Syllabus

Cambridge IGCSE Physical Science
Syllabus code 0652
For examination in November 2013

UNIVERSITY *of* CAMBRIDGE
International Examinations

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1. Introduction

1.1 Why choose Cambridge?

University of Cambridge International Examinations (CIE) is the world's largest provider of international qualifications. Around 1.5 million students from 150 countries enter Cambridge examinations every year. What makes educators around the world choose Cambridge?

Recognition

Cambridge IGCSE is internationally recognised by schools, universities and employers as equivalent to UK GCSE. Cambridge IGCSE is excellent preparation for A/AS Level, the Advanced International Certificate of Education (AICE), US Advanced Placement Programme and the International Baccalaureate (IB) Diploma. Learn more at **www.cie.org.uk/recognition**.

Support

CIE provides a world-class support service for teachers and exams officers. We offer a wide range of teacher materials to Centres, plus teacher training (online and face-to-face) and student support materials. Exams officers can trust in reliable, efficient administration of exams entry and excellent, personal support from CIE Customer Services. Learn more at **www.cie.org.uk/teachers**.

Excellence in education

Cambridge qualifications develop successful students. They build not only understanding and knowledge required for progression, but also learning and thinking skills that help students become independent learners and equip them for life.

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

CIE is part of Cambridge Assessment, a not-for profit organisation and part of the University of Cambridge. The needs of teachers and learners are at the core of what we do. CIE invests constantly in improving its qualifications and services. We draw upon education research in developing our qualifications.

1.2 Why choose Cambridge IGCSE Physical Science?

Cambridge IGCSE Physical Science is accepted by universities and employers as proof of real ability and knowledge.

As well as a subject focus, the IGCSE Physical Science syllabus enables candidates to better understand the technological world they live in, and take an informed interest in science and scientific developments. Candidates learn about the basic principles of physical science through a mix of theoretical and practical studies.

Candidates also develop an understanding of the scientific skills essential for further study at A Level, skills which are useful in everyday life. As they progress, candidates learn how science is studied and practised, and become aware that the results of scientific research can have both good and bad effects on individuals, communities and the environment.

This syllabus has been developed to

- be appropriate to the wide range of teaching environments in IGCSE Centres
- encourage the consideration of science within an international context
- be relevant to the differing backgrounds and experiences of candidates throughout the world.

The IGCSE Physical Science syllabus is aimed at candidates across a very wide range of attainments, and will allow them to show success over the full range of grades from A* to G.

1.3 Cambridge International Certificate of Education (ICE)

Cambridge ICE is the group award of the International General Certificate of Secondary Education (IGCSE). It requires the study of subjects drawn from the five different IGCSE subject groups. It gives schools the opportunity to benefit from offering a broad and balanced curriculum by recognising the achievements of students who pass examinations in at least seven subjects, including two languages, and one subject from each of the other subject groups.
The Cambridge portfolio of IGCSE qualifications provides a solid foundation for higher level courses such as GCE A and AS Levels and the International Baccalaureate Diploma as well as excellent preparation for employment.
A wide range of IGCSE subjects is available and these are grouped into five curriculum areas. Physical Science falls into Group III, Science.
Learn more about ICE at **www.cie.org.uk/qualifications/academic/middlesec/ice**.

1.4 How can I find out more?

If you are already a Cambridge Centre

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

If you are not a Cambridge Centre

You can find out how your organisation can become a Cambridge Centre. Email us at **international@cie.org.uk**. Learn more about the benefits of becoming a Cambridge Centre at **www.cie.org.uk**.

2. Assessment at a glance

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Cambridge IGCSE Physical Science candidates are awarded grades ranging from A* to G.

Candidates expected to achieve grades D, E, F or G, study the Core Curriculum only and are eligible for grades C to G.

Candidates expected to achieve grade C or higher should study the Extended Curriculum, which comprises the Core and Supplement Curriculums; these candidates are eligible for all grades from A* to G.

All candidates must enter for **three** papers.

All candidates take:		
Paper 1 (45 minutes) Multiple choice question paper Weighted at 30% of total available marks		
and either:	**or:**	
Paper 2 1 hour 15 minutes Core theory paper Weighted at 50% of total available marks	**Paper 3** 1 hour 15 minutes Extended theory paper Weighted at 50% of total available marks	
and either:	**or:**	**or:**
Paper 4 Coursework Weighted at 20% of total available marks	**Paper 5** 1 hour 30 minutes Practical test Weighted at 20% of total available marks	**Paper 6** 1 hour Alternative to Practical paper Weighted at 20% of total available marks

2. Assessment at a glance

Availability

This syllabus is examined in October/November examination session.

This syllabus is available to private candidates.

Centres in the UK that receive government funding are advised to consult the CIE website **www.cie.org.uk** for the latest information before beginning to teach this syllabus.

Combining this with other syllabuses

Candidates can combine this syllabus in an examination session with any other CIE syllabus, except:

- syllabuses with the same title at the same level
- 0620 IGCSE Chemistry
- 0625 IGCSE Physics
- 0653 IGCSE Combined Science
- 0654 IGCSE Co-ordinated Sciences (Double Award)
- 5054 O Level Physics
- 5070 O Level Chemistry
- 5129 O Level Combined Science

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

3. Syllabus aims and objectives

3.1 Aims

The aims, which are not listed in order of priority, are:

1. to provide a worthwhile educational experience for all candidates, through well-designed studies of experimental and practical science, whether or not they go on to study science beyond this level
2. to enable candidates to acquire sufficient understanding and knowledge to:
   - become confident citizens in a technological world, to take or develop an informed interest in scientific matters
   - 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 the IGCSE level in pure sciences, in applied sciences or in science-dependent vocational courses
3. to develop abilities and skills that:
   - are relevant to the study and practice of physical science
   - are useful in everyday life
   - encourage efficient and safe practice
   - encourage effective communication
4. to develop attitudes relevant to physical science such as:
   - concern for accuracy and precision
   - objectivity
   - integrity
   - enquiry
   - initiative
   - inventiveness
5. to stimulate interest in, and care for, the environment
6. to promote an awareness that:
   - scientific theories and methods have developed, and continue to do so, as a result of the co-operative activities of groups and individuals
   - the study and practice of science is subject to social, economic, technological, ethical and cultural influences and limitations
   - the applications of science may be both beneficial and detrimental to the individual, the community and the environment
   - science transcends national boundaries and that the language of science, correctly and rigorously applied, is universal

3.2 Assessment objectives

The three assessment objectives in IGCSE Physical Science are

A Knowledge with understanding

B Handling information and problem solving

C Experimental skills and investigations

A description of each assessment objective follows.

A: Knowledge with understanding

Candidates should be able to demonstrate knowledge and understanding of:

1. scientific phenomena, facts, laws, definitions, concepts and theories
2. scientific vocabulary, terminology and conventions (including symbols, quantities and units)
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 syllabus content defines the factual material that candidates may be required to recall and explain. Questions testing this will often begin with one of the following words: *define*, *state*, *describe*, *explain* or *outline*.

B: Handling information and problem solving

Candidates should be able, using oral, 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.

Questions testing these skills may be based on information that is unfamiliar to candidate, requiring them to apply the principles and concepts from the syllabus to a new situation, in a logical, reasoned or deductive way.
Questions testing these objectives will often begin with one of the following words: *discuss*, *predict*, *suggest*, *calculate* or *determine* (see Glossary of terms).

C: Experimental skills and investigations

Candidates should be able to

1. use techniques, apparatus and materials (including the following of a sequence of instructions where appropriate)
2. make and record observations, measurements and estimates
3. interpret and evaluate experimental observations and data
4. plan investigations and/or evaluate methods and suggest possible improvements (including the selection of techniques, apparatus and materials).

Specification grid

The approximate weightings allocated to each of the assessment objectives in the assessment model are summarised in the table below.

