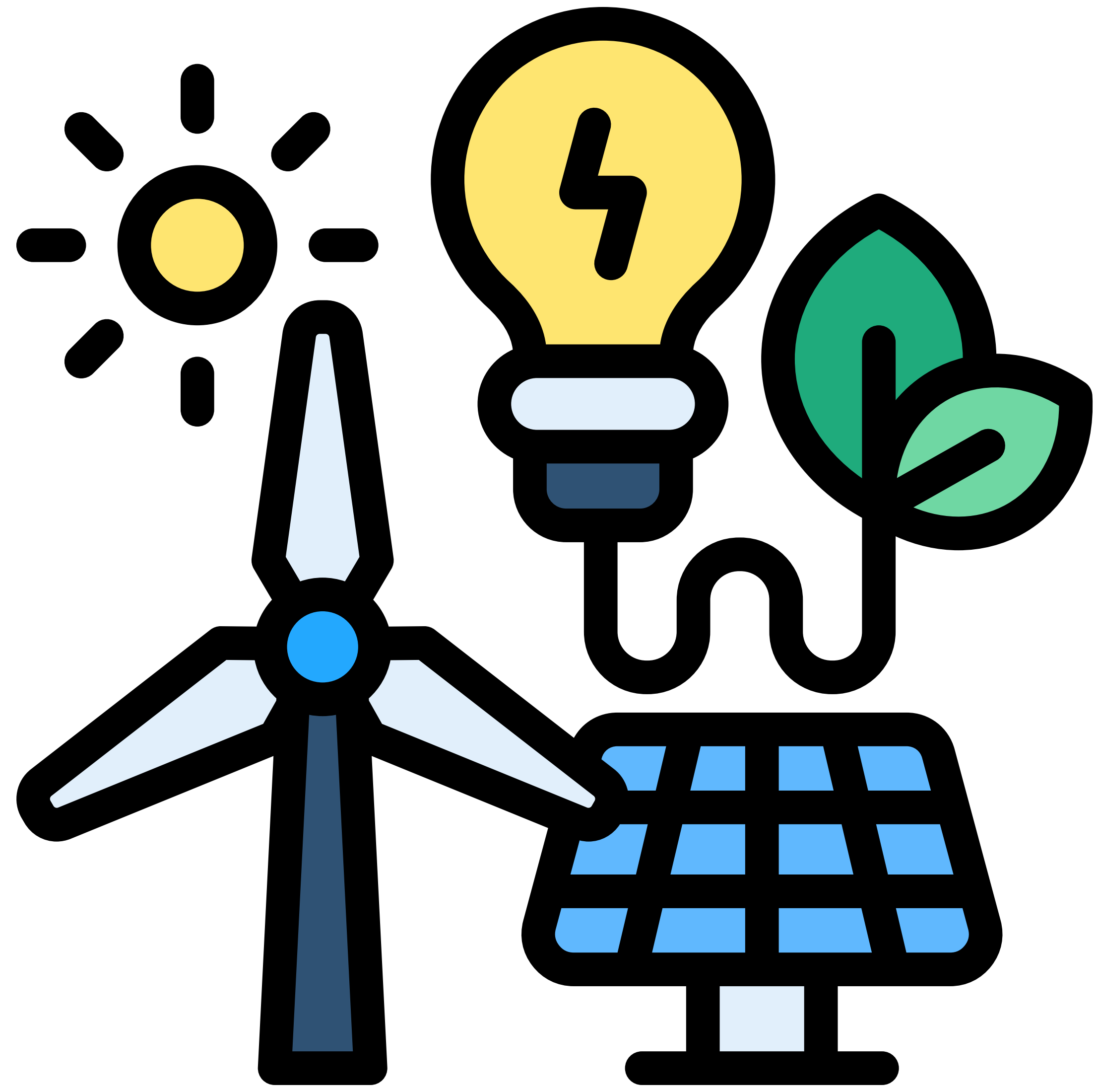
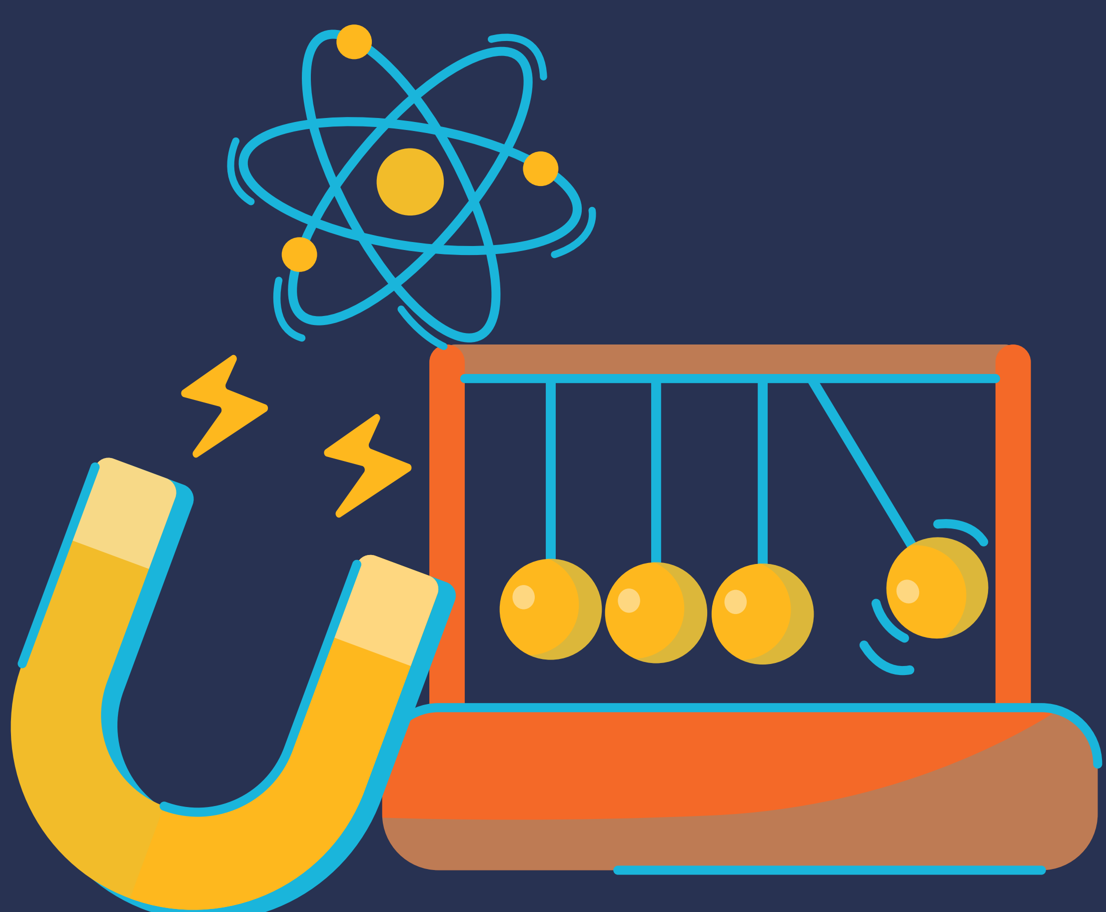
energy stores



