Please write clearly in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

AS
BIOLOGY

Paper 1

Monday 12 May 2025 Morning Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

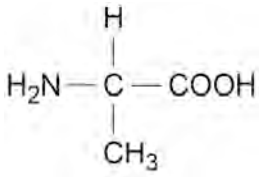
Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 75.

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

Do not write outside the box

0 1 . 1 **Figure 1** shows the structure of the amino acid alanine.

Figure 1



Name the NH_2 and COOH groups in the amino acid.

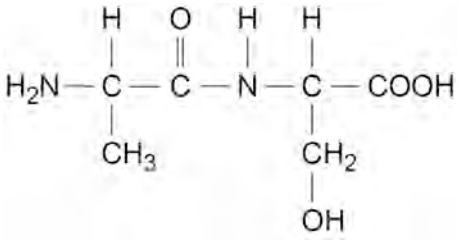
[1 mark]

NH_2 _____

COOH _____

Figure 2 shows the molecule formed from alanine and another amino acid.

Figure 2



0 1 . 2 Name the type of bond and the type of molecule formed when the two amino acids in **Figure 2** are joined.

[2 marks]

Type of bond _____

Type of molecule _____

Do not write outside the box

0 1 . 3 **Table 1** shows the R groups of six different amino acids.

Table 1

Amino acid	R group
Alanine	CH_3
Aspartic acid	CH_2COOH
Glutamine	$(CH_2)_2CONH_2$

Amino acid	R group
Glycine	H
Serine	CH_2OH
Valine	$CH(CH_3)_2$

Use the information in **Table 1** to identify the amino acid joined to alanine in **Figure 2**.

[1 mark]

Question 1 continues on the next page

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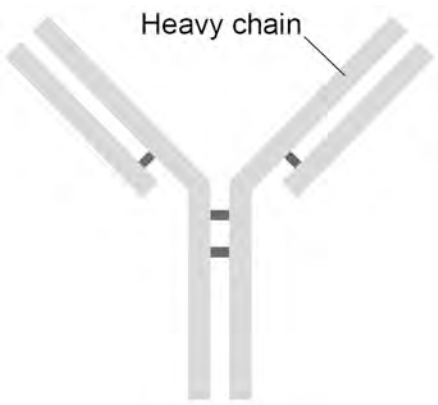
0 1 . 4 **Figure 3** represents the structure of an antibody.

Figure 3



The total number of amino acids in a particular antibody molecule is 1322

The ratio of amino acids in the heavy chains to the amino acids in the light chains is 2.13 **:** 1

Calculate how many amino acids there are in **one** heavy chain.

Give your answer to the nearest whole number.

[2 marks]

_____ amino acids

6

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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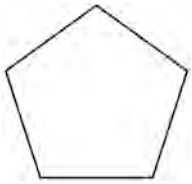
0 2 . 1 **Figure 4** shows one component of an ATP molecule.

Figure 4



Complete **Figure 4** to show the structure of an ATP molecule.

Label all of its components.

[2 marks]

0 2 . 2 Describe how phosphate is released from ATP within cells.

Explain **one** way in which this phosphate can be used by cells.

[3 marks]

How phosphate is released from ATP

One way in which phosphate can be used by cells

Do not write outside the box

0 2 . 3 Cells lining the ileum of mammals absorb glucose against a concentration gradient.

Describe how.

[3 marks]

8

Turn over for the next question

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0 3 . 1 Describe the semi-conservative replication of DNA.

[5 marks]

Do not write outside the box

Scientists designed an experiment to investigate DNA replication.