Assessment Objective	Weighting
A Knowledge with understanding	50% (not more than 25% recall)
B Handling information and problem solving	30%
C Experimental skills and investigations	20%

3.3 Scheme of assessment

All candidates must enter for three papers: Paper 1; one from either Paper 2 or Paper 3; and one from Papers 4, 5 or 6.
Candidates who have only studied the Core curriculum, or who are expected to achieve a grade D or below, should normally be entered for Paper 2.
Candidates who have studied the Extended curriculum, and who are expected to achieve a grade C or above, should be entered for Paper 3.
All candidates must take a practical paper, chosen from: Paper 4 (Coursework), Paper 5 (Practical Test), or Paper 6 (Alternative to Practical).

The data sheet (Periodic Table) will be included in Papers 1, 2 and 3.

All candidates take:	
Paper 1 45 minutes A multiple-choice paper consisting of 40 items of the four-choice type This paper will test skills mainly in Assessment objectives A and B Questions will be based on the Core curriculum and will be of a difficulty appropriate to grades C to G Weighted at 30% of total available marks	
and either:	**or:**
Paper 2 1 hour 15 minutes *Core curriculum – Grades C to G available* Core theory paper consisting of short-answer and structured questions, based on the core curriculum. The questions will be of a difficulty appropriate to grades C to G and will test skills mainly in Assessment objectives A and B. Weighted at 50% of total available marks	**Paper 3** 1 hour 15 minutes *Extended curriculum – Grades A* to G available* Extended theory paper consisting of short-answer and structured questions. The questions will be based on all of the material, both from the core and supplement, and will allow candidates to demonstrate their knowledge and understanding. The questions will be of a difficulty appropriate to the higher grades and will test skills mainly in Assessment objectives A and B. Weighted at 50% of total available marks

and either:	or:	or:
Paper 4 * Coursework School-based assessment of practical skills ** Weighted at 20% of total available marks	**Paper 5** * 1 hour 30 minutes Practical test Questions covering experimental and observational skills Weighted at 20% of total available marks	**Paper 6** * 1 hour Alternative to Practical Written paper designed to test familiarity with laboratory based procedures Weighted at 20% of total available marks

* The purpose of this component is to test appropriate skills in assessment Objective C. Candidates will not be required to use knowledge outside the Core curriculum.

** Teachers may not undertake school-based assessment without the written approval of CIE. This will only be given to teachers who satisfy CIE requirements concerning moderation and they will have to undergo special training in assessment before entering candidates. CIE offers schools in-service training in the form of occasional face-to-face courses held in countries where there is a need, and also through the IGCSE Coursework Training Handbook, available from CIE Publications.

3.4 Conventions (e.g. signs, symbols, terminology and nomenclature)

Syllabuses and question papers will conform with generally accepted international practice. In particular, attention is drawn to the following documents, published in the UK, which will be used as guidelines.
Reports produced by the Association for Science Education (ASE):

SI Units, Signs, Symbols and Abbreviations (1981)
Chemical Nomenclature, Symbols and Terminology for use in school science (1985)
Signs, Symbols and Systematics: The ASE Companion to 16-19 Science (2000)

Litre/dm^3

To avoid any confusion concerning the symbol for litre, dm^3 will be used in place of l or litre.

Experimental work

Experimental work is an essential component of all science. Experimental work within science education

- gives candidates first-hand experience of phenomena
- enables candidates to acquire practical skills
- provides candidates with the opportunity to plan and carry out investigations into practical problems.

This can be achieved by individual or group experimental work, or by demonstrations which actively involve the candidates.

Duration of course

Centres will obviously make their own decisions about the length of time taken to teach this course, though it is assumed that most Centres will attempt to cover it in two years. We suggest that Centres should allocate 3 × 40 minute lessons to science each week.

4. Curriculum content

The curriculum content that follows is divided into two sections: Chemistry (C1–C11) and Physics (P1–P5). **Candidates must study both sections.**

Candidates can either follow the core curriculum only, or they can follow the extended curriculum which includes both the core and the supplement. Candidates aiming for grades A* to C should follow the extended curriculum.

Note:

1. The curriculum content is designed to provide guidance to teachers as to what will be assessed in the overall evaluation of the candidate. It is not meant to limit, in any way, the teaching programme of any particular school or college.
2. The content is set out in topic areas within chemistry and physics. Each topic area is divided into a number of sections. The left-hand column provides amplification of the core content, which all candidates must study. The right-hand column outlines the supplementary content, which should be studied by candidates following the extended curriculum.

The Curriculum content below is a guide to the areas on which candidates are assessed.

It is important that, throughout this course, teachers should make candidates aware of the relevance of the concepts studied to everyday life, and to the natural and man-made worlds.

In particular, attention should be drawn to:

- the finite nature of the world's resources, the impact of human activities on the environment, and the need for recycling and conservation
- economic considerations for agriculture and industry, such as the availability and cost of raw materials and energy
- the importance of natural and man-made materials, including chemicals, in both industry and everyday life.

Specific content has been limited in order to encourage this approach, and to allow flexibility in the design of teaching programmes. CIE provides science schemes of work which teachers may find helpful, these can be found on the CIE Teacher Support website.

4. Curriculum content

4.1 Chemistry

It is important that, throughout this section, attention should be drawn to:

- the finite life of the world's resources and hence the need for recycling and conservation
- economic considerations in the chemical industry, such as the availability and cost of raw materials and energy
- the importance of chemicals in industry and in everyday life.

Core	Supplement
C1. The particulate nature of matter	
1 describe the states of matter and explain their interconversion in terms of the kinetic particle theory 2 describe diffusion and Brownian motion in terms of kinetic theory	
C2. Experimental techniques	
1 name appropriate apparatus for the measurement of time, temperature, mass and volume, including burettes, pipettes and measuring cylinders 2 describe paper chromatography (including the use of locating agents) and interpret simple chromatograms 3 recognise that mixtures melt and boil over a range of temperatures 4 describe methods of purification by the use of a suitable solvent, filtration, crystallisation, distillation (including use of fractionating column) Refer to the fractional distillation of crude oil (petroleum – section 11.2) and fermented liquor (section 11.6)	

4. Curriculum content

Core	Supplement
C3. Atoms, elements and compounds	
3.1 Atomic structure and the Periodic Table	
1 state the relative charge and approximate relative mass of a proton, a neutron and an electron 2 define *proton number* and *nucleon number* 3 use proton number and the simple structure of atoms to explain the basis of the Periodic Table (section 7.1 to 7.4), with special reference to the elements of proton number 1 to 20 4 use the notation $^{a}_{b}X$ for an atom 5 describe the build-up of electrons in 'shells' and understand the significance of the noble gas electronic structures and of outer electrons (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 provided in Papers 1, 2 and 3.) 6 define *isotopes*	
3.2 Bonding: the structure of matter	
1 describe the differences between *elements*, *mixtures* and *compounds*, and between *metals* and *non-metals* (section 7.1) 2 describe *alloys*, such as brass, as mixtures of a metal with other elements	3 explain how alloying affects the properties of metals (see 3.2 (d))

Core	Supplement
3.2(a) Ions and ionic bonds	
1 describe the formation of *ions* by electron loss or gain describe the formation of ionic bonds between the alkali metals and the halogens	2 describe the formation of ionic bonds between metallic and non-metallic elements
3.2(b) Molecules and covalent bonds	
1 describe the formation of single covalent bonds in H_2, Cl_2, H_2O, CH_4 and HCl as the sharing of pairs of electrons leading to the noble gas configuration 3 describe the differences in volatility, solubility and electrical conductivity between ionic and covalent compounds	2 describe the electron arrangement in more complex covalent molecules such as N_2, C_2H_4, CH_3OH and CO_2
3.2 (c) Macromolecules	
1 describe the structure of graphite and of diamond	2 relate these structures to melting point, conductivity and hardness
3.2 (d) Metallic bonding	
	1 describe metallic bonding as a lattice of positive ions in a 'sea of electrons' and use this to explain the electrical conductivity and malleability of metals

