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IGCSE

London Examinations IGCSE

Physics (4420)

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Teacher's Guide

London Examinations IGCSE

Physics (4420)

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For further information please call our International Customer Relations Unit

Tel +44 (0) 190 884 7750

international@edexcel.org.uk

www.edexcel-international.org

Authorised by Elizabeth Blount

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Contents

Introduction

This guide provides support and guidance for teachers and technicians preparing students for IGCSE Physics. It provides helpful information about the course content, including practical work, the assessment model and course planning.

The purpose of the guide is

- to advise about the different patterns of entry that are possible in this flexible specification both in terms of tier of entry and the assessment of experimental work
- to describe the assessment objectives and weightings given to them in each component of the assessment
- to assist the teacher in planning the delivery of the specification by discussing some of the parameters which need careful consideration, and suggesting a possible timetable for teaching
- to advise the teacher on the procedures relating to coursework for those who wish to pursue this option. Important features like task setting, assessment, recording marks and standardisation are all described in detail.

This guide will help the teacher to translate the specification content into a course that suits the conditions within each individual centre and reflects their preferred order of teaching.

The Specification, Specimen Papers and Mark Schemes, and Teacher's Guide provide teachers with all the support they need to deliver this course successfully.

In addition, from early 2004, a detailed Coursework Guide for all IGCSE Science subjects (Biology 4325, Chemistry 4335, Physics 4420 and Dual Award Science 4437, first examination May 2006), which will include exemplar work, will be available on the Edexcel International website. The publication code will be UG014326. The information will also be helpful to teachers preparing students for paper 03.

Tiers of entry

Students are entered for either Foundation Tier or Higher Tier.

The **Foundation Tier** written paper (1F) is designed for students who are unlikely to achieve a high grade, but whose achievement can still be recognised with a grade at the appropriate level. No matter how well students may do on the Foundation Tier paper, the highest grade they can be awarded is grade C. Students who fail to achieve grade G will be awarded 'Ungraded'.

The **Higher Tier** written paper (2H) contains questions that are more demanding, and there are some topics that are for Higher Tier students only. These topics are printed in bold type in the specification. For example, the 'Particles' topic within section 7 of the specification content will be examined at Higher Tier only. The highest grade which can be awarded on Higher Tier is A*, a grade reserved for only the highest achievers at the top of grade A. Questions in the Higher Tier are targeted at grades A* to D, but there is a 'safety net' for those who narrowly fail to achieve grade D. A grade E can be awarded to students who are within a few marks of grade D. Students who fail to achieve the safety net grade E will be awarded 'Ungraded'.

The Foundation and Higher Tier papers take place at the same time, so students cannot be entered for both examinations. This puts a responsibility on the teacher to ensure that a student is entered for the appropriate tier. Students who consistently achieve grade C standard work in practice tests would normally be entered for the Higher Tier, where they have the opportunity to achieve the higher grades.

Because of the overlap at grades C and D between the two tiers, there are some questions common to both tiers. In Physics, the overlap between the tiers is about 45 marks. On the Foundation Tier paper this is 45 marks out of a total of 100 marks, and on the Higher Tier paper this is 45 marks out of a total of 120 marks.

Investigative skills are assessed either by the **written alternative to coursework** (paper 03) or by internally assessed **coursework** (component 4). Unlike papers 1F and 2H, paper 03 and the coursework are untiered and assess achievement in the whole range of grades from A* to G. They are taken by both Foundation and Higher Tier candidates.

Structure of specification

Summary of the scheme of assessment

Paper / Component	Mode of assessment	Weighting	Length
1 OR 2	Examination Paper 1F, targeted at grades C – G (Foundation Tier)	80%	1½ hours
	Examination Paper 2H, targeted at grades A* – D (Higher Tier)	80%	2 hours
03 OR 4	Examination Paper 03, targeted at grades A* – G (common to both tiers)	20%	1¼ hours
	Coursework, targeted at grades A* – G (common to both tiers)	20%	–

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

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

- **Foundation Tier** candidates will take Paper 1F, and **either** Paper 03 **or** component 4 (coursework).
- **Higher Tier** candidates will take Paper 2H, and **either** Paper 03 **or** Component 4 (coursework).

Use of calculators is permitted in all written examinations.

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.

Weighting of assessment objectives

In the examination, the weighting given to each assessment objective will be as shown in the following table.

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

The weightings given to each assessment objective in the examination papers will be

Papers 1F and 2H

AO1 45 - 55% AO2 25 - 35% AO3 0%

Paper 03 and coursework

AO1 0% AO2 0% AO3 20%

Course content

There are seven areas of content. Each area has associated with it the units that are essential for the full understanding of the content. Some of the content is for **Higher Tier** candidates only. This content is printed in **bold**. Higher Tier candidates are required to know the content of **both** tiers.

