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IGCSE

London Examinations IGCSE

Chemistry (4335)

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delivered locally, recognised globally

Specification

London Examinations IGCSE

Chemistry (4335)

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Tel +44 (0) 190 884 7750

international@edexcel.org.uk

www.edexcel-international.org

Changes from Issue 1 are indicated by marginal lines.

Acknowledgements

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Authorised by Elizabeth Blount

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Contents

Introduction

The London Examinations IGCSE in Chemistry is designed as a two-year course that is both comprehensive and relevant to modern life. The flexible approach to assessment will allow each centre to deliver the course in a way that suits them best.

Key features

- based on the content of the equivalent Edexcel GCSE examination in Chemistry and GCE O level Chemistry
- comprehensive description of subject content
- straightforward linear assessment
- two routes of assessment: 100% examination, or 80% examination and 20% coursework for London Examinations approved Teaching Institutions only
- support for coursework assessment, including free consultancy for centres
- a full range of teacher support
- provides a solid basis for Edexcel GCE AS and Advanced level Chemistry, or equivalent qualifications.

Availability of external assessment

The specification will be examined twice a year, in May and November.

Centres are asked to note that the coursework component of this specification is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. For full details, see the section 'Availability of coursework to international centres'.

Summary of scheme of assessment

Paper / Component	Mode of assessment	Weighting	Length
1 OR 2	Examination Paper 1F, targeted at grades C – G (Foundation Tier)	80%	1½ hours
	Examination Paper 2H, targeted at grades A* – D (Higher Tier)	80%	2 hours
3 OR 4	Examination Paper 3, targeted at grades A* – G (common to both tiers)	20%	1¼ hours
	Coursework, targeted at grades A* – G (common to both tiers)	20%	-

Students are entered at **either** Foundation Tier **or** Higher Tier.

Students will be required to take **two** components.

- **Foundation Tier** students will take Paper 1F, and **either** Paper 3 **or** Component 4 (coursework).
- **Higher Tier** students will take Paper 2H, and **either** Paper 3 **or** Component 4 (coursework).

Use of calculators is permitted in all written examinations.

Summary of the specification content

There are **five** areas of content. Students will be required to demonstrate specified knowledge and critical understanding of:

1. Principles of chemistry
2. Chemistry of the elements
3. Organic chemistry
4. Physical chemistry
5. Chemistry in society

In addition, students will be assessed on the investigative skills described on pages 31 to 37, either through written assessment (Paper 3) or by teacher-assessed coursework (Component 4).

Specification aims and assessment objectives

Aims

This specification gives candidates opportunities to

- learn about the unifying patterns and themes of chemistry
- appreciate the practical nature of chemistry, acquiring experimental and investigative skills based on correct and safe laboratory techniques
- appreciate the importance to scientific methods of accurate experimental work and reporting
- form hypotheses and design experiments to test them
- develop a logical approach to problem-solving in a wider context
- understand the widespread importance of chemistry and the way materials are used in the world
- appreciate how the work of the chemist has social, industrial, technological, environmental and economic consequences for the community
- prepare for more advanced courses in chemistry and for courses which require them to have a knowledge of chemistry.

Assessment objectives

This specification requires that all candidates demonstrate the following assessment objectives in the context of the content and skills prescribed.

AO1 Knowledge and understanding

In the examination, candidates will be tested on their ability to

- recognise, recall and show understanding of specific scientific facts, terminology, principles, concepts and practical techniques, including aspects of safety
- draw on existing knowledge to show understanding of the social, economic, environmental and technological applications and implications of chemistry
- select, organise and present relevant information clearly and logically, using appropriate vocabulary.

AO2 Application of knowledge and understanding, analysis and evaluation

In the examination, candidates will be tested on their ability to:

- describe, explain and interpret phenomena, effects and ideas in terms of chemical principles and concepts, presenting arguments and ideas clearly and logically
- interpret and translate, from one form into another, data presented as continuous prose or in tables, diagrams, drawings and graphs
- carry out relevant calculations
- apply chemical principles and concepts to unfamiliar situations, including those related to applications of chemistry in different domestic, industrial and environmental contexts
- evaluate chemical information and make informed judgements based on it.

AO3 Experimental and investigative skills

In the assessment of practical skills, candidates will be tested on their ability to:

- devise and plan investigations, selecting appropriate techniques
- demonstrate or describe appropriate experimental and investigative methods, including safe and skilful practical techniques
- make observations and measurements with appropriate precision, record these methodically and present them in a suitable form
- analyse and interpret data from experimental activities to draw conclusions which are consistent with the evidence, using chemical knowledge and understanding, and communicate these findings using appropriate specialist vocabulary
- evaluate data and methods.

Scheme of assessment

Tiers of entry

Candidates are entered at **either** Foundation Tier **or** Higher Tier.

Questions in the Foundation Tier paper are targeted at grades in the range C - G. The highest grade which will be awarded at Foundation Tier is grade C.

Questions in the Higher Tier paper are targeted at grades in the range A* - D. There is a 'safety net' grade E for candidates who narrowly fail to achieve grade D.

Candidates who fail to achieve grade G on Foundation Tier or Grade E on Higher Tier will be awarded 'Ungraded'.

Some examination questions will be common to both tiers.

Weighting of assessment objectives

Assessment objective		Weighting
AO1	Knowledge and understanding	45 – 55% (of which no more than half will be recall)
AO2	Application of knowledge and understanding, analysis and evaluation	25 – 35% (evenly distributed across all aspects of the objective)
AO3	Experimental and investigative skills	20%

The percentages are not intended to provide a precise statement of the number of marks allocated to particular assessment objectives.

Relationship of assessment objectives to scheme of assessment

Paper/Component	Assessment Objective 1	Assessment Objective 2	Assessment Objective 3
Paper 1F (Foundation)	45 – 55%	25 – 35%	0
OR			
Paper 2H (Higher)	45 – 55%	25 – 35%	0
Paper 3	0	0	20%
OR			
Component 4 (Coursework)	0	0	20%

Assessment Components

Paper 1F (Foundation Tier, 1 hour 30 minutes)

This paper consists of two sections, A and B, each of which will contain a variety of shorter and longer answer questions.

The questions in Section A will be targeted at grades E to G, while those in Section B will be targeted at grades C and D.

The Paper carries 100 marks that will be scaled to 80% of the assessment and tests Assessment Objectives AO1 and AO2.

Paper 2H (Higher Tier, 2 hours)

This paper consists of two sections, A and B, each of which will contain a variety of shorter and longer answer questions.

