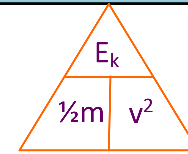
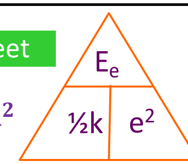
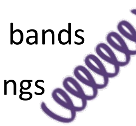
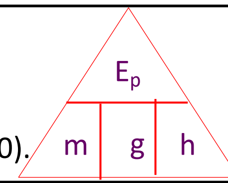
Energy Stores

1. Types of energy store

There are 8 stores we look at in this topic:

Energy is a means of working out if it is possible for something to happen.
This means each store is linked to a calculation

Energy Store	Definition	Examples
kinetic	The energy of any **moving object**. This can be calculated using: Learn $\underset{(J)}{kinetic\ energy} = \frac{1}{2} \times \underset{(kg)}{mass} \times \underset{(m/s)}{speed}^2$ 	• A person running • Particles in a solid vibrating 
thermal	**All** objects have internal energy (the sum of the kinetic and potential energy of the particles. This can be calculated using: On Sheet $\underset{(J)}{Thermal\ energy} = \underset{(kg)}{mass} \times \underset{(J/kg^oC)}{specific\ heat\ capacity} \times \underset{(^oC)}{change\ in\ temperature}$	• Hot tea or coffee • The human body 
elastic potential	The energy stored when an object is **stretched/squashed**. This can be calculated using: On Sheet $\underset{(J)}{Elastic\ potential\ energy} = \frac{1}{2} \times \underset{(N/m)}{spring\ constant} \times \underset{(m)}{extension}^2$ 	• Stretched elastic bands • Compressed springs 
gravitational potential (g.p.e)	When an object is moved **higher**, it gains g.p.e. This can be calculated using: Learn $\underset{(J)}{g.p.e} = \underset{(kg)}{mass} \times \underset{(N/kg)}{gravitational\ field\ strength} \times \underset{(m)}{height}$ Gravitational field strength on Earth is always 9.8 m/s^2 (can be rounded to 10). 	• Aeroplanes • Skydivers • A mug on a table 
electrostatic	The energy stored when two objects carrying **electrical charge** interact. These charged objects can exert forces on each other. You get an electric current when charged particles move through a wire.	• Thunderclouds • Van Der Graaf generators 
magnetic	Some objects can be **magnetised** and create magnetic fields. They can exert forces on other magnetised objects, or on magnetic materials.	• Fridge magnets • Navigational compass 
chemical	The energy stored in **chemical bonds** (e.g. between molecules). This is how energy is stored in food, and how animals store energy in their muscles.	• Food • Cells in muscles 
atomic	The energy stored in the **nucleus of an atom**. It is described by Einstein's famous equation $E=mc^2$ where c is the speed of light.	• Radioactive materials • Stars 

Energy Pathways

2. Types of energy transfer

There are 4 ways that energy can be transferred from one type of store to another. These are called pathways:

Heating by particles

Energy is transferred from a **hotter** object to a **cooler** one.

This can be done by **conduction**, **convection** or **radiation**.

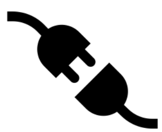
Mechanically working

Energy is transferred when something is **moved**.

Example: a person running

Electrically working

Energy is transferred when an **electrical circuit is complete**.



