Syllabus

Cambridge IGCSE Physics
Syllabus code 0625
For examination in June and November 2011

UNIVERSITY of CAMBRIDGE
International Examinations

Note for Exams Officers: Before making Final Entries, please check availability of the codes for the components and options in the E3 booklet (titled "Procedures for the Submission of Entries") relevant to the exam session. Please note that component and option codes are subject to change.

Contents

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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. They are 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 candidate 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 candidates. They not only build 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. Introduction

1.2 Why choose Cambridge IGCSE Physics?

Cambridge IGCSE Physics is accepted by universities and employers as proof of knowledge and understanding of physics. Successful candidates gain lifelong skills, including:

- confidence in a technological world, with an informed interest in scientific matters
- an understanding of how scientific theories and methods have developed, and continue to develop, as a result of groups and individuals working together
- an understanding that the study and practice of science are affected and limited by social, economic, technological, ethical and cultural factors
- an awareness that the application of science in everyday life may be both helpful and harmful to the individual, the community and the environment
- knowledge that science overcomes national boundaries and that the language of science, used correctly and thoroughly, is universal
- an understanding of the usefulness (and limitations) of scientific method, and its application in other subjects and in everyday life
- a concern for accuracy and precision
- an understanding of the importance of safe practice
- improved awareness of the importance of objectivity, integrity, enquiry, initiative and inventiveness
- an interest in, and care for, the environment
- an excellent foundation for advanced study in pure sciences, in applied science or in science-dependent vocational courses

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. Physics falls into Group III, Science.

Learn more about ICE at **www.cie.org.uk/qualifications/academic/middlesec/ice.**

1. Introduction

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, such as CIE Direct. If you have any questions, 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

Cambridge IGCSE Physics
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Cambridge IGCSE Physics 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.

<table>
<tr><th colspan="3">All candidates take:</th></tr>
<tr><td colspan="3">Paper 1 45 minutes
Multiple choice question paper
Weighted at 30% of total available marks</td></tr>
<tr><th colspan="2">and either:</th><th>or:</th></tr>
<tr><td colspan="2">Paper 2 1 hour 15 minutes
Core theory paper
Weighted at 50% of total available marks</td><td>Paper 3 1 hour 15 minutes
Extended theory paper
Weighted at 50% of total available marks</td></tr>
<tr><th>and either:</th><th>or:</th><th>or:</th></tr>
<tr><td>Paper 4
Coursework

Weighted at 20% of total available marks</td><td>Paper 5 1 hour 15 minutes
Practical test

Weighted at 20% of total available marks</td><td>Paper 6 1 hour
Alternative to Practical paper
Weighted at 20% of total available marks</td></tr>
</table>

Alterations in the syllabus aims, assessment, content and practical assessment sections for 2011 are indicated by black vertical lines on either side of the text.

3. Syllabus aims and assessment

3.1 Aims

The aims of the syllabus listed below describe the educational purposes of this examination. The aims of the syllabus are the same for all students and are not listed in order of priority. The aims 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 IGCSE 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 physics
    - are useful in everyday life
    - encourage safe practice
    - encourage effective communication
4. to develop attitudes relevant to physics 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 develop, as a result of co-operative activities of groups and individuals
    - the study and practice of science are 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. Syllabus aims and assessment

3.2 Assessment objectives

The three assessment objectives in Cambridge IGCSE Physics 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, theories
2. scientific vocabulary, terminology, 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.

Curriculum content defines the factual material that candidates may be required to recall and explain. Candidates will also be asked questions which require them to apply this material to unfamiliar contexts and to apply knowledge from one area of the syllabus to knowledge of a different syllabus area.

Questions testing these objectives will often begin with one of the following words: *define, state, describe, explain (using your knowledge and understanding)* or *outline* (see Glossary of terms).

B: Handling information and problem solving

In words or using other written forms of presentation (e.g. symbolic, graphical and numerical), candidates should be able 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 of phenomena, patterns and relationships
6. make predictions and hypotheses
7. solve problems, including some of a quantitative nature.

Questions testing these skills may be based on information that is unfamiliar to candidates, 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 skills will often begin with one of the following words: *predict, suggest, calculate* or *determine* (see Glossary of Terms).

C: Experimental skills and investigations

Candidates should be able to:

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

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).

3. Syllabus aims and assessment

<table>
<tr><th colspan="3">All candidates take:</th></tr>
<tr><td colspan="3">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
This paper will be weighted at 30% of the final total marks available</td></tr>
<tr><th colspan="2">and either:</th><th>or:</th></tr>
<tr><td colspan="2">Paper 2 1 hour 15 minutes
Written paper consisting of short-answer and structured questions
Questions will be based on the Core curriculum and will be of a difficulty appropriate to grades C to G
Questions will test skills mainly in Assessment objectives A and B
80 marks
This paper will be weighted at 50% of the final total marks available</td><td>Paper 3 1 hour 15 minutes
Written paper consisting of short-answer and structured questions
Questions will be based on the Extended curriculum and will be of a difficulty appropriate to the higher grades
Questions will test skills mainly in Assessment objectives A and B.
A quarter of the marks available will be based on Core material and the remainder on the Supplement
80 marks
This paper will be weighted at 50% of the final total marks available</td></tr>
<tr><th>and either:</th><th>or:</th><th>or:</th></tr>
<tr><td>Paper 4*
Coursework
School-based assessment of practical skills**
This paper will be weighted at 20% of the final total marks available</td><td>Paper 5* 1 hour 15 minutes
Practical test
Questions covering experimental and observational skills
This paper will be weighted at 20% of the final total marks available</td><td>Paper 6* 1 hour
Alternative to Practical
Written paper designed to test familiarity with laboratory based procedures
This paper will be weighted at 20% of the final total marks available</td></tr>
</table>

* 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 who have undergone special training in assessment. 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 *Coursework Training Handbook*, available from CIE Publications.

