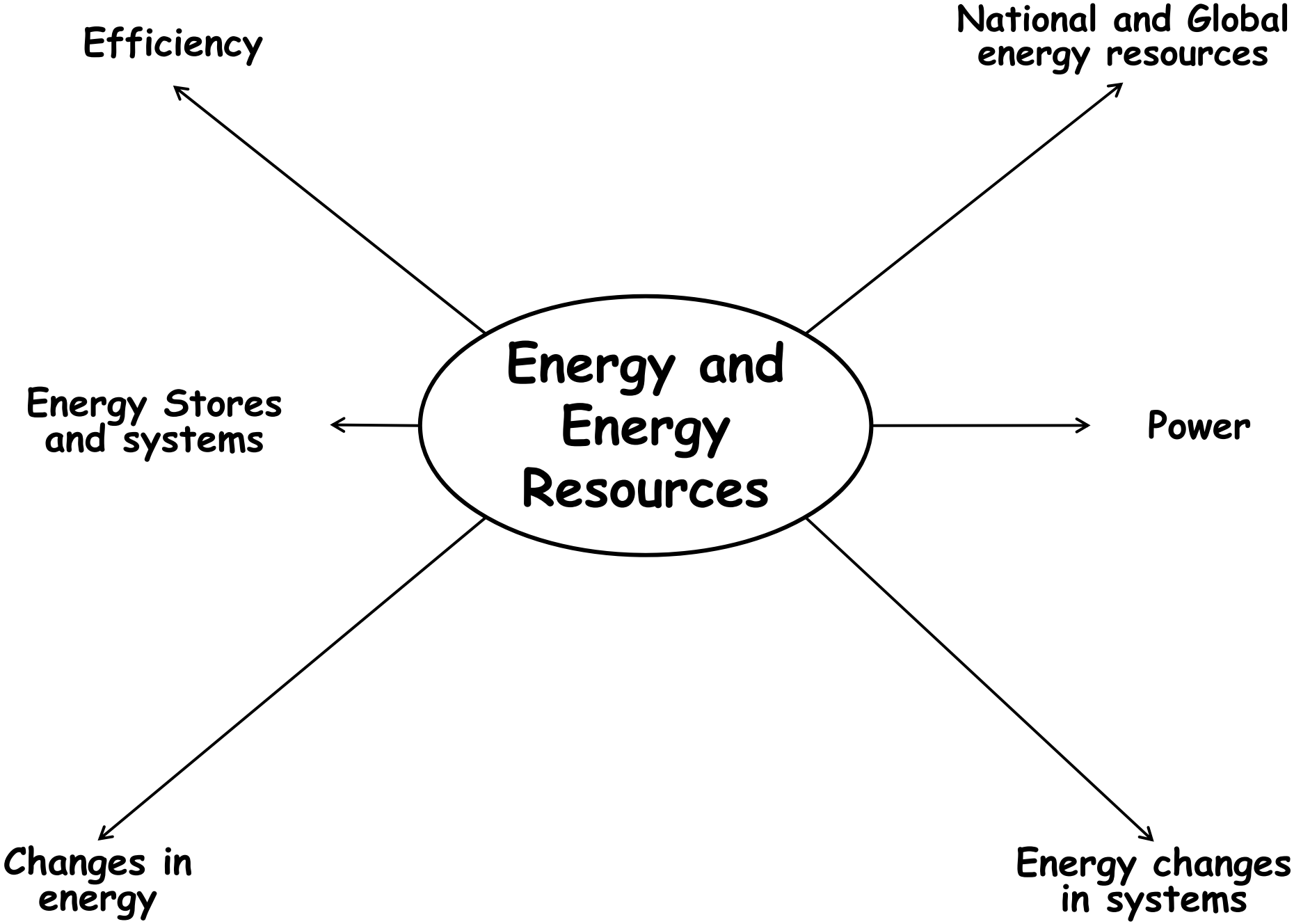
Unit 1: Energy and Energy Resources



Changes in Energy Stores

There are 10 main types of energy store and transfer that you need to know about:

Most	Magnetic	Magnets
Kids	Kinetic	Anything that moves
Hate	Heat (Thermal)	Anything that gives out heat
Learning	Light	Anything that gives out its own light
G	Gravitational Potential	Anything that is raised from the ground
C	Chemical	Batteries, food, drinks, chemical reactions
S	Sound	Anything that vibrates to make a noise
E	Electrical	Anything that has wires (and lightning)
Energy	Elastic Potential	Anything that stretches or squashes
Names	Nuclear	Energy from within atoms

Not all energy is useful. Energy that is dissipated, like heat energy from a light bulb, is transferred to the surroundings

Conservation of energy:

"Energy can be changed from one form to another, but it cannot be created or destroyed"

We can show that energy is transferred from one type to another in an energy transfer diagram. The energy is represented by an arrow.

Complete the sentence: Energy cannot be _____ or _____	
Destroyed	Transformed
Created	Transferred

Imagine a diagram showing energy for a speaker. Which of the following statements would be correct?	
Energy in should equal energy out	X
Energy transferred to the environment should be accounted for	X
Energy transfers could be labelled in Joules	X
All of the energy would be converted into sound/	

Name a type of energy that is wasted by each of the following appliances.	
A speaker wastes…	Kinetic
A lightbulb wastes…	Heat
A motor wastes…	Heat
A toaster wastes…	Light

What is the most common form of 'wasted' energy?	
Thermal energy	Sound energy
Light energy	Electrical energy

Changes in Energy Stores: Checklist

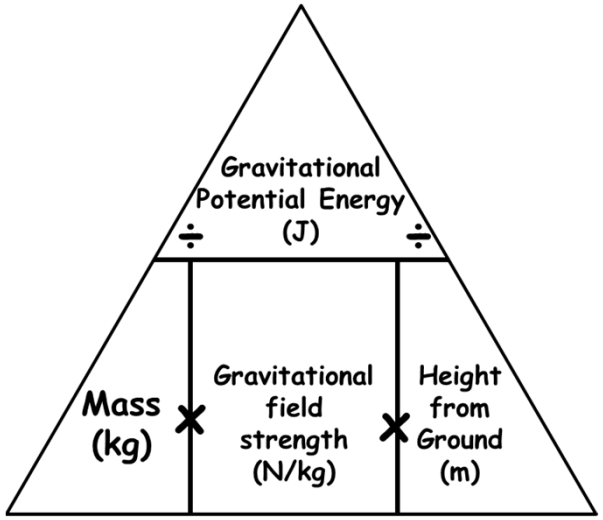
For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Identify that a 'system' is an object or a group of objects			
Identify that there are changes in the way energy is stored when a system changes			
Describe the changes that happen when a system changes			
Describe that energy can be transferred usefully, stored or dissipated, but not created or lost.			
Describe that there is no change to a system if the system is 'closed'.			
Describe that in all energy systems, energy is dissipated so that it is stored in less useful ways.			

Gravitational Potential Energy

Gravitational potential energy (sometimes shortened to GPE) is the energy stored in an object because of its position in a gravitational field.

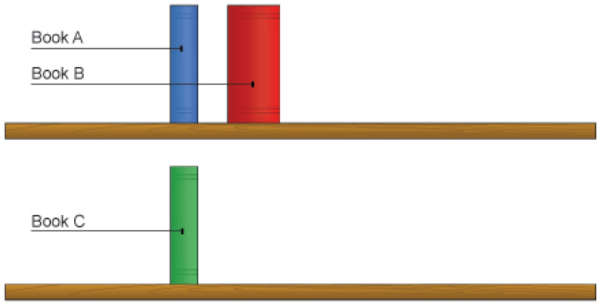
The amount of gravitational potential energy stored in an object depends on 3 things:

- The mass of the object, in kg
- The strength of the gravitational field, in N/kg (on Earth this is 10N/kg)
- The height of the object from the ground, in m



All of the books on these shelfs have GPE. However, because the books on the one shelf are higher, we would say that they have more GPE.

The red book would have more GPE than the blue book as it has a greater mass.



If an object is lifted, work is done against gravitational force. IE if the green book was raised to the top shelf, it would gain GPE. The energy gained would be:

$$\Delta GPE = m \times g \times \Delta h$$

Where Δ means a change in something.

