OXFORD

INTERNATIONAL AQA EXAMINATIONS

Please write clearly in block capitals.

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

Surname _____

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INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 5 Synoptic paper

Tuesday 19 June 2018 07:00 GMT Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- a pencil
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.
- In question 6, 2 marks will be awarded on the quality of your written communication.
  You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
TOTAL	

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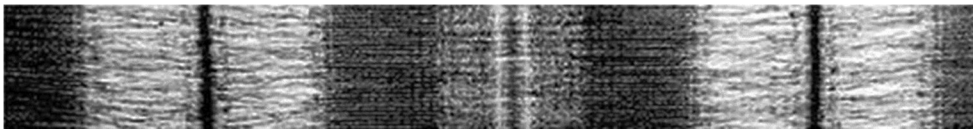
Answer **all** questions in the spaces provided.

0 1 **Figure 1** is an electron micrograph of part of a myofibril from a relaxed skeletal muscle.

Figure 1



Magnification × 40 000

0 1 . 1 Label **Figure 1** using the letters **A**, **B** and **C** to show:

A a region containing only actin filaments
B a region containing only myosin filaments
C a region containing both actin and myosin filaments.

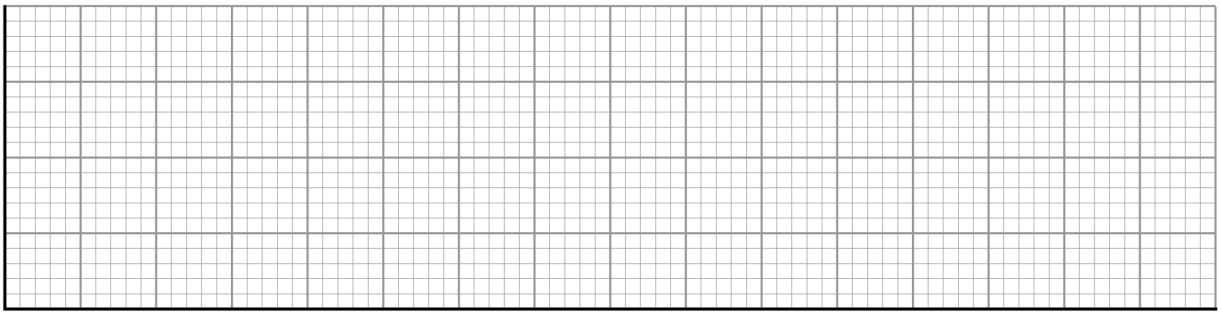
[2 marks]

0 1 . 2 Draw an **unlabelled** diagram of **one** complete sarcomere from **Figure 1**.

Do your drawing to scale on the graph paper in **Figure 2**.
Draw the sarcomere 100 mm in length.

[3 marks]

Figure 2



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0 1 . 3 The magnification of the myofibril in **Figure 1** is × 40 000

Calculate the magnification of your drawing in **Figure 2**.

[2 marks]

Magnification of drawing in **Figure 2** = _____

Question 1 continues on the next page

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The electron micrograph in **Figure 1**, on page 2, was produced using a transmission electron microscope.

The resolution of a microscope is proportional to the wavelength of the radiation used for producing the image and is given by the following formula:

$$\text{resolution} = \frac{\text{wavelength}}{2}$$

The wavelength of visible light is approximately 500 nm

0 1 . 4 Would it be possible to see the pattern of light and dark bands shown in **Figure 1** using an optical microscope?

Justify your answer using suitable calculations.

[3 marks]

10

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Turn over for the next question

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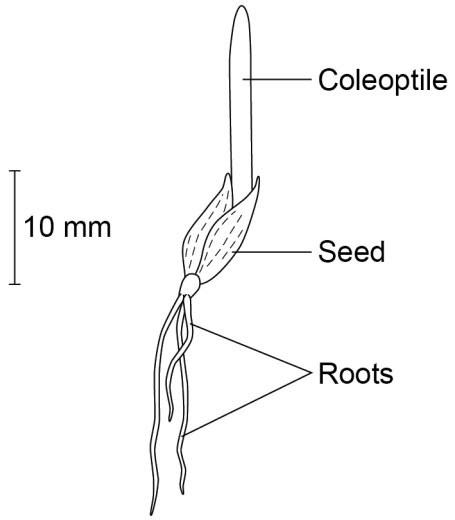
0 2 Plants produce growth substances called auxins.

