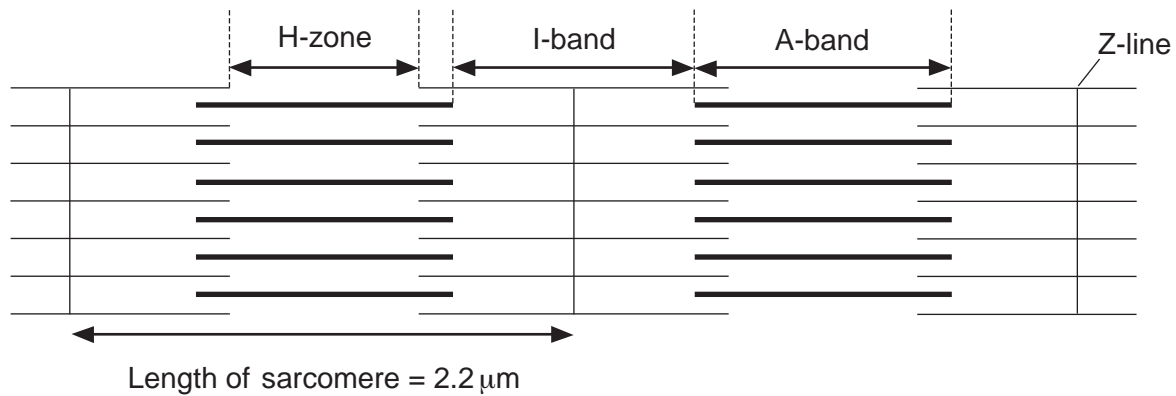


Question 1: N/A

2 The diagram shows two relaxed sarcomeres from skeletal muscle.



2 (a) When the sarcomeres contract, what happens to the length of

2 (a) (i) the I-band

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(1 mark)

2 (a) (ii) the A-band?

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(1 mark)

2 (b) The length of each sarcomere in the diagram is 2.2 μm. Use this information to calculate the magnification of the diagram. Show your working.

Magnification
(2 marks)

2 (c) People who have McArdle's disease produce less ATP than healthy people. As a result, they are not able to maintain strong muscle contraction during exercise. Use your knowledge of the sliding filament theory to suggest why.

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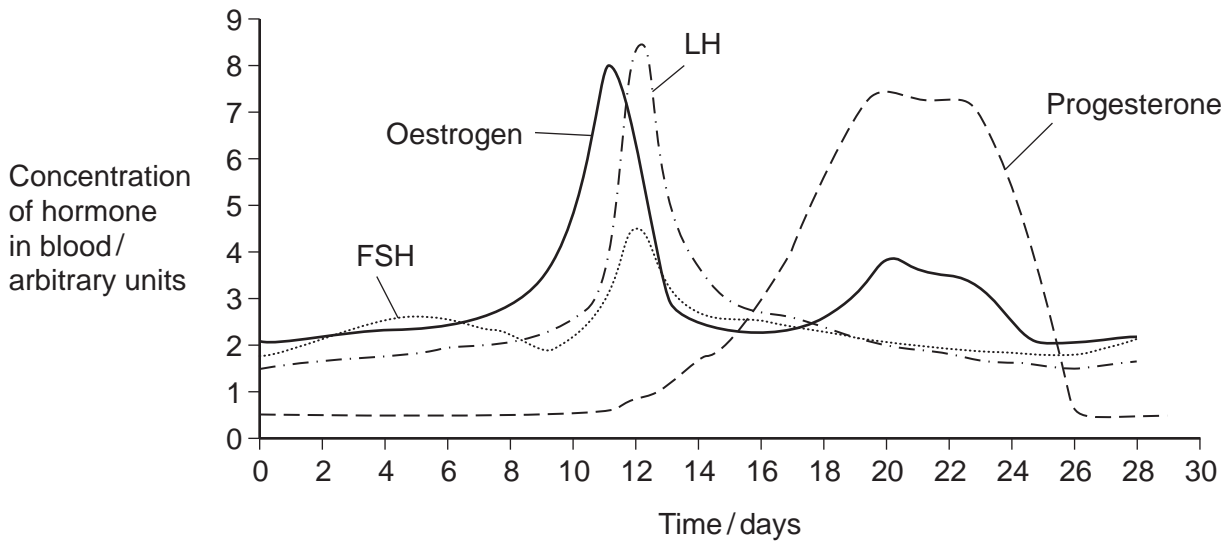
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7

Turn over for the next question

Turn over ►

3 The graph shows the concentration of four hormones in a woman's blood during one oestrous cycle.



3 (a) Explain how the graph supports the following statements.

