AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.1.2.2 EFFICIENCY (PACK 2)

SCORE	PERCENTAGE
/166	%

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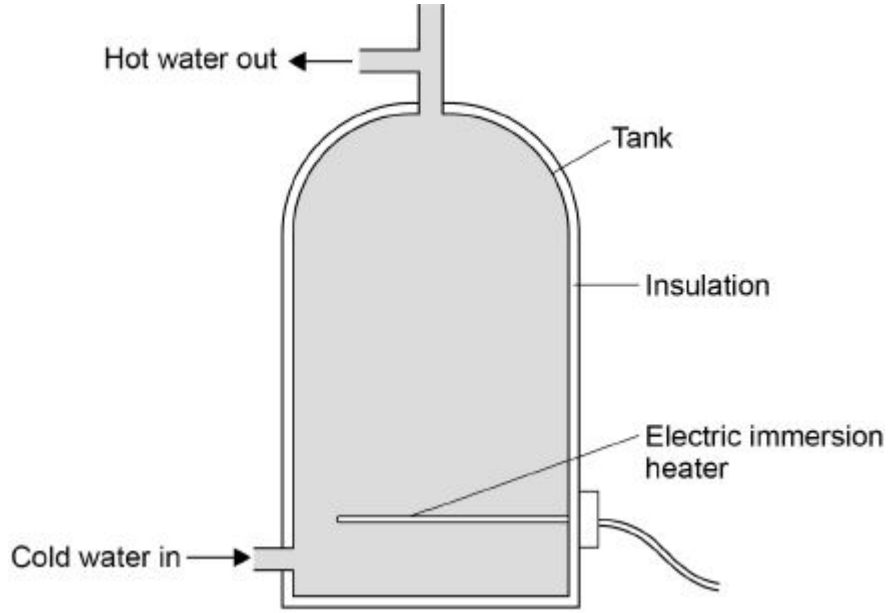
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Q1.

Figure 1 shows a hot water tank made of copper.

Figure 1



(a) Copper has a higher thermal conductivity than most metals.

How does the rate of energy transfer through copper compare with the rate of energy transfer through most metals?

Tick **one** box.

Higher ☐

Lower ☐

The same ☐

(1)

(b) The tank is insulated. When the water is hot, the immersion heater switches off.

Complete the sentences.

Compared to a tank with no insulation, the rate of energy transfer from the water in an insulated tank is _____ .

This means that the water in the insulated tank stays _____ for longer.

(2)

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Figure 2 shows how temperature varies with time for water in a tank heated with an immersion heater.

Figure 3 shows how temperature varies with time for water in a tank heated with a solar panel.

Figure 2

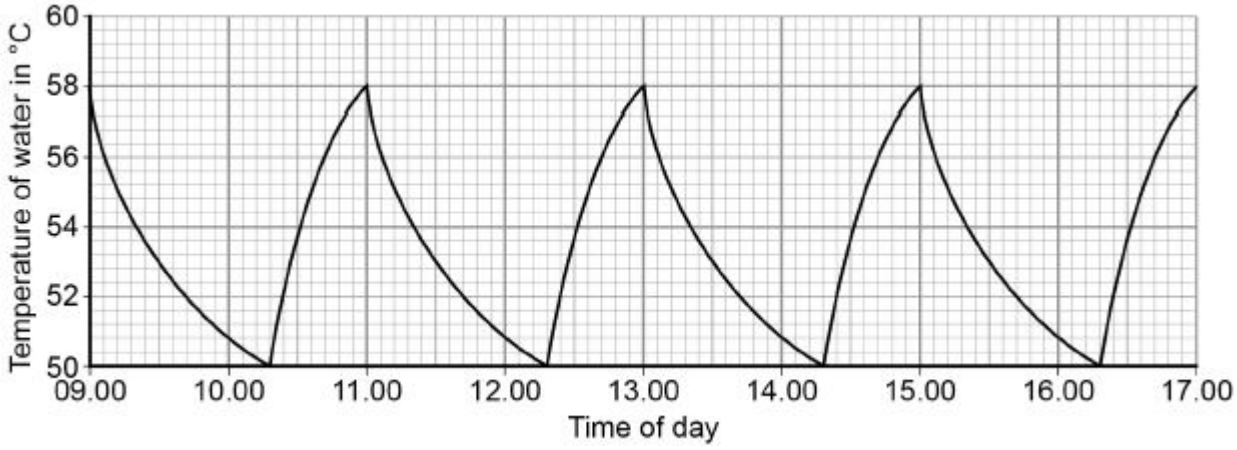
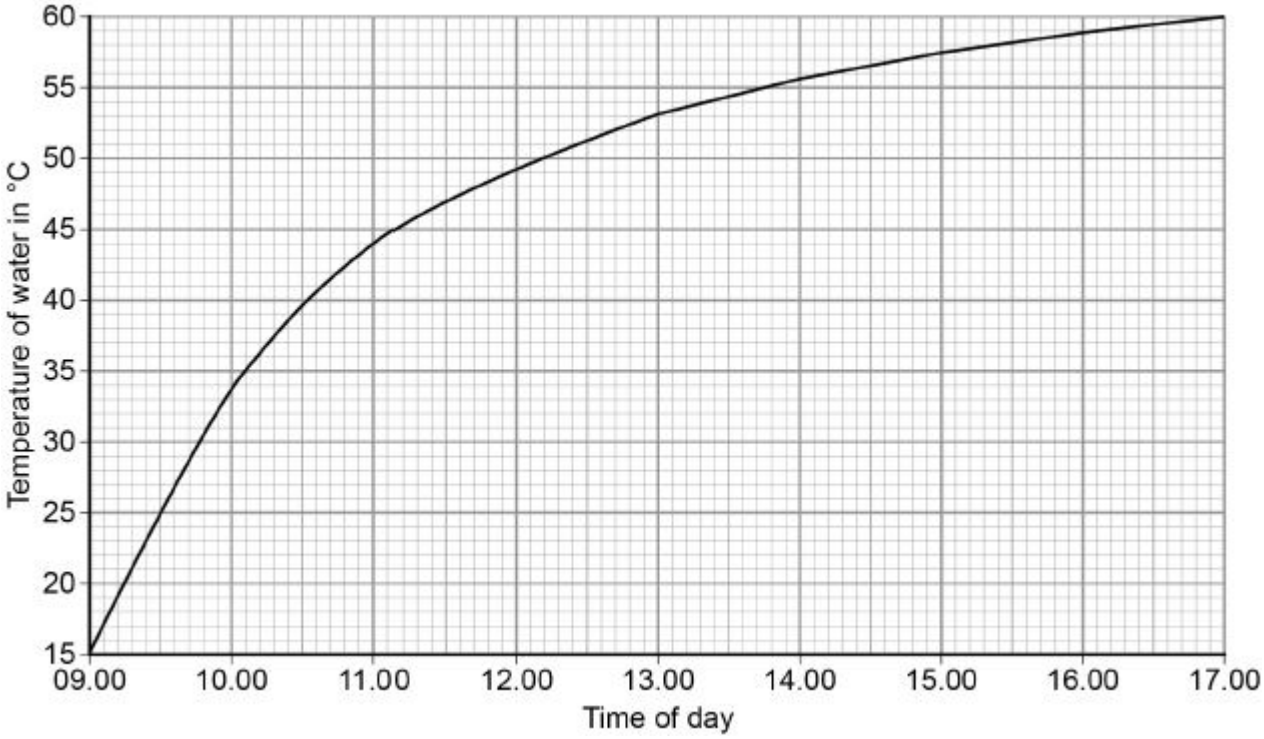


Figure 3



(c) Give **one** advantage and **one** disadvantage of heating the water using solar panels rather than an immersion heater.

