Energy

ENERGY STORES:

1. **chemical**
2. **Kinetic**

KE (J) = 0.5 x mass (kg) x speed^2 (m/s)

3. **gravitational potential**

Gravitational PE (J) = mass (kg) x gravitational field strength (N/kg) x height (m)

4. **elastic potential**

elastic potential energy (J) = 0.5 × spring constant × extension ^{2}(m)

5. **magnetic**
6. **electrostatic**

THE LAW OF CONSERVATION OF ENERGY:

Energy can be transferred usefully, stored or dissipated, but cannot be created or destroyed. Doing (mechanical) work often results in an increase in temperature or noise. Energy is dissipated when this heat or noise is transferred into the internal energy store of the surroundings These are stored in smaller and smaller amounts This energy store is not easy to recover or transfer to a useful form, and so is often referred to as wasted It will result in a very small increase in temperature of the surroundings

ENERGY TRANSFERS: How energy is moved from one store to another.

1. by **mechanical work** (a force causing an object to move)

Work done (J) = force (N) x distance moved in direction of force (m)

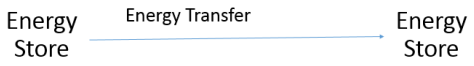
2. by **electrical work** (when charges move due to a potential difference)

energy transferred (J) = power (W) × time (s)

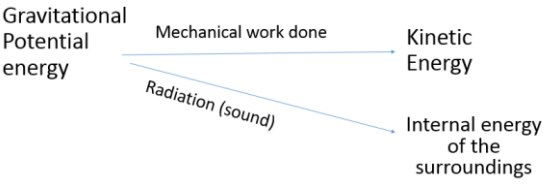
energy transferred (J) = charge (C) × potential difference (V)

3. by **heating** (due to a difference in temperature)
4. by **radiation** (includes electromagnetic waves e.g. light waves and mechanical waves e.g. sound waves)

ENERGY TRANSFER DIAGRAMS:



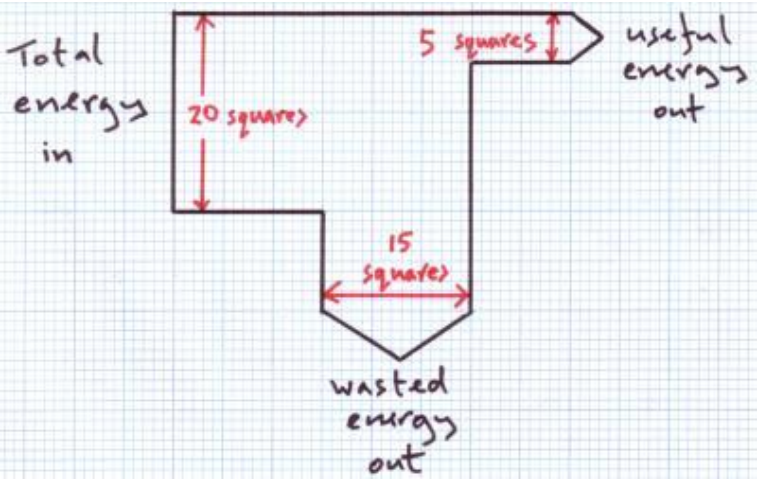
Eg for the system of a toy car starting at the top of a ramp and rolling down it:



Power is the rate of energy transfer. The more energy that is transferred (work done) each second, the higher the power. 1J/s = 1 Watt

$$Power\ (W) = \frac{work\ (J)}{time\ (s)}$$

$$Efficiency = \frac{\text{Useful Energy Output}}{\text{Energy Input}} \times 100\%$$



SANKEY DIAGRAM SHOWING EFFICIENCY

It is an energy transfer diagram drawn to scale. The number of squares tells you the amount of energy.

Reducing unwanted energy transfers:

- reducing the rise in temperature and noise that happens when (mechanical) work is done, eg by polishing surfaces or using a lubricant

or by reducing the temperature difference between objects in contact, eg through using insulators

REQUIRED PRACTICAL: Specific Heat Capacity

Energy (J) = mass (kg) x specific heat capacity (J/Kg/°C) x Temperature Change

Some materials need more energy to heat them up. The specific heat capacity tells us how much energy (J) is needed to heat up 1kg of a material by 1°C

