International® Baccalaureate

Diploma Programme
Chemistry: summary of changes

September 2007

Chemistry: summary of changes

The new group 4 guides were sent to schools in March 2007 for first examinations in May 2009.

This document is designed to help teachers of the previous course (published 2001) to follow the changes in the chemistry syllabus. It should be read in conjunction with the new *Chemistry guide* and not as an alternative to it.

The following table provides an overview of the chemistry syllabus, indicating where the content has changed significantly with the introduction of new assessment statements (AS), movement of assessment statements between sections of the syllabus or rewording of previous assessment statements. The order of the topics and options reflects the new syllabus.

Core

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
Topic 1: Quantitative chemistry (previously Stoichiometry)					
1.4.5	Apply the concept of molar volume at standard temperature and pressure in calculations.	From topic 5	1.2.2	Distinguish between *atomic mass*, *molecular mass* and *formula mass*.	
1.4.6	Solve problems involving the relationship between temperature, pressure and volume for a fixed mass of an ideal gas.	From topic 5			
1.4.7	Solve problems using the ideal gas equation, $PV = nRT$.	From topic 5			
1.4.8	Analyse graphs relating to the ideal gas equation.	From topic 5			
Topic 2: Atomic structure (previously atomic theory)					
2.1.7	Discuss the uses of radioisotopes.				
2.2.1	Describe and explain the operation of a mass spectrometer.	From AHL (topic 12)			
2.2.2	Describe how the mass spectrometer may be used to determine relative atomic mass using the 12C scale.	From AHL (topic 12)			
2.2.3	Calculate non-integer relative atomic masses and abundance of isotopes from given data.	From AHL (topic 12)			
2.3.1	Describe the electromagnetic spectrum.	From option G			

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
Topic 3: Periodicity					
3.2.1	Define the terms *first ionization energy* and *electronegativity*.				
3.2.4	Compare the relative electronegativity values of two or more elements based on their positions in the periodic table.	From topic 4			
Topic 4: Bonding					
4.1.2	Describe how ions can be formed as a result of electron transfer.		4.2.4	Compare the relative electronegativity values of two or more elements based on their positions in the periodic table.	To topic 3
4.1.7	State the formula of common polyatomic ions formed by non-metals in periods 2 and 3.				
4.1.8	Describe the lattice structure of ionic compounds.				
4.2.1	Describe the covalent bond as the electrostatic attraction between a pair of electrons and positively charged nuclei.				
4.2.9	Describe and compare the structure and bonding in the three allotropes of carbon (diamond, graphite and C_{60} fullerene).				
4.2.10	Describe the structure of and bonding in silicon and silicon dioxide.				
Topic 5: States of matter (previous syllabus only)					
			5.1.1	Describe and compare solids, liquids and gases as the three states of matter.	

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
			5.1.2	Describe kinetic theory in terms of the movement of particles whose average energy is proportional to absolute temperature.	To topic 6
			5.1.3	Describe the Maxwell–Boltzmann energy distribution curve.	To topic 6
			5.1.4	Draw and explain qualitatively Maxwell–Boltzmann energy distribution curves for different temperatures.	To topic 6
			5.1.5	Describe qualitatively the effects of temperature, pressure and volume changes on a fixed mass of an ideal gas.	To topic 1
			5.1.6	State the ideal gas equation, $PV = nRT$.	To topic 1
			5.1.7	Apply the ideal gas equation in calculations.	To topic 1
Topic 5: Energetics (previously topic 6)					
5.1.2	State that combustion and neutralization are exothermic processes.	Similar to statement 11.2.6	6.1.4	Describe and explain the changes which take place at the molecular level in chemical reactions.	To AHL (topic 15)
5.2.2	Design suitable experimental procedures for measuring the heat energy changes of reactions.		6.5.1	State and explain the factors which increase the disorder (entropy) in a system.	To AHL (topic 15)
			6.5.2	Predict whether the entropy change (ΔS) for a given reaction or process would be positive or negative.	To AHL (topic 15)
			6.6.1	Define *standard free energy change of reaction* ($\Delta G^{\ominus}$).	