The questions in Section A will be targeted at grades C to D, while those in Section B will be targeted at grades A* to B.

The Paper carries 120 marks that will be scaled to 80% of the assessment and tests Assessment Objectives AO1 and AO2.

Note: The questions in Section B of Paper 1F will be identical to those in Section A of Paper 2H.

Paper 3 – Alternative to coursework (common to both tiers, 1 hour 15 minutes)

This is a written paper and is an alternative to coursework.

There will be a range of compulsory questions based on Assessment Objective AO3, targeted at grades A* – G. The questions will test the investigative skills gained by candidates from practical work undertaken during the course.

The four skill areas (P, O, A and E) that will be assessed are described later under 'Investigative Skills'. Candidates will be required to show the ability to: plan experimental procedures (P), describe practical techniques and take measurements (O), analyse evidence and draw conclusions communicating findings using calculations, tables and graphs (A), and evaluate evidence (E).

The paper carries a total of 50 marks that will be scaled to 20% of the assessment.

Component 4 Coursework (common to both tiers)

Candidates are required to submit coursework that will be assessed by the teacher and moderated by Edexcel International. Candidates will be required to show the ability to: plan experimental procedures (P), obtain evidence (O), analyse this evidence and draw conclusions (A), and evaluate evidence (E). These four skill areas (P, O, A and E) are described later under 'Investigative Skills'.

The component is targeted at grades A* – G. It carries a total of 30 marks that will be scaled to 20% of the assessment.

The coursework, component 4 of this specification, is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. See full details under section 'Availability of coursework to international centres'.

Mathematical skills

Candidates need to have been taught and to have acquired competence in the areas of mathematics set out below in order to develop knowledge, understanding and skills in the subject content.

Candidates are permitted to use calculators in all written papers in accordance with the current regulations. For full details, please refer to the Teacher's Guide.

For the purpose of this course it will be assumed that candidates will be able to

- evaluate expressions incorporating the four operations, +, –, x, ÷, either singly or in conjunction with one another, quoting the answer to an appropriate number of significant figures
- use simple proportion, decimals, fractions and percentages

- understand and use compound measures such as speed
- manipulate formulae, equations and expressions
- plot and draw graphs from suitable data, selecting appropriate scales for the axes
- interpret graphs in terms of general trends and by interpolation
- interpret a range of graphs and diagrams
- use an electronic calculator in connection with any of the above as appropriate
- understand that a measurement given as a whole number may be inaccurate by up to one-half in either direction.

In addition, Higher Tier candidates will be expected to be able to

- **understand and use direct and inverse proportion**
- **use numbers in standard form.**

Forbidden combinations

Candidates entering for this specification may not, in the same series of examinations, enter for Edexcel International's IGCSE in Double Award Science, specification code 4437 (first examination May 2006).

Awarding and reporting

The grading, awarding and certification of this specification will comply with the requirements of the IGCSE for courses first examined in 2005.

Assessment of this specification will be available in English only. All written work for examination must be submitted in English.

Availability of coursework to international centres

Centres are asked to note that the coursework component of this specification is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. Candidates studying on their own or at centres recognised as Private Centres are not normally permitted to enter for the coursework component of the specification.

Private Centres may not undertake school-based assessment without the written approval of Edexcel International. This will only be given to centres that satisfy Edexcel International requirements concerning resources/facilities and moderation. Teachers at these centres will be required to undertake special training in assessment before entering candidates. Edexcel International offers centres in-service training in the form of courses and distance learning materials. Private centres that would like to receive more information on school-based assessment should, in the first instance, contact the International Customer Relations Unit.

International Customer Relations Unit (ICRU)
Edexcel International
190 High Holborn
London
WC1V 7BE
UK

international@edexcel.org.uk

Students with particular requirements

Regulations and guidance relating to candidates with special requirements are published annually by the Joint Council for General Qualifications in the UK and are circulated to examinations officers. Further copies of guidance documentation may be obtained from the International Customer Relations Unit (ICRU) at the address below or by telephoning +44 (0) 190 884 7750

London Examinations will assess whether or not special consideration or concessions can be made for candidates with particular requirements. Requests should be addressed to

International Customer Relations Unit (ICRU)
Edexcel International
190 High Holborn
London
WC1V 7BE
UK

Specification Content

Some of the content is designated for the **Higher Tier** candidates only. This content is printed in **bold**.

1. Principles of chemistry

a) Atoms
b) Atomic structure
c) Relative molecular and formula masses
d) Chemical formulae and chemical equations
e) Ionic compounds
f) Covalent substances
g) Electrolysis
h) Metallic crystals

a) Atoms

Candidates will be assessed on their ability to

- recall simple experiments leading to the idea of the smallness of particles and to their motion including

  — dilution of coloured solutions
  — diffusion experiments
  — Brownian motion

- define an element, and an atom as the particle of which elements are composed

- recall that atomic masses are the masses of atoms relative to $^{12}C = 12$ and are referred to as relative atomic masses

- **understand a mole of atoms as a number of atoms equal to the Avogadro constant.**

b) Atomic structure

Candidates will be assessed on their ability to

- recall that atoms consist of a central nucleus, composed of protons and neutrons, surrounded by orbiting electrons

- state the relative mass and relative charge of a proton, neutron and electron

- explain the terms atomic number, mass number, isotopes and relative atomic mass (A_r)

- **calculate the relative atomic mass of an element from the relative abundances of its isotopes**

- recall the electronic configurations of the first twenty elements of the Periodic Table
- relate periodicity to electronic configuration
- relate similarity of electronic configuration to similarity of the chemical properties of the Group 1 elements (2.1; 2.8.1; 2.8.8.1) and the Group 7 elements (2.7; 2.8.7; 2.8.18.7; 2.8.18.18.7)
- appreciate the importance of the noble gas electronic configurations (2, 2.8; 2.8.8; 2.8.18.8; 2.8.18.18.8).

