

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

| |
|--------------------|
| For Examiner's Use |
|--------------------|

General Certificate of Education
 June 2007
 Advanced Subsidiary Examination



APPLIED SCIENCE
Unit 2 Energy Transfer Systems

SC02

Tuesday 5 June 2007 1.30 pm to 3.00 pm

| |
|---|
| <p>For this paper you must have:</p> <ul style="list-style-type: none"> • a pencil and a ruler • a calculator. |
|---|

| For Examiner's Use | | | |
|---------------------|------|----------|------|
| Question | Mark | Question | Mark |
| 1 | | 5 | |
| 2 | | 6 | |
| 3 | | 7 | |
| 4 | | | |
| Total (Column 1) → | | | |
| Total (Column 2) → | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

Time allowed: 1 hour 30 minutes

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- 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 maximum mark for this paper is 80.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.

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

1 A group of students wanted to find out how fit they were.
They decided to use pulse rate change as an indicator of fitness.

(a) Describe a laboratory investigation they could carry out to find out how pulse rate changes during and after exercise.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

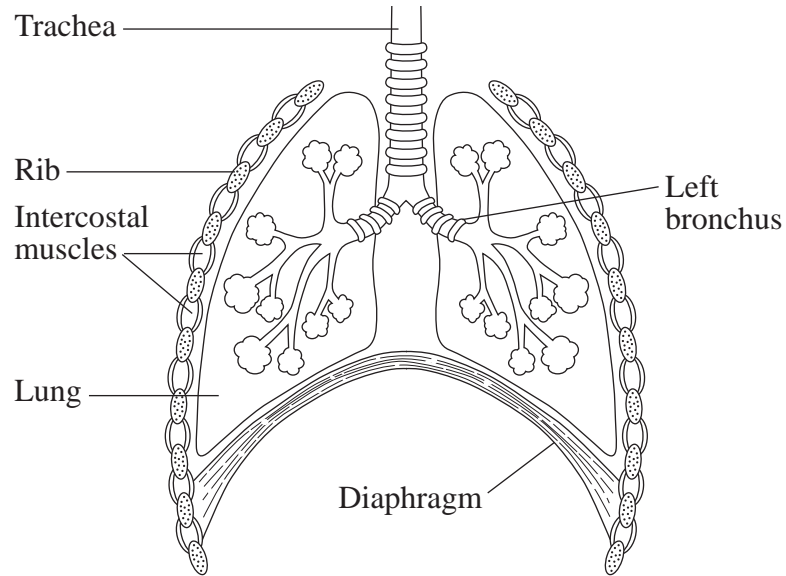
(4 marks)

(b) When the students exercise, their heart rate increases.
Describe how inputs from nerves make heart rate increase.

.....
.....
.....
.....
.....
.....

(3 marks)

- (c) As part of their course, the students were taught about the link between heart rate and breathing rate.
Describe how air is taken into the lungs during breathing.
Use the diagram below to help in your description.



.....

.....

.....

.....

.....

.....

.....

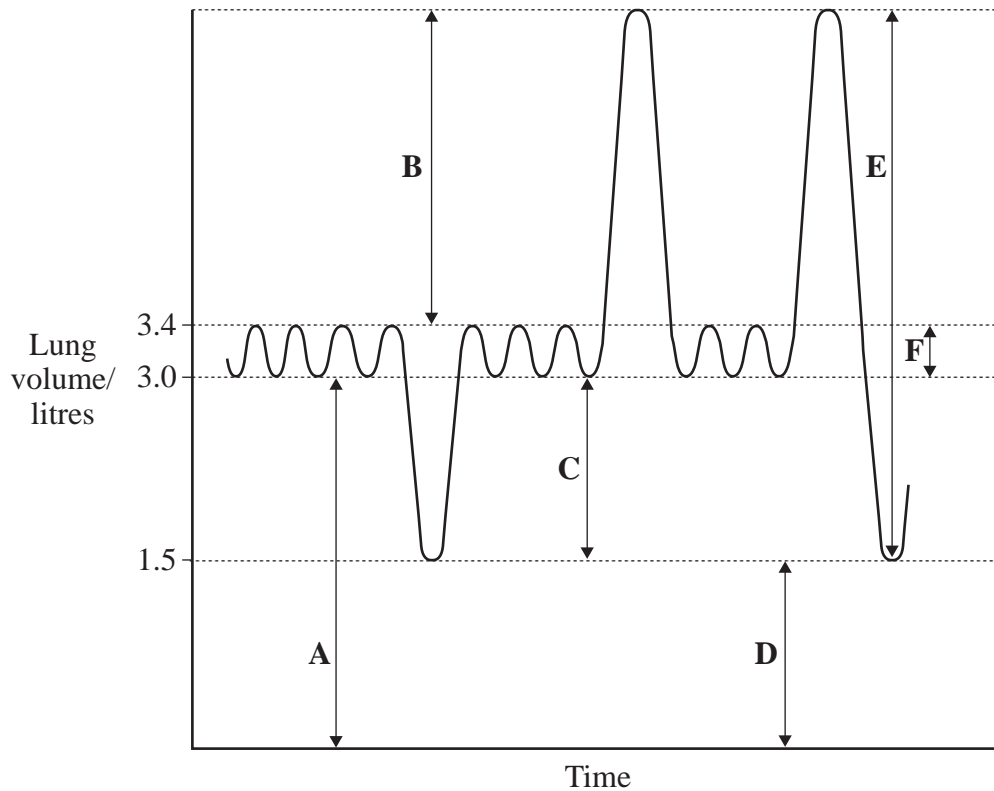
.....