Use only information from **Figure 2** and **Figure 3**.

Advantage of solar panels _____

_____

_____

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Disadvantage of solar panels _____

_____

_____

(2)

(d) During one morning, a total of 4 070 000 J of energy is transferred from the electric immersion heater.

4 030 000 J of energy are transferred to the water.

Calculate the proportion of the total energy transferred to the water.

_____

_____

_____

_____

Proportion of total energy = _____

(2)

(e) Write down the equation that links energy transferred, power and time.

_____

(1)

(f) The power output of the immersion heater is 5000 W.

Calculate the time taken for the immersion heater to transfer 4 070 000 J of energy.

Give the unit.

_____

_____

_____

_____

Time = _____ Unit _____

(4)

(Total 12 marks)

Q2.

(a) Complete the sentence. Choose answers from the box.

charge	**potential difference**	**power**	**temperature**	**time**

The current through an ohmic conductor is directly proportional to the

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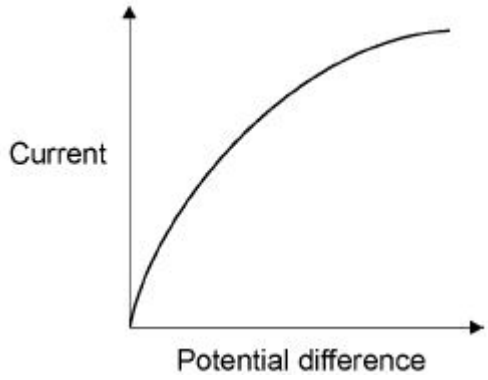
_____ across the component, provided

that the _____ remains constant.

(2)

(b) **Figure 1** shows a current − potential difference graph for a filament lamp.

Figure 1



Explain how the resistance of a filament lamp changes as the potential difference across it increases.

_____

_____

_____

_____

_____

_____

(3)

(c) Many householders are replacing their filament lamps with LED lamps which are more energy efficient.

What does more energy efficient mean?

_____

_____

_____

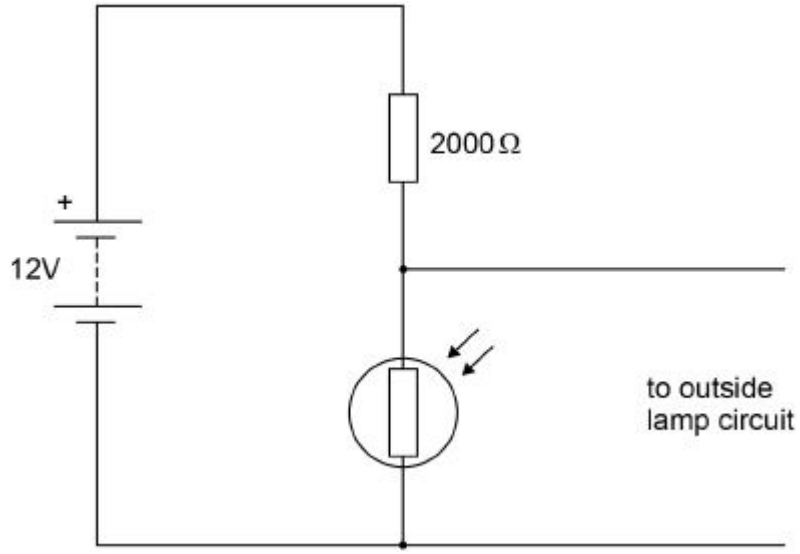
(1)

A Light Dependent Resistor (LDR) is used to turn on an outside lamp when it gets dark.

Part of the circuit is shown in **Figure 2**.

Figure 2

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(d) The light intensity decreases.

What happens to the potential difference across the LDR and the current in the LDR?

Potential difference _____

Current _____

(2)

(e) What is the resistance of the LDR when the potential difference across it is 4 V?

Give a reason for your answer.

Explain your answer.

Resistance = _____ Ω

Reason _____

_____

_____

(2)

(f) Calculate the current through the LDR when the resistance of the LDR is 5000 Ω.

Give your answer to 2 significant figures.

_____

_____

_____

_____

Current = _____ A

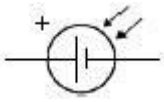
(4)

(Total 14 marks)

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Q3.

Solar cells produce electricity using light from the Sun.

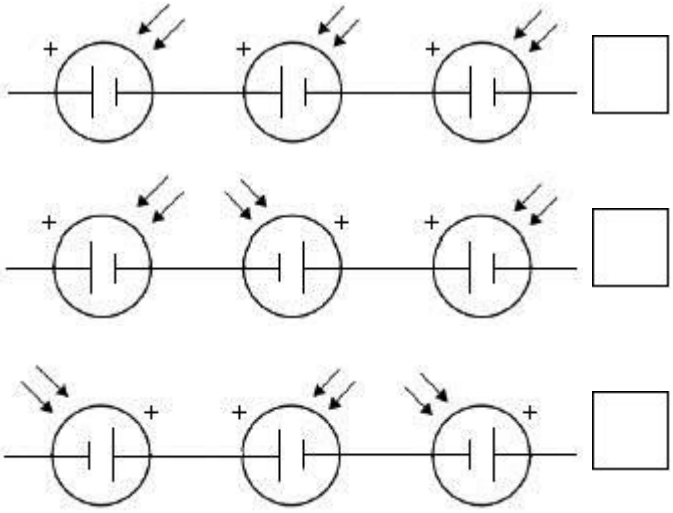
The symbol for a solar cell is: 

A householder has three solar cells.

Each solar cell has an output potential difference of 0.70 V

(a) Which arrangement of three solar cells will give a potential difference of 2.10 V?

Tick **one** box.



(1)

(b) A solar cell has a resistance of 2.5 Ω when the output potential difference is 0.70 V

Calculate the current through the solar cell.

