Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
January 2006
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Monday 16 January 2006 1.30 pm to 3.00 pm

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

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 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			
Number	Mark	Number	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 An athlete decides to run the London marathon. During the race his muscles will obtain some of their energy from *anaerobic* respiration.

(a) (i) Explain why this happens.

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(3 marks)

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

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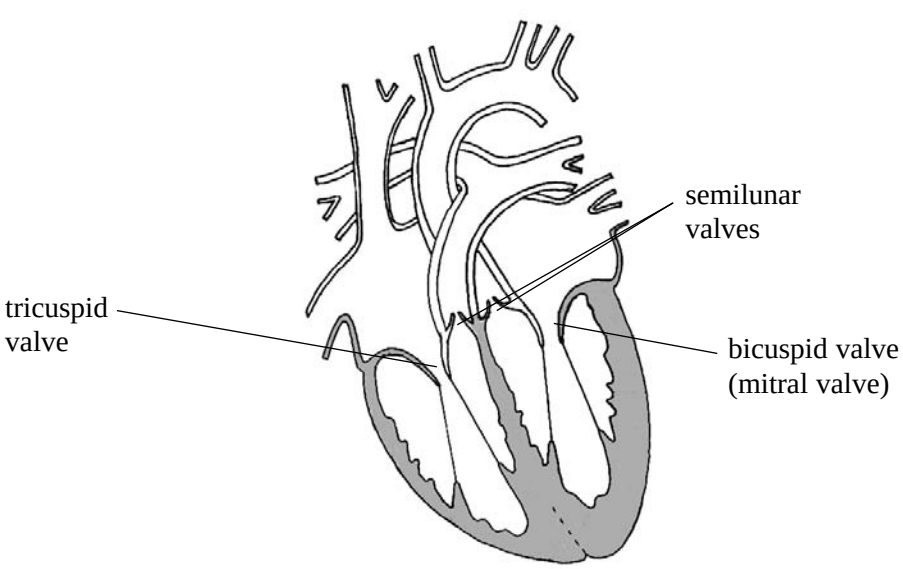
(2 marks)

(b) The diagram below shows a section through a human heart.



Write the letters **V** and **A** on the diagram to label the position of:

(i) the left ventricle (**V**); *(1 mark)*

(ii) the aorta (**A**). *(1 mark)*

(c) Complete the table below by writing the name of the blood vessel into which the blood from each ventricle flows.

Ventricle	Blood vessel
Left	
Right	

(2 marks)

9

Turn over for the next question

2 Many athletes who compete in international events go to train in the host country for several months before the event.
This helps them to acclimatise to the different conditions.
Sports scientists study the effects of climate on the physiology of athletes' bodies, paying particular attention to the regulation of body temperature.

(a) What is the normal body temperature, measured in the mouth?

.....

(1 mark)

(b) A female athlete, in good health, was found to have a body temperature of 38.5 ºC, but no infection.
What might she be suffering from?

.....

(1 mark)

(c) Non-athletes may, on occasion, experience a rise in body temperature when they are not exercising. For instance, the body is able to raise its temperature to above 37.2 ºC in response to conditions such as fever.
Explain how a rise in body temperature could aid recovery from a fever.

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(2 marks)

(d) Athletes need to maintain their fluid levels during long distance races in order to prevent dehydration occurring.

(i) Explain why dehydration causes less heat to be lost from the skin.

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(4 marks)

(ii) Apart from less heat being lost from the skin, explain **one** other reason why dehydration can cause a rise in body temperature.

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(2 marks)

(iii) A sports scientist measured the blood pressure of an athlete.
He discovered that the blood pressure was below normal as the athlete was severely dehydrated.
Explain why dehydration made the athlete's blood pressure fall.

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(1 mark)

11

Turn over for the next question

There are no questions printed on this page

3 During their training, nurses are taught about the link between cellular respiration and breathing.

(a) (i) State what is meant by *cellular respiration*.

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(1 mark)

(ii) Describe the role played by breathing in cellular respiration in humans.

