Surname		Other Names	
Centre Number			Candidate Number									
Candidate Signature												

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General Certificate of Education
January 2004
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

BIOLOGY/HUMAN BIOLOGY (SPECIFICATION A) BYA1
Unit 1 Molecules, Cells and Systems

Thursday 8 January 2004 Morning Session

In addition to this paper you will require:
- a ruler with millimetre measurements.

You may use 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 in the spaces provided. All working must be shown.
- Do all rough work in this book. Cross through any work you do not want marked.

Information
- The maximum mark for this paper is 75.
- Mark allocations are shown in brackets.
- You will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate.
- The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

For Examiner's Use			
Number	Mark	Number	Mark
1			
2			
3			
4			
5			
6			
7			
8			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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

1 A solution contains a mixture of two different sugars.

(a) Describe how you could use Benedict's reagent to show that this solution

(i) does **not** contain a reducing sugar;

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(2 marks)

(ii) contains non-reducing sugars.

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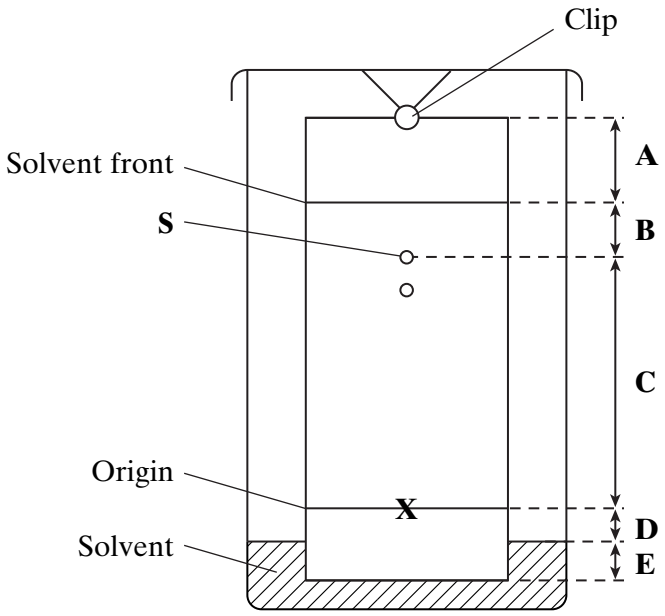
(3 marks)

(b) The diagram shows apparatus used to separate these sugars by chromatography.



A pencil line was ruled on the chromatography paper to mark the origin. A concentrated spot of the solution was produced at **X**.

(i) Explain why the origin should be marked with a pencil and not in ink.

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(1 mark)

(ii) Describe how you would produce a concentrated spot at **X**.

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(2 marks)

(c) Use the appropriate letters from **A**, **B**, **C**, **D** and **E** to write a simple equation to show how the Rf value of the sugar in spot **S** could be calculated.

Rf =

(1 mark)

9

2 (a) Tissue fluid is formed from blood plasma. Complete the table to show substances present in tissue fluid and blood plasma. Use a tick if the substance is present and a cross if it is absent.

	Substance		
	Glucose	**Sodium ions**	**Haemoglobin**
Tissue fluid			
Blood plasma			

(2 marks)

(b) The hydrostatic pressure of the blood at the arteriole end of the capillary helps to form tissue fluid. Explain how.

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(2 marks)

(c) (i) Tissue fluid contains dissolved oxygen. By what process does this oxygen enter cells?

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(1 mark)

(ii) The amount of oxygen entering these cells changes when their rate of respiration increases. Use Fick's law to explain how.

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(3 marks)

8

3 The pressure of the blood in an artery was measured during a cardiac cycle. The minimum pressure was 9.6 kPa and the maximum pressure was 13.4 kPa.

(a) Describe how the increase in pressure of the blood in the artery results from the events in the cardiac cycle.

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(2 marks)

(b) The elastin fibres in the wall of the artery help to smooth out the flow of blood. What happens to these fibres as the pressure of the blood in the artery changes?

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(2 marks)

(c) Give **one** way in which the structure of the wall of an artery is similar to the structure of the wall of a capillary.

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(1 mark)

5

TURN OVER FOR THE NEXT QUESTION

4 (a) Explain why both the heart and arteries are described as organs.

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(1 mark)

The table shows changes in the volume of blood in the left ventricle over a period of one second.

Time/s	Volume of blood as percentage of maximum
0	70
0.1	100
0.2	70
0.3	30
0.4	0
0.5	35
0.6	60
0.7	70
0.8	70
0.9	100
1.0	70

Use information in the table to answer the following questions.

