| Surname | | Other Names | |
|---|---|---|---|
| Centre Number | | | Candidate Number | | | | |
| Candidate Signature | | | | | | | | | |

For Examiner's Use

General Certificate of Education
June 2009
Advanced Subsidiary Examination

**APPLIED SCIENCE** **SC02**
**Unit 2 Energy Transfer Systems**

Friday 22 May 2009 9.00 am to 10.30 am

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

Time allowed: 1 hour 30 minutes

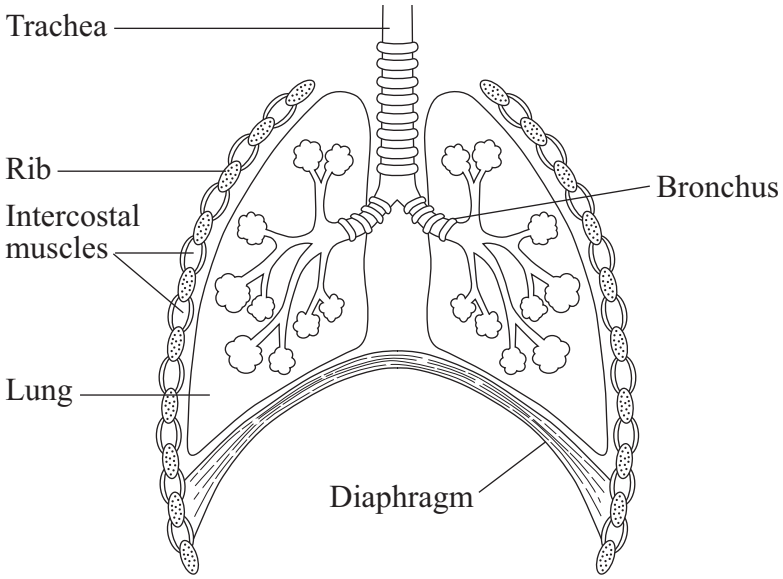
**Instructions**
- Use black ink or black ball-point pen. Use pencil only for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- Show the working of your calculations.

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

| For Examiner's Use | | | |
|---|---|---|---|
| Question | Mark | Question | Mark |
| 1 | | 5 | |
| 2 | | 6 | |
| 3 | | | |
| 4 | | | |
| Total (Column 1) → | | | |
| Total (Column 2) → | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

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

**1** The diagram shows the human respiratory system.




**1** (a) Describe how air is expelled from the lungs during breathing.

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*(4 marks)*

**1** (b) A doctor diagnoses a woman as having asthma. Tests show that the woman is allergic to cats. This allergy triggers a response in the woman's blood. This causes spasmodic contraction of the smooth muscle in the bronchioles and reduces their diameter.

**1** (b) (i) What is the normal breathing rate of an adult?

..... breaths per minute

*(1 mark)*

**1** (b) (ii) During an asthma attack, what would you expect to happen to the rate and depth of the woman's breathing?

Rate .....

.....

Depth .....

.....

*(2 marks)*

**1** (c) An experiment is conducted to see if regular exercise increases the vital capacity of the lungs.

**1** (c) (i) Define *vital capacity*.

.....

.....

.....

.....

*(2 marks)*

**1** (c) (ii) Two groups of 50 people are chosen to take part in the experiment.
Suggest why 50 people, rather than 10, are tested in each group.

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*(1 mark)*

**Question 1 continues on the next page**

**1** (c) (iii) Considering the aim of the study, suggest **two** groups of people who could be compared.

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*( 1 mark)*

**1** (c) (iv) State **three** factors you would need to control during the experiment to obtain valid results.

1 .....

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2 .....

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3 .....

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*(3 marks)*

**1** (c) (v) Explain how regular exercise increases the vital capacity of the lungs.

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*(2 marks)*

**1** (d) The data below shows average vital capacity measurements, in litres, collected from women of different ages and heights.

| Age (years) / Height (cm) | **20** | **30** | **40** | **50** | **60** | **70** | **80** |
|---|---|---|---|---|---|---|---|
| **142** | 2.5 | 2.3 | 2.2 | 2.0 | 1.8 | 1.3 | 1.2 |
| **147** | 2.7 | 2.5 | 2.3 | 2.1 | 1.9 | 1.6 | 1.3 |
| **152** | 2.8 | 2.7 | 2.5 | 2.3 | 2.0 | 1.7 | 1.4 |
| **158** | 3.1 | 2.9 | 2.7 | 2.4 | 2.2 | 1.9 | 1.5 |
| **163** | 3.2 | 3.1 | 2.8 | 2.6 | 2.3 | 2.0 | 1.6 |
| **168** | 3.4 | 3.2 | 3.0 | 2.7 | 2.4 | 2.1 | 1.7 |
| **173** | 3.7 | 3.4 | 3.2 | 2.9 | 2.6 | 2.2 | 1.8 |
| **178** | 3.9 | 3.7 | 3.4 | 3.1 | 2.7 | 2.4 | 1.9 |

Describe **two** trends seen in the data in the table.