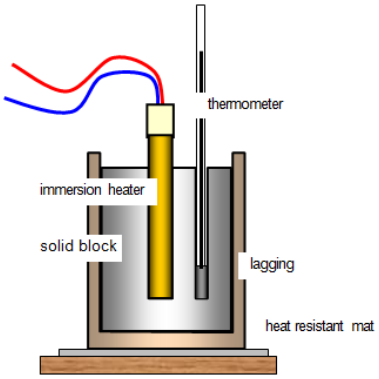
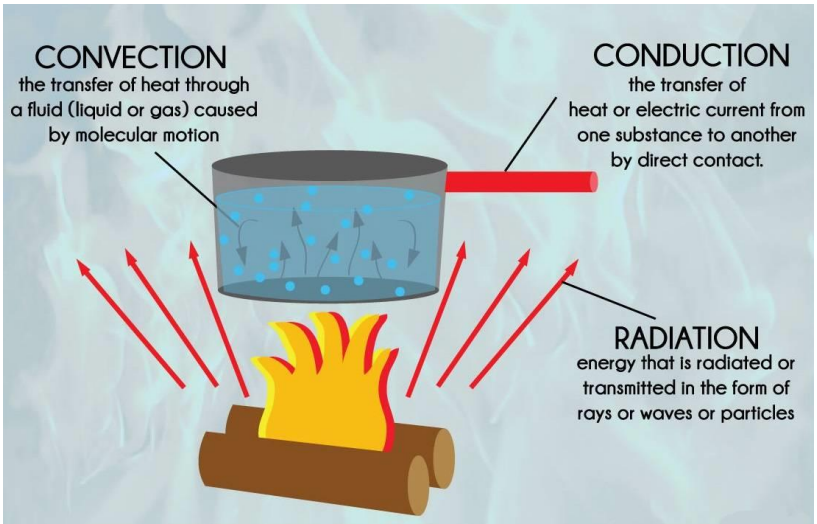
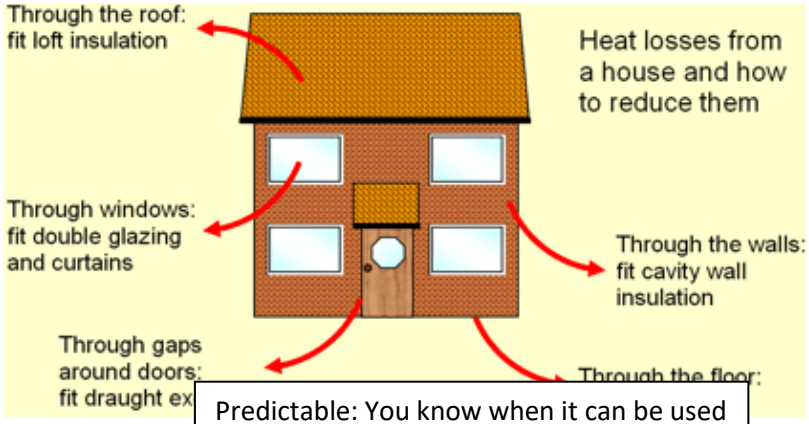


Figure 1

THREE METHODS OF HEAT TRANSFER



Insulation can reduce Heat Transfer



Predictable: You know when it can be used to generate eg Gas

Fossil Fuel: Coal, Oil and Gas: Produce Greenhouse gas Carbon Dioxide and Acid Rain Gas Sulphur dioxide: Finite

Renewable: Its will not run out if we use it

Visual Pollution: It doesn't look as nice as the country side it is put into, eg Wind Turbines

Useful in remote locations: Some places are not on the National Grid, solar is useful here

Energy Words and Meanings

L01 Energy stores and transfer systems

Energy: Energy enables something to do physical work involving the application of a force

Energy Store: when energy is in one form or part of a system e.g. an object high up, or a stretched spring. Often referred to as potential energy

System: When energy is moved from one part of a system to another it is transformed. An example of a system is a machine

Machine: Simple machines move energy from one part of the system to another

Joules: Unit of energy (J)

Kilojoule: 1000J (kJ)

L03 Kinetic energy

Kinetic energy: The energy of a moving object

Mass: the amount of matter an object is made from. Unit kg

Velocity: speed in a given direction. Units m/s

L04 Elastic Potential energy

Elastic potential energy: the energy stored in a stretched or squashed object

Directly proportional: a relationship between two variables that produces a straight line that goes through the origin on a graph.

Limit of proportionality: When an object is stretched there is a limit to its elasticity. If it is stretched beyond this point the spring or wire will snap, or not return to its original length.

