

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.1.2.2 EFFICIENCY (PACK 2)

SCORE

/166

PERCENTAGE

%

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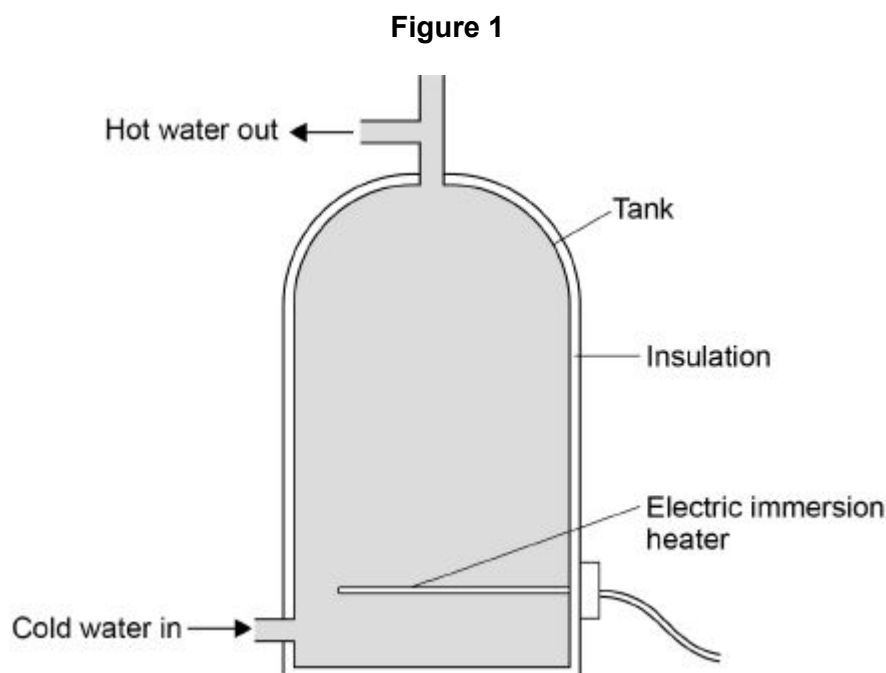
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Q1.

Figure 1 shows a hot water tank made of copper.



- (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)

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

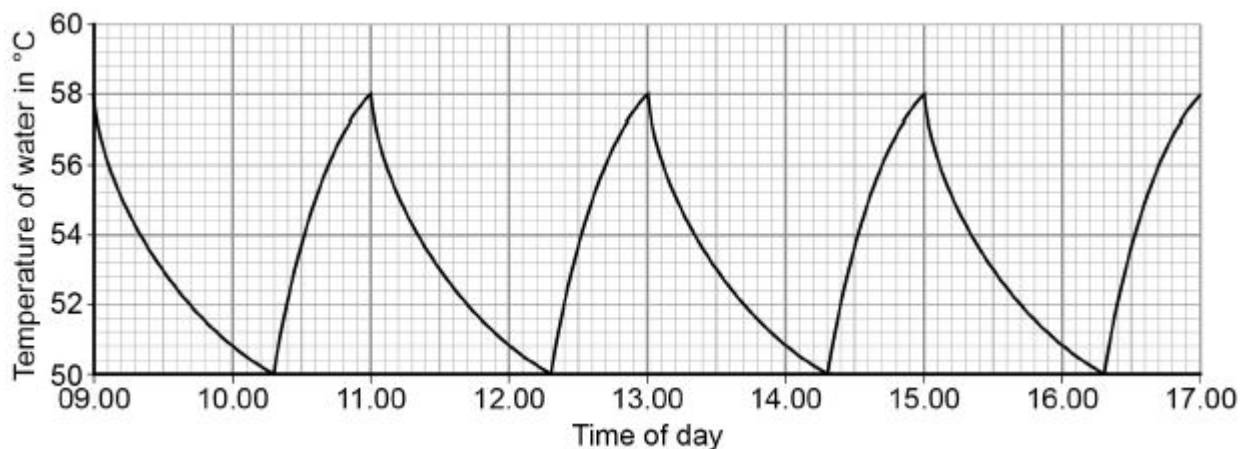
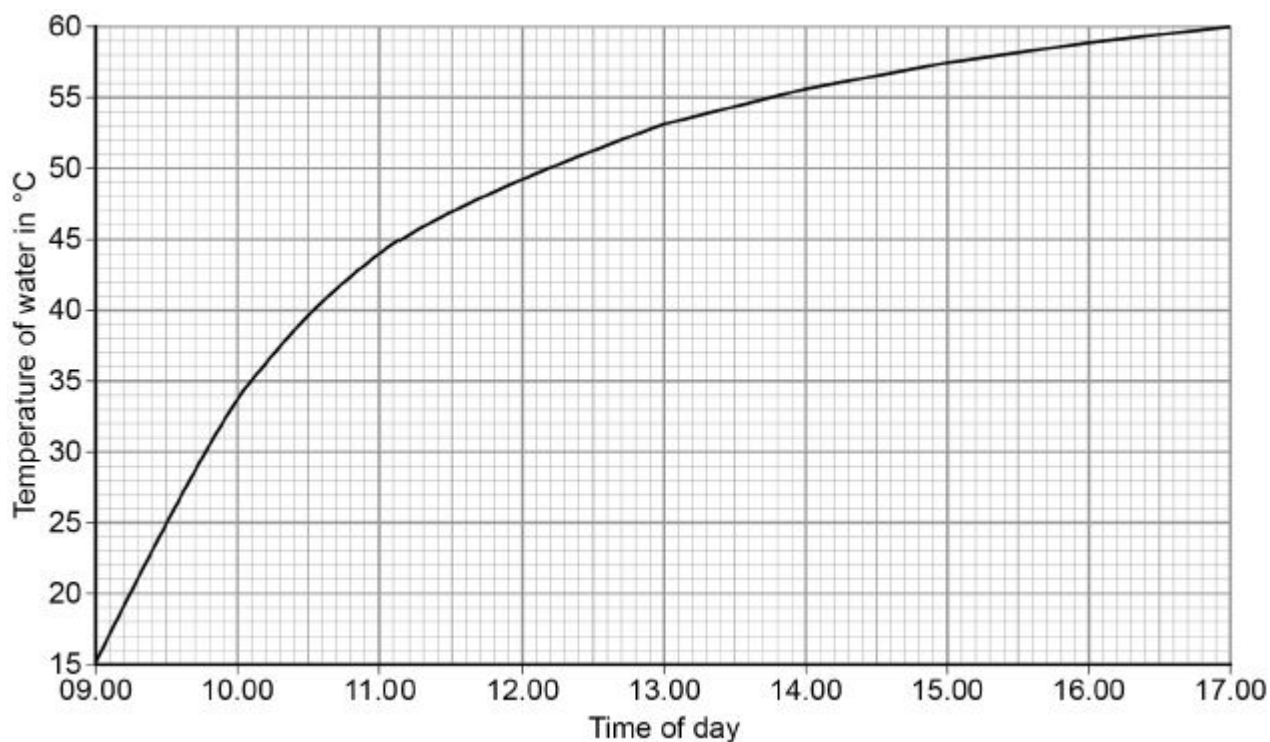


Figure 3



- (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 _____

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
--------	-------------------------	-------	-------------	------

