

OCR Gateway GCSE Physics

| Physics Module P1 | | | | |
|---------------------|--------------------------------|--|---|-------------------|
| Energy for the Home | Syllabus point (text abridged) | Boardworks presentations | | |
| | | GCSE Science | Additional Science | Separate Sciences |
| Energy for the Home | P1a. Heating houses | Energy flows from a hot body to a cooler one. This causes hotter bodies to cool, and cooler bodies to warm. Temperature is a measurement of hotness. Heat is a measurement of energy. HT: Temperature can be represented by a range of colours in a thermogram. Temperature is a measurement of hotness on a chosen scale; heat is a measure of energy on an absolute scale. | Heat Transfer Heat Loss and Insulation | |
| | | The specific heat capacity of materials is: <ul style="list-style-type: none"> • a measure of how much energy it can hold • the energy needed to raise the temperature of 1kg by 10°C • different for different materials HT: energy = mass × specific heat × temperature change capacity | Heat Transfer | |
| | | There is no temperature change when materials are boiling, melting or freezing. The specific latent heat of materials is: <ul style="list-style-type: none"> • a measure of how much energy melts or boils the material • the energy needed to melt or boil 1kg of the material • different for different materials and states HT: energy = mass × specific latent heat Explain that energy supplied during a change of state is used to break inter-molecular bonds. | | |

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| Energy for the Home | Syllabus point (text abridged) | Boardworks presentations | | |
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| Energy for the Home | P1b. Keeping homes warm | Interpret data and calculate cost savings of different energy saving strategies and payback time. HT: Conduction, convection and radiation (absorption and emission) in the home in terms of: <ul style="list-style-type: none"> • the design features of the home • the design and use of everyday appliances in the home • energy saving strategies. efficiency = useful energy output ÷ total energy input | Heat Loss and Insulation Energy Efficiency | |

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| Energy for the Home P1c. How insulation works | <p>Explain in domestic situations, how energy transfer can be reduced in terms of conduction, convection and radiation.</p> <p>HT: Describe how energy is transferred by:</p> <ul style="list-style-type: none"> • conduction - transfer of KE between particles • convection - change of density causes (bulk) fluid flow • radiation - infrared radiation needs no medium <p>Unless air is trapped in foam, there will still be energy loss by convection in a cavity wall.</p> | <p>Heat Transfer</p> <p>Heat Loss and Insulation</p> | | |

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| Energy for the Home P1d. Cooking with waves | <p>Describe properties of microwaves:</p> <ul style="list-style-type: none"> • penetrate (about 1cm) into food • are reflected by metal • can cause burns when absorbed by body tissue • go through glass and plastics <p>Describe properties of infrared radiation:</p> <ul style="list-style-type: none"> • heats the surface of the food • is reflected by shiny surfaces <p>HT: Microwaves and infrared transfer energy to materials:</p> <ul style="list-style-type: none"> • microwaves absorbed by water particles at surface increasing their KE • infrared is absorbed by particles on the surface increasing their KE • energy transferred to centre by conduction or convection <p>The energy associated with microwaves and infrared depend on their frequency: link potential danger to this.</p> | <p>Radio Waves and Microwaves</p> <p>Infrared and Visible Waves</p> | | |
| | <p>Microwaves are used to transmit information over large distances, in 'line of sight', giving some places poor signals. Recognise that there may or may not be dangers:</p> <ul style="list-style-type: none"> • to residents near to the site of a mast • to users of mobile phones <p>HT: Describe how diffraction and interference of microwaves can cause signal loss:</p> <ul style="list-style-type: none"> • limited distance between transmitters • high positioning of transmitters • nuisance of obstacles affecting signals | <p>Radio Waves and Microwaves</p> <p>Digital Communications</p> | | Waves |

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| Energy for the Home | P1e. Infrared signals | | | |
| | <p>The differences between analogue and digital signals:</p> <ul style="list-style-type: none"> analogue signals have a continuously variable value digital signals are either on (1) or off (0) <p>HT: Digital signals:</p> <ul style="list-style-type: none"> allow more information to be transmitted because of multiplexing have less interference | Digital Communications | | |
| | <p>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 by total internal reflection. Describe the transmission of light in optical fibres:</p> <ul style="list-style-type: none"> allow the rapid transmission of data allow the transmission of data pulses using light <p>HT: Draw and interpret simple ray diagrams showing the application of total internal reflection in fibre optics.</p> <p>Optical fibres allow more information to be transmitted by multiplexing and reducing interference.</p> | Digital Communications Infrared and Visible Waves | | Reflection and Refraction |

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| Energy for the Home | P1f. Wireless signals | | | |
| | <p>Radiation used for communication can be refracted. Wireless technology is commonly used in radios, mobile phones and laptop computers.</p> <p>HT: Long-distance communication depends on the reflection of waves from the Ionosphere or on re-transmission by satellites.</p> | Digital Communications | | Waves |
| | <p>Radio stations with similar frequencies often interfere.</p> <p>HT: Refraction and diffraction can affect communication:</p> <ul style="list-style-type: none"> refraction at the interfaces of different layers of Earth's atmosphere diffraction by dishes results in signal loss <p>Digital radio is advantageous as it lacks interference.</p> | Digital Communications | | Waves |

