

Edexcel Physics IGCSE

Topic 4: Energy Resources and Energy Transfers

Summary Notes

(Content in bold is for physics only)

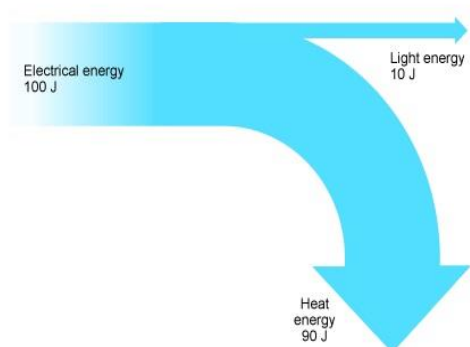
Energy transfers

Energy can be transferred between different stores including **chemical**, **kinetic**, **gravitational**, **elastic**, **thermal**, **magnetic**, **electrostatic** and **nuclear** as a result of an event or process.

Energy can be transferred in various ways including:

- **Mechanically** e.g. when gravity accelerates an object and gives it kinetic energy.
- **Electrically** e.g. when a current passes through a lamp and it emits light and heat.
- **By heating** e.g. when a fire is used to heat up an object.
- **By radiation** e.g. when vibrations cause waves to travel through the air as sound, or an object emits electromagnetic radiation.

Energy is always **conserved**. The total energy before is equal to the total energy after.



The **efficiency** is the **ratio** of the **useful energy output** to the **total energy supplied**, often expressed as a percentage.

$$\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100\%$$

Sankey diagrams can be used to represent the **transfer** of input energy into useful energy and wasted energy. For example, the diagram on the left shows the Sankey diagram for a lamp.

Conduction:

- Thermal energy in **solids** and **liquids** can be transferred by **conduction**.
- Non-metals are usually poor conductors known as **insulators**. As a non-metal is heated up, the molecules **vibrate more** and cause adjacent molecules to vibrate more also, **transferring heat energy** from hot parts to cooler parts. Because insulators transfer heat slowly, they are used to **reduce unwanted energy transfer** such as in homes.
- Metals are usually good conductors. The electrons can leave the atoms and move freely among positively charged ions. As the metal is heated, the ions and electrons **vibrate more**. The **free electrons collide with ions** throughout the metal and **transfer heat energy** from hot parts to cooler parts.

Convection:

- Thermal energy in **fluids** (liquids and gases) can be transferred by **convection**.
- Convection occurs when molecules in a fluid with high thermal energy move to an area with low thermal energy. Preventing the circulation of the fluid can help reduce unwanted energy transfer by convection.
- When part of a fluid is heated, it expands and becomes **less dense**. It therefore **rises** up to less dense areas in the fluid. Denser, colder fluid falls down to take its place.
- Examples of convection include in **water boilers** and **hot air balloons**.

Radiation

- Thermal energy is also transferred by **infrared radiation** which does **not require a medium**. Infrared radiation is part of the **electromagnetic spectrum**.
- **Black** bodies with a **dull** texture are the **best absorbers and emitters** of radiation. **White** bodies with a **shiny** texture are the **best reflectors** of radiation. Shiny surfaces can be used to **reduce unwanted energy transfer** such as on the surface of a vacuum flask.
- The **higher the temperature** and the **greater the surface area** of a body the **more infrared radiation** emitted.

Work and power

Work is done when a **force** moves something through a **distance**. The work done is **equal** to the energy transferred.

$$\text{work done} = \text{force} \times \text{distance} \quad W = Fd$$

The conservation of energy produces a link between gravitational potential energy, kinetic energy and work. For example, when a ball is dropped, gravity does **work** on it and its **gravitational potential energy** becomes **kinetic energy** as it accelerates downwards:

- $\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2$

$$E_k = \frac{1}{2}mv^2$$
- $\text{gravitational potential energy} = \text{mass} \times \text{gravitational field strength} \times \text{height}$

$$E_p = mgh$$

Power is the **rate at which energy is transferred** or the **rate at which work is done**. For example, a lamp with a greater power will be brighter because it transfers more energy from electrical energy to light and heat energy in a given time.

$$\text{power} = \frac{\text{work done}}{\text{time taken}} \quad P = \frac{W}{t}$$

Energy resources and electricity generation

- **Renewable** energy is energy which can be **replenished** as quickly as it is used.
Examples include:
 - Wind
 - Water (hydroelectricity, waves, tides)
 - Geothermal
 - Solar (heating systems and cells)**All have a **potentially infinite** energy supply, but they are usually **costlier** (e.g. the manufacture and implementation of solar panels is very expensive) and **less reliable** (e.g. the wind is intermittent and solar energy relies on good weather) than non-renewable energy.**
- **Non-renewable** energy is used more for large-scale energy supplies due to the **large energy output** but will eventually **run out**. **Examples include:**
 - Fossil fuels (coal, oil, gas)
 - **Cheaper** than most renewable sources but harmful for the environment because they release **greenhouse gases** which cause **global warming**.
 - Nuclear power
 - A **small amount** of radioactive material produces a **lot of energy**, but they produce **highly toxic nuclear** waste which needs to be safely stored underground for many years.

Energy transfers take place in the generation of electricity. For example, in a solar cell, **light energy** from the sun is transferred into **electrical energy**.