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 2013

Applied Science SC02

Unit 2 Energy Transfer Systems

Thursday 16 May 2013 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 Healthcare professionals often use imaging methods to diagnose illness and to monitor the health of patients.

1 (a) This question is about comparing different imaging methods:

X-rays ultrasound magnetic resonance imaging

1 (a) (i) State **two** advantages and **one** disadvantage of using ultrasound compared with using X-rays.

Advantage 1.....

.....

Advantage 2 .....

.....

Disadvantage.....

.....

(3 marks)

1 (a) (ii) State **two** advantages and **one** disadvantage of using X-rays compared with using magnetic resonance imaging.

Advantage 1.....

.....

Advantage 2 .....

.....

Disadvantage.....

.....

(3 marks)

1 (b) Which of the imaging methods in part 1(a) would be most appropriate to use in each of the following situations?

1 (b) (i) To find out if a person has a broken leg.

.....

(1 mark)

1 (b) (ii) To find out if a person has a brain tumour.

.....

(1 mark)

1 (c) Scientists have developed a new method of using radioactive tracers to diagnose brain damage. They want to test the method on human patients. Before starting clinical trials, they submit their research plan to an ethics committee.

Briefly discuss the issues that the ethics committee need to consider before giving permission for the trials to take place.

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(3 marks)

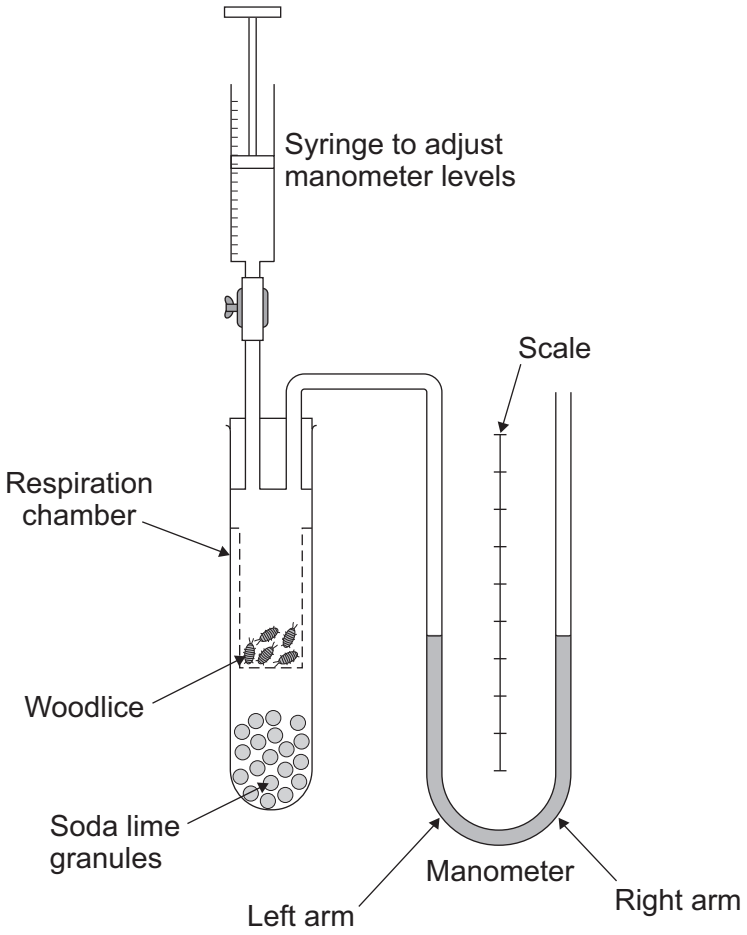
11

Turn over for the next question

2 (a) A student designed an experiment to investigate *aerobic respiration* in small organisms.

He placed five woodlice in the top of the respiration chamber. Soda lime granules in the bottom of the respiration chamber absorbed carbon dioxide produced by the woodlice. The woodlice were not harmed during the experiment. **Figure 1** shows the equipment that was used.

Figure 1



2 (a) (i) What does aerobic respiration mean?

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(1 mark)

2 (a) (ii) Write a balanced chemical equation for aerobic respiration.

