

1

Energy resources can be renewable or non-renewable.

(a) Coal is a non-renewable energy resource.

Name **two** other non-renewable energy resources.

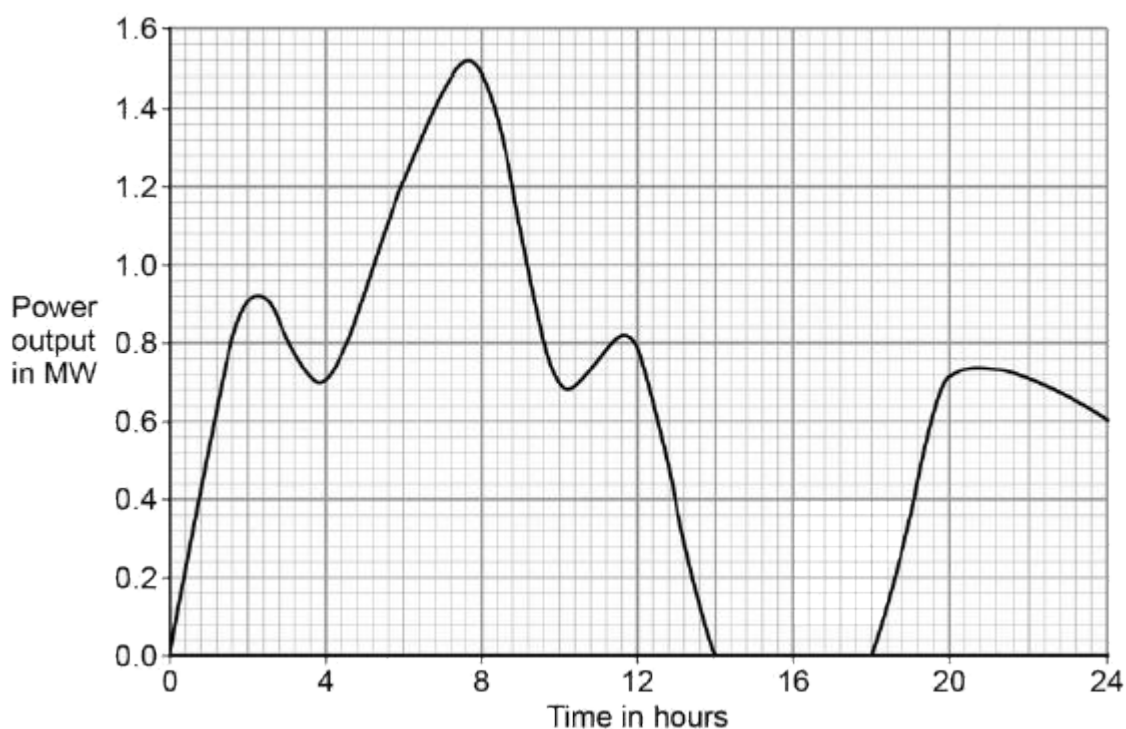
1

2

(2)

(b) Wind turbines are used to generate electricity.

The graph below shows how the power output of a wind turbine changes over one day.



A wind turbine does not generate electricity constantly.

For how many hours did the wind turbine generate no electricity?

.....

Time = hours

(1)

- (c) Electrical power is transferred from power stations to the National Grid.

What is the National Grid?

Tick **one** box.

a system of cables and pylons

☐

a system of cables and transformers

☐

a system of cables, transformers and power stations

☐

(1)

- (d) An island has a large number of wind turbines and a coal-fired power station.

The island needs to use the electricity generated by the coal-fired power station at certain times.

Choose **one** reason why.

Tick **one** box.

Wind is a renewable energy resource.

☐

Wind turbine power output is constant.

☐

The power output of wind turbines is unpredictable.

☐

The fuel cost for wind turbines is very high.

☐

(1)

- (e) A wind turbine has an average power output of 0.60 MW.

A coal-fired power station has a continuous power output of 1500 MW.

Calculate how many wind turbines would be needed to generate the same power output as one coal-fired power station.

.....

.....

Number of wind turbines =

(2)

- (f) It is important that scientists develop new energy resources.

Choose **one** reason why.

Tick **one** box.

All energy resources are running out.

☐

All energy resources are used to generate electricity.

☐

Most energy resources have negative environmental effects.

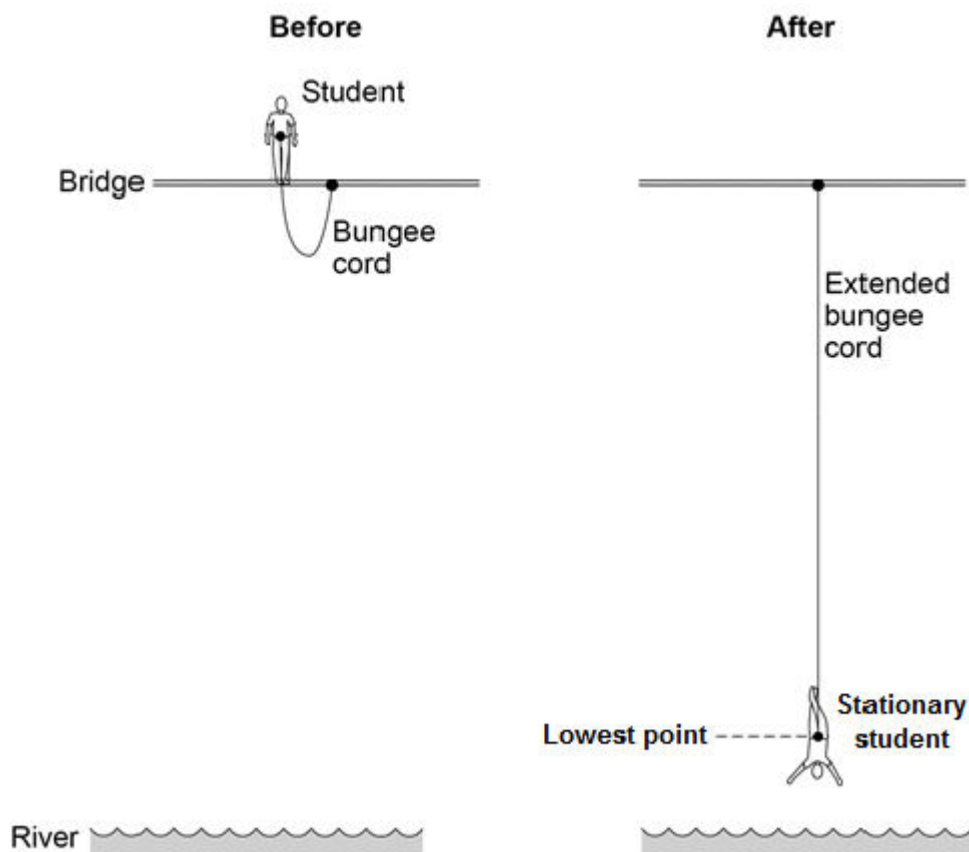
☐

(1)
(Total 8 marks)

2

The image below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.



- (a) For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

1

.....

2

.....

(2)

- (b) The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential	gravitational potential	kinetic	sound	thermal
--------------------------	--------------------------------	----------------	--------------	----------------

Before the student jumps from the bridge he has a store of

..... energy.

When he is falling, the student's store of
energy increases.

When the bungee cord is stretched, the cord stores energy as

..... energy.

(3)

- (c) At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N / m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

.....

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.....

Energy = J

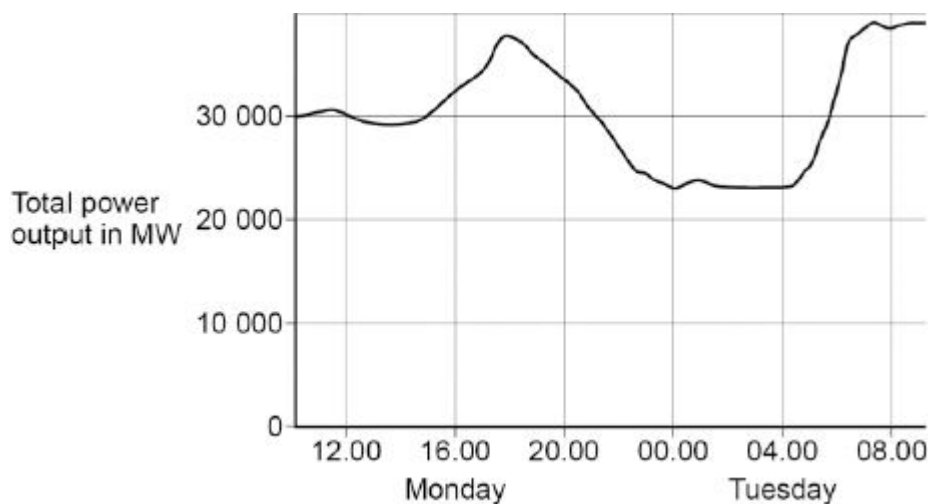
(2)

(Total 7 marks)

3

The National Grid ensures that the supply of electricity always meets the demand of the consumers.

The figure below shows how the output from fossil fuel power stations in the UK varied over a 24-hour period.



- (a) Suggest **one** reason for the shape of the graph between 15.00 and 18.00 on Monday.

.....

(1)

- (b) Gas fired power stations reduce their output when demand for electricity is low.
 Suggest **one** time on the figure above when the demand for electricity was low.

.....

(1)

- (c) The National Grid ensures that fossil fuel power stations in the UK only produce about 33% of the total electricity they could produce when operating at a maximum output.

Suggest **two** reasons why.

1

 2

(2)

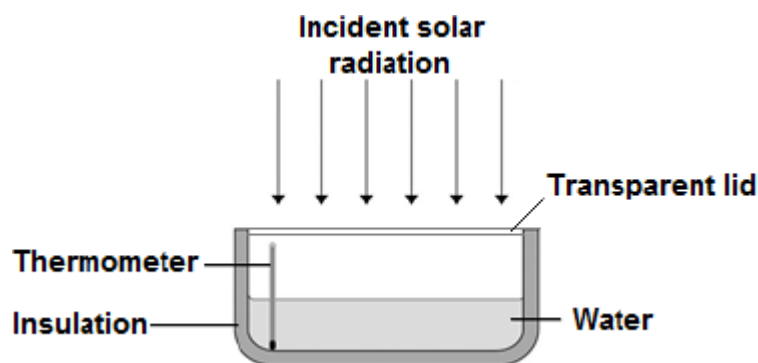
(Total 4 marks)

4

A student investigated how much energy from the Sun was incident on the Earth's surface at her location.

She put an insulated pan of water in direct sunlight and measured the time it took for the temperature of the water to increase by 0.6°C .

The apparatus she used is shown in the figure below.



- (a) Choose the most appropriate resolution for the thermometer used by the student.

Tick **one** box.

0.1 $^{\circ}\text{C}$

☐

0.5 $^{\circ}\text{C}$

☐

1.0 $^{\circ}\text{C}$

☐

(1)

- (b) The energy transferred to the water was 1050 J.

The time taken for the water temperature to increase by 0.6°C was 5 minutes.

The specific heat capacity of water is $4200 \text{ J / kg }^{\circ}\text{C}$.

Write down the equation which links energy transferred, power and time.

.....

(1)

- (c) Calculate the mean power supplied by the Sun to the water in the pan.

.....

.....

.....

Average power = W

(2)

- (d) Calculate the mass of water the student used in her investigation.

Use the correct equation from the Physics Equation Sheet.

.....

Mass = kg

(3)

- (e) The student's results can only be used as an estimate of the mean power at her location.

Give **one** reason why.

.....

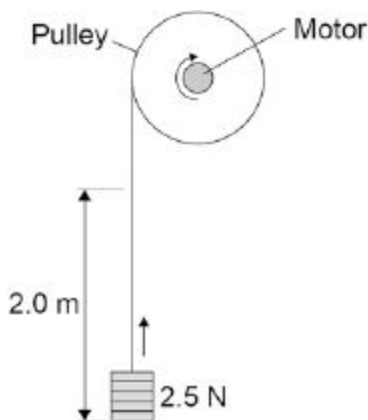
(1)

(Total 8 marks)

5

A student investigated the efficiency of a motor using the equipment in **Figure 1**.

Figure 1



He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer.

He repeated the experiment to gain two sets of data.

- (a) Give **one** variable that the student controlled in his investigation.

.....

(1)

- (b) Give **two** reasons for taking repeat readings in an investigation.

1

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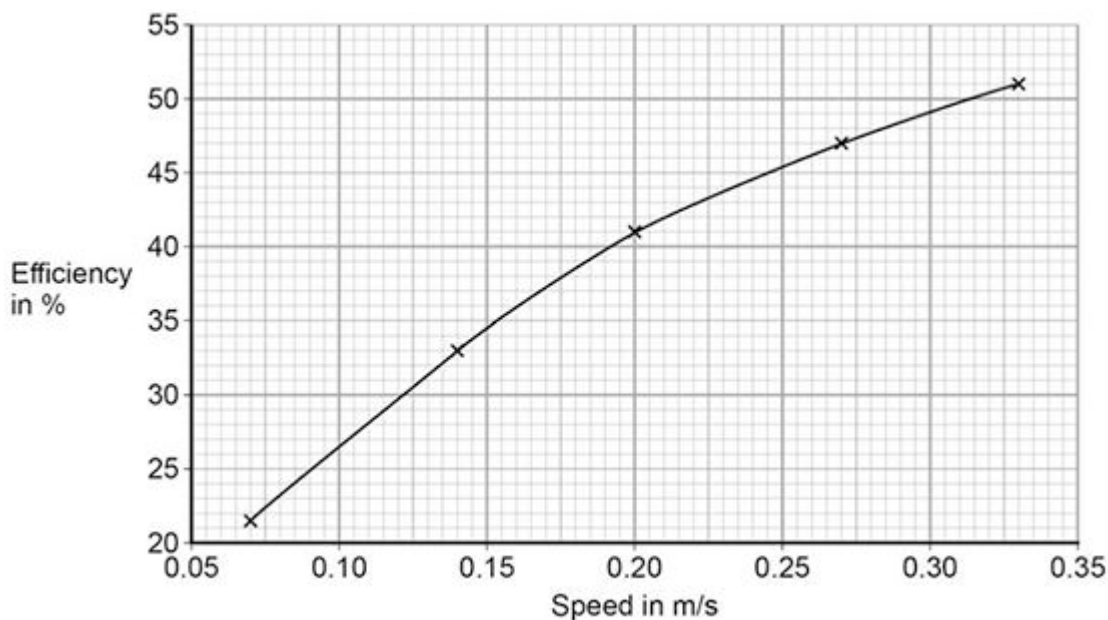
2

.....

(2)

- (c) **Figure 2** shows a graph of the student's results.

Figure 2



Give **two** conclusions that could be made from the data in **Figure 2**.

.....

.....

.....

.....

(2)

- (d) Give the main way that the motor is likely to waste energy.

.....

.....

(1)

- (e) When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight.

State the efficiency of the motor.

Efficiency = %

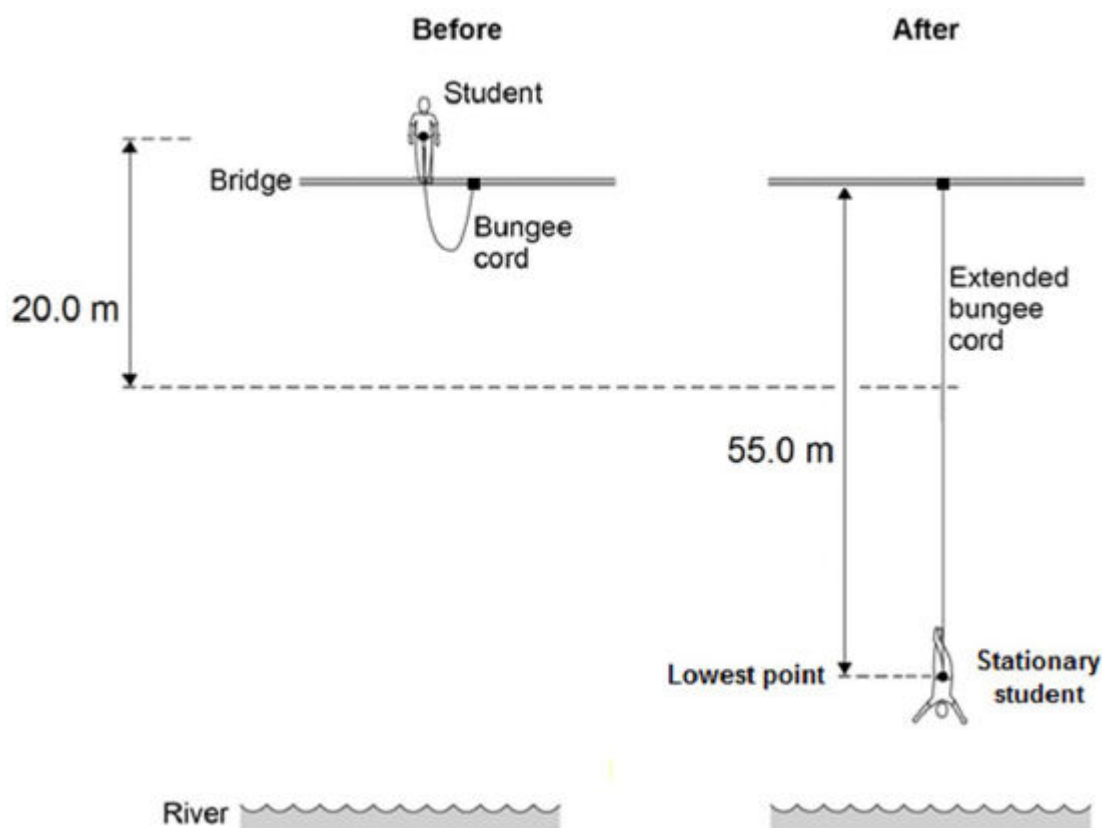
(1)

(Total 7 marks)

6

The figure below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20.0 m.



The mass of the student is 50.0 kg.

The gravitational field strength is 9.8 N / kg.

- (a) Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

.....

(1)

- (b) Calculate the change in gravitational potential energy from the position where the student jumps to the point 20.0 m below.

.....

.....

.....

Change in gravitational potential energy = J

(2)

- (c) 80% of this change in gravitational potential energy has been transferred to the student's kinetic energy store.

How much has the student's kinetic energy store increased after falling 20.0 m?

Kinetic energy gained = J

(1)

- (d) Calculate the speed of the student after falling 20.0 m.

Give your answer to two significant figures.

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.....

Speed = m / s

(4)

- (e) At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

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.....

Spring constant = N / m

(3)
(Total 11 marks)

7

The figure below shows the horizontal forces acting on a car.



- (a) Which **one** of the statements describes the motion of the car?

Tick **one** box.

It will be slowing down.

☐

It will be stationary.

☐

It will have a constant speed.

☐

It will be speeding up.

☐

(1)

- (b) During part of the journey the car is driven at a constant speed for five minutes.

Which one of the equations links distance travelled, speed and time?

Tick **one** box.

distance travelled = speed + time

☐

distance travelled = speed \times time

☐

distance travelled = speed - time

☐

distance travelled = speed \div time

☐

(1)

- (c) During a different part of the journey the car accelerates from 9m / s to 18m / s in 6 s.

Use the following equation to calculate the acceleration of the car.

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time taken}}$$

.....

.....

$$\text{acceleration} = \text{..... m / s}^2$$

(2)

- (d) Which equation links acceleration, mass and resultant force?

Tick **one** box.

resultant force = mass + acceleration

☐

resultant force = mass \times acceleration

☐

resultant force = mass - acceleration

☐

resultant force = mass \div acceleration

☐

(1)

- (e) The mass of the car is 1120 kg. The mass of the driver is 80 kg.

Calculate the resultant force acting on the car and driver while accelerating.

.....
.....

Resultant force = N

(2)

- (f) Calculate the distance travelled while the car is accelerating.

Use the correct equation from the Physics Equation Sheet.

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.....
.....

Distance = m

(3)

- (g) A car driver sees a fallen tree lying across the road ahead and makes an emergency stop.

The braking distance of the car depends on the speed of the car.

For the same braking force, explain what happens to the braking distance if the speed doubles.

You should refer to kinetic energy in your answer.

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(4)

(Total 14 marks)

8

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

(1)

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

.....

.....

(1)

- (iii) Calculate the efficiency of this light bulb.

.....

.....

Efficiency =

(2)

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

.....

.....

Time = s

(2)

- (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.

.....

(1)

- (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.

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(2)

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

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(1)

(Total 10 marks)

9

All objects emit and absorb infrared radiation.

- (a) Use the correct answer from the box to complete each sentence.

dark matt	dark shiny	light matt	light shiny
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The best emitters of infrared radiation have

..... surfaces.