Use the equation:

$$\text{current} = \frac{\text{potential difference}}{\text{resistance}}$$

_____

_____

_____

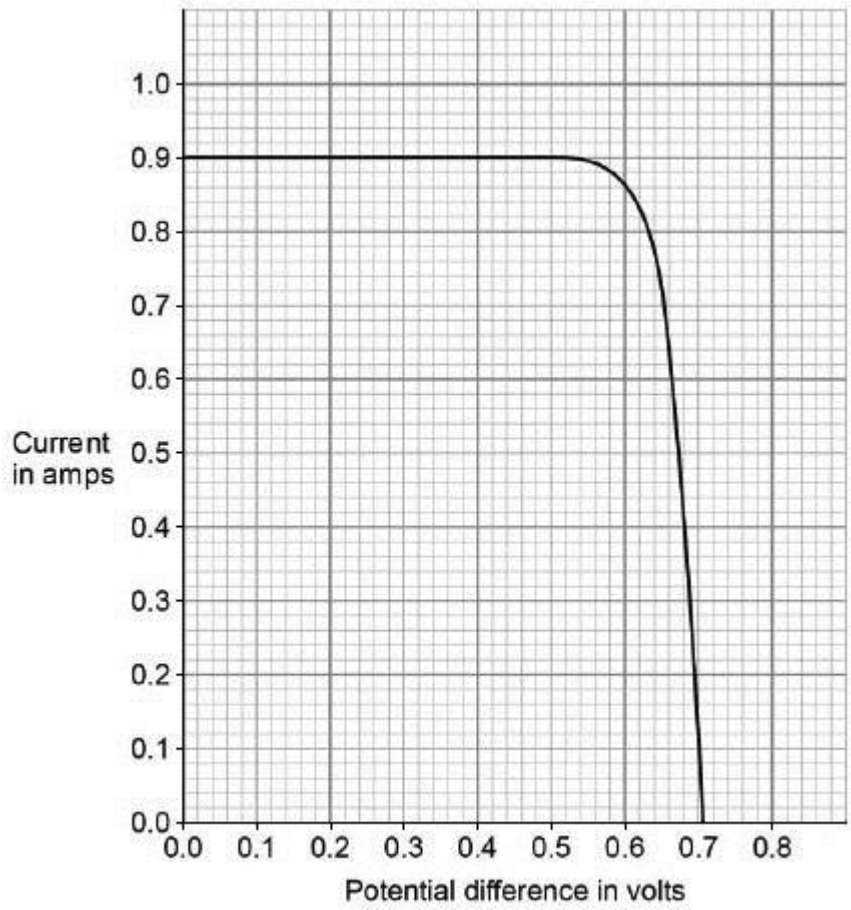
_____

Current = _____ A

(2)

The graph below shows a graph of current against potential difference for a different type of solar cell.

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(c) The power output of the solar cell is calculated using the equation.

power = current × potential difference

Which value of potential difference on the graph above gives the maximum power output of the solar cell?

Tick **one** box.

0.1 V ☐ 0.3 V ☐ 0.6 V ☐ 0.7 V ☐

Give the reason for your answer.

_____

_____

_____

(2)

(d) Write down the equation that links efficiency, total power input and useful power output.

_____

_____

(1)

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(e) The total power input to the solar cell is 2.4 W when the efficiency is 0.20

Calculate the useful power output of the solar cell.

_____

_____

_____

_____

Useful power output = _____ W

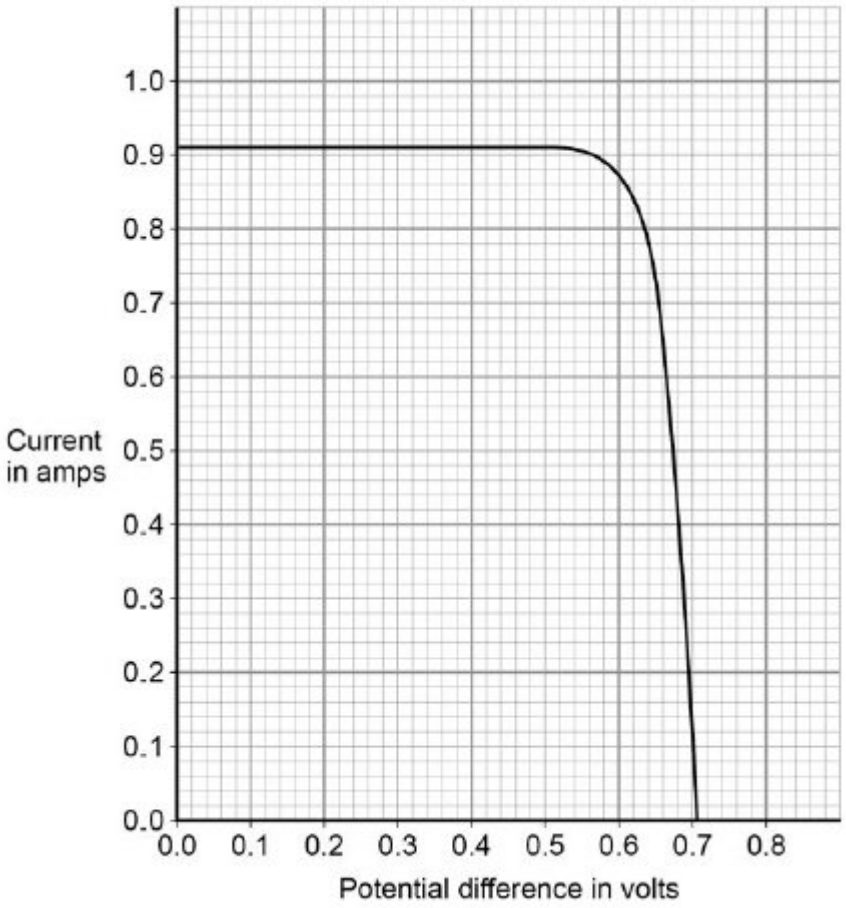
(3)

(Total 9 marks)

Q4.

Figure 1 shows a graph of current against potential difference for a solar cell when light of intensity 450 W/m^2 is incident on it.

Figure 1



(a) Determine the power output of the solar cell when the potential difference is 0.5 V

Use data from **Figure 1**.

_____

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_____

_____

_____

_____

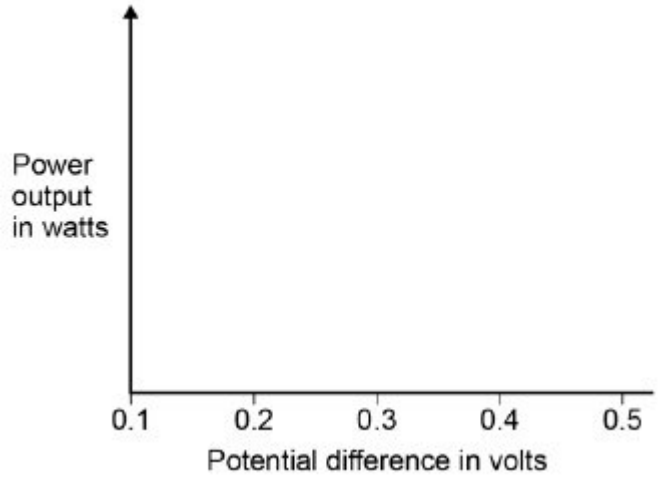
Power = _____ W

(3)

(b) Draw a sketch graph on **Figure 2** to show how the power output of the solar cell varies with potential difference between 0.1 V and 0.5 V

No values need to be included on the vertical axis.