1 .....

.....

2 .....

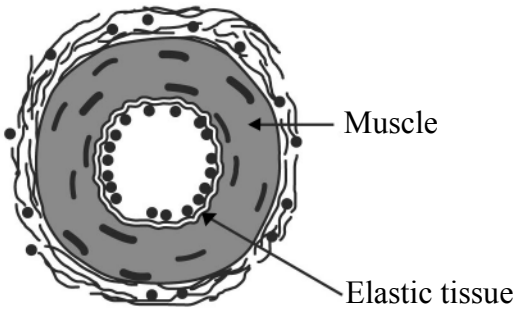
.....

*(2 marks)*

18

**Turn over for the next question**

**2** (a) Dieticians advise us to limit the amount of fat we eat. They do this because a diet high in fat can cause fat to be deposited on the inside of artery walls.
This condition is known as hardening of the arteries.
The diagram shows a cross-section of the aorta, which is a large artery.




**2** (a) (i) Explain why hardening of the arteries affects blood flow through the aorta.

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*(3 marks)*

**2** (a) (ii) Coronary artery disease can be caused by fat being deposited inside the coronary arteries supplying the heart.
Explain how this might affect the function of the heart.

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*(3 marks)*

**2** (a) (iii) Give **two** factors that help the return of blood back to the heart through the veins.

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*(2 marks)*

**2** (b) Before climbing a very high mountain, a group of six mountaineers, **A–F**, decide to have their health assessed. During the assessment their blood pressure was measured. Some of the results are shown in the table below.

| Mountaineer | Systolic pressure (mm Hg) | Diastolic pressure (mm Hg) |
|---|---|---|
| **A** | 125 | 81 |
| **B** | 135 | 80 |
| **C** | | |
| **D** | 120 | 90 |
| **E** | 85 | 55 |
| **F** | 133 | 85 |

**2** (b) (i) Mountaineer **C** is a healthy 40-year-old man. Put the results you might expect for his blood pressure in the spaces in the table.

*(1 mark)*

**2** (b) (ii) Suggest which mountaineer, **A–F**, is most likely to be asked back for further tests.

Mountaineer ……..

*(1 mark)*

**2** (b) (iii) Explain your choice.

.....

.....

*(1 mark)*

**Question 2 continues on the next page**

**2** (c) Use your knowledge of the heart to explain why there are two figures for each mountaineer's blood pressure in the table on **page 7**.

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*(2 marks)*

**2** (d) The mountaineer's blood pressure was measured using an electronic digital sphygmomanometer, rather than a manual sphygmomanometer.

Give **two** advantages of using the electronic device rather than the manual device.

Advantage 1 .....

.....

Advantage 2 .....

.....

*(2 marks)*

**15**

**3** (a) A man fell and broke his ankle. Although he was given emergency treatment, he was refused surgery to pin his bones until he had given up smoking.
Give **two** possible reasons why the hospital refused to operate on the man until he had given up smoking.

Reason 1 .....

.....

Reason 2 .....

.....

*(2 marks)*

**3** (b) Some patients attending hospital emergency departments refuse treatment. This can result in ethical dilemmas for health care practitioners.
Suggest **three** ethical dilemmas which health care practitioners might face.

1 .....

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2 .....

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3 .....

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*(3 marks)*

**3** (c) Medical practitioners often have to decide whether or not to withhold distressing information from their patients.

**3** (c) (i) Give **one** possible disadvantage to the patient if information is withheld.

.....

.....

