P1a

Environment, Electricity

P1a 1. 1 Thermal Radiation * Thermal or heat radiation is the transfer of energy by infra-red waves. * Thermal radiation is energy transfer by electromagnetic waves. * All objects emit thermal radiation. * The hotter an object, the more thermal radiation it emits. * Heat radiation can travel through a vacuum. 1. 2 Surfaces and Radiation * Dark, matt surfaces are better emitters of thermal radiation than light, shiny surfaces. * Dark, matt surfaces are better absorbers of thermal radiation than light, shiny surfaces. 1. 3 Conduction * Conduction mainly occurs in solids. Most liquids and gases are poor conductors. * Conduction in a metal is due mainly to free electrons transferring energy inside the metal. * The particles gain kinetic energy and vibrate more; this is then passed onto neighbouring particles etc. * When metals are heated free electrons gain kinetic energy and move through the metal and transfer energy by colliding with other particles. * Non-metals are poor conductors because they do not have free electrons. * Fibreglass is a good insulator because they contain pockets of trapped air. 1. 4 Convection * Polymers can be designed with specific properties by choosing different monomers and by changing the conditions used to make them 1. 5 Heat Transfer by Design * A radiator has a large surface area so heat can be lost easily. * Small objects lose heat more easily than large objects. * Heat loss from a building can be reduced by using: * Aluminium foil behind radiators. * Cavity wall insulation. * Double glazing. * Loft insulation. * Using shiny, light surfaces which are poor emitters of heat. * Trapping air in small pockets. * To maximise heat loss to keep things cool we can use: * Good conductors. * Paint objects dull black. * Have air flow around them maximised. TEST 1) Name 3 types of heat transfer. 2) Which type of heat transfer occurs mainly

in solids? 3) How are convection currents set up in fluids? 4) Describe the process of heat transfer through a metal. 5) What factors affect the amount of heat radiated by a body? 6) Why are gases poor conductors? 7) How does surface colour affect the rate of conduction? 8) Why do central heating radiators have large surface areas? 9) Why does a concrete floor feel colder to your feet than a carpeted floor at the same temperature? 10) Why are hot water tanks often wrapped in glass fibre jackets? 2. 1 Forms of Energy * Energy can transform from one form to another. * Light | From the Sun or a lamp. | Thermal | Flows from a hot object to a cold object. | Sound | From a loudspeaker or a voice. | Kinetic | Anything moving. | Nuclear | From nuclear reactions. | Electrical | Whenever an electric current flows. | Gravitational Potential | Stored in any object that can fall. | Chemical | Stored in fuels, food and batteries released when chemical reactions have taken place. | 2. 2 Conservation of Energy * Energy can be transferred from one place to another. * The total amount of energy is always the same (this is the conservation of energy). * E. G. when an object falls, GP (gravitational potential energy) is transformed into kinetic energy. 2. 3 Useful Energy * Useful energy is energy in the place we want it and in the form we need it. * Wasted energy is energy that is not useful energy. Input Energy = Useful Energy + Wasted Energy Input Energy = Useful Energy + Wasted Energy * As energy spreads out, it gets more and more difficult to use for further energy transfers. 2. 4 Energy and Efficiency * Energy is measure in joules (J) * The less energy waster by a device the more efficient the device is. * Wasted energy causes inefficiency. * No device can be 100% efficient except an electric heater, which usefully transforms all of the electrical energy

supplied to it into heat energy. Efficiency = energy usefully transformed by the device Input Energy Efficiency = energy usefully transformed by the device Input Energy TEST 1) List 3 forms of stored energy and give an example of each. 1) Explain the energy transformation that takes place if you climb to the top of a ladder then fall to the ground. 2) Why may an electric heater be 100% efficient when no other device ever is? 3) Calculate the efficiency of a kettle if it takes 720 000J of energy to raise the temperature of a kettle cold water to boiling point when 750 000J of energy is supplied to the kettle 4) What happens to the energy that is not used to heat water? 5) What energy do we give to a spring if we stretch it? 6) What is the useful energy transformation in a vacuum cleaner? 7) What energy transformation takes place in a solar cell? 2 3. 5 Electrical Devices * Electrical energy is energy transfer due to an electric current. * Uses of electrical devices include: * Heating. * Lighting * Making objects move (using an electric motor) * Creating sounds and visual images. 3. 6 Electrical Power * The power of a device is the rate at which it transforms energy. * The power of a device is measured in Watts (W) * 1 Kilowatt (kW) = 1000 Watts. Power = Energy Transferred (J) Time Taken (s) Power = Energy Transferred (J) Time Taken (s) 3. 7 Using electrical Energy * A Kilowatt-hour (kWh) is the amount of energy transferred by a kilowatt device when used for one hour. Energy Transferred (kWh) = Power of A Device (kW) * Time (s) Energy Transferred (kWh) = Power of A Device (kW) * Time (s) Total Cost of Electricity = Number of kWh * Cost per kWh Total Cost of Electricity = Number of kWh * Cost per kWh 3. 8 The National Grid * A network of cables and transformers that connect power stations to homes and other buildings.