Figure 2



(2)

(c) The maximum power output of this solar cell is 0.52 W

When the light intensity is 450 W/m^2 the cell has an efficiency of 0.15 at the maximum power output.

Calculate the area of the solar cell.

_____

_____

_____

_____

_____

_____

Area = _____ m^2

(4)

(d) A householder has four solar cells.

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Each of the solar cells has a resistance of 0.78 Ω

Explain how the solar cells should be connected so that the total resistance is as low as possible.

_____

_____

_____

_____

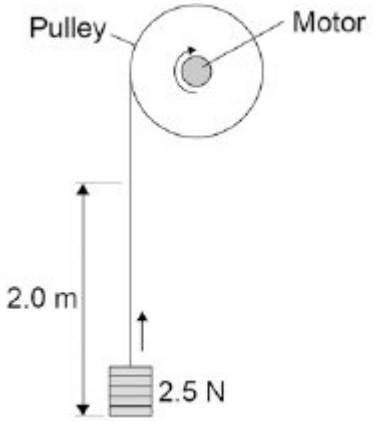
(2)

(Total 11 marks)

Q5.

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. _____

_____

2. _____

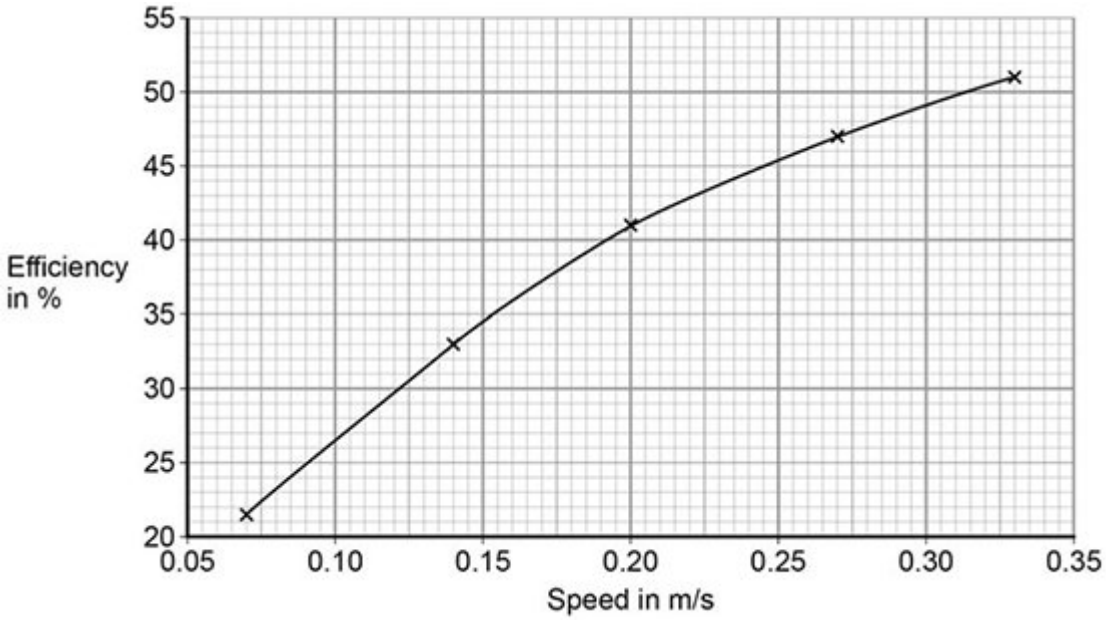
_____

(2)

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(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)

Q6.

Different energy sources are used to generate electricity.

(a) Use words from the box to match the correct energy source to each of the descriptions given in the table.

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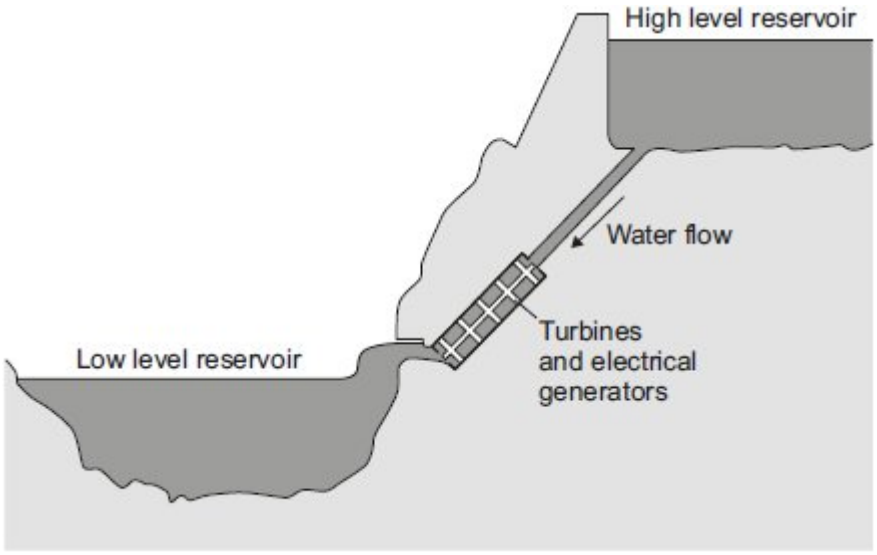
biofuel	coal	geothermal	nuclear	waves

Description	Energy source
Energy from the Earth's core is used to heat water.	
Fission of uranium nuclei is used to heat water.	
Gases from rotting plant material are burned to heat water.	

(3)

(b) Energy can be stored in a pumped storage power station.

The figure shows a pumped storage power station.



When electricity is needed, the water in the high level reservoir is allowed to flow to the low level reservoir. The flowing water generates electricity.

Use the correct answer from the box to complete each sentence.

electrical	gravitational potential	kinetic	nuclear	sound

The water in the high level reservoir stores _____ energy.

The flowing water has _____ energy.

The water turns the turbine which is connected to the generator.

The generator produces some _____, this is wasted energy.

(3)

(c) The total power input to a pumped storage power station is 600 MW.

The useful power output is 540 MW.

(i) Calculate the efficiency of this pumped storage power station.

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_____

_____

_____

Efficiency = _____

(2)

(ii) Calculate how much power is wasted by the pumped storage power station.

_____

Power = _____ MW

(1)

(iii) How is the temperature of the surroundings affected by the energy wasted by the pumped storage power station?

_____

(1)

(Total 10 marks)

Q7.