(b) What is the approximate length of one cardiac cycle?

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(1 mark)

(c) At what time is there least blood in the *right* ventricle? Explain your answer.

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(1 mark)

(d) (i) Between which times are the muscles in the wall of the left atrium contracting? Give the reason for your answer.

Times .....

Reason .....

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(1 mark)

(ii) Between which times are the semilunar valves in the arteries open? Give the reason for your answer.

Times .....

Reason .....

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(1 mark)

(e) The maximum volume of blood in the left ventricle is 45 cm^3. Calculate the volume of blood in the left ventricle at 0.5 s. Show your working.

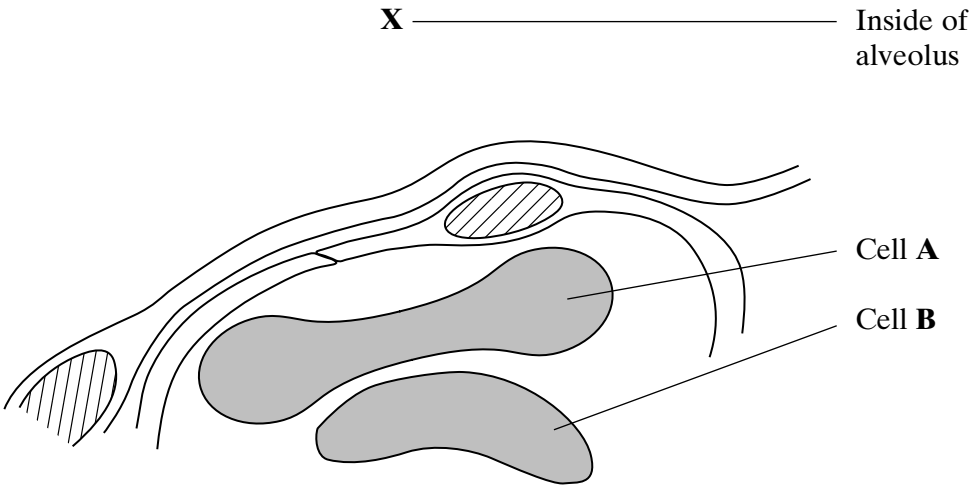
Volume of blood = ... cm^3

(2 marks)

7

TURN OVER FOR THE NEXT QUESTION

5 The drawing shows an electron micrograph of a section through part of an alveolus from a lung.



(a) Describe the path of a molecule of oxygen from the air in the alveolus at **X** to the plasma membrane of cell **A**.

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(1 mark)

(b) Cell **A** is a eukaryotic cell. Give **two** features that may be found in a prokaryotic cell which are not found in cell **A**.

1 .....

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2 .....

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(2 marks)

(c) Cells **A** and **B** are biconcave discs. Explain **one** advantage of a biconcave disc over a spherical cell of the same volume in transporting oxygen.

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(2 marks)

(d) The diameter of a human red blood cell is 7 μm.

(i) Calculate the magnification of the drawing. Show your working.

Magnification =.....
(2 marks)

(ii) In calculating the magnification, what assumption did you have to make about how the section was cut?

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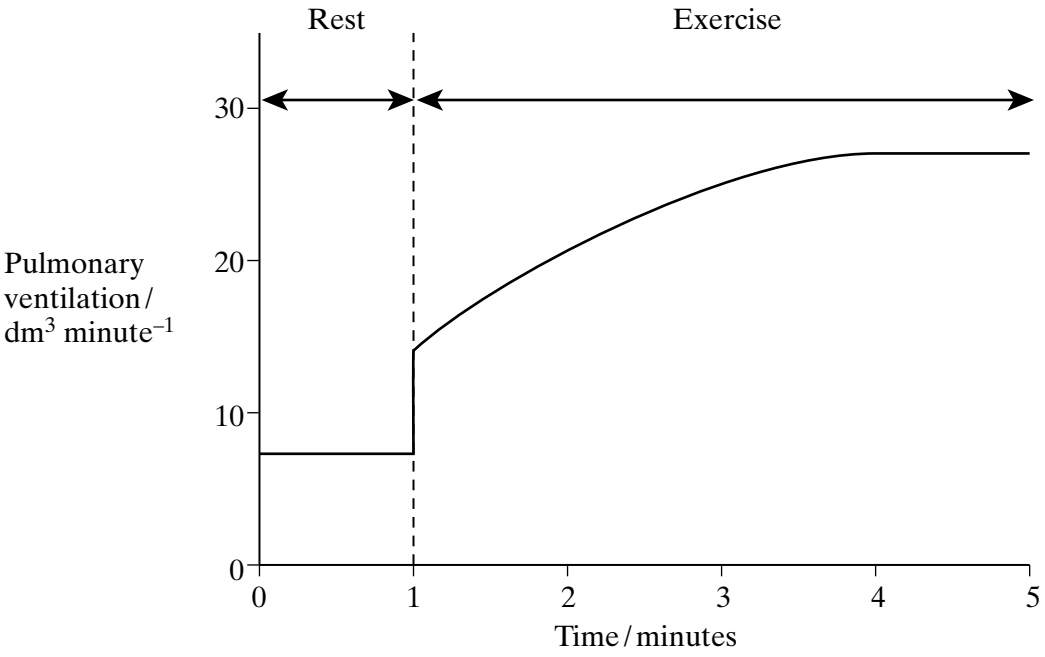
(1 mark)

