GCSE

Physics B

Gateway Science Suite

OCR GCSE in Physics B J645

Foreword to the Third Edition (October 2008)

This Third Edition of the OCR GCSE Physics B specification has been produced to include the changes to the wording of the Science in the News Level of Response Grid. These changes are intended to assist teachers in interpreting the qualities to be assessed.

The revised Level of Response Grid is in Section 5.2 (pg 113). Section 6.7 has been updated to be in line with other GCSE Specifications.

QAN 100/5634/8

Contents

1 About this Qualification

1.1 About the Gateway Science Suite

The Gateway science suite comprises five specifications which share a common approach, utilise common material, use a similar style of examination questions and have a common approach to skills assessment.

The qualifications available as part of this suite are:

- GCSE Science;
- GCSE Additional Science;
- GCSE Biology;
- GCSE Chemistry;
- GCSE Physics.

The suite emphasises explanations, theories and modelling in science along with the implications of science for society. Strong emphasis is placed on the active involvement of candidates in the learning process and each specification encourages a wide range of teaching and learning activities.

The suite is supported by resources published by Collins and Heinemann.

Centres wishing to include GCSE Additional Applied Science in their provision are advised to consider the specification which is part of the Twenty First Century Science Suite A.

1.2 About this Physics Specification

This booklet contains OCR's GCSE specification in GCSE Physics for teaching from September 2006 and first certification in June 2008.

The primary objective of this specification is to interest and engage candidates in science.

This is achieved by:

- identifying activities and experiences which will excite their interest, and link these to scientific ideas and their implications for society;
- providing opportunities to develop science explanations and theories;
- providing a scheme of assessment which gives regular feedback.

This approach will appeal to candidates of all abilities. The specification emphasises the teaching and learning activities of the course, from which emerge the learning outcomes.

This specification comprises six teaching modules which are assessed through three units. Candidates take Units 1 and 2 and either Unit 3 or Unit 4.

Unit	Unit Code	Title	Duration	Weighting	Total Mark
1	B651	Physics B Unit 1 – modules P1, P2, P3	1 hour	33⅓%	60
2	B652	Physics B Unit 2 – modules P4, P5, P6	1 hour	33⅓%	60
3	B655	Physics B Unit 3 – ‘Can-Do’ tasks and report on Science in the News	-	33⅓%	60
4	B656	Physics B Unit 4 – Research Study, Data Task and Practical Skills	-	33⅓%	60

1.3 Qualification Titles and Levels

This qualification is shown on a certificate as OCR GCSE in Physics.

This qualification is approved by the regulatory authorities (QCA, ACCAC and CEA) as part of the National Qualifications Framework (NQF).

Candidates who gain grades G to D will have achieved an award at Foundation Level (Level 1 of the NQF).
Candidates who gain grades C to A* will have achieved an award at Intermediate Level (Level 2 of the NQF).

1.4 Aims

This specification therefore aims to give candidates opportunities to:

- develop their interest in, and enthusiasm for, science;
- develop a critical approach to scientific evidence and methods;
- acquire and apply skills, knowledge and understanding of how science works and its essential role in society;
- acquire scientific skills, knowledge and understanding necessary for progression to further learning.

Close links with the Entry Level course are emphasised by grouping the Entry Level ‘items’ and relating them to the items of this specification.

OCR has taken great care in the preparation of this specification and assessment material to avoid bias of any kind.

1.5 Prior Learning/Attainment

Candidates who are taking courses leading to this qualification at Key Stage 4 should normally have followed the corresponding Key Stage 3 programme of study within the National Curriculum.

Other candidates entering this course should have achieved a general educational level equivalent to National Curriculum Level 3.

2 Summary of Content

The specification content is presented as six Physics modules. Within each module the content is shown as eight items (e.g. P1a, P1b, P1c, P1d, P1e, P1f, P1g, P1h). Thus, the specification content contains a total of 48 teaching items. Each item is approximately 2½ hours teaching time.

Module P1: Energy for the home

a Heating houses
b Keeping homes warm
c How insulation works
d Cooking with waves
e Infrared signals
f Wireless signals
g Light
h Stable Earth

Module P3: Forces for transport

a Speed
b Changing Speed
c Forces and Motion
d Work and Power
e Energy on the move
f Crumple Zones
g Falling Safely
h The energy of games and theme rides

Module P5: Space for Reflection

a Satellites, gravity and circular motion
b Vectors and Equations of motion
c Projectile motion
d Momentum
e Satellite communication
f Nature of waves
g Refraction of waves
h Optics

Module P2: Living for the future

a Collecting energy from the sun
b Generating Electricity
c Fuels for Power
d Nuclear Radiations
e Our Magnetic Field
f Exploring our solar system
g Threats to Earth
h The Big Bang

Module P4: Radiation for life

a Electrostatics – Sparks
b Electrostatics 2: uses of electrostatics
c Safe Electricals
d Ultrasound
e Treatment
f What is radioactivity?
g Uses of radioisotopes
h Fission

Module P6: Electricity for gadgets

a Resisting
b Sharing
c Motors
d Generating
e Transforming
f Charging
g It's logical
h Even more logical

3 Content

Layout of Teaching Items

The detailed specification content is displayed in tabular format, designed to provide a 'teacher-friendly' approach to the content. This allows teachers to see, at a glance, links between the development of skills and understanding of how science works, and the knowledge and understanding of different science ideas and contexts. The layout of each module follows the outline given below.

MODULE CODE AND TITLE (E.G. UNDERSTANDING OURSELVES)	
Item code and title: e.g. B1a: Fit for life **Summary:** A short overview of the item, including the skills, knowledge and understanding of how science works that may be covered within this item.	
Suggested activities and experiences to select from	**Assessable learning outcomes Foundation Tier only: low demand**
Ideas for teaching activities related to the item, which will integrate the skills, knowledge and understanding of how science works into a teaching scheme. Teachers may choose from these suggestions or develop other comparable activities.	Learning outcomes that will only be assessed in the Foundation Tier paper. The use of bullet points provides guidance on: • depth • context • exemplification
Can-Do tasks Tasks linked to the learning activities in this item which can be used for the practical skill assessment element (Can-Do tasks). The number of points for successful completion of the task are also given. e.g. I can measure blood pressure 1 point	

MODULE CODE AND TITLE	
Links to other modules: opportunities for linking ideas across modules within the Gateway suite of sciences.	
Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Learning outcomes that can be assessed on either the Foundation Tier or Higher Tier question papers. The use of bullet points provides guidance on: • depth • context • exemplification	Learning outcomes that will only be assessed in the Higher Tier paper. The use of bullet points provides guidance on: • depth • context • exemplification
	Note: It may be necessary to teach the content of the Foundation Tier only column to provide the underpinning knowledge required by Higher Tier candidates.

MODULE P1: ENERGY FOR THE HOME

Item P1a: Heating Houses

Summary: When a body is heated, it gets hotter. A common misconception is that heat and temperature are the same thing. This item develops ideas to show that heat and temperature are different and that heat gain or loss does not always result in a temperature rise. Water needs lots of energy to increase its temperature. It also stores lots of energy and so is useful for transporting and transferring energy around homes.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Carry out an experiment holding a lump of ice to explain why the ice melts and why the hand holding it gets cold. Examine thermograms to see where hot spots occur.	Recognise that hot objects have high temperatures and tend to cool down. Recognise that cold objects have low temperatures and tend to warm up. Recognise that for warm bodies the higher the temperature the quicker they cool. State that temperature is measured in ^{o}C. State that energy (heat) is measured in J.
Carry out an experiment to measure the energy required to change the temperature of different bodies by different amounts.	Apply knowledge that the energy needed to change the temperature of a body depends on: • mass; • the material it is made from; • the temperature change. Plan an experiment to measure the energy required to change the temperature of a body.
Show that energy is needed to change state by placing a small piece of chocolate on the tongue and allowing it to melt.	State that energy is needed to melt or boil things. Interpret data which shows that there is no temperature change when materials are: • boiling; • melting or freezing.

Can-Do Tasks

I can accurately measure temperature in ^{o}C.	1 point
I can use a thermogram to identify areas of different temperature.	2 points
I can carry out an experiment to find out the energy needed to melt ice.	3 points

MODULE P1: ENERGY FOR THE HOME

Links with other modules P1b Keeping Homes Warm, P1c How Insulation Works, C1h Energy

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise energy flow from a hot body to a cooler one. This will cause hotter bodies to cool and cooler bodies to warm. Recall that temperature is a measurement of hotness. Recall that heat is a measurement of energy.	Explain that temperature can be represented by a range of colours in a thermogram. Describe temperature as a measurement of hotness on a chosen scale. Describe heat as a measurement of energy on an absolute scale.
Recognise that the specific heat capacity of materials is: • a measure of how much energy they can hold; • the energy needed to raise the temperature of 1kg by 1°C; • different for different materials.	State and use the equation: energy = mass x specific heat capacity x temperature change. (A change of subject may be required).
Describe how, even though energy is still being transferred, there is no temperature change when materials are: • boiling; • melting or freezing. Recognise that the specific latent heat of materials is: • a measure of how much energy is needed to melt or boil them; • the energy needed to melt or boil 1kg of them; • different for different materials and states.	State and use the equation: energy = mass x specific latent heat. (A change of subject may be required.) Explain that energy supplied during a change of state is used to break inter-molecular bonds and this explains why temperature does not change.

MODULE P1: ENERGY FOR THE HOME

Item P1b: Keeping homes warm

Summary: A poorly insulated home means that heat is being lost to the outside environment and more energy is being used to do this. Not only are energy resources being used up but the homeowner is also paying to heat the street. This item develops ideas about using energy efficiently and reducing energy losses from homes.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine thermograms showing where energy is lost from poorly insulated houses and from well insulated houses. Examine data showing percentage of energy lost from different areas of a poorly insulated house and from a well insulated house. Survey fuel costs in the local area. Survey to compare the effectiveness for different building materials using information from the internet and builders' merchants.	Recognise everyday examples of energy saving methods in the home. Recognise good and bad conductors. Recognise that curtains reduce energy loss through windows. Recognise that many insulation materials contain air. Apply the fact that air is a very good insulator to its use in keeping homes warm: • fibreglass or mineral wool is used as loft insulation; • double glazing in windows; • cavity-wall insulation foam; • reflective foil in or on walls; • draught-proofing.

Can-Do Tasks

I can use secondary sources, e.g. the internet, to compare the effectiveness of different insulating methods of different combinations of insulation materials. 2 points

MODULE P1: ENERGY FOR THE HOME

Links with other modules P1a Heating Houses, P1c How Insulation Works, C1h Energy

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Interpret data and calculate cost savings of different energy saving strategies: • payback time. State and use the equation: $\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$	Explain in the context of the home the concepts of conduction, convection and radiation (absorption and emission) in terms of: • the design features of the home; • the design and use of everyday appliances in the home; • energy saving strategies. State and use the equation: $\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$ (A change of subject is required).

MODULE P1: ENERGY FOR THE HOME

Item: P1c How insulation works

Summary: The term insulation is used in the wider context of energy saving techniques in the home. This item develops ideas about the mechanisms of energy transfer by conduction, convection and radiation.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Use data logger to carry out an experiment to test the relative performance of different insulating materials.	State that air in a material is a very good insulator.
Use data logger to carry out an experiment to test the transfer of energy through single, double and triple glazed windows.	Recognise that hot air rises and is replaced by falling colder air.
Use data logger to carry out an experiment to test the reflection of energy from a silvered surface.	Recognise that infrared energy can be reflected from a shiny surface.
Use data logger to carry out an experiment to test the absorption of energy by a blackened dull surface.	

Can-Do Tasks

I can design a demonstration to show a convection current.	1 point
I can plot an accurate line graph of a cooling curve.	2 points
I can carry out an experiment to compare the performance of different insulating materials.	3 points

MODULE P1: ENERGY FOR THE HOME

Links with other modules: P1a Heating Houses, P1b Keeping Homes Warm

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain in domestic situations, how energy transfer can be reduced in terms of: • conduction; • convection; • radiation.	Describe how energy is transferred by: • conduction - transfer of KE between particles; • convection - change of density causes (bulk) fluid flow; • radiation – infrared radiation needs no medium. Explain that, unless air is trapped in foam, there will still be energy loss by convection in a cavity wall.

MODULE P1: ENERGY FOR THE HOME

Item P1d: Cooking with waves

Summary: All radiation in the electromagnetic spectrum can be dangerous. Infrared radiation and microwaves heat things. This item develops ideas about infrared radiation and microwaves and examines the dangers and uses.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine household objects that work by infrared radiation e.g. iron (does not glow red) toaster (does glow red).	Interpret information on the electromagnetic spectrum to include microwaves and infrared radiation. Recognise that warm and hot objects emit radiation: • hotter objects emit more radiation; • black dull objects emit more radiation. Recognise that infrared radiation is absorbed by the surface of an object causing an increase in temperature: • black surfaces are good absorbers of radiation. Recognise that microwaves cause heating when absorbed by water and this is the basis of the microwave oven.
Carry out an experiment to show that a mobile phone emits radiation by causing interference with a radio signal. Interpret given information about the use and safety of mobile phone technology, e.g. using internet search. Survey opinions about the positioning of mobile phone masts.	State that mobile phones use microwave signals. Describe some concerns about children using mobile phones.

Can-Do Tasks

I can accurately measure the temperature in ^{o}C	1 point
I can use a thermogram to identify areas of different temperature.	2 points
I can present a balanced argument in favour of or against the positioning of a mobile phone mast.	3 points

MODULE P1: ENERGY FOR THE HOME

Links with other modules: C1a Cooking, P1d Cooking with Waves, P1e Infrared Signals, P1f Wireless Signals

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Describe properties of microwaves: • penetrate (about 1cm) into food; • are reflected by metal; • can cause burns when absorbed by body tissue; • go through glass and plastics. Describe properties of infrared radiation: • heats the surface of the food; • is reflected by shiny surfaces.	Explain how microwaves and infrared transfer energy to materials: • microwaves absorbed by water particles in outside layers increasing their KE; • infrared is absorbed by all particles on the surface increasing their KE; • energy transferred to centre of food by conduction or convection. Describe how the energy associated with microwaves and infrared depend on their frequency and relate this to their potential danger.
Recognise that microwaves are used to transmit information over large distances that are in "line of sight": • some areas and places have poor signals. Recognise that there may or may not be dangers: • to residents near to the site of a mast; • to users of mobile phones.	Describe how diffraction and interference of microwaves can cause signal loss: • limited distance between transmitters; • high positioning of transmitters; • nuisance of obstacles affecting signals.

MODULE P1: ENERGY FOR THE HOME

Item P1e: Infrared signals

Summary: Infrared radiation is not just useful for cooking and heating. It is used by remote controls to make life easier, whether it is changing channels on the television or opening the garage doors when we get home on a cold, wet evening. This item considers how we use infrared radiation.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine the properties of infrared radiation by e.g. reflecting the beam from a remote control to a television and showing it to be absorbed.	Describe uses of infrared radiation: • in remote controls (TV, video, DVD,) automatic doors; • short distance data links for computer or mobile phones.
Examine passive infrared sensor and images captured by infrared cameras.	State that infrared sensors detect body heat and are used for: • burglar alarms; • security lights.
Examine waveforms of analogue and digital signals using an oscilloscope.	State the two types of signal used to transmit data: • analogue; • digital.
Show that lengths of optical fibre and a pencil torch can make a model of a fibre optic lamp. Show that infrared radiation can be transmitted along a length of optical fibre. Show that optical fibres can transmit a signal from tape recorder or CD player to an amplifier (and loudspeaker) or to send a program from one computer to another.	Recognise, in the context of optical fibres, when Total Internal Reflection (TIR) happens: • glass-air, water-air or perspex-air boundary. Recognise and describe how light and infrared radiation can both travel along an optical fibre from one end to another by reflection.

Can-Do Tasks

I can draw a ray diagram to show the path of a ray of light along an optical fibre.	1 point
I can identify analogue and digital signals on equipment.	1 point
I can find the critical angle of glass / Perspex.	3 points

MODULE P1: ENERGY FOR THE HOME

Links with other modules: P1d Cooking with Waves, P5g Refraction of Waves

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the differences between analogue and digital signals: • analogue signals have a continuously variable value; • digital signals are either on (1) or off (0).	Describe advantages of using digital signals: • to allow more information to be transmitted because of multiplexing (interleaving of many digital signals on the same data line); • less interference (noise not recognised and amplified).
Describe, in the context of optical fibres, what happens to light incident on a glass-air, water-air or Perspex-air boundary below, at and above the critical angle. Describe how light and infrared radiation can both travel along an optical fibre from one end to another by Total Internal Reflection (TIR). Describe the transmission of light in optical fibres • optical fibres allow the rapid transmission of data; • optical fibres allow the transmission of data pulses using light.	Describe the application of total internal reflection in fibre optics: • drawing and interpreting simple ray diagrams. Describe advantages of using optical fibres to allow more information to be transmitted: • multiplexing; • lack of interference.

MODULE P1: ENERGY FOR THE HOME

Item P1f: Wireless signals

Summary: Today's hi-tech world demands that people can always receive both phone calls and email. This item develops ideas about global communication and the benefits of wireless transmission and the impact of this culture on modern society

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey of use of wireless technology within the class.	Describe how radiation used for communication can be reflected. Recognise that wireless technology uses electromagnetic radiation for communication. State that wireless technology can have advantages: • available 24 hours a day; • no wiring needed; • portable and convenient.
Examine quality of radio and mobile phone reception in the area. Show that the quality of digital radio reception is superior to analogue reception.	Recognise that some radio signals are better quality than others. Interpret simple information on digital and analogue signals.

Can-Do Tasks

I can use information about transmitter location and frequencies to tune a radio. 3 points

MODULE P1: ENERGY FOR THE HOME

Links with other modules: P5e Satellite Communication, P5g Refraction of Waves, P1d Cooking with Waves, P5f Nature of Waves

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how radiation used for communication can be refracted. Recognise common uses of wireless technology. • Radio; • mobile phones' • laptop computers.	Explain how long-distance communication depends on the reflection of waves from the Ionosphere or by being received and re-transmitted from satellites.
Recognise that radio stations with similar transmission frequencies often interfere.	Explain how the refraction and diffraction of radiation can affect communications: • refraction at the interfaces of different layers of Earth's atmosphere; • diffraction by transmission dishes results in signal loss. Explain the advantage of digital radio in terms of lack of interference.