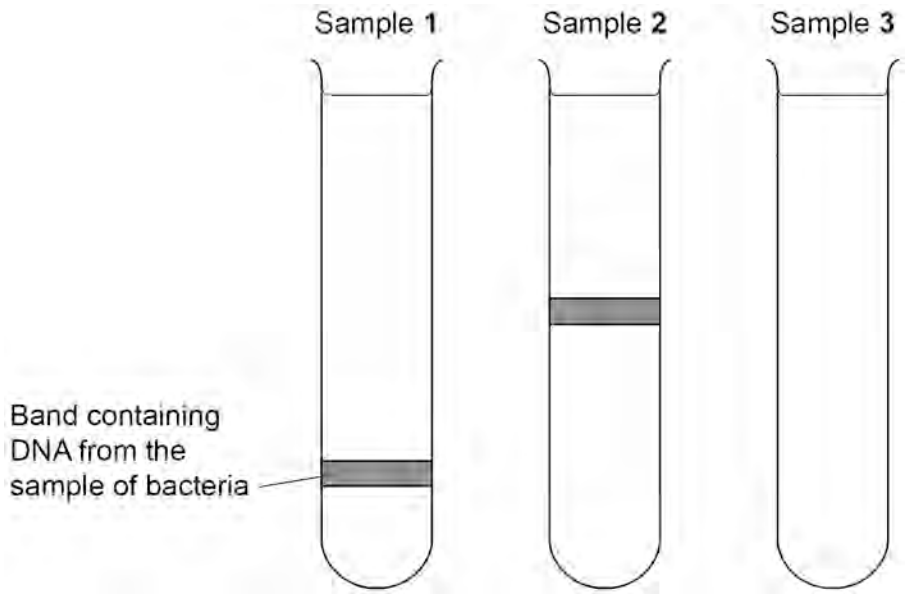
They grew bacteria for several generations in a nutrient solution containing a heavy form of nitrogen (^{15}N). They obtained DNA from a sample of these bacteria (sample **1**).

The scientists then transferred the bacteria to a nutrient solution containing a light form of nitrogen (^{14}N). They allowed the bacteria to grow and divide twice. After each division, they obtained DNA from a sample of bacteria (sample **2** and sample **3**).

They suspended DNA from each sample of bacteria in a solution in separate tubes. They spun these tubes in a centrifuge at the same speed and for the same time. Based on its density, DNA settled as bands in each tube.

Figure 5 shows the scientists' results.

Figure 5



0 3 . 2 Explain the position of the DNA band in sample **2** in **Figure 5**.

[2 marks]

0 3 . 3 Complete sample **3** in **Figure 5** to show the result you would expect after two divisions.

[1 mark]

8

Turn over ►

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0 4 This question is about genes and the genetic code.

0 4 . 1 Define **locus**, **exon** and **universal genetic code**.

[3 marks]

Locus _____

_____

Exon _____

_____

Universal genetic code _____

_____

0 4 . 2 **Table 2** shows the amino acids coded for by each mRNA codon.

Table 2

First base	Second base				Third base
	Guanine (G)	Adenine (A)	Cytosine (C)	Uracil (U)	
G	Ala	Glu	Ala	Val	G
	Gly	Glu	Ala	Val	A
	Gly	Asp	Ala	Val	C
	Gly	Asp	Ala	Val	U
A	Arg	Lys	Thr	Met	G
	Arg	Lys	Thr	Iso	A
	Ser	Asn	Thr	Iso	C
	Ser	Asn	Thr	Iso	U
C	Arg	Gln	Pro	Leu	G
	Arg	Gln	Pro	Leu	A
	Arg	Hist	Pro	Leu	C
	Arg	Hist	Pro	Leu	U
U	Trp	**stop**	Ser	Leu	G
	stop	**stop**	Ser	Leu	A
	Cyst	Tyr	Ser	Phe	C
	Cyst	Tyr	Ser	Phe	U

Do not write outside the box

Use **Table 2** to complete **Table 3** to show:

- the mRNA base sequence transcribed from the DNA base sequence
- the amino acid sequence translated from the mRNA base sequence.

[2 marks]

Table 3

DNA base sequence	**G**	**C**	**T**	**C**	**T**	**A**	**C**	**A**	**G**
mRNA base sequence									
Amino acid sequence									

0 4 . 3 Deletion of the third base thymine (T) in the **DNA** base sequence shown in **Table 3** would alter the primary structure of the polypeptide produced. However, substitution of the same base would not cause any alteration.

Use information in **Table 2** to explain why.

[3 marks]

8

Turn over for the next question

Do not write outside the box

0 5 . 1 Observable characteristics can be used to compare genetic diversity between species.

Give **two** other ways in which genetic diversity between species can be compared.
[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 5 . 2 A student compares the mean surface area of leaves on the ground from two populations of wild cherry trees.

Describe **and** explain how the student should collect these leaves to obtain valid data.
[2 marks]

_____

_____

_____

_____

_____

_____

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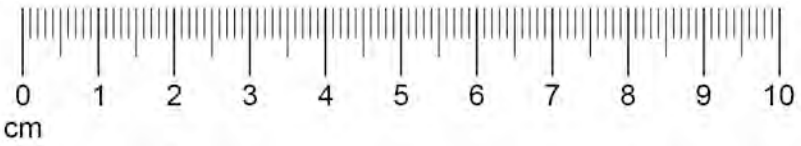
0 5 . 3 Another student investigated the variation in leaf length using the ruler shown in **Figure 6**.

