates and equilibrium	3
4.7	Acid/base equilibria	10
4.8	Further organic chemistry	12
4.9	Spectroscopy and chromatography	5
	Total teaching time (hours)	**51**
Internal assessments		*5*
	Total time (hours)	**56**

Unit 5: General Principles of Chemistry II — Transition Metals and Organic Nitrogen Chemistry		
This can be taught in the spring and summer terms of the A2		
Topic		**Time (hours)**
5.3	Redox and the chemistry of the transition metals	19
5.4	Organic chemistry — arenes, nitrogen compounds and synthesis	24
	Total teaching time (hours)	**43**
Internal assessments		*9*
	Total time (hours)	**52**

Timings for course planner 2

For course planner 2 all units are taught together, for both the AS and A2. The examinations would be taken in June for all units. This allows for a **synoptic** approach to the Edexcel GCE in Chemistry.

AS Chemistry	Timings (hours)
Autumn term	
Calculations in chemistry — reacting quantities and energetics	30
Atomic structure, the periodic table and bonding	25
Total teaching time (hours)	**55**
Internal assessments	***5***
Total time (hours)	**60**
Spring and summer terms	
Organic chemistry and analytical techniques	27
Inorganic chemistry	17
Kinetics and equilibria	8
Total teaching time (hours)	**52**
Internal assessments	***6***
Total time (hours)	**58**

A2 Chemistry	Timings (hours)
Autumn term	
Why do chemical reactions happen? — entropy and equilibria	24
Rates	12
Redox and the chemistry of the transition metals (part 1)	13
Total teaching time (hours)	**49**
Internal assessments	***3***
Total time (hours)	**52**
Spring and summer terms	
Redox and the chemistry of the transition metals (part 2)	6
Further organic chemistry	36
Total time (hours)	**42**
Internal assessments	***8***
Total time (hours)	**50**

Course planner 1

For this course planner it has been assumed that each lesson will be one hour long.

AS Chemistry

Unit 1: The Core Principles of Chemistry

1.3 Formulae, equations and amounts of substance

Lesson number	Lesson title	Specification references
1	The particle theory of matter and atoms	1.3a
2	Formulae and equations	1.3b
3	How big and heavy are atoms?	1.3c
4	The mole	1.3c, h
5	Using moles – reacting masses	1.3e
6	Using moles – reacting volumes of gases	1.3f
7	Calculating formulae using moles	1.3i
8	Measuring concentration – molarity	1.3d
9	Measuring concentration – other units	1.3c
10	More ways to calculate equations	1.3i, k
11	Yields and atom economy	1.3g
12	Calculating the percentage yield from the preparation of a salt *(internal assessment opportunity: activity ASD1)* *(internal assessment opportunity: activity ASD2)*	1.3j

1.4 Energetics

Lesson number	Lesson title	Specification references
1	Energy and energetics	1.4a
2	Measuring energy changes – enthalpy change	1.4a, b, c
3	Heat capacities and calorimeters	1.4d, f
4	Measuring enthalpy change in an insulated container *(internal assessment opportunity: activity ASC2)*	1.4f(i)
5	Measuring enthalpy of combustion	1.4f(ii)
6	Important enthalpy changes	1.4d
7	Working with enthalpy changes of reaction – Hess's Law	1.4e
8	Bond enthalpies and mean bond enthalpies	1.4g
9	Measuring an enthalpy change indirectly *(internal assessment opportunity: activity ASC4)*	1.4e, f(iii)
10	Using bond enthalpies – understanding molecules and mechanisms	1.4g
11	Using bond enthalpies – making predictions	1.4g

1.5 Atomic structure and the periodic table

Lesson number	Lesson title	Specification references
1	The mass spectrometer	1.5a, b, c
2	Using data from a mass spectrometer	1.5b, c
3	Using the mass spectrometer – radioisotopes, drugs and space	1.5c
4	The arrangement of electrons in atoms – an historical perspective (HSW)	
5	Electrons in atoms – the modern story	1.5d, e(i, ii)
6	Filling orbitals and shells	1.5g
7	Representing electrons and orbitals	1.5f
8	Electronic configuration and chemical properties – the blocks of the periodic table	1.5h, i
9	Patterns in the periodic table	1.5j, k(i,ii)

