edexcel

International GCSE

Physics (4PH0)

Teacher's guide

First examination 2011

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Acknowledgements

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Introduction

The Edexcel International General Certificate of Secondary Education (International GCSE) in Physics is designed for schools and colleges. It is part of a suite of International GCSE qualifications offered by Edexcel.

About this guide

This guide is for teachers who are delivering, or planning to deliver, the Edexcel International GCSE in Physics qualification. The guide supports you in delivering the course content and explains how to raise the achievement of your students. The guide:

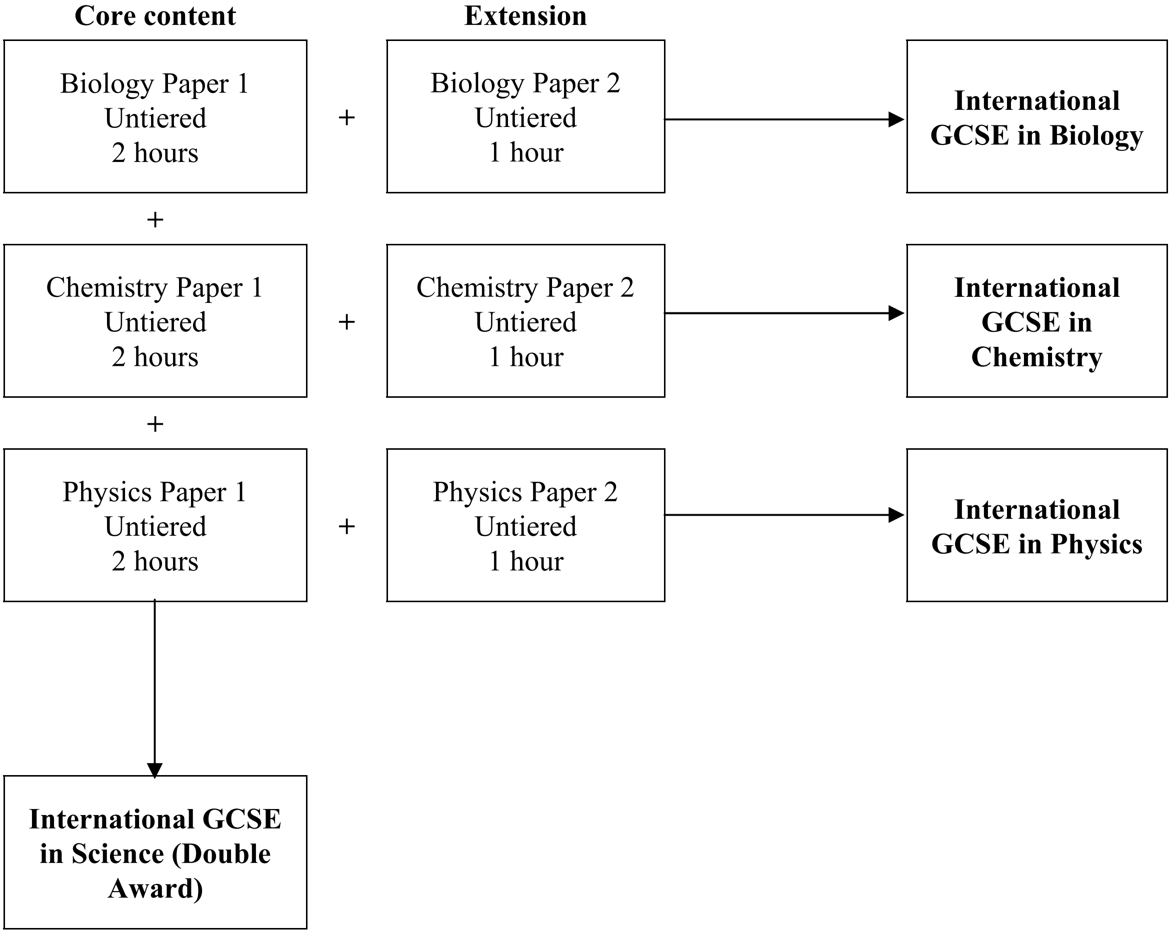
- gives essential information on the changes between this qualification and existing Edexcel and other international qualifications in the subject
- provides details of Assessment Objectives (AO) and criteria
- includes a list of command words that are directly linked to the Assessment Objectives
- gives you an example course planner
- provides experimental and investigative work that should be incorporated into teaching
- offers you suggestions for a range of textbooks and other resources.

