St Benedict's Catholic High School
Science Department

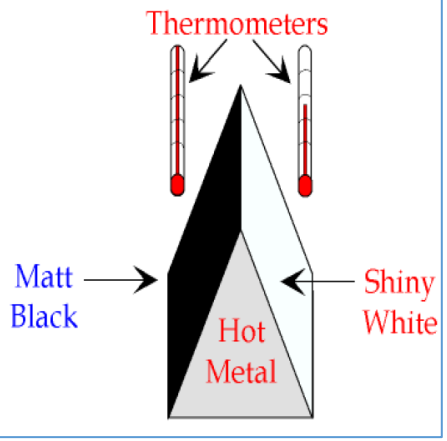
Science Revision Booklet
Year 11
AQA
Physics Higher

Thermal Radiation

- Thermal radiation is energy transfer by electromagnetic waves
- All objects emit thermal radiation
- The hotter an object is, the more thermal radiation it emits

Surfaces and Radiation

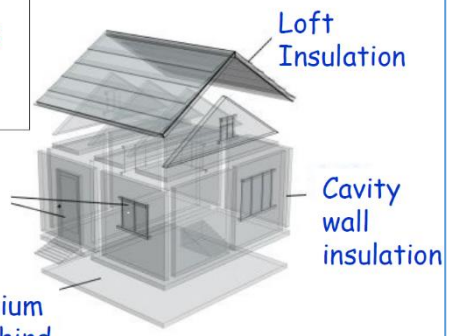
Dark matt surfaces are better emitters and absorbers of thermal radiation than light shiny surfaces



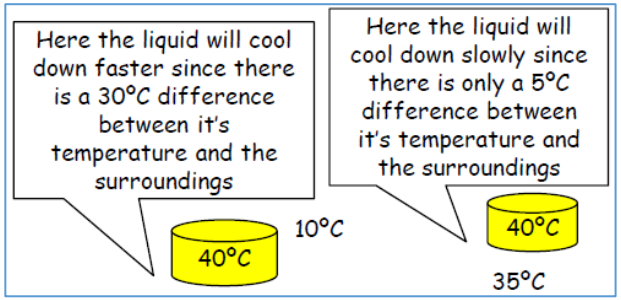
Conduction

- Conduction in a metals is due to the many free electrons transferring energy inside the metal.
- Non-metals are poor conductors because they do not contain free electrons.
- Materials like fibreglass are good insulators because they have pockets of trapped air.

How to prevent heat loss from a house



P1.1 Energy Transfer by Heating Process



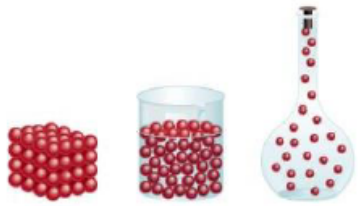
Kinetic theory

In **solids** the particles are packed very close together. They vibrate about fixed positions

In **liquids** the particles are close together but not as close as they are in solids. They can move around in any direction and are not fixed in position.

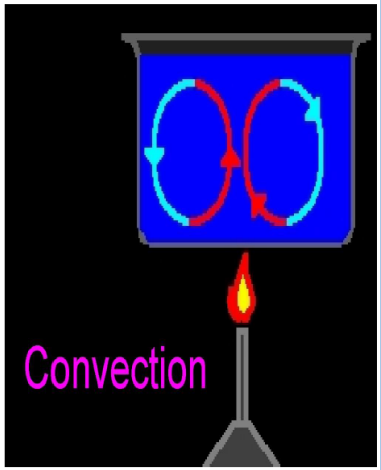
In **gases** the particles are very far apart with large distances between them. They move around very quickly in all directions

More energy = more vibrations



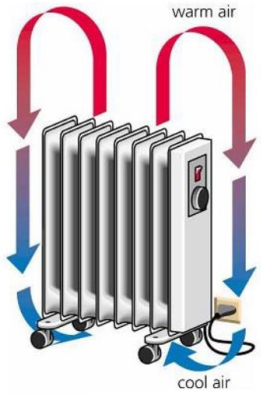
Convection

- Convection takes place in only in liquids and gases. Heating a liquid or gas makes it less dense. Convection is due to a hot liquid or gas rising



