

Surname											Other Names										
Centre Number							Candidate Number														
Candidate Signature																					

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

General Certificate of Education  
January 2008  
Advanced Subsidiary Examination

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

**SC02**



Tuesday 15 January 2008 1.30 pm to 3.00 pm

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

Time allowed: 1 hour 30 minutes

**Instructions**

- Use black ink or black 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.

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			

---

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

---

- 1 (a) Gases are exchanged between the atmosphere and the blood through the respiratory surfaces of the lungs.

- (i) Name the process by which this takes place.

.....

.....

(1 mark)

- (ii) Haemoglobin is a pigment found in the red blood cells. It combines with oxygen to form oxyhaemoglobin.  
Where in the body would the concentration of oxyhaemoglobin be at its highest?

.....

.....

(1 mark)

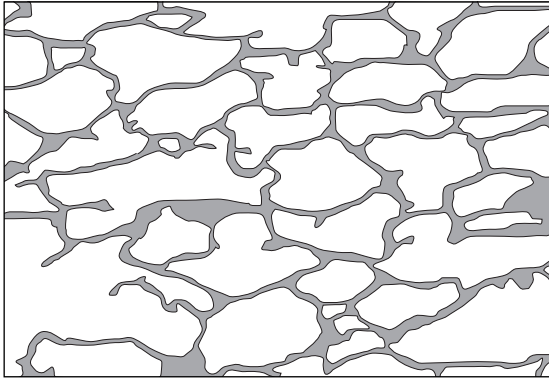
- (iii) The level of carbon dioxide in the blood is normally low in arteries and high in veins. However, one artery contains blood with a high level of carbon dioxide. Name this artery.

.....

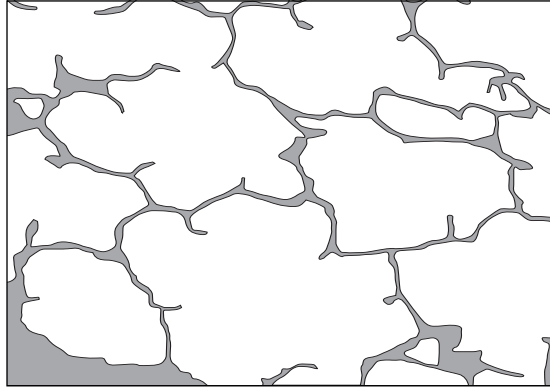
(1 mark)

- (b) Emphysema is a lung disease commonly found in ex-miners. It affects lung tissue. This is shown in the photomicrographs of alveoli which are to the same scale.

Alveoli in healthy lung tissue



Alveoli in lung tissue from a person with emphysema



People suffering from emphysema often experience severe breathing difficulties and can only walk for very short distances.

Use the evidence in the photomicrographs and your knowledge of the respiratory and cardiovascular systems to explain this.

.....

.....

.....

.....

.....