	Area of content	Both tiers	**Higher tier only**
1	Forces and motion		
	Movement and position	✓	
	Forces, movement and shape	✓	
2	Electricity		
	Mains electricity	✓	
	Energy and potential difference in circuits	✓	
	Electric charge	✓	
3	Waves		
	Properties of waves	✓	
	The electromagnetic spectrum	✓	
	Light and sound	✓	
4	Energy resources and energy transfer		
	Energy transfer	✓	
	Work and power	✓	
	Energy resources and electricity generation	✓	
5	Solids, liquids and gases		
	Density and pressure	✓	
	Change of state	✓	
	Ideal gas equation	✓	
6	Magnetism and electromagnetism		
	Magnetism	✓	
	Electromagnetism	✓	
	Electromagnetic induction	✓	
7	Radioactivity and **particles**		
	Radioactivity	✓	
	Particles		✓

Course planning

This planning sheet is offered as a rough guide for a course that might cover fifty teaching weeks spread over five terms.

Term planner

London Examinations IGCSE Physics (4420): Planning Sheet		
Term	**Area of content**	**Content with specification references**
Year 1 Term 1 10 weeks	Movement and position	Distance, speed and acceleration (1.2 – 1.6)
	Forces, movement and shape	Forces, **vectors**, moments, Hooke's Law (1.7 – 1.22)
	Mains electricity	Earthing, fuses, energy and power, **energy transferred**, d.c & a.c. (2.2 – 2.8)
Year 1 Term 2 10 weeks	Energy and potential difference in circuits	Series and parallel circuits, LDRs, thermistors, Ohm's Law, charge, **conductors, voltage and the volt** (2.9 – 2.18)
	Electric charge	insulators, conductors, attraction and repulsion between charges, electrons (2.19 – 2.25)
	Properties of waves	Transverse, longitudinal, amplitude, frequency, wavelength, wave speed, sound, electromagnetic, diffraction (3.2 – 3.8)
	The electromagnetic spectrum	Uses and detrimental effects (3.9 – 3.12)
Year 1 Term 3 10 weeks	Light and sound	Reflection, refraction, diffraction, total internal reflection, **critical angle, refractive index,** speed of sound, **oscilloscope** (3.13 – 3.29)
	Energy transfer	Efficiency, conduction, convection, radiation (4.2 – 4.8)
	Work	Force, distance, potential and kinetic energy, power (4.9 – 4.12)

Term	Area of content	Content with specification references
Year 2 Term 1 10 weeks	Power	Power, work done and time (4.13, 4.14)
	Energy resources and electricity generation	Advantages and disadvantages of using renewable and non-renewable resources (4.15, 4.16)
	Density and pressure	Density, mass, volume, pressure, force, area (5.2 – 5.6)
	Change of state	Movement and arrangement of molecules in solids, liquids and gases (5.7 – 5.10)
	Ideal gas molecules	Brownian motion, absolute zero, Kelvin scale, gas laws (5.11 – 5.19)
	Magnetism	Attraction, repulsion, field lines and patterns, hard and soft materials (6.2 – 6.7)
	Electromagnetism	Electromagnets, field patterns for wires, coils and solenoids, left hand rule (6.8 – 6.14)
Year 2 Term 2 10 weeks	Electromagnetic induction	Induced voltage, transformers (6.15 – 6.20)
	Radioactivity	Atoms, protons, neutrons, electrons, isotopes, alpha, beta, gamma radiation, nuclear equations, background radiation, half life (7.2 – 7.14)
	Particles	**Alpha scattering, fission, nuclear reactors (7.15 – 7.20)**

Weekly planner

The specification content has been further broken down into work that could be covered in a week, together with suggested resources to enable candidates to be familiar with the practical components of the assessment.