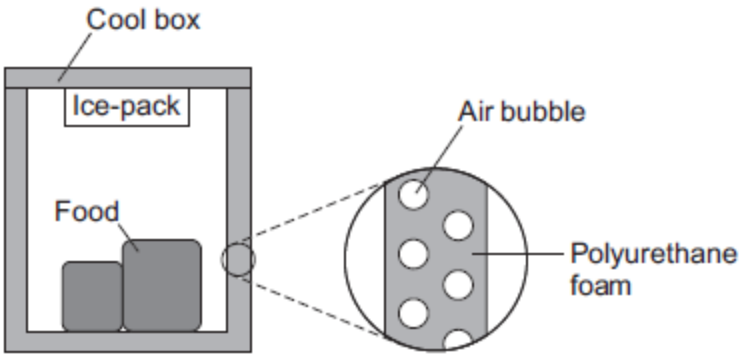
Heat Transfer

- A radiator has a large surface area so it can lose heat easily.
- Small objects lose heat more quickly than large objects



1 The figure below shows a cool box.

A cool box is used to keep food colder than the surroundings. The cool box consists of plastic walls with a layer of polyurethane foam between them.



(a) The polyurethane foam has a low U-value.

Why does the polyurethane foam need to have a low U-value?

_____

_____

(1)

(b) The polyurethane foam contains air bubbles.

Explain how the air bubbles reduce energy transfer through the walls of the cool box.

You should refer to the processes of energy transfer in your answer.

_____

_____

_____

_____

_____

_____

(3)

(c) An ice-pack can be placed inside the cool box. An ice-pack contains a material with a very high specific heat capacity. The ice-pack is frozen in a freezer and cooled to –18 °C before being put in the cool box.

The ice-pack keeps the contents of the cool box cooler than the surroundings for a long time.

Describe how.

_____

_____

_____

_____

_____

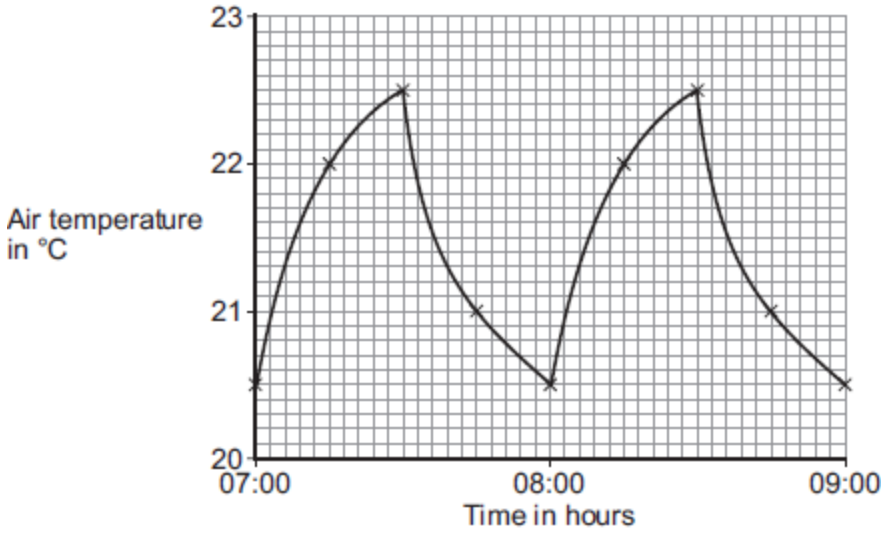
_____

(3)

(Total 7 marks)

2 A householder monitored how the air temperature inside his house changed over a 2-hour period. The householder measured the temperature every 15 minutes.

THe graph shows how the temperature changed with time.



(a) (i) The householder used a digital thermometer to measure the temperature.

What would be an appropriate resolution for the digital thermometer?

Draw a ring around your answer.

0.5 °C **1 °C** **5 °C**

(1)

(ii) The householder's results are shown on the graph above.

Why would it **not** be appropriate to use the results to plot a bar chart?

_____

_____

(1)

(b) The householder's heating is controlled by a thermostat. The thermostat switches the heating on when the temperature decreases below a certain temperature.

(i) At what temperature does the thermostat switch the heating on?

_____ °C

(1)

(ii) Use the graph to determine the number of minutes that the householder's heating was switched on between 07:00 and 09:00.