Figure 3 shows a 4-day-old oat seedling.

Figure 3



The oat seedling produces an auxin called indoleacetic acid (IAA).

The concentration of IAA in different parts of the seedling varies but is never more than a few parts per million (ppm).

You are provided with:

- 100 oat seedlings, all 4 days old
- some IAA solution with a concentration of 100 mg dm^{-3} (100 ppm)
- any other laboratory apparatus you may need.

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0 2 . 1 Plan an investigation to find the effect of six different concentrations of IAA, between 10^{-3} ppm and 100 ppm, on the growth of the oat coleoptiles.

You should include:

- how you would change the independent variable
- steps you would take to make sure any other variables are kept constant
- details of a control you would set up
- how you would measure the dependent variable.

[6 marks]

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You could use a graph and a statistical test to analyse your results.

0 2 . 2 Describe how you would present your results in a graph. Give a reason for your choice.

[4 marks]

0 2 . 3 What type of statistical test would you use to compare the highest and lowest growth rate? Give a reason for your choice.

[2 marks]

Statistical test

Reason

12

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0 3 The freshwater shrimp, *Gammarus pulex*, lives under stones on the bottom of streams and rivers.

Some students investigate the effect of water flow rate on the distribution of freshwater shrimps in a stream.

The students:

- place a 50 cm × 50 cm square metal quadrat frame on the stream bed
- place a net along the downstream edge of the quadrat
- disturb the stones in the quadrat with their hands for 30 seconds
- count the number of shrimps that have been washed into the net
- measure the water flow rate by floating an orange in the stream and recording how long it took to move 2 metres.

They repeat this procedure at 11 more sites along the stream.

0 3 . 1 The students place the quadrat at random locations in the stream.

Why is it important to place the quadrat at random?

[1 mark]

0 3 . 2 The students measure water flow rate by timing how long it takes an orange to float two metres down the stream.

Give **one** disadvantage of this method for studying the effect of flow rate on the distribution of freshwater shrimps in the stream.

[1 mark]

Question 3 continues on the next page

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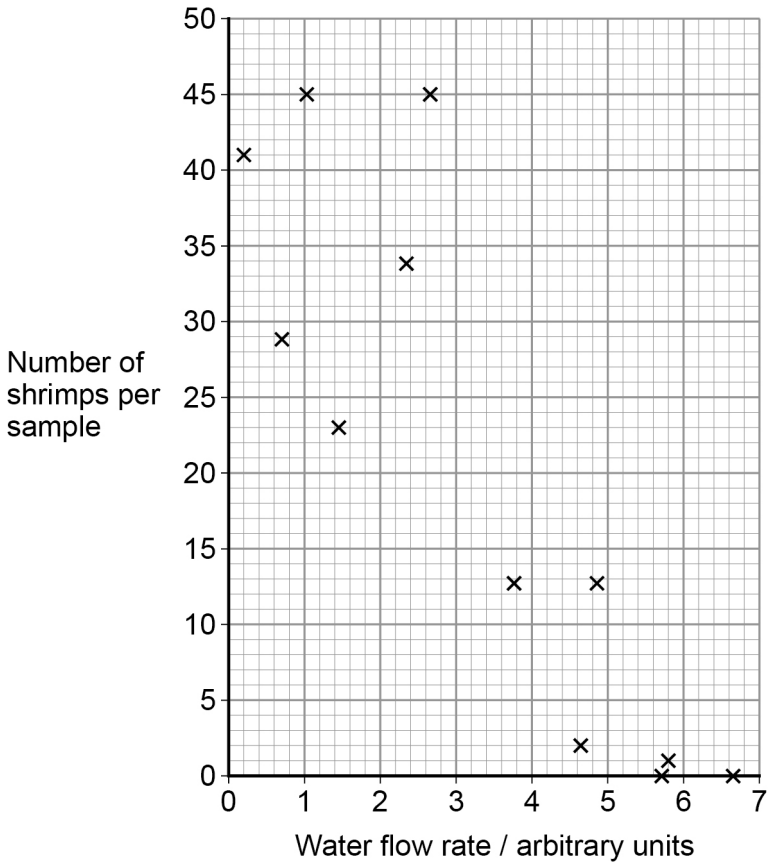
Figure 4 shows the students' results.