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(2 marks)

2 (b) (i) How would the levels of fluid in the arms of the manometer change during the investigation?

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(1 mark)

2 (b) (ii) Explain your answer to part 2(b)(i).

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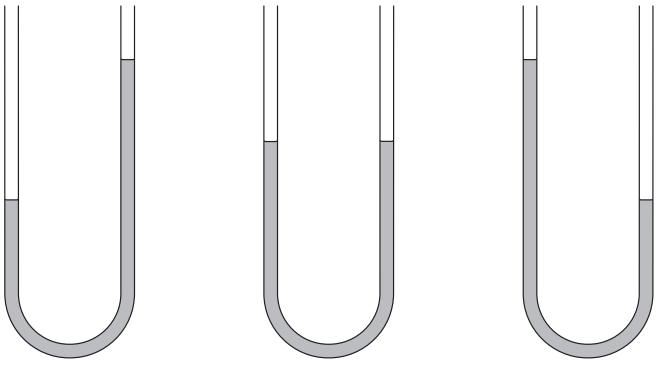
(2 marks)

2 (c) (i) The student set up a second experiment, but replaced the soda lime with water.
In **Figure 2**, which diagram, **A**, **B** or **C**, shows what you would expect the fluid levels in the manometer to be after the same length of time?

Circle the correct letter.

Figure 2



(1 mark)

2 (c) (ii) Explain your answer to part 2(c)(i).

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(2 marks)

2 (d) The student was asked to work out the respiratory quotient for the woodlice.

The respiratory quotient (RQ) is defined as the ratio of the volume of carbon dioxide produced to the volume of oxygen consumed.

Use your knowledge of aerobic respiration and your answer to part 2(a)(ii) to determine the RQ for the woodlice.

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(1 mark)

2 (e) (i) In a third experiment, germinating peas were used instead of woodlice.
Soda lime granules were placed in the bottom of the respiration chamber.
The peas mostly use anaerobic respiration to produce energy.
Anaerobic respiration is a process that does not require oxygen.

How would you expect the RQ for the germinating peas to compare with the RQ for the woodlice?

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(1 mark)

2 (e) (ii) Explain your answer to part 2(e)(i).

.....

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(1 mark)

12

3 (a) People who suffer from asthma often experience difficulties in breathing. Asthma is a respiratory condition in which the airways become inflamed and narrow.
A nurse wanted to find out if a woman had asthma and asked her to have some tests done to assess her lung function.
Her test results are shown in **Table 1**.

Table 1

	Test results	**Normal female values**
Vital capacity (dm^3)	2.8	
Expiratory peak flow rate (dm^3)	300	

3 (a) (i) Write the normal female values for each lung function in **Table 1**. *(2 marks)*

3 (a) (ii) Explain whether or not the results in **Table 1** would support a diagnosis of asthma.

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(1 mark)

3 (a) (iii) What would you expect to happen to the rate and depth of the woman's breathing when she is having an asthma attack?

Rate .....

.....

Depth .....

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(2 marks)

Question 3 continues on the next page

3 (b) People visiting places at very high altitudes sometimes experience altitude sickness. There is less oxygen available at high altitudes, leading to less oxygen in the blood.

3 (b) (i) What effects might altitude sickness have on a person's breathing?

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(2 marks)

3 (b) (ii) What effect might altitude sickness have on a person's heart rate?