3. Syllabus aims and assessment

3.4 Weightings

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%

Teachers should take note that there is an equal weighting of 50% for skills (including handling information, problem solving, practical, experimental and investigative skills) and for knowledge and understanding. Teachers' schemes of work and the sequence of learning activities should reflect this balance, so that the aims of the syllabus may be met, and the candidates fully prepared for the assessment.

Assessment objective	Paper 1 (marks)	Papers 2 or 3 (marks)	Papers 4, 5 or 6 (marks)	Whole assessment (%)
A: Knowledge with understanding	25–30	44–50	0	46–54
B: Handling information and problem solving	10–15	30–36	0	26–34
C: Experimental skills and investigations	0	0	40	20

3.5 Exam combinations

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

- syllabuses with the same title at the same level
- 0652 IGCSE Physical Science
- 0653 IGCSE Combined Science
- 0654 IGCSE Co-ordinated Sciences (Double Award)
- 5124 O Level Science (Physics, Chemistry)
- 5125 O Level Science (Physics, Biology)
- 5129 O Level Combined Science
- 5130 O Level Additional Combined Science

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

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

The syllabus and question papers will conform with generally accepted international practice.
In particular, please note 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)
- *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.

4. Curriculum content

Candidates can follow either the Core Curriculum only or they may follow the Extended Curriculum which includes both the Core and the Supplement.

Candidates aiming for grades A* to C must follow the Extended Curriculum.

Candidates must have adequate mathematical skills to cope with the curriculum.

Candidates should make use of the summary list of symbols, units and definitions of quantities.

Throughout the course, teachers should aim to show the relevance of concepts to the candidates' everyday life and to the natural and man-made world. To encourage this approach and to allow teachers to use flexible programmes to meet the course's general aims, we have limited the specified content of the syllabus. The following material should therefore be regarded as an exam syllabus rather than a teaching syllabus.

1. General physics	
1.1 Length and time **Core** • Use and describe the use of rules and measuring cylinders to calculate a length or a volume • Use and describe the use of clocks and devices for measuring an interval of time	**Supplement** • Use and describe the use of a mechanical method for the measurement of a small distance • Measure and describe how to measure a short interval of time (including the period of a pendulum)
1.2 Speed, velocity and acceleration **Core** • Define speed and calculate speed from $\frac{\text{total distance}}{\text{total time}}$ • Plot and interpret a speed/time graph or a distance/time graph • Recognise from the shape of a speed/time graph when a body is – at rest – moving with constant speed – moving with changing speed • Calculate the area under a speed/time graph to work out the distance travelled for motion with constant acceleration • Demonstrate some understanding that acceleration is related to changing speed	**Supplement** • Distinguish between speed and velocity • Recognise linear motion for which the acceleration is constant and calculate the acceleration • Recognise motion for which the acceleration is not constant

• State that the acceleration of free fall for a body near to the Earth is constant	• Describe qualitatively the motion of bodies falling in a uniform gravitational field with and without air resistance (including reference to terminal velocity)
1.3 Mass and weight **Core** • Show familiarity with the idea of the mass of a body • State that weight is a force • Demonstrate understanding that weights (and hence masses) may be compared using a balance	**Supplement** • Demonstrate an understanding that mass is a property that 'resists' change in motion • Describe, and use the concept of, weight as the effect of a gravitational field on a mass
1.4 Density **Core** • Describe an experiment to determine the density of a liquid and of a regularly shaped solid and make the necessary calculation	**Supplement** • Describe the determination of the density of an irregularly shaped solid by the method of displacement, and make the necessary calculation
1.5 Forces	
1.5 (a) Effects of forces **Core** • State that a force may produce a change in size and shape of a body • Plot extension/load graphs and describe the associated experimental procedure • Describe the ways in which a force may change the motion of a body • Find the resultant of two or more forces acting along the same line	**Supplement** • Interpret extension/load graphs • State Hooke's Law and recall and use the expression $F = kx$ • Recognise the significance of the term 'limit of proportionality' for an extension/load graph • Recall and use the relation between force, mass and acceleration (including the direction) • Describe qualitatively motion in a curved path due to a perpendicular force ($F = mv^2/r$ is *not* required)