Figure 6



The student measured the length of one leaf as 86 mm

State the uncertainty of this measurement **and** use this to calculate the percentage uncertainty in the length measurement.

[2 marks]

Uncertainty _____ mm

Percentage uncertainty _____

6

Turn over for the next question

Do not write outside the box

0 6 A scientist investigated the effect of the lung disease emphysema on lung function.

They investigated lung function in:
- a person with emphysema
- a person with healthy lungs.

The scientist told each person:
- to breathe in fully
- then breathe out fully and as quickly as possible.

The scientist measured the volume of air exhaled in one breath.

Figure 7 shows the scientist's results.

Figure 7

Figure 7 not reproduced here due to third-party copyright restrictions.

The figure is adapted from https://www.thelancet.com/journals/lancet/article/PIIS0140673604168554/fulltext

0 6 . 1 Forced expiratory volume (FEV_1) is the maximum volume of air that is breathed out in one second. FEV_1 is used to measure lung health.

What is the percentage decrease in FEV_1 for the person with emphysema compared with the healthy person?

Tick (✓) **one** box.

[1 mark]

23.1% ☐

30.0% ☐

42.5% ☐

73.9% ☐

Do not write outside the box

0 6 . 2 Use **Figure 7** to determine the speed of exhalation, in $dm^3\ s^{-1}$, for the person with healthy lungs **at** time = 2 s

Show your working.

[2 marks]

Speed of exhalation _____ $dm^3\ s^{-1}$

0 6 . 3 The main effects of emphysema on the lungs are the breakdown of:

- the walls of the alveoli
- the elastic tissue in the lungs.

Use this information and the data in **Figure 7** to suggest why gas exchange is reduced in a person with emphysema.

[3 marks]

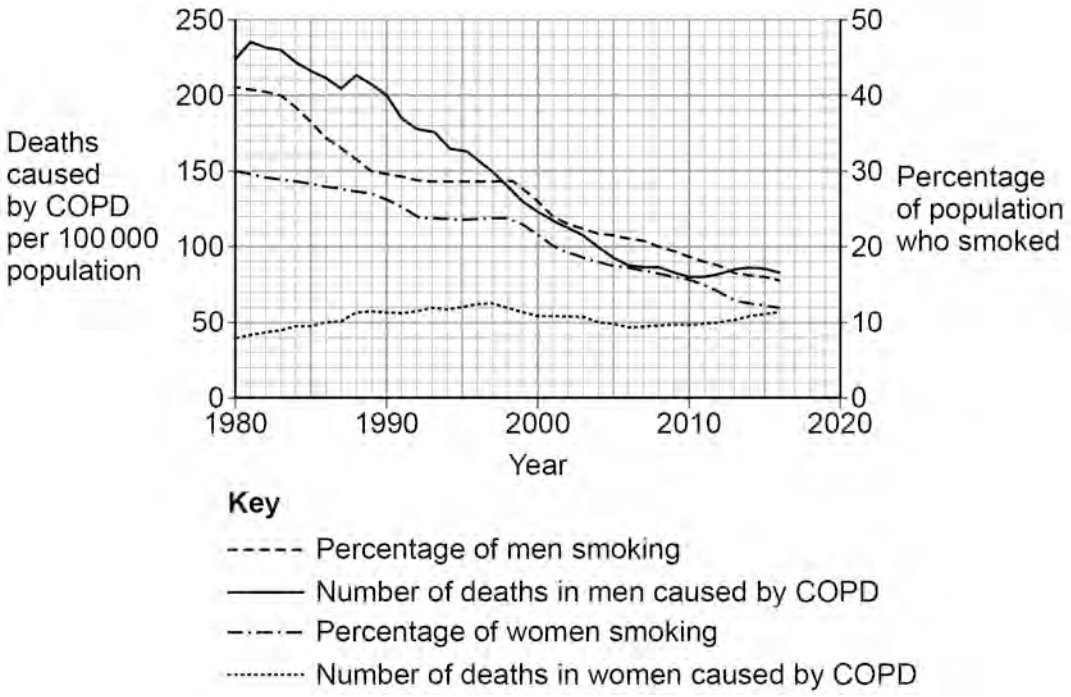
Question 6 continues on the next page

Do not write outside the box

0 6 . 4 Chronic obstructive pulmonary disease (COPD) is the name for a group of lung diseases that cause breathing difficulties. This includes emphysema.