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
			6.6.2	State whether a reaction or process will be spontaneous by using the sign of $\Delta G^{\ominus}$.	To AHL (topic 15)
			6.6.3	State and predict the effect of a change in temperature on the spontaneity of a reaction, given standard entropy and enthalpy changes.	To AHL (topic 15)
Topic 6: Kinetics (previously topic 7)					
6.1.2	Describe suitable experimental procedures for measuring rates of reactions.		7.2.4	Explain that reactions can occur by more than one step and that one step can determine the rate of reaction.	To AHL (topic 16)
6.2.1	Describe the kinetic theory in terms of the movement of particles whose average energy is proportional to temperature in kelvins.	From topic 5			
6.2.5	Sketch and explain qualitatively the Maxwell–Boltzmann energy distribution curve for a fixed amount of gas at different temperatures and its consequences for changes in reaction rate.	From topic 5			
6.2.7	Sketch and explain Maxwell–Boltzmann curves for reactions with and without catalysts.				
Topic 7 Equilibrium (previously topic 8)					
Topic 8: Acids and bases (previously topic 9)					
8.1.1	Define acids and bases according to the Brønsted–Lowry and Lewis theories.	From AHL (topic 18)	9.4.1	Describe a buffer solution in terms of its composition and behaviour.	To AHL (topic 18)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
8.1.2	Deduce whether or not a species could act as a Brønsted–Lowry and/or a Lewis acid or base.	From AHL (topic 18)	9.4.2	Describe ways of preparing buffer solutions.	To AHL (topic 18)
8.1.3	Deduce the formula of the conjugate acid (or base) of any Brønsted–Lowry base (or acid).	From AHL (topic 18)	9.5.1	Draw and explain a graph showing pH against volume of titrant for titrations involving strong acids and bases.	To AHL (topic 18)
Topic 9: Oxidation and reduction (previously topic 10)					
9.2.1	Deduce simple oxidation and reduction half-equations given the species involved in a redox reaction.		10.3.5	Describe and explain the use of electrolysis in electroplating.	To AHL (topic 19)
9.2.3	Define the terms *oxidizing agent* and *reducing agent*.				
9.2.4	Identify the oxidizing and reducing agents in redox equations.				
9.4.2	State that oxidation occurs at the negative electrode (anode) and reduction occurs at the positive electrode (cathode).	From AHL (topic 19)			
9.5.2	State that oxidation occurs at the positive electrode (anode) and reduction occurs at the negative electrode (cathode).				
Topic 10: Organic chemistry (previously topic 11)					
10.1.12	Identify primary, secondary and tertiary carbon atoms in alcohols and halogenoalkanes.	Concept was present at AHL	11.3.3	Outline the existence of optical isomers.	To AHL (topic 20)
10.1.13	Discuss the volatility and solubility in water of compounds containing the functional groups listed in 10.1.9.	From AHL (topic 20)	11.3.8	Outline the condensation reaction of an alcohol with a carboxylic acid to form an ester, and state the uses of esters.	To AHL (topic 20)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
10.2.4	Explain the reactions of methane and ethane with chlorine and bromine in terms of a free-radical mechanism.		11.3.10	Deduce the condensation polymers formed by amines and by carboxylic acids.	To AHL (topic 20)
10.5.1	Describe, using equations, the substitution reactions of halogenoalkanes with sodium hydroxide.	From AHL (topic 20)	11.3.11	Outline the formation of peptides and proteins from 2-amino acids.	To AHL (topic 20)
10.5.2	Explain the substitution reactions of halogenoalkanes with sodium hydroxide in terms of S_N1 and S_N2 mechanisms.	From AHL (topic 20)			
10.6.1	Deduce reaction pathways given the starting materials and the product.				
Topic 11: Measurement and data processing (new syllabus only)					
		All new			

AHL

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
Topic 12: Atomic structure (previously atomic theory)					
			12.1.1	State the principles of a mass spectrometer and outline the main stages in its operation.	To the core (topic 2)
			12.1.2	Describe how the mass spectrometer may be used to determine relative isotopic, atomic and molecular masses using the ^{12}C scale.	To the core (topic 2)
Topic 13: Periodicity					
13.2.8	Outline the economic significance of catalysts in the Contact and Haber processes.				
Topic 14: Bonding					
			14.4.1	Describe and explain the structures and properties of diamond, graphite and fullerene.	To the core (topic 4)
Topic 15: Energetics					
15.2.1	Define and apply the terms lattice enthalpy and electron affinity.	Electron affinity is new here			
15.2.3	Construct a Born–Haber cycle for group 1 and 2 oxides and chlorides and use it to calculate an enthalpy change.	Clarification only			
15.3.1	State and explain the factors that increase the entropy in a system.	From the core (topic 6)			
15.3.2	Predict whether the entropy change (ΔS) for a given reaction or process is positive or negative.	From the core (topic 6)			