Week	Specification reference	Content	Resources
1	1.2, 1.3	Speed, distance, time	Ticker tape timer
2	1.4, 1.5, 1.6	Acceleration, velocity, time	Ticker tape timer
3	1.7, 1.8, **1.9, 1.10, 1.11**	Types of forces, **vectors**	Spring balance
4	1.12, **1.13**	Friction, $\boldsymbol{F = m \times a}$	Ticker tape timer. Trolley, runway
5	1.14, **1.15**, 1.16	Weight, stopping distance, **terminal velocity**	Ball bearing, measuring cylinder with oil
6	1.17, 1.18, 1.19, 1.20	Moment of a force , centre of gravity, principle of moments, upward forces on loaded light beams	Metre rule, small known masses, pivot. Irregularly shaped lamina, plumb line.
7	1.21, 1.22	F-e graphs for springs, wires and rubber bands, Hooke's Law	Spring, rubber band, metre rule, masses
8	2.2, 2.3	Hazards of electricity, insulation, earthing, fuses, circuit breakers	
9	2.4, 2.5, 2.6	Electrical heating, $P = I \times V$ applied to fuses	Range of appliances with wattage stamped on them
10	**2.7**, 2.8	**Electrical energy**, a.c. & d.c.	Oscilloscope, dry cell, low voltage power supply
11	2.9, 2.10, 2.11, 2.12	Series and parallel circuits, V-I graphs for wires, filament lamps, diodes	Dry cell, lamp, ammeter, voltmeter, switch, resistor, wire, filament lamp, diode

Week	Specification reference	Content	Resources
12	2.13, 2.14	LDRs, thermistors, Ohm's Law	LDR, thermistor, ammeter, voltmeter, dry cell, low voltage power supply, rheostat
13	2.15, 2.16, **2.17, 2.18**	Current as flow of charge, $Q = I \times t$, **electrons, definition of the volt**	Polythene and cellulose acetate rods
14	2.19, 2.20, 2.21, 2.22	Conductors and insulators, charging by friction, attraction and repulsion between charges	Polythene and cellulose acetate rod, gold leaf electroscope, Van de Graaf generator
15	2.23, 2.24, 2.25	Movement of electrons, uses and dangers of electrostatic charges	
16	3.2	Longitudinal and transverse waves	Ripple tank, slinky spring, rope
17	3.3, 3.4	Amplitude, frequency, wavelength, period, energy transfer of waves	Ripple tank
18	3.5, 3.6, 3.7	Speed, frequency and wavelength & frequency and periodic time	Ripple tank
19	3.8	Dependence of wavelength and gap size on diffraction of waves	Ripple tank
20	3.9, 3.10, 3.11, 3.12	Properties, uses and dangers of different parts of the electromagnetic spectrum	Microwave generator and detector
21	3.13, 3.14	Reflection of light	Plane mirror, raybox, protractor
22	3.15	Ray diagrams for images formed in plane mirrors	
23	3.16, **3.17, 3.18**	Refraction of light, **refractive index**	Raybox, glass block, protractor
24	3.19**, 3.20, 3.21**	Total internal reflection, **critical angle**	Semicircular glass block, raybox
25	3.22, 3.23, 3.24	Analogue and digital signals, reflection, refraction and diffraction of sound waves, human frequency range	Signal generator, loudspeaker
26	3.25	Measurement of the speed of sound	Stopwatch

Week	Specification reference	Content	Resources
27	**3.26, 3.27, 3.28, 3.29**	**Determination of the frequency of a sound wave, dependence of pitch on frequency and loudness on amplitude using an oscilloscope**	Signal generator, loudspeaker, oscilloscope
28	4.2, 4.3, 4.4, 4.5	Energy transfer and efficiency	Electric motor, generator, pulley, weight
29	4.6, 4.7, 4.8	Energy transfer by conduction, convection and radiation	Bunsen burner, metal rods, paraffin wax, potassium permanganate, electric heater, shiny surface, dull black surface
30	4.9, 4.10, **4.11**, 4.12	Work done, force and distance, **kinetic energy, gravitational potential energy**	Ticker tape timer, runway, pulley, thread, weight
31	4.13, 4.14	Power, work done and time	Measure personal power using stopwatch, metre rule, bathroom scales and flight of stairs
32	6.16, 4.15, **4.16**	Demonstration of generation of electricity by rotation of a magnet within a coil of wire. Electricity generation from renewable and non-renewable resources. **Advantages and disadvantages**	Dynamo, lamp
33	5.2, 5.3	Density, mass and volume	Regularly and irregularly-shaped solids, measuring cylinder, balance, rule
34	5.4, 5.5, 5.6	Pressure, force and area. Solid and liquid pressure	Regular solid, rule, balance, U-tube manometer
35	5.7, 5.8, 5.9, 5.10	Change of state during melting, and evaporation and boiling. Movement and arrangement of molecules in solid and liquid states.	Test tube, ethanamide, beaker, water, thermometer
36	5.11, 5.12, 5.13, 5.14	Brownian motion, molecular pressure, absolute zero, kelvin scale	Microscope, glass cell, lamp, glass rod
37	5.15, **5.16**, 5.17 **5.18, 5.19**	Understand and use the relationships for **Boyle's Law** and **Pressure Law**	**Pressure Law apparatus, Boyle's Law apparatus**