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| Energy for the Home | P1g. Light | Describe the main features of a transverse wave, including trough, crest, amplitude, wavelength and frequency (number of waves per second). HT: wave speed = frequency × wavelength | Wave Properties | | |
| | | Describe how light was used to send Morse code. HT: Explain the advantages and disadvantages of using light, radio and electrical signals for communication. | Infrared and Visible Waves | | |
| | | HT: A laser produces an intense beam of light in which all of the waves are the same frequency and in phase. A laser beam is used in a CD player by reflection from the shiny surface which contains digital information in the form of patterns of pits. | | | |

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| Energy for the Home | P1h. Stable Earth | Earthquakes produce shock waves, which also travel inside the Earth. There are two types of seismic waves: <ul style="list-style-type: none"> • 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 HT: Seismic waves transmitted through the Earth can be used to provide evidence for its structure: <ul style="list-style-type: none"> • P-waves travel through solid and liquid rock • S-waves cannot travel through liquid rock | Wave Properties | | |
| | | Darker skins reduce cancer risk by absorbing more UV radiation, preventing it reaching underlying tissues. Interpret given information about sun protection factor. Calculate how long a person can spend in the sun without burning from knowledge of the sun protection factor. HT: Describe how the ozone layer protects the Earth from ultraviolet radiation. Environmental pollution from CFCs is depleting the ozone layer. | Ionizing Radiation | | |
| | | Dust from volcanoes reflects radiation from the Sun, causing cooling. Dust from factories reflects radiation from the city causing warming. HT: Interpret given information about climate change as a result of natural or human activity. | Earth's Atmosphere (Chemistry) Climate Change (Chemistry) | | |

Physics Module P2

| Living for the Future | Physics Module P2 | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | |
| | | GCSE Science | Additional Science | Separate Sciences |
| P2a. Collecting energy from the Sun | <p>DC electricity is current in a constant direction.</p> <p>Advantages and disadvantages of using photocells to provide electricity include:</p> <ul style="list-style-type: none"> • 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 <p>HT: Light energy is absorbed by a photocell. This knocks electrons loose from the silicon crystal, which flow freely. The power of a photocell depends on light intensity and surface area exposed.</p> | <p>Mains Electricity</p> <p>Renewable Energy – Solar and Thermal</p> | | |
| | <p>The Sun's energy can be harnessed:</p> <ul style="list-style-type: none"> • glass can provide passive solar heating for buildings. • light can be reflected to a focus by a curved mirror. • KE of air is converted to electricity by wind turbines. <p>HT: Passive solar heating works as glass is transparent to light but reflects infrared. The surfaces in a building are warmed by light and emit infrared.</p> <p>An efficient solar collector must track the Sun.</p> <p>Wind turbines are renewable, rugged and non-polluting. However they cause visual pollution, are dependent on wind speed and need space.</p> | <p>Renewable Energy – Solar and Thermal</p> <p>Renewable Energy – Wind and Water</p> | | |

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| | Syllabus point (text abridged) | Boardworks presentations | | | |
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| Living for the Future | P2b. Generating electricity | The dynamo effect can be increased using stronger magnets, more turns and faster movement. Describe and interpret AC using a voltage-time graph. HT: The frequency of AC is the number of cycles per sec. | Electricity to the Home Mains Electricity | Motors and Generators | Transformers |
| | Simple AC generators have a coil of wire in close proximity to a magnetic field. Relative motion between coil and field generates a current. In a conventional power station fuel is burnt to boil water. The steam produced spins a turbine which turns the generator. There is significant waste of energy in a power station. HT: Use these equations to calculate energy input, energy output, waste energy output and efficiency: $\text{fuel energy input} = \text{waste energy output} + \text{electrical energy output}$ $\text{efficiency} = \frac{\text{electrical energy output}}{\text{output fuel energy output}}$ | Electricity to the Home Non-Renewable Energy Resources | Motors and Generators | Transformers | |
| | Explain how transformers are used in the National grid. Electricity is transmitted at high voltage to reduce energy waste and costs. HT: Explain how, for a given power transmission, increased voltage reduces current, so decreasing energy waste by reducing heating of cables. | Mains Electricity | | Transformers | |

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| Living for the Future | P2c. Fuels for power | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Burning fuels releases energy as heat. Uranium fuel rods release energy as heat. Biomass can be fermented to generate methane. HT: Describe and evaluate the advantages and disadvantages of different energy sources. | Non-Renewable Energy Resources | | Other uses for Micro-organisms (Biology) |
| | | Calculate the power rating of an appliance using the equation: $\text{power} = \text{voltage} \times \text{current}$ Unit of electrical energy supplied is the kilowatt hour (kWh). Calculate the number of kWh given power (kW) and time (h). Calculate the cost of energy supplied. HT: power = voltage × time Use the kilowatt hour as a measure of the energy supplied Use energy supplied = power x time to calculate the power in KW or W, or time in hours and / or minutes. Describe the advantages and disadvantage of using off-peak electricity in the home. | Electricity to the Home | | |
| | | Ionising radiations (from radioactive waste) can cause cancer. Uranium is a non-renewable resource. Plutonium is a waste product from nuclear reactors and can be used to make nuclear bombs. HT: Describe the advantages and disadvantages of nuclear power: <ul style="list-style-type: none"> • 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 | Ionizing Radiation Radioactivity Non-Renewable Energy Resources | Nuclear Energy | |

