AQA GCSE PHYSICS (HIGHER) · 8463

PHYSICS



EXAM QUESTION PACK

4.1.1.3 ENERGY CHANGES IN SYSTEMS (PACK 2)

SCORE	PERCENTAGE
/127	%

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Q1.

The specific heat capacity of aluminium can be determined by experiment.

(a) Draw a labelled diagram showing how the apparatus used to determine the specific heat capacity of aluminium should be arranged.

(3)

(b) Describe how you could use the apparatus you drew in part (a) to determine the specific heat capacity of aluminium.

(6)

(c) Methods used to determine the specific heat capacity of aluminium may give a value greater than the actual value.

Explain why.

_____

_____

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_____

(2)

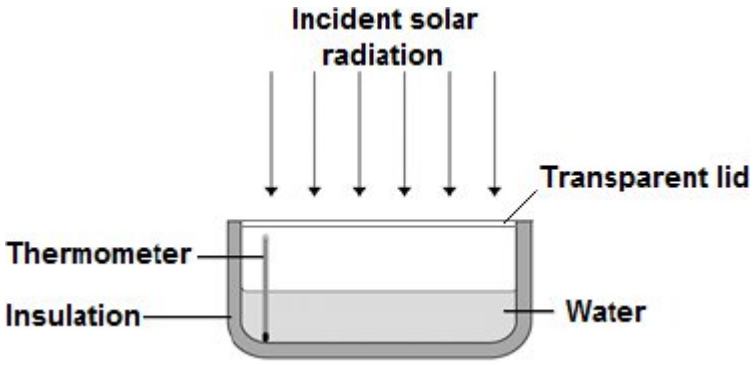
(Total 11 marks)

Q2.

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

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

The apparatus she used is shown in the figure below.



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

Tick **one** box.

0.1 °C ☐

0.5 °C ☐

1.0 °C ☐

(1)

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

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

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

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

_____

(1)

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

_____

_____

_____

Average power = _____ W

(2)

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

Use the correct equation from the Physics Equation Sheet.

_____

_____

_____

Mass = _____ kg

(3)

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

Give **one** reason why.

_____

_____

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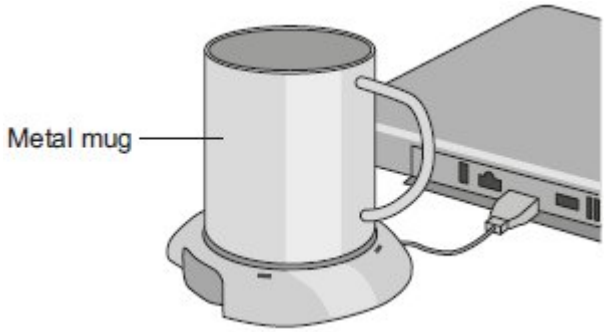
(1)

(Total 8 marks)

Q3.

A heater uses energy from a laptop computer to keep a drink hot.

The image shows a metal mug on the heater.



(a) The laptop computer is operating on battery power.
How would connecting the heater affect the amount of time the laptop computer would operate for, before needing to be recharged?

Tick (✔) **one** box.

	Tick (✔)
it would decrease the time	
it would not affect the time	
it would increase the time	

(1)

(b) The power output from the heater is 12 W.

Calculate the energy transferred to the metal mug in 60 seconds.

_____

_____

_____

Energy = _____ joules

(2)

(c) The table lists changes that may affect the energy transfer per second from the heater to the liquid.

Tick (✔) **one** box to show the effect of each change.

Change	**Energy transfer per second to the liquid**		
	increases	**decreases**	**does not**

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			change
use a mug with a smaller base			
use a lower power heater			
use a plastic mug instead of a metal mug			

(3)

(Total 6 marks)

Q4.

Under the same conditions, different materials heat up and cool down at different rates.

(a) What is meant by specific heat capacity?

_____

_____

_____

_____

(2)

(b) 'Quenching' is a process used to change the properties of steel by cooling it rapidly.

