Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2014

Applied Science SC02

Unit 2 Energy Transfer Systems

Thursday 15 May 2014 9.00 am to 10.30 am

For this paper you must have:
- a pencil
- a ruler
- a calculator.

Time allowed
- 1 hour 30 minutes

A

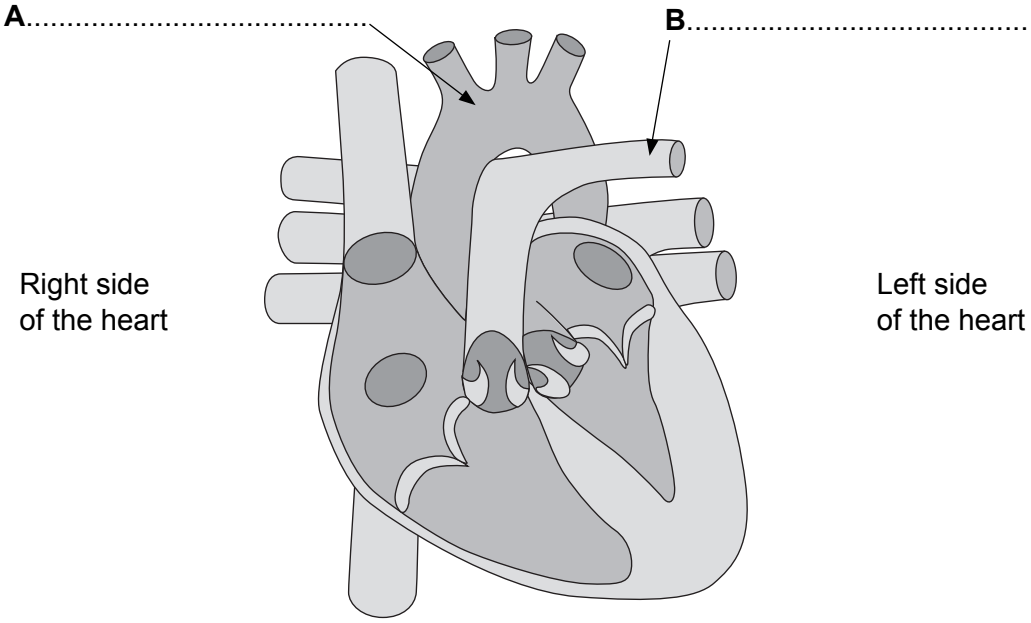
Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You are expected to use a calculator where appropriate.

Answer **all** questions in the spaces provided.

1 **Figure 1** shows a cross section through a human heart.

Figure 1



1 (a) Label the structures **A** and **B** on **Figure 1**.

[2 marks]

1 (b) Explain why the wall of the left ventricle is thicker than the wall of the right ventricle.

[2 marks]

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1 (c) Human beings have a double circulatory system.
Explain what is meant by a **double circulatory system**.

[2 marks]

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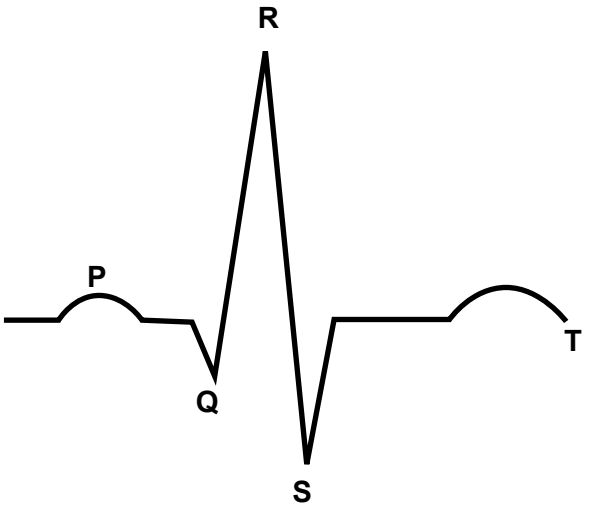
1 (d) Four women, all about 40 years old, volunteered to take part in a conservation study which involved tracking the movements of Scottish wildcats. The women were not used to taking regular exercise and planned to do some training before beginning their study.

A doctor arranged for them to have some health assessment tests before their training started.

In the first test, the function of each woman's heart was investigated using an electrocardiogram (ECG).