1.6 Bonding

Lesson number	Lesson title	Specification references
1	Bonding in ionic compounds	1.6.1a, b, c, e
2	Giant ionic lattices	1.6.1d, f
3	Evidence for the existence of ions	1.6.1a
4	Lattice energy – Born-Haber cycles	1.6.1h, l
5	Polarisation and covalent character	1.6.1i, j, k
6	Covalent compounds	1.6.2
7	Evidence for the nature of the covalent bond	1.6.2a (i, ii)
8	Diagrams for simple covalent molecules	1.6.2b
9	Metallic bonding	1.6.3a, b, c

1.7 Introductory organic chemistry

Lesson number	Lesson title	Specification references
1	About organic chemistry: Hazard and risk in organic chemistry	1.7.1c, d
2	The properties of the carbon atom – functional groups and homologous series	1.7.1a, b
3	Naming organic molecules	1.7.1b 1.7.2a
4	Isomerism in organic molecules	1.7.2b
5	The alkanes as fuels: fractional distillation, cracking and reformation	1.7.2c
6	The chemical properties of the alkanes	1.7.2e
7	Reactions of the alkanes with halogens	1.7.2e
8	Alternative fuels	1.7.2d
9	Alkenes and geometric isomerism	1.7.3a, b ,c
10	Reactions of the alkenes	1.7.3d, f
11	Reactions of alkenes and testing for alkenes	1.7.3d, f
12	Mechanisms: How do organic reactions happen?	1.7.3e
13	Polymerisation	1.7.3g
14	Using and disposing of polymers	1.7.3h

Unit 2: Application of Core Principles of Chemistry

2.3 Shapes of molecules and ions

Lesson number	Lesson title	Specification references
1	An introduction to electron-pair repulsion theory	2.3a
2	Shapes of common molecules	2.3b, c, d
3	Giant structures of carbon	2.3e

2.4 Intermediate bonding and bond polarity

Lesson number	Lesson title	Specification references
1	Ionic to covalent: a continuum	2.4a, b
2	Polar molecules	2.4c, d

2.5 Intermolecular forces

Lesson number	Lesson title	Specification references
1	Intermolecular forces involving permanent dipoles, instantaneous dipoles and induced dipoles and hydrogen bonding	2.5a
2	Explaining the boiling and melting temperatures of alkanes	2.5b(i, ii)
3	Solubility of molecules in different solvents	2.5c
4	What factors determine solubility?	2.5d

2.6 Redox

Lesson number	Lesson title	Specification references
1	Using oxidation numbers	2.6a
2	Writing half equations and full equations for redox reactions	2.6b

2.7 The periodic table — groups 2 and 7

Lesson number	Lesson title	Specification references
1	An introduction to group 2 and the trends in ionisation energy	2.7.1a
2	Flames tests for group 1 and group 2 compounds	2.7.1f, g(ii)
3, 4	Reactions of group 2 elements with oxygen, chlorine and water	2.7.1b
5	Reactions of the oxides and hydroxides of group 2 elements with water and dilute acid	2.7.1c
6	An introduction to volumetric analysis and the uncertainty in volumetric analysis	2.7.1g(iii), h
7	Carrying out titrations *(internal assessment opportunity: activity ASC5)*	2.7.1g(iii)
8	The stability of group 1 and group 2 carbonates and nitrates	2.7.1e, g(i)
9	Explaining the trends in stability of group 1 and group 2 carbonates and nitrates	2.7.1e
10	An introduction to halogens	2.7.2a, e
11	Oxidation reactions of halogens	2.7.2b(i)
12	An introduction to iodine/thiosulfate titrations	2.7.2c
13	Carrying out an iodine/thiosulfate titration *(internal assessment opportunity: activity ASC3)*	2.7.2c
14	Disproportionation reactions of halogens	2.7.2b(ii)
15	Silver halides and hydrogen halides	2.7.2d(ii, iii)
16	Reactions of potassium halides with halogens and silver nitrate solution	2.7.2d(i)
17	Observation exercise on three inorganic compounds	

2.8 Kinetics

Lesson number	Lesson title	Specification references
1	Factors that affect the rate of a chemical reaction	2.8a
2	Investigating and explaining factors that affect rate	2.8b, f
3	Activation energy and catalysts	2.8d, e
4	The Maxwell-Boltzmann model of distribution	2.8c