Figure 4



The students use the data to calculate a Spearman rank coefficient, **r** = –0.87

0 3 . 3 The students conclude that freshwater shrimps prefer slow-flowing water. Evaluate this conclusion.

[3 marks]

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0 3 . 4 Freshwater shrimps live under the stones on the stream bed.

Suggest **two** advantages for the shrimps of living under the stones rather than above them.

[2 marks]

1 _____

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2 _____

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7

Turn over for the next question

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0 4 Beta-thalassaemia is an inherited condition in which the body makes an abnormal form of haemoglobin. The abnormal haemoglobin affects the osmotic properties of the red blood cells.

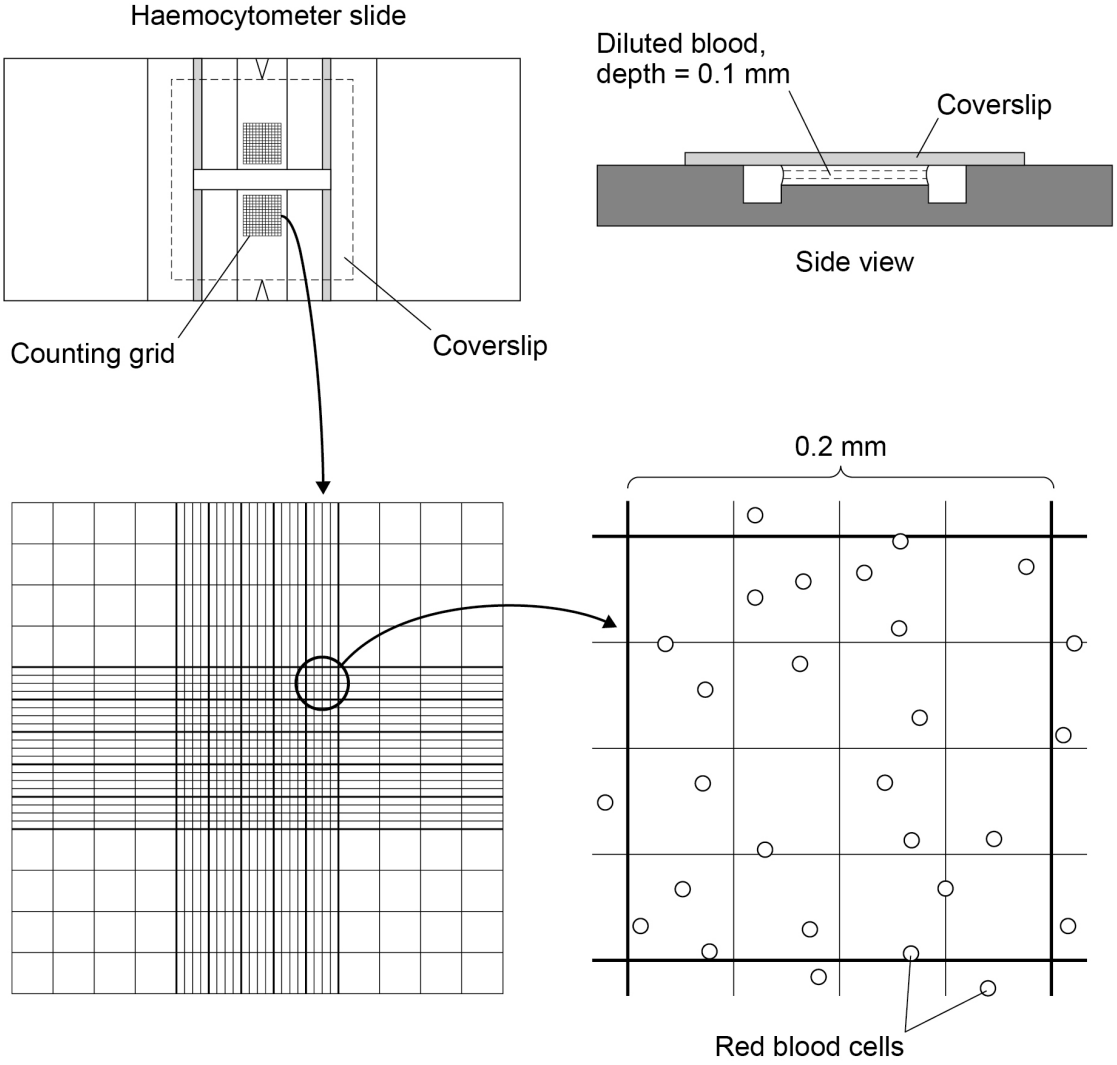
A scientist tests the effect of different concentrations of sodium chloride solution on the red blood cells in samples of blood taken from two people:

