WESTMINSTER SCHOOL

THE CHALLENGE 2021

# BIOLOGY

Thursday 29 April 2021

Time allowed: 30 minutes

Please write in black or blue ink.
Calculators are allowed.
Write your answers in the spaces provided.

For examiners use only

| Total Mark		

Questions 1 through 8 are multiple choice questions. Select one answer for each question by clearly circling in pen either A, B, C or D.

1. The diagram shows an experiment which can be used to find the energy content of different foods. Each food was completely burned and the energy content was estimated by the rise in temperature of the water.
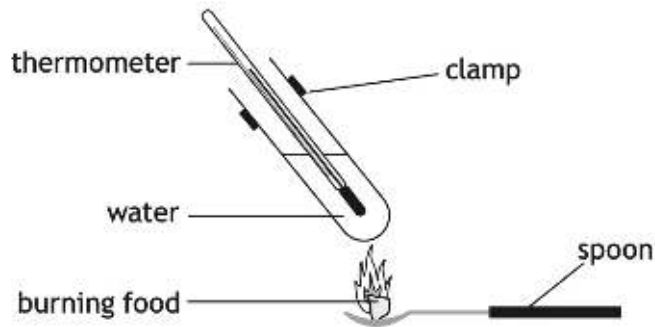
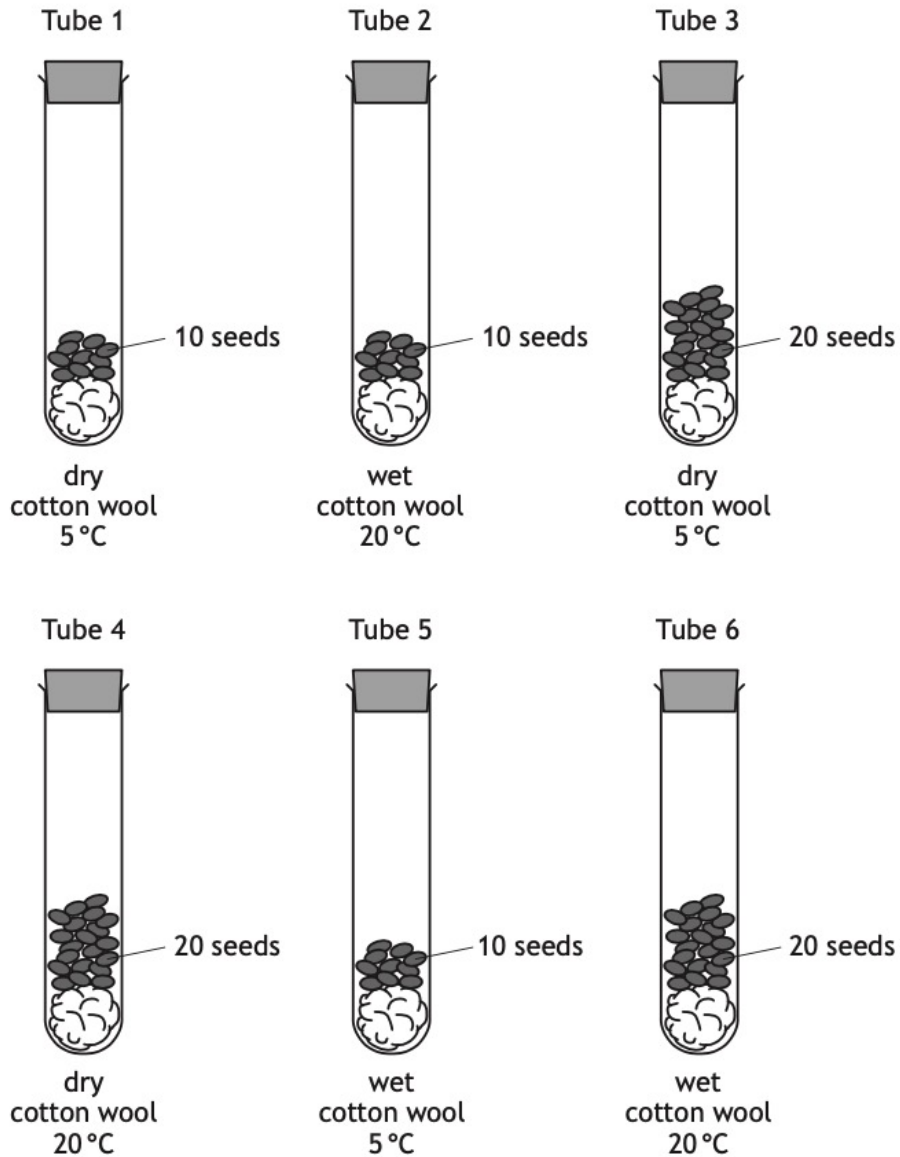The reliability of this experiment could be improved by

A   burning each food for the same length of time

B   repeating the experiment with each food several times

C   removing the thermometer from the tube to read it accurately

D   repeating the experiment using a different food each time.