4. Curriculum content

Core	Supplement
C4. Stoichiometry	
1 use the symbols of the elements and write the formulae of simple compounds	2 determine the formula of an ionic compound from the charges on the ions present
3 deduce the formula of a simple compound from the relative numbers of atoms present 5 construct word equations and simple balanced chemical equations 6 define *relative atomic mass*, A_r	4 deduce the balanced equation of a chemical reaction, given relevant information
7 define *relative molecular mass*, M_r, and calculate it as the sum of the relative atomic masses (the term relative formula mass or M_r will be used for ionic compounds)	8 calculate stoichiometric reacting masses and volumes of gases and solutions, solution concentrations expressed in g / dm^3 and mol / dm^3. (Calculations based on limiting reactants may be set; questions on the gas laws and the conversion of gaseous volumes to different temperatures and pressures will **not** be set.)
C5. Chemical reactions	
5.1 Production of energy	
1 describe the production of heat energy by burning fuels 2 describe hydrogen as a fuel 3 describe radioactive isotopes, such as ^{235}U, as a source of energy	
5.2 Energetics of a reaction	
1 describe the meaning of *exothermic* and *endothermic* reactions 2 describe bond breaking as endothermic and bond forming as exothermic	

Core	Supplement
5.3 Speed of reaction	
1 describe the effects of concentration, particle size, catalysts (including enzymes) and temperature on the speeds of reactions 3 state that organic compounds that catalyse organic reactions are called enzymes 5 describe the application of the above factors to the danger of explosive combustion with fine powders (e.g. flour mills) and gases (e.g. mines)	2 show awareness that light can provide the energy needed for a chemical reaction to occur 4 state that photosynthesis leads to the production of glucose from carbon dioxide and water in the presence of chlorophyll and sunlight (energy) 6 describe the use of silver salts in photography (i.e. reduction of silver ions to silver)
5.4 Redox	
1 define *oxidation* and *reduction* in terms of oxygen gain / loss	
C6. Acids, bases and salts	
6.1 The characteristics properties of acids and bases	
1 describe the characteristic properties of acids as reactions with metals, bases, carbonates and effect on litmus 3 describe neutrality, relative acidity and alkalinity in terms of pH (whole numbers only) measured using Universal Indicator paper 5 describe and explain the importance of the use of lime in controlling acidity in soil	2 define *acids* and *bases* in terms of proton transfer, limited to aqueous solutions 4 use these ideas to explain specified reactions as acid/base
6.2 Types of oxides	
1 classify oxides as either acidic or basic, related to metallic and non-metallic character of the element forming the oxide	2 classify other oxides as neutral or amphoteric

Core	Supplement
6.3 Preparation of salts	
1 describe the preparation, separation and purification of salts as examples of some of the techniques specified in section 2 and the reactions specified in section 6.1	2 suggest a method of making a given salt from suitable starting materials, given appropriate information, including precipitation
6.4 Identification of ions	
1 describe the use of the following tests to identify: – *aqueous cations:* ammonium, copper(II), iron(II), iron(III) and zinc, using aqueous sodium hydroxide and aqueous ammonia as appropriate. (Formulae of complex ions are **not** required.) – *anions:* carbonate (by reaction with dilute acid and then limewater), chloride (by reaction under acidic conditions with aqueous silver nitrate), nitrate (by reduction with aluminium to ammonia) and sulfate (by reaction under acidic conditions with aqueous barium ions)	
6.5 Identification of gases	
1 describe the use of the following tests to identify: ammonia (using damp red litmus paper), carbon dioxide (using limewater), chlorine (using damp litmus paper), hydrogen (using a lighted splint), oxygen (using a glowing splint)	

4. Curriculum content

Core	Supplement
C7. The Periodic Table	
1 describe the Periodic Table as a method of classifying elements and describe its use in predicting properties of elements	
7.1 Periodic trends	
1 describe the change from metallic to non-metallic character across a Period	2 describe the relationship between group number and the number of outer electrons
7.2 Group properties	
1 describe lithium, sodium and potassium in Group I as a collection of relatively soft metals showing a trend in melting point, density and reaction with water 2 predict the properties of other elements in the group given data, where appropriate 3 describe chlorine, bromine and iodine in Group VII as a collection of diatomic non-metals showing a trend in colour, and state their reaction with other halide ions 4 predict the properties of other elements in the group given data, where appropriate	5 identify trends in other groups given data about the elements concerned
7.3 Transition elements	
1 describe the transition elements as a collection of metals having high densities, high melting points and forming coloured compounds, and which, as elements and compounds, often act as catalysts	

4. Curriculum content

Core	Supplement
7.4 Noble gases	
1 describe the noble gases as being unreactive 2 describe the uses of the noble gases in providing an inert atmosphere (e.g. argon in lamps and helium for filling weather balloons)	
C8. Metals	
8.1 Properties of metals	
1 compare the general physical and chemical properties of metals with those of non-metals	
8.2 Reactivity series	
1 place in order of reactivity: calcium, copper, (hydrogen), iron, magnesium, potassium, sodium and zinc, by reference to the reactions, if any and where relevant, of the metals with – water or steam, – dilute hydrochloric acid (equations not required) – the aqueous ions of other metals 3 deduce an order of reactivity from a given set of experimental results	2 account for the apparent unreactivity of aluminium in terms of the oxide layer adhering to the metal
8.3 (a) Extraction of metals	
1 describe the ease in obtaining metals from their ores by relating the elements to the reactivity series 3 name metals that occur 'native', including copper and gold 4 name the main ores of aluminium, copper and iron	2 describe the essential reactions in the extraction of iron from haematite

Core	Supplement
8.3 (b) Uses of metal	
1 describe the idea of changing the properties of iron by the controlled use of additives to form steel alloys 3 name the uses of mild steel (car bodies and machinery) and stainless steel (chemical plant and cutlery) 4 name the uses of zinc for galvanising and making brass	2 name the uses, related to their properties, of copper (electrical wiring and in cooking utensils) and of aluminium (aircraft parts and food containers)
C9. Air and water	
1 describe a chemical test for water 2 show understanding that hydration may be reversible (e.g. by heating hydrated copper(II) sulfate or hydrated cobalt(II) chloride) 3 describe, in outline, the purification of the water supply in terms of filtration and chlorination 4 name some of the uses of water in industry and in the home 5 describe the composition of clean air as being approximately 78% nitrogen, 21% oxygen and the remainder as being a mixture of noble gases, water vapour and carbon dioxide 6 name the common pollutants in the air as being carbon monoxide, sulfur dioxide, oxides of nitrogen and lead compounds 7 state the source of each of these pollutants: – carbon monoxide from the incomplete combustion of carbon-containing substances – sulfur dioxide from the combustion of fossil fuels which contain sulfur compounds (leading to 'acid rain') – oxides of nitrogen and lead compounds from car exhausts	8 explain the catalytic removal of nitrogen oxides from car exhaust gases

Core	Supplement
9 state the adverse effect of common pollutants on buildings and on health 10 describe the separation of oxygen and nitrogen from liquid air by fractional distillation 11 name the uses of oxygen in oxygen tents in hospitals, and with acetylene (a hydrocarbon) in welding 12 describe methods of rust prevention: – paint and other coatings, to exclude oxygen – galvanising 14 describe the need for nitrogen-, phosphorous- and potassium-containing fertilisers 15 describe the formation of carbon dioxide: – as a product of complete combustion of carbon-containing substances – as a product of respiration – as a product of the reaction between an acid and a carbonate	13 explain galvanising in terms of the reactivity of zinc and iron
C10. Lime and limestone	
1 describe the manufacture of calcium oxide (lime) from calcium carbonate (limestone) in terms of the chemical reactions involved 2 name some uses of lime and calcium hydroxide (slaked lime) as in treating acidic soil and neutralising acidic industrial waste products	