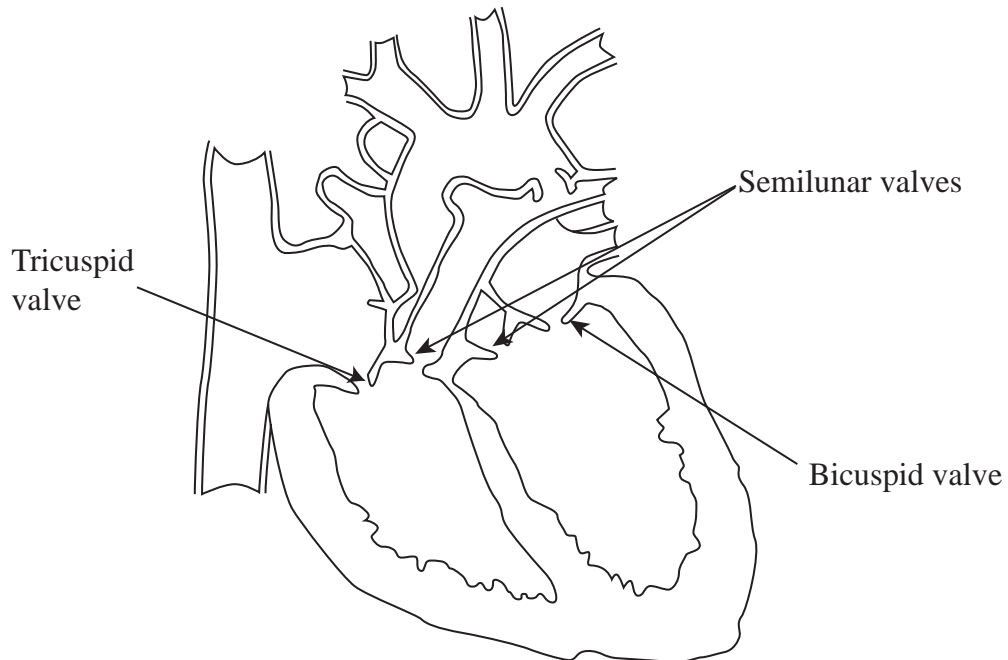
.....

.....

(4 marks)

**Question 1 continues on the next page**

- (c) This is a diagram of the heart. The heart has a double circulation.



- (i) Explain what is meant by a *double circulation*.

.....

.....

.....

.....

(2 marks)

- (ii) The semilunar valves and bicuspid valve help to maintain blood flow by preventing the back flow of blood in the heart. Name the regions of the heart that blood would flow into if each of the valves were damaged.

Semilunar valve .....

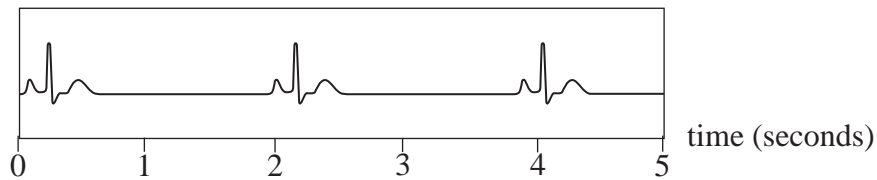
Bicuspid valve .....

(2 marks)

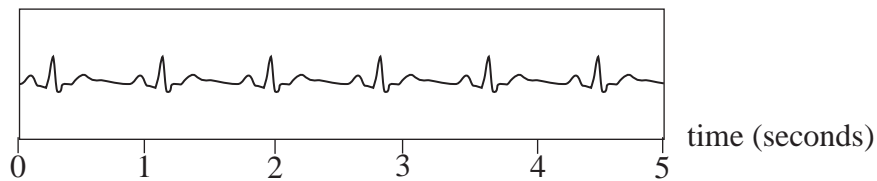
2 During a health assessment, an electrocardiogram (ECG) is recorded.

- (a) Label each of the following traces with the letter which best describes the type of heartbeat it shows. Choose letters from the list below.

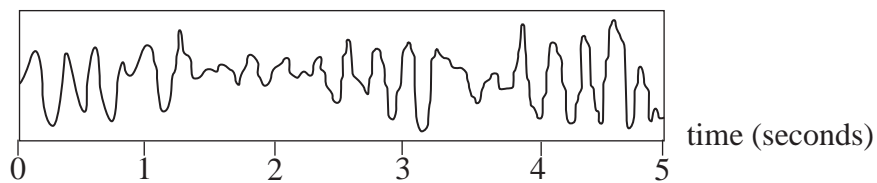
- A:** Normal heartbeat  
**B:** Tachycardia  
**C:** Bradycardia  
**D:** Ventricular fibrillation



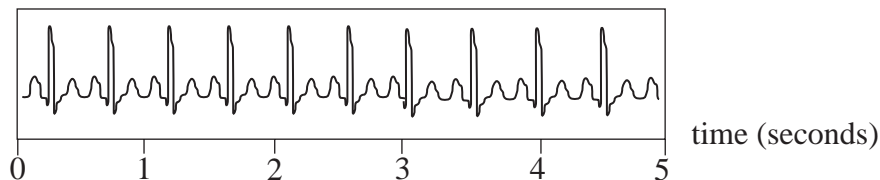
Type of heartbeat .....