*(1 mark)*

**3** (c) (ii) Give **one** reason why a medical practitioner might decide to withhold distressing information.

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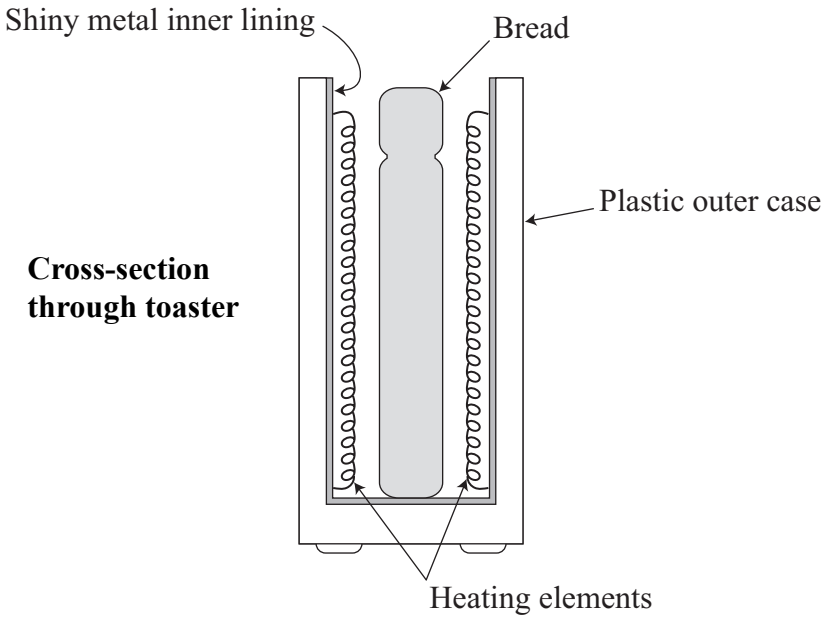
*(1 mark)*

7

**4** A kitchen appliance designer is researching how to make an energy-efficient electric toaster. An electric toaster uses heating elements, to heat the surface of the bread.




**Cross-section through toaster**

**4** (a) (i) Name the heat transfer process that carries most of the heat to the bread.

.....

*(1 mark)*

**4** (a) (ii) Name the heat transfer process that causes most of the wasted heat to escape out of the top of the toaster.

.....

*(1 mark)*

**4** (a) (iii) Explain how this wasted heat is carried out of the top of the toaster.

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*(3 marks)*

**4** (b) (i) Give **two** advantages of having a plastic outer case rather than a metal outer case.

Advantage 1 .....

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Advantage 2 .....

.....

*(2 marks)*

**4** (b) (ii) Explain why the toaster case has a shiny metal inner lining.

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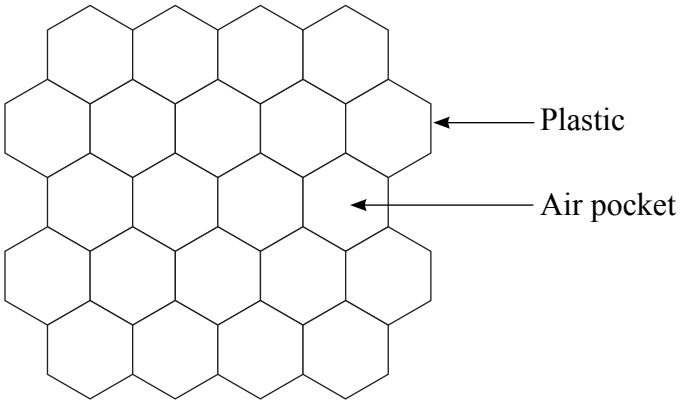
*(3 marks)*

**Question 4 continues on the next page**

**4** (b) (iii) It has been suggested that the solid plastic case should be replaced with a honeycomb matrix of plastic enclosing many tiny air pockets.
A diagram of a honeycomb matrix is shown below.




How might this reduce the rate of heat loss through the case?

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*(3 marks)*

**4** (c) The solid plastic case has a U-value of 2.5 $W/m^2/^oC$.
Explain what this U-value means.

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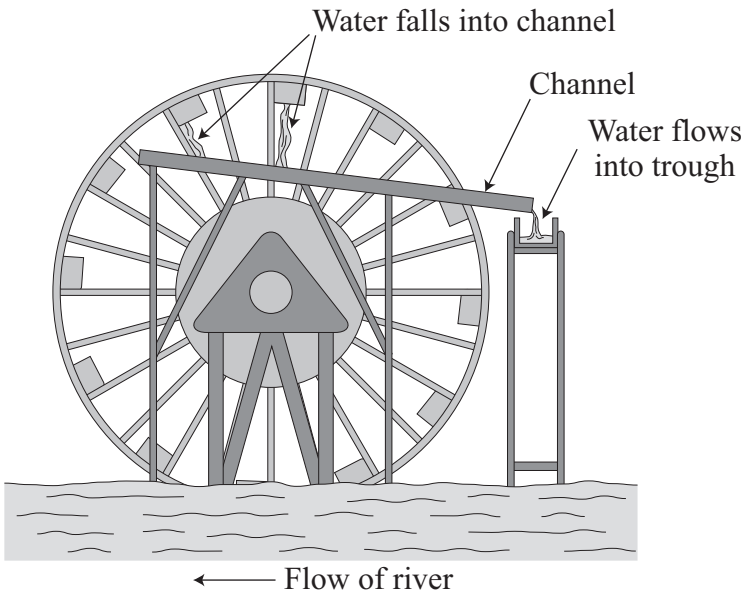
*(2 marks)*

**15**

**5** A "Noria" is a special type of waterwheel which raises water from a river. It uses the energy of the river to lift the water.