# GCSE PHYSICS

ENERGY UNIT AQA UNIT



# CHECKLIST

| 4.1.1 Energy Changes in a System, and the Ways Energy Is Stored before and after Such Changes | | | | |
|---|---|---|---|---|
| **Topic** | **Success Criteria** | **Progress** | | |
| Energy Stores and Systems | I can state what is meant by a system. | | | |
| | I can describe all the changes involved in the way energy is stored when a system changes, for common situations. | | | |
| | I can calculate the changes in energy involved when a system changes by:<br>• heating;<br>• work done by forces;<br>• work done when a current flows. | | | |
| | I can use calculations to show how the overall energy in a system is redistributed when the system is changed. | | | |
| Changes in Energy | I can recall and apply the correct equation to calculate the amount of energy associated with a moving object. | | | |
| | I can rearrange the equation linking kinetic energy, mass and speed to calculate the mass or speed of a moving object. | | | |
| | I can calculate the amount of energy associated with a stretched spring by applying the correct equation from the physics equation sheet. | | | |
| | I can rearrange the equation linking elastic potential energy, extension and spring constant to calculate the extension or spring constant of a stretched spring. | | | |
| | I can recall and apply the correct equation to calculate the amount of energy associated with an object raised above ground level. | | | |
| | I can rearrange the equation linking gravitational field strength, gravitational potential energy, height and mass to calculate the mass or height of an object or the strength of the gravitational field the object is in. | | | |
| Energy Changes in Systems | I can calculate the amount of energy stored in or released from a system as its temperature changes by applying the correct equation from the physics equation sheet. | | | |
| | I can rearrange the equation linking change in thermal energy, mass, specific heat capacity and temperature change to calculate the mass, specific heat capacity or temperature change of an object. | | | |
| | I can define the specific heat capacity of a substance. | | | |
| | I can describe an investigation to determine the specific heat capacity of one or more materials (required practical activity 1). | | | |

# CHECKLIST

| Topic | Success Criteria | Progress | | |
|---|---|---|---|---|
| Power | I can define power. | | | |
| | I can recall and apply the correct equation to calculate power from the amount of energy transferred and time. | | | |
| | I can rearrange the equation linking energy transferred, power and time to calculate the energy transferred or time. | | | |
| | I can recall and apply the correct equation to calculate power from work done and time. | | | |
| | I can rearrange the equation linking power, time and work done to calculate the work done or time. | | | |
| | I can state the energy transferred in joules per second in watts. | | | |
| | I can give examples to illustrate the definition of power. | | | |
| Energy Transfers in a System | I can describe how energy transfers in a closed system affect the total energy of the system. | | | |
| | I can describe, with examples, how energy is dissipated when a system changes. | | | |
| | I can explain ways of reducing unwanted energy transfers including the use of lubrication or thermal insulation. | | | |
| | I can describe how the thermal conductivity of a material affects the energy transfer by conduction across the material. | | | |
| | I can describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls. | | | |
| | I can describe a method to investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material (required practical activity 2). | | | |
| Efficiency | I can recall and apply the correct equation to calculate efficiency as a decimal or a percentage from the useful output energy transfer and the total input energy transfer. | | | |
| | I can rearrange the equation linking efficiency, total input energy transfer and useful output energy transfer to calculate the total input energy transfer or useful output energy transfer. | | | |
| | I can recall and apply the correct equation to calculate efficiency as a decimal or a percentage from the useful power output and the total power input. | | | |
| | I can rearrange the equation linking efficiency, total power input and useful power output to calculate the total power input or useful power output. | | | |

# CHECKLIST

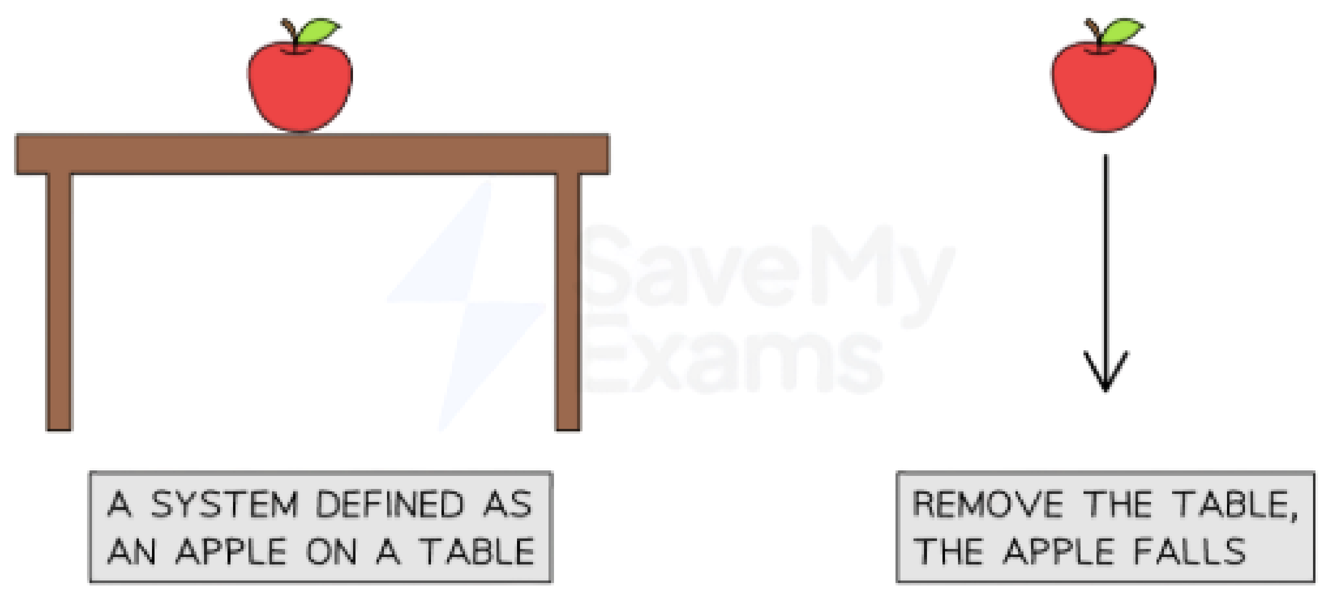
| 4.1.3 National and Global Energy Resources | | | | |
|---|---|---|---|---|
| **Topic** | **Success Criteria** | **Progress** | | |
| National and Global Energy Resources | I can name the main energy resources available for use on Earth. | | | |
| | I can describe what is meant by a renewable energy resource. | | | |
| | I can distinguish between energy resources that are renewable and energy resources that are non-renewable. | | | |
| | I can compare the ways that different energy resources are used, including for transport, electricity generation and heating. | | | |
| | I can explain why some energy resources are more reliable than others. | | | |
| | I can describe the environmental impact arising from the use of different energy resources. | | | |
| | I can explain patterns and trends in the use of energy resources. | | | |
| | I can give reasons why science does not always have the power to deal with the environmental issues arising from the use of energy resources. | | | |

# ENERGY STORES AND SYSTEMS

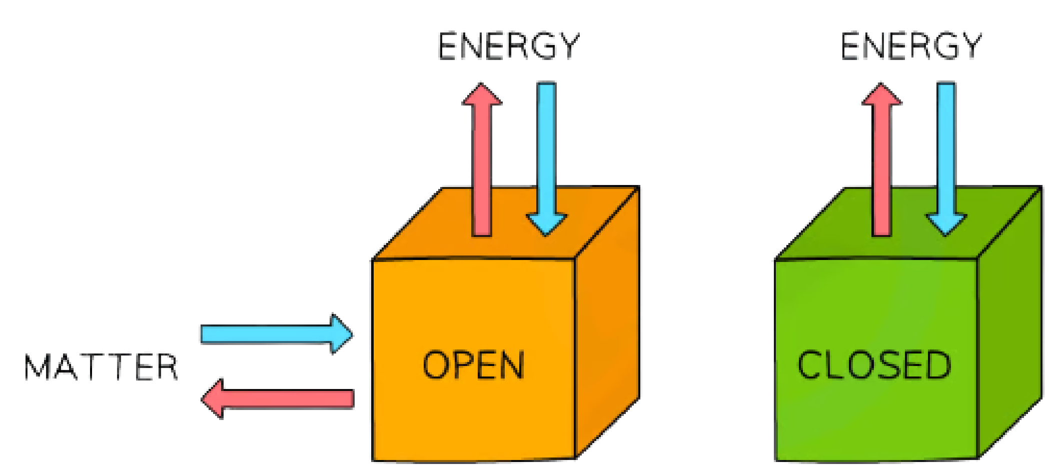
## SECTION 4.1.2

A system is just one object or a group of objects. When something in the system changes, the way energy is stored also changes.