Heating by radiation

Energy is transferred as an **electromagnetic wave.**

Example: the Sun warms the Earth

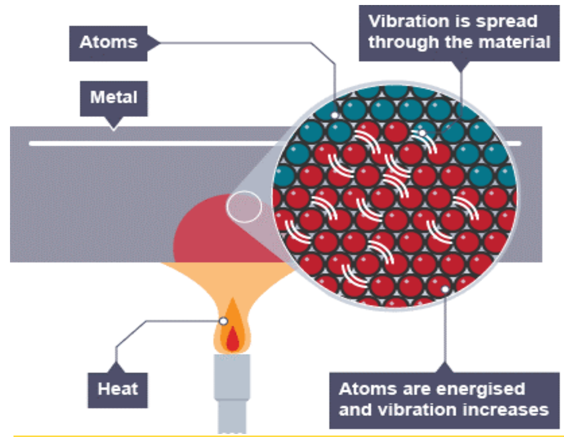
4. Thermal equilibrium

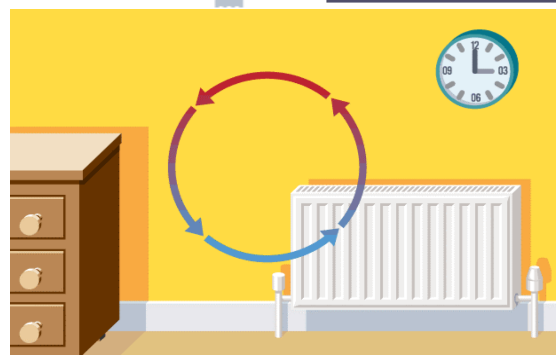
If there is a difference in temperature between 2 objects, **energy is transferred** from the hotter object to the cooler one.

When they are both the same temperature, they are in **thermal equilibrium**.

3. Energy transfer in houses

Energy can be lost from your home through **conduction**, **convection** or **radiation**:





Heat energy is lost through roofs, windows, walls, floors and through gaps around windows and doors. However, there are ways that these losses can be reduced. Ways to reduce heat transfer:

- **Fitting carpets** (conduction), **curtains**, **draught excluders** (convection) and **reflective foil** in the walls or on them (radiation).
- **double glazing** has a **vacuum** to reduce heat transfer (conduction and convection).
- **cavity wall insulation** (conduction and convection).
- **loft insulation** (conduction and convection).

Conduction

- Happens in **solids**.
- When the internal energy store is filled up, the particles move more vigorously. They **bump into particles around them** and pass internal energy through the solid. If the material has **delocalised electrons** this process is faster.
- A material that lets heat pass through it **easily** has good thermal conductivity. Therefore it is called a **conductor** (e.g. metal). A material that **doesn't** is called an **insulator** (e.g. plastic).

Example: if a metal pan is heated from underneath; the handle will eventually become hot.

Convection

- Happens in **liquids/gases** (fluids).
- These particles can move around, so the particles that have more internal energy **take the place** of the less energetic particles.
- In a liquid, the energetic particles rise to the **top** and the less energetic particles sink to the **bottom**.

Examples: radiators, hot air balloons

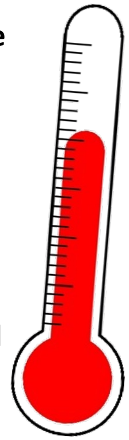
Radiation

- Energy is transferred as an **electromagnetic wave**.
- There are **no particles** involved.

Examples: radiators giving out heat.

Energy Calculations

5. Heat and temperature



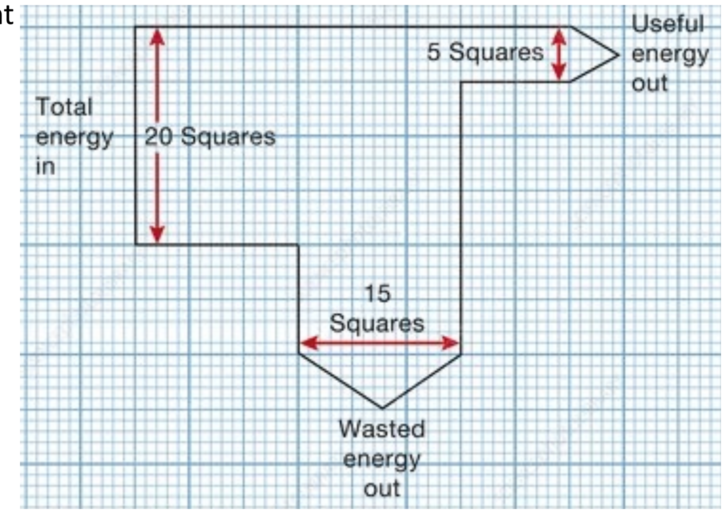
- Temperature is a measure of the **average kinetic energy per particle in a substance.**
- We use a **thermometer** to measure temperature in degrees Celsius (**ºC**).
- When the **kinetic energy** of a substance increases, the temperature does as well.
- As a material changes state the potential energy per particle increases, not the kinetic energy, so the temperature remains constant.

6. Conservation of energy

Conservation of energy rule: energy cannot be created or destroyed, only stored or transferred.

This means that the **total energy of a closed system is always the same**. The energy can be in a different form, but there is always the **same amount**.