MODULE P1: ENERGY FOR THE HOME

Item P1g: Light

Summary: The use of light as a source of digital communication, from Morse signalling to present day laser technology, has meant rapid communication is possible. This item develops ideas about communication at the speed of light.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Looking and measuring waves: • in ripple tanks; • in power-point simulations.	Identify the main features of a transverse wave: • trough and crest; • amplitude; • wavelength. Recognise that all electromagnetic waves travel at the same high speed in space.
Show that a message can be transmitted using a signal lamp.	Describe how, historically, the use of light greatly increased the speed of communication but that it requires the use of a code.
Examine the surface of a CD under a laboratory microscope and then look at images from the internet or other resource showing 10 000 x magnification.	Recall that a laser produces a narrow intense beam of light.

Can-Do Tasks

I can send and receive a message in Morse code. 2 points

MODULE P1: ENERGY FOR THE HOME

Links with other modules: P4d Ultrasound

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the main features of a transverse wave: • trough and crest; • amplitude; • wavelength; • frequency as the number of waves in each second. State and use the equation: wave speed = frequency x wavelength.	State and use the equation: wave speed = frequency x wavelength. (A change of subject may be required).
Describe how light was used as a means of communication: Morse code.	Explain the advantages and disadvantages of using light, radio and electrical signals for communication.
	Explain that a laser produces an intense beam of light in which all of the waves are: • the same frequency; • in phase with each other. Explain how a laser beam is used in a CD player by reflection from the shiny surface: • surface contains digital information; • information in the form of a patterns of pits.

MODULE P1: ENERGY FOR THE HOME

Item P1h: Stable Earth

Summary: There is much talk of Global Warming. The incidents of skin cancer are rising, even in the UK. This item develops ideas surrounding these and other observations. It also examines how climate is being affected by natural and human activity.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Examine seismographic traces of recent earthquakes. Make a seismic trace using pen suspended from retort stand and striking the bench.	Describe earthquakes as producing shock waves which can: • cause damage; • be detected by seismometers.
Examine effects of skin cancer.	State that exposure to ultraviolet radiation can cause: • suntan; • sunburn; • skin cancer. Recognise that sun block can reduce damage caused by ultraviolet light: • high factors reduce risks more; • high factors allow longer exposure without burning.
	Describe reasons for global warming: • increased energy use; • increased CO_2 • deforestation.

Can-Do Tasks

I can calculate the time I can safely spend in the Sun from a knowledge of normal burn time and the SPF of a sun screen. 1 point

MODULE P1: ENERGY FOR THE HOME

Links with other modules: C2c Does the Earth Move? C6e Depletion of the Ozone Layer

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that earthquakes produce shock waves, which can also travel inside the Earth. State that there are two types of seismic waves: • longitudinal p-waves travel through both solids and liquids and travel faster than s-waves; • transverse s-waves which travel through solids but not through liquids.	Describe how seismic waves transmitted through the Earth can be used to provide evidence for its structure: • p-waves travel through solid and liquid rock (i.e. all layers of the Earth); • s-waves cannot travel through liquid rock; (i.e. the outer core).
Explain how darker skins reduce cancer risk: • absorb more ultraviolet radiation; • let less ultraviolet radiation reach underlying body tissues. Interpret given information about sun protection factor (no recall is expected). Calculate how long a person can spend in the sun without burning from a knowledge of the sun protection factor.	Describe how the ozone layer protects the Earth from ultraviolet radiation and that environmental pollution from CFCs is depleting the layer.
Explain how human activity and natural phenomena both have effects on weather patterns. Dust from: • volcanoes reflect radiation from the Sun causing cooling; • factories reflect radiation from the city causing warming.	Interpret given information about climate change as a result of natural or human activity (no recall is expected).

MODULE P2: LIVING FOR THE FUTURE

Item P2a: Collecting Energy from the Sun

Summary: The Sun has supplied our planet with energy for a long time. This item shows how solar energy can be used, in a sustainable way, to provide us with some of our energy needs.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate how the voltage and current from a photocell varies with distance from the light source. Research the use of photocells for providing electricity in remote locations. Investigate how the power of a photocell depends on its surface area. Investigate how photocells can be connected to increase their voltage.	Describe that the Sun: • is a stable source of energy; • transfers energy to Earth as light and heat. Describe that photocells: • transfer light into electricity; • produce direct current (DC); • can operate in remote locations; • have a power that depends on the surface area exposed to sunlight.
Build a solar collector from aluminium foil and an umbrella. Investigate a model greenhouse. Survey the use of passive solar heating of buildings. Survey the distribution of wind turbines in the UK.	Describe other ways that the Sun's energy can be harnessed: • light can be absorbed by a surface and transferred into heat energy; • produce convection currents (wind) to drive turbines; Describe that the Sun is a renewable source of energy.

Can-Do Tasks

I can use a voltmeter to measure voltage.	1 point
I can accurately measure temperature in ^{o}C.	1 point
I can carry out an investigation to find out how the voltage produced by a photocell varies with distance from a light source.	3 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules: P3e Energy on the Move

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that DC electricity is current in the same direction all the time. Describe some advantages and disadvantages of using photocells to provide electricity: • low maintenance; • no need for power cables; • no need for fuel; • long life; • rugged; • renewable energy resource; • no polluting waste; • no power at night or bad weather.	Describe how light produces electricity in a photocell: • energy absorbed by photocell; • electrons are knocked loose from the silicon atoms in the crystal; • electrons flow freely. Describe how the power of a photocell depends on: • light intensity; • surface area exposed.
Describe other ways that the Sun's energy can be harnessed: • how glass can be used to provide passive solar heating for buildings; • light can be reflected to a focus by a curved mirror; • transfer KE of air to electricity in wind turbines.	Explain why passive solar heating works: • glass is transparent to sun's radiation; • heated surfaces emit infrared; • glass reflects infrared. An efficient solar collector must track the position of the Sun in the sky. Describe the advantages and disadvantages of wind turbines: • renewable; • rugged; • no polluting waste; • visual pollution; • dependency on wind speed; • space needed.

MODULE P2: LIVING FOR THE FUTURE

Item P2b: Generating Electricity

Summary: Most of our electricity is generated in power stations by burning fuels. This item shows how power stations work and how energy is transported to our homes and factories.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Build a model generator with magnets and coils to produce electricity. Examine the difference between a model generator and the generator in a power station. Examine ways in which the current of a generator can be increased. Examine the output of a generator with an oscilloscope.	Describe and recognise the dynamo effect: • electricity can be generated by moving a coil near a magnet; • moving a magnet near a coil. Describe that a generator produces alternating current (AC). Describe that a battery produces direct current (DC).
Find out about the construction of power stations. Demonstrate a steam engine transferring chemical energy of a fuel into kinetic energy.	Describe the main stages in the production and distribution of electricity: • source of energy; • power station produces electricity; • national grid of power lines connecting station to consumers; • consumers are homes, factories, offices and farms. Describe that some of the energy of the fuel in a power station is wasted as heat energy in the environment.
Find out about the national grid. Demonstrate a model transmission line system with resistance wires and a pair of transformers.	Recognise that transformers can be used to increase or decrease voltage.

Can-Do Tasks

I can use an oscilloscope to measure the maximum voltage of AC.	2 points
I can use an oscilloscope to measure the frequency of AC.	3 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules: P2c Fuels for Power, P4h Fission, P6d Generating

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe and recognise the dynamo effect can be increased (more current): • stronger magnets; • more turns; • faster movement. Describe and interpret AC using a voltage-time graph.	Describe that the frequency of AC electricity is the number of cycles per second.
Describe how simple AC generators work. • coil of wire; • magnetic field; • coil and field close; • relative motion between coil and field. Describe how electricity is generated at a conventional power station: • burning fuel; • producing steam; • spinning a turbine; • turbine turns generator. Describe and recognise that there is significant waste of energy in a conventional power station.	Use these equations in the context of a power station to calculate energy input, energy output, waste energy output and efficiency. • fuel energy input = waste energy output + electrical energy output; • $\text{efficiency} = \dfrac{\text{electrical energy output}}{\text{fuel energy input}}$ To include change of subject.
Explain how transformers are used in the National grid: • electricity is transmitted at high voltage to reduce energy waste and costs.	Explain how for a given power transmission, increased voltage reduces current, so decreasing energy waste by reducing heating of cables.

MODULE P2: LIVING FOR THE FUTURE

Item P2c: Fuels for Power

Summary: The heat energy for our power stations comes from a variety of sources. This unit considers the economic and environmental costs of the different sources we use today

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Measure the energy released by a fossil fuel by using a candle to heat water. Build a model digester to generate methane from biomass. Use software to find out how a nuclear power station operates.	Describe that the common fuels (energy sources) used in power stations: • fossil fuels - crude oil, coal, natural gas; • renewable biomass - wood, straw, manure; • nuclear fuel.
Examine the use of an electricity meter or joule-meter to measure energy transfer. Find out about the cost of electricity at different times of the day. Find out about the power of different electrical appliances. Survey the efficiency rating of fridges, freezers and light bulbs.	Describe that the unit of power is the watt or kilowatt: Interpret data to show the cost of using expensive electrical appliances depends on: • power rating in watts and kilowatts; • the length of time it is switched on.
Find out about the evidence for global warming in the last 200 years. Discuss the possible consequences of global warming. Discuss the advantages and disadvantages of using fossil fuels for making electricity.	Describe that waste from nuclear power is radioactive: • can be harmful; • does not give rise to global warming.

Can-Do Tasks

I can read a domestic electricity meter.	1 point
I can use meter readings to calculate the cost of using electricity.	2 points
I can find the energy transferred in an electrical circuit using an ammeter, voltmeter and a timer.	3 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules: P2b Generating Electricity, P2d Nuclear Radiations, P4h Fission, C1d Making Crude Oil Useful

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that: • burning fuels releases energy as heat; • uranium fuel rods release energy as heat; • biomass can be fermented to generate methane.	Describe and evaluate the advantages and disadvantages of different energy sources.
Calculate the power rating of an appliance using the equation: power = voltage $\times$ current State that the unit of electrical energy supplied is the kilowatt hour. Calculate the number of kilowatt hours given the: • power in kilowatts; • time in hours. Calculate the cost of energy supplied.	State, be able to use and manipulate the equation: power = voltage $\times$ current Use the kilowatt hour as a measure of the energy supplied; State and use the equation: energy supplied = power x time to calculate: • power in kW or W; • time in hours and / or minutes. Describe the advantages and disadvantage of using off-peak electricity in the home.
Recall that ionising radiations (from radioactive waste) can cause cancer. Recall that uranium is a non-renewable resource. Recall that plutonium: • is a waste product from nuclear reactors; • can be used to make nuclear bombs.	Describe the advantages and disadvantages of nuclear power: • decommissioning costs; • pollution from fuel processing; • risk of accidental emission of radioactive material; • high maintenance costs; • independence from fossil fuels; • high stocks of fuel; • no greenhouse gases.

MODULE P2: LIVING FOR THE FUTURE

Item P2d: Nuclear Radiations

Summary: Most people know that radioactivity can be dangerous, but do not understand why. This item develops ideas about the uses of radioactivity, the nature of ionising radiations and how to handle their sources safely.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
	Describe and recognise that nuclear radiation can be beneficial or harmful: • state one example of a beneficial use; • harmful effect: damages living cells.
Teacher to use radiation detectors to show the ionising properties of nuclear radiation. Show the differing ranges and penetrating power of alpha, beta and gamma radiation.	State and recognise the three types of nuclear radiation: • alpha; • beta; • gamma. Describe and recognise that there is background radiation in the environment which is always present.
Demonstrate the safety measures to be taken when handling radioactive sources. Do a survey to find out how radioactive waste from nuclear power stations is disposed of.	Describe how to handle radioactive materials safely: • protective clothing; • tongs / keep your distance; • short exposure time; • shielded and labelled storage.

Can-Do Tasks

I can describe how to handle radioactive sources safely. 2 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules: P2c Fuels for Power, P4e Treatment, P4f What is Radioactivity? P4g Uses of Radioisotopes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe examples of beneficial uses of radiation: • alpha - smoke detectors; • beta - tracers and paper thickness gauges; • gamma - treating cancer, non-destructive testing and sterilising equipment. Describe that radioactive materials give out nuclear radiation.	
Describe the relative penetrating power of alpha, beta and gamma.	Describe how alpha, beta and gamma can be identified by their penetrating power.
State that nuclear radiation ionises materials. Describe that ionisation produces charged particles.	Explain ionisation in terms of: • removal of electrons from particles; • gain of electrons by particles.
Describe background radiation and state that it is caused by radioactive substances, rocks, soil, living things and cosmic rays.	
Describe some ways of disposing radioactive waste e.g. • low level waste in land-fill sites; • encased in glass and left underground; • reprocessed.	Explain the problems of dealing with radioactive waste: • remains radioactive for a long time; • terrorist risk; • must be kept out of groundwater; • acceptable radioactivity level may change over time.

MODULE P2: LIVING FOR THE FUTURE

Item P2e: Our Magnetic Field

Summary: The magnetic field around our planet shields us from a lot of ionising radiation from the rest of the Universe. This field and our existence may be due to an unlikely series of events long ago. Earth may be a very special place because of its large moon.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey the sources of background radiation. Use a GM tube to record background radiation. Demonstrate the deflection of beta particles by a magnetic field. Demonstration by Teltron Tubes.	Describe that: • the Earth is surrounded by a magnetic field; • magnets have a north and south pole; • the Earth's core contains a lot of molten iron; • a plotting compass shows the direction of a magnetic field; • cosmic rays are ionising radiations from space.
Use a compass to investigate the magnetic field around a current-carrying coil.	Describe that electrical current (moving electrical charges) in a coil creates a magnetic field.
Discuss the evidence for the presence of the Moon as the result of a collision between the Earth and another planet.	Describe that the Moon may be the remains of a planet which collided with the Earth.
Survey the various uses of satellites around the Earth. Survey the electricity and communications blackouts caused by solar flares.	Describe that the Sun: • is a source of ionising radiation; • causes solar flares that can interfere with the operation of artificial satellites; State the uses of artificial satellites; • Telecommunications; • weather prediction; • spying; • (satellite) navigation systems.

Can-Do Tasks

I can use a compass to find the direction of a magnetic field.	1 point
I can use a plotting compass to map the magnetic field around a coil or magnet.	2 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules: P5a Satellites, Gravity and Circular Motion, P6c Motors, P4e Treatment, P4f What is Radioactivity? P4g Uses of Radioisotopes, P6d Generating

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe: • the shape of the Earth's magnetic field; • that charged particles are deflected by magnetic fields.	Describe that cosmic rays: • are fast moving particles which create gamma rays when they hit the atmosphere; • spiral around the Earth's magnetic field to the poles; • cause the Aurora Borealis.
Describe the shape of the magnetic field around a current-carrying coil (direction of field from current not required).	Describe that magnetic fields can be generated by moving charged particles.
Describe how a collision between two planets can result in an Earth-Moon system: • the planets collide; • their iron cores merge to form the Earth; • less dense material orbits as the Moon.	Discuss the evidence for the Earth-Moon system as the result of a collision between two planets.
Describe the nature solar flares: • clouds of charged particles from the Sun; • ejected at high speed; • produce strong disturbed magnetic fields.	Describe the consequences of a solar flare arriving at the Earth: • satellite communications; • electricity distribution.

MODULE P2: LIVING FOR THE FUTURE

Item P2f: Exploring our Solar System

Summary: When we look at the night sky, we can sometimes see the Moon, artificial satellites, planets in our Solar System and the billions of stars which make up the Universe. This item discusses the problems involved in visiting other parts of the Solar System.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Build a scale model of the Solar System and then work out where the nearest star would be on the same scale. You are a travel agent. Produce a brochure for aliens who might visit our Solar System.	State and recognise that: • Earth is one of a number of planets that orbit the Sun; • the moon orbits Earth; • Earth orbits the Sun. State and recognise that the universe consists of: • stars and planets; • comets and meteors; • black holes; • large groups of stars called galaxies. Describe that stars can be seen even though they are far away because they are: • very hot; • give off their own light.
Survey the exploration of the Moon by the Apollo missions. Discuss the problems of manned space travel. Design a manned mission to Mars.	Describe that radio signals take a long time to travel through the solar system. Explain that manned spacecraft need to take food, water and oxygen.
Survey the exploration of our Solar System by robot spacecraft. Suggest reasons why we might need to explore our Solar System. Debate the advantages and disadvantages of using robot spacecraft to explore the Solar System.	Explain that unmanned spacecraft (probes) do not need food, water or oxygen.

Can-Do Tasks

I can use ICT to produce a labelled model of our Solar System.	1 point
I can use data on sizes and distances to design a model of our Solar System to fit inside the laboratory or onto the school grounds.	3 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules: P2g Threats to Earth

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State and recognise the relative positions of Earth. Sun and planets (includes the order of the planets). Describe that gravitational force determines the motion of planets and satellites.	State the relative positions of planets, stars, comets, meteors, galaxies and black holes. State and recognise that circular motion requires a centripetal force. State and recognise that gravity provides the centripetal force for orbital motion.
Describe some of the difficulties of manned space travel between planets: • enough fuel; • long time required; • effect of low gravity on health; • shielding from cosmic rays; • maintaining a stable atmosphere; • providing enough food and water; • keeping warm.	Describe that a light-year is: • a measurement of very large distances; • the distance light travels in a year.
Recall that unmanned spacecraft can withstand conditions that are lethal to humans. State that unmanned spacecraft can send back information on: • temperature, magnetic field and radiation; • gravity, atmosphere and surroundings.	Explain the advantages and disadvantages of using unmanned spacecraft to explore the Solar System: • costs; • safety; • reliability; • maintenance.

MODULE P2: LIVING FOR THE FUTURE

Item P2g: Threats to Earth

Summary: Most people ignore the threat of asteroid collision to the Earth. This item shows that the threat is real and has proved to be lethal many times in the past. Strategies for avoiding such catastrophes are outlined.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Survey the evidence for the destruction of the dinosaurs by an asteroid. Discuss how the surface of the Moon provides evidence for the continual bombardment of the Earth by asteroids.	State that large asteroids have collided with the Earth in the past. State that asteroids are rocks. Describe some of the consequences of a collision with a large asteroid: • crater; • ejection of hot rocks; • widespread fires; • sunlight blocked by dust; • climate change; • species extinction.
Survey the history of Halley's comet. Survey the exploration of comets by robot spacecraft. Discuss the collision of a comet with Jupiter.	Describe that the tail of a comet is a trail of debris.
Debate the importance of funding telescopes to search for Near Earth Objects. Design a plan to deal with the threat of an asteroid collision.	Describe that a near-Earth object (NEO) is an asteroid or comet on a possible collision course with Earth. Describe that Near Earth Objects may be seen with telescopes.