1.5 (b) Turning effect **Core** • Describe the moment of a force as a measure of its turning effect and give everyday examples • Describe qualitatively the balancing of a beam about a pivot	**Supplement** • Perform and describe an experiment (involving vertical forces) to show that there is no net moment on a body in equilibrium • Apply the idea of opposing moments to simple systems in equilibrium
1.5 (c) Conditions for equilibrium **Core** • State that, when there is no resultant force and no resultant turning effect, a system is in equilibrium	
1.5 (d) Centre of mass **Core** • Perform and describe an experiment to determine the position of the centre of mass of a plane lamina • Describe qualitatively the effect of the position of the centre of mass on the stability of simple objects	
1.5 (e) Scalars and vectors	**Supplement** • Demonstrate an understanding of the difference between scalars and vectors and give common examples • Add vectors by graphical representation to determine a resultant • Determine graphically the resultant of two vectors

1.6 Energy, work and power	
1.6 (a) Energy **Core** • Demonstrate an understanding that an object may have energy due to its motion or its position, and that energy may be transferred and stored • Give examples of energy in different forms, including kinetic, gravitational, chemical, strain, nuclear, internal, electrical, light and sound • Give examples of the conversion of energy from one form to another, and of its transfer from one place to another • Apply the principle of energy conservation to simple examples	**Supplement** • Recall and use the expressions k.e. = ½ mv^2 and p.e. = mgh
1.6 (b) Energy resources **Core** • Distinguish between renewable and non-renewable sources of energy • Describe how electricity or other useful forms of energy may be obtained from: – chemical energy stored in fuel – water, including the energy stored in waves, in tides, and in water behind hydroelectric dams – geothermal resources – nuclear fission – heat and light from the Sun (solar cells and panels) • Give advantages and disadvantages of each method in terms of cost, reliability, scale and environmental impact • Show a qualitative understanding of efficiency	**Supplement** • Show an understanding that energy is released by nuclear fusion in the Sun • Recall and use the equation: efficiency = $\frac{\text{useful energy output}}{\text{energy input}} \times 100\%$

1.6 (c) Work **Core** • Relate (without calculation) work done to the magnitude of a force and the distance moved	**Supplement** • Describe energy changes in terms of work done • Recall and use $\Delta W = Fd = \Delta E$
1.6 (d) Power **Core** • Relate (without calculation) power to work done and time taken, using appropriate examples	**Supplement** • Recall and use the equation $P = E/t$ in simple systems
1.7 Pressure **Core** • Relate (without calculation) pressure to force and area, using appropriate examples • Describe the simple mercury barometer and its use in measuring atmospheric pressure • Relate (without calculation) the pressure beneath a liquid surface to depth and to density, using appropriate examples • Use and describe the use of a manometer	• Recall and use the equation $p = F/A$ • Recall and use the equation $p = h\rho g$

4. Curriculum content

2. Thermal physics	
2.1 Simple kinetic molecular model of matter	
2.1 (a) States of matter **Core** • State the distinguishing properties of solids, liquids and gases	
2.1 (b) Molecular model **Core** • Describe qualitatively the molecular structure of solids, liquids and gases • Interpret the temperature of a gas in terms of the motion of its molecules • Describe qualitatively the pressure of a gas in terms of the motion of its molecules • Describe qualitatively the effect of a change of temperature on the pressure of a gas at constant volume • Show an understanding of the random motion of particles in a suspension as evidence for the kinetic molecular model of matter • Describe this motion (sometimes known as Brownian motion) in terms of random molecular bombardment	**Supplement** • Relate the properties of solids, liquids and gases to the forces and distances between molecules and to the motion of the molecules • Show an appreciation that massive particles may be moved by light, fast-moving molecules
2.1 (c) Evaporation **Core** • Describe evaporation in terms of the escape of more-energetic molecules from the surface of a liquid • Relate evaporation to the consequent cooling	**Supplement** • Demonstrate an understanding of how temperature, surface area and draught over a surface influence evaporation
2.1 (d) Pressure changes **Core** • Relate the change in volume of a gas to change in pressure applied to the gas at constant temperature	**Supplement** • Recall and use the equation pV = constant at constant temperature

2.2 Thermal properties	
2.2 (a) Thermal expansion of solids, liquids and gases **Core** • Describe qualitatively the thermal expansion of solids, liquids and gases • Identify and explain some of the everyday applications and consequences of thermal expansion • Describe qualitatively the effect of a change of temperature on the volume of a gas at constant pressure	**Supplement** • Show an appreciation of the relative order of magnitude of the expansion of solids, liquids and gases
2.2 (b) Measurement of temperature **Core** • Appreciate how a physical property that varies with temperature may be used for the measurement of temperature, and state examples of such properties • Recognise the need for and identify fixed points • Describe the structure and action of liquid-in-glass thermometers	**Supplement** • Demonstrate understanding of sensitivity, range and linearity • Describe the structure of a thermocouple and show understanding of its use for measuring high temperatures and those that vary rapidly
2.2 (c) Thermal capacity **Core** • Relate a rise in the temperature of a body to an increase in internal energy • Show an understanding of the term thermal capacity	**Supplement** • Describe an experiment to measure the specific heat capacity of a substance

