Oxford Cambridge and RSA

Friday 15 October 2021 – Morning

AS Level Biology B (Advancing Biology)

H022/02 Biology in depth

Time allowed: 1 hour 30 minutes

You can use:
- a scientific or graphical calculator
- a ruler (cm/mm)

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space you should use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE
- Read each question carefully before you start your answer.

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Answer **all** the questions.

1 **Fig. 1.1** is a photomicrograph showing some of the cells that line the bronchus.

Fig. 1.1

(a) **(i)** State the function of the cell labelled **X** in **Fig. 1.1**.

..... **[1]**

(ii) Calculate the magnification of the image in **Fig. 1.1**.

Magnification = ... **[2]**

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(b) During an asthma attack, drugs known as bronchodilators can be used to increase the lumen diameter of the bronchus and therefore increase the oxygen consumption.

Fig. 1.2 shows the effect of saline and two different bronchodilators, Fenoterol and Salbutamol, on a patient following an asthma attack. The saline and the bronchodilators were breathed in using a device called a nebuliser which converts liquids into a fine mist.

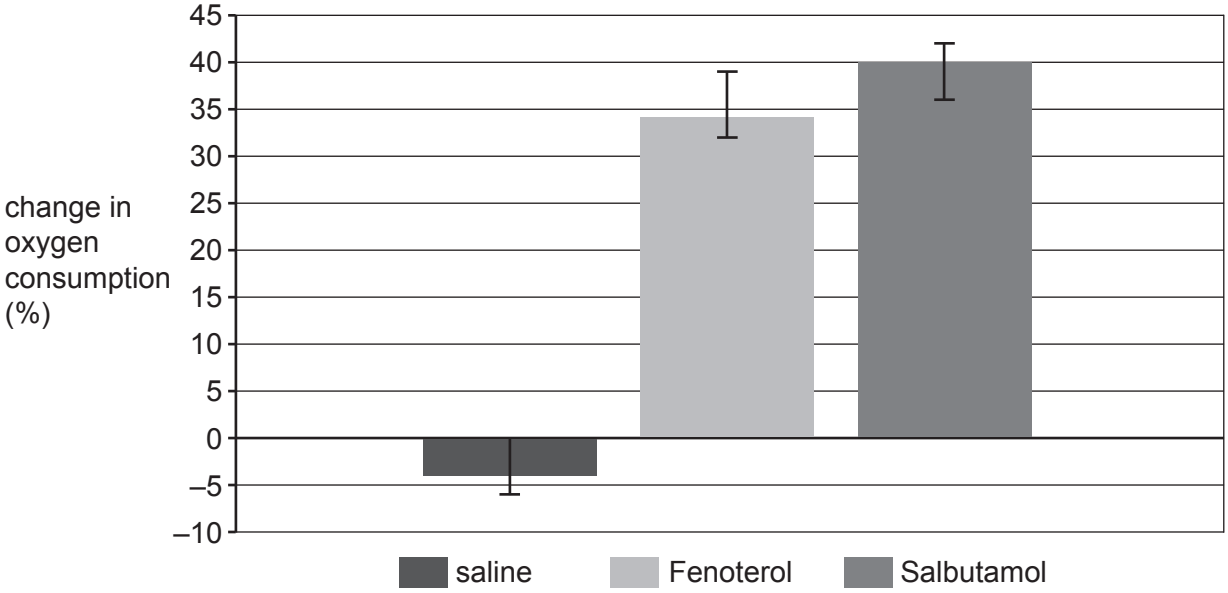

Fig. 1.2

A doctor concluded that:

'Salbutamol is the best drug for the treatment of asthma.'

Evaluate the doctor's claim.

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..... **[4]**

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(c) Saline is salt solution.

Using your knowledge of osmosis, explain how breathing in a fine mist of saline could reduce oxygen consumption.

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..... **[2]**

(d)* Eosinophils are a type of white blood cell involved in producing allergic responses during an asthma attack.

A scientist wanted to calculate the diameter of the eosinophils from a blood sample using a microscope.

Describe how the scientist could use a microscope to work out the diameter of eosinophils **and** gain accurate and reproducible results.

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..... **[6]**

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Additional answer space if required.