The steel is heated to a very high temperature and then placed in a container of cold water.

(i) A metalworker quenches a steel rod by heating it to a temperature of 900 °C before placing it in cold water. The mass of the steel rod is 20 kg.

The final temperature of the rod and water is 50 °C.

Calculate the energy transferred from the steel rod to the water.

Specific heat capacity of steel = 420 J/kg °C.

_____

_____

_____

Energy transferred = _____ J

(3)

(ii) The temperature of the steel rod eventually returns to room temperature.

Compare the movement and energies of the particles in the steel rod and in the air at room temperature.

_____

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_____

_____

_____

_____

_____

(3)

(iii) When the steel rod is being quenched, the temperature of the water rises to 50 °C. After a few hours the water cools down to room temperature.

Some of the cooling of the water is due to evaporation.

Explain in terms of particles how evaporation causes the cooling of water.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

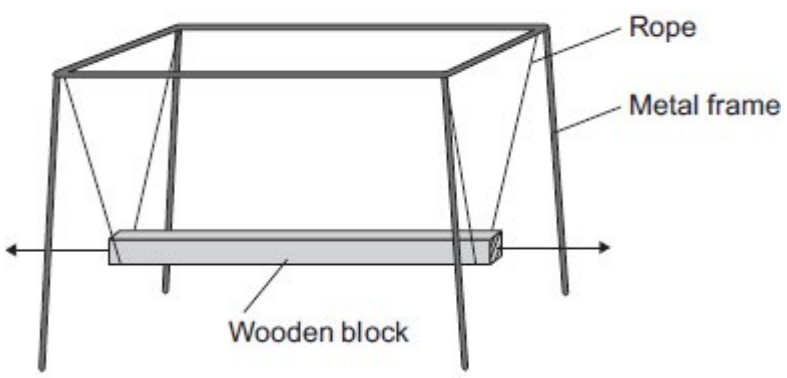
(4)

(Total 12 marks)

Q5.

Figure 1 shows the design of a playground ride.

Figure 1



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A large wooden block rests on ropes. The ropes are attached to a metal frame.

Children sit on the wooden block.

When the wooden block is moved to the left and released it moves to and fro.

When the wooden block returns to the point of release it has completed one cycle.

(a) Identify **two** possible hazards of the ride in **Figure 1**.

_____

_____

_____

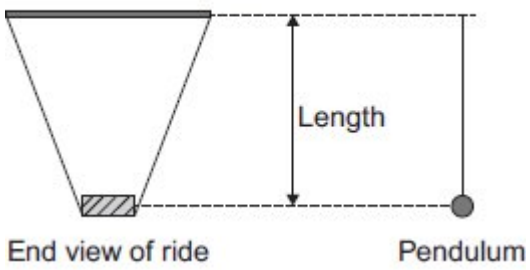
_____

(2)

(b) The designer of the ride wants to know if the ride has the same time period as a pendulum of the same length.

The designer used a model of the ride and a pendulum as shown in **Figure 2**.

Figure 2



The designer measured the time taken to complete 10 cycles for different lengths of both the model ride and the pendulum.

The results for the model ride are shown in **Table 1**.

Table 1

Length in metres	Time for 10 cycles in seconds				Mean time period in seconds
	First time	Second time	Third time	Mean	
0.100	6.36	6.37	6.29	6.34	0.63
0.150	7.76	7.74	7.80		
0.200	8.97	8.99	8.95	8.97	0.90

The results for the pendulum are shown in **Table 2**.

Table 2

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Length in metres	Time for 10 cycles in seconds				Mean time period in seconds
	First time	Second time	Third time	Mean	
0.250	10.00	10.04	10.02	10.02	1.00
0.300	10.99	11.01	10.94	10.98	1.10
0.350	11.88	11.83	11.87	11.86	1.19

(i) Complete **Table 1**, giving values to an appropriate number of significant figures.

_____

_____

(3)

(ii) The investigation already includes repeated readings.

Suggest **one** improvement that could be made to this investigation.

