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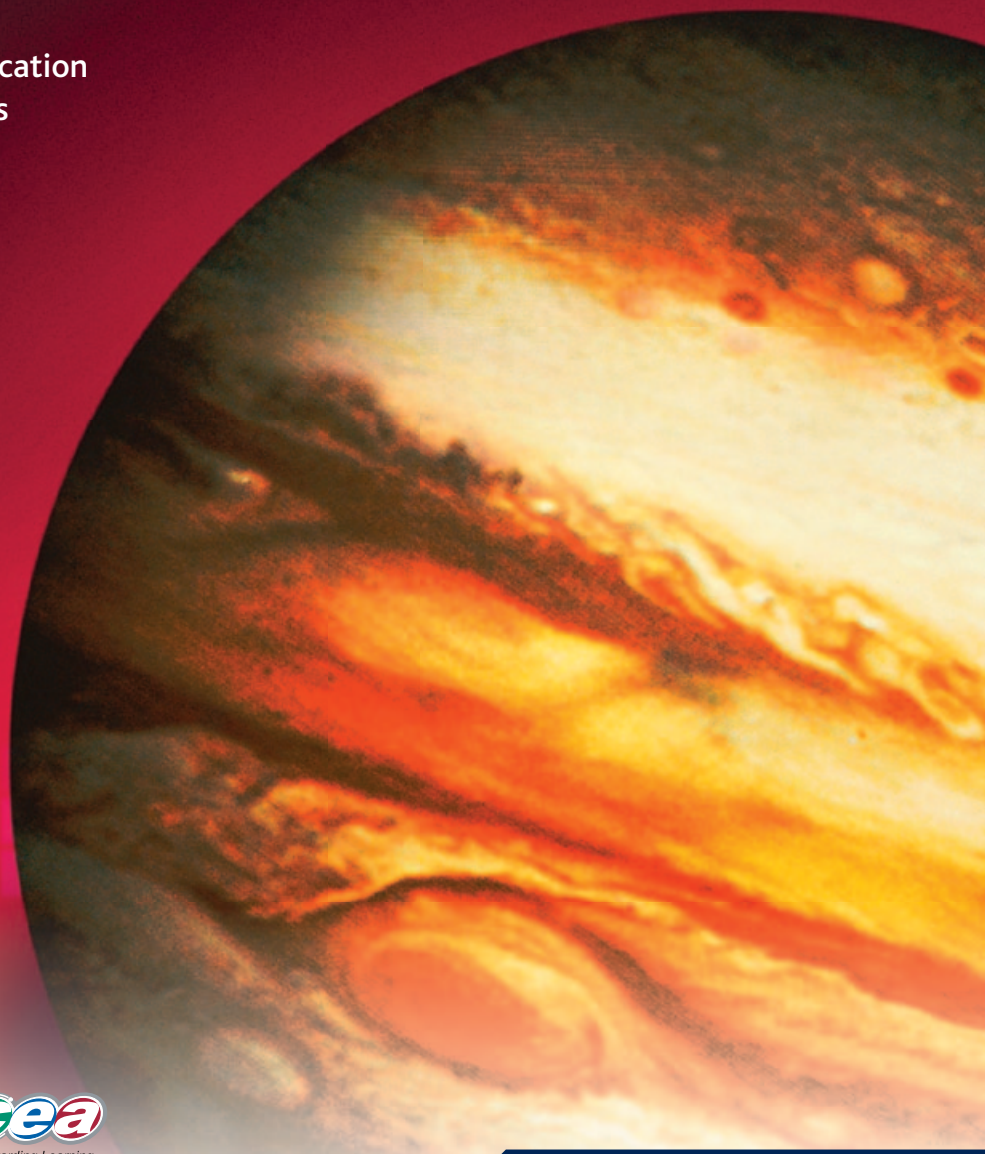
EDEXCEL GCSE SCIENCES 2011

Edexcel GCSE in Physics - 2PH01

Accredited specification booklet

This booklet provides:

- an introduction to the specification
- annotated specification pages
- the accredited specification



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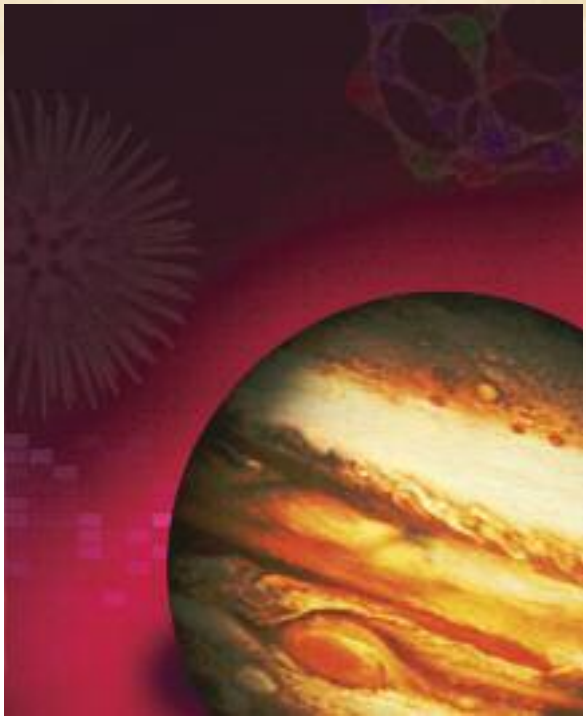


Welcome

We are delighted to introduce you to our new GCSE in Physics for 2011. At the front of this publication, we have supplied a handy guide containing annotated pages from the accredited specification that provide you with explanations and insights into its content and structure.

This introduction is then followed by the accredited specification. We've listened to science teachers and the wider science community, ensuring the development of a new suite of GCSE science qualifications that:

- puts good science at the heart of teaching, learning and assessment
- is presented in clear and detailed specifications
- has examination papers designed and trialled to be accessible to all, with appropriate stretch for your able students
- provides clear and manageable controlled assessments
- has an achievable approach to practical work.

Accompanying this specification are our accredited sample assessment and sample controlled assessment materials, plus a selection of valuable support materials that make up our Enhanced Specifications Pack. Together, these items have been created to provide you with the information you need to prepare, teach and assess our exciting new qualification.

Our team of experts are on hand to discuss any questions you may have about the information contained in this pack. You can contact our Science Subject Advisor team, led by Stephen Nugus by calling **0844 372 2188**, or emailing **ScienceSubjectAdvisor@edexcelexperts.co.uk**

Supporting science, supporting you

The following section contains annotated pages from our accredited GCSE in Physics specification to help you see quickly and easily how we've developed our qualifications to give you clear and detailed support.

Unit P1: Universal physics

Overview

Content and How Science Works overview

In Unit P1 students study six topics that give them the opportunity to explore physics in terms of waves and the Universe, helping them to develop an understanding of waves and how scientific ideas develop. Seismic waves and plate tectonics are also investigated. The electromagnetic spectrum, electricity and conservation of energy are then explored, to give students a solid grounding in important principles in physics.

Work on the Solar System and the Universe shows students how data collected over time can have different interpretations and how ideas and theories change as more data is collected. The importance of collecting data to develop new theories is illustrated by the data astronomers used to work out that red-shift varies with distance from the Earth.

Work on the heliocentric model provides opportunities to use models to explain ideas, and work on waves provides opportunities to use models to explain processes, for example in modelling the unpredictability of earthquakes.

Practical work throughout the unit will give students opportunities to work quantitatively, to assess and manage risks and to plan practical ways to answer scientific questions and test hypotheses. Students will critically evaluate evidence, suggest reasons for inconsistencies in the data collected and ways to improve precision or reproducibility of results.

Students will be shown how to represent ideas about light and sound using scientific diagram conventions and to use symbols to represent quantities in the wave equation and in relationships between current, voltage and power. They will make quantitative comparisons, for example between the power consumption and efficiency of different appliances.

Students will have the opportunity to consider how decisions about the energy sources used to generate electricity are informed by scientific evidence, such as efficiency and environmental impact, but that society must consider safety and environmental issues.

Throughout the unit students will learn about the importance of the application of physics to issues of global importance, such as how seismologists locate an earthquake. However, there are some questions that physics cannot yet answer, such as predicting when an earthquake will occur, or whether life exists on other planets.

Topic 1 explores ideas about the Solar System and how visible light and lenses have been used in discovery. This leads on to the properties of waves, including electromagnetic, sound and seismic waves, and wave equations.

The Examiner explains

This gives a basic overview of the unit. A more detailed overview can be found in the teacher support materials provided.

Examiner's teaching tip

You can organise the way in which you divide up your topics. We will provide schemes of work which suggest the number of hours to be spent on each topic. However, the decision on how many hours to allocate is left to the discretion of the individual teacher.

The Examiner explains

A more detailed assessment overview can be found within the *Assessment guide* provided.

Topic 2 covers the electromagnetic spectrum more widely, including properties, effects, dangers and uses.

Topic 3 builds on earlier topics by exploring how observations using different types of telescope led to the development of our knowledge and understanding of the Universe.

Topic 4 covers the uses of infrasound and ultrasound, and then moves to a study of seismic waves, touching on plate tectonics, including a practical activity to demonstrate the unpredictable nature of earthquakes.

Topic 5 explores how to generate an electric current and from this students will develop an understanding of factors affecting the size of induced current in a generator. Students will learn how transformers can be used to transmit electrical energy over large distances, as well as the hazards of electricity and cost-efficiency. Students will relate knowledge to wider issues in society through discussion of renewable and non-renewable sources of generation.

In Topic 6, students will study energy transfers in common situations and appliances and investigate the absorption and radiation of energy from surfaces. This will lead to the idea of energy conservation and the efficiency of energy transfer devices.

Assessment overview

This unit is externally assessed, through a one hour, 60 mark, tiered written examination, containing six questions.

The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.

Practical investigations in this unit

Within this unit, students will develop understanding of the process of scientific investigations, including that investigations:

- use hypotheses which are tested
- require assessment and management of risks
- require the collection, presentation, analysis and interpretation of primary and secondary evidence, including the use of appropriate technology
- should include a review of methodology to assess fitness for purpose
- should include a review of hypotheses in the light of outcomes.

Examiner's teaching tip

As well as the practicals that are embedded in the specification, here is an extended list of practical activities which you may wish to carry out with your students if there is time.

The following specification points are practical investigations that exemplify the scientific process and may appear in the written examination for this unit:

1.6 *Investigate the behaviour of converging lenses, including real and virtual images*

1.7 *Investigate the use of converging lenses to:*
- a *measure the focal length using a distant object*
- b *investigate factors which affect the magnification of a converging lens (formulae are not needed).*

3.8 *Construct a simple spectrometer, from a CD or DVD, and use it to analyse common light sources*

4.7 *Investigate the unpredictability of earthquakes, through sliding blocks and weights*

5.4 *Investigate the power consumption of low-voltage electrical items*

5.7 *Investigate factors affecting the generation of electric current by induction*

6.7 *Investigate how the nature of a surface affects the amount of energy radiated or absorbed*

The following are further suggestions for practical work within this unit:

- *Construct devices using two converging lenses of differing focal lengths*
- *Investigate models to show refraction, such as toy cars travelling into a region of sand*
- *Investigate the areas beyond the visible spectrum, such as the work of Herschel and Ritter in discovering IR and UV respectively*
- *Investigate the change in pitch of the sound from a moving object using a buzzer on a piece of string whirled around in a circle*

The controlled assessment task (CAT) for the GCSE in Physics will be taken from any of these practical investigations (specification points and further suggested practical work). This task will change every year, so future CATs will be chosen from this list.

Foundation and Higher

Higher tier content is highlighted in bold. Please note the different ways in which Foundation and Higher tier candidates will be expected to use equations.

[illegible] refers to higher tier only content. Italic text refers to practical investigations, which students are required to demonstrate an understanding of.

Throughout the unit

0.1 Use equations given in this unit, or in a given alternate form

0.2 **Use and rearrange equations given in this unit**

0.3 Demonstrate an understanding of which units are required in equations

Topic 1

Visible light and the Solar System

1.1 Describe how ideas about the structure of the Solar System have changed over time, including the change from the geocentric to the heliocentric models and the discovery of new planets

1.2 Demonstrate an understanding of how scientists use waves to find out information about our Universe, including:
- a the Solar System
- b the Milky Way

1.3 Discuss how Galileo's observations of Jupiter, using the telescope, provided evidence for the heliocentric model of the Solar System

1.4 Compare methods of observing the Universe using visible light, including the naked eye, photography and telescopes

1.5 Explain how to measure the focal length of a converging lens using a distant object

1.6 *Investigate the behaviour of converging lenses, including real and virtual images*

1.7 *Investigate the use of converging lenses to:*
- a *measure the focal length using a distant object*
- b *investigate factors which affect the magnification of a converging lens (formulae are not needed)*

1.8 Explain how the eyepiece of a simple telescope magnifies the image of a distant object produced by the objective lens (ray diagrams are not necessary)

1.9 Describe how a reflecting telescope works

1.10 Recall that waves are reflected and refracted at boundaries between different materials

1.11 **Explain how waves will be refracted at a boundary in terms of the change of speed and direction**

1.12 Describe that waves transfer energy and information without transferring matter

1.13 Use the terms of frequency, wavelength, amplitude and speed to describe waves

1.14 Differentiate between longitudinal and transverse waves by referring to sound, electromagnetic and seismic waves

1.15 Use both the equations below for all waves:

wave speed (metre/second, m/s) = frequency (hertz, Hz) × wavelength (metre, m)

$v = f \times \lambda$

wave speed (metre/second, m/s) = distance (metre, m) / time (second, s)

$v = \frac{x}{t}$

Topic 2

The electromagnetic spectrum

2.1 Demonstrate an understanding of how Herschel and Ritter contributed to the discovery of waves outside the limits of the visible spectrum

2.2 Demonstrate an understanding that all electromagnetic waves are transverse and that they travel at the same speed in a vacuum

2.3 Describe the continuous electromagnetic spectrum including (in order) radio waves, microwaves, infrared, visible (including the colours of the visible spectrum), ultraviolet, X-rays and gamma rays

2.4 Demonstrate an understanding that the electromagnetic spectrum is continuous from radio waves to gamma rays, but the radiations within it can be grouped in order of decreasing wavelength and increasing frequency

2.5 Demonstrate an understanding that the potential danger associated with an electromagnetic wave increases with increasing frequency

2.6 Relate the harmful effects, to life, of excessive exposure to the frequency of the electromagnetic radiation, including:

a microwaves: internal heating of body cells

b infrared: skin burns

c ultraviolet: damage to surface cells and eyes, leading to skin cancer and eye conditions

d X-rays and gamma rays: mutation or damage to cells in the body

Examiner's teaching tip

Please note that questions may require candidates to give correct units.

2.7 Describe some uses of electromagnetic radiation:

a radio waves: including broadcasting, communications and satellite transmissions

b microwaves: including cooking, communications and satellite transmissions

c infrared: including cooking, thermal imaging, short range communications, optical fibres, television remote controls and security systems

d visible light: including vision, photography and illumination

e ultraviolet: including security marking, fluorescent lamps, detecting forged bank notes and disinfecting water

f X-rays: including observing the internal structure of objects, airport security scanners and medical X-rays

g gamma rays: including sterilising food and medical equipment, and the detection of cancer and its treatment

2.8 Recall that ionising radiations are emitted all the time by radioactive sources

2.9 Describe that ionising radiation includes alpha and beta particles and gamma rays and that they transfer energy

Topic 3

Waves and the Universe

3.1 Recall that the Solar System is part of the Milky Way galaxy

3.2 Describe a galaxy as a collection of stars

3.3 Recall that the Universe includes all of the galaxies

3.4 Compare the relative sizes of and the distances between the Earth, the Moon, the planets, the Sun, galaxies and the Universe

3.5 Describe the use of other regions of the electromagnetic spectrum by some modern telescopes

3.6 Describe the methods used to gather evidence for life beyond Earth, including space probes, soil experiments by landers, Search for Extraterrestrial Intelligence (SETI)

3.7 Demonstrate an understanding of the impact of data gathered by modern telescopes on our understanding of the Universe, including:

a the observation of galaxies because of improved magnification

b the discovery of objects not detectable using visible light

c the ability to collect more data

3.8 *Construct a simple spectrometer, from a CD or DVD, and use it to analyse common light sources*

3.9 Explain why some telescopes are located outside the Earth's atmosphere

The Examiner explains

We've designed the specification so that the level of detail needed to teach is apparent.