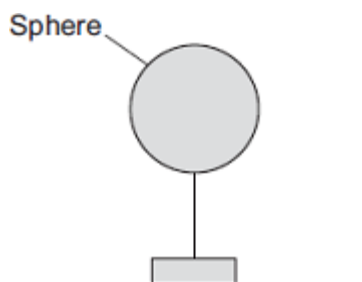
The worst emitters of infrared radiation have

..... surfaces.

(2)

- (b) **Diagram 1** shows a sphere which is at a much higher temperature than its surroundings.

Diagram 1



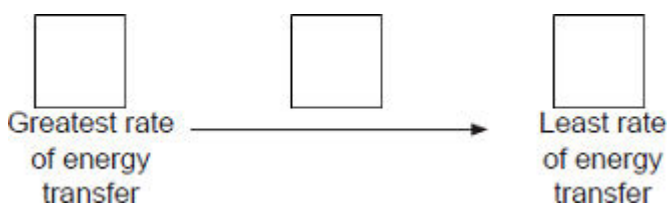
Energy is transferred from the sphere to the surroundings.

The table shows readings for the sphere in three different conditions, **A**, **B** and **C**.

Condition	Temperature of sphere in °C	Temperature of surroundings in °C
A	70	5
B	80	0
C	90	30

In each of the conditions, **A**, **B** and **C**, the sphere transfers energy to the surroundings at a different rate.

Put conditions **A**, **B** and **C** in the correct order.



Give a reason for your answer.

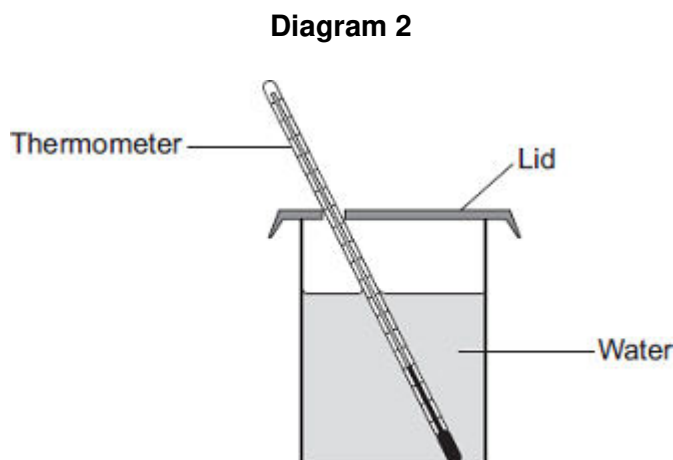
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(2)

- (c) **Diagram 2** shows a can containing water.

A student investigates how quickly a can of water heats up when it is cooler than room temperature.



The student has four cans, each made of the same material, with the following outer surfaces.

dark matt

dark shiny

light matt

light shiny

The student times how long it takes the water in each can to reach room temperature.

Each can contains the same mass of water at the same starting temperature.

- (i) Which can of water will reach room temperature the quickest?

Give a reason for your answer.

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.....

.....

(2)

- (ii) Apart from material of the can, mass of water and starting temperature, suggest **three** control variables for the student's investigation.

1

.....

2

.....

3

.....

(3)

- (d) The photographs show two different foxes.

Fox A



By Algalv (Own work) [CC-BY-3.0],
via Wikimedia Commons

Fox B



© EcoPic/iStock

Which fox is better adapted to survive cold conditions?

Give reasons for your answer.

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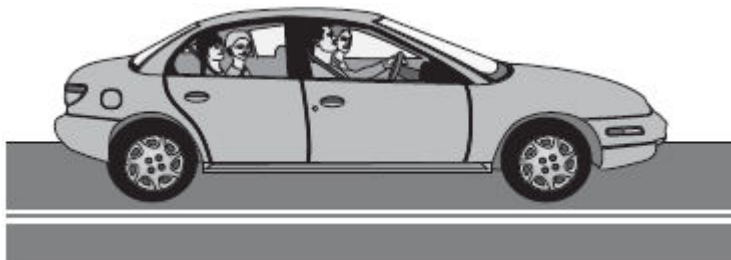
(3)

(Total 12 marks)

10

The figure below shows a car with an electric motor.

The car is moving along a flat road.



- (a) (i) Use the correct answers from the box to complete each sentence.

light	electrical	kinetic	potential	sound
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The car's motor transfers energy
 into useful energy as the car moves.
 Some energy is wasted as energy.

(3)

- (ii) What happens to the wasted energy?

.....

(1)

- (b) The electric motor has an input energy of 50 000 joules each second.

The motor transfers 35 000 joules of useful energy each second.

Calculate the efficiency of the electric motor.

.....

Efficiency =

(2)
(Total 6 marks)

11

Iceland is a country that generates most of its electricity using geothermal power stations and hydroelectric power stations.

- (a) (i) Complete the following sentences to describe how some geothermal power stations work.

In regions where volcanoes are active, the ground is hot.

Cold is pumped down into the ground

and is by hot rocks.

It returns to the surface as steam. The steam is used to turn a turbine.

The turbine drives a to produce electricity.

(3)

- (ii) Which **one** of the following statements about geothermal power stations is true?

Tick (✓) **one** box.

Geothermal power stations use fossil fuels.

☐

Geothermal power stations produce carbon dioxide.

☐

Geothermal power stations provide a reliable source of electricity.

☐
(1)

- (b) What is needed for a hydroelectric power station to be able to generate electricity?

Tick (✓) **one** box.

Falling water

☐

A long coastline

☐

Lots of sunny days

☐
(1)**(Total 5 marks)**

12

Electricity can be generated using various energy sources.

- (a) Give **one** advantage and **one** disadvantage of using nuclear power stations rather than gas-fired power stations to generate electricity.

Advantage

.....

Disadvantage

.....

(2)

- (b) (i) A single wind turbine has a maximum power output of 2 000 000 W.

The wind turbine operated continuously at maximum power for 6 hours.

Calculate the energy output in kilowatt-hours of the wind turbine.

.....

.....

.....

Energy output = kWh

(2)

- (ii) Why, on average, do wind turbines operate at maximum power output for only 30% of the time?

.....

.....

(1)

- (c) An on-shore wind farm is made up of many individual wind turbines.

They are connected to the National Grid using underground power cables.

Give **one** advantage of using underground power cables rather than overhead power cables.

.....

.....

(1)**(Total 6 marks)**

13

- (a) Iceland is a country that generates nearly all of its electricity from renewable sources.

In 2013, about 80% of Iceland's electricity was generated using hydroelectric power stations (HEP).

Describe how electricity is generated in a hydroelectric power station. Include the useful energy transfers taking place.

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(4)

- (b) The UK produces most of its electricity from fossil fuels.

Many people in the UK leave their televisions in 'stand by' mode when not in use, instead of switching them off.

It is better for the environment if people switch off their televisions, instead of leaving them in 'stand by' mode.

Explain why.

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.....

.....

(3)

- (c) A scientist wrote in a newspaper:

‘Appliances that do not automatically switch off when they are not being used should be banned.’

Suggest why scientists alone cannot make the decision to ban these appliances.

.....

.....

(1)
(Total 8 marks)

14

Table 1 shows information about different light bulbs.

The bulbs all have the same brightness.

Table 1

Type of bulb	Input power in watts	Efficiency
Halogen	40	0.15
Compact fluorescent (CFL)	14	0.42
LED	7	0.85

- (a) (i) Calculate the useful power output of the CFL bulb.

.....

.....

.....

Useful power output = watts

(2)

- (ii) Use your answer to part (i) to calculate the waste energy produced each second by a CFL bulb.

.....

Waste energy per second = joules

(1)

- (b) (i) A growth cabinet is used to investigate the effect of light on the rate of growth of plants.

The figure below shows a growth cabinet.



In the cabinet the factors that affect growth can be controlled.

A cooler unit is used to keep the temperature in the cabinet constant. The cooler unit is programmed to operate when the temperature rises above 20 °C.

The growth cabinet is lit using 50 halogen bulbs.

Changing from using halogen bulbs to LED bulbs would reduce the cost of running the growth cabinet.

Explain why.

.....

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.....

.....

(4)

- (ii) A scientist measured the rate of growth of plants for different intensities of light.

What type of graph should be drawn to present the results?

.....

Give a reason for your answer.

.....

.....

(1)

- (c) **Table 2** gives further information about both a halogen bulb and a LED bulb.

Table 2

Type of bulb	Cost to buy	Lifetime in hours	Operating cost over the lifetime of one bulb
Halogen	£1.50	2 000	£16.00
LED	£30.00	48 000	£67.20

A householder needs to replace a broken halogen light bulb.

Compare the cost efficiency of buying and using halogen bulbs rather than a LED bulb over a time span of 48 000 hours of use.

Your comparison must include calculations.

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(4)
(Total 12 marks)

15

Solar panels are often seen on the roofs of houses.

- (a) Describe the action and purpose of a solar panel.

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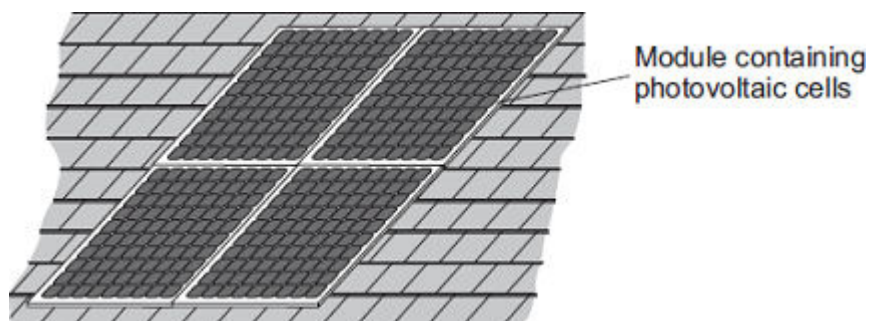
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(2)

- (b) Photovoltaic cells transfer light energy to electrical energy.

In the UK, some householders have fitted modules containing photovoltaic cells on the roofs of their houses.

Four modules are shown in the diagram.



The electricity company pays the householder for the energy transferred.

The maximum power available from the photovoltaic cells shown in the diagram is $1.4 \times 10^3 \text{ W}$.

How long, in minutes, does it take to transfer 168 kJ of energy?

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.....
..... Time = minutes

(3)

- (c) When the modules are fitted on a roof, the householder gets an extra electricity meter to measure the amount of energy transferred by the photovoltaic cells.
- (i) The diagram shows two readings of this electricity meter taken three months apart. The readings are in kilowatt-hours (kWh).

21 November

0	0	0	4	4
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21 February

0	0	1	9	4
---	---	---	---	---

Calculate the energy transferred by the photovoltaic cells during this time period.

.....

Energy transferred = kWh

(1)

- (ii) The electricity company pays 40p for each kWh of energy transferred.
- Calculate the money the electricity company would pay the householder.

.....

.....

Money paid =

(2)

- (iii) The cost of the four modules is £6000.

Calculate the payback time in years for the modules.

.....

.....

Payback time = years

(3)

- (iv) State an assumption you have made in your calculation in part (iii).

.....

.....

(1)

- (d) In the northern hemisphere, the modules should always face south for the maximum transfer of energy.

State **one** other factor that would affect the amount of energy transferred during daylight hours.

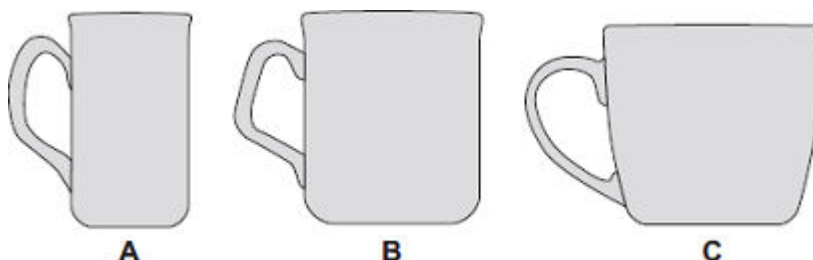
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(1)
(Total 13 marks)

16

The diagram shows three cups **A**, **B** and **C**.



Energy is transferred from hot water in the cups to the surroundings.

- (a) Use the correct answer from the box to complete each sentence.

condensation

conduction

convection

Energy is transferred through the walls of the cup by

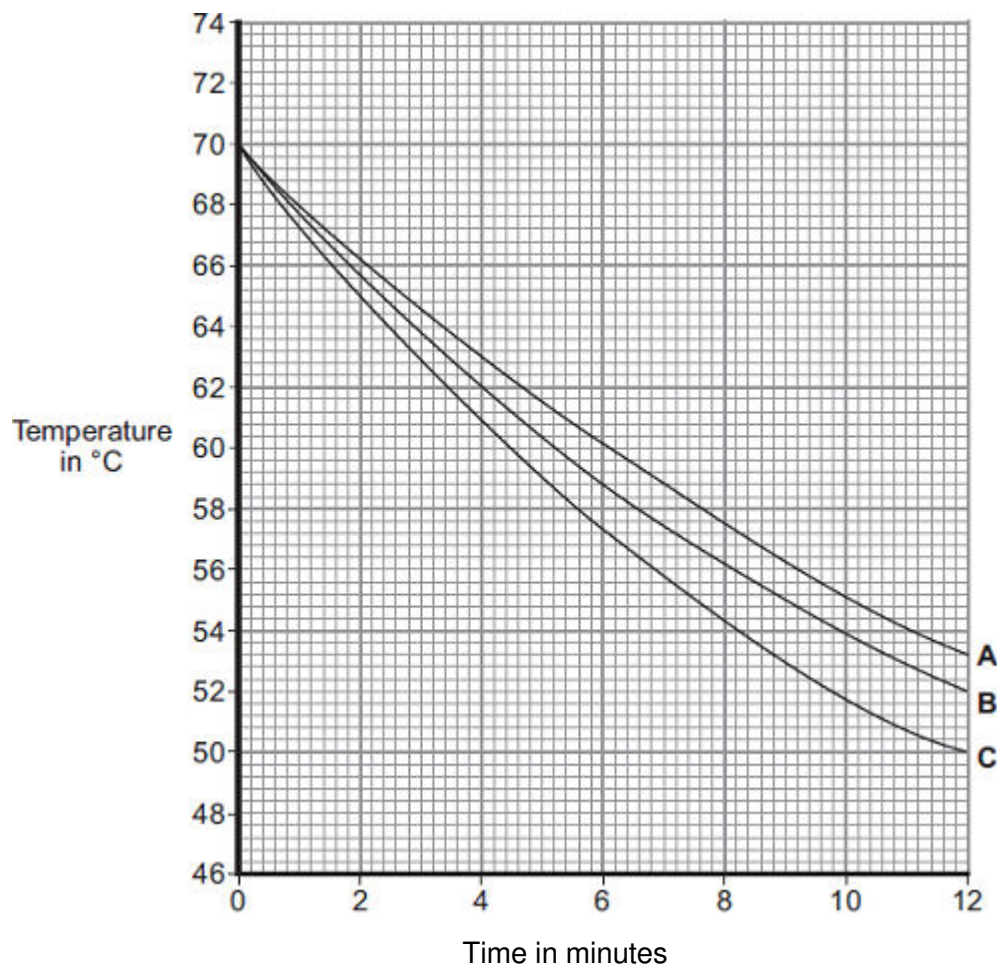
In the air around the cup, energy is transferred by

(2)

- (b) Some students investigated how the rate of cooling of water in a cup depends on the surface area of the water in contact with the air.

They used cups **A**, **B** and **C**. They poured the same volume of hot water into each cup and recorded the temperature of the water at regular time intervals.

The results are shown on the graph.



- (i) What was the starting temperature of the water for each cup?

Starting temperature = °C

(1)

- (ii) Calculate the temperature fall of the water in cup **B** in the first 9 minutes.

.....

Temperature fall = °C

(2)

- (iii) Which cup, **A**, **B** or **C**, has the greatest rate of cooling?

Using the graph, give a reason for your answer.

.....

.....

(2)

- (iv) The investigation was repeated using the bowl shown in the diagram.

The same starting temperature and volume of water were used.



Draw on the graph in part (b) another line to show the expected result.

(1)

- (v) After 4 hours, the temperature of the water in each of the cups and the bowl was 20°C.

Suggest why the temperature does **not** fall below 20°C.

.....

(1)

- (c) (i) The mass of water in each cup is 200 g.

Calculate the energy, in joules, transferred from the water in a cup when the temperature of the water falls by 8°C.

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

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Energy transferred = J

(3)

- (ii) Explain, in terms of particles, how evaporation causes the cooling of water.

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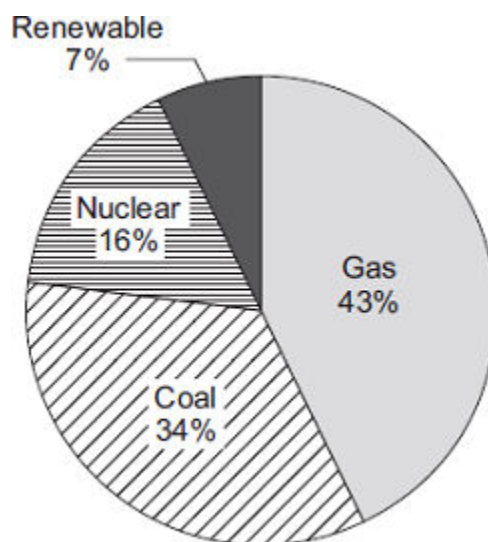
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(4)

(Total 16 marks)

17

- (a) The pie chart shows the proportions of electricity generated in the UK from different energy sources in 2010.



- (i) Calculate the percentage of electricity generated using fossil fuels.

.....

Percentage = %

(1)

- (ii) The pie chart shows that 7% of electricity was generated using renewable energy sources.

Which **one** of the following is **not** a renewable energy source?

Tick (✓) **one** box.

Oil

☐

Solar

☐

Wind

☐

(1)

- (b) Complete the following sentence.

In some types of power station, fossil fuels are burned to heat to produce steam.

(1)

- (c) Burning fossil fuels releases carbon dioxide into the atmosphere.

Why do many scientists think adding carbon dioxide to the atmosphere is harmful to the environment?

Tick (✓) **one** box.

Carbon dioxide is the main cause of acid rain.

☐

Carbon dioxide causes global warming.

☐

Carbon dioxide causes visual pollution.

☐

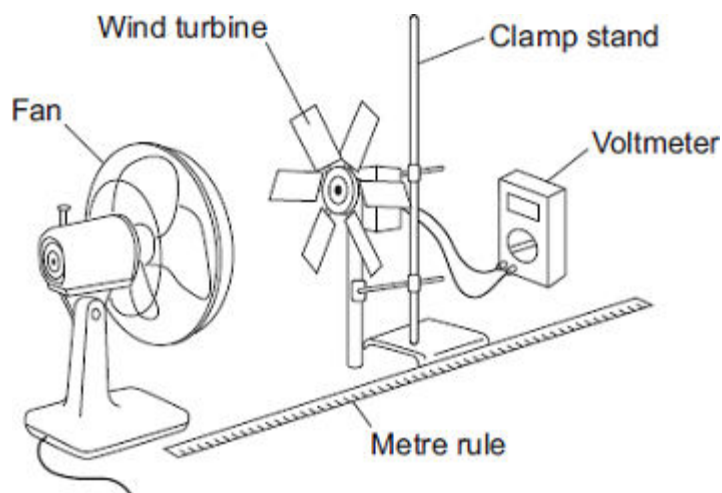
(1)

(Total 4 marks)

18

- (a) A student investigated how the number of blades on a wind turbine affects the output voltage of the turbine.

The student used the apparatus shown in the diagram.



The fan was used to turn the wind turbine.

- (i) The fan was always the same distance from the wind turbine.

Why?

.....

.....

(1)

- (ii) After switching the fan on, the student waited 20 seconds before taking the voltmeter reading.

Suggest why.

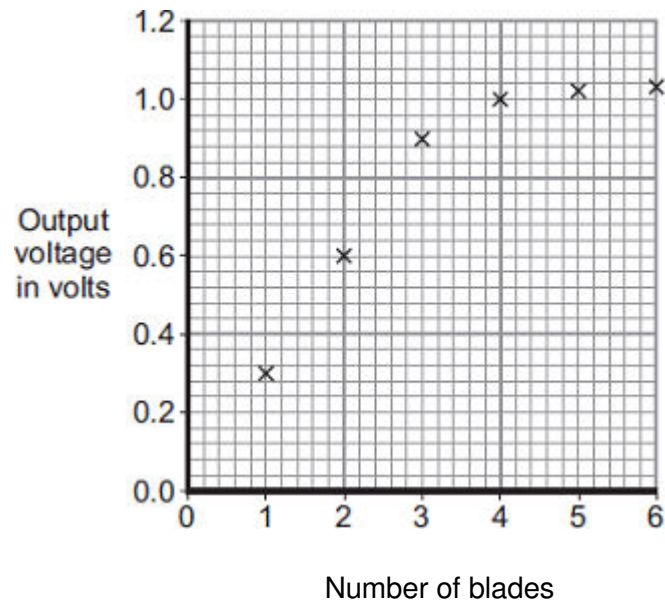
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(1)

- (iii) The student changed the number of blades on the wind turbine.