.....

(4 marks)

Question 1 continues on the next page

- (d) One of the students had her lung function tested using a spirometer. The diagram below shows the spirometer trace produced, along with the main lung volumes. These all indicated that the student had normal lung function.



- (i) What is meant by vital capacity?

.....

 (1 mark)

- (ii) Which letter on the spirometer trace shows vital capacity?

.....
 (1 mark)

- (iii) What is meant by tidal volume?

.....

 (1 mark)

- (iv) Which letter on the spirometer trace shows tidal volume?

.....
 (1 mark)

- (e) (i) Residual volume may be defined as: ‘The volume of gases remaining in the alveoli after a person has breathed out as hard as they can’.
Select the letter from the spirometer trace on **page 4** that shows this volume.

.....
(1 mark)

- (ii) Expiratory reserve volume may be defined as: ‘The extra air that a person can force out of their lungs after a normal expiration.’
Select the letter from the spirometer trace on **page 4** that shows this volume.

.....
(1 mark)

- (f) People with asthma can monitor their lung function using a peak flow meter. This measures peak expiratory flow rate.
What is the normal value of peak expiratory flow rate for a healthy adult at rest?

.....
(1 mark)

Turn over for the next question

2 A patient requires surgery to replace a faulty aortic valve in his heart.

(a) Use your knowledge of the cardiac cycle to describe how a faulty aortic valve could affect blood flow in the body.

.....
.....
.....
.....
.....
.....

(3 marks)

(b) What instrument could be used to diagnose a faulty aortic valve?

.....

(1 mark)

(c) In humans, faulty aortic valves are replaced with either an artificial valve, or a valve taken from a pig's heart.
State **two** ethical issues to be considered when deciding which is the most appropriate type of valve to be used in the patient's heart.

1

.....

2

.....

(2 marks)

(d) The patient has been asked to give up smoking and lose weight several weeks before the operation is due to take place.
State **two** pieces of information that the doctor should give to the patient before he can consent to surgery.

1

.....

2

.....

(2 marks)

(e) There is a trend to withhold some operations from people who are obese.

(i) Suggest **one** reason why it might be ethically sound to withhold such operations from obese people.

Reason

.....

(1 mark)

(ii) Suggest **two** reasons why it might **not** be ethically sound to withhold such operations from obese people.

Reason 1

.....

Reason 2

.....

(2 marks)

Turn over for the next question

3 Healthcare professionals often use imaging methods to diagnose illness and to monitor the health of patients.

(a) Give **one** advantage and **one** disadvantage of using each of the following imaging methods.

(i) Ultrasound

Advantage

.....

Disadvantage

.....

(2 marks)

(ii) Magnetic resonance imaging (MRI)

Advantage

.....

Disadvantage

.....

(2 marks)

(iii) X-rays

Advantage

.....

Disadvantage

.....

(2 marks)

(b) Suggest the method of imaging which would be most appropriate to use in each of the following situations.

(i) To assess the development of a foetus during pregnancy.

.....
(1 mark)

(ii) To determine whether or not a person has a broken leg.

.....
(1 mark)

(iii) To determine whether or not a person has a brain tumour.

.....
(1 mark)

(c) Radioactive tracers are sometimes used to diagnose and monitor the health of patients. The radioisotopes available emit alpha (α), beta (β) or gamma (γ) radiation. α radiation can be stopped by thin paper. β radiation can travel through paper but is stopped by thin aluminium. γ radiation cannot be completely stopped but thick lead can stop most γ rays.