An athlete trains by pushing a heavy rock up a hill. Every time it gets to the top, the rock slides to the bottom and they must push it to the top again. The stone has a mass of 40N, and the hill is 10m high. If he manages to push the stone up the hill 4 times an hour, how much work do they do every hour?	
400J	600J
1000J	1600J

Rashid and Mark go to the park and Rashid pushes Mark on the swing. Which two statements are correct?	
Mark works harder than Rashid	Rashid is mostly working against gravity
Mark has the most kinetic energy when the swing is at the bottom	Mark has most kinetic energy when the swing is at the top and changes direction

Which one of these is not required to work out the potential energy of an object?	
Mass	Gravity
Temperature	Height

A student lifts a 5kg box and places it onto a shelf 2m from the ground. How much potential energy has been gained?	
100J	10J
1kJ	0.1MJ

Two workers carry a bag of bricks to the top of a building. If the bricks weigh 50N and the building is 10m, how much work do they do between them?	
5J	250J
500J	1000J

Gravitational Potential Energy: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Describe all of the energy changes that take place when an object is thrown upwards			
Describe the energy changes that take place when an object falls to the ground and hits the floor without bouncing back			
Calculate the amount of gravitational potential energy gained by an object when it is raised from the ground			

Kinetic Energy

Kinetic energy can also be also called KE. This is the amount of energy an object has by moving.

The amount of KE an object has depends on:

- The mass of the object, in kg
- How fast the object is moving, in m/s

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

As an object speeds up or slows down, forces are acting to do work.

This either increases or decreases the kinetic energy of the object.

There are some situations where we can say that all of the GPE has been converted into KE. This could be an object that has fallen from a shelf, for example.

If we know that the GPE and KE are the same, we can say…

GPE = KE

If this is the case, we can find the velocity of the object after falling to the ground by using the equation

$$v = \sqrt{2 \times g \times h}$$

Doubling the mass of an object increases the KE of an object much more than if you were to double the speed of the object.

If a lorry and a car are both travelling at the same speed, the lorry would do far more damage if it hits something than the car. This means that the lorry must have more KE!

What units do we measure each of the following quantities with?	
Mass	kg
Speed	m/s
Kinetic Energy	J
Height	m

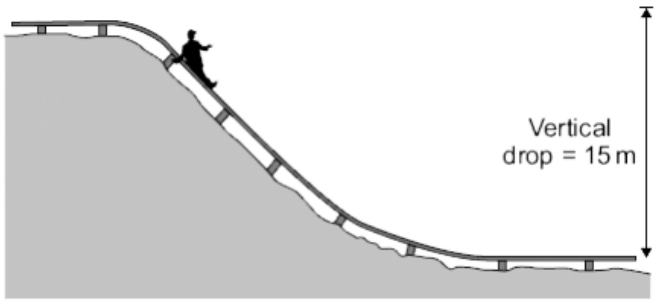
Calculate the kinetic energy of each of these objects:	
A runner travelling at 10m/s with a mass of 65kg	6500J
A tennis ball travelling at 46 m/s with a mass of 56g	118.5J
A sports car with a mass of 1350kg, travelling at 401.2km/h	16,633,350J
A cat running across a garden at a speed of 1.15m/s with a mass of 4.2kg.	5.56J

Convert a speed of 295.2 kilometres per hour (km/h) into meters per second (m/s).	
1062 m/s	82 m/s
2952 m/s	60 m/s

If you double the speed of an object, what will happen to its kinetic energy?	
Increases by a factor of 4	Halves
Decreases by a factor of 4	Doubles

Choose two options that describe the energy changes that occur as a skateboarder travels down a ramp.	
Kinetic energy transfers to GPE	Energy transfers to light and heat
GPE transfers to kinetic energy	Energy transfers to sound and heat (if it is wasted)

The miners working in a salt mine use smooth wooden slides to move quickly from one level to another.



(a) A miner of mass 90 kg travels down the slide.

Calculate the change in gravitational potential energy of the miner when he moves 15 m vertically downwards.

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

.....

.....

Change in gravitational potential energy = ... J

(b) Calculate the **maximum** possible speed that the miner could reach at the bottom of the slide.

Show clearly how you work out your answer.

Give your answer to an appropriate number of significant figures.

.....

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.....

Maximum possible speed = ... m/s

(c) The speed of the miner at the bottom of the slide is much less than the calculated maximum possible speed.

Explain why.

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.....

(a) 13 500 (J)

*allow **1** mark for correct substitution, ie 90 x 10 x 15 provided no subsequent step shown*

2

(b) 17

or

$\sqrt{\frac{\text{their (a)}}{45}}$

correctly calculated and answer given to 2 or 3 significant figures

accept 17.3

*allow **2** marks for an answer with 4 or more significant figures, ie 17.32*

or

*allow **2** marks for correct substitution, ie 13 500/ their (a) = ½ x 90 x v^2*

or

*allow **1** mark for a statement or figures showing KE = GPE*

3

(c) work is done

1

(against) friction (between the miner and slide)

*accept 'air resistance' **or** 'drag' for friction*

1

(due to the) slide not (being perfectly) smooth

accept miners clothing is rough

or

causing (kinetic) energy to be transferred as heat/internal energy of surroundings

accept lost/transformed for transferred

accept air for internal energy of surroundings

1

Kinetic Energy: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Describe all of the energy changes that take place when a moving object collides with an obstacle			
Calculate the amount of kinetic energy has when it is moving at a given velocity			
Explain that an object that doubles its velocity, will have four times as much kinetic energy			

Hooke's Law

The strength of a spring is called the spring constant.
This has the letter k and has the units of Newtons per meter (N/m).
The springs constant changes if:

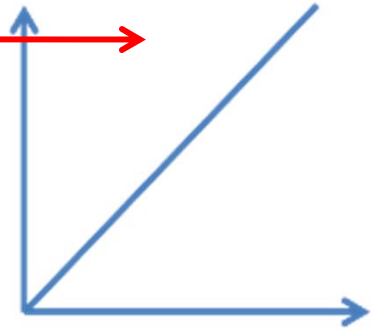
- The spring is made thinner or thicker, or;
- The spring is made of a different material.

The greater the spring constant, the more difficult it is to squash or stretch it.

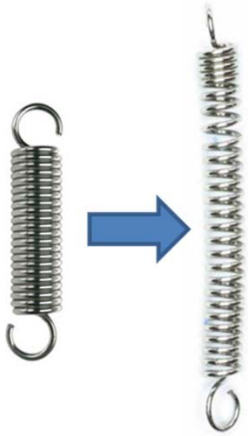
Hooke's law states that…

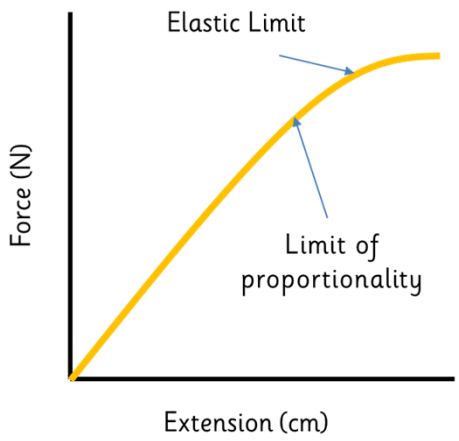
"The extension of a spring is proportional to the force that is applied to the spring."

This means that if we double the force on the spring, we will double the extension of the spring. This is true until the spring is stretched beyond its *elastic limit*.



The *elastic limit* is the point at which a spring (or any other
material that is being stretched) becomes permanently stretched.
This means that when you take the force off the spring, it will
not return to its original shape.





Hooke's Law

To find the spring constant of a spring…

Force = spring constant x extension

$F = k\,e$

In the equation…

F is the force in Newtons (N)

k is the spring constant in Newtons per metre (N/m)

e (sometimes x or l) is the extension in metres (m) – don't forget to convert into metres!

To find the energy stored in a spring…

Energy = $\frac{1}{2}$ x spring constant x extension^2

$E = \frac{1}{2} \times k \times e^2$

In the equation…

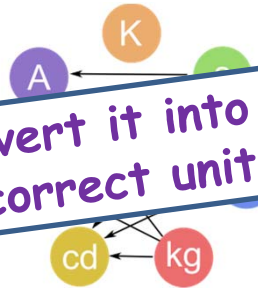
E is the energy in Joules (J)

k is the spring constant in Newtons per metre (N/m)

e (sometimes x or l) is the extension in metres (m) – don't forget to convert into metres and square it!

If you have to find the difference in energy stored in a spring, you must find the energy that is stored in the springs at both lengths and then find the difference in the energy stored!

