UNIVERSITY of CAMBRIDGE
International Examinations

Cambridge
O Level

SYLLABUS

Cambridge O Level
Combined Science
5129

For examination in June and November 2014

Contents

1. Introduction

1.1 Why choose Cambridge?

University of Cambridge International Examinations is the world's largest provider of international education programmes and qualifications for 5 to 19 year olds. We are part of the University of Cambridge, trusted for excellence in education. Our qualifications are recognised by the world's universities and employers.

Developed for an international audience

Cambridge O Levels have been designed for an international audience and are sensitive to the needs of different countries. These qualifications are designed for students whose first language may not be English and this is acknowledged throughout the examination process. The Cambridge O Level syllabus also allows teaching to be placed in a localised context, making it relevant in varying regions.

Recognition

Every year, thousands of learners gain the Cambridge qualifications they need to enter the world's universities.

Cambridge O Level is internationally recognised by schools, universities and employers as equivalent to UK GCSE. Learn more at **www.cie.org.uk/recognition**

Excellence in education

We understand education. We work with over 9000 schools in over 160 countries who offer our programmes and qualifications. Understanding learners' needs around the world means listening carefully to our community of schools, and we are pleased that 98% of Cambridge schools say they would recommend us to other schools.

Our mission is to provide excellence in education, and our vision is that Cambridge learners become confident, responsible, innovative and engaged.

Cambridge programmes and qualifications help Cambridge learners to become:

- **confident** in working with information and ideas – their own and those of others
- **responsible** for themselves, responsive to and respectful of others
- **innovative** and equipped for new and future challenges
- **engaged** intellectually and socially, ready to make a difference

Support in the classroom

We provide a world-class support service for Cambridge teachers and exams officers. We offer a wide range of teacher materials to Cambridge schools, plus teacher training (online and face-to-face), expert advice and learner-support materials. Exams officers can trust in reliable, efficient administration of exams entry and excellent, personal support from our customer services. Learn more at **www.cie.org.uk/teachers**

Not-for-profit, part of the University of Cambridge

We are a part of Cambridge Assessment, a department of the University of Cambridge and a not-for-profit organisation.

We invest constantly in research and development to improve our programmes and qualifications.

1.2 Why choose Cambridge O Level?

Cambridge helps your school improve learners' performance. Learners develop not only knowledge and understanding, but also skills in creative thinking, enquiry and problem solving, helping them to perform well and prepare for the next stage of their education.

Schools worldwide have helped develop Cambridge O Levels, which provide an excellent preparation for Cambridge International AS and A Levels.

Cambridge O Level incorporates the best in international education for learners at this level. It develops in line with changing needs, and we update and extend it regularly.

1.3 Why choose Cambridge O Level Combined Science?

Cambridge O Levels are established qualifications that keep pace with educational developments and trends. The Cambridge O Level curriculum places emphasis on broad and balanced study across a wide range of subject areas. The curriculum is structured so that candidates attain both practical skills and theoretical knowledge.

Cambridge O Level Combined Science is recognised by universities and employers as proof of scientific knowledge and understanding.

The Cambridge O Level Combined Science syllabus develops candidates' basic scientific abilities in physics, chemistry and biology. It develops knowledge and understanding of basic scientific concepts and principles, as well as the ability to handle information and solve problems. There is no practical examination, but candidates will gain experience of the study and practice of science through experimental work in class. As a result, Cambridge O Level Combined Science equips candidates with a general understanding of science, and provides an ideal basis for further study of pure or applied science, or for science-focused vocational courses.

1.4 How can I find out more?

If you are already a Cambridge school

You can make entries for this qualification through your usual channels. If you have any questions, please contact us at **international@cie.org.uk**

If you are not yet a Cambridge school

Learn about the benefits of becoming a Cambridge school at **www.cie.org.uk/startcambridge**.
Email us at **international@cie.org.uk** to find out how your organisation can become a Cambridge school.

2. Assessment at a glance

For the Cambridge O Level in combined science, candidates take **two** components: Paper 1 and Paper 2.

Paper 1	1 hour
40 compulsory multiple-choice questions (1 mark each), with equal coverage of physics, chemistry and biology Weighting: 29% of total marks	

Paper 2	2 hours 15 minutes
A number of compulsory structured questions on the physics, chemistry and biology sections of the syllabus Weighting: 71% of total marks	

Availability

This syllabus is examined in the May/June examination series and the October/November examination series.

This syllabus is available to private candidates.

Cambridge O Levels are available to Centres in Administrative Zones 3, 4 and 5. Centres in Administrative Zones 1, 2 or 6 wishing to enter candidates for Cambridge O Level examinations should contact Cambridge Customer Services.

Combining this with other syllabuses

Candidates can combine this syllabus in an examination series with any other Cambridge syllabus, except:

- syllabuses with the same title at the same level
- 0608 Cambridge IGCSE Twenty First Century Science
- 0610 Cambridge IGCSE Biology
- 0620 Cambridge IGCSE Chemistry
- 0625 Cambridge IGCSE Physics
- 0652 Cambridge IGCSE Physical Science
- 0653 Cambridge IGCSE Combined Science
- 0654 Cambridge IGCSE Co-ordinated Sciences (Double)
- 5054 Cambridge O Level Physics
- 5070 Cambridge O Level Chemistry
- 5090 Cambridge O Level Biology
- 5096 Cambridge O Level Human and Social Biology
- 5131 Cambridge O Level Science for All

Please note that Cambridge IGCSE, Cambridge International Level 1/Level 2 Certificates and Cambridge O Level syllabuses are at the same level.

3. Syllabus aims and assessment objectives

3.1 Aims

The aims of the syllabus are the same for all candidates. They are not listed in order of priority.

