AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.1.1.3 ENERGY CHANGES IN SYSTEMS (PACK 1)

SCORE	PERCENTAGE
/167	%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

There are many different energy resources.

(a) Which **two** energy resources are renewable?

Tick **two** boxes.

- Biofuel ☐
- Coal ☐
- Gas ☐
- Geothermal ☐
- Nuclear fuel ☐

(2)

(b) Some non-renewable energy resources are more reliable than others.

Which statement correctly describes a reliable resource?

Tick **one** box.

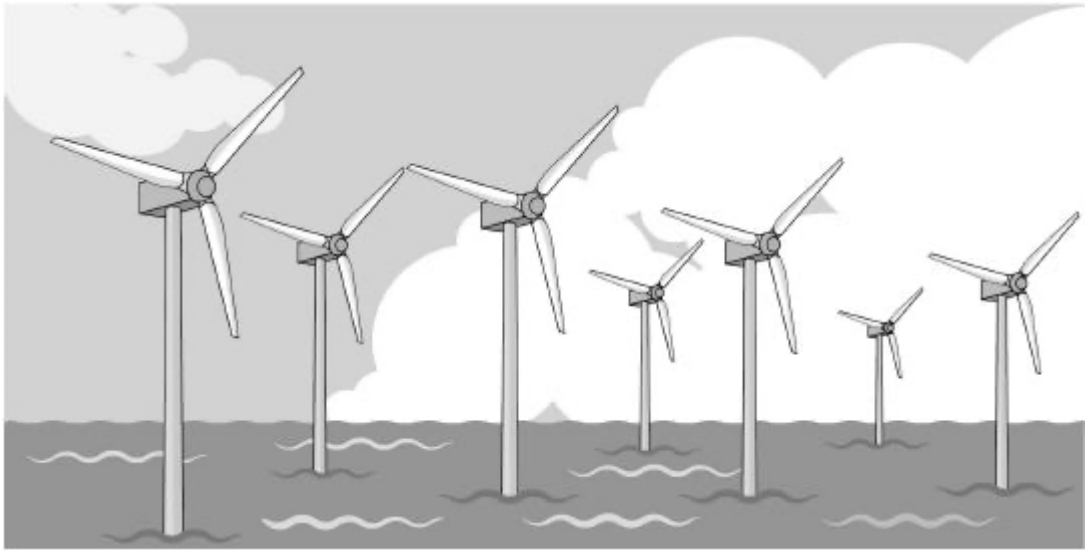
- It does not burn fuel. ☐
- It is predictable. ☐
- It will never run out. ☐
- It is cheap to use. ☐

(1)

(c) **Figure 1** shows a wind farm.

Figure 1

STEMUP.CO.UK



The total power output of the wind farm is 19.6 MW

All of the wind turbines have the same power output.

What is the power output of **one** wind turbine?

Tick **one** box.

2.7 MW ☐

2.8 MW ☐

2.9 MW ☐

3.2 MW ☐

3.3 MW ☐

(1)

(d) Give **two** reasons why people might **not** like having wind turbines near their homes.

1. _____

2. _____

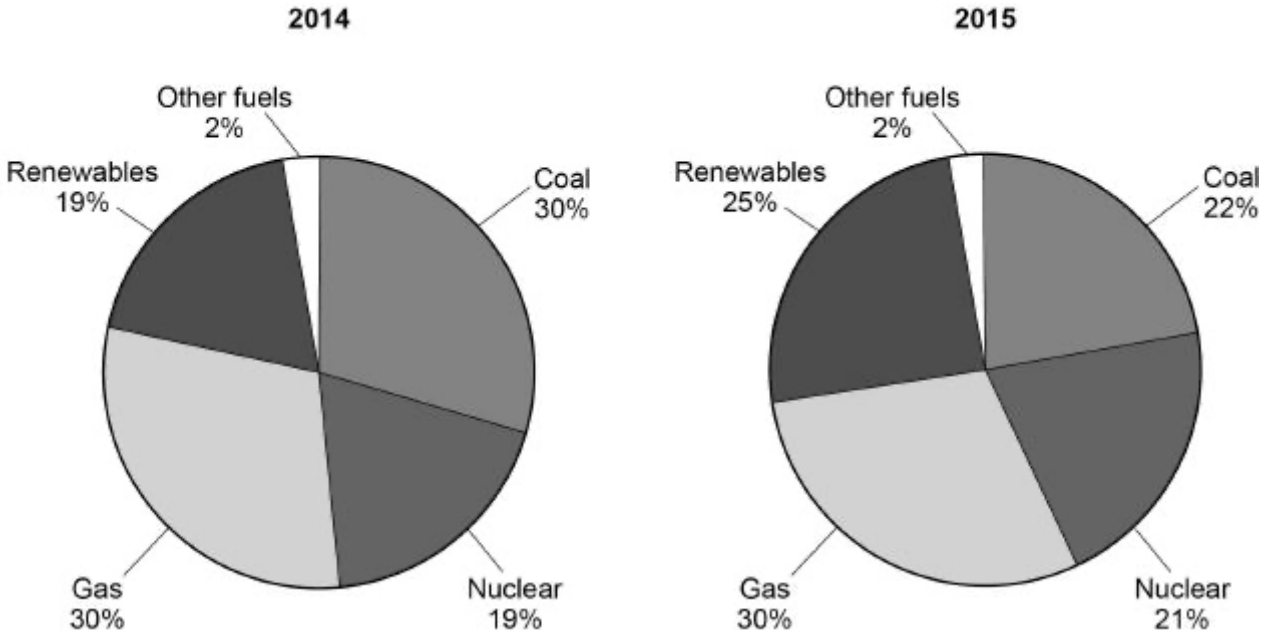
(2)

(e) **Figure 2** shows the electricity generated by different energy resources in the UK.

The total amount of electricity generated was the same in 2014 and in 2015

Figure 2

STEMUP.CO.UK



There are changes in the amounts of different energy resources used between 2014 and 2015

Explain the environmental impacts of the changes.

(4)

(Total 10 marks)

Q2.