**Example:**
**A ball rolling and hitting a wall.**
The system is the ball moving. When it hits the wall, some of its kinetic (movement) energy turns into sound. The car is slowing down. The system is the moving car. As it slows down, kinetic energy is converted into heat due to the friction between the wheels and brakes.




| system type | description | energy exchange |
|---|---|---|
| isolated | no interaction with surroundings | no |
| open | exchange energy not matter | yes |
| closed | exchange both enrgy and matter | yesyes |




**Closed and open systems**

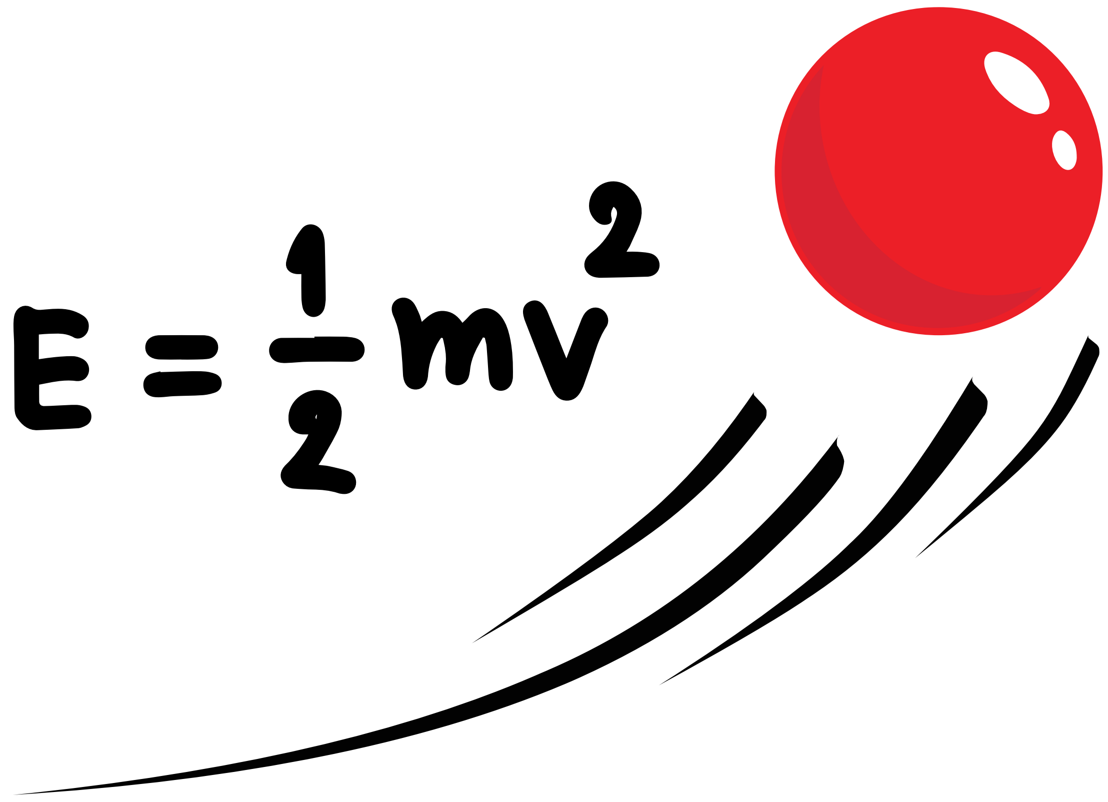
# CHANGES IN ENERGY
# ENERGY EQUATIONS

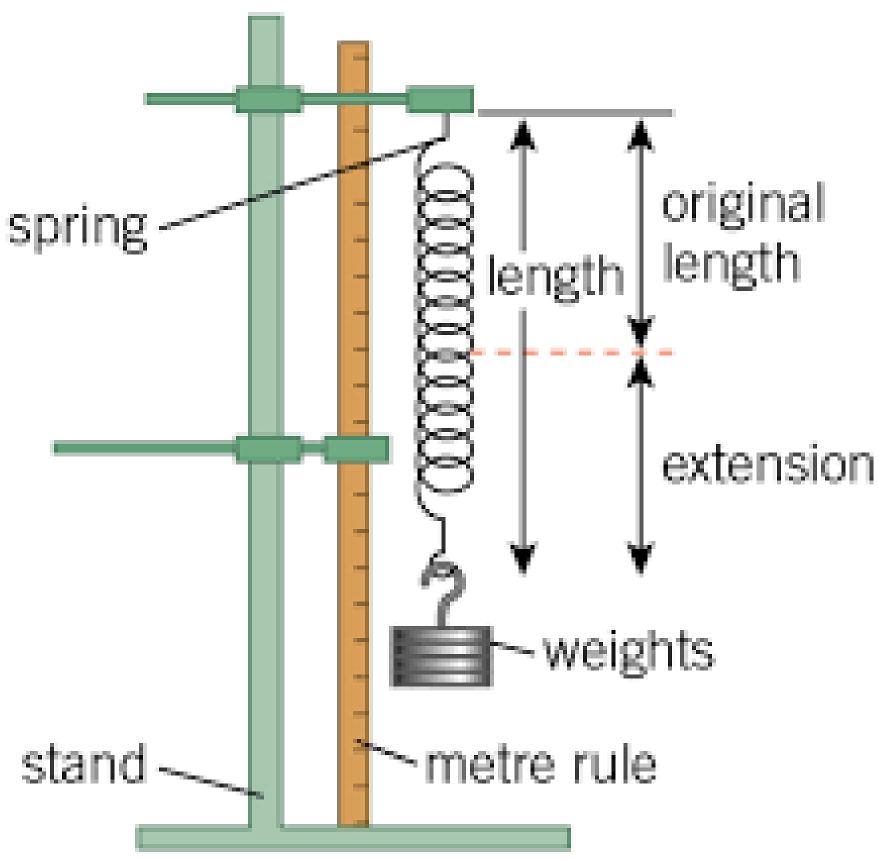
## Kinetic Energy

Kinetic energy is the energy of a moving object.

m = mass in kilograms (kg)
v = speed in metres per second (m/s)
Ek = kinetic energy in joules (J)

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






## Elastic Potential Energy

This is the energy stored in a spring when it is stretched or compressed.

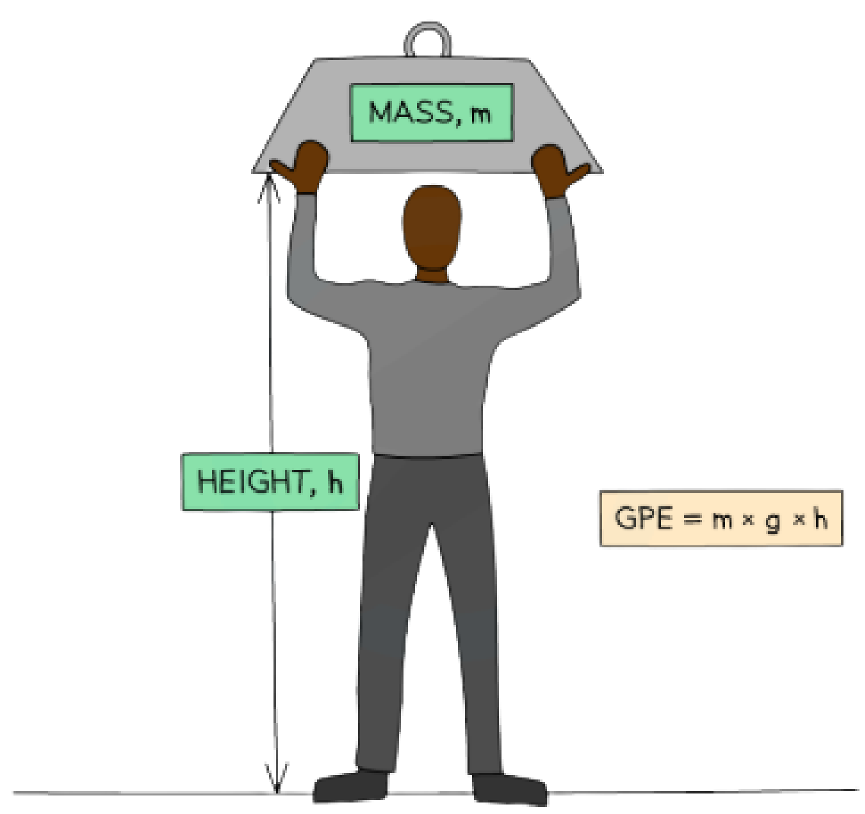
Ee = elastic potential energy (J)
k = spring constant (how stiff the spring is), in N/m
e = extension (how much the spring is stretched), in metres

$$E_p = \frac{1}{2}kx^2$$

## Gravitational Potential Energy

This is energy stored when an object is lifted off the ground.