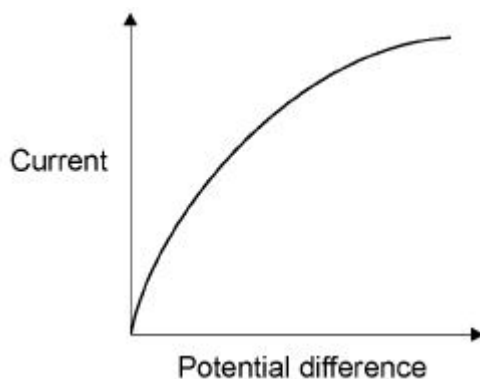
The current through an ohmic conductor is directly proportional to the

_____ 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.

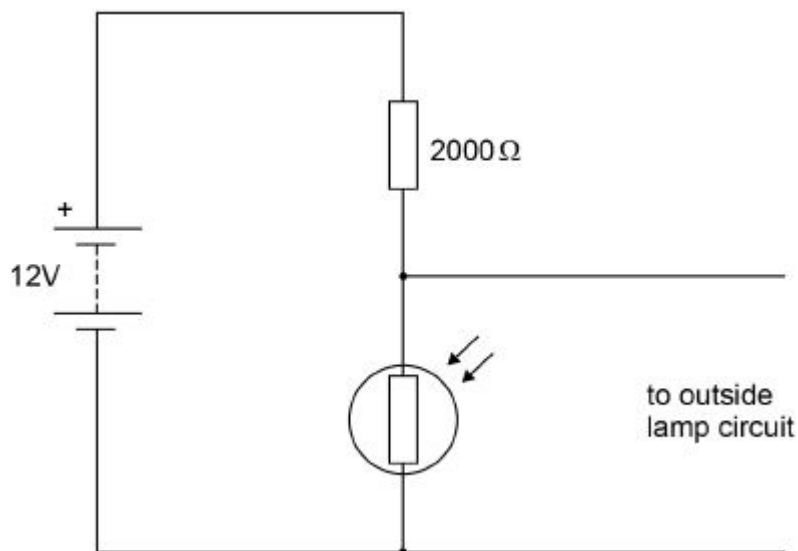
What does more energy efficient mean?

(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



- (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.

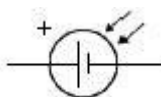
Current = _____ A

(4)

(Total 14 marks)

Q3.

Solar cells produce electricity using light from the Sun.



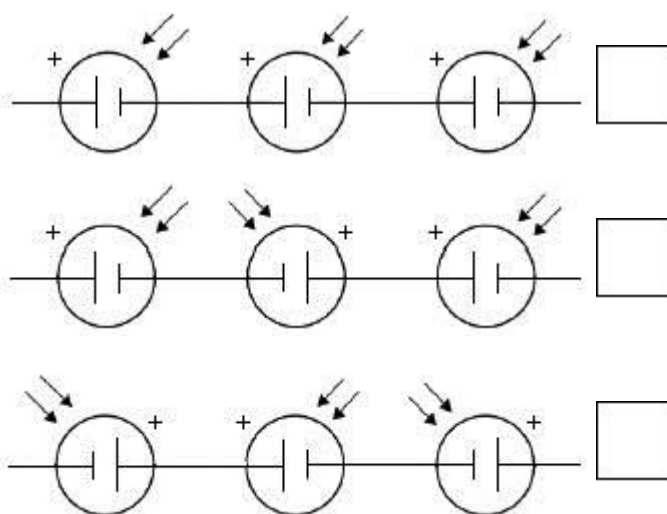
The symbol for a solar cell is:

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 2.5Ω when the output potential difference is 0.70 V

Calculate the current through the solar cell.

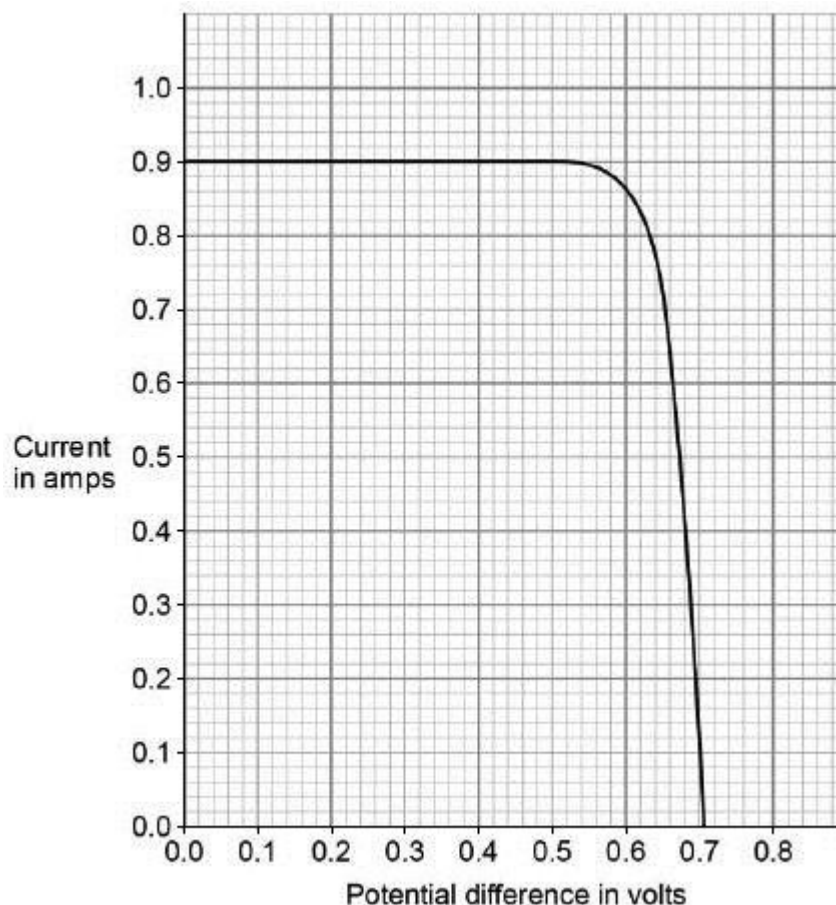
Use the equation:

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

Current = _____ A

(2)

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



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

$$\text{power} = \text{current} \times \text{potential difference}$$

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)

- (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

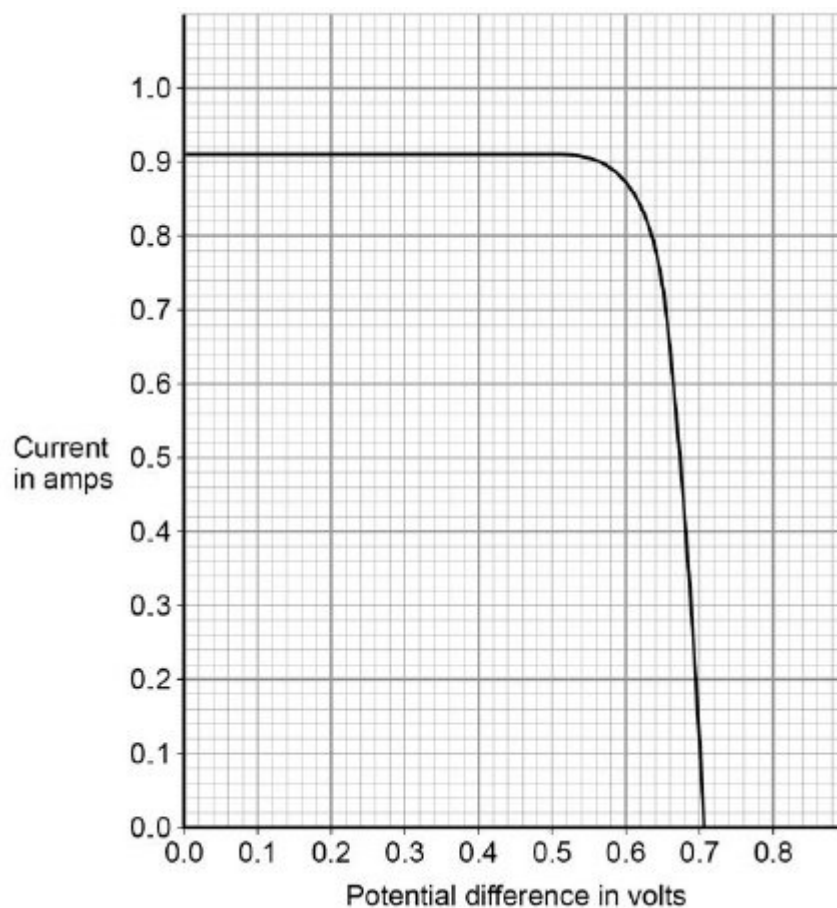
(3)