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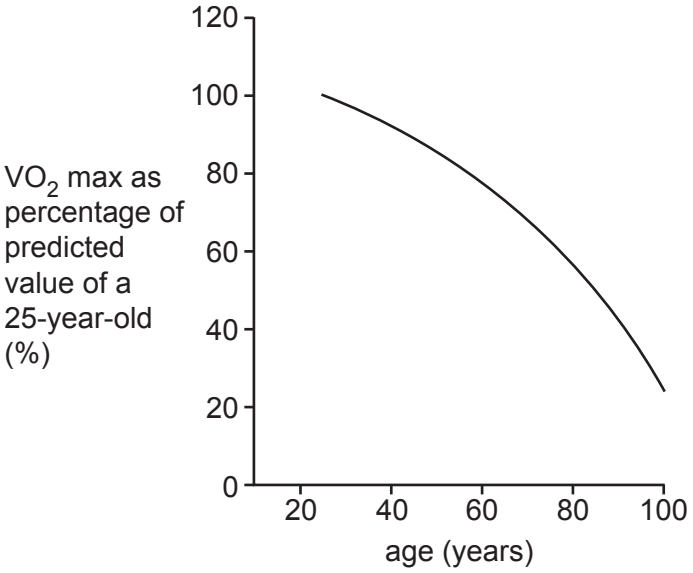
2 Ageing causes a reduction in lung function.

VO_2 max is the maximum rate at which oxygen can be taken in, transported and used.

The graph shows the change in VO_2 max as a percentage of predicted value of an average 25-year-old.



(a) In the graph, a comparison is made with the VO_2 max of an average 25-year-old.

Give **one** reason why the VO_2 max was not compared with a younger person **and one** reason why it was not compared with an older person.

Not compared with a younger person because .....

.....

Not compared with an older person because .....

.....
[2]

(b) Suggest why there is a decrease in the VO_2 max of people as they get older.

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..... **[2]**

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(c) Respiratory arrest is a condition when a patient stops breathing. The first-aid treatment for respiratory arrest is to perform expired air resuscitation on the casualty.

Describe the differences in the method used for expired air resuscitation when treating adults compared to treating babies.

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..... **[3]**

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3 Trypsin is an enzyme found in the digestive system of mammals. The enzyme is used to digest casein, a protein found in milk. The products of casein digestion can then be absorbed into the blood.

Casein is a white protein that turns colourless when it is hydrolysed.

A student wanted to investigate how the concentration of trypsin affects the hydrolysis of casein.

Trypsin was mixed with casein and placed into dialysis tubing and then placed into a beaker of warm water as shown in **Fig. 3.1**.