3 (a) (i) Oestrogen causes the release of LH.

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(1 mark)

3 (a) (ii) The woman did **not** become pregnant during this cycle.

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(1 mark)

3 (b) Implanon is a contraceptive device that is inserted under a woman's skin and prevents pregnancy for up to three years. It is a small rod that continuously releases progesterone into her blood. This progesterone prevents fertilisation from taking place.

3 (b) (i) Explain how Implanon prevents fertilisation from taking place.

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(4 marks)

(Extra space)
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3 (b) (ii) Suggest **one** advantage of using Implanon rather than an oral contraceptive.

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(1 mark)

7

4 (a) Increased intensity of exercise leads to an increased heart rate. Explain how.

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(3 marks)

(Extra space)

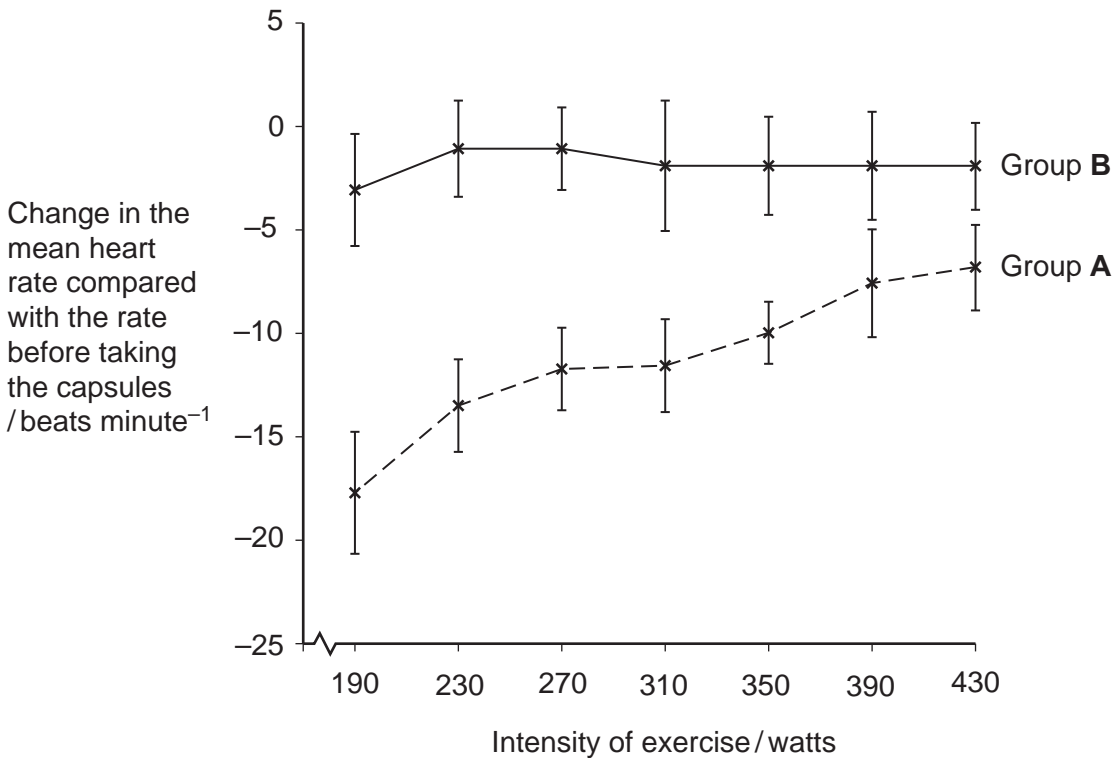
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4 (b) Scientists investigated the effect of taking omega-3 fatty acids in fish oil on heart rate during exercise. They recruited two large groups of volunteers, **A** and **B**. For each group, they measured the mean heart rates at different intensities of exercise. The volunteers were then given capsules to take for 8 weeks.

- Group **A** was given capsules containing omega-3 fatty acids in fish oil.
- Group **B** was given capsules containing olive oil.