The aims are:

1. to provide, through well designed studies of experimental and practical science, a worthwhile educational experience for all candidates, whether or not they go on to study science beyond this level and, in particular, to enable them to acquire sufficient understanding and knowledge to:
   - become confident citizens in a technological world, able to take or develop an informed interest in matters of scientific importance
   - recognise the usefulness, and limitations, of scientific method and to appreciate its applicability in other disciplines and in everyday life
   - be suitably prepared for studies beyond Cambridge O Level in pure sciences, in applied sciences or in science-dependent vocational courses
2. to develop abilities and skills that:
   - are relevant to the study and practice of science
   - are useful in everyday life
   - encourage efficient and safe practice
   - encourage effective communication
3. to develop attitudes relevant to science, such as:
   - accuracy and precision
   - objectivity
   - integrity
   - enquiry
   - initiative
   - inventiveness
4. to stimulate interest in and care for the environment
5. to promote an awareness that:
   - the study and practice of science are co-operative and cumulative activities, and are subject to social, economic, technological, ethical and cultural influences and limitations
   - the applications of sciences may be both beneficial and detrimental to the individual, the community and the environment

3.2 Assessment objectives

AO1 Knowledge with understanding

Candidates should be able to demonstrate knowledge and understanding in relation to:

1. scientific phenomena, facts, laws, definitions, concepts, theories
2. scientific vocabulary, terminology, conventions (including symbols, quantities and units contained in *'Signs, Symbols and Systematics', Association for Science Education, 2000*)
3. scientific instruments and apparatus, including techniques of operation and aspects of safety
4. scientific quantities and their determination
5. scientific and technological applications with their social, economic and environmental implications

The subject content defines the factual material that candidates need to recall and explain. Questions testing these objectives will often begin with one of the following words: *define, state, describe, explain* or *outline* (see the glossary of terms in section 5.4).

AO2 Handling information and solving problems

Candidates should be able – in words or by using other written, symbolic, graphical and numerical forms of presentation – to:

1. locate, select, organise and present information from a variety of sources
2. translate information from one form to another
3. manipulate numerical and other data
4. use information to identify patterns, report trends and draw inferences
5. present reasoned explanations for phenomena, patterns and relationships
6. make predictions and hypotheses
7. solve problems

These assessment objectives cannot be precisely specified in the syllabus content, because questions testing such skills may be based on information which is unfamiliar to the candidate. In answering such questions, candidates are required to use principles and concepts that are within the syllabus and apply them to a novel situation in a logical, deductive manner. Questions testing these objectives will often begin with one of the following words: *predict, suggest, calculate* or *determine* (see the glossary of terms in section 5.4).

3.3 Weighting of assessment objectives

Assessment objectives	Approx. % of total marks
AO1 Knowledge with understanding	65% (30% allocated to recall)
AO2 Handling information and solving problems	35%

Notes

Information for teachers

This syllabus relates to examinations taken in the year printed on the cover. It is the normal practice of Cambridge to distribute a CD ROM with a new version of this booklet on it each year. Centres should receive copies well in advance of their being required for teaching purposes.

Teachers who are about to teach syllabuses in this booklet for the first time should obtain and study the relevant past examination papers and subject reports.

Any queries relating to this booklet should be addressed to the Product Manager.

Nomenclature

The proposals in *'Signs, Symbols and Systematics'* (The Association for Science Education Companion to 16–19 Science, 2000) and the recommendations on terms, units and symbols in 'Biological Nomenclature (2009)' published by the Institute of Biology in conjunction with the ASE, will generally be adopted. Reference should be made to the joint statement on chemical nomenclature issued by the GCE boards. In particular, the traditional names sulfate, sulfite, nitrate, nitrite, sulfurous and nitrous acids will be used in question papers.

It is intended that, in order to avoid difficulties arising out of the use of *l* as the symbol for litre, use of dm^3 in place of *l* or litre will be made.

In chemistry, full structural formulae (displayed formulae) in answers should show in detail both the relative placing of atoms and the number of bonds between atoms. Hence $–CONH_2$ and $–CO_2H$ are not satisfactory as full structural formulae, although either of the usual symbols for the benzene ring is acceptable.

Units and significant figures

Candidates should be aware that misuse of units and/or significant figures, e.g. failure to quote units where necessary, the inclusion of units in quantities defined as ratios or quoting answers to an inappropriate number of significant figures, is liable to be penalised.

4. Syllabus content

4.1 Physics

Candidates are expected to have adequate mathematical skills to cope with the syllabus content.

Throughout the course, attention should be paid to showing the relevance of concepts to the candidates' everyday life and to the natural and made world.

1. Physical quantities and units

Content

1.1 Measurement of length, time and volume

Learning outcomes

Candidates should be able to:

(a) use and describe how to use rules, micrometers, vernier scales and calipers to determine lengths

(b) use and describe how to use clocks and other devices for measuring an interval of time, including the period of a pendulum

(c) use and describe how to use a measuring cylinder to measure a volume

2. Kinematics

Content

2.1 Speed, velocity and acceleration

2.2 Graphical analysis of motion

Learning outcomes

Candidates should be able to:

(a) state what is meant by *speed*, *velocity* and *acceleration*

(b) recognise motion for which the acceleration is constant

(c) recognise motion for which the acceleration is not constant

(d) plot and interpret a speed-time graph

(e) recognise from the shape of a speed-time graph when a body is

(i) at rest

(ii) moving with constant speed

(iii) moving with constant acceleration

3. Dynamics

Content

3.1 Motion

Learning outcomes

Candidates should be able to:

(a) describe the ways in which a force may change the motion of a body

(b) use the relation between force, mass and acceleration

4. Mass, weight and density

Content

4.1 Mass and weight

4.2 Density

Learning outcomes

Candidates should be able to:

(a) demonstrate an understanding that mass is a measure of the amount of substance in a body

(b) describe, and use the concept of, weight as the effect of a gravitational field on a mass

(c) demonstrate understanding that two weights, and therefore masses, can be compared using a balance

(d) use appropriate balances to measure mass and weight

(e) describe experiments to determine the density of a liquid, of a regularly shaped solid and of an irregularly shaped solid (by the method of displacement) and make the necessary calculations

5. Turning effect of forces

Content

5.1 Moments

Learning outcomes

Candidates should be able to:

(a) describe the moment of a force in terms of its turning effect and give everyday examples

(b) perform and describe an experiment to verify the principle of moments

(c) make calculations involving the principle of moments

6. Deformation

Content

6.1 Elastic deformation

Learning outcomes

Candidates should be able to:

(a) state that a force may produce a change in size and shape of a body

(b) plot, draw and interpret extension-load graphs for elastic solids and describe the associated experimental procedure

7. Energy, work and power

Content

7.1 Energy conversion and conservation

7.2 Major sources of energy

7.3 Work

7.4 Power

Learning outcomes

Candidates should be able to:

(a) give examples of energy in different forms, its conversion and conservation, and apply the principle of energy conservation to simple examples

(b) use the terms *kinetic energy* and *potential energy* in context

(c) describe, and express a qualitative understanding of, processes by which energy is converted from one form to another, including reference to

(i) chemical/fuel energy (a re-grouping of atoms)

(ii) hydroelectric generation (emphasising the mechanical energies involved)