2.2 (d) Melting and boiling **Core** • Describe melting and boiling in terms of energy input without a change in temperature • State the meaning of melting point and boiling point • Describe condensation and solidification	**Supplement** • Distinguish between boiling and evaporation • Use the terms latent heat of vaporisation and latent heat of fusion and give a molecular interpretation of latent heat • Describe an experiment to measure specific latent heats for steam and for ice
2.3 Transfer of thermal energy	
2.3 (a) Conduction **Core** • Describe experiments to demonstrate the properties of good and bad conductors of heat	**Supplement** • Give a simple molecular account of heat transfer in solids
2.3 (b) Convection **Core** • Relate convection in fluids to density changes and describe experiments to illustrate convection	
2.3 (c) Radiation **Core** • Identify infra-red radiation as part of the electromagnetic spectrum	**Supplement** • Describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation
2.3 (d) Consequences of energy transfer **Core** • Identify and explain some of the everyday applications and consequences of conduction, convection and radiation	

3. Properties of waves, including light and sound	
3.1 General wave properties **Core**	**Supplement**
• Describe what is meant by wave motion as illustrated by vibration in ropes and springs and by experiments using water waves • Use the term wavefront • Give the meaning of speed, frequency, wavelength and amplitude • Distinguish between transverse and longitudinal waves and give suitable examples • Describe the use of water waves to show: – reflection at a plane surface – refraction due to a change of speed – diffraction produced by wide and narrow gaps	• Recall and use the equation $v = f\lambda$ • Interpret reflection, refraction and diffraction using wave theory
3.2 Light	
3.2 (a) Reflection of light **Core**	**Supplement**
• Describe the formation, and give the characteristics, of an optical image by a plane mirror • Use the law angle of incidence = angle of reflection	• Perform simple constructions, measurements and calculations
3.2 (b) Refraction of light **Core**	**Supplement**
• Describe an experimental demonstration of the refraction of light • Use the terminology for the angle of incidence *i* and angle of refraction *r* and describe the passage of light through parallel-sided transparent material • Give the meaning of critical angle • Describe internal and total internal reflection	• Recall and use the definition of refractive index *n* in terms of speed • Recall and use the equation $\sin i / \sin r = n$ • Describe the action of optical fibres particularly in medicine and communications technology

3.2 (c) Thin converging lens **Core** • Describe the action of a thin converging lens on a beam of light • Use the term principal focus and focal length • Draw ray diagrams to illustrate the formation of a real image by a single lens	**Supplement** • Draw ray diagrams to illustrate the formation of a virtual image by a single lens • Use and describe the use of a single lens as a magnifying glass
3.2 (d) Dispersion of light **Core** • Give a qualitative account of the dispersion of light as shown by the action on light of a glass prism	
3.2 (e) Electromagnetic spectrum **Core** • Describe the main features of the electromagnetic spectrum and state that all e.m. waves travel with the same high speed *in vacuo* • Describe the role of electromagnetic waves in: – radio and television communications (radio waves) – satellite television and telephones (microwaves) – electrical appliances, remote controllers for televisions and intruder alarms (infrared) – medicine and security (X-rays) • Demonstrate an awareness of safety issues regarding the use of microwaves and X-rays	**Supplement** • State the approximate value of the speed of electro-magnetic waves • Use the term monochromatic

3.3 Sound **Core** • Describe the production of sound by vibrating sources • Describe the longitudinal nature of sound waves • State the approximate range of audible frequencies • Show an understanding that a medium is needed to transmit sound waves • Describe an experiment to determine the speed of sound in air • Relate the loudness and pitch of sound waves to amplitude and frequency • Describe how the reflection of sound may produce an echo	**Supplement** • Describe compression and rarefaction • State the order of magnitude of the speed of sound in air, liquids and solids
4. Electricity and magnetism	
4.1 Simple phenomena of magnetism **Core** • State the properties of magnets • Give an account of induced magnetism • Distinguish between ferrous and non-ferrous materials • Describe methods of magnetisation and of demagnetisation • Describe an experiment to identify the pattern of field lines round a bar magnet • Distinguish between the magnetic properties of iron and steel • Distinguish between the design and use of permanent magnets and electromagnets	

4.2 Electrical quantities	
4.2 (a) Electric charge **Core** • Describe simple experiments to show the production and detection of electrostatic charges • State that there are positive and negative charges • State that unlike charges attract and that like charges repel • Describe an electric field as a region in which an electric charge experiences a force • Distinguish between electrical conductors and insulators and give typical examples	**Supplement** • State that charge is measured in coulombs • State the direction of lines of force and describe simple field patterns, including the field around a point charge and the field between two parallel plates • Give an account of charging by induction • Recall and use the simple electron model to distinguish between conductors and insulators
4.2 (b) Current **Core** • State that current is related to the flow of charge • Use and describe the use of an ammeter	**Supplement** • Show understanding that a current is a rate of flow of charge and recall and use the equation $I = Q/t$ • Distinguish between the direction of flow of electrons and conventional current
4.2 (c) Electro-motive force **Core** • State that the e.m.f. of a source of electrical energy is measured in volts	**Supplement** • Show understanding that e.m.f. is defined in terms of energy supplied by a source in driving charge round a complete circuit
4.2 (d) Potential difference **Core** • State that the potential difference across a circuit component is measured in volts • Use and describe the use of a voltmeter	