- a healthy person
- a person with beta-thalassaemia.

The scientist:

- dilutes 0.1 cm^3 blood to a volume of 100 cm^3 with 0.60% sodium chloride solution
- places a drop of the diluted blood on the counting grid of a haemocytometer slide, as shown in **Figure 5**
- places a special, thick coverslip over the diluted blood to give a depth of 0.1 mm of diluted blood
- places the haemocytometer slide on the stage of a microscope
- counts the number of red blood cells in a 0.2 mm × 0.2 mm square on the slide.

Figure 5



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The scientist counts the red cells in blood diluted by a factor of 1/1000 with 0.60% sodium chloride solution. He does this in order to calculate the number of red blood cells per mm^3 of the person's blood.

0 4 . 1 Give the reason why the scientist dilutes the blood before counting the red blood cells.

Use information from **Figure 5**.

[1 mark]

_____

_____

_____

0 4 . 2 The water potential of 0.60% sodium chloride solution is slightly lower than the water potential of the cytoplasm of the red blood cells.

Explain why the scientist uses 0.60% sodium chloride solution, and not water, to dilute the blood.

[2 marks]

_____

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0 4 . 3 Use the following procedure to count the number of red blood cells in the 0.2 mm × 0.2 mm square in **Figure 5**:

- count all cells that are completely within the 0.2 mm × 0.2 mm square
- count cells that are touching the left side and the lower side of the square
- do not count cells that are touching the right side or the upper side of the square.

[1 mark]

Number of red blood cells in the 0.2 mm × 0.2 mm square = _____

Question 4 continues on the next page

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0 4 . 4 Estimate the number of red blood cells in 1.0 mm^3 of undiluted blood.

Use your answer from question **04.3**
Give your answer in standard form.

[3 marks]

Number of red blood cells in 1.0 mm^3 of undiluted blood = _____

0 4 . 5 The scientist uses a special, thick coverslip over the sample of diluted blood. A normal, thinner coverslip would have been pulled down slightly by the surface tension of the liquid beneath it.

Explain what effect the use of a normal, thinner coverslip would have had on your answer to question **04.4**

[2 marks]

_____

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0 4 . 6 What else could the scientist do to increase the accuracy of the estimate of the number of red blood cells?

[1 mark]

_____

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The scientist then investigates the effect of other concentrations of sodium chloride solution on the red blood cells. The scientist uses the same method as described previously in **Figure 5** on page 12.

The red cells burst at certain concentrations of sodium chloride.
When red cells burst they release haemoglobin into the surrounding solution.
This process is called haemolysis. The scientist calculates the percentage of cells haemolysed at each concentration of sodium chloride.

0 4 . 7 Burst red blood cells are no longer visible in the microscope.

Suggest how the scientist could determine the percentages of cells that are haemolysed.