(iii) solar energy (nuclei of atoms in the Sun)

(iv) nuclear energy

(v) geothermal energy

(vi) wind energy

(d) relate work done to the magnitude of a force and the distance moved and make calculations involving $F \times d$

(e) relate power to energy transferred and time taken, using appropriate examples and using the equation $P = E/t$ in simple systems

8. Transfer of thermal energy

Content

8.1 Conduction

8.2 Convection

8.3 Radiation

Learning outcomes

Candidates should be able to:

(a) describe experiments to distinguish between good and bad conductors of heat

(b) relate convection in fluids to density changes and describe experiments to illustrate convection

(c) describe experiments to distinguish between good and bad emitters and good and bad absorbers of infra-red radiation

(d) identify and explain some of the everyday applications and consequences of conduction, convection and radiation

9. Temperature

Content

9.1 Principles of thermometry

9.2 Liquid-in-glass thermometers

Learning outcomes

Candidates should be able to:

(a) appreciate how a physical property which varies with temperature may be used for the measurement of temperature and state examples of such properties

(b) recognise the need for, and identify, fixed points

(c) show understanding of *sensitivity* and *range*

(d) describe the structure and action of liquid-in-glass thermometers (laboratory and clinical)

10. Thermal properties of matter

Content

10.1 Thermal expansion of solids, liquids and gases

Learning outcomes

Candidates should be able to:

(a) describe qualitatively the thermal expansion of solids, liquids and gases

(b) identify and explain some of the everyday applications and consequences of thermal expansion

11. General wave properties

Content

11.1 Describing wave motion

11.2 Wave terms

11.3 Longitudinal and transverse waves

Learning outcomes

Candidates should be able to:

(a) describe what is meant by *wave motion* as illustrated by vibration in ropes, springs and by experiments using a ripple tank

(b) give the meaning of *speed*, *frequency*, *wavelength* and *amplitude* and use the equation $c = f \times \lambda$

(c) distinguish between *longitudinal* and *transverse* waves and give suitable examples

12. Light

Content

12.1 Reflection of light

12.2 Refraction of light

12.3 Thin converging lens

Learning outcomes

Candidates should be able to:

(a) perform and describe experiments to illustrate the laws of reflection

(b) describe an experiment to find the position of an optical image formed by a plane mirror

(c) use the law $i = r$ in reflection

(d) perform simple constructions, measurements and calculations for reflection

(e) describe and perform experiments to demonstrate refraction of light through glass blocks

(f) use the terminology for the angles i and r in refraction and describe the passage of light through parallel-sided transparent material

(g) use the equation $\sin i / \sin r = n$ (refractive index)

(h) give the meaning of *refractive index*

(i) describe the action of a thin converging lens on a beam of light

13. Electromagnetic spectrum

Content

13.1 Properties of electromagnetic waves

Learning outcomes

Candidates should be able to:

(a) state that all electromagnetic waves are transverse waves that travel with the same high speed in vacuo and state the magnitude of this speed

(b) describe the main components of the electromagnetic spectrum

14. Static electricity

Content

14.1 Principles of electrostatics

Learning outcomes

Candidates should be able to:

(a) show understanding that there are positive and negative charges and that charge is measured in coulombs

(b) show understanding that unlike charges attract and that like charges repel

15. Current electricity

Content

15.1 Electric current

15.2 Electromotive force

15.3 Potential difference

15.4 Resistance

Learning outcomes

Candidates should be able to:

(a) show understanding that a current is a rate of flow of charge and is measured in amperes (amps)

(b) use the equation $I = Q/t$

(c) use and describe the use of an ammeter

(d) use the concept that the e.m.f. is measured by the energy dissipated by a source in driving charge round the complete circuit

(e) show appreciation that the volt is given by J/C

(f) show understanding that the potential difference across a circuit component is measured in volts

(g) use and describe the use of a voltmeter

(h) state that *resistance = p.d./current* and use the equation $R = V/I$

16. Direct current (d.c.) circuits

Content

16.1 Current and potential difference in circuits

16.2 Series and parallel circuits

Learning outcomes

Candidates should be able to:

(a) draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), ammeters and voltmeters

(b) show understanding that the current at every point in a series circuit is the same

(c) use the fact that the sum of the p.d.s in a series circuit is equal to the p.d. across the whole circuit

(d) calculate the combined resistance of two or more resistors in series

(e) use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit, the current from the source being larger than the current in each branch

17. Practical electricity

Content

17.1 Electric power and energy

17.2 Dangers of electricity

17.3 Safe use of electricity in the home

Learning outcomes

Candidates should be able to:

(a) describe the uses of electricity in heating and lighting

(b) use the equations $P=VI$ and $E=VIt$

(c) state the hazards of

(i) damaged insulation

(ii) overheating of cables

(iii) damp conditions

(d) show understanding of the use of fuses and fuse ratings

(e) explain the need for earthing metal cases and for double insulation

(f) give the meaning of the terms *live*, *neutral* and *earth*

(g) wire, and describe how to wire, a mains plug

(h) give the reasons for switches and fuses in live leads

18. Magnetism

Content

18.1 Laws of magnetism

18.2 Magnetic properties of matter

Learning outcomes

Candidates should be able to:

(a) state the properties of magnets

(b) give an account of *induced magnetism*

(c) distinguish between *magnetic* and *non-magnetic* materials

(d) distinguish between the magnetic properties of iron and steel

(e) distinguish between the design and use of permanent magnets and electromagnets

19. Electromagnetic induction

Content

19.1 Principles of electromagnetic induction

19.2 The a.c. generator

19.3 The transformer

Learning outcomes

Candidates should be able to:

(a) describe an experiment which shows that a changing magnetic field can induce an e.m.f. in a circuit

(b) state the factors affecting the magnitude of the induced e.m.f.

