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IGCSE

London Examinations IGCSE

Physics (4420)

For examination in May and November 2005, 2006, 2007

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delivered locally, recognised globally

Specification

London Examinations IGCSE

Physics (4420)

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Changes from Issue 1 are indicated by marginal lines.

Acknowledgements

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Authorised by Elizabeth Blount

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Contents

Introduction

The London Examinations IGCSE in Physics is designed as a two-year course of study combining features of London Examinations O level Physics and Edexcel GCSE Physics.

Key features

- comprehensive and detailed description of subject content
- straightforward linear assessment
- incorporates elements of the UK Key Stage 3 programme of study
- assessment of practical work through coursework (Edexcel-approved International Teaching Institutions only), or through a written alternative paper
- tiers of entry allow students to be entered at the appropriate level
- a full range of teacher support
- provides a solid basis for Edexcel GCE AS and Advanced Level Physics, or equivalent qualifications.

Availability of external assessment

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

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

Summary of scheme of assessment

Paper/ Component	Mode of assessment	Weighting	Length
1	Examination Paper 1F, targeted at grades C – G (Foundation Tier)	80%	1½ hours
OR			
2	Examination Paper 2H, targeted at grades A* – D (Higher Tier)	80%	2 hours
3	Examination Paper 03, targeted at grades A* – G (Common to both tiers)	20%	1 ¼ hours
OR			
4	Coursework, targeted at grades A* – G (Common to both tiers) Edexcel approved centres only.	20%	–

Students will be entered at **either** Foundation Tier **or** Higher Tier.

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

> **Foundation Tier students** will take Paper 1F and **either** Paper 03 **or** Component 4 (coursework).
>
> **Higher Tier students** will take Paper 2H and **either** Paper 03 **or** Component 4 (coursework).

Use of calculators is permitted in all written examinations.

Summary of the specification content

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

1. Forces and motion
2. Electricity
3. Waves
4. Energy resources and energy transfer
5. Solids, liquids and gases
6. Magnetism and electromagnetism
7. Radioactivity and particles

See pages 11 - 25 for a detailed description of specification content.

In addition, candidates will be assessed on the investigative skills described on pages 28 to 34, either through written assessment (Paper 03) or by teacher-assessed coursework (Component 4).

Specification aims and assessment objectives

Aims

This specification gives candidates opportunities to

- acquire a systematic body of scientific knowledge and the skills needed to apply this in new and changing situations in many domestic, industrial and environmental contexts
- appreciate the practical nature of physics, acquiring experimental and investigative skills based on correct and safe laboratory techniques
- appreciate the importance of accurate experimental work and reporting to scientific method
- form hypotheses and design experiments to test them
- evaluate, in terms of their scientific knowledge and understanding, the benefits and drawbacks (including social, environmental and economic) of scientific and technological developments
- select, organise and present information clearly and logically, using appropriate scientific terms and conventions.

Assessment objectives

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

AO1 Knowledge and understanding

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

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

AO2 Application of knowledge and understanding, analysis and evaluation

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

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

AO3 Experimental and investigative skills

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

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

Scheme of Assessment

Tiers of entry

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

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

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

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

Some examination questions will be common to both tiers.

Weighting of assessment objectives

Assessment objectives		Weighting
AO1	Knowledge and understanding	45 - 55% (of which about one third for recall)
AO2	Application of knowledge and understanding, analysis and evaluation	25 - 35% (evenly distributed across all aspects of the objective)
AO3	Investigative skills	20%

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

Relationship of assessment objectives to scheme of assessment

Paper / Component	Assessment Objective 1	Assessment Objective 2	Assessment Objective 3
Paper 1F (Foundation)	45 – 55%	25 – 35%	0
OR			
Paper 2H (Higher)	45 – 55%	25 – 35%	0
Paper 03	0	0	20%
OR			
Component 4 (Coursework)	0	0	20%

Assessment components

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

There will be sixteen compulsory short-answer structured questions, testing understanding of the Specification Content for Foundation Tier (see pages 11 – 25).

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

Candidates may be required to perform calculations, draw graphs and describe, explain and interpret physics phenomena.

Approximately 45 of the 100 marks available will be common with Paper 2H (see next page).