Figure 8 shows the number of deaths caused by COPD from 1980–2016. It also shows the percentage of the population who smoked, for the same time period.

Figure 8



A journalist looked at the data in **Figure 8** and concluded that smoking is a cause of COPD.

Evaluate this conclusion.

[3 marks]

9

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0 7 . 1 Name the main carbohydrate transported through the phloem.

[1 mark]

0 7 . 2 In the storage tissues of plants, carbohydrates transported through the phloem can be converted into starch.

Explain **three** features of starch that make it a good storage molecule.

[3 marks]

1

2

3

Question 7 continues on the next page

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Scientists investigated the mass flow hypothesis in geranium plants.

The scientists:

- separated the phloem from the xylem in a part of the stem by placing an impermeable layer between them
- enclosed a leaf above the separated section, and supplied it with radioactive carbon dioxide ($^{14}CO_2$)
- illuminated the plant for 15 hours
- cut the stem into sections as shown in **Figure 9**
- measured the radioactivity in the phloem and xylem of each section.

Figure 9

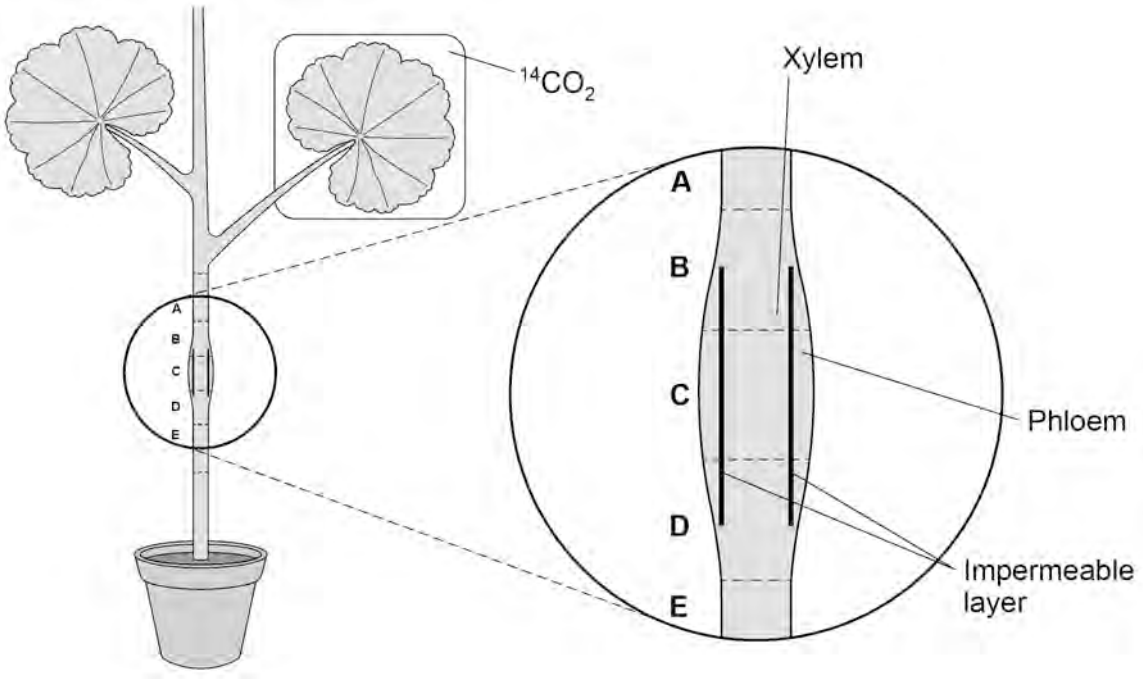

Table 4 shows the scientists' results.

Table 4

Section of tissue	Radioactivity in phloem / counts per minute	Radioactivity in xylem / counts per minute
A	41 100	24 210
B	2 761	755
C	130	74
D	101	47
E	157	75

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0 7 . 3 The total radioactivity of the phloem and xylem tissues shown in **Table 4** was lower than the total radioactivity absorbed by the enclosed leaf.

Suggest **one** reason why.

[1 mark]

0 7 . 4 The mass flow hypothesis states that organic substances are transported through the phloem, from leaves to all parts of plants.

Evaluate whether the information from this investigation supports this hypothesis.

Do **not** refer to statistical tests or sample size in your answer.