Highlight the key information!



Convert it into the correct units!

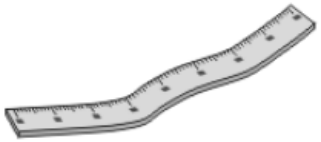
Substitute it into the question!

Calculate the spring constants for each of the springs.	
A force of 3N and an extension of 0.2m	15N/m
A force of 2N and an extension of 5cm	40N/m
A force of 6N and an extension of 0.5m	12N/m
A force of 0.5kN and an extension of 40cm	1250N/m

An experiment is set up to measure the extension of a suspended spring when weights are hung from one end of it. Which of the following will have an impact on the extension measured?	
The mass of the spring	The mass of the weights
The material the spring is made from	The material the weight is made from

A group of students performed an experiment to investigate the extension of three springs when varying forces were applied to them. Which of the following would you predict they found?1	
In the graph of *force* on the y-axis against *extension* on the x-axis, the lightest spring has the smallest gradient	In the graph of *force* on the y-axis against *extension* on the x-axis, the heaviest spring has the smallest gradient
The graph of *force* on the y-axis against *extension* on the x-axis showed three straight lines of different gradients	The graph of *force* on the y-axis against *extension* on the x-axis showed three straight lines of the same gradient

(a) The pictures show four objects. Each object has had its shape changed.



Bent metal ruler

A

Stretched bungee cords

B

Springs on a playground ride

C

Moulded plastic model car body

D

Which of the objects are storing elastic potential energy?

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Explain the reason for your choice or choices.

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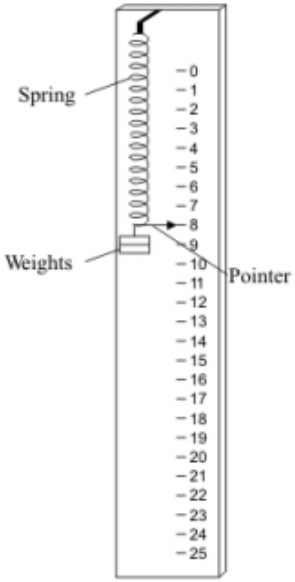
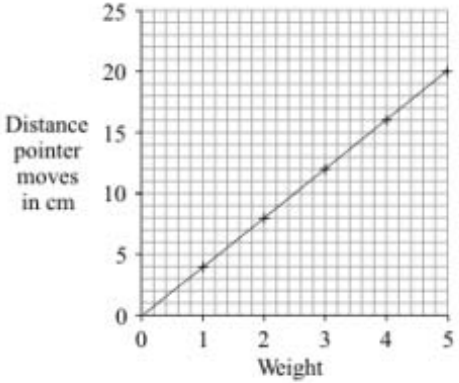
(b) A student makes a simple spring balance. To make a scale, the student uses a range of weights. Each weight is put onto the spring and the position of the pointer marked



The graph below shows how increasing the weight made the pointer move further.



(i) Which **one** of the following is the unit of weight?.

Draw a ring around your answer.

joule **kilogram** **newton** **watt**

(ii) What range of weights did the student use?

.....

(iii) How far does the pointer move when **4** units of weight are on the spring?

.....

(iv) The student ties a stone to the spring. The spring stretches 10 cm.

What is the weight of the stone?

.....

(a) **B** or bungee cords

1

C or springs or playground ride

*each additional answer loses **1** mark minimum mark zero*

1

will go back to original shape/size

1

(b) (i) newton

1

(ii) 0 – 5 (N) or 5

accept1 – 5 (N)
*do **not** accept 4*

1

(iii) 16 (cm)

1

(iv) 2.5 (N)

accept answer between 2.4 and 2.6 inclusive

1

Hooke's Law: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Describe the energy changes that take place when a spring is stretched, released and moves back towards its original position			
Calculate the spring constant, k, of a spring			
Calculate the energy stored in a spring using the spring constant and extension , in meters, of a given spring			
Explain how to complete an investigation into the relationship between the force and extension of a material			

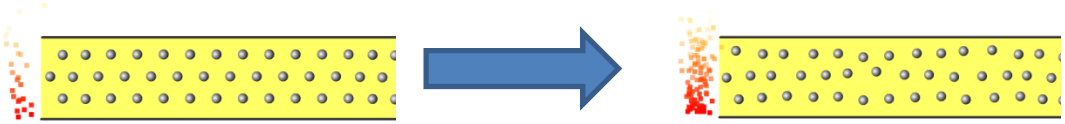
Thermal Conductivity

There are a number of different factors that affect how quickly heat can be lost:

- Is the material a good conductor?
- Is there a large temperature difference between the material and the surroundings?
- Is there a draught (can air flow freely through the material)?

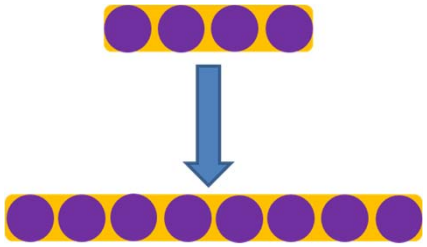



Heat energy can be passed throughout a solid by a process called conduction.

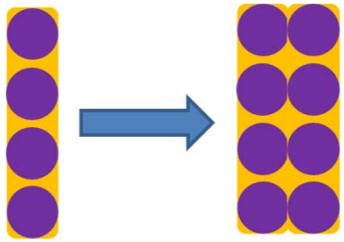


- This is where the heat energy is transferred into kinetic energy to the atoms in the solid.
- Metals are better conductors because they have free (delocalised) electrons, that help to pass the energy through the material quicker.

If the length of the metal is doubled in size, it will take twice as long for the energy to pass through to the end of the metal. This is because the energy has twice the distance to pass through the substance.



If the length of the metal stays the same, but is now thicker, the energy will pass through quicker. This is because there are more free electrons to pass along the energy through the metal.



Which of the following words describes a material that does not allow heat energy to flow through it?	
Conductor	Convector
Radiator	Insulator

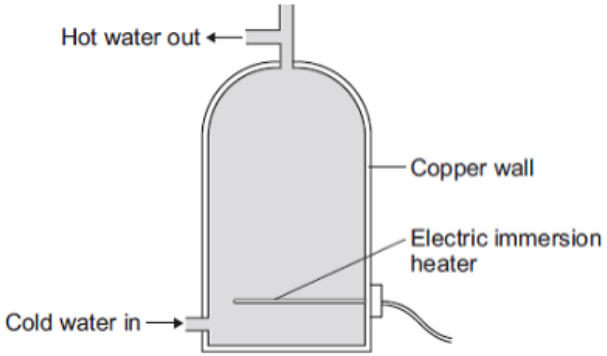
What is temperature measured in?	
Degrees	Degrees Celsius
Joules	Newtons

Which two materials below are good thermal conductors	
Aluminium	Sponge
Plastic	Steel

Which two materials below are good thermal insulators	
Brass	Air
Bronze	Polystyrene

Use the definitions to find the keywords.	
How heat is transferred in a fluid due to changes in density	Convection
How heat is transferred by infrared electromagnetic waves	Radiation
How heat is transferred by nearby particles colliding and passing on their energy	Conduction
A scale for measuring the temperature of a substance	Degrees Celcius

An electric immersion heater is used to heat the water in a domestic hot water tank. When the immersion heater is switched on the water at the bottom of the tank gets hot.



(a) Complete the following sentence.

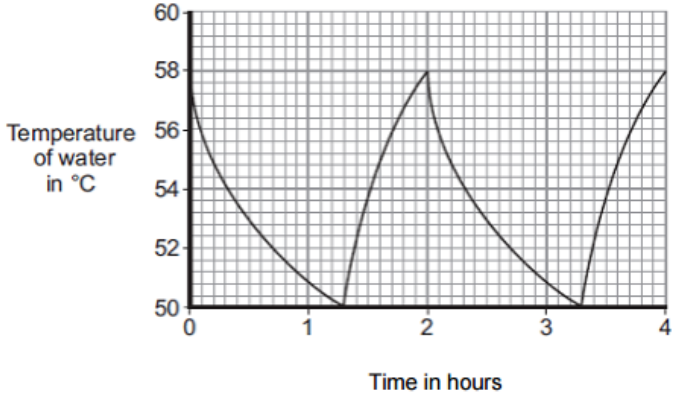
The main way the energy is transferred through the copper wall of the water tank is by the process of ..... .