All European Union countries are expected to generate 20% of their electricity using renewable energy sources by 2020.

The estimated cost of generating electricity in the year 2020 using different energy sources is shown in **Table 1**.

Table 1

Energy source	Estimated cost (in the year 2020) in pence per kWh
Nuclear	7.8
Solar	25.3
Tidal	18.8
Wind	10.0

France generated 542 billion kWh of electricity using nuclear power stations in 2011. France used 478 billion kWh of electricity and sold the rest of the electricity to other countries in 2011.

(a) France may continue generating large amounts of electricity using nuclear power stations instead of using renewable energy resources.

Suggest **two** reasons why.

1. _____

_____

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2. _____

_____

(2)

(b) Give **two** disadvantages of generating electricity using nuclear power stations.

1. _____

_____

2. _____

_____

(2)

(c) A panel of solar cells has an efficiency of 0.15.

The total power input to the panel of solar cells is 3.2 kW.

Calculate the useful power output of this panel of solar cells in kW.

_____

_____

_____

_____

Useful power output = _____ kW

(2)

(d) **Table 2** shows the manufacturing cost and efficiency of different types of panels of solar cells.

Table 2

Type of Solar Panel	Cost to manufacture a 1 m^2 solar panel in £	Efficiency in %
A	40.00	20
B	22.50	15
C	5.00	10

Some scientists think that having a low manufacturing cost is more important than improving the efficiency of solar cells.

Use information from **Table 2** to suggest why.

_____

_____

_____

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_____

_____

_____

(2)

(Total 8 marks)

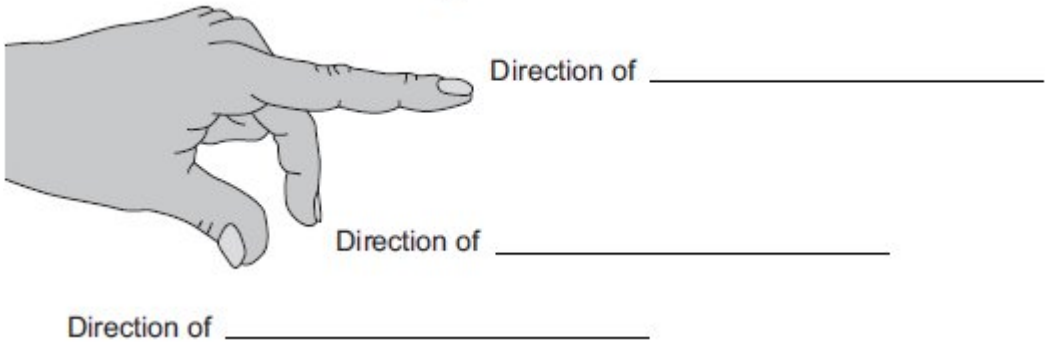
Q8.

The left-hand rule can be used to identify the direction of the force acting on a current-carrying conductor in a magnetic field.

(a) Use words from the box to label **Figure 1**.

current	**field**	**force**	**potential difference**

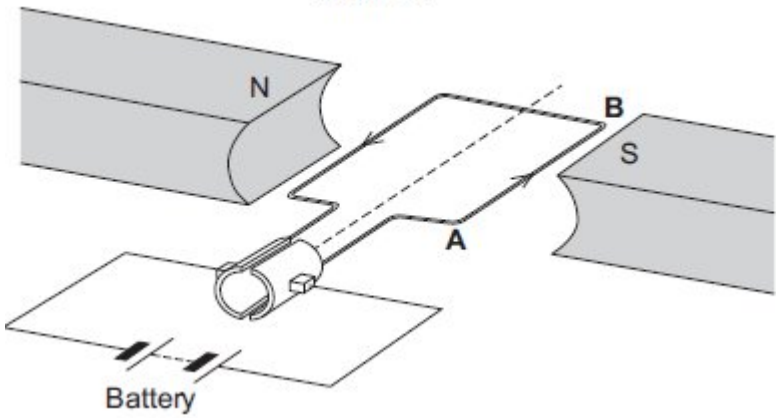
Figure 1



(3)

(b) **Figure 2** shows an electric motor.

Figure 2



(i) Draw an arrow on **Figure 2** to show the direction of the force acting on the wire **AB**.

(1)

(ii) Suggest **two** changes that would increase the force acting on the wire **AB**.

1. _____

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2. _____

(2)

(iii) Suggest **two** changes that would reverse the direction of the force acting on the wire **AB**.

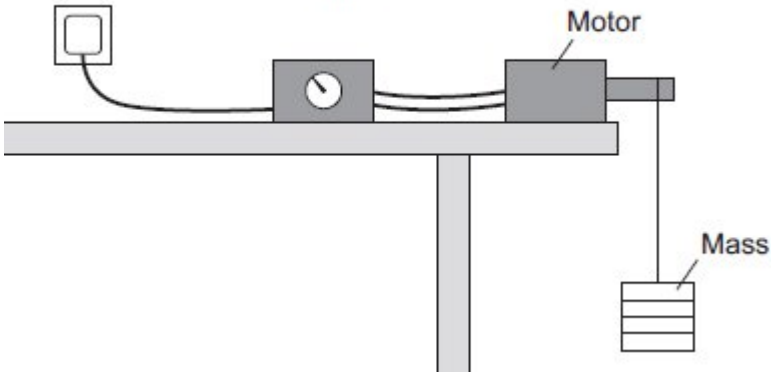
1. _____

2. _____

(2)

(c) A student used an electric motor to lift a mass. This is shown in **Figure 3**.

Figure 3



The student varied the electrical input power to the motor. For each different electrical input power, he recorded the time taken to lift the mass and calculated the output power of the motor.

The results are shown in the table.

Test	Electrical input power in watts	Work done lifting the mass in joules	Time taken to lift the mass in seconds	Output power in watts
A	20	24	2.4	10
B	40	24	1.2	20
C	60	24	0.8	30
D	80	24	0.2	120

The result for **Test D** is anomalous.

(i) Calculate the efficiency of the motor in **Test D**.

_____

_____

Efficiency = _____

(2)

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(ii) Comment on your answer to part (c)(i).

_____

_____

(1)

(iii) Suggest a reason for this anomalous result.

_____

_____

(1)

(Total 12 marks)

Q9.

The image shows a man using a leaf blower to move some leaves.



The leaf blower is powered by an electric motor connected to a battery.

(a) Energy transfers take place when the leaf blower is being used.

Use the correct answer from the box to complete each sentence.

chemical	electrical	kinetic	nuclear	sound

The battery stores _____ energy which is transferred into electrical energy.

The electric motor transfers electrical energy usefully into _____ energy.

The motor wastes energy as _____ energy and as energy that heats the surroundings.

(3)

(b) The total power input to the leaf blower is 750 W.
The useful power output of the leaf blower is 360 W.

Calculate the efficiency of the leaf blower.