Core	Supplement
C11. Organic chemistry	
11.1 Names of compounds	
1 name, and draw, the structures of methane, ethane, ethanol, ethanoic acid and the products of the reactions stated in sections 11.4 to 11.6 2 state the type of compound present, given a chemical name ending in -*ane*, -*ene*, -*ol*, or -*oic* acid or a molecular structure	
11.2 Fuels	
1 name the fuels coal, natural gas and petroleum 2 name methane as the main constituent of natural gas 3 describe petroleum as a mixture of hydrocarbons and its separation into useful fractions by fractional distillation 4 name the uses of the fractions: – petrol fraction as fuel in cars – paraffin fraction for oil stoves and aircraft fuel – diesel fraction for fuel in diesel engines – lubricating fraction for lubricants and making waxes and polishes – bitumen for making roads	
11.3 Homologous series	
1 describe the concept of homologous series as a 'family' of similar compounds with similar properties due to the presence of the same functional group	

Core	Supplement
11.4 Alkanes	
1 describe the properties of alkanes (exemplified by methane) as being generally unreactive, except in terms of burning	
11.5 Alkenes	
1 describe the properties of alkenes in terms of addition reactions with bromine, hydrogen and steam 3 distinguish between *saturated* and *unsaturated* hydrocarbons from molecular structures, by simple chemical tests 4 describe the formation of poly(ethene) as an example of addition polymerisation of monomer units	2 describe the manufacture of alkenes and of hydrogen by cracking
11.6 Alcohols	
1 name the uses of ethanol: as a solvent, as a fuel and as a constituent of wine and beer	2 describe the formation of ethanol by fermentation and by the catalytic addition of steam to ethene

4. Curriculum content

4.2 Physics

Throughout this section, attention should be paid to showing the relevance of concepts to the student's everyday life and to the natural and man-made world.

Core	Supplement
P1. General physics	
1.1 Length and time	
1 use and describe the use of rules and measuring cylinders to determine a length or a volume 3 use and describe the use of clocks and devices for measuring an interval of time	2 use and describe the use of a mechanical method for the measurement of a small distance 4 measure and describe how to measure a short interval of time (including the period of a pendulum)
1.2 Speed, velocity and acceleration	
1 define *speed* and calculate speed from $\frac{\textit{total distance}}{\textit{total time}}$	2 distinguish between *speed* and *velocity*
3 plot and interpret a speed / time graph	4 recognise linear motion for which the acceleration is constant and calculate the acceleration
5 recognise from the shape of a speed / time graph when a body is: – at rest – moving with constant speed – moving with changing speed 7 calculate the area under a speed / time graph to determine the distance travelled for motion with constant acceleration 8 demonstrate some understanding that acceleration is related to changing speed	6 recognise motion for which the acceleration is not constant
9 state that the acceleration of free fall for a body near to the Earth is constant	10 describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance (including reference to terminal velocity)

4. Curriculum content

Core	Supplement
1.3 Mass and weight	
1 show familiarity with the idea of the mass of a body 3 state that weight is a force 4 calculate the weight of a body from its mass 5 demonstrate understanding that weights (and hence masses) may be compared using a balance	2 demonstrate an understanding that mass is a property which 'resists' change in motion 6 describe, and use the concept of, weight as the effect of a gravitational field on a mass
1.4 Density	
1 describe an experiment to determine the density of a liquid and of a regularly shaped solid, and make the necessary calculation	2 describe the determination of the density of an irregularly shaped solid by the method of displacement
1.5 Forces	
1.5 (a) Effects of forces	
1 state that a force may produce a change in size and shape of a body 3 plot extension-load graphs and describe the associated experimental procedure 5 describe the ways in which a force may change the motion of a body	2 take readings from and interpret extension-load graphs (Hooke's law, as such, is **not** required) 4 recognise the significance of the term 'limit of proportionality' for an extension-load graph and use proportionality in simple calculations 6 recall and use the relation between force, mass and acceleration (including the direction)
1.5 (b) Turning effect	
1 describe the moment of a force as a measure of its turning effect and give everyday examples	2 perform and describe an experiment (involving vertical forces) to verify that there is no net moment on a body in equilibrium

4. Curriculum content

Core	Supplement
1.5 (c) Centre of mass	
1 calculate the moment of a force given the necessary information 2 perform and describe an experiment to determine the position of the centre of mass of a plane lamina 3 describe qualitatively the effect of the position of the centre of mass on the stability of simple objects	
1.6 Energy, work and power	
1.6 (a) Energy	
1 give examples of energy in different forms, its conversion and conservation and apply the principle of energy conservation to simple examples 3 show some understanding of energy of motion and energy of position (i.e. gravitational and strain)	2 describe energy transfer in terms of work done and make calculations involving $F \times d$ 4 use the terms *kinetic* and *potential energy* in context 5 recall and use the expressions: k.e. = $\frac{1}{2} mv^2$ p.e. = mgh
1.6 (b) Major sources of energy and alternative sources of energy	
1 describe processes by which energy is converted from one form to another, including reference to: – chemical/fuel energy (a regrouping of atoms) – energy from water (hydroelectric energy, waves, tides) – geothermal energy	2 express a qualitative understanding of efficiency

Core	Supplement
– nuclear energy (fission of heavy atoms)	– solar energy (fusion of nuclei of atoms in the Sun) • recall and use the mass/energy equation $E = mc^2$
1.6 (c) Work	
1 relate, without calculation, work done to the magnitude of a force and distance moved	2 recall and use $\Delta W = F \times d = \Delta E$
1.6 (d) Power	
1 relate, without calculation, power to work done and time taken, using appropriate examples	2 recall and use the equation $P = E/t$ in simple systems
P2. Thermal physics	
2.1 Thermal properties	
2.1 (a) Thermal expansion of solids, liquids and gases	
1 describe qualitatively the thermal expansion of solids, liquids and gases 3 identify and explain some of the everyday applications and consequences of thermal expansion	2 show an appreciation of the relative order of magnitude of the expansion of solids, liquids and gases
2.1 (b) Measurement of temperature	
1 appreciate how a physical property which varies with temperature may be used for the measurement of temperature and state examples of such properties 4 recognise the need for and identify a fixed point 5 describe the structure and action of liquid-in-glass thermometers	2 apply a given property to the measurement of temperature 3 demonstrate understanding of sensitivity, range and linearity 6 describe the structure and action of a thermocouple and show understanding of its use for measuring high temperatures and those which vary rapidly

4. Curriculum content

Core	Supplement
2.1 (c) Melting and boiling	
1 describe melting and boiling in terms of energy input without a change in temperature 3 state the meaning of *melting point* and *boiling point*	2 distinguish between *boiling* and *evaporation*
2.2 Transfer of thermal energy	
2.2 (a) Conduction	
1 describe experiments to demonstrate the properties of good and bad conductors of heat	2 give a simple molecular account of the heat transfer in solids
2.2 (b) Convection	
1 relate convection in fluids to density changes and describe experiments to illustrate convection	
2.2 (c) Radiation	
1 identify infra-red radiation as part of the electromagnetic spectrum	2 describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation
2.2 (d) Consequences of energy transfer	
1 identify and explain some of the everyday applications and consequences of conduction, convection and radiation	

Core	Supplement
P3. Properties of waves, including light and sound	
3.1 General wave properties	
1 describe what is meant by wave motion as illustrated by vibration in ropes, springs and by experiments using water waves 2 use the term *wavefront* 3 give the meaning of *speed*, *frequency*, *wavelength* and *amplitude* 5 describe the use of water waves to show – reflection at a plane surface – refraction due to a change of speed	4 recall and use the equation $c = f\lambda$ 6 interpret reflection, refraction and diffraction using wave theory
3.2 Light	
3.2 (a) Reflection of light	
1 describe the formation, and give the characteristics, of an optical image formed by a plane mirror 3 use the law *angle of incidence = angle of reflection*	2 perform simple constructions, measurements and calculations
3.2 (b) Refraction of light	
1 describe the refraction, including angle of refraction, in terms of the passage of light through a parallel sided glass block	2 determine and calculate refractive index using $n = \sin i / \sin r$
3.2 (c) Thin converging lens	
1 describe the action of a thin converging lens on a beam of light 3 use the term *focal length*	2 use and describe the use of a single lens as a magnifying glass