(c) show understanding that the direction of the induced e.m.f. opposes the change producing it

(d) describe a simple form of generator (e.g. rotating coil or rotating magnet) and the use of slip rings

(e) sketch a graph of voltage output against time for a simple a.c. generator

(f) describe the structure and principle of operation of a basic iron-cored transformer as used for voltage transformations

20. The nuclear atom

Content

20.1 Atomic model

20.2 Composition of a nucleus

20.3 Proton number and nucleon number

20.4 Nuclide notation

Learning outcomes

Candidates should be able to:

(a) describe the structure of an atom in terms of a nucleus and electrons

(b) describe the composition of the nucleus in terms of protons and neutrons

(c) use the term *nucleon number, A*

(d) use the term *proton number, Z*

(e) use the term *nuclide* and use the nuclide notation ${}^{A}_{Z}X$

21. Radioactivity

Content

21.1 Detection of radioactivity

21.2 Characteristics of the three types of emission

21.3 Nuclear reactions

21.4 Half-life

21.5 Safety precautions

Learning outcomes

Candidates should be able to:

(a) describe the detection of alpha-particles, beta-particles and gamma-rays

(b) state, for radioactive emissions,

(i) their nature

(ii) their relative ionising effects

(iii) their relative penetrating powers

(c) show understanding of the meaning of *radioactive decay*, using equations (involving symbols) to represent changes in the composition of the nucleus when particles are emitted

(d) use the term *half-life* in simple calculations which might involve information in tables or in decay curves

(e) describe how radioactive materials are handled, used, stored and disposed of, in a safe way

4.2 Chemistry

It is important that, throughout the course, attention should be drawn to:

(i) the finite life of the world's resources and hence the need for recycling and conservation

(ii) some economic considerations in the chemical industry, such as the availability and cost of raw materials and energy

(iii) the importance of chemicals in industry and in everyday life

1. Experimental chemistry

Content

1.1 Experimental design

1.2 Methods of purification and analysis

Learning outcomes

Candidates should be able to:

(a) name and use appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders

(b) design arrangements of apparatus, given information about the substances involved

(c) describe and use methods of purification by the use of a suitable solvent, filtration, crystallisation and distillation (including description but **not** use of fractional distillation) (Refer to the fractional distillation of crude oil (petroleum) (topic 17.2(c)).)

(d) suggest suitable purification techniques, given information about the substances involved

(e) describe and use paper chromatography and interpret chromatograms

(f) identify substances and test their purity by melting point and boiling point determination and by paper chromatography

2. Kinetic particle theory

Learning outcomes

Candidates should be able to:

(a) describe the states of matter and explain their inter-conversion in terms of the kinetic particle theory

3. Atomic structure

Content

3.1 Atomic structure

3.2 Isotopes

Learning outcomes

Candidates should be able to:

(a) state the relative charge and approximate relative mass of a proton, a neutron and an electron

(b) define *proton number* and *nucleon number*

(c) use and interpret such symbols as ${}^{12}_{6}C$

(d) use proton number and the simple structure of atoms to explain the Periodic Table, with special reference to the elements of proton number 1 to 20

(e) define *isotopes*

(f) describe the build-up of electrons in 'shells' and understand the significance of outer electrons and the noble gas electronic structures

(The ideas of the distribution of electrons in s- and p-orbitals and in d-block elements are not required. Note that a copy of the Periodic Table will be available in the examination.)

4. Structure and properties of materials

Learning outcomes

Candidates should be able to:

(a) describe the differences between elements, compounds and mixtures, and between metals and non-metals

(b) describe alloys, such as brass, as a mixture of a metal with other elements

5. Ionic bonding

Content

5.1 Ion formation

5.2 Ionic bond formation

Learning outcomes

Candidates should be able to:

(a) describe the formation of ions by electron loss or gain

(b) describe the formation of ionic bonds between metallic and non-metallic elements (e.g. in NaCl and $CaCl_2$)

6. Covalent bonding

Content

6.1 Covalent bond formation

6.2 Physical properties of covalent compounds

Learning outcomes

Candidates should be able to:

(a) describe the formation of covalent bonds as the sharing of pairs of electrons leading to the noble gas configuration (e.g. H_2, Cl_2, HCl, H_2O, CH_4 and CO_2)

(b) deduce the electron arrangement in other covalent molecules

(c) construct 'dot and cross' diagrams to show the outer electrons in covalent molecules

(d) describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds

7. Formulae and equations

Content

7.1 Formulae

7.2 Equations

Learning outcomes

Candidates should be able to:

(a) state the symbols of the elements and the formulae of the compounds mentioned in the syllabus

(b) deduce the formula of a simple compound from the relative numbers of atoms present and vice versa

(c) determine the formula of an ionic compound from the charges on the ions present and vice versa

(d) construct equations with state symbols, including ionic equations

(e) deduce, from experimental results, the identity of the reactants and the products and the balanced chemical equation for a chemical reaction. (calculations will **not** be required)

(f) define *relative atomic mass,* A_r

(g) define *relative molecular mass,* M_r

(h) perform calculations concerning reacting masses using simple proportions. (calculations will **not** involve the mole concept)

8. The chemistry and uses of acids, bases and salts

Content

8.1 Characteristic properties of acids and bases

8.2 pH

8.3 Types of oxides

8.4 Preparation of salts

Learning outcomes

Candidates should be able to:

(a) describe the meanings of the terms *acid* and *alkali* in terms of the ions they contain or produce in aqueous solution

(b) describe the characteristic properties of acids as in their reactions with metals, bases, carbonates and their effects on indicator paper

(c) describe the characteristic properties of bases as in their reactions with acids and with ammonium salts and their effects on indicator paper

(d) describe neutrality and relative acidity and alkalinity in terms of pH (whole numbers only), measured using Universal Indicator paper

(e) describe and explain the importance of controlling acidity in soil

(f) classify oxides as either acidic, basic, or amphoteric related to metallic/non-metallic character

(g) describe the preparation, separation and purification of salts as examples of some of the techniques specified in topic 1.2(c): methods of preparing salts to illustrate the practical techniques should include the action of acids with insoluble bases, and acids with insoluble carbonates

(h) suggest a method of preparing a given salt from suitable starting materials, given appropriate information

9. The Periodic Table

Content

9.1 Periodic trends

9.2 Group properties

Learning outcomes

Candidates should be able to:

(a) describe the Periodic Table as a method of classifying elements and describe its use in predicting properties of elements

(b) describe the change from metallic to non-metallic character across a period

(c) describe the relationship between group number, number of outer electrons and metallic/non-metallic character

(d) describe lithium, sodium and potassium in Group I (the alkali metals) as a collection of relatively soft metals showing a trend in melting point and in reaction with water and with chlorine

(e) predict the properties of other elements in Group I, given data, where appropriate

(f) describe chlorine, bromine and iodine in Group VII (the halogens) as a collection of diatomic non-metals showing a trend in colour, state, and in their displacement reactions with other halide ions

(g) predict the properties of other elements in Group VII, given data, where appropriate

(h) identify trends in other groups, given information about the elements concerned

(i) describe the noble gases as being unreactive

(j) describe the uses of the noble gases in providing an inert atmosphere (e.g. argon in lamps and helium for filling balloons)