Can-Do Tasks

I can make a telescope from a pair of lenses. — 2 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules: P2f Exploring our Solar System

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Describe that asteroids: • are left over from the formation of the Solar System; • orbit between Mars and Jupiter. Describe some of the evidence for past asteroid collisions: • craters; • layers of unusual elements in rocks; • sudden changes of fossil numbers between adjacent layers of rock.	Explain why the asteroid belt is between Mars and Jupiter: • the large gravity of Jupiter disrupts the formation of a planet.
Describe that comets: • have highly elliptical orbits; • are made from ice and dust; • come from objects orbiting the Sun far beyond the planets. Describe that the speed of a comet increases as it approaches a star.	Explain why the speed of a comet increases as it approaches a star: • the strength of gravity increases.
Describe that observations of near-Earth objects (NEO) can be used to determine their trajectories.	Suggest and discuss possible actions which could be taken to reduce the threat of near-Earth objects (NEO): • surveys by telescope; • monitoring by satellites; • deflection by explosions.

MODULE P2: LIVING FOR THE FUTURE

Item P2h: The Big Bang

Summary: There are a number of theories about how the Universe was formed and how it will continue to evolve. This item develops ideas about the evolution of the Universe and its possible future. The Big Bang theory is considered.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Identify examples of the Doppler effect e.g. passing police siren, whirling a buzzer round on a string. Doppler simulations on PowerPoint. Build a model of the expanding Universe with a balloon to show that spots on the surface are moving faster and further away from each other as the balloon is inflated. Draw a time line for the age of the Universe. Discuss ideas about the origin of the Universe.	Describe some ideas about the Big Bang theory for the origin of the Universe; • started with an explosion; • the Universe is still expanding.
Demonstrate heating by compression with a fire piston. Discuss ideas about the birth and death of stars. Survey the evidence for the Black Hole at the centre of the Milky Way.	Describe that stars: • have a finite 'life'; • start as a huge gas cloud. Describe that not even light can escape from a black hole.

Can-Do Tasks

I can use ICT to find out about the stages of a star's life cycle and put the stages in the correct order.
2 points

MODULE P2: LIVING FOR THE FUTURE

Links with other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that: • all galaxies are moving away from us; • distant galaxies are moving away more quickly; • microwave radiation is received from all parts of the universe.	Explain how the Big Bang theory accounts for: • light from galaxies is shifted to the red end of the spectrum; • the further away galaxies are, the greater the red shift; • the age and starting point of the Universe.
Describe the end of a medium-weight star like our Sun: • red giant; • planetary nebula; • white dwarf; Describe the end of a heavy-weight star: • red giant; • supernova; • neutron star or black hole.	Describe the life history of a star: • interstellar gas cloud; • gravitational collapse producing a proto-star; • thermonuclear fusion; • long period of normal life (main sequence); • end depends on mass of star; Explain the properties of a black hole; • large mass; • large gravity; • not even light can escape.

MODULE P3: FORCES FOR TRANSPORT

Item P3a: Speed

Summary: Transport and road safety provide the context for this module. The abilities to describe and measure motion are used in the treatment of issues involving everyday transport, including potentially hazardous situations. The safe design and operation of cars (including braking) are also covered. A number of key ideas in this unit underpin later work for those taking P5 and P6. The experiments on vehicle speeds allows the opportunity to collect and analyse science data using ICT tools and the interpretation of the data using creative thought to develop theories.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Calculating speeds from measurements of time and distance. Practical experiment to investigate the speeds of vehicles near school: • are male drivers faster than female?; • have the speed-bumps made any difference? Practical experiment to investigate the speeds of toy cars on ramps: • how does the slope angle or height affect the speed?; • which cars are fastest? Find out how different speed cameras work. Exploration of speed records (cars, animals, planes, people etc).	Describe faster objects as covering more distance in a given time. State that speed is measured in metres per second, m/s. State that the measurements needed to determine speed are: • distance; • time. Describe appropriate means of measuring distance and time in everyday situations using a: • stopwatch/stopclock; • measuring tape or trundle wheel. Describe why speed cameras generally take two photographs: • a certain time apart; • near marked lines on the road.
Looking at data from cars, sport and animals then transferring it to graphical form for analysis (distance -time graphs).	Interpret simple graphs of distance against time: • straight line gradient - steady speed; • horizontal line - stationary (zero speed).

MODULE P3: FORCES FOR TRANSPORT

Links with other modules: P3b Changing Speed, P5b Vectors and Equations of Motion, P3c Forces and Motion

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Interpret the relationship between speed, distance and time including: • increasing the speed, which increases the distance travelled in the same time. • increasing the speed reduces the time needed to cover the same distance. State and use the equation: $\text{speed} = \frac{\text{distance}}{\text{time}}$	Interpret the relationship between speed, distance and time including the: • effect of changing any one or two of the quantities. State and use the equation: $\text{speed} = \frac{\text{distance}}{\text{time}}$ (A change of subject may be required).
Describe, draw and interpret qualitatively simple graphs of distance against time. Describe and interpret the gradient (steepness) of a distance-time graph as speed: • higher speed steeper gradient.	Draw and interpret quantitatively simple graphs of distance against time: • qualitatively for non-uniform speed; • calculate speed from the gradient of a straight line graph.

MODULE P3: FORCES FOR TRANSPORT

Item P3b: Changing Speed

Summary: In this item the idea of acceleration is developed. The concept of velocity is not used here to avoid confusion. This is developed further in P5 and P6. Accelerations (involving the change in speed) of real cars can be used and graphically illustrated and studied. Practical measurements of bicycles and sprint starts can be done to collect and analyse real data. The experiments on acceleration allow the opportunity to collect and analyse science data using ICT tools and the interpretation of the data using creative thought to develop theories.

Suggested activities and experiences to select from	Suggested activities and experiences to select from
Practical measurements of bicycles, sprint starts, falling objects can be done to collect and analyse real data for calculating acceleration.	Describe the trends in speed and time from a simple speed-time graph. • horizontal line – constant speed; • straight line positive gradient – increasing speed; • straight line negative gradient – decreasing speed.
Use of real car data from web sites or magazines to illustrate and develop further the concepts of: • speed; • acceleration.	Recognise that acceleration involves a change in speed (limited to a straight line): • speeding up; • slowing down. State that acceleration is measured in metres per second squared, m/s^2.

MODULE P3: FORCES FOR TRANSPORT

Links with other modules: P3a Speed, P5b Vectors and Equations of Motions, P3c Forces and Motion

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe and interpret the gradient (steepness) of a speed-time graph as a measure of acceleration. • more acceleration, steeper gradient. Describe, draw and interpret qualitatively simple graphs of speed against time for uniform accelerations. Describe the area under the line of a speed-time graph as distance travelled.	Describe, draw and interpret simple graphs of speed against time including: • quantitatively for uniform acceleration; • calculations of speed from the gradient of a distance-time graph; • calculations of distance travelled from a speed-time graph for uniform acceleration; • calculations of acceleration from a speed-time graph for uniform acceleration and only qualitatively for non uniform acceleration.
Describe acceleration as change in speed per unit time. State and use the equation: acceleration = change in speed/ time taken.	State and use the equation: • acceleration = change in speed/ time taken. (A change of subject may be required.) Explain that acceleration could involve either a change: • in speed; • in direction. Interpret the relationship between acceleration, change of speed and time to include: • effect of changing any one or two of the quantities.

MODULE P3: FORCES FOR TRANSPORT

Item P3c: Forces and Motion

Summary: Before taking your driving test you need to pass a theory test. Part of this involves driving safely and a knowledge of car stopping distances. Driving fast may be tempting but stopping safely is more important. In this item we start to understand the effects of forces on braking and the factors which affect stopping distances. The experiments using elastics, light gates and trolleys allows the opportunity to collect and analyse science data using ICT tools and the interpretation of the data using creative thought to develop theories. Work on stopping distances provides the opportunity to discuss how and why decisions about science and technology are made, including ethical issues and the social, economic and environmental effects of such decisions. This also provides the opportunity to illustrate that there are some questions that science cannot answer.

Suggested activities and experiences to select from	**Assessable learning outcomes** **Foundation Tier only: low demand**
Use of elastics, light gates and trolleys to explore acceleration.	Describe and recognise simple situations where forces cause things to speed up or slow down. Describe and recognise that for a given mass: • more force = more acceleration; • less force = less acceleration. Describe and recognise that for a given force: • more mass = less acceleration; • less mass = more acceleration. Describe and recognise that for a given acceleration: • more mass = more force; • less mass = less force.
Modelling stopping distances using a bicycle. Use of real car data from Highway Code data and web sites or magazines to illustrate the science of stopping distances.	Explain the significance to road safety of: • thinking distance; • braking distance; • stopping distance. Describe thinking distance as: • the distance travelled between the need for braking occurring and the brakes starting to act. Describe braking distance as: • the distance taken to stop once the brakes have been applied. Describe stopping distance as: • thinking distance + braking distance.

MODULE P3: FORCES FOR TRANSPORT

Links with other modules: P3a Speed, P3b Changing Speed

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe and interpret the relationship between force, mass and acceleration in everyday examples. State and use the equation: force = mass x acceleration.	State and use the equation: force = mass x acceleration. (A change of subject may be required.) Recognise that when body A exerts a force on body B, body B exerts an equal but opposite force on body A: • these constitute two different views of the same interaction and are not balanced forces.
Describe the factors which might increase thinking distance: • driver tiredness; • influence of alcohol or other drugs ; • more speed; • distractions or lack of concentration. Describe the factors which might increase braking distance: • road conditions – slippy, icy, wet; • car conditions - bald tyres, poor brakes; • more speed. Interpret charts of thinking distances and braking distances. Explain the implications of stopping distances in road safety. • driving too close to the car in front; • speed limits; • road conditions.	Explain qualitatively everyday situations where braking distance is changed including: • friction; • mass; • speed; • braking force.

MODULE P3: FORCES FOR TRANSPORT

Item P3d: Work and Power

Summary: We do work whenever a force moves something. Transport, by its nature, is always on the move and energy is being transferred all the time. Some vehicles are more powerful than others but they still get us from A to B. In this item we will learn about power and the energy we use to provide it. Different power ratings, fuel consumption, costs and associated environmental issues about car use can be used to develop the skills of presenting information, developing an argument and drawing a conclusion using scientific terms. This also provides the opportunity to discuss how scientific knowledge and ideas change over time.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
	Recognise everyday examples in which work is done and power is developed for example: • lifting weights; • climbing stairs; • pulling a sledge; • pushing a shopping trolley.
Measuring work done by candidates lifting weights themselves.	Recognise that work is done when a force moves an object. Recognise that when work is done it depends on: • the size of the force in newtons; • the distance in metres. State that energy is needed to do work. State that the joule is the unit for both work and energy.
Measuring power developed by candidates lifting known weights in for instance 100s time period. The plenary could focus on how efficient we are as machines.	Describe power as a measurement of how quickly work is being done. State that power is measured in watts (W). Recognise that cars: • have different power ratings; • have different fuel consumptions.

MODULE P3: FORCES FOR TRANSPORT

Links with other modules:

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
State and use the equation: work done = force x distance.	State and use the equation: work done = force x distance. (A change of subject may be required.)
State and use the equation: $\text{power} = \frac{\text{work done}}{\text{time}}$ Interpret fuel consumption figures from data on cars to include; • environmental issues; • costs.	State and use the equation: $\text{power} = \frac{\text{work done}}{\text{time}}$ (A change of subject may be required).

MODULE P3: FORCES FOR TRANSPORT

Item P3e: Energy on the move

Summary: Transport is essential to modern life whether it be bus, train, tram, bicycle, walking or car. All these need a source of energy which results in kinetic energy. Some vehicles use more fossil fuels than others and this has implications for cost, pollution in our cities and future energy reserves. Other vehicles may use bio-fuel which is renewable.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Exploring the significance of KE in braking distances applied to stopping distance charts.	Recognise everyday examples in which objects have kinetic energy.
Evaluating data from fuel consumption figures for cars.	Recognise and describe fossil fuels as the main fuel in road transport: • petrol; • diesel. Recognise and describe how electricity can be used for road transport: • battery driven cars; • solar power.
	Interpret data about fuel consumption (no recall required.)

MODULE P3: FORCES FOR TRANSPORT

Links with other modules: B4e Energy Flow, P2a Collecting Energy from the Sun, P3h The Energy of Games and Theme Rides

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe everyday examples in which objects have kinetic energy. State and recognise that kinetic energy is greater for objects with: • higher speed; • greater mass.	Use the equation: $KE = \frac{1}{2} mv^2$ Apply the ideas of kinetic energy: • relationship between braking distances and speed; • everyday situations involving objects moving.
Interpret data about fuel consumption.	Describe and explain that car fuel consumption figures depend on: • energy required to increase KE; • energy required to do work against friction; • different driving styles and speeds; • different road conditions. Interpret data about fuel consumption.
Explain that electrically powered cars do not pollute at the point of use whereas fossil fuel cars do. Recognise that battery driven cars need to have the battery recharged: • this uses electricity produced from a power station; • power stations cause pollution.	

MODULE P3: FORCES FOR TRANSPORT

Item P3f: Crumple Zones

Summary: Stopping cars safely involves absorbing energy. This happens in braking and also in collisions. Injuries can be reduced by clever car design and this unit explores the science behind the safety features of modern vehicles. Collisions are studied here in terms of energy, acceleration and force. In later units, P5 and P6, a more in depth study of collisions will involve the ideas of momentum and provides the opportunity to discuss how scientific knowledge and ideas change over time.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Design, build and test model crumple zones with trolleys, paper and straws. Test seatbelt materials for stretching. Find out about safety features of cars and how they are tested, compared, and reported to the public. Research safety features in modern cars.	Describe the typical safety features of modern cars that require energy to be absorbed when vehicles stop: • heating in brakes; • crumple zones; • seat-belts; • air bags. State some typical active safety features of cars: • ABS brakes; • traction control; • safety cage. State some typical passive safety features of cars: • electric windows; • cruise control; • paddle shift controls - gears, stereo; • adjustable seating. Explain why seatbelts have to be replaced after a crash.

MODULE P3: FORCES FOR TRANSPORT

Links with other modules: P5d Momentum

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how seatbelts, crumple zones, air bags are useful in a crash because they: • change shape; • reduce injuries; • absorb energy.	Explain that forces can be reduced when stopping (eg. crumple zones, braking distances, escape lanes, crash barriers, seatbelts and air bags) by: • increasing stopping or collision time; • increasing stopping or collision distance; • decreasing acceleration.
Describe how typical active safety features can make driving safer.	Describe using the ideas of friction why ABS brakes reduce braking distances. Evaluate the effectiveness of given safety features in terms of saving lives.
Describe how typical passive safety features can make driving safer.	

MODULE P3: FORCES FOR TRANSPORT

Item P3g: Falling safely

Summary: Falling objects are usually subject to two forces at least - weight and drag. Some cars have similar engines to others yet have very different top speeds. All this is to do with pairs of forces which may or may not balance. These ideas are of vital importance to the parachutist and drag-racer who want to slow down in time - safely! Investigating the falling whirly-gig, parachute or plasticine shapes provides the opportunity to explain phenomena by developing and using scientific theories. Work on the balance of forces illustrates the use of modelling in developing scientific understanding.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate factors affecting the speed of a falling whirly-gig or parachute.	Describe how falling objects: • get faster as they fall; • are pulled by a force called weight (gravity) towards the centre of the earth.
Investigate factors affecting the speed of plasticine shapes as they fall through wall-paper paste.	Recognise that air resistance or drag can slow-down falling objects: • parachutes; • shuttle-cock in badminton. Recognise that frictional forces (drag, friction, air resistance): • act against the movement; • can be reduced (shape, lubricant). Recognise that the shape of moving objects can influence their top speeds: • wedge shape of sports car; • deflectors on lorries and caravans; • roof boxes on cars.
	Recognise that falling object do not experience drag when there is no atmosphere: • moon; • outer space.

MODULE P3: FORCES FOR TRANSPORT

Links with other modules: P5c Projectile Motion

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how objects falling through Earth's atmosphere reach a terminal speed. Explain in terms of the balance of forces why objects: • increase speed; • decrease speed; • maintain steady speed.	Explain, in terms of balance of forces, why objects reach a terminal speed: • higher speed = more drag; • larger area = more drag; • weight (driving force) = drag gives terminal speed.
Recognise that acceleration in free-fall (g) is constant.	

MODULE P3: FORCES FOR TRANSPORT

Item P3h: The energy of games and theme rides

Summary: Theme rides are designed to thrill and frighten you in a safe way. We pay good money to have our 'gravity' distorted. Theme ride designers are experts on energy and forces. Their simple trick is to use gravity and potential energy as the source of movement. This item will help you understand the science of theme rides and how scientific understanding can be applied by society.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate bouncing balls as an energy system whose efficiency can be measured (100% x bounce height / drop height).	Recognise that objects have gravitational potential energy because of their mass and position in Earth's gravitational field: • more mass = greater PE; • more height = greater PE.
Investigate models (toy cars on plastic track) or real roller-coasters as an energy system whose efficiency can be measured (100% x climb height / drop height).	Recognise everyday examples in which objects use gravitational potential energy.
	Recognise that moving objects have kinetic energy.

MODULE P3: FORCES FOR TRANSPORT

Links with other modules: P3e Energy on the Move

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe everyday examples in which objects have gravitational potential energy. Recognise and interpret examples of energy transfer between gravitational potential energy and kinetic energy. When an object falls it converts PE to KE. PE is also greater when the gravitational field strength (g) is higher.	Explain that at terminal speed: • KE does not increase; • PE does work against friction. Use the equation: PE=mgh. (A change of subject is required.)
Interpret a gravity ride (roller-coaster) in terms of: • KE; • PE; • energy transfer.	
Describe the effect of changing mass and speed on KE e.g. • doubling mass doubles KE • doubling speed quadruples KE	State and use the equation: weight = mass x gravitational field strength. (A change of subject is required.)