2.9 Chemical equilibria

Lesson number	Lesson title	Specification references
1	An introduction to chemical equilibria and how temperature, pressure and concentration affect them	2.9a, c(i, ii)
2	Predicting changes in the position of equilibrium	2.9b

2.10 Organic chemistry

Lesson number	Lesson title	Specification references
1	An introduction to alcohols and how to test for them	2.10.1a, b, c(i, ii)
2	Reactions of alcohols	2.10.1.c(i, ii, iii, iv)
3	Preparation of an aldehyde	2.10.1.d
4	Preparation of a carboxylic acid *(internal assessment opportunity: activity ASD3)*	2.10.1.d
5	An introduction to halogenoalkanes and their uses	2.10.2a, f
6	Reactions of halogenoalkanes with aqueous alkali, alcoholic alkali and alcoholic ammonia	2.10.2d(i, ii, iv)
7	The reaction of halogenoalkanes with water containing dissolved silver nitrate: comparing primary, secondary and tertiary	2.10.2b, d(iii)
8	Preparation of halogenoalkanes *(internal assessment opportunity: activity ASD3)*	2.10.2c

2.11 Mechanisms

Lesson number	Lesson title	Specification references
1	Classifying reactions	2.11a
2	Classifying reagents	2.11b, c, d, e
3	Mechanisms in reactions of halogenoalkanes, alkanes and alkenes	2.11f
4	Chemistry in the ozone layer	2.11g

2.12 Mass spectra and IR

Lesson number	Lesson title	Specification references
1	Identifying organic molecules by mass spectroscopy	2.12a
2	An introduction to infrared spectroscopy — which molecules absorb infrared?	2.12c, d
3	Using infrared spectroscopy	2.12b
4	Observation exercise on organic compounds	

2.13 Green chemistry

Lesson number	Lesson title	Specification references
1	Greenhouse gases and global warming	2.13b, c
2	Carbon footprints and carbon neutrality	2.13d, e
3	CFCs and the ozone layer	2.13f
4	Sustainability in the chemical industry: reducing hazards and pollution	2.13a(i, ii, v)
5	Sustainability in the chemical industry: increasing efficiency	2.13a(iii, iv)

A2 Chemistry

Unit 4: General Principles of Chemistry I — Rates, Equilibria and Further Organic Chemistry

4.3 How fast? — rates

Lesson number	Lesson title	Specification references
1	Techniques to measure rate of reaction	4.3b
2	Rate equations, rate constants and the order of a reaction	4.3a
3	Determining the order of a reaction and the rate equation from experimental data	4.3f(ii, iii)
4	Graphical representation of kinetic measurements	4.3d
5	Half-life in a chemical reaction	4.3a, f(i)
6	Investigating the rate of a reaction *(internal assessment opportunity: activity A2C2)*	4.3c
7	Activation energy and types of catalysts	4.3a
8	Investigating the activation energy of a reaction *(internal assessment opportunity: activity A2C4)*	4.3f(v), g
9	Relating a mechanism to the rate-determining step	4.3a, f(iv), h, j
10	The mechanism of the reaction of iodine with propanone	4.3e, i

4.4 How far? — entropy

Lesson number	Lesson title	Specification references
1	What is entropy?	4.4b, c, d
2	The natural direction of change	4.4e, f
3	Increases in entropy during chemical reactions	4.4a, g (i, ii, iii, iv)
4	Calculating entropy changes	4.4h, i, j
5	The feasibility of a reaction, thermodynamic stability and kinetic inertness	4.4k, l, m
6	Predicting solubility from the enthalpy and entropy of solution	4.4n, o, p

4.5 Equilibria

Lesson number	Lesson title	Specification references
1	The idea of an equilibrium constant	4.5a, b, c, e
2	Calculations involving K_c and K_p	4.5e
3	More calculations involving K_c and K_p	4.5g
4	Determination of an equilibrium constant	4.5d
5	Relating entropy to equilibrium constants	4.5f, h

4.6 Application of rates and equilibrium

Lesson number	Lesson title	Specification references
1	Explaining why temperature, pressure and catalysis affect an equilibrium constant (if at all) and the interplay with rate of reaction	4.6a
2	Choosing conditions for industrial processes	4.6b
3	Controlling reactions for safety, yield, cost and atom economy	4.6c, d