10. Properties of metals

Content

10.1 Physical properties

10.2 Alloys

Learning outcomes

Candidates should be able to:

(a) describe the general physical properties of metals

(b) explain why metals are often used in the form of alloys

(c) identify representations of metals and alloys from diagrams of structures

11. Reactivity series

Content

11.1 Order of reactivity

Learning outcomes

Candidates should be able to:

(a) place in order of reactivity calcium, copper, (hydrogen), iron, magnesium, potassium, sodium and zinc by reference to the reactions, if any, of the metals with water (or steam) and dilute hydrochloric acid

(b) account for the apparent unreactivity of aluminium in terms of the presence of an oxide layer which adheres to the metal

(c) deduce an order of reactivity from a given set of experimental results

12. Extraction and uses of metals

Content

12.1 Metal ores

12.2 The blast furnace

12.3 Iron and steel

12.4 Aluminium

12.5 Zinc

12.6 Copper

Learning outcomes

Candidates should be able to:

(a) describe the ease in obtaining metals from their ores by relating the elements to the reactivity series

(b) describe the essential reactions in the extraction of iron from haematite

(c) describe the idea of changing the properties of iron by the controlled use of additives to form alloys called steels

(d) state the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery)

(e) state the uses of aluminium (e.g. in the manufacture of aircraft parts because of its strength and low density and in food containers because of its resistance to corrosion)

(f) state the uses of zinc for galvanising and for making brass (with copper)

(g) state the uses of copper related to its properties (e.g. electrical wiring)

13. Atmosphere and environment

Content

13.1 Air

13.2 Corrosion

13.3 Pollution

13.4 Water

Learning outcomes

Candidates should be able to:

(a) describe the volume composition of clean air in terms of 78% nitrogen, 21% oxygen, with the remainder being noble gases (with argon as the main constituent), carbon dioxide and variable amounts of water vapour

(b) name the uses of oxygen in making steel, oxygen tents in hospitals, and with acetylene (a hydrocarbon) in welding

(c) describe, in simple terms, the ideas of respiration, combustion and rusting

(d) describe methods of rust prevention by painting and other coatings (including galvanising)

(e) identify processes involving the addition of oxygen as oxidation and the removal of oxygen as reduction

(f) define *oxidation* and *reduction* in terms of oxygen/hydrogen gain/loss

(g) describe the identification of oxygen using a glowing splint

(h) describe the identification of carbon dioxide using limewater. (equations are **not** required)

(i) name common pollutants of air (carbon monoxide, sulfur dioxide, oxides of nitrogen and lead compounds)

(j) state the source of each of these pollutants

(i) carbon monoxide from the incomplete combustion of carbon-containing substances

(ii) sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds (leading to acid rain)

(iii) oxides of nitrogen and lead compounds from car exhausts

(k) state the adverse effect of acidic pollutants on buildings and plants, and of carbon monoxide and lead compounds on health

(l) describe, in outline, the purification of the water supply in terms of filtration and chlorination

(m) state some of the uses of water in industry and in the home

14. Hydrogen

Learning outcomes

Candidates should be able to:

(a) describe the formation of hydrogen as a product of the reaction between
  (i) reactive metals and water
  (ii) metals and acids

(b) name the uses of hydrogen in the manufacture of ammonia and margarine, and as a fuel in rockets

(c) describe the identification of hydrogen using a lighted splint (water being formed)

15. Nitrogen

Content

15.1 Ammonia and the Haber process

15.2 Fertiliser manufacture

Learning outcomes

Candidates should be able to:

(a) describe the need for nitrogen, phosphorus and potassium compounds in plant life

(b) name the use of nitrogen in the manufacture of ammonia

(c) describe the essential conditions for the manufacture of ammonia by the Haber process

(d) name the uses of ammonia in the manufacture of fertilisers such as ammonium sulfate and nitrate

16. Organic chemistry

Content

16.1 Names of compounds

16.2 Structures of compounds

16.3 Homologous series

Learning outcomes

Candidates should be able to:

(a) name, and draw the structure of, methane, ethane, ethene, ethanol and poly(ethene)

(b) state the type of compound present given a chemical name, ending in -ane, -ene, or -ol, or given a molecular structure

(c) describe the general characteristics of a homologous series

17. Fuels

Content

17.1 Natural gas and petroleum as energy sources

17.2 Fractional distillation

17.3 Uses of fractions

Learning outcomes

Candidates should be able to:

(a) name natural gas and petroleum as sources of fuels

(b) name methane as the main constituent of natural gas

(c) describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation

(d) name the uses of petroleum fractions: petrol (gasoline), as fuel in cars; paraffin (kerosene), for oil stoves and aircraft fuel; diesel, for fuel in diesel engines; oils, for lubricants and making waxes and polishes; bitumen, for making roads

18. Alkanes

Content

18.1 Properties of alkanes

Learning outcomes

Candidates should be able to:

(a) describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning

19. Alkenes

Content

19.1 Cracking

19.2 Unsaturated hydrocarbons

Learning outcomes

Candidates should be able to:

(a) describe the manufacture of alkenes and of hydrogen by cracking

(b) describe the properties of alkenes in terms of burning and addition reactions with hydrogen and steam

(c) distinguish between saturated and unsaturated hydrocarbons

(i) from molecular structures

(ii) by using aqueous bromine

(d) describe the formation of poly(ethene) as an example of additional polymerisation of monomer units

(e) name some uses of poly(ethene) as a typical plastic (e.g. plastic bags)

20. Alcohols

Content

20.1 Formation of ethanol

20.2 Combustion and oxidation

20.3 Uses of ethanol

Learning outcomes

Candidates should be able to:

(a) describe the formation of ethanol by fermentation and by the catalytic addition of steam to ethene

(b) describe the properties of ethanol in terms of combustion and of oxidation

(c) name the uses of ethanol (e.g. as a solvent, as a fuel and as a constituent of wine and beer)

4.3 Biology

1. Cell structure and organisation

Content

1.1 Plant and animal cells

1.2 Specialised cells

Learning outcomes

Candidates should be able to:

(a) examine under the microscope an animal cell (e.g. from fresh liver) and a plant cell (e.g. from *Elodea*, a moss, or any suitable locally available material)

(b) identify and describe the structures seen, (cell membrane, nucleus and cytoplasm for animal cells; cell wall, cell membrane, nucleus, cytoplasm, sap vacuole and chloroplasts for plant cells)