_____

_____

(1)

(iii) The designer reads in an Advanced Physics textbook that:
'The square of the time period, *T*, for a simple pendulum is proportional to its length, l.'

$$T^2 \propto l$$

Would the model ride have the same time period as a simple pendulum of the same length?

Use **one** row of data from **Table 1** and **one** row of data from **Table 2** to work out your answer.

State your conclusion.

_____

_____

_____

_____

_____

_____

(3)

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(c) The ride was redesigned and built to make it safer.

The wood was moving at maximum speed. The maximum kinetic energy of the wood was 180 J.

A parent applied a force to the wood and stopped it in a distance of 0.25 m.

Calculate the force required.

_____

_____

Force = _____ N

(3)

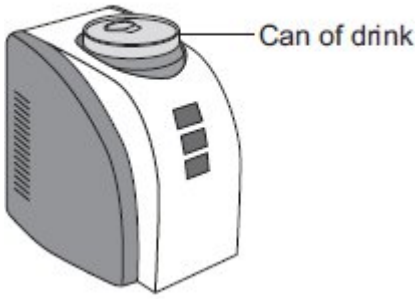
(Total 12 marks)

Q6.

A 'can-chiller' is used to make a can of drink colder.

Figure 1 shows a can-chiller.

Figure 1



(a) The can-chiller decreases the temperature of the liquid in the can by 15 °C.
The mass of liquid is 0.33 kg.
The specific heat capacity of the liquid is 4200 J / kg °C.

Calculate the energy transferred from the liquid as it cools.

_____

_____

_____

Energy = _____ J

(2)

(b) Complete the following sentence.

The specific heat capacity of a substance is the amount of energy required to

change the _____ of one kilogram of the

substance by one degree Celsius.

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(1)

(c) To calculate the specific heat capacity of a material, the mass of the material needs to be measured.

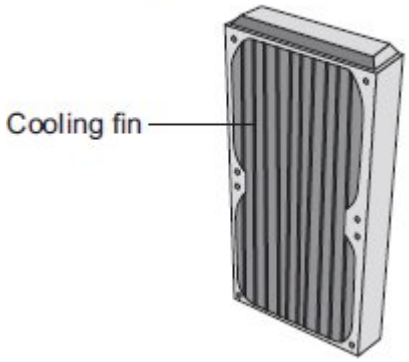
State the name of a measuring instrument used to measure mass.

_____

(1)

(d) The back of the can-chiller has cooling fins, as shown in **Figure 2**.

Figure 2



The cooling fins increase the rate of energy transfer from the can-chiller to the surroundings.

Complete the following sentences.

The cooling fins are a _____ colour because that makes them

good emitters of infrared radiation.

The large surface area of the cooling fins allows the air around the can-chiller

to gain energy quickly and rise, transferring energy by _____ .

(2)

(e) (i) The energy input to the can-chiller is the same as the energy output. This shows that energy is conserved.

Complete the following sentence.

Energy can be transferred usefully, stored or dissipated, but cannot be

_____ or destroyed.

(1)

(ii) The temperature of the can of drink decreases while it is in the can-chiller.

What happens to the temperature of the air around the cooling fins?

_____

(1)

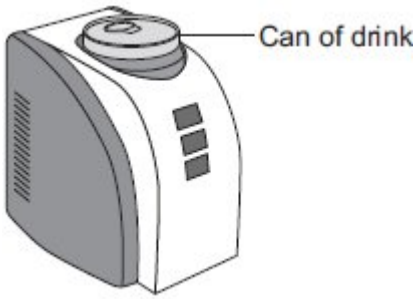
(Total 8 marks)

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Q7.

A ‘can-chiller’ is used to make a can of drink colder.

The image below shows a can-chiller.



(a) The initial temperature of the liquid in the can was 25.0 °C.
The can-chiller decreased the temperature of the liquid to 20.0 °C.
The amount of energy transferred from the liquid was 6930 J.
The mass of liquid in the can was 0.330 kg.

Calculate the specific heat capacity of the liquid.