4.7 Acid/base equilibria

Lesson number	Lesson title	Specification references
1	What are acids and bases?	4.7a, b, c
2	A definition for pH and measuring pH for a variety of substances	4.7d, f (i, ii)
3	K_a, K_w and strong and weak acids and bases	4.7d, e
4	Calculating K_a for a weak acid	4.7h
5	Determination of K_a for a weak acid	4.7g
6	pH changes during acid/base titrations	4.7i
7	Choosing suitable indicators	4.7j
8	Finding K_a for a weak acid from a pH titration ***(internal assessment opportunity: activity A2C1)***	4.7l
9	An introduction to buffer solutions	4.7k, l
10	Buffers in biological systems	4.7m

4.8 Further organic chemistry

Lesson number	Lesson title	Specification references
1	Isomerism and chirality	4.8.1a, b
2	Optical activity of chiral molecules	4.8.1c
3	Evidence for reaction mechanisms from optical activity	4.8.1d
4	An introduction to aldehydes and ketones: examples and solubility	4.8.2a, b
5	Testing and identifying carbonyl compounds	4.8.2c(iv)
6	Reactions of carbonyl compounds	4.8.2c(i, ii, iii, v)
7	An introduction to carboxylic acids: examples, physical properties and preparation	4.8.3a, b, c
8	Reactions of carboxylic acids	4.8.3d(i, ii, iii)
9	Synthesis of esters *(internal assessment opportunity: activity A2D3)*	4.8.3d(iv)
10	Reactions of esters	4.8.4a, c
11	Polyesters	4.8.4d
12	Reactions of acyl chlorides	4.8.4a, b

4.9 Spectroscopy and chromatography

Lesson number	Lesson title	Specification references
1	How does radiation affect molecules?	4.9a(i, ii, iii, iv), c
2	High resolution nmr	4.9b(i, ii, iii)
3	Using nmr to identify molecular structures and in magnetic resonance imaging	4.9b(iv)
4	A review of mass spectroscopy	4.9d
5	Gas chromatography and HPLC	4.9e
6	Observation exercise on three organic compounds	

Unit 5: General Principles of Chemistry II — Transition Metals and Organic Nitrogen Chemistry

5.3 Redox and the chemistry of the transition metals

Lesson number	Lesson title	Specification references
1	Linking oxidation number and reaction stoichiometry	5.3.1a, b
2	Redox titrations with potassium manganate(VII) *(internal assessment opportunity: activity A2C3)*	5.3.1h(i)
3	Redox titrations with sodium thiosulfate	5.3.1h(ii)
4	Measuring standard electrode potentials	5.3.1c
5	Predicting the thermodynamic feasibility and the extent of reactions (vanadium)	5.3.1d, e, f
6	Hydrogen and alcohol fuel cells	5.3.1j
7	How breathalysers work	5.3.1k
8	An introduction to transition metals	5.3.2a, b, c
9	Characteristics of transition metals	5.3.2d(i, ii, iii, iv)
10	Using standard electrode potentials to predict the feasibility of forming different oxidation states of a transition metal	5.3.1g and 5.3.2d(i), f(i)
11	The chemistry of copper	5.3.2e, f, g(i)
12	The chemistry of chromium	5.3.2e, f, g(ii)
13	Explaining the chemistry of copper and chromium	5.3.2f(i, ii, iii, iv)
14	Preparing a sample of a complex ion *(internal assessment opportunity: activity A2D2)*	5.3.2g(iii)
15	Reactions of transition metal ions with aqueous sodium hydroxide	5.3.2j
16	Reactions of transition metal ions with aqueous ammonia	5.3.2j
17	Ionic equations for the reaction of transition metal ions with aqueous sodium hydroxide	5.3.2k
18	Observation exercises	
19	Transition metals as catalysts	5.3.2h, i
20	Modern uses of transition metals	5.3.2l