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| Living for the Future | P2d. Nuclear reactions | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Alpha radiation is used in smoke detectors. Beta radiation is used in tracers and paper thickness gauges. Gamma radiation is used in treating cancer, non-destructive testing and sterilising equipment. Radioactive materials give out nuclear radiation. | Radioactivity | | |
| | | The relative penetrating power of alpha, beta and gamma. Nuclear radiation ionises materials. That ionisation produces charged particles. Background radiation is caused by radioactive substances, rocks, soil, living things and cosmic rays. HT: Describe how alpha, beta and gamma can be identified by their penetrating power. Explain ionisation in terms of the removal of electrons and gain of electrons. | Radioactivity | Radioactive Decay | |
| | | Low-level radioactive waste can be disposed of by land-fill. High-level waste is reprocessed or encased in glass and buried. HT: Radioactive waste remains radioactive for a long time, is a terrorist risk, and must be kept out of groundwater. Acceptable radioactivity level may change over time. | Radioactivity Non-Renewable Energy Resources | | |

Physics Module P2

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| Living for the Future | P2e. Our magnetic field | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Describe the shape of the Earth's magnetic field. Charged particles are deflected by magnetic fields. HT: Cosmic rays are fast moving particles which create gamma rays when they hit the atmosphere. They spiral around the Earth's magnetic field to the poles and cause the Aurora Borealis. | Radioactivity | | |
| | | The shape of the magnetic field around a current-carrying coil. HT: Magnetic fields are made by moving charged particles. | | | Transformers |
| | | When two planets collide an Earth-Moon system can form. Their iron cores merge to form the Earth and the less dense material orbits as the Moon. HT: Discuss the evidence for the Earth-Moon system as the result of a collision between two planets. | | | |
| | | Solar flares are clouds of charged particles ejected from the Sun at high speed, producing strong disturbed magnetic fields. HT: A solar flare arriving at the Earth can disturb satellite communications and electricity distribution. | | | |

Physics Module P2

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|-----------------------|---------------------------------|---|---|--------------------|-------------------|
| Living for the Future | P2f. Exploring our Solar System | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Recognise the relative positions of Earth, Sun and planets. Gravity determines the motion of planets and satellites. HT: The relative positions of planets, stars, comets, meteors, galaxies and black holes. Circular motion requires a centripetal force. Gravity provides the centripetal force for orbital motion. | The Universe Gravity and Space | | Orbits |
| | | The difficulties of manned space travel between planets are: <ul style="list-style-type: none"> • 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 HT: Describe that a light-year is a measurement of large distances, specifically the distance light travels in a year. | The Universe Gravity and Space | | |
| | | Unmanned spacecraft can withstand conditions lethal to man. Unmanned spacecraft can transmit information on temperature, magnetic field, radiation, gravity, atmosphere and geography. HT: Explain the advantages and disadvantages of using unmanned spacecraft to explore the Solar System, with regard to costs, safety, reliability and maintenance. | Gravity and Space | | |

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| | Syllabus point (text abridged) | Boardworks presentations | | | |
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| Living for the Future | P2g. Threats to Earth | Asteroids are left over from the formation of the Solar System and orbit between Mars and Jupiter. Past asteroid collisions are revealed by craters, layers of unusual elements in rocks and sudden changes of fossil numbers between adjacent layers of rock. HT: The asteroid belt is between Mars and Jupiter as the large gravity of Jupiter disrupts the formation of a planet. | Gravity and Space | | |
| | | Comets have highly elliptical orbits and are made from ice and dust. They come from objects orbiting the Sun beyond the planets. The speed of a comet increases as it approaches a star. HT: The speed of a comet increases as it approaches a star as the strength of gravity increases. | The Universe Gravity and Space | | Orbits |
| | | Observations of Near Earth objects (NEO) can be used to determine their trajectories. HT: 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 | Gravity and Space | | |

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| | Syllabus point (text abridged) | Boardworks presentations | | | |
| | | GCSE Science | Additional Science | Separate Sciences | |
| Living for the Future | P2h. The Big Bang | All galaxies are moving away from us, distant galaxies move more quickly. Microwave radiation is received from all parts of the Universe. HT: Explain how the Big Bang theory accounts for: • light from galaxies is shifted to the red • the further away galaxies are, the greater the red shift • the age and starting point of the Universe. | The Universe | | |
| | | At the end of its life a medium sized star, like our Sun, becomes a red giant, then a planetary nebula and white dwarf. At the end of its life a heavy-weight star, becomes a red giant, before supernova. It can then form a neutron star or black hole. HT: The life history of a star (nebula, protostar, fusion, main sequence). End depends on mass of star. A black hole has a large mass and large gravity, meaning light cannot escape. | The Universe | | Stars |

| Physics Module P3 | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | |
| | | GCSE Science | Additional Science | Separate Sciences |
| Forces for Transport | P3a. Speed | | Speed and Acceleration | |
| | <p>Interpret the relationship between speed, distance and time. Increasing speed increases distance travelled in a given time or reduces the time needed to cover a given distance.</p> <p style="text-align: center;">$\text{speed} = \text{distance} \div \text{time}$</p> <p>HT: The effect of changing any one or two of the quantities in the equation.</p> <p>Describe, draw and interpret qualitatively simple graphs of distance against time. The gradient of a distance-time graph is the speed: a steeper gradient shows a higher speed.</p> <p>HT: Draw and interpret graphs of distance against time qualitatively for non-uniform speed, and calculate speed from a straight line graph.</p> | | Speed and Acceleration | |