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
15.4.1	Predict whether a reaction or process will be spontaneous by using the sign of $\Delta G^{\ominus}$.	From the core (topic 6)			
15.4.3	Predict the effect of a change in temperature on the spontaneity of a reaction using standard entropy and enthalpy changes and the equation $\Delta G^{\ominus} = \Delta H^{\ominus} - T\Delta S^{\ominus}$.	From the core (topic 6)			
Topic 16: Kinetics					
16.2.1	Explain that reactions can occur by more than one step and that the slowest step determines the rate of reaction (rate-determining step).	From the core (topic 7)	16.1.4	Define the term *half-life* and calculate the half-life for first-order reactions only.	
			16.2.1	Define the terms *rate-determining step*, *molecularity* and *activated complex*.	
			16.3.5	Outline the use of homogeneous and heterogeneous catalysts.	
Topic 17: Equilibrium					
		No changes			
Topic 18: Acids and bases					
18.2.1	Describe the composition of a buffer solution and explain its action.	From the core (topic 9)	18.1.1	Define acids and bases according to the Brønsted–Lowry theory.	To the core (topic 8)
			18.1.2	Identify whether or not a compound could act as a Brønsted–Lowry acid or base.	To the core (topic 8)
			18.1.3	Identify the conjugate acid–base pairs in a given acid–base reaction.	To the core (topic 8)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
			18.1.4	Determine the structure for the conjugate acid (or base) of any Brønsted–Lowry base (or acid).	To the core (topic 8)
			18.2.1	Define and apply the terms *Lewis acid* and *Lewis base*.	To the core (topic 8)
Topic 19: Oxidation and reduction					
19.2.3	Describe the use of electrolysis in electroplating.	From the core (topic 9)	19.1.1	Balance redox equations in acid solution.	
Topic 20: Organic chemistry					
20.1.1	Deduce structural formulas for compounds containing up to six carbon atoms with one of the following functional groups: amine, amide, ester and nitrile.		20.1.1	State that the structure of a compound can be determined using information from a variety of spectroscopic and chemical techniques.	To option A
20.1.2	Apply IUPAC rules for naming compounds containing up to six carbon atoms with one of the following functional groups: amine, amide, ester and nitrile.		20.1.2	Describe and explain how information from an infrared spectrum can be used to identify functional groups in a compound.	To option A
20.2.1	Explain why the hydroxide ion is a better nucleophile than water.		20.1.3	Describe and explain how information from a mass spectrum can be used to determine the structure of a compound.	To option A
20.2.4	Describe, using equations, the substitution reactions of halogenoalkanes with ammonia and potassium cyanide.		20.1.4	Describe and explain how information from a ^{1}H NMR spectrum can be used to determine the structure of a compound.	To option A
20.2.5	Explain the reactions of primary halogenoalkanes with ammonia and potassium cyanide in terms of the S_N2 mechanism.		20.2.1	State and explain the low reactivity of alkanes in terms of the inertness of C–H and C–C bonds.	To the core (topic 10)
20.2.6	Describe, using equations, the reduction of nitriles using hydrogen and a nickel catalyst.		20.2.2	State that alkanes can react with halogens and distinguish between *homolytic* and *heterolytic fission*.	Similar statement now in the core (topic 10)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
20.3.1	Describe, using equations, the elimination of HBr from bromoalkanes.		20.2.3	Describe and explain the structure of benzene using chemical and physical evidence.	
20.3.2	Describe and explain the mechanism for the elimination of HBr from bromoalkanes.		20.3.1	Distinguish between *primary*, *secondary* and *tertiary halogenoalkanes*.	To the core (topic 10)
20.4.1	Describe, using equations, the reactions of alcohols with carboxylic acids to form esters, and state the uses of esters.	From the core (topic 11)	20.3.2	Describe and explain the S_N1 and S_N2 mechanisms in nucleophilic substitution.	To the core (topic 10)
20.4.3	Deduce the structures of the polymers formed in the reactions of alcohols with carboxylic acids.		20.3.3	Describe and explain the molecularity for the S_N1 and S_N2 mechanisms.	To the core (topic 10)
20.4.4	Deduce the structures of the polymers formed in the reactions of amines with carboxylic acids	From the core (topic 11)	20.4.2	Determine the products formed by the oxidation of primary, secondary and tertiary alcohols using acidified potassium dichromate (VI) solution.	To the core (topic 10)
20.4.5	Outline the economic importance of condensation reactions.	From the core (topic 11)			
20.5.1	Deduce reaction pathways given the starting materials and the product.				
20.6.1	Describe stereoisomers as compounds with the same structural formula but with different arrangements of atoms in space.				
20.6.2	Describe and explain geometrical isomerism in non-cyclic alkenes.	From the core (topic 11)			
20.6.3	Describe and explain geometrical isomerism in C_3 and C_4 cycloalkanes.	From option H			
20.6.4	Explain the difference in the physical and chemical properties of geometrical isomers.	From option H			