Contents

Why choose this qualification?

The Edexcel International GCSE in Physics is designed for use in schools and colleges. It is part of a suite of the International GCSE suite of science qualifications offered by Edexcel. The course gives students the opportunity to experience physics within the context of their general education. The design of the course provides a basis for progression to further study in GCE Advanced Subsidiary and Advanced Level in Physics.

The relationship of assessment and the qualifications available is shown below.



Go to www.edexcel.com for more information about this International GCSE and related resources.

Support from Edexcel

We are dedicated to giving you exceptional customer service. Details of our main support services are given below. They will all help you to keep up to date with International GCSE 2009.

Website

Our website www.edexcel.com is where you will find the resources and information you need to successfully deliver International GCSE qualifications. To stay ahead of all the latest developments visit the microsite and sign up for our email alerts.

Ask Edexcel

Ask Edexcel is our free, comprehensive online enquiry service. Use Ask Edexcel to get the answer to your queries about the administration of all Edexcel qualifications. To ask a question please go to www.edexcel.com/ask and fill out the online form.

Ask the Expert

This free service puts teachers in direct contact with over 200 senior examiners, moderators and external verifiers who will respond to subject-specific queries about International GCSE 2009 and other Edexcel qualifications.

You can contact our experts via email or by completing our online form. Go to www.edexcel.com/asktheexpert for contact details.

Regional offices

If you have any queries about the International GCSE 2009 qualifications, or if you are interested in offering other Edexcel qualifications your Regional Development Manager can help you. Go to www.edexcel.com/international for details of our regional offices.

Training

A programme of professional development and training courses, covering various aspects of the specification and examination is available. Go to www.edexcel.com for details.

Section A: Qualification content

Information for Edexcel centres

The Edexcel International GCSE in Physics has been developed by drawing on the legacy International GCSE in Physics (4420) and making a minimum of changes. These changes are detailed below.

- New sections on astronomy (in Double Award and Physics) and momentum (Physics only).
- New content on *diffraction of waves*.
- Other minor revisions.
- Emboldened content is in International GCSE Physics only.
- Tiers have been removed.
- Investigative skills are embedded throughout.

Changes to content from the legacy Edexcel International GCSE in Physics (4420) to this qualification

The table below sets out the relationship between the legacy International GCSE in Physics qualification (4420) to this qualification.

Unit/topic	New content
Forces and motion	*Students will be assessed on their ability to:*
Forces, movement and shape	1.18 recall and use the relationship between momentum, mass and velocity momentum = mass × velocity 1.19 use the ideas of momentum to explain safety features 1.20 use the conservation of momentum to calculate the mass, velocity or momentum of objects 1.21 use the relationship between force, change in momentum and time taken $\text{force} = \dfrac{\text{change in momentum}}{\text{time taken}}$ 1.22 understand Newton's third law 1.29 associate elastic behaviour with the ability of a material to recover its original shape after the forces causing deformation have been removed.