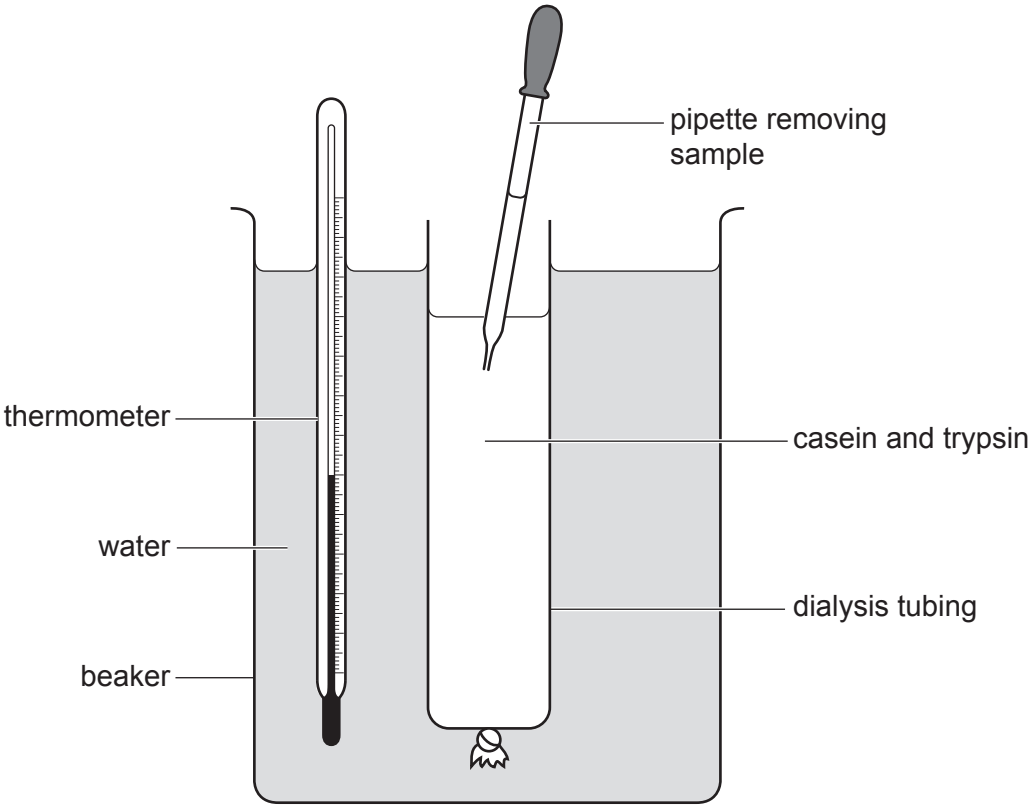

Fig. 3.1

Every minute a sample was removed from the dialysis tubing and was placed immediately into a colorimeter. The absorbance was recorded by the colorimeter.

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(a) **(i)** State the independent and dependent variables in this investigation.

Independent variable .....

Dependent variable .....
[1]

(ii) The temperature of the water in the beaker was maintained at 30 °C.

Explain why the temperature had to be controlled.

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..... **[2]**

(iii) Temperature was maintained by adding hot water to the beaker.

Give **one** method of maintaining temperature that is more accurate than adding hot water.

..... **[1]**

(b) State **two** variables, other than temperature, that should have been controlled in the investigation **and** explain why they could alter the results if they were not controlled.

Variable 1 .....

Explanation .....

.....

Variable 2 .....

Explanation .....

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[4]

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(c) Protein shakes containing casein are regularly used by athletes as a protein supplement.

Fig. 3.2 shows the percentage of casein hydrolysed in the body following the consumption of a protein shake.