(b) The immersion heater has a thermostat to control the water temperature.

When the temperature of the water inside the tank reaches 58°C the thermostat switches the heater off. The thermostat switches the heater back on when the temperature of the water falls to 50°C.

Graph A shows how the temperature of the water inside a hot water tank changes with time. The tank is **not** insulated.

Graph A (no insulation)



(i) The temperature of the water falls at the fastest rate just after the heater switches off.

Explain why.

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(ii) To heat the water in the tank from 50°C to 58°C the immersion heater transfers 4032 kJ of energy to the water.

Calculate the mass of water in the tank.

Specific heat capacity of water = 4200 J/kg°C

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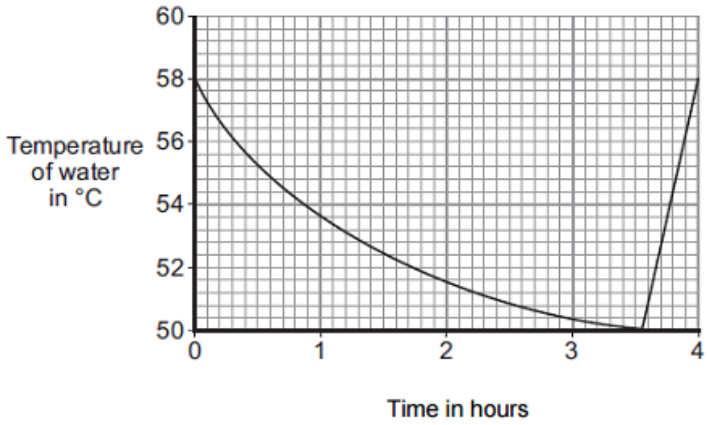
.....

Mass = ... kg

(iii) An insulating jacket is fitted to the hot water tank.

Graph B shows how the temperature of the water inside the insulated hot water tank changes with time.

Graph B



An insulating jacket only costs £12.

By comparing **Graph A** with **Graph B**, explain why fitting an insulating jacket to a hot water tank saves money.

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.....

.....

(a) conduction

1

(b) (i) there is a bigger temperature difference between the water and the surrounding air

accept the water is hottest / hotter

1

so the transfer of energy (from hot water) is faster

accept heat for energy

ignore temperature falls the fastest

1

(ii) 120

*allow **1** mark for converting kJ to J correctly, ie 4 032 000*

or

correctly calculating temperature fall as 8°C

or

allow **2** marks for correct substitution, ie 4 032 000 = m × 4200 × 8

answers of 0.12, 19.2 **or** 16.6 gain **2** marks

answers of 0.019 **or** 0.017 gain **1** mark

3

(iii) water stays hot for longer

1

so heater is on for less time

accept so less energy needed to heat water

1

so cost of the jacket is soon recovered from) lower energy costs / bills

accept short payback time

1

Thermal Conductivity: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Identify that the higher the thermal conductivity of a material, the higher the rate of energy transfer by conduction through the material			
Describe how the rate of cooling of a building is affected by the thickness and thermal conductivity of its walls			
Explain ways of reducing unwanted energy transfers, for example through lubrication and the use of thermal insulation			
Explain how to investigate the effectiveness of different materials as thermal insulators and the factors that may affect the thermal insulation properties of a material.			

Specific Heat Capacity

You need to know the definition of the specific heat capacity of a substance:

"Specific heat capacity is how much energy is required to increase the temperature of 1kg of a substance by 1°C."

Different substances have different specific heat capacities. For example, it takes more energy to raise the temperature of 1kg of water than 1kg of aluminium.

There are 3 key factors that affect how much energy is required to heat a material up:

- The mass of the substance (in kg) — m
- The type of substance that you are heating (J/kg°C) — c
- How much the temperature changes (in °C) — ΔT

We use the specific heat capacity equation to find out how much energy this would require:

$$\text{Energy required (J)} = m \times c \times \Delta T$$

You have completed a practical on finding the specific heat capacity of different materials.

- Your independent variable was the material that the block was made of.
- Your dependent variable was the change in temperature that was measured.
- Your control variables included the type of heater you used, the time you heated the block and the potential difference supplied to the heater.

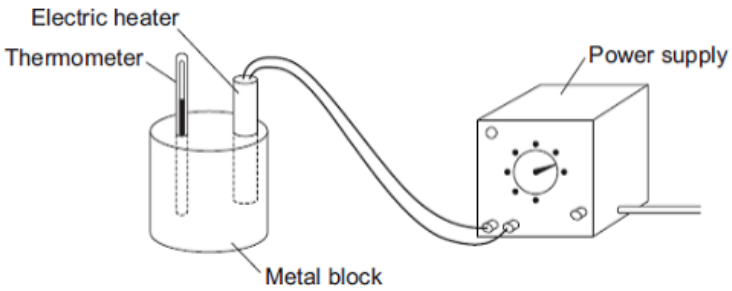
Which of these materials has the highest specific heat capacity?	
Water	Copper
Steel	Concrete

What would the temperature change be when supplying 2kg of water with 2100J of thermal energy?	
4200°C	0.5°C
0.25°C	1550°C

Which two of the statements are true?	
Temperature and heat are the same thing	The energy required to heat up a block of mass depends on its mass
Materials with a high specific heat capacity are bad at insulating	Hot water tanks cool down when not supplied with extra heat

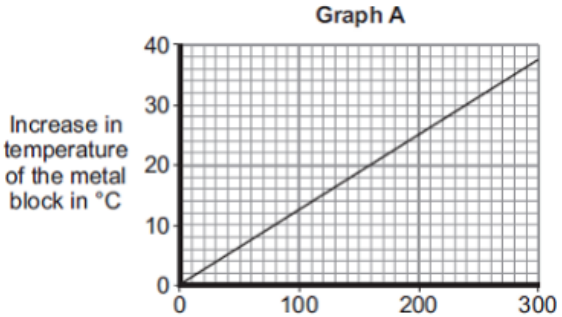
When a block of 1kg copper at 300°C is added to a 1kg sample of water at 20°C, which two of the following will happen?	
The water will absorb the energy, and its temperature will rise to 300°C	The energy in the materials will combine, and both of the temperatures will rise
The copper will cool down	The final temperature reached by both materials will be closer to that of the water than the copper at the start

(a) A student used the apparatus drawn below to investigate the heating effect of an electric heater.



(i) Before starting the experiment, the student drew **Graph A**.

Graph A shows how the student expected the temperature of the metal block to change after the heater was switched on.



Describe the pattern shown in **Graph A**.

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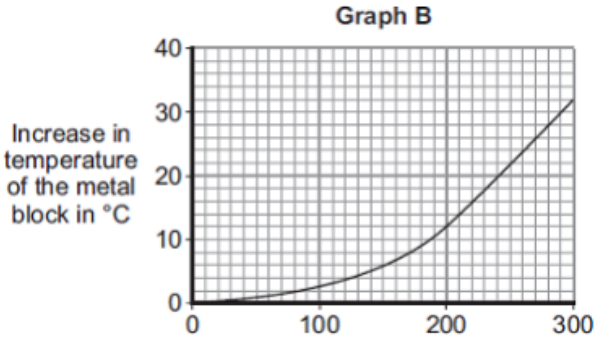
(ii) The student measured the room temperature. He then switched the heater on and measured the temperature of the metal block every 50 seconds.

The student calculated the increase in temperature of the metal block and plotted **Graph B**.



After 300 seconds, **Graph B** shows the increase in temperature of the metal block is lower than the increase in temperature expected from **Graph A**.

Suggest **one** reason why.

.....

.....

(iii) The power of the electric heater is 50 watts.

Calculate the energy transferred to the heater from the electricity supply in 300 seconds.

.....

.....

.....

Energy transferred = ... J

(b) The student uses the same heater to heat blocks of different metals. Each time the heater is switched on for 300 seconds.

Each block of metal has the same mass but a different specific heat capacity.

Metal	Specific heat capacity in J/kg°C
Aluminium	900
Iron	450
Lead	130

Which **one** of the metals will heat up the most?

Draw a ring around the correct answer.

aluminium **iron** **lead**

Give, in terms of the amount of energy needed to heat the metal blocks, a reason for your answer.

.....

.....

.....

.....