Unit/topic	New content
Forces and motion Astronomy	*Students will be assessed on their ability to:* 1.30 recall that the Moon orbits the Earth and that some other planets also have moons 1.31 understand gravitational field strength, g, and recall that it is different on other planets and the Moon to that on the Earth 1.32 explain that gravitational force • causes the planets to orbit the Sun • causes the Moon and artificial satellites to orbit the Earth • causes comets to orbit the Sun 1.33 use the relationship between orbital speed, orbital radius and time period $\text{orbital speed} = \dfrac{2\pi \times \text{orbital radius}}{\text{time period}}$ $v = \dfrac{2 \times \pi \times r}{T}$ 1.34 describe how the orbit of a comet differs from that of a planet 1.35 recall that the solar system is part of the Milky Way galaxy • describe a galaxy as a large collection of billions of stars • state that the universe is a large collection of billions of galaxies.
Electricity Energy and potential difference in circuits	*Students will be assessed on their ability to:* 2.14 know that lamps and LEDs can be used to indicate the presence of a current in a circuit.
Waves Light and sound	*Students will be assessed on their ability to:* 3.24 describe the advantages of using digital signals rather than analogue signals 3.25 describe how digital signals can carry more information 3.28 describe how to measure the speed of sound in air. **Note**: this gives the opportunity to use methods other than a simple direct method.

Comparison of the content from the Cambridge International Examinations (CIE) International GCSE in Physics (0625) to this qualification

Adapting from teaching the Cambridge International Examinations (CIE) course is simplified as much of the content of the CIE and Edexcel specifications is common to both courses. Resources that are suitable for the CIE International GCSE will, therefore, also cover most of the Edexcel International GCSE. The additional content of the Edexcel course (particularly the quantitative work) will be covered by textbooks available at this level. Schools currently teaching the CIE International GCSE should be able to continue with the same schemes of work as long as they are modified to reflect the changes in content.

The table below shows how the content of the Cambridge International Examinations (CIE) International GCSE in Physics qualification (0625) maps onto the Edexcel International GCSE in Physics.

Legacy CIE content (0625)	This qualification content reference	Comment	
		Content not in Edexcel	Additional content
Topic 1 **General Physics**		N/A	1.18–1.22 Momentum Newton's third law 1.30–1.35 Astronomy
Length and time	1.2–1.7	N/A	N/A
Speed, velocity and acceleration	1.2–1.7, 1.16–1.17	N/A	N/A
Mass and weight	1.15	N/A	N/A
Density	5.2–5.3	N/A	N/A
Effect of forces	1.8–1.14, 1.27–1.29	N/A	N/A
Conditions for equilibrium	1.23–1.26	N/A	N/A
Centre of mass	1.24	N/A	N/A
Scalars and vectors	1.10	N/A	N/A
Energy, work and power	4.2–4.15	N/A	N/A
Energy resources	4.16–4.17, 7.17–7.20	N/A	N/A
Pressure	5.4–5.6	N/A	N/A

Legacy CIE content (0625)	This qualification content reference	Comment	
		Content not in Edexcel	Additional content
Topic 2 **Thermal Physics**		N/A	5.13–5.14, 5.18 Absolute zero Kelvin temperature p/T = constant
States of matter	5.7–5.10	N/A	N/A
Molecular model	5.11–5.17	N/A	N/A
Evaporation	5.8	N/A	N/A
Pressure changes	5.19	N/A	N/A
Thermal properties	5.7–5.8	N/A	N/A
Thermal energy transfer	4.6–4.7	N/A	N/A
Topic 3 **Properties of waves**		N/A	N/A
General properties	3.2–3.9, 3.14	N/A	N/A
Reflection	3.15–3.16	N/A	N/A
Refraction	3.17–3.22	N/A	N/A
Lenses	N/A	Lenses	N/A
Dispersion	N/A	Dispersion	N/A
Electromagnetic spectrum	3.10–3.13	N/A	N/A
Sound	3.26–3.32	N/A	N/A
Topic 4 **Electricity and magnetism**		N/A	N/A
Simple magnetism	6.2–6.7	N/A	N/A
Electrical quantities	2.4–2.8, 2.15–2.17, 2.20–2.26	N/A	N/A
Electric circuits	2.9–2.19, 3.23–3.25	N/A	N/A
Dangers	2.2–2.3	N/A	N/A
Electromagnetic effects	6.8–6.20	N/A	N/A
C.R.O.	Uses: 3.29–3.30	N/A	N/A