Type of heartbeat .....



Type of heartbeat .....



Type of heartbeat .....

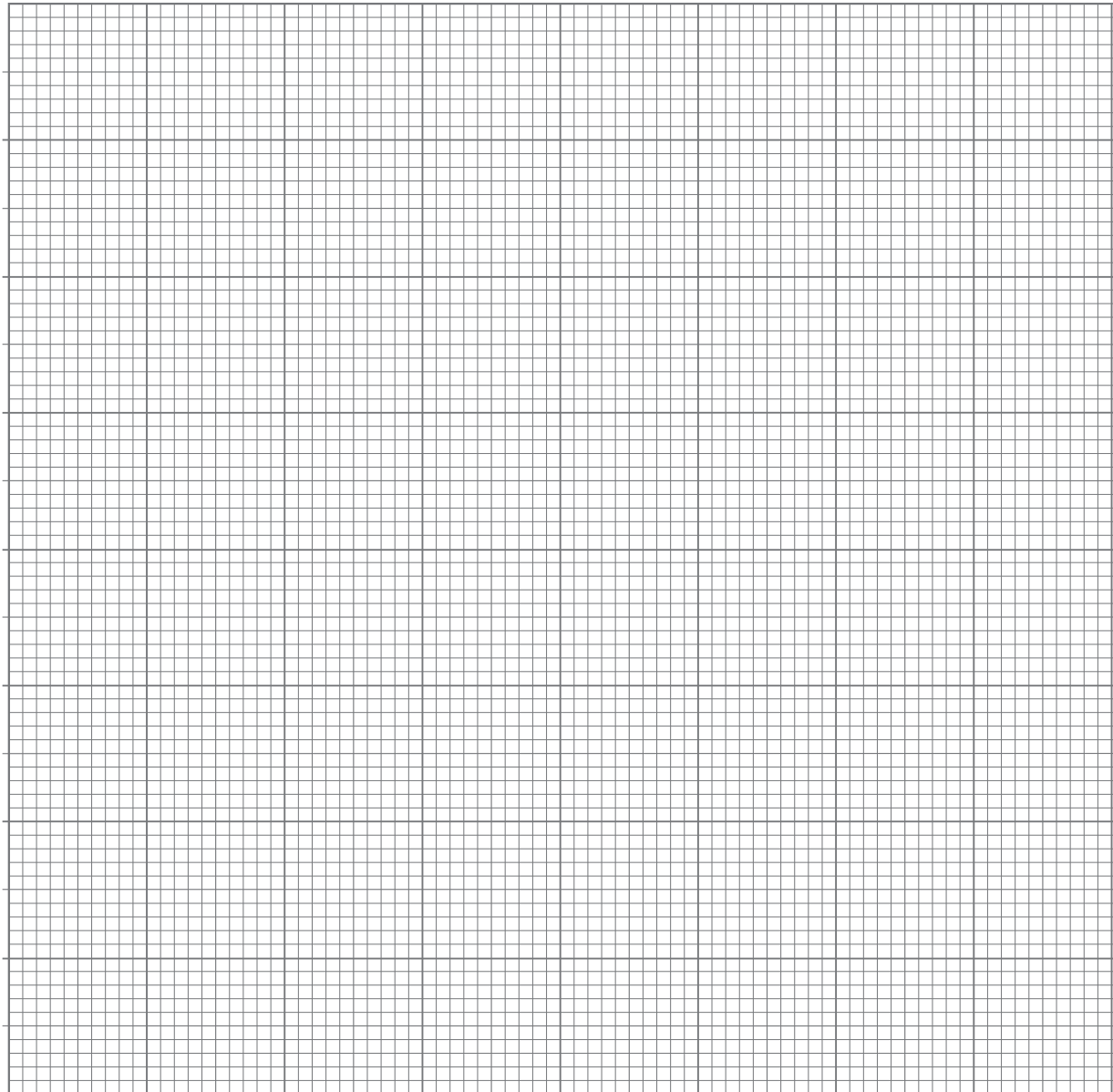
(4 marks)