[4 marks]

9

Turn over for the next question

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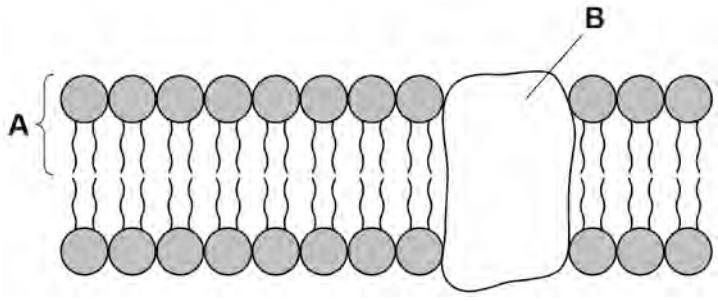
0 8 . 1 **Figure 10** shows a diagram of a cell-surface membrane.

Figure 10



Name **and** give the functions of the molecules labelled **A** and **B**.

[2 marks]

Molecule **A** name _____

Molecule **A** function _____

_____

_____

Molecule **B** name _____

Molecule **B** function _____

_____

_____

Do not write outside the box

0 8 . 2 A student investigated the effect of temperature on the permeability of cell-surface membranes in beetroot cells. Beetroot cells contain a red pigment that is not transported across intact cell-surface membranes.

The student:

- cut discs of beetroot tissue
- took five boiling tubes and placed two discs of beetroot into each boiling tube
- added water to the boiling tubes
- placed each boiling tube into a water bath at a different temperature for 30 minutes
- removed the discs and examined the water in each boiling tube.

Give **one** variable the student should have controlled in this investigation **and** explain why.

Do **not** refer to number of discs or length of time.

[2 marks]

Controlled variable _____

_____

Explanation _____

_____

_____

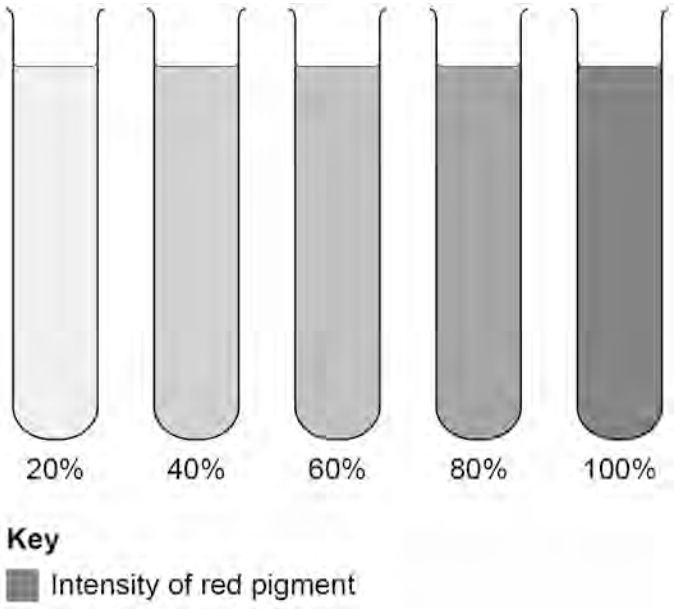
Question 8 continues on the next page

Do not write outside the box

Another student carried out the same investigation, ensuring that **all** variables were controlled.

Figure 11 shows a dilution series the student prepared from 100% red beetroot pigment solution.

Figure 11



This student used the colours of the dilution series to estimate the percentage concentration of pigment in the boiling tubes at each temperature.

Figure 12 shows the student's results.