Paper 2H (Higher Tier, 2 hours)

There will be eighteen compulsory short-answer structured questions, testing understanding of the entire Specification Content (see pages 11 - 25).

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

Candidates may be required to perform calculations, draw graphs and describe, explain and interpret physics phenomena.

Approximately 45 of the 120 marks available will be common with Paper 1F (see previous page).

Paper 03 – Alternative to coursework (common to both tiers, 1 hour 15 minutes)

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

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

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

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

Component 4 Coursework (common to both tiers)

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

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

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

Mathematical skills

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

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

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

- evaluate expressions incorporating the four operations, +, –, ×, ÷, either singly or in conjunction with one another, quoting the answer to an appropriate number of significant figures
- use simple proportion, decimals, fractions and percentages
- understand and use compound measures such as speed
- manipulate formulae, equations and expressions
- plot and draw graphs from suitable data, selecting appropriate scales for the axes
- interpret graphs in terms of general trends and by interpolation
- interpret a range of graphs and diagrams
- use an electronic calculator in connection with any of the above as appropriate
- understand that a measurement given as a whole number may be inaccurate by up to one-half in either direction

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

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

Forbidden combinations

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

Awarding and reporting

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

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

Availability of coursework to international centres

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

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

International Customer Relations Unit (ICRU)
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Students with particular requirements

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

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

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Specification Content

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

Higher Tier candidates will be required to know the content of **both** tiers.

1. Forces and motion

- Units
- Movement and position
- Forces, movement and shape

Units

Candidates will be assessed on their ability to

1.1 use the following units: kilogram (kg), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s)

Movement and position

Candidates will be assessed on their ability to

1.2 understand and use distance - time graphs

1.3 recall and use the relationship between average speed, distance moved and time

$$\text{average speed} = \frac{\text{distance moved}}{\text{time taken}}$$

1.4 recall and use the relationship between acceleration, velocity and time

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

$$a = \frac{(v-u)}{t}$$

1.5 interpret velocity - time graphs

1.6 determine acceleration from the gradient of a velocity - time graph and the distance travelled from the area between the graph and the time axis

Forces, movement and shape

Candidates will be assessed on their ability to

1.7 express a force as a push or pull of one body on another

1.8 identify various types of force (e.g. gravitational, electrostatic etc)

1.9 distinguish between vector and scalar quantities

1.10 appreciate the vector nature of a force

1.11 add forces that act along a line

1.12 understand that friction is a force that opposes motion

1.13 recall and use the relationship between unbalanced force, mass and acceleration

force = mass × acceleration

$\boldsymbol{F = m \times a}$

1.14 recall and use the relationship between weight, mass and g :

weight = mass × g

$W = m \times g$

1.15 describe the forces acting on falling objects and explain why falling objects reach a terminal velocity

1.16 describe the factors affecting vehicle stopping distance including speed, mass, road condition and reaction time

1.17 recall and use the relationship between the moment of a force and its distance from the pivot:

moment = force × perpendicular distance from pivot

1.18 recall that the weight of a body acts through its centre of gravity

1.19 recall and use the principle of moments for a simple system of parallel forces acting in one plane

1.20 understand that the upward forces on a light beam supported at its ends vary with the position of a heavy object placed on the beam

1.21 describe how extension varies with applied force for helical springs, metal wires and rubber bands

1.22 recall that the initial linear region of a force **-** extension graph is associated with Hooke's law

2. Electricity

- Units
- Mains electricity
- Energy and potential difference in circuits
- Electric charge

Units

Candidates will be assessed on their ability to

2.1 use the following units: ampere (A), coulomb (C), joule (J), ohm (Ω), second (s), volt (V), watt (W)

Mains electricity

Candidates will be assessed on their ability to

2.2 recall the hazards of electricity including frayed cables, long cables, damaged plugs, water around sockets, and pushing metal objects into sockets

2.3 describe the uses of insulation, double insulation, earthing, fuses and circuit breakers in a range of domestic appliances

2.4 know some of the different ways in which electrical heating is used in a variety of domestic contexts

2.5 understand that a current in a resistor results in the electrical transfer of energy and an increase in temperature