Legacy CIE content (0625)	This qualification content reference	Comment	
		Content not in Edexcel	Additional content
Topic 5 **Atomic Physics**		N/A	N/A
Radioactivity	7.4–7.12, 7.14	N/A	N/A
The nuclear atom	7.2–7.3, 7.13, 7.15–7.16	N/A	N/A

Section B: Assessment

This section describes the nature of assessment for this qualification including the logistics of examinations and what can be expected from the Edexcel examination papers.

Assessment overview

The table below gives an overview of the assessment for this course.

We recommend that you make this information available to students to help ensure they are fully prepared and know exactly what to expect in each assessment.

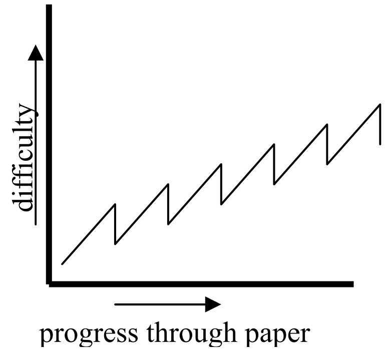
Paper 1	Percentage	Marks	Time	Availability
Physics Paper 1	$66\frac{2}{3}$	120	2 hours	January and June examination series First assessment June 2011
Paper 2	**Percentage**	**Marks**	**Time**	**Availability**
Physics Paper 2	$33\frac{1}{3}$	60	1 hour	January and June examination series First assessment June 2011

Assessment Objectives and weightings

		% in International GCSE
AO1:	Knowledge and understanding	45-55%
AO2:	Application of knowledge and understanding, analysis and evaluation	25-35%
AO3:	Investigative skills	20%
	TOTAL	**100%**

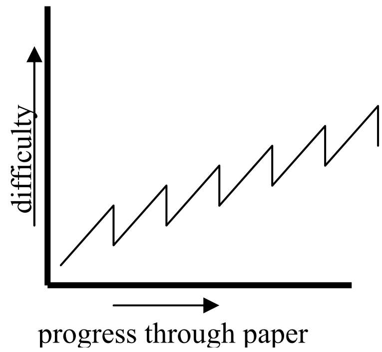
Assessment summary

Paper 1	Description	Knowledge and skills

Physics Paper 1	• The time allowed for the examination is 2 hours. There are 120 marks available.
	• The paper consists of one section. All questions are compulsory – there is no choice of questions. All questions will be structured.
	• As you progress through a question it will become more difficult. As you progress through the paper the questions will also generally increase in difficulty.
	
	This means that the end of one question will often be more difficult than the start of the next question. Do not stop working just because you get stuck on one question.
	• This paper covers the full range of grades from G to A*.
	• All parts of the specification content except those printed in **bold** are covered.
	• Although all questions will be of the structured type, you can expect to find some questions requiring longer answers towards the end of the paper.
	• You should take into the examination:
	  • a **black** pen
	  • a pencil (for graphs)
	  • a rule
	  • an eraser
	  • a calculator.
		The Assessment Objectives covered in this assessment are:
		AO1: 45-55%
		AO2: 25-35%
		AO3: 20%.
		For AO1 you will be required to recall and show understanding of facts, terminology, principles, concepts and practical techniques. You will need to draw on your knowledge to show an understanding of the applications and implications of science. You will need to make use of and present information logically and using appropriate vocabulary. No more than 50 per cent of the AO1 marks will be for direct recall.
		For AO2 you will be required to explain phenomena and interpret data based on your knowledge of science. This may involve unfamiliar contexts and you should be able to use your knowledge and apply it to work out the answer. You will be required to carry out calculations; in calculations it is important that you show clearly all the steps of your working.
		For AO3 you will not be expected to need factual recall of physics. You will need to show that you are familiar with laboratory apparatus and its use, including the reading of scales. You may be asked to plan experimental procedures; to record results in table and/or to plot them on a graph and draw straight lines or curves of best fit. You will need to be able to offer explanations for results and to be able to spot anomalous results and suggest explanations for them. You are expected to be able to evaluate data obtained from experiments and experimental methods and to suggest improvements.
		To obtain a high mark you will need to be able to recall the factual content of the specification and apply those facts to novel situations. You will also need to be familiar with laboratory work and the way in which science is conducted in a practical situation.

