Year 8 Autumn Term – 8K: Energy transfers

Section A: Key Vocabulary

Keyword	Definition
Internal energy	The energy stored in the movement of particles. Sometimes called thermal energy.
thermal energy	Another term for internal energy.
absorb	'To soak up' or 'to take in'.
emit	To give out.
medium	Any substance through which something travels.
reflect	To bounce off a surface instead of passing through it or being absorbed.
accurate	A measurement that is close to the true value.
precise	Measurements that are close to one another.
appliance	A machine, usually one powered by electricity and used in the home.
efficiency	A way of saying how much energy something wastes.
climate change	Changes that will happen to the weather as a result of global warming.
fossil fuel	A fuel formed from the dead remains of organisms over millions of years (e.g. coal, oil or natural gas).

Section B: Content

Temperature changes

The particles that everything is made from are always moving. The energy stored in the movement of particles is called **internal energy**. It is sometimes called **thermal energy** or 'heat' energy. Energy is measured in **joules (J)**.

Temperature describes how hot or cold an object is. It is usually measured in **degrees Celsius (°C)**.

Temperature and internal energy are not the same. We can measure temperature with a thermometer, but we cannot measure the amount of internal energy something contains in the same way.

The amount of internal energy stored in something depends on:

- its temperature
- the material it is made from
- its mass.

Radiation

When you stand near something hot, such as a radiator, your skin feels warmer. Energy is transferred from hot objects by radiation (sometimes called **infrared radiation**).

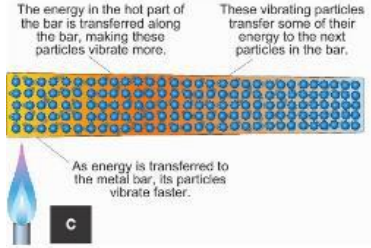
All things give out or **emit** infrared radiation. The hotter the object, the more infrared radiation it emits. When radiation hits something, it can be **absorbed** (taken into the object) or **reflected**.

Convection

Energy is transferred through **fluids** (liquids and gases) by convection. When part of a fluid is heated it expands and becomes less dense than the fluid around it. It floats upwards through the remaining fluid. Cooler fluid moves in to take its place and a **convection current** forms. Convection currents can also form when part of a fluid is colder than its surroundings.

Section C: Diagrams

Transferring Energy



Conduction

Energy can be transferred through many solid materials by conduction. When a solid is heated, the particles vibrate more. These vibrations are passed through the solid. Energy is transferred easily through metals in this way. Metals are good **thermal conductors**. Materials such as wood and plastics are good **thermal insulators** – energy is not transferred through them by conduction very well.

Section D: Content

Controlling transfers

In cold climates, people can keep their houses warm by burning fuel for heating. Insulation can help to keep the warmth inside the house and save money on fuel bills. Brick, wood and other building materials are good insulators.

Air is a very poor conductor because the particles are far apart. Air does allow convection to take place, so air is a good thermal insulator only when it cannot move. Carpets, feathers and wool all contain a lot of trapped air.

Controlling transfers

In hot countries, the challenge is to stop a house warming up too much. There were different ways of doing this long before air conditioning systems were invented.

Light colours and shiny surfaces reflect infrared radiation, so painting houses white helps to keep them cool in summer. They are also poor emitters of radiation. Dark colours absorb and emit infrared radiation well, so **solar panels** (used to heat water) are painted black.

D | This infrared image shows where energy is being transferred from the building. White shows the hottest parts and blue the coolest.

Section E: Content

Power

Different appliances transfer different amounts of energy. For example, an electric shower needs to heat the water running through it very quickly, so it transfers a lot of energy in a short time. It can transfer up to 10 000 J of energy each second.

B The power rating of this hair straightener is 40 W.

We can find out how much energy different appliances transfer by looking for their **power ratings**.

The hair straightener in photo B has a power rating of 40 W and so it transfers 40 joules of energy each second.

The amount of energy transferred per second is the **power** of the appliance. The units for power are **watts (W)** or **kilowatts (kW)**.

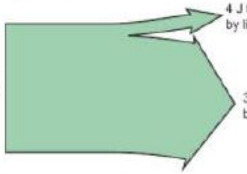
1 watt = 1 joule transferred every second

1000 W = 1 kW

Efficiency

Appliances do not transfer all the energy supplied to them into useful forms of energy. Some of it is wasted. The amount of useful energy transferred compared with the total amount supplied is the **efficiency** of an appliance. Wasted energy usually makes the surroundings warmer.

We can use a **Sankey diagram** to show energy transfers. The width of each arrow represents the proportion of the energy.



D | a Sankey diagram for the light bulb in photo C

Energy cannot be created or destroyed, so the total amount of energy supplied must be equal to the total amount transferred or stored.

We can calculate efficiency using the following formula:

$$\text{efficiency} = \frac{\text{useful energy transferred}}{\text{total energy supplied}} \times 100\%$$

Section F: Content

Paying for energy

For electricity and gas, we pay for the amount of energy transferred. Energy companies use a unit called a **kilowatt-hour (kWh)** to measure energy. A kilowatt-hour is the amount of energy transferred in 1 hour by an appliance with a power of 1 kW. For example, using a 2 kW electric fire for 4 hours would use 8 kWh of energy:

$$\underset{(\text{kWh})}{\text{energy use}} = \underset{(\text{kW})}{\text{power rating}} \times \underset{(\text{hours})}{\text{time}}$$

Your electricity use this period

Reading last time	1763
Reading this time	2547
	784 Units
784 Units at 15.0p	**£117.60**
VAT at 5%	£5.88
Total charges	**£123.48**

B | A kilowatt-hour is usually called a 'Unit' in electricity bills.

Paying for energy

D | the costs and savings of some ways of reducing energy bills

Sometimes buying a new, more efficient appliance or improving the insulation can cost more money than it will save you. The **payback time** tells you how long it will take to save the money that an efficiency measure costs:

$$\text{payback time} = \frac{\text{cost of change}}{\text{saving per year}}$$

For example, diagram D shows some ways in which a homeowner could save money:

$$\text{payback time for cavity wall insulation} = \frac{350}{100}$$

$$= 3.5 \text{ years}$$