Part of a typical ECG trace is shown in **Figure 2**.

Figure 2



State what is happening to the heart at:

[3 marks]

P .....

.....

QRS .....

.....

T.....

.....

Question 1 continues on the next page

1 (e) An ECG trace was obtained for each woman (**A**, **B**, **C** and **D**) and these are shown in **Figure 3**.

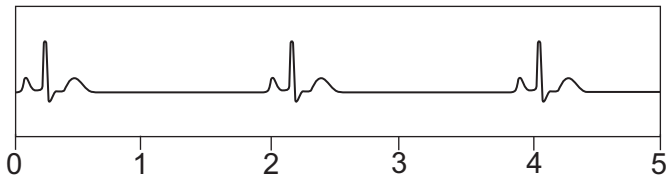
For each ECG trace, identify the type of heartbeat from the list below.

[4 marks]

normal heartbeat **tachycardia** **ventricular fibrillation** **bradycardia**

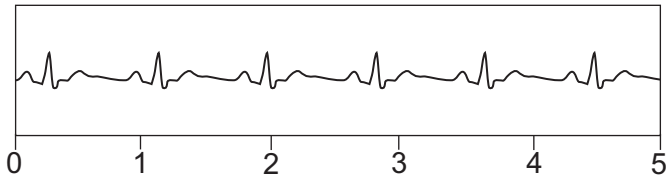
Figure 3

Woman **A**



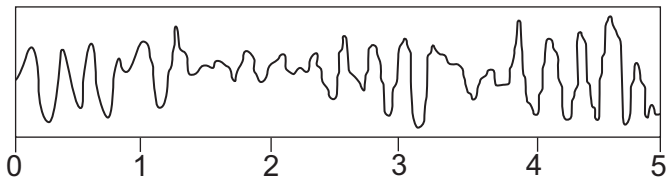
Type of heartbeat .....

Woman **B**



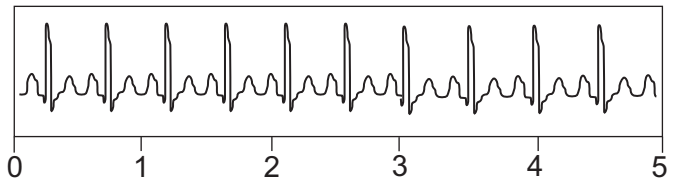
Type of heartbeat .....

Woman **C**



Type of heartbeat .....

Woman **D**



Type of heartbeat .....

1 (f) As part of the health assessment, each woman's blood pressure was measured. What is the normal blood pressure for a healthy 40-year-old woman?

[1 mark]

.....mm Hg

1 (g) Further health assessment tests showed that woman **D**'s vital capacity was 2.5 dm^3.

Explain why the results of woman **D**'s ECG trace in part **(e)** and her vital capacity measurement might result in her not being able to go on the conservation study.

[2 marks]

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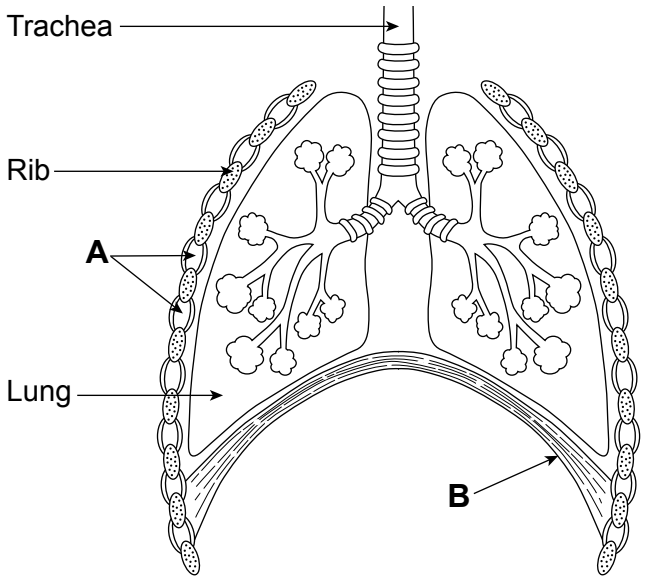
16

Turn over for the next question

2 The human respiratory system is shown in **Figure 4**.

Figure 4



2 (a) (i) Complete **Table 1** by naming the parts that letters **A** and **B** represent.