_____

_____

Time = _____ minutes

(1)

(c) The householder read the following extract from a newspaper article about reducing energy use in the home.

> . . . decreasing the temperature setting on your thermostat by 1 °C will reduce your heating bill by 10% . . .

On Monday, the householder set his thermostat at 20.0 °C and recorded the energy, in kWh, used to heat his house.

On Tuesday, the householder set his thermostat at 19.0 °C and recorded the energy, in kWh, used to heat his house.

The table shows the results of the householder's investigation.

Thermostat setting in °C	**Energy in kWh**
20.0	8.0
19.0	7.2

(i) The outside temperature was the same on both days.

Give **one** reason why this was important.

_____

_____

(1)

(ii) Explain how the results shown in the table above support the extract from the newspaper article.

Justify your answer with a calculation.

_____

_____

_____

_____

(2)

(iii) The statement in the extract is **not** valid for all situations.
Suggest why.

_____

_____

_____

_____

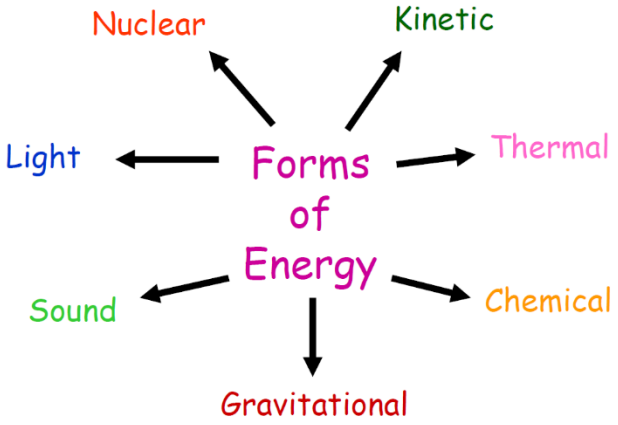
(2)

(Total 9 marks)

Energy and Efficiency

- Energy is measured in joules (J)

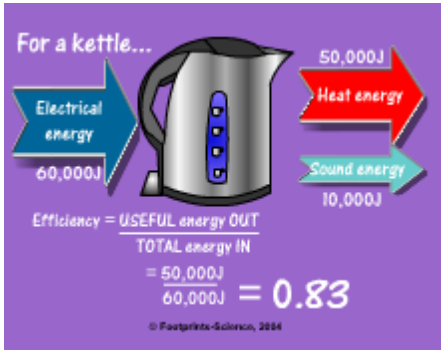
Efficiency of a device = $\frac{\text{Useful energy transferred by a device}}{\text{Total energy supplied to a device}}$