Question 2 continues on the next page

- (b) During the health assessment, two people were asked to exercise for three minutes. Their pulse rates were recorded before, during and after exercise. The results are shown in the table below.

<b>Time (min)</b>	<b>Person 1 Pulse rate (beats per minute)</b>	<b>Person 2 Pulse rate (beats per minute)</b>
0	65	85
1	75	100
2	95	125
3	100	140
4	90	130
5	75	120
6	65	110

- (i) Plot the data on the grid below using suitable scales.



- (ii) Explain why the data in the table on **page 6** indicate why **Person 1** is fitter than **Person 2**.

.....

.....

.....

.....

.....

.....

(3 marks)

- (c) When the two people begin to exercise they need energy for muscle contraction. This is initially produced by aerobic respiration within the cells.

- (i) Explain how this happens.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

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

.....

.....

(2 marks)

- (d) What would be the probable physical status of a person with tachycardia?

.....

.....

(1 mark)

- 3 A mountain rescue team is called out to rescue a group of skiers who are trapped on a mountain during a snow storm. They are not prepared for a night in the open and do not have the necessary clothing to maintain their core body temperature.

(a) (i) What is the normal core body temperature? ..... °C  
(1 mark)

(ii) At what core body temperature does hypothermia set in?

..... °C  
(1 mark)

- (b) Another group of people, staying at the same hotel as the skiers, decide to make use of the sauna. Unfortunately, the thermostat is broken and the temperature in the sauna room becomes dangerously high. This causes some people to suffer heat stroke.

(i) In the absence of infection, at what temperature would heat stroke start to develop?

..... °C  
(1 mark)

(ii) If the group of people became unconscious and the temperature in the sauna room rose still higher this might result in death.  
Above which temperature is death likely to occur?

..... °C  
(1 mark)

- (c) How does the body try to maintain its core temperature when the temperature in the sauna room becomes too high?

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

- (d) Heat is generated by the body by chemical reactions taking place within it. Heat energy is constantly lost from the surface of the body through the skin.  
Name **three** other ways in which a small amount of heat is lost from the body.

1 .....

2 .....

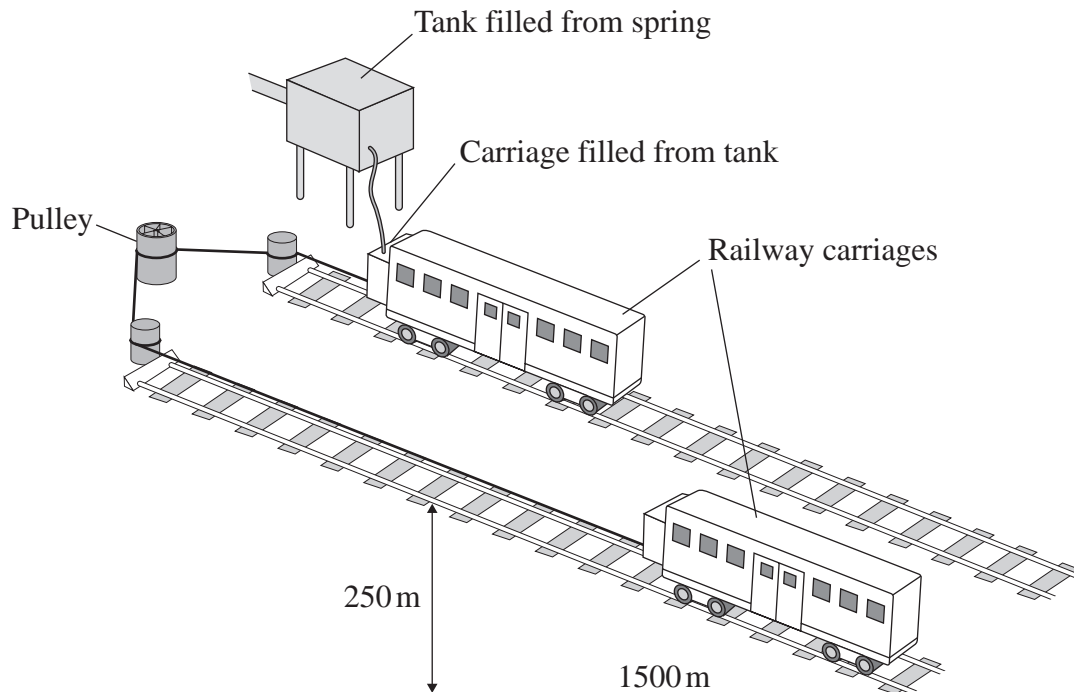
3 .....