[2 marks]

Table 1

	Name of part
A	
B	

2 (a) (ii) Describe how air is drawn into the lungs during breathing.

[4 marks]

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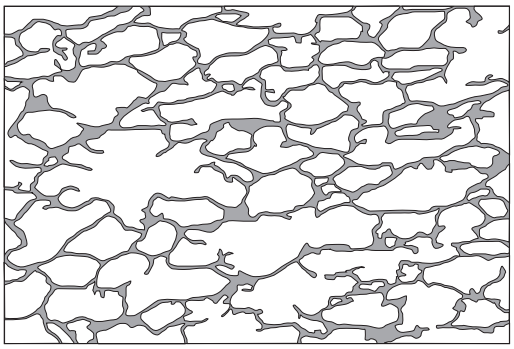
Question 2 continues on the next page

2 (b) Emphysema is a lung disease that causes breathing difficulties. Some smokers and ex-mineworkers suffer from the disease.

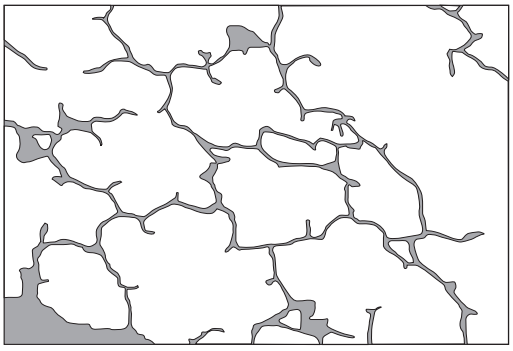
Emphysema affects alveoli, as shown in the photomicrographs in **Figure 5**. The photomicrographs have the same scale.

Figure 5

Alveoli in healthy lung tissue



Alveoli in lung tissue from a person with emphysema



People with emphysema often experience severe breathing difficulties.

Use the evidence in the photomicrographs in **Figure 5** and your knowledge of the respiratory and vascular systems to explain why.

[4 marks]

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2 (c) A 15-year-old boy has inherited a disease called cystic fibrosis and he suffers from frequent chest infections. A hospital consultant suggests that he would benefit from a heart and lung transplant, as soon as suitable organs become available.

Suggest **two** pieces of information that the consultant should give the boy and the boy's parents before they agree to the surgery.

[2 marks]

1 .....

.....

2 .....

.....

12

Turn over for the next question

3 A team of wildlife experts were looking for traces of a rare animal in the hills of Wales. The weather was unpredictable and when it began to rain and became very cold they looked for shelter. They spent the night in a cave and the body temperature of each member of the team began to fall.

3 (a) What is the normal body temperature of a human?

[1 mark]

……..°C

3 (b) (i) The body temperature of a person is usually maintained by homeostasis.

Explain what is meant by the term **homeostasis**.

[1 mark]

.....

.....

3 (b) (ii) Other than control of body temperature, give **one** other example of a physiological process that is regulated by homeostasis.

[1 mark]

.....

.....

3 (c) One member of the wildlife team was a doctor and he was concerned that the team might be suffering from hypothermia. He decided to measure each person's body temperature.

How could he ensure that the temperature readings taken were reliable?

