P1 Energy

What's the science story? The concept of energy emerged in the 19th century. The idea was used to explain the work output of steam engines and then generalised to understand other heat engines. It also became a key tool for understanding chemical reactions and biological systems. Limits to the use of fossil fuels and global warming are critical problems for this century. Physicists and engineers are working hard to identify ways to reduce our energy usage.

Previous knowledge: Year 8 – Energy – insulation, conduction. Energy efficiency. SMSC: Energy efficiency/green power.	**Next steps…** P4 – Electricity – use of similar equations. Use of equations throughout all physics topics.

Keywords

Conservation	Work done	Kinetic
Dissipation	Potential	Thermal
Joules	Spring constant	Elastic
Efficiency	Proportionality	Gravitational
		Specific Heat Capacity
		Latent Heat Capacity
		Resource

Working scientifically skills:	Assessments:
MS8: Writing Methods WS10: Selecting equipment WS14: Drawing graphs WS15: Using data WS16: Using equations WS18: Converting units WS19: Prefixes and powers	End of unit test (summative) (out of 50) Exit tickets x 2/3 (formative) • Power station • I do (SHC)

Lesson No. and Title	Learning objectives	AQA Specification	Practical equipment
1.Changes in Energy stores.	3/4 – State the ways in which energy can be stored and transferred. 4/5 – Describe wasted and useful energy. 7+ – Explain the energy transfers in a variety of systems.	6.1.1.1 Energy stores and systems A system is an object or group of objects. There are changes in the way energy is stored when a system changes. Students should be able to describe all the changes involved in the way energy is stored when a system changes, for common situations. For example: • an object projected upwards • a moving object hitting an obstacle • an object accelerated by a constant force • a vehicle slowing down • bringing water to a boil in an electric kettle. Throughout this section on Energy students should be able to calculate the changes in energy involved when a system is changed by: • heating • work done by forces • work done when a current flows	

2.Conservation of energy and work done.	3/4 – State the rule of energy conservation and show in a simple example. 4/5 – Use Work Done equation in simple form. 7+ – Apply Work Done equation in a range of situations.	6.5 Work done The work done by a force on an object can be calculated using the equation: work done = force × distance moved along the line of action of the force $W = F s$ work done, W, in joules, J force, F, in newtons, N distance, s, in metres Students should be able to recall and apply this equation. One joule of work is done when a force of one newton causes a displacement of one metre. 1 joule = 1 newton-metre Students should be able to describe the energy transfer involved when work is done.	
3. Conservation of energy.	4/5 To investigate the energy transfers in a pendulum and bungee. 6 – To apply the law of conservation of energy in straightforward situations. 7/8 – To describe closed systems and the energy stores within them by using the principle of conservation of energy.	**6.1.2.1 Energy changes in a system** Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed. Students should be able to describe with examples where there are energy transfers in a closed system, that there is no net change to the total energy. Students should be able to describe, with examples, how in all system changes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being ‘wasted’.	• Mass • Long rubber band/elastic • Metre rule • Clamp stand

4.Energy equations	4 – State the key equations 5/6 - Apply the equations to novel situations 7+ Rearrange the equations and apply	**6.1.1.2 Changes in energy** The kinetic energy of a moving object can be calculated using the equation: *kinetic energy* = 0.5 × *mass* × *speed* 2 kinetic energy, *E*k, 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: *elastic potential energy* = 0.5 × *spring constant* × *extension* 2 (assuming the limit of proportionality has not been exceeded) elastic potential energy, *E*e, 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 ground level can be calculated using the equation: *g . p . e .* = *mass* × *gravitational field strength* × *height* gravitational potential energy, *E*p, in joules, J mass, *m*, in kilograms, kg gravitational field strength, *g*, in newtons per kilogram, N/kg (In any calculation the value of the gravitational field strength (*g*) will be given). height, *h*, in metres, m	
5. Elastic Energy Stores	4 – To state the factors that affect the elastic potential energy of a spring. 5/6 To calculate the elastic potential energy store of a stretched spring. 7+ - Apply knowledge with links to car safety features.	**6.1.1.2 Energy Changes** *elastic potential energy* = 0.5 × *s pring constant* × *extension* 2 *E*e = 12 *k e*2 (assuming the limit of proportionality has not been exceeded) elastic potential energy, *E*e, in joules, J spring constant, *k*, in newtons per metre, N/m extension, *e*, in metres, m	Hooke's Law Masses Spring Metre rule Clamp and clamp stand

6. Specific Heat Capacity	4 – State the factors that affect the amount of energy required to increase the temperature of an object. 6 – Calculate the energy required to change the temperature of an object. 7+ – Use the specific heat capacity equation to make calculations in unfamiliar contexts.	**6.1.1.3 Energy changes in systems** 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 = mass × specific heat capacity × temperature change* $\Delta E = m\, c\, \Delta \theta$ 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, $\Delta\vartheta$, 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.	
7.SHC RP	4 – To state the factors that affect the elastic potential energy of a spring. 5/6 To calculate the elastic potential energy store of a stretched spring. 7+ Answer the applied question in the form of a 6 mark answer.	**Required practical activity 14:** an investigation to determine the specific heat capacity of one or more materials. 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.	SHC RP Blocks of metal Ammeter Voltmeter Power Pack and wires Thermometer