(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**.

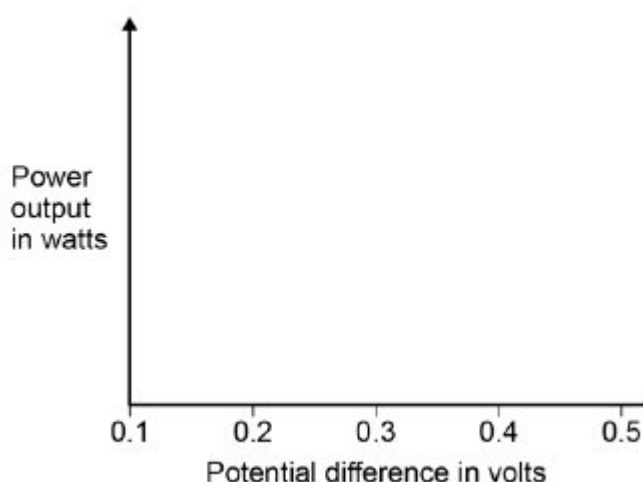
Power = _____ W

(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.

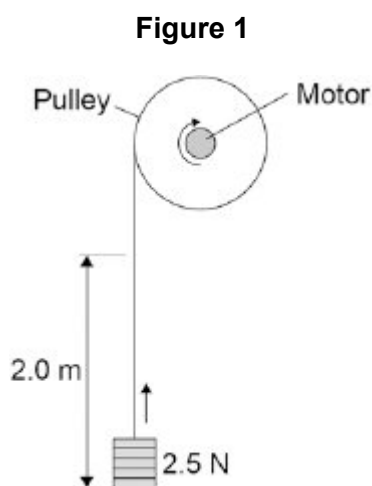
Each of the solar cells has a resistance of $0.78\ \Omega$

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**.



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.

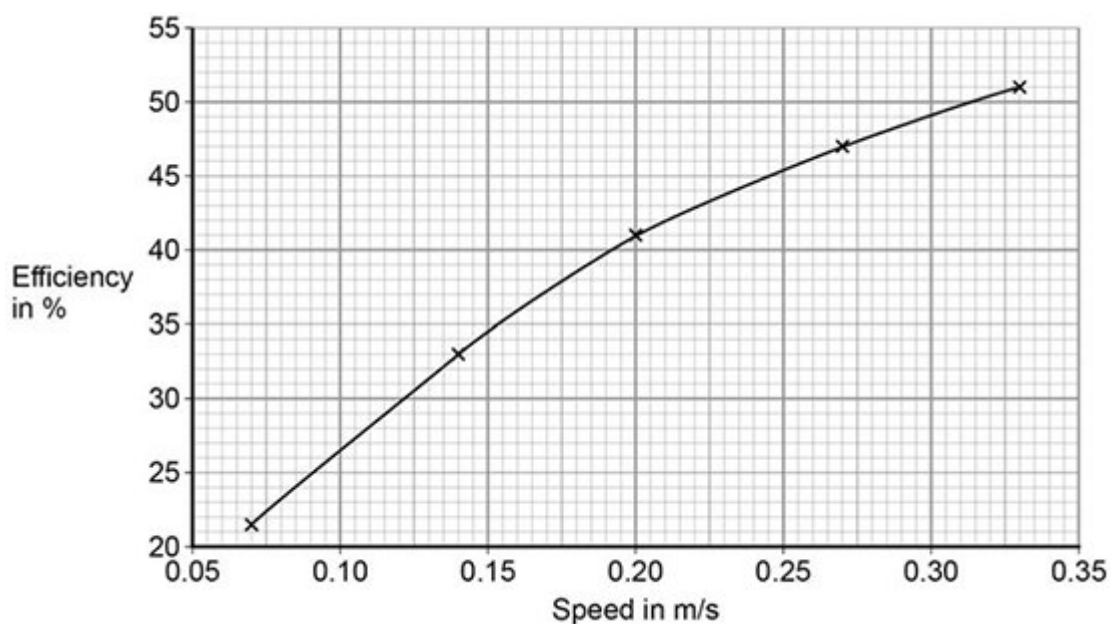
1.

2.

(2)

- (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.

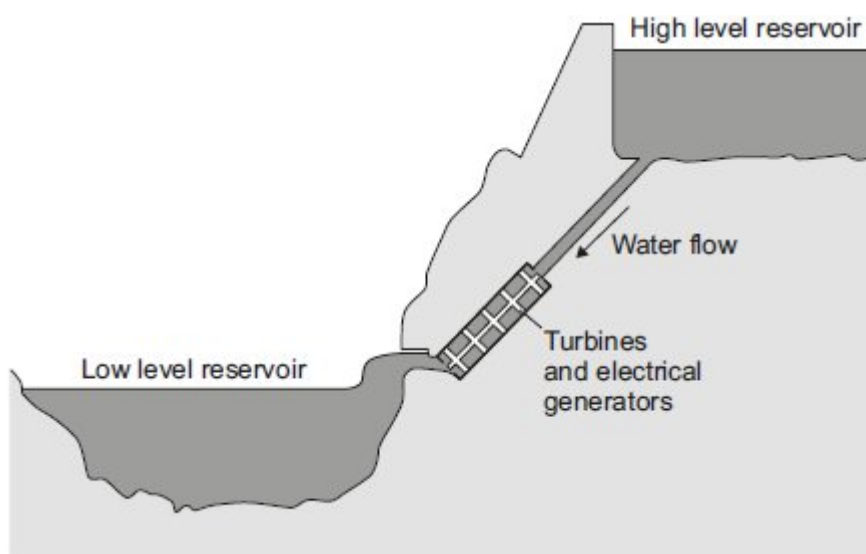
biofuel	coal	geothermal	nuclear	waves
----------------	-------------	-------------------	----------------	--------------

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.

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. _____

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.