_____

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_____

_____

_____

Efficiency = _____

(2)

(Total 5 marks)

Q10.

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 £

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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.

_____

_____

_____

_____

(2)

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

_____

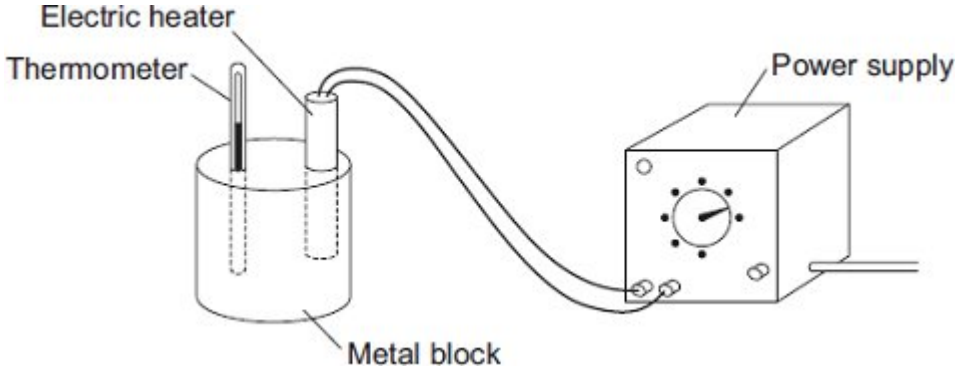
_____

(1)

(Total 10 marks)

Q11.

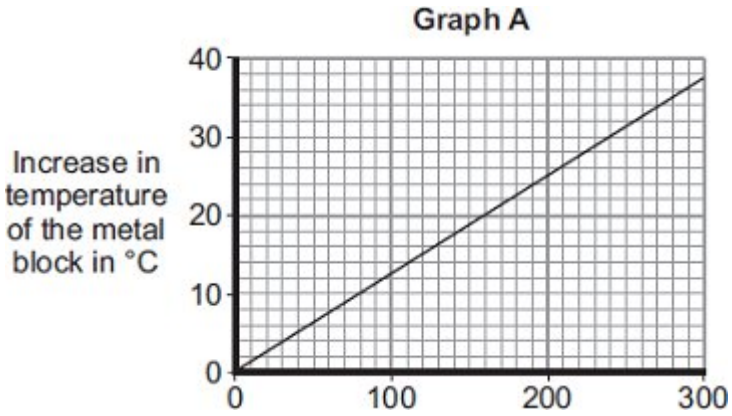
(a) A student used the apparatus drawn below to investigate the heating effect of an electric heater.



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

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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**.

_____

_____

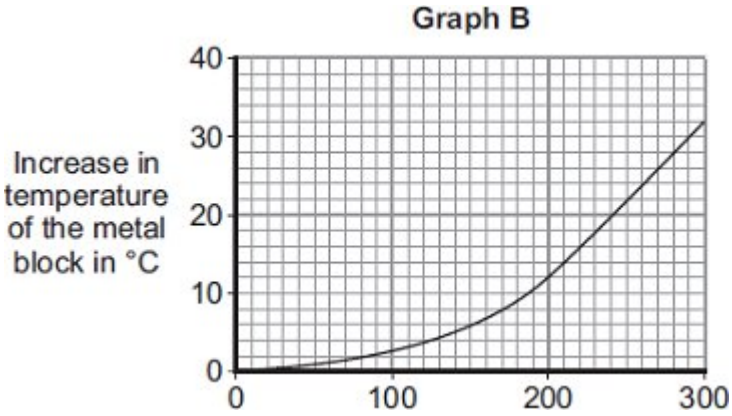
_____

_____

(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.

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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.

_____

_____

_____

_____

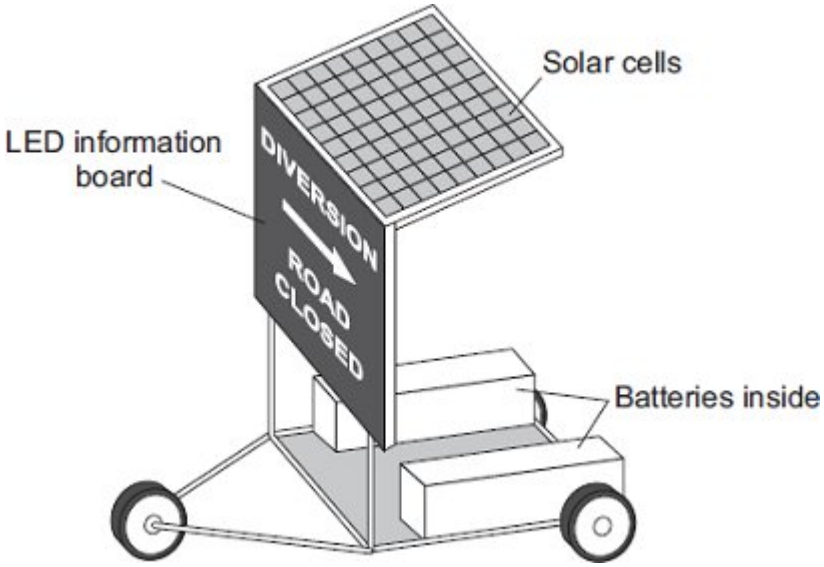
(2)

(Total 7 marks)

Q12.

The picture shows a temporary road traffic information board.

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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. ☐

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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)

Q13.

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

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

_____

_____

(1)

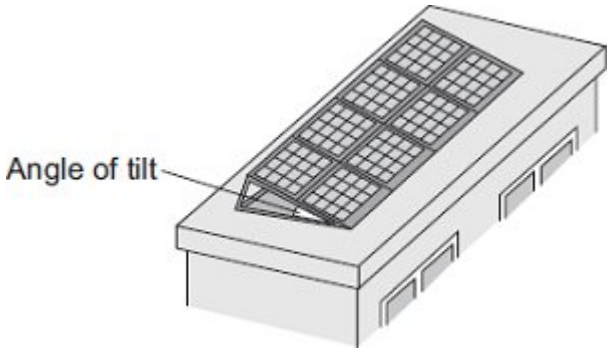
(ii) Name **two** other renewable energy sources used to generate electricity.

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

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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.