<table>
<tr><th>Paper 2</th><th>Description</th><th>Knowledge and skills</th></tr>
<tr><td>Physics paper 2</td><td>

The time allowed for the examination is 1 hour. There are 60 marks available.
The paper consists of one section. All questions are compulsory – there is no choice of questions. All questions will be structured.
As you progress through a question it will become more difficult. As you progress through the paper the questions will also generally increase in difficulty.



This means that the end of one question will often be more difficult than the start of the next question. Do not stop working just because you get stuck on one question.

This paper targets grades from E to A*.
All parts of the specification (those in bold and those <u>not</u> in bold) are covered.
Although all questions will be of the structured type, you can expect to find some questions requiring longer answers towards the end of the paper.
You should take into the examination:

a black pen
a pencil (for graphs)
a rule
an eraser
a calculator.

</td><td>
All three Assessment Objectives are covered. The breakdown of marks available is:
AO1: 45%-55% (27 to 33 marks)
AO2: 25%-35% (15 to 21 marks)
AO3: 20% (12 marks).
For AO1 you will be required to recall and show understanding of facts, terminology, principles, concepts and practical techniques. You will need to draw on your knowledge to show an understanding of the applications and implications of physics. You will need to make use of and present information logically and using appropriate vocabulary. No more than 50 per cent of the AO1 marks will be for direct recall.
For AO2 you will be required to explain phenomena and interpret data based on you knowledge of physics. This may involve unfamiliar contexts and you should be able to use your knowledge and apply it to work out the answer. You will be required to carry out calculations; in calculations it is important that you show clearly all the steps of your working.
For AO3 you will not be expected to need factual recall of physics. You will need to show that you are familiar with laboratory apparatus and its use, including the reading of scales. You may be asked to plan experimental procedures, to record results in table and/or to plot them on a graph and draw straight lines or curves of best fit. You will need to be able to offer explanations for results and to be able to spot anomalous results and suggest explanations for them. You are expected to be able to evaluate data obtained from experiments and experimental methods and to suggest improvements.
To obtain a high mark you will need to be able to recall the factual content of the specification and apply those facts to novel situations. You will also need to be familiar with laboratory work and the way in which science is conducted in a practical situation.
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Command words

Terms used within the papers include the following.

- **Calculate** – students may be asked to perform calculations.
- **Compare** – students should offer similarities and differences between the items being compared. This should not be answered by writing two paragraphs that deal separately with the two items.
- **Describe** – students should offer a response that includes the fundamental facts about the item or process for which the description is requested.
- **Design** – students may be asked to design an experiment.
- **Explain** – students should offer a response that utilises the underlying principles and concepts involved.
- **Name** – students should offer the name of the object or process in question. They should not describe or explain it.
- **Plot/draw/complete/measure** – students may be asked questions requiring them to plot data, draw diagrams, complete tables or measure drawn apparatus.
- **State/identify** – students should offer a concise response with no explanation unless this is also requested.
- **Suggest** – students will be expected to offer a logical response, not based on recall of knowledge, but on applying the principles and concepts gained during the course. This may be related to new situations or may relate to familiar situations in which there is no single correct response.

