WJEC (Eduqas) Physics GCSE

1.1: Energy Changes in a System

Detailed Notes

(Content in **bold** is for higher tier **only**)

Energy Stores

There are **seven** key sources of energy which can be transferred between one another:

- **Kinetic** energy (KE) - the energy of moving objects.
- **Thermal** energy - internal energy of vibrating particles within an object.
- **Chemical** energy - energy stored within the chemical bonds of molecules.
- **Magnetic** energy - stored energy between magnetic poles.
- **Electrostatic** energy - stored energy between charges.
- **Elastic** Potential energy (EPE) - stored energy when an object is stretched or squashed.
- **Gravitational** Potential energy (GPE) - stored energy of an elevated object.

Energy Transfers

The law of the **conservation** of energy states that energy **cannot be created or destroyed**, **only transferred** between stores. There are **four** main methods of energy transfer:

- Heating
- Radiation
- Mechanical work
- Electrical work

When a force acts on an object to move it, energy is transferred. This is known as **work** being done.

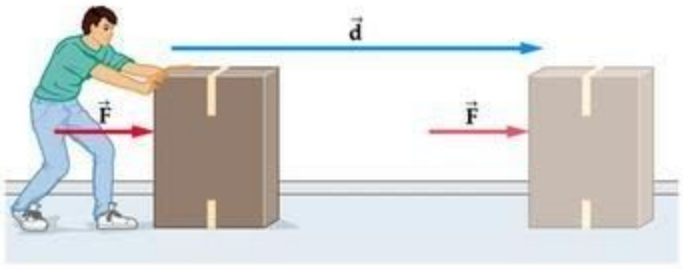
Work Done

Energy transferred through work done is proportional to the **force applied** and the **distance moved**.

$$W = Fx$$

W is work done (J), F is the force applied (N) and x is the distance moved along the line of action of the force (m).

The **total** amount of energy remains **constant** as the energy from the object doing the work is transferred to another form. For example, if a book is lifted 1m in the air, work is done against gravity. Energy is transferred from your muscles to the book, increasing its gravitational potential.



Work is done moving the box a distance, d (pintrest.com).

In **electrical** transfers, electrical work is done by the power supply to move current around the circuit when there is a potential difference. In this setting, work done is referred to as energy transferred.

$$E = VQ$$

E is energy transferred (J), V is the voltage (V) and Q is the charge flowing in the circuit (C).

Elevation Change

Stored energy of an object can change as a result of its elevation as objects have **gravitational potential energy (GPE)**. An elevated object has **more energy** and an object can **lose or gain** energy as it changes elevation. GPE depends on the **height** and the **mass** of the object. Elevation change is a form of **mechanical** work.

$$GPE = mg\Delta h$$

m is mass (kg), g is gravitational field strength (N/kg) and Δh is the change height (m).

Velocity Change

Energy of an object can change as a result of its velocity as moving objects have **kinetic energy (KE)**. The faster it is moving, the greater its kinetic energy. KE also depends on the **mass** of the object. Velocity change is a form of **mechanical** work.

$$KE = \frac{1}{2}(mv^2)$$

m is mass (kg), v is velocity (m/s).

Shape Change (Deformation)

Energy of an object can change if it is **deformed** as it has elastic potential energy. When an object is **under strain** by being stretched or squashed, it is deformed so it **stores energy**. Deformation is a form of **mechanical** work.

Springs are **elastic** objects meaning they can store **elastic potential energy** when deformed. This deformation typically involves a **change in length** that depends on the **force applied** and a value known as the **spring constant (k)**. This spring constant is specific to each spring and is a measure of its **stiffness**.

$$F = kx$$

F is the force applied (N), k is the spring constant (N/m) and x is the extension (m).

Temperature Change

Thermal energy transfers depend on the **heat supply** to an object. This supplied heat energy results in a temperature change of an object over time that depends on its **specific heat capacity** and **specific latent heat**. Temperature change occurs as a result of **heating**.

Specific heat capacity (s.h.c) of a substance is the amount of energy required to increase **1kg** of it by **1ºC (or 1K) without a change of state**. It is measured in **J/kgºC** (or J/kgK). Each substance has a unique specific heat capacity. Those with a **high s.h.c.** can store lots of **heat** for a relatively small mass. Water is an example of this, which makes it useful for things such as central heating.

$$Q = mc\Delta T$$

Q is energy is Joules (J), m is mass in kg, ΔT is the change in temperature in ºC or Kelvin and c is the specific heat capacity.

When a substance changes state, its **temperature does not change** despite energy being transferred. **Specific latent heat** (s.l.h) of a substance is the amount of energy required to change the state of **1kg** of that substance **without any change to its temperature**. It is measured in **J/kg**.

$$Q = mL$$

Q is energy is Joules (J), m is mass in kg, L is specific latent heat in J/kg.

The value of specific latent heat is different for each substance and can show how easily a substance can change state.

Energy & Power

Power and energy are related as power is the **rate of energy transfer**. An object that transfers a lot of energy over a short period of time is said to be very powerful. Power is measured in **Watts**, equal to **Joules per second**.

$$P = W / \Delta t$$

P is energy is Power (W), W is work done (J), Δt is the change in time (s).

Power from electrical work can be calculated and is directly proportional to current and voltage.

$$P = E / \Delta t$$

$$P = IV$$

E is energy in joules (J) and P is power in watts (W).