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 13 May 2024 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	

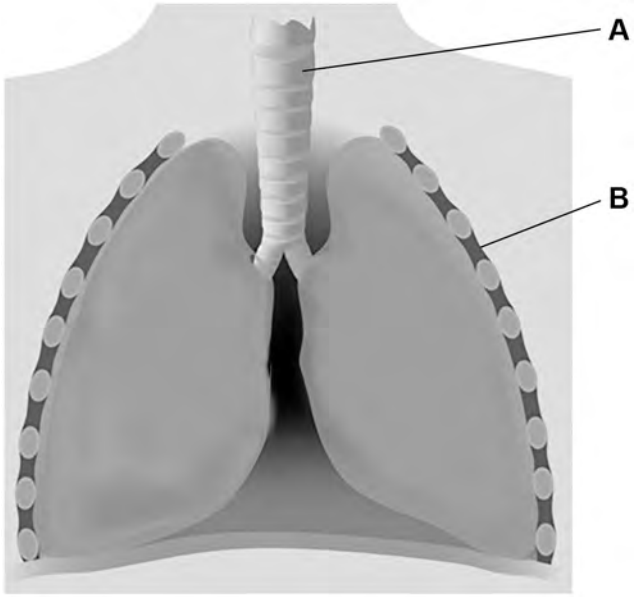
Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 75.

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

Do not write outside the box

0 1 . 1 **Figure 1** shows a diagram of the human gas exchange system.

Figure 1



Structure **B** is muscle. The volume of the thorax is increased when structure **B** contracts.

Name the structures labelled **A** and **B**.

[2 marks]

A _____

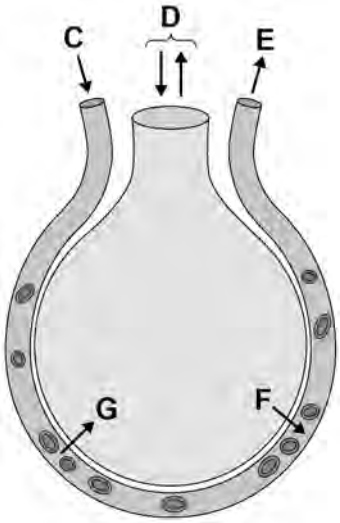
B _____

Do not write outside the box

0 1 . 2 **Figure 2** is a diagram of an alveolus and a blood vessel associated with the alveolus.

The direction of the movement of substances is shown by the arrows labelled **C**, **D**, **E**, **F** and **G**.

Figure 2



Complete **Table 1** by writing the correct letter, **C**, **D**, **E**, **F** or **G**, in the box next to each statement. You may use each letter once, more than once or not at all.

[2 marks]

Table 1

Box	**Statement**
	represents the diffusion of oxygen
	represents the transport of a gas mixture
	represents blood moving at the highest pressure

Do not write outside the box

0 1 . 3 Describe and explain **one** adaptation of a **single** alveolus for gas exchange.

[2 marks]

6

Do not write outside the box

0 2 . 1 **Table 2** contains information on the digestion of two biological molecules.

Complete **Table 2**.

[4 marks]

Table 2

Biological molecule	Enzyme	Name of bond hydrolysed	Product of digestion
Starch			Maltose
Dipeptide	Dipeptidase		

A student investigated starch digestion by mixing starch with a solution of the enzyme used to digest starch.

The student did a biochemical test for **protein** when starch digestion was completed.

0 2 . 2 Describe a biochemical test to show the presence of protein.

[2 marks]

Question 2 continues on the next page

Do not write outside the box

0 2 . 3 The student's test for protein was positive.

Explain why.