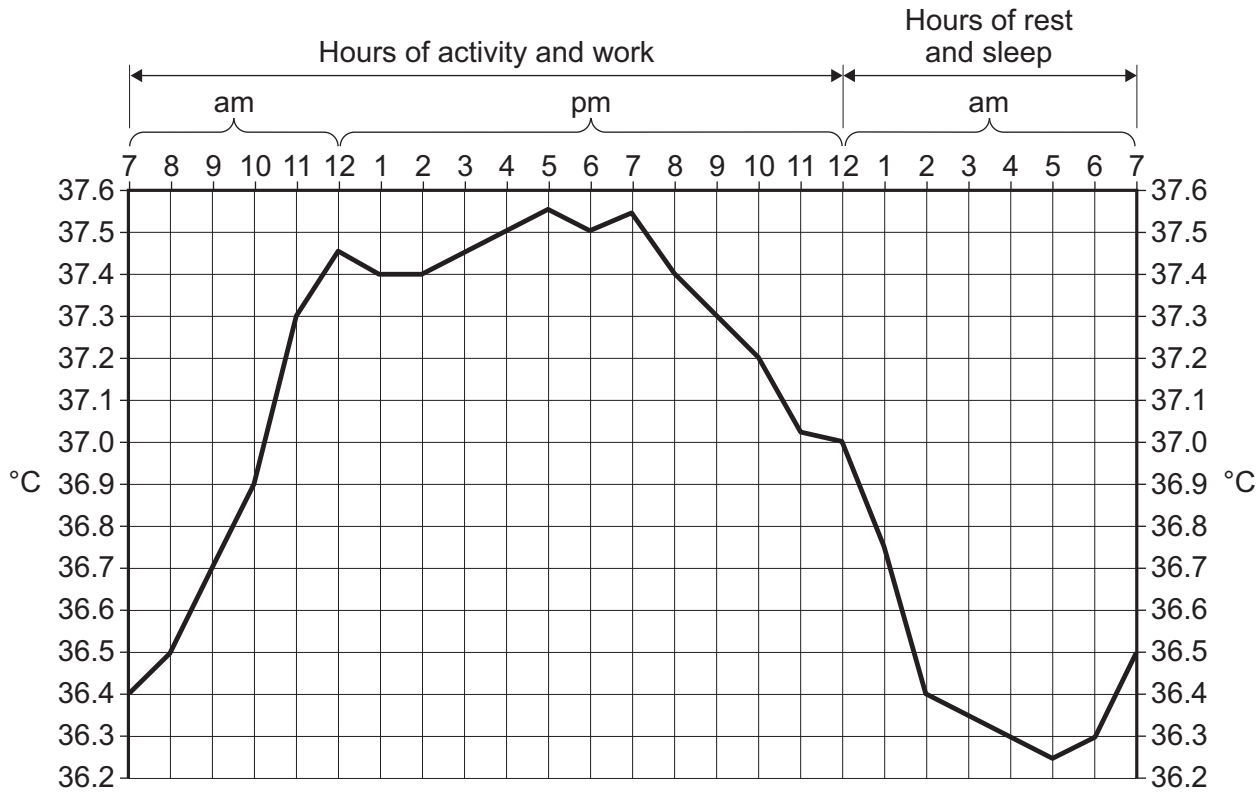
[1 mark]

.....

.....

3 (d) A human being does not have the same temperature throughout the day. The graph in **Figure 6** shows the temperature recorded for a person over a 24-hour period. Use the graph to answer the following questions.

Figure 6



3 (d) (i) At what time, during a 24-hour period, is the person's temperature at its lowest?

[1 mark]

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3 (d) (ii) Suggest why the person's temperature is highest between 5.00 pm and 7.00 pm.

[1 mark]

.....

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3 (d) (iii) A nurse is working a night shift at a hospital. He works from 11.00 pm to 7.00 am and then sleeps between 9.00 am and 4.00 pm.

Suggest at what time of day his body temperature is likely to be lowest.

[1 mark]

.....

Turn over ▶

3 (e) About 75% of the energy produced by a human body is lost as heat energy.

Name **three** ways in which heat energy can be lost from the body.

[3 marks]

1 .....

2 .....

3 .....

3 (f) State **two** factors that may affect the rate at which heat energy is lost from the body.

[2 marks]

1 .....

.....

2 .....

.....

12

4 An engineer is designing a hybrid car. The hybrid car will have a petrol engine for travelling long distances and also an electric motor for short journeys. The electric motor will take its energy from a battery, which will be charged from the mains.

4 (a) Suggest **one** advantage to the driver and **one** advantage to the environment of using the electric motor instead of the petrol engine.

[2 marks]

Advantage to the driver .....

.....

Advantage to the environment.....

.....

4 (b) Braking systems have to convert the kinetic energy of a car into other forms of energy.

4 (b) (i) Name **one** form of energy resulting from the use of the brakes on a car.

[1 mark]

.....

4 (b) (ii) How much kinetic energy does a 700 kg car have when it is travelling at 30 $m\,s^{-1}$?

[2 marks]

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Kinetic energy = ...J

Question 4 continues on the next page

4 (b) (iii) The 700 kg car takes 72 m to stop when it is travelling at 30 $m\,s^{-1}$.
If it is travelling faster than 30 $m\,s^{-1}$ it takes more than 72 m to stop.

Use ideas about momentum to explain why it takes more than 72 m to stop the car when it is travelling faster than 30 $m\,s^{-1}$.