(3 marks)

11
----

**Turn over for the next question**

- 4 A railway company intends to build a mountain railway operated by water power. There are to be two carriages, one at each end of a wire cable. The cable will run over a pulley near the top of the mountain.



Water is poured from a natural spring at the top station into a water tank in the upper carriage. When the upper carriage (and water) weighs more than the lower carriage plus passengers, the driver releases the brakes and the upper carriage rolls down the railway, pulling the lower carriage up the slope. When each carriage reaches the other station the driver applies the brakes. The lower carriage then empties its water tank.

- (a) What form of energy is being used to drive this railway?

.....  
(1 mark)

- (b) Some passengers, with a total mass of 600 kg, get into the lower carriage. They are lifted a total of 250 m vertically above their starting point, as they move a distance of 1500 m horizontally.

How much energy is transferred to the passengers?

(Assume the acceleration due to gravity  $g = 10 \text{ m s}^{-2}$ )

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

.....joules  
(2 marks)

- (c) In practice, more energy than the amount calculated in part (b) has to be supplied to move the carriages from one station to the other.  
Explain why.

.....

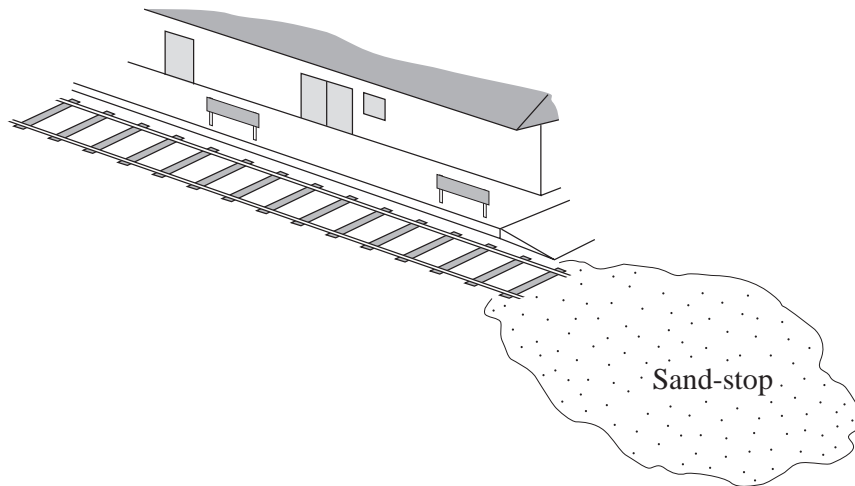
.....

.....

.....

(2 marks)

- (d) As an extra safety measure, a sand-stop is fitted at each end of the line. A sand-stop is a length of railway track covered with sand to a height of around a metre. The sand is held in place by a strong bank of earth on both sides of the track.