(a) (i) temperature (increase) and time switched on are directly proportional

accept the idea of equal increases in time giving equal increases in temperature

answers such as:

- *as time increases, temperature increases*
- *positive correlation*
- *linear relationship*
- *temperature and time are proportional*

*score **1** mark*

2

(ii) any **one** from:

"it" refers to the metal block

- energy transfer (from the block) to the surroundings

  accept lost for transfer

  accept air for surroundings

- (some) energy used to warm the heater / thermometer (itself)

  accept takes time for heater to warm up

- (metal) block is not insulated

1

(iii) 15 000

*allow **1** mark for correct substitution, ie 50 × 300 provided no subsequent step shown*

2

(b) lead

reason only scores if lead is chosen

1

needs least energy to raise temperature by 1°C

accept needs less energy to heat it (by the same amount)

lowest specific heat capacity is insufficient

1

Specific Heat Capacity: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Identify that the specific heat capacity of a substance is the amount of energy required to raise 1kg of substance, by 1°C			
Describe all of the changes that happen in a system heating a block of a material			
Calculate the amount of energy that is transferred to or from a system using the equation for specific heat capacity			
Explain how to investigate the specific heat capacities of different materials.			

Energy and Power

Energy is…

- The ability to do work
- Normally measured in Joules (J)
- Can be stored

For example, a battery stores energy!

Power is…

- The amount of energy used per second
- Measured in watts (W) or kilowatts (kW)
- Cannot be stored

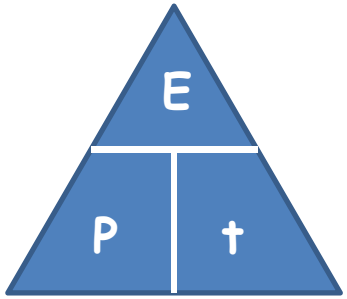
For example, an engine is powerful!

More powerful devices are normally plugged into the wall. This allows a larger current to be drawn by the device.

We can link power and energy together using the equation…

$$\text{power} = \frac{\text{energy}}{\text{time}}$$

$$P = \frac{E}{t}$$



In the equation…

P is the power in watts (W)

E is the energy that is being provided to the device in Joules (J)

t is the time in seconds (s) – don't forget to convert into seconds!

Remember to use your conversions when calculating the power!

1 minute = 60 seconds

1 hour = 60 minutes x 60 seconds in a minute = 3600 seconds

1 kilowatt = 1000 watts

Which of these appliances uses the most energy?	
A 2000W kettle on for 120 seconds	A 60W lightbulb on for 3 hours
A 1.2kW dishwasher on for 30 minutes	A 50W laptop on for a whole day

A student moves up some stairs at a steady pace. The student did 2240J of work to move up the stairs. It took 2.8 seconds for them to make it to the top. What is the power of the student?	
62.72kW	0.8kW
6272W	8000W

What is the power of a device that uses 20,000J of energy in 40 seconds	
5×10^2 W	5kW
0.002 W	5×10^2J

How many seconds are in the following?	
15 minutes	900s
3 hours	10,800J
1 day	86,400J
1 week	604,800J

A student climbs 20m to the top of the cliff. Use the information to answer the questions.	
What type of energy does the student gain when climbing the cliff?	Gravitational Potential Energy
What is the work done if the student weighs 660N?	13,200J
What is the power of the student if it takes 800s to climb to the top	16.5W
The student used 18000J of energy to get to the top. What is their efficiency?	73.3%

Energy and Power: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Identify that power is the rate at which energy is transferred from one energy store to another, or the rate at which work is done			
Describe 1 Watt of power as the transfer of 1 Joule of energy in 1 second			
Compare objects to show the definition of power, for example comparing two motors that both lift the same weight through the same height, but one does it faster than the other.			

Efficiency

The efficiency of a device compares how much energy is put into the device with how much useful energy is produced by the device. The more energy a device wastes, the less efficient the device will be.

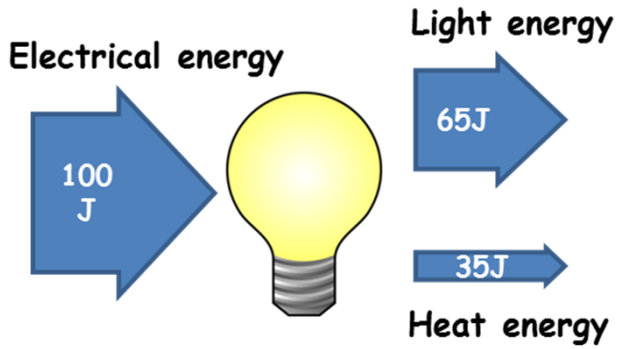
$$\text{Efficiency} = \frac{\text{useful energy out}}{\text{total energy in}}$$

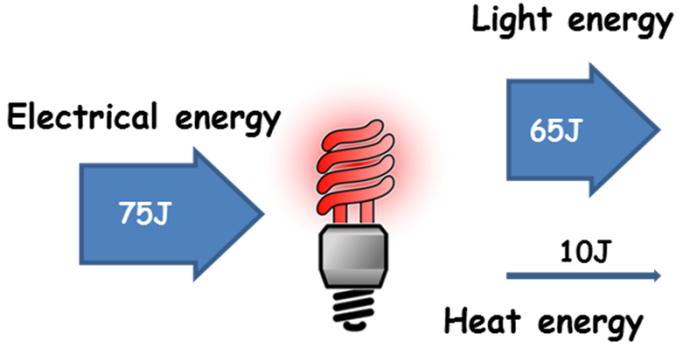
$$\text{Efficiency} = \frac{\text{useful energy out}}{\text{total energy in}}$$

Energy efficient devices have some newer features:

- Newer electronics turning off when they have not been used for a while
- Cars having stop start technology to save fuel when not moving
- Temperature select kettles, that heat water to a certain temperature to save energy

Remember that not all energy is transferred as useful energy. Useful energy is the type of output energy that we want the device to provide. For example, a lightbulb is designed to produce light. However, some of the energy is wasted as heat.





Energy saving devices are more efficient because they produce a larger percentage of light energy, and a smaller percentage of heat energy. This means that we can give the device less input energy to get the same brightness, saving you money!

Efficiency

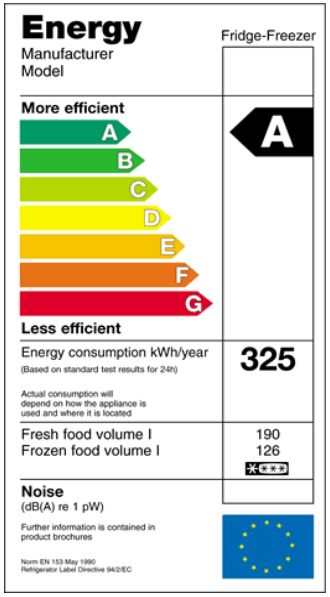
Energy efficient labels were introduced by the European Union to show consumers how energy efficient a device is. These labels can be found on most electrical appliances, houses and tyres.

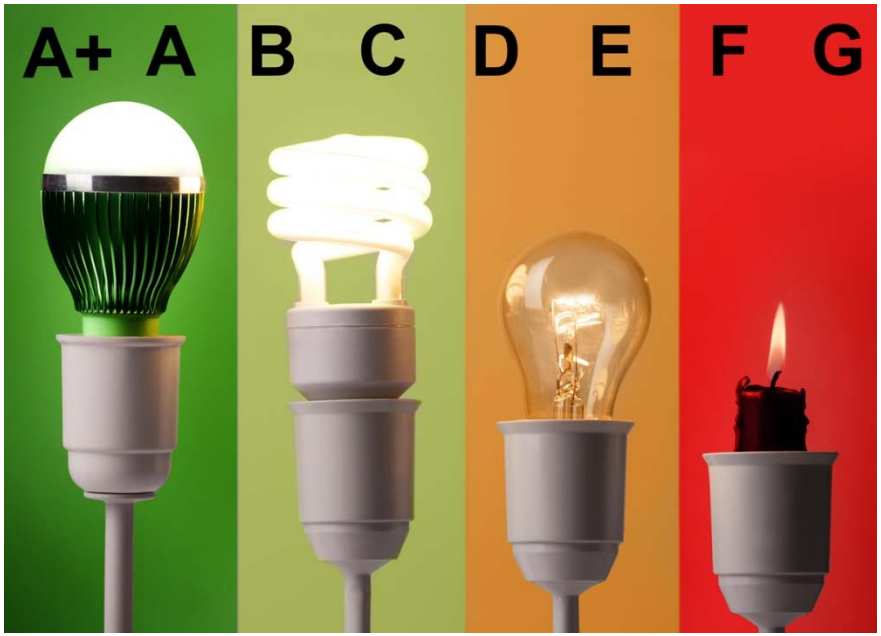
An A++, A+ and A rating shows that they are the most energy efficient item in their category.