c) Relative formula masses and molar volumes

Candidates will be assessed on their ability to

- calculate relative formula masses (M_r) from relative atomic masses (A_r)
- **recall that the mole is an amount of substance which can also be expressed as the Avogadro constant number of particles (atoms, molecules, formulae, ions or electrons) or as a relative formula mass in grams**
- **find the molar volumes of some gases from experimental data and from relative formula masses and densities**
- **understand the significance of the molar volume of a gas**
- **use the values of molar volume of a gas at stp and rtp.**

d) Chemical formulae and chemical equations

Candidates will be assessed on their ability to

- recall experiments to find the formulae of simple compounds such as copper (II) oxide and water
- recall that the formulae of other compounds have been obtained experimentally
- **apply the idea of a mole of atoms in finding chemical formulae**
- **calculate empirical formulae and molecular formulae**
- **calculate percentage yield and percentage purity**
- recall quantitative experiments, including direct mass determination, the use of standard solutions and the measurement of volumes in reactions involving gases, to determine the relative numbers of particles involved in chemical reactions
- write word equations to represent the reactions studied in this specification
- write chemical equations that do not require balancing to represent the reactions studied in this specification

- use the state symbols (l), (s), (g) and (aq) in chemical equations to represent liquids, solids, gases and aqueous solutions respectively

- **write balanced chemical equations to represent the reactions studied in this specification.**

e) Ionic compounds

Candidates will be assessed on their ability to

- describe the formation of ions by gain or loss of electrons

- link electronic configuration and ionic charge

- use the dot and cross model to explain the formation of an ionic compound by electron transfer, limited to combinations of Li^+, Na^+, Mg^{2+}, F^-, Cl^- and O^{2-}

- recall that

  — ionic compounds, such as NaCl and MgO, have high melting points and high boiling points because of strong electrostatic forces between ions
  — MgO has a much higher melting point and boiling point than NaCl because of the increased charges on the ions

- **recall that there is a strong electrostatic attraction between oppositely charged ions, called an ionic bond, and this extends throughout the ionic structure**

- **describe an ionic crystal as a giant three-dimensional ionic structure held together by attraction between oppositely charged ions.**

f) Covalent substances

Candidates will be assessed on their ability to

- describe how covalent bonds involve the sharing of electron pairs between outer electron shells of atoms, and that these bonds are strong

- **recall that the covalent bond is the result of attraction between the bonding pair of electrons and the nuclei of the atoms involved in the bond**

- use dot and cross diagrams to represent single covalent bonds in

  — hydrogen
  — water
  — methane
  — hydrogen chloride.

- **describe the electron arrangement in more complex covalent molecules such as**

  — nitrogen
  — ethane
  — carbon dioxide.

- draw and describe the shapes of the following molecules

  — carbon dioxide
  — water
  — methane
  — ammonia.

- recall the existence of simple molecular crystals of ice, solid carbon dioxide, solid methane, solid ammonia and iodine at suitable temperatures

- recall that substances with molecular structures are usually gases, liquids or solids with low melting points and boiling points and be able to explain this in terms of the relatively weak forces between the molecules

- describe and explain the physical properties of a typical simple covalent compound

- recall that diamond and graphite are allotropes of carbon

- **describe and explain the giant molecular covalent structures of diamond and graphite and relate their structures to their use - graphite as a lubricant and diamond in cutting**

- **understand that atoms in diamond and graphite are held together by strong covalent bonds which result in high sublimation points.**

g) Electrolysis

Candidates will be assessed on their ability to

- recall simple experiments to distinguish between electrolytes and non-electrolytes

- understand an electric current as a flow of electrons or ions

- recall the charges on common ions met in the specification

- **recall that one Faraday represents one mole of electrons**

- **calculate the amounts of the products of the electrolysis of molten salts and aqueous solutions**

- **write ionic half-equations representing the reactions at the electrodes during electrolysis**

- recognise oxidation as the loss of electrons and reduction as the gain of electrons

- recall that experiments on migration of ions provide some evidence for the ionic theory.

h) Metallic crystals

Candidates will be assessed on their ability to

- **describe a metal as a giant structure in which electrons are free to move throughout the whole structure**

- **relate the structure of a metal to physical properties such as conductivity and malleability.**

2. Chemistry of the elements

a) The Periodic Table
b) The Group 1 elements – lithium, sodium and potassium
c) The Group 2 elements – magnesium and calcium
d) The Group 7 elements – chlorine, bromine and iodine
e) Oxygen and oxides
f) Sulphur and nitrogen
g) Hydrogen
h) The transition metals – iron and copper
i) Reactivity series
j) Preparing and analysing

a) The Periodic Table

Candidates will be assessed on their ability to

- appreciate the Periodic Table as the arrangement of elements in a table according to atomic number
- classify elements as 'metals' and 'non-metals' on the basis of their properties and be aware that some elements exhibit a mixture of the properties of metals and non-metals
- recall families of elements including the alkali metals (Group 1), the alkaline earth metals (Group 2) and the halogens (Group 7)
- describe the correlation of charges of ions with the position of an element in the Periodic Table
- recall the relative reactivities of the elements within Groups 1, 2 and 7
- recall the noble gases (Group 0) as a family of inert gases
- **understand the relationship between group number, number of outer electrons and metallic-nonmetallic character across periods.**

b) The Group 1 elements - lithium, sodium and potassium

Candidates will be assessed on their ability to

- describe the reactions of these elements with water
- recognise that the reactivities of these elements with water provide a basis for their recognition as a family of elements

- discuss the simple physical and chemical properties of the hydroxides, halides, sulphates, nitrates and carbonates of these elements

- **make predictions about the properties of other elements and their compounds in this group.**

c) The Group 2 elements - magnesium and calcium

Candidates will be assessed on their ability to

- describe the reactions of these elements with water

- recall the simple physical and chemical properties of the oxides, hydroxides, chlorides, nitrates and carbonates of these elements

- **make predictions about the properties of other elements and their compounds in this group.**

d) The Group 7 elements - chlorine, bromine and iodine

Candidates will be assessed on their ability to

- recall the colour and physical states of the elements at room temperature

- recall the interconversion of halogen and halide ion

- understand the difference between hydrogen chloride and hydrochloric acid

- describe the properties of solutions of hydrogen chloride in water and in methylbenzene

- describe the laboratory preparation of chlorine from hydrochloric acid

- describe a simple chemical test for chlorine

- describe similarities in the chemistry of these elements which establish them as a family of elements

- recall that a more reactive halogen will displace a less reactive halogen from a solution of one of its salts