MODULE P4: RADIATION FOR LIFE

Item P4a: Sparks

Summary: The concept of medical physics runs through this unit. Electrostatics plays an important part in our lives. We investigate some of the ideas of electrostatics and look at the problems caused.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate the effect of charged insulators on small uncharged particles.	Describe and recognise that insulating materials can become charged when rubbed with another insulating material. State that there are two kinds of charge: • positive; • negative.
Carry out experiments to investigate the efficiency of different types of duster. Carry out experiments to demonstrate the forces between charges.	Describe and recognise that when some materials are rubbed they attract other objects: • small pieces of paper or cork to a rubbed comb or strip of plastic; • certain types of dusting brushes become charged and attract dust as they pass over it.
	Recognise and describe how you can get an electrostatic shock from charged objects: • synthetic clothing. Recognise and describe how you can get an electrostatic shock if you become charged and then become earthed: • touching water pipes after walking a floor covered with an insulating material e.g. vinyl.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P4b Electrostatics 2: Uses of Electrostatics

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
	Describe static electricity in terms of the movement of electrons: • a positive charge due to lack of electrons; • a negative charge due to an excess of electrons.
State and recognise that like charges repel and unlike charges attract. State and recognise that electrostatic phenomena are caused by the transfer of electrons.	
Explain how static electricity can be dangerous when: • in atmospheres where explosions could occur eg inflammable gases or vapours or with high concentrations of oxygen; • in situations where large quantities of charge could flow through the body to earth. Explain how static electricity can be a nuisance: • dirt and dust attracted to insulators (plastic containers, TV monitors etc); • causing clothing to “cling”.	Explain how the chance of receiving an electric shock can be reduced by: • correct earthing; • use of insulating mats; • using shoes with insulating soles. Explain why it is necessary to earth lorries containing inflammable gases and liquids and powders before unloading. Explain how anti-static sprays, liquids and cloths help reduce the problems of static electricity.

MODULE P4: RADIATION FOR LIFE

Item P4b: Uses of Electrostatics

Summary: Electrostatics has many uses. This unit looks at some of the uses both in medicine and everyday life and illustrates the use of contemporary scientific and technological developments and their benefits, drawbacks and risks.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
	Recognise and describe how static electricity can be useful: • restarting a heart when it has stopped (defibrillator); • photocopiers/laser printers (detailed structural knowledge not required); • removing dust from smoke in chimneys; • paint spraying.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P4a Electrostatics - Sparks

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how static electricity can be useful for restarting the heart when it has stopped (defibrillator): • paddles charged; • good electrical contact with patient's chest; • charge passed through patient to make heart contract; • care taken not to shock operator.	Explain how static electricity can be useful for restarting the heart when it has stopped (defibrillator): • paddles charged; • good electrical contact with patient's chest; • charge passed through patient to make heart contract; • care taken not to shock operator.
Describe how static electricity can be useful for electrostatic dust precipitators to remove smoke particles etc from chimneys: • metal plates/grids put into chimneys; • connected to a high PD; • dust particles attracted to plate/grid; • dust attracts together to form larger particles; • dust falls back down chimney when particles are heavy enough.	Explain how static electricity can be useful in electrostatic dust precipitators to remove smoke particles etc from chimneys: • metal plates/grids put into chimneys; • connected to a high PD; • dust particles attracted to plate/grid; • dust particles are attracted together to form larger particles; dust falls back down chimney when particles are heavy enough.
Describe how static electricity can be useful for paint spraying: • spray gun charged; • paint particles charged; • repel giving fine spray; • object charged oppositely to paint; • attracts paint; • even coat, less waste, shadows painted.	Explain how static electricity can be useful for paint spraying: • spray gun charged; • paint particles charged; • repel giving fine spray; • object charged oppositely to paint; • attracts paint; • even coat, less waste, shadows painted.

MODULE P4: RADIATION FOR LIFE

Item P4c: Safe Electricals

Summary: The unit investigates basic electricity. Safety is a major requirement when electricity is used in a medical situation. Here the principles of fuses and earthing are studied.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
	Recognise that a complete loop is required for a circuit to work. State that an earthed conductor cannot become live.
Carry out an experiment to investigate circuits and the effects of resistors and variable resistors.	Describe and recognise how resistors can be used to change the current in a circuit.
	State the colour coding for live, neutral and earth wires: • live – brown; • neutral – blue; • earth – green/yellow. Describe that an earthed conductor cannot become live.
Investigate fuses and RCDs.	Describe reasons for the use of fuses circuit breakers (as re-settable fuses).
	Describe and recognise that “double insulated” appliances do not need earthing.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P6a Resisting

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain the behaviour of simple circuits in terms of the flow of electric charge.	
Describe how variable resistors can be used to change the current in a circuit: • rheostat configured as a variable resistor only. Describe the relationships between current, potential difference (pd) and resistance: • for a given resistor, current increases as pd increases and vice versa; • for a fixed pd, current decreases as resistance increases and vice versa. State and use the equation: $\text{resistance} = \frac{\text{voltage}}{\text{current}}$	State and use the equation: $\text{resistance} = \frac{\text{voltage}}{\text{current}}$ (A change of subject may be required.)
Describe and explain the functions of the live, neutral and earth wires: • live – carries the high voltage; • neutral – the second wire to complete the circuit; • earth – a safety wire to stop the appliance becoming live.	
Describe how a wire fuse works: • if the current becomes too large; • wire fuse melts, breaking the circuit.	Explain how a wire fuse reduces the risk of fire: If the appliance develops a fault: • too large a current causes the fuse melt; • preventing flow of current; • prevents flex overheating and causing fire; • prevents further damage to appliance. Explain the reasons for the use of fuses/circuit breakers as re-settable fuses (structure and mode of operation not required). Explain how a wire fuse and earthing protects people.
Explain why “double insulated” appliances do not need earthing: • case of appliance is a non conductor and cannot become live.	

MODULE P4: RADIATION FOR LIFE

Item P4d: Ultrasound

Summary: The concept of medical physics runs through this unit. Ultrasound is an important diagnostic tool. This unit looks at the properties of waves including ultrasound and investigates some of its uses.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Look at ultrasound pictures and investigate the hearing range of pupils in the class. Investigate the properties of longitudinal waves.	State and recognise that ultrasound is a longitudinal wave. Recognise features of a longitudinal wave: • amplitude; • wavelength; • frequency; • compression; • rarefaction.
	Describe and recognise that ultrasound can be used in medicine: • to look inside people by scanning the body; • to break down kidney and other stones; • to measure the speed of blood flow in the body.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P1g Light

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe features of longitudinal waves: • amplitude; • wavelength; • frequency; • compression; • rarefaction. State and recognise that the frequency of ultrasound is higher than the upper threshold of human hearing.	Describe the motion of particles in longitudinal and transverse waves.
Describe applications of ultrasound: • body scans; • breaking down kidney and other stones.	Explain how ultrasound is used in: • body scans (reflections from different layers; • breaking down accumulations in the body such as kidney stones. Explain the reasons for using ultrasound rather than X-rays: • able to produce images of soft tissue; • does not damage living cells.

MODULE P4: RADIATION FOR LIFE

Item P4e: Treatment

Summary: The concept of medical physics runs through this unit. Ultrasound is an important diagnostic tool. This unit looks at the properties of waves including ultrasound and investigates some of its uses.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Demonstrate and model the tracer idea with a radioactive source hidden in school skeleton and detect outside.	Recall that nuclear radiation is used in medicine. Recall that x-rays and gamma rays are electromagnetic waves.
	Recall that nuclear radiation can damage cells. Recognise that gamma rays are used to treat cancer. Recall that nuclear radiation is used to sterilize hospital equipment. Recall that the person in hospitals who takes x-rays and uses radiation is a radiographer.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P2d Nuclear Radiations, P2e Our Magnetic Field, P4f What is radioactivity?

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recall that only beta and gamma radiation can pass through skin.	Explain that: • gamma rays are given out from the nucleus of certain radioactive materials; • X-rays are made by firing high speed electrons at metal targets; • X-rays are easier to control than gamma rays.
Describe that beta or gamma emitters are used as tracers in the body.	Explain how radioactive sources are used in medicine: 1. to treat cancer: • gamma rays focused on tumour; • wide beam used; • rotated round the patient with tumour at centre; • limiting damage to non-cancerous tissue. 2. as a tracer: • beta or gamma emitter; • drunk/eaten/ingested/injected into the body; • allowed to spread through the body; • followed on the outside by a radiation detector.
Describe that X-rays and gamma rays: • have similar wavelengths; • are produced in different ways.	

MODULE P4: RADIATION FOR LIFE

Item P4f: What is radioactivity?

Summary: Nuclear radiation is often misunderstood and frightening. Many people will come across these nuclear radiations in everyday life. This unit explores the properties and uses of nuclear radiation.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Investigate the variation of background radiation with location.	Describe and recognise that the radioactivity of an object is measured by the number of nuclear decays emitted per second.
Investigate the reality of long half-lives and the dangers of nuclear waste.	Describe and recognise that radioactivity decreases with time.
Explore how the idea of half-life is used to date artefacts in archaeology.	
	Describe that radiation comes from the nucleus.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P2d Nuclear Radiations, P2e Our Magnetic Field, P4e Treatment, P4g Uses of Radioisotopes, P4h Fission, C3a Cooking, C3b How Atoms Combine – Ionic Bonding

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe radioactive substances as decaying naturally and giving out nuclear radiation in the form of alpha, beta and gamma. Describe radioactivity as coming from the nucleus of an atom that is unstable. State that an alpha particle is a helium nucleus. State that a beta particle is a fast moving electron.	Explain and use the concept of half-life. Interpret graphical or numerical data of radioactive decay.
	Describe what happens to a nucleus when an alpha particle is emitted: • mass number decreases by 4; • nucleus has two less neutrons; • nucleus has two less protons; • atomic number decreases by 2; • new element formed. Describe what happens to a nucleus when a beta particle is emitted: • mass number is unchanged; • nucleus has one less neutron; • nucleus has one more proton; • atomic number increases by one. Construct and balance simple equations in terms of mass numbers and atomic numbers to represent alpha and beta decay.

MODULE P4: RADIATION FOR LIFE

Item P4g: Uses of radioisotopes

Summary: The uses of radioisotopes include tracers, smoke alarms, cancer treatment and radioactive dating. This item illustrates the use of contemporary scientific and technological developments and their benefits, drawback and risks. It also provides the opportunity to use ICT in teaching and learning, while work on dating rocks illustrates how ICT is used by scientists.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Use the internet to find levels of background radiation in different parts of the UK.	Describe and recognise that there is background radiation in the environment which is always present.
	State that radioisotopes are used as tracers in industry and hospitals.
Look inside ionisation based smoke detectors and identify the relevant parts.	Describe that alpha sources are used in some smoke detectors.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P2d Nuclear Radiations, P2e Our Magnetic Field, P4f What is radioactivity? P4h Fission

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe background radiation and state that it is caused by radioactive substances in rocks and soil and by cosmic rays.	Explain that some background radiation comes from waste products and man made sources eg waste from: • industry; • hospitals.
Recall examples of the use of tracers: • to track dispersal of waste; • to find leaks/blockages in underground pipes; • to find the route of underground pipes. .	Describe how tracers are used in industry: • radioactive material put into pipe; • gamma source used so that it can penetrate to the surface; • progress tracked with detector above ground; • leak/blockage shown by reduction/no radioactivity after this point.
Describe how a smoke detector with an alpha source works.	
Recall that radioactivity can be used to date rocks. Recall that measurements from radioactive carbon can be used to find the date of old materials.	Explain how the radioactive dating of rocks depends on the calculation of the uranium/lead ratio. Explain how measurements of the activity of radioactive carbon can lead to an approximate age for different materials: • the amount of Carbon 14 in the air has not changed for thousands of years; • when an object dies (eg wood) gaseous exchange with the air stops; • as the Carbon 14 in the wood decays the activity of the sample decreases; • the ratio of current activity from living matter to the activity of the sample leads to a reasonably accurate date.

MODULE P4: RADIATION FOR LIFE

Item P4h: Fission

Summary: This unit deals with work on nuclear fission. Nuclear fission is a major source of energy and can be used to produce electricity. Oil and gas will become less important as supplies decrease and alternative forms of energy will be needed. This unit explains the process of nuclear fission and how the energy produced can be harnessed to produce electricity.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier only: low demand
Use ICT simulations of chain reactions.	Recognise that nuclear power stations use uranium as a fuel. Describe the main stages in the production of electricity: • source of energy; • used to produce steam; • used to produce electricity.
	Describe that the decay of uranium can be a chain reaction. Describe that a nuclear bomb is a chain reaction that has gone out of control. Recall that materials can be made radioactive by putting them into a nuclear reactor.

MODULE P4: RADIATION FOR LIFE

Links with other modules: P2b Generating Electricity, P2c Fuels for Power, P4f What is Radioactivity? P4g Uses of Radioisotopes

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how domestic electricity is generated at a nuclear power station: • nuclear reaction; • producing heat; • producing steam; • turning a turbine; • turning a generator.	Describe what happens to allow Uranium to release energy: • uranium nucleus hit by neutron; • causes nucleus to split; • energy released.
Describe the process that gives out energy in a nuclear reactor as nuclear fission. State that nuclear fission produces radioactive waste. Describe how materials become radioactive when they absorb extra neutrons.	Explain what is meant by a chain reaction: • when each uranium nucleus splits more than one neutron is given out; • these neutrons can cause further uranium nuclei to split. Explain how scientists stop nuclear reactions going out of control: • rods placed in the reactor; • to absorb some of the neutrons; • allowing enough neutrons to remain to keep the process operating.

MODULE P5: SPACE FOR REFLECTION

Item P5a: Satellites, gravity and circular motion

Summary: Satellites have played a major part in the global communications revolution. We can call someone on the other side of the world using a mobile phone or watch events around the world, as they happen, in the comfort of our own homes. This unit looks at what satellites are, their use, other than communication and satellite TV, and the physics behind what keeps them in the desired orbit. Newton's experiment illustrates how uncertainties about science ideas change over time, and the use of models to explain phenomena.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Observe the International Space Station across the sky.	State and recognise that a satellite is an object that orbits a larger object in space. State that a gravitational force keeps a satellite in orbit. State and recognise the difference between artificial and natural satellites.
Use the internet to find images of the Earth taken by satellites. (Use images recorded in other wavelengths as well as visible light). Demonstration of circular motion by swinging a bung around with masses pulling it down. A glass tube is needed to thread the wire through and to hold as you rotate the bung.	Recognise that height above the Earth's surface affects the orbit of an artificial satellite. State that height of orbit of an artificial satellite determines it's use.
Describe Newton's thought experiment regarding a cannonball fired from a high mountain which, at the right speed, will orbit the Earth.	State and recognise some of the applications of artificial satellites, such as: • Communications; • Weather forecasting; • Military uses; • Scientific research; • GPS.

Can-Do Tasks

I can show the two types of orbit of an artificial satellite on a world globe. 1 point

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P2e Our Magnetic Field

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe gravity as a universal force of attraction between masses. Explain that the Moon remains in orbit around the Earth and the Earth in orbit around the Sun due to gravitational forces between them.	Describe the variation of gravitational force with distance. Explain the variation in speed of a periodic comet during its orbit around the sun. Explain that the orbit period of a planet depends upon its distance from the sun.
Describe that a geostationary artificial satellite orbits the Earth once in 24 hours around the equator. State that a geostationary artificial satellite remains in a fixed position above the Earth's surface. Describe that the orbital period of an artificial satellite increases with height above the Earth's surface. Know that circular motion requires a centripetal force and that gravity provides the centripetal force for orbital motion.	Explain that artificial satellites in lower orbits travel faster because the gravitational force is stronger. Explain that artificial satellites are continually accelerating towards the Earth due to the Earth's gravitational pull, but that their tangential motion keeps them moving in an approximately circular orbit.
Describe how satellites in low polar orbit can be used for: • weather forecasting; • imaging the Earth's surface. Describe how satellites in high geostationary orbit are used for: • communicatons; • weather forecasting.	Explain why: • Low polar orbit satellites orbit in a few hours. • Geostationary satellites orbit more slowly with a period of 24 hours.

MODULE P5: SPACE FOR REFLECTION

Item P5b: Vectors and equations of motion

Summary: When considering the motion of objects, knowing how fast they are travelling is only half the information. We also need to know in which direction they are travelling. Two cars travelling towards each other at high speed is entirely different from the same cars travelling at the same speed in the same direction.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
	Recognise that direction is important when describing the motion of an object. State and recognise that for two cars travelling on a straight road: • their relative speed is lower if they are moving in the same direction; • their relative speeds are higher if they are moving in opposite directions.
Measure the average speed on an object moving in a straight line, horizontally or falling under gravity. Use sense and control equipment to measure speed and acceleration. Use an equation of motion to calculate the acceleration due to gravity.	State and recognise that: • speed is a measure of how fast an object is moving; • direction is not important when measuring speed; Recognise that for any journey; • speed can change during the journey; • average speed can be calculated.

Can-Do Tasks

I can perform an experiment with electrical or electronic equipment and then calculate the acceleration due to gravity. 3 points

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P3a Speed, P3b Changing Speed

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Know the difference between vector and scalar quantities in that for some quantities, (e.g. force); direction is important whereas for other quantities, (e.g. mass), direction is not important. Calculate the vector sum from vector diagrams of parallel vectors (limited to force and velocity).	Calculate the resultant of two vectors by adding vectors that occur in parallel or at right angles to each other.
Use the equations: $v = u + at$ $s = \frac{(u + v)}{2} t$ Change of subject not required.	Use the equations: $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2} at^2$ To include change of subject.

MODULE P5: SPACE FOR REFLECTION

Item P5c: Projectile motion

Summary: Many sports involve throwing, striking or kicking a ball. We are more than familiar with the path taken by a ball that is thrown to us. Yet to have our hands in the right position in order to catch it, requires our brain to analyse the situation very quickly. The shape of the path or 'trajectory' together with the calculations behind this are considered here. Trajectories taken by golf balls and cricket balls can be illustrated by using ICT for teaching and learning. The 'pearls in the air' demonstration provides experience of scientific models.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Use TV images of golfers or footballers to show that the trajectories taken by golf balls and footballs are parabolic. Show "pearls in air" demonstration to show parabolic trajectory.	State and recognise that the path of an object projected horizontally in the Earth's gravitational field is curved. State, recognise and describe the trajectory of an object projected in the Earth's gravitational field as parabolic. State that the path of a projectile is called the trajectory.
Use 'horizontal and vertical' projectile apparatus to show the independence of the two. Show video clips of stroboscopic motion of falling objects and bouncing balls.	Describe and recognise that missiles and cannon balls when fired in the air are projectiles. State and recognise that golf balls, footballs, netballs, darts and long-jumpers moving through the air are further examples of projectile motion. Recognise everyday examples of projectiles.

Can-Do Tasks

There are no Can Do tasks in this item.

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P3g Falling Safely

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that an object projected horizontally in the Earth's gravitational field, ignoring air resistance: • has a constant horizontal velocity; • is accelerating towards the ground so has a steadily increasing vertical velocity.	Use the equations of motion (in Item P5b) for an object projected horizontally above the Earth's surface where the gravitational field is still uniform.
Explain that, ignoring air resistance, the only force acting on a ball during the flight is gravity. Explain that projectiles have a downward acceleration and that this only affects the vertical velocity.	Explain that the horizontal and vertical velocities of a projectile are vectors. Explain that the resultant velocity of a projectile is the vector sum of the horizontal and vertical velocities. Explain that for a projectile there is no acceleration in the horizontal direction.