Spring constant: The force needed to stretch or compress a spring, a measure of how elastic a material is

Extension: how far the spring or wire stretches from its original length. New length – original length

L05 Gravitational potential energy

Gravitational potential energy: The energy stored in an object that is raised above the ground

Gravitational field strength: the strength of a planets pull of gravity. On Earth the gravitational field strength is 9.8N/kg. Usually rounded to 10N/kg. So an object of Mass 1Kg has a force of 10N due to gravity. We call this weight

Newton: The Unit of Force (N)

Weight: The downward force of an object. Calculated by Mass of Object x Gravitational field strength

L06 specific heat capacity

Specific heat capacity: the heat required to raise the temperature of the unit mass of a given substance by a given amount (usually one degree). A substance with a large specific Heat capacity (e.g. water) will require a lot of heat energy to raise its temperature.

Heat: a measure of energy stored in an object (system) in joules (J)

Temperature: a measurement of how hot or cold something is, in °C

Storage heaters: Electric heaters in a home that contain a material of high specific heat capacity (e.g. concrete) that are heated and then emit the heat slowly

Thermal mass: Materials with a high specific heat capacity are used in buildings to store the heat energy. (E.g. bricks)

Central heating: a system using a boiler to heat water that is pumped around a house through radiators where the heat is emitted into the rooms

L7 Power

Power: **power** is the rate of doing work. It is the amount of energy moved from one store to another per unit time. Having no direction, it is a scalar quantity. In the SI system, the unit of **power** is the joule per second (J/s), known as the watt

Watts: The unit of Power (W). 1 Watt is 1 Joule of energy transformed every second 1J/s

Energy Transformed: The amount of energy moved from one part of a system to another (J)

Joules: The unit of energy (J)

Time taken: the length of time (s) it takes a machine to move energy from one part of a system to another

L9 Heat Transfer

Insulation: Materials that prevent the movement of heat energy, by being poor conductors or preventing the convention of air.

Conduction: The movement of heat energy by means of molecules moving within a substance

Convection: The movement of heat energy in a liquid or gas by the expansion of the substance causing a lower density causing the hot area of the substance to rise up. The rise and fall of the gas or liquid is called a convection current

Cavity Wall insulation: Placing an insulating material, e.g. polystyrene, in between two walls of a house to trap the air and prevent convection, therefore trapping heat in the house.

Loft insulation: A fluffy material made from glass fibres that is placed in the loft of a house to prevent convection of air, therefore trapping heat in the house.

Insulator: A material that has a low conductivity, e.g. plastics

L10 Conservation of energy

Energy Store: when energy is in one form or part of a system e.g. an object high up, or a stretched spring. Often referred to as potential energy

System: When energy is moved from one part of a system to another it is transformed. An example of a system is a machine

Useful energy: Energy that is in a store that we want it to be in to do work.

Wasted energy: energy that is in a store that is not wanted

Lubrication: The addition of substances like oils to reduce friction between 2 moving parts, e.g. on a bike chain.

Streamline / Aerodynamic: A shape that moves through fluids (e.g. water or air) with reduced friction, drag or air resistance.

L11 Efficiency

Useful energy: Energy that is in a store that we want it to be in to do work.

Wasted energy: energy that in a store that is not wanted

Sankey diagram: A form of flow diagram that displays the quantities of energy that move from one store to another within a system.

Joules: Unit of energy (J)

Efficiency: The proportion of energy (J) that is moved into a useful store within a system

L12 Energy resources

Renewable: A source of energy that will not run out due to use, e.g. Wlnd

Non-renewable: A source of energy that is finite, one day it will all be used up, e.g. Natural Gas

Fossil fuels: Non-renewable sources of energy that were formed by fossilisation of plants and animals over millions of years. Coal, Oil and Natural Gas

Predictability: How easy it is to predict when a source of energy will be available for use. E.g. Tidal, Hydroelectric and Geothermal are very predictable

Start-up time: The time it takes to begin generating electricity from a source of energy. Short start up times are useful to meet a sudden increase in demand.

Pumped storage: Water can be pumped up hill from one reservoir to another in a hydroelectric system using spare capacity in times of low demand, ready to generate electricity in times of high demand. It is a way of storing energy

Intermittent: Some sources of energy are not always available when you need them, e.g. Wind

Acid rain: Rain of low pH caused by Sulphur Dioxide and Nitrogen Oxides formed by the combustion of fossil fuels in power stations and cars

Global warming: The increase in the global temperature over time caused by the release of the greenhouse gas Carbon Dioxide during combustion. Global Warming has led to ongoing climate change.

Demand: How much electricity is being used by the country at any one time?

Remote Areas: Areas that are a long way away from big cities and town and so often have less infrastructure.