2.6 recall and use the relationship

power = current × voltage

$P = I \times V$

and apply the relationship to the selection of appropriate fuses

2.7 use the relationship between energy transferred, current, voltage and time:

energy transferred = current × voltage × time

$\boldsymbol{E = I \times V \times t}$

2.8 recall that mains electricity is alternating current (a.c.) and understand the difference between this and the direct current (d.c.) supplied by a cell or battery

Energy and potential difference in circuits

Candidates will be assessed on their ability to

2.9 explain why a series or parallel circuit is more appropriate for particular applications, including domestic lighting

2.10 understand that the current in a series circuit depends on the applied voltage and the number and nature of other components

2.11 describe how current varies with voltage in wires, resistors, metal filament lamps and diodes, and how this can be investigated experimentally

2.12 describe the qualitative effect of changing resistance on the current in a circuit

2.13 describe the qualitative variation of resistance of LDRs with illumination and of thermistors with temperature

2.14 recall and use the relationship between voltage, current and resistance:

voltage = current × resistance

$V = I \times R$

2.15 understand that current is the rate of flow of charge

2.16 recall and use the relationship between charge, current and time :

charge = current × time

$Q = I \times t$

2.17 recall that electric current in solid metallic conductors is a flow of negatively charged electrons

2.18 recall that:

- **voltage is the energy transferred per unit charge passed**
- **the volt is a joule per coulomb**

Electric charge

Candidates will be assessed on their ability to

2.19 identify common materials which are electrical conductors or insulators, including metals and plastics

2.20 recall that insulating materials can be charged by friction

2.21 explain that positive and negative electrostatic charges are produced on materials by the loss and gain of electrons

2.22 recall that there are forces of attraction between unlike charges and forces of repulsion between like charges

2.23 explain electrostatic phenomena in terms of the movement of electrons

2.24 recall the potential dangers of electrostatic charges, e.g. when fuelling aircraft and tankers

2.25 recall some uses of electrostatic charges, e.g. in photocopiers and inkjet printers

3. Waves

- Units
- Properties of waves
- The electromagnetic spectrum
- Light and sound

Units

Candidates will be assessed on their ability to

3.1 use the following units: degree (^{o}), hertz (Hz), metre (m), metre/second (m/s), second (s)

Properties of waves

Candidates will be assessed on their ability to

3.2 describe longitudinal and transverse waves in ropes, springs and water where appropriate

3.3 state the meaning of amplitude, frequency, wavelength and period of a wave

3.4 recall that waves transfer energy and information without transferring matter

3.5 recall and use the relationship between the speed, frequency and wavelength of a wave:

wave speed = frequency × wavelength

$v = f \times \lambda$

3.6 use the relationship between frequency and time period:

$$\text{frequency} = \frac{1}{\text{time period}}$$

$$f = \frac{1}{T}$$

3.7 use the above relationships in different contexts including sound waves and electromagnetic waves

3.8 understand that waves can be diffracted through gaps or when they pass an edge, and that the extent of diffraction depends on the wavelength and the physical dimension of the gap

The electromagnetic spectrum

Candidates will be assessed on their ability to

3.9 understand that light is part of a continuous electromagnetic spectrum which includes radio, microwave, infra-red, visible, ultraviolet, X-ray and gamma ray radiations and that all these waves travel at the same speed in free space

3.10 recall the order of the electromagnetic spectrum in decreasing wavelength and increasing frequency, including the colours of the visible spectrum

3.11 recall some of the uses of electromagnetic radiations, including

- radio waves: broadcasting and communications
- microwaves: cooking and satellite transmissions
- infra-red: heaters and night vision equipment
- visible light: optical fibres and photography
- ultraviolet: fluorescent lamps
- X-rays: observing the internal structure of objects and materials and medical applications
- gamma rays: sterilising food and medical equipment

3.12 recall the detrimental effects of excessive exposure of the human body to electromagnetic waves, including

- microwaves : internal heating of body tissue
- infra-red : skin burns
- ultraviolet : damage to surface cells and blindness
- gamma rays : cancer, mutation

Light and sound

Candidates will be assessed on their ability to

3.13 recall that light waves are transverse waves which can be reflected, refracted and diffracted

