# EDEXCEL TOPIC 3 - CONSERVATION OF ENERGY (PART 1)

## Energy transfers

| System | An object or group of objects that interact together |
|---|---|

| | |
|---|---|
| Closed system | No change in total energy in system |
| Open system | Energy can dissipate (can enter or leave) |

| Dissipate | To scatter in all directions or to use wastefully | When energy is 'wasted', it dissipates into the surroundings as thermal energy and the temperature rises. |
|---|---|---|

| | |
|---|---|
| Useful energy | Energy transferred and used |
| Wasted energy | Dissipated energy, stored less usefully |

| | |
|---|---|
| Kinetic | Anything moving has energy in its kinetic energy store. |
| Thermal | Any object – the hotter it is the more energy is in its thermal energy store |
| Chemical | Anything that can release energy by a chemical reaction e.g. food, fuels |
| GPE | Anything that can fall / in a gravitational field |
| EPE | Anything stretched e.g. springs, rubber bands |
| Electrostatic | Two charges that attract or repel each other |
| Magnetic | Two magnets that attract or repel each other |
| Nuclear | Atomic nuclei release energy from this store in nuclear reactions |

| | |
|---|---|
| Gravitational Potential energy (GPE) | Energy gained by an object raised above the ground |
| Kinetic energy (KE) | Energy stored by a moving object |

Change in GPE = Mass X gravitational field strength X change in vertical height
$\Delta GPE = m \times g \times \Delta h$

$KE = \frac{1}{2} \times mass \times (speed)^2$
$KE = \frac{1}{2} \times m \times v^2$

| Energy transfer diagrams | An easy way to show what happens to the energy |
|---|---|
| | Boxes = energy stores and arrows = energy transfers |

| Unit |
|---|
| Joules (J) |

Thermal energy store of hot drink

**By heating Thermal energy transfers from hot liquid to cooler air and cup** →

Thermal energy store of cup and surrounding s

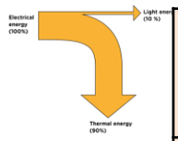
| Transfers between stores | |
|---|---|
| Mechanical | A force acts on an object (doing work e.g. push, squash, stretch |
| Electrically | A charge doing work against resistance e.g. charges moving round a circuit |
| By heating | Energy transfers from a hot object to a cooler object e.g. hot drink |
| By radiation | Energy transfers by waves e.g. sunlight reaching the Earth |

Total energy input = useful energy output + wasted energy

| Principle of conservation of energy | The amount of energy always stays the same. | Energy cannot be created or destroyed, only changed from one store to another. |
|---|---|---|

Energy is only useful when it is transferred from one store to another useful store

## Conservation of energy



Conduction transfers thermal energy through solid objects.

| Thermal conductivity |
|---|
| How well a material conducts energy |
| Metals have high thermal conductivity. |


| | |
|---|---|
| Cavity walls | An air gap reduces the amount of energy transfer by conduction |
| Thick walls | Thick walls have a slow rate of energy transfer |

In buildings the lower the thermal conductivity the slower the rate of energy transfer

| | |
|---|---|
| Energy (KE, EPE, GPE, thermal) | Joules (J) |
| Velocity | Metres per second (m/s) |
| Mass | Kilogram (Kg) |
| Gravitational field strength | Newton per kilogram (N/Kg) |
| Height | Metres (m) |

## Efficiency

| Efficiency | How much energy is usefully transferred |
|---|---|

Efficiency = $\frac{\text{Useful output energy transfer}}{\text{Total input energy transfer}}$

Efficiency = $\frac{\text{Useful power output}}{\text{Total power input}}$

**HIGHER ONLY**

Efficiency can be increased by reducing the thermal energy transferred due to friction by lubricating and the energy transferred by heating by insulation.

| Important energy Transfers between stores | | |
|---|---|---|
| | An object projected upwards or up a slope | The object does work against gravity so energy is transferred mechanically from the object's KE store to the GPE store. |
| | A moving object hitting an obstacle | The moving object has energy in it's KE store. Some of this is mechanically transferred to the obstacle's KE store. Some energy is mechanically transferred to the thermal energy store of the object and obstacle, to the thermal energy store of the surroundings by heat and the rest of the energy is 'carried' away by sound |
| | An object being accelerated by a constant force | Assuming there is no air resistance, gravity does work on the object. The object accelerates constantly towards the ground. Energy is transferred mechanically from the GPE store to the object's KE store. |
| | A vehicle slowing down | Energy in the vehicle's KE store is transferred mechanically due to friction between the road and tyres, and then by heating to the thermal energy store of the vehicle and road. |
| | Boiling water in an electric kettle | Energy is transferred electrically from the mains to the element in the kettle. The energy is then transferred by heating to the thermal energy store of the water. |