5.4 Organic chemistry — arenes, nitrogen compounds and synthesis

Lesson number	Lesson title	Specification references
1	Evidence for the structure of the benzene ring	5.4.1a
2	Reactions of benzene: combustion, addition of hydrogen and bromine, and with fuming sulphuric acid	5.4.1b(i, ii, iv, vi)
3	Reactions of benzene: concentrated nitric and sulphuric acids	5.4.1b(iii),d
4	Reactions of benzene: halogenoalkanes and acyl chlorides	5.4.1b(v),d
5	Reactions of phenol	5.4.1e
6	An introduction to amines and the formation of aromatic amines	5.4.2a(i), b(i, ii, iii, iv),c
7	Making paracetamol: reactions of amines with ethanoyl chloride and halogenoalkanes	5.4.2b(v)
8	Making an azo dye	5.4.2d
9	Amides and polyamides	5.4.2e, f(i, ii), g
10	Properties of polyamides	5.4.2h
11	An introduction to amino acids	5.4.2a(ii), i(i)
12	Separation of amino acids	5.4.2i(ii, v)
13	Optical activity of amino acids	5.4.2i(iii)
14	Proteins	5.4.2i(iv)
15	The importance of synthetic organic chemistry	5.4.3a
16	Identifying organic molecules for synthesis	5.4.3b, c
17	Predicting reactions of organic compounds	5.4.3d(i)
18	Planning synthetic routes	5.4.3d(ii, iii)
19	Synthesis of stereo-specific drugs	5.4.3d(v)
20	Practical techniques in organic synthesis	5.4.3f (i–ix)
21	Practical techniques in organic synthesis	5.4.3f (i–ix)
22	Practical techniques in organic synthesis	5.4.3f (i–ix)
23	Control measures for hazards in organic synthesis	5.4.3d(iv)
24	Combinatorial chemistry	5.4.3e
25	The preparation or synthesis of aspirin in two stages ***(internal assessment opportunity: activity A2D1)*** ***(internal assessment opportunity: activity A2M1)***	
26	Continuing the synthesis of aspirin in two stages ***(internal assessment opportunity: activity A2M1)***	

Course planner 2

For this course planner it has been assumed that each lesson will be one hour long.

AS Chemistry

Calculations in chemistry — reacting quantities and energetics

Lesson number	Lesson title	Specification references
1	Introduction to Advanced GCE in Chemistry and explanation of links with GCSE in Science (atoms, elements, ions, molecules, compounds and balanced equations)	1.3a, b
2	Relative masses in chemistry	1.5a
3	Measuring relative isotopic mass, relative atomic mass and relative molecular mass using a mass spectrometer, and further uses of mass spectrometers	1.5b, c
4	Displacement reactions and reactions of acids	1.3b, k
5	Precipitation reactions	1.3b, k
6	Reacting quantities: molar mass	1.3c
7	The Avogadro constant	1.3h
8	Empirical and molecular formulae	1.3a
9	Linking reacting quantities to chemical equations	1.3e
10	Reacting quantities: volumes of gases	1.3f
11	How much hydrogen is produced when lithium reacts with water?	1.3i
12	Greenhouse gases and global warming	2.13b, c
13	Carbon footprints and carbon neutrality	2.13d, e
14	Describing concentrations in gases and solutions	1.3c, d
15	An introduction to volumetric analysis and the uncertainty in volumetric analysis	2.7.1g(iii), h
16	Carrying out titrations *(internal assessment opportunity: activity ASC1)*	2.7.1g(iii)
17	The percentage yield of a chemical reaction	1.3g
18	Calculating the percentage yield from the preparation of a salt *(internal assessment opportunity: activity ASD1)* *(internal assessment opportunity: activity ASD2)*	1.3j
19	The importance of atom economy	1.3g

Lesson number	Lesson title	Specification references
20	Enthalpy change and exothermic and endothermic reactions	1.4a, b, c
21	Making more efficient use of energy in the chemical industry	2.13a(iv)
22	Standard enthalpy changes	1.4d
23	An introduction to measuring enthalpy changes	1.4d, f
24	Measuring enthalpy change in an insulated container ***(internal assessment opportunity: activity ASC2)***	1.4f(i)
25	Measuring enthalpy of combustion	1.4f(ii)
26	An introduction to Hess's Law	1.4e
27	Hess's Law calculations	1.4e
28	Measuring an enthalpy change indirectly ***(internal assessment opportunity: activity ASC4)***	1.4e, f(iii)
29	Using bond enthalpy to find enthalpy changes	1.4g
30	Making predictions about reactions using bond enthalpy data	1.4g

