Combined Science CP3 Conservation of Energy

System	
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		
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*

Conduction transfers thermal energy through solid objects.

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

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

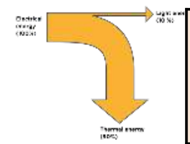
Cavity walls	*An air gap reduces the amount of energy transfer by conduction*
Thick walls	*Thick walls have a slow rate of energy transfer*

Conservation of energy

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



Energy transfers

Store	
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*

Quantity	Unit
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 = 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.

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 = ½ X mass X (speed)^2

$KE = \frac{1}{2} \times m \times v^2$

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

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

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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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

- Research into improving the reliability of renewable energy resources is expensive and takes time.
- People object to wind farms (visual pollution).
- Hybrid cars and solar panels for houses are still very expensive

Energy resources

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.

- Burning coal and oil release sulphur dioxide which causes acid rain.
- Oil spillages cause serious marine environmental problems
- Nuclear waste is dangerous and difficult to dispose of and there is always a risk of catastrophes.
- 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.

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.