Scheme of work

Physics – Energy

This resource provides guidance for teaching the Energy topic from our new GCSE Physics (8463). It has been updated from the draft version to reflect the changes made in the accredited specification such as the specification reference numbers. A few changes have been made to the learning outcomes and the opportunities to develop skills columns.

The scheme of work is designed to be a flexible medium term plan for teaching content and development of the skills that will be assessed.

It is provided in Word format to help you create your own teaching plan – you can edit and customise it according to your needs. This scheme of work is not exhaustive; it only suggests activities and resources you could find useful in your teaching.

### 4.1 Energy

### 4.1.1 Energy changes in a system, and the ways energy is stored before and after such changes

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most students should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
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| 4.1.1.1 | The changes involved in the way energy is stored when a system changes.  Calculations to include work done by forces and when a current flows.  The equations are covered in detail in sections 4.2.4, and 4.5.2.  Equations for work done by a force and work done when a charge moves through a potential difference should be known. | A system is an object or group of objects.  Describe, for common situations, the changes involved in the way energy is stored when a system changes. For example:   * an object projected upwards * a moving object hitting an obstacle * an object accelerated by a constant force * a vehicle slowing down * an electric kettle boiling water.   Calculate how energy is redistributed in a system when it changes.  Work is done when charge flows in a circuit. | 2 | Presenting and writing descriptions and explanations:  Ask students to explore questions such as:   * Why do the wheels of a bike get very hot when braking hard? * Which type of car is more efficient – petrol or electric? * How is the gravitational potential energy store of an object increased? * Why does a flow of electrons along a wire allow bulbs to light and motors to spin?   Describe the changes involved in the way energy is stored in simple systems. Examples could include:   * vehicle braking systems (such as bike brakes) * a ball being thrown upwards   Presenting and writing descriptions and explanations:  Describe and explain what is happening in terms of changes in energy stores when a motor is used to raise a load. | Obtaining and presenting primary evidence:  Investigation using simple machines around a classroom/laboratory to look at changes in energy stores.  Compare three of the machines investigated showing their similarities and differences. Present the findings to the group.  Discuss energy wasted by the machines and ways to reduce it.  Why does increasing the spring constant make a spring more difficult to stretch? Why does doubling the speed of a vehicle more than double the braking distance?  Obtaining and presenting primary evidence:  Plan and carry out an investigation to find the amount of energy transferred when various electrical appliances are in use. This should be restricted to appliances that can be run from standard laboratory power supply units. | Energy:  [BBC Bitesize – Forms of energy](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/energyefficiency/energytransfersrev1.shtml)  [BBC Bitesize – Energy transfers and efficiency](http://www.bbc.co.uk/education/guides/zhhcwmn/revision/2)  [Pass My Exams – Work and Energy](http://www.passmyexams.co.uk/GCSE/physics/work-energy.html)  GCSE Boardworks – Work and Power Section  Mini White Boards based on teacher’s own questions or Boardworks activities.  [Exampro user guide PowerPoint](http://filestore.aqa.org.uk/resources/science/AQA-GCSE-SCIENCE-EXAMPRO-UG.PPTX)  [S-cool, the revision website – Work and Energy](http://www.s-cool.co.uk/gcse/physics/energy-calculations/revise-it/work-and-energy) (animations)  Kinetic energy: [BBC Bitesize – Work, force and distance](http://www.bbc.co.uk/schools/gcsebitesize/science/add_aqa_pre_2011/forces/kineticenergyrev1.shtml) |
| 4.1.1.2 | The amount of energy associated with a moving object, or stored by an object can be calculated.  Calculations to include kinetic energy, elastic potential energy and gravitational potential energy.  Equations for kinetic energy and gravitational potential energy should be known. | Calculate the kinetic energy of a moving object, stored by a stretched spring and an object raised above ground level.  The kinetic energy of a moving object can be calculated using the equation:  Kinetic energy, EK, in joules, J Mass, m, in kilograms, kg Speed, v, in metres per second, m/s  The amount of elastic potential energy stored in a stretched spring can be calculated using the equation:  (assuming the limit of proportionality has not been exceeded) elastic potential energy, Ee, in joules, J spring constant, k, in newtons per metre, N/m extension, e, in metres, m  The amount of gravitational potential energy gained by an object raised above the ground level can be calculated using the equation:  gravitational potential energy, Ep, in joules, J  mass, m, in kilograms, kg  gravitational field strength, g, in newtons per kilogram, N/kg height, h, in metres, m | 2 | Ask students to explore questions such as:  When an object falls is the decrease in the gravitational potential energy store equal to the increase in the kinetic energy store?  Calculate:  Calculate the kinetic energy of a moving body.  Calculate the amount of energy stored by various objects including stretched springs and objects raised above the ground.  Calculation of an object’s speed given the kinetic energy of the object.  Calculate the speed of an object, just before impact, when dropped from a given height by equating the increase in the kinetic energy store to the decrease in the gravitational potential energy store.  Presenting and writing descriptions and explanations:  Explain the effect on the kinetic energy of an object when the speed and mass increases. In particular what will happen to the kinetic energy when the speed doubles and when the mass doubles?  Application and implication:  Explain the effect of increasing the spring constant of a spring on the ease that it stretches and on the amount of energy stored in the spring. | Planning an approach. Selecting and managing variables:  Determine the amount of energy stored in a spring.  