Week	Specification reference	Content	Resources
38	6.2, 6.3, 6.4, 6.5, 6.6, 6.7	Magnetic poles, materials, field lines and patterns	Bar magnets, plotting compass, iron filings.
39	6.8, 6.9, 6.10	Magnetic field due electric current in wire, coil and solenoid. Electromagnet	Plotting compasses. Wire, coil and solenoid each with current passing through. Low voltage supply, ammeter, electromagnet, paperclips
40	6.11, 6.12, **6.13, 6.14**	Force on a charged particle or conductor in a magnetic field. **Direction and size of resulting force**.	Model motor
41	6.15, 6.16	Factors affecting the size of an induced voltage when a conductor moves in a magnetic field	Sensitive centre-zero meter, bar magnet, solenoid
42	6.17, 6.18, 6.19, **6.20**	Transformers. Step-up and step-down, turns ratio, **efficiency**	C-cores, wire, a.c. supply, lamp
43	7.2, 7.3	Protons, neutron, electrons, isotopes	
44	7.8, 7.9	Detection of ionising radiation, background radiation	Radioactive sources, Geiger-Muller tube
45	7.4, 7.5, **7.6**, **7.7**	Radioactivity. Nature and penetrating power of alpha, beta and gamma radiation. **Effect of decay on atomic and mass number.** **Balanced nuclear equations**	Radioactive sources, Geiger-Muller tube, lead sheet, thin aluminium sheet, paper
46	7.10, 7.11, 7.12	Half life	
47	7.13, 7.14	Uses and dangers of ionising radiations	
48	**7.15, 7.16**	**Alpha particle scattering**	
49	**7.17, 7.18, 7.19**	**Nuclear fission**	
50	**7.20**	**Nuclear reactors**	

Experimental and investigative work

Experimental work should be an integral part of the study of Physics and consequently it is appropriate that assessment of experimental and investigative skills should form 20% of the final assessment.

It is strongly recommended that 20% of the teaching time should be devoted to practical work carried out by the students themselves, whether they are being assessed via coursework or via Paper 03. It is envisaged that many of the topics in the specification will be taught in a way that allows the facts to arise from practical work rather than the practical work being used to demonstrate what the students have already been taught.

Practical work should be carried out by all students, whichever assessment route is planned. It should be marked using the criteria for assessing the four practical skill areas, P (Planning), O (Obtaining evidence), A (Analysing and considering evidence) and E (Evaluating). The mark descriptions for assessing practical skills are given in Appendix 1, and a 'student-speak' version for issue to students is provided as Appendix 2.

From early 2004, a detailed Coursework Guide for all IGCSE Science subjects (Biology 4325, Chemistry 4335, Physics 4420 and Dual Award Science 4437, first examination May 2006), which will include exemplar work, will be available on the Edexcel International website. The publication code will be UG014326. The information will also be helpful to teachers preparing students for paper 03.

The two alternative assessment routes are outlined on the next page, for reference.

- **Paper 03 – written alternative to coursework**

Candidates will be assessed on their 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).

The paper carries a total of 50 marks that will be scaled to 20% of the assessment. A specimen paper and mark scheme have been produced to illustrate the types of questions that will be asked.

- **Coursework**

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, communicating findings using calculations, tables and graphs (A)
- evaluate evidence (E).

The component carries a total of 30 marks that will be scaled to 20% of the assessment.

Guidance for teachers on how to select work for assessment and how to complete the final mark aggregation sheet will be found in Appendices 3 and 4. Instructions for submitting samples of coursework and the coursework marks to London Examinations will be sent to centres once London Examinations has received estimated entries from the centre.

Paper 03 or coursework? Which is better?

There is no 'best way' to assess practical skills – both methods have their advantages and their drawbacks. Bearing in mind the limitations described below, it is for each centre to decide the most appropriate assessment method for their candidates.

Paper 03 is a written examination. The questions are designed to assess the same four skill areas as the coursework, to the same marking criteria, so the best way to prepare students for Paper 03 is to give them the same opportunities to carry out experimental and investigative tasks as those students following the coursework option.

The same advice for training and guiding students should be followed, including the use of 'student-speak' marking criteria (Appendix 2) and the gradual introduction to carrying out whole investigations (see below). Students should be offered several opportunities to plan and carry out experimental tasks and whole investigations themselves, and to practise the skills needed to achieve their highest potential in such work.

The specimen paper and mark scheme illustrate the range of question types that will be set on paper 03.

Teachers are asked to note that only centres which have been specifically approved by Edexcel International may offer the coursework option. Please refer to the section 'Availability of coursework to international centres' in the Specification for full details.