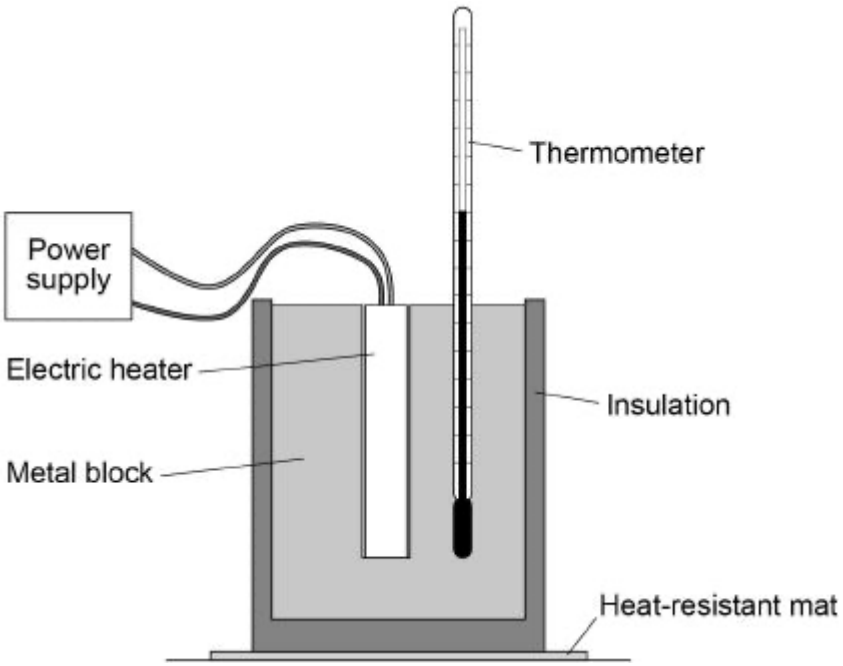
A student investigated how the temperature of a metal block changed with time.

An electric heater was used to increase the temperature of the block.

The heater was placed in a hole drilled in the block as shown in **Figure 1**.

Figure 1

STEMUP.CO.UK



The student measured the temperature of the metal block every 60 seconds.
The table below shows the student's results.

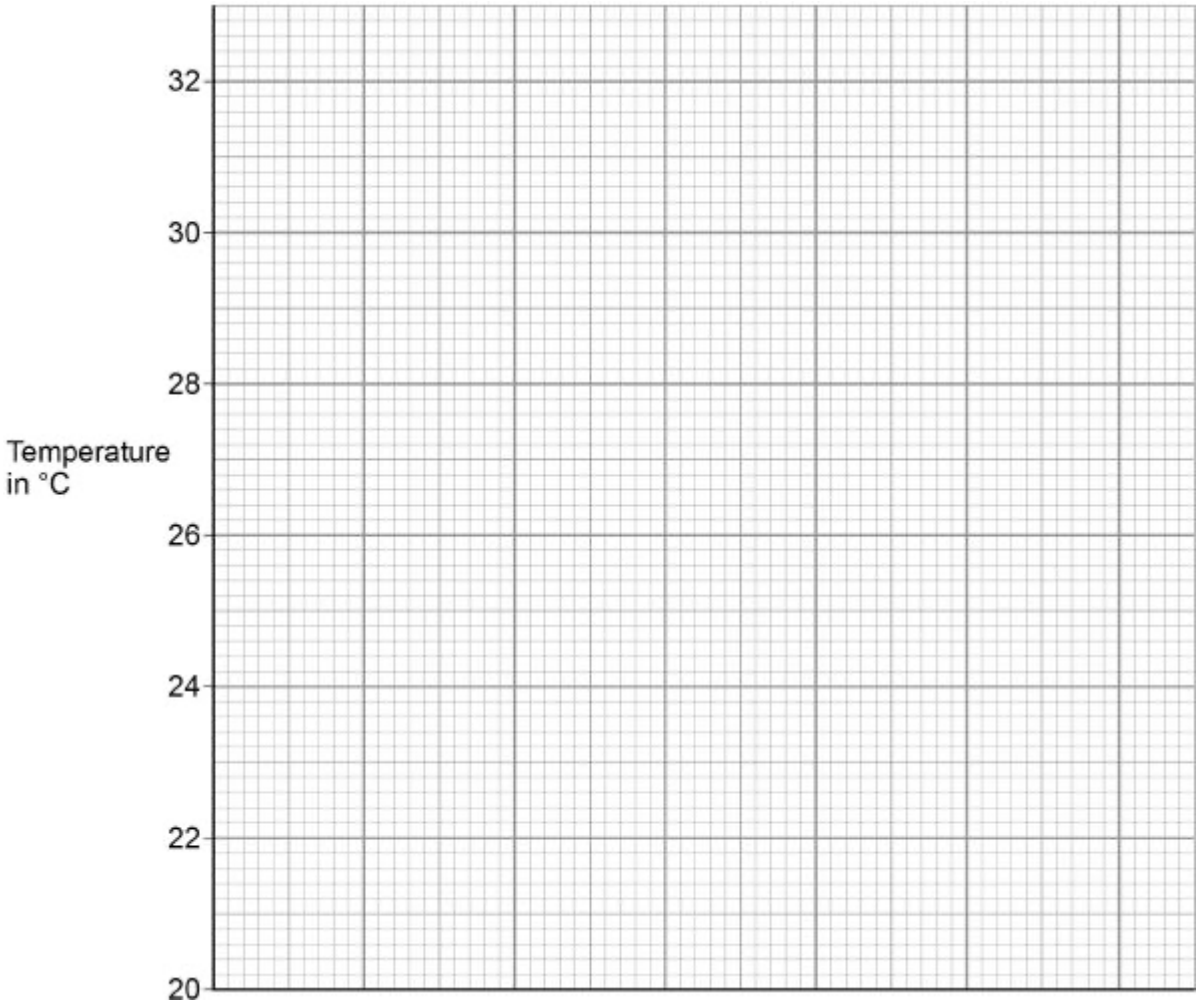
Time in s	Temperature in °C
0	20.0
60	24.5
120	29.0
180	31.0
240	31.5

(a) Complete the graph of the data from the table above on the graph below.

- Choose a suitable scale for the x-axis.
- Label the x-axis.
- Plot the student's results.
- Draw a line of best fit.

Figure 2

STEMUP.CO.UK



(4)

(b) The rate of change of temperature of the block is given by the gradient of the graph.

Determine the gradient of the graph over the first 60 seconds.

_____

_____

_____

_____

Gradient = _____

(2)

(c) The metal block had a mass of 1.50 kg

The specific heat capacity of the metal was 900 J/kg °C

Calculate the change in thermal energy of the metal during 240 seconds.

Use the Physics Equations Sheet.

Give your answer in kilojoules.

STEMUP.CO.UK

Change in thermal energy = _____ kJ

(4)

(d) Another student repeated the investigation.

Give **two** variables this student would need to control to be able to compare their results with the results in the table above.

1. _____

2. _____

(2)

(Total 12 marks)

Q3.

Astronauts have landed on the Moon on six separate occasions.

(a) The Moon is in a circular orbit around the Earth. The speed of the Moon is constant.