Atomic structure, the periodic table and bonding

Lesson number	Lesson title	Specification references
1	Ionisation energy	1.5d
2	Evidence for quantum shells	1.5e(i)
3	Evidence for electron sub-shells — the trend in ionisation energy across a period	1.5e(ii), k(ii)
4	The shapes of s and p orbitals	1.5f
5	The electronic configuration of the atoms from hydrogen to krypton	1.5g
6	The relationship between electronic structure and chemical properties	1.5h
7	The periodic table and periodic properties and explaining trends in melting temperature across a period	1.5i, j, k(i, ii)
8	What are ions and what evidence is there for them?	1.6.1a, b, c
9	Ionic compounds	1.6.1a, d, e
10	Trends in the sizes of ions	1.6.1f
11	Measuring the energy formation of an ionic lattice	1.6.1g
12	Why don't experimental values always match with theoretical predictions of lattice energy?	1.6.1h, i, j, k
13	Predicting the formula of ionic compounds	1.6.1l
14	What are covalent bonds and what evidence is there for them?	1.6.2a
15	Diagrams for simple covalent molecules	1.6.2b
16	An introduction to electron-pair repulsion theory	2.3a
17	Shapes of common molecules	2.3b, c, d
18	Giant structures of carbon	2.3e
19	What is metallic bonding?	1.6.3a, b, c
20	Ionic to covalent: a continuum	2.4a, b
21	Polar molecules	2.4c, d
22	Intermolecular forces involving permanent dipoles, instantaneous dipoles, induced dipoles (London forces) and hydrogen bonding	2.5a
23	Explaining the boiling and melting temperatures of alkanes	2.5b(i, ii)
24	Solubility of molecules in different solvents	2.5c
25	What factors determine solubility?	2.5d

Organic chemistry and analytical techniques

Throughout this section reactions should be classified as addition, elimination, substitution, oxidation, reduction, hydrolysis or polymerisation and the terms 'free radical', 'electrophile' and 'nucleophile' should be defined (as per the specification 2.11a, b, c, d, e).

Lesson number	Lesson title	Specification references
1	How do we deal with hazards and risks in organic chemistry?	1.7.1c, d
2	Sustainability in the chemical industry: reducing hazards and pollution	2.13a(i, ii, v)
3	Naming organic molecules	1.7.1a, b
4	An introduction to alkanes and their use as fuels	1.7.2a, b, e
5	Where are alkanes obtained from?	1.7.2c
6	The need for alternative fuels	1.7.2d
7	The mechanism for the reaction of alkanes with halogens	1.7.2e, 2.11f
8	Chemistry in the ozone layer	2.11g
9	CFCs and the ozone layer	2.13f
10	Bonding in alkenes: σ and π bonds	1.7.3a
11	Geometric isomerism in alkenes	1.7.3b, c
12	Reactions of alkenes and testing for alkenes	1.7.3d, f
13	Mechanisms for addition reactions of alkenes	1.7.3e, 2.11f
14	Addition polymerisation of alkenes	1.7.3g
15	More sustainable production of polymers	1.7.3h
16	An introduction to alcohols and how to test for them	2.10.1a, b, c(iii)
17	Reactions of alcohols	2.10.1.c
18	Preparation of an aldehyde	2.10.1.d
19	Preparation of a carboxylic acid ***(internal assessment opportunity: activity ASD3)***	2.10.1.d
20	An introduction to halogenoalkanes and their uses	2.10.2a, f
21	Reactions of halogenoalkanes with aqueous alkali, alcoholic alkali and alcoholic ammonia	2.10.2d(i, ii, iv)
22	Mechanisms in addition reactions of halogenoalkanes	2.11f
23	The reaction of halogenoalkanes with water containing dissolved silver nitrate: comparing primary, secondary and tertiary	2.10.2b, d(iii)

Lesson number	Lesson title	Specification references
24	Preparation of halogenoalkanes *(internal assessment opportunity: activity ASD3)*	2.10.2c
25	Identifying organic molecules by mass spectroscopy	2.12a
26	An introduction to infrared spectroscopy — which molecules absorb infrared?	2.12c, d
27	Using infrared spectroscopy	2.12b
28	Observation exercise on organic compounds	