Training students in practical skills

Many students will need considerable guidance in order to progress from simply carrying out a set of practical instructions provided by the teacher, to the point where they are able to plan and carry out a whole investigation themselves, and critically evaluate the outcome. However, the effort required will be well rewarded, as the student will then more fully understand the principles and parameters upon which scientific method is based.

Whether the student will ultimately be assessed via coursework or via Paper 03, the written alternative to coursework, the course plan should allow for the gradual development of experimental skills over the two years (advisory minimum time). As 20% of the final marks is derived from these skills, it would be advisable to devote this proportion of teaching time to them.

Please note that it is beneficial to students to be introduced to the concept of practical investigative work well before they begin the two-year examination course; research evidence has shown that students take a considerable time to gain the confidence needed for higher level investigative skills such as critical evaluation.

Students should be encouraged to participate in practical work wherever possible. The scheme is designed to encourage a wide variety of activities, including those based on the collection of first-hand evidence and those which depend on secondary evidence. (The term 'evidence' is used to mean observations, measurements or other data.)

Before attempting whole investigations, students should be given experimental tasks that test only one or two skill areas. For example, as an introduction to the concept of planning whole investigations, students could be asked to write a plan for an experiment that is subsequently carried out in class. Teacher feedback is essential during this early stage of learning.

Towards the second half of the course, students should be provided with several opportunities to develop their investigative skills to allow them to achieve their highest potential in such work.

A simpler, 'student-speak' version of the coursework criteria is given in Appendix 2 and it is recommended that this is given to all students at the start of the course, and thereafter referred to frequently.

Suggestions for practical work

The following is a guide to the practical work that students could carry out themselves and the demonstrations that teachers could use to amplify the teaching of the seven areas of content.

1. Force and motion

- Measurement of speed using a tickertape timer and tape
- Measurement of acceleration using a tickertape timer and tape
- Measuring various forces, e.g. that required to open a door, using a spring balance
- Observation and measurement of terminal speed for a ball bearing falling through a measuring cylinder containing oil
- Investigation of the principle of moments using a metre rule, pivot and two known masses
- Determination of the position of the centre of gravity of an irregularly-shaped lamina using a plumb line
- Determination of the force-extension graphs for a metal spring and a rubber band by suspension of masses

2. Electricity

- Observation of a.c. and d.c. outputs using an oscilloscope, low voltage power supply and dry cell
- Construction of series and parallel circuits using light bulbs, switches and a power supply
- Determination of V-I graphs for a wire, filament wire and diode
- Observation of variation of resistance with level of illumination for an LDR
- Observation of variation of resistance with temperature for a thermistor
- Verification of Ohm's Law for a standard resistor
- Using a gold leaf electroscope to show the opposite charges on charged polythene and cellulose acetate rods rubbed with the same cloth
- Using a Van de Graaf generator to show that an electric current consists of a stream of charges

3. Waves

- Using a slinky spring to demonstrate the wavelength and amplitude of transverse and longitudinal waves
- Using a ripple tank to demonstrate diffraction of water waves
- Using a microwave generator and detector to demonstrate wave properties of microwaves
- Investigating the law of reflection of light using a plane mirror and a raybox (or pins)
- Investigating the refraction of light using a raybox (or pins) and rectangular glass prism
- Measuring critical angle using a circular glass block and a raybox (or pins)
- Measurement of the range of human hearing using a signal generator and loudspeaker
- Measurement of the speed of sound by a simple clapping method using a stopwatch
- Using an oscilloscope and a signal generator to determine the frequency of a sound wave
- Using an oscilloscope, signal generator and speaker to investigate the dependence of loudness on amplitude and pitch on frequency for a sound wave

4. Energy resources and energy transfer

- Measurement of efficiency using an electric motor lifting a weight attached to a string over a pulley
- Using a falling mass connected to a dynamics trolley via a thread passing over a pulley to investigate the conversion of gravitational potential energy to kinetic energy
- Determination of power generated by climbing a flight of stairs and timing the ascent of a known vertical height
- Using a dynamo and lamp to demonstrate the generation of electrical energy

5. Solids, liquids and gases

- Determination of the density of regularly and irregularly shaped objects
- Determination of solid and liquid pressure
- Plotting a cooling curve for ethanamide
- Observing Brownian motion using a microscope, glass cell, lamp and glass rod
- Investigating Boyle's Law and the Pressure Law

6. Magnetism and electromagnetism

- Plotting magnetic fields using bar magnets, plotting compasses (and/or iron filings)
- Investigating the magnetic fields associated with a straight wire, coil and solenoid carrying an electric current
- Investigating the factors affecting the strength of an electromagnet
- Building a model motor
- Investigating the factors affecting the size and direction of an induced voltage using a bar magnet, long solenoid and centre-zero meter
- Investigating a transformer using C-cores, wiring, a low voltage a.c. supply, voltmeter and lamp.