- **make predictions about the properties of other halogens in this group.**

e) Oxygen and oxides

Candidates will be assessed on their ability to

- recall the gases present in air and their approximate percentage by volume
- recall the industrial extraction of oxygen, by fractional distillation, from liquid air
- describe the reactions with oxygen in air of magnesium, iron, copper, carbon, sulphur and methane
- recall how to determine the percentage by volume of oxygen in the air from at least one of the above reactions
- understand oxidation and reduction as the addition and removal of oxygen respectively
- recall the acidic nature of sulphur dioxide and its reaction with water and alkalis
- describe the laboratory preparation of carbon dioxide
- recall the physical properties of carbon dioxide and its reaction with water and alkalis
- recall uses of carbon dioxide limited to carbonating drinks and in fire extinguishers
- recall the reaction of nitrogen with oxygen to form nitrogen monoxide and nitrogen dioxide
- recall the conditions under which iron rusts
- describe how rusting of iron and mild steel may be prevented by grease, oil, paint, plastic and galvanising
- understand the reduction of oxides in terms of the reactivity of elements.

f) Sulphur and nitrogen

Candidates will be assessed on their ability to

- describe the physical characteristics of the allotropes of sulphur, including its allotropes
- describe the reaction of sulphites with dilute acid
- recall the industrial extraction of nitrogen, by fractional distillation, from liquid air
- recall the importance of the inert nature of nitrogen in protecting food
- describe the laboratory preparation of ammonia
- recall the physical properties of ammonia
- describe the simple chemistry of aqueous ammonia, ammonium chloride, ammonium nitrate and ammonium sulphate.

g) Hydrogen

Candidates will be assessed on their ability to

- recall the effect of dilute hydrochloric and dilute sulphuric acids on magnesium, aluminium, zinc and iron
- describe the laboratory preparation of hydrogen
- describe the combustion of hydrogen with oxygen to form water
- describe a simple chemical test for water
- describe a physical test to show if water is pure
- **describe the reaction of hydrogen with chlorine.**

h) The transition metals - iron and copper

Candidates will be assessed on their ability to

- describe the action of steam, hydrogen chloride and chlorine on iron
- discuss the formation of iron(II) and iron(III) hydroxides from salt solutions
- describe the redox reaction of concentrated nitric acid on copper
- describe the simple physical and chemical properties of copper(II) oxide, hydroxide, nitrate, sulphate, carbonate, and chloride
- recall the existence of copper(I) compounds such as copper(I) oxide
- **describe the reaction of copper(II) ions with ammonia to form the complex ion $[Cu(H_2O)_2(NH_3)_4]^{2+}$**
- **understand that the study of these two metals and their compounds illustrates typical transition metal properties of variable valency, formation of coloured compounds and formation of complex ions.**

i) Reactivity series

Candidates will be assessed on their ability to

- understand that elements can be arranged in order of their reactivity
- relate the pattern in the reactions of the elements and their compounds, included elsewhere in the specification, to a reactivity series

- recall reactions used to establish the following order of reactivity: potassium, sodium, lithium, calcium, magnesium, aluminium, zinc, iron, (hydrogen) and copper

- establish position within the reactivity series using displacement reactions involving metals and their compounds in aqueous solutions

- **describe the sacrificial protection of iron and mild steel in terms of the reactivity series.**

j) Preparing and analysing

Candidates will be assessed on their ability to

- recall simple tests for the cations

  — Li^+ , Na^+, K^+, Ca^{2+} using flame tests
  — NH_4^+ using aqueous sodium hydroxide and identifying the ammonia evolved
  — Cu^{2+}, Fe^{2+} and Fe^{3+} using aqueous sodium hydroxide

- recall simple tests for the anions

  — chloride, bromide and iodide, using dilute nitric acid and silver nitrate solution
  — sulphate, using dilute hydrochloric acid and barium chloride solution
  — sulphite, using dilute hydrochloric acid and identifying the sulphur dioxide evolved
  — carbonate, using dilute hydrochloric acid and identifying the carbon dioxide evolved

- recall simple tests for the gases

  — ammonia
  — carbon dioxide
  — chlorine
  — hydrogen
  — oxygen
  — sulphur dioxide

- recall the general rules that describe the solubility of common types of salts in water

  — all common sodium, potassium and ammonium salts are soluble
  — all nitrates are soluble
  — common chlorides are soluble, except silver chloride
  — common sulphates are soluble, except barium and calcium
  — common carbonates and hydroxides are insoluble, except those of sodium, potassium and ammonium

- understand that insoluble salts can be formed as precipitates by the reaction of suitable reagents in solution

- use information on solubility to predict methods of preparing salts.

3. Organic chemistry

a) Alkanes
b) Alkenes
c) Ethanol

a) Alkanes

Candidates will be assessed on their ability to

- recall that alkanes are saturated hydrocarbons
- explain the terms ‘homologous series’ and ‘general formula’
- recall that, in alkanes, the four bonds on each carbon atom are directed to the corners of a tetrahedron
- draw displayed formulae for alkanes containing up to 4 carbon atoms in a molecule
- explain the term ‘isomerism’
- **draw displayed formulae of alkanes containing up to five carbon atoms where they exist, and name them**
- **recall the chlorination of methane.**

b) Alkenes

Candidates will be assessed on their ability to

- recall that alkenes are unsaturated hydrocarbons
- recall that, in alkenes, the bonds on each carbon atom are directed to the corners of an equilateral triangle
- draw displayed formulae for alkenes containing up to 4 carbon atoms in a molecule
- describe the addition of halogens to alkenes, including the decolorising of bromine water as a test for alkenes.

c) Ethanol

Candidates will be assessed on their ability to

- recall the industrial preparation of ethanol by

  — passing ethene and steam over a heated phosphoric acid catalyst
  — fermentation of sugars

- **evaluate the factors which are relevant to the choice of method to be used in the manufacture of ethanol, e.g. the relative availability of sugar cane and crude oil**

- **describe the reaction of ethanol with sodium**

- **describe the oxidation of ethanol to ethanoic acid**

- **describe the dehydration of ethanol to ethene**

- describe the reaction of ethanol with carboxylic acids, e.g. ethanoic acid, to form esters

- recall that many esters have distinct pleasant smells.