Explain how the sand-stop halts the train if it passes the end of the station.

.....

.....

.....

.....

(2 marks)

- (e) Why would a longer, shallower sand-stop be better than a shorter deeper one?

.....

.....

.....

.....

(2 marks)

- (f) In an emergency, the sand-stop needs to be able to stop a train of mass 2500 kg moving at a speed of  $8 \text{ m s}^{-1}$ .

- (i) How much kinetic energy does this train have?

.....

.....

.....

.....

(2 marks)

- (ii) The sand-stop halts the train in 2.0 seconds. What is the rate of energy transfer? Include the correct unit in your answer.

.....

.....

.....

(2 marks)

- 5 You are considering buying a portable music player for a friend's birthday. It uses energy stored in a battery, which is recharged from the mains.

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

.....  
(1 mark)

(ii) State **two** forms of energy that the music player produces.

.....  
.....  
(2 marks)

- (b) The battery can store 54 000 joules of energy. A fully-charged battery can only transfer 45 900 joules to the music player.

What is the efficiency of the battery in the music player?

.....  
.....  
.....  
(2 marks)

5
---

**Turn over for the next question**

- 6 A food store manager has decided to replace her old freezer with a newer one, which is more energy efficient. All the freezers she might choose have the same internal volume, but some have thicker walls than the others.

(a) Why would a thicker wall suggest that a freezer would be more energy efficient?

.....

.....

.....

.....

(2 marks)

(b) Suggest a material to use in filling the wall. Explain how it reduces heat loss by conduction and by convection.

.....

.....

.....

.....

(4 marks)

(c) Would you expect a well-designed freezer to have a thicker top or thicker base? Explain why you think your choice would make the freezer more energy efficient.

.....

.....

.....

.....

(2 marks)

(d) The freezer uses an electric heat pump to pump heat out of the food to a heat sink on the outside. Heat is lost from the heat sink by radiation. What colour should the heat sink be?

.....

(1 mark)

- (e) After months of use, ice builds up between the inside of the heat pump and the food container. Explain why this would make the freezer less effective.

.....

.....

.....

.....

.....

(2 marks)

- (f) A thermostat controls the temperature of the freezer. The thermostat works using a bimetallic strip. A bimetallic strip bends in one direction when it is hot, and in the opposite direction when it is cold.  
Explain how this could operate an electric circuit that operates the freezer's heat pump and keeps the freezer's temperature almost constant.

.....

.....

.....

.....

.....

.....

(3 marks)

- (g) One manufacturer claims that his freezer draws a maximum power of 600 watts, and that the heat pump is typically on for 4 hours a day. Electricity costs 15p per unit (kWh).  
Calculate the expected cost of running this freezer for one day.  
(You may ignore the power used by the rest of the freezer.)

.....

.....

.....

.....

(2 marks)

- 7 While flying to Spain you became interested in the force supplied by the aircraft engines as it takes off. You used your watch to time the take-off run and found the take-off speed and typical aircraft mass from the travel website. This gave you the information to work out the acceleration, and thus the force from the engines.

Typical information:

time to accelerate to take-off speed	= 20 seconds
take-off speed	= $70 \text{ m s}^{-1}$
mass of aircraft at take-off	= 50 000 kg

(You do not need to do this calculation; these figures are provided to give a feel for the data.)

- (a) You are allowed to talk to the pilot after the flight, but you are not allowed on the flight deck during the flight because of security rules. You are also able to spend a day at the airport if you wish. How might you improve the accuracy of your data for the following:

- (i) the time needed to reach take-off speed,

.....

.....

.....

(2 marks)

- (ii) the actual take-off speed?

.....

.....

(1 mark)

- (b) What precaution would you take to make sure your data were valid?

.....

.....

(1 mark)

- (c) Give **two** disadvantages of cheap mass air travel.

1 .....

.....

2 .....

.....

(2 marks)

**END OF QUESTIONS**