(c) compare the visible differences in structure of the animal and plant cells examined

(d) state the function of the cell membrane in controlling the passage of substances into and out of the cell

(e) state, in simple terms, the relationship between cell structure and cell function for

(i) root hair cells – absorption

(ii) red blood cells – transport of oxygen

(f) identify these cells from diagrams and from photomicrographs

2. Diffusion and osmosis

Content

2.1 Diffusion

2.2 Osmosis

Learning outcomes

Candidates should be able to:

(a) define *diffusion* as the movement of molecules from a region of their higher concentration to a region of their lower concentration, down a concentration gradient

(b) define *osmosis* as the passage of water molecules from a region of their higher concentration to a region of their lower concentration, through a partially permeable membrane

(c) describe the importance of osmosis in the uptake of water by plants and the effects of osmosis on animal tissue

3. Enzymes

Content

3.1 Enzyme action

3.2 Effects of temperature and of pH

Learning outcomes

Candidates should be able to:

(a) define *enzymes* as proteins which function as biological catalysts

(b) describe the effect of temperature and of pH on enzyme activity

(c) state the effect of enzymes on the germination of seeds

4. Plant nutrition

Content

4.1 Photosynthesis

4.2 Leaf structure

4.3 Mineral nutrition

Learning outcomes

Candidates should be able to:

(a) understand that photosynthesis is the fundamental process by which plants manufacture carbohydrates from raw materials

(b) define *photosynthesis* and state the equation for photosynthesis (in words or symbols)

(c) state the effect of varying light intensity and temperature on the rate of photosynthesis (e.g. in submerged aquatic plants, such as *Elodea*)

(d) describe the intake of carbon dioxide and water by plants, the trapping of light energy by chlorophyll, the conversion of light energy into chemical energy, the formation of carbohydrates, their subsequent storage, and the release of oxygen

(e) explain why most forms of life are completely dependent on photosynthesis

(f) identify and label the cellular and tissue structure of a dicotyledonous leaf, as seen in cross-section under the microscope

(g) investigate and state the effect of insufficient nitrogen on plant growth and state the importance of nitrogen-containing ions for protein synthesis and their use in nitrogen-containing fertilisers for agriculture

5. Animal nutrition

Content

5.1 Diet

5.2 Human alimentary canal

5.3 Mechanical and physical digestion

5.4 Chemical digestion

5.5 Absorption and assimilation

Learning outcomes

Candidates should be able to:

(a) define a *balanced diet* as a diet supplying sufficient quantities of protein, carbohydrates, fat, vitamins, minerals, fibre, water and energy to sustain a healthy life

(b) explain why diet, especially energy intake, should be related to age, sex, and activity of an individual

(c) state the effects of malnutrition in relation to constipation and obesity

(d) identify, on diagrams and photographs, and name the main regions of the alimentary canal and the associated organs: mouth, salivary glands, oesophagus, stomach, duodenum, pancreas, gall bladder, liver, ileum, colon, rectum and anus

(e) describe the main functions of these parts in relation to ingestion, digestion, absorption, assimilation and egestion of food, as appropriate

(f) describe the function of the teeth in reducing the size of food particles

(g) state the causes of dental decay and describe the proper care of teeth

(h) describe chewing and peristalsis

(i) describe the function of a typical amylase, listing the substrate and end products as an example of extra-cellular digestion in the alimentary canal

(j) describe absorption as the passage of soluble products of digestion through the wall of the small intestine and into the blood capillaries. (structure of villi is **not** required)

(k) state

(i) the role of the liver in the metabolism of glucose and amino acids

(ii) the role of fat as a storage substance

(l) state that the formation of urea and the breakdown of alcohol occur in the liver

6. Transport in flowering plants

Content

6.1 Water and ion uptake

6.2 Transpiration

Learning outcomes

Candidates should be able to:

(a) describe the structure and function of root hairs in relation to their surface area, and to water and ion uptake (topic 1.2(e))

(b) define *transpiration* as the loss of water vapour from stomata

(c) describe how wilting occurs

7. Transport in humans

Content

7.1 Circulatory system

Learning outcomes

Candidates should be able to:

(a) describe the circulatory system as a system of tubes with a pump and valves to ensure one-way flow of blood

(b) describe the structure and function of the heart in terms of muscular contraction and the working of valves

(c) compare the structure and function of arteries, veins and capillaries

(d) describe coronary heart disease in terms of blockage of coronary arteries and list the possible causes

(e) identify red and white blood cells as seen under the microscope on prepared slides, and in diagrams and photomicrographs

(f) list the components of blood as red blood cells, white blood cells, platelets and plasma

(g) state the functions of blood

(i) red blood cells – haemoglobin and oxygen transport

(ii) white blood cells – phagocytosis, antibody formation and tissue rejection

(iii) platelets – fibrinogen to fibrin causing clotting

(iv) plasma – transport of blood cells, ions, soluble food substances, hormones, carbon dioxide, urea, vitamins and plasma proteins

8. Respiration

Content

8.1 Aerobic respiration

8.2 Anaerobic respiration

8.3 Human gaseous exchange

Learning outcomes

Candidates should be able to:

(a) define *respiration* as the release of energy from food substances in living cells

(b) define aerobic *respiration* as the release of a relatively large amount of energy by the breakdown of food substances in the presence of oxygen

(c) state the equation for aerobic respiration, using words only

(d) define *anaerobic respiration* as the release of a relatively small amount of energy by the breakdown of food substances in the absence of oxygen

(e) state the equation for anaerobic respiration, using words only

(f) describe the production of lactic acid in muscles during exercise

(g) state the differences between inspired and expired air

(h) investigate and state the effect of physical activity on rate and depth of breathing

(i) describe the role of the exchange surface of the alveoli in gaseous exchange. (details of the role of the diaphragm, ribs and intercostal muscles in breathing are **not** required)

9. Excretion

Learning outcomes

Candidates should be able to:

(a) define *excretion* as the removal of toxic materials and the waste products of metabolism from organisms

(b) describe the removal of carbon dioxide from the lungs, and of water and urea through the kidneys. (details of kidney structure and nephron are **not** required)

10. Co-ordination and response

Content

10.1 Receptors

10.2 Reflex action

10.3 Hormones

Learning outcomes

Candidates should be able to:

(a) state the principal functions of component parts of the eye in producing a focused image of near and distant objects on the retina

(b) describe the pupil reflex in response to bright and dim light

(c) define a *hormone* as a chemical substance, produced by a gland, carried by the blood, which alters the activity of one or more specific target organs and is then destroyed by the liver