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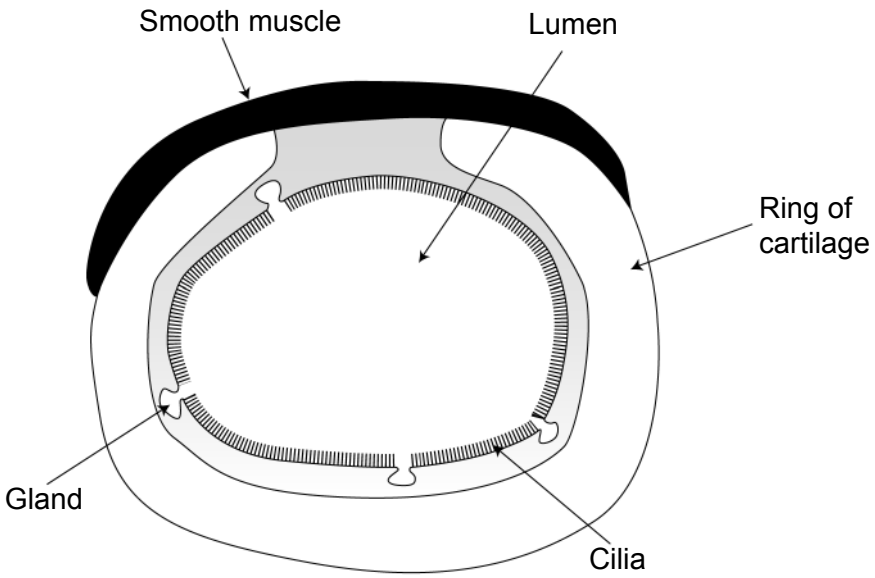
(1 mark)

3 (c) Air travels into and out of the lungs through the trachea.
Figure 3 shows a cross section through the trachea.

Figure 3



For each of the structures listed below, state its function and say why it is important.

3 (c) (i) Ring of cartilage:

Function .....

.....

Importance. .....

.....

(2 marks)

3 (c) (ii) Cilia:

Function .....

.....

Importance. .....

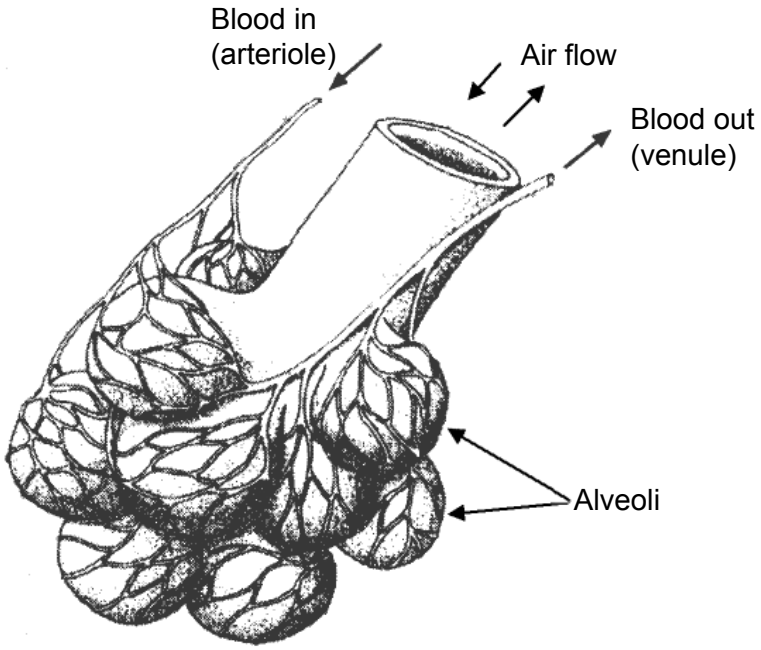
.....

(2 marks)

Question 3 continues on the next page

3 (d) **Figure 4** shows a small part of a human lung.

Figure 4



3 (d) (i) Give **two** features of alveoli that help the diffusion of gases.

1 .....

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2 .....

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(2 marks)

3 (d) (ii) Describe how the blood vessels shown in **Figure 4** help in the exchange of gases between the blood and the air in the lungs.

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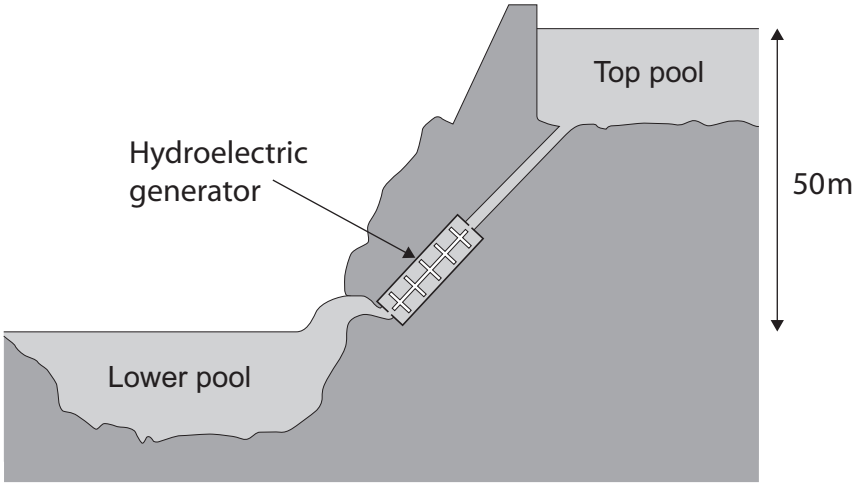
(3 marks)