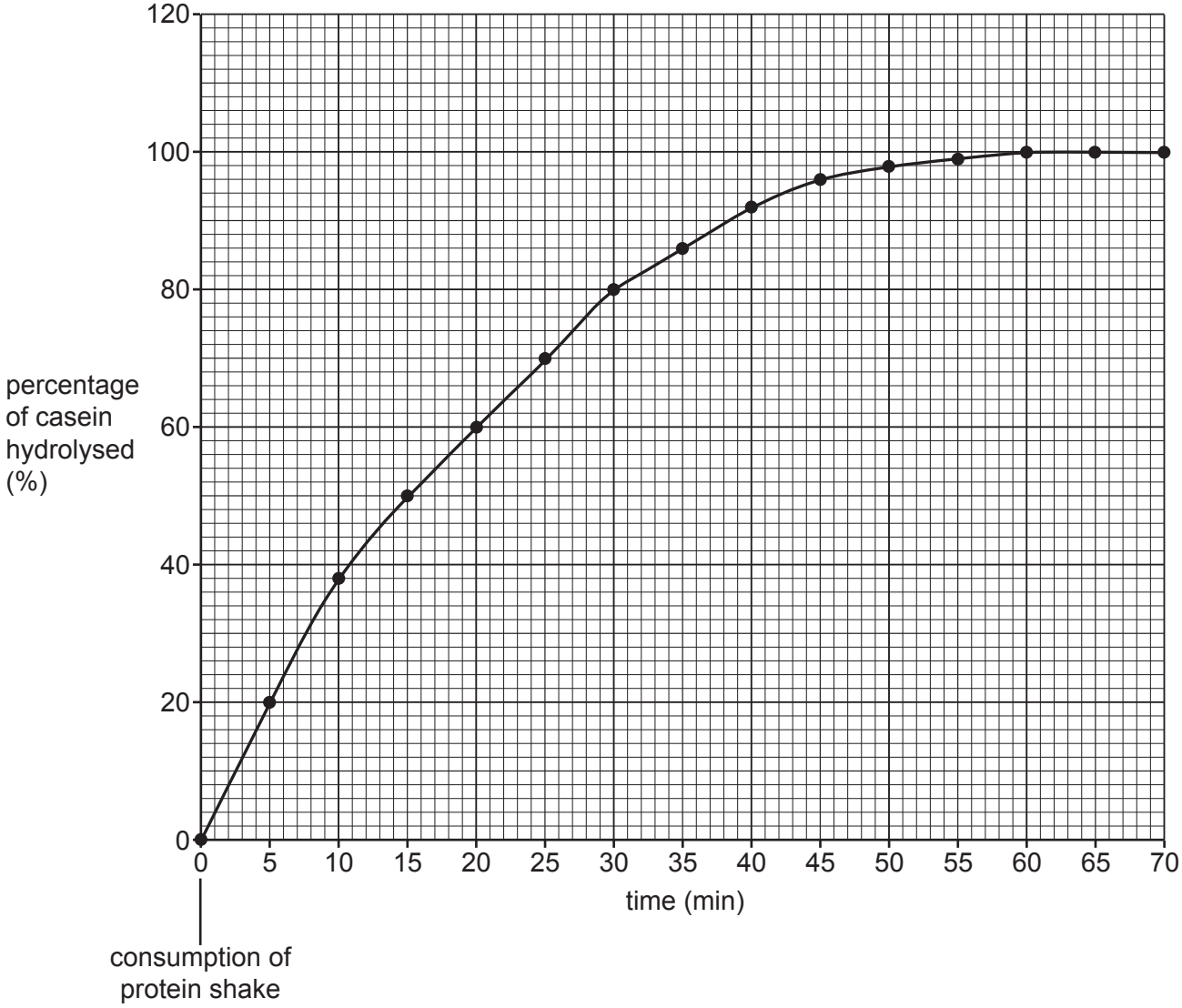

Fig. 3.2

A leading brand of protein shake contains 26 g of casein per drink.

Draw a tangent on Fig. 3.2 and use it to calculate the rate of casein hydrolysis at 30 minutes after consuming this protein shake.

Rate = ... $g\,min^{-1}$ **[3]**

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(d) Soybean Trypsin Inhibitor, a naturally occurring inhibitor of trypsin, is found in soybeans.

Suggest why animals fed on a diet of soybeans may have reduced muscle growth.

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..... **[2]**

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4 It is estimated that 100 000 people in the UK carry the Human Immunodeficiency Virus (HIV).

Fig. 4.1 shows the structure of HIV.

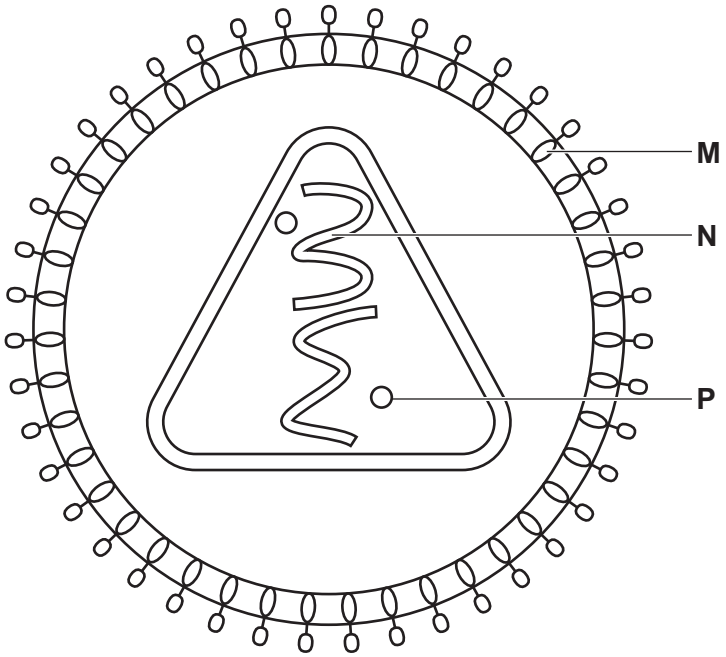

Fig. 4.1

(a) **(i)** State the roles of the following structures.