The student's results are shown in the scatter graph.



What conclusion can be made from the results in the scatter graph?

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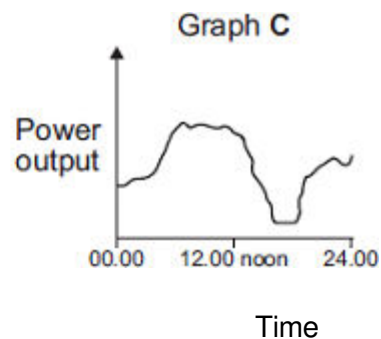
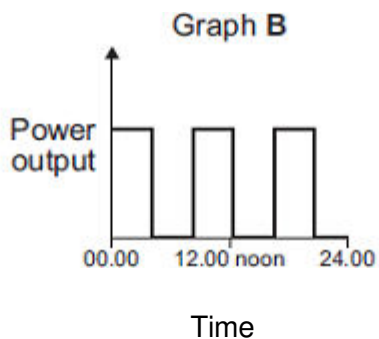
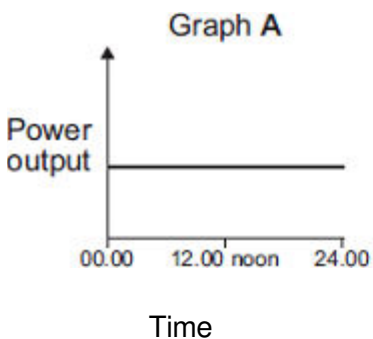
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(2)

- (b) The amount of electricity generated using wind turbines is increasing.

Which graph, **A**, **B** or **C**, is most likely to show the electrical power output from a wind turbine over one day?



Write the correct answer, **A**, **B** or **C**, in the box.

Give a reason for your answer.

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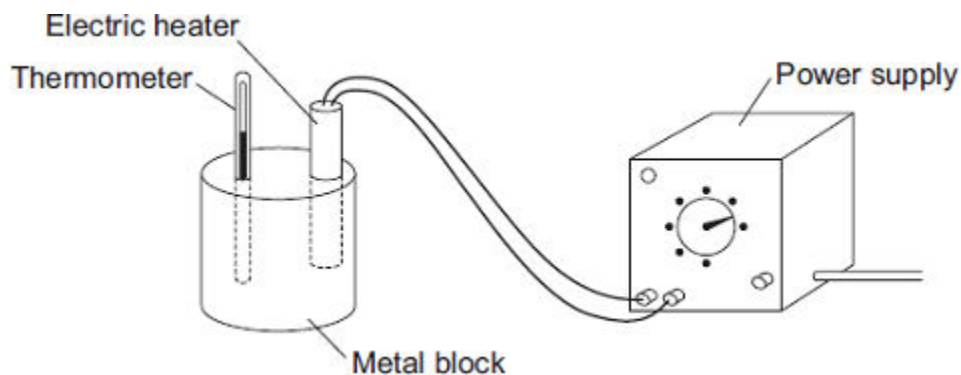
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(2)
(Total 6 marks)

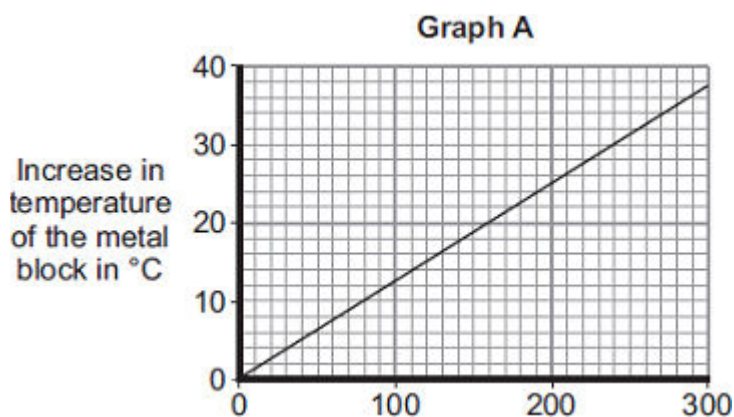
19

- (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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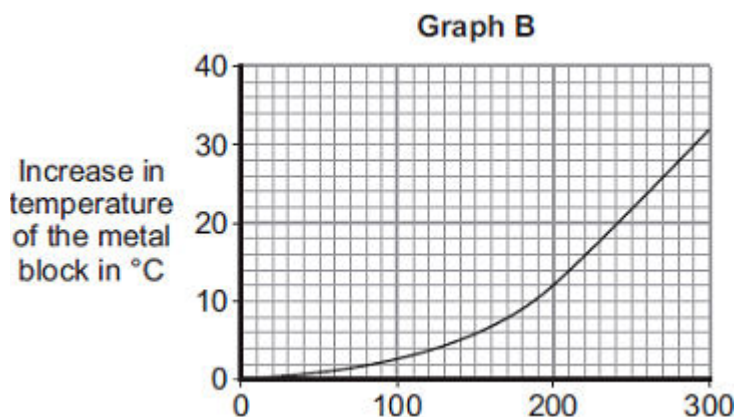
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(2)

- (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.

.....

(1)

- (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

(2)

- (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.

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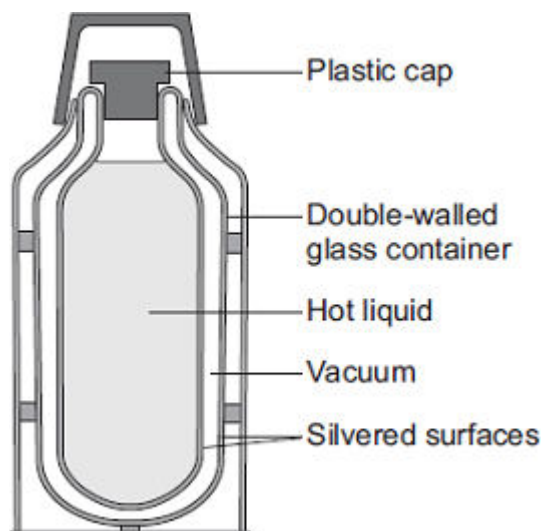
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(2)
(Total 7 marks)

20

- (a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The diagram shows the structure of a vacuum flask.



A vacuum flask is designed to reduce the rate of energy transfer by heating processes.

Describe how the design of a vacuum flask keeps the liquid inside hot.

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(6)

- (b) Arctic foxes live in a very cold environment.



© Purestock/Thinkstock

Arctic foxes have small ears.

How does the size of the ears help to keep the fox warm in a cold environment?

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.....

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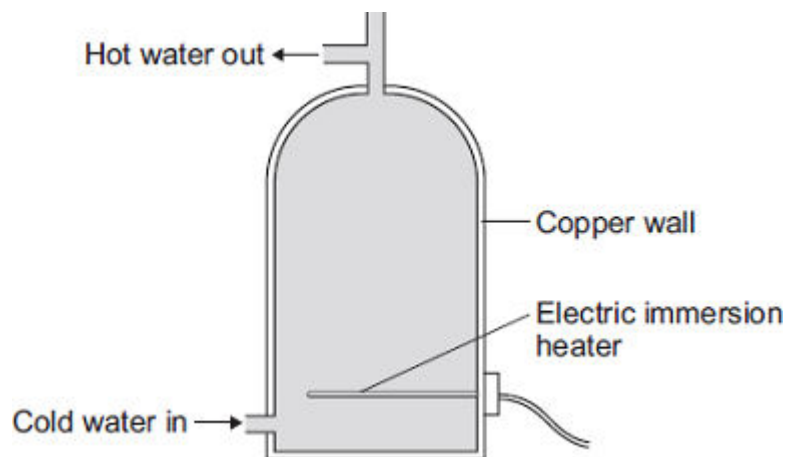
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(2)
(Total 8 marks)

21

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.

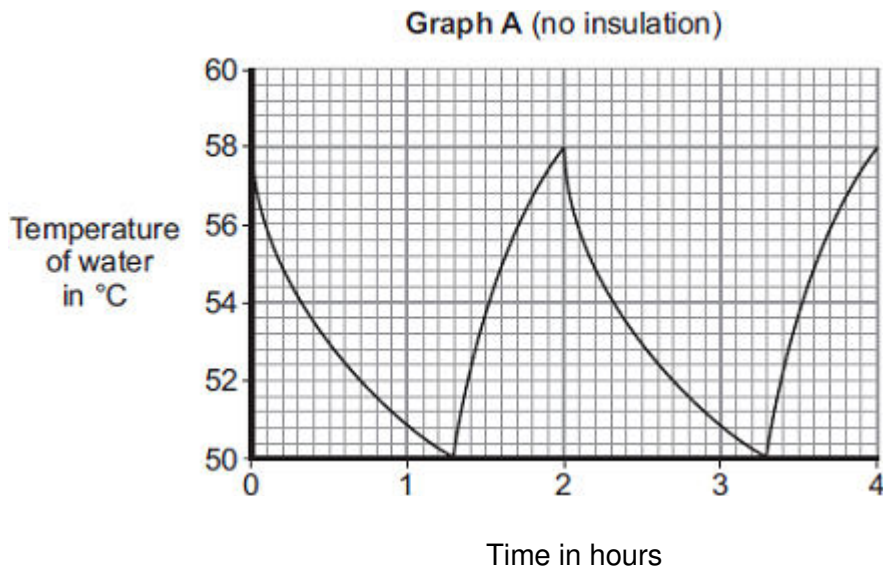
The main way the energy is transferred through the copper wall of the water tank is by the process of

(1)

- (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.



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

Explain why.

.....

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.....

.....

(2)

- (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 = $4200 \text{ J/kg}^{\circ}\text{C}$

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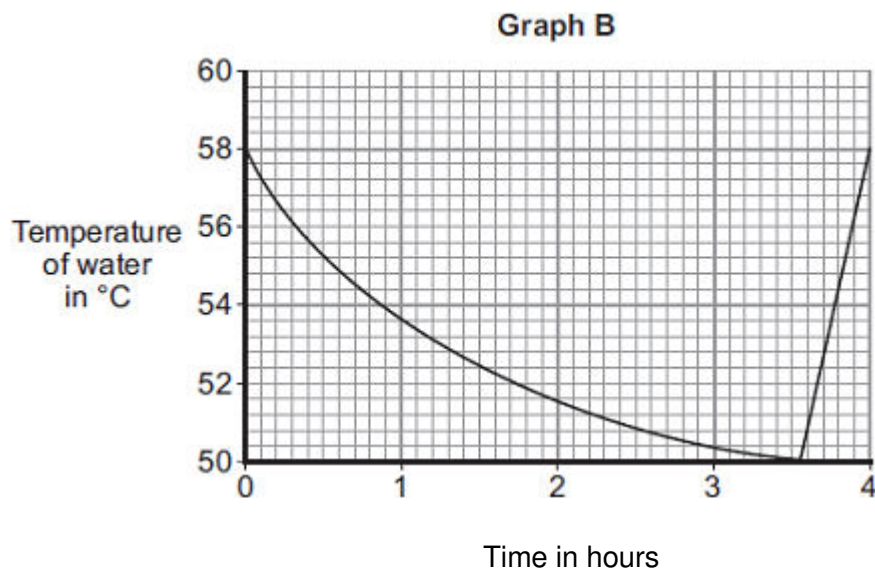
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Mass = kg

(3)

- (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.



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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(3)
(Total 9 marks)

22

- (a) In the UK, over 70% of the electricity is generated in power stations that burn fossil fuels.

- (i) Explain **one** effect that burning fossil fuels has on the environment.

.....

.....

.....

.....

(2)

- (ii) Give **one** way the effect on the environment described in part (a)(i) could be reduced.

Assume the amount of fossil fuels burnt stays the same.

.....

.....

(1)

- (b) Electricity can also be generated in a pumped storage hydroelectric power station.

An advantage of pumped storage hydroelectric power stations is the short start-up time they have.

- (i) What is the importance of the short start-up time?

.....

.....

(1)

- (ii) Give **one** other advantage of a pumped storage hydroelectric power station.

.....

.....

(1)

- (c) Read the extract below from a newspaper article.

In the future it may not be possible to have constant electricity. Families will have to get used to using power when it is available.

- (i) In the UK, the proportion of electricity generated using wind turbines is due to increase a lot. Some opponents of wind turbines think this increase will cause big fluctuations in the electricity supply.

Suggest **one** reason why this may be true.

.....

.....

(1)

- (ii) Between 2002 and 2008 the amount of electricity used for lighting in homes in the UK decreased.

Suggest **one** reason why.

.....

.....

(1)
(Total 7 marks)

23

Three energy sources used to generate electricity are given in **List A**.
Statements about the energy sources used to generate electricity are given in **List B**.

Draw **one** line from each energy source in **List A** to the statement about the energy source in **List B**.

List A
Energy source

Geothermal

Hydroelectric

Nuclear

List B
Statement about energy source

Uses energy from falling water

Uses energy from inside the Earth

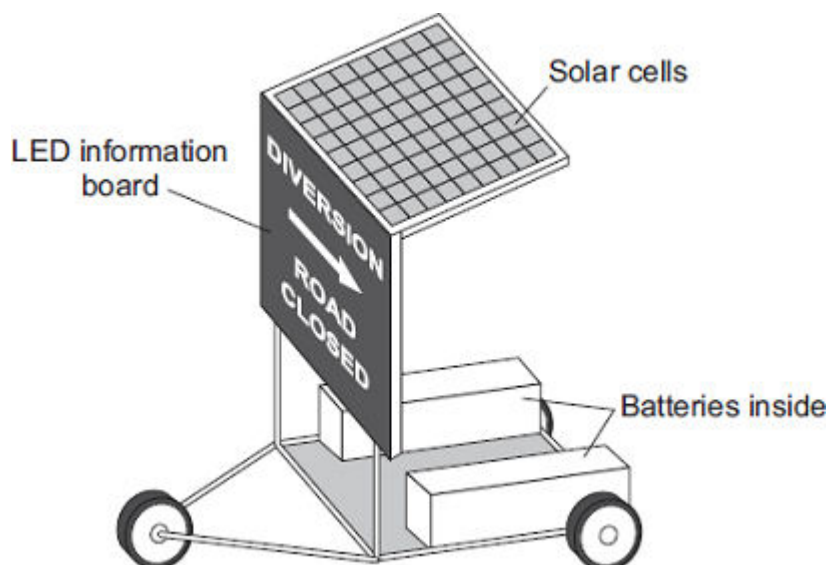
Is unpredictable

Produces dangerous waste

(Total 3 marks)

24

The picture shows a temporary road traffic information board.



The batteries power the LEDs used in the information board.
The solar cells keep the batteries charged.

- (a) Use words from the box to complete each of the following sentences.

chemical	electrical	light	sound
-----------------	-------------------	--------------	--------------

The solar cells transfer light energy to energy.

The batteries transfer energy to electrical energy.

The LEDs transfer electrical energy to energy.

(3)

- (b) When the total energy input to the solar cells is 200 joules, the useful energy output from the solar cells to the batteries is 50 joules.

Calculate the efficiency of the solar cells.

.....

Efficiency =

(2)

- (c) Which **one** of the following statements gives the reason for using solar cells to charge the batteries?

Tick (✓) **one** box.

Solar cells will charge the batteries day and night.

☐

The information board can be used anywhere it is needed.

☐

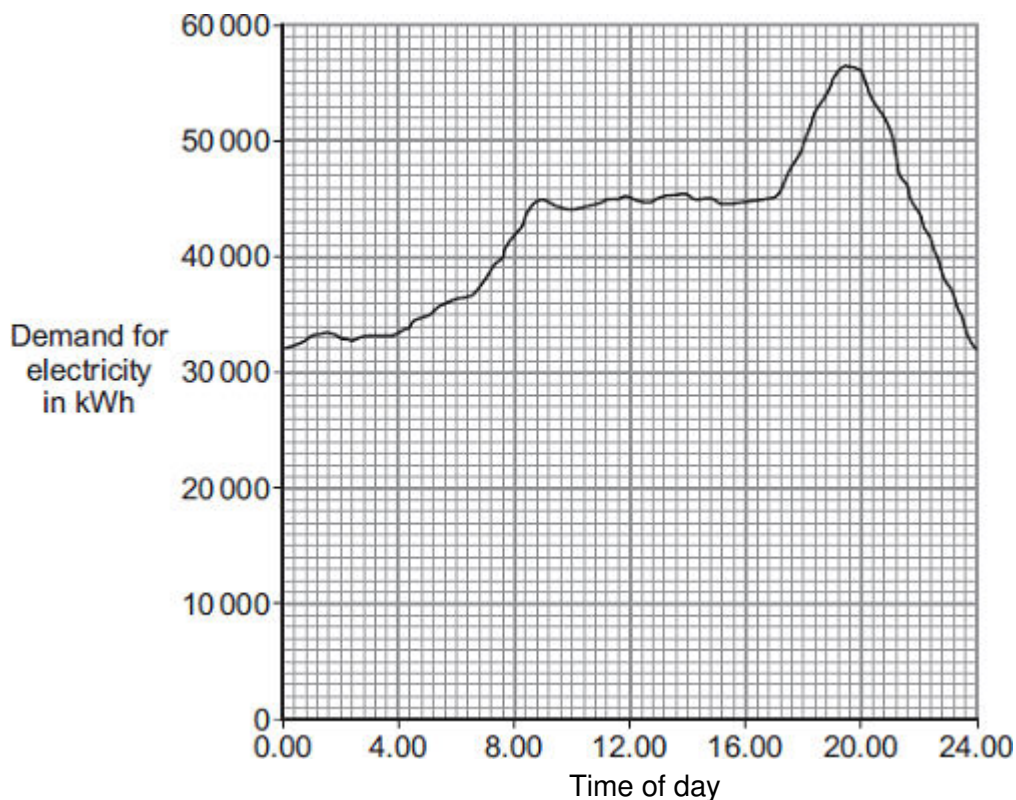
A small number of solar cells produce a lot of electricity.

☐

(1)
(Total 6 marks)

25

- (a) The graph shows how the demand for electricity in the UK changes during one 24-hour period.



The table gives the start-up times for two types of power station.

Type of power station	Start-up time
Gas	A few minutes
Nuclear	Several days

How would these two types of power station be used to meet the demand for electricity during this 24-hour period?

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.....

(3)

- (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

A farmer plans to generate all the electricity needed on her farm, using either a biogas generator or a small wind turbine.

The biogas generator would burn methane gas. The methane gas would come from rotting the animal waste produced on the farm. When burnt, methane produces carbon dioxide.

The biogas generator would cost £18 000 to buy and install. The wind turbine would cost £25 000 to buy and install.

The average power output from the wind turbine would be the same as the continuous output from the biogas generator.

Evaluate the advantages and disadvantages of the two methods of generating electricity.

Conclude, with a reason, which system would be better for the farmer to buy and install.

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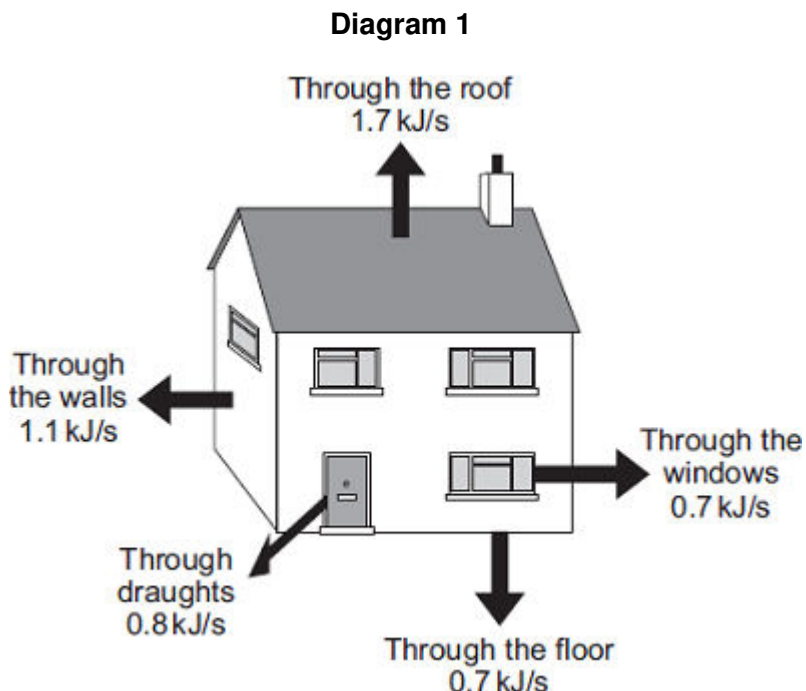
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(6)
(Total 9 marks)

26

Diagram 1 shows the energy transferred per second from a badly insulated house on a cold day in winter.



- (a) (i) When the inside of the house is at a constant temperature, the energy transferred from the heating system to the inside of the house equals the energy transferred from the house to the outside.

Calculate, in kilowatts, the power of the heating system used to keep the inside of the house in **Diagram 1** at a constant temperature.