Using the mark scheme

The mark scheme gives the responses we expect from students. Indicative answers are given but during the standardisation of examiners process the mark scheme is updated and expanded to cover unexpected, correct student responses.

Section C: Planning and teaching

Course planner

This planning sheet is offered as a rough guide for a course that might cover 50 teaching weeks spread over five terms.

Term planner

Edexcel International GCSE Physics (4PH0): Planning Sheet		
Term	**Area of content**	**Content with specification references**
Year 1 Term 1 10 weeks	Movement and position	Distance, speed and acceleration (1.2–1.7)
	Forces, movement and shape	Forces, vectors, momentum, moments, Hooke's Law (1.8–1.29)
	Astronomy	Orbits, planets, comets, solar system, galaxies (1.30–1.35)
Year 1 Term 2 10 weeks	Mains electricity	Earthing, fuses, energy and power, energy transferred, d.c and a.c. (2.2–2.8)
	Energy and potential difference in circuits	Series and parallel circuits, LDRs, thermistors, LEDs, Ohm's Law, charge, conductors, voltage and the volt (2.9–2.19)
	Electric charge	Insulators, conductors, attraction and repulsion between charges, electrons (2.20–2.26)
	Properties of waves	Transverse, longitudinal, amplitude, frequency, wavelength, wave speed, sound, electromagnetic waves (3.2–3.7)
Year 1 Term 3 10 weeks	Properties of waves	Diffraction (3.8, 3.9)
	The electromagnetic spectrum	Uses and detrimental effects (3.10–3.13)
	Light and sound	Reflection, refraction, diffraction, total internal reflection, critical angle, refractive index, speed of sound, oscilloscope (3.13–3.32)
	Energy transfer	Efficiency, conduction, convection, radiation (4.2–4.8)

Term	Area of content	Content with specification references
Year 2 Term 1 10 weeks	Work	Force, distance, potential and kinetic energy (4.9–4.12)
	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)
Year 2 Term 2 10 weeks	Electromagnetism	Electromagnets, field patterns for wires, coils and solenoids, left-hand rule (6.8–6.14)
	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 so that students are 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, 1.7	Acceleration, velocity, time	Ticker tape timer
3	1.8, 1.9, 1.10, 1.11, 1.12	Types of force, vectors	Spring balance
4	1.13, 1.14	Friction, $F = m \times a$	Ticker tape timer, trolley, runway
5	1.15, 1.16, 1.17	Weight, stopping distance, terminal velocity	Ball bearing, measuring cylinder with oil
6	1.18, 1.19, 1.20	Momentum, safety	Linear air track
7	1.21, 1.22	Force and momentum, Third Law	
8	1.23, 1.24, 1.25, 1.26	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
9	1.27, 1.28, 1.29	F-e graphs for springs, wires and rubber bands, Hooke's Law, elastic behaviour	Spring, rubber band, metre rule, masses
10	1.30, 1.31, 1.32, 1.33, 1.34, 1.35	Astronomy	
11	2.2, 2.3	Hazards of electricity, insulation, earthing, fuses, circuit breakers	Plugs, fuses
12	2.4, 2.5, 2.6	Electrical heating, $P = I \times V$ applied to fuses	Range of appliances with wattage stamped on them
13	2.7, 2.8	Electrical energy, a.c. and d.c.	Oscilloscope, dry cell, low voltage power supply