M .....

N .....
[2]

(ii) Identify molecule **P**.

P ..... **[1]**

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(b)* The UK has tried to control the spread of HIV since its discovery in 1981.

Describe how HIV can be transmitted between individuals **and** explain why this has resulted in difficulty in controlling the spread of the disease.

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Additional answer space if required.

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(c) **(i)** HIV infections can be detected by two different tests.

- A nucleic acid test can detect HIV infection 10 to 33 days after an exposure.
- An antigen blood test can detect HIV infection 18 to 45 days after an exposure.

Suggest why it takes longer after exposure for an antigen blood test to detect HIV infection compared to a nucleic acid test.

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..... **[2]**

(ii) The time taken for HIV to replicate is called one HIV life cycle.

It takes 16 hours to go through one HIV life cycle.

After one HIV life cycle, 300 viruses are produced from one original virus.

Starting with this one original virus, calculate the minimum number of HIV viruses present when an antigen blood test could detect the viruses.

Give your answer in standard form.

Number of viruses = ... **[3]**

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(d) The blood of people living with HIV contains antibodies that can neutralise a range of different strains of the HIV virus.

Researchers combined portions of these antibodies to produce antibodies in the laboratory known as tri-specific antibodies. These can bind to three different sites on the virus. **Fig. 4.2** shows the structure of a tri-specific antibody.

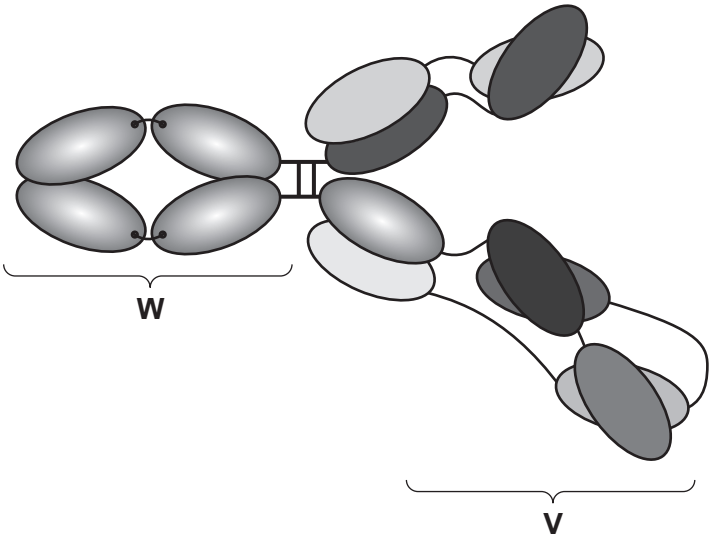

Fig. 4.2

(i) Name the region of the antibody labelled **W** and state its function.

Name .....

Function .....

.....

..... **[2]**

(ii) Explain how the structure of the region labelled **V** allows the antibody to bind to different antigens on different viruses.

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..... **[2]**

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5 Energy drinks are sports supplements used by some athletes.

A sports scientist wanted to investigate the reducing sugar content of one of the drinks.

They used the following method:

1. Take a 5% glucose solution and add it to a labelled test tube.
2. Add excess Benedict's reagent.
3. Boil the sample in a water bath.
4. Filter the solution using filter paper.
5. Dry the filter paper and measure the mass of precipitate.
6. Repeat steps 1–5 for glucose concentrations of 4%, 3%, 2% and 1%.
7. Plot a graph of concentration of glucose against the mass of precipitate.
8. Repeat steps 1–5 for the energy drink.

(a) State **three** improvements that the scientist could make to the method.

1 .....

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2 .....

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3 .....

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[3]

(b) Suggest a suitable control for the investigation.