| Physics Module P3 | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | |
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| Forces for Transport | P3b. Changing speed | | Speed and Acceleration | |
| | <p>The gradient of a speed-time graph shows acceleration. Higher acceleration gives a steeper gradient. Describe, draw and interpret qualitatively, simple graphs of speed against time for uniform accelerations. The area under a speed-time graph is distance travelled.</p> <p>HT: Calculate speed from the gradient of a distance-time graph and distance travelled from a speed-time graph for uniform acceleration. Calculate acceleration from a speed-time graph for uniform acceleration, and qualitatively assess acceleration when non-uniform.</p> | | Speed and Acceleration | |
| | <p>Describe acceleration as change in speed per unit time.</p> <p style="text-align: center;">$\text{acceleration} = \text{change in speed} / \text{time taken}$</p> | | Speed and Acceleration | |
| | <p>HT: Explain that acceleration could involve either a change in speed or direction. The effect of changing any one or two of the quantities in the acceleration equation.</p> | | Speed and Acceleration | Orbits |

| Physics Module P3 | | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | | |
| | | GCSE Science | Additional Science | Separate Sciences | |
| Forces for Transport | P3c. Forces and Motion | Describe and interpret the relationship between force, mass and acceleration in everyday examples. force = mass × acceleration HT: 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. | | Laws of Motion | |
| | | The factors which might increase thinking distance are driver tiredness, influence of alcohol or other drugs, high speed and distractions or lack of concentration. The factors which might increase braking distance are road conditions (slippy, icy, wet), car conditions (bald tyres, poor brakes) and high 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 HT: Explain qualitatively everyday situations where braking distance is changed, with regard to friction, mass, speed, braking force. | | Speed and Acceleration | |

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| Forces for Transport | P3d. Work and Power | work done = force × distance | | Work and Power | |
| | | power = work done ÷ time Interpret fuel consumption figures from data on cars to include environmental issues and costs. | | Work and Power | |

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| | Syllabus point (text abridged) | Boardworks presentations | | | |
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| Forces for Transport | P3e. Energy on the move | Everyday examples in which objects have kinetic energy. Kinetic energy is greater for objects with higher speed or greater mass. HT: Use the equation: $KE = 0.5 \times mv^2$ Apply the ideas of kinetic energy to the relationship between braking distances and speed, and everyday situations involving objects moving. | | Energy and Movement | |
| | | Interpret data about fuel consumption. HT: Describe and explain that car fuel consumption figures depend on: <ul style="list-style-type: none"> • energy required to increase KE • energy required to do work against friction • different driving styles and speeds • different road conditions | | | |
| | | Electrically powered cars do not pollute at the point of use, whereas fossil fuel cars do. Battery driven cars need to have the battery recharged, this uses electricity produced from a power station, which cause pollution. | | | Foods and Fuels (Chemistry) |

| Physics Module P3 | | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | | |
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| Forces for Transport | P3f. Crumple zones | Seatbelts, crumple zones, air bags are useful in a crash because they change shape, helping to absorb energy and reduce injuries. Describe how active safety features can make driving safer. Describe how passive safety features can make driving safer. HT: Forces can be reduced when stopping (eg. crumple zones, braking distances, escape lanes, crash barriers, seatbelts and air bags) by: <ul style="list-style-type: none"> • increasing stopping or collision time • increasing stopping or collision distance • decreasing acceleration. Describe using the ideas of friction why ABS brakes reduce braking distances. Evaluate the effectiveness of given safety features in terms of saving lives. | | Momentum | |

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| Forces for Transport | P3g. Falling safely Describe how objects falling through Earth's atmosphere reach a terminal speed. Explain in terms of the balance of forces why objects: <ul style="list-style-type: none"> • increase speed • decrease speed • maintain steady speed. HT: Explain why objects reach a terminal speed: <ul style="list-style-type: none"> • higher speed = more drag • larger area = more drag • weight (driving force) = drag gives terminal speed | | Laws of Motion | |
| | Recognise that acceleration in free-fall (g) is constant. | | Laws of Motion | Forces and Motion |

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| Forces for Transport | 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 greater when the gravitational field strength (g) is higher. HT: At terminal speed KE does not increase and PE does work against friction. $PE=mgh$ | Energy Efficiency | Energy and Movement | |
| | Interpret a gravity ride (roller-coaster) in terms of KE and PE. Discuss energy transfer. | Energy Efficiency | Energy and Movement | |
| | P3h. The energy of games and theme rides Describe the effect of changing mass and speed on KE e.g. <ul style="list-style-type: none"> • doubling mass doubles KE • doubling speed quadruples KE HT: State and use the equation: weight = mass x gravitational field strength | Gravity and Space | Energy and Movement | |

| Physics Module P4 | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | |
| | | GCSE Science | Additional Science | Separate Sciences |
| Radiation for Life | P4a. Sparks | | Static Electricity | |
| | HT: Describe static electricity in terms of the movement of electrons. Positive charge forms due to lack of electrons, negative charge forms due to an excess of electrons. | | Static Electricity | |
| | Like charges repel and unlike charges attract. Electrostatic phenomena are caused by the transfer of electrons. Static electricity can be dangerous when: <ul style="list-style-type: none"> • in atmospheres where explosions could occur e.g. inflammable gases or with high concentrations of oxygen. • in situations where large quantities of charge could flow through the body to earth. Static electricity can attract dirt and dust to insulators (plastic containers, TV monitors etc) and cause clothing to 'cling'. HT: The chance of receiving an electric shock can be reduced by correct earthing, the use of insulating mats or wearing shoes with insulating soles. Explain why it is necessary to earth lorries containing inflammable substances before unloading. Explain how anti-static sprays, liquids and cloths help reduce the problems of static electricity. | | Static Electricity Electrical Safety | |