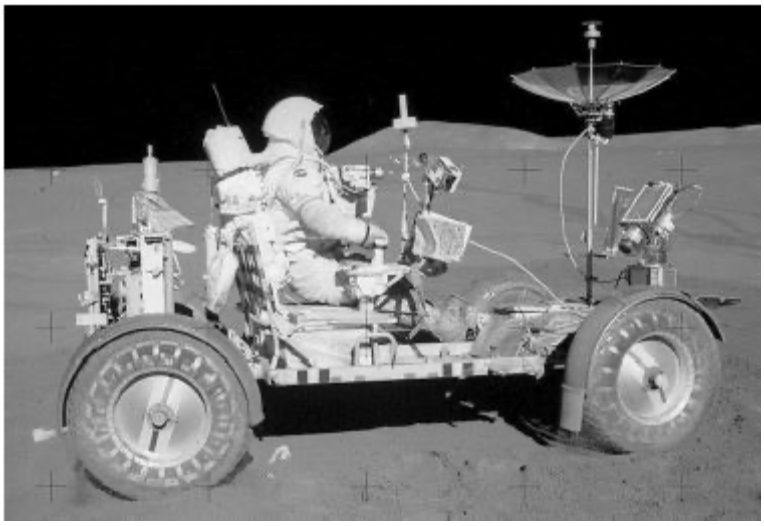
Explain why the Moon is accelerating.

(3)

The astronauts moved around the surface of the Moon in a lunar rover.

The photograph below shows a lunar rover.

STEMUP.CO.UK



(b) At one point, the lunar rover accelerated from 1.4 m/s to 2.6 m/s

The acceleration of the lunar rover was 0.31 m/s^2

Which calculation could be used to calculate the distance travelled s during this acceleration?

Tick **one** box.

$s = \sqrt{2.6^2 - 1.4^2 - 2 \times 0.31}$ ☐

$s = \frac{1.4^2 - 2.6^2}{2 \times 0.31}$ ☐

$s = \frac{2.6^2 - 1.4^2}{2 \times 0.31}$ ☐

$s = \frac{2 \times (2.6^2 - 1.4^2)}{0.31}$ ☐

(1)

(c) The lunar rover used four electric motors connected in parallel to a 36 V battery.

The maximum output power of one motor was 190 W

The efficiency of each motor was 72%

Calculate the current drawn from the battery when all four motors were operating at maximum power.

_____

_____

_____

_____

STEMUP.CO.UK

Current = _____ A

(6)

(d) Scientists once thought that the Moon formed elsewhere in the solar system and later came to orbit the Earth.

Studies of Moon rocks brought back by the astronauts showed that the rocks were extremely similar to those found on Earth.

This led to a new theory about how the Moon formed called the 'Giant Impact Hypothesis'.

According to the Giant Impact Hypothesis, a small planet collided with the Earth. Molten rock thrown up by the collision then formed the Moon.

Suggest why a new theory was developed.

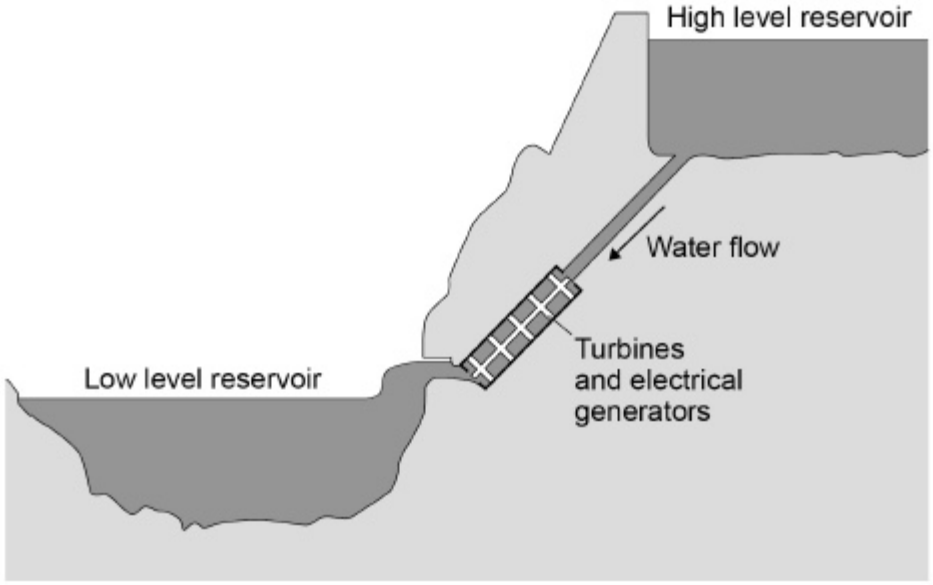
(2)

(Total 12 marks)

Q4.

The diagram shows the flow of water through a hydroelectric power station.

STEMUP.CO.UK



The falling water turns the turbines.

The movement of the turbines causes the electrical generators to generate electricity.

(a) Write the equation which links kinetic energy, mass and speed.

_____

(1)

(b) In 1 minute, a mass of 9 000 kg of water flows through the turbines.

The speed of the water is 30 m/s

Calculate the total kinetic energy of the water passing through the turbines in 1 minute.

Give your answer in kilojoules (kJ).

_____

_____

_____

_____

Kinetic energy = _____ kJ

(3)

(c) Write the equation which links efficiency, total input energy transfer and useful output energy transfer.

_____

_____

(1)

(d) The efficiency of the turbines and generators is 80%

STEMUP.CO.UK

Calculate the useful output energy transfer from the hydroelectric power station in 1 minute.

Use your answer to part (b).

Useful output energy transfer = _____ kJ

(3)

(e) A small group of people live in an area in the mountains.

The people plan to buy an electricity generating system that uses either the wind or the flowing water in a nearby river.

- The wind turbine costs £50 000 to buy and install.
- The hydroelectric generator costs £20 000 to buy and install.
- The average power output from the wind turbine is 10 kW
- The hydroelectric generator will produce a constant power output of 8 kW

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

Use your knowledge of energy resources and information given.

(4)

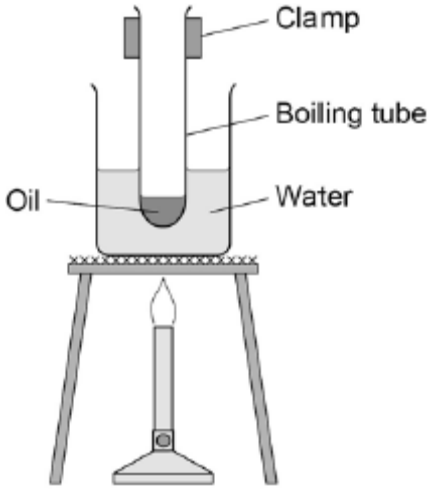
(Total 12 marks)

STEMUP.CO.UK

Q5.