3.10 **Analyse data provided to support the location of telescopes outside the Earth's atmosphere**

3.11 Describe the evolution of stars of similar mass to the Sun through the following stages:
- a nebula
- b star (main sequence)
- c red giant
- d white dwarf

3.12 Describe the role of gravity in the life cycle of stars

3.13 **Describe how the evolution of stars with a mass larger than the Sun is different, and may end in a black hole or neutron star**

3.14 Demonstrate an understanding of the Steady State and Big Bang theories

3.15 Describe evidence supporting the Big Bang theory, limited to red-shift and the cosmic microwave background (CMB) radiation

3.16 Recognise that as there is more evidence supporting the Big Bang theory than the Steady State theory, it is the currently accepted model for the origin of the Universe

3.17 Describe that if a wave source is moving relative to an observer there will be a change in the observed frequency and wavelength

3.18 **Demonstrate an understanding that if a wave source is moving relative to an observer there will be a change in the observed frequency and wavelength**

3.19 **Describe the red-shift in light received from galaxies at different distances away from the Earth**

3.20 **Explain why the red-shift of galaxies provides evidence for the Universe expanding**

3.21 **Explain how both the Big Bang and Steady State theories of the origin of the Universe both account for red-shift of galaxies**

3.22 **Explain how the discovery of the CMB radiation led to the Big Bang theory becoming the currently accepted model**

Topic 4

Waves and the Earth

4.1 Recall that sound with frequencies greater than 20 000 hertz, Hz, is known as ultrasound

4.2 Describe uses of ultrasound, including:
- a sonar
- b communication between animals
- c foetal scanning

4.3 Calculate depth or distance from tim

4.4 Recall that sound with frequencies less than 20 hertz, Hz, is known as infrasound

4.5 Describe uses of infrasound, including:
- a communication between animals
- b detection of animal movement in remote locations
- c detection of volcanic eruptions and meteors

4.6 Recall that seismic waves are generated by earthquakes or explosions

4.7 *Investigate the unpredictability of earthquakes, through sliding blocks and weights*

4.8 Explain why scientists find it difficult to predict earthquakes and tsunami waves even with available data

4.9 Recall that seismic waves can be longitudinal (P) waves and transverse (S) waves and that they can be reflected and refracted at boundaries between the crust, mantle and core

4.10 Explain how data from seismometers can be used to identify the location of an earthquake

4.11 **Demonstrate an understanding of how P and S waves travel inside the Earth including reflection and refraction**

4.12 Explain how the Earth's outermost layer is composed of (tectonic) plates and is in relative motion due to convection currents in the mantle

4.13 Demonstrate an understanding of how, at plate boundaries, plates may slide past each other, sometimes causing earthquakes

Topic 5

Generation and transmission of electricity

5.1 Describe current as the rate of flow of charge and voltage as an electrical pressure giving a measure of the energy transferred

5.2 Define power as the energy transferred per second and measured in watts

5.3 Use the equation:

electrical power (watt, W) = current (ampere, A) × potential difference (volt, V)

$P = I \times V$

5.4 *Investigate the power consumption of low-voltage electrical items*

5.5 Discuss the advantages and disadvantages of methods of large-scale electricity production using a variety of renewable and non-renewable resources

5.6 Demonstrate an understanding of the factors that affect the size and direction of the induced current

Foundation and Higher

All students should have an understanding of P and S waves, but only Higher tier candidates should understand how they travel inside the Earth.

5.7 *Investigate factors affecting the generation of electric current by induction*

5.8 Explain how to produce an electric current by the relative movement of a magnet and a coil of wire

a on a small scale

b in the large-scale generation of electrical energy

5.9 Recall that generators supply current which alternates in direction

5.10 Explain the difference between direct and alternating current

5.11 Recall that a transformer can change the size of an alternating voltage

5.12 **Use the turns ratio equation for transformers to predict either the missing voltage or the missing number of turns**

5.13 Explain why electrical energy is transmitted at high voltages, as it improves the efficiency by reducing heat loss in transmission lines

5.14 Explain where and why step-up and step-down transformers are used in the transmission of electricity in the National Grid

5.15 Describe the hazards associated with electricity transmission

5.16 Recall that energy from the mains supply is measured in kilowatt-hours

5.17 Use the equation:

cost (p) = power (kilowatts, kW) × time (hour, h) × cost of 1 kilowatt-hour (p/kW h)

5.18 Demonstrate an understanding of the advantages of the use of low-energy appliances

5.19 Use data to compare and contrast the advantages and disadvantages of energy-saving devices

5.20 Use data to consider cost-efficiency by calculating payback times

5.21 Use the equation:

power (watt, W) = energy used (joule, J) / time taken (second, s)

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

Topic 6

Energy and the future

6.1 Demonstrate an understanding that energy is conserved

6.2 Describe energy transfer chains involving the following forms of energy: thermal (heat), light, electrical, sound, kinetic (movement), chemical, nuclear and potential (elastic and gravitational)

6.3 Demonstrate an understanding of how diagrams can be used to represent energy transfers

6.4 Apply the idea that efficiency is the transferred to useful forms to every

Examiner's teaching tip

There are plenty of opportunities to go further into *How Science Works*, should time allow.

6.5 Use the efficiency equation:

$$efficiency = \frac{(useful\ energy\ transferred\ by\ the\ device)}{(total\ energy\ supplied\ to\ the\ device)} \times 100\%$$

6.6 Demonstrate an understanding that for a system to be at a constant temperature it needs to radiate the same average power that it absorbs

6.7 *Investigate how the nature of a surface affects the amount of thermal energy radiated or absorbed*

Examiner's teaching tip

Where students are required to use an equation, the equation will be provided in the formulae sheet in the exam.

Make the most of your Edexcel Enhanced Specifications Pack

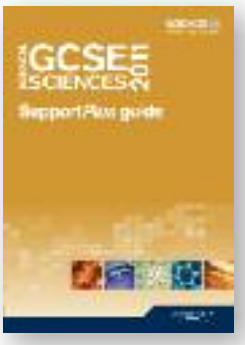
In addition to our five specifications, your Enhanced Specifications Pack includes our accredited sample assessment and sample controlled assessment materials. These too have been produced with annotated introductions to help you see how we've made our assessment clear to understand. We have also developed the following support materials, which provide valuable tools for your preparation, teaching and assessment of our exciting new specifications.

Getting started guide

An at-a-glance introduction to our specifications. This guide shows you how easy it is to move to Edexcel, detailing the support available to help you do so. It also offers guidance on teaching each unit, providing suggestions for managing assessment and support with preparing students for extended writing and mathematics.

Assessment guide

Developed to give you detailed support with managing assessment, the Assessment guide covers ways of scheduling and administering controlled assessment, including suggestions for making entries and choosing tiers. It provides information on Results*Plus*, our free results analysis service that provides unrivalled support with performance analysis, and includes a selection of exemplar answers to exam questions, with comments on how these should be assessed using our mark schemes.



SupportPlus guide

Providing detailed support with planning and implementation of our specifications, our Support*Plus* guide includes exemplar course plans, schemes of work and worksheets, all of which are ready-to-use, or available in editable format on our website.

GCSE & BTEC Links guide

This guide details the support we provide to make it easy for your students to move between GCSE and BTEC, and choose the learning pathway to which they are best suited.

Now turn to your copy of our accredited GCSE in Physics specification

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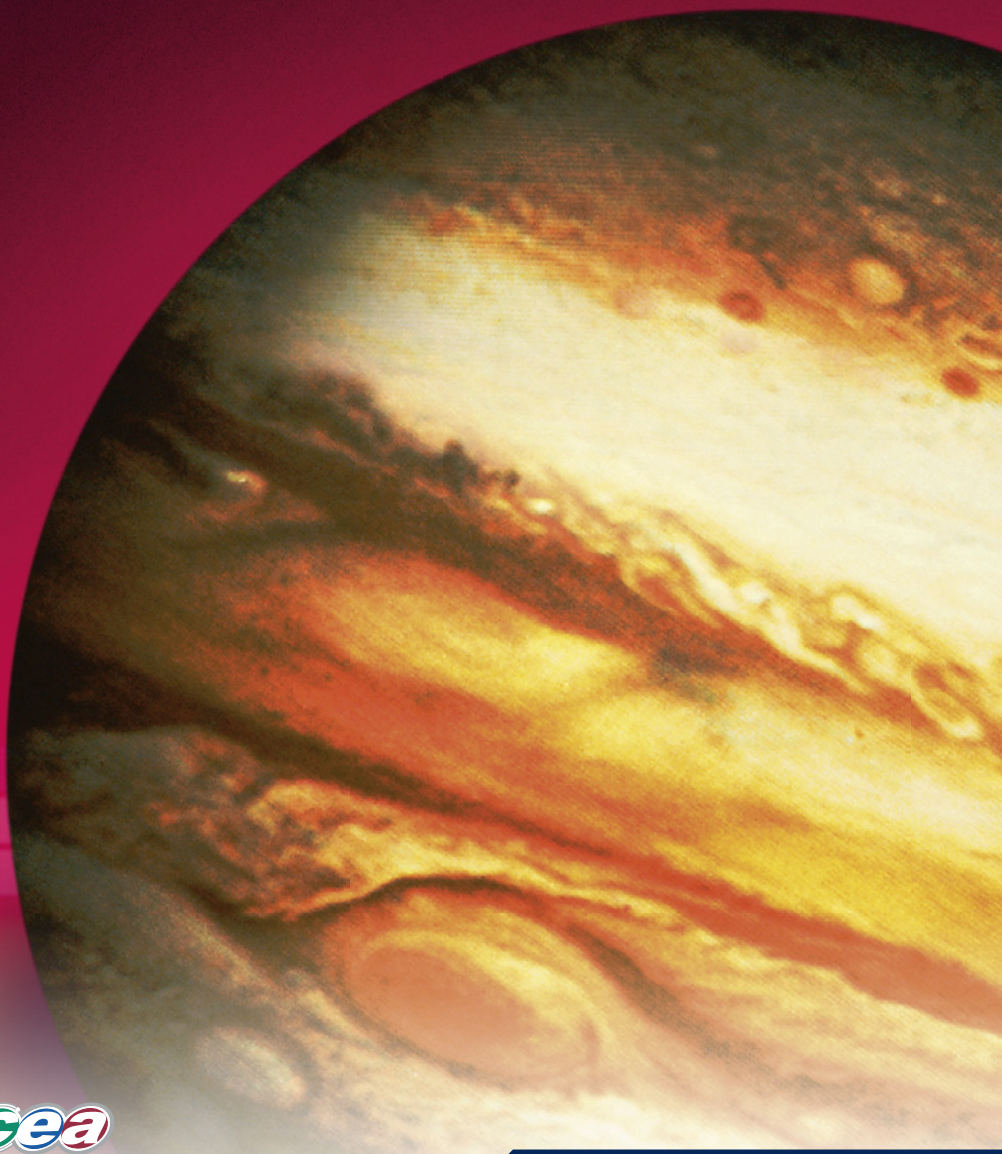
EDEXCEL GCSE SCIENCES 2011

Accredited specification

Edexcel GCSE in Physics 2PH01



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Specification

To help students fulfil their potential, we have developed a new suite of GCSE qualifications for Science that:

- puts good science at the heart of teaching, learning and assessment
- is presented in clear and detailed specifications
- has examination papers designed and trialled to be accessible with appropriate stretch
- has a clear and achievable approach to new requirements for controlled assessment and practical work
- is designed to allow you to choose the best learning pathway for each student
- supports you with help available online, on the phone and locally.

You will see that this specification is extremely detailed. This is to:

- ensure that you have a clear idea about what might be assessed in an examination
- make it easy for you to plan your teaching
- make sure you don't have to cover material twice in successive units because the progression of ideas is clear.

www.edexcel.com/science2011

Our website will be regularly updated with a vast range of materials to support you with the delivery of our qualifications, including:

- our accredited specifications, sample assessment materials and sample controlled assessment materials
- free planning and teaching resources
- access to our Subject Advisor Service
- information on our published resources
- access to ResultsPlus, our FREE online results analysis and mocks analysis service
- information on events taking place in your area.

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GCSE in Physics

Specification

Edexcel GCSE in Physics (2PH01)

First teaching September 2011

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Introduction

The Edexcel GCSE in Physics is designed for use in schools and colleges. It is part of a suite of GCSE qualifications offered by Edexcel.

About this specification

Why choose Edexcel?

Every student can fulfil their potential

We are here to help you ensure that every student can fulfil their potential. At Key Stage 4 this is done by ensuring that they have the qualification they need to find work or progress to further learning.

To help students fulfil their potential, we have developed a new suite of GCSEs for Science that puts good science at the heart of teaching, learning and assessment, and:

- is based on an extremely clear and detailed specification
- has exam papers designed and trialled to be accessible and with appropriate stretch
- has a clear and achievable approach to new requirements for controlled assessment and practical work
- is designed to allow you to choose the best learning pathway for each student
- supports you with help available online, on the phone and locally.

An extremely clear and detailed specification

You will see that the specification is extremely detailed. This is to:

- ensure that you have a clear idea about what might be assessed in an exam
- make it easy for you to plan
- make sure you don't have to cover material twice in successive units because the progression of ideas is clear.

Exam papers designed and trialled to be accessible and with appropriate stretch

The new GCSEs for 2011 bring with them new regulatory requirements to test students using a variety of question types. The types we have included are:

- objective questions
- short answer questions
- longer answer questions, testing quality of written communication.

This represents an opportunity to ensure the exam papers remain accessible to students with a wide range of abilities while also giving them an opportunity to excel.
In response to this opportunity, using research undertaken by our Assessment Design team and in consultation with teachers, we have developed exam papers that are:

- accessible – early questions will generate confidence in students
- clear – the language is carefully checked and simple rules are followed for consistency

- able to stretch the students aiming for higher grades – longer answer questions are carefully written to ensure more able students know what they need to do to access all the marks and to ensure students aiming for lower grades can gain some marks
- consistent – to ensure that students are familiar with the paper style. This includes producing Sample Assessment Materials using the same quality control processes as live papers.

An achievable approach to new requirements for controlled assessment and practical investigations

We have designed the controlled assessment and theory content to ensure that the controlled assessment:

- is easy to plan
- is straightforward to mark
- follows a structure that helps test students' actual investigative skills
- is based on students' own practical work and collection of secondary evidence – as required by Ofqual subject criteria.

To help with planning and to develop skills, we have embedded a small number of practical investigations in to the theory units. The benefits are twofold:

- development of knowledge and skills can happen simultaneously, thus maximising teaching time.
- a mix of theory and practical learning is more likely to lead to secure acquisition of knowledge and skills.

Knowledge of these practical investigations and the ability to interpret the data that can result from them can be assessed in the examination papers. The best way to ensure this is to undertake the practical investigations.

Controlled assessment – Planning, Observations and Conclusions (POC)

To allow students to experience what a full investigation is like, within the limitations of a real school environment, the controlled assessments have been split into three parts – Planning, Observations and Conclusions. Marks from each can be submitted from separate tasks or from the same task. Whole task responses, from which marks have been submitted, should be retained for moderation.

For each controlled assessment we will produce specific marking support to help you apply the generic assessment criteria. All controlled assessments are marked to these generic assessment criteria regardless of subject. This means that you can apply generic assessment criteria to award marks where a student gives an answer that you see is correct, but falls outside the specific guidance for that controlled assessment.

Designed to allow you to choose the best learning pathway for each student

Depending on the learning approach that suits them, and the progression route that they wish to follow, different learning pathways can suit different students.

There's a great deal of shared content between BTEC Applied Science and our new GCSE Science suite, as both are based on the Key Stage 4 Programme of Study. We've used this overlap to your advantage by creating highly flexible KS4 Science learning pathways. The volume of shared content means you can take your time to choose the progression route that best meets your students' needs and most fits their learning approach.

We'll provide you with high-quality guidance and comprehensive teaching schemes, enabling you to identify the best pathway for your students. You can use the schemes to set work

that provides evidence that meets BTEC criteria and also forms a valuable part of your GCSE teaching. This will help you to:

- see if a student works best with the BTEC approach or the GCSE approach
- delay the decision on moving students completely to BTEC or GCSE, or allow them the option of gaining both a GCSE and a BTEC qualification – depending on whether they become more interested in following a vocational or academic route
- have evidence gathered towards BTEC assignments for any students that move to a full BTEC course
- ensure you can cover GCSE teaching in the time available even if you are allowing students to try the BTEC approach early on in your Key Stage 4 teaching
- introduce some of the motivational aspects of the BTEC approach to all your students.

Supporting you with help available online, on the phone and locally

We recognise that the changing nature of teaching, with less time to travel to training, the need to continually review whether the expectations of students, parents and the community are being met, and a greater number of qualifications to offer means that you need more support available more quickly than ever before.

To help you we have committed to delivering expert support locally, online and at the end of the phone.

- We will be running free Launch, Getting Started and Getting Ready to Teach events.
- There will be online events at 4pm so you don't have to miss teaching.
- We will be working with your LA to provide you with the information and support you need. Look out for cluster groups and briefings in your area.
- If you have individual needs, you can call us to find out if an advisor can speak to you or visit you to discuss how to meet those needs.
- Our Science Subject Advisor team is on the end of the phone to help you with both subject-related and administrative queries.
- Our website is being radically updated. Visit www.Edexcel.com/Science/ to find:
    - free teaching resources
    - a Y9 starter programme to help you with transition
    - free information on teaching GCSEs in Science with BTEC
    - a free mocks resource
    - our ResultsPlus Mock Analysis Service – get an early feel for how your students are coping with the new exam styles
    - our Subject Advisor webpage and Ask the Expert services – proven to help you.