MODULE P5: SPACE FOR REFLECTION

Item P5d: Momentum

Summary: Coming to a sudden stop is far more painful and dangerous than stopping gently. Seatbelts and crumple zones in cars are designed to bring people and moving objects to rest slowly and safely. People falling from a burning building are caught in a ‘Fireman’s Blanket’ for the same reasons. The ideas of momentum in collisions help us to understand how this happens.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Use skateboards or chairs on wheels to show the effect of equal and opposite forces.	Describe and recognise that every action has an equal and opposite reaction.
Carry out a demonstration using air tracks or trolleys to illustrate the conservation of momentum.	Describe and recognise the opposite reactions in a simple collision (i.e. velocities parallel).
Launch a water rocket to demonstrate that the explosion propels the water down with the same momentum as the rocket shoots up. Show videos on road safety and describe how seatbelts reduce the rate at which momentum changes.	Describe that a ball struck by an object in sport (e.g. cricket ball and bat) is an example of a collision. Recognise everyday examples of collisions.
Can-Do Tasks There are no Can-Do tasks in this item.	

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P3f Crumple Zones

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the opposite reactions in a number of static situations including examples involving gravity.	
Describe that the greater the mass of an object and/or the greater velocity, the more momentum the object has in that direction. Use the equation: momentum = mass x velocity to calculate momentum.	Explain that when an object collides with another object, the two objects exert an equal and opposite force on each other. Use the equation: $\text{force} = \frac{\text{change in momentum}}{\text{time}}$ to calculate: • force; • change in momentum; • time taken.
Describe that injuries in vehicle collision and many sporting injuries are due to a very rapid acceleration of parts of the body. Explain, using the ideas about momentum, the use of: • crumple zones; • seatbelts; • airbags in cars.	Explain that spreading the change in momentum over a longer time: • reduces the forces required to act; • reduces the injury.
	Explain that momentum is a property that is always conserved and use that to explain: • explosions; • recoil; • rocket propulsion. Interpret the principle of conservation of momentum to collisions of two objects moving in the same direction (including calculations of mass, speed or momentum).

MODULE P5: SPACE FOR REFLECTION

Item P5e: Satellite Communication

Summary: Using microwave and satellite technology, you can call anyone from anywhere on the planet, or receive a TV signal via a satellite dish. This technology has moved at a rapid pace. But how does the signal from our mobile phones get to the person receiving the call? This section looks at why we use microwaves and the physics behind the industry.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Use the internet to research the parts of the Earth's atmosphere and their effects on absorbing or transmitting electromagnetic radiation. Predict where a satellite sending digital TV signals to Earth is by looking at which direction the satellite dishes are all pointing at in a street of houses.	Describe that some frequencies of radio waves: • pass through the Earth's atmosphere; • are stopped by the Earth's atmosphere. Recognise that different frequencies are used for low orbit satellites and geostationary satellites.
Show that mobile phones give off electromagnetic waves by placing them near loudspeakers and listening for the crackle. Examine pictures of waves coming into harbours. Use ripple tanks or microwaves kits to show that waves spread out from a gap.	Describe and recognise that radio waves are reflected by part of the Earth's upper atmosphere. Recognise that radio waves can 'spread' around large objects. Describe a practical example of waves spreading out from a gap.
	Describe and recognise that radio waves have a very long wavelength. Describe and recognise that for reception of radio and TV programmes: • an aerial is needed for radio signals; • a 'dish' is needed for satellite TV signals.
Can-Do Tasks There are no Can-Do tasks in this section.	

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P1f Wireless Signals

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe how information can be transmitted using microwaves to orbiting artificial satellites and then retransmitted back to Earth.	Explain that microwaves are sent as a thin beam because they only diffract by a small amount due to their short wavelength.
Describe that radio frequencies below 30MHz are reflected by the ionosphere. Describe that above 30GHz, rain, dust and other atmospheric effects reduce the strength of the signal due to absorption and scattering; Recall the wave patterns produced by a plane wave passing through different sized gaps.	Explain reflection of waves (frequency less than 30MHz) are reflected by the ionosphere. Describe how the amount of diffraction depends upon the size of the gap and the wavelength of the wave. State that maximum diffraction occurs when the wavelength equals the size of the gap.
Describe that radio waves are readily diffracted so are more suitable for broadcasting. Describe that long wave radio waves have a very long range because they diffract around hills and over the horizon.	Explain how long wavelength radio waves are diffracted around hills and over the horizon. Describe that longwave radio waves carry signals by amplitude modulation (AM).

MODULE P5: SPACE FOR REFLECTION

Item P5f: Nature of waves

Summary: Particles can behave like waves. At other times waves behave like particles. The nature of waves is fundamental to our understanding of the world around us as is interaction of particles due to forces. This section looks at the most important of all wave properties - interference. When people talk about interference they usually mean 'noise' or 'crackle' in a radio receiver. In physics, interference means the effect produced when two waves meet each other.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Carry out a demonstration to show the interference of waves using a ripple tank. Listen to interference by placing two speakers 1m apart and playing the same note. Pupils will notice the loud and quiet spots. Look at waves down a slinky and see what happens when two waves travelling in opposite directions interfere with each other.	Describe and recognise that interference is an effect resulting from two waves that overlap. Recognise that when waves overlap there are: • areas where the waves add together; • areas where the waves subtract from each other. State that interference results in: • louder and quieter areas in sound; • bright and dark areas in light. Describe that interference of two waves results in a pattern of reinforcement and cancellation of the waves.
Examine the pattern of light made by a laser passing through two slits. Use OHP wave plates to show interference patterns. Use Polaroid glasses to block out rays of light. Use Polaroids to show that light reflected off water is polarised.	Recall that light travels in straight lines. Recognise that under certain circumstances light can 'bend'.

Can-Do Tasks

I can produce an interference pattern in a ripple tank. 1 point

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P1d Cooking with Waves, P1f Wireless Signals, P5g Refraction of Waves

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Describe a demonstration of interference effects using either sound waves, surface water waves or microwaves. Describe the interference of two waves in terms of reinforcement and cancellation of the waves.	Describe and explain interference patterns in terms of constructive and destructive interference. Explain that the number of half wavelengths in the path difference for two waves from the same source is: • an odd number for destructive interference; • an even number for constructive interference.
Explain that the diffraction of light and its associated interference patterns are evidence for the wave nature of light. Describe that electromagnetic waves are transverse waves and so can be plane polarised.	Describe and explain a diffraction pattern for light. Explain how polarisation is used in the application of Polaroid sunglasses.

MODULE P5: SPACE FOR REFLECTION

Item P5g: Refraction of waves

Summary: Drive along a road on a hot day and you may see water appear to be on the surface of the road. Even more strangely, however, is that this puddle is not actually there when you get there. Such optical illusions are common place and involve the passage of light as it enters different mediums. This item illustrates how phenomena can be explained by using scientific theories, models and ideas.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Examine the dispersion of light through a prism and look at how rainbows are made. Survey effects due to refraction such as mirages and apparent depth.	Describe a substance that light passes through as a medium. Describe and recognise that refraction involves a change in direction of a wave due to the wave passing from one medium into another. State and recognise that for a ray of light travelling from air into glass the angle of incidence is usually greater than the angle of refraction.
Carry out an experiment to test Snell's law.	Describe and recognise that dispersion happens when light is refracted. State that blue light is deviated more than red light.
Look in detail at bicycle reflectors and cat's eyes to show that they are prisms. Show fibre optic cables in action. Fibre optic Christmas tree lights are a good source of these.	Describe and recognise that some, or all, of a light ray can be reflected when travelling from glass, or water, to air.

Can-Do Tasks

I can project a visible spectrum onto a screen using a prism. 1 point

I can measure the angles of incidence and refraction and use the values to calculate the refractive index of a material. 3 points

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P1e Infrared Signals, P1f Wireless Signals, P5f Nature of Waves, P5h Optics

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that refraction occurs at the boundary between two mediums due to a change in the wave speed. Describe that when the wave speed decreases the wave bends towards the normal and vice versa. Describe that refractive index is limited to the amount of bending after a boundary.	Explain that a change in speed causes a change in wavelength and may cause a change in direction. Calculate refractive index using the equation: $\text{refractive index} = \dfrac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$
Recall that the amount of bending increases with greater change of wave speed and refractive index. Explain dispersion in terms of spectral colours having different wave speeds. State the order of the spectral colours.	Use and manipulate Snell's law in terms of angles of incidence and refraction: $n = \dfrac{\sin i}{\sin r}$ (to include change of subject.) Explain dispersion in terms of refractive indices.
Describe what happens to light incident on a glass/air surface when the angle of incidence is less than, equal to or above the critical angle. Recognise that different media have different critical angles.	Explain that total internal reflection can only occur when a ray of light travels from a medium with a higher refractive index into a medium with a lower refractive index and the angle of incidence is greater than the critical angle. Calculate the critical angle from the refractive index using the equation: $\sin c = \dfrac{n_r}{n_i}$ Explain that the higher the refractive index of a medium the lower is its critical angle.

MODULE P5: SPACE FOR REFLECTION

Item P5h Optics

Summary: Projecting an image onto a screen is today's big business and involves big money; especially if it's you they are projecting. The cameras used to film the movies use a complex arrangement of lenses to zoom in and focus on the actors, and the images they form are real but inverted. This unit takes a look behind the scenes of how it is done

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Examine an optical instrument. It may be a telescope, microscope or a camera. Look at the arrangement and number of lenses. Look in particular at their differing size and focal lengths. Carry out an experiment with a convex lens to focus the image of a distant object on the lab wall, e.g. window of lab or inside of lab window. Observe how the distance between the lens and screen varies with focal length. (Focusing image of a distant object on a screen). Construct a simple telescope with one short focal length lens and one long focal length lens.	Recognise the shape of a convex lens. State that convex lenses are also called converging lenses. Describe that light incident on a convex lens parallel to the axis passes through the focal point after passing through the lens. Describe the focal length of a convex lens as being measured from the centre of the lens to focal point (focus). State and recognise that 'fat' lenses have short focal lengths.
Carry out an experiment with convex lenses to see how the image of a light bulb varies with the distance of the bulb from the lens.	Recognise and state that projectors and cameras produce real images on a screen.
Use pin hole cameras to explore how the size of the aperture (opening) affects both the sharpness and brightness of the image and how focussing is achieved with a lens.	State that convex lenses are used: • as a magnifying glass; • in cameras; • in projectors.

Can-Do Tasks

I can use a convex lens to project a real image onto a screen.	1 point
I can construct my own refracting telescope.	3 points

MODULE P5: SPACE FOR REFLECTION

Links with other modules: P5g Refraction of Waves

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe the effect of a convex lens on: • a diverging beam of light; • a parallel beam of light.	
Describe how a camera or projector produces a real image on film and screen respectively.	Explain how to find the position and size of the real image formed by a convex lens by drawing suitable ray diagrams.
Describe the use of a convex lens: • as a magnifying glass; • in a camera; • in a projector. Explain how the images produced by cameras and projectors are focussed.	Describe that real images can be projected onto a screen and are inverted. Explain that virtual images cannot be projected onto a screen but are the right way up. Use the formula for magnification: $\text{magnification} = \frac{\text{image size}}{\text{object size}}$

MODULE P6: ELECTRICITY FOR GADGETS

Item P6a: Resisting

Summary: Most electrical devices have some form of control built into their circuits. Simple examples are the volume of a personal CD-player or the speed of the food processor. More sophisticated examples include the ability to program devices such as microwave cookers or DVD players.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Carry out an experiment using a variable resistor as a dimmer unit to control the brightness of a bulb and measure the current in the circuit.	State the circuit symbols for resistor, variable resistor, bulb, cell, battery, switch and power supply. Describe and recognise that a variable resistor can be used to vary the brightness of a lamp.
Carry out an experiment to investigate the voltage-current characteristics of an ohmic conductor.	State the units of voltage, current and resistance. State and recognise that for a given ohmic conductor the current increases as the voltage increases.
Carry out an experiment to investigate the voltage-current characteristics of a non-ohmic device, such as a bulb.	Describe and recognise that when a wire is hot its resistance increases.

Can-Do Tasks

I can wire a simple series circuit, to include resistors, from a circuit diagram. 2 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P4c Safe Electricals, P6b Sharing

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe and explain the effect of a variable resistor in a circuit in terms of: • control of the current; • varying the brightness of a bulb or speed of a motor.	Explain that the resistance is varied as a result of changing length of resistance wire in a variable resistor.
Use the equation: resistance = voltage ÷ current. Describe how a voltage-current graph can be used to find the resistance of an ohmic conductor.	Use and manipulate the equation: resistance = voltage ÷ current. Calculate the resistance of an ohmic conductor from a voltage-current graph.
Describe how a voltage-current graph shows the changing resistance of a non-ohmic device, such as a bulb.	Explain the shape of a voltage-current graph for a non-ohmic conductor, such as the filament in a lamp, in terms of changing resistance.

MODULE P6: ELECTRICITY FOR GADGETS

Item P6b: Sharing

Summary: Electronic circuits rely on supply potential difference (pd) being split into two smaller pds. Sometimes, these output pds also need to be adjusted to a threshold level to give the required output pd. This item develops ideas about how both fixed and variable resistors are used, together with LDRs and thermistors, to achieve the desired output pd.

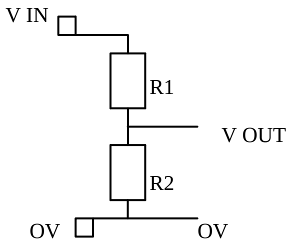
Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Examine a potential divider circuit in an electronic device. Use a rheostat as a potential divider to control the brightness of two bulbs in series.	Recognise the arrangement of how fixed resistors in a circuit can be used as a potential divider. Describe and recognise that a potential divider is used to produce a required pd in a circuit.
Examine circuits which use LDRs to control output e.g. lights which come on at night. Examine circuits which use thermistors to control output.	Describe and recognise that a LDR responds to a change in light level. Describe and recognise that a thermistor responds to changes in temperature.

Can-Do Tasks

I can design and construct a potential divider circuit to achieve a given output pd. 3 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P6a Resisting

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain how two fixed resistors can be used as a potential divider. Explain how one fixed resistor and one variable resistor in a potential divider allows variation of the output pd.	Calculate the output pd of a potential divider from the values of its resistors using: $V_{out} = V_{in} \times \frac{R_2}{(R_1 + R_2)}$  Explain how a variable resistor can be used in place of the fixed resistor to provide an output pd with an adjustable threshold.
Describe how the resistance of an LDR varies with light level. Describe how the resistance of a thermistor (ntc only) varies with temperature.	Explain how an LDR or a thermistor can be used in a potential divider with a fixed resistor to provide an output signal which depends on light or temperature conditions.

MODULE P6: ELECTRICITY FOR GADGETS

Item P6c: Motoring

Summary: Many of the electrical devices we use every day contain electric motors. They can be very small such as in a CD player or much larger in devices such as washing machines. This item develops ideas about the magnetic effect of an electric current and how magnetic fields interact to produce the movement needed for a motor.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Examine the magnetic field around a current carrying wire and a coil. Show that a current carrying wire placed in a magnetic field has a force acting on it.	Describe that a current carrying wire has a circular magnetic field around it. Describe and recognise that this field is made up of concentric circles. Recognise and describe that a current carrying straight wire placed in a magnetic field can move.
Examine the construction of both simple and practical motors.	State that motors are found in a variety of everyday applications e.g. washing machine, CD player, food processor, electric drill, electric lawnmower, windscreen wiper.

Can-Do Tasks

I can build a model DC electric motor. 3 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P2e Our Magnetic Field, P6d Generating

Assessable learning outcomes both tiers: standard demand	**Assessable learning outcomes Higher Tier only: high demand**
Describe the shape of the magnetic field around a straight wire, rectangular coil, or solenoid. Describe that a current carrying wire at right angles to a magnetic field experiences a force. Describe the effect of reversing the current and/or the direction of the magnetic field.	Describe how Fleming's Left Hand Rule is used to predict the direction of the force on a current carrying wire.
Explain how the forces on a current carrying coil in a magnetic field produce a turning effect on the coil. Explain how this effect is used in a simple DC motor. Describe the effect of changing: • the size of the electric current; • the number of turns on the coil; • the strength of the magnetic field.	Explain how the direction of the force on the coil in a DC electric motor is maintained in terms of the change of current direction every half-turn. Describe how this is achieved using a split-ring commutator in a simple DC electric motor. Explain why practical motors have a radial field produced by curved pole pieces.

MODULE P6: ELECTRICITY FOR GADGETS

Item P6d: Generating

Summary: Electricity is a very convenient energy source which allows us to use the everyday appliances at home, school and work. As well as being convenient it is readily available, easy to use, versatile and clean at the point of use. This item develops ideas about how electricity is generated.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Build a model generator to produce electricity. Examine the difference between a model generator and the generator in a power station.	Describe and recognise the dynamo effect. Electricity can be generated by: • moving a wire near a magnet; • moving a magnet near a wire. Label a diagram of a DC generator to show the coil, the magnets and the commutator.
Examine ways in which the electrical output from a generator can be increased.	Describe that a DC generator is a motor working in reverse. Describe that in the UK, mains electricity is supplied at 50Hz.

Can-Do Tasks

I can build a model generator. 3 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P2b Generating Electricity, P2e Our Magnetic Field, P6c Motors

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that a voltage is induced across a wire when the wire moves relative to a magnetic field. Describe that a voltage is induced across a coil when the magnetic field within it changes. Describe the effect of reversing the direction of the changing magnetic field.	Explain how the size of the induced voltage depends on the rate at which the magnetic field changes.
Describe that an alternating current is generated when a magnet rotates inside a coil of wire. Describe that electricity in a power station is generated when an electromagnet rotates inside coils of wire. Describe how changing the speed of rotation of the electromagnet's coil(s) affects the size and frequency of the voltage generated. Describe how changing the number of turns on the electromagnet's coil(s) affects the size of the voltage generated.	When provided with a diagram, explain how an AC generator works including the action of the slip-rings and brushes.

MODULE P6: ELECTRICITY FOR GADGETS

Item P6e: Transforming

Summary: There are many electrical and electronic devices which work on voltages much lower than mains voltage. Electricity is transmitted around the country at voltages very much higher than mains voltage. This means that the current is lower therefore less energy is wasted heating up the power lines. This item develops ideas about transformers as devices which change voltage or isolate a supply. The research on the different voltages in the National Grid allow the use of ICT as a teaching and learning resource.