Give the unit.

_____

_____

_____

_____

Specific heat capacity = _____ unit _____

(4)

(b) Energy is transferred through the metal walls of the can of drink by conduction.
Explain how.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(c) The energy from the can of drink is transferred to the air around the can-chiller.
A convection current is set up around the can-chiller. Explain how.

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_____

_____

_____

_____

_____

_____

(3)

(d) The can-chiller has metal cooling fins that are designed to transfer energy quickly to the surroundings.

Give **two** features that would help the metal cooling fins to transfer energy quickly to the surroundings.

1. _____

2. _____

(2)

(Total 13 marks)

Q8.

All objects emit and absorb infrared radiation.

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

dark matt	dark shiny	light matt	light shiny

The best emitters of infrared radiation have

_____ surfaces.

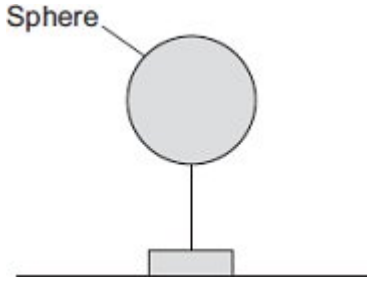
The worst emitters of infrared radiation have

_____ surfaces.

(2)

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

Diagram 1



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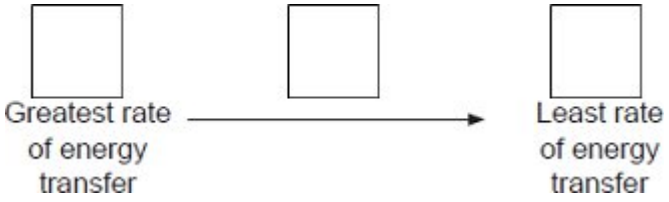
Energy is transferred from the sphere to the surroundings.

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

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

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

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



Give a reason for your answer.

_____

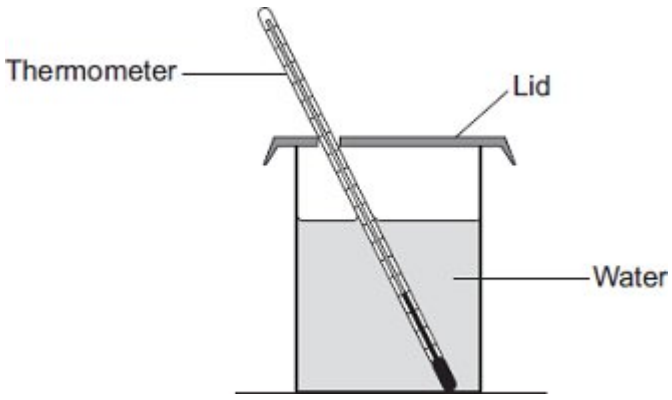
_____

(2)

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

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

Diagram 2



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

dark matt **dark shiny** **light matt** **light shiny**

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

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

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

Give a reason for your answer.

_____

_____

_____

_____

(2)

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

1. _____

_____

2. _____

_____

3. _____

_____

(3)

(d) The photographs show two different foxes.

Fox A **Fox B**



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



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Which fox is better adapted to survive cold conditions?

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Give reasons for your answer.

_____

_____

_____

_____

_____

_____

_____

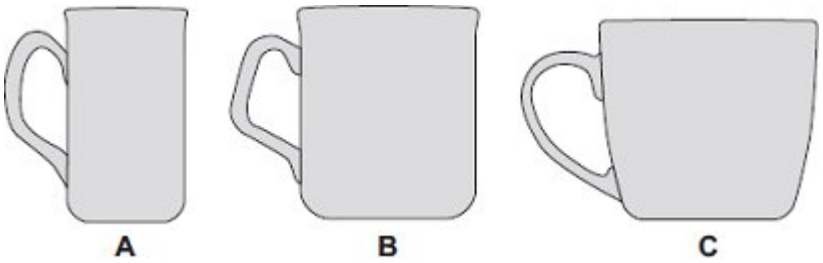
_____

(3)

(Total 12 marks)

Q9.