4. Physical chemistry

a) States of matter
b) Acidity, alkalinity and neutralisation
c) Energetics
d) Rates of reaction
e) Equilibria

a) States of matter

Candidates will be assessed on their ability to

- recall that there are three states of matter; gas, liquid and solid
- describe the interconversion of gas, liquid and solid
- understand the differences between mixtures and compounds
- recall techniques for separation, including distillation, fractional distillation, filtration, crystallisation, paper chromatography
- **discuss the states of matter in terms of the kinetic theory**
- **explain how heats of vaporisation can be used to compare the energy needed to separate the same number of different particles.**

b) Acidity, alkalinity and neutralisation

Candidates will be assessed on their ability to

- recall how to test for acidity and alkalinity, using suitable indicators
- recall the colours produced by the following indicators in acidic solution and alkaline solution: litmus, phenolphthalein, methyl orange and universal indicator
- describe the pH scale, running from 0-14, as a scale of acidity and alkalinity
- describe solutions which have a pH value less than 7 as acidic, those with a pH value of more than 7 as alkaline and those with a pH of 7 as neutral
- define acids and alkalis in terms of proton transfer
- describe how to prepare salts using neutralisation reactions, including the reaction of excess metal oxide/metal carbonate and dilute acid
- **describe how to carry out acid-alkali titrations whose concentrations are given in mol dm $^{-3}$**
- **carry our calculations involving solutions whose concentrations are given in mol dm $^{-3}$**
- **explain the terms ‘weak’ and ‘strong’ when applied to acids and alkalis in terms of dissociation**

c) Energetics

Candidates will be assessed on their ability to

- recall that chemical reactions are accompanied by an energy change which, in solution, may be detected as a temperature change
- recall that reactions may be described as exothermic when heat energy is given out and endothermic when heat energy is taken in
- recall that energy changes accompany combustion, solution and neutralisation
- explain the term 'enthalpy change'
- recall the use of the ΔH notation
- recall the principle of conservation of energy
- **recall that the breaking of bonds is endothermic and that the making of bonds is exothermic**
- **understand that heats of reaction are the result of energy changes when bonds are broken and formed**
- **draw energy profiles for exothermic and endothermic reactions**
- **use average bond dissociation energies to calculate the energy change during a simple chemical reaction.**

d) Rates of reaction

Candidates will be assessed on their ability to

- describe the effect of surface area, concentration, temperature and the use of a catalyst on the rate of a reaction
- describe experiments to investigate the effects of temperature, concentration and surface area of a solid on the rate of reaction
- **explain the effects of particle size, concentration and temperature in terms of effective collisions, using a simple kinetic model.**

e) Equilibria

Candidates will be assessed on their ability to

- discuss the idea of a simple reversible reaction, such as the hydration of heated anhydrous copper(II) sulphate or the effect of heat on ammonium chloride
- describe other reversible reactions
- **explain the concept of dynamic equilibrium and the use of the symbol ⇌ in equations**
- **predict the effects of changing the conditions (pressure and temperature) on reversible reactions including the industrial processes outlined in section 5d.**

5. Chemistry in Society

a) Extraction and uses of metals
b) Natural oil and gas
c) Synthetic polymers
d) The manufacture of some important chemicals

a) Extraction and uses of metals

Candidates will be assessed on their ability to

- describe and explain the extraction of aluminium from purified aluminium oxide by electrolysis, including

  — use of molten cryolite
  — need to replace the positive electrodes
  — cost of the electricity as a major consideration

- **write ionic half-equations for the reactions at the electrodes in aluminium extraction**

- describe the reaction of carbon with metal oxides

- recall how iron is extracted from iron ore in a blast furnace using the raw materials iron oxide, coke, limestone and air

- describe and explain the main reactions involved in the extraction of iron, including the role of carbon dioxide and limestone

- **describe the extraction of zinc by both electrolysis and reduction by carbon monoxide**

- **describe the extraction of chromium by the thermite process**

- explain how the methods of extraction of the metals in this section are related to their positions in the reactivity series

- describe and explain the purification of copper by electrolysis using impure copper as the positive electrode, pure copper as the negative electrode in a solution of copper(II) sulphate

- recall some important uses of the metals in this section and relate the uses to specified properties.

b) Natural oil and gas

Candidates will be assessed on their ability to

- recall that crude oil is a complex mixture of hydrocarbons
- describe how the process of fractional distillation can be used to separate the hydrocarbons in crude oil
- recall that the fractions obtained from crude oil are refinery gases, gasoline, kerosene, diesel, fuel oil and bitumen
- describe the physical properties and uses of the main fractions
- recall that incomplete combustion of fuels may produce carbon monoxide
- recall that carbon monoxide is poisonous because it reduces the capacity of blood to carry oxygen
- **recall that fractional distillation of crude oil produces more long-chain and fewer short-chain hydrocarbons than required**
- **describe how long-chain hydrocarbons are cracked to give more short-chain hydrocarbons**
- **discuss the damage to the environment that may arise from the spillage of crude oil and the release of hydrocarbons into the atmosphere.**

c) Synthetic polymers

Candidates will be assessed on their ability to

- recall that a polymer is formed by joining up many small molecules of monomer
- recall that polymers may be made by two different processes: addition and condensation
- recall that ethene is used in the manufacture of the addition polymer poly(ethene) (polyethene)
- describe the manufacture of poly(ethene) and draw its structure, showing the repeat unit
- **apply the principles of addition polymerisation to the addition polymers poly(propene) and poly(chloroethene)**
- recall the uses of polymers: poly(ethene), poly(propene) and poly(chloroethene) and be able to link the properties of a polymer to its use
- recall the types of monomers used in the manufacture of the condensation polymer nylon

- describe the formation of nylon and draw its structure in a block diagram format
- **apply the principles of condensation polymerisation to other condensation polymers, including terylene.**

d) The manufacture of some important chemicals

Candidates will be assessed on their ability to

- recall how nitrogen, from air, and hydrogen, from natural gas or the cracking of hydrocarbons are used in the manufacture of ammonia
- recall the conditions used in the Haber process
  - a temperature of about 450 °C
  - a pressure of about 200 atmospheres
  - an iron catalyst
  - how the ammonia produced is liquefied and any unused hydrogen and nitrogen recycled
- recall important uses of ammonia, including the manufacture of nitric acid and NPK fertilisers
- **describe the manufacture of nitric acid from ammonia**
- recall the sources of sulphur
- recall the raw materials used in the manufacture of sulphuric acid
- describe the manufacture of sulphuric acid by the contact process, including essential conditions
- recall important uses of sulphuric acid, to illustrate its economic importance
- understand that sulphur dioxide and nitrogen oxides are pollutant gases which contribute to acid rain
- discuss some of the problems associated with acid rain
- describe the manufacture of sodium hydroxide and chlorine by the electrolysis of sodium chloride solution (brine) in a diaphragm cell
- recall important uses of sodium hydroxide (manufacture of soap, paper, ceramics) and chlorine (in bleach and sterilising water supplies).

Grade Descriptions

Grade descriptions are provided to give a general indication of the standards of achievement likely to have been shown by candidates awarded particular grades. The descriptions must be interpreted in relation to the specification content; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performances in others.