(2)
(Total 8 marks)

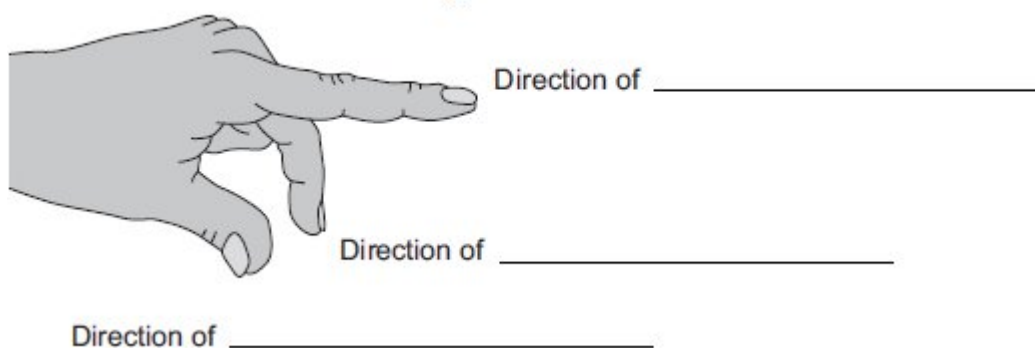
Q8.

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
---------	-------	-------	----------------------

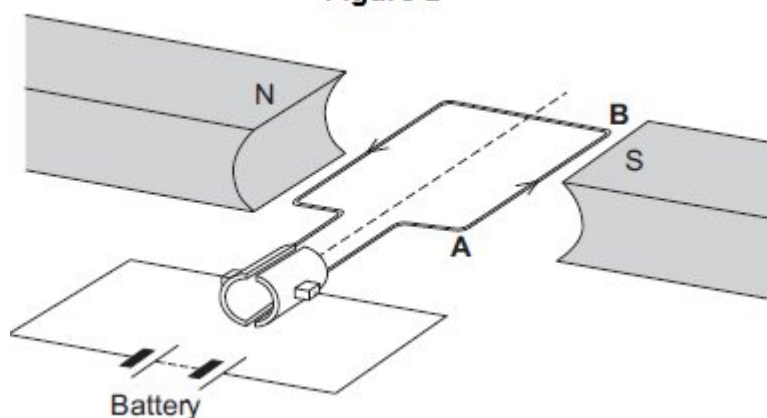
Figure 1



(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. _____

2. _____ (2)

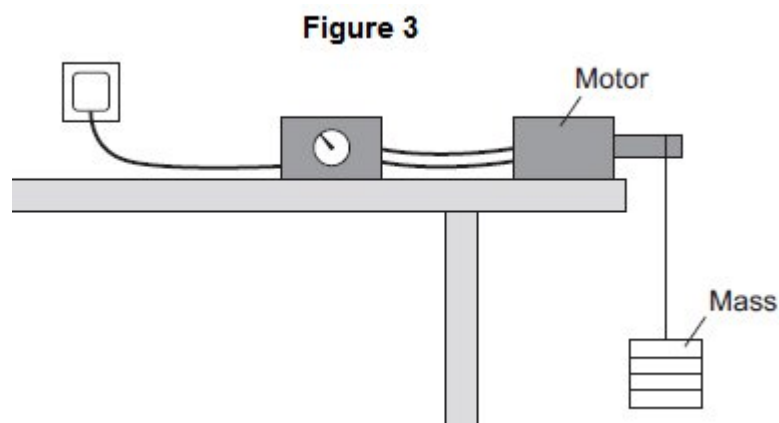
- (iii) Suggest **two** changes that would reverse the direction of the force acting on the wire **AB**.

1. _____

2. _____

(2)

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



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)

(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.

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 £
----------------	-------------------	-------------------

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)

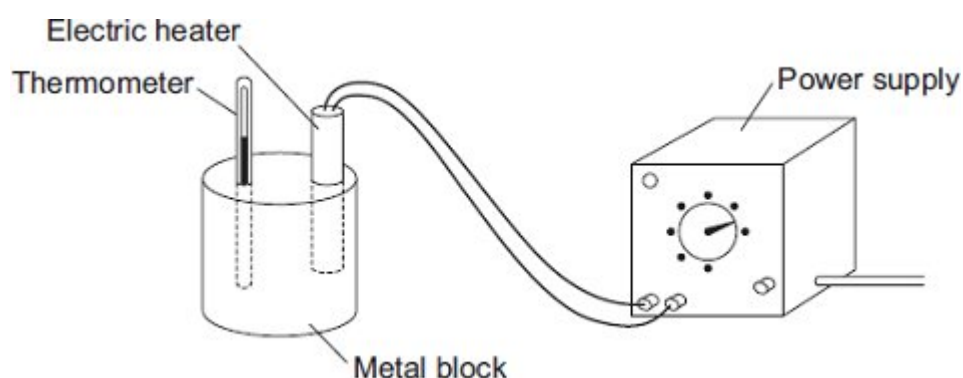
- (iii) State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

(1)

(Total 10 marks)

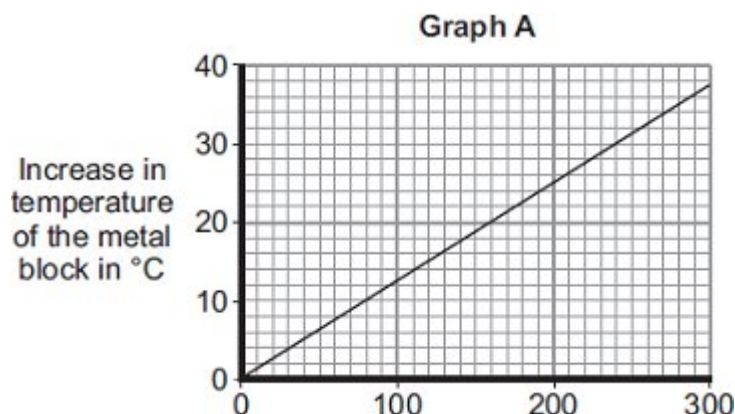
Q11.

- (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**.

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

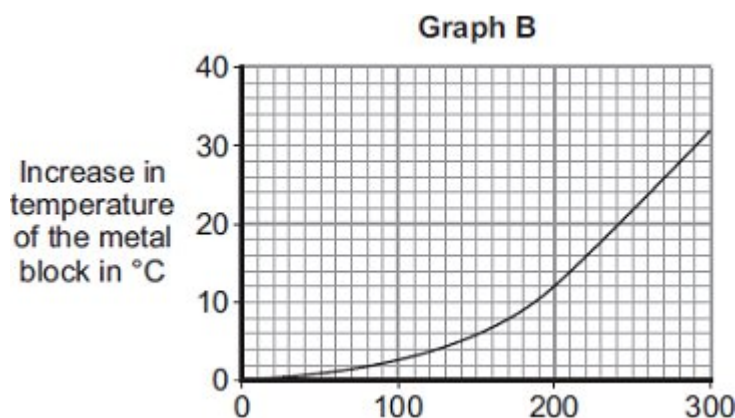


Describe the pattern shown in **Graph A**.

(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.

