Y7 Energy Summary Booklet

Energy Units

Energy changes are measured in joules (J) or kilojoules (kJ).

Energy Stores and Transfers

Energy stores		
Key word	Description	Examples
Magnetic	The energy stored in two separated magnets that are attracting, or repelling	Fridge magnets, compasses.
Thermal	The energy stored in a warm object.	Human bodies, hot coffees, stoves or hobs.
Chemical	The energy stored in chemical bonds, such as those between molecules.	Food, muscles, electrical cells.
Kinetic	The energy stored in a moving object	Runners, buses.
Electrostatic	The energy stored in two separated electric charges that are attracting, or repelling.	Thunderclouds, Van De Graaff generators.
Elastic	The energy stored when an object is stretched or compressed.	Stretched elastic, compressed springs, inflated balloons.
Gravitational	The energy stored when an object is moved higher.	Aeroplanes, kites, mugs on a table.
Nuclear	The energy stored in atoms.	Nuclear fuel, radioactive material
Energy Transfers		
Heating	Energy is transferred from a hotter object to a cooler one.	A radiator heating the air in a room.
Mechanical	Energy is transferred when a force moves through a distance.	An engine turning a wheel.
Electrical	Energy is transferred when moving charges in a wire.	Turning on a torch.
Radiation	Energy is transferred by waves; such as light, infrared, microwaves and radio waves.	Heating up food in a microwave oven.

Energy Conservation

Energy cannot be created or destroyed, but it can be transferred usefully, stored or dissipated.

The total energy of a system stays the same. The idea that the total energy has the same value before and after a change is called conservation of energy.

Energy Dissipation

Any energy that is not transferred to useful energy stores is said to be dissipated (or wasted) because it is lost to the surroundings.

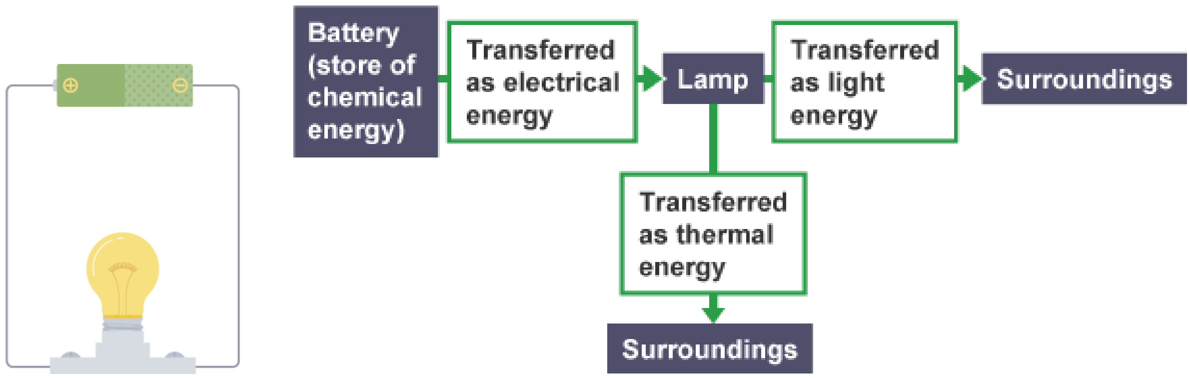
Energy is usually lost by heating up the surroundings

<u>Examples</u>

- Friction in mechanical systems, such as motors.
- Tumble dryers heating the surrounding air.
- Filament bulbs wasting energy as heat.

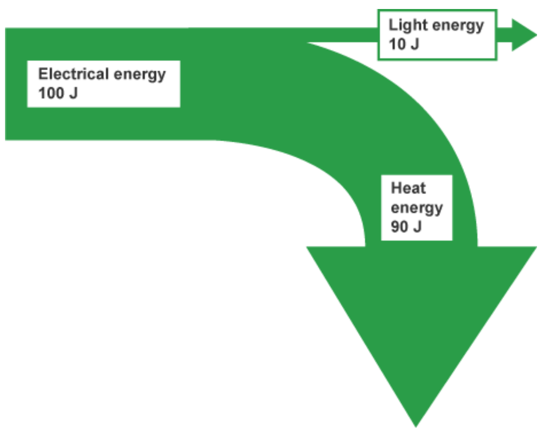
Energy transfer diagrams

Energy transfer diagrams may be used to show the locations of energy stores and energy transfers. For example, consider the energy transfers in this simple electrical circuit:



Sankey diagrams

You can show energy transfers in a Sankey diagram. In these diagrams, the thicker the line or arrow, the greater the amount of energy involved.