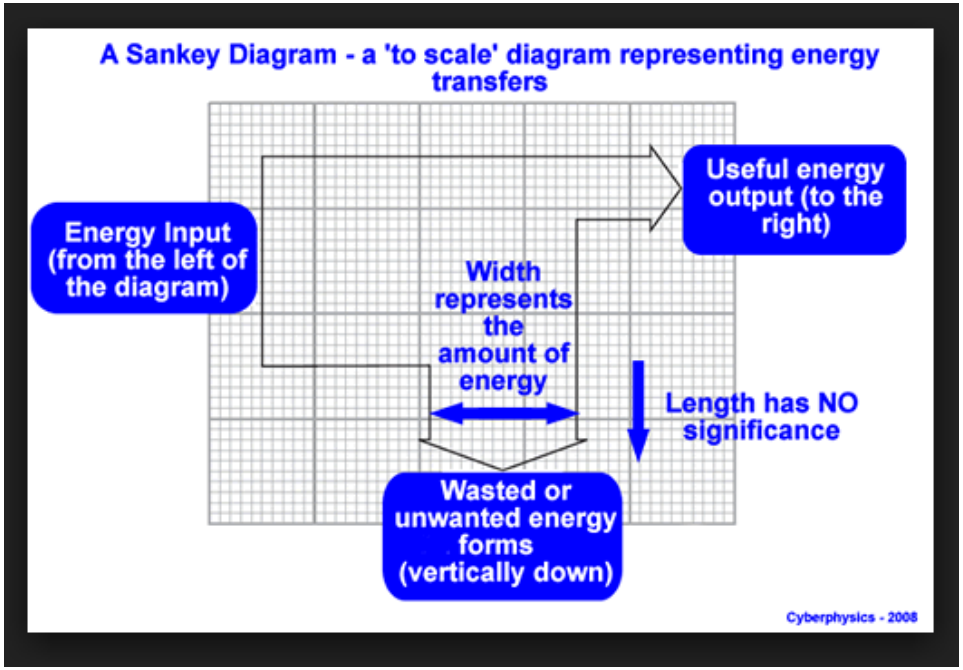


Conservation of Energy

P1.2 Energy and efficiency

- Energy can be transformed from one form into another or from one place to another.
- Electrical Energy → Heat Energy
- Energy cannot be created or destroyed





1 The table gives data about two types of low energy bulb.

Type of bulb	Power input in watts	Efficiency	Lifetime in hours	Cost of one bulb
Compact Fluorescent Lamp (CFL)	8	20%	10 000	£3.10
Light Emitting Diode (LED)	5		50 000	£29.85

(a) Both types of bulb produce the same useful power output.

(i) Calculate the useful power output of the CFL.

Show clearly how you work out your answer.

Useful power output = _____ W

(2)

(ii) Calculate the efficiency of the LED bulb.

Show clearly how you work out your answer.

Efficiency = _____

(1)

(b) LED bulbs are expensive. This is because of the large number of individual electronic LED chips needed to produce sufficient light from each bulb.

(i) Use the data in the table to evaluate the cost-effectiveness of an LED bulb compared to a CFL.

(2)

(ii) Scientists are developing brighter and more efficient LED chips than those currently used in LED bulbs.

Suggest **one** benefit of developing brighter and more efficient LED chips.

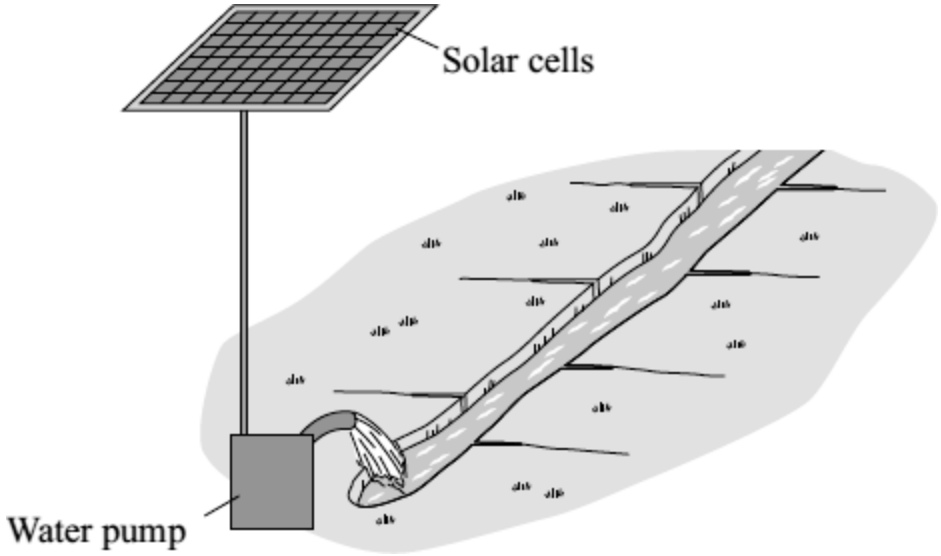
_____

_____

(1)

(Total 6 marks)

2 The farmers in a village in India use solar powered water pumps to irrigate the fields.



On average, a one square metre panel of solar cells receives 5 kWh of energy from the Sun each day.
The solar cells have an efficiency of 0.15

(a) (i) Calculate the electrical energy available from a one square metre panel of solar cells.

Show clearly how you work out your answer.

_____

_____

Electrical energy = _____ kWh

(2)

(ii) On average, each solar water pump uses 1.5 kWh of energy each day.

Calculate the area of solar cells required by one solar water pump.

Area = _____ square metres

(1)

(b) Give **one** reason why the area of solar cells needed will probably be greater than the answer to part (a)(ii).