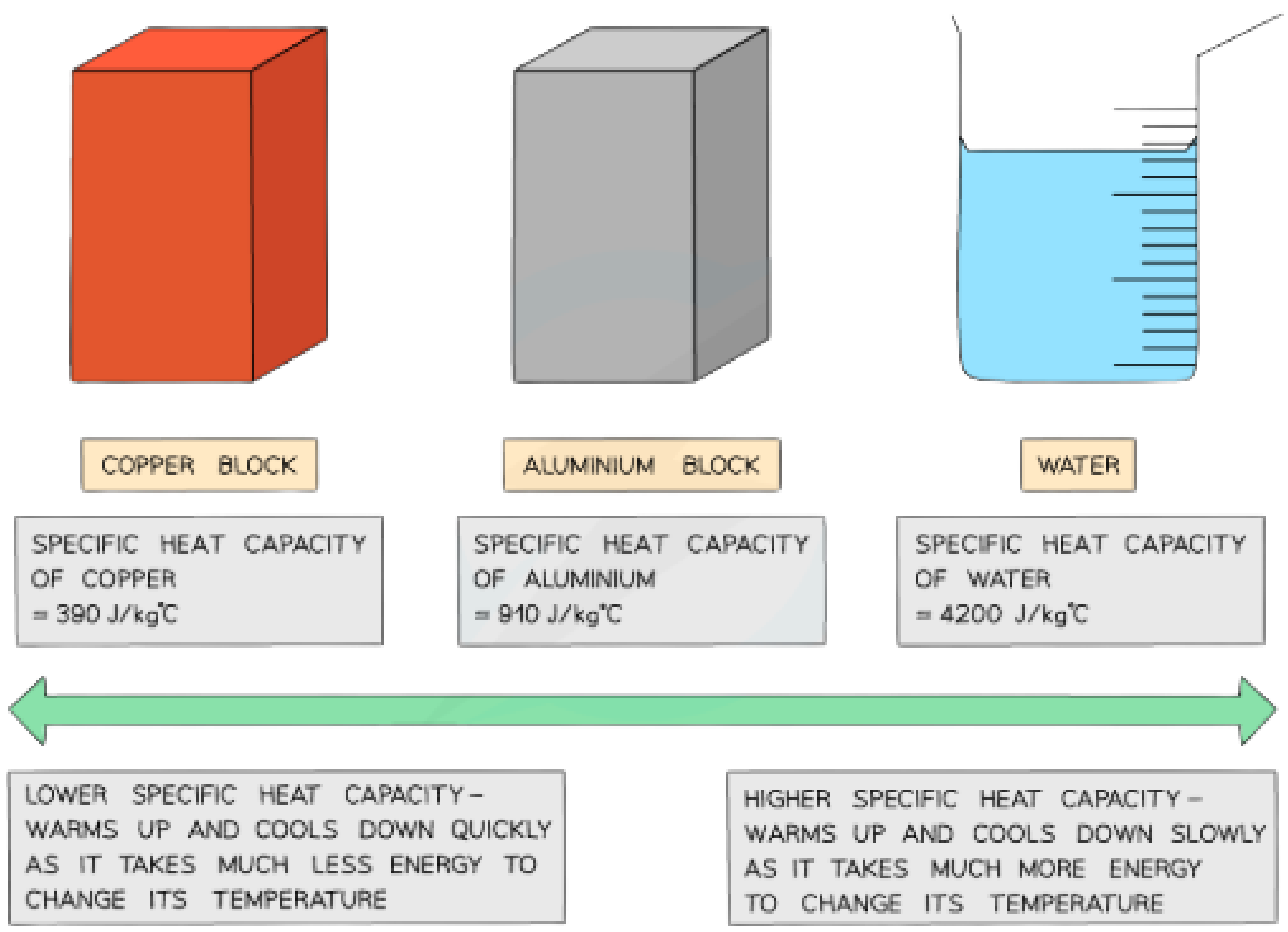
Ep = gravitational potential energy (J)
m = mass (kg)
g = gravitational field strength (9.8 N/kg)
h = height (m)




$$E_p = mgh$$

# SPECIFIC HEAT CAPACITY

This tells you how much energy is needed to heat up 1 kg of a substance by 1°C.
Energy=mass×specific heat capacity×temperature change




$$Specific\,Heat\,Capacity(c) = \frac{Q}{m \times \Delta T}$$

- ΔE = change in thermal energy (J)
- m = mass (kg)
- c = specific heat capacity (J/kg°C)
- ΔT\Delta TΔT = temperature change in °C

# EFFICIENCY

## Efficiency

Efficiency tells us how much of the input energy becomes useful output.

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

Efficiency is usually written as a percentage.

How to increase efficiency

Reduce wasted energy

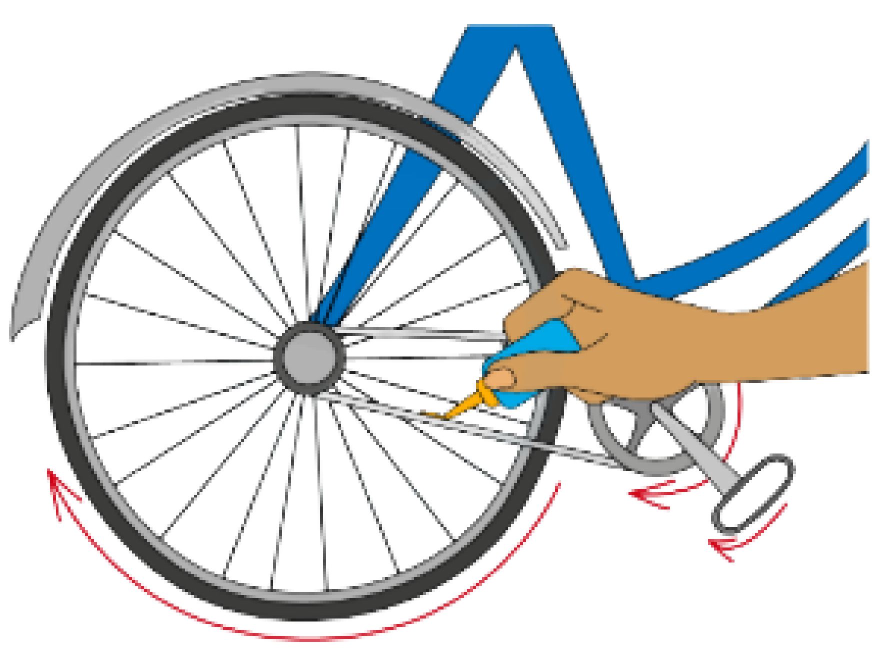
(e.g., using lubrication, insulation, better materials)

Recycle wasted energy

(e.g., capturing wasted heat and reusing it)