Grade F

Candidates can

- recall a limited range of information, e.g. state some uses of materials obtained from oil
- use and apply knowledge and understanding in some specific everyday contexts, e.g. suggest a way of speeding up a particular chemical reaction
- make some use of scientific and technical vocabulary and make simple generalisations from information
- devise fair tests in contexts which involve only a few factors. They can recall or use simple apparatus to make measurements appropriate to the task and record observations and measurements in tables and graphs. Candidates obtain information from simple tables, charts and graphs and identify simple patterns in information and observations. They offer explanations consistent with the evidence obtained.

Grade C

Candidates can

- recall a range of scientific information from all areas of the specification, e.g. recall simple chemical symbols and formulae
- use and apply scientific knowledge and understanding in some general contexts, e.g. use simple balanced equations
- describe links between related phenomena in different contexts, use diagrams, charts and graphs to support arguments, use appropriate scientific and technical vocabulary in a range of contexts
- use scientific knowledge and understanding to identify an approach to a question: for example, identifying key factors which can be varied and controlled. Candidates can recall or use a range of apparatus to make careful and precise measurements and systematic observations, and can recognise when it is necessary to repeat measurements and observations. They present data systematically, in graphs where appropriate, and use lines of best fit. Candidates identify and explain patterns within data and draw conclusions consistent with the evidence. They explain these conclusions on the basis of their scientific knowledge and understanding, and evaluate how strongly their evidence supports the conclusions.

Grade A

Candidates can

- recall a wide range of knowledge from all areas of the specification

- use detailed scientific knowledge and understanding in many different applications relating to scientific systems or phenomena, e.g. routinely use a range of balanced chemical equations and the particle model to explain variations in reaction rates. Candidates draw together and communicate knowledge from more than one area, routinely use scientific or mathematical conventions in support of arguments, and use a wide range of scientific and technical vocabulary throughout their work

- use scientific knowledge and understanding to select an appropriate strategy for a task, identifying the key factors to be considered. They make systematic observations in qualitative work and decide which observations are relevant to the task in hand. When making measurements they decide the level of precision needed and can recall or use a range of apparatus to make appropriately precise measurements. They select a method of presenting data which is appropriate to the task; they use information from a range of sources where it is appropriate to do so. They identify and explain anomalous observations and measurements and the salient features of graphs

- use scientific knowledge and understanding to identify and explain patterns and draw conclusions from the evidence by combining data of more than one kind or from more than one source. They identify shortcomings in the evidence, use scientific knowledge and understanding to draw conclusions from their evidence and suggest improvements to the methods used that would enable them to collect more reliable evidence.

Investigative Skills

Experimental work is an integral part of the study of any scientific subject, and it is important that a candidate's practical investigative skills form part of the final assessment. To reflect this importance, the investigative skills described in Assessment Objective 3 carry 20% of the final mark for the subject. For the IGCSE, investigative skills may be assessed by two alternative routes, which allow all candidates access to the qualification. Candidates either take the written alternative to coursework examination (Paper 3) or submit internally–assessed coursework, which is assessed by the teacher and moderated by Edexcel International. These alternatives are described below.

Written alternative to coursework (Paper 3)

The examination paper will consist of a range of compulsory questions targeted at grades A* - G and based on the skills listed in Assessment Objective AO3. The questions will be designed to test the four main skill areas P, O, A and E, described in the following section.

Candidates will be assessed on the ability to

- plan experimental procedures (P)
- describe practical techniques and take measurements (O)
- analyse evidence and draw conclusions communicating findings using calculations, tables and graphs (A)
- evaluate evidence (E).

It would be helpful for candidates preparing for the examination to carry out experimental work and investigations as described below for coursework. Candidates should be encouraged to become familiar with the criteria used to assess the coursework, as the examination questions will reward skills in a similar way.

The specimen paper and mark scheme (available from September 2003) will illustrate the type of questions and the way in which they will be marked. The paper carries a total of 50 marks that will be scaled to 20% of the final assessment.

Coursework (Component 4)

The coursework option is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions. See full details under section 'Availability of coursework to international centres'.

Candidates who submit coursework are required to produce evidence in the four skill areas P, O, A and E, described in the next section. The coursework will be assessed by the school or college according to the principles described below and will be moderated by London Examinations. Coursework carries a total of 30 marks that will be scaled to 20% of the assessment.

The evidence for assessment will be coursework carried out by the candidate, in the context of the specification content. The assessment scheme caters for a wide range of experimental and investigative work. Candidates should undertake experimental and investigative work during the course and be assessed on several occasions in both types

of activity. The aim is to allow them to achieve their highest potential in such work. Candidates are required to produce the evidence for assessment based on the guidelines in the following pages.

- The term 'evidence' is used throughout the assessment scheme to mean data, observations or measurements
- An activity can take the form of experimental work or an investigation. Experimental work may be used to assess one, two or three skill areas
- An investigation consists of work that covers each of the four skill areas, although not all of these need to be used for assessment.

The scheme of internal assessment is designed to encourage a wide variety of activities. These include those based on the collection of first-hand evidence and those which depend on secondary evidence. The term 'evidence' has been used consistently throughout the assessment scheme to mean observations, measurements or other data. Through the teaching of investigative skills, candidates may be given opportunities to apply and develop their ICT capability. For example, candidates could: use data-handling software to analyse data from fieldwork or to create, analyse and evaluate charts and graphs; use dataloggers in investigations; use spreadsheets for data analysis; use the internet or CD ROM software as sources of secondary evidence.

Assessment of investigative skills

Four skill areas are used to assess activities, as appropriate.

Candidates will be expected to

	Mark scale
Plan experimental procedures (P)	0 – 8
Obtain evidence (O)	0 – 8
Analyse this evidence and draw conclusions (A)	0 – 8
Evaluate evidence (E)	0 – 6

Mark descriptions are defined at steps 0, 2, 4, 6 and 8 as appropriate. Mark descriptions comprising a number of statements are provided in each skill area. Activities chosen for assessment should, wherever possible, provide opportunities for all the statements in a mark description to be addressed. It should be noted that some of the statements in a mark description contain a phrase such as 'where appropriate' and therefore may not apply to a particular activity.

Descriptions are provided for 2, 4, 6 and 8 marks in skill areas P, O and A and 2, 4 and 6 marks in skill area E. The performance needed to gain 6 marks in skill area E is commensurate with that for 8 marks in the other skill areas.