[2 marks]

0 2 . 4 An enzyme's turnover number (k_{cat}) is the number of substrate molecules converted into product molecules by one enzyme molecule in 1 second. It is determined using this equation.

$$k_{cat} = \frac{\text{Maximum rate of enzyme-controlled reaction / } \mu\text{mol dm}^{-3}\ \text{s}^{-1}}{\text{Enzyme concentration / } \mu\text{mol dm}^{-3}}$$

A scientist investigated the action of a protease enzyme. The scientist prepared a reaction mixture with a protease concentration of 0.0118 μmol dm^{-3}. The k_{cat} for the protease is 110 substrate molecules per second.

Use this information and the formula to calculate the maximum rate of the protease-controlled reaction.

Give your answer to **3** significant figures.

Show your working.

[2 marks]

Answer _____ μmol $dm^{-3}\ s^{-1}$

10

Do not write outside the box

0 3 . 1 Describe how viruses are replicated.

[4 marks]

Question 3 continues on the next page

Do not write outside the box

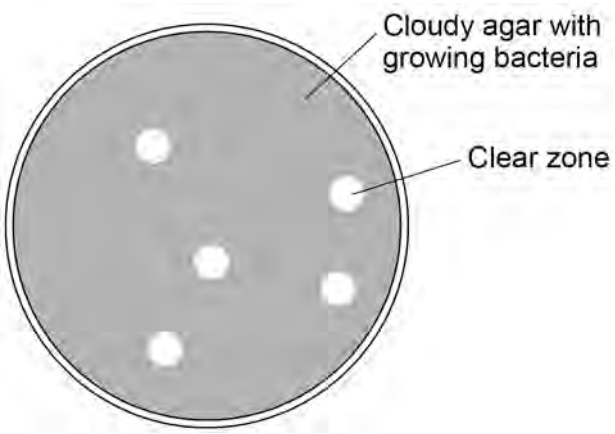
0 3 . 2 A scientist investigated the effect of a virus species on a bacterial culture.

The scientist:

- mixed a diluted sample of the virus with a bacterial culture in liquid agar
- poured the liquid agar into a Petri dish and let the agar set
- incubated the virus-bacterial culture at 30 °C for 24 hours.

Figure 3 shows the appearance of the Petri dish after 24 hours.

Figure 3



Explain why clear zones are present in **Figure 3**.

[1 mark]

0 3 . 3 Predict the appearance of the Petri dish if the incubation was extended by a few more hours.

[1 mark]

Do not write outside the box

0 3 . 4 Animal cells replicate during the cell cycle.

Figure 4 shows one animal cell at a stage of the cell cycle.

Figure 4

Identify the stage of the cell cycle shown in **Figure 4**.

Explain the appearance of the cell shown in **Figure 4**.

Do **not** refer to organelles in your answer.

[2 marks]

Identity of stage _____

Explanation _____

_____

_____

8

Turn over for the next question

Do not write outside the box

0 4 . 1 Complete **Table 3** to show whether the feature of DNA is associated with the DNA molecule found in each of these locations.

Tick (✓) the appropriate boxes.

[3 marks]

Table 3

Feature of DNA	**Location of DNA molecule**		
	Prokaryotic cell	Nucleus	Chloroplast
Is circular			
Contains four different types of nucleotide			
Is associated with histones			

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Question 4 continues on the next page

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ANSWER IN THE SPACES PROVIDED

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Some strains of the bacterium, *Escherichia coli*, are known to be resistant to antibiotics.