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to new guide)**
20.6.5	Describe and explain optical isomerism in simple organic molecules.	From option H			
20.6.6	Outline the use of a polarimeter in distinguishing between optical isomers.	From the core (topic 11)			
20.6.7	Compare the physical and chemical properties of enantiomers.				

Options

Option A: Modern analytical chemistry (previously option G)

The main change to this option is that it was previously only available at HL. It has therefore been reorganized into “SL and HL” and “HL only” sections. Many of the assessment statements have been reworded.

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
Option A: Modern analytical chemistry					
A.1.2	State that the structure of a compound can be determined by using information from a variety of analytical techniques singularly or in combination.	Significantly reworded from G.1.2	G.1.2	Outline the information that can be obtained from analytical techniques, singly or in combination.	
A.3.2	Describe how information from an IR spectrum can be used to identify bonds.	Similar to G.4.3	G.4.2	State the relationship between wavelength and wavenumber.	
A.3.4	Analyse IR spectra of organic compounds.	Similar to G.4.3	G.4.3	Deduce the functional groups in an organic molecule from its infrared spectrum.	

Option B: Human biochemistry (previously option C)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
Option B: Human biochemistry					
B.2.2	Describe the characteristic properties of 2-amino acids.		C.3.2	Describe the straight-chain formula of glucose and the structural difference between α-glucose and β-glucose.	
B.3.2	Draw the straight-chain and ring structural formulas of glucose and fructose.		C.4.3	Calculate the number of C=C double bonds in an unsaturated fat using addition reactions.	
B.3.5	Compare the structural properties of starch and cellulose and explain why humans can digest starch but not cellulose.		C.4.4	Describe the hydrolysis of fats to form soaps and the action of soaps.	
B.3.6	State what is meant by the term dietary fibre.		C.5.1	Define the term *vitamin*.	
B.3.7	Describe the importance of a diet high in dietary fibre.		C.5.4	Describe the effects of food processing on the vitamin content of food.	
B.4.2	Outline the difference between HDL and LDL cholesterol and outline its importance.		C.9.1	Explain that different metal ions fulfill different roles in the body due to their different chemical properties.	
B.4.4	Compare the structures of the two essential fatty acids linoleic (omega-6 fatty acid) and linolenic (omega-3 fatty acid) and state their importance.		C.9.2	Describe the importance of the difference in Na^+ and K^+ concentrations across the cell membrane.	
B.4.5	Define the term *iodine number* and calculate the number of C=C double bonds in an unsaturated fat/oil using addition reactions.		C.9.3	Outline the importance of copper ions in electron transport and iron ions in oxygen carriers.	
B.4.6	Describe the condensation of glycerol and three fatty acid molecules to make a triglyceride.				

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
B.4.7	Describe the enzyme-catalysed hydrolysis of triglycerides during digestion.				
B.4.8	Explain the higher energy value of fats as compared to carbohydrates.				
B.5.1	Outline the difference between micronutrients and macronutrients.				
B.5.4	Discuss the causes and effects of nutrient deficiencies in different countries and suggest solutions.				
B.7.2	Compare inorganic catalysts and biological catalysts (enzymes).				
B.7.3	Describe the relationship between substrate concentration and enzyme activity.				
B.8.2	Distinguish between the structures of DNA and RNA.				
B.9.1	Compare aerobic and anaerobic respiration of glucose in terms of oxidation/reduction and energy released.				