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



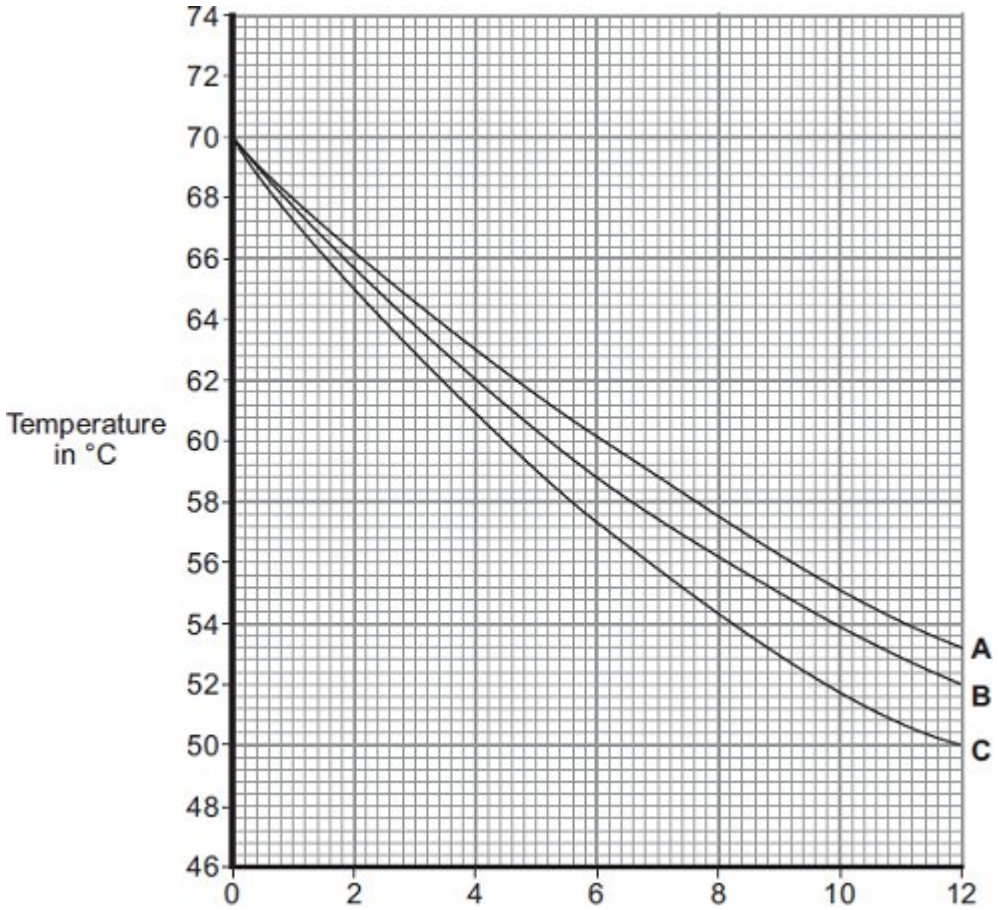
Energy is transferred from hot water in the cups to the surroundings.

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

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

The results are shown on the graph.

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

Starting temperature = _____ °C

(1)

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

_____

Temperature fall = _____ °C

(2)

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

Using the graph, give a reason for your answer.

_____

_____

(2)

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

The same starting temperature and volume of water were used.