2. The apparatus shown was used to investigate the rate of respiration in yeast at 20 °C.
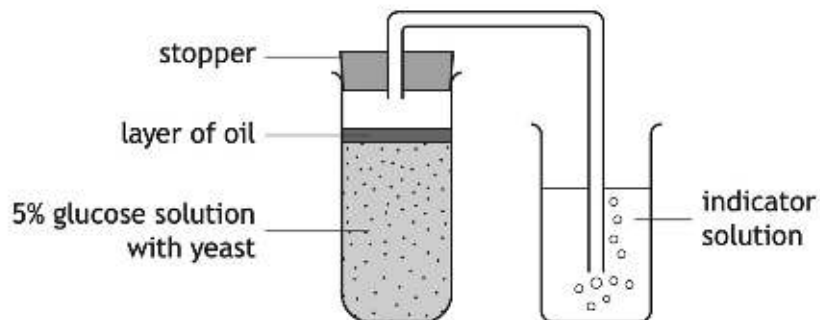
Which of the following changes would cause a decrease in the rate of respiration of the yeast?

A   Increase the thickness of the layer of oil by 1 mm.

B   Increase the temperature of the glucose solution by 1 °C.

C   Decrease the concentration of the glucose solution by 1%.

D   Decrease the volume of indicator solution by 1 cm^3.

3. The diagrams show an investigation into seed germination.

Tube 1 — 10 seeds — dry cotton wool — 5 °C

Tube 2 — 10 seeds — wet cotton wool — 20 °C

Tube 3 — 20 seeds — dry cotton wool — 5 °C

Tube 4 — 20 seeds — dry cotton wool — 20 °C

Tube 5 — 10 seeds — wet cotton wool — 5 °C

Tube 6 — 20 seeds — wet cotton wool — 20 °C

For a valid conclusion to be drawn, which two tubes should be compared to show the effect of temperature on germination?

A   1 and 3

B   3 and 6

C   2 and 5

D   4 and 6

4. A single strand of DNA contains 830 adenine, 929 cytosine, 774 guanine and 615 thymine bases.

How many guanine bases would be in the complementary strand?

A   615

B   774

C   830

D   929

PTO

5. Proteins are broken down in the stomach into polypeptides.

The graph shows the concentration of proteins and polypeptides in the stomach over 90 minutes.

Key

●——● protein concentration

●----● polypeptide concentration
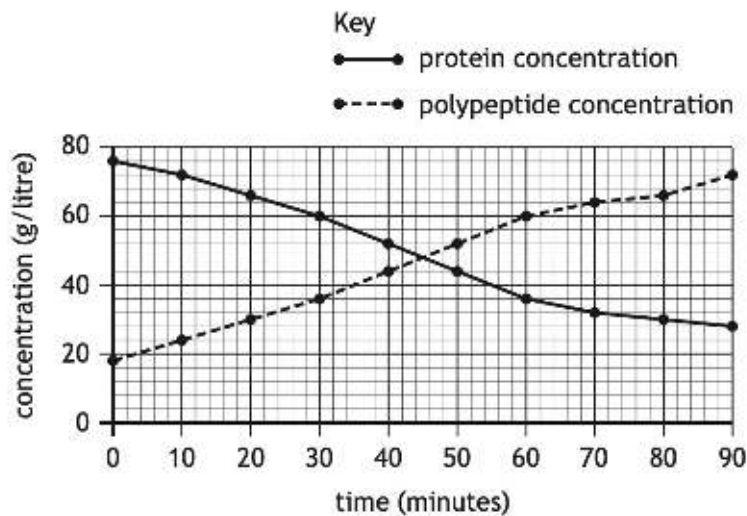
The ratio of protein concentration to polypeptide concentration in the stomach after 30 minutes is