4. Curriculum content

4.2 (e) Resistance **Core** • State that resistance = p.d./current and understand qualitatively how changes in p.d. or resistance affect current • Recall and use the equation $R = V/I$ • Describe an experiment to determine resistance using a voltmeter and an ammeter • Relate (without calculation) the resistance of a wire to its length and to its diameter	**Supplement** • Recall and use quantitatively the proportionality between resistance and length, and the inverse proportionality between resistance and cross-sectional area of a wire
4.2 (f) Electrical energy	**Supplement** • Recall and use the equations $P = IV$ and $E = IVt$
4.3 Electric circuits	
4.3 (a) Circuit diagrams **Core** • Draw and interpret circuit diagrams containing sources, switches, resistors (fixed and variable), lamps, ammeters voltmeters, magnetising coils, transformers, bells, fuses and relays	**Supplement** • Draw and interpret circuit diagrams containing diodes and transistors
4.3 (b) Series and parallel circuits **Core** • Understand that the current at every point in a series circuit is the same • Give the combined resistance of two or more resistors in series • State that, for a parallel circuit, the current from the source is larger than the current in each branch • State that the combined resistance of two resistors in parallel is less than that of either resistor by itself • State the advantages of connecting lamps in parallel in a lighting circuit	**Supplement** • 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 • 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 • Calculate the effective resistance of two resistors in parallel

4.3 (c) Action and use of circuit components **Core** • Describe the action of a variable potential divider (potentiometer) • Describe the action of thermistors and light-dependent resistors and show understanding of their use as input transducers • Describe the action of a capacitor as an energy store and show understanding of its use in time-delay circuits • Describe the action of a relay and show understanding of its use in switching circuits	**Supplement** • Describe the action of a diode and show understanding of its use as a rectifier • Describe the action of a transistor as an electrically operated switch and show understanding of its use in switching circuits • Recognise and show understanding of circuits operating as light sensitive switches and temperature-operated alarms (using a relay or a transistor)
4.3 (d) Digital electronics	**Supplement** • Explain and use the terms digital and analogue • State that logic gates are circuits containing transistors and other components • Describe the action of NOT, AND, OR, NAND and NOR gates • Design and understand simple digital circuits combining several logic gates • State and use the symbols for logic gates (candidates should use the American ANSI#Y 32.14 symbols)

4.4 Dangers of electricity **Core** • state the hazards of – damaged insulation – overheating of cables – damp conditions • Show an understanding of the use of fuses and circuit-breakers	
4.5 Electromagnetic effects	
4.5 (a) Electromagnetic induction **Core** • Describe an experiment that shows that a changing magnetic field can induce an e.m.f. in a circuit	**Supplement** • State the factors affecting the magnitude of an induced e.m.f. • Show understanding that the direction of an induced e.m.f. opposes the change causing it
4.5 (b) a.c. generator **Core** • Describe a rotating-coil generator and the use of slip rings • Sketch a graph of voltage output against time for a simple a.c. generator	
4.5 (c) Transformer **Core** • Describe the construction of a basic iron-cored transformer as used for voltage transformations • Recall and use the equation $(V_p/V_s) = (N_p/N_s)$ • Describe the use of the transformer in high-voltage transmission of electricity • Give the advantages of high-voltage transmission	**Supplement** • Describe the principle of operation of a transformer • Recall and use the equation $V_p I_p = V_s I_s$ (for 100% efficiency) • Explain why energy losses in cables are lower when the voltage is high

4.5 (d) The magnetic effect of a current **Core** • Describe the pattern of the magnetic field due to currents in straight wires and in solenoids • Describe applications of the magnetic effect of current, including the action of a relay	**Supplement** • State the qualitative variation of the strength of the magnetic field over salient parts of the pattern • Describe the effect on the magnetic field of changing the magnitude and direction of the current
4.5 (e) Force on a current-carrying conductor **Core** • Describe an experiment to show that a force acts on a current-carrying conductor in a magnetic field, including the effect of reversing: (i) the current (ii) the direction of the field	**Supplement** • Describe an experiment to show the corresponding force on beams of charged particles • State and use the relative directions of force, field and current
4.5 (f) d.c. motor **Core** • 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 • Relate this turning effect to the action of an electric motor	**Supplement** • Describe the effect of increasing the current
4.6 Cathode-ray oscilloscopes	
4.6 (a) Cathode rays **Core** • Describe the production and detection of cathode rays • Describe their deflection in electric fields • State that the particles emitted in thermionic emission are electrons	

4.6 (b) Simple treatment of cathode-ray oscilloscope	**Supplement** • Describe (in outline) the basic structure and action of a cathode-ray oscilloscope (detailed circuits are **not** required) • Use and describe the use of a cathode-ray oscilloscope to display waveforms
5. Atomic physics	
5.1 Radioactivity	
5.1 (a) Detection of radioactivity **Core** • Show awareness of the existence of background radiation • Describe the detection of α-particles, β-particles and γ-rays (β^+ are not included: β-particles will be taken to refer to β^-)	
5.1 (b) Characteristics of the three kinds of emission **Core** • State that radioactive emissions occur randomly over space and time	
• State, for radioactive emissions: – their nature – their relative ionising effects – their relative penetrating abilities	• Describe their deflection in electric fields and magnetic fields • Interpret their relative ionising effects
5.1 (c) Radioactive decay **Core** • State the meaning of radioactive decay, using equations (involving words or symbols) to represent changes in the composition of the nucleus when particles are emitted	