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Specification at a glance

Units

The suite of GCSEs in Science qualifications are a nested set of qualifications:

GCSE in Science →	B1 25%	C1 25%	P1 25%	Science controlled assessment (SCA) 25%
GCSE in Additional Science →	B2 25%	C2 25%	P2 25%	Additional Science controlled assessment (ASCA) 25%
	B3 25%	C3 25%	P3 25%	
	Biology controlled assessment (BCA) 25%	Chemistry controlled assessment (CCA) 25%	Physics controlled assessment (PCA) 25%	
	GCSE in Biology ↑	**GCSE in Chemistry** ↑	**GCSE in Physics** ↑	

Details of each unit are given on the following pages.

The Edexcel GCSE in Physics comprises four units:

- Units P1, P2, P3 and PCA

In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students should have completed.

All externally assessed units will be assessed by tiered examinations. Students will need to be entered for a specific tier at the time of entry.

Unit P1: Universal physics	***Unit code: 5PH1F/5PH1H**
• Externally assessed • Availability: November, March and June • First assessment: November 2011	**25% of the total GCSE**
Overview of content This unit is split into six compulsory topics: • Visible light and the Solar System • The electromagnetic spectrum • Waves and the Universe • Waves and the Earth • Generation and transmission of electricity • Energy and the future	
Overview of assessment • This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions. • The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.	

Unit P2: Physics for your future	***Unit code: 5PH2F/5PH2H**
• Externally assessed • Availability: November, March and June • First assessment: June 2012	**25% of the total GCSE**
Overview of content This unit is split into six compulsory topics: • Static and current electricity • Controlling and using electric current • Motion and forces • Momentum, energy, work and power • Nuclear fission and nuclear fusion • Advantages and disadvantages of using radioactive materials	
Overview of assessment • This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions. • The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.	

Unit P3: Applications of physics	***Unit code: 5PH3F/5PH3H**
• Externally assessed • Availability: November, March and June • First assessment: June 2013	**25% of the total GCSE**
Overview of content This unit is split into five compulsory topics: • Radiation in treatment and medicine • X-rays and ECGs • Production, uses and risks of ionising radiation from radioactive sources • Motion of particles • Kinetic theory and gases	
Overview of assessment • This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions. • The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.	

Unit PCA: Physics controlled assessment	***Unit code: 5PH04**
• Internally assessed • Available for moderation: November and June • First assessment: June 2013	**25% of the total GCSE**
Overview of content • For this unit students will complete one or more controlled assessment tasks related to Unit P2 or P3 content. • Each task consists of **three** parts. Part A is planning activity, Part B is an observation, collecting primary and secondary evidence. Part C consists of conclusions related to the primary and secondary evidence collected in Part B.	
Overview of assessment • This unit is internally assessed under controlled conditions. • There will be two tasks available each year – one task from P2 and one task from P3. • Each task has a shelf life of one year. • The tasks will be available to teachers one year in advance. • Each task has three parts – Part A: Planning, Part B: Observations and Part C: Conclusions. • The total number of marks available for the three parts is 50. • Students must attempt all three parts of a task. • If they attempt both tasks, then the best marks from Part A, B and C should be submitted for the unit.	

*See *Appendix 1* for a description of this code and all other codes relevant to this qualification.

External assessments (examination papers)

Our overriding priority with exam papers is to ensure that:

- every student can show what they know, understand and are able to do
- every teacher knows what they must teach.

To do this we have produced a very detailed specification so that you and your students understand exactly what students need to know, understand and be able to do. To help you use this detailed specification, we have split it into topics.

Secondly, we have carried out extensive work, using science experts in our Assessment Design team and working closely with our senior examiners, to develop an exam paper style that can be consistently delivered and will be familiar to students. It includes three types of question part:

1. objective questions – used only where this will provide credible evidence of knowledge and skills
2. structured short answers – for maths, How Science Works or theory
3. longer answers worth six marks – to help provide stretch and challenge.

Papers are designed to allow students likely to get lower grades to achieve, while ensuring that some questions provide the stretch required to differentiate between students. Even the six mark question parts are designed with this aim.

Every question is designed to have an accessible starting point and then become more challenging. In addition, the paper itself is slightly ramped in difficulty. This maximises the opportunity for students to demonstrate their knowledge, understanding and skills in the exam.

Controlled assessment tasks (internal assessments)

Practical investigations in the theory units – the simplest way to plan controlled assessment

The criteria for GCSEs in Science indicate that an investigative approach to internal assessment is required. The best way to develop investigative skills is to embed practical work in your teaching of theory. The benefits are twofold:

- development of knowledge, understanding and skills can happen together, thus saving time that can then be used by you in other aspects of your teaching
- a mix of theory and practical learning is more likely to lead to secure acquisition of knowledge and skills.

We have extended the benefit of this approach, if you choose to use it, by defining a small number of practicals in the theory units of the specification. Knowledge of these practical investigations, and the ability to interpret the data that can result, is required for exams.

Planning, Observations and Conclusions (POCs)

To allow students to experience what a full investigation is like, within the limitations of a real school environment, the controlled assessment task has been split into three parts, Part A – Planning, Part B – Observations and Part C – Conclusions. Students are required to attempt all three parts of the task. However, students can do two tasks. The best part marks from across both tasks can be submitted for the unit.

There is a set of assessment criteria within this specification. This assessment criteria is generic across the controlled assessment tasks for the GCSEs in Additional Science, Biology, Chemistry and Physics. Edexcel will give additional guidance on the application of the generic assessment criteria in support documentation.

A Qualification content

Key subject aims

GCSE in Physics

This GCSE in Physics encourages students to be inspired, motivated and challenged by following a broad, coherent, practical, satisfying and worthwhile course of study. It encourages students to develop their curiosity about the physical world, and provides insight into and experience of how science works. It enables students to engage with physics in their everyday lives and to make informed choices about further study in physics and related disciplines, and career choices.

Knowledge and understanding

This Edexcel GCSE in Physics qualification requires students to demonstrate knowledge and understanding of:

- physics as an evidence-based discipline
- the collaborative nature of science as a subject discipline and the way new scientific knowledge is validated
- how scientific understanding and theories develop and the limitations of science
- how and why decisions about science and technology are made
- the ethical implications of physics and its applications
- the importance of scale in terms of size, time and space in physics
- the importance of working accurately and safely
- hazard identification and risk assessment
- risk factors and risk assessment in the context of potential benefit
- the use of modelling, including mathematical modelling, to explain aspects of physics
- energy conservation, the efficiency of energy transfer and the associated economic and environmental implications
- the relationship between work and energy, and changes in kinetic energy and gravitational potential energy

- the use of kinetic theory and atomic structure as models to explain physical phenomena
- Newton's laws of motion and their theoretical and practical uses
- calculating changes in the velocity and acceleration of organisations acted on by forces, including momentum
- the generation and control of electrical power and the relationship between power, current and voltage
- the distribution and uses of electricity
- the relationship between power, energy and time
- electrical circuits, including the relationship between resistance, current and voltage
- the wave equation and the transfer of energy and information by waves
- the relationship between the properties of electromagnetic waves and their uses
- radioactivity, sources of background radiation
- ionising radiations, including that they are emitted all the time by radioactive materials and that they can transfer energy
- effects of ionising radiations
- radioactive decay, half-life, fission and fusion
- the evidence for the origin, structure and continuing evolution of the Universe.

Skills

This Edexcel GCSE in Physics provides students with the opportunity to develop the ability to:

- develop hypotheses and plan practical ways to test them including risk assessment; manage risks when carrying out practical work; collect, process, analyse and interpret primary and secondary data including the use of appropriate technology to draw evidence-based conclusions; review methodology to assess fitness for purpose, and review hypotheses in light of outcomes
- use scientific theories, models and evidence to develop hypotheses, arguments and explanations; develop and use models to explain systems, processes and abstract ideas
- communicate scientific information using scientific, technical and mathematical language, conventions and symbols.

How Science Works

The GCSE in Physics requires students to develop the skills, knowledge and understanding of *How Science Works*, described as follows:

Data, evidence, theories and explanations

1. the collection and analysis of scientific data
2. the interpretation of data, using creative thought, to provide evidence for testing ideas and developing theories
3. many phenomena can be explained by developing and using scientific theories, models and ideas
4. there are some questions that science cannot currently answer and some that science cannot address

Practical and enquiry skills

5. planning to test a scientific idea, answer a scientific question or solve a scientific problem
6. collecting data from primary or secondary sources, including the use of ICT sources and tools
7. working accurately and safely, individually and with others, when collecting first-hand data
8. evaluating methods of data collection and considering their validity and reliability as evidence

Communication skills

9. recalling, analysing, interpreting, applying and questioning scientific information or ideas
10. using both qualitative and quantitative approaches
11. presenting information, developing an argument and drawing a conclusion, and using scientific, technical and mathematical language, conventions and symbols, and ICT tools

Applications and implications of science

12. the use of contemporary science and technological developments and their benefits, drawbacks and risks
13. how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions
14. how uncertainties in scientific knowledge and scientific ideas change over time and the role of the scientific community in validating these changes.

Mathematical skills

Students should be able to:

1. understand number size and scale, and the quantitative relationship between units
2. understand when and how to use estimation
3. carry out calculations involving +, − , ×, ÷, either singly or in combination, decimals, fractions, percentages and positive whole number powers
4. provide answers to calculations to an appropriate number of significant figures
5. understand and use the symbols =, <, >, ~
6. understand and use direct proportion and simple ratios
7. calculate arithmetic means
8. understand and use common measures and simple compound measures such as speed
9. plot and draw graphs (line graphs, bar charts, pie charts, scatter graphs, histograms), selecting appropriate scales for the axes
10. substitute numerical values into simple formulae and equations using appropriate units
11. translate information between graphical and numeric form
12. extract and interpret information from charts, graphs and tables
13. understand the idea of probability
14. calculate area, perimeters and volumes of simple shapes

In addition, higher tier students should be able to:

15. interpret, order and calculate with numbers written in standard form
16. carry out calculations involving negative powers (only −1 for rate)
17. change the subject of an equation
18. understand and use inverse proportion
19. understand and use percentiles and deciles.

List of unit contents

Unit P1: Universal physics

Topic 1 Visible light and the Solar System

Topic 2 The electromagnetic spectrum

Topic 3 Waves and the Universe

Topic 4 Waves and the Earth

Topic 5 Generation and transmission of electricity

Topic 6 Energy and the future

Unit P2: Physics for your future

Topic 1 Static and current electricity

Topic 2 Controlling and using electric current

Topic 3 Motion and forces

Topic 4 Momentum, energy, work and power

Topic 5 Nuclear fission and nuclear fusion

Topic 6 Advantages and disadvantages of using radioactive materials

Unit P3: Applications of physics

Topic 1 Radiation in treatment and medicine

Topic 2 X-rays and ECGs

Topic 3 Production, uses and risks of ionising radiation from radioactive sources

Topic 4 Motion of particles

Topic 5 Kinetic theory and gases

Unit PCA: Physics controlled assessment

Unit P1: Universal physics

Overview

Content and How Science Works overview

In Unit P1 students study six topics that give them the opportunity to explore physics in terms of waves and the Universe, helping them to develop an understanding of waves and how scientific ideas develop. Seismic waves and plate tectonics are also investigated. The electromagnetic spectrum, electricity and conservation of energy are then explored, to give students a solid grounding in important principles in physics.

Work on the Solar System and the Universe shows students how data collected over time can have different interpretations and how ideas and theories change as more data is collected. The importance of collecting data to develop new theories is illustrated by the data astronomers used to work out that red-shift varies with distance from the Earth.

Work on the heliocentric model provides opportunities to use models to explain ideas, and work on waves provides opportunities to use models to explain processes, for example in modelling the unpredictability of earthquakes.

Practical work throughout the unit will give students opportunities to work quantitatively, to assess and manage risks and to plan practical ways to answer scientific questions and test hypotheses. Students will critically evaluate evidence, suggest reasons for inconsistencies in the data collected and ways to improve precision or reproducibility of results.

Students will be shown how to represent ideas about light and sound using scientific diagram conventions and to use symbols to represent quantities in the wave equation and in relationships between current, voltage and power. They will make quantitative comparisons, for example between the power consumption and efficiency of different appliances.

Students will have the opportunity to consider how decisions about the energy sources used to generate electricity are informed by scientific evidence, such as efficiency and environmental impact, but that society must consider safety and environmental issues.

Throughout the unit students will learn about the importance of the application of physics to issues of global importance, such as how seismologists locate an earthquake. However, there are some questions that physics cannot yet answer, such as predicting when an earthquake will occur, or whether life exists on other planets.

Topic 1 explores ideas about the Solar System and how visible light and lenses have been used in discovery. This leads on to the properties of waves, including electromagnetic, sound and seismic waves, and wave equations.

Topic 2 covers the electromagnetic spectrum more widely, including properties, effects, dangers and uses.

Topic 3 builds on earlier topics by exploring how observations using different types of telescope led to the development of our knowledge and understanding of the Universe.

Topic 4 covers the uses of infrasound and ultrasound, and then moves to a study of seismic waves, touching on plate tectonics, including a practical activity to demonstrate the unpredictable nature of earthquakes.

Topic 5 explores how to generate an electric current and from this students will develop an understanding of factors affecting the size of induced current in a generator. Students will learn how transformers can be used to transmit electrical energy over large distances, as well as the hazards of electricity and cost-efficiency. Students will relate knowledge to wider issues in society through discussion of renewable and non-renewable sources of generation.

In Topic 6, students will study energy transfers in common situations and appliances and investigate the absorption and radiation of energy from surfaces. This will lead to the idea of energy conservation and the efficiency of energy transfer devices.

Assessment overview

This unit is externally assessed, through a one hour, 60 mark, tiered written examination, containing six questions.

The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.

Practical investigations in this unit

Within this unit, students will develop understanding of the process of scientific investigations, including that investigations:

- use hypotheses which are tested
- require assessment and management of risks
- require the collection, presentation, analysis and interpretation of primary and secondary evidence, including the use of appropriate technology
- should include a review of methodology to assess fitness for purpose
- should include a review of hypotheses in the light of outcomes.

The following specification points are practical investigations that exemplify the scientific process and may appear in the written examination for this unit:

1.6 *Investigate the behaviour of converging lenses, including real and virtual images*

1.7 *Investigate the use of converging lenses to:*

a *measure the focal length using a distant object*

b *investigate factors which affect the magnification of a converging lens (formulae are not needed).*

3.8 *Construct a simple spectrometer, from a CD or DVD, and use it to analyse common light sources*

4.7 *Investigate the unpredictability of earthquakes, through sliding blocks and weights*

5.4 *Investigate the power consumption of low-voltage electrical items*

5.7 *Investigate factors affecting the generation of electric current by induction*

6.7 *Investigate how the nature of a surface affects the amount of energy radiated or absorbed*

The following are further suggestions for practical work within this unit:

- *Construct devices using two converging lenses of differing focal lengths*
- *Investigate models to show refraction, such as toy cars travelling into a region of sand*
- *Investigate the areas beyond the visible spectrum, such as the work of Herschel and Ritter in discovering IR and UV respectively*
- *Investigate the change in pitch of the sound from a moving object using a buzzer on a piece of string whirled around in a circle*

The controlled assessment task (CAT) for the GCSE in Physics will be taken from any of these practical investigations (specification points and further suggested practical work). This task will change every year, so future CATs will be chosen from this list.

Detailed unit content

In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students are required to demonstrate an understanding of.