We can draw **Sankey diagrams** to demonstrate the conservation of energy:



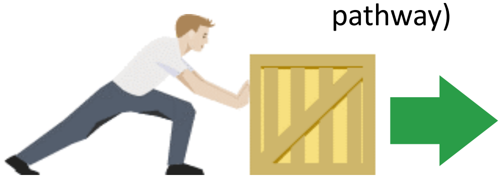
We can use these diagrams to calculate the **efficiency** of something:

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

Learn

7. Work Done

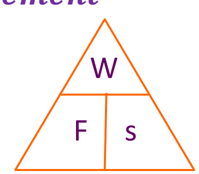
(Mechanically working pathway)



- When a force causes something to move, we say that **work is being done** on the object.
- Work is the measure of **how much energy has been transferred, in Joules (J).**
- We can calculate work done using:

$$work\ done = force \times displacement$$

Learn (J) (N) (m)



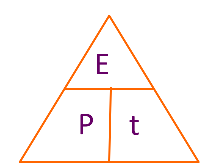
- Work done is **the same** as the energy transferred to the moving object.
- The direction of the force and the displacement must be parallel, or no work is done.

8. Power

- Power is the **rate at which energy is transferred, or the energy per unit of time**
- Power is measured in **Watts (W).** **1 Watt = 1 Joule per second**
- Energy used in the home is measured in **kilowatt hours (kWh),** and can be calculated using:

$$energy\ used = power \times time$$

Learn (kWh) (kW) (h)



- You can calculate the **cost of energy** using:

$$cost = energy\ used\ (in\ kWh) \times cost\ per\ kWh$$

Energy Resources

Humans can generate energy in lots of different ways.
An energy resource has high energy density.
All energy resources are **renewable**, except for **fossil fuels and nuclear power**.
A renewable resource is one that can be replenished as it is used.

Energy Resource	Positives	Negatives
Fossil Fuels (Coal, Oil and Gas)	✓ Relatively cheap fuel ✓ Infrastructure already exists	✗ Releases carbon dioxide (greenhouse gas) ✗ Releases sulphur dioxide, which causes acid rain ✗ Finite resource
Nuclear	✓ Doesn't produce greenhouse gases ✓ Very high energy density	✗ Radioactive material could be released into the environment ✗ Expensive to store safely (nuclear waste remains dangerous for a long time) ✗ Finite resource
Wind	✓ No fuel costs ✓ Doesn't produce any harmful chemicals ✓ Wind energy is available all over the world	✗ Noise pollution ✗ Visual pollution ✗ Unreliable (depends on the wind)
Wave	✓ No fuel costs ✓ Doesn't produce any harmful chemicals ✓ Low-lying, so little visual pollution	✗ Unreliable (depends on the waves) ✗ Difficult for wave machines to produce large amounts of electricity ✗ Limited suitable sites
Tidal	✓ Very reliable (tides are predictable) ✓ No fuel costs ✓ Doesn't produce any harmful chemicals	✗ Can destroy the habitats of estuary species (e.g. wading birds) ✗ Only produces energy for about 10 hours a day ✗ Affects shipping trying to navigate estuaries
Hydroelectric	✓ Very reliable and quick to start ✓ No fuel costs ✓ Doesn't produce any harmful chemicals	✗ Dams create reservoirs, which can force people/local wildlife to relocate ✗ The vegetation underwater releases methane (a greenhouse gas) ✗ Fast flowing rivers are needed, so limited sties available
Geothermal	✓ Hot water/steam can be used to directly heat buildings ✓ No fuel costs ✓ Doesn't produce any harmful chemicals	✗ Most parts of the world do not have suitable areas where geothermal energy can be exploited ✗ Hazardous gases and minerals may be release (difficult to dispose of safely)
Solar	✓ No fuel costs ✓ Doesn't produce any harmful chemicals ✓ Solar energy is available all over the world	✗ Very expensive ✗ Not very efficient ✗ Unreliable (depends on amount of sunlight)
Bioenergy	✓ Carbon neutral ✓ Can be stored for when it is needed ✓ Available all over the world	✗ Burning fuels (e.g. rubbish) causes some air pollution/greenhouse gases ✗ Growing biofuels uses land that could be used for food crops ✗ Materials for fuels are bulky, so have high transport costs