5.1 (d) Half-life **Core** • Use the term half-life in simple calculations, which might involve information in tables or decay curves	
5.1 (e) Safety precautions **Core** • Describe how radioactive materials are handled, used and stored in a safe way	
5.2 The nuclear atom	
5.2 (a) Atomic model **Core** • Describe the structure of an atom in terms of a nucleus and electrons	**Supplement** • Describe how the scattering of α-particles by thin metal foils provides evidence for the nuclear atom
5.2 (b) Nucleus **Core** • Describe the composition of the nucleus in terms of protons and neutrons • Use the term proton number Z • Use the term nucleon number A Use the term nuclide and use the nuclide notation ${}^{A}_{Z}X$	
5.2 (c) Isotopes	**Supplement** • Use the term isotope • Give and explain examples of practical applications of isotopes

5. Practical assessment

Scientific subjects are, by their nature, experimental. So it is important that an assessment of a candidate's knowledge and understanding of physics should contain a practical component (see Assessment objective C).

Schools' circumstances (e.g. the availability of resources) differ greatly, so three alternative ways of examining the relevant assessment are provided. The three alternatives are:

- Paper 4 – Coursework (school-based assessment)
- Paper 5 – Practical Test
- Paper 6 – Alternative to Practical (written 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

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 courses held at intervals in Cambridge and elsewhere, and also via the *Coursework Training Handbook*.

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 and evaluating investigations

The four skills carry equal weighting.

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

5. Practical assessment

It is expected that the teaching and assessment of experimental skills and abilities will take place throughout the course

Teachers must ensure that they can make available to CIE evidence of two assessments of 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. In addition, for skills C2, C3 and C4, the candidates' written work will also be required.

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

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 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 assessing 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.

5. Practical assessment

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.

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.

5. Practical assessment

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.

5. Practical assessment

Guidance on candidate assessment

The following notes are intended to provide teachers with information to help them 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.
- 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.
- Extended experimental investigations are of great educational value. If such investigations are used for assessment purposes, teachers should make sure that the candidates have ample opportunity for displaying the skills and abilities required by the scheme of assessment.
- It is not necessary for all candidates within a teaching group, or within a Centre, to be assessed on exactly the same practical work, although teachers can use work that is undertaken by all of their candidates.
- When assessing group work, teachers must ensure that the each candidate's individual contribution is assessed.
- Skill C1 might 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 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, plus the Sciences Experiment Form, are at the back 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 should **not** be given to the candidate.

5. Practical assessment

Moderation

Internal moderation

When several teachers in a Centre are involved in internal assessment, arrangements must be made within the Centre for all candidates to be assessed to the same standard. It is essential that the marks for each skill assigned within different teaching groups (or classes) are moderated internally for the whole Centre entry. The Centre assessments will then be moderated externally by CIE.

External moderation

CIE must receive internally moderated marks for all candidates by 30 April for the May/June examination and by 31 October for the November examination. See page 46 of this booklet, the *Handbook for Centres* and the *Administrative Guide for Centres* for more information on external moderation and on how to submit marks.

Once it has received the marks, CIE will draw up a list of sample candidates whose work will be moderated (a further sample may also be requested), and will ask the Centre to send immediately every piece of work that has contributed towards these candidates' final marks. Individual Candidate Record Cards and Coursework Assessment Summary Forms must also be sent with the coursework. All remaining coursework and records should be kept by the Centre until results are published.

Ideally, Centres should use loose-leaf A4 file paper for practical written work, as this is cheaper to send by post. Original work is preferred for moderation, but authenticated photocopies can be sent if absolutely necessary.

Pieces of work for each skill should not be stapled together. Each piece of work should be clearly and securely labelled with:

- the skill being assessed
- the Centre number
- the candidate's name and number
- the title of the experiment
- a copy of the mark scheme used
- the mark awarded.

5. Practical assessment

5.2 Paper 5: Practical test

Candidates taking this paper must be able to:

- follow written instructions for the assembly and use of provided apparatus: for example, for using ray tracing equipment, or for wiring up simple electrical circuits
- select, from given items, the measuring device suitable for the task
- give reasons for choosing particular items of apparatus
- draw, complete and/or label diagrams of apparatus
- 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
  - making consistent use of significant figures
  - use of appropriate units
  - interpolating between scale divisions
  - allowing for zero errors, where appropriate
- take 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
- describe precautions taken in carrying out a procedure
- explain and/or comment critically on described procedures or points of practical detail
- comment on a procedure used in an experiment and suggest an improvement.
- plan an investigation, including suggesting suitable techniques and apparatus.

Candidates may not use textbooks in the exam, nor any of their own records of laboratory work carried out during their course. They must carry out the experiments from the instructions given in the paper. Candidates must answer on the question paper.