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

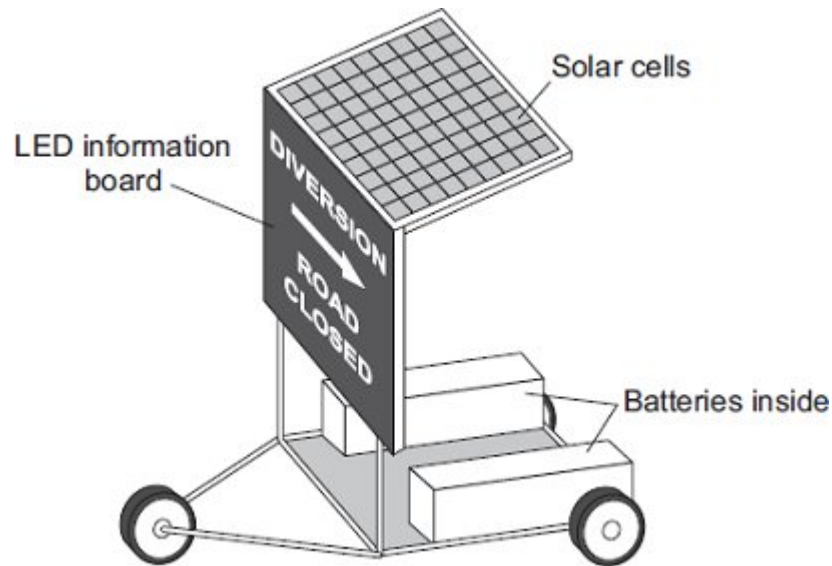
Give, in terms of the amount of energy needed to heat the metal blocks, a reason for your answer.

(2)

(Total 7 marks)

Q12.

The picture shows a temporary road traffic information board.



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)

Q13.

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

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

(1)

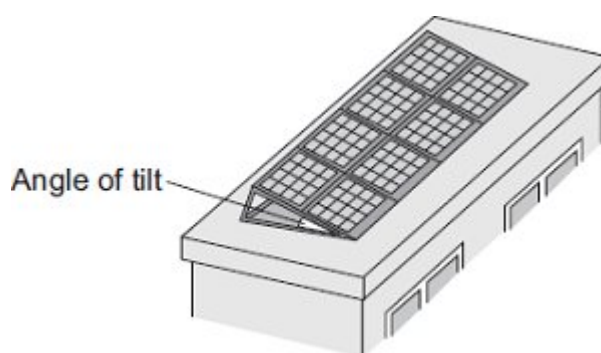
(ii) Name **two** other renewable energy sources used to generate electricity.

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 m² 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 m².

The efficiency of the solar cells is 0.18.

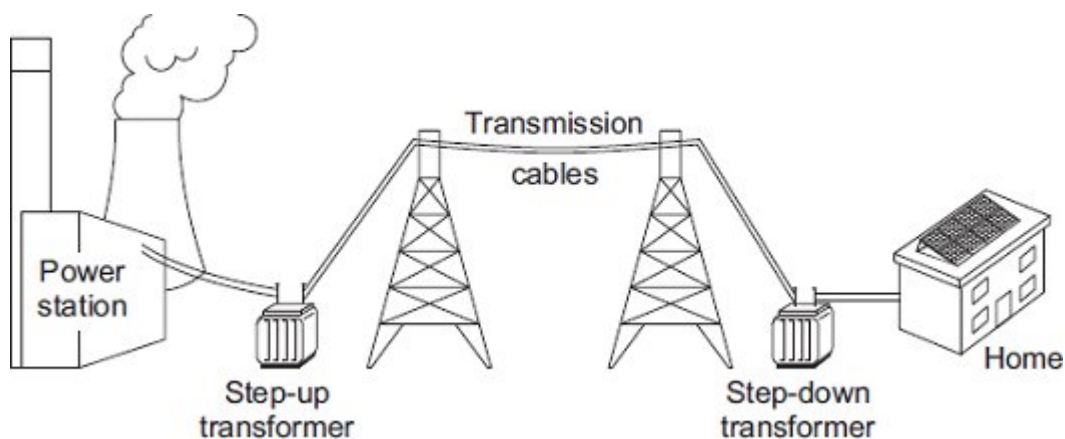
Calculate the average **maximum** electrical energy available from the solar cell panels each second in June.

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)

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 = _____

(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.



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)

- (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.

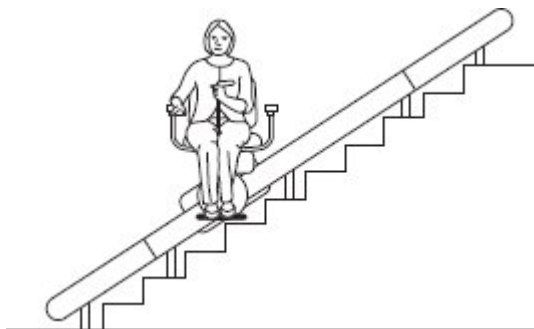
Energy required = _____

(3)

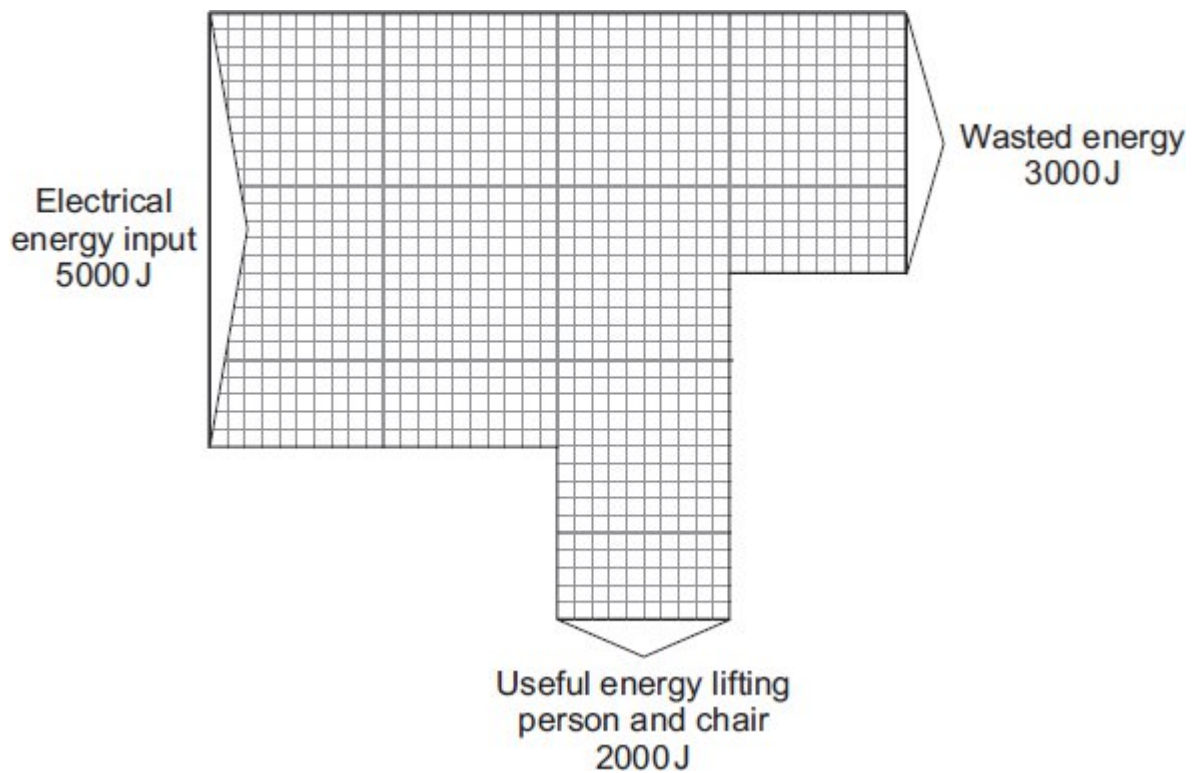
(Total 10 marks)

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.



- (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.

