science physics

Year 9 – Energy

1. Definitions

- **Energy system** – when an object changes there is a change in the energy store
- **Kinetic energy** - Energy stored in a moving object
- **Elastic potential energy** - Energy stored in a stretched or compressed object
- **Gravitational potential energy** - Energy stored in an object due to its mass and position in a gravitational field
- **Conduction** - Heat energy transfer through solids
- **Convection** - Heat energy transfer through fluids (liquids and gases)
- **Radiation** - Heat energy transfer through a vacuum by waves
- **Specific heat capacity** - The amount of energy required to raise 1kg of material by 1°C
- **Thermal insulator** - Material that reduces the transfer of heat energy
- **Power** - The rate that energy is transferred OR the rate that work is done
- **Work done** - When a force causes an object to move a distance, energy is transferred
- **Efficiency** - How well a device transfers input energy into output energy
- **Dissipation** - The transfer of input energy to the surroundings

2. Prefixes

Name	Operation	Standard form
Micro (μ)	1/1000,000th	$\times 10^{-6}$
Milli (m)	1/1000th	$\times 10^{-3}$
Kilo (k)	1000x bigger	$\times 10^{3}$
Mega (M)	1 000 000x bigger	$\times 10^{6}$
Giga (G)	1 000 000 000x bigger	$\times 10^{9}$

5. Law of conservation of energy:

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

3. Energy equations

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

Kinetic energy (J) = ½ x mass (kg) x velocity² (m/s)

$$E_p = mgh$$

GPE (J) = mass (kg) x gravitational field (N/kg) x height (m)

$$\text{Efficiency} = \frac{\text{Useful Output}}{\text{Total Input}}$$

$$W = F \times s$$

Work done (J) = force (N) x distance (m)

$$P = W/t = E/t$$

$$\text{Power (W)} = \frac{\text{Work done (J)}}{\text{Time taken (s)}} = \frac{\text{Energy used (J)}}{\text{Time taken (s)}}$$

4. Units

Quantity	Unit	Unit symbol
Energy/Work	Joules	J
Mass	Kilograms	kg
Force	Newtons	N
Speed	Metres per second	m/s
Power	Watts	W
Gravitational field strength	Newtons per kilogram	N/kg
Specific heat capacity	Joules per kilogram degree Celsius	J/kg°C

6. Insulation

Unwanted energy transfers can be reduced by lubrication and thermal insulation.

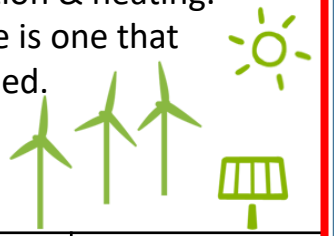
The higher the thermal conductivity of a material the higher the rate of energy transfer by conduction across the material. Examples of household insulation:

- Roof and cavity wall insulation
- Double glazed windows
- Carpets/curtains
- Draught excluders

7. Energy resources

Earth's energy resources are used for transport, electricity generation & heating.

A renewable energy resource is one that can be **replenished** as it is used.



Energy resource	Disadvantages	Advantages
Wind	Not reliable, visual pollution, noisy, damage to bird life.	No air pollution, free once installed
Solar	Not reliable as not always sunny, initial cost high.	No air pollution, free once installed
Hydroelectric	Damage to habitat when valleys are flooded, don't work in drought areas.	No fuel costs, reliable, good for quick high demand, no air pollution
Geothermal	Only able to use in volcanic areas – heat from Earth drives a turbine. Not good for large scale	No air pollution, no fuel costs
Biomass	Air pollution: CO_2 – greenhouse gas, visual pollution	Reliable, gets rid of landfill.
Tidal	Damage to water habitats & fish, visual pollution, expensive to install	Reliable – can predict tides, no air pollution, no fuel costs
Wave	Initial cost high, damage fish, visual pollution, not reliable,	No fuel costs, no air pollution
Nuclear	High decommissioning costs, dangerous, water pollution	No air pollution, reliable, generate large amounts of energy.
Coal/oil and gas	Will run out one day, air pollution: CO_2 – greenhouse gas.	Reliable, easy to transport

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8. Energy Stores

Energy store	Description	Examples
Magnetic	The energy stored when repelling poles have been pushed closer together or when attracting poles have been pulled further apart.	Fridge magnets, compasses, maglev trains which use magnetic levitation.
Internal (thermal)	The total kinetic and potential energy of the particles in an object, in most cases this is the vibrations - also known as the kinetic energy - of particles. In hotter objects, the particles have more internal energy and vibrate faster.	Human bodies, hot coffees, stoves or hobs. Ice particles vibrate slower, but still have energy.
Chemical	The energy stored in chemical bonds, such as those between molecules.	Foods, muscles, electrical cells.
Kinetic	The energy of a moving object.	Runners, buses, comets.
Electrostatic	The energy stored when repelling charges have been moved closer together or when attracting charges have been pulled further apart.	Thunderclouds, Van De Graaff generators.
Elastic potential	The energy stored when an object is stretched or squashed.	Drawn catapults, compressed springs, inflated balloons.
Gravitational potential	The energy of an object at height.	Aeroplanes, kites, mugs on a table.
Nuclear	The energy stored in the nucleus of an atom.	Uranium nuclear power, nuclear reactors.

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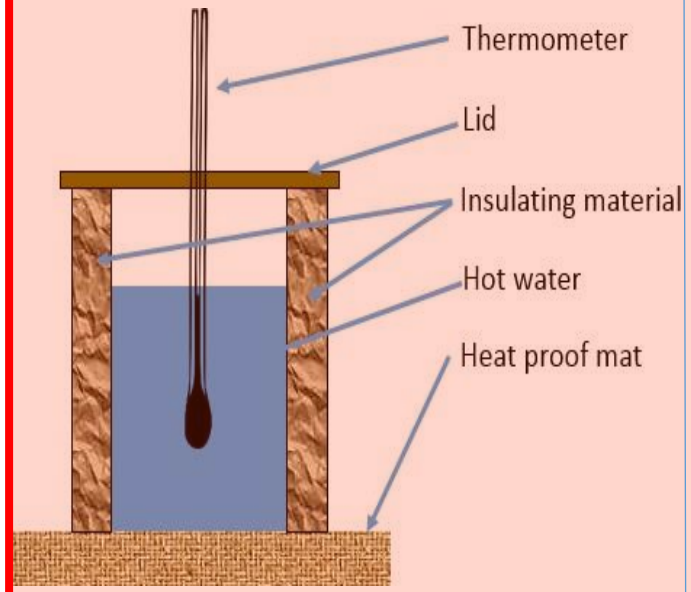
8. Required Practical – Thermal insulation 1

Test 1 – investigate the effectiveness of different materials as thermal insulators.

- Independent = type of material
- Dependent = rate of water cooling
- Controls = time, thickness of material, volume of water



9. Required Practical – Thermal insulation 2

Test 2 – investigate the factors that may affect the thermal insulation of a material.

- Independent = thickness of material
- Dependent = rate of water cooling
- Controls = time, same material, volume of water