Throughout the unit

0.1 Use equations given in this unit, or in a given alternate form

0.2 **Use and rearrange equations given in this unit**

0.3 Demonstrate an understanding of which units are required in equations

Topic 1

Visible light and the Solar System

1.1 Describe how ideas about the structure of the Solar System have changed over time, including the change from the geocentric to the heliocentric models and the discovery of new planets

1.2 Demonstrate an understanding of how scientists use waves to find out information about our Universe, including:

a the Solar System

b the Milky Way

1.3 Discuss how Galileo's observations of Jupiter, using the telescope, provided evidence for the heliocentric model of the Solar System

1.4 Compare methods of observing the Universe using visible light, including the naked eye, photography and telescopes

1.5 Explain how to measure the focal length of a converging lens using a distant object

1.6 *Investigate the behaviour of converging lenses, including real and virtual images*

1.7 *Investigate the use of converging lenses to:*

a *measure the focal length using a distant object*

b *investigate factors which affect the magnification of a converging lens (formulae are not needed)*

1.8 Explain how the eyepiece of a simple telescope magnifies the image of a distant object produced by the objective lens (ray diagrams are not necessary)

1.9 Describe how a reflecting telescope works

1.10 Recall that waves are reflected and refracted at boundaries between different materials

1.11 **Explain how waves will be refracted at a boundary in terms of the change of speed and direction**

1.12 Describe that waves transfer energy and information without transferring matter

1.13 Use the terms of frequency, wavelength, amplitude and speed to describe waves

1.14 Differentiate between longitudinal and transverse waves by referring to sound, electromagnetic and seismic waves

1.15 Use both the equations below for all waves:

wave speed (metre/second, m/s) = frequency (hertz, Hz) × wavelength (metre, m)

$v = f \times \lambda$

wave speed (metre/second, m/s) = distance (metre, m) / time (second, s)

$v = \frac{x}{t}$

Topic 2

The electromagnetic spectrum

2.1 Demonstrate an understanding of how Herschel and Ritter contributed to the discovery of waves outside the limits of the visible spectrum

2.2 Demonstrate an understanding that all electromagnetic waves are transverse and that they travel at the same speed in a vacuum

2.3 Describe the continuous electromagnetic spectrum including (in order) radio waves, microwaves, infrared, visible (including the colours of the visible spectrum), ultraviolet, X-rays and gamma rays

2.4 Demonstrate an understanding that the electromagnetic spectrum is continuous from radio waves to gamma rays, but the radiations within it can be grouped in order of decreasing wavelength and increasing frequency

2.5 Demonstrate an understanding that the potential danger associated with an electromagnetic wave increases with increasing frequency

2.6 Relate the harmful effects, to life, of excessive exposure to the frequency of the electromagnetic radiation, including:

a microwaves: internal heating of body cells

b infrared: skin burns

c ultraviolet: damage to surface cells and eyes, leading to skin cancer and eye conditions

d X-rays and gamma rays: mutation or damage to cells in the body

2.7 Describe some uses of electromagnetic radiation:

a radio waves: including broadcasting, communications and satellite transmissions

b microwaves: including cooking, communications and satellite transmissions

c infrared: including cooking, thermal imaging, short range communications, optical fibres, television remote controls and security systems

d visible light: including vision, photography and illumination

e ultraviolet: including security marking, fluorescent lamps, detecting forged bank notes and disinfecting water

f X-rays: including observing the internal structure of objects, airport security scanners and medical X-rays

g gamma rays: including sterilising food and medical equipment, and the detection of cancer and its treatment

2.8 Recall that ionising radiations are emitted all the time by radioactive sources

2.9 Describe that ionising radiation includes alpha and beta particles and gamma rays and that they transfer energy

Topic 3

Waves and the Universe

3.1 Recall that the Solar System is part of the Milky Way galaxy

3.2 Describe a galaxy as a collection of stars

3.3 Recall that the Universe includes all of the galaxies

3.4 Compare the relative sizes of and the distances between the Earth, the Moon, the planets, the Sun, galaxies and the Universe

3.5 Describe the use of other regions of the electromagnetic spectrum by some modern telescopes

3.6 Describe the methods used to gather evidence for life beyond Earth, including space probes, soil experiments by landers, Search for Extraterrestrial Intelligence (SETI)

3.7 Demonstrate an understanding of the impact of data gathered by modern telescopes on our understanding of the Universe, including:

a the observation of galaxies because of improved magnification

b the discovery of objects not detectable using visible light

c the ability to collect more data

3.8 *Construct a simple spectrometer, from a CD or DVD, and use it to analyse common light sources*

3.9 Explain why some telescopes are located outside the Earth's atmosphere

3.10 **Analyse data provided to support the location of telescopes outside the Earth's atmosphere**

3.11 Describe the evolution of stars of similar mass to the Sun through the following stages:

a nebula

b star (main sequence)

c red giant

d white dwarf

3.12 Describe the role of gravity in the life cycle of stars

3.13 **Describe how the evolution of stars with a mass larger than the Sun is different, and may end in a black hole or neutron star**

3.14 Demonstrate an understanding of the Steady State and Big Bang theories

3.15 Describe evidence supporting the Big Bang theory, limited to red-shift and the cosmic microwave background (CMB) radiation

3.16 Recognise that as there is more evidence supporting the Big Bang theory than the Steady State theory, it is the currently accepted model for the origin of the Universe

3.17 Describe that if a wave source is moving relative to an observer there will be a change in the observed frequency and wavelength

3.18 **Demonstrate an understanding that if a wave source is moving relative to an observer there will be a change in the observed frequency and wavelength**

3.19 **Describe the red-shift in light received from galaxies at different distances away from the Earth**

3.20 **Explain why the red-shift of galaxies provides evidence for the Universe expanding**

3.21 **Explain how both the Big Bang and Steady State theories of the origin of the Universe both account for red-shift of galaxies**

3.22 **Explain how the discovery of the CMB radiation led to the Big Bang theory becoming the currently accepted model**

Topic 4

Waves and the Earth

4.1 Recall that sound with frequencies greater than 20 000 hertz, Hz, is known as ultrasound

4.2 Describe uses of ultrasound, including:

a sonar

b communication between animals

c foetal scanning

4.3 Calculate depth or distance from time and velocity of ultrasound

4.4 Recall that sound with frequencies less than 20 hertz, Hz, is known as infrasound

4.5 Describe uses of infrasound, including:

a communication between animals

b detection of animal movement in remote locations

c detection of volcanic eruptions and meteors

4.6 Recall that seismic waves are generated by earthquakes or explosions

4.7 *Investigate the unpredictability of earthquakes, through sliding blocks and weights*

4.8 Explain why scientists find it difficult to predict earthquakes and tsunami waves even with available data

4.9 Recall that seismic waves can be longitudinal (P) waves and transverse (S) waves and that they can be reflected and refracted at boundaries between the crust, mantle and core

4.10 Explain how data from seismometers can be used to identify the location of an earthquake

4.11 **Demonstrate an understanding of how P and S waves travel inside the Earth including reflection and refraction**

4.12 Explain how the Earth's outermost layer is composed of (tectonic) plates and is in relative motion due to convection currents in the mantle

4.13 Demonstrate an understanding of how, at plate boundaries, plates may slide past each other, sometimes causing earthquakes

Topic 5

Generation and transmission of electricity

5.1 Describe current as the rate of flow of charge and voltage as an electrical pressure giving a measure of the energy transferred

5.2 Define power as the energy transferred per second and measured in watts

5.3 Use the equation:

electrical power (watt, W) = current (ampere, A) × potential difference (volt, V)

$P = I \times V$

5.4 *Investigate the power consumption of low-voltage electrical items*

5.5 Discuss the advantages and disadvantages of methods of large-scale electricity production using a variety of renewable and non-renewable resources

5.6 Demonstrate an understanding of the factors that affect the size and direction of the induced current

5.7 *Investigate factors affecting the generation of electric current by induction*

5.8 Explain how to produce an electric current by the relative movement of a magnet and a coil of wire

a on a small scale

b in the large-scale generation of electrical energy

5.9 Recall that generators supply current which alternates in direction

5.10 Explain the difference between direct and alternating current

5.11 Recall that a transformer can change the size of an alternating voltage

5.12 **Use the turns ratio equation for transformers to predict either the missing voltage or the missing number of turns**

5.13 Explain why electrical energy is transmitted at high voltages, as it improves the efficiency by reducing heat loss in transmission lines

5.14 Explain where and why step-up and step-down transformers are used in the transmission of electricity in the National Grid

5.15 Describe the hazards associated with electricity transmission

5.16 Recall that energy from the mains supply is measured in kilowatt-hours

5.17 Use the equation:

cost (p) = power (kilowatts, kW) × time (hour, h) × cost of 1 kilowatt-hour (p/kW h)

5.18 Demonstrate an understanding of the advantages of the use of low-energy appliances

5.19 Use data to compare and contrast the advantages and disadvantages of energy-saving devices

5.20 Use data to consider cost-efficiency by calculating payback times

5.21 Use the equation:

power (watt, W) = energy used (joule, J) / time taken (second, s)

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

Topic 6

Energy and the future

6.1 Demonstrate an understanding that energy is conserved

6.2 Describe energy transfer chains involving the following forms of energy: thermal (heat), light, electrical, sound, kinetic (movement), chemical, nuclear and potential (elastic and gravitational)

6.3 Demonstrate an understanding of how diagrams can be used to represent energy transfers

6.4 Apply the idea that efficiency is the proportion of energy transferred to useful forms to everyday situations

6.5 Use the efficiency equation:

$$efficiency = \frac{(useful\ energy\ transferred\ by\ the\ device)}{(total\ energy\ supplied\ to\ the\ device)} \times 100\%$$

6.6 Demonstrate an understanding that for a system to be at a constant temperature it needs to radiate the same average power that it absorbs

6.7 *Investigate how the nature of a surface affects the amount of thermal energy radiated or absorbed*

Unit P2: Physics for the future

Overview

Content and How Science Works overview

In Unit P2 students study six topics that give them the opportunity to develop their understanding of significant concepts and relate them to important uses both for today and the future. Electricity is explained further, building on Unit P1. Students are introduced to motion, forces and momentum. Nuclear reactions and nuclear power are then discussed, including the uses and dangers of radioactivity.

Practical work in this unit will give students opportunities to plan practical ways to answer scientific questions; devise appropriate methods for the collection of numerical and other data; assess and manage risks when carrying out practical work; collect, process, analyse and interpret primary and secondary data; draw evidence-based conclusions; and evaluate methods of data collection and the quality of the resulting data.

Work on static and current electricity and on nuclear reactions provides opportunities to use models to explain ideas and processes. Students will work quantitatively when studying charge, resistance, electrical power, motion, energy, momentum and half-lives. They will have opportunities to communicate scientific information using scientific and mathematical conventions and symbols during work on resistance and motion.

Work on the applications of static electricity, car safety features, stopping distances, nuclear energy and the uses of radioactivity allow students to consider the role that physics and physicists play in providing safe and useful machines. Students also have the opportunity to consider the advantages, disadvantages and risks of these applications, and the safe uses of radioactive substances.

In Topic 1 students will learn about static electricity before discussing some uses and dangers of electrical charges. Direct current is introduced.

Topic 2 leads students to understand the relationship between current, voltage and resistance. Equations for electrical power and energy transferred are also used. Further investigations lead to an understanding of how current varies with voltage in some common components.

In Topic 3 students will develop an understanding of the motion of objects and Newton's second law of motion. This is then exemplified by considering the motion of an object as it falls through a vacuum and the atmosphere.

In Topic 4 students will learn about conservation of momentum by investigating collisions between bodies. This will enable students to apply ideas about rate of change of momentum to crumple zones, seat

belts and air bags. Students will then develop an understanding of the relationship between work done, energy transferred and power.

In Topic 5 students will develop an understanding of radioactive decay, including chain reactions, and difference between fission and fusion. Students will use this context to study the role of the wider scientific community in validating theories.

In Topic 6 students will develop an understanding of the uses of different ionising radiations. They will compare and contrast the advantages and risks involved and use models to investigate radioactive decay. Students will research and discuss the advantages and disadvantages of using nuclear power for generating electricity.

Assessment overview

This unit is externally assessed, through a one hour, 60 mark, tiered written examination, containing six questions.

The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.

Practical investigations in this unit

Within this unit, students will develop understanding of the process of scientific investigations, including that investigations:

- use hypotheses which are tested
- require assessment and management of risks
- require the collection, presentation, analysis and interpretation of primary and secondary evidence, including the use of appropriate technology
- should include review of methodology to assess fitness for purpose
- should include a review of hypotheses in the light of outcomes.

The following specification points are practical investigations that exemplify the scientific process and may appear in the written examination for this unit:

2.6 *Investigate the relationship between potential difference (voltage), current and resistance*

3.15 *Investigate the relationship between force, mass and acceleration*

4.3 *Investigate the forces required to slide blocks along different surfaces, with differing amounts of friction*

4.8 *Investigate how crumple zones can be used to reduce the forces in collisions*

6.8 *Investigate models which simulate radioactive decay*

The following are further suggestions for practical work within this unit:

- *Investigate forces between charges*
- *Conduct experiments to show the relationship between potential difference (voltage), current and resistance, for a component whose resistance varies with a given factor, such as temperature, light intensity and pressure*
- *Investigate the motion of falling*
- *Investigate momentum during collisions*
- *Investigate power by running up the stairs or lifting objects of different weights*

The controlled assessment task (CAT) for the GCSE in Physics will be taken from any of these practical investigations (specification points and further suggested practical investigations). This task will change every year, so future CATs will be chosen from this list.

Detailed unit content

In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students are required to demonstrate an understanding of.

Throughout the unit

0.1 Use equations given in this unit, or in a given alternate form

0.2 **Use and rearrange equations given in this unit**

0.3 Demonstrate an understanding of which units are required in equations

Topic 1

Static and current electricity

1.1 Describe the structure of the atom, limited to the position, mass and charge of protons, neutrons and electrons

1.2 Explain how an insulator can be charged by friction, through the transfer of electrons

1.3 Explain how the material gaining electrons becomes negatively charged and the material losing electrons is left with an equal positive charge

1.4 Recall that like charges repel and unlike charges attract

1.5 Demonstrate an understanding of common electrostatic phenomena in terms of movement of electrons, including:

a shocks from everyday objects

b lightning

c attraction by induction such as a charged balloon attracted to a wall and a charged comb picking up small pieces of paper

1.6 Explain how earthing removes excess charge by movement of electrons

1.7 Explain some of the uses of electrostatic charges in everyday situations, including paint and insecticide sprayers

1.8 Demonstrate an understanding of some of the dangers of electrostatic charges in everyday situations, including fuelling aircraft and tankers together with the use of earthing to prevent the build-up of charge and danger arising

1.9 Recall that an electric current is the rate of flow of charge

1.10 Recall that the current in metals is a flow of electrons

1.11 Use the equation:

charge (coulomb, C) = current (ampere, A) × time (second, s)
$Q = I \times t$

1.12 Recall that cells and batteries supply direct current (d.c.)

1.13 Demonstrate an understanding that direct current (d.c.) is movement of charge in one direction only

Topic 2

Controlling and using electric current

2.1 Describe how an ammeter is placed in series with a component to measure the current, in amps, in the component

2.2 Explain how current is conserved at a junction

2.3 Explain how the current in a circuit depends on the potential difference of the source

2.4 Describe how a voltmeter is placed in parallel with a component to measure the potential difference (voltage), in volts, across it

2.5 **Demonstrate an understanding that potential difference (voltage) is the energy transferred per unit charge passed and hence that the volt is a joule per coulomb**

2.6 *Investigate the relationship between potential difference (voltage), current and resistance*

2.7 Explain how changing the resistance in a circuit changes the current and how this can be achieved using a variable resistor

2.8 Use the equation:

potential difference (volt, V) = current (ampere, A) × resistance (ohm, Ω)
$V = I \times R$

2.9 Demonstrate an understanding of how current varies with potential difference for the following devices

a filament lamps

b diodes

c fixed resistors

2.10 Demonstrate an understanding of how the resistance of a light-dependent resistor (LDR) changes with light intensity

2.11 Demonstrate an understanding of how the resistance of a thermistor changes with change of temperature (negative temperature coefficient thermistors only)

2.12 Explain why, when there is an electric current in a resistor, there is an energy transfer which heats the resistor

2.13 **Explain the energy transfer (in 2.12 above) as the result of collisions between electrons and the ions in the lattice**

2.14 Distinguish between the advantages and disadvantages of the heating effect of an electric current

2.15 Use the equation:

electrical power (watt, W) = current (ampere, A) × potential difference (volt, V)
$P = I \times V$

2.16 Use the equation:

energy transferred (joule, J) = current (ampere, A) × potential difference (volt, V) × time (second, s)

$E = I \times V \times t$

Topic 3

Motion and forces

3.1 Demonstrate an understanding of the following as vector quantities:

a displacement

b velocity

c acceleration

d force

3.2 Interpret distance/time graphs including determination of speed from the gradient

3.3 Recall that velocity is speed in a stated direction

3.4 Use the equation:

speed (m/s) = distance (m) / time (s)

3.5 Use the equation:

acceleration (metre per second squared, m/s^2) = change in velocity (metre per second, m/s) / time taken (second, s)

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

3.6 Interpret velocity/time graphs to:

a compare acceleration from gradients qualitatively

b calculate the acceleration from the gradient (for uniform acceleration only)

c **determine the distance travelled using the area between the graph line and the time axis (for uniform acceleration only**

3.7 Draw and interpret a free-body force diagram

3.8 Demonstrate an understanding that when two bodies interact, the forces they exert on each other are equal in size and opposite in direction and that these are known as action and reaction forces

3.9 Calculate a resultant force using a range of forces (limited to the resultant of forces acting along a line) including resistive forces

3.10 Demonstrate an understanding that if the resultant force acting on a body is zero, it will remain at rest or continue to move at the same velocity

3.11 Demonstrate an understanding that if the resultant force acting on a body is not zero, it will accelerate in the direction of the resultant force

3.12 Demonstrate an understanding that a resultant force acting on an object produces an acceleration which depends on:

a the size of the resultant force

b the mass of the object

3.13 Use the equation:

force (newton, N) = mass (kilogram, kg) × acceleration (metre per second squared, m/s^2)
$F = m \times a$