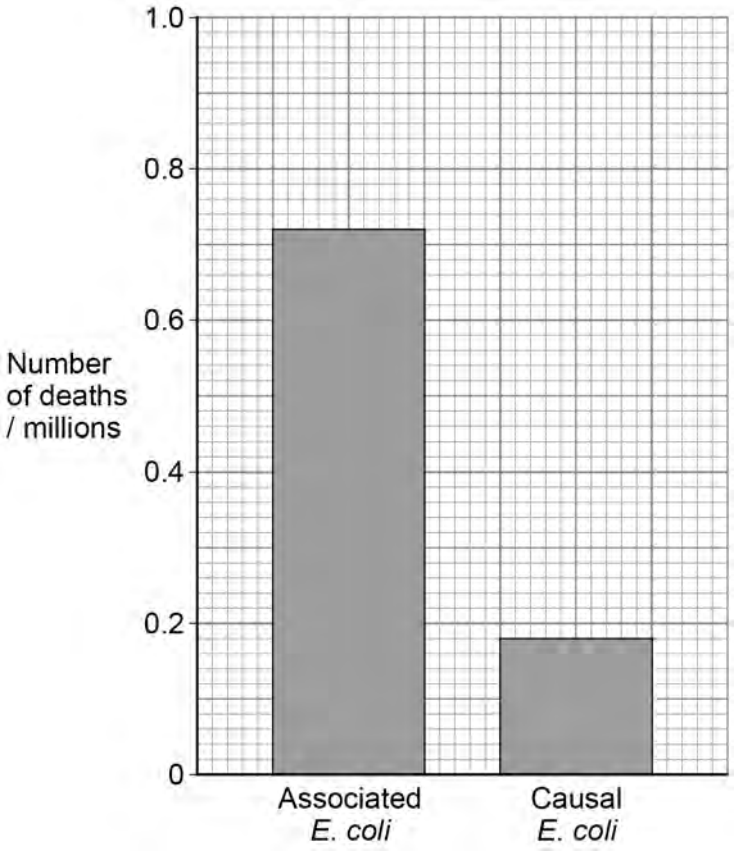
Scientists analysed data recording the deaths of people in hospitals across the world during 2019.

They used the data to find how many of the bodies of people who died in hospitals contained antibiotic-resistant *E. coli* bacteria and whether the *E. coli* were:

- **not** the cause of death (**associated** *E. coli*)
- the cause of death (**causal** *E. coli*).

Figure 5 shows their results.

Figure 5



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0 4 . 2 Using **Figure 5**, a student calculated that out of all the people who died when antibiotic-resistant *E. coli* were present, 25% of those deaths involved **causal** *E. coli*.

The student's calculation is **incorrect**.

Use **Figure 5** to calculate the correct percentage of deaths involving **causal** *E. coli* in people who died when infected with antibiotic-resistant *E. coli*.

Identify the mathematical step the student performed incorrectly in their calculation.

[3 marks]

Correct answer _____ %

Incorrect mathematical step _____

_____

0 4 . 3 Which method is most likely to be successful in **decreasing** the frequency of antibiotic-resistant bacteria in populations of people?

Tick (✓) **one** box.

[1 mark]

Give people lower doses of antibiotics to treat disease. ☐

Test more people to determine if they are infected with antibiotic-resistant bacteria. ☐

Vaccinate more people to reach herd immunity against bacteria that cause diseases common in human populations. ☐

7

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0 5 . 1 *Malva sylvestris* is a plant species.

A student wanted to determine the mean height of *M. sylvestris* plants growing in a field.

Describe how the student should obtain measurements of the plants **and** then process these measurements to obtain a reliable mean height of plants growing in that field.

[5 marks]

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0 5 . 2 The student wanted to present the results for the distribution of plant heights in a histogram.

Figure 6 shows the outline of a results table.

Use **Figure 6** to design a suitable results table the student should use for a histogram of plant height measurements ranging between 60 cm and 120 cm.

[2 marks]

Figure 6

Question 5 continues on the next page

Do not write outside the box

0 5 . 3 A student investigated biodiversity in a community of bee species in a field of wild flowers.

The student trapped and identified the bee species in the field over 6 months.

Table 4 shows some of the student's results.

Table 4

Bee species	Total number of trapped bees after 6 months
Cuckoo bee	250
Domestic honeybee	800
Clover bee	200

The index of diversity in a community of organisms is determined using the formula

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where N = total number of organisms of all species
and n = total number of organisms of each species.

Use the formula and information in **Table 4** to calculate the index of diversity in this community of bee species.