Whenever assessments are made, the mark descriptions should be used to judge which mark best fits the candidate's performance. The statements should not be taken as discrete and literal hurdles, all of which must be fulfilled for a mark to be awarded.

The mark descriptions within a skill area are designed to be hierarchical. This means that, in general, a description at a particular mark subsumes those at lower marks. It is assumed that activities that access higher marks will involve a more sophisticated approach and/or a more complex treatment. Adjacent descriptions should be considered

when making judgements and use made of the intermediate marks (i.e. 3, 5 and 7) where performance exceeds one description and only partially satisfies the next.

A candidate who fails to meet the requirements for 2 marks but who has made a creditworthy attempt in a skill area should be given 1 mark for that skill. Zero marks should only be awarded for a skill area in the unlikely event of a candidate failing to demonstrate any achievement in that skill.

The professional judgement of the teacher in making these assessments is important.

The scheme is supported by materials with suggested experiments and investigations, plus exemplar assessed work.

Safe practice

Attention is drawn to the need for safe practice when candidates carry out laboratory investigations or observe demonstrations. Particular attention is drawn to the possible hazards associated with electrical equipment, the handling of micro-organisms, and ionising radiations. Strict aseptic conditions should be used when undertaking practical work. Reference must be made to local health and safety regulations, and widely accepted publications such as:

COSHH; *Guidance for Schools* (HSC, 1989) (HMSO) ISBN 011 885 5115

Topics in Safety – Association for Science Education (ASE) 2001 3rd Edition
ISBN 086 357 3169

CLEAPSS Laboratory Handbook and Hazards, available from Consortium of Local Education Authorities for the Provision of Science Services (CLEAPSS) to members or associates only.

Skill Area P: Planning

Skill Area P
Candidates should be encouraged to **a** use scientific knowledge and understanding to turn ideas into a form that can be investigated, and to plan an appropriate strategy **b** decide whether to use evidence from first-hand experience or secondary sources **c** carry out preliminary work and make predictions, where appropriate **d** consider key factors that need to be taken into account when collecting evidence, and how evidence can be collected in contexts in which the variables cannot readily be controlled **e** decide the extent and range of data to be collected, and the techniques, equipment and materials to use.

Mark descriptions for internal assessment			
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the specification content.			
		Candidates:	Increasing demand of activity
2 marks	P.2a	outline a simple procedure	↓
4 marks	P.4a P.4b	plan to collect evidence which will be valid plan the use of suitable equipment or sources of evidence	
6 marks	P.6a P.6b	use scientific knowledge and understanding to plan and communicate a procedure, to identify key factors to vary, control or take into account, and to make a prediction where appropriate decide a suitable extent and range of evidence to be collected	
8 marks	P.8a P.8b	use detailed scientific knowledge and understanding to plan and communicate an appropriate strategy, taking into account the need to produce precise and reliable evidence, and to justify a prediction, when one has been made use relevant information from preliminary work, where appropriate, to inform the plan	

Skill Area O: Obtaining evidence

Skill Area O
Candidates should be encouraged to **f** use a wide range of equipment and materials appropriately, and manage their working environment to ensure the safety of themselves and others **g** make observations and measurements, to a degree of precision appropriate to the context **h** make sufficient observations and measurements to reduce error and obtain reliable evidence **i** judge the level of uncertainty in observations and measurements **j** represent and communicate qualitative and quantitative data using diagrams, tables, charts and graphs.

Mark descriptions for internal assessment			
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the specification content.			
	Candidates		Increasing demand of activity
2 marks	O.2a	collect some evidence using a simple and safe procedure	↓
4 marks	O.4a O.4b	collect appropriate evidence which is adequate for the activity record the evidence	
6 marks	O.6a O.6b	collect sufficient systematic and accurate evidence and repeat or check where appropriate record clearly and accurately the evidence collected	
8 marks	O.8a	use a procedure with precision and skill to obtain and record an appropriate range of reliable evidence	

Skill Area A: Analysing and considering evidence

Skill Area A
Candidates should be encouraged to **k** use diagrams, tables, charts and graphs, and identify and explain patterns or relationships in data **l** present the results of calculations to an appropriate degree of accuracy **m** use observations, measurements or other data to draw conclusions **n** explain to what extent these conclusions support any predictions made, and enable further predictions to be made **o** use scientific knowledge and understanding to explain and interpret observations, measurements or other data, and conclusions.

Mark descriptions for internal assessment			
The mark descriptions are designed to be hierarchical. All work should be assessed in the context of the specification content.			
		Candidates	Increasing demand of activity
2 marks	A.2a	state simply what is shown by the evidence	
4 marks	A.4a A.4b	use simple diagrams, charts or graphs as a basis for explaining the evidence identify trends and patterns in the evidence	
6 marks	A.6a A.6b	construct and use suitable diagrams, charts, graphs (with lines of best fit, where appropriate), or use numerical methods, to process evidence for a conclusion draw a conclusion consistent with the evidence and explain it using scientific knowledge and understanding	
8 marks	A.8a A.8b	use detailed scientific knowledge and understanding to explain a valid conclusion drawn from processed evidence explain the extent to which the conclusion supports the prediction, if one has been made	

Skill Area E: Evaluating

Skill Area E
Candidates should be encouraged to **p** consider anomalous data, giving reasons for rejecting or accepting them, and consider the reliability of data in terms of uncertainty of measurements and observations **q** consider whether the evidence collected is sufficient to support any conclusions or interpretations made **r** suggest improvements to the methods used **s** suggest further investigations.

Mark descriptions for internal assessment

The mark descriptions are designed to be hierarchical.

All work should be assessed in the context of the specification content.

		Candidates	Increasing demand of activity
2 marks	E.2a	make a relevant comment about the procedure used or the evidence obtained	↓
4 marks	E.4a	comment on the quality of the evidence, identifying any anomalies	
	E.4b	comment on the suitability of the procedure and, where appropriate, suggest changes to improve it	
6 marks	E.6a	consider critically the reliability of the evidence and whether it is sufficient to support the conclusion, accounting for any anomalies	
	E.6b	describe, in detail, further work to provide additional relevant evidence	

Textbooks and other resources

The following textbooks are comprehensive first examination texts suitable for use on IGCSE Chemistry courses.