[2 marks]

Question 4 continues on the next page

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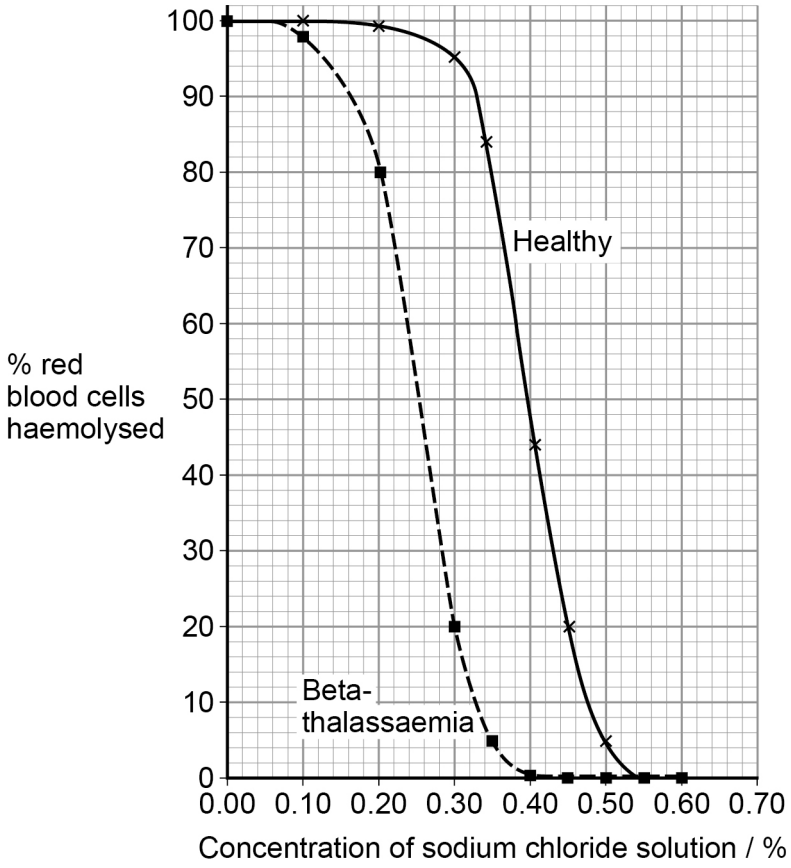
Figure 6 shows the scientist's results using blood from the healthy person and from the person with beta-thalassaemia.

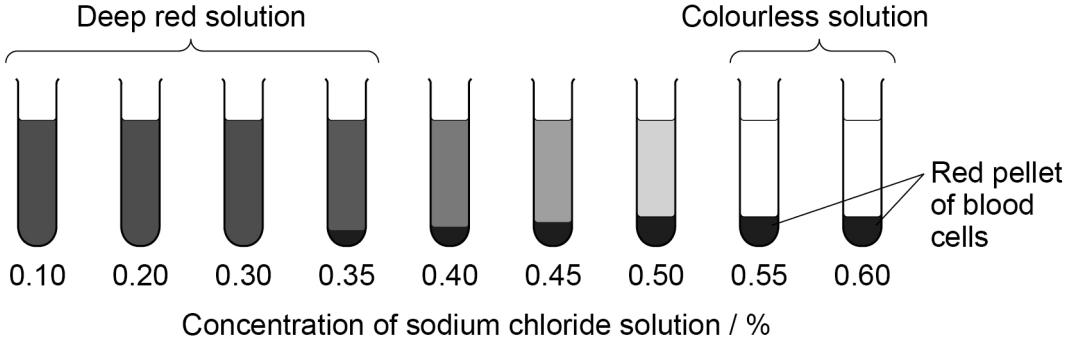
Figure 6



After counting cells in samples of blood in the different concentrations of sodium chloride, the scientist centrifuges each sample.

Figure 7 shows the results, after centrifugation, for the healthy person.

Figure 7



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0 4 . 8 Explain how the results for the person with beta-thalassaemia would be different from those in **Figure 7**.

Use information from **Figure 6**.

[2 marks]

_____

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_____

14

Turn over for the next question

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0 5 Electrophoresis is a technique that can be used for separating molecules of different substances.

A scientist separates amino acids and peptides in a solution as follows.

The scientist:

- places a drop of the solution in the middle of a large sheet of filter paper
- makes the filter paper moist with a buffer solution at pH 7.0
- places the paper into a tank with the ends of the paper dipping into more buffer solution at pH 7.0
- connects an electrode to each end of the paper
- applies a potential difference of 3 kV (kilovolts) across the paper for 30 minutes.