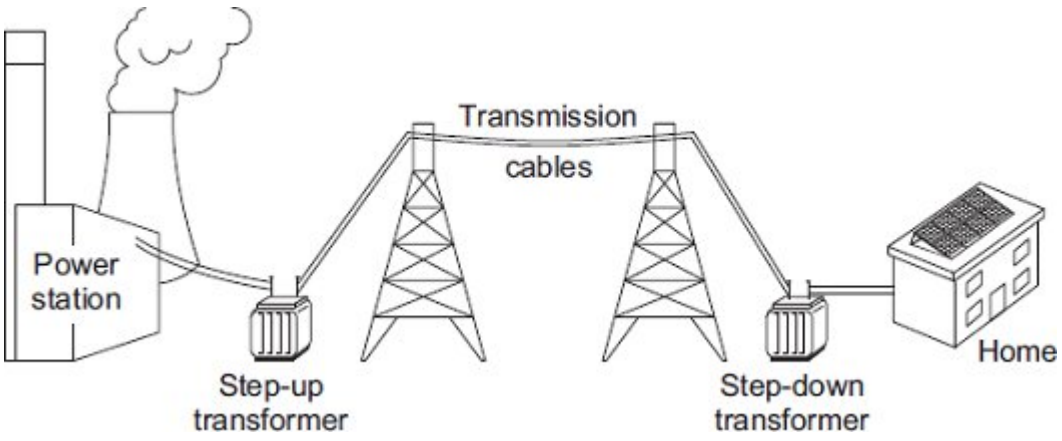
_____

_____

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.

_____

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_____

(1)

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

Explain how.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q14.

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

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

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

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

Show clearly how you work out your answer.

_____

_____

_____

Useful power output = _____ W

(2)

(ii) Calculate the efficiency of the LED bulb.

Show clearly how you work out your answer.

_____

_____

_____

Efficiency = _____

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(1)

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

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

_____

_____

_____

_____

(2)

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

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

_____

_____

(1)

(Total 6 marks)

Q15.

A wood burning stove is used to heat a room.



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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?

_____

_____

_____

_____

(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)

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(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.

_____

_____

_____

_____

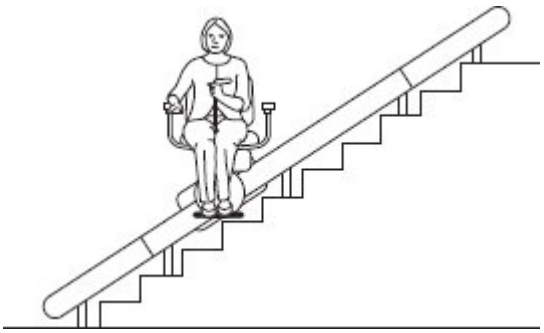
Energy required = _____

(3)

(Total 10 marks)

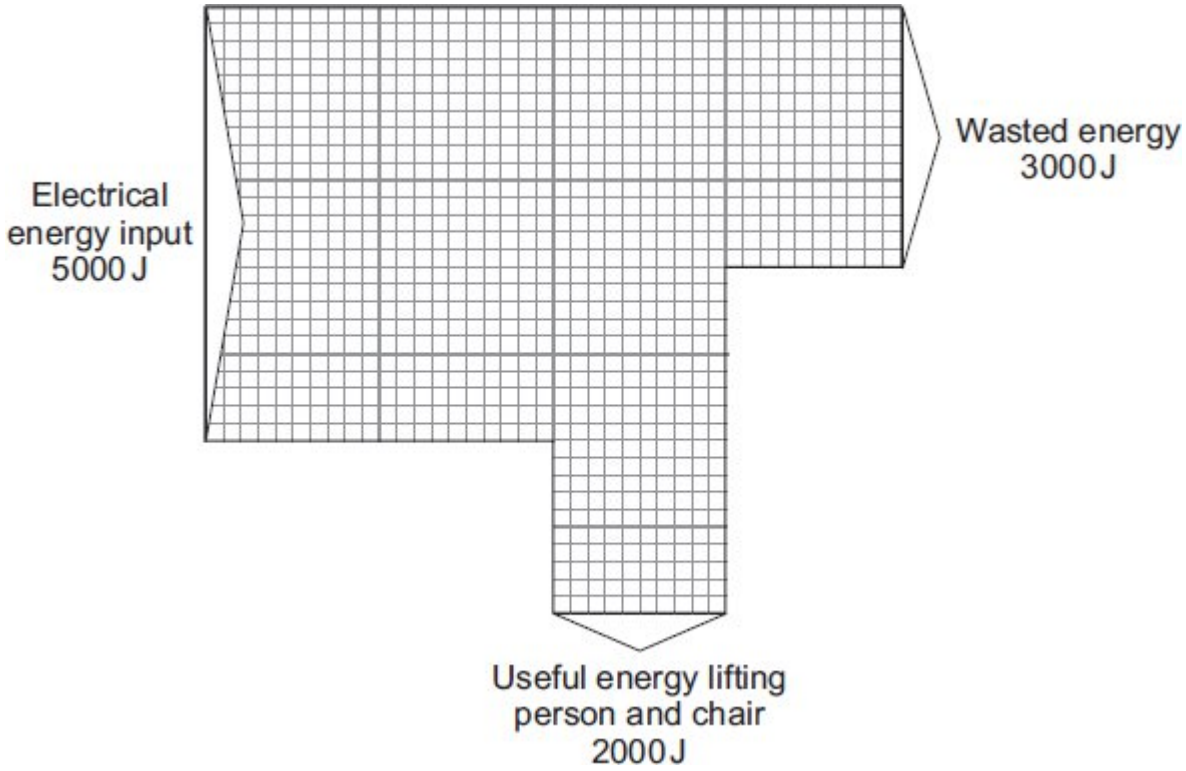
Q16.

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.

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(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 = _____

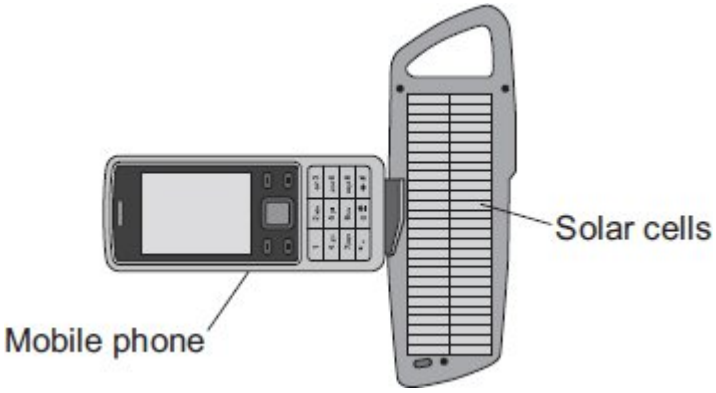
(2)

(Total 3 marks)

Q17.