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

(1)

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

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

_____

(1)

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

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

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

_____

_____

_____

Energy transferred = _____ J

(3)

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

_____

_____

_____

_____

_____

_____

_____

_____

(4)

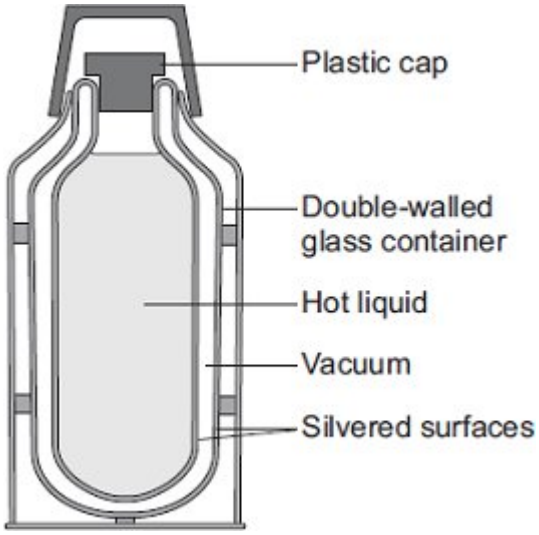
(Total 14 marks)

Q10.

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

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The diagram shows the structure of a vacuum flask.



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

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

(6)

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

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Arctic foxes have small ears.

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

_____

_____

_____

_____

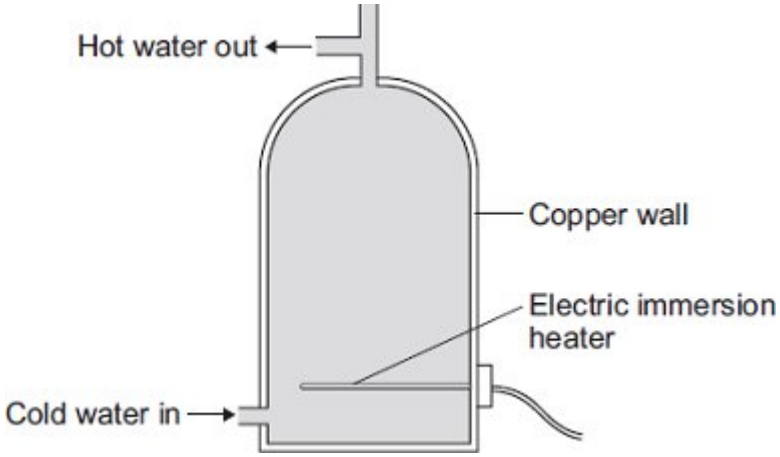
_____

(2)

(Total 8 marks)

Q11.

An electric immersion heater is used to heat the water in a domestic hot water tank. When the immersion heater is switched on the water at the bottom of the tank gets hot.



(a) Complete the following sentence.

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

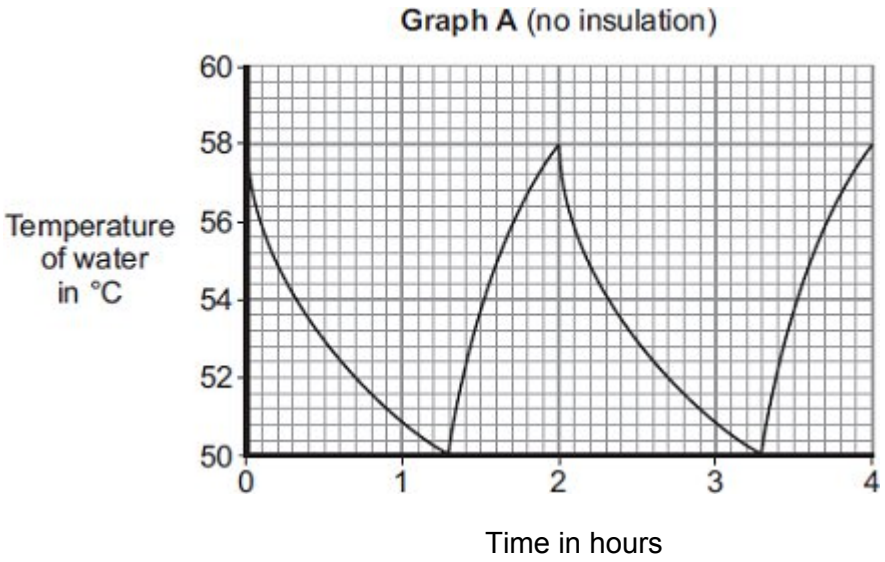
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(1)

(b) The immersion heater has a thermostat to control the water temperature.