(i) Which of these three types of radiation should a radioisotope emit if it is to be used as a tracer?

.....
(1 mark)

(ii) Explain your answer.

.....
.....
.....
(1 mark)

- 4 A scientist lives near a waterfall and wants to use some of its energy to generate electricity for her house. The waterfall is 12 m high, and 50 kg of water falls over it every second. Assume acceleration due to gravity (g) = 10 m s^{-2} .

- (a) Calculate the potential energy transferred by each kilogram of water as it falls from the top of the waterfall to the lower level.

.....
.....
.....
.....

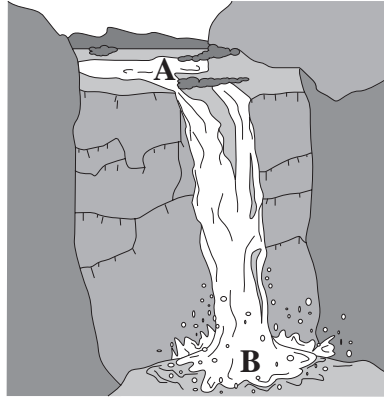
..... J
(2 marks)

- (b) Calculate the maximum possible power available from this waterfall.

.....
.....
.....
.....

.....
(2 marks)

- (c) The scientist measures the temperature of the water just before the waterfall at **A**, and at the bottom at **B**. The water is slightly warmer at point **B** than at point **A**. Why is this?



.....

.....

.....

.....

(2 marks)

- (d) The scientist channels all the water through a turbine that turns an electrical generator. The efficiency of the combined turbine and generator is 40%. Calculate the maximum electrical power available.

.....

.....

.....

.....

.....W
(2 marks)

Question 4 continues on the next page

- (e) When the builders installed the turbine and generator they used an electric concrete mixer that had a power of 2 kW. It was used for a total of 36 hours. Each unit of electricity costs 12p.
Calculate the total cost of the electricity used.

.....
.....
.....
.....

(2 marks)

- (f) The scientist had considered several other sources of energy for her house, but had rejected them for different reasons.
State **one** disadvantage of using each of the following energy sources.

(i) Fossil fuels

.....
(1 mark)

(ii) Solar power

.....
(1 mark)

(iii) Wind turbine

.....
(1 mark)

(iv) Biogas

.....
(1 mark)

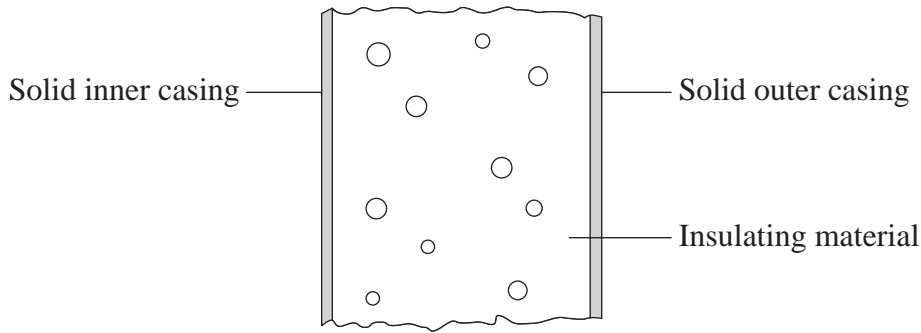
Turn over for the next question

5 A research team was asked to develop a new freezer.

The design brief specifications were:

- total surface area of freezer = 10 m²
- internal temperature of freezer = -20 °C
- typical external temperature = 25 °C

Cross-section of freezer wall



(a) The outer casing of the freezer will be solid.
By what method is most heat passed through a solid?

.....

 (1 mark)

(b) Suggest a suitable material to use for the insulation.

.....

 (1 mark)

(c) Explain how the insulating material suggested in part (b) would minimise

(i) conduction,

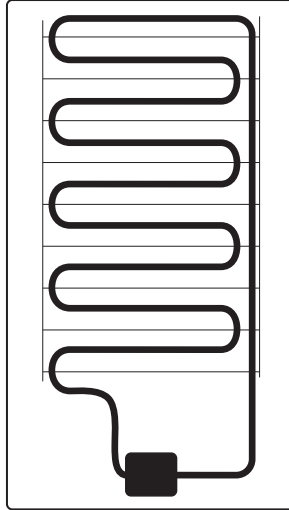
.....
 (1 mark)

(ii) convection.

.....