A   3:5

B   5:3

C   13:7

D   7:13

6. Four flasks, J, K, L and M, were set up to investigate the production of carbon dioxide during respiration.

flow of air in

flow of air out

sodium hydroxide to absorb carbon dioxide

limewater

worms
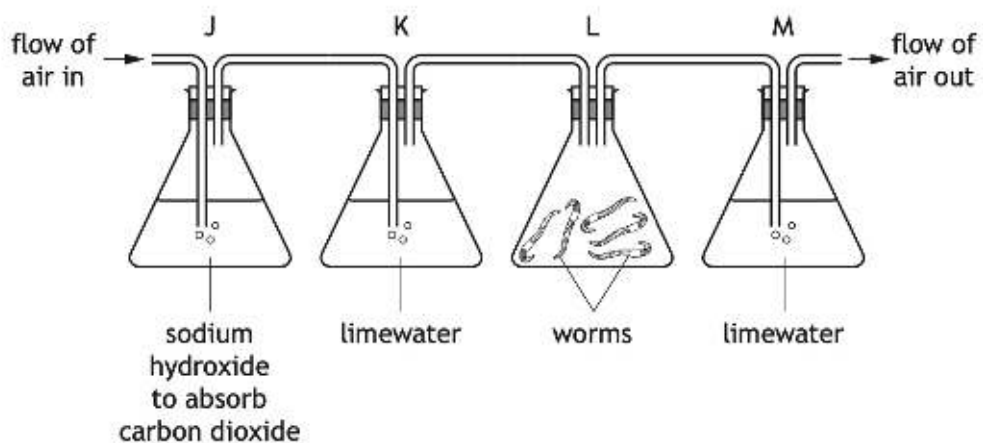
limewater

Limewater turns increasingly cloudy as more carbon dioxide is passed through it.

Predict what would happen if only one worm was used in flask L.

The limewater in flask

A   K would turn cloudy more slowly

B   K would turn cloudy more quickly

C   M would turn cloudy more slowly

D   M would turn cloudy more quickly.

7. At six different sample sites in a stream, the oxygen concentration, pH and numbers of different organisms were recorded.

The higher the number of organisms in the sample the more abundant they are.

The results are shown in the tables.

Table 1

Factor	Sample site					
	1	2	3	4	5	6
Oxygen concentration (units)	88	80	75	72	28	61
pH	5·7	6·0	6·6	7·3	7·6	8·0

Table 2

Organism	Sample site					
	1	2	3	4	5	6
Mayfly nymphs	0	0	0	5	7	122
Dragonfly nymphs	3	3	2	3	2	2
Chironimid fly larvae	0	1	1	2	227	32
Freshwater snails	0	0	0	0	50	75

Using the results from both tables identify which of the following conclusions is **false**.

A Freshwater snails do not survive in water with a lower pH

B Changes in pH have little effect on the distribution of dragonfly nymphs

C Mayfly nymphs are at their most abundant when the oxygen concentration is lowest

D Chironimid fly larvae are at their most abundant when the oxygen concentration is lowest

8. In which parts of a green leaf would most photosynthesis occur?

A Palisade mesophyll and lower epidermis

B Lower epidermis and guard cells

C Guard cells and spongy mesophyll

D Spongy mesophyll and palisade mesophyll

9. In a study, volunteers were injected with substance V on day 0 and again on day 35. Substance V causes antibodies to be produced.

The graph shows the antibody concentration in the blood of one of the volunteers in response to the two injections.
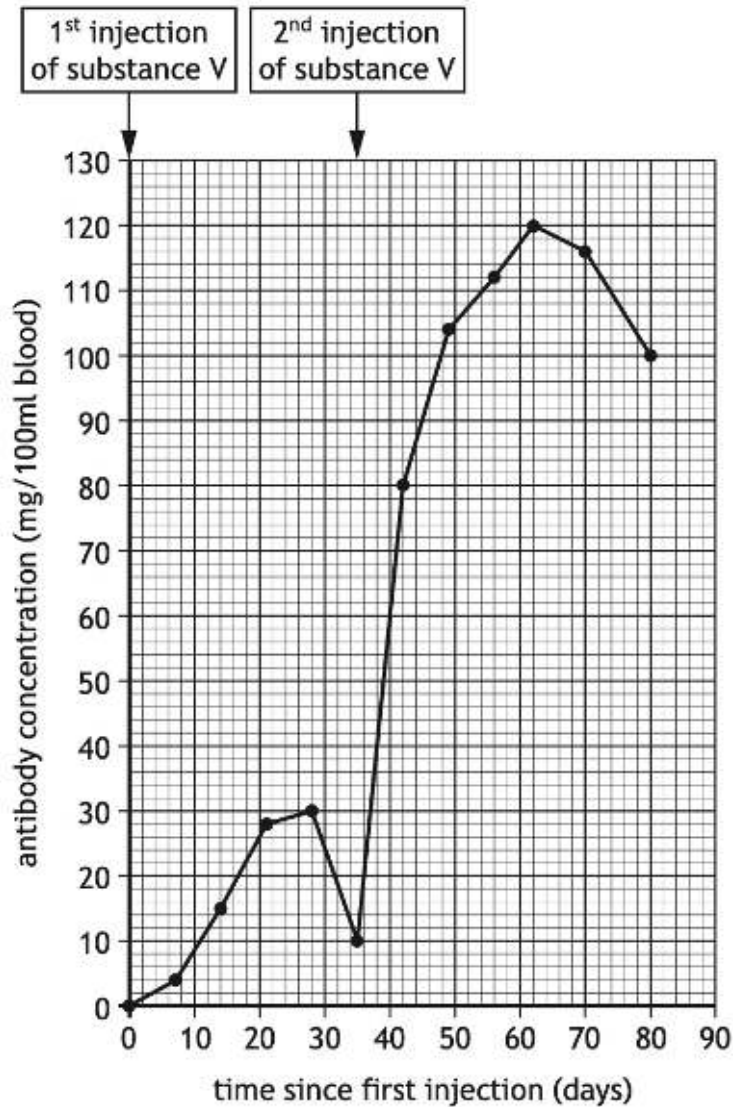
The second injection caused a higher concentration of antibody to be produced than the first.