8

TURN OVER FOR THE NEXT QUESTION

6 The graph shows how pulmonary ventilation changes during a period of exercise.



(a) Describe how pulmonary ventilation changed during the period of exercise.

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(1 mark)

(b) After 4 minutes of exercise, the breathing rate was 20 breaths per minute. Explain how you could use this information and the graph to calculate tidal volume.

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(2 marks)

(c) Describe how the phrenic nerve and muscles increase breathing rate during exercise.

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(3 marks)

(d) When a person starts to breathe out, the percentage of oxygen in the air first exhaled is the same as the percentage of oxygen in the atmospheric air. Explain why.

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(2 marks)

8

TURN OVER FOR THE NEXT QUESTION

7 Read the following passage.

Human milk contains all the nutrients a young baby needs in exactly the right proportions. It is formed in the mammary glands by small groups of milk-producing cells. These cells absorb substances from the blood and use them to synthesise the lipids, carbohydrates and proteins found in milk. Milk-producing cells are roughly cube-shaped and have a height to breadth ratio of approximately 1.2 : 1.

The main carbohydrate in milk is lactose. Lactose is a disaccharide formed by the condensation of two monosaccharides, glucose and galactose. (A molecule of galactose has the same formula as a molecule of glucose – the atoms are just arranged in a different way.)

Lactose is synthesised in the Golgi apparatus and transported in vesicles through the cytoplasm. Because lactose is unable to escape from these vesicles, they increase in diameter as they move towards the plasma membrane. The vesicle membranes fuse with the plasma membrane and the vesicles empty their contents out of the cell.

Use the information from the passage and your own knowledge to answer the following questions.

(a) (i) The breadth of a milk-producing cell is 26 μm. Calculate the height of this cell.

Height = ... μm

(1 mark)

(ii) Describe and explain how you would expect the height to breadth ratio of an epithelial cell from a lung alveolus to differ from the height to breadth ratio of a milk-producing cell.

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(2 marks)

(b) How many oxygen atoms are there in a molecule of

(i) galactose;

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(1 mark)

(ii) lactose?

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(1 mark)

(c) The lactose-containing vesicles increase in diameter as they move towards the plasma membrane of the milk-producing cell (lines 11-12). Use your knowledge of water potential to explain why.

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(2 marks)

(d) Suggest **one** advantage of milk-producing cells containing large numbers of mitochondria.

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(2 marks)

(e) Some substances pass through the plasma membrane of a milk-producing cell by diffusion. Describe the structure of a plasma membrane and explain how different substances are able to pass through the membrane by diffusion.

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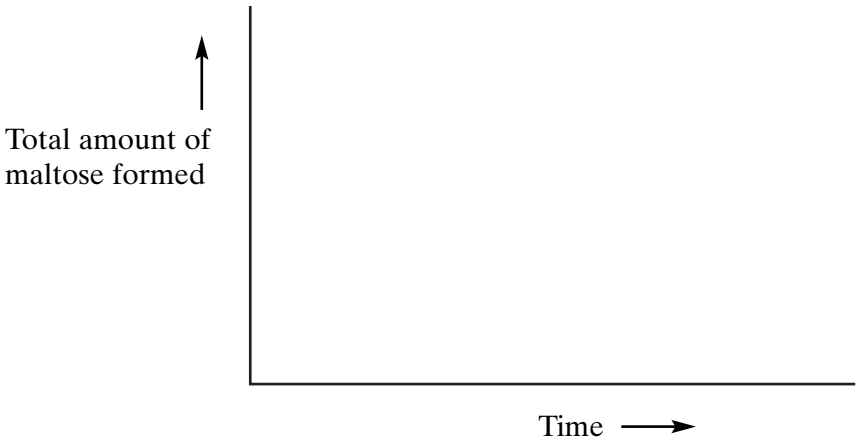
(6 marks)

8 (a) Amylase is an enzyme which hydrolyses starch to maltose. Some amylase and starch were mixed and the mixture incubated at 37 °C until the reaction was complete.