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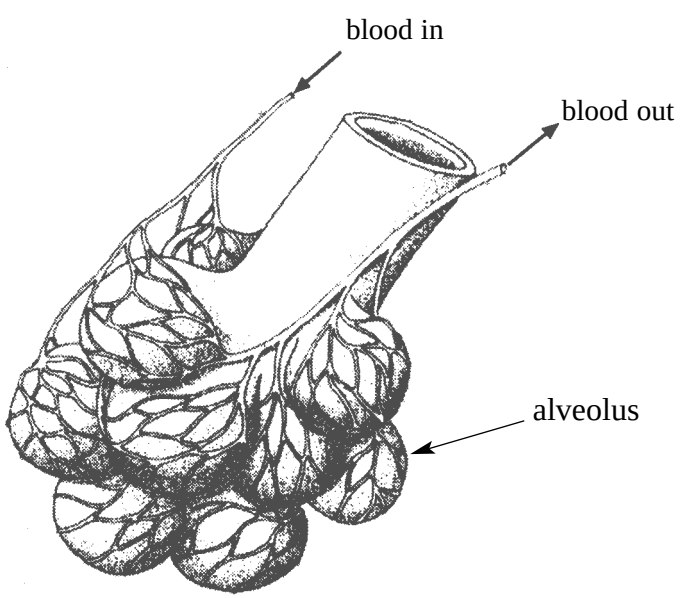
(2 marks)

(b) The diagram shows a small part of a human lung.



(i) Give **two** features of alveoli that aid the diffusion of gases.

1 .....

.....

2 .....

.....

(2 marks)

Question 3 continues on the next page

(ii) Describe how the blood vessels shown in the diagram on **page 7** help in the exchange of gases between the blood and the air in the lung.

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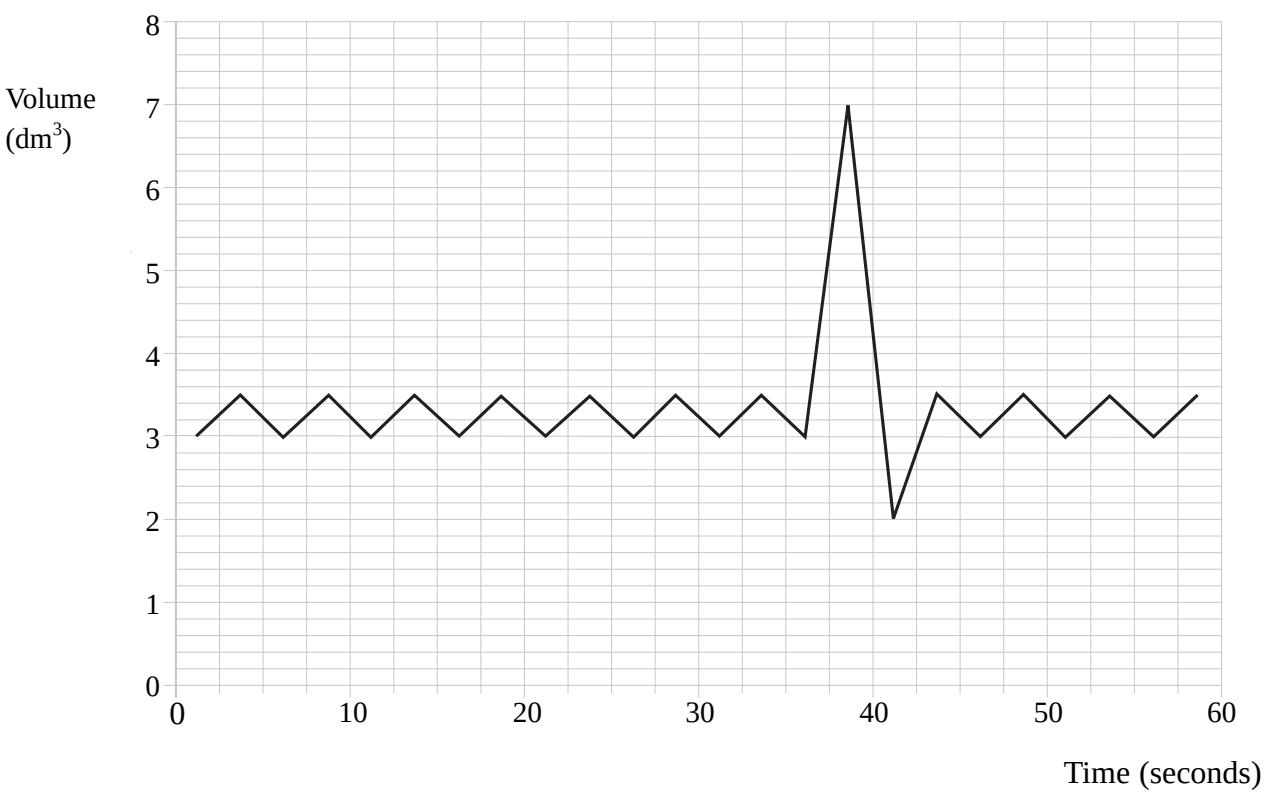
(3 marks)

(c) A specialist nurse, working in a chest clinic, monitored patients' lung function. The spirometer trace shown was made by an adult female patient.



(i) Calculate the average breathing rate of the woman in breaths per minute.

.....

.....