Option C: Chemistry in industry and technology (previously option E: chemical industries)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
Option C: Chemistry in industry and technology					
C.1.4	Describe alloys as a homogeneous mixture of metals or a mixture of a metal and non-metal.		E.1.1	Outline the abundance, occurrence and availability of sources of materials.	
C.1.5	Explain how alloying can modify the properties of metals.		E.1.2	Identify the factors that influence the establishment of a chemical industry in a particular location.	
C.1.6	Describe the effect of heat treatment of steel.		E.1.3	Outline the division of the industry into both intermediates and consumer products.	
C.2.1	Compare the use of oil as an energy source and as a chemical feedstock.	Changed	E.1.4	State the increasing importance of biotechnology in chemical manufacture.	
C.4.1	Compare the modes of action of homogeneous and heterogeneous catalysts.		E.2.1	Outline the principles used in the physical separation of materials.	
C.4.2	Outline the advantages and disadvantages of homogeneous and heterogeneous catalysts.		E.2.2	Discuss the chemical principles involved in the extraction of metals from their ores.	
C.4.3	Discuss the factors in choosing a catalyst for a process.		E.4.1	Outline the importance of oil as a source of chemical feedstock.	Changed
C.5.1	Describe how a hydrogen–oxygen fuel cell works.	From option F	E.4.2	Outline the removal of sulfur from crude oil.	
C.5.2	Describe the workings of rechargeable batteries.		E.4.3	Describe the fractional distillation of oil.	
C.5.3	Discuss the similarities and differences between fuel cells and rechargeable batteries.		E.4.5	Describe reforming processes and their products.	

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
C.6.1	Describe the meaning of the term liquid crystals.		E.4.6	State the uses of refinery products as feedstock for the organic chemical industry.	
C.6.2	Distinguish between *thermotropic* and *lyotropic* liquid crystals.		E.6.1	Describe the extraction and purification of silicon.	
C.6.3	Describe the liquid-crystal state in terms of the arrangement of the molecules and explain thermotropic behaviour.		E.6.2	Compare the electrical conductivity of a semiconductor with that of metals and non-metals.	
C.6.4	Outline the principles of the liquid-crystal display device.		E.7.1	Analyse Ellingham diagrams to predict the feasibility of reducing metal oxides.	
C.6.5	Discuss the properties needed for a substance to be used in liquid-crystal displays.				
C.7.1	Define the term *nanotechnology*.				
C.7.2	Distinguish between *physical* and *chemical* techniques in manipulating atoms to form molecules.				
C.7.3	Describe the structure and properties of carbon nanotubes.				
C.7.4	Discuss some of the implications of nanotechnology.				
C.8.1	Distinguish between *addition* and *condensation* polymers in terms of their structures.				
C.8.2	Describe how condensation polymers are formed from their monomers.				
C.8.3	Describe and explain how the properties of polymers depend on their structural features.				

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
C.8.4	Describe ways of modifying the properties of polymers.				
C.8.5	Discuss the advantages and disadvantages of polymer use.				
C.10.2	Describe how sunlight interacts with semiconductors.				
C.11.1	Identify molecules that are likely to show liquid-crystal properties, and explain their liquid-crystal behaviour on a molecular level.				
C.11.2	Describe and explain in molecular terms the workings of a twisted nematic liquid crystal.				
C.11.3	Describe the liquid-crystal properties of Kevlar, and explain its strength and its solubility in concentrated sulfuric acid.				

Option D: Medicines and drugs (previously option B)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
Option D: Medicines and drugs					
D.1.4	Discuss the terms therapeutic window, tolerance and side-effects.		B.1.4	Discuss the terms *lethal dosage* (LD_{50}), *tolerance* and *side effects*.	
D.6.3	Discuss and explain the importance of patient compliance and the effect of penicillin overprescription.		B.6.2	Compare *broad-spectrum* and *narrow-spectrum* antibiotics.	
D.8.3	Explain the importance of the beta-lactam ring action of penicillin.		B.6.4	Discuss and explain the effect overprescription of penicillins has, and the use of penicillins in animal feedstock.	
D.8.4	Explain the increased potency of diamorphine (heroin) compared to morphine.		B.9.1	Compare local and general anesthetics in terms of their mode of action.	
D.9.1	Discuss the use of a compound library in drug design.		B.9.2	Compare the structures and effects of cocaine, procaine and lidocaine.	
D.9.3	Describe how computers are used in drug design.		B.9.3	Discuss the advantages and disadvantages of nitrous oxide, ethoxyethane, trichloromethane, cyclopropane and halothane.	
D.9.4	Discuss how the polarity of a molecule can be modified to increase its aqueous solubility and how this facilitates its distribution around the body.		B.9.4	Calculate the partial pressures of component gases in an anesthetic mixture.	