Suggested activities and experiences to select from	**Assessable learning outcomes Foundation Tier: low demand**
Examine household devices that contain transformers. Find out about different voltages used from the National Grid.	Describe that a transformer changes the size of a voltage – it does not change AC into DC. State and recognise that transformers do not work with DC. Describe that transformers can increase or reduce a voltage. State and recognise that: • step-down transformers reduce voltage; • step-up transformers increase voltage. Describe that step-down transformers are used in a variety of everyday applications e.g. phone chargers, radios, laptops.
	State that an isolating transformer is used in a bathroom shaver socket.
	Describe that step-up transformers are used to increase the voltage from the generator at a power station to supply the National Grid. Describe that step-down transformers are used in sub-stations to reduce the voltage for domestic and commercial use.

Can-Do Tasks

I can construct and explain a model high voltage power line. 3 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P2b Generating Electricity

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Explain that a transformer changes the size of an alternating voltage. Describe the construction of a transformer as two coils of wire wound on an iron core. Describe the difference in construction of a step-up and a step-down transformer. Be able to state and manipulate the equation: $\frac{V_p}{V_s} = \frac{N_p}{N_s}$	Explain why the use of transformers requires the use of alternating current. Describe how the changing field in the primary coil of a transformer induces an output voltage in the secondary coil.
Describe that an isolating transformer is used in some mains circuits (e.g. bathroom shaver socket) for safety reasons. Explain the reason for using an isolating transformer.	Explain that isolating transformers: • have equal numbers of turns in the primary and secondary coils; • limit the risk of contact between live parts and the earth lead.
Describe that power loss in the transmission of electrical power is related to the square of the current flowing in the transmission lines.	Use and manipulate the equation: $V_pI_p = V_sI_s$ applied to a transformer. Use this relationship to explain why power is transmitted at high voltages.

MODULE P6: ELECTRICITY FOR GADGETS

Item P6f: Charging

Summary: As well as changing the voltage, using a transformer, it is often necessary to change the current from AC to DC. This item develops ideas about the use of diodes and capacitors to obtain a constant DC output. This is because many things, such as micro chips need a DC supply to work. This item provides the opportunity to discuss contemporary scientific and technological developments.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Examine the current – voltage characteristics of a diode.	Recognise and draw the symbol for a diode. State that a diode only allows a current to pass in one direction. State the direction of current flow from the diode symbol. Recognise half-wave rectification from a voltage – time graph.
Carry out an experiment to show the difference between half-wave and full-wave rectification.	Recognise full-wave rectification from a voltage – time graph.
Show that a capacitor can store charge.	Recognise and draw the symbol for a capacitor. State that a capacitor stores charge which can be discharged later.

Can-Do Tasks

I can build a full-wave rectification circuit. 3 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P2b Generating Electricity

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Recognise the current – voltage characteristics for a silicon diode. Use this graph to explain that a diode only allows current to flow in one direction. State and recognise that a single diode produces half-wave rectification.	Explain the current voltage graph for a silicon diode in terms of high and low resistance in reverse and forward directions. Describe the action of a silicon diode in terms of the movement of holes and electrons.
Describe how four diodes can be used in the construction of a bridge circuit to obtain full-wave rectification.	Explain how four diodes in a bridge circuit produce full-wave rectification.
Describe that when a current flows in a circuit containing an uncharged capacitor, charge is stored and the pd across the capacitor increases. Describe the flow of current from a charged capacitor when a conductor is connected across it. State that many devices need a more constant voltage supply. State and recognise that a capacitor will produce a more constant (smoothed) output.	Explain the flow of current and reduction in pd across a capacitor when a conductor is connected across it. Explain the action of a capacitor in a simple smoothing circuit.

MODULE P6: ELECTRICITY FOR GADGETS

Item P6g: It's logical

Summary: Many electronic devices rely on some form of logic circuit. The personal computer is probably the best known example, but washing machines and car ignitions also contain the silicon chip. This item develops ideas about logic circuits and the gates which are used.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
	State that the input signal for a logic gate is either a high voltage (about 5 V) or a low voltage (about 0 V).
Show that setting conditions, such as either driver's door OR passenger's door OR both doors need to be open before the courtesy light in a car switches on, leads to a truth table. Carry out an experiment to show the actions of NOT, AND and OR (higher tier NAND and NOR) logic gates.	Describe the truth table for a NOT logic gate in terms of high and low signals.

Can-Do Tasks

I can build a logic gate circuit using either an AND or an OR gate to perform a particular job. 2 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P6h Even more logical

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Describe that the output of a logic gate is high or low depending on its input signal(s).	
Describe the truth tables for AND and OR logic gates in terms of high and low signals.	Describe the truth table for NAND and NOR logic gates in terms of high and low signals.
Describe how to use switches, LDRs and thermistors in series with fixed resistors to provide input signals for logic gates.	Explain how a thermistor or an LDR can be used with a fixed resistor to generate a signal for a logic gate which depends on temperature or light conditions. Explain how a thermistor or an LDR can be used with a variable resistor to provide a signal with an adjustable threshold voltage for a logic gate.

MODULE P6: ELECTRICITY FOR GADGETS

Item P6h: Even more logical

Summary: In practice, most electronic devices require many logic gates combined to give the necessary output under a variety of conditions. This item develops ideas about how truth tables are used to show how logic gates can be combined.

Suggested activities and experiences to select from	Assessable learning outcomes Foundation Tier: low demand
Examine common devices which use more than one logic gate.	State and recognise the input and output signals in an electronic system with a combination of logic gates.
Examine a bistable circuit.	Describe that a latch in a car or burglar alarm causes it to remain on once it has been triggered.
Carry out investigations with MFA boards to solve problems using two or more logic gates combined together.	Recognise that the output current from a logic gate is able to light a LED. Recognise and recall the symbol for a relay. State that a relay can be used as a switch.

Can-Do Tasks

I can build a logic gate circuit using at least two AND or OR gates to perform a particular job. 3 points

MODULE P6: ELECTRICITY FOR GADGETS

Links with other modules: P6g It's Logical

Assessable learning outcomes both tiers: standard demand	Assessable learning outcomes Higher Tier only: high demand
Complete a truth table of a logic system with up to three inputs made from logic gates.	Explain how to work out the truth table of a logic system with up to four inputs made from logic gates.
	Describe how to connect NOR gates to make a bistable latch circuit. Explain how, for a NOR gate latch: • a brief high signal at one input results in a permanent high signal at the latch output; • a brief high signal at the other input causes a low signal at the latch output; • a low signal at both inputs leaves the latch output signal unchanged.
Describe the use of an LED as an output for a logic gate. Describe how a relay uses a small current in the relay coil to switch on a circuit in which a larger current flows.	Explain how an LED and series resistor can be used to indicate the output of a logic gate. Describe that a relay is needed for a logic gate to switch a current in a mains circuit because: • a logic gate has a low power output; • the relay isolates the low voltage from the high voltage mains.

4 Scheme of Assessment

4.1 Units of Assessment

The specification provides staged assessment using a unitised scheme. Candidates take three units of assessment B651, B652 and either B655 or B656.

Individual entries are required for each unit of assessment and for the specification overall (J645) when certification is required.

GCSE Physics (J645)	
Unit 1: Physics B Unit 1 – modules P1, P2, P3 (B651)	
33⅓% of the total GCSE marks 60 minutes written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers; • focuses on modules P1, P2 and P3; • uses structured questions throughout (there is no choice of questions).
Unit 2: Physics B Unit 2 – modules P4, P5, P6 (B652)	
33⅓% of the total GCSE marks 60 minutes written paper 60 marks	This question paper: • is offered in Foundation and Higher Tiers; • focuses on modules P4, P5 and P6; • uses structured questions throughout (there is no choice of questions).
Unit 3: Physics B Unit 3 – 'Can Do' tasks and 'Science in the News' (B655)	
33⅓% of the total GCSE marks Skills assessment 60 marks	Skills assessment consists of two elements: • Can-do tasks (24 marks) • Report on Science in the news (36 marks)
Unit 4: Physics B Unit 4 – Research Study, Data Task and Practical Skills (B656)	
33⅓% of the total GCSE marks Skills assessment 60 marks	Candidates produce a portfolio comprising three elements: • Research Study (24 marks) • Data Task (30 marks) • Practical Skills (6 marks)

4.2 Unit Options

Candidates take Units 1 and 2 and either Unit 3 or Unit 4.

4.3 Tiers

All written papers are set in one of two tiers: Foundation Tier and Higher Tier. Foundation Tier papers assess grades G to C and Higher Tier papers assess Grades D to A*. An allowed grade E may be awarded on the Higher Tier components. In Units B651 and B652, candidates are entered for an option in either the Foundation Tier or the Higher Tier. Units B655 and B656 (internal assessment) are not tiered.

Candidates may enter for either the Foundation Tier or Higher Tier in each of the externally assessed units. So, a candidate may take, for example B651/01 and B652/02.

4.4 Assessment Availability

There are two examination sessions each year, in January and June.

	B651	B652	B655	B656
June 2007	✓	-	-	-
January 2008	✓	✓	-	-
June 2008	✓	✓	✓	✓

After June 2008, Units B651 and B652 will be available in the January and June sessions. The skills assessment, Units B655 and B656, will only be available in the June session.

The Foundation and Higher tier papers covering the same unit will be timetabled on the same day, and will commence at the same time. The papers timetabled simultaneously will contain common questions, or part questions, targeting the overlapping grades C and D.

4.5 Assessment Objectives

The Assessment Objectives describe the intellectual and practical skills that candidates should be able to demonstrate, and which will be assessed.

Assessment Objective 1 (AO1): Knowledge and understanding of science and how science works

Candidates should be able to:

- demonstrate knowledge and understanding of the scientific facts, concepts techniques and terminology in the specification;
- show understanding of how scientific evidence is collected and its relationship with scientific explanations and theories;
- show understanding of how scientific knowledge and ideas change over time and how these changes are validated.

Assessment Objective 2 (AO2): Application of skills knowledge and understanding

Candidates should be able to:

- apply concepts, develop arguments or draw conclusions related to familiar and unfamiliar situations;
- plan a scientific task, such as a practical procedure, testing an idea, answering a question or solving a problem;
- show understanding of how decisions about science and technology are made in different situations, including contemporary situations and those raising ethical issues;
- evaluate the impact of scientific developments or processes on individuals, communities or the environment.

Assessment Objective 3 (AO3): Practical, enquiry and data-handling skills

Candidates should be able to:

- carry out practical tasks safely and skillfully;
- evaluate the methods they use when collecting first-hand and secondary data;
- analyse and interpret qualitative and quantitative data from different sources;
- consider the validity and reliability of data in presenting and justifying conclusions.

Weighting of Assessment Objectives

Assessment Objective	Weighting
AO1	34.0%
AO2	39.3%
AO3	26.6%

4.6 Quality of Written Communication

Candidates are expected to:

- present relevant information in a form that suits its purpose;
- ensure text is legible and that spelling, punctuation and grammar are accurate, so that meaning is clear.

Where appropriate they should also use a suitable structure and style of writing.

Candidates' quality of written communication will be assessed in the Report on Science in the News and the Research Study.

5 Internal Assessment

5.1 Nature of Skills Assessment

Rationale

The assessment of skills involves a variety of approaches to avoid the 'done that before' response. It provides regular feedback to candidates to ensure a sense of achievement and continuous motivation. It contains assessment targets that are achievable by the least able candidates, but differentiation to challenge and reward the most able.

Skills assessment comprises:

either Unit 3 (B655) the skills assessment similar to that of the Gateway Science B specification which comprises:

- a set of **Can-Do tasks**;
- and a report on **Science in the News**.

or Unit 4 (B656) the skills assessment similar to that of the Gateway Additional Science B specification which comprises:

- a **Research Study**;
- a **Data Task**;
- and **Practical Skills**.

The portfolio of work done during the course (for Unit B655 or Unit B656) accounts for one third of the marks for this specification. Portfolio work is assessed by teachers, internally standardised and then externally moderated.

Summary of the Elements of Unit 3 (B655)

Can-Do tasks: These are assessed and recorded throughout the course as the candidate fulfils them. The marks are recorded on the Candidate Record Card.

Report on Science in the News: Candidates are required to use stimulus material provided by OCR and other sources of information to research the way in which scientific data and ideas are dealt with by the media. The number of reports attempted is at the discretion of the centre, but the results of **only one** may be submitted.

Assessment element	Element marks		Weighting
Can-Do tasks	The results of 8 Can-Do tasks are submitted. These tasks are available at three levels: Basic Skills 1 point Intermediate Skills 2 points Advanced Skills 3 points Total max mark = 24 marks		13.3% overall
Report on Science in the News	A Approach to the task B Analysis of the data C Evaluation of the data D Relating the data to the issues E Justifying a conclusion F Quality of written communication Total max mark = 36 marks	6 marks 6 marks 6 marks 6 marks 6 marks 6 marks	20% overall

Summary of the Elements of Unit 4 (B656)

Research Study: Candidates are required to use stimulus material provided by OCR and other sources of information to research scientific ideas. The number of reports attempted is at the discretion of the centre, but the results of **only one** may be submitted.

Data Task: Candidates are required to analyse and evaluate data and to plan further work (which will not be carried out). The number of tasks attempted is at the discretion of the centre, but the results of **only one** may be submitted.

Practical Skills: The ability to carry out practical tasks safely and skilfully is assessed holistically.

Assessment element	Element marks		Weighting
Research Study	A Collecting information B Linking information to explanations C Developing and using scientific ideas D Quality of written communication Total max mark = 24 marks	6 marks 6 marks 6 marks 6 marks	13.3% overall
Data Task	A Interpreting the data B Analysis of the data C Evaluation of the data D Justifying a conclusion E Planning further work Total max mark = 30 marks	6 marks 6 marks 6 marks 6 marks 6 marks	16.6% overall
Practical Skills	An overview of practical skills throughout the course. Total max mark = 6 marks		3.4% overall

5.2 Marking Internally Assessed Work

Unit 3 (B655) Element 1: Can – Do tasks

Mark submitted out of 24.

These tasks enable all candidates to achieve success but still provide challenge and reward for high attainers. The tasks are set at three levels:

Basic Skills: 1 point tasks	Simple tasks which should be within the reach of all candidates.
Intermediate Skills: 2 point tasks	More complex tasks which require more than one skill.
Advanced Skills: 3 point tasks	Extended tasks which require a candidate to perform a sequence of more demanding operations.

Detailed advice on assessing Can-Do tasks will be provided in guidance material published separately. Essentially however, to demonstrate proficiency at a Can-Do task, a candidate must complete the task safely and skillfully, without the help of the teacher.

Can-Do tasks are assessed on an 'all or nothing' basis: if a candidate demonstrates proficiency, the number of points associated with the task is credited in full. Thus candidates may not be given partial credit for a 2 or 3 point task if the task has only been partially completed.

Opportunities to demonstrate proficiency in Can-Do tasks are indicated throughout the specification content. Results can be submitted from eight tasks. A candidate can gain a maximum of 8 points from successfully completing eight Basic Skills tasks, 16 points for eight Intermediate Skills tasks or 24 points for eight Advanced Skills tasks. Any combination of eight tasks set at different levels is acceptable. It is expected that during their course candidates will attempt a wide range of tasks at a variety of levels and that all candidates will be able to achieve success at appropriate levels. At the end of the course, results for the highest scoring eight tasks should be identified and the total points score out of a maximum of 24 should be submitted.

Unit 3 (B655) Element 2: Report on Science in the News

Mark submitted out of 36.

This element of the assessment requires candidates to use stimulus material provided by OCR, supplemented by electronic (internet, CD ROMs, databases, simulations) and/or more traditional sources of information (books, magazines, leaflets) to research the way in which scientific data and ideas are dealt with by the media. Candidates are given about a week to carry out this research and they then complete a written report, under supervision, on their findings.

The report may be submitted as a hand written or word processed document or in another suitable format, for example a PowerPoint presentation with appropriate accompanying notes.

The report should be less than 800 words in length. Reports in excess of 800 words will indicate poor structure and unselective choice of material. A written report should be illustrated by pictures, diagrams and tables as appropriate. At the end of the report the sources used should be listed with references made to these sources in the body of the report, where appropriate.

A set of Science in the News tasks will be available from OCR. Alternatively, centres may provide their own Science in the News stimulus material and assess work using the OCR level of response grid. Advice on the suitability of such material and application of the level of response grid must be obtained by using the OCR Internal Assessment Consultancy Service before the task is given to candidates.

Arrival at Marks for Report on Science in the News

The award of marks is based on the professional judgment of the science teacher, working within a framework of performance descriptions related to various qualities. For each quality, different aspects of performance are identified in the level of response grid. For each quality, a series of three descriptions of performance (for 2, 4 and 6 marks) illustrates what might be expected for candidates working at different levels.

Marking decisions for candidates should be recorded on the Science in the News cover sheet downloaded from the OCR website www.ocr.org.uk.

Candidates may not always report their work in a particular order; evidence of achievement may be located almost anywhere in the report. Thus, it is necessary to look at the whole report for evidence of each quality.

For any one quality, a tick on the grid should be used to indicate the performance statement that best matches the work. Intermediate marks of 1, 3 or 5 can be used where performance exceeds that required by one statement but does not adequately match that required by the next higher statement. When each aspect of performance has been assessed in this way, the marks are added together to give a total mark on a scale 0-36 marks.

This method of marking can be applied even where there is a wide variation between performance for different qualities. Thus, weak performance for one quality need not depress marks too far if other qualities show better performance.

Skills to be assessed (Programme of Study – PoS references are given for each)

A: Approach to the task

The ability to plan an approach to the task, including the selection of suitable sources of data/information, which will address the issues.

Candidates are expected to be able to:

Plan to answer a scientific question (PoS 3.6ia)

Collect data from secondary sources, including the use of ICT sources and tools (PoS 3.6iib)

Apply and question scientific information or ideas (PoS 3.6iiia)

B: Analysis of the data

The ability to analyse the data/information and interpret it to show trends or patterns.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib)

Analyse scientific information or ideas (PoS 3.6iiia)

C: Evaluation of the data

The ability to evaluate the data/information to reach judgements about its reliability and validity.

Candidates are expected to be able to:

Consider the validity and reliability of data as evidence (PoS 3.6id)

Interpret and question scientific information or ideas (PoS 3.6iiia)

D: Relating the data to the issues

The ability to relate the data/information to social, economic and environmental issues and understand how science can contribute to decision making.

Candidates are expected to be able to:

Know why decisions about science and technology are made, including those that raise ethical issues, and know about the social, economic and environmental effects of such decisions (PoS 3.6ivb)

Know that uncertainty in scientific knowledge and ideas changes over time and know the role of the scientific community in validating these changes (PoS 3.6ivc)

E: Justifying a conclusion

The ability to draw a conclusion based on the evidence and to justify this.