3.14 Use the equation:

weight (newton, N) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg)
$W = m \times g$

3.15 *Investigate the relationship between force, mass and acceleration*

3.16 Recall that in a vacuum all falling bodies accelerate at the same rate

3.17 Demonstrate an understanding that:

a when an object falls through an atmosphere air resistance increases with increasing speed

b air resistance increases until it is equal in size to the weight of the falling object

c when the two forces are balanced, acceleration is zero and terminal velocity is reached

Topic 4

Momentum, energy, work and power

4.1 Recall that the stopping distance of a vehicle is made up of the sum of the thinking distance and the braking distance

4.2 Demonstrate an understanding of the factors affecting the stopping distance of a vehicle, including:

a the mass of the vehicle

b the speed of the vehicle

c the driver's reaction time

d the state of the vehicle's brakes

e the state of the road

f the amount of friction between the tyre and the road surface

4.3 *Investigate the forces required to slide blocks along different surfaces, with differing amounts of friction*

4.4 Use the equation:

momentum (kilogram metre per second, kg m/s) = mass (kilogram, kg) × velocity (metre per second, m/s)

to calculate the momentum of a moving object

4.5 Demonstrate an understanding of momentum as a vector quantity

4.6 Demonstrate an understanding of the idea of linear momentum conservation

4.7 Demonstrate an understanding of the idea of rate of change of momentum to explain protective features including bubble wraps, seat belts, crumple zones and air bags

4.8 *Investigate how crumple zones can be used to reduce the forces in collisions*

4.9 **Use the equation:**

force (newton, N) = change in momentum (kilogram metre per second, kg m/s) / time (second, s)
$\boldsymbol{F = (mv - mu) / t}$

to calculate the change in momentum of a system, as in 4.6

4.10 Use the equation:

work done (joule, J) = force (newton, N) × distance moved in the direction of the force (metre, m)
$E = F \times d$

4.11 Demonstrate an understanding that energy transferred (joule, J) is equal to work done (joule, J)

4.12 Recall that power is the rate of doing work and is measured in watts, W

4.13 Use the equation:

power (watt, W) = work done (joule, J) / time taken (second, s)

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

4.14 Recall that one watt is equal to one joule per second, J/s

4.15 Use the equation:

gravitational potential energy (joule, J) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) × vertical height (metre, m)
GPE $= m \times g \times h$

4.16 Use the equation:

kinetic energy (joule, J) = $\frac{1}{2}$ × mass (kilogram, kg) × velocity^2 ((metre/second)^2 (m/s)^2)

KE $= \frac{1}{2} \times m \times v^2$

4.17 Demonstrate an understanding of the idea of conservation of energy in various energy transfers

4.18 **Carry out calculations on work done to show the dependence of braking distance for a vehicle on initial velocity squared (work done to bring a vehicle to rest equals its initial kinetic energy)**

Topic 5

Nuclear fission and nuclear fusion

5.1 Describe the structure of nuclei of isotopes using the terms atomic (proton) number and mass (nucleon) number and using symbols in the format $^{14}_{6}C$

5.2 Explain how atoms may gain or lose electrons to form ions

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

5.4 Recall that an alpha particle is equivalent to a helium nucleus, a beta particle is an electron emitted from the nucleus and a gamma ray is electromagnetic radiation

5.5 Compare alpha, beta and gamma radiations in terms of their abilities to penetrate and ionise

5.6 Demonstrate an understanding that nuclear reactions can be a source of energy, including fission, fusion and radioactive decay

5.7 Explain how the fission of U-235 produces two daughter nuclei and two or more neutrons, accompanied by a release of energy

5.8 Explain the principle of a controlled nuclear chain reaction

5.9 Explain how the chain reaction is controlled in a nuclear reactor including the action of moderators and control rods

5.10 Describe how thermal (heat) energy from the chain reaction is converted into electrical energy in a nuclear power station

5.11 Recall that the products of nuclear fission are radioactive

5.12 Describe nuclear fusion as the creation of larger nuclei from smaller nuclei, accompanied by a release of energy and recognise fusion as the energy source for stars

5.13 Explain the difference between nuclear fusion and nuclear fission

5.14 **Explain why nuclear fusion does not happen at low temperatures and pressures, due to electrostatic repulsion of protons**

5.15 **Relate the conditions for fusion to the difficulty of making a practical and economic form of power station**

5.16 Demonstrate an understanding that new scientific theories, such as 'cold fusion', are not accepted until they have been validated by the scientific community

Topic 6

Advantages and disadvantages of using radioactive materials

6.1 Explain what is meant by background radiation, including how regional variations within the UK are caused in particular by radon gas

6.2 Recall the origins of background radiation from Earth and space

6.3 Describe uses of radioactivity, including:
- a household fire (smoke) alarms
- b irradiating food
- c sterilisation of equipment
- d tracing and gauging thicknesses
- e diagnosis and treatment of cancer

6.4 Describe how the activity of a radioactive source decreases over a period of time

6.5 Recall that the unit of activity of a radioactive isotope is the Becquerel, Bq

6.6 Recall that the half-life of a radioactive isotope is the time taken for half the undecayed nuclei to decay

6.7 Use the concept of half-life to carry out simple calculations on the decay of a radioactive isotope, including graphical representations

6.8 *Investigate models which simulate radioactive decay*

6.9 Demonstrate an understanding of the dangers of ionising radiation in terms of tissue damage and possible mutations and relate this to the precautions needed

6.10 Describe how scientists have changed their ideas of radioactivity over time, including:
- a the awareness of the hazards associated with radioactive sources
- b why the scientific ideas change over time

6.11 Discuss the long-term possibilities for storage and disposal of nuclear waste

6.12 Evaluate the advantages and disadvantages of nuclear power for generating electricity, including the lack of carbon dioxide emissions, risks, public perception, waste disposal and safety issues

Unit P3: Applications of physics

Overview

Content and How Science Works overview

This highly engaging unit builds on the knowledge gained in units P1 and P2 by introducing students to medical physics. Students will learn how physics principles are vital in modern medicine in the way in which they are applied to diagnosis, treatment and storage of medicines.

Practical work in this unit will give students opportunities to plan practical ways to answer scientific questions; devise appropriate methods for the collection of numerical and other data; assess and manage risks when carrying out practical work; collect, process, analyse and interpret primary and secondary data; draw evidence-based conclusions; and evaluate methods of data collection and the quality of the resulting data.

Students will explain ideas and processes using models while studying radiation, radioactive decay, subatomic structure, momentum and kinetic theory. Work on the intensity of radiation, lenses, momentum, kinetic energy, frequency and gases will provide students with opportunities to work quantitatively. They will have opportunities to communicate scientific information using scientific and mathematical conventions and symbols during work on ray diagrams and vision, and when constructing nuclear equations.

Students will consider the role that physics and physicists play in our lives through the study of laser and other treatments for correcting vision, the use of X-rays in medicine, ECGs and pacemakers, and the uses of radioactive materials. They will consider advantages, disadvantages and risks of using radioactive materials, and consider how decisions about their use are made. They will look at how international collaboration is necessary for the building of particle accelerators and how these can lead to new discoveries about the world around us.

In Topic 1 students will learn about the use of radiation and other waves in medical treatment and diagnosis. Students will apply their understanding of lenses to treatments for long and short sightedness.

In Topic 2 students will learn about the production of X-rays and then discuss the risks and advantages of using X-rays for treatment and diagnosis. A brief study of the use of an electrocardiogram (ECG) will enable students to develop a simple understanding of the use of a pacemaker to regulate heart action.

In Topic 3 students will discuss the ethical and social issues relating to the use of radioactive techniques in medical physics. Students will learn in detail about the decay of radio isotopes and the use of beta decay. They will relate their knowledge to medical treatments and diagnosis and the dangers of using radiation.

In Topic 4 students will investigate circular motion, momentum and conservation of energy. Students will develop an understanding of particle accelerators and their use in medical physics and wider research.

In Topic 5 students will learn simple kinetic theory and the gas laws. They will learn the general gas equation and how to apply this equation to, for example, bottled gases in medicine.

Assessment overview

This unit is externally assessed, through a one hour, 60 mark, tiered written examination, containing six questions.

The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.

Practical investigations in this unit

Within this unit, students will develop understanding of the process of scientific investigations, including that investigations:

- use hypotheses which are tested
- require assessment and management of risks
- require the collection, presentation, analysis and interpretation of primary and secondary evidence including the use of appropriate technology
- should include review of methodology to assess fitness for purpose
- should include a review of hypotheses in the light of outcomes.

The following specification points are practical investigations that exemplify the scientific process and may appear in the written examination for this unit:

1.8 *Investigate variations of image characteristics with objects at different distances from a converging lens*

1.18 *Investigate the critical angle for perspex/air or glass/air or water/air boundaries*

1.19 *Investigate TIR between different media*

4.12 *Investigate factors affecting the height of rebound of bouncing balls*

5.7 *Investigate the temperature and volume relationship for a gas*

5.9 *Investigate the volume and pressure relationship for a gas*

The following are further suggestions for practical work within this unit:

- *Investigate the relationship between the intensity of radiation and the distance from the source*
- *Investigate the absorption of light by translucent materials in order to simulate X-rays' absorption*

- *Investigate conservation of energy and momentum during collisions using models to represent particles*
- *Investigate inelastic collisions with the two objects remaining together after the collision and also 'near' elastic collisions*
- *Investigate the temperature and pressure relationship for a gas*

The controlled assessment task (CAT) for the GCSE in Physics will be taken from any of these practical investigations (specification points and further suggested practical investigations). This task will change every year, so future CATs will be chosen from this list.

Detailed unit content

In this specification bold text refers to higher tier only content. Italic text refers to practical investigations, which students are required to demonstrate an understanding of.

Throughout the unit

0.1 Use equations given in this unit, or in a given alternate form

0.2 **Use and rearrange equations given in this unit**

0.3 Demonstrate an understanding of which units are required in equations

Topic 1

Radiation in treatment and medicine

1.1 Demonstrate an understanding of the methods that medical physicists can employ to help doctors solve medical problems, including:

a CAT scans

b ultrasounds

c endoscopes

d ionising and non-ionising radiation

1.2 Use the word 'radiation' to describe any form of energy originating from a source, including both waves and particles

1.3 Demonstrate an understanding that the intensity of radiation will decrease with distance from a source and according to the nature of the medium through which it is travelling

1.4 **Use the equation:**

intensity = power of incident radiation / area
$\boldsymbol{I = P/A}$

1.5 Describe the refraction of light by converging and diverging lenses

1.6 Relate the power of a lens to its shape

1.7 Use the equation:

power of lens (dioptre, D) = 1/focal length (metre, m)

1.8 *Investigate variations of image characteristics with objects at different distances from a converging lens*

1.9 **Use the lens equation:**

$\boldsymbol{1/f = 1/u + 1/v}$

(f = focal length (m), u = object distance (m), v = image distance (m))

The use of the real is positive sign convention is preferred and will be used in the exam

1.10 Identify the following features in a diagram of the eye – cornea, iris, pupil, lens, retina, ciliary muscles

1.11 Demonstrate an understanding that light is focused on the retina by the action of the lens and cornea

1.12 Recall that the average adult human eye has a near point at about 25 cm and a far point at infinity

1.13 Explain the symptoms and causes of short sight and long sight (students will not be expected to draw scaled ray diagrams, but may be expected to interpret them)

1.14 Compare and contrast treatments for short sight and long sight, including the use of:

a simple lenses

b contact lenses

c **laser correction**

(combined lens equation is not required; students will not be expected to draw scaled ray diagrams, but may be expected to interpret them)

1.15 Explain, with the aid of ray diagrams, reflection, refraction and total internal reflection (TIR), including the law of reflection and critical angle

1.16 **Calculate critical angle using Snell's Law**

1.17 Explain refraction in terms of change of speed of radiation

1.18 *Investigate the critical angle for perspex/air or glass/air or water/air boundaries*

1.19 *Investigate TIR between different media*

1.20 Explain how TIR is used in optical fibres

1.21 Explain uses of optical fibres in endoscopes

1.22 Explain uses of ultrasound in diagnosis and treatment

Topic 2

X-rays and ECGs

2.1 Relate the ionisation by X-rays to their frequency and energy qualitatively ($E = hf$ is not required)

2.2 Explain the key features of passing a current through an evacuated tube, including:

a thermionic emission of electrons from a heated filament

b potential difference between the cathode (filament) and the anode (metal target)

c why the vacuum is necessary

d possible production of X-rays by collision with a metal target

2.3 Explain why a beam of charged particles is equivalent to an electric current

2.4 **Use the equation:**

current (ampere, A) = number of particles per second (1/second, 1/s) × charge on each particle (coulomb, C)

$$I = N \times q$$

2.5 **Use the equation:**

kinetic energy (joule, J) = charge on the electron (coulomb, C) × accelerating potential difference (volt, V)

$\mathbf{KE = \frac{1}{2}mv^2 = e \times V}$

2.6 Demonstrate an understanding of the inverse square law for electromagnetic radiation

2.7 Relate the absorption of X-rays to the thickness of the material through which they are travelling, quantitatively

2.8 Describe how X-rays are used in CAT scans and fluoroscopes

2.9 Demonstrate an understanding of the comparison of the risks and advantages of using X-rays for treatment and diagnosis

2.10 Explain how action potentials can be measured with an electrocardiogram (ECG) to monitor heart action

2.11 Relate the characteristic shape of a normal ECG to heart action

2.12 Use the equation:

frequency (hertz, Hz) = 1/time period (second, s)

$f = 1/T$

2.13 Describe the use of a pacemaker to regulate the heart action

2.14 Describe the principles and use of pulse oximetry

Topic 3

Production, uses and risks of ionising radiation from radioactive sources

3.1 Evaluate the social and ethical issues relating to the use of radioactive techniques in medical physics

3.2 Describe the properties of alpha, beta, gamma, positron and neutron radiation

3.3 Recall the relative masses and relative electric charges of protons, neutrons, electrons and positrons

3.4 Recall that in an atom the number of protons equals the number of electrons

3.5 Describe the process of $\beta-$ decay (a neutron becomes a proton plus an electron)

3.6 **Describe the process of $\beta+$ decay (a proton becomes a neutron plus a positron)**

3.7 Explain the effects on the atomic (proton) number and mass (nucleon) number of radioactive decays (α, β and γ decay)

3.8 **Use given data to balance nuclear equations**

3.9 **Describe the features of the *N-Z* curve for stable isotopes**

3.10 **Identify isotopes as radioactive from their position relative to the stability curve**

3.11 **Recall that nuclei with high values of *Z* (above 82) usually undergo alpha decay**

3.12 **Recall that an isotope above the curve has too many neutrons to be stable and will undergo β− decay**

3.13 **Recall that an isotope below the curve has too many protons to be stable and will undergo β+ decay**

3.14 **Recall that the proton and neutron each contain three particles called quarks**

3.15 **Describe the arrangement of up and down quarks in protons and neutrons**

3.16 **Use given data to explain the arrangement of up and down quarks in protons and neutrons in terms of charge and mass**

3.17 **Explain β− decay as a process that involves a down quark changing into an up quark (a neutron becomes a proton and an electron)**

3.18 **Explain β+ decay as a process that involves an up quark changing into a down quark (a proton becomes a neutron and a positron)**

3.19 Recall that nuclei that have undergone radioactive decay often undergo nuclear rearrangement with a loss of energy as gamma radiation

3.20 Describe the dangers of ionising radiation in terms of tissue damage and possible mutations

3.21 Explain the precautions taken to ensure the safety of people exposed to radiation, including limiting the dose for patients and the risks to medical personnel

3.22 Compare and contrast the treatment of tumours using radiation applied internally or externally

3.23 Describe palliative care including the use of radiation in some instances

3.24 Explain some of the uses of radioactive substances in diagnosis of medical conditions, including PET scanners and tracers

3.25 Explain why isotopes used in PET scanners have to be produced nearby

Topic 4

Motion of particles

4.1 Discuss how instruments, including particle accelerators, can help scientists develop better explanations about the physical world

4.2 Discuss reasons for collaborative, international research into big scientific questions, including particle physics

4.3 Explain how for motion in a circle there must be a resultant force known as a centripetal force that acts towards the centre of the circle

4.4 Explain how particle accelerators called cyclotrons cause charged particles to move in a circular or spiral path, due to a magnetic field

4.5 Demonstrate an understanding that certain stable elements can be bombarded with proton radiation to change them into radioactive isotopes

4.6 Describe the use of particle accelerators (cyclotrons) to produce radioactive isotopes for medical purposes

4.7 Demonstrate an understanding that for inelastic collisions momentum is conserved but kinetic energy is not conserved

4.8 Demonstrate an understanding that for elastic collisions both momentum and kinetic energy are conserved

4.9 Analyse collisions in one dimension in terms of momentum and kinetic energy

4.10 **Carry out calculations using momentum conservation for a two-body collision (in one dimension only)**

4.11 **Carry out calculations using conservation of kinetic energy for a two-body elastic collision (in one dimension only)**

4.12 *Investigate factors affecting the height of rebound of bouncing balls*

4.13 Recall that gamma rays can be produced by the annihilation of an electron and a positron

4.14 Apply conservation of momentum and charge to positron electron annihilation

4.15 Apply the idea of conservation of mass energy for positron electron annihilation

a in a qualitative way (calculations involving $E = mc^2$ will not be required)

b in a quantitive way using the equation $E = mc^2$

4.16 Explain the use of radio isotopes in PET scanners to produce gamma rays

Topic 5

Kinetic theory and gases

5.1 Use a simple kinetic theory model to describe movement of particles in the three states of matter

5.2 Explain the pressure of a gas in terms of the motion of its particles

5.3 Describe the effect of changing the temperature of a gas on the speed of its particles

5.4 Describe the term absolute zero, −273°C, in terms of the lack of movement of particles

5.5 Convert between the Kelvin and Celsius scales

5.6 Recall that the average kinetic energy of the particles in a gas is directly proportional to the Kelvin temperature of the gas

5.7 *Investigate the temperature and volume relationship for a gas*

5.8 Use the relationship:

$V_1 = V_2T_1/T_2$

to calculate volume for gases of fixed mass at constant pressure (rearranging not required)

5.9 *Investigate the volume and pressure relationship for a gas*

5.10 Use the relationship:

$V_1P_1 = V_2P_2$

to calculate volume or pressure for gases of fixed mass at constant temperature

5.11 **Use the equation:**

initial pressure (pascal, Pa) × initial volume (metre^3, m^3) / initial temperature (kelvin, K) = final pressure (pascal, Pa) × final volume (metre^3, m^3) / final temperature (kelvin, K)

$\boldsymbol{P_1V_1/T_1 = P_2V_2/T_2}$

5.12 Apply an understanding of the equation in 5.11 to the use of bottled gases in medicine, including the need for a pressure above atmospheric and the calculation of the volume of gas released at atmospheric pressure

Unit PCA: Physics controlled assessment

Overview

Content and How Science Works overview

The controlled assessment is designed to enable students to engage with the scientific process through setting a hypothesis relevant to a given set of variables and then planning an investigation, observing, recording and presenting outcomes and conclusions.