Energy Efficiency

Devices are designed to waste as little energy as possible. This means that as much of the input energy as possible should be transferred into useful energy stores.

How good a device is at transferring energy input to useful energy output is called efficiency.

A very efficient device will waste very little of its input energy.

A very inefficient device will waste most of its input energy.

$$\textbf{\textit{Efficiency}} = \frac{\textbf{useful output energy}}{\textbf{total input energy}}$$

$$\textbf{\textit{Percentage Efficiency}} = \frac{\textbf{useful output energy}}{\textbf{total input energy}} \textbf{ x100\%}$$

Energy changes are measured in joules (J) or kilojoules (kJ).

There are no units for efficiency.

Example: The energy supplied to a light bulb is 200J. a total of 28J of this is usefully transferred as light. How efficient is the light bulb?

$\textit{Efficiency} = \frac{useful\ output\ energy}{total\ input\ energy} = \frac{28J}{200J} = 0.14$

$\textit{Percentage Efficiency} = \frac{useful\ output\ energy}{total\ input\ energy} x100 = \frac{28J}{200J} x100 = 0.14 \text{ x } 100 = 14\%$

Power

Power is the rate at which energy is transferred.

$$\textbf{\textit{Power}} = \frac{\textbf{Energy transferred}}{\textbf{time}} \qquad \textbf{\textit{P}} = \frac{\textbf{\textit{E}}}{\textbf{\textit{t}}}$$

$$\textbf{\textit{Energy = Power x time}} \qquad \textbf{\textit{E = P x t}}$$

Power is measured in watts (W). 1 watt is equal to 1 joule per second.

Energy transferred is measured in joules (J) or kilojoules (kJ).

Time is measured in seconds (s)

Example: An electric motor is uses 20J of energy to lift a weight in 5 seconds. What power is the motor?

$\textit{Power} = \frac{Energy\ transferred}{time} = \frac{20J}{5s} = 4W$

Energy cost

In science, the unit used for energy is the joule, J. However, energy suppliers (companies that provide electricity and gas) use a different unit. This is the kilowatt hour, shown as kW hour or kWh.

One kWh is the same as the amount of energy used by a 1 kW appliance for 1 hour

Cost = Power (kW) x time (hours) x price (per kWh)

Example

A 12,000W oven takes 2 hours to cook a roast beef. If the price per kilowatt hour, kWh, is 12p, how much does it cost to cook the roast beef?

Convert the power into kilowatts:

12,000 W = 12 kW

Calculate the cost:

Cost = 12 kW x 2 hours x 12p = 12 x 2 x 12 = 288p or £2.88

Non-renewable energy resources

A non-renewable energy resource cannot be replaced once it is used up, such as:

- Fossil fuels – coal, oil, gas
- Nuclear fuel

Fossil fuels

Fossil fuels were formed over millions of years, from the remains of dead plants and animals.

Fossil fuels took a very long time to form and we are using them up faster than they can be replaced. Once they have all been used up, they cannot be replaced.

Advantages	Disadvantages
Cheapest source of energy, because it is; • Cheap to extract fuel • Cheap to transport fuel • Cheap to build the power stations Can be built anywhere, as long as you can get fuel to it Reliable source of energy	Will run out Produce greenhouse gases, which increases global warming Produce pollutants which cause acid rain

Nuclear fuel

Nuclear fuels release energy through nuclear reaction, rather than chemical reactions, The main reactor fuels are uranium and plutonium.

In a nuclear power station, the energy released is used to boil water. The expanding steam spins turbines, which then drive generators to produce electricity.

Advantages	Disadvantages
Do not produce carbon dioxide or sulfur dioxide.	Will run out If there is an accident, radioactive material could be released into the environment Nuclear waste remains harmful to health for thousands of years

Renewable energy resources.

Renewable energy resources can be replaced, and will not run out.