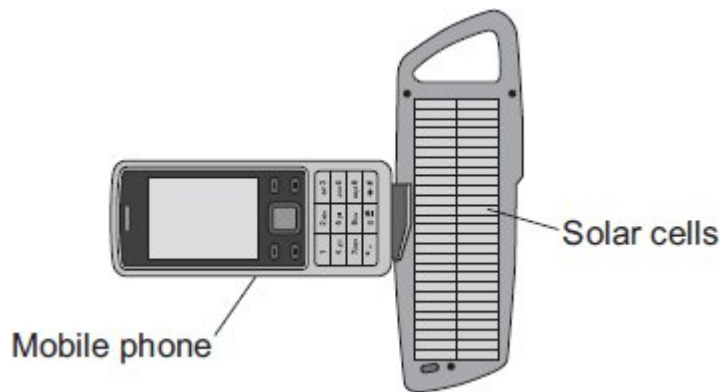
Efficiency = _____

(2)

(Total 3 marks)

Q17.

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



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)

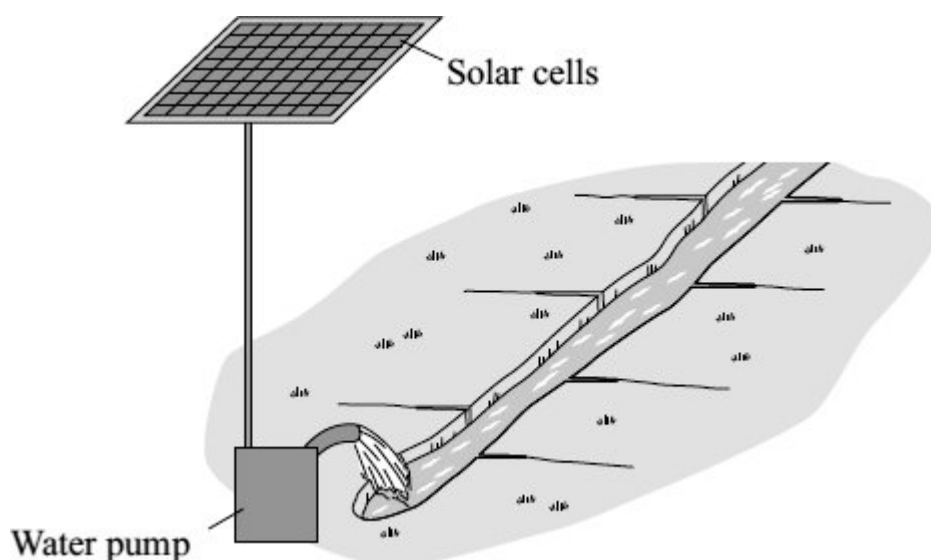
- (c) The electricity used in homes in the UK is normally generated in a fossil fuel power station.

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

(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).

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.

_____ (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.

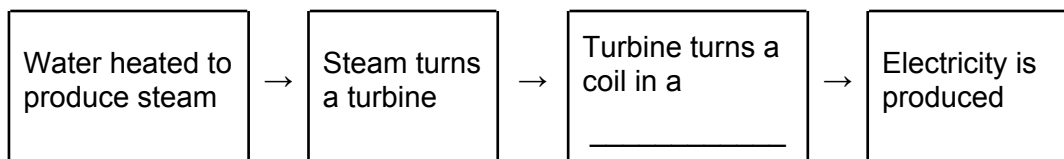
Suggest **one** possible use for an aircraft such as this.

(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)

- (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

Wind

Tides

Falling water
(hydroelectricity)

List B
Environmental problem that may be caused

Destroys the habitat of wading birds in river estuaries

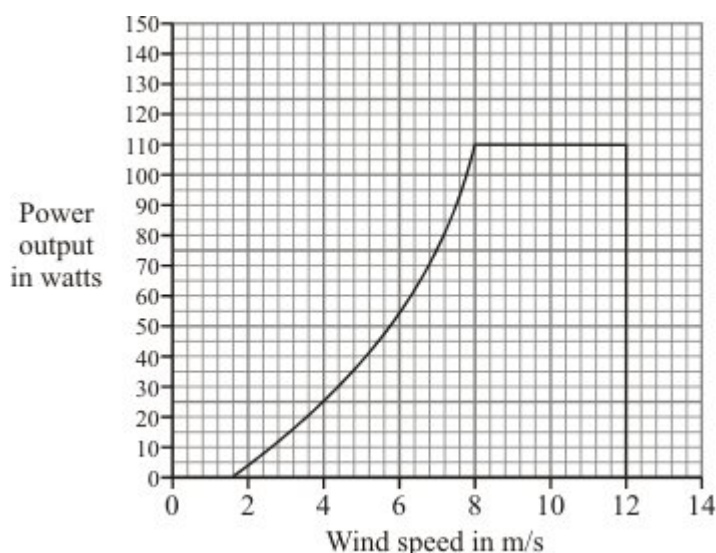
Produces a lot of noise

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.

(1)
(Total 10 marks)

Mark schemes

Q1.

- (a) higher 1
- (b) low(er) 1
- hot(ter)
allow warm(er) 1
- (c) advantage:
 • water heated continuously (by the Sun) 1
- one** disadvantage from:
 • temperature of water is lower (for most of the time than water heated by immersion heater)
 • water may not be hot enough
allow less control over water temperature
 • it takes longer to heat the water 1
- (d)
$$\frac{4\,030\,000}{4\,070\,000}$$
 1
- 0.99
an answer of 99% scores 2 marks
an answer of 99 or 0.99% scores 1 mark 1
- an answer of 0.99 scores 2 marks*
allow an answer that rounds to 0.99 for 2 marks
- (e) power = energy transferred / time
allow $P = E / t$ 1
- (f)
$$5000 = \frac{4\,070\,000}{t}$$
 1
- $$t = \frac{4\,070\,000}{5000}$$
 1
- $$t = 814$$
 1
- seconds

other units of time must be consistent with numerical value

1

an answer of 814 seconds scores 4 marks

an answer of 13.57 minutes scores 4 marks

[12]

Q2.

- (a) potential difference

allow p.d.

allow voltage

1

temperature

1

in this order only

- (b) the current increases (when the potential difference increases)

1

(which) causes the temperature of the filament to increase

1

(so) the resistance increases

*do **not** accept resistance increases and then levels off*

1

- (c) a higher proportion / percentage of the (total) power / energy input is usefully transferred

wastes less energy is insufficient

or

higher (useful) power / energy output for the same (total) power / energy input

1

- (d) potential difference increases

1

current decreases

1

- (e) 1000 (Ω)

reason only scores if $R = 1000\ (\Omega)$

1

potential difference is shared in proportion to the resistance

allow a justification using a correct calculation

1

- (f) $12 = I \times 7000$

1

$$I = \frac{12}{7000}$$

1

$$I = 1.71 \times 10^{-3} \text{ (A)}$$

an answer that rounds to $1.7 \times 10^{-3} \text{ (A)}$ scores 3 marks

1

$$I = 1.7 \times 10^{-3} \text{ (A)}$$

this answer only

or

$$I = 0.0017 \text{ (A)}$$

an answer of $2.4 \times 10^{-3} \text{ (A)}$ scores 2 marks

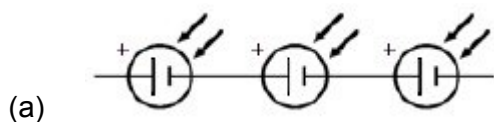
if no other marks scored allow 1 mark for calculation of total resistance (7000Ω)

1

an answer of $1.7 \times 10^{-3} \text{ (A)}$ scores 4 marks

[14]

Q3.