The student task will consist of three parts:

Part A – Planning

Part B – Observations

Part C – Conclusions

The tasks, provided by Edexcel, will relate to the following units in this specification:

P2 – Physics for your future

P3 – Applications of physics

Students must NOT submit a controlled assessment task for P1 for this qualification.

The quality of written communication will be important in all reports produced as how students present, order and explain their work links directly to how well it is understood by the reader.

Assessment overview

- This unit is internally assessed under controlled conditions.
- There will be two tasks available each year – one task from P2 and one task from P3.
- Each task has a shelf life of one year.
- The tasks will be available to teachers one year in advance.
- Each task has three parts – Part A: Planning, Part B: Observations and Part C: Conclusions.
- The total number of marks available for the three parts is 50.
- Students must attempt all three parts of a task.
- If they attempt both tasks, then the best marks from Part A, B and C should be submitted for the unit.

Detailed unit content

Delivery of the controlled assessment

Skills

Students should demonstrate the ability to carry out the following skills when completing a task:

a develop a hypothesis and plan practical ways to test it including risk assessment

b manage risks when carrying out practical work

c collect, process, analyse and interpret primary and secondary evidence including the use of appropriate technology to draw evidence-based conclusions

d review methodology to assess fitness for purpose, and review the hypothesis in light of outcomes.

Parts of the controlled assessment tasks

Part A – Planning (20 marks)

Includes choosing equipment, hypothesis, controls needed for the task, evidence/observations and range, identification and management of risk.

Part B – Observations (6 marks)

Includes primary and secondary evidence collection and recording.

Part C – Conclusions (24 marks)

Includes processing and presentation of evidence, quality of evidence, conclusions based on evidence, evaluation of method, evaluation of conclusion.

Student support

Where students produce a plan that is unworkable or dangerous, it is permitted for teachers to provide students with a plan, provided it is clear that students will not receive Part A marks for this plan.

Levels of control

Internal assessment under controlled conditions has levels of control for task setting, task taking and task marking. These must be adhered to when students are completing their controlled assessment tasks.

Summary of levels of control

Area	Level of control
Part A – Planning	Limited
Part B – Observations	Limited
Part C – Conclusions	High

Task setting

High level of control

A high level of control means that tasks will be set by Edexcel and centres will choose from a list of tasks, from the other units in this qualification.

The tasks will change every year, in accordance with the Ofqual regulations for GCSE Science. Teachers must take care when using these tasks to ensure that students are completing the correct task for a particular year. The front sheet of each task will show the dates for which it is valid.

When will the tasks be available?

They will be available on the Edexcel website for teachers to download a year ahead of their first assessment opportunity. Teachers can view all the task sheets available before deciding which task the students will complete.

When should the tasks be made available to students?

The task sheets for this controlled assessment are confidential and must not be shown to students before they start the tasks. Task sheets should not be shown to students until the start of the task planning stage of the controlled assessment.

Do all my students have to do the same task?

It is acceptable for all the students in a class to complete the same task. However, the same task does not have to be chosen for all students and they can work on a mixture of different tasks from P2 and P3.

The tasks will change every year, in accordance with the Ofqual regulations for GCSE Science. Teachers must take care when using these tasks to ensure that students are completing the correct task for a particular year. The front sheet of each task will show the dates for which it is valid.

Task taking

a Research and data collection – limited level of control

Research and data collection, including practical work, will be carried out under limited control. This means that students may work collaboratively when collecting data from practical activities.

Students may carry out any secondary research whilst not being directly supervised by a teacher, for example in a library or at home. The secondary research can include extracts from books and websites.

b Analysis, conclusions and evaluation of findings – high level of control

The analysis, conclusions and evaluation will be produced by students under high levels of control. This means that students must carry out this part of the write-up individually, under the supervision of a teacher.

The production of the final report will usually take place over several lessons, so the students' materials must be collected in at the end of the lesson and handed back at the beginning of the next one. Students' final reports must be produced individually.

Communication with students during the controlled assessment

Feedback can be given to students during the controlled assessment, but this must be general rather than specific feedback. Teachers may give students general feedback on:

- the equipment chosen
- the controls for the task
- data to be collected or observations to be made
- risks involved with the task
- techniques for processing data/observations
- skills involved in the conclusions and evaluation.

Students should receive a copy of the assessment criteria so that they are aware of what they need to do to access the full range of marks.

Suggested timings of each area

The suggested timings for each part of the controlled assessment task are as follows:

Part A – Planning	1 hour
Part B – Observations	1 hour
Part C – Conclusions	1 hour

Total of 3 hours

For this controlled assessment unit, it is expected that students should be given approximately 6 hours of time specifically on preparing for tasks. By using the practicals noted in the theory units, this can be achieved as part of your normal teaching.

Task marking

Task marking – medium level of control

A medium level of control means that the marking of the tasks will be carried out by teachers and moderated by Edexcel.

Marking procedure

Teachers should use the assessment criteria to mark the tasks and use the *Controlled Assessment Record Sheet* (Appendix 5) to record the marks. Edexcel will give additional guidance of the application of the generic marking criteria in support documentation.

It is good practice for teachers to annotate students' work to show how the marks have been allocated for each section.

Submitting marks

Students must attempt all three parts of any task they do.

Final marks for each section of the student's work should be recorded on the *Controlled Assessment Record Sheet* in Appendix 5.

They don't need to submit all marks from a task but can submit the best marks from any of the tasks they have attempted.

If a mark is submitted from a task, the student response to all three parts must be marked and retained by the centre for moderation.

Each CAT may be submitted for moderation in either May (for a June session) or October (for a November session).

Health and safety

Students must observe safe practice when they are carrying out practical work. It is the responsibility of centres to carry out risk assessments for all practical work that they undertake with their students.

In this internal assessment teachers will have limited control when students are collecting their data, but it should be carried out under full supervision for health and safety reasons. The limited control means that students can work collaboratively to collect their data.

Assessment criteria

Part A - Planning

Element	Marks		Criteria
Equipment	2	0 marks	Gives no relevant detail
		1–2 marks	a) Chooses most relevant resources/equipment b) Explains reasons for choices and choices are fully relevant to method

Element	Marks		Criteria
Controls (If variables are to be controlled, criteria a1 and b1 will be used. If there are no variables to control, criteria a2 and b2 will be used. The specific criteria needed will be in the controlled assessment task.)	6	0 marks	Gives no relevant controls
		1–2 marks	a1) Identifies one appropriate variable to control b1) Describes how this variable can be controlled OR a2) Identifies one appropriate way to control the task b2) Describes this way of controlling the task
		3–4 marks	a1) Identifies some relevant variables to control b1) Gives an appropriate description of how to control these variables OR a2) Identifies some relevant ways to control the task to produce meaningful results b2) Describes how these ways control the task
		5–6 marks	a1) Identifies a range of variables appropriate to control b1) Gives an appropriate explanation of how to control these variables OR a2) Provides a comprehensive list of relevant ways to control the task to produce meaningful results b2) Explains how these ways control the task

Element	Marks		Criteria
Hypothesis	4	0 marks	Provides no relevant hypothesis
		1–2 marks	a) Provides a hypothesis that is appropriate for most of the task b) Partially justifies the hypothesis
		3–4 marks	a) Provides a hypothesis that is appropriate for the full scope of the task, based on relevant scientific ideas b) Justifies the hypothesis fully using relevant scientific ideas
Risks	4	0 marks	No relevant detail given
		1–2 marks	a) Identifies a relevant risk which is specific to the task b) Suggests measure(s) to manage the risk
		3–4 marks	a) Identifies most of the relevant risks which are specific to the task b) Method reflects how risks need to be managed
Overall plan	4	0 marks	Gives no relevant method
		1–2 marks	a) Method is logically ordered to produce results b) Chooses range of data/observations that would test the hypothesis
		3–4 marks	a) Method is logically ordered to produce results and includes an explanation of why it would test the hypothesis b) Chooses range of data/observations that would test the hypothesis and explains why the range was chosen
Total marks	**20**		

Part B - Observations

Element	Marks		Criteria
Primary evidence and recording	4	0 marks	Collects no primary evidence
		1 mark	Records some data/observations that are appropriate for the topic
		2 marks	Collects a suitable range of data/observations and records some appropriately (depends on the practical)
		3 marks	Collects a suitable range of data/observations and records all appropriately (depends on the practical)
		4 marks	Collects a suitable range of data/observations and records all appropriately (depends on the practical) and records further/repeat data
Secondary evidence	2	0 marks	Collects no secondary evidence
		1 mark	Collects and records secondary evidence relevant to the hypothesis in a way appropriate for the topic
		2 marks	Collects and records secondary evidence relevant to the hypothesis in a way appropriate for the topic. Comments on the quality of the sources of secondary evidence
Total marks	**6**		

Part C - Conclusions

Element	Marks		Criteria
Processing evidence	4	0 marks	Evidence is not processed
		1–2 marks	a) Attempts to process all collected evidence, using appropriate mathematical skills b) Attempts to present the processed evidence in a way appropriate for the topic
		3–4 marks	a) Processes all collected evidence in a way that is appropriate to the task, using appropriate mathematical skills b) Presents processed evidence in a way that allows conclusions to be drawn
Quality of evidence	4	0 marks	Makes no comments on the quality of the evidence
		1–2 marks	a) Comments on the quality of the primary evidence, dealing with anomalies appropriately (if no anomalies in evidence candidates need to state this) b) Comments on the quality of the secondary evidence, dealing with anomalies appropriately (if no anomalies in evidence candidates need to state this)
		3–4 marks	a) Explains any adjustments to the evidence needed, or decision not to exclude evidence b) Takes account of anomalies in primary and secondary evidence when processing evidence (using all evidence if no anomalies)

Element	Marks		Criteria
Conclusions based on evidence	6	0 marks	Makes no relevant conclusions
		1–2 marks	a) Provides a conclusion based on all collected evidence, but does not link it to the hypothesis b) Attempts to explain the conclusion using all collected evidence, including appropriate mathematical relationships
		3–4 marks	a) Provides a conclusion which refers to the hypothesis based on all collected evidence b) Explains the conclusion using the evidence, including appropriate mathematical relationships
		5–6 marks	a) Provides a conclusion which refers to the hypothesis based on all collected evidence and relevant scientific ideas b) Explains the conclusion using relevant scientific ideas and all collected evidence, including appropriate mathematical relationships
Evaluation of conclusion	4	0 marks	Makes no relevant evaluation
		1–2 marks	a) Evaluates conclusion based on all collected evidence b) Suggests how all collected evidence can be improved to provide stronger support for the conclusion
		3–4 marks	a) Evaluates conclusion based on all collected evidence and relevant scientific ideas b) Suggests how all collected evidence can be improved and extended to provide stronger support for the conclusion

Element	Marks		Criteria
Evaluation of method	6	0 marks	Makes no relevant evaluation
		1–2 marks	a) Identifies a strength or weakness in the method b) Suggests how to improve method and justifies comments made
		3–4 marks	a) Describes strengths or weaknesses in the method and reasons for any anomalies b) Suggests how to improve method and justifies comments made relating to the quality of the evidence collected (including reasons for anomalies)
		5–6 marks	a) Describes strengths and weaknesses in the method and relates them to the hypothesis, and reasons for any anomalies b) Suggests how to improve method, justifying comments made relating to the hypothesis and how better quality evidence could be produced (including reasons for anomalies)
Total marks	**24**		

B Assessment

Assessment summary

Unit P1 is externally assessed by a one hour examination

Unit P2 is externally assessed by a one hour examination

Unit P3 is externally assessed by a one hour examination

Unit PCA is an internally assessed unit

Summary of table of assessment

Unit P1:	Universal physics	Unit code: 5PH1F/5PH1H

- This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.
- The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.
- Availability: November, March and June.
- First assessment: November 2011.

Unit P2:	Physics for your future	Unit code: 5PH2F/5PH2H

- This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.
- The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.
- Availability: November, March and June.
- First assessment: June 2012.

Unit P3:	Applications of physics	Unit code: 5PH3F/5PH3H

- This unit is assessed through a one hour, 60 mark, tiered written examination, containing six questions.
- The examination will contain a mixture of question styles, including objective questions, short answer questions and extended writing questions.
- Availability: November, March and June.
- First assessment: June 2013.

Unit PCA: Physics controlled assessment	Unit code: 5PH04

- This unit is internally assessed under controlled conditions.
- There will be two tasks available each year – one task from P2 and one task from P3.
- Each task has a shelf life of one year.
- The tasks will be available to teachers one year in advance.
- Each task has three parts - Part A: Planning, Part B: Observations and Part C: Conclusions.
- The total number of marks available for the three parts is 50.
- Students must attempt all three parts of a task.
- If they attempt both tasks, then the best marks from Part A, B and C should be submitted for the unit.
- Availability: November and June.
- First assessment: June 2013.

Assessment Objectives and weightings

		% in GCSE
AO1:	Recall, select and communicate their knowledge and understanding of physics	**33 – 39%**
AO2:	Apply skills, knowledge and understanding of science in practical and other contexts	**34 – 40%**
AO3:	Analyse and evaluate evidence, make reasoned judgements and draw conclusions based on evidence	**25.5 – 28.5%**
	TOTAL	**100%**

Relationship of Assessment Objectives to units

Unit	Assessment Objective			
	AO1	**AO2**	**AO3**	**Total for AO1, AO2 and AO3**
Unit P1: Universal physics	11 – 13%	7 – 9%	4.5 – 5.5%	25%
Unit P2: Physics for your future	11 – 13%	7 – 9%	4.5 – 5.5%	25%
Unit P3: Applications of physics	11 – 13%	7 – 9%	4.5 – 5.5%	25%
Unit PCA: Physics controlled assessment	0%	13%	12%	25%
Total for GCSE in Physics	**33 – 39%**	**34 – 40%**	**25.5 – 28.5%**	**100%**

Entering your students for assessment

Student entry

Details of how to enter students for this qualification can be found in Edexcel's *Information Manual*, a copy is sent to all examinations officers. The information can also be found on Edexcel's website (www.edexcel.com).

There is a requirement that at least 40 per cent of the assessment must be taken in the examination series in which certification is requested. The final qualification grade will include assessment results which satisfy this terminal requirement.

All externally assessed units will be assessed by tiered examinations. Students will need to be entered for a specific tier at the time of entry.

Forbidden combinations and classification code

Centres should be aware that students who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the School and College Performance Tables.