| Physics Module P4 | | | | |
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| Radiation for Life | P4b. Uses of electrostatics | | Static Electricity | Diodes and Capacitors |
| | Static electricity can be useful for restarting the heart when it has stopped (defibrillator): <ul style="list-style-type: none"> • paddles charged • good electrical contact with patient's chest • charge passed through patient to make heart contract • care taken not to shock operator. | | Static Electricity | |
| | Static electricity can be useful for electrostatic dust precipitators to remove smoke particles from chimneys: <ul style="list-style-type: none"> • metal plates/grids put into chimneys and connected to high PD • dust particles attracted to plate/grid • dust attracts together to form larger particles • dust falls back down chimney when particles are heavy. | | Static Electricity | |
| | Static electricity can be useful for paint spraying: <ul style="list-style-type: none"> • spray gun and paint particles are charged • they repel one-another giving a fine spray • object charged oppositely to paint, attracting it • even coat, less waste, shadows painted. | | Static Electricity | |

Physics Module P4

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| | | Syllabus point (text abridged) | Boardworks presentations | | |
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| Radiation for Life | P4c. Safe electricals | Explain the behaviour of simple circuits in terms of the flow of electric charge. | | Electric Circuits | |
| | | Variable resistors can be used to change the current in a circuit. Describe the relationships between current, potential difference (pd) and resistance. For a given resistor, current increases as pd increases. For a fixed pd, current decreases as resistance increases. $\text{resistance} = \text{voltage} \div \text{current}$ | | Electric Circuits Resistance and Resistors | Controlling Current and Voltage |
| | | The functions of the live, neutral and earth wires are: • live - carries the high voltage • neutral - the second wire to complete the circuit • earth - a safety wire to stop the appliance becoming live | | Electrical Safety | |
| | | In a wire fuse, if the current becomes too large the wire fuse melts, breaking the circuit. HT: If an appliance develops a fault a large current causes the fuse to melt preventing the flow of current. This prevents the flex overheating and causing fire, and damage to the appliance. Explain the reasons for the use of fuses/circuit breakers as re-settable fuses. Explain how a wire fuse and earthing protects people. | | Electrical Safety | |
| | | 'Double insulated' appliances do not need earthing as the case of the appliance is a non conductor and cannot become live. | | Electrical Safety | |

Physics Module P4

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| | | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| Radiation for Life | P4d. Ultrasound | Describe features of longitudinal waves including amplitude, wavelength, frequency, compression and rarefaction. The frequency of ultrasound is higher than the upper threshold of human hearing. HT: Describe the motion of particles in longitudinal and transverse waves. | Wave Properties | | Waves |
| | | Ultrasound is used in body scans, and for breaking down kidney and other stones. HT: Explain how ultrasound is used in body scans (reflections from different layers) and the removal of accumulations in the body such as kidney stones. Ultrasound is used rather than X-rays as it can produce images of soft tissue and does not damage living cells. | | | Waves |

| Physics Module P4 | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | |
| | | GCSE Science | Additional Science | Separate Sciences |
| Radiation for Life | <p>Only beta and gamma radiation can pass through skin. HT: Gamma rays are given out from the nucleus of certain radioactive materials. X-rays are made by firing high speed electrons at metal. X-rays are easier to control than gamma rays.</p> | <p>Ionizing Radiation Radioactivity</p> | <p>Radioactive Decay</p> | |
| | <p>Beta or gamma emitters are used as tracers in the body. HT: Explain how radioactive sources are used in medicine: 1) to treat cancer: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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 </p> | <p>Ionizing Radiation</p> | | |
| | <p>X-rays and gamma rays have similar wavelengths but are produced in different ways</p> | <p>Ionizing Radiation</p> | | |

| Physics Module P4 | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | |
| | | GCSE Science | Additional Science | Separate Sciences |
| Radiation for Life | <p>Radioactive substances decay naturally and give out nuclear radiation in the form of alpha, beta and gamma. Radioactivity comes from the nucleus of an atom that is unstable. An alpha particle is a helium nucleus. A beta particle is a fast moving electron. HT: Explain and use the concept of half-life. Interpret graphical or numerical data of radioactive decay.</p> | <p>Radiation</p> | <p>Radioactive Decay</p> | |
| | <p>HT: When a nucleus emits an alpha particle its mass number decreases by 4 and its atomic number decreases by 2. It has two less neutrons and two less protons meaning a new element is formed. When a nucleus emits a beta particle its mass number is unchanged while its atomic number increases by one. The nucleus has one less neutron but one more proton. Construct and balance simple equations for mass numbers and atomic numbers to represent alpha and beta decay.</p> | | <p>Radioactive Decay</p> | |