[2 marks]

Answer _____

Do not write outside the box

0 5 . 4 In a different investigation, the student found that:

- the species richness of plants in a field of wild flowers is greater than the species richness of plants in a field of wheat
- the species richness of **bees** in a field of wild flowers is greater than the species richness of **bees** in a field of wheat.

Suggest **one** reason why the species richness of bees in a field of wild flowers is greater than the species richness of bees in a field of wheat.

Explain your answer.

[2 marks]

11

Turn over for the next question

Do not write outside the box

0 6 . 1 Give **two** roles of phosphate ions in cells.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 6 . 2 Diseased lungs can cause carbon dioxide to build up in the blood plasma. This leads to an increase in hydrogen ion concentration in the plasma.

Describe the effect this increase in hydrogen ion concentration has on the plasma **and** on the proteins in the plasma.

Do **not** refer to the Bohr effect.

[2 marks]

_____

_____

_____

_____

_____

_____

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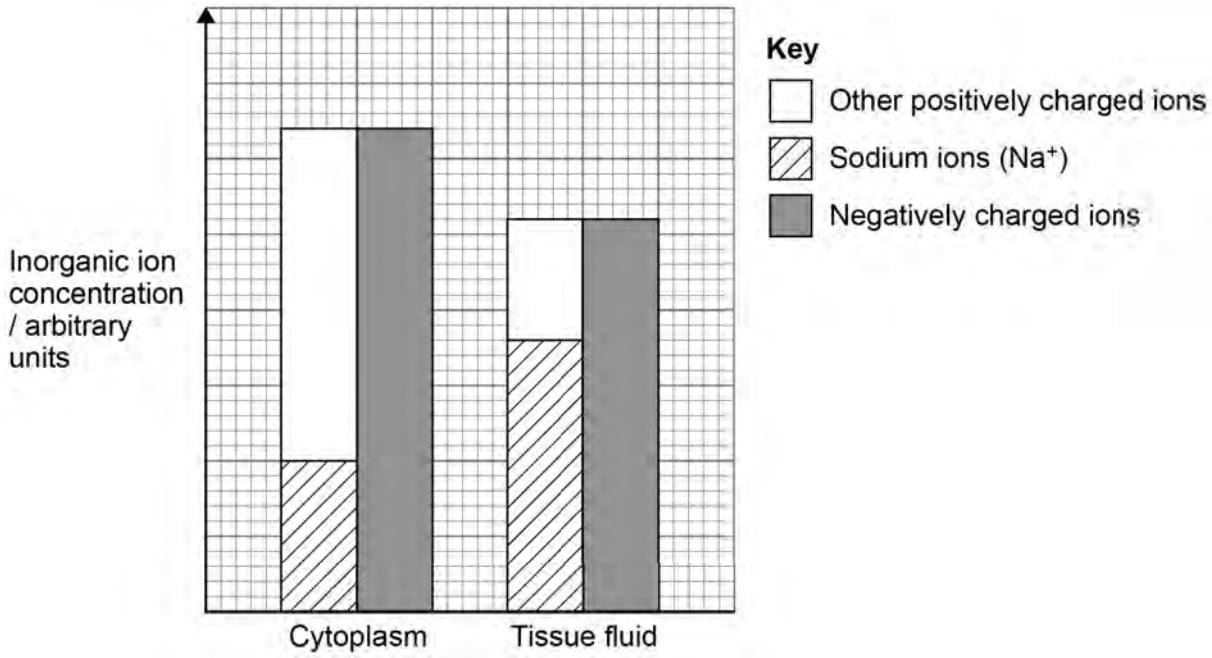
Scientists measured the concentration of inorganic ions in the cytoplasm of mammalian cells and in the tissue fluid surrounding those cells.

Figure 7 shows their results.