After 8 weeks, they repeated the measurements of mean heart rates at different intensities of exercise. The graph shows their results. The bars represent the standard deviations.



4 (b) (i) Group B was given capsules containing olive oil. Explain why.

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(1 mark)

4 (b) (ii) The scientists concluded that omega-3 fatty acids lower the heart rate during exercise. Explain how the information in the graph supports this conclusion.

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(3 marks)

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Question 5: N/A

6 (a) Adrenaline binds to receptors in the plasma membranes of liver cells. Explain how this causes the blood glucose concentration to increase.

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(2 marks)

(Extra space)
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6 (b) Scientists made an artificial gene which codes for insulin. They put the gene into a virus which was then injected into rats with type I diabetes. The virus was harmless to the rats but carried the gene into the cells of the rats.

The treated rats produced insulin for up to 8 months and showed no side-effects. The scientists measured the blood glucose concentrations of the rats at regular intervals. While the rats were producing the insulin, their blood glucose concentrations were normal.

6 (b) (i) The rats were not fed for at least 6 hours before their blood glucose concentration was measured. Explain why.

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(1 mark)

6 (b) (ii) The rats used in the investigation had type I diabetes. This form of gene therapy may be less effective in treating rats that have type II diabetes. Explain why.

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(1 mark)

6 (b) (iii) Research workers have suggested that treating diabetes in humans by this method of gene therapy would be better than injecting insulin. Evaluate this suggestion.

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(Extra space)

(4 marks)

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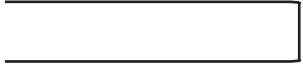

8

Turn over for the next question

Turn over ►

7 Scientists investigated the response of the roots of pea seedlings to gravity.

They took three samples of seedlings, **A**, **B**, and **C**, and placed them so that their roots were growing horizontally. The root tips of each sample had been given different treatments. After a set time, the scientists recorded whether the roots of the seedlings had grown upwards or downwards and the amount of curvature. The table shows the treatment they gave to each sample and their results.

Treatment	Results	
	Direction of growth	Mean amount of curvature / degrees
A None 	Downwards	60
B Root tip removed 	Continues to grow horizontally	0
C Upper half of root tip removed 	Downwards	30

7 (a) The pea seedlings were kept in the dark after each treatment. Explain why this was necessary.

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(1 mark)

7 (b) What conclusion can be made from the results for treatment **B**?

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(1 mark)

7 (c) Suggest how indoleacetic acid (IAA) could have caused the results for

7 (c) (i) treatment **A**

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(2 marks)

7 (c) (ii) treatment **C**.

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(2 marks)

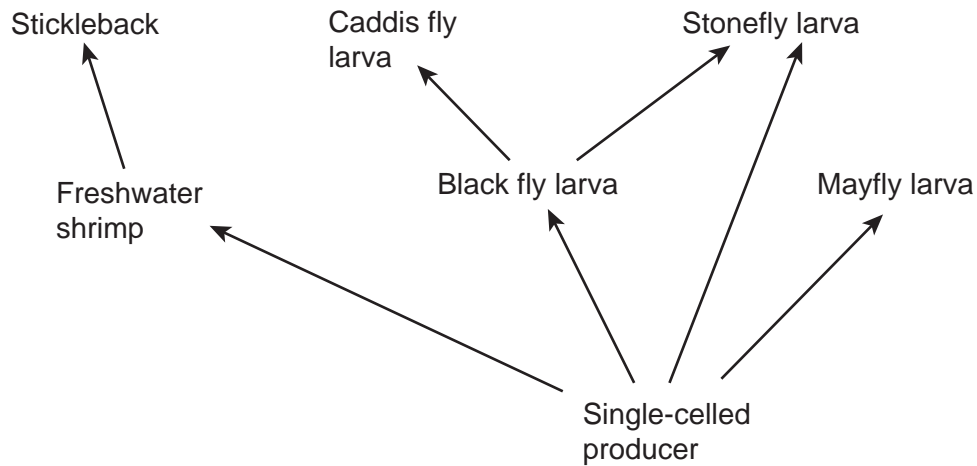
6

Turn over for the next question

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8

The diagram shows organisms in a food web.



(a) (i) Name **all** the secondary consumers in this food web.