(i) Sketch a curve on the axes below to show the progress of this reaction.



(1 mark)

(ii) Explain why the rate of the reaction decreases as the reaction progresses.

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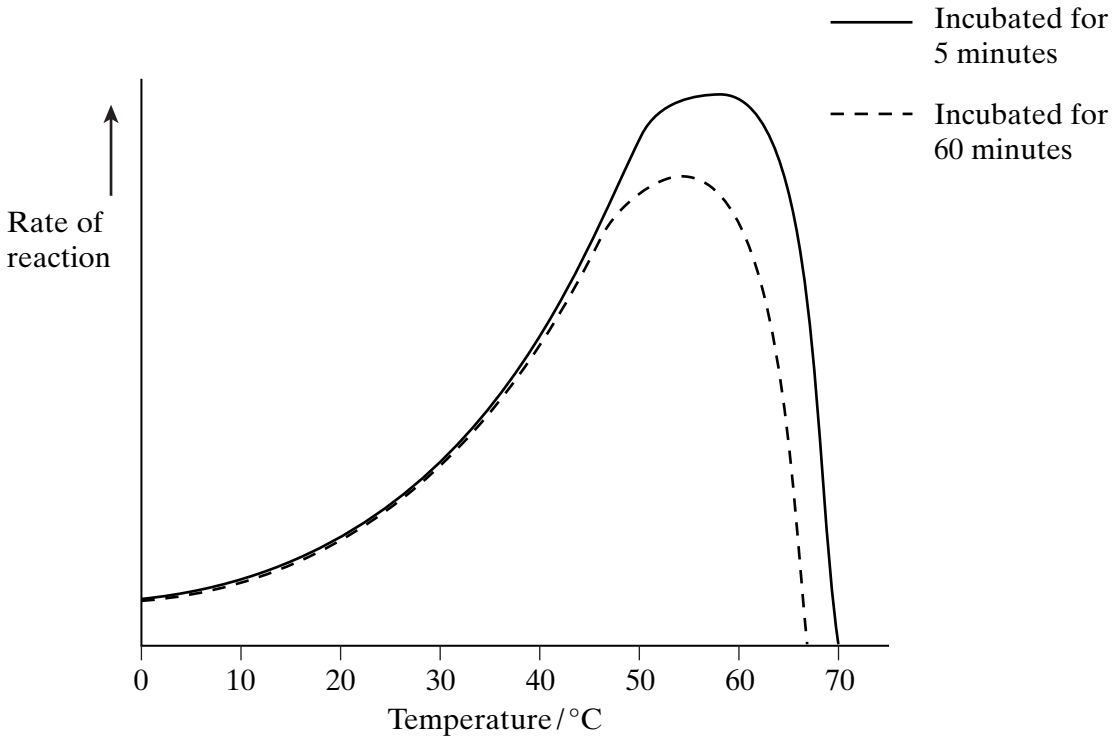
(2 marks)

The effect of temperature on the rate of reaction of an enzyme was investigated. A test tube containing the enzyme and a test tube containing the substrate were incubated separately at each of the temperatures being investigated.
After 5 minutes, they were mixed and the rate of reaction was determined. The experiment was repeated but, this time, the enzyme and the substrate were left for 60 minutes before they were mixed.
The results of the investigation are shown in the graph.



(b) The enzyme solution used in this investigation was made by dissolving a known mass of enzyme in a buffer solution. Explain why a buffer solution was used.

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(1 mark)

(c) (i) Use the graph to describe how incubation time affects the rate of the reaction.

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(2 marks)

QUESTION 8 CONTINUES ON THE NEXT PAGE

(ii) The maximum rate of reaction with an incubation time of 60 minutes is less than the maximum rate of reaction with an incubation time of 5 minutes. Explain why.

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(3 marks)

(d) Explain how inhibitors affect the rate of enzyme-controlled reactions.

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(6 marks)

END OF QUESTIONS