Figure 7



0 6 . 3 Use **Figure 7** to describe **two** patterns shown in the **total** concentrations of positively and negatively charged ions in the cytoplasm and in tissue fluid.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

Turn over ►

Do not write outside the box

0 6 . 4 In these mammalian cells, the:

- cell-surface membrane is permeable to sodium ions
- sodium ion concentration does not increase in the cytoplasm over time.

Use this information and **Figure 7** to suggest and explain the ion transport mechanisms involved in the transport of sodium ions.

[2 marks]

8

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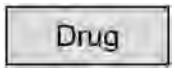
0 7 . 1 A drug is delivered to diseased body cells by a monoclonal antibody. The monoclonal antibody is attached to a drug to form an antibody–drug complex (ADC).

Figure 8



Complete **Figure 8** to show a monoclonal antibody attached to the drug.

Label **one** structural feature of the monoclonal antibody in your drawing of the ADC.

[2 marks]

Question 7 continues on the next page

Do not write outside the box

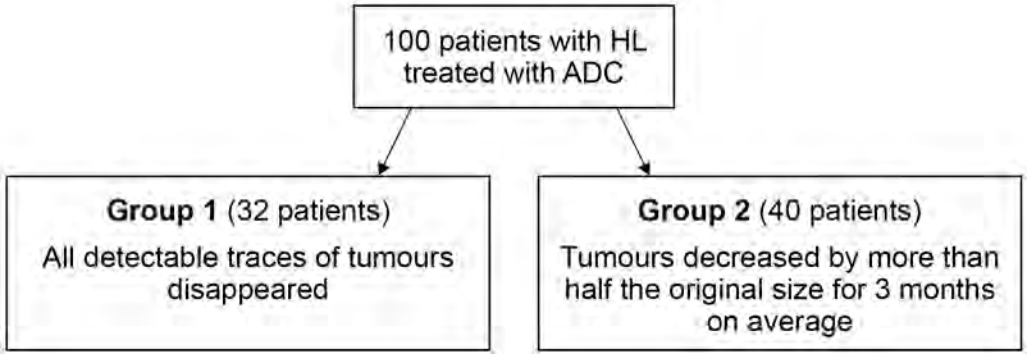
0 7 . 2 Scientists used a clinical trial to test an ADC designed to treat people diagnosed with the cancer, Hodgkin lymphoma (HL).

In the clinical trial, the patients with HL:

- were selected at random
- had tumours of a similar size at the start of the trial
- received identical doses of the ADC.

Figure 9 shows some of the results from the clinical trial.

Figure 9



Use all the information to evaluate the effectiveness of the ADC in treating people with HL.

Do **not** refer to statistical tests in your answer.

[4 marks]

6

Do not write outside the box

0 8 . 1 A non-competitive inhibitor decreases the rate of an enzyme-controlled reaction.

Explain how.

[3 marks]

0 8 . 2 A scientist investigated the hydrolysis of the protein casein.

The scientist:

- mixed a solution of a protease enzyme with a solution of casein
- then measured the casein concentration in the mixture at intervals
- controlled all relevant variables appropriately.

For this investigation, identify:

[2 marks]