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(1 mark)

(a) (ii) Use the diagram to explain the likely effect of a sudden decrease in the stickleback population on the population of mayfly larvae.

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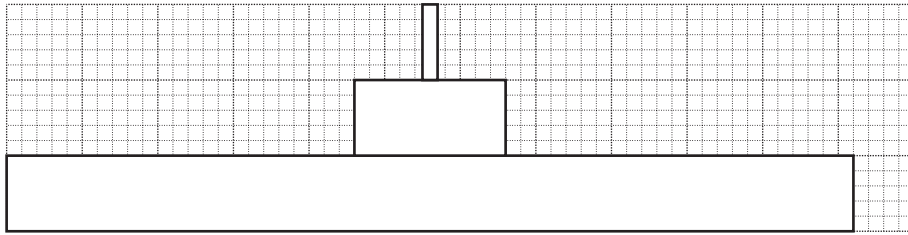
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(2 marks)

- 8 (b) A pyramid of energy for this food web is shown below. The bars are drawn to the same scale.



- (b) (i) Use the pyramid of energy to calculate the percentage efficiency of energy transfer between producers and primary consumers. Show your working.

efficiency = %
(2 marks)

- (b) (ii) The average efficiency of energy transfer between producers and primary consumers in pyramids of energy is around 10 %.

Suggest why the efficiency of energy transfer from producers to primary consumers in this food web is higher than 10 %.

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(2 marks)

- (c) Energy from the sun may ultimately end up in dead plant matter. Describe how.

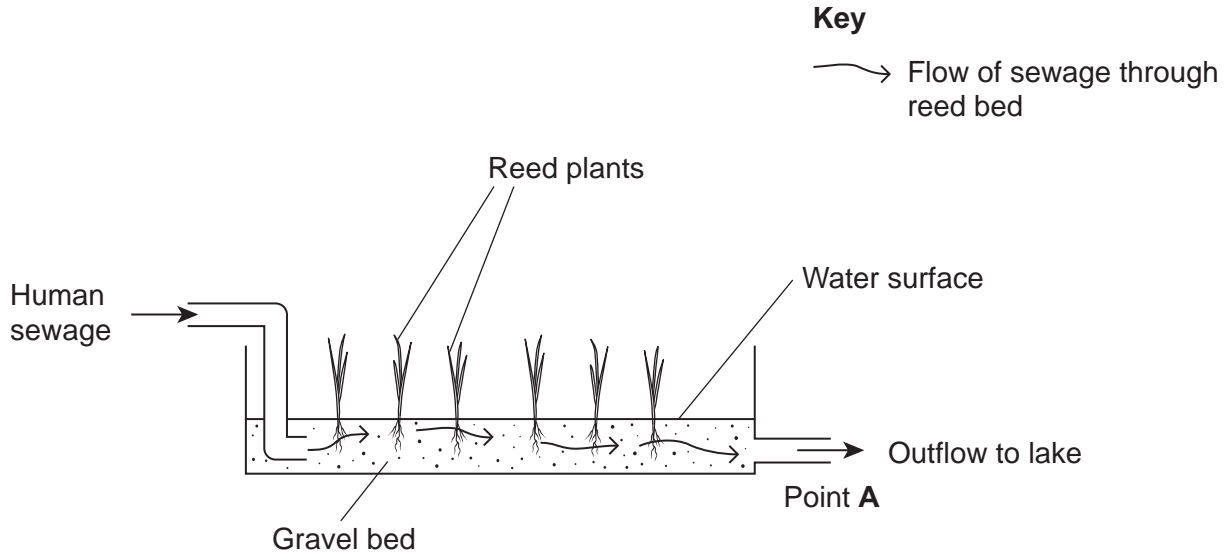
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(2 marks)

9 (a) Name the process by which some bacteria oxidise ammonia to nitrate.

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(1 mark)

Reeds are plants that grow with their roots under water. A reed bed contains a large number of growing reeds. Reed beds may be used to absorb nitrates produced when bacteria break down human sewage. The diagram shows a reed bed.



(b) Reeds have hollow, air-filled tissue in their stems which supplies oxygen to their roots. Explain how this enables the roots to take up nitrogen-containing substances.

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(2 marks)

(c) (i) There is an optimum rate at which human sewage should flow through the reed bed. If the flow of human sewage is too fast, the nitrate concentration at point **A** falls. Explain why.