Physics Module P4

| Physics Module P4 | | | | | |
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| Radiation for Life | P4e. Treatment | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Describe background radiation and state that it is caused by radioactive substances in rocks and soil and by cosmic rays. HT: Some background radiation comes from waste products and man-made sources like industrial and medical waste. | Radioactivity | Radioactive Decay | |
| | | Tracers are used to track the dispersal of waste, to find leaks/blockages in underground pipes and to find the route of underground pipes. HT: Describe how tracers are used in industry: <ul style="list-style-type: none"> • 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 drop in radioactivity after point | Radioactivity | | |
| | | Describe how a smoke detector with an alpha source works. | Radioactivity | | |
| | | Radioactivity can be used to date rocks. Measurements from radioactive carbon can be used to find the date of old materials. HT: The radioactive dating of rocks depends on the calculation of the uranium/lead ratio. Measurements of the activity of radioactive carbon can lead to an approximate age for different materials: <ul style="list-style-type: none"> • the amount of Carbon 14 in the air has not changed for thousands of years • when an object dies gaseous exchange with the air stops • as the C14 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 | | Radioactive Decay | |

| Physics Module P4 | | | | | |
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| | Syllabus point (text abridged) | Boardworks presentations | | | |
| | | GCSE Science | Additional Science | Separate Sciences | |
| Radiation for Life | P4h. Fission | In a nuclear power station a nuclear reaction produces heat. This makes steam which turns a turbine. This drives a generator. HT: Describe what happens to allow uranium to release energy. The uranium nucleus is hit by neutron, splitting the nucleus and releasing energy. | Non-renewable Energy Resources | Nuclear Energy | |
| | | The process that gives out energy in a nuclear reactor is nuclear fission. Nuclear fission produces radioactive waste. Materials become radioactive when they absorb extra neutrons. HT: 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 fission. Scientists stop nuclear reactions going out of control using rods placed in the reactor which absorb some of the neutrons. This allows enough neutrons to remain to keep the process operating. | | Nuclear Energy | |

Physics Module P5

| Physics Module P5 | | | | | |
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| Space for Reflection | P5a. Satellites, gravity and circular motion | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Gravity is a universal force of attraction between masses. The Moon remains in orbit around the Earth, and the Earth in orbit around the Sun due to gravitational forces between them. HT: The variation of gravitational force with distance. The variation in speed of a periodic comet during its orbit. The orbit period of a planet depends upon its distance from the sun. | Gravity and Space | | Orbits |
| | | A geostationary artificial satellite orbits the Earth once every 24 hours, around the equator. A geostationary artificial satellite remains in a fixed position above the Earth's surface. The orbital period of an artificial satellite increases with height above the Earth's surface. Circular motion requires a centripetal force. Gravity provides the centripetal force for orbital motion. HT: Artificial satellites in lower orbits travel faster because the gravitational force is stronger. Artificial satellites are continually accelerating towards the Earth, due to the Earth's gravitational pull. Their tangential motion keeps them moving in an approximately circular orbit. | | | Orbits |
| | | Satellites in low polar orbit can be used for weather forecasting and imaging the Earth's surface. Satellites in high geostationary orbit are used for communications and weather forecasting. HT: Explain why low polar orbit satellites orbit in a few Hours, while geostationary satellites orbit more slowly, with a period of 24 hours. | | | Orbits |

Physics Module P5

| Physics Module P5 | | | | | |
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| Space for Reflection | P5b. Vectors and equations of motion | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Know the difference between vector and scalar quantities. Direction is important for some quantities, (e.g. force); whereas direction is not important for other quantities, (e.g. mass). Calculate the vector sum from vector diagrams of parallel vectors (limited to force and velocity). HT: Calculate the resultant of two vectors by adding vectors that occur in parallel or perpendicular to each other. | | | Forces and Motion |
| | | $v = u + at$ $s = \frac{(u + v)}{2} t$ HT: Use the equations, including change of subject: $v^2 = u^2 + 2as$ $s = ut + \frac{1}{2} at^2$ | | | Forces and Motion |

Physics Module P5

| Physics Module P5 | | | | | |
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| Space for Reflection | P5c. Projectile Motion | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | An object projected horizontally in the Earth's gravitational field, ignoring air resistance: <ul style="list-style-type: none"> • has a constant horizontal velocity; • is accelerating towards the ground so has a steadily increasing vertical velocity. HT: Use the equations of motion for an object projected horizontally above the Earth's surface, where the gravitational field is still uniform. | | | Forces and Motion |
| | | Ignoring air resistance, the only force acting on a ball during flight is gravity. Projectiles have a downward acceleration and this only affects the vertical velocity. HT: The horizontal and vertical velocities of a projectile are vectors. The resultant velocity of a projectile is the vector sum of these velocities. A projectile has no acceleration in the horizontal direction. | | | Forces and Motion |

Physics Module P5

| Physics Module P5 | | | | | |
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| Space for Reflection | P5d. Momentum | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Describe the opposite reactions in a number of static situations, including examples involving gravity. | | Momentum | |
| | | The greater the mass of an object and/or the greater velocity, the more momentum the object has in that direction. $\text{momentum} = \text{mass} \times \text{velocity}$ HT: Explain that when an object collides with another object, they exert an equal and opposite force on each other. $\text{force} = \frac{\text{change in momentum}}{\text{time}}$ Calculate force, change in momentum and time taken. | | Momentum | |
| | | 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 and airbags in cars. HT: Spreading the change in momentum over a longer time reduces the forces required to act, and reduces injury risk. | | Momentum | |
| | | HT: Momentum is always conserved. Explain this in the context of explosions, recoil and 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). | | Momentum | |