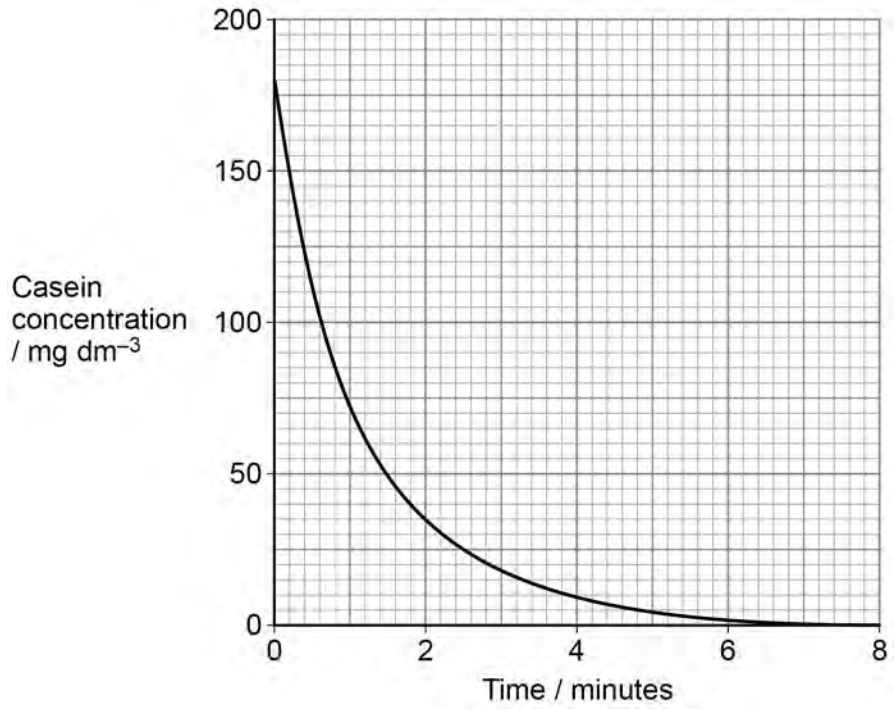
the independent variable

the dependent variable

Do not write outside the box

0 8 . 3 **Figure 10** shows the scientist's results.

Figure 10



Use **Figure 10** to determine the rate of casein hydrolysis at 2 minutes.

Show how you obtained your answer.

[2 marks]

Answer _____ mg dm^{-3} minute^{-1}

0 8 . 4 The scientist repeated the investigation but increased the temperature to the optimum temperature for this protease.

Sketch a line on **Figure 10** showing the results you predict if the investigation is repeated at the optimum temperature for the protease.

[2 marks]

9

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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.

DNA is a stable molecule but, even under normal cell conditions, spontaneous changes occur to the DNA nucleotide sequence. One example of a spontaneous change occurs when a cytosine base in a guanine–cytosine nucleotide pair is changed to a uracil base. This produces a guanine–uracil nucleotide pair in the DNA molecule. Scientists estimate this type of spontaneous change occurs to 100 guanine–cytosine nucleotide pairs in the genome of healthy human cells every day.

In healthy cells, enzyme-controlled processes repair these spontaneous changes in the DNA molecule by changing uracil bases back to cytosine bases. If these repairs do **not** happen, the uracil DNA nucleotide attracts an adenine DNA nucleotide when the DNA is replicated in the cell cycle. A mutation of the original DNA has now occurred.

Healthy cells with damaged DNA produce enzyme **X**. This enzyme slows the cell cycle by delaying the start of DNA replication. People with the disease ataxia telangiectasia (AT) do not produce functional enzyme **X**. Mutations occur at a higher rate in people with AT.

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

0 9 . 1 Give **one** similarity in structure between a guanine–cytosine nucleotide pair and a guanine–uracil nucleotide pair in a DNA molecule (lines 3–5).

Do **not** refer to guanine in your answer.

[1 mark]

Do not write outside the box

0 9 . 2 The DNA in a human genome contained 3×10^9 nucleotide pairs.

Assume 40% of these nucleotide pairs are guanine–cytosine nucleotide pairs.

Use this information and lines 5–7 to calculate the percentage of guanine–cytosine nucleotide pairs that change to guanine–uracil nucleotide pairs in this genome every day.

Give your answer in standard form.

Show your working.

[2 marks]

Answer _____ %

0 9 . 3 The type of mutation that occurs when 'repairs do **not** happen' (lines 10–11) may still produce a functional protein.

Suggest and explain why.

[4 marks]

Do not write outside the box

0 9 . 4 Suggest and explain why 'mutations occur at a higher rate' in people with AT (lines 15–16).

[3 marks]

10

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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