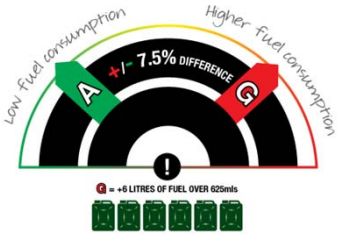
Compared to a G rated item in the same category, they can use up to 50% less energy to complete the same job.

A rated tyres can use up to 10% less fuel than G grade tyres!

A rated houses could cost up to £1000 less per year to heat up!







For every 1250J of electrical energy supplied to a microwave oven, 800J is transformed to heat energy. How efficient is the microwave oven?	
88%	64%
48%	26%

An energy-saving lightbulb has an efficiency of 10%. If it is supplied with 20J of electrical energy, how much energy is wasted as heat?	
2J	10J
18J	1J

An oven has an efficiency of 45%. If 25,000J are usefully used by the oven, what is the input energy?	
5.6×10^4 J	1.1×10^4 J
1.8×10^{-5} J	4.5×10^4 J

Calculate the efficiency of each of the devices.	
A vacuum cleaner is supplied with 1200J of electrical energy; 900J is converted to kinetic and the rest is wasted	**75%**
A hairdryer is supplied with 2200J of electrical energy; 220J is wasted as sound energy.	**90%**
A TV is supplied with 50J of electrical energy, and wastes 15J as heat.	**30%**
The battery of an MP3 player supplies 0.4J of energy every second. 0.2J is wasted every second as heat.	**50%**

A student finds some information about energy-saving light bulbs.

(a) A 30W light bulb uses 600J of electrical energy in a certain period of time. In that time, it produces 450 J of light energy. The rest of the energy is wasted.

(i) Calculate the energy wasted by the light bulb in this period of time.

.....

Wasted energy = ... J

(ii) What happens to the energy wasted by the light bulb?

.....

.....

(iii) Calculate the efficiency of this light bulb.

.....

.....

Efficiency = ...

(iv) Calculate the period of time, in seconds, during which the 600 J is provided to the 30 W light bulb.

.....

.....

Time = ... s

(b) A company that makes light bulbs provides information about some of their products.

The table shows some of this information.

	Power in watts	Lifetime in hours	Cost of bulb in £
Filament bulb	60	1250	2.00
LED bulb	12	50 000	16.00

(i) Suggest why it is important to confirm this information independently.

.....

(ii) A homeowner is thinking about replacing his filament bulbs with LED bulbs.

A 12 W LED bulb gives the same light output as a 60 W filament bulb.

Suggest reasons why the homeowner is likely to choose LED bulbs.

Use the information given in the table.

.....

.....

.....

.....

(iii) State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

.....

.....

(a) (i) 150

1

(ii) transferred to the surroundings by heating

reference to sound negates mark

1

(iii) 0.75

*450 / 600 gains **1** mark*

*accept 75% for **2** marks*

*maximum of **1** mark awarded if a unit is given*

2

(iv) 20 (s)

*correct answer with or without working gains **2** marks*

*correct substitution of 600 / 30 gains **1** mark*

2

(b) (i) to avoid bias

1

(ii) use less power and last longer

1

1 LED costs £16, 40 filament bulbs cost £80

or

filament costs (5 times) more in energy consumption

1

(iii) any **one** from:

- availability of bulbs
- colour output
- temperature of bulb surface

1

Efficiency: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Identify that efficiency is a ratio to show how much useful energy or power a device produces			
Describe efficiency using both the equation for energy and power			
HT Only – Describe ways to increase the efficiency of a useful energy transfer			

National and Global Energy Resources

Power stations are places where large amounts of fuel are burned to create electricity.

Power stations can be quite inefficient, and can waste a lot of energy this is because:

- Some of the coal may not have released all of its energy
- Some of the steam used to turn the turbines may not have been recycled
- Electrical energy could have been lost as heat

Power stations improve their efficiency by recycling water and using low resistance wires!

Coal
Stores chemical energy

Energy transferred as heat energy

Water and steam
Store of heat energy

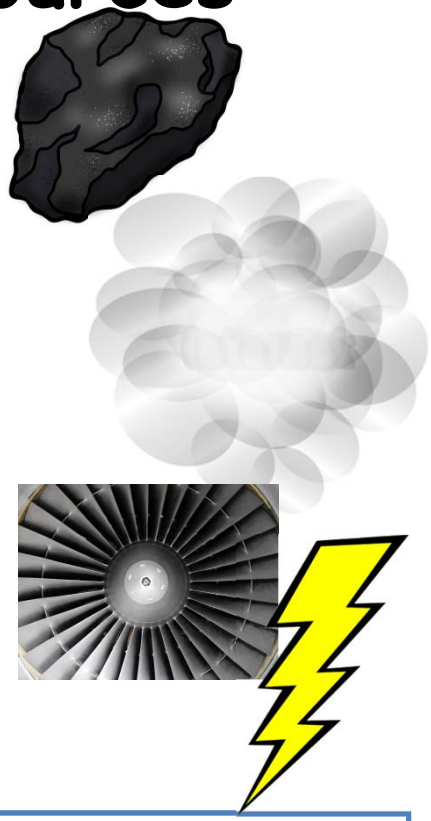
Energy transferred as kinetic energy

Turbine

Energy transferred as kinetic energy

Generator

Energy transferred as electrical energy



The start up time of a power station is how long it takes for the power station to turn on and start to begin providing electrical energy. Gas stations have the quickest start up times, and nuclear have the longest start up time.

Shortest Time

Gas

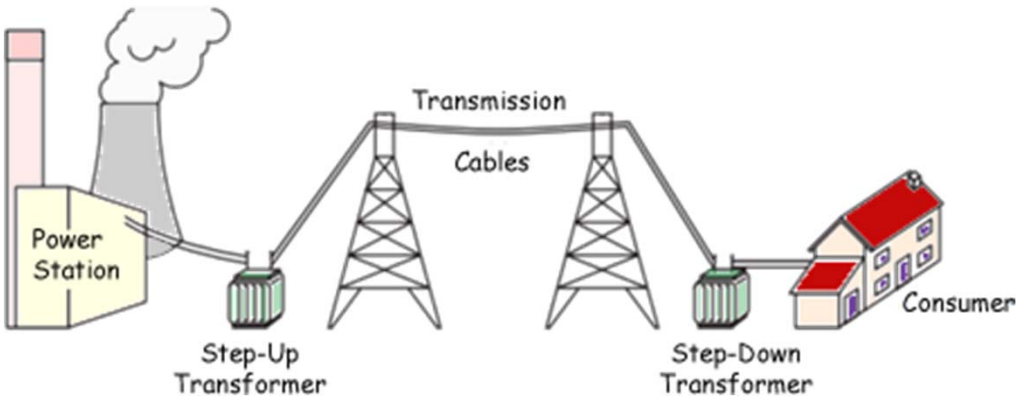
Oil

Coal

Nuclear

Longest Time

National and Global Energy Resources



The National Grid consists of 3 key parts:

- Transformers
- Cables
- Pylons

Transformers are devices that increase or decrease the potential difference of the electricity supply that leaves the power station.

Step-Up transformer

- Increases potential difference to 400,000V
- Reduces electrical current
- This reduces power loss.

Step-Down Transformer

- Decreases potential difference to 230V
- Increases electrical current
- This makes it safe for us to use in our homes

There is a problem with cables: they get hot! This would mean that lots of energy would be lost as heat as the electricity is transferred.

To reduce the energy loss, the current is kept low, and the potential difference is increased. This means that each electron will have more electrical energy, but will move slower through the cable!

Pylons are used to keep the wires from the ground. This reduces the risk of people being electrocuted, but increases the risk of low flying air craft hitting them

National and Global Energy Resources

Renewable energy describes energy that has been created from a source that does not run out.