 (2 marks)

- (d) The freezer is cooled by fluid pumped round a pipe in the freezer. At the back of the freezer is a heat exchanger. It is designed to lose heat as effectively as possible. A typical heat exchanger at the back of a freezer is shown below. Comment on the design features of the heat exchanger.



.....

.....

.....

.....

(2 marks)

- (e) The material finally chosen for the walls of the freezer has an average U-value of $0.2 \text{ W m}^{-2} \text{ K}^{-1}$. The rate of heat loss through the walls can be calculated using the equation

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

Calculate the rate of heat loss through the walls, using the data provided on **page 14**. Show your working.

.....

.....

.....

.....

.....W
(2 marks)

Question 5 continues on the next page

- (f) The cooling system of the freezer needs to have a greater power than required to meet the losses calculated in part (e).
Suggest **three** reasons why this is a good idea.

Reason 1

.....

Reason 2

.....

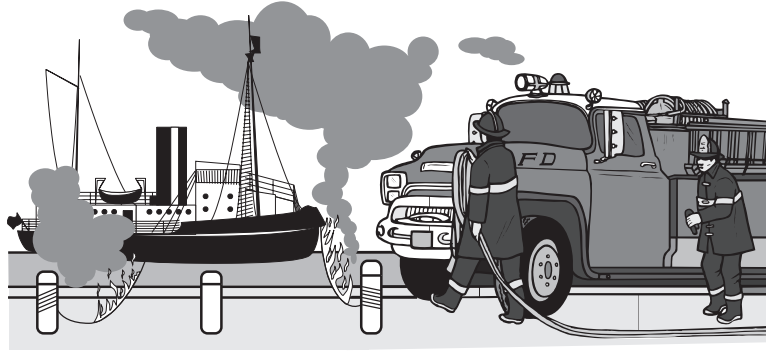
Reason 3

.....

(3 marks)

| |
|-----------|
| |
| 12 |

- 6 A ship is on fire in a harbour. The fire has burnt through the ropes holding it in place, and the ship is free to move. There is no wind and no tidal effect in the harbour.



The fire brigade sprayed water onto the ship to put out the fire. Every minute 480 kg of water leaves the nozzle of the hosepipe. The water leaves the nozzle at a speed of 30 m s^{-1} .

- (a) Calculate the total momentum of the water sprayed in one minute as it leaves the nozzle. Use the equation

$$\text{momentum} = \text{mass} \times \text{velocity}$$

.....

.....

.....

(2 marks)

- (b) (i) What happens to the momentum of the water when the water hits the ship?

.....

.....

(1 mark)

- (ii) Explain the effect this would have on the ship.

.....

.....

.....

(2 marks)

- (c) Explain why it is important for the firefighter using the hosepipe to wear footwear which has soles with a good grip.

.....

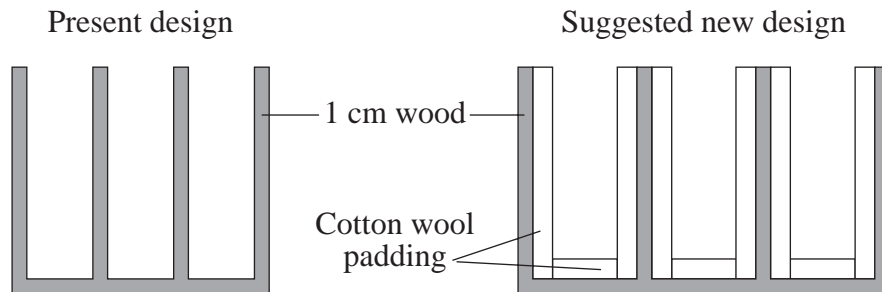
.....

.....

(2 marks)

- 7 You have been asked to help a champagne bottler to improve the design of the containers that are used for holding the filled bottles. The present design is made out of wood, 1 cm thick. If the container is dropped, one or more of the bottles often breaks and spills its contents.

The present design has just enough space inside to hold the bottles, and a suggested new design has space for cotton-wool padding for each bottle.



- (a) Explain how the cotton-wool padding helps to prevent damage to the bottles if the container is dropped.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

(b) You have been asked to test the new container to see if it is significantly better than the old container at protecting the bottles inside it. You intend to test the containers by dropping them.

(i) Suggest **one** safety precaution you would take before testing the container.

.....

.....

(1 mark)

(ii) State **two** factors that you would keep the same during your tests.

.....

.....

.....

.....

(2 marks)

(iii) Apart from the container used, what factor would you vary as you carry out different tests?

.....

.....

(1 mark)

| |
|---|
| |
| 7 |

END OF QUESTIONS

There are no questions printed on this page