## Reducing Friction

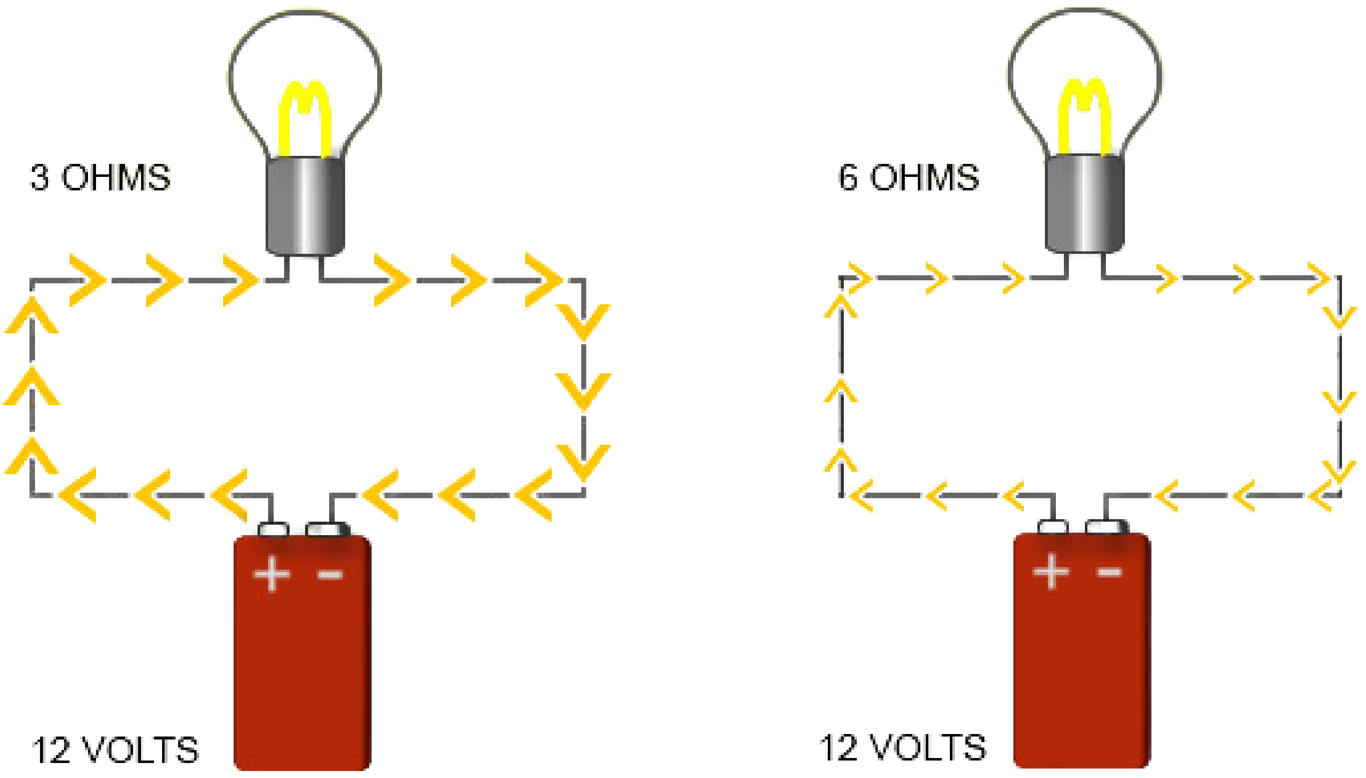
- In a mechanical system, for example, there is often friction between the moving parts of the machinery
- This results in unwanted energy transfers by heating to the machinery and the surroundings
- Friction can be reduced by:
    - Adding bearings to prevent components from directly rubbing together
    - Lubricating parts



# EFFICIENCY

## Reducing Electrical Resistance

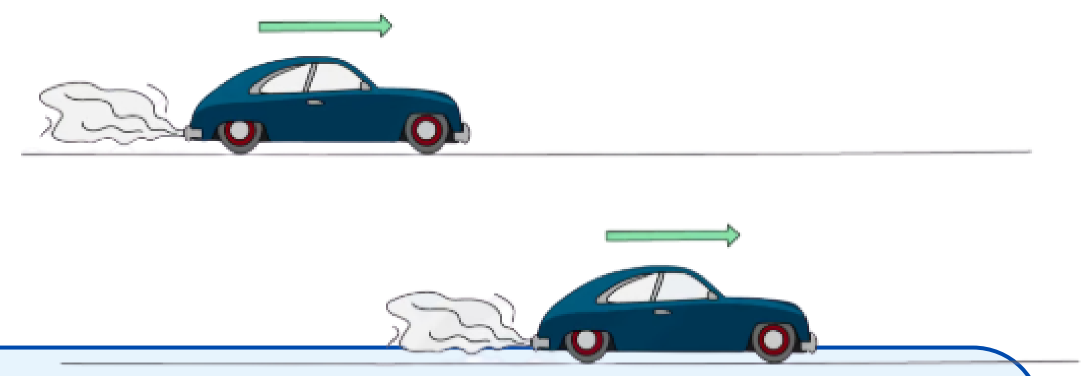
- In electric circuits, there is resistance as current flows through the wires and components
- This results in unwanted energy transfers by heating to the wires, components and the surroundings
- Resistance can be reduced by:
  - Using components with lower resistance
  - Reducing the current




## Reducing Air Resistance

- Air resistance causes a frictional force between the moving object and the air that opposes its motion
- This results in unwanted energy transfers by heating to the object and the surroundings
- Air resistance can be reduced by:
  - Streamlining the shapes of moving objects
- For example, a racing cyclist adopts a more streamlined posture to reduce the effects of air resistance
  - Also, the bicycle, clothing and helmet are designed to allow them to go as fast as possible

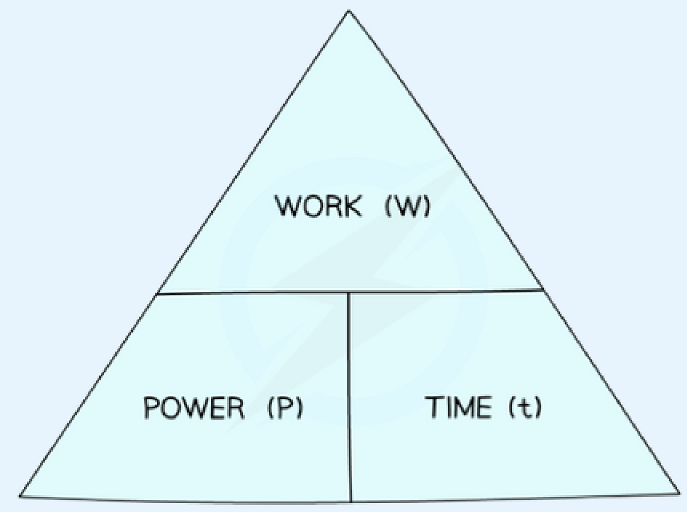
# POWER



## Power

Power tells us how fast energy is transferred or how fast work is done.

$$P=\frac{W}{t}$$



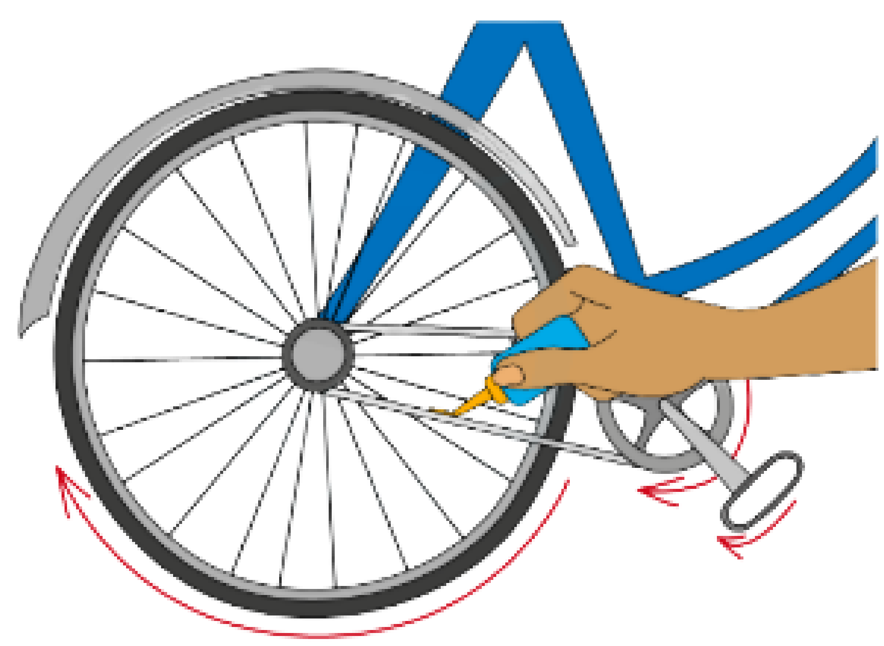

- Power (P) is measured in watts (W)
- Energy transferred (E) is in joules (J)
- Time (t) is in seconds (s)
- Work done (W) is also in joules (J)