1

(b)
$$\text{current} = \frac{0.70}{2.5}$$

1

$$\text{current} = 0.28 \text{ (A)}$$

an answer of 0.28 (A) scores 2 marks

1

(c) 0.60 (V)

1

product of potential difference and current gives highest value

1

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

1

(e)
$$0.20 = \frac{\text{useful power output}}{2.4}$$

1

$$\text{useful power output} = 0.20 \times 2.4$$

1

$$\text{useful power output} = 0.48 \text{ (W)}$$

an answer of 0.48 (W) scores 3 marks

1

[9]

Q4.

- (a) current at 0.5 V = 0.91 (A) 1
- $P = 0.91 \times 0.5$ 1
- $P = 0.455$ (W)
an answer of 0.455 (W) scores 3 marks 1
- (b) straight line with positive gradient
allow for 1 mark a straight line that passes through (0.1, 0) 1
- positive y-axis intercept
ignore any values on y-axis 1
- (c) $0.15 = \frac{0.52}{\text{total } P}$ 1
- total P = 3.47 (W) 1
- area = $\frac{3.47}{450}$ 1
- area = 7.7×10^{-3} (m²)
an answer of 7.7×10^{-3} (m²) scores 4 marks
allow use of student's calculated incorrect total power for last 2 marking points 1
- (d) connect the solar cells in parallel 1
- (so that) the current has multiple paths it can take
- or**
- the total resistance is less than the resistance of one solar cell 1
- [11]**

Q5.

- (a) weight (lifted)
- or**
- height (lifted) 1
- (b) any **two** from:
- calculate a mean

- spot anomalies
 - reduce the effect of random errors
- 2
- (c) as speed increases, the efficiency increases
- 1
- (but) graph tends towards a constant value
- or**
- appears to reach a limit
- accept efficiency cannot be greater than 100%*
- 1
- (d) heating the surroundings
- 1
- (e) 0 (%)
- 1
- [7]**

Q6.

- (a) geothermal
- 1
- nuclear
- 1
- biofuel
- 1
- (b) gravitational (potential)
- 1
- kinetic
- 1
- sound
- 1
- (c) (i) 90% or 0.9(0)
- an answer of 0.9(0) with a unit gains 1 mark*
- 2
- (ii) 60 (MW)
- allow 10%*
- 1
- (iii) increased
- 1
- [10]**

Q7.

- (a) any **two** from:
- cost per kWh is lower (than all other energy resources)

allow it is cheaper
ignore fuel cost
ignore energy released per kg of nuclear fuel

- infrastructure for nuclear power already exists
accept cost of setting up renewable energy resources is high
accept many renewable power stations would be needed to replace one nuclear power station
accept (France in 2011 already had a) surplus of nuclear energy, so less need to develop more renewable capacity for increased demand in the future
accept France benefits economically from selling electricity
- more reliable (than renewable energy resources)
accept (nuclear) fuel is readily available
ignore destruction of habitats for renewables

2

(b) any **two** from:

- non-renewable
allow nuclear fuel is running out
- high decommissioning costs
accept high commissioning costs
- produces radioactive / nuclear waste
allow waste has a long half-life
- long start-up time
- nuclear accidents have widespread implications
allow for nuclear accident a named nuclear accident
eg Fukushima, Chernobyl
ignore visual pollution

2

(c) 0.48 (kW)

allow 1 mark for correct substitution
ie $0.15 = P / 3.2$
an answer of 480 W gains 2 marks
an answer of 48 or 480 scores 1 mark

2

(d) the higher the efficiency, the higher the cost (per m² to manufacture)

accept a specific numerical example

1

more electricity could be generated for the same (manufacturing) cost using lower efficiency solar panels

or

(reducing the cost) allows more solar panels to be bought

accept a specific numerical example

1

Q8.

- (a) field
correct order only 1
- current 1
- force
accept motion
accept thrust 1
- (b) (i) arrow pointing vertically downwards 1
- (ii) increase current / p.d.
accept voltage for p.d. 1
- increase strength of magnetic field
accept move poles closer together 1
- (iii) reverse (poles of) magnets 1
- reverse battery / current 1
- (c) (i) 1.5 or 150%
efficiency = $120 / 80 (\times 100)$
gains 1 mark
an answer of 1.5 % or 150
gains 1 mark 2
- (ii) efficiency greater than 100%
or
output is greater than input
or
output should be 40 (W) 1
- (iii) recorded time much shorter than actual time
accept timer started too late
accept timer stopped too soon 1

[12]

Q9.

- (a) chemical

	<i>correct order only</i>	1
	kinetic	1
	sound	1
(b)	48% or 0.48	
	<i>an answer of 0.48 with a unit gains 1 mark</i>	
	<i>an answer of 0.48% gains 1 mark</i>	
	<i>an answer of 48 with or without a unit gains 1 mark</i>	2
		[5]

Q10.

(a)	(i)	150	1
	(ii)	transferred to the surroundings by heating <i>reference to sound negates mark</i>	1
	(iii)	0.75 <i>450 / 600 gains 1 mark</i> <i>accept 75% for 2 marks</i> <i>maximum of 1 mark awarded if a unit is given</i>	2
	(iv)	20 (s) <i>correct answer with or without working gains 2 marks</i> <i>correct substitution of 600 / 30 gains 1 mark</i>	2
(b)	(i)	to avoid bias	1
	(ii)	use less power and last longer	1
		1 LED costs £16, 40 filament bulbs cost £80	
		or	
		filament costs (5 times) more in energy consumption	1
	(iii)	any one from:	
		• availability of bulbs • colour output • temperature of bulb surface	1
			[10]

Q11.

- (a) (i) temperature (increase) and time switched on are directly proportional
accept the idea of equal increases in time giving equal increases in temperature
answers such as:

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

score 1 mark

2

- (ii) any **one** from:

"it" refers to the metal block

- energy transfer (from the block) to the surroundings
accept lost for transfer
accept air for surroundings
- (some) energy used to warm the heater / thermometer (itself)
accept takes time for heater to warm up
- (metal) block is not insulated

1

- (iii) 15 000

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

2

- (b) lead

reason only scores if lead is chosen

1

needs least energy to raise temperature by 1°C

accept needs less energy to heat it (by the same amount)
lowest specific heat capacity is insufficient

1

[7]

Q12.

- (a) electrical

1

chemical

1

light

1

- (b) 25% **or** 0.25

allow 1 mark for correct substitution, ie $50 \div 200$ provided no subsequent step shown
or

answers of 25 with a unit **or** 0.25 with a unit gain **1** mark
 answers of 25 without a unit **or** 0.25% gain **1** mark

2

- (c) the information board can be used anywhere it is needed

1

[6]

Q13.