A student investigated the change in temperature when oils of different specific heat capacities were heated.

She set up the apparatus shown in the figure below.



This is the method used.

1. Put 25 g of oil into a boiling tube.
2. Pour 100 ml of water into a beaker and heat it with a Bunsen burner.
3. When the water is boiling, put the boiling tube into the beaker.
4. When the temperature of the oil reaches 30 °C, heat for a further 30 seconds and record the rise in temperature.
5. Repeat with different oils.
6. Repeat the whole investigation.

(a) Name **two** pieces of apparatus the student used that are **not** shown in the figure above.

1. _____

2. _____

(2)

(b) What are the independent and dependent variables in the student's investigation?

Independent _____

_____

Dependent _____

_____

(2)

(c) Give **two** safety precautions the student should have taken.

1. _____

_____

2. _____

STEMUP.CO.UK

_____

(2)

(d) Suggest **one** improvement to the student's method.

_____

_____

_____

_____

(2)

(e) The table below shows the student's results.

	Temperature rise in °C			
Type of oil	**1**	**2**	**3**	**Mean**
Castor oil	20	19	21	20
Linseed oil	19	18	19	19
Mineral oil	21	21	21	21
Olive oil	17	17	18	
Sesame oil	23	23	20	22

Calculate the mean temperature rise for olive oil.

Give your answer to two significant figures.

_____

_____

_____

_____

Mean temperature rise = _____ °C

(2)

(f) The mean change in temperature of the castor oil is 20 °C

The specific heat capacity of castor oil is 1 800 J / kg °C

The mass of oil used is 0.025 kg

Calculate the change in thermal energy of the castor oil the student used.

Use the correct equation from the Physics Equations Sheet.

Select the correct unit from the box.

STEMUP.CO.UK

joule	newton	volt

_____

_____

_____

_____

_____

Change in thermal energy = _____

Unit = _____

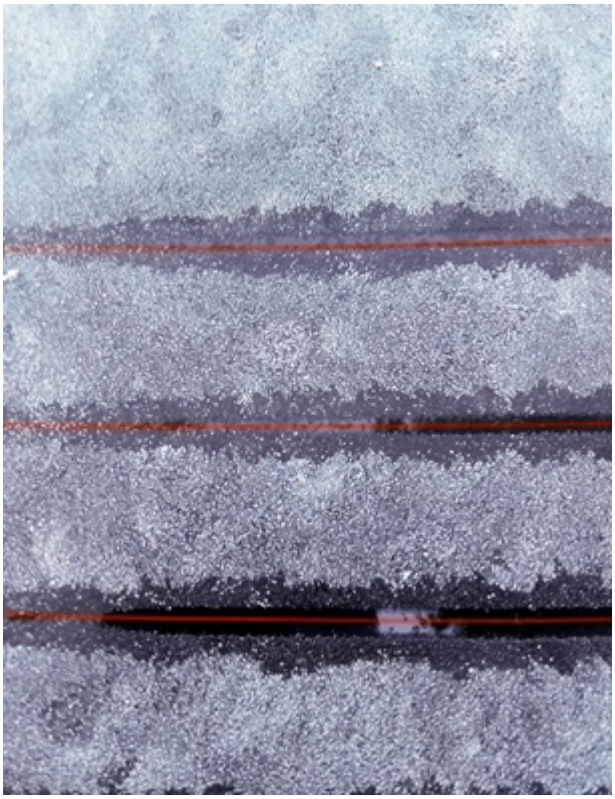
(3)

(Total 13 marks)

Q6.

Figure 1 shows solid ice on a car's rear window.

Figure 1



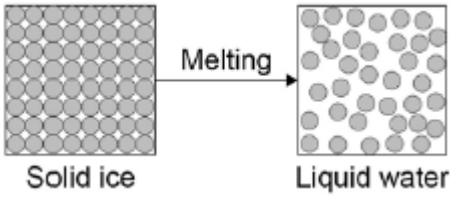
© Captive cookies/iStock/Thinkstock

The glass window contains an electrical heating element.

(a) Use the particle model in **Figure 2** to describe how the heating element causes the arrangement of the ice particles to change as the ice melts.

Figure 2

STEMUP.CO.UK



You should include a description of how the particles are arranged in the solid ice and in the water.

(6)

(b) A car manufacturer tests different heating elements by measuring how long it takes ice to melt.

During the test some variables must be controlled.

Identify **two** control variables in the car manufacturer's test.

Tick **two** boxes.

- The colour of the car ☐
- The current in the heating element ☐
- The mass of ice ☐
- The size of the car ☐
- The time taken for the ice to melt ☐

(2)

(c) Some of the energy supplied by the heater causes the ice to melt without the temperature of the ice increasing.

STEMUP.CO.UK

What is the name given to this energy supplied by the heater?

Tick **one** box.

Latent heat of freezing ☐

Latent heat of fusion ☐

Latent heat of vaporisation ☐

(1)

(d) When the heater is supplied with 120 J of energy each second, the internal energy of the ice increases by 45 J each second.

Use the following equation to calculate the efficiency of the heater.

$$\text{Efficiency} = \frac{\text{Output energy transfer}}{\text{input energy transfer}}$$

Give your answer to two decimal places.

_____

_____

_____

Efficiency = _____

(2)

(Total 11 marks)

Q7.

Figure 1 shows a battery operated remote control car.

Figure 1

STEMUP.CO.UK



© Brandon Bolin/iStock/Thinkstock

(a) The car's battery contains a store of energy.

As the car moves, energy from one store is transferred to another store.

Describe how different stores of energy change as the car moves.

_____

_____

_____

_____

(2)

(b) The car has a top speed of 12 m / s and a mass of 800 g.

Write down the equation that links kinetic energy, mass and speed.

Equation _____

(1)

(c) Calculate the maximum kinetic energy of the car.

_____

_____

_____

Maximum kinetic energy = _____ J

(2)

(d) Explain why having a more efficient motor increases the top speed of the car.

_____

_____

STEMUP.CO.UK

(2)

(e) **Figure 2** shows an electric car being charged.

Figure 2



By Alan Trotter Electric Car Charging [CC-BY-2.0]via Flickr

A driver wishes to buy a new car.

The table below gives some data about an electric car and one with a petrol engine.

	Electric car	**Petrol engine car**
Cost (£)	27 000	15 000
Running cost per year (£)	250	2 000
Average lifetime (years)	12	12

Which car would be the most economic over its 12 year lifetime?