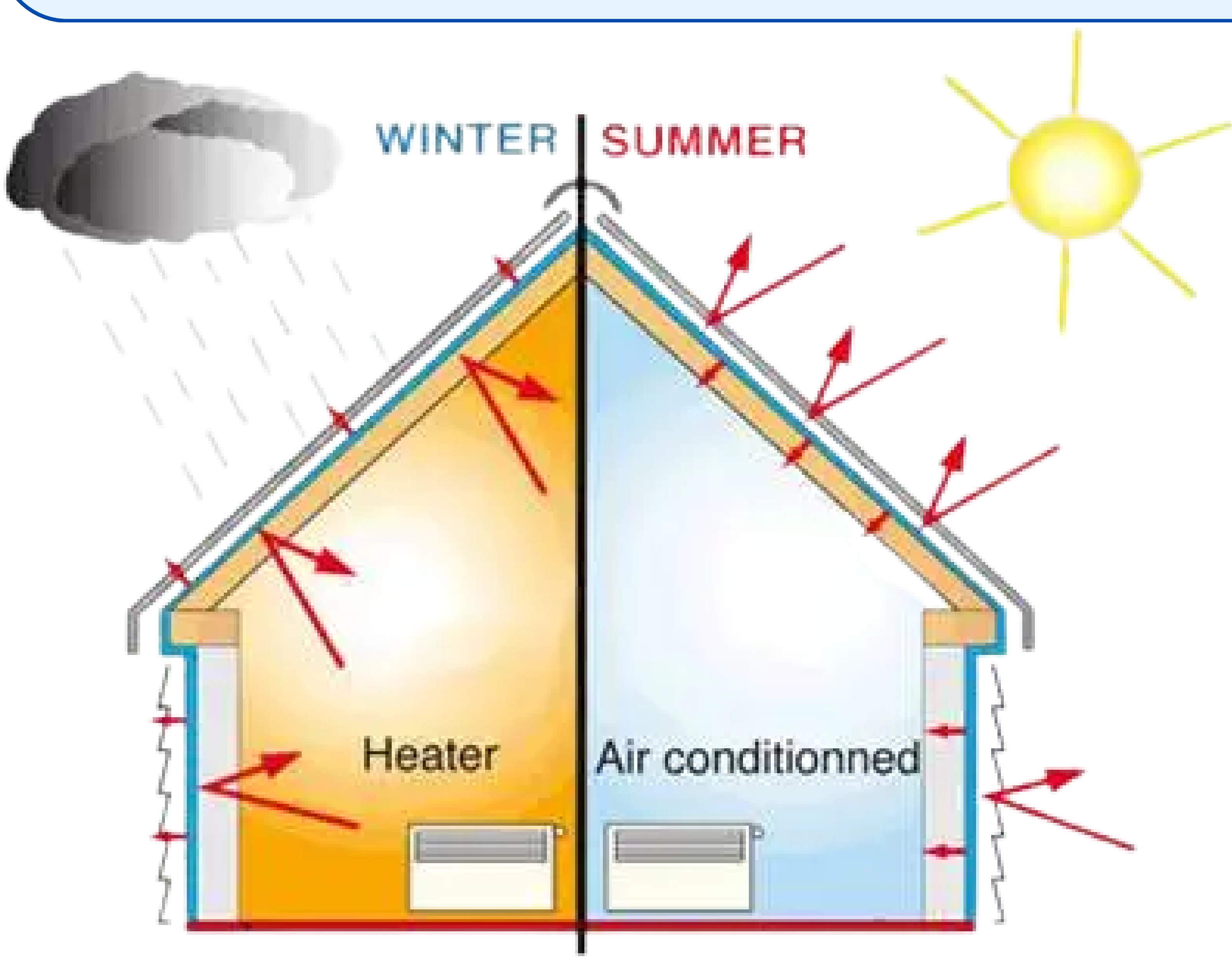
If 1 joule of energy is transferred every second, the power is 1 watt.
If you have two motors doing the same job, the one that transfers energy faster has a higher power , meaning it is more powerful.

## Reducing Energy Loss

**Lubrication**

- Friction is a major cause of wasted energy in machines
- For example, the gears on a bike can become hot if the rider has been cycling for a long time
    - Energy is wasted as it is transferred from the kinetic energy store of the bike to the thermal energy store of the gears and the chain
    - This friction makes them become hot and transfers energy by heating to the thermal energy store of the surrounding air






## Reducing Energy Loss

**Insulation**

- In many situations, the energy transferred by heating is wanted. For example:
    - When heating a home
    - When boiling a kettle
- If this energy can be prevented from dissipating, then less energy will be needed to replace the wasted energy

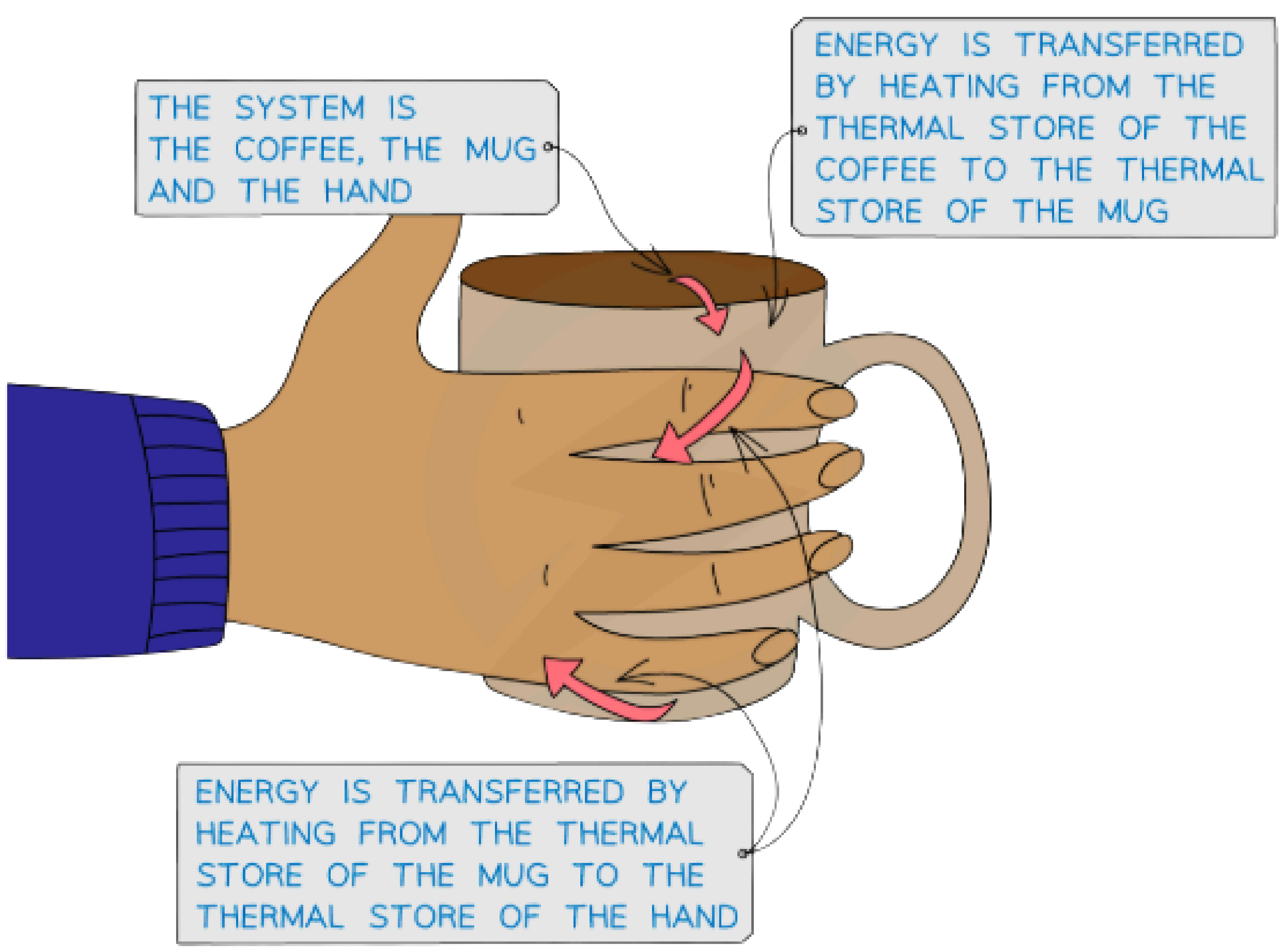
This can be achieved by surrounding the appliance with insulation.

