Energy can be kept in a number of different stores.

Chemical energy store: Different chemical bonds store different amounts of energy.
Kinetic energy store: Anything which is moving.
Gravitational potential energy store: Anything above the surface of a planet.
Thermal energy store: Anything which is above -273°C
Elastic potential energy store: Anything which is stretched out of its resting shape.
Vibrational energy store: Anything moves to and fro.
Nuclear energy store: Atoms being split apart of fused together.
Magnetostatic/electrostatic energy store: When magnets and electric charges are attracting or repelling.

A system is an object or group of objects.
Energy can move between stores when a system changes.

For example:

- An object projected upwards: (e.g. ball thrown upwards)
  Kinetic energy store of ball → Gravitational potential energy store of ball
- A moving object hitting an obstacle: (e.g. car hitting a traffic cone)
  Kinetic energy store of moving object → Kinetic energy store of obstacle
- An object accelerated by a constant force: (e.g. skydiver accelerated by their weight)
  Gravitational potential energy of skydiver → Kinetic energy of skydiver
- A vehicle slowing down (e.g. car applying brakes)
  Kinetic energy store of car → Thermal energy store of brake pads
- Bringing water to boil in an electrical kettle
  Thermal energy store of element → Thermal energy store of water in kettle

Changes in the amount of energy stored in a system can be caused by:

- **heating**
  ($\Delta E = mc\Delta\theta$)
  Change in thermal energy = mass x specific heat capacity x change in temperature
- **work done by forces**
  ($W = Fd$)
  Work done = Force x distance
- **work done when a current flows**
  ($W = IVt$)
  Work done = Current x potential difference x time

P1

The equation for kinetic energy is:
$E_K = 0.5 \times m \times v^2$
Kinetic energy = 0.5 x mass x velocity^2

E_K = Kinetic energy (J)
m = mass (kg)
v = velocity (m/s)

$$\frac{E_K}{\frac{1}{2} \times m \times v^2}$$

The equation for elastic potential energy is:
$E_e = 0.5 \times k \times e^2$
Elastic potential energy = 0.5 x spring constant x extension2

E_e = Elastic potential energy (J)
k = Spring constant (N/m)
e = extension (m)

$$\frac{E_e}{\frac{1}{2} \times k \times e^2}$$

The equation for gravitational potential energy is:
$E_P = m \times g \times h$
Gravitational potential energy = mass x gravitational field strength x height

E_P = Gravitational potential energy (J)
m = Mass (kg)
g = gravitational field strength (N/kg)
h = Height (m)

$$\frac{E_P}{m \times g \times h}$$

The equation for change in thermal energy is:
$\Delta E = m \times c \times \Delta\theta$
Change in thermal energy = mass x specific heat capacity x change in temperature

ΔE = Change in thermal energy (J)
m = Mass (kg)
c = Specific heat capacity (J/kg°C)
$\Delta\theta$ = Change in temperature (°C)

$$\frac{\Delta E}{m \times c \times \Delta\theta}$$

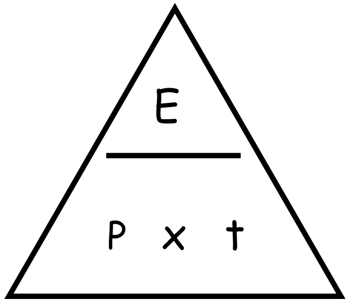
The specific heat capacity of a substance is the amount of energy required to raise the temperature of one kilogram of the substance by one degree Celsius.

P1

Power is defined as the rate at which energy is transferred or the rate at which work is done.

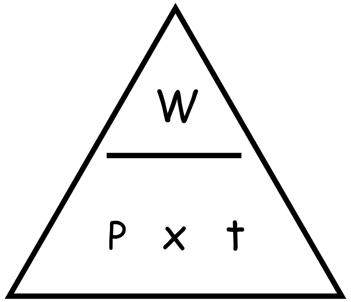
The equation for power is:
$P = E \div t$
Power = Energy transferred ÷ time

P = Power (W)
E = Energy transferred (J)
t = time (s)



The equation for power can also be written:
$P = W \div t$
Power = Energy transferred ÷ time

P = Power (W)
W = Work done (J)
t = time (s)



An energy transfer of 1 joule per second is equal to a power of 1 watt.

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

Sometimes energy is dissipated, so that it is stored in less useful ways. This energy is often described as being 'wasted'.
Because energy cannot be lost: **Total energy = useful energy + wasted energy**

Unwanted energy transfers can be reduced by a range of methods, for example through lubrication and the use of thermal insulation.

The higher the thermal conductivity of a material the higher the rate of energy transfer by conduction across the material.

The rate of cooling of a building is affected by the thickness and thermal conductivity of its walls.

P1

Efficiency is a measure of how much something does what we want it to do.
The energy efficiency for any energy transfer can be calculated using the equation:
efficiency = useful output energy transfer ÷ total input energy transfer
Efficiency may also be calculated using the equation:
efficiency = useful power output ÷ total power input

A renewable energy resource is one that is being (or can be) replenished as it is used.

The uses of energy resources include: transport, electricity generation and heating.