7. Radioactivity and Particles

- Detection of background radiation using a Geiger-Muller tube
- Investigating the penetrating power of alpha, beta and gamma radiation using radioactive sources, absorbers and a Geiger-Muller tube.

Suggested titles for investigations

The experimental and investigative tasks below could be performed using the resources recommended in the Course Planner plus other available resources.

1. Compare the insulating properties of different materials such as bubble wrap, cotton wool and plastic foam.
2. Investigate the effect of length on the resistance of a wire.
3. Investigate the effect of the height fallen by an object on the depth of the crater produced.
4. When light travels through a glass block, investigate how the length of the glass block affects the lateral displacement of the light ray
5. Investigate the factors affecting the time period of a simple pendulum
6. Investigate how the temperature of a squash ball affects the height it bounces off the floor
7. Investigate the percentage energy losses of different bouncing balls
8. Investigate how the weight of a body affects the size of the frictional force opposing its motion
9. Investigate how the area of a model parachute affects its rate of descent
10. Investigate how the depth of water affects the speed of water waves

Coursework

The coursework option is normally available only to candidates studying at centres that have been recognised by Edexcel International as International Teaching Institutions.

Candidates who submit coursework are required to produce evidence in the four skill areas P, O, A and E. 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

The coursework will be assessed by the school or college according to the principles described below and the mark descriptions in Appendix 1 and will be moderated by Edexcel International.

The evidence for assessment will be coursework carried out by the candidate, in the context of the specification content.

The coursework must be the candidate's own unaided work, carried out under the supervision of the teacher.

Candidates should undertake experimental and investigative work during the course, as described earlier, 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.

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.

A whole investigation consists of work that covers each of the four skill areas, although not all of these need to be used for the final assessment.

Applying the mark descriptions

The mark descriptions are given in Appendix 1.

Mark descriptions are provided for 2, 4, 6 and 8 marks in skill areas P (Planning), O (Obtaining evidence) and A (Analysing and considering evidence), and for 2, 4 and 6 marks in the skill area E (Evaluating).

Although the general mark descriptions give guidance for the level of performance to be expected at 2, 4, 6 and 8 teachers may give marks of 1, 3, 5 and 7 for intermediate performance.

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 hurdles, all of which must be fulfilled for a mark to be awarded. Adjacent descriptions should be considered when making judgements and use made of the intermediate marks (3, 5 and 7) where performance exceeds one description and only partially satisfies the next.

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.

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.

Examples

Part of the mark description for skill area O is shown below.

6 marks	O.6a	collect sufficient systematic and accurate evidence and repeat or check where appropriate
	O.6b	record clearly and accurately the evidence collected

Where a student fully satisfies the requirements of O.6a but fails to include units in the results table (thereby not meeting the requirements of O.6b) a mark of 5 should be given.

Intermediate marks may also be awarded to the student who partially satisfies both of the mark descriptions at a particular level.

Part of the mark description for skill area A is shown below.

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

At A.6a, a student might meet the description except for mis-plotting a point, and at A.6b there might be an explanation containing an error in the scientific knowledge. In this case, 5 marks should be awarded.

Each of the tables of mark descriptions in Appendix 1 has a vertical arrow running down the page to signify that an important consideration in designing appropriate assessment tasks is the level of demand expected.

Differentiation by outcome using a common task is appropriate for a group of students with similar ability, but difficult where a class is of mixed ability. However, students do need to be given appropriate tasks to match their abilities, and which fully challenge them. A possible solution is to present two or three similar activities (targeted at different abilities) and to allow students to make a guided choice as to which activity to engage in.

Keeping records

Whenever a student's work is assessed by the teacher, a form such as the *Provisional Assessment Record* (Appendix 5) should be attached to the work. As the teacher reads the work, a tick is all that is needed to show that the particular mark description is achieved. There is enough space to write a few words to explain why a particular mark description may not have been fully satisfied.

The work with its attached form may then be returned to the student so that they can have an opportunity to consider their work, and redraft if appropriate. This procedure is perfectly acceptable so long as 'material help' is not given. For example, a teacher assessing P.8a might write

'*not awarded – insufficient scientific knowledge provided'*

This is not 'material help', so a student could have the opportunity to revise the work. However, a comment such as

'*no reference to the cross section area of the wire'*

would be considered 'material help' by the centre's moderator.

The teacher should also indicate in the margin alongside the appropriate part of the script, P.4a✓**,** etc.

Where there is any doubt about whether a particular mark should be awarded, external moderators appreciate a written comment to help to understand the rationale behind the teacher's decision.