# ENERGY TRANSFERS

## Energy Transfer Pathways

- Energy is transferred between stores via transfer pathways
- Examples of these are:
  - Mechanically
  - Electrically
  - By heating
  - By radiation

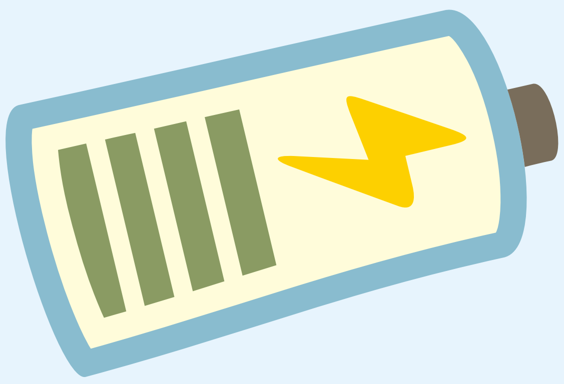
| Transfer Pathway | Description |
|---|---|
| Mechanical working | When a force acts on an object (e.g. pulling, pushing, stretching, squashing) |
| Electrical working | A charge moving through a potential difference (e.g. current) |
| Heating (by particles) | Energy is transferred from a hotter object to a colder one (e.g. conduction) |
| (Heating by) radiation | Energy transferred by electromagnetic waves (e.g. visible light) |



# RENEWABLE ENERGY

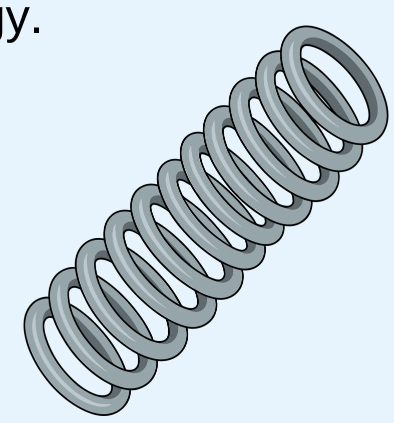
**CHEMICAL STORE - IN FUELS , FOOD ,BATTTERIES**

Chemical energy is released when chemical bonds break. In renewable systems, this mainly applies to biofuels and battery storage, where energy stored during photosynthesis or charging is later used.



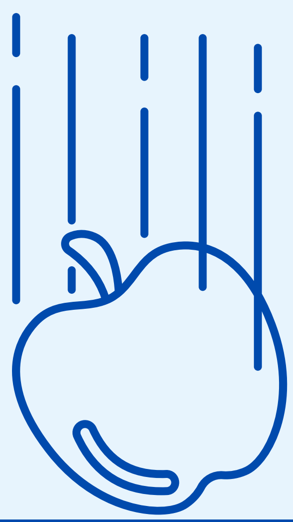
**ELASTIC POTENTIAL STORE - IN STRECHED OR COMPRESSED OBJECTS**

Although not a major renewable source, elastic energy explains how waves, tides, and even some experimental renewable systems (like wave springs) store energy.



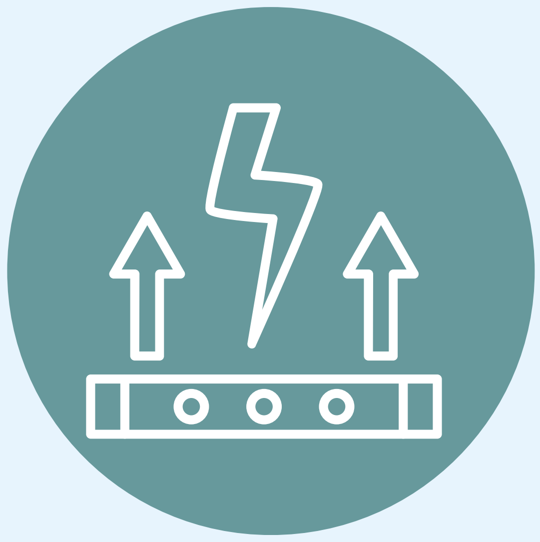
**GRAVITATIONAL POTENTIAL STORE - IN RAISED OBJECTS**

This relates to hydropower, where water held at height behind a dam stores gravitational energy and releases it to turn turbines.



**ELECTROSTATIC STORE - IN CHARGES**

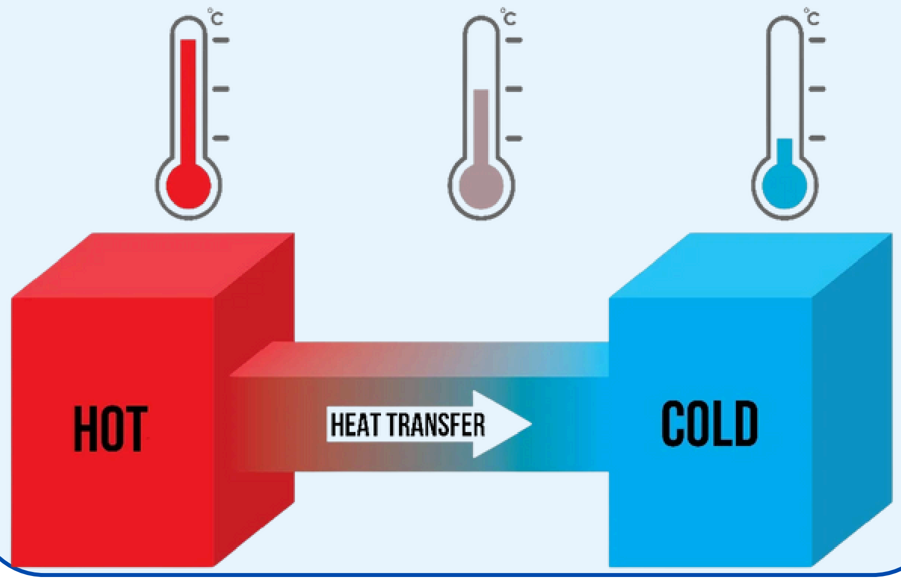
Electrostatic principles help explain solar panels and how they move electrons to create electric current.