(1 mark)

(ii) Use the spirometer trace shown opposite to find the following measurements.

Tidal volume ..... dm^3 *(1 mark)*

Vital capacity ..... dm^3 *(1 mark)*

(d) In order to obtain more information about the health status of his patient, the nurse also measured her blood pressure.

(i) Describe the procedure the nurse would follow when measuring blood pressure using a sphygmomanometer.

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(4 marks)

(ii) How is a blood pressure reading usually expressed?

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(2 marks)

17

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4 A car designer is improving the front impact protection features of a car for passengers in a planned new model.

(a) (i) State the energy changes that happen in a crumple zone during a collision.

.....

.....

(2 marks)

(ii) Explain the advantages of using a longer crumple zone.

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(3 marks)

(iii) Some car bodies are made from glass fibre, and some are made from mild steel. Mild steel is more difficult to deform than glass fibre. Use this fact to explain why mild steel is preferred to glass fibre for use in the crumple zone

.....

.....

(1 mark)

(iv) Give another safety feature of the car which the designer could improve that uses the same principle as the crumple zone.
Explain how this will reduce injury in a collision.

Feature .....

Explanation .....

.....

(1 mark)

(v) Why is the damage done in a collision so dependent on the speed of the car?

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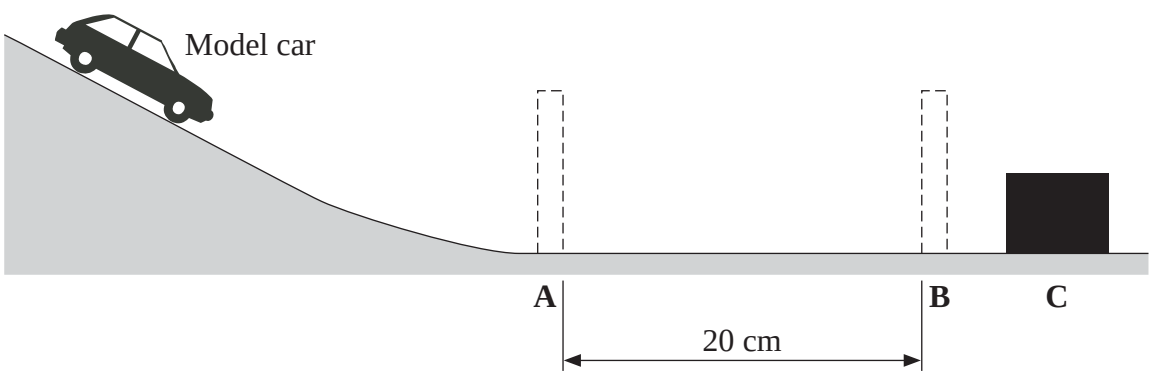
(*2 marks*)

(b) To investigate different designs of crumple zone, the designer intends to test a scale model of her new design. She decides to roll the model down a slope until it collides with a metal block, **C**, at the foot of the slope, as shown below.

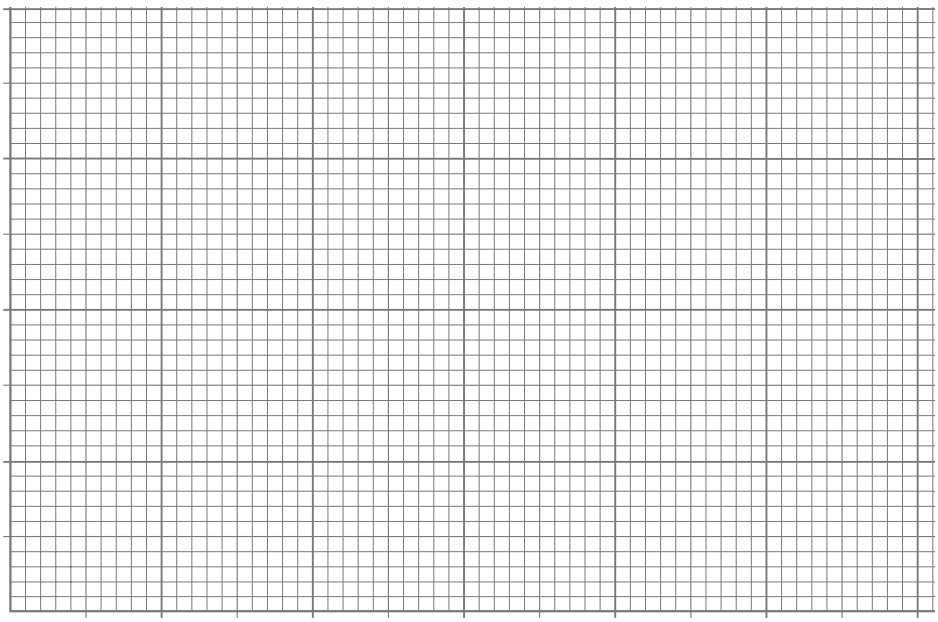
To measure the speed of the model car, she measures the time it takes to move between two light gates (**A** and **B**) 20 cm apart.