Students should be advised that, if they take two qualifications with the same classification code, schools and colleges are very likely to take the view that they have achieved only one of the two GCSEs. The same view may be taken if students take two GCSE qualifications that have different classification codes but have significant overlap of content. Students who have any doubts about their subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

Access arrangements and special requirements

Edexcel's policy on access arrangements and special considerations for GCE, GCSE and Entry Level aims to enhance access to the qualifications for students with disabilities and other difficulties (as defined by the Disability Discrimination Act 1995 and the amendments to the Act) without compromising the assessment of skills, knowledge, understanding or competence.

Please see the Edexcel website (www.edexcel.com) for:

- the JCQ policy Access Arrangements and Special Considerations, Regulations and Guidance Relating to Students who are Eligible for Adjustments in Examinations
- the forms to submit for requests for access arrangements and special considerations
- dates for submission of the forms.

Requests for access arrangements and special considerations must be addressed to:

Special Requirements
Edexcel
One90 High Holborn
London WC1V 7BH

Disability Discrimination Act (DDA)

Please see the Edexcel website (www.edexcel.com) for information with regard to the Disability Discrimination Act.

Controlled assessment

In controlled assessments, control levels are set for three linked processes: task setting, task taking and task marking. The control levels (high, medium or limited are dependent on the subject) are set for each process so that the overall level of control secures validity and reliability, provides good manageability for all involved and allows teachers to authenticate the student work confidently.

The summary of the controlled conditions for this qualification is shown below.

Summary of conditions for controlled assessment

Levels of control

Internal assessment under controlled conditions has levels of control for task setting, task taking and task marking. These must be adhered to when students are completing their controlled assessment tasks.

Summary of levels of control

Area	Level of control
Part A – Planning	Limited
Part B – Observations	Limited
Part C – Conclusions	High

Task setting

High level of control

A high level of control means that tasks will be set by Edexcel and centres will choose from a list of tasks, from the other units in this qualification.

When will the tasks be available?

They will be available on the Edexcel website for teachers to download a year ahead of their first assessment opportunity. Teachers can view all the task sheets available before deciding which task the students will complete.

When should the tasks be made available to students?

The task sheets for this controlled assessment are confidential and must not be shown to students before they start the tasks. Task sheets should not be shown to students until the start of the task planning stage of the controlled assessment.

Do all my students have to do the same task?

It is acceptable for all the students in a class to complete the same task. However, the same task does not have to be chosen for all students and they can work on a mixture of different tasks from P2 and P3.

The tasks will change every year, in accordance with the Ofqual regulations for GCSE Science. Teachers must take care when using these tasks to ensure that students are completing the correct task for a particular year. The front sheet of each task will show the dates for which it is valid.

Task taking

a Research and data collection – limited level of control

Research and data collection, including practical work, will be carried out under limited control. This means that students may work collaboratively when collecting data from practical activities.

Students may carry out any secondary research whilst not being directly supervised by a teacher, for example in a library or at home. The secondary research can include extracts from books and websites.

b Analysis, conclusions and evaluation of findings – high level of control

The analysis, conclusions and evaluation will be produced by students under high levels of control. This means that this part of the write-up must be carried out individually by the students, under the supervision of a teacher.

The production of the final report will usually take place over several lessons, so the students' materials must be collected in at the end of the lesson and handed back at the beginning of the next one. Students' final reports must be produced individually.

Task marking

Task marking – medium level of control

A medium level of control means that the marking of the tasks will be carried out by teachers and moderated by Edexcel.

Internal standardisation

Teachers must show clearly how the marks have been awarded in relation to the assessment criteria. If more than one teacher in a centre is marking students' work, there must be a process of internal standardisation to ensure that there is consistent application of the assessment criteria.

Authentication

All students must sign an authentication statement. Statements relating to work not sampled should be held securely in your centre. Those that relate to sampled students must be attached to the work and sent to the moderator. In accordance with a revision to the current Code of Practice, any student unable to provide an authentication statement will receive zero credit for the component. Where credit has been awarded by a centre-assessor to sampled work without an accompanying authentication statement, the moderator will inform Edexcel and the mark will be adjusted to zero.

Further information

For more information on annotation, authentication, mark submission and moderation procedures, please refer to the *Edexcel GCSEs in Science, Additional Science, Biology, Chemistry and Physics: Instructions and administrative documentation for internally assessed units* document, which is available on the Edexcel website.

For up-to-date advice on teacher involvement, please refer to the Joint Council for Qualifications (JCQ) *Instructions for conducting coursework/portfolio* document on the JCQ website (www.jcq.org.uk).

For up-to-date advice on malpractice and plagiarism, please refer to the Joint Council for Qualifications (JCQ) *Suspected Malpractice in Examinations: Policies and Procedures and Instructions for conducting coursework/portfolio* document on the JCQ website (www.jcq.org.uk).

Assessing your students

The first assessment opportunity for Unit P1 of this qualification will take place in the November 2011 series and in each following March, June and November series for the lifetime of the qualification. The first assessment opportunity for; Unit P2 will be in June 2012, Unit P3 will be in June 2013 and then in each following November, March and June series for the lifetime of the qualification. The first assessment opportunity for Unit PCA of this qualification will take place in the June 2013 series and in each following November and June series for the lifetime of the qualification.

Your student assessment opportunities

GCSE in Physics

Unit	Nov 2011	March 2012	June 2012	Nov 2012	March 2013	June 2013	Nov 2013	March 2014
Unit P1: Universal physics	✓	✓	✓	✓	✓	✓	✓	✓
Unit P2: Physics for your future			✓	✓	✓	✓	✓	✓
Unit P3: Applications of physics						✓	✓	✓
Unit PCA: Physics controlled assessment						✓	✓	

Awarding and reporting

The grading, awarding and certification of this qualification will comply with the requirements of the current GCSE/GCE Code of Practice, which is published by the Office of Qualifications and Examinations Regulation (Ofqual). The GCSE qualification will be graded and certificated on an eight-grade scale from A* to G. Individual unit results will be reported.

The first certification opportunity for the Edexcel GCSE in Physics will be in 2013.

Students whose level of achievement is below the minimum judged by Edexcel to be of sufficient standard to be recorded on a certificate will receive an unclassified U result.

Unit results

The minimum uniform marks required for each grade for each unit:

All units

Unit grade	A*	A	B	C	D	E	F	G
Maximum uniform mark = 80	72	64	56	48	40	32	24	16

Students who do not achieve the standard required for a grade G will receive a uniform mark in the range 0–15.

Qualification results

The minimum uniform marks required for each grade:

GCSEs in Physics Cash-in code: 2PH01

Qualification grade	A*	A	B	C	D	E	F	G
Maximum uniform mark = 320	288	256	224	192	160	128	96	64

Students who do not achieve the standard required for a grade G will receive a uniform mark in the range 0–63.

Resitting of units

Students can resit a unit once (regardless of tier) before claiming certification for the qualification. For internally assessed units students will need to retake the entire assessment requirements for that unit.

At least 40 per cent of the assessment must be taken in the examination series in which certification is requested and the results from these assessments must be used. Therefore, any previous, banked results for the unit(s) that are being used to satisfy the terminal requirement cannot be used even if they are better than the results achieved in the terminal series.

Results of units held in Edexcel's unit bank have a shelf-life limited only by the shelf-life of this qualification and, subject to the terminal requirement, these unit results may be re-used after certification.

Language of assessment

Assessment of this qualification will be available in English only. Assessment materials will be published in English only and all work submitted for examination and moderation must be produced in English.

Quality of written communication

Students will be assessed on their ability to:

- write legibly, with accurate use of spelling, grammar and punctuation, in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise relevant information clearly and coherently, using specialist vocabulary when appropriate.

Stretch and challenge

Students can be stretched and challenged in units through the use of different assessment strategies, for example:

- using a variety of stems in questions – for example analyse, evaluate, discuss, compare, describe, explain
- ensuring connectivity between sections of questions
- a requirement for extended writing
- use of a wider range of question types to address different skills – for example open-ended questions, case studies, etc.

Malpractice and plagiarism

For up-to-date advice on malpractice and plagiarism, please refer to the Joint Council for Qualifications (JCQ) *Suspected Malpractice in Examinations: Policies and Procedures* document on the JCQ website (www.jcq.org.uk).

Student recruitment

Edexcel's access policy concerning recruitment to our qualifications is that:

- they must be available to anyone who is capable of reaching the required standard
- they must be free from barriers that restrict access and progression
- equal opportunities exist for all students.

Progression

- Students who successfully achieve this GCSE in Physics can progress onto a number of qualifications, such as the Level 3 GCE in Physics.
- Students could also progress onto an Edexcel BTEC Level 3 Applied Science qualification.
- Students could also progress into employment.

Grade descriptions

Physics

A	Students recall, select and communicate precise knowledge and detailed understanding of physics. They demonstrate a comprehensive understanding of the nature of physics, its laws, principles and applications and the relationship between physics and society. They understand the relationships between scientific advances, their ethical implications and the benefits and risks associated with them. They use scientific and technical knowledge, terminology and conventions appropriately and consistently, showing a detailed understanding of scale in terms of time, size and space. They apply appropriate skills, including mathematical, technical and observational skills, knowledge and understanding effectively in a wide range of practical and other contexts. They show a comprehensive understanding of the relationships between hypotheses, evidence, theories and explanations and make effective use of models, including mathematical models, to explain abstract ideas, phenomena, events and processes. They use a wide range of appropriate methods, sources of information and data consistently, applying relevant skills to address scientific questions, solve problems and test hypotheses. Students analyse, interpret and critically evaluate a broad range of quantitative and qualitative data and information. They evaluate information systematically to develop arguments and explanations taking account of the limitations of the available evidence. They make reasoned judgements consistently and draw detailed, evidence-based conclusions.

C	Students recall, select and communicate secure knowledge and understanding of physics. They demonstrate understanding of the nature of physics, its laws, principles and applications and the relationship between physics and society. They understand that scientific advances may have ethical implications, benefits and risks. They use scientific and technical knowledge, terminology and conventions appropriately, showing understanding of scale in terms of time, size and space. They apply appropriate skills, including mathematical, technical and observational skills, knowledge and understanding in a range of practical and other contexts. They show understanding of the relationships between hypotheses, evidence, theories and explanations and use models, including mathematical models, to describe abstract ideas, phenomena, events and processes. They use a range of appropriate methods, sources of information and data, applying their skills to address scientific questions, solve problems and test hypotheses. Students analyse, interpret and evaluate a range of quantitative and qualitative data and information. They understand the limitations of evidence and use evidence and information to develop arguments with supporting explanations. They draw conclusions based on the available evidence.
F	Students recall, select and communicate limited knowledge and understanding of physics. They recognise simple inter-relationships between physics and society. They show a basic understanding that scientific advances may have ethical implications, benefits and risks. They use limited scientific and technical knowledge, terminology and conventions, showing some understanding of scale in terms of time, size and space. They apply skills, including limited mathematical, technical and observational skills, knowledge and understanding, in practical and some other contexts. They recognise and use hypotheses, evidence and explanations and can explain straightforward models of phenomena, events and processes. Using a limited range of skills and techniques, they answer scientific questions, solve straightforward problems and test ideas. Students interpret and evaluate limited quantitative and qualitative data and information from a narrow range of sources. They can draw elementary conclusions having collected limited evidence.

C Resources, support and training

Edexcel resources

Edexcel aims to provide the most comprehensive support for our qualifications.

Edexcel publications

You can order further copies of the specification, Sample Assessment Materials (SAMs) and Teacher's Guide documents from:

Edexcel Publications
Adamsway
Mansfield
Nottinghamshire NG18 4FN

Telephone: 01623 467 467
Fax: 01623 450 481
Email: publications@linney.com
Website: www.edexcel.com

Endorsed resources

Edexcel also endorses some additional materials written to support this qualification. Any resources bearing the Edexcel logo have been through a quality assurance process to ensure complete and accurate support for the specification. For up-to-date information about endorsed resources, please visit www.edexcel.com/endorsed.

Please note that while resources are checked at the time of publication, materials may be withdrawn from circulation and website locations may change.

Edexcel support services

Edexcel has a wide range of support services to help you implement this qualification successfully.

ResultsPlus – ResultsPlus is an application launched by Edexcel to help subject teachers, senior management teams and students by providing detailed analysis of examination performance. Reports that compare performance between subjects, classes, your centre and similar centres can be generated in just a few clicks. Skills maps that show performance according to the specification topic being tested are available for some subjects. For further information about which subjects will be analysed through ResultsPlus, and for information on how to access and use the service, please visit www.edexcel.com/resultsplus.

Ask the Expert – To make it easier for you to raise a query with us online, we have merged our **Ask Edexcel** and **Ask the Expert** services.

There is now one easy-to-use web query form that will allow you to ask any question about the delivery or teaching of Edexcel qualifications. You'll get a personal response, from one of our administrative or teaching experts, sent to the email address you provide.

We'll also be doing lots of work to improve the quantity and quality of information in our FAQ database, so you'll be able to find answers to many questions you might have by searching before you submit the question to us.

Examzone – The Examzone site is aimed at students sitting external examinations and gives information on revision, advice from examiners and guidance on results, including re-marking, resitting and progression opportunities. Further services for students – many of which will also be of interest to parents – will be available in the near future. Links to this site can be found on the main homepage at www.examzone.co.uk.

Training

A programme of professional development and training courses covering various aspects of the specification and examination will be arranged by Edexcel each year on a regional basis. Full details can be obtained from:

Training from Edexcel
Edexcel
One90 High Holborn
London WC1V 7BH

Telephone: 0844 576 0027
Email: trainingbookings@edexcel.com
Website: www.edexcel.com

D Appendices

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Appendix 1: Codes

Type of code	Use of code	Code number
National classification codes	Every qualification is assigned to a national classification code indicating the subject area to which it belongs. Centres should be aware that students who enter for more than one GCSE qualification with the same classification code will have only one grade (the highest) counted for the purpose of the school and college performance tables.	1210
National Qualifications Framework (NQF) codes	Each qualification title is allocated a National Qualifications Framework (NQF) code. The NQF code is known as a Qualification Number (QN). This is the code that features in the DfE Funding Schedule, Sections 96 and 97, and is to be used for all qualification funding purposes. The QN is the number that will appear on the student's final certification documentation.	The QN for the qualification in this publication is: GCSE in Physics – 600/0771/0
Unit codes	Each unit is assigned a unit code. This unit code is used as an entry code to indicate that a student wishes to take the assessment for that unit. Centres will need to use the entry codes only when entering students for their examination.	Unit P1 – 5PH1F/5PH1H Unit P2 – 5PH2F/5PH2H Unit P3 – 5PH3F/5PH3H Unit PCA – 5PH04
Cash-in codes	The cash-in code is used as an entry code to aggregate the student's unit scores to obtain the overall grade for the qualification. Centres will need to use the entry codes only when entering students for their qualification.	GCSE in Physics – 2PH01
Entry codes	The entry codes are used to: • enter a student for the assessment of a unit • aggregate the student's unit scores to obtain the overall grade for the qualification.	Please refer to the *Edexcel Information Manual*, available on the Edexcel website

Appendix 2: How Science Works mapping

How Science Works reference *(see page 9)*	Unit P1 specification reference
1	1.2, 1.4, 1.7, 1.8, 3.7, 3.8, 3.14, 3.17, 3.21, 4.7, 5.3, 5.4, 5.6, 5.7, 6.6, 6.7
2	1.3, 2.1, 3.10, 3.19, 4.9
3	1.1, 1.3, 1.7, 1.13, 3.8, 3.16, 3.19, 3.21, 3.22, 4.8, 4.10, 6.3
4	3.6, 3.7, 3.8, 3.13, 3.14, 3.15, 3.21, 4.6, 4.7, 4.8
5	1.7, 1.8, 3.8, 4.6, 4.7, 5.3, 5.4, 5.6, 5.7, 6.6, 6.7
6	1.7, 1.8, 2.1, 3.8, 4.6, 4.7, 5.3, 5.4, 5.7, 5.6, 6.6, 6.7
7	1.7, 1.8, 3.8, 4.6, 4.7, 5.3, 5.4, 5.6, 5.7, 6.6, 6.7
8	1.7, 1.8, 3.8, 4.6, 4.7, 5.3, 5.4, 5.6, 5.7, 6.6, 6.7
9	Throughout the unit
10	1.7, 1.8, 1.14, 2.3, 2.4, 3.4, 3.5, 3.7, 3.8, 3.9, 4.6, 4.7, 4.9, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.16, 5.18, 5.19, 6.4, 6.5, 6.6, 6.7
11	1.5, 1.8, 1.10, 1.12, 1.14, 3.8, 3.9, 3.16, 4.1, 4.4, 4.6, 4.9, 4.10, 5.3
12	1.10, 2.7, 2.8, 3.6, 3.7, 3.13, 4.1, 4.4, 4.9, 5.4, 5.17, 5.18, 5.19
13	3.6, 5.4
14	1.1, 1.3, 2.1, 3.4, 3.6, 3.7, 3.13, 3.14, 3.15, 3.20, 3.21, 3.22