Option E: Environmental chemistry (previously option D)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
Option E: Environmental chemistry					
E.4.3	Discuss the alternatives to CFCs in terms of their properties.		D.1.2	Outline the effects of primary air pollution on health.	
E.6.1	List the primary pollutants found in waste water and identify their sources.	Previously HL extension material	D.2.3	State the environmental effects of ozone depletion.	
E.7.1	Discuss salinization, nutrient depletion and soil pollution as causes of soil degradation.		D.3.4	Outline the influence of particulates on the Earth's surface temperature.	
E.7.2	Describe the relevance of the soil organic matter (SOM) in preventing soil degradation, and outline its physical and biological functions.		D.5.1	Discuss the demand for fresh water and reasons for the inadequacy of its supply.	
E.7.3	List common organic soil pollutants and their sources.		D.5.2	Compare the advantages and disadvantages of treating drinking water with chlorine and ozone.	
E.8.1	Outline and compare the various methods for waste disposal.		D.5.4	Discuss ways to reduce the amount of water used and to recycle water.	
E.8.2	Describe the recycling of metal, glass, plastic and paper products and outline its benefits.		D.7.2	Discuss the increasing use of tertiary treatment.	
E.8.3	Describe the characteristics and sources of different types of radioactive waste.		D.8.4	Discuss the formation of thermal inversions and their effects on air quality.	
E.8.4	Compare the storage and disposal methods for different types of radioactive waste.		D.9.4	Describe the properties required for sun-screening compounds.	
E.11.1	Describe the mechanism of acid deposition caused by the oxides of nitrogen and oxides of sulfur.		D.10.1	Discuss the different approaches to expressing toxicity.	

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
E.11.2	Explain the role of ammonia in acid deposition.		D.10.2	State the principal toxic types of chemicals that may be found in polluted water.	
E.12.1	Solve problems relating to the removal of heavy-metal ions, phosphates and nitrates from water by chemical precipitation.		D.10.3	Outline the sources, health and environmental effects of cadmium, mercury and lead compounds.	
E.12.2	State what is meant by the term cation-exchange capacity (CEC) and outline its importance.		D.10.4	Describe the sources and possible health effects of nitrates in drinking water.	
E.12.3	Discuss the effects of soil pH on cation-exchange capacity and availability of nutrients.				
E.12.4	Describe the chemical functions of soil organic matter (SOM).				

Option F: Food chemistry

This is a new option.

Option G: Further organic chemistry (previously option H)

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
Option G: Further organic chemistry					
G.2.3	Describe, using equations, the hydrolysis of cyanohydrins to form carboxylic acids.	New	H.1.1	Describe and explain geometrical isomerism in non-cyclic alkenes.	To topic 20
G.5.1	Describe and explain the structure of benzene using physical and chemical evidence.		H.1.2	Explain the difference in physical and chemical properties of geometrical isomers.	To topic 20
G.6.1	Outline the formation of Grignard reagents.		H.1.3	Describe geometrical isomerism in C_3 and C_4 cyclo-alkanes.	To topic 20
G.6.2	Describe, using equations, the reactions of Grignard reagents with water, carbon dioxide, aldehydes and ketones.		H.1.4	Define *plane-polarized light* and describe how it interacts with enantiomers.	Changed but can now be found as 20.6.5
G.7.1	Deduce reaction pathways given the starting materials and the product.		H.1.5	Define the term *racemic mixture*.	
G.9.1	Describe, using equations, the reactions of acid anhydrides with nucleophiles to form carboxylic acids, esters, amides and substituted amides.		H.1.6	Compare the physical and chemical properties of enantiomers.	
G.9.2	Describe, using equations, the reactions of acyl chlorides with nucleophiles to form carboxylic acids, esters, amides and substituted amides.		H.6.1	Outline how the relative rate of nucleophilic substitution is affected by different nucleophiles.	To topic 20
G.9.3	Explain the reactions of acyl chlorides with nucleophiles in terms of an addition–elimination mechanism.		H.6.2	Describe and explain inductive and steric effects of substituents on substitution reaction.	To topic 20

New to syllabus			Removed from previous syllabus		
AS		**Comment (refers to previous guide)**	**AS**		**Comment (refers to previous guide)**
G.11.1	Deduce reaction pathways given the starting materials and the product.		H.6.3	Describe and explain the relative rates of hydrolysis of halogenated benzene compounds.	
			H.7.2	Describe and explain the mechanism for the elimination of HBr from bromoalkanes.	