1 kilowatt (kW) = 1 kilojoule per second (kJ/s)

.....

Power of the heating system = kW

(1)

- (ii) In the winter, the heating system is switched on for a total of 7 hours each day.

Calculate, in kilowatt-hours, the energy transferred each day from the heating system to the inside of the house.

.....

.....

Energy transferred each day = kWh

(2)

- (iii) Energy costs 15 p per kilowatt-hour.

Calculate the cost of heating the house for one day.

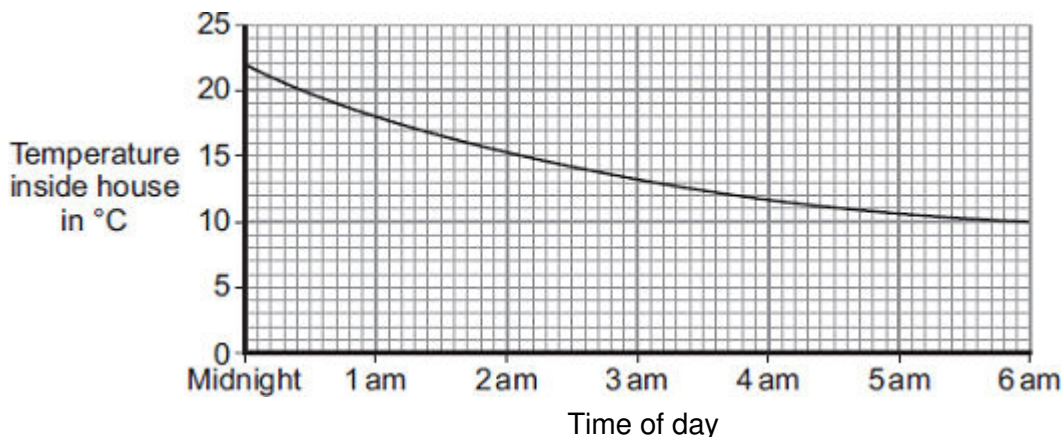
.....

Cost =

(1)

- (iv) The heating system is switched off at midnight.

The graph shows how the temperature inside the house changes after the heating system has been switched off.



Draw a ring around the correct answer in the box to complete the sentence.

Between midnight and 6 am the rate of energy transfer from

the house

decreases.

decreases then stays constant.

increases.

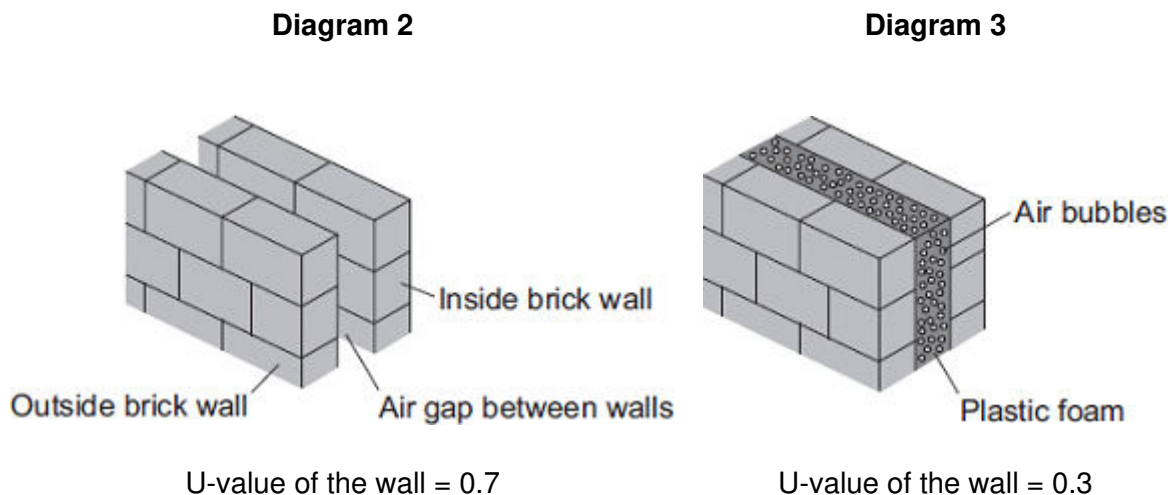
Give the reason for your answer.

.....

.....

(2)

- (b) **Diagram 2** shows how the walls of the house are constructed.
Diagram 3 shows how the insulation of the house could be improved by filling the air gap between the two brick walls with plastic foam.



The plastic foam reduces energy transfer by convection.

Explain why.

.....

.....

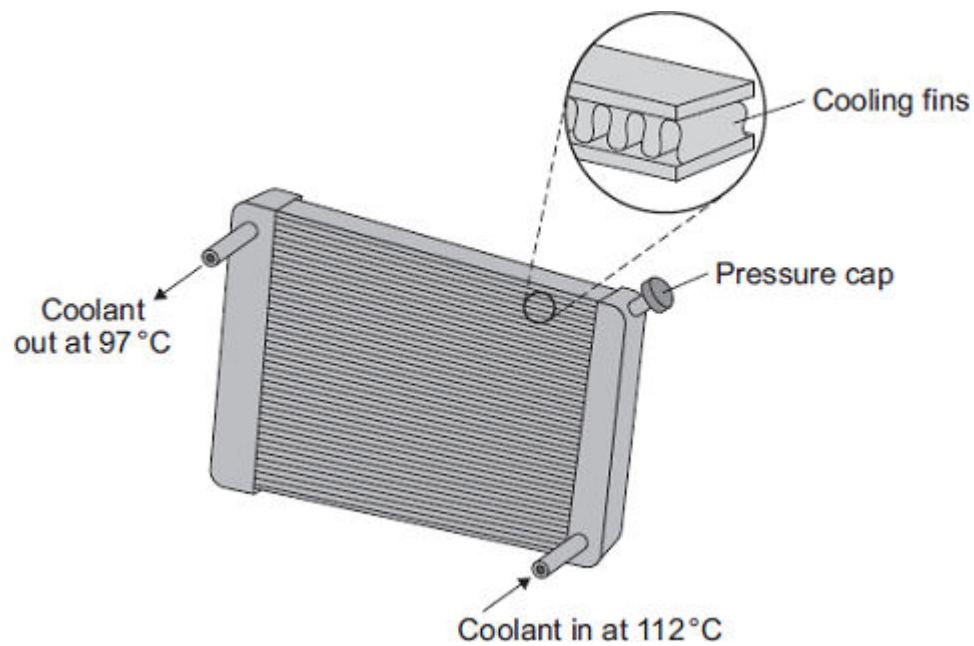
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(2)
(Total 8 marks)

27

The diagram shows a car radiator. The radiator is part of the engine cooling system.



Liquid coolant, heated by the car engine, enters the radiator. As the coolant passes through the radiator, the radiator transfers energy to the surroundings and the temperature of the coolant falls.

(a) Why is the radiator painted black?

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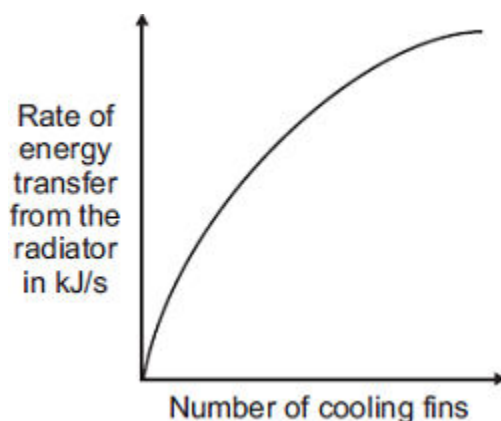
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(2)

- (b) Different radiators have different numbers of cooling fins along the length of the radiator.

The sketch graph shows how the number of cooling fins affects the rate of energy transfer from the radiator.



The number of cooling fins affects the rate of energy transfer from the radiator.

Explain how.

.....

.....

.....

.....

(2)

- (c) When the car engine is working normally, 2 kg of coolant passes through the radiator each second. The temperature of the coolant falls from 112 °C to 97 °C.

Calculate the energy transferred each second from the coolant.

Specific heat capacity of the coolant = 3800 J/kg °C.

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.....

Energy transferred each second = J

(3)

- (d) On cold days, some of the energy transferred from a hot car engine is used to warm the air inside the car. This is a useful energy transfer.

What effect, if any, does this energy transfer have on the overall efficiency of the car engine?

Draw a ring around the correct answer.

**decreases the
efficiency**

**does not change the
efficiency**

**increases the
efficiency**

Give a reason for your answer.

.....

.....

.....

(2)
(Total 9 marks)

28

About half of the UK's electricity is generated in coal-burning power stations and nuclear power stations.

- (a) Coal-burning power stations and nuclear power stations provide a reliable way of generating electricity.

What is meant by a *reliable way of generating electricity*?

.....

.....

(1)

- (b) Over the next few years, most of the older nuclear power stations in the UK will be closed down, and the process of decommissioning will start.

What does it mean to *decommission* a nuclear power station?

.....

.....

(1)

- (c) Climate change has been strongly linked to the emission of carbon dioxide. Many governments around the world are committed to reducing carbon dioxide emissions.

Generating electricity can increase carbon dioxide emissions.

The companies generating electricity could reduce carbon dioxide emissions.

Give **two** ways the companies could do this.

1

.....

2

.....

(2)

- (d) Electricity is distributed from power stations to consumers along the National Grid.

The voltage across the overhead cables of the National Grid needs to be much higher than the output voltage from the power station generators.

Explain why.

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(3)

(Total 7 marks)

29

The pictures show six different household appliances.

Fan heater

Iron

Hairdryer

Vacuum cleaner

Table lamp

Kettle



- (a) Four of the appliances, including the fan heater, are designed to transform electrical energy into heat.

Name the other **three** appliances designed to transform electrical energy into heat.

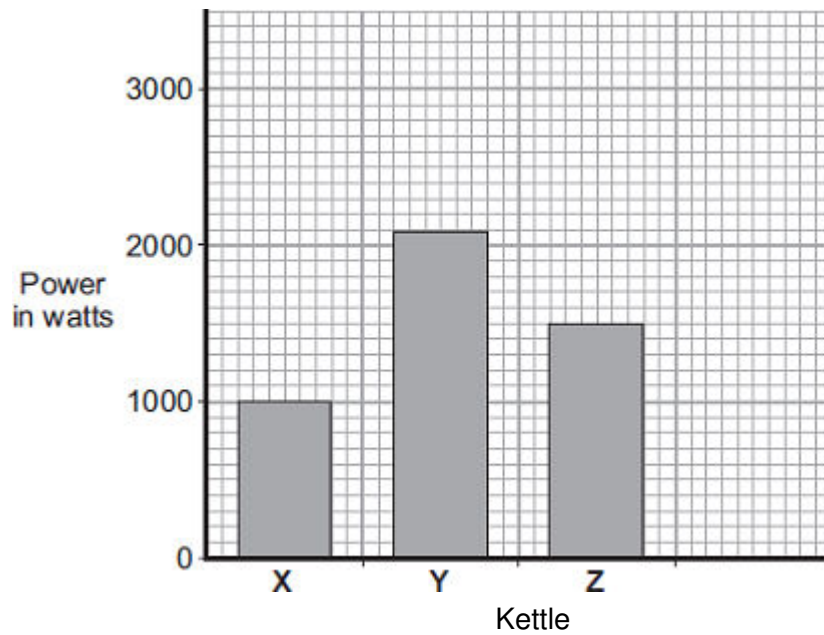
1

2

3

(3)

- (b) The bar chart shows the power of three electric kettles, **X**, **Y** and **Z**.



- (i) In one week, each kettle is used for a total of 30 minutes.

Which kettle costs the most to use?

Put a tick (✓) next to your answer.

X

☐

Y

☐

Z

☐

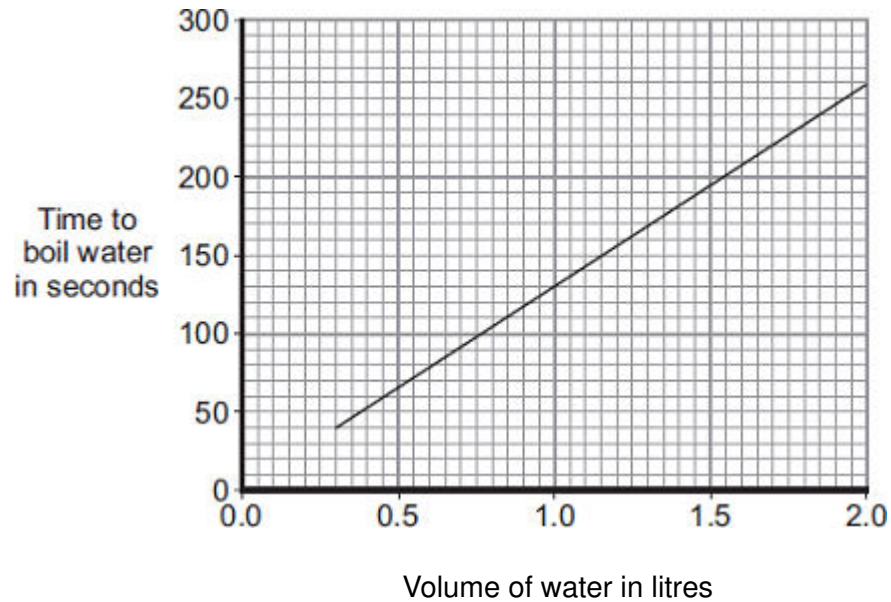
(1)

- (ii) A new 'express boil' kettle boils water faster than any other kettle.

Draw a fourth bar on the chart to show the possible power of an 'express boil' kettle.

(1)

- (c) The graph shows how the time to boil water in an electric kettle depends on the volume of water in the kettle.



A householder always fills the electric kettle to the top, even when only enough boiling water for one small cup of coffee is wanted.

Explain how the householder is wasting money.

.....

.....

.....

.....

.....

.....

(3)
(Total 8 marks)

30

Wind and tides are energy sources that are used to generate electricity.

(a) Complete each sentence by putting a tick (✓) in the box next to the correct answer.

(i) The wind is

a non-renewable energy source.

☐

a constant energy source.

☐

an unreliable energy source.

☐

(1)

(ii) The tides are

a renewable energy source.

☐

a constant energy source.

☐

an unreliable energy source.

☐

(1)

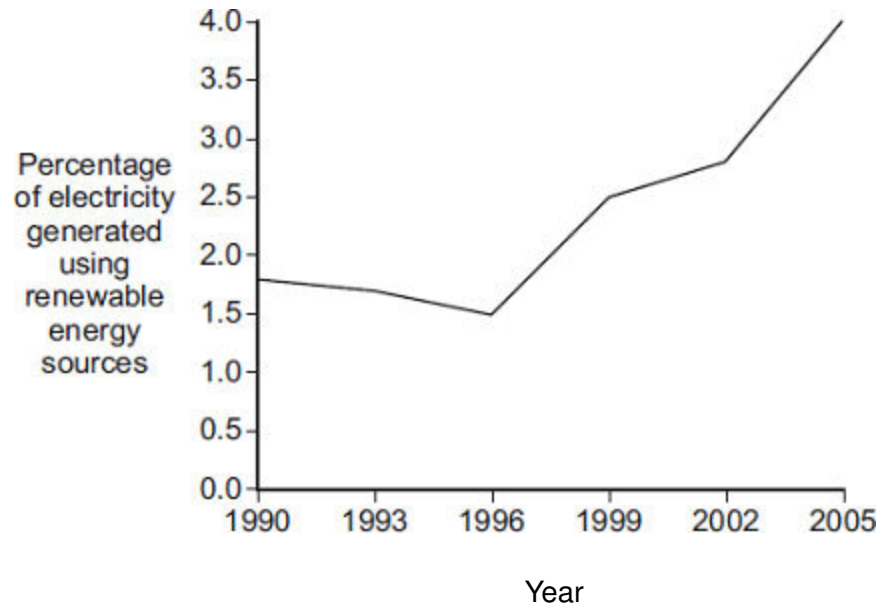
(b) If wood is to be used as a renewable energy source, what must be done each time a tree is chopped down?

.....

.....

(1)

- (c) In the UK, electricity is generated using renewable and non-renewable energy sources. The graph shows the percentage of electricity generated using renewable energy sources between 1990 and 2005.



Complete the following sentence by drawing a ring around the correct answer in the box.

In 2015, the percentage of electricity generated using renewable energy sources

is most likely to be

greater than 4 %.
equal to 4 %.
less than 4 %.

(1)
(Total 4 marks)

31

The picture shows a solar-powered aircraft. The aircraft has no pilot.



By NASA/Nick Galante [Public domain], via Wikimedia Commons

- (a) Use words from the box to complete the following sentence.

electrical	heat	light	sound
-------------------	-------------	--------------	--------------

Solar cells are designed to transform energy
into energy.

(2)

- (b) On a summer day, 175 000 joules of energy are supplied to the aircraft's solar cells every second. The useful energy transferred by the solar cells is 35 000 joules every second.

Use the equation in the box to calculate the efficiency of the solar cells.

$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$

Show clearly how you work out your answer.

.....
.....

Efficiency =

(2)

- (c) The aircraft propellers are driven by electric motors.

Give **one** environmental advantage of using electric motors to drive the aircraft propellers rather than motors that burn a fuel.

.....

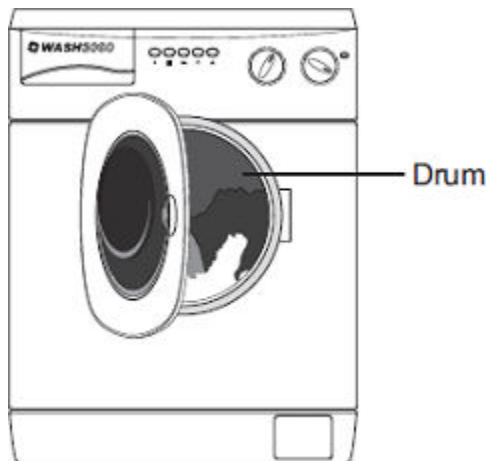
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(1)

(Total 5 marks)

32

The picture shows a washing machine. When the door is closed and the machine switched on, an electric motor rotates the drum and washing.



- (a) Complete the following sentences.

- (i) An electric motor is designed to transform electrical energy into

..... energy.

(1)

- (ii) Some of the electrical energy supplied to the motor is wasted as

..... energy and energy.

(1)

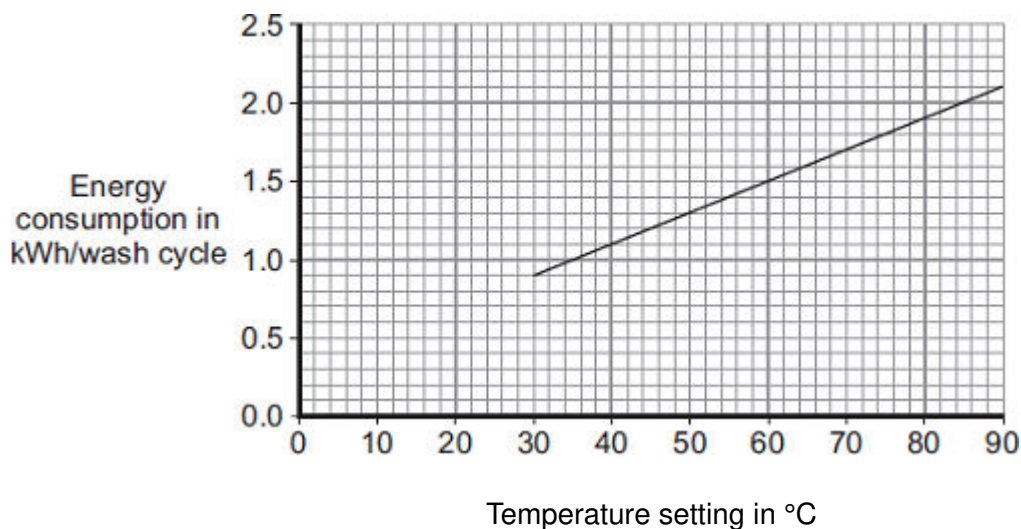
- (b) What happens to the energy wasted by the electric motor?

.....

.....

(1)

- (c) The graph shows that washing clothes at a lower temperature uses less energy than washing them at a higher temperature. Using less energy will save money.



- (i) Electricity costs 15p per kilowatt-hour (kWh).

The temperature setting is turned down from 40 °C to 30 °C.

Use the graph and equation in the box to calculate the money saved each wash cycle.

$$\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$$

Show clearly how you work out your answer.

.....

Money saved =

(2)

- (ii) Reducing the amount of energy used by washing machines could reduce the amount of carbon dioxide emitted into the atmosphere.

Explain why.

.....

(2)

(Total 7 marks)

33

(a) Solar energy is a *renewable* energy source used to generate electricity.

(i) What is meant by an energy source being *renewable*?

.....
.....