[3 marks]

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4 (c) The engineer is also considering using the electric motor as part of the braking system when the car is moving at high speeds.
While braking, the motor acts as a generator and charges the battery.

4 (c) (i) In what form is energy stored in the battery?

[1 mark]

.....

4 (c) (ii) Give **one** advantage of using the electric motor as part of the braking system.

[1 mark]

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4 (d) An engineer at the Road Research Laboratory is planning to investigate the effect of this 'electric braking'. She needs to produce precise and accurate measurements for the stopping distance of a car over a range of speeds.

4 (d) (i) State the dependent variable in this investigation.

[1 mark]

.....

4 (d) (ii) The engineer has decided to measure the stopping distance several times, at the same speed, to calculate an average reading.

Suggest **three** precautions she should take to make these readings as valid as possible.

[3 marks]

Precaution 1.....

.....

Precaution 2.....

.....

Precaution 3.....

.....

4 (d) (iii) Experimental errors can be described as systematic errors or random errors.

What do these terms mean?

[2 marks]

Systematic errors .....

.....

Random errors .....

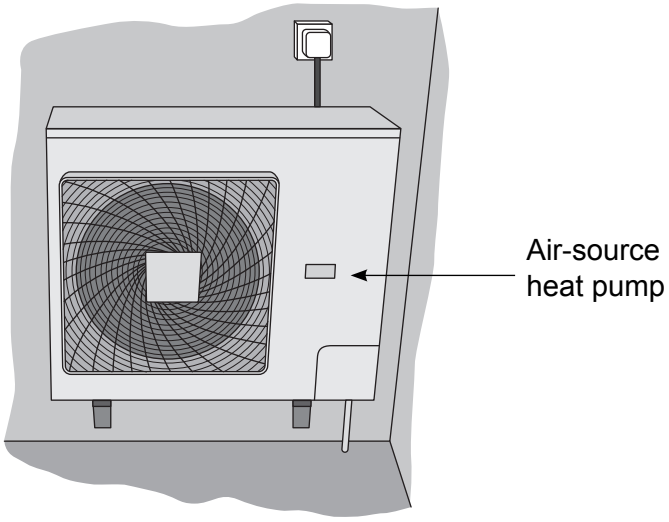
.....

16

Turn over for the next question

5 A home-owner is thinking about replacing her central heating system with an 'air-source heat pump', as shown in **Figure 7**.
This warms the house by taking heat from the air outside, and transferring the heat to water that is fed to the radiators in the house.
The power to do this is taken from the electricity supply.

Figure 7



The heat pump shown in **Figure 7** takes 3 kW of power from the mains. Electricity costs 12 p per unit, and the bill for using the heat pump in the autumn was £194.40.

5 (a) For how many hours did the heat pump run during that autumn?

[3 marks]

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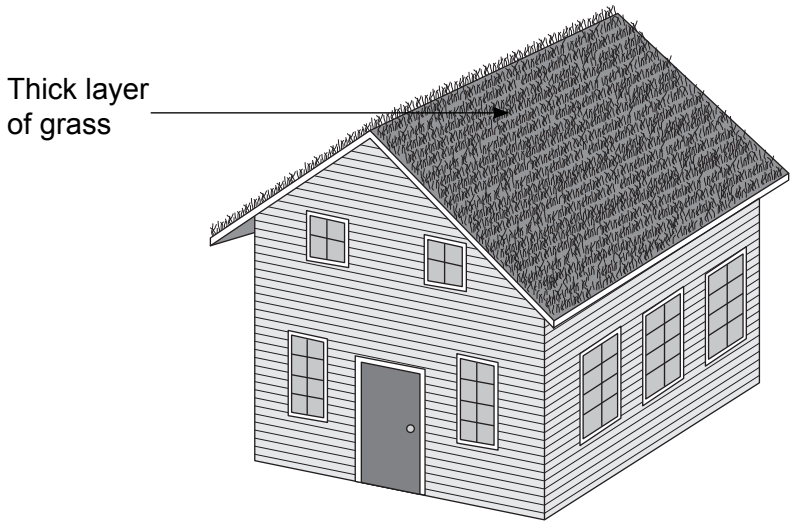
.....