Core	Supplement
3.2 (d) Electromagnetic spectrum	
1 describe the main features of the electromagnetic spectrum and state that all e.m. waves travel with the same high speed *in vacuo*	2 state the approximate value of the speed of electromagnetic waves 3 use the term *monochromatic*
3.3 Sound	
1 describe the production of sound by vibrating sources 2 state the approximate range of audible frequencies 3 show an understanding that a medium is required in order to transmit sound waves	
P4. Electricity and magnetism	
4.1 Simple phenomena of magnetism	
1 state the properties of magnets 2 give an account of induced magnetism 3 distinguish between ferrous and non-ferrous materials 4 describe an experiment to identify the pattern of field lines round a bar magnet 5 distinguish between the magnetic properties of iron and steel 6 distinguish between the design and use of permanent magnets and electro-magnets	
4.2 Electrostatics	
1 describe simple experiments to show the production and detection of electrostatic charges	

4. Curriculum content

Core	Supplement
4.2 (a) Electric charge	
1 state that there are positive and negative charges 3 state that unlike charges attract and that like charges repel	2 state that charge is measured in coulombs
4.3 Electricity	
1 state that current is related to the flow of charge	2 show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q/t$
4.3 (a) Current	
1 use and describe the use of an ammeter	
4.3 (b) Electro-motive force (e.m.f.)	
1 state that the e.m.f. of a source of electrical energy is measured in volts	2 show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit
4.3 (c) Potential difference (p.d.)	
1 state that the potential difference across a circuit component is measured in volts 2 use and describe the use of a voltmeter	
4.3 (d) Resistance	
1 recall and use the equation $V = IR$ 3 describe an experiment to determine resistance using a voltmeter and an ammeter 4 relate (without calculation) the resistance of a wire to its length and to its diameter	2 recall and use quantitatively the proportionality between resistance and the length, and the inverse proportionality between resistance and cross-sectional area, of a wire

Core	Supplement
4.3 (e) V/I characteristic graphs	
1 sketch the V/I characteristic graphs for metallic (ohmic) conductors	
4.4 Electric circuits	
1 draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), ammeters, voltmeters, magnetising coils, bells, fuses, relays	2 draw and interpret circuit diagrams containing diodes as rectifiers
3 understand that the current at every point in a series circuit is the same	4 recall and use the fact that the sum of the p.d.'s across the components in a series circuit is equal to the total p.d. across the supply
5 give the combined resistance of two or more resistors in series	
6 state that, for a parallel circuit, the current from the source is larger than the current in each branch	7 recall and use the fact that the current from the source is the sum of the currents in the separate branches of a parallel circuit
8 state that the combined resistance of two resistors in parallel is less than that of either resistor by itself	9 calculate the effective resistance of two resistors in parallel
4.5 Practical electric circuitry	
4.5 (a) Uses of electricity	
1 describe the uses of electricity in heating, lighting (including lamps in parallel), motors	2 recall and use the equations $P = I\,V$ and $E = I\,V\,t$ and their alternative forms
4.5 (b) Safety considerations	
1 state the hazards of – damaged insulation – overheating of cables – damp conditions	

Core	Supplement
4.6 Electromagnetic effects	
4.6 (a) Electromagnetic induction	
	1 describe an experiment which shows that a changing magnetic field can induce an e.m.f. in a circuit 2 state the factors affecting the magnitude of the induced e.m.f. 3 show understanding that the direction of an induced e.m.f. opposes the change causing it
4.6 (b) a.c. generator	
	1 describe a rotating-coil generator and the use of slip rings 2 sketch a graph of voltage output against time for a simple a.c. generator
4.6 (c) d.c. motor	
1 state that a current-carrying coil in a magnetic field experiences a turning effect and that the effect is increased by increasing the number of turns on the coil 3 relate this turning effect to the action of an electric motor	2 describe the effect of increasing the current

4. Curriculum content

Core	Supplement
4.6 (d) Transformer	
	1 describe the construction of a basic iron-cored transformer as used for voltage transformations 2 show an understanding of the principle of operation of a transformer 3 use the equation $(V_p / V_s) = (N_p / N_s)$ 4 recall and use the equation $V_p I_p = V_s I_s$ (for 100% efficiency) 5 show understanding of energy loss in cables (calculation not required) 6 describe the use of the transformer in high-voltage transmission of electricity 7 advantages of high voltage transmission
4.7 Cathode rays and the cathode-ray oscilloscope (c.r.o.)	
4.7 (a) Cathode rays	
1 describe the production and detection of cathode rays 3 describe their deflection in electric fields and magnetic fields 4 deduce that the particles emitted in thermionic emission are negatively charged 5 state that the particles emitted in thermionic emission are electrons	2 distinguish between the direction of electron current and conventional current
4.7 (b) Simple treatment of cathode-ray oscilloscope	
1 describe in outline the basic structure, and action, of a cathode-ray oscilloscope (detailed circuits are **not** required) 3 use and describe the use of a cathode-ray oscilloscope to display waveforms	2 use and describe the use of a c.r.o. to measure p.d.s and short intervals of time (detailed circuits are **not** required)

4. Curriculum content

Core	Supplement
P5. Atomic physics	
5.1 Radioactivity	
5.1 (a) Detection of radioactivity	
1 show awareness of the existence of background radioactivity 2 describe the detection of alpha-particles, beta-articles and gamma-rays	
5.1 (b) Characteristics of the three kinds of emission	
1 state that radioactive emissions occur randomly over space and time 2 state, for radioactive emissions: – their nature – their relative ionising effects – their relative penetrating abilities 3 describe their deflection in electric fields and magnetic fields	
5.1 (c) Radioactive decay	
1 state the meaning of *radioactive decay*, using word equations to represent changes in the composition of the nucleus when particles are emitted	
5.1 (d) Half-life	
1 use the term *half-life* in simple calculations which might involve information in tables or decay curves	
5.1 (e) Safety precautions	
1 describe how radioactive materials are handled, used and stored in a safe way	

Core	Supplement
5.2 The nuclear atom	
5.2 (a) Nucleus	
1 describe the composition of the nucleus in terms of protons and neutrons 2 use the term *proton number, Z* 3 use the term *nucleon number, A* 4 use the term *nuclide* and nuclide notation $^{A}_{Z}X$ 5 use the nuclide notation in equations to show alpha and beta decay	
5.2 (b) Isotopes	
1 use the term *isotopes*	2 give and explain examples of practical applications of isotopes

5. Practical assessment

Practical assessment: Papers 4, 5 or 6

Scientific subjects are, by their nature, experimental. It is therefore important that an assessment of a student's knowledge and understanding of Science should contain a component relating to practical work and experimental skills (as identified by assessment objective C). To accommodate, within IGCSE, differing circumstances – such as the availability of resources – CIE provides three different means of assessing assessment objective C objective: School-based assessment, a formal Practical Test and an Alternative to Practical Paper.

Whichever practical assessment route is chosen, the following points should be noted:

- the same assessment objectives apply
- the same practical skills are to be learned and developed
- the same benefits to theoretical understanding come from all practical work
- the same motivational effect, enthusiasm and enjoyment should be experienced
- the same sequence of practical activities is appropriate.

5.1 Paper 4: Coursework (School-based assessment of practical skills)

The experimental skills and abilities to be assessed are:

C1 Using and organising techniques, apparatus and materials

C2 Observing, measuring and recording

C3 Handling experimental observations and data

C4 Planning, carrying out and evaluating investigations

The four skills carry equal weighting.

All assessments must be based upon experimental work carried out by the candidates.

The teaching and assessment of experimental skills and abilities should take place throughout the course.