* We use step-up transformers to step power stations voltages up to the grid voltage. * We use step-down transformers to step the grid voltage down for use in our homes as… * It would be dangerous to supply electricity to consumers at these very high voltages; step-down transformers are used to reduce the voltage to 230V. * A high grid voltage reduces energy loss and makes the system more efficient. TEST 1) State an equivalent unit to watt. 2) What device transforms sound energy to electrical energy? 3) What device transforms electrical energy to sound energy? 4) In a 3 kW kettle how many joules of electrical energy are transformed from electrical energy to heat energy each second? 5) An immersion heater converts 36 000 000J of electrical energy into heat energy when it is switched on for 1 hour. What is the power of the heater in kilowatts? 6) How much does it cost to use a 1200W vacuum cleaner for 10 minutes if electrical energy costs 7p per kilowatt-hour? 7) Draw a block diagram showing the different parts of the National Grid system and the order in which they are used. 8) Why are voltages reduced to 230V before reaching homes? 3 4. 9 Fuel for Electricity * Water heated Steam turns the turbine Rotates the generators ELECTRICITY. * Heat comes from burning a fuel such as a fossil fuel; or hot gases drive the turbine directly. * Uranium or Plutonium is used in a nuclear power station * Fission happens which produces a lot of heat turning the water into steam. * More energy is released per kilogram from uranium than fossil fuels. 4. 10 Energy from Wind and Water * A wind turbine is an electricity generator on top of a tall tower. * Wind makes the wind turbines rotate and drive a generator. * Electricity can be produced from energy obtained from falling water, waves and tides. * A wave generator is a floating generator turned by

the waves. * Hydroelectricity generators are turned by water flowing downhill. * A tidal power station traps each high tide and uses it to turn generators. The energy is stored at times of high demand the water can be released to fall through turbines. 4. 11 Power from the Sun and the Earth * We can convert solar energy into electricity using solar cells or use it to heat water directly in solar heating panels. * Each cell produces a small amount of energy so they are useful to power small devices e. g. calculators, watches etc. * Water flowing in a solar heating panel is heated directly by the sun's energy. * Geothermal energy comes from the energy released by radioactive substances deep inside the Earth. * Geothermal energy comes from radioactive processes in the rocks deep in the earth. * Deep holes are drilled and cold water is pumped down to the hot rocks and comes back to the surface as steam. * Steam turns the turbine Rotates the generators ELECTRICITY. 4. 12 Energy and the Environment Energy Resource | Advantages | Disadvantages | Coal | * Bigger reserves than other fossil fuels. * Reliable. | * Non-renewable. * Production of CO2, a greenhouse gas. * Production of SO2, causing acid rain. | Oil | * Reliable. | * Non-renewable. * Production of CO2, a greenhouse gas. * Production of SO2, causing acid rain. | Gas | * Reliable. * Gas power stations can be started up quickly to deal with sudden demand. | * Non-renewable. * Production of CO2, a greenhouse gas. * Production of SO2, causing acid rain. | Nuclear | * No production of polluting gases. * Reliable. | * Non-renewable. * Produces nuclear waste, which is difficult to dispose of safely. * Risk of big accident, such as Chernobyl. | Wind | * Renewable. * Free * No production of polluting gases. | * Requires many large turbines. * Unsightly and noisy. * Not reliable, the wind does not always

blow. | Falling Water | * Renewable. * Free * No production of polluting gases. * Reliable in wet areas. * Pumped storage systems allow storage of energy. * Can be started up quickly to deal with sudden demand. | * Only work in wet and hilly areas. * Flooding of an area affects the local ecology. | Waves | * Renewable. * Free. * No production of polluting gases. | * Can be hazard to boats. * Not reliable. | Tides | * Renewable. * Free. * No production of polluting gases. * Reliable, always tides twice a day. | * Only a few river estuaries are suitable. * Building a barrage affects the local ecology. | Solar | * Renewable. * Free. * No production of polluting gases. * Reliable in hot countries, in the daytime. | * Only suitable for small amounts of electricity, or requires large number of cells. * Unreliable in less sunny countries. | Geothermal | * Renewable. * Free. * No production of polluting gases. | * Only economically viable in a very few places. * Drilling through large depth of rock is difficult and expensive. | TEST 1) Explain the difference between renewable and non-renewable energy resources. 2) In which three ways can water be used as an energy resource to generate electricity? 3) How can geothermal energy be used to produce heat and electricity? 4) What are the advantages of using fossil fuels in power stations to produce electricity? 5) What are the disadvantages of using fossil fuels in power stations to produce electricity? 6) Suggest a disadvantage of a nuclear power station. 7) Why is geothermal energy economically unviable in most places? 8) What colour are solar heating panels usually painted?