3.14 recall that the angle of incidence equals the angle of reflection

3.15 construct ray diagrams to illustrate the formation of a virtual image in a plane mirror

3.16 describe experiments to investigate the refraction of light, using rectangular blocks, semicircular blocks and triangular prisms

3.17 recall and use the relationship between refractive index, angle of incidence and angle of refraction

$$n = \frac{\sin i}{\sin r}$$

3.18 describe an experiment to determine the refractive index of glass, using a glass block

3.19 describe the role of total internal reflection in transmitting information along optical fibres and in prisms

3.20 recall the meaning of critical angle *c*

3.21 recall and use the relationship between critical angle and refractive index

$$\sin c = \frac{1}{n}$$

3.22 understand the difference between analogue and digital signals

3.23 recall that sound waves are longitudinal waves which can be reflected, refracted and diffracted

3.24 recall that the frequency range for human hearing is 20 Hz – 20 000 Hz

3.25 describe how to measure the speed of sound in air by a simple direct method

3.26 understand how an oscilloscope and microphone can be used to display a sound wave

3.27 use an oscilloscope to determine the frequency of a sound wave and appreciate that the pitch of a sound depends on the frequency of vibration

3.28 appreciate that the pitch of a sound depends on the frequency of vibration of the source

3.29 appreciate that the loudness of a sound depends on the amplitude of vibration

4. Energy resources and energy transfer

- Units
- Energy transfer
- Work and power
- Energy resources and electricity generation

Units

Candidates will be assessed on their ability to

4.1 use the following units: kilogram (kg), joule (J), metre (m), metre/second (m/s), metre/second^2 (m/s^2), newton (N), second (s), watt (W)

Energy transfer

Candidates will be assessed on their ability to

4.2 describe energy transfers involving the following forms of energy: thermal (heat), light, electrical, sound, kinetic, chemical, nuclear and potential (elastic and gravitational)

4.3 understand that energy is conserved

4.4 recall and use the relationship

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy output}}$$

4.5 describe a variety of everyday and scientific devices and situations, explaining the fate of the input energy in terms of the above relationship, including their representation by flow diagrams

4.6 recall that energy transfer may take place by conduction, convection and radiation

4.7 describe the role of convection in everyday phenomena

4.8 describe how insulation is used to reduce energy transfers from buildings and the human body

Work and power

Candidates will be assessed on their ability to

4.9 recall and use the relationship between work, force and distance moved in the direction of the force

work done = force × distance moved
$W = F \times d$

4.10 understand that work done is equal to energy transferred

4.11 recall and use the relationships:

gravitational potential energy = mass × *g* × height

GPE = *m* × *g* × *h*

kinetic energy = ½ × mass × speed^2

KE = ½ × *m* × *v*^{2}

4.12 understand how conservation of energy produces a link between potential energy, kinetic energy and work

4.13 describe power as the rate of transfer of energy or the rate of doing work

4.14 use the relationship between power, work done (energy transferred) and time taken

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

$$P = \frac{W}{t}$$

Energy resources and electricity generation

Candidates will be assessed on their ability to

4.15 understand the energy transfers involved in generating electricity using:

- wind
- water
- geothermal resources
- solar heating systems
- solar cells
- fossil fuels
- nuclear power

4.16 describe the advantages and disadvantages of methods of large-scale electricity production from various renewable and non-renewable resources

5. Solids, liquids and gases

- Units
- Density and pressure
- Change of state
- Ideal gas molecules

Units

Candidates will be assessed on their ability to

5.1 use the following units : degrees Celsius (^{o}C), kelvin (K), joule (J), kilogram (kg), kilogram/metre ^{3} (kg/m^{3}), metre (m), metre^{2} (m^{2}), metre^{3} (m^{3}), metre/second (m/s), metre/second^{2} (m/s^{2}), newton (N), pascal (Pa)

Density and pressure

Candidates will be assessed on their ability to

5.2 recall and use the relationship between density, mass and volume

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

$$\rho = \frac{m}{V}$$

5.3 describe how to determine density using direct measurements of mass and volume

5.4 recall and use the relationship between pressure, force and area:

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

$$p = \frac{F}{A}$$

5.5 understand that the pressure at a point in a gas or liquid which is at rest acts equally in all directions

5.6 recall and use the relationship for pressure difference:

$$\text{pressure difference} = \text{height} \times \text{density} \times g$$

$$p = h \times \rho \times g$$

Change of state

Candidates will be assessed on their ability to

5.7 understand that a substance can change state from solid to liquid by the process of melting

5.8 understand that a substance can change state from liquid to gas by the process of evaporation or boiling

5.9 recall that particles in a liquid have a random motion within a close-packed structure

5.10 recall that particles in a solid vibrate about fixed positions within a close-packed regular structure

Ideal gas molecules

Candidates will be assessed on their ability to

5.11 understand the significance of Brownian motion

5.12 recall that molecules in a gas have a random motion and that they exert a force and hence a pressure on the walls of the container

5.13 understand that there is an absolute zero of temperature which is – 273 ^{o}C

5.14 describe the kelvin scale of temperature and be able to convert between the kelvin and Celsius scales

5.15 understand that an increase in temperature results in an increase in the speed of gas molecules

5.16 understand that the kelvin temperature of the gas is proportional to the average kinetic energy of its molecules

5.17 describe the qualitative relationship between pressure and kelvin temperature for a gas in a sealed container

5.18 use the relationship between the pressure and kelvin temperature of a fixed mass of gas at constant volume:

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

5.19 use the relationship between pressure and volume of a fixed mass of gas at constant temperature

$$p_1V_1 = p_2V_2$$

6. Magnetism and electromagnetism

- Units
- Magnetism
- Electromagnetism
- Electromagnetic induction

Units

Candidates will be assessed on their ability to

6.1 use the following units: ampere (A), volt (V), watt (W)

Magnetism

Candidates will be assessed on their ability to

6.2 recall that magnets repel and attract other magnets, and attract magnetic substances

6.3 recall the properties of magnetically hard and soft materials

6.4 understand the term ‘magnetic field line’

6.5 understand that magnetism is induced in some materials when they are placed in a magnetic field)

6.6 sketch and recognise the magnetic field pattern for a permanent bar magnet and that between two bar magnets

6.7 know how to use two permanent magnets to produce a uniform magnetic field pattern

Electromagnetism

Candidates will be assessed on their ability to

6.8 recall that an electric current in a conductor produces a magnetic field round it

6.9 describe the construction of electromagnets

6.10 sketch and recognise magnetic field patterns for a straight wire, a flat circular coil and a solenoid when each is carrying a current

6.11 appreciate that there is a force on a charged particle when it moves in a magnetic field as long as its motion is not parallel to the field

6.12 recall that a force is exerted on a current-carrying wire in a magnetic field, and, how this effect is applied in simple d.c. electric motors and loudspeakers

6.13 predict the direction of the resulting force when a wire carries a current perpendicular to a magnetic field

6.14 recall that the force on a current-carrying conductor in a magnetic field increases with the strength of the field and with the current

Electromagnetic induction

Candidates will be assessed on their ability to

6.15 recall that a voltage is induced in a conductor when it moves through a magnetic field or when a magnetic field changes through a coil; also recall the factors which affect the size of the induced voltage

6.16 describe the generation of electricity by the rotation of a magnet within a coil of wire and of a coil of wire within a magnetic field; also describe the factors which affect the size of the induced voltage

6.17 recall the structure of a transformer, and understand that a transformer changes the size of an alternating voltage by having different numbers of turns on the input and output sides

6.18 explain the use of step-up and step-down transformers in the large-scale generation and transmission of electrical energy

6.19 recall and use the relationship between input (primary) and output (secondary) voltages and the turns ratio for a transformer

$$\frac{\text{input (primary) voltage}}{\text{output (secondary) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$$

$$\frac{V_\text{p}}{V\text{s}} = \frac{n_\text{p}}{n\text{s}}$$

6.20 recall and use the relationship

input power = output power

$$\boldsymbol{V_\text{P} I_\text{P}} = \boldsymbol{V_\text{S} I_\text{S}}$$

for 100% efficiency

7. Radioactivity and particles

- Units
- Radioactivity
- Particles

Units

Candidates will be assessed on their ability to

7.1 use the following units: becquerel (Bq), centimetre (cm), hour (h), minute (min), second (s)