Candidates are expected to be able to:

Draw a conclusion using scientific, technical and mathematical language, conventions and symbols and ICT tools (PoS 3.6iiic)

Question scientific information or ideas (PoS 3.6iiia)

F: Quality of written communication

Candidates are expected to be able to:

Develop an argument using scientific, technical and mathematical language (PoS 3.6iiic)

Science in the News Level of Response Grid

Quality Assessed		0	1	2	3	4	5	6
A	Approach to the task			Some research is carried out; some information is collected from at least one suitable source.		The information provided is used to plan their research; information is collected from more than one suitable source and used in the report. All sources are fully referenced.		Makes good use of the information provided to structure a balanced report; information is relevant, detailed and logically presented.
B	Analysis of the data			At least one trend /pattern is identified and outlined correctly.		The main trends/patterns are described correctly and there is some evidence of correct processing of quantitative data.		The main trends/ patterns are described correctly with reference to quantitative data. These data have been further processed to reveal additional information and/or detect anomalies.
C	Evaluation of the data			A comment has been made about the quality of the evidence.		There is a comparison of the reliability of the various forms of evidence, including an attempt to identify which evidence is most/least reliable.		There is detailed consideration of the evidence showing a good understanding of the relative merits of the evidence gathered in terms of both reliability and validity.
D	Relating the data to issues			An attempt has been made to relate some of the data/information to the impact on people or the environment.		The report shows some understanding of the social, economic or environmental issues as they relate to the task.		The report shows a clear understanding of the social, economic or environmental issues as they relate to the task with an understanding of the science involved.
E	Justifying a conclusion			A conclusion is given with justification based on at least one piece of evidence.		A considered conclusion is given with justification based on the significance of more than one piece of evidence.		A considered conclusion is given with a well-argued justification based on careful analysis of the relative significance of more than one piece of evidence.
F	Quality of written communication			Spelling, punctuation and grammar are of generally poor quality. Little or no relevant scientific or technical vocabulary is used.		Spelling, punctuation and grammar are generally sound. Appropriate scientific or technical vocabulary is used.		Spelling, punctuation and grammar show very few errors. The report shows full and effective use of relevant scientific and technical terms.

Unit 4 (B656) Element 1: Research Study

Mark submitted out of 24.

This element of the assessment requires the candidates to use stimulus material provided by OCR, supplemented by electronic (internet, CD ROMs, databases, simulations) and/or more traditional sources of information (books, magazines, leaflets.

Candidates are required to research scientific ideas and the way they, for example:

- have developed over time;
- influence technological developments;
- interact with social, economic and environmental contexts.

Candidates are given about a week to carry out this research and they then complete a written report, under supervision, on their findings.

The report may be submitted as a hand written or word processed document.

The report should be less than 800 words in length. Reports in excess of 800 words will indicate poor structure and unselective choice of material. A written report should be illustrated by pictures, diagrams and tables as appropriate. At the end of the report the sources used should be listed, with references made to these sources in the body of the report, where appropriate.

A set of Research Study tasks, including detailed guidance for teachers, will be available.

Arrival at Marks for Research Study

The award of marks is based on the professional judgement of the science teacher working within a framework of performance descriptions related to various qualities. For each quality different aspects of performance are identified in the level of response grid. For each quality, a series of three descriptions of performance (for 2, 4 and 6 marks) illustrates what might be expected for candidates working at different levels.

Marking decisions should be recorded on the Research Study cover sheet. This cover sheet can be downloaded from the OCR website www.ocr.org.uk.

Candidates may not always report their work in a particular order; evidence of achievement may be located almost anywhere in the report. Thus, it is necessary to look at the whole report for evidence of each quality.

For any one quality, a tick on the grid should be used to indicate the performance statement that best matches the work. Intermediate marks 1, 3 or 5 can be used where performance exceeds that required by one statement but does not adequately match that required by the next higher statement. When each aspect of performance has been assessed in this way, the marks are added together to give a total mark on a scale 0-24 marks.

This method of marking can be applied even where there is a wide variation between performance for different qualities. Thus, weak performance for one quality need not depress marks too far if other qualities show better performance.

Skills to be assessed (Programme of Study – PoS – references are given for each)

A: Collecting Information

The ability to structure research to select suitable sources of information, which will address the issues.

Candidates are expected to be able to:

Provide evidence for testing ideas and developing theories (PoS 3.6ib)

Collect data from secondary sources, including the use of ICT sources and tools (PoS 3.6iib)

B: Interpreting Information

The ability to analyse information and make connections to scientific theories and models.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib)

Analyse scientific information or ideas (PoS 3.6iiia)

Understand that many phenomena can be explained by developing and using scientific theories, models and ideas (PoS 3.6ic)

C: Developing and Using Scientific Ideas

The ability to relate research to the development of scientific ideas over time.

Candidates are expected to be able to:

Show how uncertainties in scientific theories and explanations change over time. (PoS 3.6ivc)

Describe the role of the scientific community in validating these changes. (PoS 3.6ivc)

Know why decisions about science and technology are made, including those that raise ethical issues and know about the social, economic and environmental effects of such decisions (POS 3.6ivb)

D: Quality of written communication

Candidates are expected to be able to:

Develop an argument using scientific, technical and mathematical language (PoS 3.6iiic)

Research Study Level of Response Grid

Quality Assessed		Number of Marks					
		1	2	3	4	5	6
A	Collecting information		An attempt has been made to collect some information from at least one suitable source.		Relevant information is collected from more than one suitable source.		Relevant, detailed information is collected from more than one suitable source and is clearly referenced in the report.
B	Interpreting information		At attempt has been made to interpret the information.		The information has been interpreted but not always thoroughly and/or correctly.		The information has been interpreted effectively, with skill and understanding.
C	Developing and using scientific ideas		An attempt has been made to describe the influences and/ or development of scientific ideas.		Demonstrates some understanding of the interaction between scientific ideas and their context.		Demonstrates a clear and detailed understanding of the interaction between scientific ideas and their context.
D	Quality of written communication		Spelling, punctuation and grammar are of generally poor quality. Little or no relevant scientific or technical vocabulary is used.		Spelling, punctuation and grammar are generally sound. Appropriate scientific or technical vocabulary is used.		Spelling, punctuation and grammar show very few errors. The report shows full and effective use of relevant scientific and technical terms.

Unit 4 (B656) Element 2: Data Task

Mark submitted out of 30.

This element of the assessment requires candidates to analyse and evaluate data.

The task will consist of two stages. In the first stage the candidates will obtain some data.

Because the actual collection of the data is not assessed, a flexible approach can be used. Some tasks will allow the candidates to collect data by using a practical procedure and they can work individually, or in pairs or small groups or as a whole class or by viewing a teacher-demonstration. For other tasks the collection of the data can be made using a CD-ROM or an internet search or a literature search. The principal reasons for the candidates having to collect the data are to:

- enhance their awareness of the techniques required;
- focus on the quality of what they have collected;
- provide help in planning the collection of further data;
- increase their access to ways of analysing and evaluating it.

For the second stage of the task the candidates can either analyse and evaluate the data they have collected or can use similar data provide by OCR.

Candidates will then work individually to complete a written report about the data which is based on questions given to them. The report will be produced under supervision.

The report may be submitted as a hand written or word processed document.

Candidates may attempt any number of the Data Tasks during the course, but the assessment of only one of them will 'count' for their GCSE award.

A set of Data Tasks, including teacher guidance, will be available for use.

Arrival at Marks for Data Task

The award of marks is based on the professional judgement of the science teacher working within a framework of performance descriptions related to various qualities. For each quality, different aspects of performance are identified in the level of response grid. For each quality, a series of three descriptions of performance (for 2, 4 and 6 marks) illustrates what might be expected for candidates working at different levels.

Marking decisions for candidates should be recorded on the Data Task cover sheet. This cover sheet can be downloaded from the OCR website www.ocr.org.uk.

Candidates may not always report their work in a particular order; evidence of achievement may be located almost anywhere in the report. Thus, it is necessary to look at the whole report for evidence of each quality.

For any one quality, a tick on the grid should be used to indicate the performance statement that best matches the work. Intermediate marks of 1, 3 or 5 can be used where performance exceeds that required by one statement but does not adequately match that required by the next higher statement. When each aspect of performance has been assessed in this way, the marks are added together to give a total mark on a scale 0-30 marks.

This method of marking can be applied even where there is a wide variation between performance for different qualities. Thus, a weak performance for one quality need not depress marks too far if other qualities show better performance.

Detailed advice on the award of marks for each OCR-set task will be provided with the task.

Skills to be assessed (Programme of Study – PoS – references are given for each)

A: Interpreting the data

The ability to present data in such a manner as to bring out any patterns that are present.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib)

Present information using scientific conventions and symbols (PoS 3.6iiic)

B: Analysis of the data

The ability to analyse the data/information and interpret it to show trends or patterns.

Candidates are expected to be able to:

Interpret data, using creative thought, to provide evidence for testing ideas (PoS 3.6ib)

Analyse scientific information or ideas (PoS 3.6iiia)

C: Evaluation of the data

The ability to evaluate the data/information to reach judgements about its reliability and validity.

Candidates are expected to be able to:

Consider the validity and reliability of data as evidence (PoS 3.6id)

Interpret and question scientific information or ideas (PoS 3.6iiia)

D: Justifying a conclusion

The ability to draw a conclusion based on the evidence and to justify this.

Candidates are expected to be able to:

Draw a conclusion using scientific, technical and mathematical language, conventions and symbols and ICT tools (PoS 3.6iiic)

Question scientific information or ideas (PoS 3.6iiia)

E: Planning further work

The ability to plan further work which would help to make the conclusions more secure.

Candidates are expected to be able to:

Plan to test a scientific idea, answer a scientific question or solve a scientific problem (PoS 3.6iia)

Data Task Level of Response Grid

	Quality Assessed	1	2	3	4	5	6
		Number of Marks					
A	Interpreting the data		A limited number of results are displayed in tables, charts or graphs using given axes and scales.		Data is displayed using appropriate tables, charts or graphs, allowing some errors in scaling or plotting.		Data is displayed to show general relationships using appropriate complex charts or diagrams e.g. histograms, scatter-grams, or in graphs with correctly selected scales and axes.
B	Analysis of the data		At least one trend / pattern is identified and outlined correctly.		The main trend(s)/pattern(s) are described correctly and there is some evidence of processing quantitative data.		The main trends/ patterns are described correctly with reference to the quantitative data. The data has been processed to reveal additional information and/or detect anomalies.
C	Evaluation of the data		An attempt has been made to consider the quality of the data and the methods used to collect it.		There is consideration of the reliability of the data and an attempt to identify how the methods used enabled valid data to be collected.		There is detailed consideration of the data in terms of both validity and reliability and a clear appreciation of the limitations of the methods used.
D	Justifying a conclusion		A conclusion is given which is related to the data collected.		A considered conclusion is given with justification based on an analysis of the data collected and linked to the underpinning science.		A considered conclusion is given with a well-argued justification based on careful analysis of the data and clearly linked to relevant scientific knowledge and understanding.
E	Planning further work		Some consideration is given to further relevant practical work.		Relevant further practical work is planned in detail.		There is detailed consideration of relevant further practical work and a clear appreciation of how this would further understanding of the topic.

Unit 4 (B656) Element 3: Practical Skills

Mark submitted out of 6.

This element of the assessment requires the teacher to take an overview of each candidate's practical work during the course.

Arrival at Marks for Practical Skills

The award of marks is based on the professional judgment of the science teacher working within a framework of descriptions of performance.

Skill to be assessed (Programme of Study – PoS – references are given)

Practical Skills

The ability to work safely and accurately when carrying out practical activities in science.

Candidates are expected to be able to:

Work accurately and safely, individually and with others, when collecting first-hand data.

Practical Skills Level of Response Grid

Quality Assessed	Number of Marks					
	1	2	3	4	5	6
Working safely and accurately		Practical work is carried out safely and accurately under close supervision and with much guidance.		Practical work is carried out safely and accurately with some guidance.		Practical work is carried out safely and accurately with awareness of risks.

Further detailed guidance on how to assess the practical skills will be provided in guidance to teachers.

Recording and Submitting Marks for Internally Assessed Work

The final total mark for either Unit 3 (B655) or Unit 4 (B656) must be submitted to OCR on form MS1 by 15th May in the year of entry for the unit. These forms are produced and despatched at the relevant time based on entry information provided by the centre.

All assessed work which has contributed to candidates' final totals must be available for moderation.

5.3 Regulations for Internally Assessed Work

Supervision and Authentication of work

OCR expects teachers to supervise and guide candidates who are undertaking work that is internally assessed. The degree of teacher guidance will vary according to the kind of work being undertaken. It should be remembered, however, that candidates are required to reach their own judgments and conclusions.

When supervising internally assessed tasks, teachers are expected to:

- offer candidates advice about how best to approach such tasks;
- exercise supervision of the work in order to monitor progress and to prevent plagiarism;
- ensure that the work is completed in accordance with the specification requirements and can be assessed in accordance with the specified mark descriptions and procedures.

Work should, wherever possible, be carried out under supervision. However, it is accepted that some tasks may require candidates to undertake work outside the centre. Where this is the case, the centre must ensure that sufficient supervised work takes place to allow the teachers concerned to authenticate each candidate's work with confidence.

Production and Presentation of Internally Assessed Work

Candidates must observe certain procedures in the production of internally assessed work.

Any copied material must be suitably acknowledged.

Where work is based on the use of secondary data, the original sources must be clearly identified.

Annotation of Candidates' Work

Each piece of internally assessed work should show how the marks have been awarded in relation to the mark descriptions.

The writing of comments on candidates' work provides a means of dialogue and feedback between teacher and candidate and a means of communication between teachers during the internal standardisation.

Moderation

All internally assessed work is marked by the teacher and internally standardised by the centre. Marks are then submitted to OCR by 15th May, after which moderation takes place in accordance with OCR procedures. The purpose of moderation is to ensure that the standard of the award of marks is the same for each centre and that each teacher has applied the standards appropriately across the range of candidates within the centre.

It is the responsibility of the centre to carry out effective internal standardisation to ensure that similar standards are applied by each teacher involved in the assessment. The Moderator will require a written statement describing how internal standardisation has been carried out within the centre.

External moderation will be by postal sample selected by the Moderator.

Minimum Requirements for Internally Assessed Work

If a candidate submits no work for this internally assessed unit, then the candidate should be indicated as being absent from that unit on the mark sheets submitted to OCR. If a candidate completes any work at all for an internally assessed unit, then the work should be assessed and the appropriate mark awarded, which may be zero.

6 Technical Information

6.1 Making Unit Entries

Please note that centres must be registered with OCR in order to make any entries, including estimated entries. It is recommended that centres apply to OCR to become a registered centre well in advance of making their first entries. Centres should be aware that a minimum of ten candidates for summer examinations is normally required.

Unit Entry Options

Within Units B651 and B652 candidates must be entered for either the Foundation Tier or the Higher Tier option. It is not necessary for candidates to enter at the same tier in every unit. Candidates may, if they wish, attempt papers at both tiers, but not in the **same examination session**, since the papers will be timetabled simultaneously.

Entry code	Option code	Component to be taken	
B651	F	01	Physics B Unit 1 – modules P1, P2, P3 Foundation
	H	02	Physics B Unit 1 – modules P1, P2, P3 Higher
B652	F	01	Physics B Unit 2 – modules P4, P5, P6 Foundation
	H	02	Physics B Unit 2 – modules P4, P5, P6 Higher
B655	-	01	Physics B Unit 3 – 'Can do' tasks and report on Science in the News
B656	-	01	Physics B Unit 4 – Research Study, Data Task and Practical Skills

Candidate entries must be made by 21 October for the January session and by 21 February for the June session.

6.2 Making Qualification Entries

Candidates must be entered for certification code **J645** to claim their overall GCSE grade.

If a certification entry is not made, no overall grade can be awarded.

A candidate who has completed all the units required for the qualification may enter for certification either in the same examination session (within a specified period after publication of results) or at a later session.

First certification will be available in June 2008 and every January and June thereafter.

Certification cannot be declined.

6.3 Grading

GCSE results are awarded on the scale A* to G. Units are awarded a* to g. Grades are awarded on certificates. Results for candidates who fail to achieve the minimum grade (G or g) will be recorded as *unclassified* (U or u).

In unitised schemes candidates can take units across several different sessions. They can also re-sit units or choose from optional units where available. When working out candidates' overall grades OCR needs to be able to compare performance on the same unit in different sessions when different grade boundaries have been set, and between different units. OCR uses uniform marks to enable this to be done.

A candidate's uniform mark is calculated from the candidate's raw mark. The raw grade boundary marks are converted to the equivalent uniform mark boundary. Marks between grade boundaries are converted on a pro rata basis.

When unit results are issued, the candidate's unit grade and uniform mark are given. The uniform mark is shown out of the maximum uniform mark for the unit e.g. 71/100.

Results for each unit will be published in the form of uniform marks according to the following scales.

	Unit Grade								
	a*	a	b	c	d	e	f	g	u
Units 1, 2 3 and 4	100-90	89-80	79-70	69-60	59-50	49-40	39-30	29-20	19-0

Higher tier candidates may achieve an "allowed e". Higher tier candidates who miss a grade e will be given a uniform mark in the range f-u but will be graded as 'u'.

Candidates' uniform marks for each module are aggregated and grades for the specification are generated on the following scale.

Qualification Grade								
A*	A	B	C	D	E	F	G	U
300-270	269-240	239-210	209-180	179-150	149-120	119-90	89-60	59-0

The candidate's grade will be determined by this total mark. Thus, the grade awarded will depend in practice upon the extent to which the candidate has met the assessment objectives overall. Shortcomings in some aspects of the assessment may be balanced by better performance in others. Candidates achieving less than the minimum mark for grade G will be unclassified.

6.4 Result Enquiries and Appeals

Under certain circumstances, a centre may wish to query the grade available to one or more candidates or to submit an appeal against an outcome of such an enquiry. Enquiries about unit results must be made immediately following the series in which the relevant unit was taken.

For procedures relating to enquires on results and appeals, centres should consult the OCR *Handbook for Centres* and the document *Enquiries about Results and Appeals – Information and Guidance for Centres* produced by the Joint Council. Copies of the most recent editions of these papers can be obtained from OCR.

6.5 Shelf-Life of Units

Individual unit results, prior to certification of the qualification, have a shelf-life limited only by that of the qualification.

6.6 Unit and Qualification Re-sits

Candidates may re-sit any unit an **unlimited** number of times.

For each unit the best score will be used towards the final overall grade.

Candidates may enter for the full qualification an unlimited number of times.

