GCSE Physics – Energy (page 1)

START

Energy Type	Examples
Light	Bulb, TV screen
Thermal	Any hot object
Sound	Drum, engine, loud speaker
Electrical	TV, kettle, computer
Kinetic	Any moving object
Gravitational potential	Stored in objects when they are off the ground
Elastic potential	Stored in Springs, bungee chord
Chemical potential	Stored in fuels & batteries
Nuclear potential	Stored in the nuclei of atoms

The law for the conservation of energy states that energy cannot be created or destroyed, only transferred from one type into another.

E.g.1. A lightbulb:

60J electrical energy →  → 40J thermal energy, 20J light energy

Joules (J) are the units of energy

Elastic Potential energy is energy stored in a stretched spring – it depends on the spring constant (stiffness of the spring) & how much the spring is stretched (the extension)

Elastic potential energy
= 0.5 x spring constant x (extension in m)^2

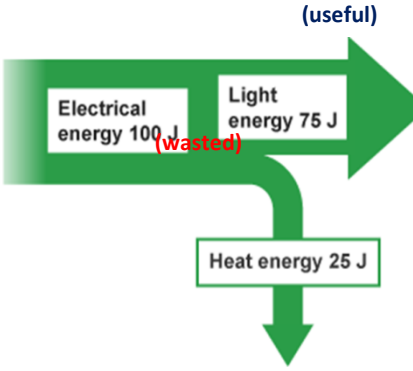
E.g. A spring has a spring constant of 500N/m. How much energy is stored when it is stretched 10cm.

$E_K = ½ke^2 = ½ \times 500 \times 0.1^2$
$= 250 \times 0.01 = \underline{2.5J}$

Key words:

1. **Potential Energy** – Energy stored in a system
2. **Conservation of Energy** – the rule that states the total amount of energy stays the same
3. **Efficiency** – the proportion of the energy supplied that is transferred usefully
4. **Dissipated** – when energy is wasted & 'lost', usually as heat
5. **Work** – the transfer of energy
6. **Power** – the rate of doing work/transferring energy
7. **Specific Heat Capacity** – the amount of energy required to raise the temperature of 1kg of a substance by 1°C
8. **Energy Resource** – a way of getting energy for generating electricity
9. **Renewable** – a resource that can be replaced (eg. Wind)
10. **Non-renewable** – a resource that cannot be replaced (eg. Coal)
11. **Fuel** – a concentrated store of energy
12. **Fossil fuel** – a fuel made from the remains of living things

E.g.2. Sankey Diagram for an energy efficient light bulb:



Rollercoaster Energy Transfers

Dropping down: Gravitational potential energy is transferred into kinetic energy

Going back up: Kinetic energy is transferred back into gravitational potential energy

Gravitational Potential Energy is energy stored in an object because of its height above the ground.

To work out how much GPE an object gains when it is lifted up we would use the simple equation…

GPE = mass (kg) × gravitational field strength × height (m)

E.g. How much GPE does a 50kg person have when lifted up 0.5m by a friend. On Earth g=10N/kg

$E_P = mgh = 50x10x0.5 = \underline{250J}$

Kinetic energy is energy an object has because it is moving – it depends on the object's speed & mass.

Kinetic energy= 0.5 x mass x(speed)^2
in J *in kg* *in m/s*

E.g. A bike at a speed of 10m/s. If the mass of the bike & rider is 80kg what is their kinetic energy?

$E_K = ½mv^2 = ½ \times 80 \times 10^2$
$= 40 \times 100 = \underline{400J}$

Power is the rate of doing work/transferring energy – measured in **Watts (W)**.

$$Power = \frac{Energy\ (or\ Work)}{Time}$$

E.g. What is the power of an electric fire that transfers 10,000J of energy in 5 seconds?

P = E/t = 10,000/5 = <u>2000W</u>

- When energy is used it is transferred from one type to another we say that **Work** is done.
- The amount of Work (in Joules) is equal to the amount of energy transferred (in Joules)
- Whenever a force is applied to move an object (eg. Lifting a box), work has to be done.

Energy Resources

Type Of Power	Advantages	Disadvantages
Coal	Cheap to use High power output Can be used easily Large reserves still available	Lowest energy density of fossil fuels Non-renewable High CO_2 and SO_2 emissions Contribute to the enhanced greenhouse effect
Oil	Convenient in some oil producing countries Can be used in engines	Medium energy density Non-renewable High CO_2 and SO_2 emissions Contribute to the enhanced greenhouse effect
Natural gas	High energy density Cleaner and more efficient than other fossil fuels Can be used in engines	Medium CO_2 emissions Non-renewable Contribute to the enhanced greenhouse effect
Nuclear	High power output Reserves available	Expensive to build and run Radioactive materials have to be disposed of Possible nuclear accident
Passive solar	No fuel costs Renewable Non-polluting	Only works in daylight Not efficient when clouds present Power output is low
Photovoltaic solar	No fuel costs Renewable Non-polluting	Only works in daylight Not efficient when clouds present Power output is low Initial costs high Energy needs to be stored
Hydro-electric Tidal	No fuel costs Renewable Non-polluting	Need correct location Changes in the environment destroys ecosystems and can displace people Expensive to construct
Wind	No fuel costs Renewable Non-polluting	Need a windy location Power output is low Environmentally noisy High maintenance costs due to metal stress and strain
Wave	No fuel costs Renewable Non-polluting	High maintenance due to the power of waves High establishment costs.