Resource	Description	Advantages	Disadvantages
Wind	As the wind blows, it transfers some of its kinetic energy to the turbine blades, which turn and drive the generator.	No fuel costs No harmful gases produced	Noisy Visual pollution Unreliable - If there is no wind, there is no electricity
Wave	Wave machines use the kinetic energy in the movement of waves to drive generators.	No fuel costs No harmful gases produced	Can only be built on the coast Can be damaged by storms
Tidal	The kinetic energy in the movement of tides in and out of river mouths each day drives generators in a tidal barrage..	Reliable – can be easily switched on No fuel costs No harmful gases produced	Can only be built on the coast Can be harmful to marine life
Hydroelectric	Water held behind a dam has gravitational potential energy. This is transferred to kinetic energy as the water rushes down the dam, driving generators.	Reliable – can be easily switched on No fuel costs No harmful gases produced	Expensive to build Take a large amount of land for reservoir – flood farmland and push people from their homes
Geothermal	Hot water and steam from deep underground can be used to drive generators.	No fuel costs No harmful gases produced Hot water and steam can be used to heat buildings directly	Very few places on Earth where geothermal energy can be exploited
Solar	Coverts light energy from the sun directly to electrical energy/	No fuel costs No harmful gases produced Can provide electricity in remote locations	Expensive and inefficient, so the cost of their electricity is high Do not work at night or when it is very cloudy
Biofuel	Plants or organic material are burnt to transfer the chemical energy stored in them to drive generators.	Carbon neutral Uses waste products which are normally thrown away	Produces some harmful gases Produces little energy Land conversion from food to fuel

Energy in food – (Worksheet 7Ia3)

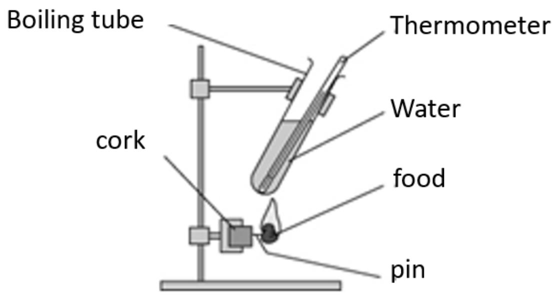
Burning food experiment

Energy stored in food can be released by combustion(burning) or by respiration in our cells. The labels on packets of food show how much energy is available from the food.

The amount of energy available may be shown in a unit called the calorie, as in the photograph. However, the scientific unit for energy is the joule, which has the symbol J.

A lot of energy is available from most foods, so food labels usually show kJ (kilojoules) instead of J:

1 kJ = 1000 J



Method

1. Choose three different types of food
2. Draw a results table
3. Put one piece of food on the pin and find the mass of the cork, pin and food together. Write this in your table.
4. Use the measuring cylinder to measure $10cm^3$ of water, and put it into the boiling tube. Record the temperature of the water.
5. Light the food using the Bunsen burner, and hold the burning food under the boiling tube. Make sure the flame is touching the boiling tube.
6. When the food has finished burning record the temperature of the water again. Let the food cool down and find the total mass of the cork, pin and food remaining on it.
7. Repeat for the other foods.

Conclusion

When the food is burned, the energy stored in it is transferred to the water and made it hotter.

The food that gives the highest temperature stored the most energy.

Energy in the home

Appliance	Useful energy	Wasted energy
Electric kettle	Energy that heats the water.	Internal (thermal) energy heating the kettle. Infrared radiation lost to the surroundings.
Hair dryer	Internal (thermal) energy heating the air. Kinetic energy of the fan that blows the air.	Sound radiation. Internal (thermal) energy heating the hairdryer. Infrared radiation lost to the surroundings.
Light bulb	Light radiation given out by the hot filament.	Infrared radiation lost to the surroundings.
TV	Light radiation that allows the image to be seen. Sound radiation that allows the audio to be heard.	Internal (thermal) energy heating the TV set. Infrared radiation lost to the surroundings.
Washing machine	Kinetic energy of the drum spinning and thermal energy of the warm water.	Mechanical (sound) and infrared radiation to the surroundings.

Some appliances use a lot of energy per second – their power is very high. This means that their power may be shown in kW (kilowatts) rather than W: 1 kW = 1000 W

Appliance	Power in W	Power in kW	Energy used per hour in kJ	Cost of energy per hour
Clock	10	0.01	3.6	Less than 1p
Lamp	50	0.05	180	Less than 1p
Drill	800	0.8	2,880	£0.10
Kettle	2400	2.4	8,640	£0.29
Electric oven	12000	12	43,200	£1.44

The cost of running a kettle for an hour is much higher than running a clock for an hour. This is mainly due to the tasks they perform. The kettle requires a lot of energy to boil water, but the clock mechanism requires very little energy to move the hands on the clock face. However, the kettle is likely to only be used for a few minutes each day, whereas a clock will run all day and all night. This means they may cost the same amount to use per day.