Inorganic chemistry

Lesson number	Lesson title	Specification references
1	An introduction to group 2 and the trends in ionisation energy	2.7.1a
2	Flames tests for group 1 and group 2 compounds	2.7.1f, g(ii)
3	Reactions of group 2 elements with oxygen	2.7.1b
4	Reactions of group 2 elements with chlorine	2.7.1b
5	Reactions of group 2 elements with water	2.7.1b
6	Reactions of the oxides and hydroxides of group 2 elements with water and dilute acid	2.7.1c
7	The stability of group 1 and group 2 carbonates and nitrates	2.7.1e, g(i)
8	Explaining the trends in stability of group 1 and group 2 carbonates and nitrates	2.7.1e
9	Using oxidation numbers	2.6a
10	Writing half-equations and full equations for redox reactions	2.6b
11	An introduction to halogens	2.7.2a, e
12	Oxidation reactions of halogens	2.7.2b(i)
13	An introduction to iodine/thiosulfate titrations	2.7.2c
14	Carrying out an iodine/thiosulfate titration ***(internal assessment opportunity: activity ASC3)***	2.7.2c
15	Disproportionation reactions of halogens	2.7.2b(ii)
16	Silver halides and hydrogen halides	2.7.2d(ii, iii)
17	Reactions of potassium halides with halogens and silver nitrate solution	2.7.2d(i)
18	Observation exercise on three inorganic compounds	

Kinetics and equilibria

Lesson number	Lesson title	Specification references
1	Factors that affect the rate of a reaction	2.8a
2	Investigating and explaining factors that affect rate	2.8b, f
3	Activation energy	2.8d
4	Catalysts	2.8e
5	Improving atom economy by using catalysts	2.13a(iii)
6	The Maxwell-Boltzmann model of distribution	2.8c
7	An introduction to chemical equilibria and how temperature, pressure and concentration affect them	2.9a, c(i, ii)
8	Predicting changes in the position of equilibrium	2.9b

A2 Chemistry

Why do chemical reactions happen? — entropy and equilibria

Lesson number	Lesson title	Specification references
1	What is entropy?	4.4b, c, d
2	The natural direction of change	4.4e, f
3	Increases in entropy during chemical reactions	4.4a, g
4	Calculating entropy changes	4.4h, i, j
5	The feasibility of a reaction, thermodynamic stability and kinetic inertness	4.4k, l, m
6	Predicting solubility from the enthalpy and entropy of solution	4.4n, o, p
7	The idea of an equilibrium constant	4.5a, b, c, e
8	Relating entropy to equilibrium constants	4.5f, h
9	Calculations involving K_c and K_p	4.5e
10	More calculations involving K_c and K_p	4.5g
11	Determination of an equilibrium constant	4.5d
12	Explaining why temperature, pressure and catalysis affect an equilibrium constant (if at all) and the interplay with rate of reaction	4.6a
13	Choosing conditions for industrial processes	4.6b
14	Controlling reactions for safety, yield, cost and atom economy	4.6c, d
15	What are acids and bases?	4.7a, b, c
16	A definition for pH and measuring pH for a variety of substances	4.7d, f
17	K_a, K_w and strong and weak acids and bases	4.7d, e
18	Calculating K_a for a weak acid	4.7h
19	Determination of K_a for a weak acid	4.7g
20	pH changes during acid/base titrations	4.7i
21	Choosing suitable indicators	4.7j
22	Finding K_a for a weak acid from a pH titration ***(internal assessment opportunity: activity A2C1)***	4.7l
23	An introduction to buffer solutions	4.7k, l
24	Buffers in biological systems	4.7m

Rates

Lesson number	Lesson title	Specification references
1	Techniques to measure rate of reaction	4.3b
2	Rate equations, rate constants and the order of a reaction	4.3a
3	Determining the order of a reaction and the rate equation from experimental data	4.3f(ii, iii)
4	Graphical representation of kinetic measurements	4.3d
5	Half life in a chemical reaction	4.3a, f(i)
6	Investigating the rate of a reaction ***(internal assessment opportunity: activity A2C2)***	4.3c
7	Activation energy and types of catalysts	4.3a
8	Investigating the activation energy of a reaction ***(internal assessment opportunity: activity A2C4)***	4.3f(v), g
9	Relating a mechanism to the rate determining step	4.3a, f(iv), h, j
10	Isomerism and chirality	4.8.1a, b
11	Optical activity of chiral molecules	4.8.1c
12	Evidence for reaction mechanisms from optical activity	4.8.1d

Redox and the chemistry of the transition metals (part 1)