17

4 An engineer has been asked to install a hydroelectric generator for a farmer who lives near a hill that is 50 m high.
A pipe runs down the hill, as shown in **Figure 5** (viewed from the side).

Figure 5



4 (a) Suggest **three** advantages of installing a hydroelectric generator rather than a diesel-powered generator.

1 .....

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2 .....

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3 .....

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(3 marks)

4 (b) In the hydroelectric system, water from the top pool flows through a large, smooth pipe to the lower pool.
Explain why it is important that the pipe should be smooth.

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(1 mark)

Question 4 continues on the next page

4 (c) Calculate how much gravitational potential energy (GPE) is converted into other forms of energy when 8 kg of water flows down from the top pool through the generator to the lower pool.
State the correct unit in your answer.
Assume $g = 10\,m\,s^{-2}$.

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.....

GPE =.....

(3 marks)

4 (d) The engineer stated that "not all the gravitational potential energy is converted into electrical energy at the generator".

Name **two** forms of energy, other than electrical, that will be produced as the water flows down the hill and through the generator.

1.....

2.....

(2 marks)

4 (e) (i) Sometimes, the water flows fast enough to convert gravitational potential energy into other forms (including electrical energy) at a rate of 2000 W (2 kW). However, the generator only produces 600 W of electrical power.

What is the efficiency of this system?

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Efficiency =.....

(2 marks)

4 (e) (ii) Suggest **two** reasons why the generator may not produce a constant power of 600 W.

1 .....

.....

2 .....

.....

(2 marks)

4 (f) After the generator is set up and working, the farmer finds that the energy from the generator has saved him £43.20 in one month.

What is the average power generated during this month? Include the correct unit in your answer.
Assume that a month contains 720 hours, and that the farmer pays 15p per unit of electricity.

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Average power = ...

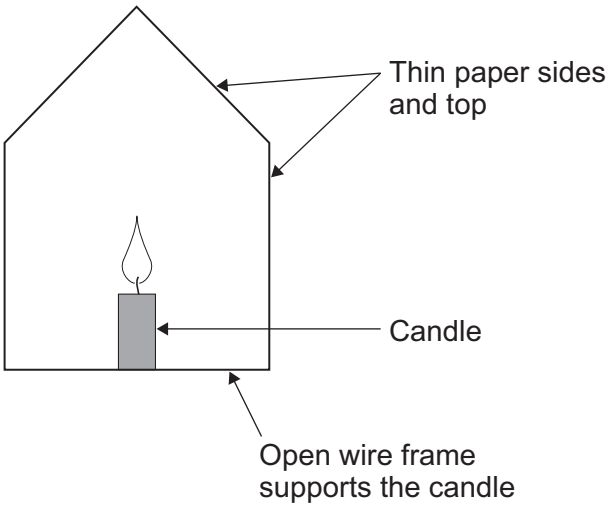
(3 marks)

16

Turn over for the next question

5 A lantern is made from a wire frame supporting a thin layer of paper. The lantern contains a small candle, as shown in **Figure 6** (side view).

Figure 6



5 (a) What form of energy does the candle store before it is lit?

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(1 mark)

5 (b) Explain why the flame from the candle points upwards.

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(3 marks)

5 (c) Paper burns easily, but lanterns made from paper are usually safe to use.
Give **two** reasons why the candle flame does not heat the paper to burning point.

1 .....

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2 .....

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(2 marks)

5 (d) The lantern manufacturer ran out of white paper so they used black paper instead. Many of these black paper lanterns caught fire after the candle was lit.