**5** (a) (i) What sort of energy does the water have in a flowing river?

.....

*(1 mark)*

**5** (a) (ii) The waterwheel lifts 900 kg of water a distance of 8 m every minute. How much potential energy is gained by the water in 1 minute?
The acceleration due to gravity is $10\,m\,s^{-2}$.

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*(2 marks)*

**5** (a) (iii) Calculate the useful power output, in watts, of the waterwheel.

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*(2 marks)*

**Turn over ▶**

**5** (b) (i) The efficiency of the waterwheel is stated to be 60%.
Calculate the rate at which the river is transferring energy to the waterwheel.

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*(2 marks)*

**5** (b) (ii) What happens to the energy transferred by the river that does **not** become useful output energy?

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*(2 marks)*

**5** (b) (iii) After some months, the waterwheel is not working well, and its efficiency has fallen to 30%. The operator applies some grease to the bearings, and the efficiency rises to 60% again.
How does applying grease to the bearings improve the efficiency?

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*(2 marks)*

**5** (b) (iv) The operator suggests that by applying even more grease, the efficiency could be raised to 120%.
Explain why this is not possible.

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*(1 mark)*

**5** (c) A technician suggests that this system should be replaced by a 3 kW electric pump.

**5** (c) (i) Suggest an effective way of providing the electrical power required for this pump if no mains electricity is available.
State **one** advantage and **one** disadvantage for choosing this energy source.

Energy source .....

.....

Advantage .....

.....

Disadvantage .....

.....

*(3 marks)*

**5** (c) (ii) Electricity is now available in the area. Calculate the cost of operating the 3 kW pump continuously for a year, if the cost of supplying mains electricity is 12p per unit.
Assume that there are 8760 hours in a year.

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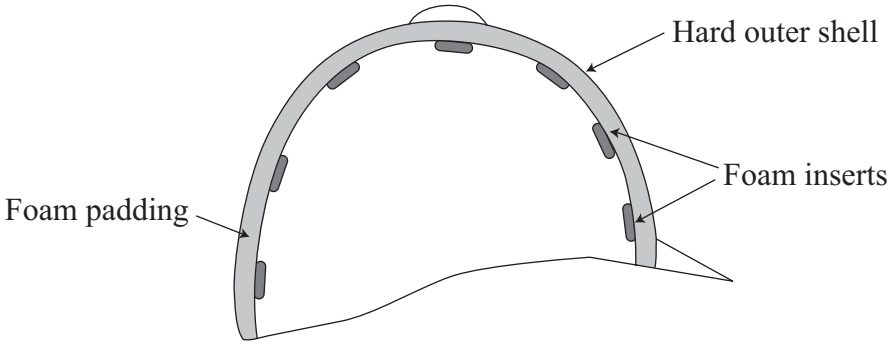
*(2 marks)*

**17**

**6** A horse rider's helmet is intended to protect his head from injury. The helmet has a hard outer shell and a softer inner layer of padding.




A horse rider can choose between two helmets – one has an inner layer of padding 5 cm thick, and the other has 3 cm of padding.

**6** (a) (i) Explain why the thicker padding gives more protection to the horse rider's head in an accident.

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*(3 marks)*

**6** (a) (ii) Explain why the designer did not choose an inner layer of padding 20 cm thick.

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*(1 mark)*

**6** (b) Experiments were carried out to test the helmet. A technician dropped a hammer onto the helmet. She wants to measure the speed of the hammer just before it hits the helmet.

The technician used the method below to test how effective the helmet is likely to be:

- fit the helmet over an object which is the same size and mass as a human head.
- drop a hammer on to the helmet.
- use a datalogger, connected to a computer, to measure the speed of the hammer just before it hits the helmet.

Why is it better to use a position sensor and datalogging equipment to measure the speed of the hammer, rather than to calculate the speed of the hammer from its height of fall?

.....

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*(1 mark)*

**6** (c) The technician has been given **three** different helmets to compare.
Explain how she would ensure that the experiment was a fair test.

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*(2 marks)*

**6** (d) Suggest **one** safety precaution to take when carrying out this experiment.

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*(1 mark)*

**8**

**END OF QUESTIONS**

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