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

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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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_____

_____

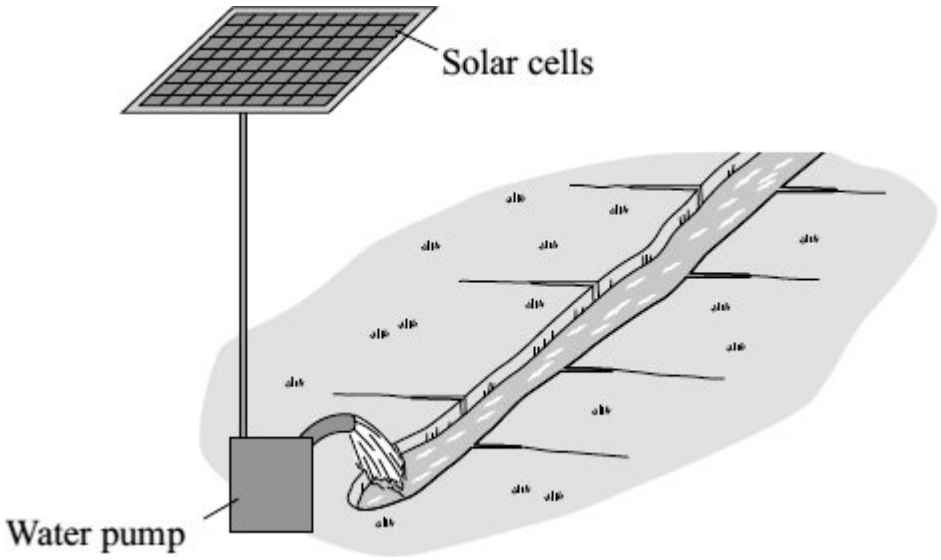
_____

(2)

(Total 6 marks)

Q18.

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



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

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

Show clearly how you work out your answer.

_____

_____

Electrical energy = _____ kWh

(2)

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

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

Area = _____ square metres

(1)

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

_____

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_____

(1)

(Total 4 marks)

Q19.

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

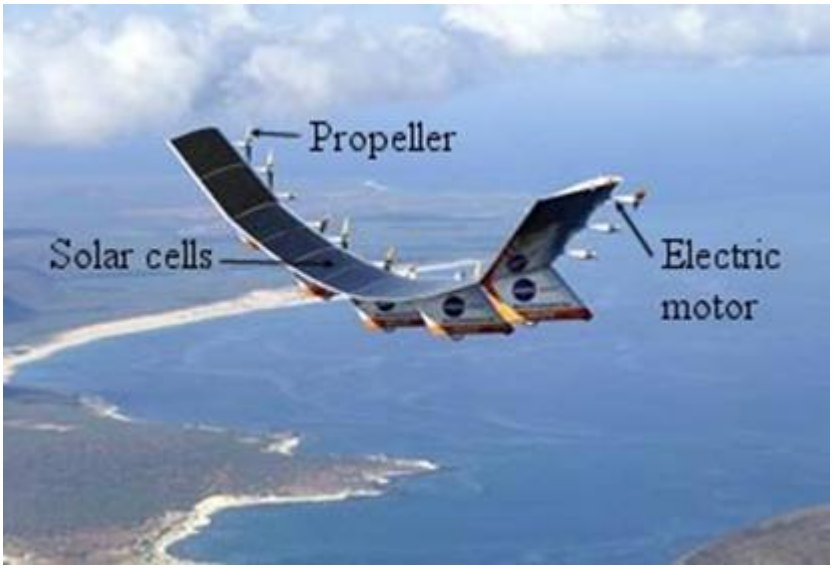


Photo by NASA.

(a) 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.

(i) 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)

(ii) What happens to the energy that is **not** usefully transferred by the solar cells?

_____

(1)

(b) The aircraft propellers are driven by electric motors. As well as the solar cells, there are fuel cells that provide additional power to the electric motors.

(i) Suggest **one** advantage of the aircraft having fuel cells as well as the solar cells.

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_____

(1)

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

_____

_____

(1)

(iii) Eventually, the designers want to produce an unmanned aircraft that can fly at twice the height of a passenger jet for up to six months.

Suggest **one** possible use for an aircraft such as this.

_____

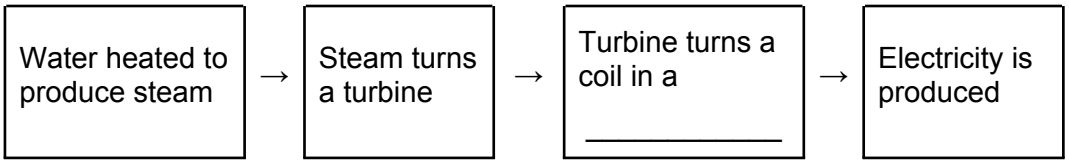
_____

(1)

(Total 6 marks)

Q20.

(a) In Britain most power stations burn fuel to produce heat. The diagram shows the stages by which the heat is transferred into electrical energy.
Complete the diagram by filling in the missing word.



(1)

(b) A fuel burning power station uses 2000 joules of fuel energy to generate 600 joules of electrical energy. The rest of the fuel energy is wasted as heat.

(i) For every 600 joules of electrical energy generated, how much fuel energy is wasted as heat?

_____

_____

(1)

(ii) Calculate the efficiency of the power station.
Show clearly how you work out your answer.

_____

_____

efficiency = _____

(2)

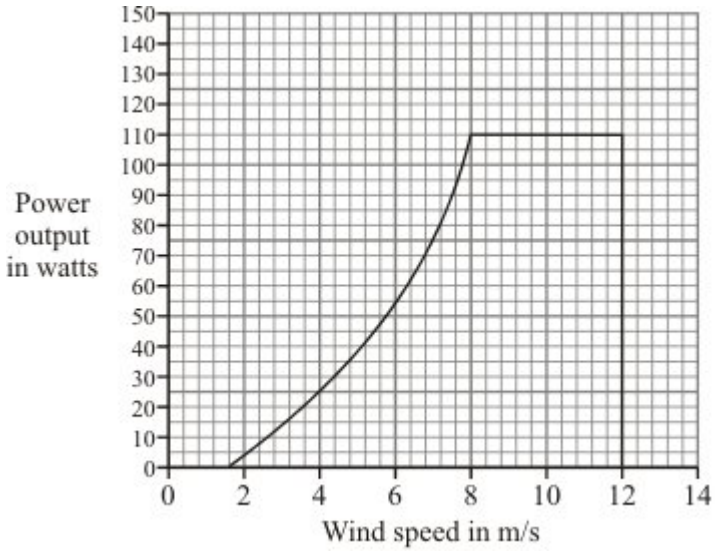
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(c) List **A** gives three energy resources used to generate electricity. List **B** gives environmental problems that may be caused by using different energy resources. Draw a straight line from each energy resource in List **A** to the environmental problem it may cause in List **B**. Draw **three** lines only.

List A Energy resource	List B Environmental problem that may be caused
Wind	Destroys the habitat of wading birds in river estuaries
Tides	Produces a lot of noise
Falling water (hydroelectricity)	Produces the gas sulphur dioxide
	Floods land used for farming or forestry

(3)

(d) A small wind generator is used to charge a battery. The graph shows the power output of the generator at different wind speeds.



(i) What is the maximum power produced by the generator?

_____ watts

(1)

(ii) The generator is designed to stop if the wind speed is too high.

At what wind speed does the generator stop working?

_____ m/s

(1)

(iii) Give **one** disadvantage of using a wind generator to charge a battery.

_____

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(1)

(Total 10 marks)

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