Time =..... hours

5 (b) The same home-owner has fitted extra-thick walls to her house and has grown a thick layer of grass on the roof as shown in **Figure 8**. This has reduced the *U*-value of the house to 1.2 $W m^{-2} °C^{-1}$.

Figure 8



5 (b) (i) Explain why a low *U*-value for a house is good for the environment.

[2 marks]

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5 (b) (ii) Suggest **one** reason why the house design described in part **5(b)** and shown in **Figure 8** is likely to lead to a lower *U*-value for the house.

[1 mark]

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Question 5 continues on the next page

5 (b) (iii) On a day when the heating system delivers heat at a rate of 10.8 kW to the house, the mean temperature of the house is kept steady at 20 °C, even though the outside temperature is only 5 °C.
The *U*-value of the house is 1.2 $W m^{-2} °C^{-1}$.
Assume no heat is lost through the floor.

Calculate the total area of the walls and roof of the house.

Use this equation:

rate of heat loss (watts) = *U*-value × area (m^2) × temperature difference (°C)

[3 marks]

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Total area =..... m^2

5 (b) (iv) One room of the house had a wooden ceiling and there was a thick woollen carpet on the floor.

Give **three** reasons why the rate of heat loss through a thick woollen carpet will be much less than the rate of heat loss through the wooden ceiling of the same room.

[3 marks]

1 .....

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2 .....

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3 .....

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5 (c) The home-owner is concerned that the layer of grass on the roof will not minimise heat loss from the house. She decides to replace it with a different kind of roof.

5 (c) (i) What colour should the new roof be in order to minimise heat loss from the house?

[1 mark]

.....

5 (c) (ii) Explain why you have selected this colour.

[1 mark]

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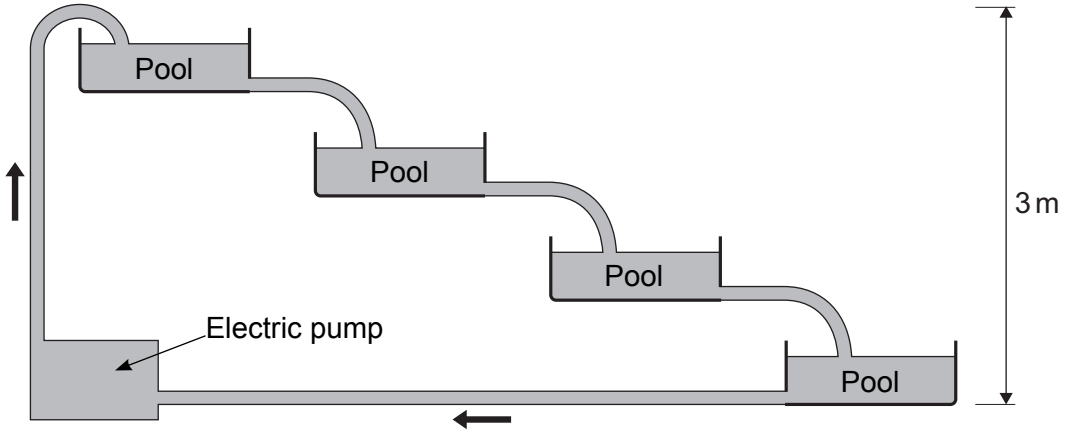
14

Turn over for the next question

6 A gardener decided to fit a 'water feature' to a client's garden, as shown in **Figure 9**.

Figure 9



The pump is intended to raise the water by 3 m, to the top of a series of pools. The water then trickles down, as if a stream ran through the garden.

6 (a) After a certain time, enough water had been raised by 3 m to store 14 400 J of gravitational potential energy.

What mass of water had been pumped during this time?
Assume that g = 10 m s^{-2}.

[3 marks]

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Mass of water = ...kg

6 (b) The pump delivered 90 W of power to the water.
How much time did the pump take to do 14 400 J of useful work?
Include the correct unit in your answer.

[2 marks]

.....

.....

.....

Time taken =.....

6 (c) To transfer energy to the water at a rate of 90 W, the input power to the pump had to be 120 W.

What was the efficiency of the pump?

[2 marks]

.....

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.....

Efficiency =.....

6 (d) When the pump had been working for some time, it had warmed up until it was warmer than its surroundings.

Explain why the temperature of the pump reached a maximum, even when heat was still being produced in the pump.

[3 marks]

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10

END OF QUESTIONS

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