Investigate the efficiency of an electric motor used to lift a load by calculating the energy input from the power of the motor x time. The energy stored by the object can be found using:  Obtaining and presenting primary evidence:  Investigations looking into finding the speed of a trolley that travels down a ramp. Calculate the g.p.e. at the top of the ramp and the kinetic energy at the bottom. Are they the same? Account for any differences that are observed. | Gravitational potential energy: [BBC Bitesize – Work and power](http://www.bbc.co.uk/education/guides/zssk7ty/revision/2)  [Kinetic energy: BBC Bitesize – Work and power](http://www.bbc.co.uk/education/guides/zssk7ty/revision/3)  [Pass My Exams – Kinetic Energy](http://www.passmyexams.co.uk/GCSE/physics/kinetic-energy.html)  Gravitational to kinetic energy transfers: [BBC Bitesize – Work and power](http://www.bbc.co.uk/education/guides/zssk7ty/revision/4)  [Pass My Exams – Kinetic Energy](http://www.passmyexams.co.uk/GCSE/physics/kinetic-energy.html)  (links to other types of energy, calculations that can be done using Mini White Boards) |
| 4.1.1.3 | The distribution of energy in a system can change. This change can be calculated.  The equation is covered in detail in section 4.3.2  The specific heat capacity of a substance is the amount of energy required to change the temperature of one kilogram of the substance by one degree Celsius. | Calculate changes in the way energy is stored when a system is changed by heating.  Use calculations to show how the overall energy in a system is redistributed when the system is changed.  The amount of energy stored in or released from a system as its temperature changes can be calculated using the equation:  change in thermal energy, ΔE, in joules, J  mass, m, in kilograms, kg  specific heat capacity, c, in joules per kilogram per degree Celsius, J/kg°C  temperature change, Δθ, in degrees Celsius, °C  The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius. | 2 | Ask students to explore questions such as:   * What determines how fast the temperature of a substance increases?   Presenting and writing descriptions and explanations:  Describe how the energy stored in a system changes when it is heated.  Calculate:  Calculate the increase in stored energy when a substance is heated.  Presenting and writing descriptions and explanations:  Describe what is happening at an atomic level when a substance is heated.  Developing explanations using ideas and models:  Give students an opportunity to create their own models to explain what is happening when a solid is heated. This can be in the form of a diagram, a 2D or 3D model as they see fit.  Calculate:  Carry out calculations involving specific heat capacity. Students should also be able to rearrange the equation to find any unknown in the equation.  Presenting and writing arguments:  Evaluate the use of concrete in storage heaters:   * Why is concrete used? * What are the problems associated with the use of concrete? * Why aren’t other materials with a higher or lower specific heat capacity used? | Why are concrete blocks used as thermal storage heaters?  Why doesthe temperature of a pan of oil increase faster than a pan of water? Why does the filling of a pie feel hotter than the pastry even though it has been in the same oven?  Obtaining and presenting primary evidence.  Required practical:  Investigation to determine the specific heat capacity of one or more materials. (8.2.1)  The investigation will involve linking the decrease of one energy store (or work done) to the increase in temperature and subsequent increase in thermal energy stored.  In measuring specific heat capacity students will have to measure energy or work done, this could be decrease in the g.p.e. store, electrical work (VIt) and the change in thermal energy. This may be better completed after section 4.2.4 when all of the preliminary work has been completed.  Working critically with primary and secondary evidence:  How much energy is stored in a crisp? Do some research to find out the published figures and then investigate.  Working scientifically:   * Research different methods for measuring specific heat capacity. * Design safe practical procedures that allow data to be collected. * Select suitable apparatus for carrying out the experiment accurately and safely. * Identify possible hazards, the risks associated with these hazards, and methods of minimising the risks. * Make measurements with appropriate precision and record data in appropriate tables. * Evaluate data and working methods. * Recognise random and systematic errors; identify their causes. * Identify causes of uncertainty in final calculated values and suggest ways of reducing the inaccuracies to improve the accuracy of the calculated values. | GCSE Boardworks – Energy Efficiency, Energy and Movement (Mini White Boards for teacher’s Q&A or activities)  Kinetic energy: [BBC Bitesize – Specific heat capacity](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa/heatingandcooling/buildingsrev3.shtml)  Video clip  [YouTube: GCSE Science Revision – Specific Heat Capacity](https://www.youtube.com/watch?v=D3CwpfBzF94) |
| 4.1.1.4 | The power rating of an appliance states the rate that energy is being transferred or the rate at which work is done.  Equations for power as the rate of transfer of energy or work done should be known. | Power is defined as the rate at which energy is transferred or the rate at which work is done.  Power, P, in watts, W  Energy transferred, E, in joules, J  Time, t, in seconds, s  Work done, W, in joules, J  An energy transfer of one joule per second is equal to a power of 1 watt. | 1 | Applications, implications and cultural understanding. Developing argument:  Evaluate the benefits and drawbacks of using lower power devices such as compact fluorescent lamps (CFLs).  Calculations:  Carry out calculations to determine power, using energy transferred divided by time and work done divided by time. | Planning an approach:  Investigating power. Find out how much power students have by getting them to perform simple tasks. Examples could include walking up a flight of stairs, lifting masses up a known height and pulling an object across a floor. For each case the students need to know the work done and the time taken.  To introduce the equation for work done by a force section 4.5.2 needs to be covered.  Obtaining and presenting primary evidence:  Is mechanical power the same as electrical power?  Demonstrate the difference in time taken when two different motors lift the same weight through at the same height. | Work done: [BBC Bitesize – Work and power](http://www.bbc.co.uk/education/guides/zssk7ty/revision/1) |

