Highsted Knowledge Organiser Physics Year 9: Conservation and dissipation of energy

What I need to know
Types of energy stores
Definition
Equations and their application
Units

Key Vocabulary:

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

Conservation of energy:
In a closed system, energy cannot be created or destroyed. The total energy is constant.

Equations and Units

Work done = Force x Distance
W = F x s

Force in Newtons, N.
Distance in metres, m

Kinetic Energy = ½ x mass x speed²
$E_k = \frac{1}{2} \times m \times v^2$

Mass in kilograms, kg
Speed in metres per second, m/s

Gravitational Potential Energy = mass x gravitational field strength x height
$E_p = m \times g \times h$

Mass in kilograms, kg
Height in metres, m
g in Newtons per kilogram, N/kg
g = 9.8 N/kg on Earth – you don't need to recall this.

Power = Energy / Time
P = E / t
Power in Watts (W)
Time in seconds (s)

Elastic Energy = ½ x spring constant x extension²
$E_e = \frac{1}{2} \times k \times e^2$

Spring constant in Newtons per metre, N/m
Extension in metres, m

Efficiency = Useful Energy Output / Total Energy Input

Useful Power Output / Total Power Input

Efficiency has no unit.

Student reference point

Energy Store	Description
Kinetic Energy 	The energy stored by objects that are moving
Gravitational Potential Energy 	The energy stored in objects raised above ground
Chemical Energy 	The energy stored in fuels, food and batteries
Thermal Energy 	The energy stored by hot objects
Elastic Potential Energy 	The energy stored by stretched or squashed objects

System Change	Decreasing Energy Stores	Increasing Energy Stores
Tennis Ball Projected Upwards	Kinetic	Gravitational Potential
A vehicle slowing down	Kinetic	Thermal
A battery powered drill is turned on	Chemical	Kinetic, Thermal
A person sliding down a zip-wire	Gravitational Potential	Kinetic, Thermal

A system is an object or group of objects.

Conservation of energy:

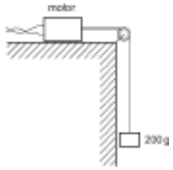
In all system changes, energy is dissipated so that it is stored in less useful ways (wasted energy). Dissipated energy usually ends up a thermal store in the surroundings.

These unwanted energy transfers can be reduced using, for example, **lubrication** (to reduce friction) or **insulation** (to reduce the rate of thermal energy transfer).

Power

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

Two motors lift the same mass.
A higher power motor will lift the mass in a shorter time.
A lower power motor will lift the mass in a longer time.



Challenge question: A 0.25kg ball is placed on a catapult. The catapult is pulled back 0.5m and has a spring constant of 50N/m. What is the velocity of the ball when it leaves the catapult? (Hint, you will need the elastic potential energy and kinetic energy equations)

Suggested video Isaac Physics Kinetic Energy Equation: https://isaacphysics.org/pages/covid19_gcse_archive?stage=all#3

Highsted Knowledge Organiser Physics Year 9: Energy Transfer by Heating

What I need to know

Definitions
Recall of practicals
Labelling of diagrams
How to use the equation

Key Vocabulary:

Specific heat capacity

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.

Rate: The speed at which something happens

Thermal conductivity is a measure of how well a material conducts energy when it is heated.

Specific heat capacity in Joules per kilogram per degree Celsius, J/(kg°C)

Equation

Change in thermal energy = mass x specific heat capacity x change in temperature

$$\Delta E = m \times c \times \Delta\theta$$

Δ = change in
ΔE = change in energy
m = mass
Δθ = change in temperature

Student reference point

Energy transfer by conduction

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

Reducing the rate of energy transfers at home

The energy transfer per second through a layer of insulation material depends on:

- The temperature difference across the material. *The larger the temperature difference the higher the rate of energy transfer by conduction.*
- The thickness of the material. *The thicker the material the lower the rate of energy transfer by conduction.*
- The thermal conductivity of the material.

Ways to reduce energy loss in homes	Reducing the cost of producing energy in the home
Loft insulation	Energy efficient boiler
Cavity wall insulation	Install solar panels
Double glazing	
Draft excluders	

Insulation traps the air in small pockets, reducing the rate of energy transfer via conduction

Thermal Insulation Results

The thicker the material the slower the rate of energy transfer (heat loss) from the container.

In the above example M has the thickest insulation

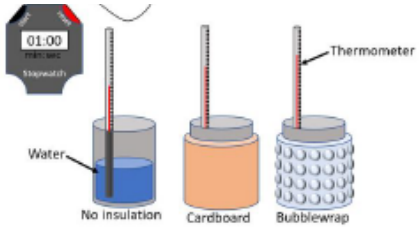
Thermal Insulation

Aim; Investigate the effectiveness of different materials as thermal insulators, or how the thickness of a material affects the rate of energy transfer.

Independent Variable: Material

Dependent Variable:
Temperature change

Control variables:
Thickness of the material
Volume of hot water
Time the water is allowed to cool
The container
Starting temperature of water



Method

- Cover the container in an insulating material.
- Pour 200ml of water into the beaker using a measuring cylinder.
- Measure the starting temperature using a thermometer.
- Time 10minutes using a stopwatch.
- Measure the end temperature using a thermometer and calculate the temperature difference
- Repeat for other insulating materials.

Thermal Insulation

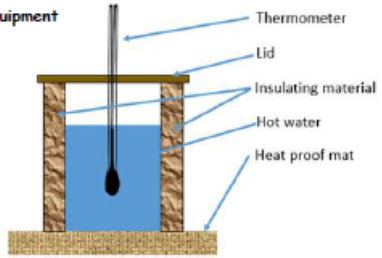
Aim; Investigate the effectiveness of different materials as thermal insulators, or how the thickness of a material affects the rate of energy transfer.

Independent Variable: Thickness of material

Dependent Variable:
Temperature change

Control variables:
Material
Volume of hot water
Time the water is allowed to cool
The container
Starting temperature of water

Equipment



Method

- Cover the container in one layer of insulating material.
- Pour 200ml of water into the beaker using a measuring cylinder.
- Measure the starting temperature using a thermometer.
- Record the temperature every 30seconds for 10minutes using a stopwatch.
- Repeat for other 2,3,4 & 5 layers of insulating material
- Plot a graph of temperature against time for each thickness.

Specific Heat Capacity Required Practical

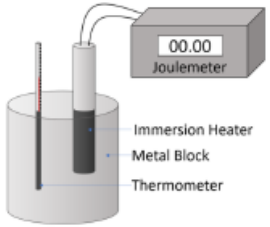
Aim: Determine the specific heat capacity of one or more materials

Independent Variable: Material

Dependent Variable:
Energy input using a Joule meter
Temperature change using a thermometer
Mass of the block using a balance

Equation: $c = \Delta E \div (m \times \Delta\theta)$

Equipment



Method

1. Measure the mass of the block using a balance
2. Measure the starting temperature of the block using a thermometer.
3. Switch on the powerpack and increase the temperature of the block using an immersion heater
4. Measure the energy input using a Joulemeter.
5. Record the end temperature and calculate the temperature difference.
6. Use the equation to find the Specific heat capacity of the block.

Improvements

- Wrap the block in insulation to minimise heat loss to the room
- Repeat investigation and calculate an average to reduce random error

Challenge question: What is the specific heat capacity of 2Kg of material when 4000J changes the temperature by 3 degrees? Include the unit.

Suggested reading: Specific heat capacity - Temperature change and energy - AQA - GCSE Combined Science Revision - AQA Trilogy - BBC Bitesize