- (a) (i) replaced faster than it is used
accept replaced as quick as it is used
accept it will never run out
*do **not** accept can be used again*

1

- (ii) any **two** from:
***two** sources required for the mark*

- wind
- waves
- tides
- fall of water
*do **not** accept water / oceans*
accept hydroelectric
- biofuel
accept a named biofuel eg wood
- geothermal

1

- (b) (i) any **two** from:
- increases from 20° to 30°
 - reaches maximum value at 30°
 - then decreases from 30°
 - same pattern for each month
*accept peaks at 30° for **both** marks*
*accept goes up then down for **1** mark*
ignore it's always the lowest at 50°

2

- (ii) 648
*an answer of 129.6 gains **2** marks*
*allow **1** mark for using 720 value only from table*
*allow **2** marks for answers 639, 612, 576, 618(.75)*
*allow **1** mark for answers 127.8, 122.4, 115.2, 123.75*

3

- (c) (i) (sometimes) electricity demand may be greater than supply (of electricity from the system)

accept cloudy weather, night time affects supply

or

can sell (excess) electricity (to the National Grid)

1

(ii) decreases the current

accept increases the voltage

1

reducing energy loss (along cables)

accept less heat / thermal energy lost / produced

1

[10]

Q14.

(a) (i)
$$\text{efficiency} = \frac{\text{useful energy out} (\times 100\%)}{\text{total energy in}}$$

1.6 (W)

$$\frac{0.2}{100} = \frac{20}{\text{output}}$$

allow 1 mark for correct substitution ie

2

(ii)
$$\text{efficiency} = \frac{\text{useful energy out} (\times 100\%)}{\text{total energy in}}$$

32 (%) / 0.32

or

their (a)(i) ÷ 5 correctly calculated

ignore any units

1

(b) (i) any **two** from:

- comparison over same period of time of relative numbers of bulbs required eg over 50 000 hours 5 CFL's required to 1 LED

accept an LED lasts 5 times longer

- link number of bulbs to cost eg 5 CFL's cheaper than 1 LED
an answer in terms of over a period of 50 000 hours CFLs cost £15.50 (to buy), LED costs £29.85 (to buy) so CFLs are cheaper scores both marks

an answer in terms of the cost per hour (of lifetime) being cheaper for CFL scores 1 mark if then correctly calculated scores both marks

- over the same period of time LEDs cost less to operate (than CFLs)

2

(ii) any **one** from:

- price of LED bulbs will drop
*do **not** accept they become cheaper*
- less electricity needs to be generated
accept we will use less electricity
- less CO₂ produced
- fewer chips needed (for each LED bulb)
- fewer bulbs required (for same brightness / light)
- less energy wasted
*do **not** accept electricity for energy*

1

[6]

Q15.

(a) any **two** from:

- black is a good emitter of (infrared radiation)
accept heat for radiation
ignore reference to absorbing radiation
- large surface (area)
- matt surfaces are better emitters (than shiny surfaces)
accept matt surfaces are good emitters
ignore reference to good conductor

2

(b) 90% or 0.9(0)

$$\text{efficiency} = \frac{\text{useful energy out} (\times 100\%)}{\text{total energy in}}$$

allow 1 mark for correct substitution, ie $\frac{13.5}{15}$
provided no subsequent step shown
an answer of 90 scores 1 mark
an answer of 90 / 0.90 with a unit scores 1 mark

2

(c) (producing) light

allow (producing) sound

1

(d) any **two** from:

- wood is renewable
accept wood grows again / quickly
accept wood can be replanted
- (using wood) conserves fossil fuels

accept doesn't use fossil fuels

- wood is carbon neutral
accept a description
cheaper / saves money is insufficient

2

(e) $E = m \times c \times \theta$

2 550 000

allow 1 mark for correct substitution
ie $100 \times 510 \times 50$
provided no subsequent step shown
answers of 1 020 000, 3 570 000 gain 1 mark

2

joules /J

accept kJ / MJ
*do **not** accept j*
for full credit the unit and numerical answer must be consistent

1

[10]

Q16.

- (a) heat / thermal
or / and
sound

*do **not** accept noise*
other forms of energy eg light negates answer

1

- (b) 0.4
or
40 %

allow 1 mark for $\frac{2000}{5000}$
or
equivalent fraction
an answer 0.4 % gains 1 mark
answers 0.4 or 40 given with any unit gains 1 mark
40 without % gains 1 mark

2

[3]

Q17.

- (a) (i) 4

allow 1 mark for correct transformation and substitution

$\frac{0.6}{0.15}$
ie

substitution only scores if no subsequent steps are shown

2

- (ii) diagram showing two output arrows with one arrow wider than the other with the narrower arrow labelled electrical / electricity / useful

1

(b) any **one** from:

- to check reliability / validity / accuracy
- to avoid bias

1

(c) any **two** from:

- produce no / less (air) pollution
accept named pollutant
accept produces no waste (gases)
- energy is free
accept it is a free resource
*do **not** accept it is free*
- (energy) is renewable
- conserves fossil fuel stocks
- can be used in remote areas
- do not need to connect to the National Grid

2

[6]

Q18.

(a) (i) 0.75

allow 1 mark for correct transformation and substitution
ie $0.15 = 5$

2

(ii) 2

accept $1.5 \div$ their (a)(i) correctly calculated

1

(b) any **one** from:

- seasonal changes
accept specific changes in conditions
eg shorter hours of daylight in winter
- cloud cover
accept idea of change
must be stated or unambiguously implied

eg demand for water will not (always) match supply of solar energy

*do **not** accept figures are average on its own*

*do **not** accept solar panels are in the shade*

1

[4]

Q19.

- (a) (i) 0.2 **or** 1/5

accept 20% for both marks

*allow **1** mark for correct substitution answer of 0.2%*

***or** 20 gains **1** mark*

ignore units

2

- (ii) wasted

accept transformed to heat / other forms

accept transferred to the air / surroundings sound = neutral

1

- (b) (i) any **one** from:

- can fly at night
accept can fly when it is cloudy
accept as a back-up
- can stay in the air for longer
- can fly in the winter
- can fly faster
increases power is neutral

1

- (ii) any **one** from:

- produces no (pollutant) gases

or no greenhouse gases

accept named gas

accept no air pollution

*do **not** accept no pollution*

accept less global warming

accept harmful for pollutant

accept produces no carbon

*do **not** accept environmentally friendly*

- produces no / less noise
- less demand for fuels
accept any other sensible environmental advantage

1

- (iii) accept any sensible suggestion eg, map the Earth's surface / weather forecasting / spying / monitoring changes to the Earth's atmosphere, etc
do **not** accept ideas in terms of transporting
accept use as a satellite

1

[6]

Q20.

- (a) generator

accept dynamo
accept alternator

1

- (b) (i) 1400

ignore units

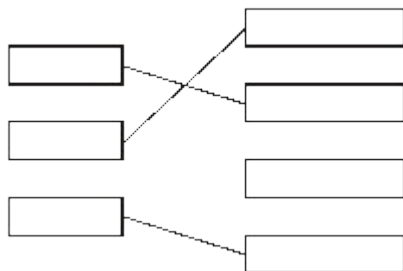
1

- (ii) 0.3 or 30%

any incorrect unit penalise **1** mark
allow **1** mark for the correct use of 600
or 0.3% or 30

2

- (c) **1** mark for each correct link



if more than 3 lines are drawn, mark only
3 lines starting with those that are incorrect

3

- (d) (i) 110

no tolerance

1

- (ii) 12

no tolerance

1

- (iii) wind speed may be too low to operate the generator
accept wind may not always blow
accept power depends on wind speed
accept does not generate if wind speed is too high
accept does not generate if wind speed is above 12 (m/s)
accept does not generate if wind speed is below 1.6 (m/s)
accept it is unreliable
do **not** accept answers referring to cost only

1