Each time coursework is assessed by the teacher, the provisional marks awarded should be recorded.

Standardising teachers and submitting the coursework marks

It is in the centre's own interest to devise an efficient method of internal standardisation, so that all teachers apply the criteria in the same way. This is particularly important where work from several teaching groups and several teachers is being presented for moderation.

Once coursework marks have been internally standardised and agreed, the Final mark aggregation sheet (Appendices 3 and 4) may be completed for each student.

Instructions for submitting samples of coursework and the coursework marks to London Examinations - *Instructions for moderation of internal assessment* - will be found in later editions of the specification, and on the Edexcel International website.

A teacher's checklist for final assessment of coursework

- one mark from each skill area P, O, A and E should be identified
- these marks are added together to form the final mark
- the marks should be drawn from one or two pieces of work only
- the work must be derived from the content of the Physics specification
- at least one mark must be from a practically based, whole investigation

  A *whole investigation* is defined as a piece of work, carried out by the student, in which all four skill areas are attempted. A *practically based investigation* is one in which first-hand evidence is gathered by the student through observation or measurement
- the *Final mark aggregation sheet* (see Appendices 1 and 2) is completed for the candidate and attached to the corresponding practical work
- the work must be the candidate's own unaided work, carried out under the supervision of the teacher. The declaration of authentication on the bottom of the Final mark aggregation sheet (Appendix 2) must be signed by the candidate and the teacher.

Use of ICT

The use of ICT, where available, e.g. for word-processing, data-logging and graphical display (including lines of best fit) is to be encouraged. However, teachers are advised that some spreadsheet software does not properly produce a line of best fit on graphs.

Data loggers might be used to carry out investigations. A comparison could be made using data-logging with more traditional techniques. The rate of a chemical reaction might be monitored by recording changes in pH, for example.

Formulae functions in a spreadsheet can be used to analyse data. Students could compare this with using a calculator or manual calculations.

Data-handling software could be used to create, analyse and evaluate charts or graphs.

The Internet or CD-ROM software could be used as a source of secondary evidence.

Students should develop the ability to judge when it is appropriate to use ICT in their work. All sources and references used must be clearly identified by the student.

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 and the handling of ionising radiations. Reference should 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)

Subject-specific information

Using and recalling formulae

Some formulae will appear inside the examination paper and candidates may be expected to use these formulae.

For example :

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

  energy transferred = current × voltage × time

  $$E = I \times V \times t \qquad \textbf{(2.7)}$$

Candidates are expected to recall and use the formulae shown in Appendix 1 of the specification.

For example

- recall and use the relationship

  power = current × voltage

  $P = I \times V$

  and apply the relationship to the selection of appropriate fuses (2.6)

Resources

Physics text books

The following textbook is particularly recommended for studying this specification:

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

In addition to those recommended on page 35 of the specification the following is also recommended

T Duncan and H Kennett, *IGCSE Physics* (John Murray, 2002) ISBN 0 7195 7849 3

CD ROM

Physics for ages 11-14 Key Stage 3 (The Times 2003)

CD ROM 1 Forces, Motion and Energy Changes

CD ROM 2 Electricity and Magnetism

GCSE Physics – Revision Series (The Times 2003)

Website

www.bbc.co.uk/schools/gcsebitesize/physics

Support and training

Training

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

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

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 International Publications
Adamsway
Mansfield
Notts NG18 4LN

UK

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

Other materials available in 2003 include

- Specimen papers and mark schemes (Publication code: UG013059)
- Specification (Publication code: UG013282)
- Coursework Guide for all IGCSE Science subjects (Publication code: UG014326)

Available 2004.

Appendices

Appendix 1 – Mark descriptions for the four skill areas

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	

Appendix 2 – A student guide to science coursework criteria

Skill Area P Planning

- 2 marks
  - Plan a simple procedure
- 4 marks
  - Plan to collect valid evidence
  - Make a list of the equipment or other sources of evidence
- 6 marks
  - Produce a plan for your task using scientific knowledge and understanding
  - Say what things will affect how well the investigation will work and say how you plan to change or control these
  - Give scientific reasons for why you think these things are important
  - Say what you think will happen and give scientific reasons
  - Say what evidence you are planning to obtain and how much evidence you think will be needed
- 8 marks
  - Give a detailed description of what you are planning to do
  - Use detailed scientific reasons to explain why you think your plan is a good way of carrying out the task
  - Explain how you will use the equipment to make sure the results you obtain will be correct and as precise as possible
  - Say what you think will happen and give detailed scientific reasons to explain this.
  - Describe any earlier work that helped your planning
  - Give any information that you have obtained from books CD ROMs, the Internet, or other sources to help your planning