11. The use and abuse of drugs

Content

11.1 Effects of heroin

11.2 Effects of alcohol

Learning outcomes

Candidates should be able to:

(a) define a *drug* as an externally administered substance which modifies or affects chemical reactions in the body

(b) describe a drug such as heroin as a drug of abuse and its related effects such as a powerful depressant, problems of addiction, severe withdrawal symptoms, associated problems such as crime and infection (e.g. AIDS/HIV)

(c) describe the effects of excessive consumption of alcohol: reduced self-control, depressant, problems of addiction, severe withdrawal symptoms, associated problems such as crime and infection (e.g. AIDS/HIV)

12. Relationships of organisms with one another and with the environment

Content

12.1 Energy flow

12.2 Food chains and food webs

12.3 Carbon cycle

12.4 Effects of humans on the ecosystem

12.5 Pollution

Learning outcomes

Candidates should be able to:

(a) state that the Sun is the principal source of energy input to biological systems

(b) describe the non-cyclical nature of energy flow

(c) define *food chain, food web, producer, consumer, herbivore, carnivore* and *decomposer*

(d) describe energy losses between trophic levels and the advantages of short food chains

(e) describe the carbon cycle in terms of photosynthesis, animal nutrition, respiration and combustion

(f) describe the effects of humans on the ecosystem with emphasis on examples of international importance (tropical rain forests, oceans and rivers)

(g) describe the problems which contribute to famine (unequal distribution of food, drought, flooding and increasing population)

(h) describe the undesirable effects of air pollution on gaseous exchange surfaces

13. Development of organisms and continuity of life

Content

13.1 Asexual reproduction

13.2 Sexual reproduction in plants

13.3 Sexual reproduction in humans

13.4 Sexually transmitted diseases

Learning outcomes

Candidates should be able to:

(a) define *asexual reproduction* as the process resulting in the production of genetically identical offspring from one parent

(b) describe *sexual reproduction* as the process involving the fusion of nuclei to form a zygote and the production of genetically dissimilar offspring

(c) identify the sepals, petals, stamens and carpels of one, locally available, named dicotyledonous flower

(d) state the functions of the sepals, petals, anthers and carpels

(e) investigate and describe the structure of a non-endospermic seed in terms of the embryo (radicle, plumule and cotyledons) and the testa, protected by the pericarp (fruit wall)

(f) state that seed and fruit dispersal by wind and animals provides a means of colonising new areas

(g) investigate and state the environmental conditions which affect germination of seeds (suitable temperature, water and oxygen)

(h) identify on diagrams of the male reproductive system and give the functions of: testes, scrotum, sperm ducts, prostate gland, urethra and penis

(i) identify on diagrams of the female reproductive system and give the functions of: ovaries, oviducts, uterus, cervix and vagina

(j) describe the menstrual cycle with reference to the alternation of menstruation and ovulation, the natural variation in its length, and fertile and infertile phases of the cycle

(k) state the effect of factors, such as diet and emotional state, which affect the menstrual cycle

(l) describe *fertilisation* and the early development of the zygote simply in terms of the formation of a ball of cells which becomes implanted in the wall of the uterus, where it develops as the fetus

(m) describe the advantages of breast milk compared with bottle-feeding

(n) describe the following methods of birth control: natural, chemical (spermicides), mechanical, hormonal and surgical

(o) describe the symptoms, signs, effects and treatment of gonorrhoea and syphilis

(p) discuss the spread of human immuno-deficiency virus (HIV) and methods by which it may be controlled

5. Appendix

5.1 The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 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
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
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	64 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
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	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
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 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	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac actinium 89 †															

*58–71 Lanthanoid series
†90–103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	163 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key

a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

5.2 Mathematical requirements

Calculators may be used in all parts of the examination.

Candidates should be able to:

1. add, subtract, multiply and divide
2. understand and use *averages, decimals, fractions, percentages, ratios* and *reciprocals*
3. recognise and use standard notation
4. use direct and inverse proportion
5. use positive, whole number indices
6. draw charts and graphs from given data
7. interpret charts and graphs
8. select suitable scales and axes for graphs
9. make approximate evaluations of numerical expressions
10. recognise and use the relationship between length, surface area and volume, and their units on metric scales
11. use usual mathematical instruments (ruler, compasses, protractor, set square)
12. understand the meaning of *angle, curve, circle, radius, diameter, square, parallelogram, rectangle* and *diagonal*
13. solve equations of the form $x = yz$ for any one term when the other two are known
14. recognise and use points of the compass (N, S, E, W)

5.3 Symbols, units and definitions of physical quantities

Candidates should be able to state the symbols for the following physical quantities and, where indicated, state the units in which they are measured.

Quantity	Symbol	Unit
length	*l, h...*	km, m, cm, mm
area	*A*	m^2, cm^2
volume	*V*	m^3, cm^3
weight	*W*	N
mass	*m, M*	kg, g, mg
time	*t*	h, min, s
density	*d, p*	g/cm^3, kg/m^3
speed	*u, v*	km/h, m/s, cm/s
acceleration	*a*	m/s^2
acceleration of free fall	*g*	
force	*F, P...*	N
moment of a force		Nm
work done	*W, E*	J
energy	*E*	J, kW h
power	*P*	W
pressure	*p, P*	Pa, N/m^2
atmospheric pressure		use of millibar
temperature	*t*	°C
frequency	*f*	Hz
wavelength	*λ*	m, cm
focal length	*f*	
angle of incidence	*i*	degree (°)
angles of reflection, refraction	*r*	degree (°)
critical angle	*c*	degree (°)
potential difference/voltage	*V*	V, mV
current	*I*	A, mA
charge		C, A s
e.m.f.	*E*	V
resistance	*R*	Ω

5.4 Glossary of terms used in science papers

During the moderation of a question paper, care is taken to try and ensure that the paper and its individual questions are, in relation to the syllabus, fair as regards balance, overall difficulty and suitability. Attention is also paid to wording to make questions as concise and yet as unambiguous as possible. In many instances, Examiners are able to make appropriate allowance for an interpretation that differs, but acceptably so, from the one intended.

It is hoped that the glossary (which is relevant only to science subjects) will prove helpful to candidates as a guide (i.e. it is neither exhaustive nor definitive). The glossary has been deliberately kept brief not only with respect to the number of terms included but also to their definitions. Candidates should appreciate that the meaning of a term must depend in part on its context.