Use data from the table above to support your answer.

You should include the difference in cost in your answer.

STEMUP.CO.UK

(4)

(Total 11 marks)

Q8.

Figure 1 shows a kettle a student used to determine the specific heat capacity of water.

Figure 1



© vladimirkim3722/iStock/Thinkstock

The student placed different masses of water into the kettle and timed how long it took for the water to reach boiling point.

The student carried out the experiment three times.

The student's results are shown in the table below.

	Time for water to boil in seconds					
Mass of water in kg	**1**	**2**	**3**	**Mean**	**Mass × change in temperature in kg°C**	**Energy supplied in kJ**
0.25	55	60	63	59	20	131
0.50	105	110	116	110	40	243
0.75	140	148	141	143	60	314
1.00	184	190	183	182	80	401
1.25	216	215	211	214	100	471
1.50	272	263	266	267	120	587

STEMUP.CO.UK

1.75	298	300	302		140	

(a) Suggest how the student was able to ensure that the change in temperature was the same for each mass of water.

_____

_____

_____

_____

(2)

(b) Calculate the uncertainty in the student's measurements of time to boil when the mass of water was 1.75 kg.

_____

_____

Uncertainty = _____ s

(2)

(c) The power rating of the kettle is 2.20 kW.

Calculate the average electrical energy used by the kettle, in kJ, for 1.75 kg of water to reach boiling point.

_____

_____

_____

Average energy = _____ kJ

(2)

(d) Use information from the table above to calculate the change in temperature of the water during the investigation.

_____

_____

Change in temperature = _____ °C

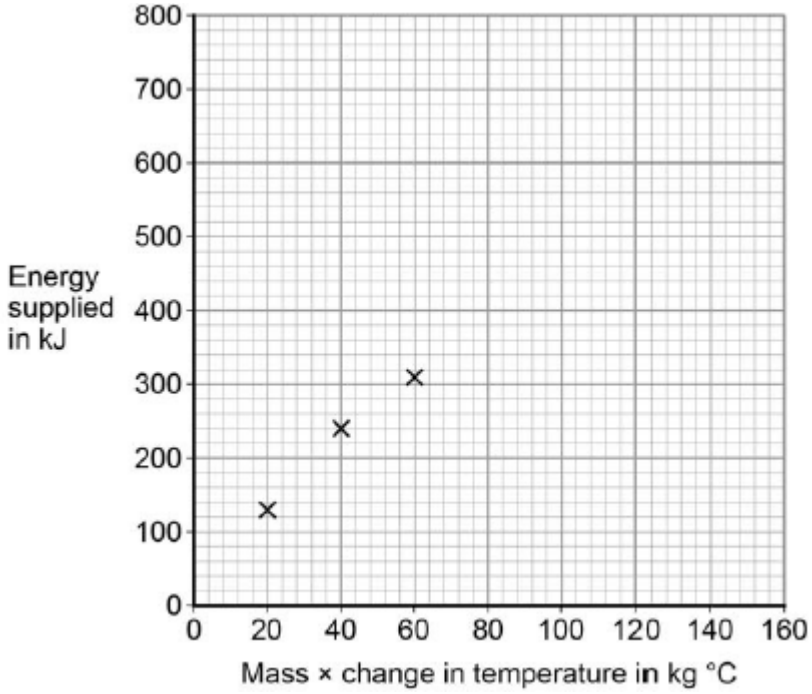
(2)

(e) The student plotted a graph of energy supplied in kJ against mass × change in temperature in kg °C.

Figure 2 shows the graph the student plotted.

Figure 2

STEMUP.CO.UK



Use data from the table above to plot the four missing points.

Draw a line of best fit on the graph.

(3)

(f) Use the graph to determine the mean value of the specific heat capacity of water, for the student's investigation.

_____

_____

_____

_____

_____

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

(4)

(g) The student's value for the specific heat capacity of water was greater than the accepted value.

Suggest why.

_____

_____

(1)

(h) The kettle used in the experiment had a label stating that the power rating of the kettle was 2.2 kW.

The student did not measure the power of the kettle.

STEMUP.CO.UK

Suggest why measuring the power of the kettle may improve the student's investigation.

_____

_____

(1)

(Total 17 marks)

Q9.

A student investigated the specific heat capacity of metals.

(a) Describe an experiment the student could do to measure the specific heat capacity of a metal.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(b) The student calculated the specific heat capacity of four metals.

The table below shows the student's results.

Metal	Mass of material in kg	Time in minutes	Temperature in °C	Change in thermal energy in J	Calculated specific heat capacity of material in J / kg °C
Aluminium	1	10	2	4 780	2 390
Brass	1	10	4	4 660	1 165
Copper	1	10		4 600	657
Steel	1	10	5	4 690	938

Use data from the table above to calculate the temperature change for copper.

STEMUP.CO.UK

Use the correct equation from the Physics Equation Sheet.

Temperature change = _____ °C

(3)

(c) What is the independent variable in the student's investigation?

Tick **one** box.

- Mass of material ☐
- Power used ☐
- Time in minutes ☐
- Type of material ☐

(1)

(d) The student calculated the specific heat capacity of aluminium to be 2390 J / kg °C.

The 'true' specific heat capacity of aluminium is 900 J / kg °C.

Suggest why the student's result for aluminium is different from the 'true' value.

(2)

(e) The teacher suggested that putting bubble wrap round the metal block would change the results.

How would using bubble wrap change the results?

Give a reason for your answer.

STEMUP.CO.UK

_____

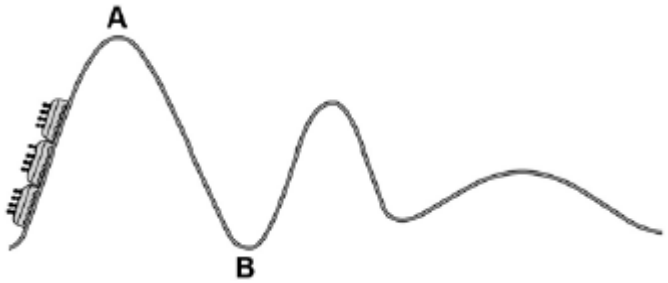
_____

(2)

(Total 14 marks)

Q10.

The figure below shows a rollercoaster.



The rollercoaster car is raised a vertical distance of 35 m to point **A** by a motor in 45 seconds.

The mass of the rollercoaster is 600 kg.

The motor has a power rating of 8 000 W.

(a) Calculate the percentage efficiency of the motor.

Gravitational field strength = 9.8 N / kg.