Lesson number	Lesson title	Specification references
1	Linking oxidation number and reaction stoichiometry	5.3.1a, b
2	Redox titrations with potassium manganate(VII)	5.3.1h(i)
3	Redox titrations with sodium thiosulfate	5.3.1h(ii)
4	Measuring standard electrode potentials	5.3.1c
5	Predicting the thermodynamic feasibility and the extent of reactions (vanadium)	5.3.1d, e, f
6	Hydrogen and alcohol fuel cells	5.3.1j
7	How breathalysers work	5.3.1k
8	An introduction to transition metals	5.3.2a, b, c
9	Characteristics of transition metals	5.3.2d
10	Using standard electrode potentials to predict the feasibility of forming different oxidation states of a transition metal	5.3.1g and 5.3.2d(i), f(i)
11	The chemistry of copper	5.3.2e, f, g(i)
12	The chemistry of chromium	5.3.2e, f, g(ii)
13	Explaining the chemistry of copper and chromium	5.3.2f

Redox and the chemistry of the transition metals (part 2)

Lesson number	Lesson title	Specification references
14	Preparing a sample of a complex ion ***(internal assessment opportunity: activity A2D2)***	5.3.2g(iii)
15	Reactions of transition metal ions with aqueous sodium hydroxide	5.3.2j
16	Reactions of transition metal ions with aqueous ammonia	5.3.2j
17	Ionic equations for the reaction of transition metal ions with aqueous sodium hydroxide	5.3.2k
18	Observation exercises	
19	Transition metals as catalysts	5.3.2h, i
20	Modern uses of transition metals	5.3.2l

Further organic chemistry

Throughout this section the techniques listed in specification reference 5.4.3f should be described and carried out where appropriate. Opportunities should also be given to plan reaction schemes of up to four steps and to identify control measures to reduce risk during a synthesis. See specification references 5.4.3d (ii, iii, iv).

Lesson number	Lesson title	Specification references
1	An introduction to aldehydes and ketones: examples and solubility	4.8.2a, b
2	Testing and identifying carbonyl compounds	4.8.2c(iv)
3	Reactions of carbonyl compounds	4.8.2c(i, ii, iii, v)
4	The mechanism of the reaction of iodine with propanone	4.3.1e, i
5	An introduction to carboxylic acids: examples, physical properties and preparation	4.8.3a, b, c
6	Reactions of carboxylic acids	4.8.3d(i, ii, iii)
7	Synthesis of esters ***(internal assessment opportunity: activity A2D3)***	4.8.3d(iv)
8	Reactions of esters	4.8.4a, c
9	Polyesters	4.8.4d
10	Reactions of acyl chlorides	4.8.4a, b
11	Evidence for the structure of the benzene ring	5.4.1a
12	Reactions of benzene: combustion, addition of hydrogen and bromine, and with fuming sulphuric acid	5.4.1b
13	Reactions of benzene: concentrated nitric and sulphuric acids	5.4.1b, d
15	Reactions of benzene: halogenoalkanes and acyl chlorides	5.4.1b, d
16	Reactions of phenol	5.4.1e
17	An introduction to amines and the formation of aromatic amines	5.4.2a(i), b(i, ii, iii, iv), c
18	Making paracetamol: reactions of amines with ethanoyl chloride and halogenoalkanes	5.4.2b(v)
19	Making an azo dye	5.4.2d
20	Amides and polyamides	5.4.2e, f, g
21	Properties of polyamides	5.4.2h
22	An introduction to amino acids	5.4.2a(ii), i(i)
23	Separation of amino acids	5.4.2i(ii, v)

Lesson number	Lesson title	Specification references
24	Proteins	5.4.2i(iv)
25	Optical activity of amino acids	5.4.2i(iii)
26	Synthesis of stereo-specific drugs	5.4.3d(v)
27	How does radiation affect molecules?	4.9a, c
28	High resolution nmr	4.9b(i, ii, iii)
29	Using nmr to identify molecular structures and in magnetic resonance imaging	4.9b(iv)
30	A review of mass spectroscopy	4.9d
31	Gas chromatography and HPLC	4.9e
32	Identifying organic molecules for synthesis	5.4.3b, c
33	The importance of synthetic organic chemistry	5.4.3a
34	Predicting reactions of organic compounds	5.4.3d(i)
35	Control measures for hazards in organic synthesis	5.4.3d(iv)
36	Combinatorial chemistry	5.4.3e
37	The preparation of aspirin or the synthesis of aspirin in two stages *(internal assessment opportunity: activity A2D1)* *(internal assessment opportunity: activity A2M1)*	
38	Continuing the synthesis of aspirin in two stages *(internal assessment opportunity: activity A2M1)*	

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