Teachers must ensure that they can make available to CIE evidence of **two** assessments for each skill for each candidate. For skills C1 to C4 inclusive, information about the tasks set and how the marks were awarded will be required. For skills C2, C3 and C4 the candidate's written work will also be required.

The final assessment scores for each skill must represent the candidate's best performances.

5. Practical assessment

For candidates who miss the assessment of a given skill through no fault of their own, for example because of illness, and who cannot be assessed on another occasion, CIE's procedure for special consideration should be followed. However, candidates who for no good reason absent themselves from an assessment of a given skill should be given a mark of zero for that assessment.

Criteria for assessment of experimental skills and abilities

Each skill must be assessed on a six-point scale, level 6 being the highest level of achievement.
Each of the skills is defined in terms of three levels of achievement at scores of 2, 4 and 6.

A score of 0 is available if there is no evidence of positive achievement for a skill.

For candidates who do not meet the criteria for a score of 2, a score of 1 is available if there is some evidence of positive achievement.

A score of 3 is available for candidates who go beyond the level defined by 2, but who do not meet fully the criteria for 4.

Similarly, a score of 5 is available for those who go beyond the level defined for 4, but do not meet fully the criteria for 6.

Score	Skill C1: Using and organising techniques, apparatus and materials
0	No evidence of positive achievement for this skill.
1	Some evidence of positive achievement, but the criteria for a score of 2 are not met.
2	Follows written, diagrammatic or oral instructions to perform a single practical operation. Uses familiar apparatus and materials adequately, needing reminders on points of safety.
3	Is beyond the level defined for 2, but does not meet fully the criteria for 4.
4	Follows written, diagrammatic or oral instructions to perform an experiment involving a series of step-by-step practical operations. Uses familiar apparatus, materials and techniques adequately and safely.
5	Is beyond the level defined for 4, but does not meet fully the criteria for 6.
6	Follows written, diagrammatic or oral instructions to perform an experiment involving a series of practical operations where there may be a need to modify or adjust one step in the light of the effect of a previous step. Uses familiar apparatus, materials and techniques safely, correctly and methodically.

5. Practical assessment

Score	Skill C2: Observing, measuring and recording
0	No evidence of positive achievement for this skill.
1	Some evidence of positive achievement, but the criteria for a score of 2 are not met.
2	Makes observations or readings given detailed instructions. Records results in an appropriate manner given a detailed format.
3	Is beyond the level defined for 2, but does not meet fully the criteria for 4.
4	Makes relevant observations, measurements or estimates given an outline format or brief guidelines. Records results in an appropriate manner given an outline format.
5	Is beyond the level defined for 4, but does not meet fully the criteria for 6.
6	Makes relevant observations, measurements or estimates to a degree of accuracy appropriate to the instruments or techniques used. Records results in an appropriate manner given no format.

Score	Skill C3: Handling experimental observations and data
0	No evidence of positive achievement for this skill.
1	Some evidence of positive achievement, but the criteria for a score of 2 are not met.
2	Processes results in an appropriate manner given a detailed format. Draws an obvious qualitative conclusion from the results of an experiment.
3	Is beyond the level defined for 2, but does not meet fully the criteria for 4.
4	Processes results in an appropriate manner given an outline format. Recognises and comments on anomalous results. Draws qualitative conclusions which are consistent with obtained results and deduces patterns in data.
5	Is beyond the level defined for 4, but does not meet fully the criteria for 6.
6	Processes results in an appropriate manner given no format. Deals appropriately with anomalous or inconsistent results. Recognises and comments on possible sources of experimental error. Expresses conclusions as generalisations or patterns where appropriate.

Score	Skill C4: Planning, carrying out and evaluating investigations
0	No evidence of positive achievement for this skill.
1	Some evidence of positive achievement, but the criteria for a score of 2 are not met.
2	Suggests a simple experimental strategy to investigate a given practical problem. Attempts ‘trial and error’ modification in the light of the experimental work carried out.
3	Is beyond the level defined for 2, but does not meet fully the criteria for 4.
4	Specifies a sequence of activities to investigate a given practical problem. In a situation where there are two variables, recognises the need to keep one of them constant while the other is being changed. Comments critically on the original plan, and implements appropriate changes in the light of the experimental work carried out.
5	Is beyond the level defined for 4, but does not meet fully the criteria for 6.
6	Analyses a practical problem systematically and produces a logical plan for an investigation. In a given situation, recognises there are a number of variables and attempts to control them. Evaluates chosen procedures, suggests/implements modifications where appropriate and shows a systematic approach in dealing with unexpected results.

Notes for guidance

The following notes are intended to help teachers to make valid and reliable assessments of the skills and abilities of their candidates.

The assessments should be based on the principle of positive achievement: candidates should be given opportunities to demonstrate what they understand and can do.

It is expected that candidates will have had opportunities to acquire a given skill before assessment takes place.

It is not expected that all of the practical work undertaken by a candidate will be assessed.

Assessments can be carried out at any time during the course. However, at whatever stage assessments are done, the standards applied must be those expected at the end of the course as exemplified in the criteria for the skills.

Assessments should normally be made by the person responsible for teaching the candidates.

5. Practical assessment

It is recognised that a given practical task is unlikely to provide opportunities for all aspects of the criteria at a given level for a particular skill to be satisfied, for example, there may not be any anomalous results (Skill C3). However, by using a range of practical work, teachers should ensure that opportunities are provided for all aspects of the criteria to be satisfied during the course.

The educational value of extended experimental investigations is widely recognised. Where such investigations are used for assessment purposes, teachers should make sure that candidates have ample opportunity for displaying the skills and abilities required by the scheme of assessment.

It is not necessary for all candidates in a Centre, or in a teaching group within a Centre, to be assessed on exactly the same practical work, although teachers may well wish to make use of work that is undertaken by all of their candidates.

When an assessment is carried out on group work the teacher must ensure that the individual contribution of each candidate can be assessed.

Skill C1 may not generate a written product from the candidates. It will often be assessed by watching the candidates carrying out practical work.

Skills C2, C3 and C4 will usually generate a written product from the candidates. This product will provide evidence for moderation.

Raw scores for individual practical assessments should be recorded on the Individual Candidate Record Card. The final, internally-moderated, total score should be recorded on the Coursework Assessment Summary Form. Examples of both forms are provided at the end of this syllabus.

Raw scores for individual practical assessments may be given to candidates as part of the normal feedback from the teacher. The final, internally-moderated, total score, which is submitted to CIE should not be given to the candidate.

5. Practical assessment

Moderation

(a) Internal moderation

When several teachers in a Centre are involved in internal assessments, arrangements must be made within the Centre for all candidates to be assessed to a common standard.

It is essential that within each Centre the marks for each skill assigned within different teaching groups (e.g. different classes) are moderated internally for the whole Centre entry. The Centre assessments will then be subject to external moderation.

(b) External moderation

External moderation of internal assessment will be carried out by CIE.

The internally moderated marks for all candidates must be received at CIE by 30 April for the June examination and 31 October for the November examination. These marks may be submitted either by using MS1 mark sheets or by using Cameo as described in the Handbook for Centres.

Once CIE has received the marks, CIE will select a sample of candidates whose work should be submitted for external moderation. CIE will communicate the list of candidates to the Centre, and the Centre should despatch the coursework of these candidates to CIE immediately. For each candidate on the list, every piece of work which has contributed to the final mark should be sent to CIE. Individual Candidate Record Cards and Coursework Assessment Summary Forms (copies of which may be found at the back of this syllabus booklet) must be enclosed with the coursework.

Further information about external moderation may be found in the Handbook for Centres and the Administrative Guide for Centres.

A further sample may be required. All records and supporting written work should be retained until after publication of results. Centres may find it convenient to use loose-leaf A4 file paper for assessed written work. This is because samples will be sent through the post for moderation and postage bills are likely to be large if whole exercise books are sent. Authenticated photocopies of the sample required would be acceptable.