Particularly recommended

Longman Chemistry for IGCSE – J Clark (Longman 2005) ISBN: 1405 80208 1

Also recommended

Author	Title/ISBN	Publisher
R Harwood	*Chemistry* (ISBN 0 521 576288)	C U P 1998
G C Hill	*Chemistry Counts* (ISBN 0 340 63934 2)	Hodder and Stoughton 1999

Useful websites for Chemistry

4Learning on the web
http://www.4learning.co.uk
Aluminium Packaging Recycling Organisation
http://www.alupro.org.uk/
Association of British Pharmaceutical Industry
http://www.abpi.org.uk
Association for Science Education
http://www.ase.org.uk
BBC Science
http://www.bbc.co.uk/science
Biochemistry Society
http://www.biochemistry.org
Biotechnology and Biological Research Council
http://www.bbsrc.ac.uk
BP Amoco Educational Service
http://www.bpes.com
British Aerosoles
http://www.bama.co.uk
British Association for the Advancement of Science
http://www.britassoc.org.uk
British Batteries Manufacturing Association
http://www.bbma.co.uk
British Library
http://www.bl.uk/
British Nutrition Foundation
http://www.nutrition.org.uk
British Plastics Federation
http://www.bpf.co.uk
Centre of Alternative Technology

http://www.cat.org.uk
Chemdex
http://www.chemdex.org/
Chemical Industry Education Centre (CIEC)
http://www.york.ac.uk/org/ciec
Chemical Society Network
http://www.chemsoc.org
Community Recycling Network
http://www.crn.org.uk/indexjs.html
Corus Education Support Service
http://www.coruseducation.com
Dairy Council
http://www.milk.co.uk
Energy from Waste Association
http://www.efw.org.uk
Esso
http://www.esso.co.uk
Friends of the Earth
http://www.foe.co.uk
GlaxoSmithKline
www.gsk.com
Glaxo Wellcome
http://www.glaxowellcome.co.uk
ICI
http://www.ici.com
Institute of Biology
http://www.bio.org
Institute of Education (London)
http://www.ioe.ac.uk
Institute of Electrical Engineers
www.iee.org.uk
Institute of Physics
http://www.iop.org
Laboratory of the Government Chemist
http://www.lgc.co.uk
Liverpool University
http://www.liv.ac.uk/Chemistry
Merk, Shap and Dohme (Neuroscience)
www.msd-nrc.co.uk
Multimedia – Key Concepts in Science
http://www.new-media.co.uk
National Grid
http://www.nationalgrid.com
National Physics Laboratory
http://www.npl.co.uk
Nature
http://www.nature.com
New Scientist
http://www.newscientist.com/
Pfizier Pharmaceuticals
www.pfizier.com
Philipallan updates/ Chemistry Review
http://www.philipallan.co.uk
Physical Sciences Info. Gateway
http://www.psigate.ac.uk
RECOUP – Recycling Used Plastic
http://www.recoup.org/recoup/

Recycling around the World
http://www.recyclers-info.com/hotlink.htm
Research Machines Learning
http://www.learningschools.net
Rod Beavon website
http://www.rod.beavon.clara.net
Royal Society of Chemistry
http://www.rsc.org
Salters A-level Chemistry
http://www.franklin.ac.uk/salters
Schoolscience
http://www.schoolscience.org.uk
School Science Service
http://www.cleapss.org.uk
Science Consortium
http://www.scienceconsortium.co.uk
Science Enhancement Programme
http://www.sep.org.uk
Science Museum
http://www.sciencemuseum.org.uk
Sheffield College
http://www.sheffcol.ac.uk/links
Shell
http://www.shell.co.uk
Society of Chemical Industry
http://www.mond.org
Society of General Microbiology
http://www.sgm.ac.uk
Spectroscopy: Mass, UV/Visible and IR Spectra
http://webbook.nist.gov/chemistry/
Spectroscopy: Mass, NMR and IR Spectra
http://www.aist.go.jp/RIODB/SDBS/menu-e.html
Steel Can Recycling
http://www.scrib.org
The Biodiversity Association
www.biodiversity.org
UK Cartridge Recyclers
http://www.ukcra.com
Unilever
http://www.unilever.com
Waste Book
http://www.recycle.mcmail.com
Wellcome Trust
http://www.welcome.ac.uk/education
World Wide Website for Chemists
http://www.ChemWeb.com

Support and training

Training

A programme of INSET courses covering various aspects of the specifications and assessment will be arranged by London Examinations on a regular basis. Full details may be obtained from

International Customer Relations Unit
Edexcel International
190 High Holborn
London
WC1V 7BE
UK

Tel: +44 (0) 190 884 7750
E-mail: international@edexcel.org.uk

Edexcel publications

Support materials and further copies of this specification can be obtained from

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4LN
UK

Tel: +44 (0) 1623 450 781
Fax: +44 (0) 1623 450 481
E-mail: intpublications@linneydirect.com

The following support materials will be available from 2003 onwards

- Specimen papers and mark schemes (Publication code: UG013060)
- Teacher's Guide (Publication code: UG013050)

Appendix 1 – Periodic table

THE PERIODIC TABLE

Group

Period	1	2											3	4	5	6	7	0
1							1 H Hydrogen 1											4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number

Appendix 2 – Subject-specific requirements

Units and nomenclature

In the written papers and tests, the units and the nomenclature used will conform to the recommendations contained in the following booklets:

Signs, Symbols and Systematics, The ASE Companion to 16-19 Science – 1st Edition, (Association for Science Education (ASE), 2000).

www.ase.org.uk

Appendix 3 - Assessment of practical skills - final mark aggregation sheet

Month and year of examination:	Specification title:
Specification number:	
Centre:	Candidate name:
	Teaching group:
Centre number:	Candidate number:

Marks should be reported for each of the skill areas P, O, A and E.

One mark is required for **each** skill area. Thus four marks are required in total to give a maximum mark of 30. These marks should be drawn from **not more than two** pieces of work. At least **one** mark must be from a practically based whole investigation.

The reported marks from each activity should be ringed.

Activity title(s)	P	O	A	E

Please indicate whether the reported mark(s) are taken from an investigation by putting an asterisk next to the appropriate mark(s).

The skill area marks are reported in the appropriate Centre Mark boxes in the table below and then aggregated to give a total reported mark.

	Skill area P	Skill area O	Skill area A	Skill area E	Total mark	Max mark
Centre mark						30
Moderator Mark						
Team leader Mark						

Declaration of Authentication

I declare that the work submitted for assessment has been carried out without assistance other than that which is acceptable under the scheme of assessment.

Candidate's signature……Date……

Teacher's signature……Date……

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