(1)

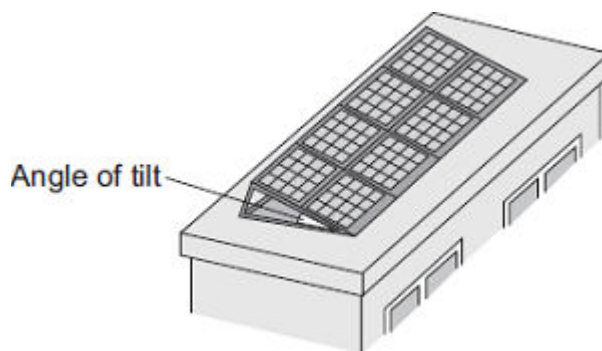
(ii) Name **two** other renewable energy sources used to generate electricity.

1

2

(1)

- (b) A householder uses panels of solar cells to generate electricity for his home. The solar cells are tilted to receive the maximum energy input from the Sun.



The data in the table gives the average energy input each second (in J/s), to a 1 m^2 area of solar cells for different angles of tilt and different months of the year.

Month	Angle of tilt			
	20°	30°	40°	50°
February	460	500	480	440
April	600	620	610	600
June	710	720	680	640
August	640	660	640	580
October	480	520	500	460
December	400	440	420	410

- (i) Use the data in the table to describe how the average energy input to the solar cells depends on the angle of tilt.

.....

.....

.....

.....

(2)

- (ii) The total area of the solar cell panels used by the householder is 5 m^2 .

The efficiency of the solar cells is 0.18.

Calculate the average **maximum** electrical energy available from the solar cell panels each second in June.

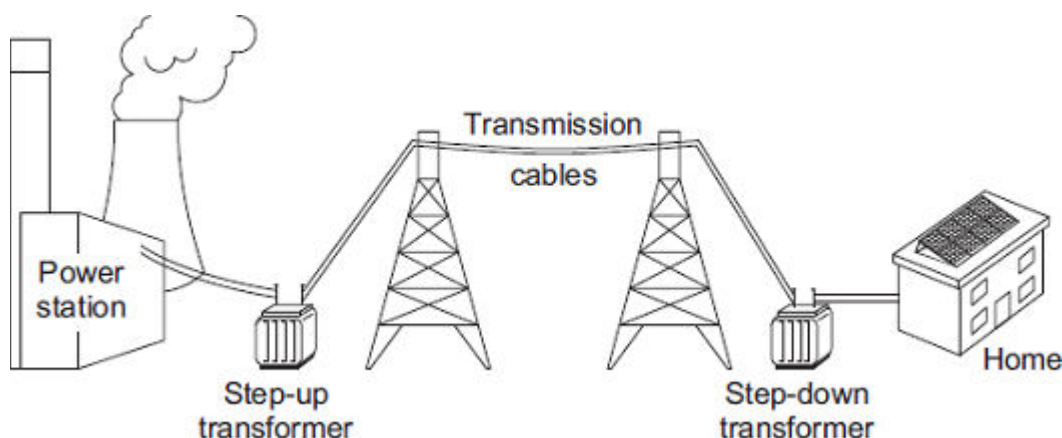
Show clearly how you work out your answer.

.....

Maximum energy = joules/second

(3)

- (c) The diagram shows part of the National Grid.



- (i) Even though the householder uses solar cells to generate electricity for his home, the home stays connected to the National Grid.

Give **one** reason why the householder should stay connected to the National Grid.

.....

(1)

- (ii) The step-up transformer increases the efficiency of the National Grid.

Explain how.

.....

(2)

(Total 10 marks)

34

Electricity is generated in power stations. It is then sent to all parts of the country through a network of cables.

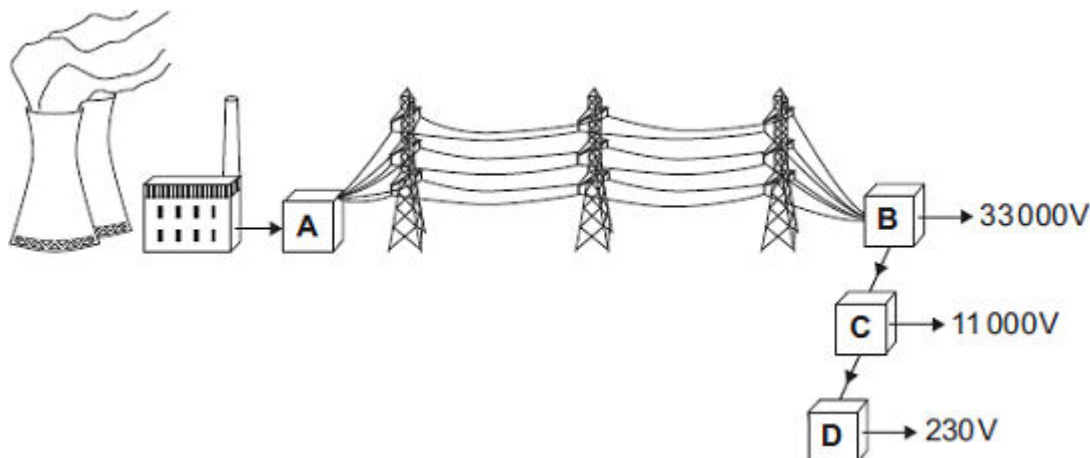
- (a) Complete the following sentence by using **one** of the words in the box.

Grid	Power	Supply
-------------	--------------	---------------

The network is called the National

(1)

- (b) In the diagram, **A**, **B**, **C** and **D** are transformers.



- (i) Which transformer, **A**, **B**, **C** or **D**, is a step-up transformer?

Transformer

(1)

- (ii) Which transformer, **A**, **B**, **C** or **D** will supply homes, offices and shops?

Transformer

(1)

- (c) Complete the following sentence by drawing a ring around the correct line in the box.

In a step-up transformer, the potential difference (p.d.) across the

primary coil is

less than
the same as
more than

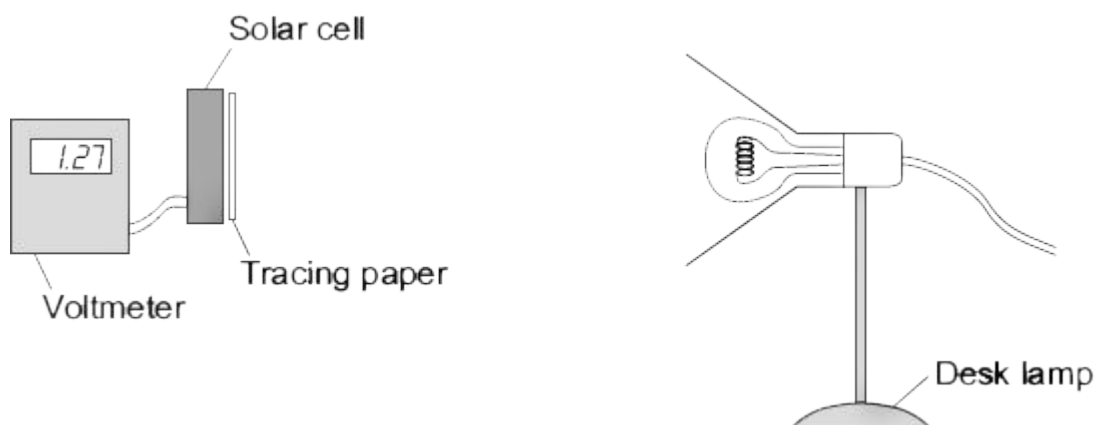
the p.d. across the secondary coil.

(1)**(Total 4 marks)**

35

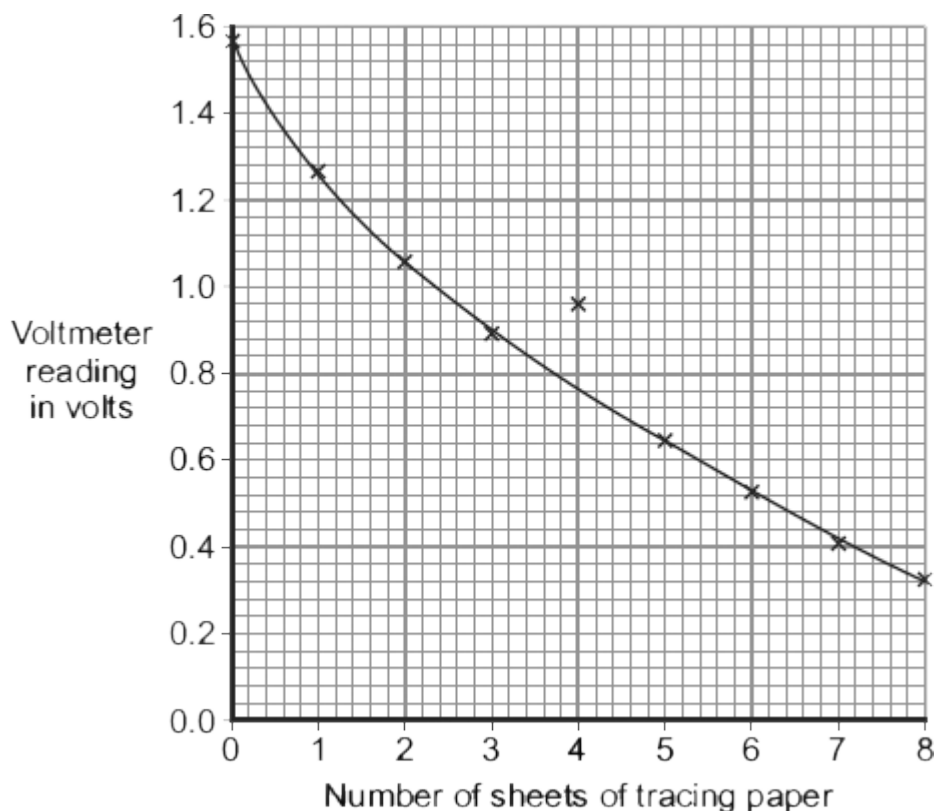
A student has read that a solar cell with a dirty surface will not work as well as a solar cell with a clean surface.

To test the effect of a dirty surface on a solar cell, the student set up the following equipment.



The student put the desk lamp a fixed distance from the solar cell. To represent the effect of a dirty surface, the student covered the surface of the solar cell with pieces of tracing paper. Each time the student added a piece of paper, she measured the output voltage of the solar cell.

(a) The results taken by the student have been used to draw the graph below.



(i) One of the results seems to be anomalous.

Draw a ring around the anomalous data point on the graph.

(1)

- (ii) The larger the number of sheets of tracing paper used, the lower the intensity of the light reaching the solar cell.

Draw a ring around the correct answer in the box to complete the sentence.

A decrease in the intensity of the light reaching the solar cell causes

a decrease in
no change to
an increase in

(1)

the output voltage from the solar cell.

- (b) People can buy panels of solar cells to generate electricity for their homes. Any surplus electricity can be sold to the electricity supply company.

- (i) Give **one** environmental advantage of generating electricity using solar cells rather than generating electricity in a coal-burning power station.

.....

(1)

- (ii) A homeowner pays £7600 to have solar panels fitted on the roof of their house. The homeowner expects to save £950 each year from reduced energy bills and from selling the electricity.

Assuming these figures to be correct, calculate the pay-back time for the solar panels.

Show clearly how you work out your answer.

.....

Pay-back time = years

(2)

- (iii) Draw a ring around the correct answer in the box to complete the sentence.

Allowing the surface of the solar panels to become very dirty will

decrease
not change
increase

the pay-back time.

(1)

- (iv) Explain your answer to part (b)(iii).

.....

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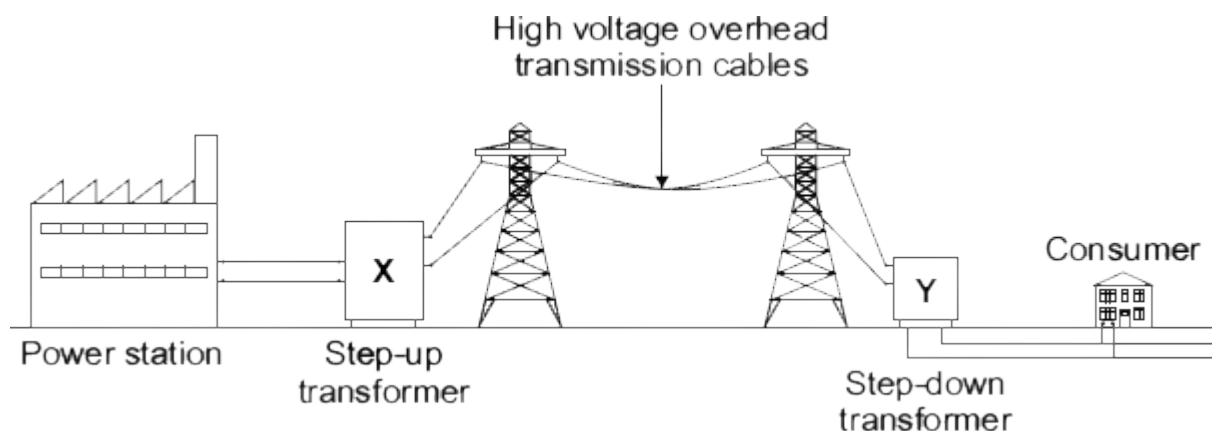
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(2)

(Total 8 marks)

36

The diagram shows the National Grid system.



- (a) The National Grid includes step-up transformers.

Explain why.

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(2)

- (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Over the next 10 years, more than 300 kilometres of new high voltage transmission cables are to be added to the National Grid. Most of the new cables will be suspended from pylons and run overhead while the rest will be buried underground.

Outline the advantages and disadvantages of both overhead transmission cables and underground transmission cables.

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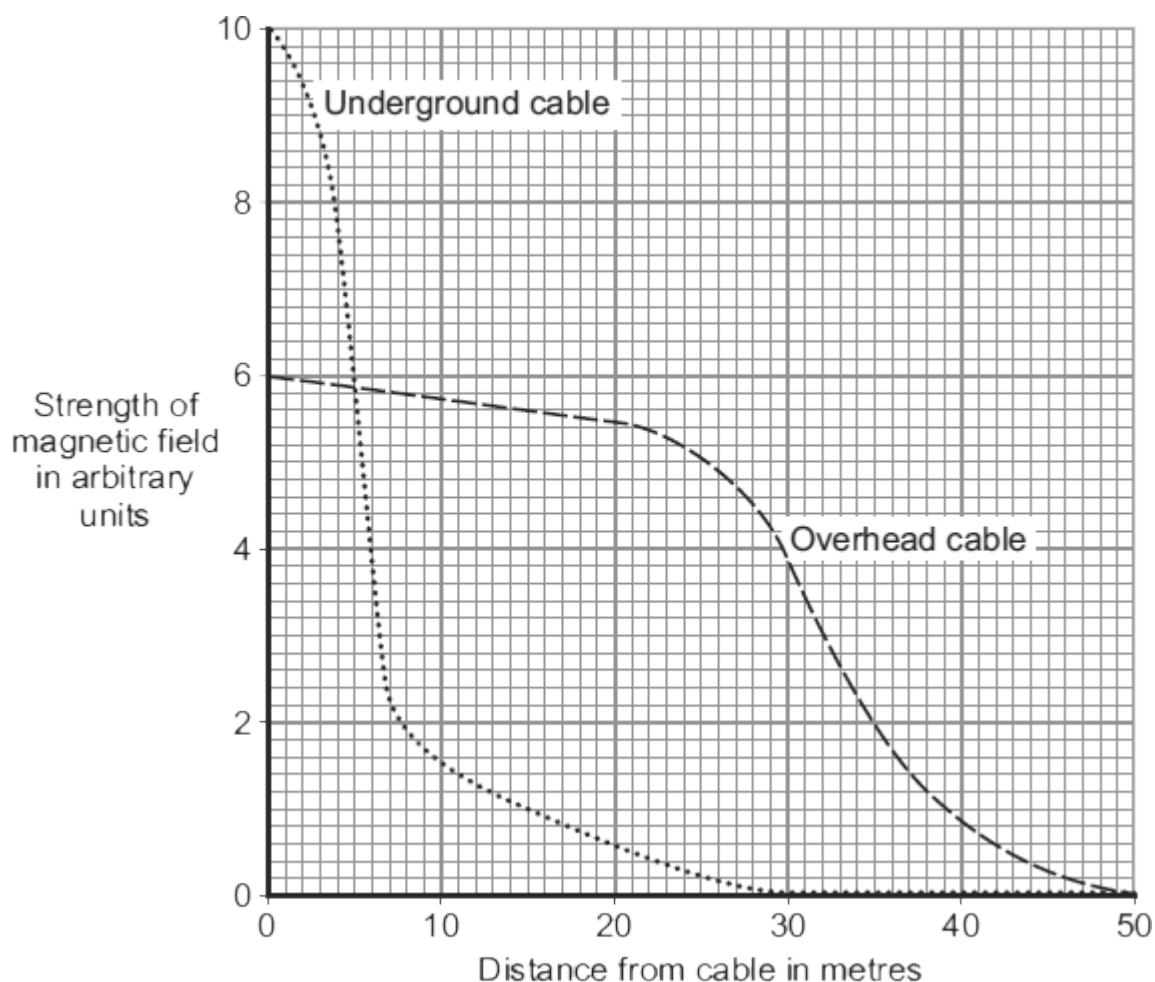
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(6)

- (c) When an electric current flows through a transmission cable, a magnetic field is produced.

The graph shows how the strength of the magnetic field varies with distance from both overhead and underground transmission cables that carry the same current.



What conclusions may be drawn from this graph?

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(2)

- (d) Some people think that, because of the magnetic fields, living close to transmission cables is dangerous to health. Laboratory studies on mice and rats exposed to magnetic fields for two or more years found that the magnetic fields had no effect on the animals' health.

Draw a ring around the correct answer in the box to complete the sentence.

Using animals in scientific research raises

economic

environmental

ethical

issues.

(1)
(Total 11 marks)

37

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.

.....

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.....

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.

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(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)

38

- (a) Nuclear fuels and the wind are two of the energy sources used to generate electricity in the UK.

Explain the advantages of using energy from nuclear fuels to generate electricity rather than using energy from the wind.

Include in your answer a brief description of the process used to generate electricity from nuclear fuels.

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(4)

- (b) In the UK, most electricity is generated in power stations that emit carbon dioxide into the atmosphere. The impact of these power stations on the environment could be reduced by the increased use of 'carbon capture' technology.

Describe how 'carbon capture' would prevent the build-up of carbon dioxide in the atmosphere.

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(2)**(Total 6 marks)**

39

The world's biggest offshore wind farm, built off the Kent coast, started generating electricity in September 2010.

- (a) One advantage of using the wind to generate electricity is that it is a renewable energy source.

- (i) Give **one** other advantage of using the wind to generate electricity.

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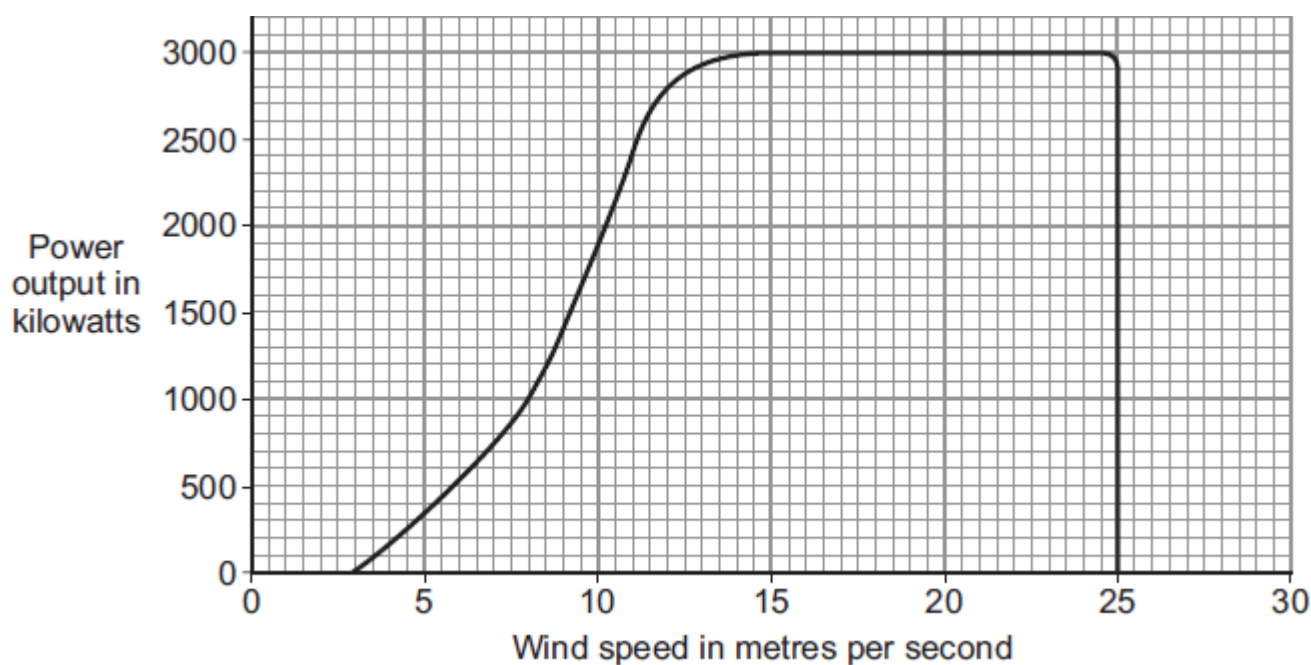
(1)

- (ii) Name **one** other renewable energy source used to generate electricity.