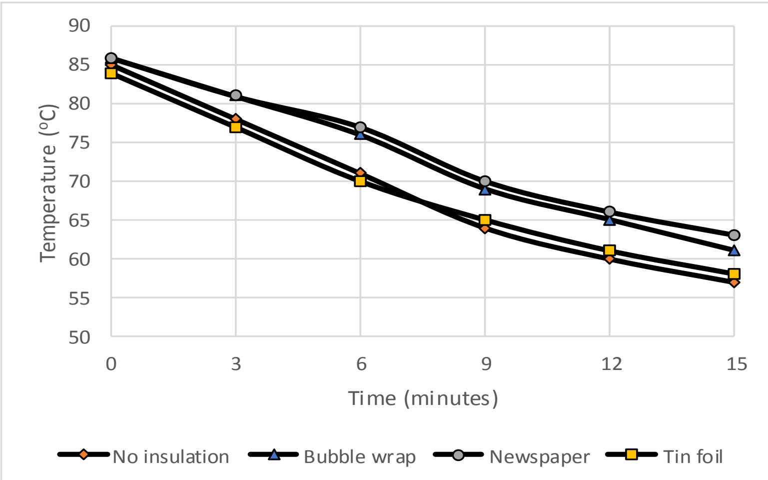
Energy Resource	Renewable/ Non-renewable	Description	Environmental impact	Uses of energy resource	Reliability
Fossil fuels	Non-renewable	Coal, oil and gas can be burned to heat water, to make stream, to turn a turbine.	Greenhouse Gases	Electricity generation, transport	Reliable
Nuclear	Non-renewable	Nuclear fission heats water, to make steam, to turn a turbine.	Radioactive waste	Electricity generation	Reliable
Biofuel	Renewable	Biofuel is burnt to heat water, to make steam, to turn a turbine.	Carbon - neutral	Electricity generation, heating, transport	Reliable
Wind	Renewable	Wind turns a turbine.	Noise	Electricity generation	Unreliable
Hydro-electric	Renewable	Water through a dam turns a turbine.	Flooding of habitats	Electricity generation	Reliable
Geothermal	Renewable	Heat from underground heats water, to make steam, to turn a turbine.	None	Electricity generation, heating	Reliable
Tides	Renewable	Water is trapped behind a barrage at high tide and released turning a turbine.	Flooding of habitats	Electricity generation	Reliable
Sun	Renewable	Photovoltaic cells turn light into electricity. Solar cells heat water for heating.	None	Electricity generation, heating	Unreliable
Water waves	Renewable	The motion of a wave turns a turbine.	None	Electricity generation	Reliable

Required Practical: Thermal Insulators

1. Get a set of 5 boiling tubes and wrap one in each of the insulating materials (leave one beaker without any insulation.)
2. Use the kettle to boil water.
3. Measure 50ml of hot water into each container.
4. Insert the thermometer so that its bulb is in the hot water.
5. Record the temperature of the water and start the stopwatch.
6. Record the temperature of the water every 3 minutes for 18 minutes
7. Add your results to the results table.

Time mins	Material used for insulation			
	No insulation	Bubble wrap	Newspaper	Tin foil
	Temperature °C			
0	85	86	86	84
3	78	81	81	77
6	71	76	77	70
9	64	69	70	65
12	60	65	66	61
15	57	61	63	58
Change in temperature °C				

8. Plot cooling curve graphs for each material with:
   'Temperature in °C' on the y-axis
   'Time in minutes' on the x-axis.
9. Use your graphs to determine which material is the best insulator.



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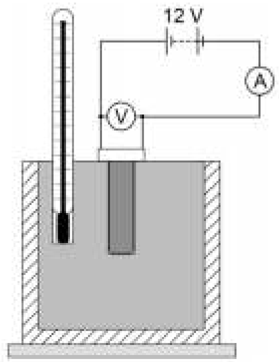
Required Practical: Specific Heat Capacity



1. Measure and record the mass of the copper block in kg.
2. Wrap the insulation around the block.
3. Place the heater in the larger hole in the block.
4. Connect the ammeter, power pack and heater in series.
5. Connect the voltmeter across the heater.
6. Use the pipette to put a small amount of water in the other hole.
7. Put the thermometer in this hole.
8. Set the power pack to 12 V. Switch on the power pack to turn on the heater.
9. Record the ammeter and voltmeter readings. These shouldn't change during the experiment.
10. Measure the temperature and start the stopwatch.
11. Record the temperature every minute for 10 minutes.
12. Calculate the power of the heater in watts.
    Power in watts = potential difference in volts x current in amps
13. Calculate the energy transferred (work done) by the heater. To do this, multiply the time in seconds by the power of the heater.
14. Plot a graph of the temperature in °C against work done in J.
15. Draw a line of best fit. Take care as the beginning of the graph may be curved.
16. Calculate the gradient of the straight part of your graph.
    (The gradient is $\Delta\theta \div \Delta E$)
17. Rearrange the equation for Change in thermal energy to get:
    $$\frac{\Delta\theta}{\Delta E} = \frac{1}{mc}$$
18. We therefore know that the gradient is equal to:
    $$\text{gradient} = \frac{1}{mc}$$
19. We can calculate c (specific heat capacity)
    $$c = \frac{1}{m \times \text{gradient}}$$