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..... **[1]**

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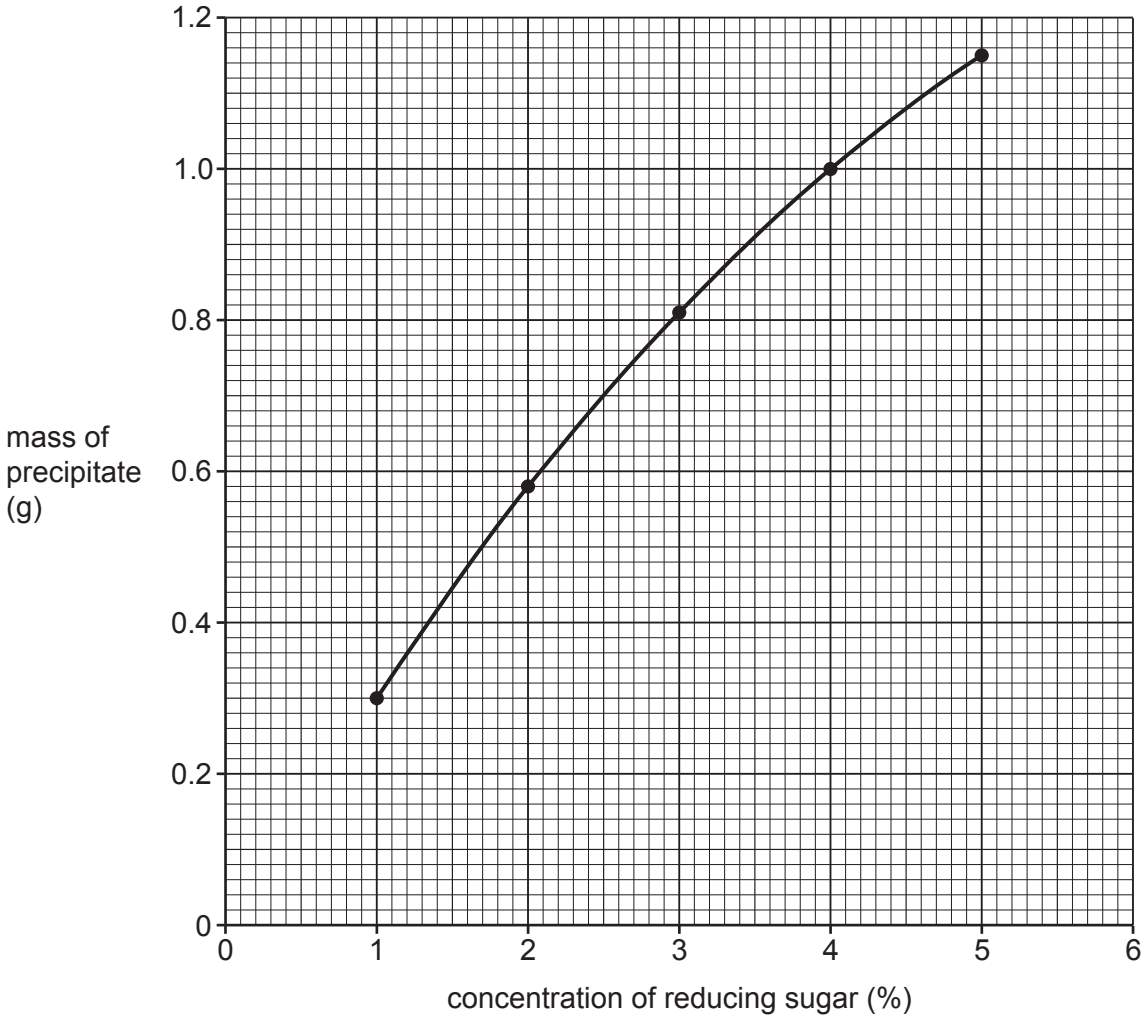
(c) The results of the investigation are shown in the graph.



The mass of the precipitate produced by the energy drink was 0.66 g.

Use the graph to calculate the concentration of reducing sugar in the energy drink.

Concentration of reducing sugar = ... (%) **[1]**

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(d) The concentration of sugar in the energy drink was 5.5% as it also contained non-reducing sugars.

State **two** additional steps that could be added to the method to allow the total concentration of sugar to be measured. Explain why each of these additional steps is carried out.

Additional step 1 .....

Explanation .....

.....

Additional step 2 .....

Explanation .....

.....

[4]

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6 Tuberculosis is a disease caused by the pathogen *Mycobacterium tuberculosis*.

M. tuberculosis is a prokaryotic cell which does not contain plasmids.

(a) Describe **two** structural differences between an **erythrocyte** and a prokaryotic cell such as *M. tuberculosis*.