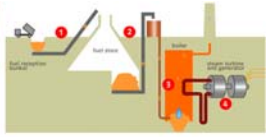
Wind

Advantages
- Once the wind turbine is built, running costs are very low
- It does not produce any carbon dioxide, which contributes to the greenhouse effect
- The land occupied by a wind farm can still be used for farming
- Wind is a renewable source so it will not run out

Disadvantages
- We cannot control when the wind blows. Wind turbines shut down in very strong or very weak winds
- They can only be built in certain areas. These areas need to be windy places, usually hilly areas or coasts
- Not everyone likes the appearance of wind farms

Biomass

Advantages
- It is renewable – new plants and trees can be grown to replace those used for fuel
- It supports farmers and foresters by providing markets for their crops
- It is a carbon neutral source of energy. This means that the amount of carbon dioxide released when the fuel is burnt is the same as the amount of carbon dioxide absorbed by the plants when they were growing



Disadvantages
- It is an expensive method of generating electricity
- Biomass power plants need to be built near a plentiful supply of biomass fuel

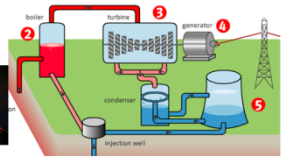
Solar

Advantages
- Solar energy can be used to generate electricity in remote places where other electricity supplies are hard to come by
- It does not produce any carbon dioxide, which contributes to the greenhouse effect
- Energy is usually generated at or near to the location it will be used. This keeps transmission and distribution costs to an absolute minimum

Disadvantages
- Cells do not work so well when it is cloudy and do not work at night
- The UK is not a very sunny country! Solar power works better in hot places, so its use is therefore limited

Learn the advantages and disadvantages to each type of renewable energy production!

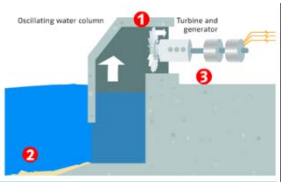
Geothermal Energy



Advantages
- Geothermal energy does not produce any pollution
- Running costs for a geothermal power station are very low

Disadvantages
- It is difficult to find suitable sites to put a geothermal power station
- If not carefully managed, a borehole can 'run out of steam' and may not be useable for several decades
- Dangerous gases and minerals can come out of a borehole, which may be difficult to dispose of

Wave Energy

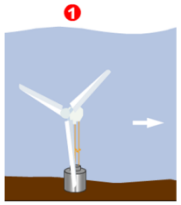


Advantages
- It is a huge potential resource for the UK
- It is a more predictable energy source than wind
- There are no fuel costs, unlike conventional power generation

Disadvantages
- Equipment needs to be designed to survive bad weather conditions such as storms
- There may be high maintenance costs, because the devices can be far out at sea
- There is no leading device at the moment

Tidal Energy

Advantages
- Tides are predictable
- Once the plant is built, operating costs are very low, so the energy produced is very cheap
- It does not produce carbon dioxide or waste
- It needs no fuel

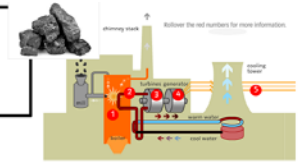


Disadvantages
- There is no leading device at the moment
- Barrages can be very expensive to build

National and Global Energy Resources

Non-Renewable energy resources are limited in supply, and take a very long time to produce. This means that once they've gone, they've gone!

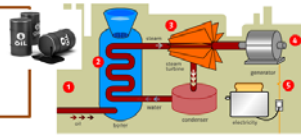
Coal



Advantages
- Burning coal is one of the cheapest ways to generate power at the moment
- Coal power stations can be built anywhere where there are good transport links and where there is a plentiful supply of cooling water
- The world has many coal reserves

Disadvantages
- Burning coal produces carbon dioxide, which contributes to the greenhouse effect. It also produces sulphur dioxide, a gas found in acid rain
- Coal is not renewable. There are limited supplies which will run out one day
- Coal-fired power stations need huge amounts of fuel

Oil

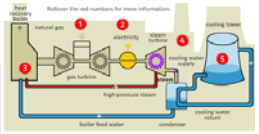


Advantages
- Oil is easy to transport by pipeline or ship
- Oil-fired power stations can be built anywhere there are good transport links and where there is a plentiful supply of cooling water
- A large amount of electricity can be generated from one power station quickly

Disadvantages
- Burning oil produces carbon dioxide, which contributes to the greenhouse effect
- It also produces other emissions eg sulphur dioxide
- Oil is not renewable. The world's supply of oil is running out quickly
- Using oil is very expensive compared to coal and gas

Learn the advantages and disadvantages to each type of non-renewable energy production!

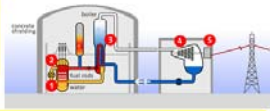
Natural Gas



Advantages
- Gas is light and easy to transport by pipeline
- Large amounts of electricity can be generated from one gas-fired power station
- Gas-fired power stations are normally built near rivers and the gas pipeline network but they can be built anywhere

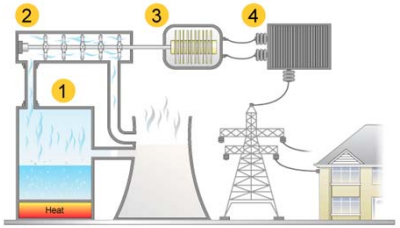
Disadvantages
- Burning gas produces carbon dioxide, which contributes to the greenhouse effect
- Gas is not renewable. There is a limited supply, which will eventually be used up
- The UK is importing most of its gas. This means that our energy supplies may become quite costly if wholesale prices rise

Nuclear

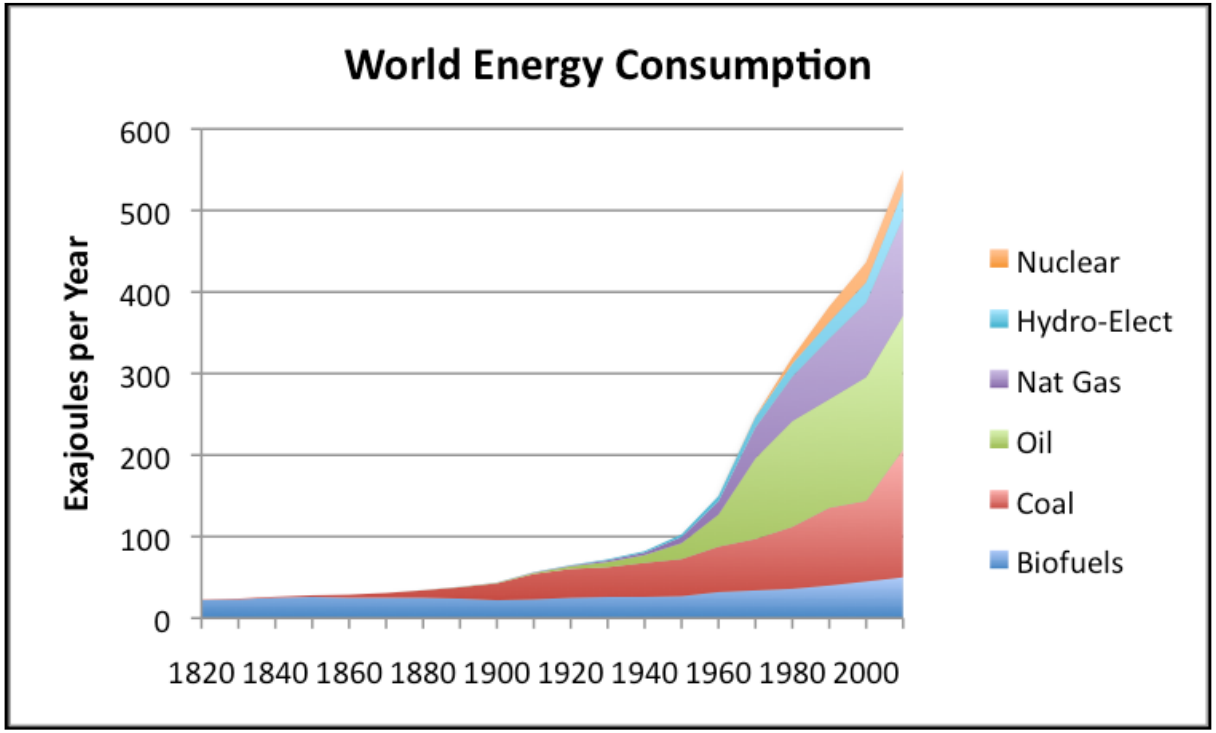


Advantages
- Uranium is readily and cheaply available, and nuclear fuel is easily stored
- A small amount of nuclear fuel produces a lot of electricity
- Nuclear power stations do not produce any carbon dioxide from nuclear fission