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**Energy transfers**

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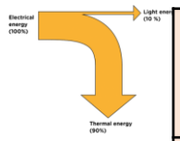

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| | Thick walls have a slow rate of energy transfer |

In buildings the lower the thermal conductivity the slower the rate of energy transfer

**Conservation of energy**

| | |
|---|---|
| | Joules (J) |
| | Metres per second (m/s) |
| | Kilogram (Kg) |
| | Newton per kilogram (N/Kg) |
| | Metres (m) |

**Efficiency**

| | |
|---|---|
| | How much energy is usefully transferred |

Efficiency = Useful output energy transfer / Total input energy transfer

Efficiency = Useful power output / Total power input

**HIGHER ONLY**

Efficiency can be increased by reducing the thermal energy transferred due to friction by lubricating and the energy transferred by heating by insulation.

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| Joules (J) |

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# EDEXCEL TOPIC 3 - CONSERVATION OF ENERGY (PART 1)

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| System | |
|---|---|

| Closed system | |
|---|---|
| Open system | |

| Dissipate | | |
|---|---|---|

| Useful energy | |
|---|---|
| Wasted energy | |

Conduction transfers thermal energy

| Thermal conductivity |
|---|
| |
| |

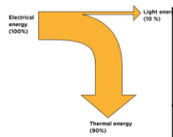

In buildings the lower the thermal conductivity

| Cavity walls | |
|---|---|
| Thick walls | |

Total energy input =

| Principle of conservation of energy | | |
|---|---|---|

Energy is only



**Conservation of energy**

**Energy transfers**

| Kinetic | |
|---|---|
| Thermal | |
| Chemical | |
| GPE | |
| EPE | |
| Electrostatic | |
| Magnetic | |
| Nuclear | |

| Energy (KE, EPE, GPE, thermal) | |
|---|---|
| Velocity | |
| Mass | |
| Gravitational field strength | |
| Height | |

**Efficiency**

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|---|---|

Efficiency =

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**HIGHER ONLY**

Efficiency can be increased

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| Transfers between stores | |
|---|---|
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| | |

| Energy transfer diagrams | |
|---|---|
| | |

| Unit |
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Thermal energy store

Thermal energy store

| Important energy Transfers between stores | | |
|---|---|---|
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| | | |

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# EDEXCEL TOPIC 3 - CONSERVATION OF ENERGY (PART 1)

Energy transfers

Conservation of energy

Conduction transfers thermal energy through solid objects.


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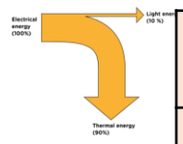


Efficiency

HIGHER ONLY

Efficiency can be increased

Change in GPE

KE =
KE =

# EDEXCEL TOPIC 3 - CONSERVATION OF ENERGY (PART 2)

## Energy resources

| | | |
|---|---|---|
| Non-renewable energy resource | ***These will run out. It is a finite reserve. It cannot be replenished.*** | e.g. Fossil fuels (coal, oil and gas) and nuclear fuels. |
| Renewable energy resource | ***These will never run out. It is an infinite reserve. It can be replenished.*** | e.g. Solar, Tides, Waves, Wind, Geothermal, Biomass, Hydroelectric |

Most do cause some damage to the environment but less than non-renewables

Do not provide a lot of energy and some are unreliable

**Biofuels**

***Made from plants and animal waste dung***

| Positives. | Negatives. |
|---|---|
| Renewable. | Cost to refine biofuels is very high. |
| Can be solid, liquid or gas and can be burnt to produce electricity. | Growing biofuels takes space away from growing food. |
| Reliable and take a short time to grow. | Natural habitats are destroyed to make room to grow biofuels. |
| 'Carbon neutral' theoretically plants take in the same amount of $CO_2$ as they release when burnt | Decay or burning of the cleared vegetation increases methane and $CO_2$ emissions. |

**Solar cells**

***Made from materials that use energy transferred by light to create an electric current***

| Positives. | Negatives. |
|---|---|
| No damage to the environment | Expensive |
| Used in remote places. | Weather dependant – cannot be used in cloudy countries. |

**Tidal barrages**

***Big dams built across river estuaries with turbines in them. As the tide comes in, water fills up the estuary, then water is let out through the turbines to generate electricity***

| Positives. | Negatives. |
|---|---|
| No polluting gases | Visual pollution |
| Reliable as tides occur twice a day | Prevent boat access |
| | Alter habitats for wading birds |
| No fuel costs, minimal running costs | Initial costs high |