Physics Module P5

| Physics Module P5 | | | | | |
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| | | Boardworks presentations | | | |
| | | GCSE Science | Additional Science | Separate Sciences | |
| | Syllabus point (text abridged) | | | | |
| Space for Reflection | P5e. Satellite Communication | Information can be transmitted using microwaves to orbiting artificial satellites and then re-transmitted back to Earth. HT: Microwaves are sent as a thin beam because they only diffract by a small amount due to their short wavelength. | | | Waves |
| | | Radio waves below 30MHz are reflected by the ionosphere. 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. HT: Explain reflection of waves (frequency less than 30MHz) that are reflected by the ionosphere. The amount of diffraction depends upon the size of the gap and the wavelength of the wave. Maximum diffraction occurs when the wavelength equals the size of the gap. | | | Waves |
| | | Radio waves are readily diffracted so are suitable for broadcasting. Long wave radio waves have a very long range because they diffract around hills and over the horizon. HT: Explain how long wavelength radio waves are diffracted around hills and over the horizon. Describe that long wave radio waves carry signals by amplitude modulation (AM). | | | Waves |

Physics Module P5

| Physics Module P5 | | | | | |
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| | | Boardworks presentations | | | |
| | | GCSE Science | Additional Science | Separate Sciences | |
| | Syllabus point (text abridged) | | | | |
| Space for Reflection | P5f. Nature of Waves | Demonstrate interference effects using sound waves, surface water waves or microwaves. Describe the interference of two waves in terms of reinforcement and cancellation of the waves. HT: Describe and explain interference patterns in terms of constructive and destructive interference. The number of half wavelengths in the path difference for two waves from the same source is an odd number for destructive interference and an even number for constructive interference. | | | Waves |
| | | The diffraction of light and its associated interference patterns are evidence for the wave nature of light. Electromagnetic waves are transverse waves and so can be plane polarised. HT: Describe and explain a diffraction pattern for light. Explain how polarisation is used in the application of Polaroid sunglasses. | | | Reflection and Refraction Waves |

Physics Module P5

| Physics Module P5 | | | | | |
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| Syllabus point (text abridged) | | Boardworks presentations | | | |
| | | GCSE Science | Additional Science | Separate Sciences | |
| Space for Reflection | P5g. Refraction of Waves | <p>Refraction occurs at the boundary between two mediums due to a change in the wave speed. When the wave speed decreases the wave bends towards the normal and vice versa. Refractive index is limited to the bending after a boundary. HT: Explain that a change in speed causes a change in wavelength and may cause a change in direction.</p> <p style="text-align: center;">refractive index = $\frac{\text{speed of light in vacuum}}{\text{speed of light in medium}}$</p> | | | Reflection and Refraction |
| | <p>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 and know their order in the spectrum. HT: Use and manipulate Snell's law:</p> <p style="text-align: center;">$n = \frac{\sin i}{\sin r}$</p> <p>Explain dispersion in terms of refractive indices.</p> | | | Reflection and Refraction | |
| | <p>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. Different media have different critical angles. HT: 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:</p> <p style="text-align: center;">$\sin c = \frac{n_r}{n_i}$</p> <p>The higher the refractive index of a medium the lower its critical angle.</p> | | | Reflection and Refraction | |

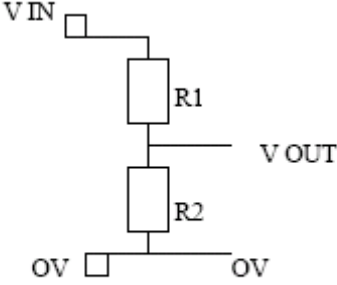
Physics Module P5

| | | Boardworks presentations | | | |
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| | | GCSE Science | Additional Science | Separate Sciences | |
| Space for Reflection | P5h. Optics | Syllabus point (text abridged) | | | |
| | | <p>The effect of a convex lens on both a diverging beam of light and a parallel beam of light.</p> | | | Lenses |
| | | <p>Describe how a camera or projector produces a real image on film and screen respectively. HT: Draw ray diagrams to find the position and size of the real image formed by a convex lens.</p> | | | Lenses |
| | | <p>Describe the use of a convex lens as a magnifying glass, in a camera and in a projector. Explain how the images produced by cameras and projectors are focussed. HT: Real images can be projected onto a screen and are inverted. Virtual images cannot be projected onto a screen but are the right way up.</p> <p style="text-align: center;">magnification = $\frac{\text{image size}}{\text{object size}}$</p> | | | Lenses |

Physics Module P6

| Electricity for Gadgets | Syllabus point (text abridged) | Boardworks presentations | | |
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| | | GCSE Science | Additional Science | Separate Sciences |
| | | P6a. Resisting | <p>Describe and explain how a variable resistor in a circuit affects the current, the brightness of a bulb or speed of a motor. HT: Resistance is varied as a result of changing length of resistance wire in a variable resistor.</p> <p style="text-align: center;">resistance = voltage ÷ current.</p> <p>Describe how a voltage-current graph can be used to find the resistance of an ohmic conductor. HT: Use and manipulate $R = V \div I$. Calculate the resistance of an ohmic conductor from a voltage-current graph.</p> <p>Describe how a voltage-current graph shows the changing resistance of a non-ohmic device, such as a bulb. HT: 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.</p> | |
| | | | Resistance and Resistors | Controlling Current and Voltage |
| | | | Resistance and Resistors | Controlling Current and Voltage |