Figure 8 shows the apparatus.

Figure 8

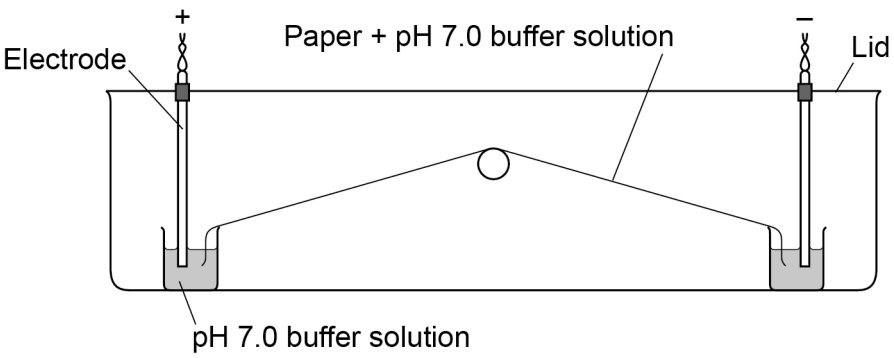

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Table 1 gives information about three substances the scientist separated.

Table 1

Substance	Structure	Molecular mass, M	Electric charge, e
Aspartate	$^{+}H_3N$ — Asp(COO$^-$) — COO$^-$	132	–1
Peptide **A**	$^{+}H_3N$ — Ala — Met — Lys(NH_3^+) — COO$^-$	349	
Peptide **B**	$^{+}H_3N$ — Gly — Asp(COO$^-$) — Glu(COO$^-$) — Phe — COO$^-$	464	

0 5 . 1 Complete **Table 1** to show the electric charge on peptide **A** and on peptide **B**.

[2 marks]

Question 5 continues on the next page

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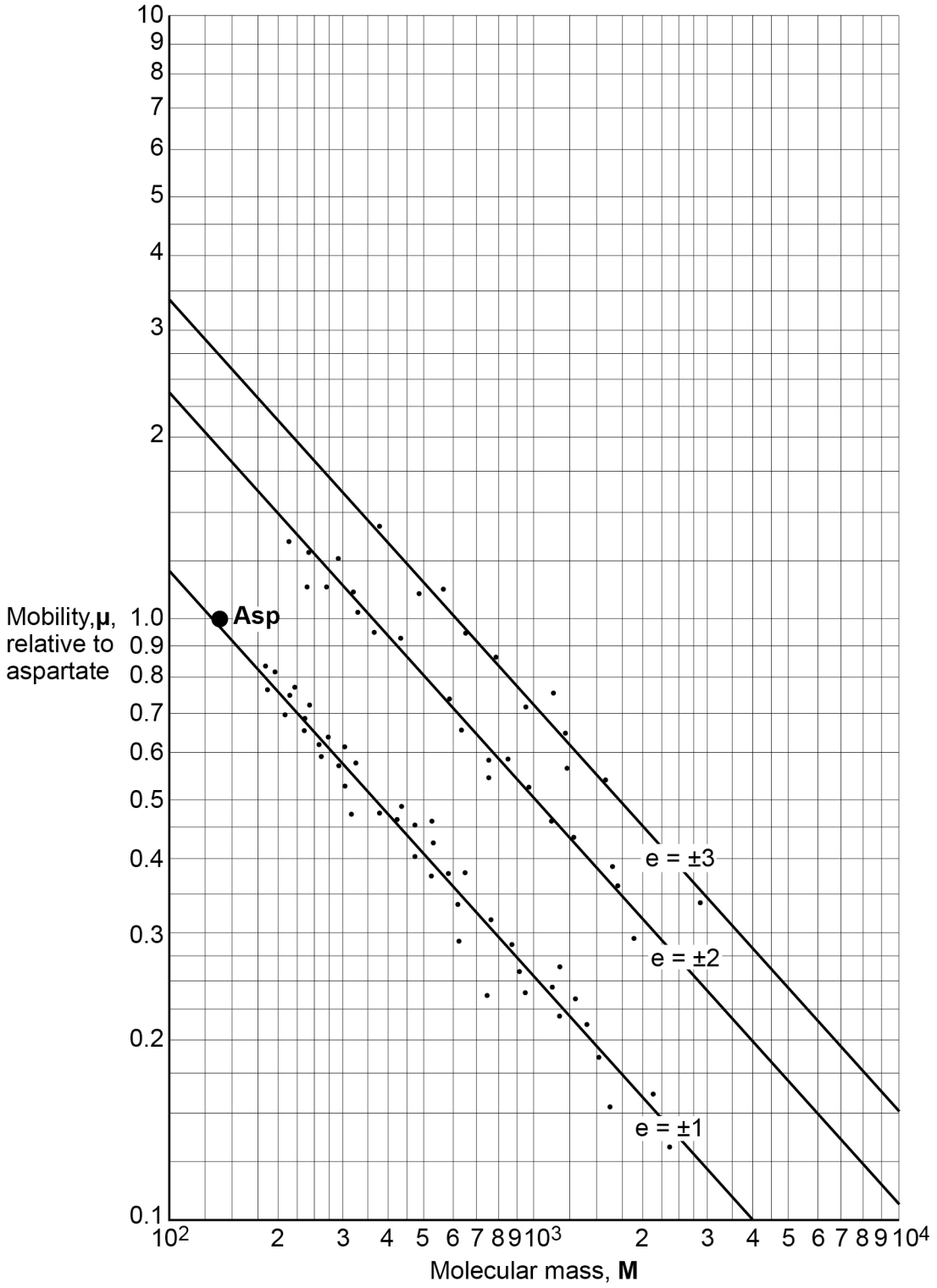
The scientist:

- measures the distance moved along the paper by each substance
- repeats the process for many more peptides of different mass and charge
- calculates the 'mobility', μ, of each peptide as the distance moved by the peptide relative to the distance moved by aspartate (Asp).

Figure 9 shows the scientist's results plotted on logarithmic graph paper.

Figure 9



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0 5 . 2 Why does the scientist plot the mobility of each peptide relative to the distance moved by Asp instead of plotting the actual distance moved by each peptide?

[2 marks]

0 5 . 3 The mobility of Asp is shown on the graph in **Figure 9**.

Plot the mobility of peptide **A** and the mobility of peptide **B** on **Figure 9**.

Use data from **Table 1** on page 19.

[2 marks]

0 5 . 4 The scientist found that the mobility, μ, of each peptide was related to its charge, **e**, and its molecular mass, **M**, as shown by the following formula:

$$\mu \propto \mathbf{e}\,\mathbf{M}^{-2/3}$$

$$\text{or} \quad \log_{10}\mu \propto \log_{10}\mathbf{e} - \frac{2}{3}\log_{10}\mathbf{M}$$

The data in **Figure 9** form three lines with the same slope.

What is the slope of each line in **Figure 9**?

[1 mark]

Tick (✓) **one** box.

$-\frac{2}{3}$ ☐

$-\frac{1}{3}$ ☐

$+\frac{1}{2}$ ☐

$+\frac{2}{3}$ ☐

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0 5 . 5 Paper chromatography is another method for separating amino acids and peptides.

Describe how you could use paper chromatography to separate aspartate, peptide **A** and peptide **B** from a solution containing all three substances.

[4 marks]

0 5 . 6 The $\mathbf{R_f}$ value is used as a measure of the mobility of a substance in paper chromatography.

Give the equation for $\mathbf{R_f}$.

[1 mark]

12

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You are reminded that 2 marks will be awarded
on the quality of your written communication in question 6.

0 6 Transport of substances is important to plants and animals.

0 6 . 1 Describe the different methods of transporting organic substances in and out of cells. Give examples in your answer.

[7 marks]

Question 6 continues on the next page

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0 6 . 2 Explain the importance of mass transport systems to large organisms.

[5 marks]

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0 6 . 3 What are the similarities **and** differences between the mass transport systems of plants and animals?

[6 marks]

20

END OF QUESTIONS

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