How Science Works reference *(see page 9)*	Unit P2 specification reference
1	2.6, 2.12, 3.2, 3.6, 3.15, 3.16, 4.3, 4.8, 5.6, 6.8
2	2.6, 2.12, 3.7, 3.16, 4.3, 4.8, 5.6
3	1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.9, 1.10, 2.2, 2.6, 2.7, 2.12, 2.16, 3.16, 4.3, 4.8, 5.2, 5.6, 5.13
4	5.16
5	2.6, 2.12, 3.15, 3.16, 4.3, 4.8, 6.8
6	2.6, 2.12, 3.15, 3.16, 4.3, 4.8, 6.8
7	2.6, 2.12, 3.15, 3.16, 4.3, 4.8, 6.8
8	2.6, 2.12, 3.15, 3.16, 4.3, 4.8, 6.8
9	Throughout the unit
10	1.11, 2.6, 2.8, 2.12, 2.16, 3.2, 3.5, 3.6, 3.7, 3.12, 3.13, 3.15, 4.3, 4.4, 4.5, 4.8, 4.9, 4.10, 4.13, 4.18, 5.6, 6.8
11	1.11, 2.5, 2.6, 2.8, 2.9, 2.12, 2.16, 3.1, 3.2, 3.5, 3.6, 3.7, 3.12, 3.13, 3.16, 4.3, 4.4, 4.5, 4.8, 4.9, 4.10, 4.13, 4.18, 5.2, 5.6
12	1.7, 1.12, 2.15, 4.5, 4.7, 5.1, 5.16, 6.3, 6.9, 6.11, 6.12
13	1.7, 4.2, 4.7, 5.1, 5.16, 6.3, 6.9, 6.11, 6.12
14	4.7, 5.1, 5.16, 6.3, 6.10, 6.11, 6.12

How Science Works reference *(see page 9)*	Unit P3 specification reference
1	1.8, 1.17, 1.18, 3.10, 3.12, 3.13, 4.12, 5.7, 5.9
2	1.8, 3.10, 3.12, 3.13, 4.1, 5.7, 5.9
3	1.8, 1.13, 1.14, 1.15, 3.2, 3.5, 3.6, 3.10, 3.12, 3.13, 3.14, 3.15, 3.16
4	4.1
5	1.8, 1.17, 1.18, 4.12, 5.7, 5.9
6	1.8, 1.17, 1.18, 4.12, 5.7, 5.9
7	1.8, 1.18, 4.12, 5.7, 5.9
8	1.8, 1.18, 4.12, 5.7, 5.9
9	Throughout the unit
10	1.4, 1.7, 1.8, 1.9, 1.18, 2.4, 2.5, 2.11, 3.7, 3.8, 4.12, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12
11	1.8, 1.9, 1.13, 1.14, 1.15, 1.18, 2.4, 2.5, 2.11, 3.8, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12
12	1.14, 1.18, 1.19, 1.20, 2.9, 2.10, 2.12, 2.14, 3.1, 3.20, 3.21, 3.22, 3.23, 3.24, 4.6, 4.8, 5.12
13	1.14, 1.18, 1.20, 2.8, 2.12, 3.1, 3.21, 3.22, 3.24, 4.6, 4.8
14	3.21, 3.22, 3.23, 3.24, 4.1, 4.2

Appendix 3: Mathematical skills mapping

Mathematical skills reference *(see page 10)*	Unit specification reference		
	P1	**P2**	**P3**
1	1.5, 1.8, 2.4, 3.4, 3.10, 3.16, 4.2, 5.2, 5.4, 5.5, 5.14, 5.15, 6.5, 6.7	1.11, 2.15, 2.6, 2.8, 2.16, 3.14, 3.4, 3.5, 3.8, 3.12, 3.13, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18, 6.7, 6.8	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
2	1.5, 1.8, 5.2, 5.4, 5.5, 5.15, 6.5	1.11, 2.15, 2.6, 2.8, 2.16, 3.5, 3.8, 3.12, 3.13, 3.14, 3.4, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18, 6.7, 6.8	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
3	1.5, 1.8, 5.2, 5.4, 5.15, 6.5	1.11, 2.15, 2.6, 2.8, 2.16, 3.5, 3.8, 3.12, 3.13, 3.14, 3.4, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 3.8, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
4	5.2, 5.4, 5.15, 6.5	1.11, 2.15, 2.6, 2.8, 2.16, 3.5, 3.8, 3.12, 3.13, 3.14, 3.4, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 2.11, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
5	5.2, 5.4, 5.15, 6.5	1.11, 2.15, 2.6, 2.8, 2.16, 3.5, 3.8, 3.12, 3.13, 3.14, 3.4, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
6	2.4, 2.6, 3.16, 5.2, 5.4, 5.15, 6.5	1.11, 2.15, 2.6, 2.8, 2.16, 3.5, 3.8, 3.12, 3.13, 3.14, 3.4, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18, 6.7, 6.8	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
7		2.6, 3.5, 4.9	
8	5.2, 5.4	1.11, 2.16, 2.6, 2.8, 3.5, 3.8, 3.12, 3.13, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18	1.4, 1.7, 1.8, 1.9, 2.15, 2.4, 2.5, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
9	4.6, 5.4, 6.7	2.6, 3.5, 3.6, 4.9, 6.7, 6.8	1.4, 1.7, 1.8, 1.9, 1.17, 2.15, 2.4, 2.5, 2.7, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11

Mathematical skills reference *(see page 10)*	Unit specification reference		
	P1	**P2**	**P3**
10	1.15, 5.17, 5.2, 5.21, 5.3, 5.4, 5.15, 6.5	1.11, 2.6, 2.8, 2.16, 3.13, 4.9, 4.10	1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
11	4.6, 5.4, 6.7	2.6, 3.5, 3.6, 4.3, 4.8, 4.9, 6.6, 6.7, 6.8	1.4, 1.7, 1.8, 1.9, 1.17, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
12	4.6, 5.4, 6.7	2.6, 3.5, 3.6, 4.3, 4.8, 4.9, 6.6, 6.7, 6.8	1.4, 1.7, 1.8, 1.9, 1.17, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
13		6.7, 6.8	
14		3.5, 3.6, 4.9	1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.14, 3.4,
15	1.15, 3.4, 5.21	3.5, 3.12, 3.13, 4.4, 4.9, 4.10, 4.13, 4.15, 4.16, 4.18	1.4,1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.14, 3.4, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
16	1.15, 5.21		5.10, 5.11
17	1.15, 5.2, 5.3, 5.4, 5.15, 5.17, 5.21, 6.5	1.11, 2.6, 2.8, 2.15, 2.16, 3.4, 3.12, 3.13, 3.14, 4.4, 4.10, 4.13, 4.15, 4.16, 4.18	1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.4, 3.14, 5.5, 5.7, 5.8, 5.9, 5.10, 5.11
18	2.4, 6.5	2.6, 2.8, 2.16, 3.5, 4.13, 4.9, 6.6, 6.7, 6.8	1.4, 1.7, 1.8, 1.9, 2.4, 2.5, 2.15, 3.4, 3.14,5.5, 5.7, 5.8, 5.9, 5.10, 5.11
19	6.5	6.6, 6.7	

Appendix 4: The periodic table of the elements

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantaium 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenicated						

* The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.

The relevant atomic masses of copper and chlorine have not been rounded to the nearest whole number.

Appendix 5: Controlled Assessment Record Sheet

Centre Name:	Centre Number:
Teacher Name:	Qualification Number:
Qualification Title:	Examination Series:
Candidate Name:	Candidate Number:

One mark is required for each of the areas shown in Part A, Part B and Part C. The marks can either be for Part A, Part B and Part C from the same task or from different tasks relating to Units P2/P3 for this GCSE. Centres must retain all parts of the task for moderation.

Part A – Planning			**Part B – Observations**			**Part C – Conclusions**		
Marks from	**P2 / P3** delete as appropriate		**Marks from**	**P2 / P3** delete as appropriate		**Marks from**	**P2 / P3** delete as appropriate	
Area	**Centre mark awarded**	**Max. mark**	**Area**	**Centre mark awarded**	**Max. mark**	**Area**	**Centre mark awarded**	**Max. mark**
Equipment		**2**	**Primary evidence and recording**		**4**	**Processing evidence**		**4**
Controls		**6**	**Secondary evidence**		**2**	**Quality of evidence**		**4**
Hypothesis		**4**						
Risks		**4**				**Conclusions based on evidence**		**6**
Overall plan		**4**				**Evaluation of conclusion**		**4**
						Evaluation of method		**6**
Total		**20**	**Total**		**6**	**Total**		**24**
Total for Unit PCA: Physics controlled assessment								

Declaration of authentication

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

Candidate signature _____

Teacher signature _____

Date final record sheet signed _____

By signing the above declaration, you agree to your controlled assessment task(s) being used to support Professional Development, Online Support and Training of both Centre-Assessors and Edexcel Moderators. If you have any concerns regarding this, please contact Science2011@edexcel.com.

Appendix 6: Physics formulae

Formulae sheets will be given to students in their examinations. These will contain all the formulae from the unit which is being examined.

The following formulae are from Unit P1

Specification reference	Equation
1.15	The relationship between wave speed, frequency and wavelength: wave speed (metre/second, m/s) = frequency (hertz, Hz) × wavelength (metre, m) $v = f \times \lambda$ The relationship between wave speed, distance and time: wave speed (metre/second, m/s) = distance (metre, m)/time (second, s) $v = \frac{x}{t}$
5.3	The relationship between electric power, current and potential difference: electrical power (watt, W) = current (ampere, A) × potential difference (volt, V) $P = I \times V$
5.17	Calculating the cost of electricity: cost = power (kilowatts, kW) × time (hour, h) × cost of 1 kilowatt-hour (p/kW h)
5.21	The relationship between power, energy and time: power (watt, W) = energy used (joule, J) / time taken (second, s) $P = \frac{E}{t}$
6.5	The term efficiency calculated from: $efficiency = \frac{(useful\ energy\ transferred\ by\ the\ device)}{(total\ energy\ supplied\ to\ the\ device)} \times 100\%$

The following formulae are from Unit P2

Specification reference	Equation
1.11	The relationship between electric charge, current and time: charge (coulomb, C) = current (ampere, A) × time (second, s) $Q = I \times t$
2.8	The relationship between voltage, current and resistance: potential difference (volt, V) = current (ampere, A) × resistance (ohm, Ω) $V = I \times R$
2.15	The relationship between power, current and voltage: electrical power (watt, W) = current (ampere, A) × potential difference (volt, V) $P = I \times V$
2.16	Calculate electrical energy: energy transferred (joule, J) = current (ampere, A) × potential difference (volt, V) × time (second, s) $E = I \times V \times t$
3.4	Calculate speed: speed (m/s) = distance (m) / time (s)
3.5	Calculate acceleration: acceleration (metre per second squared, m/s^2) = change in velocity (metre per second, m/s) / time taken (second, s) $a = \frac{(v - u)}{t}$
3.13	The relationship between force, mass and acceleration: force (newton, N) = mass (kilogram, kg) × acceleration (metre per second squared, m/s^2) $F = m \times a$
3.14	The relationship between mass, weight an gravitational field strength: weight (newton, N) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) $W = m \times g$
4.4	The relationship between momentum, mass and velocity: momentum (kilogram metre per second, kg m/s) = mass (kilogram, kg) × velocity (metre per second, m/s)
4.9	**Calculate the momentum conservation for a two-body collision (in one dimension only):** **force (newton, N) = change in momentum (kilogram metre per second, kg m/s) / time (second, s)** $F = (mv - mu) / t$

Specification reference	Equation
4.10	The relationship between work done, force and distance: work done (joule, J) = force (newton, N) × distance moved in the direction of the force (metre, m) $E = F \times d$
4.13	The relationship between power, work done and time taken: power (watt, W) = work done (joule, J) / time taken (second, s) $P = \frac{E}{t}$
4.15	Calculate potential energy: gravitational potential energy (joule, J) = mass (kilogram, kg) × gravitational field strength (newton per kilogram, N/kg) × vertical height (metre, m) GPE = $m \times g \times h$
4.16	Calculate kinetic energy: kinetic energy (joule, J) = $\frac{1}{2}$ × mass (kilogram, kg) × velocity^2 ((metre/second)^2 (m/s)^2) KE = $\frac{1}{2} \times m \times v^2$

The following formulae are from Unit P3

Specification reference	Equation
1.4	**Calculate intensity of radiation:** **intensity = power of incident radiation /area** $I = P/A$
1.7	The relationship between the power of lens and its focal length: power of lens (dioptre, D) = 1/focal length (metre, m)
1.9	**The relationship between focal length, object distance and image distance:** $1/f = 1/u + 1/v$ **(f = focal length (m), u = object distance (m), v = image distance (m))**
2.4	**The relationship between current, number of particles and the charge on each particles:** **current (ampere, A) = number of particles per second (1/second, 1/s) × charge on each particle (coulomb, C)** $I = N \times q$
2.5	**Calculate kinetic energy:** **kinetic energy (joule, J) = charge on the electron (coulomb, C) × accelerating potential difference (volt, V)** $KE = \frac{1}{2}mv^2 = e \times V$
2.12	Calculate frequency: frequency (hertz, Hz) = 1/time period (second, s) $f = 1/T$
5.8	The relationship between temperature and volume for a gas: $V_1 = V_2T_1/T_2$
5.10	The relationship between volume and pressure for a gas $V_1P_1 = V_2P_2$
5.11	**The relationship between the volume, pressure and temperature for a gas:** **initial pressure (pascal, Pa) × initial volume (metre^3, m^3) / initial temperature (kelvin, K) = final pressure (pascal, Pa) × final volume (metre^3, m^3) / final temperature (kelvin, K)** $P_1V_1/T_1 = P_2V_2/T_2$

Appendix 7 Certification, cash-in, transfer rules and entry code for transferring units

Certification and cash-in rules

Certification for the GCSE in Physics may be claimed in March, June or November, providing all of the contributing units have been entered and assessed and at least 40 per cent of the assessment has been taken in that examination series.

Students may also cash in for any of the other four science qualifications in the same examination series.

Externally assessed components

There is one unit code for any common external units.

The result of an external unit can only count towards one qualification. For example, if the result for 5PH1F (Unit 1 foundation tier) is used towards GCSE in Physics (2PH01), this same unit result cannot be used towards GCSE in Science (2SC01), or vice versa.

Transfer rules

If a student wishes to claim certification for GCSE in Physics **and** GCSE in Additional Science then the student must take the relevant external units for the two qualifications.

For the internal unit, a student's result from GCSE in Physics to GCSE in Additional Science and vice versa may be transferred providing the work submitted meets the requirements for the appropriate qualification.

A transfer can only be made once a centre can confirm this. If the requirement is not met for the second qualification then the student will need to do a new controlled assessment task.

Example 1: transferring the Physics internal unit result to Additional Science

If a student wishes to use the unit result from Unit PCA in the GCSE Physics qualification (2PH01) towards Unit ASCA of the GCSE in Additional Science qualification (2SA01), then this is acceptable but only if the PCA unit result uses marks **only** from the P2 controlled assessment. If the PCA unit result uses any marks from P3, then the result **cannot** be transferred to GCSE in Additional Science, Unit ASCA.

Example 2: transferring an Additional Science unit result to Physics

If a student wishes to use the unit result from Unit ASCA in the GCSE Additional Science qualification (2SA01) towards Unit PCA of the GCSE in Physics qualification (2PH01), then this is acceptable but only if the ASCA unit result uses marks **only** from the P2 controlled assessment. If the ASCA unit result uses any marks from B2 and/or C2, then the result **cannot** be transferred to GCSE in Physics, Unit PCA.

Transfer of a unit result

When a transfer is being requested for a unit result the following must be done by the Centre

- make the correct entry code
- provide evidence to Edexcel that the controlled assessment fulfils the requirements for the other qualification.

Evidence to support transfer of a unit result

Centres are advised to check before requesting a transfer that they have a copy of the record sheet of the original work. Although entries will be accepted for a transfer, if it is found that a centre has not provided a copy of the record sheet then the transfer request will **not** be granted.

If a centre requests the transfer of a controlled assessment unit result, the centre will need to provide a hardcopy or a scanned copy of the original record sheet to Edexcel to show that the work fulfils the rules for the second qualification.

The deadline for submission of this evidence is the same as the deadline for submission of controlled assessment work.

Please send a hardcopy of the record sheet to:

Edexcel
Lowton House
Lowton Way
Hellaby
Rotherham
South Yorkshire
S66 8SS

Or email a scanned copy to: Science2011@edexcel.com

Entry codes for transferring units

The following entry codes should be used when transferring the unit results for the internal controlled assessed unit.

Entry code	When it should be used
5SA0T/01	When the unit result for a separate science is transferred towards a qualification in GCSE in Additional Science (2SA01)
5BI0T/01 5CH0T/01 5PH0T/01	When the unit result for 5SA04 is transferred towards a qualification in GCSE in Biology (2BI01), GCSE in Chemistry (2CH01) or GCSE in Physics (2PH01)

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