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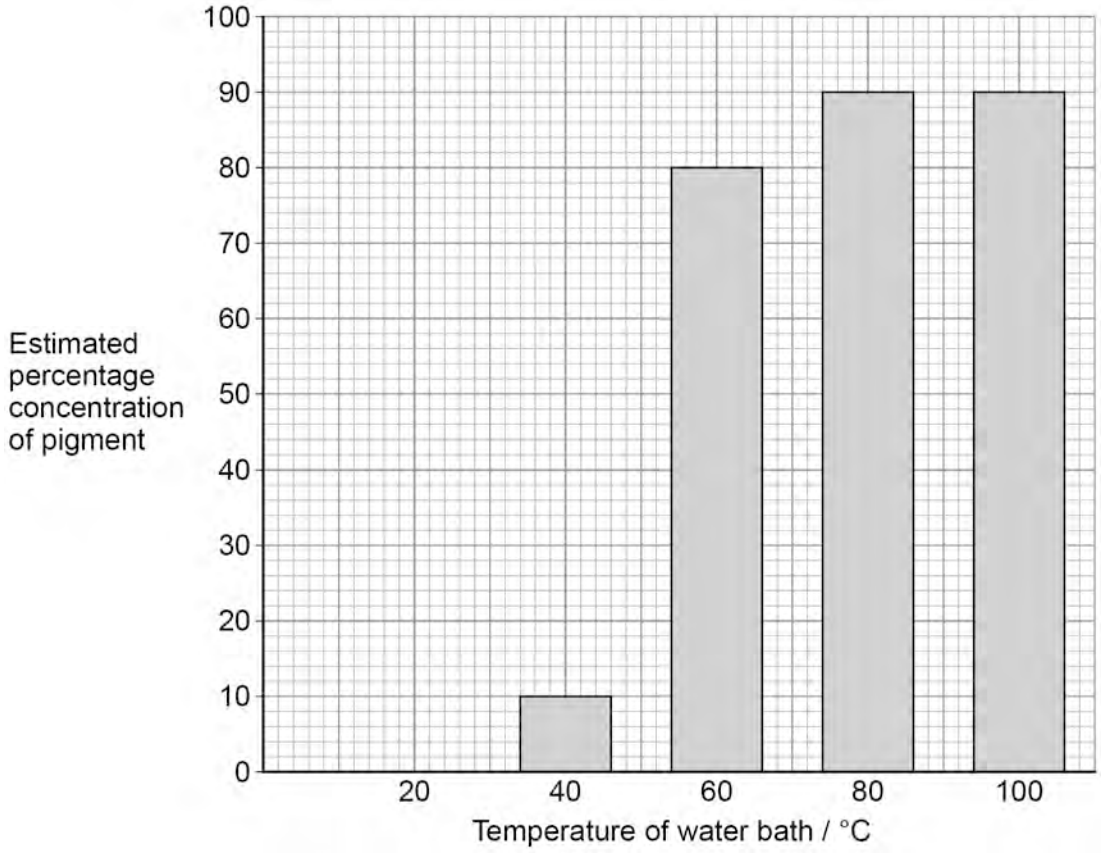
Figure 12



0 8 . 3 Describe and explain the general trend of the results in **Figure 12**.

[4 marks]

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0 8 . 4 Describe how the student could use the dilution series (**Figure 11**, on page 22) and a colorimeter to determine an accurate measurement of the pigment concentration in the tubes at different temperatures.

[3 marks]

11

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Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

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0 9 Read the following passage.

Penicillin-resistant *Staphylococcus aureus* (PRSA) bacteria have evolved by natural selection. From 1941, penicillin was used extensively to treat *S. aureus* infections. The first case of PRSA was reported in 1942. By the late 1960s, more than 80% of *S. aureus* bacteria were resistant to penicillin.

Many antibiotics have a beta-lactam ring in their chemical structure, which inhibits the synthesis of bacterial cell walls. PRSA have an allele of a gene *blaZ* that codes for an enzyme called beta lactamase. This enzyme hydrolyses beta-lactam rings in antibiotics such as penicillin.

The evolution of PRSA resulted in the development of new antibiotics, such as methicillin in 1960. However, by 1961, methicillin-resistant *S. aureus* (MRSA) were identified. In 2022, 675 cases of MRSA were reported in England. However, in 2023, the number of cases of MRSA rose to 787. Patients in hospitals are at greater risk of MRSA infections than the general population.

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

0 9 . 1 Penicillin-resistant *Staphylococcus aureus* (PRSA) have evolved by natural selection (lines 1–2).

Name the type of natural selection.

[1 mark]

0 9 . 2 By the late 1960s, more than 80% of *S. aureus* were resistant to penicillin (lines 3–4).

Explain why.

[3 marks]

Do not write outside the box

0 9 . 3 Many antibiotics have a beta-lactam ring in their chemical structure, which inhibits synthesis of bacterial cell walls (lines 5–6).

Suggest **two** reasons why this makes infections caused by PRSA difficult to treat.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 9 . 4 In 2022, the population of England was 5.644×10^7

In 2023, the population of England was 5.672×10^7

Use information in lines 10–12 to calculate the increase in MRSA cases per 100 000 population.

Show your working.

[2 marks]

Increase in MRSA cases per 100 000 population _____

Question 9 continues on the next page

Do not write outside the box

0 9 . 5 Patients in hospitals are at greater risk from MRSA infections than the general population (lines 12–13).

Suggest **and** explain **two** reasons why.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

10

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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