_____

_____

_____

_____

_____

_____

_____

Efficiency = _____ %

(5)

(b) The rollercoaster rolls from point **A** to point **B**, a drop of 35 m.

Calculate the speed of the roller coaster at point **B**.

Assume that the decrease in potential energy store is equal to the increase in kinetic energy store.

_____

_____

STEMUP.CO.UK

_____

_____

_____

_____

_____

Speed at point **B** = _____ m / s

(6)

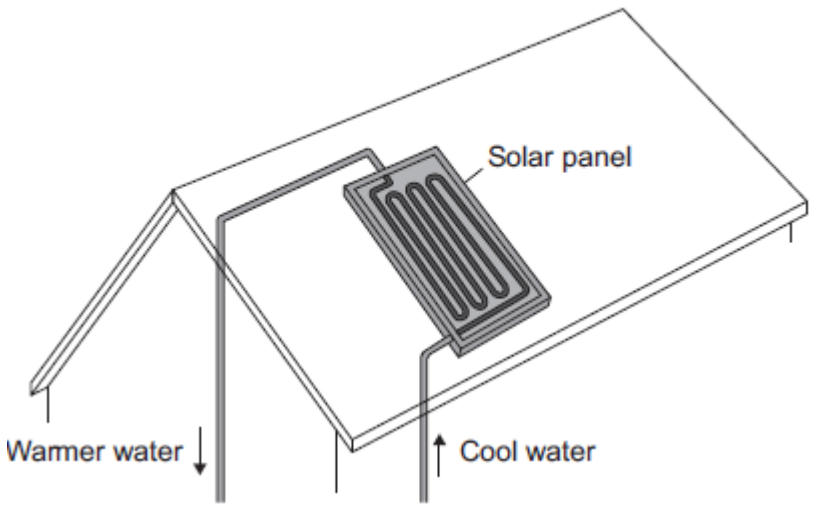
(Total 11 marks)

Q21.

Solar panels can heat water for use in a home.

Figure 1 shows a solar panel on the roof of a house.

Figure 1



(a) The solar panel is designed to transfer as much energy to the water as possible.

(i) Draw a ring around the correct answer to complete the sentence.

The solar panel is black to increase energy transferred to the water by

conduction. **infrared radiation.**

(1)

(ii) Draw a ring around the correct answer to complete the sentence.

Solar panels usually have a large surface area so that more energy can be

absorbed. **emitted.** **reflected.**

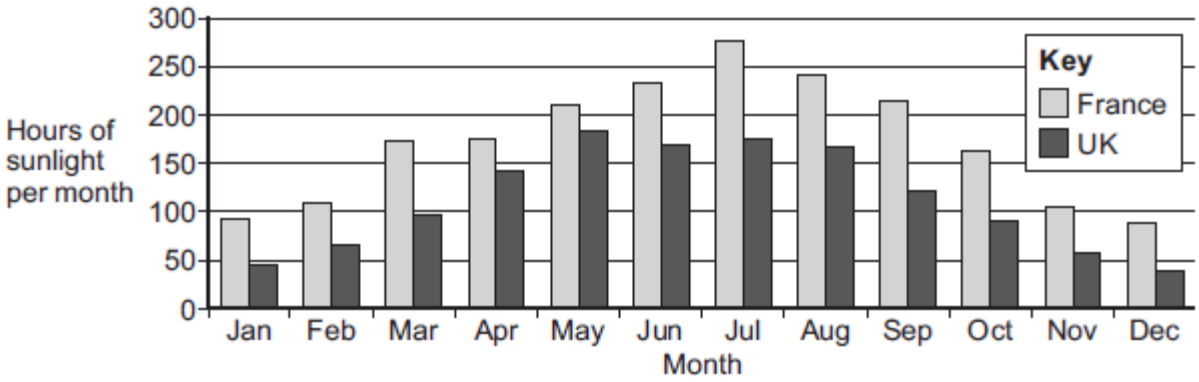
(1)

(b) **Figure 2** shows the hours of sunlight each month for one year in France and in the

STEMUP.CO.UK

UK.

Figure 2



Solar panels are used more in France than in the UK.

Use **Figure 2** to explain why.

_____

_____

_____

_____

(2)

(c) The solar panel heats 200 kg of water each day. On one day it increases the temperature of the water by 50 °C.

The specific heat capacity of water is 4200 J / kg °C.

Calculate the energy needed to increase the temperature of 200 kg of water by 50 °C.

Use the correct equation from the Physics Equations Sheet.

Tick (✓) the correct unit.

_____

_____

_____

_____

Energy = _____

	Tick (✓)
joules	
seconds	

STEMUP.CO.UK

watts	

(3)
(Total 7 marks)

Q22.

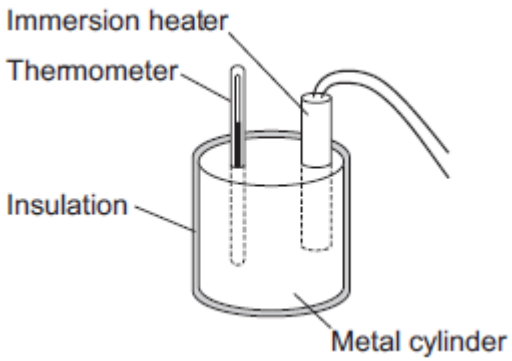
A student investigated the specific heat capacity of five different metal cylinders.

Each metal cylinder had a mass of 2 kg.

He used an immersion heater to transfer 18 000 J of energy to each different metal cylinder.

Figure 1 shows the apparatus he used.