.....

(1)

- (b) The graph shows how wind speed affects the power output from a large wind turbine.



- (i) What is the maximum possible power output from this wind turbine?

.....

(1)

- (ii) Read this part of a newspaper article.

Cold weather stops wind turbines

For the past two weeks, most of the UK's wind turbines have been generating less than one sixth of their maximum power output. To avoid major power cuts in the future, some experts have said that more nuclear power stations need to be built to provide a reliable source of energy.

Use the graph to explain why the power output from the wind turbines was less than one sixth of the maximum.

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(2)

- (iii) Having more nuclear power stations will help to avoid power cuts in the future.

Which **two** of these reasons explain why?

Put a tick (✓) in the boxes next to your answers.

A small amount of nuclear fuel generates a large amount of electricity.

☐

The radioactive waste produced must be stored for many years.

☐

Nuclear power stations do not depend on the weather to generate electricity.

☐

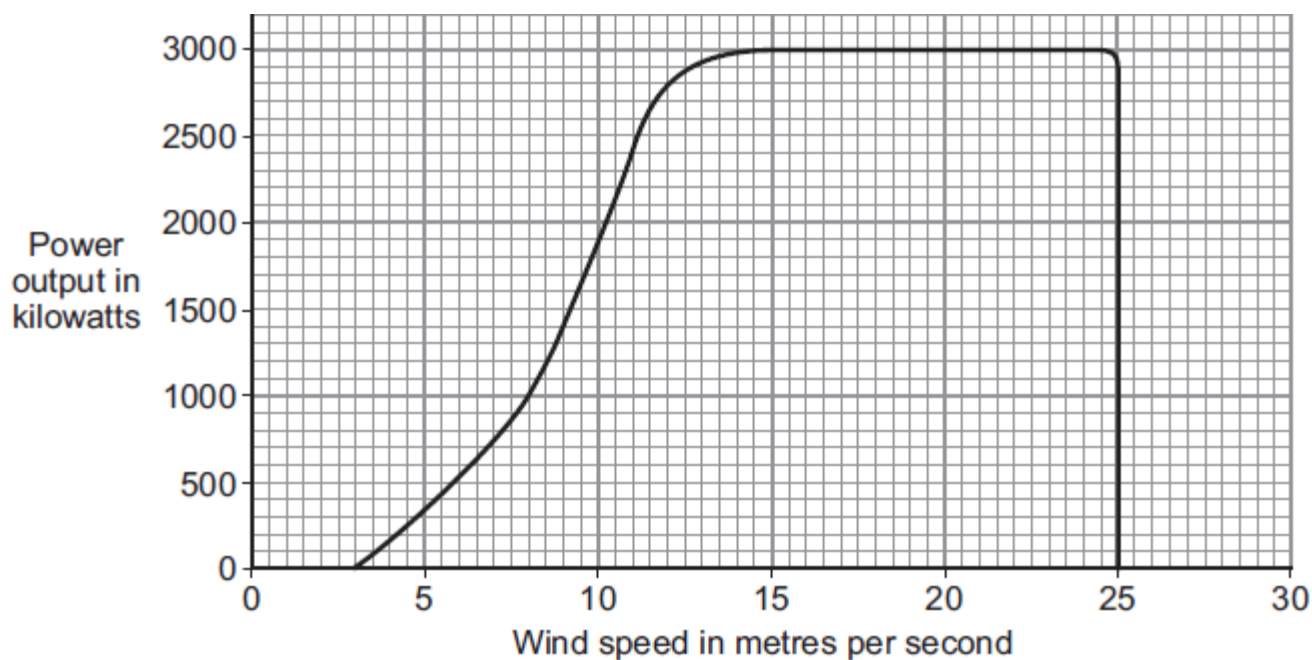
(1)

(Total 6 marks)

40

The world's biggest offshore wind farm, built off the Kent coast, started generating electricity in September 2010.

- (a) The graph shows how wind speed affects the power output from one of the wind turbines.



In one 4-hour period, the wind turbine transfers 5600 kilowatt-hours of electrical energy.

Use the data in the graph to calculate the average wind speed during this 4-hour period.

Show clearly how you work out your answer.

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Average wind speed = m/s

(3)

- (b) The wind turbines are linked to the National Grid by underwater cables.

- (i) What is the National Grid?

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(1)

(ii) How is the National Grid designed to reduce energy losses during transmission?

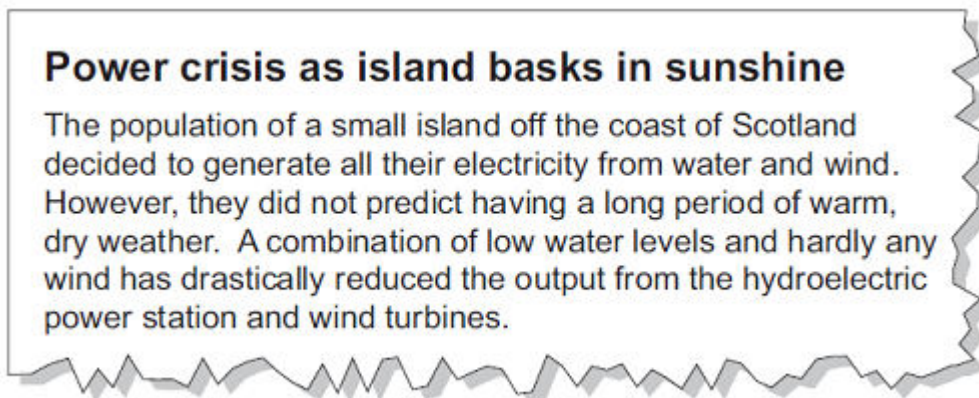
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(1)

(c) Read this extract from a newspaper.



Explain **one** way in which the islanders could try to ensure that a similar power crisis does **not** happen in the future.

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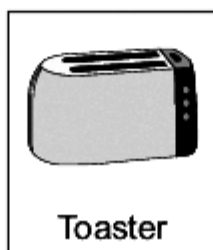
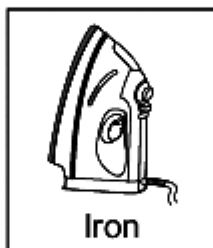
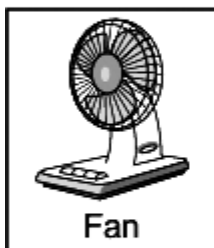
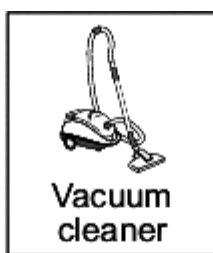
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(2)

(Total 7 marks)



- (a) The vacuum cleaner is designed to transfer electrical energy to kinetic energy.

Three more of the appliances are also designed to transfer electrical energy to kinetic energy. Which **three**?

Draw a ring around each correct appliance.

- (b) Which **two** of the following statements are true?

Tick (✓) **two** boxes.

Appliances only transfer part of the energy usefully.

☐

The energy transferred by appliances will be destroyed.

☐

The energy transferred by appliances makes the surroundings warmer.

☐

The energy output from an appliance is bigger than the energy input.

☐

(2)
(Total 5 marks)

42

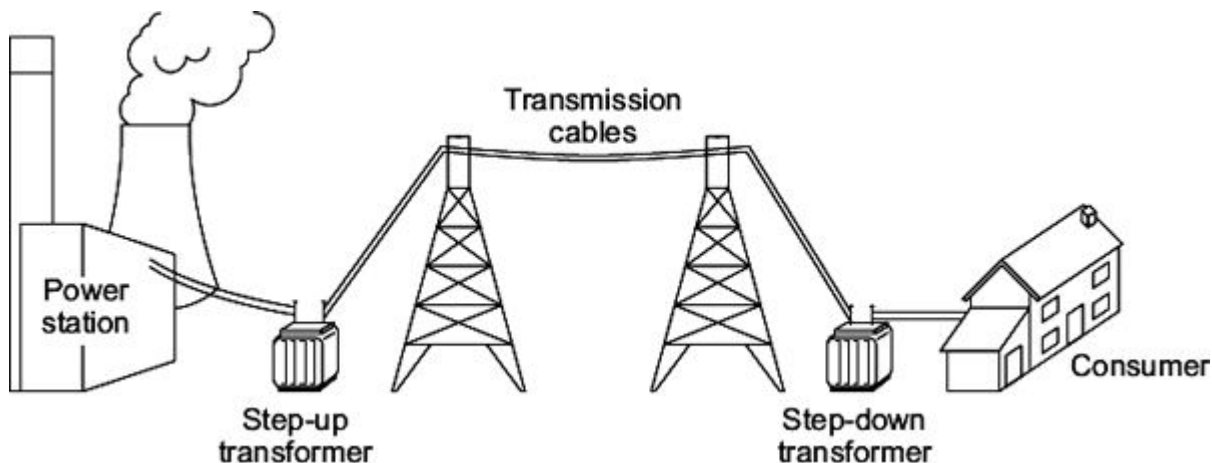
In the UK, most electricity is generated in power stations that burn fossil fuels.

- (a) Which type of fossil fuel power station has the shortest start-up time?

.....

(1)

- (b) The diagram shows how electricity is distributed around the UK.



- (i) Which of the parts labelled in the diagram form the National Grid?

.....

(1)

- (ii) A step-up transformer is used near the power station.

Draw a ring around the correct answer in each box to complete each sentence.

A step-up transformer increases the

current.

power.

voltage.

Using a step-up transformer makes the distribution of electricity

less dangerous.

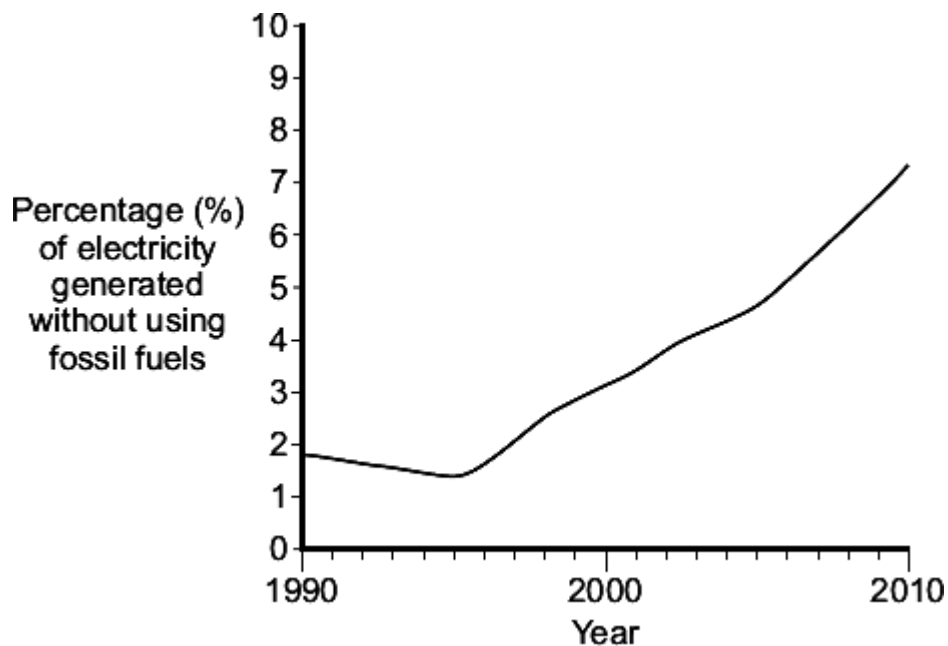
more efficient.

work faster.

(2)

- (c) Electricity in the UK is also generated without using fossil fuels.

The graph shows how the percentage of electricity generated in the UK without using fossil fuels changed between 1990 and 2010.



What does the data in the graph suggest will probably happen to the percentage of electricity generated in the UK without using fossil fuels over the next 10 years?

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.....

(1)

43

A wood burning stove is used to heat a room.



Photograph supplied by iStockphoto/Thinkstock

The fire in the stove uses wood as a fuel. The fire heats the matt black metal case of the stove.

- (a) The air next to the stove is warmed by infrared radiation.

How does the design of the stove help to improve the rate of energy transfer by infrared radiation?

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(2)

- (b) Burning 1 kg of wood transfers 15 MJ of energy to the stove. The stove then transfers 13.5 MJ of energy to the room.

Calculate the efficiency of the stove.

Show clearly how you work out your answer.

.....
.....
.....

Efficiency =

(2)

- (c) Some of the energy from the burning wood is wasted as the hot gases leave the chimney and warm the air outside the house.

Name **one** other way energy is wasted by the stove.

.....

(1)

- (d) Some people heat their homes using electric heaters. Other people heat their homes using a wood burning stove.

Give **two** environmental advantages of using a wood burning stove to heat a home rather than heaters that use electricity generated from fossil fuels.

1

.....

2

.....

(2)

- (e) The metal case of the stove gets hot when the fire is lit.

Here is some information about the stove.

Mass of metal case	100 kg
Starting temperature of metal case	20 °C
Final temperature of metal case	70 °C
Specific heat capacity of metal case	510 J/kg °C

Calculate the energy required to raise the temperature of the metal case to 70 °C.

Show clearly how you work out your answer and give the unit.

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Energy required =

(3)
(Total 10 marks)

44

- (a) Geothermal energy and the energy of falling water are two resources used to generate electricity.

- (i) What is geothermal energy?

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(1)

- (ii) Hydroelectric systems generate electricity using the energy of falling water.

A pumped storage hydroelectric system can also be used as a way of storing energy for future use.

Explain how.

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(2)

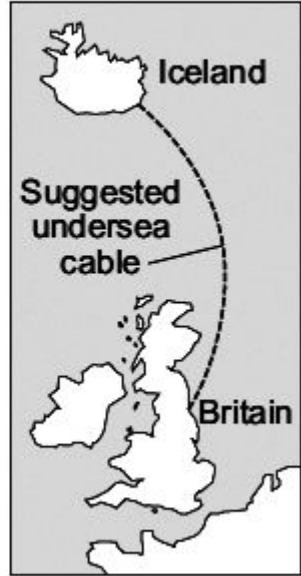
- (b) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

Read the following extract from a newspaper.

Britain may be switched on by Iceland

Iceland is the only country in the world generating all of its electricity from a combination of geothermal and hydroelectric power stations. However, Iceland is using only a small fraction of its energy resources. It is estimated that using only these resources, the amount of electricity generated could be increased by up to four times.

To help supply the future demand for electricity in Britain, there are plans to build thousands of new offshore wind turbines. It has also been suggested that the National Grid in Britain could be linked to the electricity generating systems in Iceland. This would involve laying a 700 mile undersea electricity cable between Iceland and Britain.



Discuss the advantages and disadvantages of the plan to build thousands of offshore wind turbines around Britain **and** the suggested electricity power link between Britain and Iceland.

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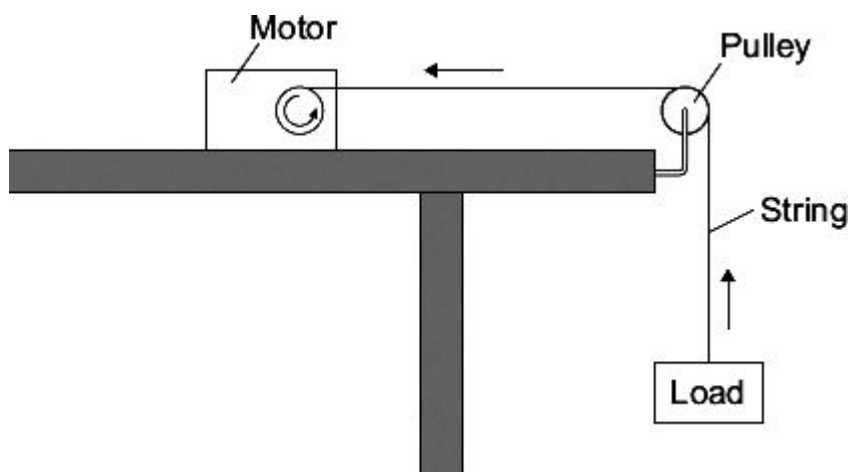
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(6)
(Total 9 marks)

45

A student uses an electric motor to lift a load.



In the motor, the electrical energy is transferred into other types of energy. Some of this energy is useful and the rest of the energy is wasted.

- (a) (i) Name the useful energy output from the electric motor.

.....

(1)

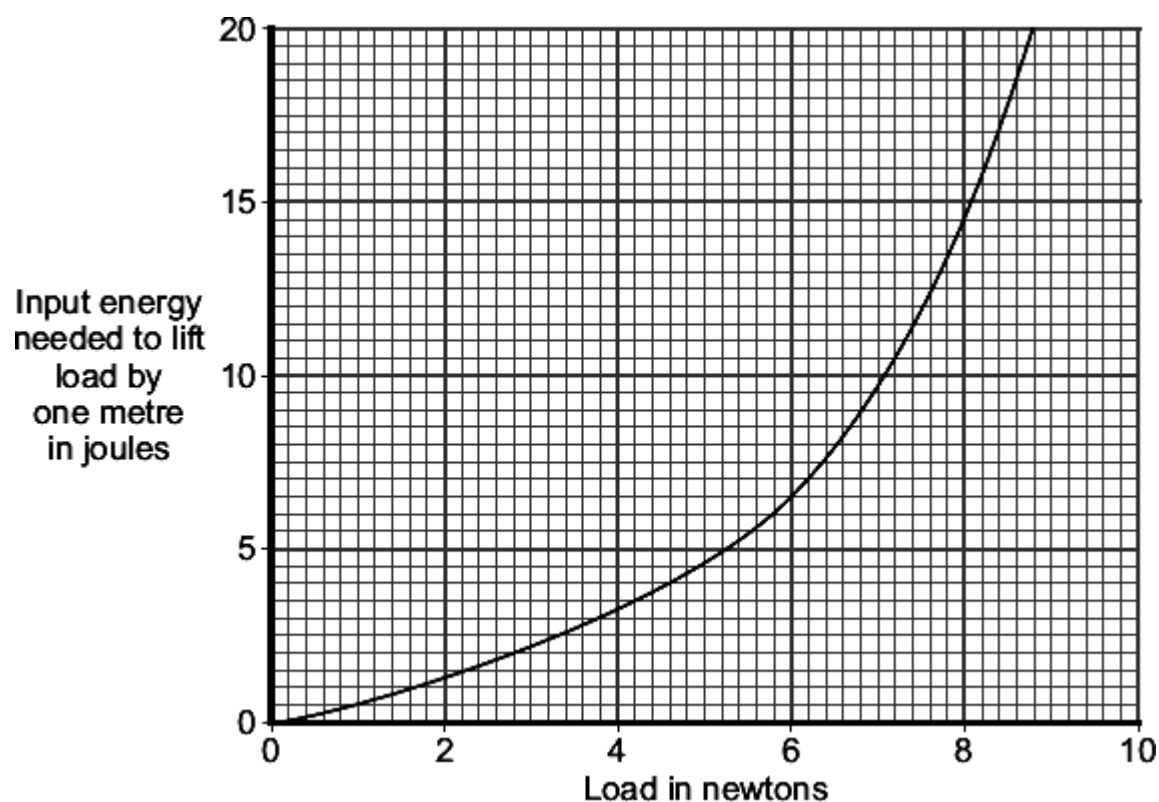
- (ii) What eventually happens to the wasted energy?

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(1)

- (b) The graph shows the input energy the motor needs to lift different loads by one metre.



What can you conclude from the graph about the relationship between the load lifted and the input energy needed?

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.....

(2)

- (c) A shop uses escalators to lift customers to different floor levels. The escalators use electric motors. When the shop is not busy some escalators are turned off. A sign tells the customers that the escalators are turned off to save energy.



- (i) Each escalator has one motor with an average power of 4000 W. The motor is turned on for an average of 8 hours each day, 6 days each week. Electricity costs 15 pence per kilowatt-hour.

Calculate the cost of the electricity used in an average week to run **one** escalator.

Show clearly how you work out your answer.

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Cost = pence

(3)

- (ii) Give **one** environmental advantage to turning off electrical appliances when they are not being used.