Difference 1 .....

.....

Difference 2 .....

.....

[2]

Question 6(b) begins on page 20

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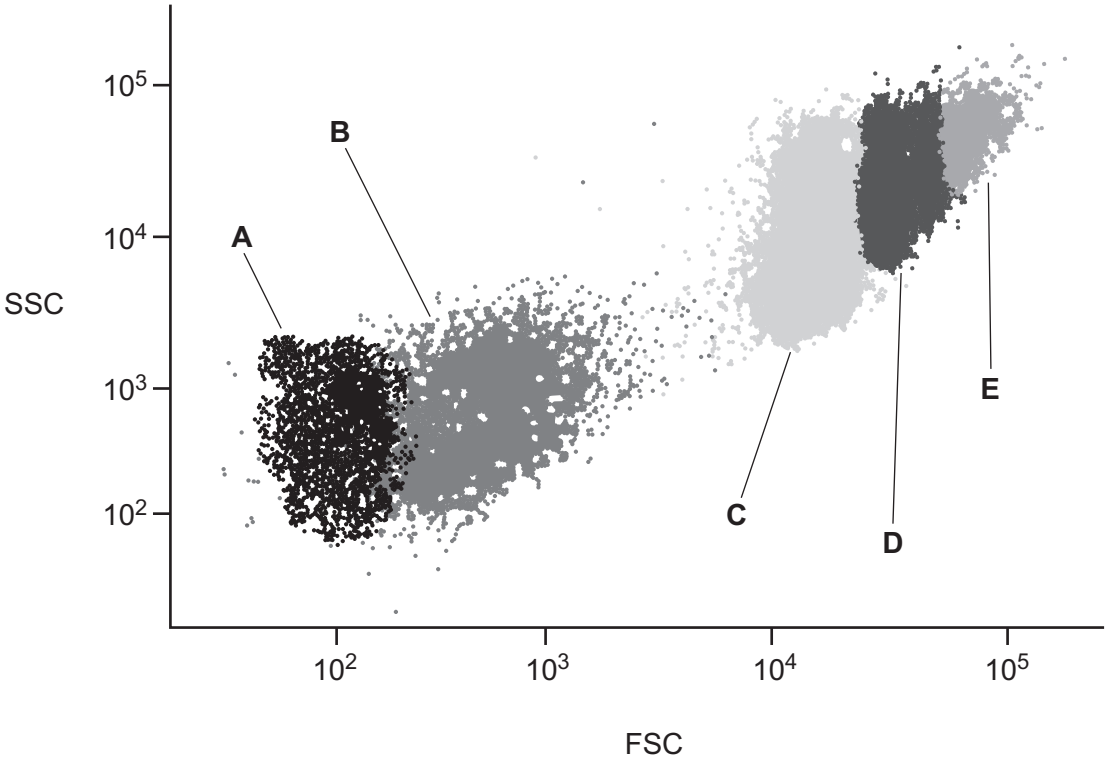
(b) Flow cytometry is a technique used to detect and measure the physical characteristics of blood cells and platelets.

The graph shows the analysis of a blood sample from a patient suffering from septicaemia.

- FSC = Forward Scatter of light. The greater the FSC, the larger the cell.
- SSC = Side Scatter of light. The greater the SSC, the more granular the cell.
- Areas **A**–**E** contain many dots, each representing a single cell.



Using the graph, state the letter that corresponds to the type of cell, or cell fragment, found in the blood sample.

Cell	Letter
Erythrocytes	
Lymphocytes	
Monocytes	**E**
M. tuberculosis	
Platelets	

[3]

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(c) Plant research is an important part of biology as plants are a potential source of medicinal drugs.

Describe how a scientist could investigate if a plant extract has antimicrobial properties.

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..... **[2]**

(d) The National Institute for Health and Care Excellence (NICE) is responsible for issuing guidance on the use of drugs such as those with antimicrobial properties.

The NHS in England and Wales has to provide the drugs that NICE recommends for the patients who need them.

Suggest **one** reason why NICE may **not** recommend a particular drug in their published guidance.

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..... **[1]**

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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