Week	Specification reference	Content	Resources
14	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
15	2.13, 2.14, 2.15	LDRs, thermistors, LEDs, Ohm's Law	LDR, thermistor, LED, ammeter, voltmeter, dry cell, low voltage power supply, rheostat
16	2.16, 2.17, 2.18, 2.19	Current as flow of charge, $Q = I \times t$, electrons, definition of the volt	Polythene and cellulose acetate rods
17	2.20, 2.21, 2.22, 2.23	Conductors and insulators, charging by friction, attraction and repulsion between charges	Polythene and cellulose acetate rod, gold leaf electroscope, Van de Graaf generator
18	2.24, 2.25, 2.26	Movement of electrons, uses and dangers of electrostatic charges	
19	3.2, 3.3, 3.4	Longitudinal and transverse waves Amplitude, frequency, wavelength, period, energy transfer of waves	Ripple tank, slinky spring, rope
20	3.5, 3.6, 3.7	Speed, frequency and wavelength; frequency and periodic time	Ripple tank
21	3.8, 3.9	Dependence of wavelength and gap size on diffraction of waves. Edge effect	Ripple tank
22	3.10, 3.11, 3.12, 3.13	Properties, uses and dangers of different parts of the electromagnetic spectrum	Microwave generator and detector
23	3.14, 3.15	Reflection of light Ray diagrams for images formed in plane mirrors	Plane mirror, raybox, protractor
24	3.17, 3.18, 3.19,	Refraction of light, refractive index	Raybox, glass block, protractor
25	3.20, 3.21, 3.22	Total internal reflection, critical angle	Semicircular glass block, raybox

Week	Specification reference	Content	Resources
26	3.23, 3.24, 3.25, 3.26, 3.27	Analogue and digital signals, reflection, refraction and diffraction of sound waves, human frequency range	Signal generator, loudspeaker
27	3.28	Measurement of the speed of sound	Stopwatch; resonant tube; tuning forks
28	3.29, 3.30, 3.31, 3.32	Determination of the frequency of a sound wave, dependence of pitch on frequency and loudness on amplitude using an oscilloscope	Signal generator, loudspeaker, oscilloscope
29	4.2, 4.3, 4.4, 4.5	Energy transfer and efficiency	Electric motor, generator, pulley, weight
30	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
31	4.9, 4.10, 4.11, 4.12, 4.13	Work done, force and distance, kinetic energy, gravitational potential energy	Ticker tape timer, runway, pulley, thread, weight
32	4.14, 4.15	Power, work done and time	Measure personal power using stopwatch, metre rule, bathroom scales and flight of stairs
33	6.16, 4.16, 4.17	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

Week	Specification reference	Content	Resources
34	5.2, 5.3	Density, mass and volume	Regularly and irregularly-shaped solids, measuring cylinder, balance, rule
35	5.4, 5.5, 5.6	Pressure, force and area. Solid and liquid pressure	Regular solid, rule, balance, U-tube manometer
36	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
37	5.11, 5.12, 5.13, 5.14	Brownian motion, molecular pressure, absolute zero, Kelvin scale	Microscope, glass cell, lamp, glass rod
38	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
39	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
40	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
41	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
42	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
43	6.17, 6.18, 6.19, 6.20	Transformers. Step-up and step-down, turns ratio, efficiency	C-cores, wire, a.c. supply, lamp

Week	Specification reference	Content	Resources
44	7.2, 7.3	Protons, neutron, electrons, isotopes	
45	7.8, 7.9	Detection of ionising radiation, background radiation	Radioactive sources, Geiger-Muller tube
46	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
47	7.10, 7.11, 7.12	Half life	Simulation using dice
48	7.13, 7.14	Uses and dangers of ionising radiations	
49	7.15, 7.16	Alpha particle scattering	
50	7.17, 7.18, 7.19, 7.20	Nuclear fission Nuclear reactors	

Teaching ideas — experimental and investigative work

Experimental work is an integral part of the study of physics so it is appropriate that assessment of experimental and investigative skills should form approximately 20 per cent of the final assessment.

It is strongly recommended that 20 per cent of the teaching time should be devoted to practical work carried out by the students themselves. However, there may be circumstances where it is possible for the work to be carried out only in small groups or even by demonstration alone. Between 24 and 30 of the 120 marks in Paper 1 will be set as questions with a practical bias, along with approximately 12 of the 60 marks in Paper 2.