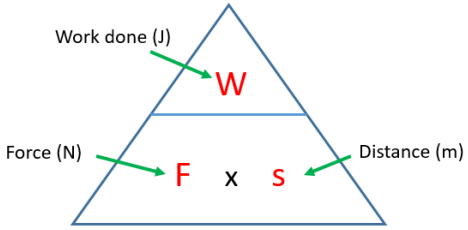
_____

_____

(1)

(Total 4 marks)

Work Done

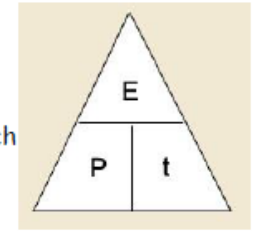


Work done (J) = Force (N) x Distance (m)

The distance must be in the line of action of the force

Power

Power (W)= energy (J) / time (s)



Power is the rate at which energy is transferred.

1 watt means 1 joule of energy is transferred every second.

Gravitational Potential Energy

P.E. = m x g x h

m : mass

g : Gravitational Acceleration ($9.8\ m/s^2$)

h : Height

P1.3 Useful Equations

Specific heat capacity

- This is the amount of energy needed to raise the temperature of 1kg of a material by 1°C

$$E = m \times c \times \Theta$$

Energy (J)

Mass (kg)

Specific heat Capacity ($J\ °C^{-1}\ kg^{-1}$)

Change in temperature (°C)

Using Electrical Energy

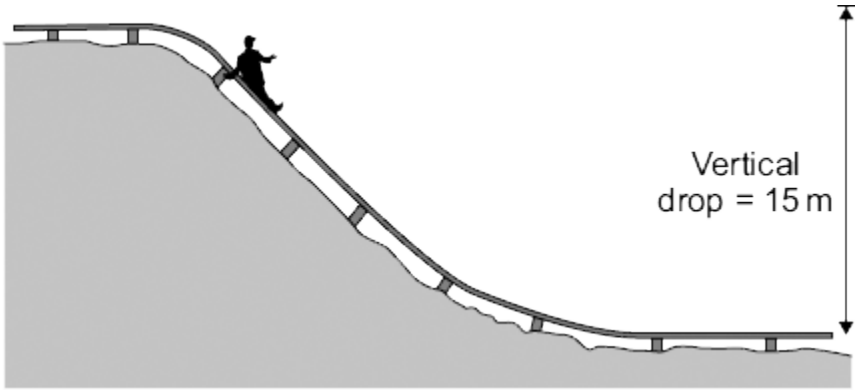
Energy Transferred = Power of device / Time in Use

Total Cost = Number of Kilowatt hours / Cost Per Kilowatt

Kinetic Energy depends on mass and speed

- $KE = \frac{1}{2} m v^2$
- The equation shows that . . .
  - the more mass a body has
  - or the faster it's moving
- . . . the more kinetic energy it has.
- Speed has more effect on Kinetic energy than mass.

1 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

(2)

(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.

_____

_____

_____

_____

Maximum possible speed = _____ m/s

(3)

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

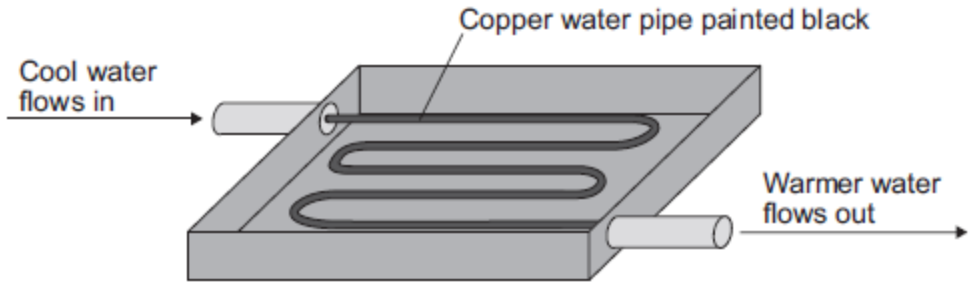
Explain why.

(3)

(Total 8 marks)

2 (a) **Figure 1** shows a solar panel. Solar panels can be fitted to house roofs and used to heat water for domestic hot water systems.