**Wind**

***Each wind turbine has a generator inside it. As the wind rotates the blades, the generator turns and produces electricity***

| Positives. | Negatives. |
|---|---|
| No polluting gases. | Initial costs quite high |
| | Need lots to make enough electricity. |
| Running costs minimal. | Visual and noise pollution. |
| | Weather dependant – only work when windy |

**Hydro-electric power**

***Rainwater collects behind the dam and is allowed out through turbines.***

| Positives. | Negatives. |
|---|---|
| Can respond immediately to demand. | Building dams and flooding valleys |
| | Big impact upon environment. Loss of habitats. . |
| No polluting gases. | Initial costs high but minimal running costs. |

## Trends in Energy resource use

**Fossil fuels**

| | |
|---|---|
| ***Produce most of our electricity*** | The need for electricity increased greatly in the 20th century |
| ***Devices are becoming more efficient*** | Designers are trying to reduce the amount of wasted energy |

**Other uses of fossil fuels**

| |
|---|
| ***Oil (diesel and petrol) used to fuel cars*** |
| ***Gas is used to heat homes and to cook food*** |

Energy resources are chosen for their effect upon the environment.

Fossil fuels have a negative effect upon the environment.

Targets have been introduced to reduce the use of fossil fuels.

Car companies are designing electric and hybrid cars.

**Renewable fuels**

| | |
|---|---|
| ***Limited by reliability*** | Energy resources cannot quickly respond to demand like fossil fuels |
| ***Limited by cost*** | Building new renewable power stations is expensive |

Hybrid cars and solar panels for houses are still very expensive

Research into improving the reliability of renewable energy resources is expensive and takes time.

People object to wind farms (visual pollution).

**Negatives for using fossil fuels and nuclear fuel**

| | |
|---|---|
| ***Create environmental problems*** | Fossil fuels release carbon dioxide when burnt. |
| ***Non-renewable*** | Will run out. |
| ***Nuclear power stations are expensive*** | To build and to decommission safely. |

Oil spillages cause serious marine environmental problems

Nuclear waste is dangerous and difficult to dispose of and there is always a risk of catastrophes.

Burning coal and oil release sulphur dioxide which causes acid rain.

$CO_2$ is a greenhouse gas and contributes to global warming

**Positives for using fossil fuels and nuclear fuel**

| | |
|---|---|
| ***Reliable*** | Provides lots of energy. |
| ***Plenty of fuel to meet current demand*** | Respond quickly to electrical needs from National Grid. |
| ***Cost to extract is low*** | Fossil fuel power plants relatively cheap to build and run. |

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## Trends in Energy resource use

| | |
|---|---|
| ***Produce most of our electricity*** | The need for electricity increased greatly in the 20th century |
| ***Devices are becoming more efficient*** | Designers are trying to reduce the amount of wasted energy |

| | |
|---|---|
| ***Limited by reliability*** | Energy resources cannot quickly respond to demand like fossil fuels |
| ***Limited by cost*** | Building new renewable power stations is expensive |

Research into improving the reliability of renewable energy resources is expensive and takes time.

Hybrid cars and solar panels for houses are still very expensive

People object to wind farms (visual pollution).

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| ***Oil (diesel and petrol) used to fuel cars*** | |
| ***Gas is used to heat homes and to cook food*** | |

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Fossil fuels have a negative effect upon the environment.

Targets have been introduced to reduce the use of fossil fuels.

Car companies are designing electric and hybrid cars.

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## Energy resources

Non-renewable energy resource

Renewable energy resource

Most do cause some damage

Do not provide a lot of energy

Biofuels

## Trends in Energy resource use

Fossil fuels

Other uses of fossil fuels

Energy resources are chosen

Fossil fuels have a

Targets have been introduced

Car companies are designing

Renewable fuels

Hybrid cars and solar panels

Research into improving the reliability of renewable

People object

Solar cells

Wind

Tidal barrages

Hydro-electric power

Negatives for using fossil fuels and nuclear fuel

Burning coal and oil release

Oil spillages cause

Nuclear waste is

$CO_2$ is a greenhouse gas

Positives for using fossil fuels and nuclear fuel

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Burning coal and oil

Oil spillages

Nuclear waste

$CO_2$ is

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Most do cause

Do not provide

| Biofuels | |
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## Trends in Energy resource use

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Energy resources

Fossil fuels

Targets

Car companies

Hybrid cars and

Research

People

| Solar cells | |
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| Tidal barrages | |
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| Wind | |
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| Hydro-electric power | |
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