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(2 marks)

(c) (ii) An increase in nitrate concentration in the water entering the lake could affect algae and fish in the lake. Explain how.

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(3 marks)

(Extra space)

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10 In some countries, pigs are reared in intensive units in which the temperature is controlled. Agricultural scientists investigated the effect of temperature on pig growth and on the efficiency with which the pigs converted food to biomass.

(a) (i) In the investigation, the scientists used pigs of the same breed, with similar genotypes. Explain why.

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(2 marks)

(a) (ii) The pigs were allowed to eat as much food as they wanted. How could this have decreased the reliability of any conclusions drawn from the investigation?

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(2 marks)

The table shows the results of this investigation.

Temperature / °C	Mean growth rate / kg per day	Efficiency of conversion of food to biomass / %
0	0.54	19
10	0.80	42
20	0.85	48
30	0.45	37
35	0.31	37

(b) (i) Describe the effect of temperature on mean growth rate.

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(1 mark)

(b) (ii) A student concluded from these data that the mean growth rate of the pigs was fastest at 20°C. Do you agree with this conclusion? Explain your answer.

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(2 marks)

(c) (i) Pigs can survive at temperatures above 35°C. Use the data to suggest why scientists did **not** carry out any investigations at temperatures higher than 35°C.

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(2 marks)

(c) (ii) The efficiency of conversion of food to biomass is lower at 0°C than it is at 20°C. Suggest an explanation for the lower efficiency.

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(2 marks)

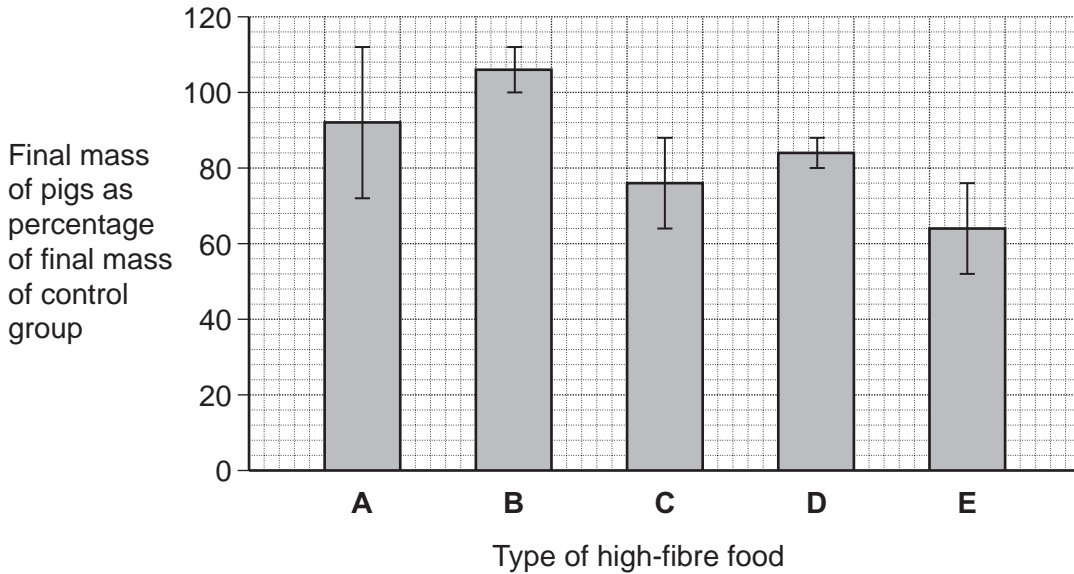
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(d) Pigs require a mixture of fibre and protein in their food. The greater the ratio of fibre to protein, the less the food costs.

Scientists took five large groups of pigs. They fed each group a different high-fibre food. Each of the foods contained fibre from different plant species, but they all had the same energy content. The scientists fed a control group of pigs a low-fibre food with the same energy content. After 10 days, the scientists compared the masses of the pigs fed on high-fibre food to those fed on low-fibre food.

The graph shows the results of the investigation. The bars represent ± 2 standard errors of the mean.



A farmer saw these results and concluded that he should replace his pigs' usual food with food **B**. Evaluate this conclusion.

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(4 marks)

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11 (a) ATP is useful in many biological processes. Explain why.

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(4 marks)

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Turn over ►