Figure 1

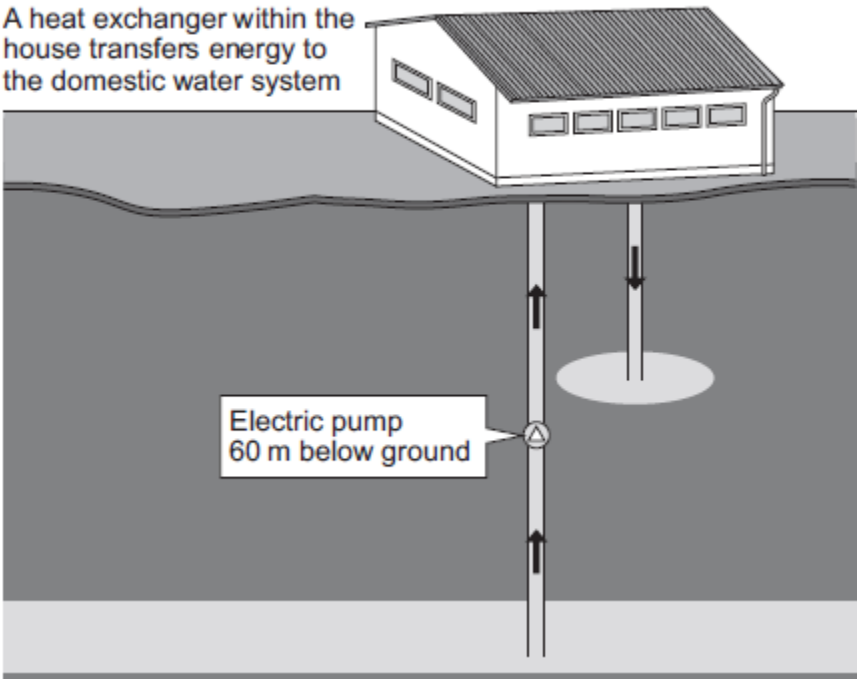


Use **Figure 1** to explain how the design of the water pipe increases the rate of energy transfer from the Sun to the water.

(3)

(b) **Figure 2** shows a different method of heating water called a ground source heat pump. Two holes are drilled into the ground and fitted with pipes. Warm water is pumped up one pipe and waste water is returned to the ground through the other pipe. In the house, energy is transferred from the warm water by a heat exchanger.

Figure 2



(i) Suggest **one** advantage of using this method of heating water rather than using solar panels.

_____

_____

(1)

(ii) A leaflet about a ground source heat pump states:

'Ground source heat pumps are 300 – 400% efficient. For each joule of mains electrical energy the pumps use, they transfer three to four times more energy from the water'.

Two students read the leaflet.

Student **A** says, 'It is incorrect to say that a device is 300 – 400% efficient'.

Student **B** says, 'The statement is correct'.

Both conclusions could be considered to be correct.

Explain why.

Student **A**'s conclusion _____

_____

_____

_____

_____

Student **B**'s conclusion _____

_____

_____

_____

_____

_____

(4)

(iii) Domestic water enters the heat exchanger at a temperature of 7.0 °C and leaves the heat exchanger at a temperature of 55 °C.

Each day 19 000 000 joules of energy are supplied to the water passing through the heat exchanger.

Calculate the mass of water that can be heated each day.

Choose the correct equation from the Physics Equations Sheet.

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

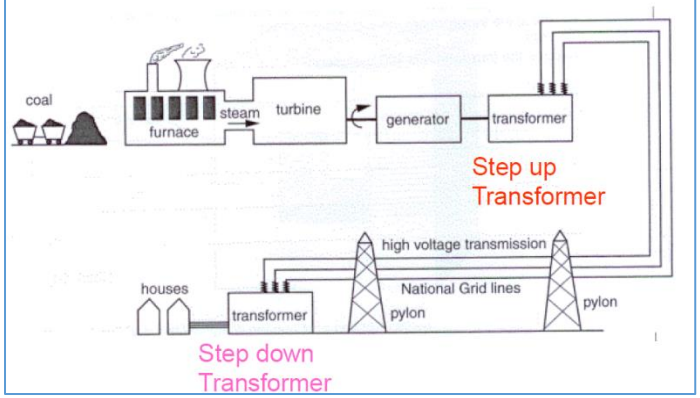
Give your answer to 2 significant figures.