# RENEWABLE ENERGY PT 2

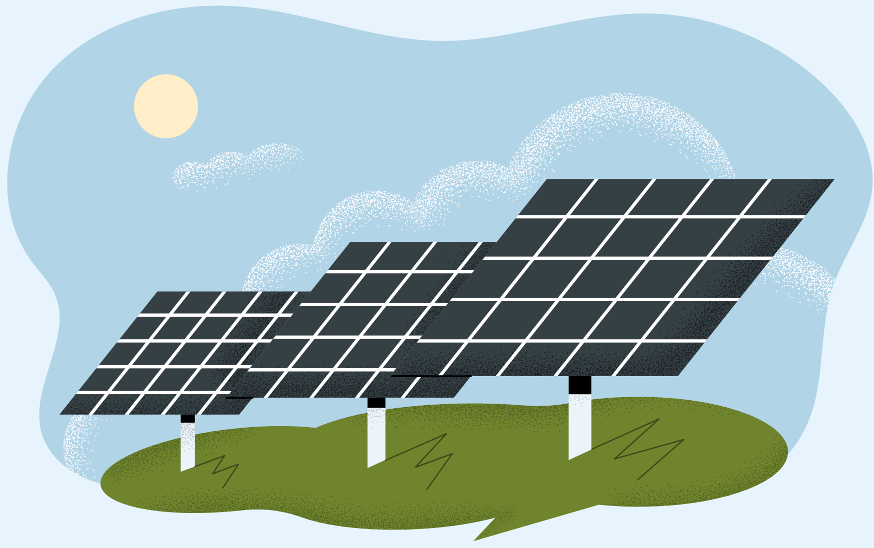
**THERMAL STORE - IN HOT OBJECTS**

Geothermal energy converts heat trapped inside the Earth into electricity or heating. Hot water or steam turns turbines, producing renewable electricity.




## Solar Energy

Solar panels convert sunlight directly into electricity using photovoltaic cells. It's clean, renewable, and increasingly affordable but depends on sunlight availability.



## Wind Energy

Wind turbines convert the kinetic energy of moving air into electricity. Stronger and more consistent wind = more power generated.

## Hydroelectricity Energy

Flowing water spins turbines to produce electricity. It's one of the most reliable renewable sources with consistent output, especially in large dams.

# RENEWABLE ENERGY PT 2

## Biofuel Energy

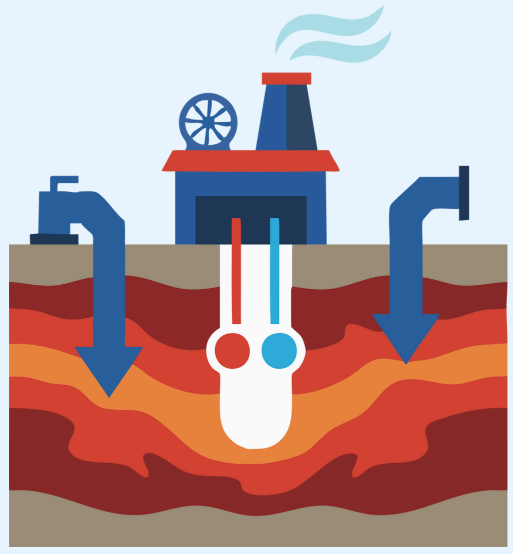
Biofuels are made from plants and organic waste. They release energy stored through photosynthesis. They produce fewer emissions than fossil fuels and can replace petrol and diesel in some engines.

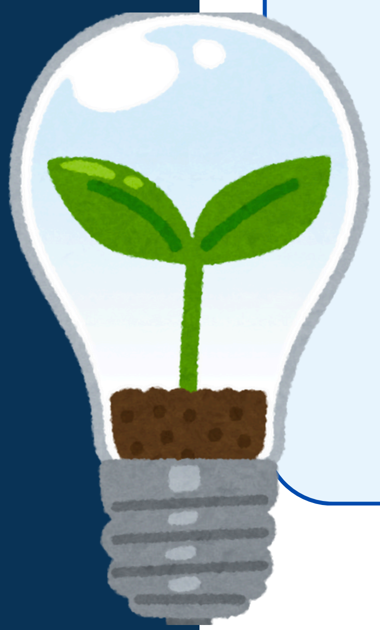

## Tidal Energy

Tidal power uses the rise and fall of ocean tides to turn underwater turbines. It's predictable and reliable because tides follow the moon’s cycle.

## Geothermal Energy

Uses heat from beneath the Earth’s crust to produce electricity or provide heating. Works best in volcanic regions.





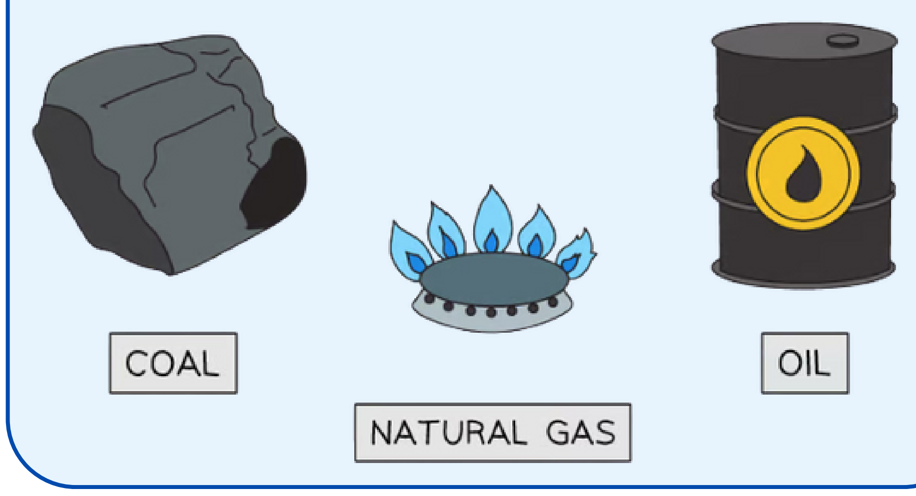
## Wave Energy

Captures the up-and-down motion of waves to generate electricity. A developing but promising technology.

# NON - RENEWABLE ENERGY

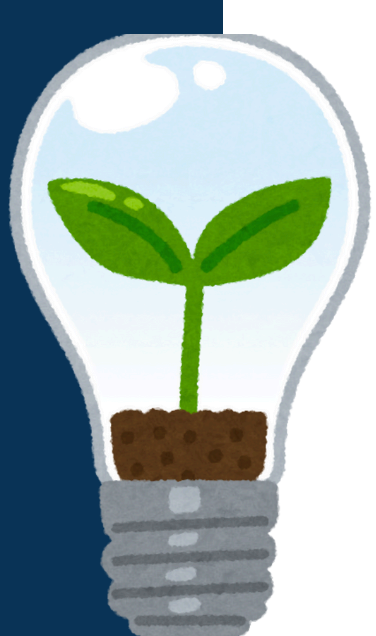
## Fossil Fuels (coal, oil, and natural gas)

These are formed from dead plants and animals buried for millions of years. They release large amounts of energy when burned but also release carbon dioxide, contributing to climate change.




## Nuclear fuel

Nuclear fission splits uranium atoms to release energy. It produces massive amounts of electricity with no carbon emissions, but creates radioactive waste that must be stored safely.



# PROS & CONS OF RENEWABLE ENERGY

## PROS OF RENEWABLE ENERGY

**1. Environmentally Friendly**

Produces little to no greenhouse gases, helping reduce climate change.

**2. Infinite Supply**

Sources like sunlight, wind, tides, and flowing water will never run out.

**3. Low Operating Costs**

Once installed, solar, wind, and hydro systems are cheap to run and maintain.

**4. Reduces Air Pollution**

No harmful smoke or toxic emissions → cleaner air and better health.

**5. Energy Security**

Countries rely less on imported fuels and more on locally available resources.

**6. Creates Jobs**

Solar and wind industries create employment in installation, manufacturing, and maintenance.

# PROS & CONS OF RENEWABLE ENERGY

## CONS OF RENEWABLE ENERGY

**1. High Initial Cost**

Solar panels, wind turbines, and hydro dams require expensive setup.

**2. Weather Dependent**

Solar works best on sunny days, wind needs strong winds, and hydro depends on water supply.

**3. Requires Large Space**

Wind farms and solar farms take up big areas to produce high amounts of energy.

**4. Intermittent Supply**

Energy production can drop at night (solar) or during calm days (wind), needing backup systems.

**5. Storage Challenges**

Batteries for storing renewable energy are still costly and have limited capacity.

**6. Can Impact Wildlife**

Wind turbines can affect birds, hydro dams can affect fish ecosystems.