When the temperature of the water inside the tank reaches 58°C the thermostat switches the heater off. The thermostat switches the heater back on when the temperature of the water falls to 50°C.

Graph A shows how the temperature of the water inside a hot water tank changes with time. The tank is **not** insulated.



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

Explain why.

_____

_____

_____

_____

(2)

(ii) To heat the water in the tank from 50°C to 58°C the immersion heater transfers 4032 kJ of energy to the water.

Calculate the mass of water in the tank.

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

_____

_____

_____

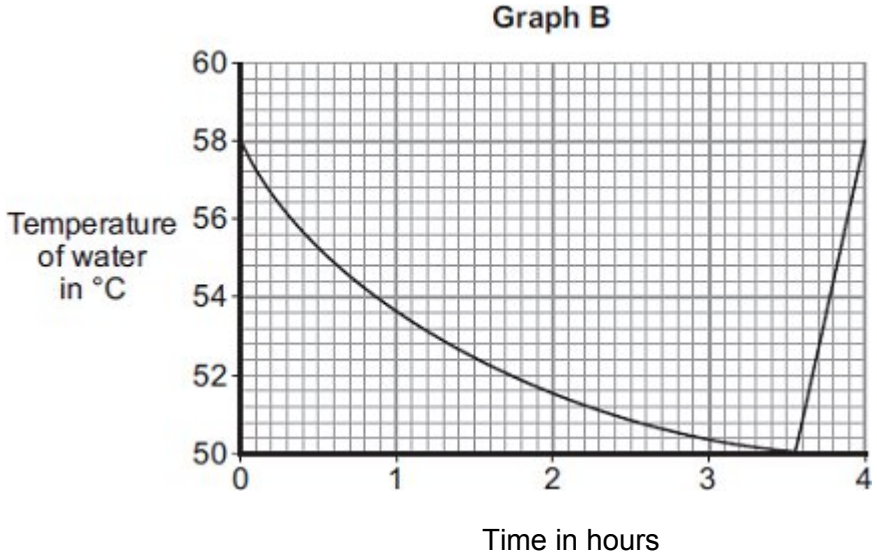
Mass = _____ kg

(3)

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(iii) An insulating jacket is fitted to the hot water tank.

Graph B shows how the temperature of the water inside the insulated hot water tank changes with time.



An insulating jacket only costs £12.

By comparing **Graph A** with **Graph B**, explain why fitting an insulating jacket to a hot water tank saves money.

_____

_____

_____

_____

_____

_____

(3)

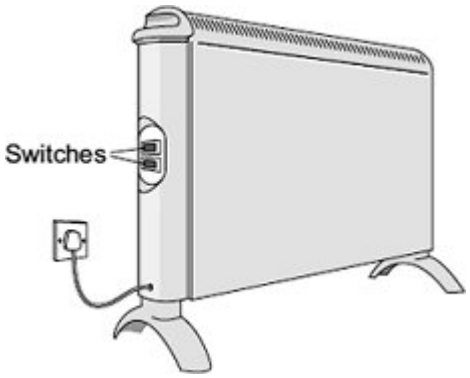
(Total 9 marks)

Q12.

(a) The diagram shows two switches on a room heater. The heater has three power settings. The power produced by two of the settings is given in the table.

Setting	Power in watts
Low	700
Medium	1400

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High	

(i) When both switches are on, the heater works at the high power setting.

What is the power of the heater, in kilowatts, when it is switched to the **high** power setting?

_____

Power = _____ kilowatts

(1)

(ii) The heater is used on the **high** power setting. It is switched on for 1½ hours.

Calculate the energy transferred from the mains to the heater in 1½ hours.

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

_____

_____

_____

Energy transferred = _____

(3)

(iii) This type of heater is a very efficient device.

What is meant by a device being very efficient?