6.7 Guided Learning Hours

GCSE Physics requires 120-140 guided learning hours in total.

6.8 Code of Practice/Subject Criteria/Common Criteria Requirements

These specifications comply in all respects with the revised *GCSE, GCE, VCE, GNVQ and AEA Code of Practice 2005/6*, the subject criteria for GCSE Physics and *The Statutory Regulation of External Qualifications 2004*.

6.9 Arrangements for Candidates with Particular Requirements

For candidates who are unable to complete the full assessment or whose performance may be adversely affected through no fault of their own, teachers should consult the *Access Arrangements and Special Consideration Regulations and Guidance Relating to Candidates who are Eligible for Adjustments in Examinations*. In such cases advice should be sought from OCR as early as possible during the course.

6.10 Prohibited Qualifications and Classification Code

Every specification is assigned to a national classification code indicating the subject area to which it belongs.

Centres should be aware that candidates 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.

The classification code for this specification is 1210.

7 Other Specification Issues

7.1 Overlap with other Qualifications

This specification has been developed alongside GCSE Science; GCSE Additional Science; GCSE Biology; GCSE Chemistry.

7.2 Progression from these Qualifications

GCSE qualifications are general qualifications that enable candidates to progress either directly to employment, or to proceed to further qualifications.

Many candidates who enter employment with one or more GCSEs will undertake training or further part-time study with the support of their employers.

Progression to further study from GCSE will depend upon the number and nature of the grades achieved. Candidates who are awarded mainly grades G to D at GCSE may either strengthen their base through further study of qualifications at Foundation Level (Level1) and Intermediate Level (Level 2), for example OCR GCSE Applied Science (Double Award), OCR Additional Applied Science. Candidates who are awarded grades C to A* at GCSE are well prepared to broaden their base through further study of qualifications at Intermediate level, for example, OCR GCSE Applied Science (Double Award), OCR Additional Applied Science or study Physics at Advanced Level (Level 3) within the National Qualifications Framework.

7.3 ICT

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

Opportunities for ICT include:

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

The examples listed in the table show some points in the specification where opportunities might more easily be found.

ICT	Possible Opportunities
Gathering information	Internal Assessment P1b, P2a, P3c, P5e, P4g, P5c
Datalogging	Internal Assessment P1c, P3a
Processing data	Internal Assessment P1c, P3a
Visualisation	Internal Assessment P2c, P2h, P4h
Making presentations	Internal Assessment P1d, P2c, P2f

7.4 Citizenship

From September 2002, the National Curriculum for England at Key Stage 4 includes a mandatory programme of study for Citizenship.

GCSE Science is designed as a science education for future citizens which not only covers aspects of the Citizenship programme of study but also extends beyond that programme by dealing with important aspects of science which all people encounter in their everyday lives.

Citizenship Programme of Study	Examples of opportunities for Teaching the Issues during the Course
Section 1: Knowledge and understanding about becoming informed citizens	
The work of parliament, the government and the courts in making and shaping the law	
How the economy functions, including the role of business and financial services	
The opportunities for individuals and voluntary groups to bring about social change locally, nationally, in Europe and internationally	
The media's role in society, including the internet, in providing information and affecting opinion	Internal Assessment
The rights and responsibilities of consumers, employers and employees	P3f
The issues and challenges of global interdependence and responsibility, including sustainable development and Local Agenda 21	P2a, P2c
Section 2 : Enquiry and communication	
Researching a topical scientific issue by analysing information from different sources, including ICT-based sources, showing an awareness of the use and abuse of statistics	Internal Assessment P3f, P3e, P2a
Expressing, justifying and defending orally and in writing a personal opinion about a topical scientific issue.	Internal Assessment P1d
Contributing to group and class discussions	There will be opportunities for discussion in every module. Here are some specific examples. P3d, P2g, P2f
Section 3: Developing skills of participation and responsible action	
Consider and evaluate views that are not their own	Internal Assessment P2a
Participating in science-based school and community activities	P1g

7.5 Key Skills

These specifications provide opportunities for the development of the Key Skills of *Communication*, *Application of Number*, *Information Technology*, *Working with Others*, I*mproving Own Learning and Performance* and *Problem Solving* at Levels 1 and/or 2. However, the extent to which this evidence fulfils the Key Skills criteria at these levels will be totally dependent on the style of teaching and learning adopted for each unit.

The following table indicates where opportunities *may* exist for at least some coverage of the various Key Skills criteria at Levels 1 and/or 2 for each unit.

Level	Communication				Application of Number			IT			Working with Others			Improving Own Learning and Performance			Problem Solving		
	.1a	.1b	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3	.1	.2	.3
1			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
2			✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓

7.6 Spiritual, Moral, Ethical, Social, Legislative, Economic and Cultural Issues

Spiritual, moral, ethical, social and cultural issues are a major feature of this specification. The content of this course includes aspects which have a profound influence on how people think about themselves, their immediate environment, the Earth as a whole and the Universe.

Issue	Examples of opportunities for Teaching the Issues during the Course
The commitment of scientists to publish their findings and subject their ideas to testing by others.	P2g, P2h, P5g
Risk and the factors which decide the level of risk people are willing to accept in different circumstances	P1h, P2d, P3c, P3f, P4a
The range of factors which have to be considered when weighing the costs and benefits of scientific activity.	Internal Assessment P1d, P2a
The ethical implications of selected scientific issues.	P2d
Scientific explanations which give insight into human nature.	
Scientific explanations which give insight into the local and global environment.	Internal Assessment P4f, P4g
Scientific explanations which give insight into our planet and its place in the Universe	P2f, P2g, P2h, P5a

7.7 Sustainable Development, Health and Safety Considerations and European Developments

OCR has taken account of the 1988 Resolution of the Council of the European Community and the Report Environmental Responsibility: An Agenda for Further and Higher Education, 1993 in preparing this specification and associated specimen assessments.

Issue	Examples of opportunities for Teaching the Issues during the Course
Environmental issues	
Air pollution	P2c
Natural disasters and how to predict them	P2g
Food and agriculture	
Origins and management of waste materials	P2d, P2c
Energy resources	P1b, P1c, P1d, P2a, P2c
Health and Safety issues	
Safe practice in the laboratory	There will be opportunities to demonstrate safe practice in the laboratory in most modules. Internal Assessment.
Health and disease	P1h, P2d, P4b, P4d
Food and nutrition	
Living with radiation	P1d, P2d

Although this specification does not make specific reference to the European dimension it may be drawn into the course of study in a number of ways. The table below provides some appropriate opportunities.

Issue	Examples of opportunities for Teaching the Issues during the Course
The importance of the science-based industry to European economies	
Environmental issues which extend over a larger area than the UK	P2b, P2c, P2f
Differences in attitudes to key issues in different parts of Europe	

7.8 Avoidance of Bias

OCR has taken great care in preparation of these specifications and assessment materials to avoid bias of any kind.

7.9 Language

These specifications and associated assessment materials are in English only.

7.10 Support and Resources

Support and additional resources are available from the OCR GCSE science website **www.gcse-science.com** where centres should register their intention to offer this qualification. Registering on this site provides access to a teachers' forum and local support networks.

Appendix A: Grade Descriptions

Grade F

Candidates demonstrate a limited knowledge and understanding of science content and how science works. They use a limited range of the concepts, techniques and facts from the specification, and demonstrate basic communication and numerical skills, with some limited use of technical terms and techniques.

They show some awareness of how scientific information is collected and that science can explain many phenomena.

They use and apply their knowledge and understanding of simple principles and concepts in some specific contexts. With help they plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem, using a limited range of information in an uncritical manner. They are aware that decisions have to be made about uses of science and technology and, in simple situations familiar to them, identify some of those responsible for the decisions. They describe some benefits and drawbacks of scientific developments with which they are familiar and issues related to these.

They follow simple instructions for carrying out a practical task and work safely as they do so.

Candidates identify simple patterns in data they gather from first-hand and secondary sources. They present evidence as simple tables, charts and graphs, and draw simple conclusions consistent with the evidence they have collected.

Grade C

Candidates demonstrate a good overall knowledge and understanding of science content and how science works, and of the concepts, techniques, and facts across most of the specification. They demonstrate knowledge of technical vocabulary and techniques, and use these appropriately. They demonstrate communication and numerical skills appropriate to most situations.

They demonstrate an awareness of how scientific evidence is collected and are aware that scientific knowledge and theories can be changed by new evidence.

Candidates use and apply scientific knowledge and understanding in some general situations. They use this knowledge, together with information from other sources, to help plan a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

They describe how, and why, decisions about uses of science are made in some familiar contexts. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They carry out practical tasks safely and competently, using equipment appropriately and making relevant observations, appropriate to the task. They use appropriate methods for collecting first-hand and secondary data, interpret the data appropriately, and undertake some evaluation of their methods.

Candidates present data in ways appropriate to the context. They draw conclusions consistent with the evidence they have collected and evaluate how strongly their evidence supports these conclusions.

Grade A

Candidates demonstrate a detailed knowledge and understanding of science content and how science works, encompassing the principal concepts, techniques, and facts across all areas of the specification. They use technical vocabulary and techniques with fluency, clearly demonstrating communication and numerical skills appropriate to a range of situations.

They demonstrate a good understanding of the relationships between data, evidence and scientific explanations and theories. They are aware of areas of uncertainty in scientific knowledge and explain how scientific theories can be changed by new evidence.

Candidates use and apply their knowledge and understanding in a range of tasks and situations. They use this knowledge, together with information from other sources, effectively in planning a scientific task, such as a practical procedure, testing an idea, answering a question, or solving a problem.

Candidates describe how, and why, decisions about uses of science are made in contexts familiar to them, and apply this knowledge to unfamiliar situations. They demonstrate good understanding of the benefits and risks of scientific advances, and identify ethical issues related to these.

They choose appropriate methods for collecting first-hand and secondary data, interpret and question data skilfully, and evaluate the methods they use. They carry out a range of practical tasks safely and skilfully, selecting and using equipment appropriately to make relevant and precise observations.

Candidates select a method of presenting data appropriate to the task. They draw and justify conclusions consistent with the evidence they have collected and suggest improvements to the methods used that would enable them to collect more valid and reliable evidence.

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Appendix B: Requirements Relating to Mathematics

During the course of study for this specification, many opportunities will arise for quantitative work, including appropriate calculations. The mathematical requirements which form part of the specification are listed below. Items in the first table may be examined in written papers covering both Tiers. Items in the second table may be examined only in written papers covering the Higher Tier.

Both Tiers
add, subtract, multiply and divide whole numbers
recognise and use expressions in decimal form
make approximations and estimates to obtain reasonable answers
use simple formulae expressed in words
understand and use averages
read, interpret, and draw simple inferences from tables and statistical diagrams
find fractions or percentages of quantities
construct and interpret pie-charts
calculate with fractions, decimals, percentage or ratio
solve simple equations
substitute numbers in simple equations
interpret and use graphs
plot graphs from data provided, given the axes and scales
choose by simple inspection and then draw the best smooth curve through a set of points on a graph

Higher Tier only
recognise and use expressions in standard form
manipulate equations
select appropriate axes and scales for graph plotting
determine the intercept of a linear graph
understand and use inverse proportion
calculate the gradient of a graph
statistical methods e.g. cumulative frequency, box plots, histograms

Appendix C: Physical Quantities and Units

Physical Quantities and Units

It is expected that candidates will show an understanding of the physical quantities and corresponding SI units listed below and will be able to use them in quantitative work and calculations. Whenever they are required for such questions, units will be provided and, where necessary, explained.

Fundamental Physical Quantities	
Physical quantity	Unit(s)
length	metre (m); kilometre (km); centimetre (cm); millimetre (mm)
mass	kilogram (kg); gram (g); milligram (mg)
time	second (s); millisecond (ms)
temperature	degree Celsius (ºC); kelvin (K)
current	ampere (A); milliampere (mA)
voltage	volt (V); millivolt (mV)

Derived Quantities and Units	
Physical quantity	Unit(s)
area	cm^2; m^2
volume	cm^3; dm^3; m^3; litre (l); millilitre (ml)
density	kg/m^3; g/cm^3
force	newtons (N)
speed	m/s; km/h
energy	joule (J) ; kilojoule (kJ); megajoule (MJ)
power	watt (W); kilowatt (kW); megawatt (MW)
frequency	hertz (Hz); kilohertz (kHz)
gravitational field strength	N/kg
radioactivity	becquerel (Bq)
acceleration	m/s^2; km/h^2
specific heat capacity	J/kg^oC
specific latent heat	J/kg

Appendix D: Health and Safety

In UK law, health and safety is the responsibility of the employer. For most Centres entering candidates for GCSE examinations this is likely to be the Local Education Authority or the Governing Body. Teachers have a duty to co-operate with their employer on health and safety matters. Various regulations, but especially the COSHH Regulations 1996 and the Management of Health and Safety at Work Regulations 1992, require that before any activity involving a hazardous procedure or harmful microorganisms is carried out, or hazardous chemicals are used or made, the employer must provide a risk assessment.

A useful summary of the requirements for risk assessment in school or college science can be found in Chapter 4 of Safety in Science Education. For members, the CLEAPSS guide, Managing Risk Assessment in Science offers detailed advice.

Most education employers have adopted a range of nationally available publications as the basis for their Model Risk Assessments. Those commonly used include:

Safety in Science Education, DfEE, 1996, HMSO, ISBN 0 11 270915 X;

Topics in Safety 3rd edition, 2001, ASE ISBN 0 86357 316 9;

Safeguards in the School Laboratory, 10th edition, 1996, ASE ISBN 0 86357 250 2;

Hazcards, 1995 with 1998 and 2000 updates, CLEAPSS School Science Service*;

CLEAPSS Laboratory Handbook, 1997 with 2001 update, CLEAPSS School Science Service*;

CLEAPSS Shorter Handbook (CLEAPSS 2000) CLEAPSS School Science Service*;

Hazardous Chemicals, A manual for Science Education, (SSERC, 1997) ISBN 0 9531776 0 2.

*Note that CLEAPSS publications are only available to members or associates.

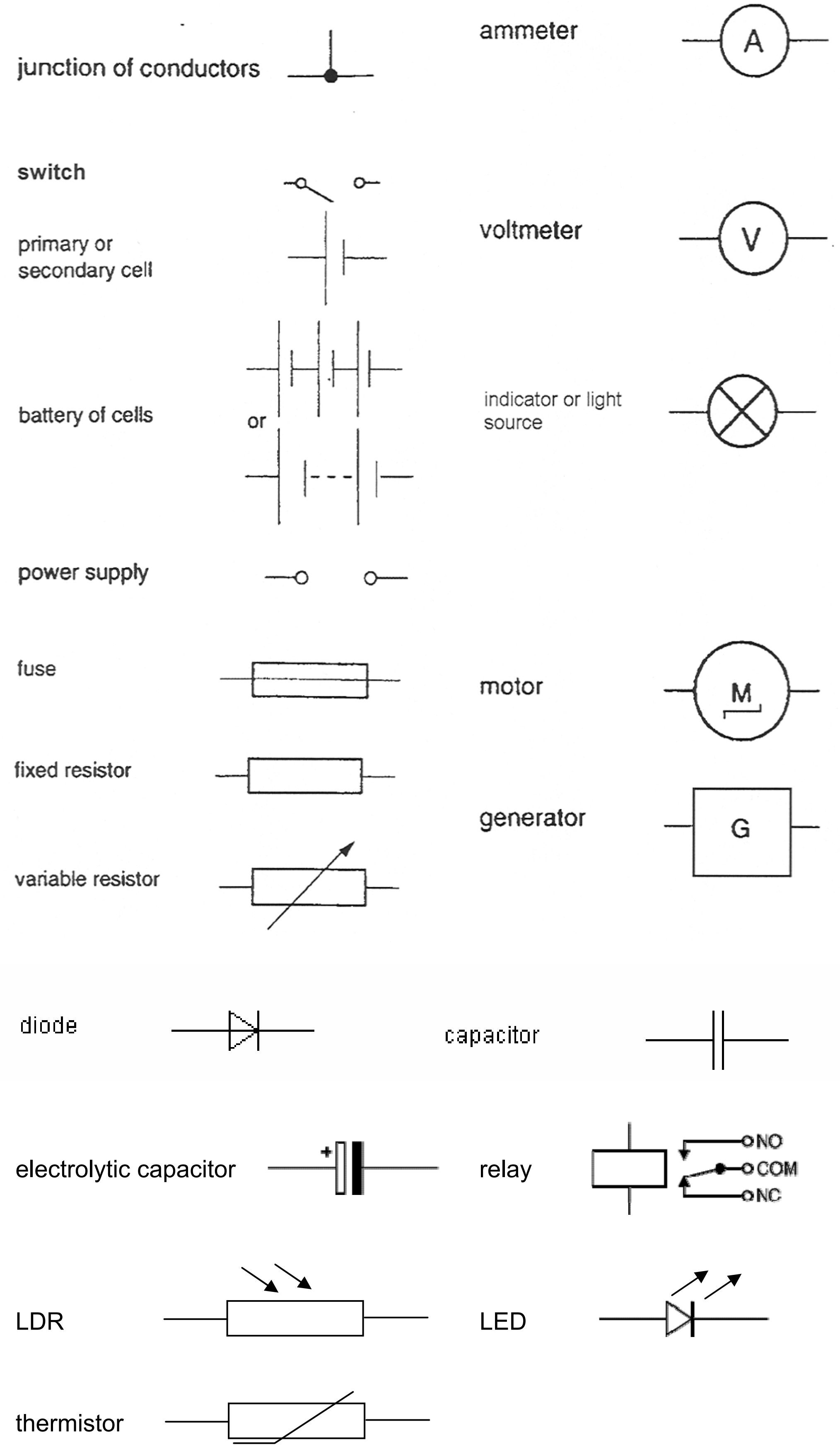
Where an employer has adopted these or other publications as the basis of their model risk assessments, an individual Centre then has to review them, to see if there is a need to modify or adapt them in some way to suit the particular conditions of the establishment. Such adaptations might include a reduced scale of working, deciding that the fume cupboard provision was inadequate or the skills of the candidates were insufficient to attempt particular activities safely.

The significant findings of such risk assessment should then be recorded, for example on schemes of work, published teachers guides, work sheets, etc.

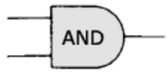
There is no specific legal requirement that detailed risk assessment forms should be completed, although a few employers require this.

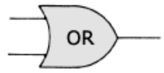
When candidates are planning their own investigative work the teacher has a duty to check the plans before the practical work starts and to monitor the activity as it proceeds.

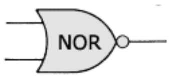
Appendix E: Electrical Symbols



NOT gate 

AND gate 

OR gate 

NOR gate 

NAND gate