8. Power	3/4 – Define Power use equations, including units. 4/5 – Rearrange the power equations. 7+ – Explain the energy transfers in a variety of systems.	**6.1.1.4 Power** Power is defined as the rate at which energy is transferred or the rate at which work is done. $power = \frac{energy\ transferred}{time}$ $P = E/t$ $power = \frac{work\ done}{time}$ $P = W/t$ 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 1 joule per second is equal to a power of 1watt. Students should be able to give examples that illustrate the definition of power eg comparing two electric motors that both lift the same weight through the same height but one does it faster than the other.	
9.Energy and efficiency	4/5 - To describe energy efficiency and how to calculate it. 5/6 - To use the law of conservation of energy to explain why efficiency can never be greater than 100%. 6/7 – Apply equation for a range of appliances.	**6.1.2.2 Efficiency** The energy efficiency for any energy transfer can be calculated using the equation: $efficiency = \frac{use\ f\ ul\ output\ energy\ transfer}{total\ in\ put\ energy\ transfer}$ Efficiency may also be calculated using the equation: $efficiency = \frac{useful\ power\ output}{total\ power\ in\ put}$	

10. Energy and efficiency	4/5 - To describe energy efficiency and how to calculate it. 5/6 – Use a Sankey diagram to show efficiency.	**6.1.2.2 Efficiency** The energy efficiency for any energy transfer can be calculated using the equation: *efficiency* = <u>*use f ul output energy transfer*</u> *total in put energy transfer* Efficiency may also be calculated using the equation: *efficiency* = <u>*useful power output*</u> *total power in put*	
11.Insulation and conductivity	3/4 – Define conduction, convection and radiation 4/5 – Design and plan a practical to measure energy transfer 7+ – Apply knowledge by conducing practical and writing a scientific report	**6.1.2.1. Energy transfers in a system** Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed. Students should be able to describe with examples where there are energy transfers in a closed system, that there is no net change to the total energy. Students should be able to describe, with examples, how in all system changes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being 'wasted'. Students should be able to explain ways of reducing unwanted energy transfers, for example through lubrication and the use of thermal insulation. The higher the thermal conductivity of a material the higher the rate of energy transfer by conduction across the material. Students should be able to describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls. Students do not need to know the definition of thermal conductivity.	

12. Renewable energy	3/4 – Define 'renewable' energy 4/5 – Evaluate renewable energy 7+ – Apply knowledge to explain the effects of renewable energy on the environment	**6.1.3 National and global energy reserves** The main energy resources available for use on Earth include: fossil fuels (coal, oil and gas), nuclear fuel, bio-fuel, wind, hydroelectricity, geothermal, the tides, the Sun and water waves. A renewable energy resource is one that is being (or can be) replenished as it is used. The uses of energy resources include: transport, electricity generation and heating. Students should be able to: • describe the main energy sources available • distinguish between energy resources that are renewable and energy resources that are non-renewable • compare 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 • describe the environmental impact arising from the use of different energy resources • explain patterns and trends in the use of energy resources. Descriptions of how energy resources are used to generate electricity are **not** required. Students should be able to: • consider the environmental issues that may arise from the use of different energy resources • show that science has the ability to identify environmental issues arising from the use of energy resources but not always the power to deal with the issues because of political, social, ethical or economic considerations.	

13.Non-renewable energy resources	3/4 – Define non-renewable energy 4/5 – Describe and explain the difference between renewable and non-renewable sources 7+ – Evaluate the effect of energy use on the environment	**6.1.3 National and global energy reserves** The main energy resources available for use on Earth include: fossil fuels (coal, oil and gas), nuclear fuel, bio-fuel, wind, hydroelectricity, geothermal, the tides, the Sun and water waves. A renewable energy resource is one that is being (or can be) replenished as it is used. The uses of energy resources include: transport, electricity generation and heating. Students should be able to: • describe the main energy sources available • distinguish between energy resources that are renewable and energy resources that are non-renewable • compare 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 • describe the environmental impact arising from the use of different energy resources • explain patterns and trends in the use of energy resources. Descriptions of how energy resources are used to generate electricity are **not** required. Students should be able to: • consider the environmental issues that may arise from the use of different energy resources • show that science has the ability to identify environmental issues arising from the use of energy resources but not always the power to deal with the issues because of political, social, ethical or economic considerations.	

14./15.Energy efficient house	3/4 – State energy saving factors of the house. 4/5 – Describe energy saving factors of the house, using keywords. 7+ – Explain energy saving factors, linking to environmental issues. To include saving energy and providing renewable energy.	**6.1.1 Energy changes in a system** Students should be able to explain ways of reducing unwanted energy transfers, for example through lubrication and the use of thermal insulation. The higher the thermal conductivity of a material the higher the rate of energy transfer by conduction across the material. Students should be able to describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls. Students do not need to know the definition of thermal conductivity. Students should be able to: • consider the environmental issues that may arise from the use of different energy resources • show that science has the ability to identify environmental issues arising from the use of energy resources but not always the power to deal with the issues because of political, social, ethical or economic considerations.	Materials to build a model/make a poster.