5.3 Paper 6: Alternative to Practical

This paper is designed to test candidates' familiarity with laboratory practical procedure. Questions may ask candidates to do the following:

- follow instructions for drawing diagrams e.g. ray-tracing, simple electrical circuits
- select a measuring device suitable for the task
- give reasons for making a choice of apparatus
- draw, complete and/or label diagrams of apparatus
- describe in simple terms how they would carry out practical procedures e.g.:

  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 their own diagrams, drawn as instructed, and/or from printed diagrams including:

  reading a scale with appropriate precision/accuracy;

  consistent use of significant figures;

  use of appropriate units;

  interpolating between scale divisions
- recognise the need to take repeated measurements and obtain an average value
- record observations systematically, with appropriate units
- process data as required
- 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
- describe precautions taken in carrying out a procedure
- explain and/or comment critically on described procedures or points of practical detail
- comment on a procedure used in an experiment and suggest an improvement
- plan an investigation, including suggesting suitable techniques and apparatus

6. Appendix

6.1 Grade descriptions

The scheme of assessment is intended to encourage positive achievement by all candidates.

Grade A	**Candidate must show mastery of the Core curriculum and the Extended curriculum**
A **Grade A** candidate will be able 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 a hypothesis
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 C** candidate will be able 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 a problem involving more than one step, but with a limited range of variables • generate a hypothesis to explain a given set of facts or data
Grade F	**Candidate must show competence in answering questions based on the Core curriculum.**
A **Grade F** candidate will be able 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 minor manipulation of data is needed • recognise which of two given hypotheses explains a set of facts or data

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6.2 Symbols, units and definitions of physical quantities

Candidates should be able to give the symbols for the following physical quantities and, where indicated, state the units in which they are measured. Candidates should be able to define the 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, cm^3			
weight	*W*	N			N*
mass	*m, M*	kg, g			mg
time	*t*	h, min, s			ms
density*		g/cm^3, kg/m^3			
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*
pressure	*p, P*		pressure*		Pa*, N/m^2
			atmospheric pressure		millibar

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Core			Supplement		
Quantity	***Symbol***	***Unit***	***Quantity***	***Symbol***	***Unit***
temperature	θ, T	°C			
specific heat capacity	c	J/(g °C), J/(kg °C)	specific heat capacity*		
latent heat	L	J	specific latent heat*	l	J/kg, J/g
			frequency*	f	Hz
			wavelength*	λ	m, cm
focal length	f				
angle of incidence	i	degree (°)	refractive index	n	
angle of reflection, refraction	r	degree (°)			
critical angle	c	degree (°)			
potential difference/ voltage	V	V, mV	potential difference*		V*
current	I	A, mA	current*		
			charge		C, A s
e.m.f.	E	V	e.m.f.*		
resistance	R	Ω			

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6.3 Glossary of terms used in science papers

The glossary (which is relevant only to Science subjects) will prove helpful to candidates as a guide but it is neither exhaustive nor definitive. The glossary has been deliberately kept brief, not only with respect to the numbers 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 easily 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 to refer either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should refer 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 similar way to *predict* except that some supporting statement is required e.g. reference to a law, a principle or the necessary reasoning should 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 Physics there are several examples of energy resources from which electricity, or other useful forms of energy, may be obtained), 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' – many data-response and problem-solving questions are of this type.

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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 in question cannot be measured directly but must be found by calculation, placing measured or known values of other quantities into a standard formula.
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.

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6.4 Mathematical requirements

Candidates may use calculators in all parts of the exam.

Candidates should be able to:

- add, subtract, multiply and divide
- 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
- choose 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).

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6.5 Resource list

Books endorsed by CIE for use with this syllabus

These books have been through an independent quality assurance process and match the syllabus content closely.

Author	Title	Date	Publisher	ISBN number
T. Duncan & H. Kennett	*IGCSE Physics*		John Murray	0719578493
M. Folland	*IGCSE Study Guide for Physics*	2005	Hodder Murray	0719579031

Other helpful textbooks

Teachers may also find the following books helpful. These are suitable for use with this syllabus. Content of the books does not necessarily match the CIE syllabus closely.

Author	Title	Date	Publisher	ISBN number
J. Breithaupt	*Key Science – Physics*		Stanley Thornes	0748716742
S. Pople	*Explaining Physics* (GCSE Edition)		Oxford University Press	0199142726

These titles represent some of the books available at the time that this booklet was printed. CIE encourages teachers to choose texts for class use that they feel will interest their students and that will support their own teaching style.

CIE provides all Centres with the Syllabus and Support Materials CD-ROM. This contains copies of syllabuses, the most recent question papers and Principal Examiners' reports. A list of resources is also given on CIE's website at **www.cie.org.uk**.

The CIE Teacher Support website **http://teachers.cie.org.uk** gives access to teachers' email discussion groups and suggested schemes of work. All teachers at registered CIE Centres may use this site.

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6.6 ICT

In order to play a full part in modern society, candidates need to be confident and effective users of ICT. This syllabus provides candidates with a wide range of opportunities to use ICT in their study of Physics.

Opportunities for ICT include:

- gathering information from the World Wide Web and CD-ROMs;
- gathering data using sensors linked to data-loggers or directly to computers;
- using spreadsheets and other software to process data;
- using animations and simulations to visualise scientific ideas;
- using software to present ideas and information on paper and on screen.

The examples listed in the table show some of the points in the syllabus where opportunities may be found.