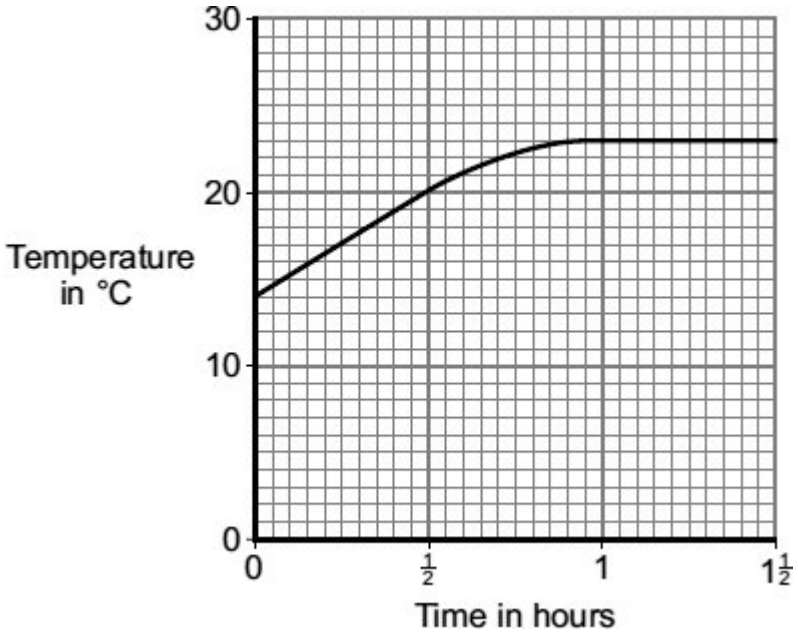
_____

_____

(1)

(b) The graph shows how the temperature of a room changes during the 1½ hours that the heater is used.

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After 1 hour, the temperature of the room has become constant, even though the heater is still switched on.

Explain why.

_____

_____

_____

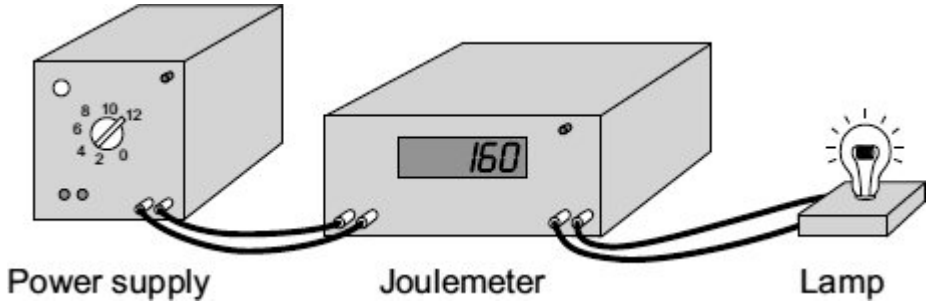
_____

(2)

(Total 7 marks)

Q13.

A student used a joulemeter to measure the energy transformed by a lamp.



The student set the joulemeter to zero, and then switched on the power supply.

After 120 seconds (2 minutes), the reading on the joulemeter had increased to 2880.

(a) In the space below, draw the circuit symbol used to represent a lamp.

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(1)

(b) (i) Use the equation in the box to calculate the power of the lamp.

$$\text{power} = \frac{\text{energy transformed}}{\text{time}}$$

Show clearly how you work out your answer.

_____

_____

Power = _____

(2)

(ii) Which **one** of the following is the unit of power?

Draw a ring around your answer.

joule **newton** **watt**

(1)

(c) Complete the following sentence using one of the phrases from the box.

larger than	the same as	smaller than

If the lamp was left switched on for 10 minutes, the amount of energy transformed would be _____ the amount of energy transformed in 2 minutes.

(1)

(Total 5 marks)

Q14.

When you transfer *energy* to a shopping trolley, the amount of *work done* depends on the *force* used and the *distance moved*.

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Complete the table by using the correct units from the box.

joule (J)	metre (m)	newton (N)

The first one has been done for you.

Quantity	Unit
energy (transferred)	joule
force	
distance (moved)	
work done	

(Total 2 marks)

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