Explain why the paper in the black paper lanterns heated up more than the paper in the white lanterns did.

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(2 marks)

5 (e) A typical lantern has a total surface area of $0.3\,m^2$ and a *U*-value of $4\ W\ m^{-2}\ °C^{-1}$. When the candle has been burning for a reasonable time, the temperature difference between the heated air in the lantern and the air outside reaches a steady value of 20 °C.

Use the equation:

rate of heat loss = total surface area $\times$ *U*-value $\times$ temperature difference

to calculate the rate at which heat is being emitted by the lantern.

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Rate = ...W

(2 marks)

Question 5 continues on the next page

5 (f) The lantern manufacturer is concerned that the *U*-value for one of his lantern designs is not known accurately. You are required to set up and run an experiment to measure the *U*-value of this type of lantern.

You may wish to use bulbs, resistors, power packs, meters, and other measuring equipment normally found in a Physics lab.

5 (f) (i) Describe how you would provide and measure a heat source to replace the candle inside the lantern.
You can draw a diagram to help you to answer this question.

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(2 marks)

5 (f) (ii) State what temperature measurements you would make.

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(2 marks)

5 (g) It is suggested that a lantern of low weight might be able to fly, like a hot-air balloon. Suggest **two** negative effects on the environment of such flying lanterns.

1 .....

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2 .....

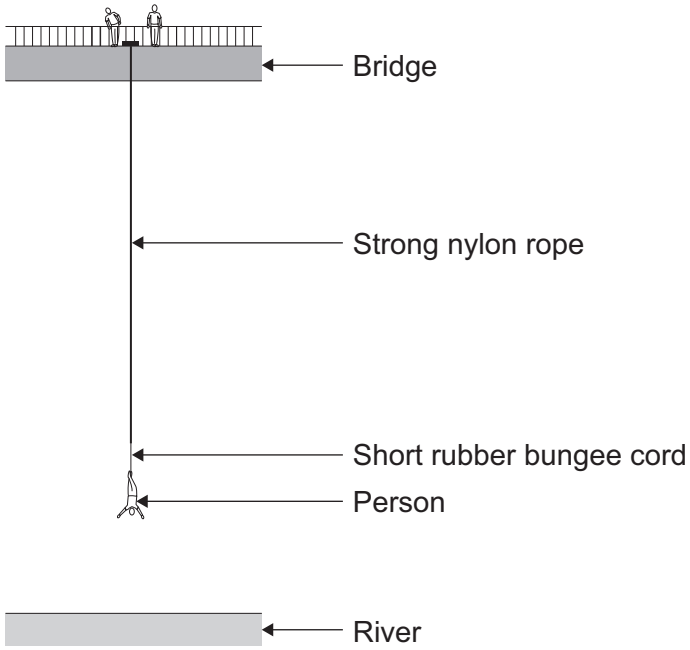
.....

(2 marks)

16

6 An adventure sports company has instructed an engineer to design a bungee jump. The jump is to be done from a disused bridge. A strong nylon rope is attached to a short rubber bungee cord. The nylon rope helps to bring the falling person to a safe stop, just before they reach the river surface, as shown in **Figure 7**. This nylon rope does not stretch when a bungee jump takes place.

Figure 7



On a first trial run, using a sandbag of mass 90 kg, the rubber bungee cord stretched so much that the sandbag went deep into the river. The engineer decided to replace the rubber bungee cord with new different cord that stretched much less when pulled by the same force.

6 (a) Use your knowledge of momentum to explain why using this different cord might be harmful to the person jumping.

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(3 marks)

Question 6 continues on the next page

Turn over ▶

6 (b) (i) The engineer estimates that a person with a mass of 90 kg will have gained 45 000 J of kinetic energy (KE) just before the cord starts to stretch. At what speed must this person be falling to have this kinetic energy?

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Speed = ... $m\,s^{-1}$

(3 marks)

6 (b) (ii) The new rubber cord brings this person to a halt in 3.0 seconds.
At what rate is the cord converting energy from one form to another?

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.....

.....

Rate = ...W

(2 marks)

8

END OF QUESTIONS

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