Skill Area O Obtaining Evidence

- 2 marks
  - Collect some evidence in a safe way
- 4 marks
  - When you carry out the task, make sure you have enough evidence so that you will be able to say what you have found out.
  - Keep a record of your results
- 6 marks
  - Use the equipment to obtain the evidence as accurately as possible.
  - Make sure your evidence covers a good range.
  - Make sure you have enough evidence to allow you to draw a conclusion.
  - If you think your evidence varies a lot, then take some repeat readings if you can
  - Use a clear way of accurately recording your evidence
  - Consider using a table of results with clear headings and correct units
- 8 marks
  - Use equipment that will help you obtain precise evidence
  - Repeat results in order to obtain averages readings. Check that your evidence is reliable
  - Record the evidence in a clear and accurate way

Skill Area A **Analysing and considering evidence**	Skill Area E **Evaluating**
❑ 2 marks ♦ Say what you have found out from your evidence ❑ 4 marks ♦ Choose a way of showing any pattern in your evidence more clearly ♦ Use a pie chart, bar chart, graph or a clearer way of showing your evidence ♦ Say what pattern or trend you can see in your evidence ❑ 6 marks ♦ Use the best way of displaying your evidence clearly e.g. by using a chart, diagram, line graph or by doing calculations that help you to make good use of your data. ♦ Is a line of best fit appropriate? ♦ Make use of your evidence and any processing that you have done to write a sensible conclusion that explains what has been found out. ♦ Using your evidence, include in your conclusion a scientific explanation. ❑ 8 marks ♦ Use the best way of processing your evidence eg diagrams, graphs, calculations. ♦ Use this work to draw a meaningful conclusion for the investigation. ♦ Use scientific knowledge in a detailed way to explain the conclusion you have written. ♦ If you have made a prediction of what you thought would happen, say if your results turned out the way you expected. ♦ If the evidence did turn out as expected, explain how well the evidence matched your prediction. ♦ If the evidence did not turn out as expected, explain why you think the evidence did not support your prediction.	❑ 2 marks ♦ Say if you think the task worked out well or not, (give a reason for what you have said) based on what you did, or what evidence you got. ❑ 4 marks ♦ Say if you think the evidence was accurate enough for the task–refer to your graph. ♦ Were there any anomalous results? If so show where they are on the graph. If not, say something about the shape of your graph. ♦ Suggest at least one improvement that you would like to make to the method to try to get more accurate evidence. ❑ 6 marks ♦ Say whether your method gave evidence that is reliable and so could always be counted on to be correct – give detailed reasons for what you have said. ♦ Point out any results that did not seem to fit in with the main pattern and explain why you think these differences happened. ♦ Say if you think you have enough evidence to draw a conclusion – give detailed reasons for what you have said. ♦ Think about your method and your evidence. How might you improve your method to obtain more evidence to support your conclusion?

Appendix 3 – Assessment of practical skills – an example of a completed final mark aggregation sheet

Month and year of examination: ***May 2005***	Specification title: ***IGCSE Physics***
Specification code: ***4420***	
Centre: ***xyz International School***	Candidate name: ***Fatima Khan***
	Teaching group: ***5H***
Centre number: ***9xxxx***	Candidate number: ***xxxx***

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. For the single award, all marks may be drawn from one attainment target.

The reported marks from each activity should be ringed.

Activity title(s)	P	O	A	E
How the area of a model parachute affects its rate of descent	****5***	***5***	****6***	***4***
The effect of length on the resistance of a wire	***4***	****6***	***5***	****5***

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	***5***	***6***	***6***	***5***	***22***	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 ……***F. Khan***…… Date ……***28 / 01 / 05***…..

Teacher's signature ……***A. N. Other***…… Date ……***02 / 02 / 05***……

Appendix 4 – Assessment of practical skills – final mark aggregation sheet

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

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

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

The reported marks from each activity should be ringed.

Activity title(s)	P	O	A	E

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

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

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

Declaration of Authentication

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

Candidate's signature …… Date …….

Teacher's signature …… Date …….

Appendix 5 – Provisional assessment record

Student Name…… Group/Set ……..

Task ……

P.2a ……

P.4a ……

P.4b ……

P.6a ……

P.6b ……

P.8a ……

P.8b ……

O.2a ……

O.4a ……

O.4b ……

O.6a ……

O.6b ……

O.8a ……

A.2a ……

A.4a ……

A.4b ……

A.6a ……

A.6b ……

A.8a ……

A.8b ……

E.2a ……

E.4a ……

E.4b ……

E.6a ……

E.6b ……

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