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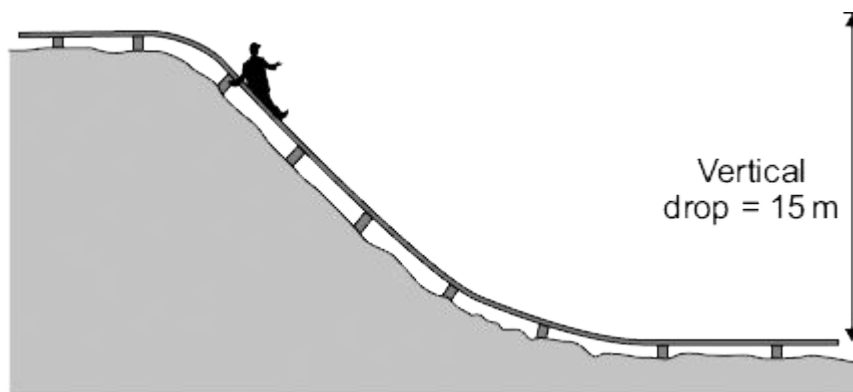
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(1)

(Total 8 marks)

46

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.

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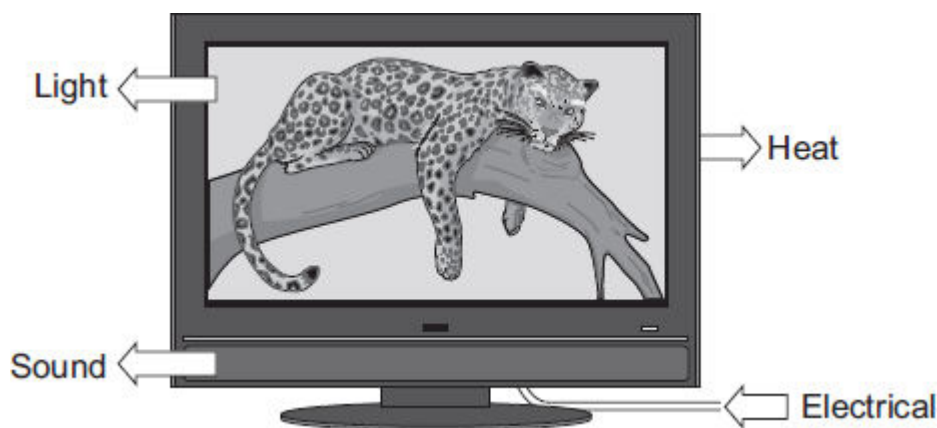
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(3)
(Total 8 marks)

47

- (a) The diagram shows the energy transformations produced by a television.



When the television is working, 1200 joules of energy are supplied to the television every second. The useful energy transferred by the television is 720 joules every second.

- (i) Use the equation in the box to calculate the efficiency of the television.

$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$

Show clearly how you work out your answer.

.....

Efficiency =

(2)

- (ii) Use **one** word from the diagram to complete the following sentence.

The electrical energy that is **not** usefully transformed by the television is wasted as

.....

(1)

- (b) A homeowner is sent an electricity bill every 3 months. The total amount of electrical energy used during one 3-month period was 800 kilowatt-hours. Electrical energy costs 15p per kilowatt-hour.

Use the equation in the box to calculate the cost of the energy transferred from the mains electricity supply.

total cost	=	number of kilowatt-hours	×	cost per kilowatt-hour
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Show clearly how you work out your answer and give the unit.

.....

Cost =

(2)
 (Total 5 marks)

48

A farmer has installed a biogas electricity generator on his farm. This device generates electricity by burning the methane gas produced from rotting animal waste. Methane is a greenhouse gas. When methane burns, carbon dioxide and water are produced.

The animal waste rots in an anaerobic digester. The digester and the generator are kept inside a farm building and cannot be seen from the outside.

- (a) The animal waste used in the anaerobic digester is a *renewable* energy source.

What is meant by an energy source being *renewable*?

.....

(1)

- (b) Suggest **one** reason why farmers have been encouraged to install their own biogas generators.

.....

(1)

- (c) The farmer's monthly electricity bill using the mains electricity supply was £300.
The biogas generator cost the farmer £18 000 to buy and install.

Assuming the biogas generator provides all of the farmer's electricity, what is the pay-back time for the generator?

.....

Pay-back time =

(1)

- (d) It would have been cheaper for the farmer to have bought and installed a small wind turbine.

Give **two** advantages of using the biogas generator rather than a wind turbine, to generate the electricity used on the farm.

1

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2

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(2)

(Total 5 marks)

49

A homeowner had a new gas boiler installed.

- (a) The following information is an extract from the information booklet supplied with the boiler.

Fuel	Natural Gas
Water temperature	60 °C
Energy supplied to gas boiler	8.0 kJ/s (8.0 kW)
Efficiency	0.95

- (i) Calculate the energy transferred each second by the gas boiler to the water inside the boiler.

Show clearly how you work out your answer.

.....

Energy transferred by the gas boiler each second = kJ

(2)

- (ii) The energy value of the gas used in a home is measured in kilowatt-hours (kWh).

The homeowner has a pre-payment meter and pays £30 into his account. With a pre-payment meter, gas costs 15p per kilowatt-hour.

Calculate the total number of hours that the gas boiler would operate for £30.

Show clearly how you work out your answer.

.....

Number of hours =

(2)

- (b) Although the gas boiler is very efficient, some energy is wasted.

Explain what happens to the waste energy.

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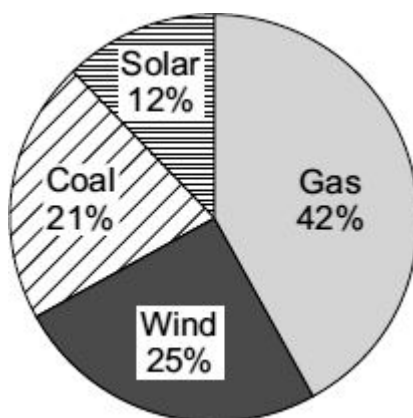
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(2)
(Total 6 marks)

50

- (a) The pie chart shows the energy sources used by one company to generate electricity.



- (i) Which two energy sources used by the company do **not** produce any polluting gases?

..... and

(1)

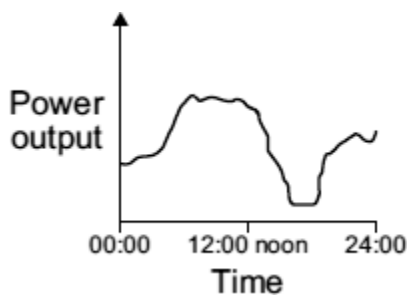
- (ii) Calculate the percentage (%) of electricity that is generated using energy sources that do **not** produce any polluting gases.

Percentage =

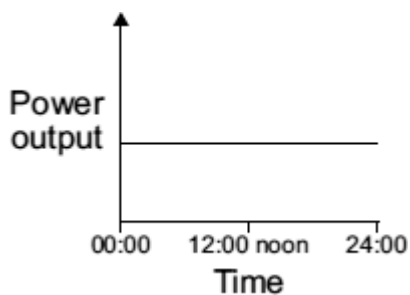
(1)

- (b) Which graph, **A**, **B** or **C**, is most likely to show the electrical power output from a wind turbine over one day?

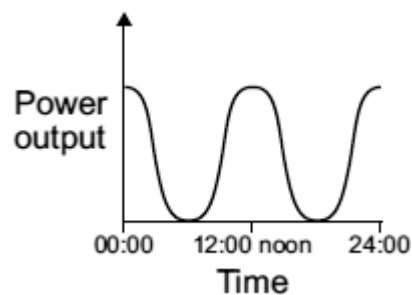
Write your answer, **A**, **B** or **C**, in the box.



Graph **A**



Graph **B**

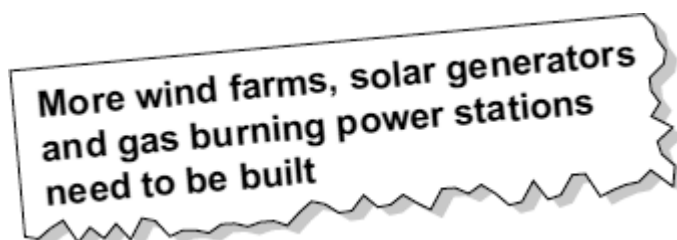


Graph **C**

Graph

(1)

- (c) The government has said that more electricity must be generated from renewable energy sources. A newspaper reported that:



Why is the statement in the newspaper incorrect?

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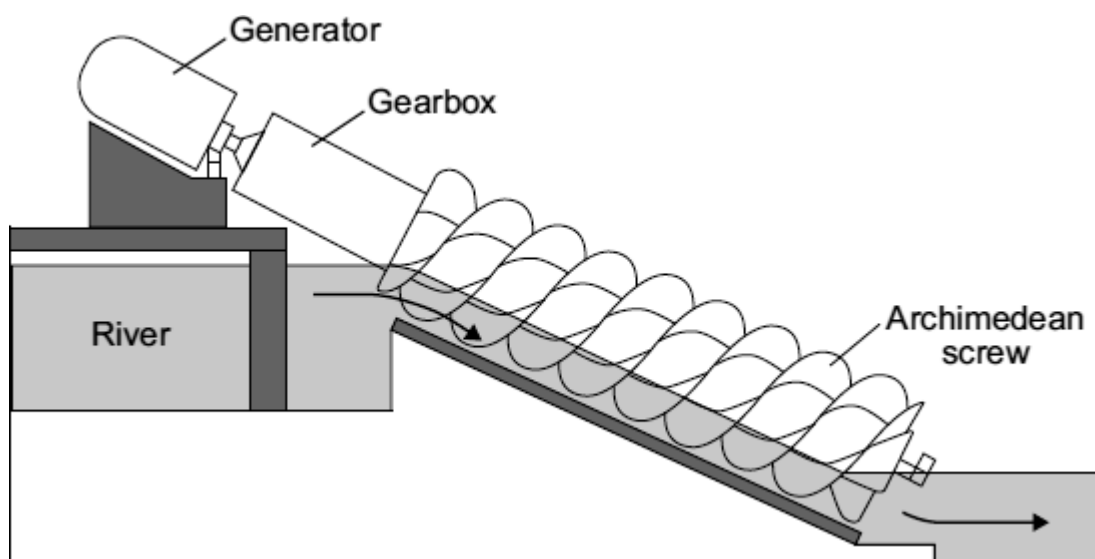
(1)

(Total 4 marks)

51

The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedean screw, to rotate.

The Archimedean screw is linked to the generator by a gearbox.



- (a) Complete the following sentence by drawing a ring around the correct word in the box.

The gravitational potential energy of the falling water is transformed

into the

chemical
electrical
kinetic

energy of the Archimedean screw.

(1)

- (b) A micro-hydroelectric system generates about 60 kW of electricity, enough for 50 homes. A conventional large-scale hydroelectric power station may generate more than 5 000 000 kW of electricity.

- (i) Give **one** advantage of a conventional large-scale hydroelectric power station compared to a micro-hydroelectric system.

.....

(1)

- (ii) Which **one** of the following statements gives a **disadvantage** of a conventional large-scale hydroelectric power station compared to a micro-hydroelectric system?

Put a tick (✓) in the box next to your answer.

Energy is wasted as heat and sound.

☐

Large areas of land are flooded.

☐

A constant flow of water is needed.

☐

(1)

- (c) The electricity generated by the micro-hydroelectric system is transferred directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to homes anywhere in the country through a system of cables and transformers.

- (i) What name is given to the system of cables and transformers used to transfer electricity to homes anywhere in the country?

.....

(1)

- (ii) Using short cables to transfer electricity to local homes is much more efficient than using very long cables to transfer electricity to homes anywhere in the country.

Why?

.....

.....

(1)

- (d) Nepal is a mountainous country with over 6000 rivers. In Nepal, 9000 kW of electricity are generated using micro-hydroelectric generators.

Suggest **one** reason why in the UK much less electricity is generated using micro-hydroelectric generators, than in Nepal.

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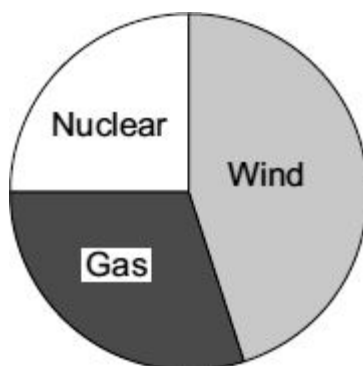
(1)

(Total 6 marks)

52

- (a) An electricity company claims to generate all of its electricity from environmentally friendly energy sources.

The energy sources used by the company are shown in the pie chart.



Do you think that the claim made by the company is correct?

Draw a ring around your answer.

Yes

No

Maybe

Explain the reasons for your answer.

.....

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.....

.....

(2)

- (b) The government is committed to increasing the amount of electricity generated from renewable sources. A newspaper reported that:

More wind farms, wave powered generators, solar generators and nuclear power stations would need to be built

Why is the statement made in the newspaper incorrect?

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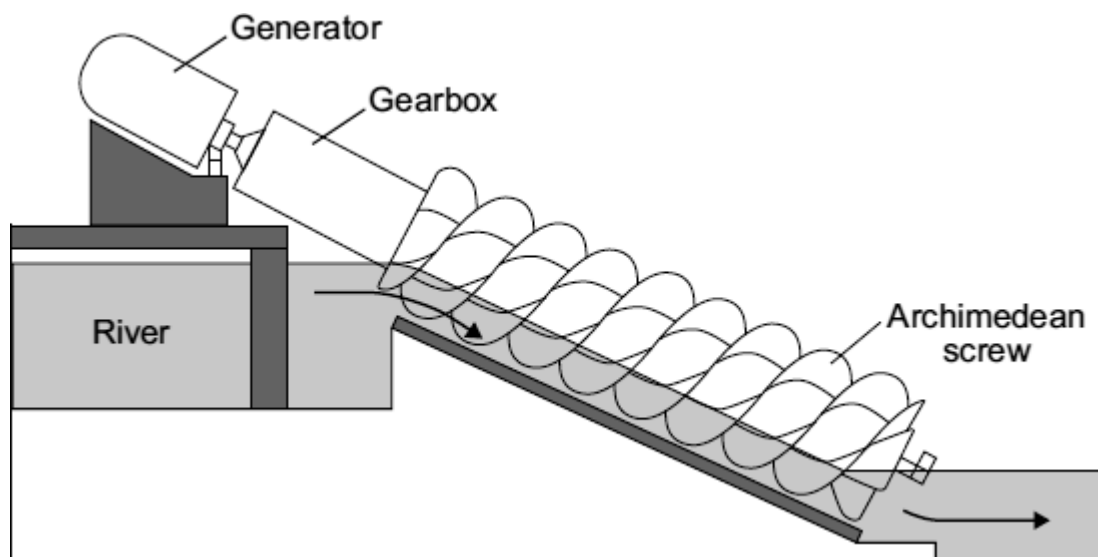
(1)

(Total 3 marks)

53

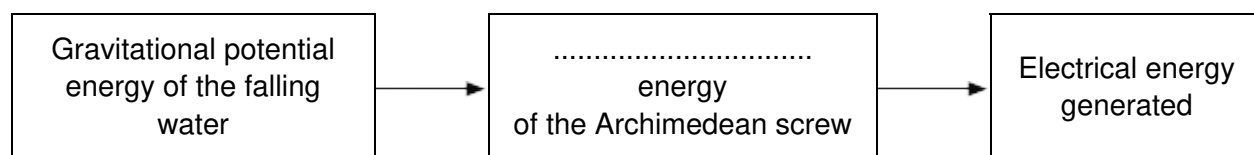
The diagram shows a small-scale, *micro-hydroelectricity* generator which uses the energy of falling river water to generate electricity. The water causes a device, called an Archimedeian screw, to rotate.

The Archimedeian screw is linked to the generator by a gearbox.



- (a) Each second, the *micro-hydroelectricity* generator transforms 80 000 joules of gravitational potential energy into 60 000 joules of electrical energy.

- (i) Fill in the missing word to complete the energy transformation diagram.



(1)

- (ii) Use the equation in the box to calculate the efficiency of the *micro-hydroelectricity* generator.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

.....

.....

Efficiency =

(2)

- (b) The power output from a conventional large-scale hydroelectric power station is 100 000 times more than the power output from a micro-hydroelectric system.

Give **one** disadvantage of a conventional large-scale hydroelectric power station compared to the micro-hydroelectric system.

.....

.....

(1)

- (c) The electricity generated by a micro-hydroelectric system is transferred via a transformer directly to local homes. The electricity generated by a conventional large-scale hydroelectric power station is transferred to the National Grid, which distributes the electricity to homes anywhere in the country.

- (i) What is the National Grid?

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(1)

- (ii) Explain why transferring the electricity directly to local homes is more efficient than using the National Grid to distribute the electricity.

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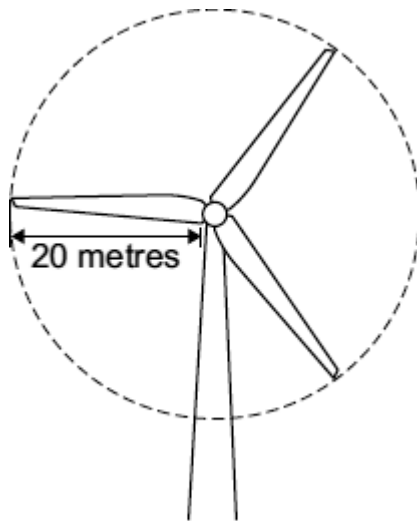
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(2)

(Total 7 marks)

54

The diagram shows a wind turbine.



- (a) The blades of the turbine are 20 metres long. On average, 15 000 kg of air, moving at a speed of 12 m/s, hit the blades every second.

Calculate the kinetic energy of the air hitting the blades every second.

Show clearly how you work out your answer.

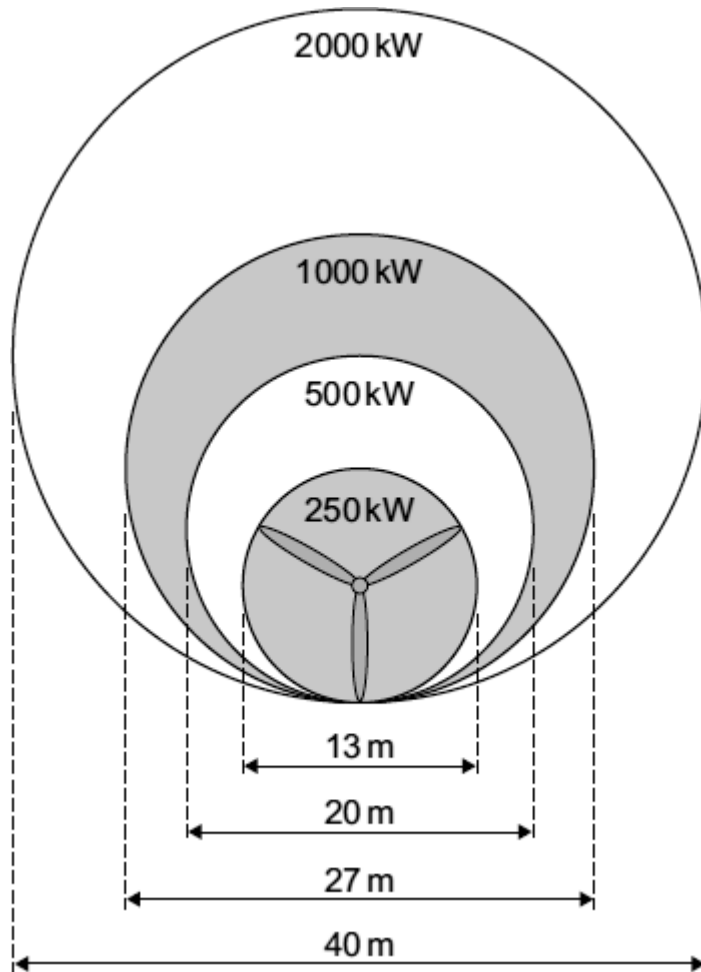
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Kinetic energy = J

(2)

- (b) Part of the kinetic energy of the wind is transformed into electrical energy. The diagram shows that, for the same wind speed, the power output of a turbine, in kilowatts, depends on the length of the turbine blades.



Give a reason why doubling the diameter of the blades more than doubles the power output of a turbine.