Figure 1



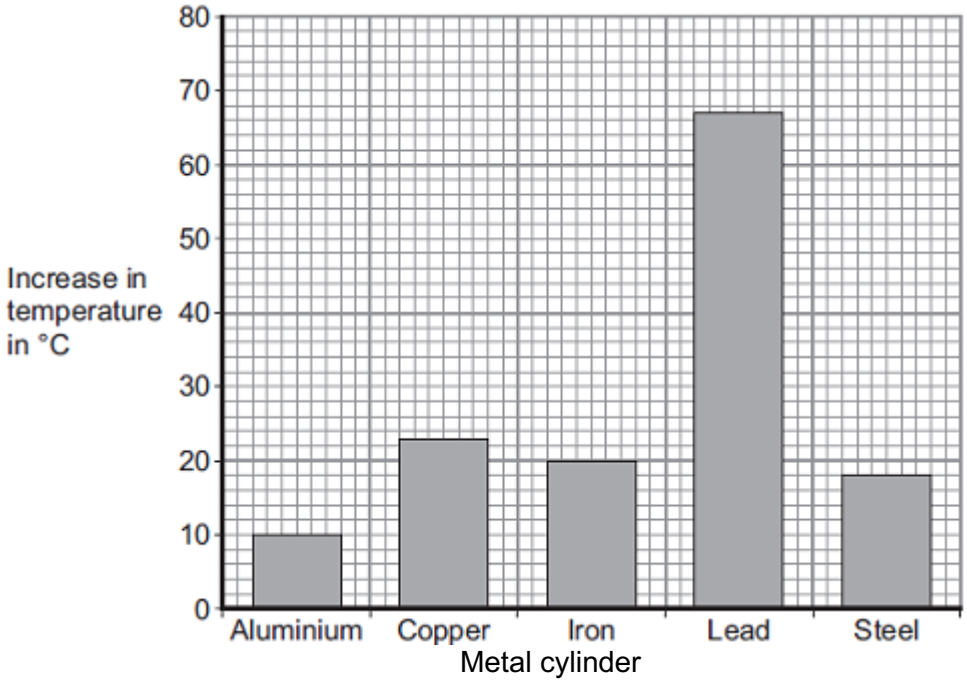
He measured the temperature of the metal cylinder at the start and at the end of each experiment, using a thermometer.

He calculated the temperature rise of each metal cylinder.

The results are shown in **Figure 2**.

Figure 2

STEMUP.CO.UK



(a) Suggest an appropriate resolution for the thermometer used in the investigation.

Resolution = _____ °C

Give a reason for your answer.

_____

_____

(2)

(b) The mass of metal and the energy transferred to each metal were control variables in the investigation.

Suggest another variable that should have been controlled.

_____

(1)

(c) Which metal has the highest specific heat capacity? _____

Give a reason for your answer.

_____

_____

_____

_____

(2)

(d) In this investigation, 18 000 J of energy was supplied to a 2 kg cylinder of steel.

Calculate the specific heat capacity of steel.

STEMUP.CO.UK

Use the correct equation from the Physics Equations Sheet.

Specific heat capacity = _____ J / kg °C

(3)

(Total 8 marks)

Q23.

During the day, the Sun transfers energy to an outdoor swimming pool.



© Volodymyr Burdiak/iStock

(a) By which method of energy transfer does the pool receive energy from the Sun?

(1)

(b) (i) The mass of water in the pool is 5000 kg. The specific heat capacity of water is 4200 J/kg°C.

Calculate how much energy needs to be supplied to increase the water temperature by 5°C and state the correct unit.

Use the correct equation from the Physics Equations Sheet.

Give the unit.

Energy = _____

(3)

STEMUP.CO.UK

(ii) The Sun supplies energy to the water in the pool at a rate of 16 kJ every second.

Calculate how much time it would take for energy from the Sun to raise the water temperature by 5 °C.

You will need to use your answer to **(b)(i)** and the correct equation from the Physics Equations Sheet.

_____

_____

_____

Time = _____ seconds

(3)

(iii) On one day, the temperature of the pool is 7 °C lower than the air temperature.

The time it takes for the pool temperature to rise by 5 °C is less than the answer to part **(b)(ii)**.

Suggest a reason why.

_____

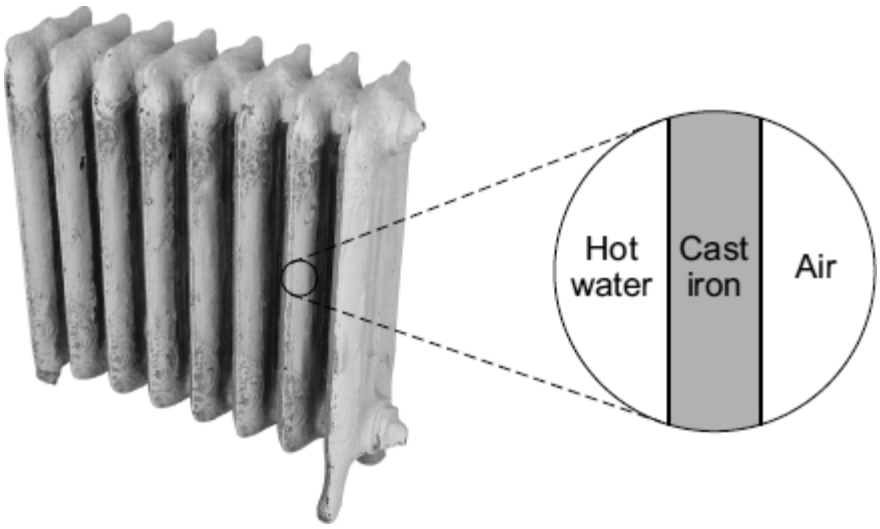
_____

(1)

(Total 8 marks)

Q24.

An old house has a cast iron radiator. The radiator has hot water inside it.



Photograph supplied by PhotoObjects.net/Thinkstock

(a) The table shows how the power output of the radiator varies with the temperature difference between the hot water and the air temperature of the room.

STEMUP.CO.UK

Temperature difference in °C	10	20	30	40	50	60
Power output in W	400	900	1480	2200	3050	4000

(i) Describe fully the relationship between temperature difference and power output.

_____

_____

(1)

(ii) The house owner wants to reduce their heating bills.

Use the data in the table to advise the house owner.

_____

_____

(1)

(b) The air in a room is at a temperature of 12 °C.

The house owner switches the heating on until the temperature reaches 22 °C. The amount of energy needed to raise the temperature of the air to 22 °C is 580 000 J.

The mass of air in the room is 58 kg.

Calculate the specific heat capacity of air and give the unit.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

_____

_____

_____

_____

_____

Specific heat capacity = _____

(3)

(Total 5 marks)

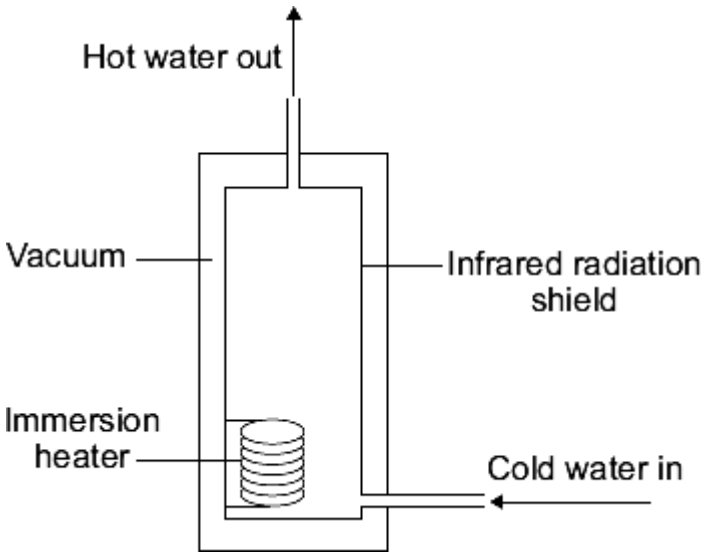
Q25.