The results of one of the experiments are shown in the table below.

Time for model car to travel 20 cm (s)	Speed (m/s)	Original length of model car (cm)	Length of model car after collision (cm)	Change in length of model car (cm)
2.15	0.09	32	31.1	0.9
1.00	0.20	32	30.1	1.9
0.63	0.32	32	29.3	2.7
0.44	0.46	32	29.1	2.9
0.38	0.53	32	29.0	3.0

(i) On the grid below, plot a graph showing the change in length of the model car against its speed. Draw a line of best fit.



(3 marks)

(ii) Assuming that the effects of friction can be ignored, suggest how the speed, of the model car could be measured at the point of collision with the metal block, **C**.

.....

(1 mark)

(iii) What factors need to be controlled to make this investigation fair?

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(2 marks)

(iv) What does the shape of the graph tell you about the behaviour of the crumple zone in the model car?

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(2 marks)

5 An architect is designing a house that is intended to lose as little heat as is reasonably possible. It has a total external surface area of 400 m^2.

The architect has decided to specify a construction with a U-value of 0.3 W/m^2 K (W/m^2 °C).

(a) Explain what is meant by a *U-value of 0.3 W/m^2 K*.

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(3 marks)

(b) Use the following equation to calculate the rate of thermal transfer from this house, when the inside temperature is 20°C (293 K) and the outside temperature is 5°C (278 K).

rate = U-value × surface area × temperature difference.

.....

.....

.....

rate = ...W

(2 marks)

(c) A different house loses heat at a rate of 2 kW.
If it was heated by electricity costing 8 p per unit, calculate the annual cost of the wasted heat.

.....

.....

.....

.....

(2 marks)

(d) Give **two** environmental problems that arise from heating houses by electricity.

1 .....

.....

2 .....

.....

(2 marks)

(e) There are many ways of insulating a house to reduce energy loss. Explain why insulating the loft is more effective than fitting underfloor insulation.

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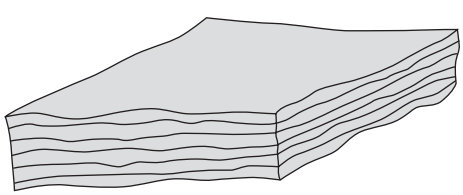
(2 marks)

(f) The diagram shows a typical piece of loft insulation.



Explain how a material suitable for use as loft insulation limits the rate at which thermal energy is passed from the house to the outside.

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(3 marks)

14

6 A boatbuilder decides to fit a solar panel to her boat. The solar panel will help to keep the battery charged and to operate lights and pumps when the petrol engine is not running. She has been told that in the UK the power of radiation from the Sun (reaching the surface of the Earth) is about 1000 watts per square metre.

(a) The solar panel has an area of 2 m^2. Estimate the maximum amount of energy in units (kilowatt-hours) reaching it in one week in summer. Comment on any assumption you make.

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energy =..... kWh

(3 marks)

(b) The maximum output of electrical power from the solar panel is 80 watts. Calculate the efficiency of the panel.

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(2 marks)

(c) What happens to the energy from the solar radiation that is **not** turned into electrical energy?

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(2 marks)

(d) Instead of recharging the battery by running the boat petrol engine it can be recharged from a mains power supply on shore.
The boat owner wishes to cause the least pollution possible, while recharging the battery.

State **one** advantage of recharging the battery from:

(i) running the boat engine.....

.....

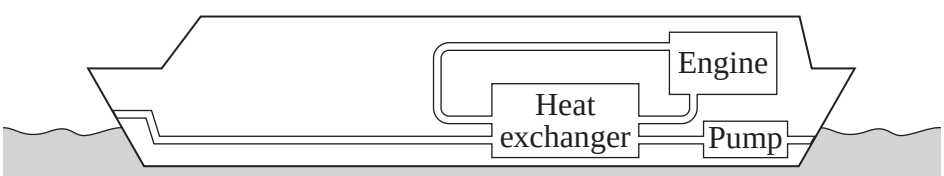
(1 mark)

(ii) mains power on shore .....

.....

(1 mark)

(e) Waste heat from the engine is passed to a heat exchanger, which is cooled by water pumped from the canal as shown.
The pump is switched on by a thermostat in the heat exchanger.



Suggest how this feedback system could keep the temperature of the engine reasonably constant.

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(3 marks)

12

END OF QUESTIONS

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