Many of the topics in the specification should be taught in a way that allows the facts to arise from practical work, rather than the practical work being used to demonstrate what students have already been taught.

Students are expected to acquire skills that allow them to be assessed on their ability to:

- plan experimental procedures
- describe practical techniques and take measurements
- analyse evidence and draw conclusions, communicating findings using calculations, tables and graphs
- evaluate evidence.

The sample assessment materials, which include mark schemes illustrate the range of skills that will be tested. Question 3(c) on Paper 2 asks students to describe an investigation with which they would not be familiar, although it is introduced in the question.

Training students in practical skills

Students should be offered as many opportunities as possible to plan and carry out experimental tasks and whole investigations themselves, and to practise the skills needed to achieve their highest potential in this work.

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 on which scientific method is based.

The course plan should allow for the gradual development of experimental skills over the two years (advisory minimum time). As 20 per cent of the final marks are derived from these skills, it would be advisable to devote this proportion of teaching time to them.

Students would benefit from being 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 that depend on secondary evidence. (The term ‘evidence’ is used to mean observations, measurements or other data.)

Before attempting investigations, students should be given shorter 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.

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 ticker tape timer and tape
- Measurement of acceleration using a ticker tape timer and tape
- Investigation of the momentum of bodies before and after collisions
- Measuring various forces, for example 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
- Measurement of the speed of sound using a resonance tube and tuning forks
- Measurement of the speed of sound using a microphone, signal generator and oscilloscope
- 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 and 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 along with 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.

Resources

Please note that while resources are correct at the time of publication, they may be updated or withdrawn from circulation. Website addresses may change at any time.

Textbooks

The following textbooks are recommended for this course

Blunt J and Chapple D — *IGCSE Physics Resource Pack* (NEC, 2005) ISBN 1843083094

Duncan T — *IGCSE Physics* (Hodder, 2002) ISBN 9780719578496

Website

Practical experiments (Institute of Physics (IOP)) — www.practicalphysics.org

Appendices

Appendix 1 — Physics formulae for relationships

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

(i) The relationship between average speed, distance and time:

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

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

force = mass × 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:

work done = force × distance moved in direction of force

(v) The energy relationships:

energy transferred = work done

kinetic energy = ½ × mass × speed^2

gravitational potential energy = mass × g × height

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

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

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

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

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

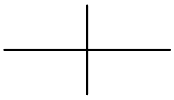
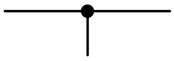
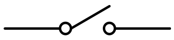
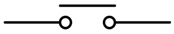
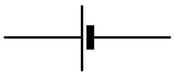
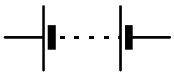
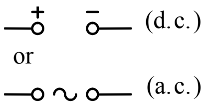
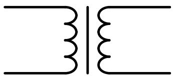
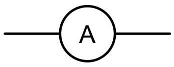
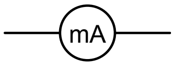
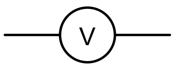
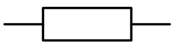
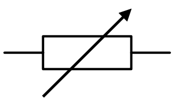
$$\sin c = \frac{\mathbf{1}}{\boldsymbol{n}}$$

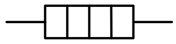
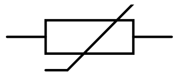
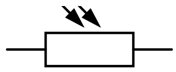
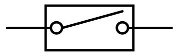
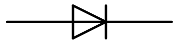
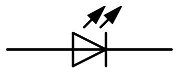
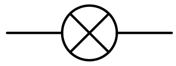
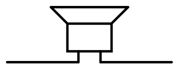
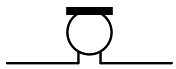
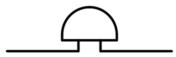
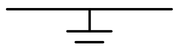
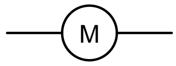
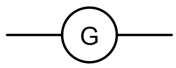
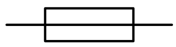
(xiv) The relationship for pressure difference:

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	

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