### 4.1.2 Conservation and dissipation of energy

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most students should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
| --- | --- | --- | --- | --- | --- | --- |
| 4.1.2.1 | The total amount of energy in a system remains constant though the way the energy is stored in the system can change.  The energy transfers in a system are not always useful. Energy that is transferred in a way that is not considered useful is often described as being wasted.  Reducing unwanted energy transfers.  Reducing heat loss from a home by use of insulation. | Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed.  Where energy transfersin a closed system occur there is no net change to the total energy.  Whenever there are energy transfers in a system only part of the energy is usefully transferred. The rest of the energy is dissipated so that it is stored in less useful ways. This energy is often described as being wasted.  Unwanted energy transfers can be reduced in a number of ways, for example, through lubrication and the use of thermal insulation.  The rate of cooling of a building is affected by the thickness and thermal conductivity of its walls.  The higher the thermal conductivity of a material; the higher the rate of energy transfer by conduction across the material. | 2 | Ask students to explore questions such as:   * Can energy be created or destroyed? * What is meant when people say ‘energy is lost’? * How can we reduce the amount of energy being wasted by a machine? * What is the best way to reduce heat loss in the home?   Presenting and writing descriptions and explanations:  Presenting and writing arguments:  Describe, in terms of energy stores/work done, what happens when an appliance (such as a radio) is working.  Evaluate the use of various types of insulation in the home. Look in particular at the effectiveness of loft insulation and cavity wall insulation.  Communication for audience and purpose:  Design a poster to illustrate the reasons why insulating the home is beneficial for both the homeowner and the environment. Select specific examples and suggest what could happen if insulation was not used in the home. | Working critically with primary and secondary evidence:  What is the best type of insulation to use in the home?  Plan and carry out an investigation to find out which type of insulation will reduce heat loss the most.  Investigate how the thickness of the insulating material used affects heat loss.  Required practical: (Physics only)  Investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material. (8.2.2)  Obtaining and presenting primary evidence:  Design a building that will have very low heating bills. This can be a 2D or 3D model – it is possible using a beaker of hot water and a thermometer to find out how effective the insulation is in a 3D model that has been built.  Investigate ways of reducing the wasted energy transfer in a rollercoaster – so that a marble dropped down a U-shaped track will roll higher up the opposite side of the track. | Video clips  YouTube: [GCSE BBC Bitesize Revision Physics 5 Energy Transfer 2](https://www.youtube.com/watch?v=XoKiU6CDeb0)  YouTube: [How to insulate Your Home: Types of Loft Insulation](https://www.youtube.com/watch?v=jbSiqWtfcZU)  Episodes of ’Grand Designs’ may get students thinking about the design of buildings and insulation. Good examples include:  YouTube: [Grand Designs – S9E09 The Cambridgeshire Eco Home Cambridgeshire Revisited](https://www.youtube.com/watch?v=Y2XWYAitICo)  YouTube: [Grand Designs Australia – S04E06 Forest Lodge Eco [Full Episode]](https://www.youtube.com/watch?v=57g3G-PwCI0)  Energy changes that take place in a rollercoaster: [BBC Bitesize – Gravitational potential energy](http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_gateway/forces/themeridesrev1.shtml)  [Pass My Exams – Conservation of Energy & Energy Transfer](http://www.passmyexams.co.uk/GCSE/physics/conservation-of-energy-and-energy-transfer.html)  Boardworks – very good sections on this topic and activities which can be done using Mini White Boards. |
| 4.1.2.2 | Calculating efficiency.  How to increase efficiency.  Equations for the efficiency of an energy transfer should be known. | The energy efficiency for any energy transfer can be calculated using the equation:  Efficiency may also be calculated using the equation:  Describe ways to increase the efficiency of an intended energy transfer.HT only | 1 | Ask students to explore questions such as:   * Which type of power station is the most efficient? * Which type of light bulb would cost the least amount of money to use?   Research different types of power station to find out if combustion based power stations are less efficient that either nuclear or wind. Investigate ways of increasing the efficiency of a coal fired power station.  Prepare a presentation on different types of light bulb. Find out the cost of buying and running the light bulbs in a home for one year. Determine whether energy saving light bulbs will save money over incandescent light bulbs.  State the equations used to find efficiency.  Calculate the efficiency of a machine as either a decimal or a percentage.  Rearrange the equation to determine the total power input the machine or the useful power output.  Students may have to analyse data to determine the useful energy output if they are told the energy input and the amount of wasted energy.  Interpret data on efficiencies of different machines. |  | Energy efficiency calculations: [BBC Bitesize – Efficiency](http://www.bbc.co.uk/schools/gcsebitesize/science/aqa_pre_2011/energy/heatrev6.shtml)  Efficiency of power stations video clip:  YouTube: [Which Power Source Is most Efficient?](https://www.youtube.com/watch?v=0c4xk5dB014)  [Pass My Exams – Energy Transfer Diagrams and Efficiency](http://www.passmyexams.co.uk/GCSE/physics/energy-transfer.html)  [Cyberphysics – Sankey diagrams](http://www.cyberphysics.co.uk/general_pages/sankey/sankey.htm)  GCSE Boardworks – Energy & Efficiency section  Mini White Boards based on teacher’s own questions or activities from Boardworks |