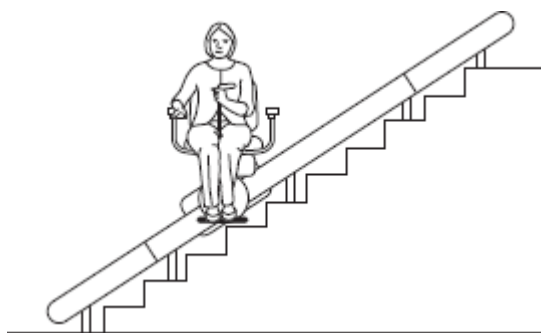
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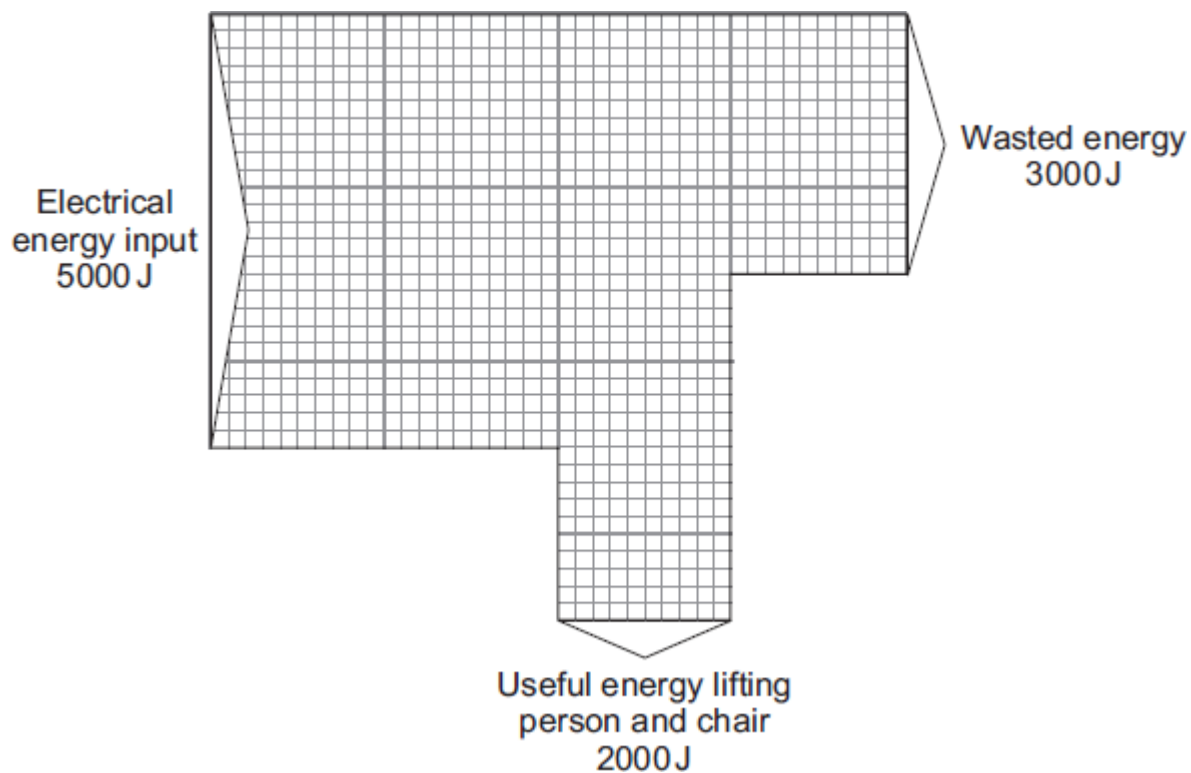
(1)
(Total 3 marks)

55

A person uses a stairlift to go upstairs. The stairlift is powered by an electric motor.



The Sankey diagram shows the energy transfers for the electric motor.



(a) Complete the following sentence.

The electric motor wastes energy as energy.

(1)

- (b) Use the equation in the box to calculate the efficiency of the electric motor.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

.....

Efficiency =

(2)
 (Total 3 marks)

56

- (a) By 2023, nearly all of the existing nuclear power stations in the UK will be closed down.

- (i) Before a nuclear power station can be demolished, the remaining nuclear fuel, radioactive waste materials and reactor must be carefully removed.

What is this process called?

Put a tick (✓) in the box next to your answer.

decommissioning

☐

decontaminating

☐

dismantling

☐

(1)

- (ii) The workers are exposed to radiation as they remove the reactor. One of the biggest risks is from the isotope cobalt-60, which has a half-life of 5.3 years.

Explain the advantage of waiting 11 years after a nuclear power station has closed down before starting to remove the reactor.

.....

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.....

(2)

- (b) It is almost certain that new nuclear power stations will be built in the UK.

The table shows the results of surveys asking people in the UK whether they were in favour of, or against, the building of new nuclear power stations.

	2001	2005	2007
Percentage (%) in favour	20	41	65
Percentage (%) against	60	28	20
Percentage (%) not sure	20	31	15

- (i) From these surveys, how did public opinion on the building of new nuclear power stations change between 2001 and 2007?

.....

.....

(1)

- (ii) Suggest a reason why some people may think that the results from these surveys are unreliable.

.....

.....

(1)

- (iii) Give **one** reason in favour of building new nuclear power stations.

.....

.....

(1)

- (c) The government of one Middle Eastern country has decided to build its first nuclear power station. The oil that would have been used to generate electricity can then be sold to other countries.

On what is this decision based?

Put a tick (✓) in the box next to your answer.

economic issues

☐

ethical issues

☐

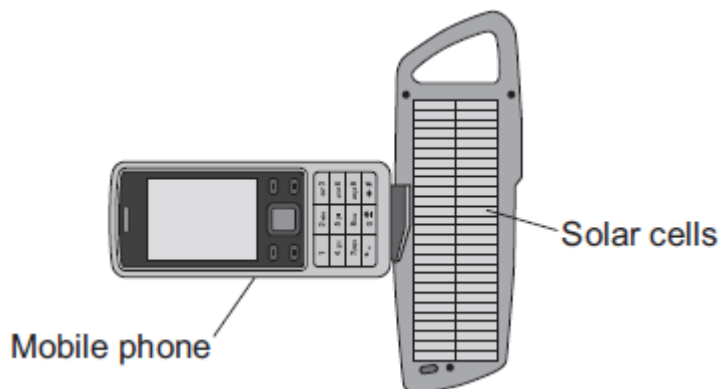
social issues

☐

(1)
(Total 7 marks)

57

- (a) The diagram shows a solar powered device being used to recharge a mobile phone.



On average, the solar cells produce 0.6 joules of electrical energy each second. The solar cells have an efficiency of 0.15.

- (i) Calculate the average energy input each second to the device.

Show clearly how you work out your answer.

.....
.....

Average energy input each second = J/s

(2)

- (ii) Draw a labelled Sankey diagram for the solar cells.
The diagram does **not** need to be drawn to scale.

(1)

- (b) Scientists have developed a new type of solar cell with an efficiency of over 40 %.
The efficiency of the solar cell was confirmed independently by other scientists.

Suggest why it was important to confirm the efficiency independently.

.....

.....

(1)

- (c) The electricity used in homes in the UK is normally generated in a fossil fuel power station.

Outline some of the advantages of using solar cells to generate this electricity.

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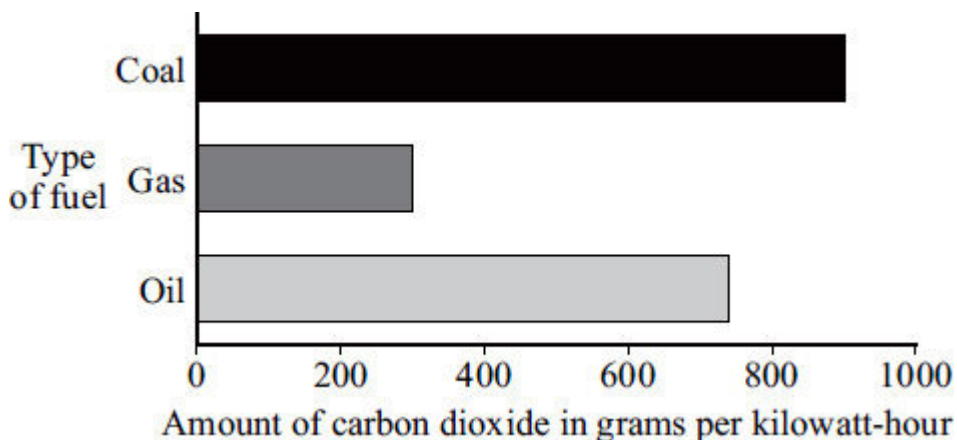
(2)

(Total 6 marks)

58

- (a) Most electricity in the UK is generated in power stations that burn fossil fuels.

The bar chart shows how much carbon dioxide is produced for each kilowatt-hour of electricity generated using a fossil fuel.



- (i) Which fossil fuel produces the smallest amount of carbon dioxide for each kilowatt-hour of electricity generated?

.....

(1)

- (ii) Which **one** of the following statements gives the reason why the data has been shown as a bar chart and not as a line graph?

Put a tick (✓) in the box next to your answer.

Both variables are categoric.

☐

Both variables are continuous.

☐

One variable is categoric, the other is continuous.

☐

(1)

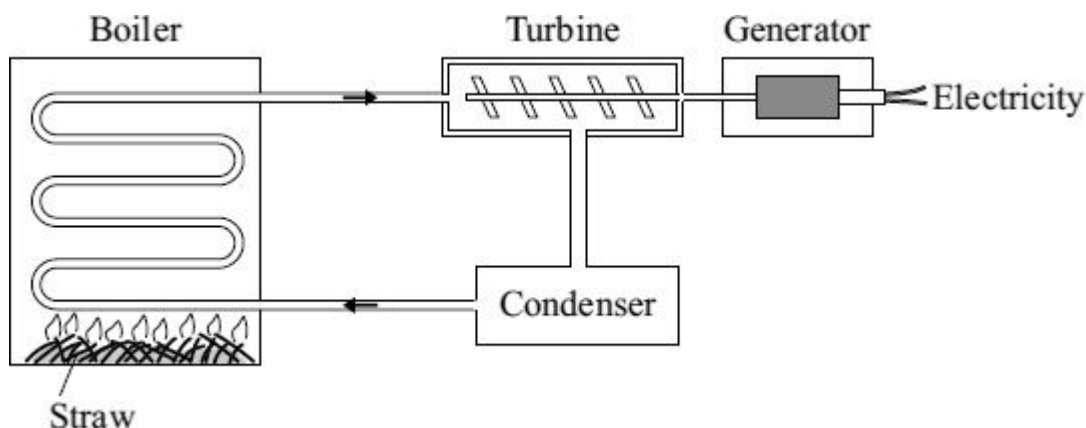
- (iii) Why does a nuclear power station **not** produce any carbon dioxide?

.....

.....

(1)

- (b) Some types of power station generate electricity by burning straw.



- (i) Use words from the box to complete the following sentences.

boiler	gas	generator	steam	turbine	water
---------------	------------	------------------	--------------	----------------	--------------

Straw is burned in a Water is heated to make
 which is used to drive a
 This turns a to produce electricity.

(4)

- (ii) Straw is a type of renewable energy source known as a biofuel.

Name **one** other type of renewable energy source used to produce electricity.

.....

(1)

- (iii) A power station generates 36 000 000 watts (36 MW) of electrical power by burning straw. The average power used in each home in the UK over one year is 2000 watts.

Calculate the number of homes that the power station could supply electricity to.

Show clearly how you work out your answer.

.....

.....

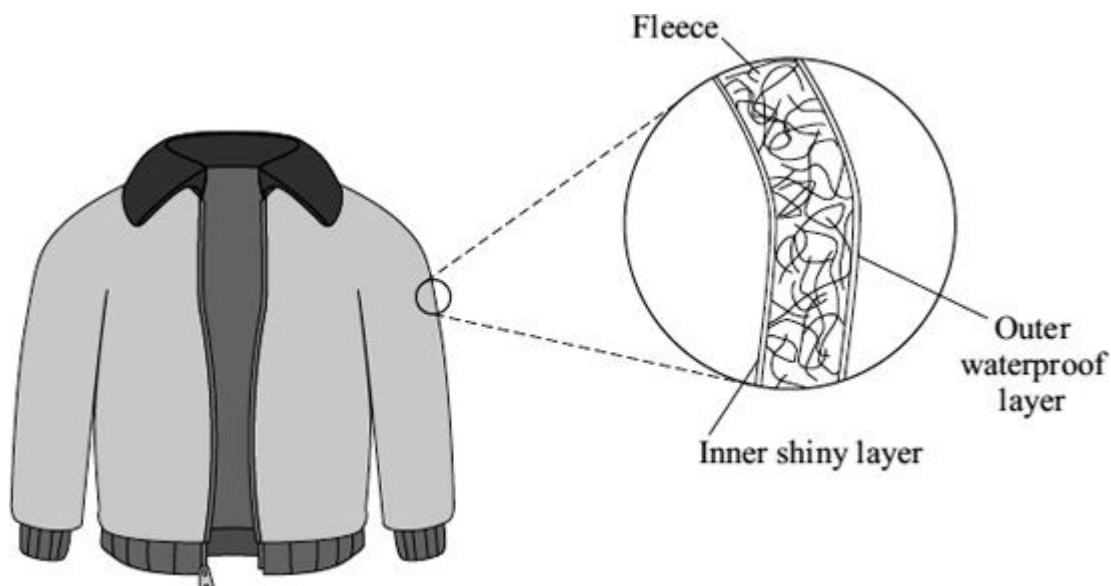
Number of homes =

(2)

(Total 10 marks)

59

- (a) The diagram shows a ski jacket that has been designed to keep a skier warm. The jacket is made from layers of different materials.



- (i) The inner layer is shiny to reduce heat transfer.

Which process of heat transfer will it reduce?

.....

(1)

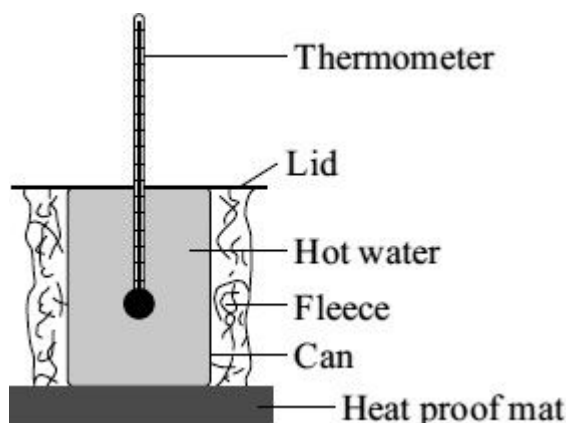
- (ii) Why is the layer of fleece good at reducing the transfer of heat from a skier's body?

.....

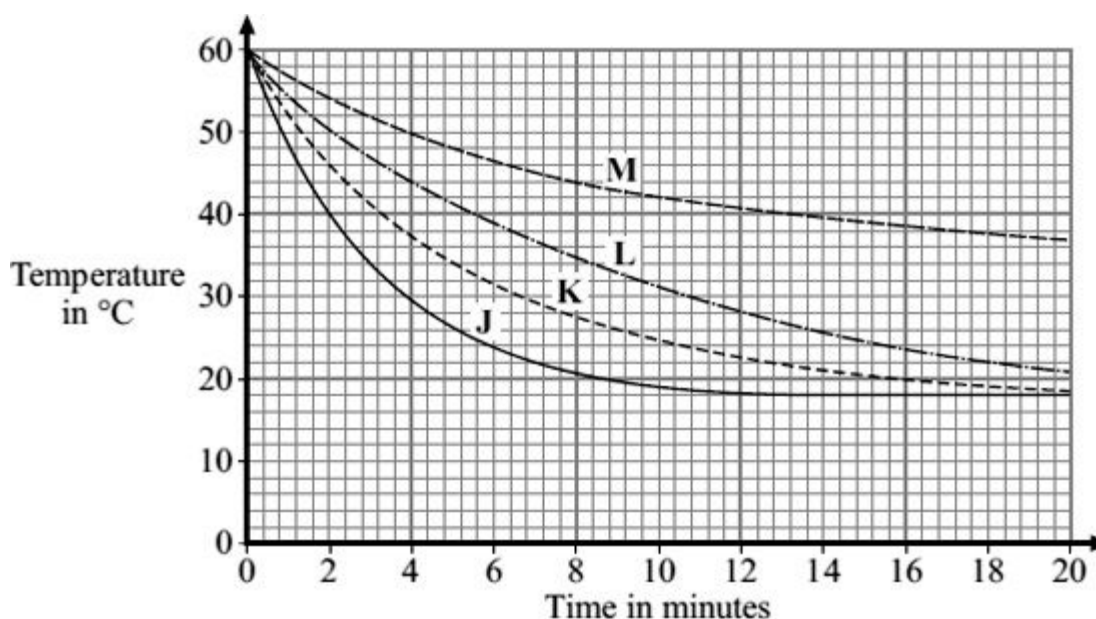
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(1)

- (b) A student tested four different types of fleece, **J**, **K**, **L** and **M**, to find which would make the warmest jacket. Each type of fleece was wrapped around a can which was then filled with hot water. The temperature of the water was taken every two minutes for 20 minutes.



The graph shows the student's results.



- (i) In each test, the water cooled faster during the first five minutes than during the last five minutes. Why?

.....

(1)

- (ii) To be able to compare the results, it was important to use the same volume of water in each test.

Give **one** other quantity that was the same in each test.

.....

(1)

- (iii) Look at the graph line for fleece **K**.

Estimate what the temperature of the water in the can wrapped in fleece **K** would be after 40 minutes.

.....

(1)

- (iv) Which type of fleece, **J**, **K**, **L** or **M**, should the student recommend to be used in the ski jacket?

.....

Give a reason for your answer.

.....

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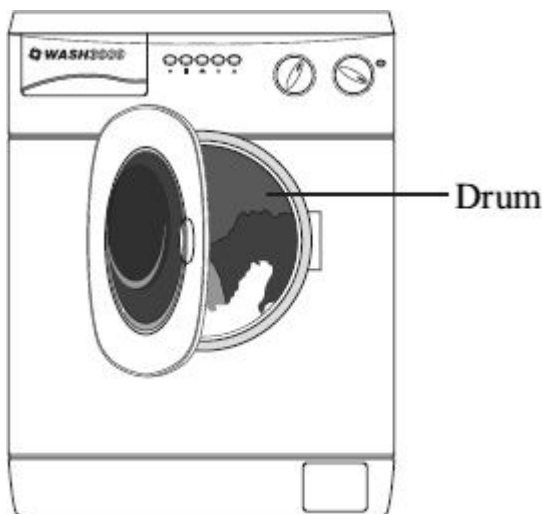
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(2)

(Total 7 marks)

60

The picture shows a new washing machine. When the door is closed and the machine switched on, an electric motor rotates the drum and washing.



- (a) What happens to the energy wasted by the electric motor?

.....

.....

(1)

- (b) The diagram shows the label from the new washing machine.

Model – Wash 3000 Energy A	
More efficient Less efficient	
Energy consumption kWh/wash cycle (based on 40 °C wash)	1.1

An 'A' rated washing machine is *more energy efficient* than a 'C' rated washing machine.

Explain what being *more energy efficient* means.

.....

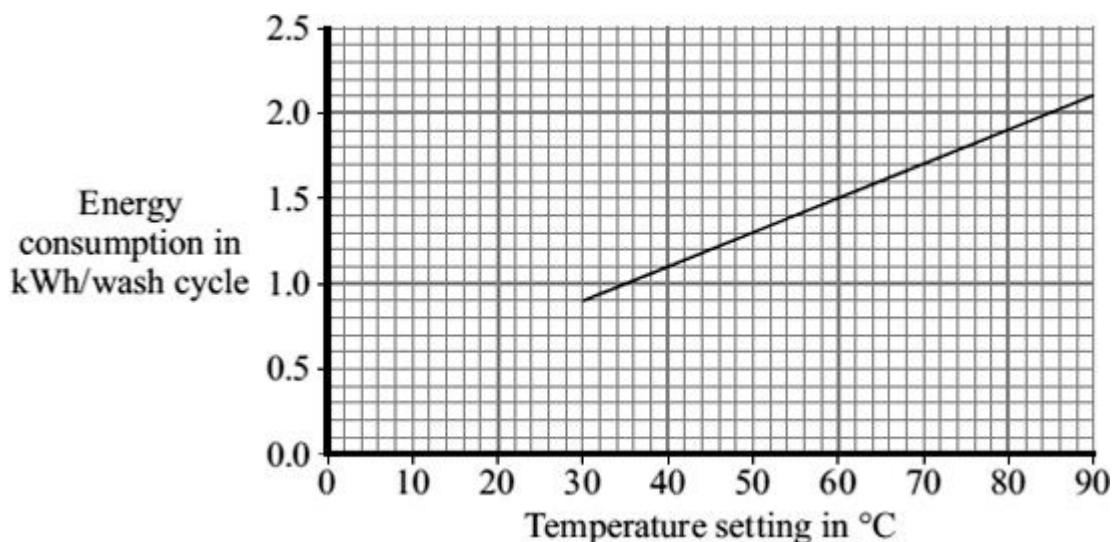
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.....

(2)

- (c) The graph shows that washing clothes at a lower temperature uses less energy than washing them at a higher temperature. Using less energy will save money.



- (i) Electricity costs 12 p per kilowatt-hour (kWh).
The temperature setting is turned down from 40 °C to 30 °C.

Use the graph and equation in the box to calculate the money saved each wash cycle.

$\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$
--

Show clearly how you work out your answer.

.....
.....

Money saved = p

(2)

- (ii) Suggest why reducing the amount of energy used by washing machines could reduce the amount of carbon dioxide emitted into the atmosphere.

.....
.....

(1)

(Total 6 marks)