Mass of water = _____ kg

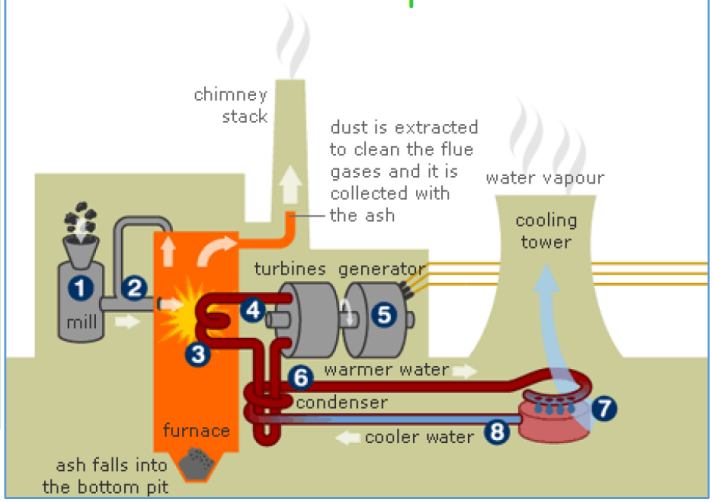
(4)

(Total 12 marks)

The National Grid



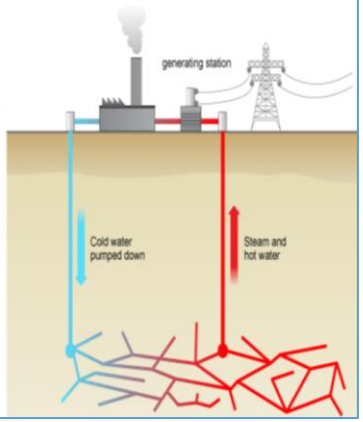
Inside a fossil fuel power station



Energy from the Earth

Geothermal energy comes from hot rocks deep inside the Earth.

The rocks are hot because they contain radioactive substances



P1.4 Methods we used to generate Electricity

Energy from the Sun

We can convert solar energy into electricity using solar cells or we can use it to heat water in solar heating panels

Energy from Wind

- A wind turbine is an electricity generator on top of a tall tower
- The amount of electricity generator depends on the amount of wind

Energy from Water

- A wave generator is a floating generator turned by waves
- A tidal generator traps water when the tide comes in and uses it to generate electricity
- Hydroelectricity generators are turned by water running down hill

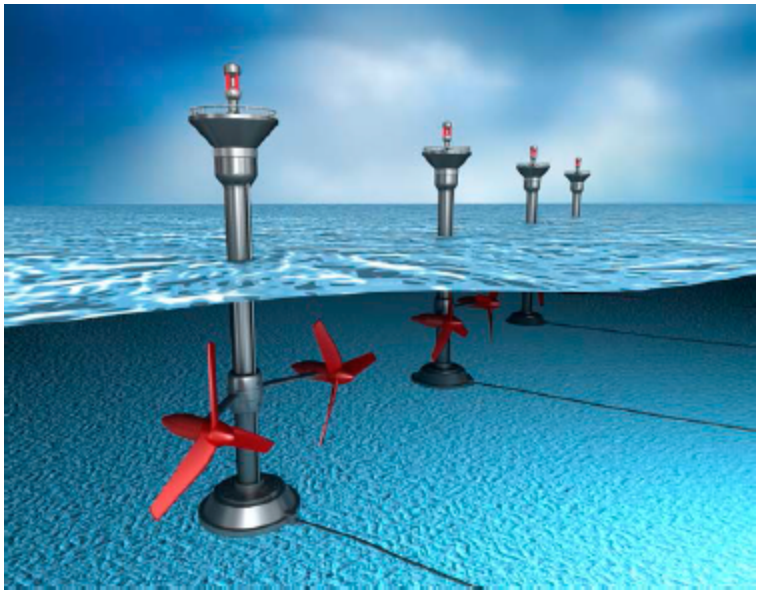
Energy and the Environment

- Fossil fuels produce greenhouse gases
- Nuclear power produces radioactive waste
- Renewable energy resources can affect animal and plant life

1 Electricity in the UK is generated in many ways.

The figure below shows an undersea turbine.

The undersea turbine uses tidal energy to generate electricity.



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(a) What is the original source of energy for tidal power schemes?