The individual pieces of work should **not** be stapled together. Each piece of work should be labelled with the skill being assessed, the Centre number and candidate name and number, title of the experiment, a copy of the mark scheme used, and the mark awarded. This information should be attached securely, mindful that adhesive labels tend to peel off some plastic surfaces.

5.2 Paper 5: Practical test

Chemistry

Candidates may be asked to carry out exercises involving:

- simple quantitative experiments involving the measurement of volumes
- speeds of reaction
- measurement of temperature based on a thermometer with 1°C graduations
- problems of an investigatory nature, possibly including suitable organic compounds
- filtration
- identification of ions and gases as specified in the Core curriculum. The question paper will include *Notes for Use in Qualitative Analysis*
- making suitable observations without necessarily identifying compounds.

Candidates may be required to do the following:

- record readings from apparatus
- estimate small volumes without the use of measuring devices
- describe, explain or comment on experimental arrangements and techniques
- complete tables of data
- draw conclusions from observations and/or from information given
- interpret and evaluate observations and experimental data
- plot graphs and/or interpret graphical information
- identify sources of error and suggest possible improvements in procedures
- plan an investigation, including suggesting suitable techniques and apparatus.

Note on taking readings

When approximate volumes are used, e.g. about 2 cm^3, it is expected that candidates will estimate this and not use measuring devices. Thermometers may be marked with intervals of 1°C. It is however appropriate to record a reading which coincides exactly with a mark, e.g. 22.0°C rather than 22°C. Interpolation between scale divisions should also be used such that a figure of 22.5°C may be more appropriate.

5. Practical assessment

Apparatus List

The list below details the apparatus expected to be generally available for examination purposes. The list is not exhaustive: in particular, items that are commonly regarded as standard equipment in a chemical laboratory (such as Bunsen burners, tripods, hot water baths etc.) are not included. It is expected that the following items would be available for each candidate.

- two conical flasks within the range 150 cm^3 to 250 cm^3
- measuring cylinders, 100 cm^3, 25 cm^3 and 10 cm^3
- a filter funnel
- two beakers, 250 cm^3 and 100 cm^3
- a thermometer, –10°C to +110°C at 1°C graduations
- a dropping pipette
- clocks (or wall clock) to measure to an accuracy of about 1 s. Candidates own wristwatch may be used
- a plastic trough of approximate size W150 mm × L220 mm × D80 mm
- test-tubes. Sizes approximately 125 × 15 mm and 150 × 25 mm should be available and should include some hard glass test-tubes.

Physics

Candidates should be able to:

- follow written instructions for the assembly and use of provided apparatus (e.g. for using ray-tracing equipment, for wiring up simple electrical circuits)
- select, from given items, the measuring device suitable for the task
- carry out the specified manipulation of the apparatus, for example:
  - when determining a (derived) quantity such as the extension per unit load for a spring
  - when testing/identifying the relationship between two variables, such as between the p.d. across a wire and its length
  - when comparing physical quantities such as the thermal capacity of two metals
- take readings from a measuring device, including:
  - reading a scale with appropriate precision / accuracy
  - consistent use of significant figures
  - interpolating between scale divisions
  - allowing for zero errors, where appropriate
  - taking repeated measurements to obtain an average value
- record their observations systematically, with appropriate units
- process their data, as required
- present their data graphically, using suitable axes and scales (appropriately labelled) and plotting the points accurately

- take readings from a graph by interpolation and extrapolation
- determine a gradient, intercept or intersection on a graph
- draw and report a conclusion or result clearly
- indicate how they carried out a required instruction
- describe precautions taken in carrying out a procedure
- give reasons for making a choice of items of apparatus
- comment on a procedure used in an experiment and suggest an improvement

Note: a measuring instrument should be used to its full precision. Thermometers may be marked in 1°C intervals but it is often appropriate to interpolate between scale divisions and record a temperature as 21.5°C. Measurements using a rule requires suitable accuracy of recording such as 15.0 cm rather than 15 and use of millimetres used more regularly. Similarly, when measuring current, it is often more useful to use milliamperes rather than amperes.

Apparatus List
The list below details the apparatus expected to be generally available for examination purposes. The list is not exhaustive: in particular, items that are commonly regarded as standard equipment in a physics laboratory are not included. It is expected that the following items would be available for each candidate.

- an ammeter FSD 1 A or 1.5 A
- voltmeter FSD 1 V, 5 V
- cells and holders to enable several cells to be joined
- connecting leads and crocodile clips
- d.c. power supply – variable to 12 V
- metre rule
- converging lens with f = 15 cm
- low voltage filament bulbs in holders
- good supply of masses and holder
- Newton meter
- plastic or polystyrene cup
- Plasticine or modelling clay
- various resistors
- switch
- thermometer, –10°C to +110°C at 1°C graduations
- wooden board
- glass or perspex block, rectangular and semi circular
- measuring cylinder, 100 cm^3, 250 cm^3

- springs
- stopwatch
- ray box.

Note:
The examination will **not** require the use of textbooks, nor will candidates need to have access to their own records of laboratory work made during their course; candidates will be expected to carry out the experiments from the instructions given in the paper.

5.3 Paper 6: Alternative to practical

This paper is designed to test candidates' familiarity with laboratory practical procedures.

Questions may be set requesting candidates to:

- describe in simple terms how they would carry out practical procedures
- explain and/or comment critically on described procedures or points of practical detail
- follow instructions for drawing diagrams
- draw, complete and/or label diagrams of apparatus
- take readings from their own diagrams, drawn as instructed, and/or from printed diagrams including:
  - reading a scale with appropriate precision/accuracy with consistent use of significant figures and with appropriate units
  - interpolating between scale divisions
  - taking repeat measurements to obtain an average value
- process data as required, complete tables of data
- present data graphically, using suitable axes and scales (appropriately labelled) and plotting the points accurately
- take readings from a graph by interpolation and extrapolation
- determine a gradient, intercept or intersection on a graph
- draw and report a conclusion or result clearly
- identify and/or select, with reasons, items of apparatus to be used for carrying out practical procedures
- explain, suggest and/or comment critically on precautions taken and/or possible improvements to techniques and procedures
- describe, from memory, tests for gases and ions, and/or draw conclusions from such tests

(*Notes for Use in Qualitative Analysis*, will **not** be provided in the question paper.)

6. Appendix

6.1 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. Candidates should be able to define those items indicated by an asterisk (*). The list for the extended curriculum includes both the core and the supplement.

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

6. Appendix

6.2 Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate (CO_3^{2-})	add dilute acid	effervescence, carbon dioxide produced
chloride (Cl^-) [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
nitrate (NO_3^-) [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate (SO_4^{2-}) [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
ammonium (NH_4^+)	ammonia produced on warming	-
copper(II) (Cu^{2+})	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II) (Fe^{2+})	green ppt., insoluble in excess	green ppt., insoluble in excess
iron(III) (Fe^{3+})	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc (Zn^{2+})	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

Tests for gases

gas	test and test result
ammonia (NH_3)	turns damp red litmus paper blue
carbon dioxide (CO_2)	turns lime water milky
chlorine (Cl_2)	bleaches damp litmus paper
hydrogen (H_2)	'pops' with a lighted splint
oxygen (O_2)	relights a glowing splint

6.3 Data sheet

Group																	
I	II											III	IV	V	VI	VII	
							1 H Hydrogen 1										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

6.4 Grade descriptions

The scheme of assessment is intended to encourage positive achievement by all candidates. Mastery of the core curriculum is required for further academic study.

A **Grade A** candidate must show mastery of the core curriculum and the extended curriculum.

A **Grade C** candidate must show mastery of the core curriculum plus some ability to answer questions which are pitched at a higher level.

A **Grade F** candidate must show competence in the core curriculum.