### 4.1.3 National and global energy resources

| **Spec ref.** | **Summary of the specification content** | **Learning outcomes**  *What most students should be able to do* | **Suggested timing (hours)** | **Opportunities to develop Scientific Communication skills** | **Opportunities to develop and apply practical and enquiry skills** | **Self/peer assessment opportunities and resources**  *Reference to past questions that indicate success* |
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| 4.1.3 | Energy Resources.  Renewable and non-renewable energy resources. | Describe the main energy resources available for use on Earth. These include:   * fossil fuels (coal, oil and gas) * nuclear fuel * bio-fuel * wind * hydro-electricity * geothermal * the tides * the Sun * water waves.   Distinguish between energy resources that are renewable and energy resources that are non-renewable.  Compare the ways that different energy resources are used. The uses to include transport, electricity generation and heating.  Understand why some energy resources are more reliable than others. | 1 | Define renewable energy resource and give examples of them.  Define non-renewable energy resource and give examples of them.  Describe the way in which different energy resources are used and identify patterns and trends in the use of energy resources.  Research the different types of energy resources that are available to generate electricity.  For each type of energy resource find the environmental impacts. Explain why each type of energy resource is used to generate electricity even though it does have these environmental impacts.  For a given location determine the best way of generating electricity.  Role-play a meeting between a group of local councillors/MPs, local environmental groups and electricity companies trying to get a new power station built. Which type of power station would each group want? How persuasive are each group in getting their choice?  Evaluate the use of different energy resources for a given situation, eg generating electricity in remote locations. The evaluation should include ethical and environmental issues.  Compare the use of different fuels for heating homes and transport. Determine the most suitable fuel for a particular use depending on the characteristics of the fuel.  Identify the political, social, ethical and economic considerations that may arise from the use of different energy resources. | Investigations into output of a model wind turbine or solar cell. | [S-cool, the revision website – Non-renewable Energy Sources](http://www.s-cool.co.uk/gcse/physics/energy-transfers/revise-it/non-renewable-energy-sources)  [Cyberphysics – Energy Resources](http://www.cyberphysics.co.uk/topics/energy/sources.htm)  [The Energy Story – Chapter 20: Hydrogen and Future Energy Sources](http://www.energyquest.ca.gov/story/chapter20.html)  [Pass My Exams – Electricity Generation](http://www.passmyexams.co.uk/GCSE/physics/electricity-generation.html)  Video clip  [YouTube: Energy Resources](https://www.youtube.com/watch?v=SO-Ds0jlraE)  GCSE Boardworks – Non Renewable, Renewable sections  Mini White Boards based on teacher’s own questions or activities from Boardworks |