_____

_____

(1)

(b) Explain **two** advantages of using undersea tidal turbines to generate electricity rather than burning fossil fuels.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) Some power stations burn wood instead of fossil fuels to generate electricity.

A coal-burning power station burns 6 million tonnes of coal per year.

Coal has an average energy value of 29.25 MJ per kg.

Wood chip from willow trees has an energy value of 13 MJ per kg.

A hectare of agricultural land can produce 9 tonnes of dry willow wood per year.

If this power station burned dry willow wood instead of coal, how much agricultural land would be needed to grow the willow?

_____

_____

_____

_____

_____

Amount of land needed = _____ hectares

(3)

(d) The table below shows the carbon dioxide emissions of four fuels used to generate electricity.

Fuel	Direct CO_2 emissions in kg per MWh	Lifecycle CO_2 emissions in kg per MWh
Coal	460	540
Natural gas	185	215
Oil	264	313
Wood	2 100	58

Direct CO_2 emissions are the amounts of carbon dioxide released when the fuel is burned.

Lifecycle CO_2 emissions is the total amount of carbon dioxide released during all stages from fuel extraction to when the fuel has been used.

Use the data from the table above to explain why wood is considered to be a low carbon dioxide emitting fuel.

(2)

(Total 10 marks)

2 (a) Explain how energy is produced in the Sun.

(3)

(b) Read the following article that appeared in a magazine.

"Conservation of energy is important in today's society. Energy sources, such as oil and coal, which have been used for the development of an industrial society, cannot be relied upon as heavily in the future. Renewable energy sources cannot provide such large quantities of energy for society without causing problems."

(i) Give **two** reasons why oil should not be relied on as a major source of energy for the future.

1. _____

_____

2. _____

_____

(2)

(ii) Energy from the wind is a renewable energy resource. State **three** problems which may arise if the wind were to be used to meet the energy requirements of a large industrial city in Britain.

1. _____

_____

_____

2. _____

_____

_____

3. _____

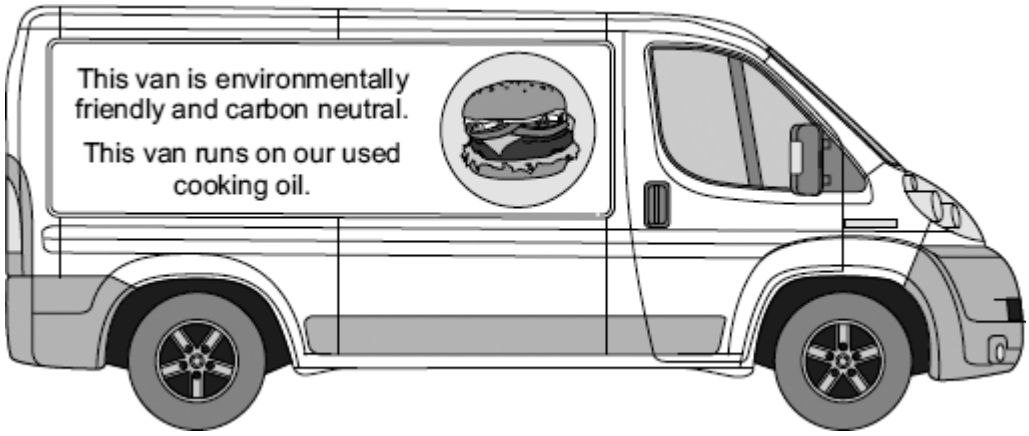
_____

_____

(3)

(Total 8 marks)

3 A burger van has a sign on the side.



The company that owns the van makes biodiesel from cooking oil.

A scientist investigated the emissions from biodiesel and petroleum diesel.

The scientist burned the same mass of each fuel in a diesel engine.

The scientist compared the emissions produced.

The results are shown in the table.

	Biodiesel	**Petroleum diesel**
Carbon dioxide emitted in g	3000	3000
Unburnt hydrocarbons emitted in g	7	10
Soot emitted in g	6	12
Nitrogen oxides emitted in g	5	2

Use your scientific knowledge and the data in the table to evaluate the advantages and disadvantages of using biodiesel rather than petroleum diesel as a fuel.

Remember to include a supported conclusion in your answer.

(Total 5 marks)