Radioactivity

Candidates will be assessed on their ability to

7.2 describe the structure of an atom in terms of protons, neutrons and electrons and use symbols such as $^{14}_{6}C$ to describe particular nuclei

7.3 understand the terms atomic (proton) number, mass (nucleon) number and isotope

7.4 understand that alpha and beta particles and gamma rays are ionising radiations emitted from unstable nuclei in a random process

7.5 describe the nature of alpha and beta particles and gamma rays and recall that they may be distinguished in terms of penetrating power

7.6 describe the effects on the atomic and mass numbers of a nucleus of the emission of each of the three main types of radiation

7.7 understand how to complete balanced nuclear equations

7.8 understand that ionising radiations can be detected using a photographic film or a Geiger-Muller detector

7.9 recall the sources of background radiation

7.10 understand that the activity of a radioactive source decreases over a period of time and is measured in becquerels

7.11 recall the term ‘half-life’ and understand that it is different for different radioactive isotopes

7.12 use the concept of half-life to carry out simple calculations on activity

7.13 describe the uses of radioactivity in medical and non-medical tracers, in radiotherapy and in the radioactive dating of archaeological specimens and rocks

7.14 describe the dangers of ionising radiations, including

- radiation can cause mutations in living organisms
- radiation can damage cells and tissue
- the problems arising in the disposal of radioactive waste

Particles

Candidates will be assessed on their ability to

7.15 describe the results of Geiger and Marsden's experiments with gold foil and alpha particles

7.16 describe Rutherford's nuclear model of the atom and how it accounts for the results of Geiger and Marsden's experiment and understand the factors (charge and speed) which affect the deflection of alpha particles by a nucleus

7.17 understand that a nucleus of U-235 can be split (the process of fission) by collision with a neutron, and that this process releases energy in the form of kinetic energy of the fission products

7.18 recall that the fission of U-235 produces two daughter nuclei and a small number of neutrons

7.19 understand that a chain reaction can be set up if the neutrons produced by one fission strike other U-235 nuclei

7.20 understand the role played by the control rods and moderator when the fission process is used as an energy source to generate electricity

Grade descriptions

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

Grade F

Candidates can

- recall a limited range of information, e.g. suggest ways in which insulation is used in domestic contexts
- use and apply knowledge and understanding in some specific everyday contexts, e.g. explain that fuels are energy resources
- make some use of scientific and technical vocabulary and make simple generalisations from information
- devise fair tests in contexts which involve only a few factors; they can recall or use simple apparatus to make measurements appropriate to the task, and record observations and measurements in tables and graphs. They can obtain information from simple tables, charts and graphs and identify simple patterns; they offer explanations consistent with the evidence obtained.

Grade C

Candidates can

- recall a range of scientific information from all areas of the specification, including units
- use and apply scientific knowledge and understanding in some general contexts, e.g. use quantitative relationships between physical quantities to perform calculations
- describe links between related phenomena in different contexts; use diagrams, charts and graphs to support arguments; use appropriate scientific and technical vocabulary in various contexts
- use scientific knowledge and understanding to identify an approach to a question: e.g. identifying key factors which need to be varied and controlled. Candidates can recall or use various types of apparatus to make careful and precise measurements and systematic observations, and recognise when it is necessary to repeat measurements and observations; they present data systematically e.g. in graphs, and use lines of best fit; they identify and explain patterns within data and draw conclusions consistent with the evidence. They explain these conclusions using scientific knowledge and understanding and evaluate how strongly their evidence supports the conclusions.