A **Grade A** candidate is likely to

- relate facts to principles and theories and vice versa
- state why particular techniques are preferred for a procedure or operation
- select and collate information from a number of sources and present it in a clear logical form
- solve problems in situations which may involve a wide range of variables
- process data from a number of sources to identify any patterns or trends
- generate a hypothesis to explain facts, or find facts to support an hypothesis.

A **Grade C** candidate is likely to

- link facts to situations not specified in the syllabus
- describe the correct procedure(s) for a multi-stage operation
- select a range of information from a given source and present it in a clear logical form
- identify patterns or trends in given information
- solve problems involving more than one step, but with a limited range of variables
- generate a hypothesis to explain a given set of facts or data.

A **Grade F** candidate is likely to

- recall facts contained in the syllabus
- indicate the correct procedure for a single operation
- select and present a single piece of information from a given source
- solve a problem involving one step, or more than one step if structured help is given
- identify a pattern or trend where only a minor manipulation of data is needed
- recognise which of two given hypotheses explains a set of facts or data.

6.5 Mathematical requirements

Calculators may be used in all parts of the assessment.

Candidates should be able to:

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

6.6 Glossary of terms used in science papers

It is hoped that the glossary (which is relevant only to Science subjects) will prove helpful to candidates as a guide (e.g. 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 the descriptions of their meanings. 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. *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 other contexts, *describe* 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, as may *state and explain*.
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. resistance, the formula of an ionic compound).
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).

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

6.7 Forms

This section contains copies of the following forms, together with instructions on how to complete them:

Individual Candidate Record Card

Coursework Assessment Summary Form

Sciences Experiment Form

Please read the instructions printed overleaf and the General Coursework Regulations before completing this form.

Centre number						Centre name		November	2	0	1	3
Candidate number						Candidate name		Teaching group/set				

Date of assessment	Experiment number from Sciences Experiment Form	Assess at least twice: ring highest two marks for each skill (Max 6 each assessment)				Relevant comments (for example, if help was given)
		C1	C2	C3	C4	
Marks to be transferred to Coursework Assessment Summary Form		(max 12)	(max 12)	(max 12)	(max 12)	TOTAL (max 48)

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Instructions for completing individual candidate record cards

1. Complete the information at the head of the form.
2. Mark each item of Coursework for each candidate according to instructions given in the Syllabus and Training Manual.
3. Enter marks and total marks in the appropriate spaces. Complete any other sections of the form required.
4. Ensure that the addition of marks is independently checked.
5. **It is essential that the marks of candidates from different teaching groups within each Centre are moderated internally.** This means that the marks awarded to all candidates within a Centre must be brought to a common standard by the teacher responsible for co-ordinating the internal assessment (i.e. the internal moderator), and a single valid and reliable set of marks should be produced which reflects the relative attainment of all the candidates in the Coursework component at the Centre.
6. Transfer the marks to the Coursework Assessment Summary Form in accordance with the instructions given on that document.
7. Retain all Individual Candidate Record Cards and Coursework **which will be required for external moderation.** Further detailed instructions about external moderation will be sent in early October of the year of the examination. See also the instructions on the Coursework Assessment Summary Form.

Note: These Record Cards are only to be used by teachers for candidates who have undertaken Coursework as part of their IGCSE.

SCIENCES
Coursework Assessment Summary Form
IGCSE 2013

Please read the instructions printed overleaf and the General Coursework Regulations before completing this form.

Centre number					Centre name		November	**2**	**0**	**1**	**3**

Syllabus code	**0**	**6**	**5**	**2**	Syllabus title	**PHYSICAL SCIENCE**	Component number	**0**	**4**	Component title	**COURSEWORK**

Candidate number	Candidate name	Teaching group/ set	C1 (max 12)	C2 (max 12)	C3 (max 12)	C4 (max 12)	Total mark (max 48)	Internally moderated mark (max 48)

Name of teacher completing this form		Signature		Date	
Name of internal moderator		Signature		Date	

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A. Instructions for completing coursework assessment summary forms

1. Complete the information at the head of the form.
2. List the candidates in an order which will allow ease of transfer of information to a computer-printed Coursework mark sheet MS1 at a later stage (i.e. in candidate index number order, where this is known; see item B.1 below). Show the teaching group or set for each candidate. The initials of the teacher may be used to indicate group or set.
3. Transfer each candidate's marks from his or her Individual Candidate Record Card to this form as follows:
   (a) Where there are columns for individual skills or assignments, enter the marks initially awarded (i.e. before internal moderation took place).
   (b) In the column headed 'Total Mark', enter the total mark awarded before internal moderation took place.
   (c) In the column headed 'Internally Moderated Mark', enter the total mark awarded *after* internal moderation took place.
4. Both the teacher completing the form and the internal moderator (or moderators) should check the form and complete and sign the bottom portion.

B. Procedures for external moderation

1. University of Cambridge International Examinations (CIE) sends a computer-printed Coursework mark sheet MS1 to each Centre in early October showing the names and index numbers of each candidate. Transfer the total internally moderated mark for each candidate from the Coursework Assessment Summary Form to the computer-printed Coursework mark sheet MS1.
2. The top copy of the computer-printed Coursework mark sheet MS1 must be despatched in the specially provided envelope to arrive as soon as possible at CIE but no later than 31 October.
3. CIE will select a list of candidates whose work is required for external moderation. As soon as this list is received, send candidates' work, with the corresponding Individual Candidate Record Cards, this summary form and the second copy of MS1, to CIE.
4. Experiment Forms, Work Sheets and Marking Schemes must be included for each task **that has contributed to the final mark of these candidates**.
5. Photocopies of the samples may be sent **but** candidates' original work, with marks and comments from the teacher, is preferred.
6. (a) The pieces of work for each skill should **not** be stapled together, nor should individual sheets be enclosed in plastic wallets.
   (b) Each piece of work should be clearly labelled with the skill being assessed, Centre name, candidate name and index number and the mark awarded. For each task, supply the information requested in B.4 above.
7. CIE reserves the right to ask for further samples of Coursework.

SCIENCES
Experiment Form
IGCSE 2013

Please read the instructions printed overleaf.

Centre number						Centre name	
Syllabus code						Syllabus title	
Component number						Component title	**Coursework**
November	**2**	**0**	**1**	**3**			

Experiment number	Experiment	Skill(s) assessed

Instructions for completing sciences experiment form

1. Complete the information at the head of the form.
2. Use a separate form for each Syllabus.
3. Give a brief description of each of the experiments your candidates performed for assessment in the IGCSE Science Syllabus indicated. Use additional sheets as necessary.
4. Copies of the experiment forms and the corresponding worksheets/instructions and marking schemes will be required for each assessed task sampled, for each of Skills C1 to C4 inclusive.

7. Additional information

7.1 Guided learning hours

IGCSE 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.

7.2 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.

7.3 Progression

IGCSE 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 IGCSE Physical Science are well prepared to follow courses leading to AS Level Physical Science, or the equivalent.

7.4 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.

7.5 Grading and reporting

IGCSE results are shown by one of the grades A*, A, B, C, D, E, F or G indicating the standard achieved, Grade A* being the highest and Grade G the lowest. 'Ungraded' indicates that the candidate's performance fell short of the standard required for Grade G. '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%.

  … the minimum mark necessary for a Grade F obtains a percentage uniform mark of 30%.

  … the minimum mark necessary for a Grade G obtains a percentage uniform mark of 20%.

  … 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 uniform percentage 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 session to another and from one subject to another) and it has been turned into a percentage.

7.6 Resources

Copies of syllabuses, the most recent question papers and Principal Examiners' reports for teachers are available on the Syllabus and Support Materials CD-ROM, which is sent to all CIE Centres.

Resources are also listed on CIE's public website at **www.cie.org.uk**. Please visit this site on a regular basis as the Resource lists are updated through the year.

Access to teachers' email discussion groups, suggested schemes of work and regularly updated resource lists may be found on the CIE Teacher Support website at **http://teachers.cie.org.uk**. This website is available to teachers at registered CIE Centres.

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