ICT	**Possible opportunities**
Gathering information	Independent research into 1.6b, 3.2e, 4.5c, 4.6b, 5.1
Datalogging	Practical work associated with 1.2, 2.3
Processing data	Practical work associated with 3.2b, 4.3c, 5.1d
Visualisation	Demonstration of 1.2, 2.1b, 3.3, 4.5b, 4.5e
Making presentations	Practical work or independent research in 5.1a, 1.6b, 4.2a

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6.7 Procedures for external moderation

1 CIE will send form MS1 to each Centre in late March (for the May/June exams) or early October (for the October/November exams). MS1 will list the name and index number of each candidate.

2 Transfer each candidate's total internally moderated mark from the Coursework Assessment Summary Form to MS1.

3 MS1 is in two parts: return the top copy to CIE as soon as possible, using the envelope provided. Deadlines for return are:

- 30 April (for the May/June exams)
- 31 October (for the October/November exams)

4 CIE will select a number of candidates for external moderation; when you receive the list of selected candidates, send CIE:

- the candidates' Coursework
- their Individual Candidate Record Cards
- the relevant Coursework Assessment Summary Form
- the second copy of MS1

5 Label each piece of work clearly with:

- the skill being assessed
- the Centre name
- the candidate's name and index number
- the title of the experiment
- a copy of the marking scheme used
- the mark awarded

6 You must supply Experiment Forms, Work Sheets and Marking Schemes for each task **that has contributed to the final mark of these candidates**.

7 You may send photocopies of the samples **but** CIE prefers to see candidates' original work, with marks and comments from the teacher.

8 Do not staple pieces of work for each skill together. Do not place individual sheets in plastic wallets.

Note: CIE reserves the right to request additional samples of Coursework as part of the external moderation process.

SCIENCES
Experiment Form
IGCSE

Please read the instructions printed overleaf.

Centre Number						Centre Name	
Syllabus Code	**0**	**6**	**2**	**5**		Syllabus Title	**Physics**
Component Number	**0**		**4**			Component Title	**Coursework**
November	**2**	**0**	**1**	**1**			

Experiment Number	Experiment	Skill(s) Assessed

Sciences experiment form – instructions

To complete the Sciences Experiment Form:

1 Enter the information required at the head of the form.

2 Use a separate form for each Syllabus.

3 Give a brief description of each of the experiments that your candidates performed for assessment in the IGCSE Science Syllabus indicated. Use additional sheets as necessary.

4 Teachers must send to CIE copies of the experiment forms and the corresponding worksheets/ instructions and marking schemes for each assessed task sampled, for each of Skills C1 to C4.

SCIENCES
Individual Candidate Record Card
IGCSE 2011

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

Centre number						Centre name					June/November	**2**	**0**	**1**	**1**
Candidate number						Candidate name					Teaching group/set				
Syllabus code	**0**	**6**	**2**	**5**		Syllabus title	**PHYSICS**	Component number	**0**	**4**	Component title	**COURSEWORK**			

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)

Individual candidate record card – instructions

The Individual Candidate Record Card is only for use by teachers of candidates who have undertaken Coursework as part of the IGCSE assessment.

Important:

When entering candidates from different teaching groups (for example, difference classes), the Centre must make sure that the marks for each skill are moderated internally. In practice, this means that all marks within a Centre must be brought to a common standard by the teacher responsible for co-ordinating internal assessment (i.e. the internal moderator). The aim is to produce a valid and reliable set of marks, which reflects the relative attainment of all Coursework candidates in the Centre. The outcome of internal moderation, in terms of the number of marks added to (or subtracted from) the candidate's initial total, must be clearly shown when these marks are transferred onto the Coursework Assessment Summary Form.
To complete the Individual Candidate Record Form:

1 Enter the information required at the head of the form.

2 After marking each item of Coursework (see Syllabus for more information), enter the marks awarded for each Assessment Objective, and the total marks awarded, into the appropriate boxes. Make sure that the addition of marks is independently checked.

3 Transfer the marks to the Coursework Assessment Summary Form – see this Form for further instructions, and see the note on internal moderation above.

4 Keep all Individual Candidate Record Cards, and Coursework, as these may be required for external moderation.

For more information at this stage please refer to the Syllabus booklet, and see the Coursework Assessment Summary Form. Detailed instructions on external moderation will be sent in late March (for the May/June exams) and early October (for the October/November exams).

SCIENCES
Coursework Assessment Summary Form
IGCSE 2011

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

Centre number						Centre name		June/November	2	0	1	1
Syllabus code	0	6	2	5	Syllabus title	**PHYSICS**	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						

Coursework assessment summary form – instructions

1 Enter the information required at the head of the form.

2 List candidates so that their details can be easily transferred to the computer-printed Coursework mark sheet MS1, i.e. in candidate index number order. Show the teaching group or set for each candidate – this can be done using the teacher's initials.

3 Transfer each candidate's marks from their Individual Candidate Record Card as follows:

- In the columns for individual skills or assignments, enter the marks awarded before internal moderation.
- In the column headed 'Total Mark', enter the total mark awarded before internal moderation.
- In the column headed 'Internally Moderated Mark', enter the total mark awarded *after* internal moderation took place.

4 The teacher completing the form, and the internal moderator/s, must check and sign the form where indicated.

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