Grade A

Candidates can

- recall a wide range of knowledge from all areas of the specification
- use detailed scientific knowledge and understanding in a range of applications relating to scientific systems or phenomena e.g. use many different relationships between physical quantities to carry out calculations effectively. Candidates draw together and communicate knowledge from more than one area, routinely use scientific or mathematical conventions in support of arguments and use a wide range of scientific and technical vocabulary throughout their work
- use scientific knowledge and understanding to select an appropriate strategy for a task, identifying the key factors to be considered. They make systematic observations in qualitative work and decide which observations are relevant to the task in hand. When making measurements they decide the level of precision needed and can recall or use different types of apparatus to make appropriately precise measurements. They select a method of presenting data appropriate to the task; they use information from a range of sources where it is appropriate to do. They identify and explain anomalous observations and measurements and the salient features of graphs
- use scientific knowledge and understanding to identify and explain patterns and draw conclusions from the evidence by combining data of more than one kind or from more than one source. They identify shortcomings in evidence, use scientific knowledge and understanding to draw conclusions from their evidence and suggest improvements to methods used that would enable them to collect more reliable evidence.

Investigative skills

Experimental work is an integral part of the study of any scientific subject, and it is important that a candidate's practical investigative skills form part of the final assessment. To reflect this importance, the investigative skills described in Assessment Objective 3 carry 20% of the final mark for the subject. For the IGCSE, investigative skills may be assessed by two alternative routes, which allow all candidates access to the qualification. Candidates either take the written alternative to coursework examination (Paper 03) or submit internally–assessed coursework, which is assessed by the teacher and moderated by Edexcel International. These alternatives are described below.

Written alternative to coursework (Paper 03)

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

Candidates will be assessed on the ability to

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

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

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

Coursework (Component 4)

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

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

The evidence for assessment will be coursework carried out by the candidate, in the context of the specification content. The assessment scheme caters for a wide range of experimental and investigative work. Candidates should undertake experimental and investigative work during the course and be assessed on several occasions in both types of activity. The aim is to allow them to achieve their highest potential in such work. Candidates are required to produce the evidence for assessment based on the guidelines in the following pages.

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

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

Assessment of investigative skills

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

Candidates will be expected to

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

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

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

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

The mark descriptions within a skill area are designed to be hierarchical. This means that, in general, a description at a particular mark subsumes those at lower marks. It is assumed that activities that access higher marks will involve a more sophisticated approach and/or a more complex treatment. Adjacent descriptions should be considered when making judgements and use made of the intermediate marks (ie 3, 5 and 7) where performance exceeds one description and only partially satisfies the next.

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

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

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

Safe practice

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

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

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

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

Skill Area P: Planning

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

Mark descriptions for internal assessment

The mark descriptions are designed to be hierarchical.

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

Candidates			Increasing demand of activity
2 marks	P.2a	outline a simple procedure	
4 marks	P.4a P.4b	plan to collect evidence which will be valid plan the use of suitable equipment or sources of evidence	
6 marks	P.6a P.6b	use scientific knowledge and understanding to plan and communicate a procedure, to identify key factors to vary, control or take into account, and to make a prediction where appropriate decide a suitable extent and range of evidence to be collected	
8 marks	P.8a P.8b	use detailed scientific knowledge and understanding to plan and communicate an appropriate strategy, taking into account the need to produce precise and reliable evidence, and to justify a prediction, when one has been made use relevant information from preliminary work, where appropriate, to inform the plan	

Skill Area O: Obtaining evidence

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

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

Skill Area A: Analysing and considering evidence

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

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

Skill Area E: Evaluating

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

Mark descriptions for internal assessment

The mark descriptions are designed to be hierarchical.

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

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

Textbooks and other resources

Particularly recommended

Longman Physics for IGCSE – S Woolley, P Johnson and B Arnold (Longman 2004)
ISBN: 1405 80213 8

Also recommended

Physics for You, Student's Book – K Johnson (Nelson Thornes, 1996)
ISBN: 0 7487 6236 1

Physics for You, *Teacher's Support Pack* – K Johnson (Nelson Thornes, 1996)
ISBN: 0 7487 2755 8

Physics Matters 3rd Edition – N England (Hodder & Stoughton, 2001)
ISBN: 0 340 79054 7

Addresses of scientific organisations

Institute of Physics

Education Manager (Schools and Colleges)
Institute of Physics
76 Portland Place
London
W1N 3DH
UK

Wellcome Trust

210 Euston Road
London
NW1 2BE
UK

Support and training

Training

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

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

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

Edexcel publications

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

Edexcel Publications
Adamsway
Mansfield
Notts NG18 4LN

UK

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

The following support materials will be available from 2003 onwards:

- Specimen papers and mark schemes (Publication code: UG013059)
- Teacher's Guide (Publication code: UG013049)

Subject-specific requirements

Units and nomenclature

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

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

www.ase.org.uk

Appendices

Appendix 1 – Formulae for relationships

The relationships listed below will **not** be provided for IGCSE candidates either in the form given or in re-arranged form.