Disadvantages
- Nuclear power stations may be unpopular with people who are concerned about how safe they are
- Nuclear energy is not renewable. When uranium runs out it cannot be replaced
- Nuclear energy produces radioactive waste which must be buried in sealed containers for a long time
- Nuclear power stations cannot be switched on and off easily



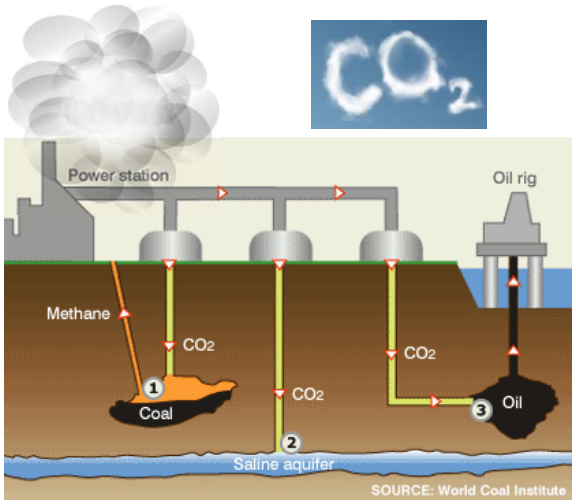
National and Global Energy Resources



Over time, the amount of energy that is being consumed by the world is increasing. This increase is caused by:

- Increasing population – More people living on the planet are using devices
- Increased access to electricity – People who were not able to use electricity before can now access it because it is cheaper.
- Developing countries – As countries like India and China develop, they are using more energy for industrial things, like factories.

Carbon Capture and Storage is a process where waste carbon dioxide is captured before it is released into the atmosphere. It is then pumped into old oil fields, to help slow down the greenhouse effect.



Which one of the following is <u>not</u> a fossil fuel?	
Gas	Coal
Uranium	Oil

Which one of the following energy sources is a store of energy that has originally come from the Sun's rays?	
Geothermal	Fossil fuels
Wind	Nuclear

Which of the following are renewable energy resources?	
Biofuel	Nuclear
Oil	Wind

Which of the following are fossil fuels?	
Oil	Biofuel
Coal	Gas

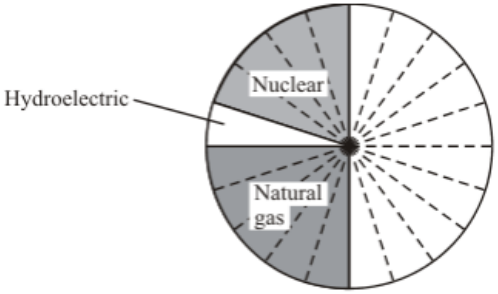
Use the description below to write the correct renewable energy resource	
The gravitational potential energy of water is converted into kinetic energy to drive turbines	**Hydroelectric**
Photovoltaic cells convert energy from sunlight into electricity	**Solar**
Heat energy from inside the Earth is used to turn water into steam that drives turbines to produce electricity	**Geothermal**
Produced by the breakdown of organic materials that can be burned as a fuel for cooking or used in motor vehicles.	**Biofuel**

The table shows the main sources of energy used to generate electricity.

Energy source	Percentage (%)
coal	35
hydroelectric	5
natural gas	25
nuclear	
oil	15

(a) Complete the table by writing in the percentage for nuclear power.

(b) Use the information from the table to complete and label the pie chart below.



(c) Why can hydroelectric generators be used to meet sudden increases in the demand for electricity?

.....

(d) Gases are released when fossil fuels burn.

(i) Which **one** of these gases increases the greenhouse effect?

.....

(ii) Which **one** of these gases produces acid rain?

.....

(a) 20

accept twenty

1

(b) correct division 35/15

1

larger area labelled coal

accept smaller area labelled oil

1

(c) can be started up very quickly

1

(d) (i) carbon dioxide

1

(ii) sulphur dioxide

accept nitrogen oxidestotal

1

State and explain the advantages and disadvantages of using nuclear power stations to produce electricity.	Read all the answer first. See below. **Mark the first two advantages and disadvantages (√ or *X*) ignoring** *neutral answers. Only allow a third advantage if there is only one disadvantage given. Only allow a third disadvantage if only one advantage is given.* <u>max. 3 advantages</u> (e.g. cheap fuel, good availability, saving fossil fuels, low running costs, reliable, more energy / kg, less fuel needed, no greenhouse gases emitted, no SO_2 causing acid rain) <u>max. 3 disadvantages</u> (e.g. danger to health of local community, non renewable, high cost of decommissioning, long half life of waste materials, need for safe storage of waste, high cost of commissioning, danger involved in transporting fuel / waste) *max. 4 marks*

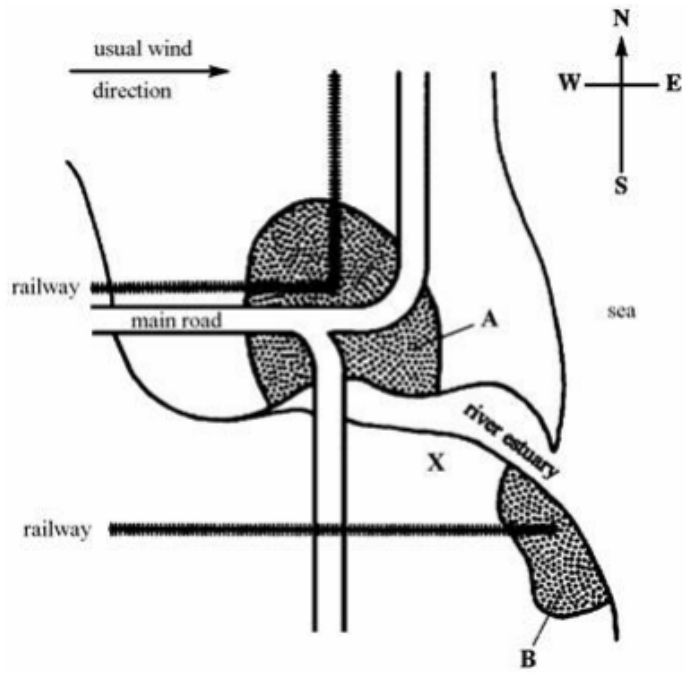
The map below shows the position of two towns, **A** and **B**, on the banks of a large river estuary.

A is an important fishing and ferry port.

The wind usually blows from the west. The major roads and railways are shown.

A power station is to be built in area X to generate electricity for the region.

The choice is between a nuclear power station and a coal fired power station.



(a) State the advantages and disadvantages of the two methods of generating electrical energy.

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(b) Which method would you choose for this site?

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Explain the reason for your choice.

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(a) *must give one advantage and one disadvantage of each to get 4 marks and 2 further scoring points*

Advantages and disadvantages relevant to:

(1) health risk
(5) cost
(6) environmental factors
(7) transport/ storage

e.g. common coal / nuclear – high cost of building both

anti-nuclear examples
nuclear fuel transported on roads/rail in region
possible effects on public health in surrounding area
high cost of de-commissioning
long life very active waste materials produced
how waste materials stored safely for a long time

anti-coal examples
unsightly
pollution
supplies of fuel limited
acid rain
non-renewable

pro-nuclear examples
fuel cheap
no foreseeable fuel shortage

pro-coal examples
safe
reliable
large coal reserves
disposal of solid waste is easier

to max 6

6

(b) choice 0 marks

any three valid reasons each with explanation, which may or may not be comparisons with other fuel

But

at least two of which must be relevant to this site

3

National and Global Energy Resources: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Identify the main energy sources available for use on Earth, including fossil fuels and renewable energy sources			
Identify a renewable energy resource is on that can be reproduced as quickly as it is being used			
Identify uses of renewable energy resources, including generating electricity, transport and heating			
Describe the main energy sources available			
Describe the environmental impacts of using different energy resources			
Explain the differences between energy resources that are renewable and energy sources that are non-renewable			

National and Global Energy Resources: Checklist

For your exam, you must be able to…	I have looked at this once	I have reviewed this	I have mastered this
Explain, by using comparisons, different ways that different energy sources are used in transport, electricity generation and heating			
Explain the patterns and trends in the use of energy resources			
Apply scientific understanding to consider the environmental issues that may arise from the use of different energy resources			
Apply scientific understanding to show that science has the ability to identify environmental issues arising from the use of energy resources but not always the power to deal with the political, social, ethical or economical considerations			