Modern kitchens can be fitted with a device that immediately supplies water at a temperature of 93 °C.

A tank that stores very hot water is fitted under the sink so that hot water is always available.

STEMUP.CO.UK

The infrared radiation shield and the vacuum reduce the energy transfer to the surroundings.



(a) The infrared radiation shield is made of shiny metal.

Why does the shiny metal reduce energy transfer?

_____

_____

(1)

(b) When the hot water tank is filled with water, the immersion heater can heat the water from a temperature of 15 °C to 93 °C in 10 minutes.
The energy transferred to the water is 982 800 joules.
The specific heat capacity of water is 4200 J/kg°C.

Calculate the mass of water needed to fill the hot water tank.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

_____

_____

_____

_____

Mass = _____ kg

(3)

(c) When hot water is **not** needed the immersion heater has a power input of 10 W.
The energy is used to maintain the 93 °C temperature in the hot water tank.

How much energy, in joules, does the immersion heater transfer in 30 minutes when the power input is 10 W?

STEMUP.CO.UK

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

Energy = _____ J

(2)

(d) The manufacturer of the device made the following claim:
'When people use conventional electric kettles, they always boil more water than they actually need. This system makes sure you only heat the water you need.'

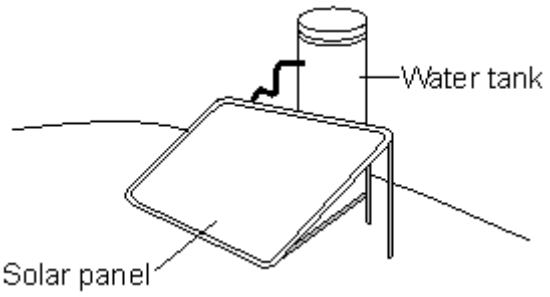
Suggest **one** other advantage of using the device compared to using a conventional electric kettle.

(1)

(Total 7 marks)

Q26.

The picture shows one type of solar water heater. Water from the tank is slowly pumped through copper pipes inside the solar panel where the water is heated by energy from the Sun.



(a) Each day the average European family uses 100 kg of hot water.
To kill bacteria, the water going into the tank at 20 °C must be heated to 60 °C.

Calculate the energy needed to increase the temperature of 100 kg of water by 40 °C.

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

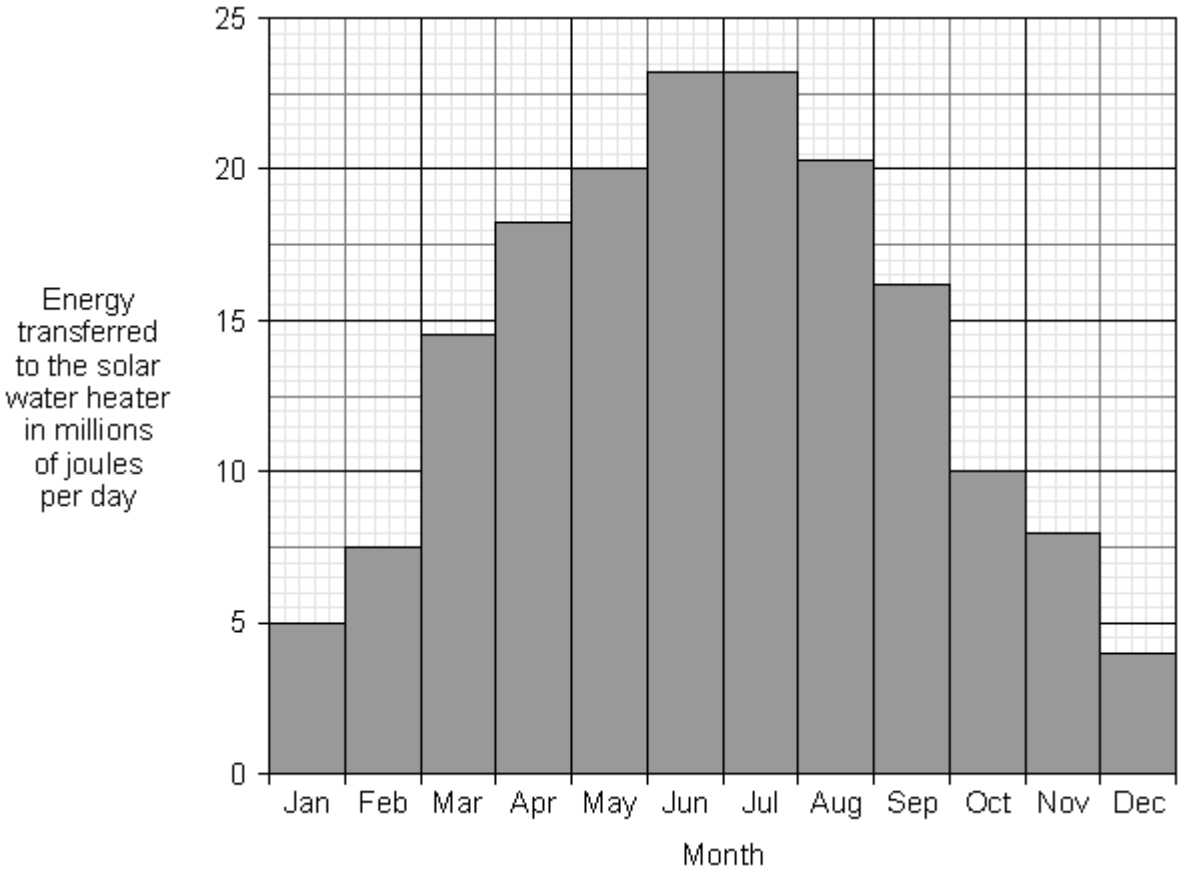
Write down the equation you use, and then show clearly how you work out your answer.

STEMUP.CO.UK

Energy transferred = _____ J

(2)

(b) The bar chart shows how the amount of solar energy transferred to the water heater varies throughout the year.



How many months each year will there **not** be enough solar energy to provide the hot water used by an average European family?

_____ months

(1)

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

The water in the tank could be heated by using an electric immersion heater.

Outline the advantages and disadvantages of using solar energy to heat the water rather than using an electric immersion heater.

_____

_____

_____

_____

STEMUP.CO.UK

(6)
(Total 9 marks)

STEMUP.CO.UK