1. *Define (the term(s)...)* is intended literally, only a formal statement or equivalent paraphrase being required.
2. *What do you understand by/What is meant by (the term(s)...)* normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.
3. *State* implies a concise answer with little or no supporting argument (e.g. a numerical answer that can readily be obtained 'by inspection').
4. *List* requires a number of points, generally each of one word, with no elaboration. Where a given number of points is specified, this should not be exceeded.
5. *State and explain* normally also implies conciseness; *explain* may imply reasoning or some reference to theory, depending on the context.
6. *Describe* requires the candidate to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. In the latter instance, the answer may often follow a standard pattern (e.g. Apparatus, Method, Measurements, Results and Precautions).

   In other contexts, *describe* and *give an account of* should be interpreted more generally (i.e. the candidate has greater discretion about the nature and the organisation of the material to be included in the answer). *Describe and explain* may be coupled in a similar way to *state and explain* – see paragraph 5.
7. *Discuss* requires the candidate to give a critical account of the points involved in the topic.
8. *Outline* implies brevity (i.e. restricting the answer to giving essentials).
9. *Predict* implies that the candidate is not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question.

   Predict also implies a concise answer with no supporting statement required.
10. *Deduce* is used in a similar way to *predict* except that some supporting statement is required (e.g. reference to a law/principle or the necessary reasoning is to be included in the answer).
11. *Suggest* is used in two main contexts, i.e. either to imply that there is no unique answer (e.g. in chemistry, two or more substances may satisfy the given conditions describing an 'unknown'), or to imply that candidates are expected to apply their general knowledge to a 'novel' situation, one that may be formally 'not in the syllabus'.
12. *Find* is a general term that may variously be interpreted as *calculate*, *measure*, *determine*, etc.
13. *Calculate* is used when a numerical answer is required. In general working should be shown, especially where two or more steps are involved.

14. *Measure* implies that the quantity concerned can be directly obtained from a suitable measuring instrument (e.g. length, using a rule or mass, using a balance).
15. *Determine* often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula (e.g. Young modulus, relative molecular mass).
16. *Estimate* implies a reasoned order of magnitude statement or calculation of the quantity concerned, making such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.
17. *Sketch*, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct *but* candidates should be aware that, depending on the context, some quantitative aspects may be looked for (e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value).

    In diagrams, *sketch* implies that a simple freehand drawing is acceptable; nevertheless, care should be taken over proportions and the clear exposition of important details.

6. Additional information

6.1 Guided learning hours

Cambridge O Level syllabuses are designed on the assumption that candidates have about 130 guided learning hours per subject over the duration of the course. ('Guided learning hours' include direct teaching and any other supervised or directed study time. They do not include private study by the candidate.)

However, this figure is for guidance only, and the number of hours required may vary according to local curricular practice and the candidates' prior experience of the subject.

6.2 Recommended prior learning

We recommend that candidates who are beginning this course should have previously studied a science curriculum such as that of the Cambridge Lower Secondary Programme or equivalent national educational frameworks. Candidates should also have adequate mathematical skills for the content contained in this syllabus.

6.3 Progression

Cambridge O Level Certificates are general qualifications that enable candidates to progress either directly to employment, or to proceed to further qualifications.

Candidates who are awarded grades C to A* in Cambridge O Level Combined Science are well prepared to follow courses leading to Cambridge International AS and A Level in a Science subject.

6.4 Component codes

Because of local variations, in some cases component codes will be different in instructions about making entries for examinations and timetables from those printed in this syllabus, but the component names will be unchanged to make identification straightforward.

6.5 Grading and reporting

Cambridge O Level results are shown by one of the grades A*, A, B, C, D or E indicating the standard achieved, Grade A* being the highest and Grade E the lowest. 'Ungraded' indicates that the candidate's performance fell short of the standard required for Grade E. 'Ungraded' will be reported on the statement of results but not on the certificate.

Percentage uniform marks are also provided on each candidate's statement of results to supplement their grade for a syllabus. They are determined in this way:

- A candidate who obtains…
  … the minimum mark necessary for a Grade A* obtains a percentage uniform mark of 90%.
  … the minimum mark necessary for a Grade A obtains a percentage uniform mark of 80%.
  … the minimum mark necessary for a Grade B obtains a percentage uniform mark of 70%.

… the minimum mark necessary for a Grade C obtains a percentage uniform mark of 60%.
… the minimum mark necessary for a Grade D obtains a percentage uniform mark of 50%.
… the minimum mark necessary for a Grade E obtains a percentage uniform mark of 40%.
… no marks receives a percentage uniform mark of 0%.

Candidates whose mark is none of the above receive a percentage mark in between those stated according to the position of their mark in relation to the grade 'thresholds' (i.e. the minimum mark for obtaining a grade). For example, a candidate whose mark is halfway between the minimum for a Grade C and the minimum for a Grade D (and whose grade is therefore D) receives a percentage uniform mark of 55%.

The percentage uniform mark is stated at syllabus level only. It is not the same as the 'raw' mark obtained by the candidate, since it depends on the position of the grade thresholds (which may vary from one series to another and from one subject to another) and it has been turned into a percentage.

6.6 Access

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments and to demonstrate what they know and what they can do. For this reason, very few candidates will have a complete barrier to the assessment. Information on reasonable adjustments is found in the *Cambridge Handbook* which can be downloaded from the website **www.cie.org.uk**

Candidates who are unable to access part of the assessment, even after exploring all possibilities through reasonable adjustments, may still be able to receive an award based on the parts of the assessment they have taken.

6.7 Support and resources

Copies of syllabuses, the most recent question papers and Principal Examiners' reports for teachers are on the Syllabus and Support Materials CD-ROM, which we send to all Cambridge International Schools. They are also on our public website – go to **www.cie.org.uk/olevel**. Click the **Subjects** tab and choose your subject. For resources, click 'Resource List'.

You can use the 'Filter by' list to show all resources or only resources categorised as 'Endorsed by Cambridge'. Endorsed resources are written to align closely with the syllabus they support. They have been through a detailed quality-assurance process. As new resources are published, we review them against the syllabus and publish their details on the relevant resource list section of the website.

Additional syllabus-specific support is available from our secure Teacher Support website **http://teachers.cie.org.uk** which is available to teachers at registered Cambridge schools. It provides past question papers and examiner reports on previous examinations, as well as any extra resources such as schemes of work or examples of candidate responses. You can also find a range of subject communities on the Teacher Support website, where Cambridge teachers can share their own materials and join discussion groups.

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