(i) the relationship between speed, distance and time:

$$\text{speed} = \frac{\text{distance}}{\text{time}}$$

(ii) the relationship between force, mass and acceleration:

$$\text{force} = \text{mass} \times \text{acceleration}$$

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

(iii) the relationship between density, mass and volume:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(iv) the relationship between force, distance and work:

$$\text{work done} = \text{force} \times \text{distance moved in direction of force}$$

(v) the energy relationships:

$$\text{energy transferred} = \text{work done}$$

$$\text{kinetic energy} = \tfrac{1}{2} \times \text{mass} \times \text{speed}^2$$

$$\text{change in potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{change in height}$$

(vi) the relationship between mass, weight and gravitational field strength:

$$\text{weight} = \text{mass} \times \text{gravitational field strength}$$

(vii) the relationship between an applied force, the area over which it acts and the resulting pressure:

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

(viii) the relationship between the moment of a force and its distance from the pivot:

moment = force × perpendicular distance from pivot

(ix) the relationships between charge, current, voltage, resistance and electrical power:

charge = current × time

voltage = current × resistance

electrical power = voltage × current

(x) the relationship between speed, frequency and wavelength:

wave speed = frequency × wavelength

(xi) the relationship between the voltage across the coils in a transformer and the number of turns in them:

$$\frac{\text{input (primary) voltage}}{\text{output (seconday) voltage}} = \frac{\text{primary turns}}{\text{secondary turns}}$$

(xii) The relationship between refractive index, angle of incidence and angle of refraction:

$$n = \frac{\sin i}{\sin r}$$

(xiii) The relationship between refractive index and critical angle:

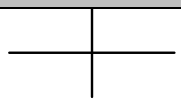
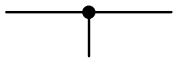
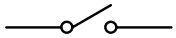
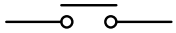
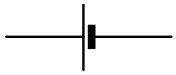
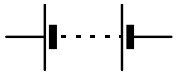
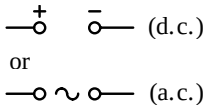
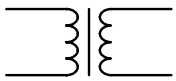
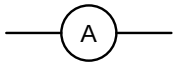
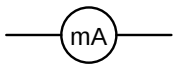
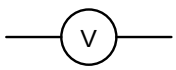
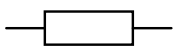
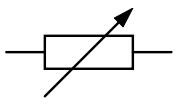
$$\sin c = \frac{1}{n}$$

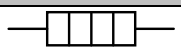
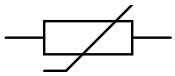
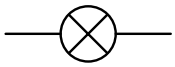
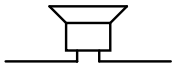
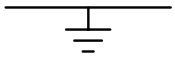
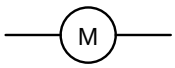
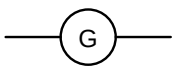
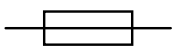
(xiv) The relationship for pressure difference

pressure difference = height × density × g

$$p = h\rho g$$

Appendix 2 – Electrical circuit symbols

Description	Symbol
Conductors crossing with no connection	
Junction of conductors	
Open switch	
Closed switch	
Open push switch	
Closed push switch	
Cell	
Battery of cells	
Power supply	
Transformer	
Ammeter	
Milliammeter	
Voltmeter	
Fixed resistor	
Variable resistor	

Description	Symbol
heater	
thermistor	
light-dependent resistor (LDR)	
relay	
diode	
light-emitting diode (LED)	
lamp	
loudspeaker	
microphone	
electric bell	
earth or ground	
motor	
generator	
fuse/circuit breaker	

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

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

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

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

The reported marks from each activity should be ringed.

Activity title(s)	P	O	A	E

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

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

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

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

Candidate's signature…… Date ……

Teacher's signature…….Date ……

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