What is specific heat capacity ?

Energy = specific heat capacity x mass x change in temperature
(J) (J/kg/ ^{0}C) (kg) (^{0}C)

If you calculate how much energy 1kg of water needs to become 1^{0}C hotter, you will find it needs 4200J. This number is called the specific heat capacity of water.

The specific heat capacity of a substance is the amount of energy that is needed to raise the temperature of 1kg of the substance by 1^{0}C.

Copper is used for pans has it has a very low specific heat capacity, and hence warms up very fast.

Water has a high specific heat capacity, and hence it takes a lot of energy to heat up the water for a bath. And also very expensive – take a shower!!!

E.g. How much energy is needed to heat 2kg of water from 10 ^{0}C to 30 ^{0}C?

Energy needed = mcΔθ
= 4200 x 2 x 20
= 168000 J

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Using Specific Heat Capacity to Calculate the Energy Gained by a Block

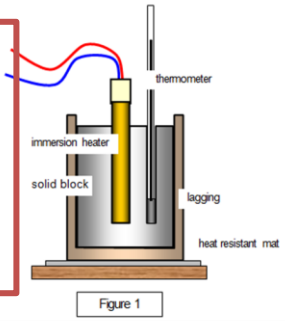

Figure 1

1. Use a top-pan balance to measure the mass of the block.
2. Set up the apparatus as shown in the diagram.
3. Use the thermometer to measure the initial temperature of the block.
4. Attach the Immersion heater to the power pack set at 12V and switch on.
5. After 5 minutes switch the power pack off and measure the final temperature of the block.

CAUTION – THE HEATER & BLOCK WILL GET HOT!

Material	S.H.C (J/kg/°C)	Mass (kg)	Initial Temp. (°C)	Final Temp. (°C)	Temp. change (°C)	Energy gained (J)

Most of the electricity we use is generated from fossil fuels (coal, oil, and gas) in big power stations. Figure 3 shows how electricity is generated in a typical fossil fuel power station.

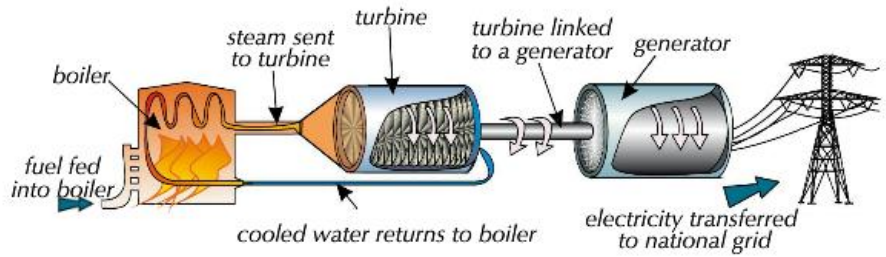

Figure 3: *Electricity generation in a fossil fuel power station.*

Efficiency is a measure of how much of the energy supplied to a device is transferred into useful energy.

An energy efficient light bulb converts 10J of electrical energy into 8J of light energy every second. Calculate its efficiency.

- efficiency = useful energy out (x100%)
  total energy in
- Efficiency = 8 x 100
  10
- Efficiency = **0.8** x 100 = **80%**

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

The efficiency of a system can be increased by reducing the amount of wasted energy (usually heat) by lubricating moving parts with oil to reduce friction or by insulating the device to stop heat being lost to the surroundings.

GCSE Physics – Energy Questions

Energy Stores and Systems

1) Write down four energy stores.
2) Describe the energy transfers that occur as a ball falls to the ground.
3) Give the equation for finding the energy in an object's kinetic energy store.
4) If energy is transferred to an object's kinetic energy store, what happens to its speed?
5) Give the equation for finding the energy in an object's gravitational potential energy store.
6) What kind of energy store is energy transferred to when you compress a spring?

Specific Heat Capacity

7) What is the definition of the specific heat capacity of a material?
8) Give the equation that relates energy transferred and specific heat capacity.
9) Describe an experiment to find the specific heat capacity of a material.

Conservation of Energy and Power

10) State the conservation of energy principle.
11) Define power and give two equations to calculate power.
12) What are the units of power?

GCSE Physics – Energy Questions

Reducing Unwanted Energy Transfers and Improving Efficiency

13) How can you reduce unwanted energy transfers in a machine with moving, touching components? ☐
14) True or false? A high thermal conductivity means there is a high rate of energy transfer. ☐
15) Give four ways to prevent unwanted energy transfers in a home. ☐
16) True or false? Thicker walls make a house cool down quicker. ☐
17) What is the efficiency of an energy transfer? Give the equation that relates efficiency to power. ☐

Energy Resources and Trends in their Use

18) Name four renewable energy resources and four non-renewable energy resources. ☐
19) What is the difference between renewable and non-renewable energy resources? ☐
20) Give an example of how a renewable energy resource is used in everyday life. ☐
21) Explain why solar power is considered to be a fairly reliable energy resource. ☐
22) True or false? Tidal barrages are useful for storing energy to be used during times of high demand. ☐
23) Give two ways in which the environment can be damaged when using fossil fuels. ☐
24) Give one environmental benefit of using nuclear power. ☐
25) Explain why the UK plans to use more renewable energy resources in the future. ☐