Physics Module P6

| Electricity for Gadgets | Syllabus point (text abridged) | Boardworks presentations | | |
|-------------------------|---|--------------------------|---|---------------------------------|
| | | GCSE Science | Additional Science | Separate Sciences |
| | | P6b. Sharing | <p>Two fixed resistors can be used as a potential divider. One fixed resistor and one variable resistor in a potential divider allows variation of the output pd. HT: Calculate the output pd of a potential divider from the values of its resistors using:</p> <div style="text-align: center;">  <p style="margin-top: 10px;">$V_{out} = V_{in} \times \frac{R_2}{(R_1 + R_2)}$</p> </div> <p>A variable resistor can be used in place of the fixed resistor to provide an output pd with an adjustable threshold.</p> | |
| | <p>Describe how the resistance of an LDR varies with light level. Describe how the resistance of a thermistor varies with temperature. HT: 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.</p> | | | Controlling Current and Voltage |

Physics Module P6

| Physics Module P6 | | | | | |
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| Electricity for Gadgets | P6c. Motoring | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Describe the shape of the magnetic field around a straight wire, rectangular coil, or solenoid. 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. HT: Fleming's Left Hand Rule is used to predict the direction of the force on a current carrying wire. | | Motors and Generators | Transformers |
| | | 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; and the magnetic field strength. HT: 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. | | Motors and Generators | |

Physics Module P6

| Physics Module P6 | | | | | |
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| Electricity for Gadgets | P6d. Generating | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | A voltage is induced across a wire when the wire moves relative to a magnetic field. 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. HT: Explain how the size of the induced voltage depends on the rate at which the magnetic field changes. | Electricity to the Home | Motors and Generators | Transformers |
| | | An alternating current is generated when a magnet rotates inside a coil of wire. 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. HT: Explain, with a diagram, how an AC generator works including the action of the sliprings and brushes. | | Motors and Generators | Transformers |

Physics Module P6

| Physics Module P6 | | | | |
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| Syllabus point (text abridged) | | Boardworks presentations | | |
| | | GCSE Science | Additional Science | Separate Sciences |
| Electricity for Gadgets | P6e. Transforming | <p>A transformer changes the size of an alternating voltage. A transformer is two coils of wire wound on an iron core. Describe the difference in construction of a step-up and a step-down transformer.</p> $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ <p>HT: Transformers require the use of alternating current. The changing field in the primary coil of a transformer induces an output voltage in the secondary coil.</p> | Mains Electricity | Transformers |
| | | <p>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. HT: Isolating transformers have equal numbers of turns in the primary and secondary coils. They limit the risk of contact between live parts and the earth lead.</p> | | Transformers |
| | | <p>Power loss in the transmission of electrical power is related to the square of the current flowing in the transmission lines. HT: Use and manipulate the equation:</p> $V_p I_p = V_s I_s$ <p>Use this relationship to explain why power is transmitted at high voltages.</p> | | Transformers |

Physics Module P6

| Physics Module P6 | | | | | |
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| Electricity for Gadgets | P6f. Charging | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | Recognise the V–I characteristics for a silicon diode. Use this graph to explain that a diode only allows current to flow in one direction. A single diode produces half-wave rectification. HT: Explain the V–I 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. | | Resistance and Resistors | Diodes and Capacitors |
| | | Four diodes can be used in the construction of a bridge circuit to obtain full-wave rectification. HT: Explain how four diodes in a bridge circuit produce full-wave rectification. | | | Diodes and Capacitors |
| | | As current flows in a circuit containing an uncharged capacitor, charge is stored, increasing the pd across the capacitor. Describe the flow of current from a charged capacitor when a conductor is connected across it. Many devices need a more constant voltage supply. A capacitor will produce a more constant (smoothed) output. HT: 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 smoothing circuit. | | | Diodes and Capacitors |

Physics Module P6

| Physics Module P6 | | | | | |
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| Electricity for Gadgets | P6g. It's logical | Syllabus point (text abridged) | Boardworks presentations | | |
| | | | GCSE Science | Additional Science | Separate Sciences |
| | | The output of a logic gate is high or low depending on its input signal(s). | | | Logic Gates |
| | | Describe the truth tables for AND and OR logic gates in terms of high and low signals. HT: Describe the truth table for NAND and NOR logic gates in terms of high and low signals. | | | Logic Gates |
| | | Describe how to use switches, LDRs and thermistors in series with fixed resistors to provide input signals for logic gates. HT: 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. 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. | | | Logic Gates |

Physics Module P6

| Physics Module P6 | | | | | |
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| Syllabus point (text abridged) | | Boardworks presentations | | | |
| | | GCSE Science | Additional Science | Separate Sciences | |
| Electricity for Gadgets | P6h. Even more logical | Complete a truth table of a logic system with up to three inputs. HT: Explain how to work out the truth table of a logic system with up to four inputs made from logic gates. | | | Logic Gates |
| | | HT: Describe how to connect NOR gates to make a bistable latch circuit. Explain how, for a NOR gate latch: <ul style="list-style-type: none"> • 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. | | | Logic Gates |
| | | An LED can be used as an output for a logic gate. A relay uses a small current in the relay coil to switch on a circuit in which a larger current flows. HT: An LED and series resistor can be used to indicate the output of a logic gate. A relay is needed for a logic gate to switch a current in a mains circuit: the relay isolates the low voltage needed for a logic circuit from the high voltage mains. | | | Logic Gates |