Give **two** other differences in the antibody production in response to the two injections.

1 _____

_____

2 _____

_____

2

10. A study found that exercise can reduce the risk of developing some types of cancer.

Researchers examined the level of exercise of 1·4 million people over an 11 year period and recorded any diagnosis of cancer and when it occurred.

Participants were asked to keep their own record of the frequency and intensity of their exercise.

Those participants who exercised were found to have a reduced risk of developing some types of cancer. These results are shown in the table.

Type of cancer	Average risk reduction (%)
lung	26
kidney	23
stomach	22
myeloma	17
bladder	13

The study did not take into account factors such as diet and smoking, which may have affected the results. The fact that participants were asked to record their own exercise is another limitation of this study.

The doctor in charge of the research suggested that these results support the promotion of exercise as a means of reducing the risk of cancer.

However, it was suggested by a different researcher that further studies would need to be carried out before the results could be considered valid.

(a) Most research starts off with a question. For example, 'Is enzyme activity affected by pH?'

Suggest a question that could have led to the research described above. **1**

_____

_____

(b) Name the type of graph that should be used to present the results shown in the table. **1**

_____

10. (continued)

(c) Suggest one reason why the participants recording their own exercise is
described as a limitation. **1**

_____

_____

_____

(d) Three factors that could affect the results are age, duration of exercise
and type of exercise.

Choose one of these factors.

Describe how the study would be carried out to take the chosen factor
into account and improve the validity of the results. **1**

Factor _____

Description _____

_____

_____

11. The field of view of a light microscope measures 2 mm in diameter.

20 plant cells were counted in a line across the diameter.

1 mm = 1000 micrometres

Calculate the average size of a cell in micrometres. **1**

Space for calculation

_____ micrometres

12. An investigation was carried out into the effect of pH on the activity of the enzyme pepsin. Pepsin is a molecule that breaks down protein.

A Petri dish was filled with cloudy protein agar. Six holes were made in the agar and each was filled with pepsin solution at the pH values shown.
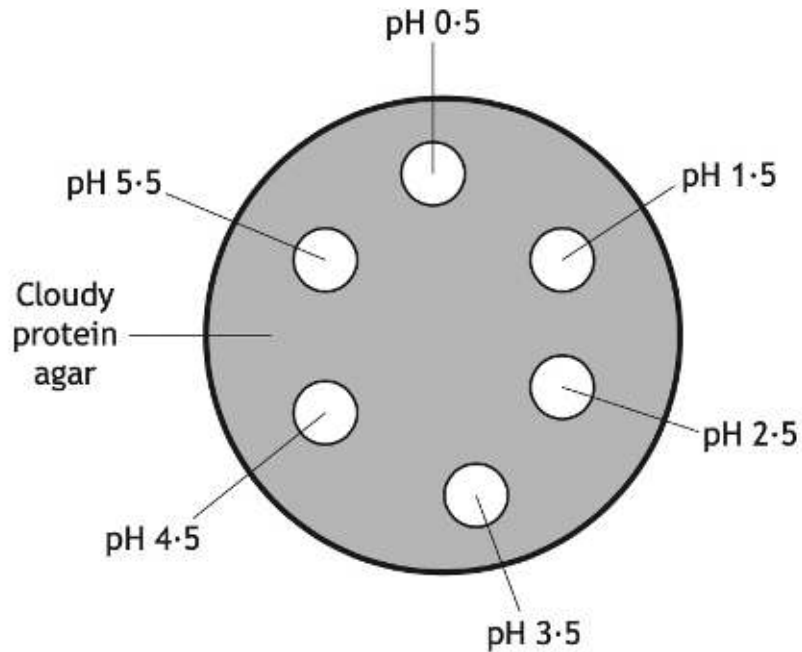
When the protein is broken down, cloudy agar becomes clear.

The dish was examined after 24 hours and the diameter of the clear area around each hole was measured. The larger the clear area, the more active the enzyme.

The results are shown in the graph.
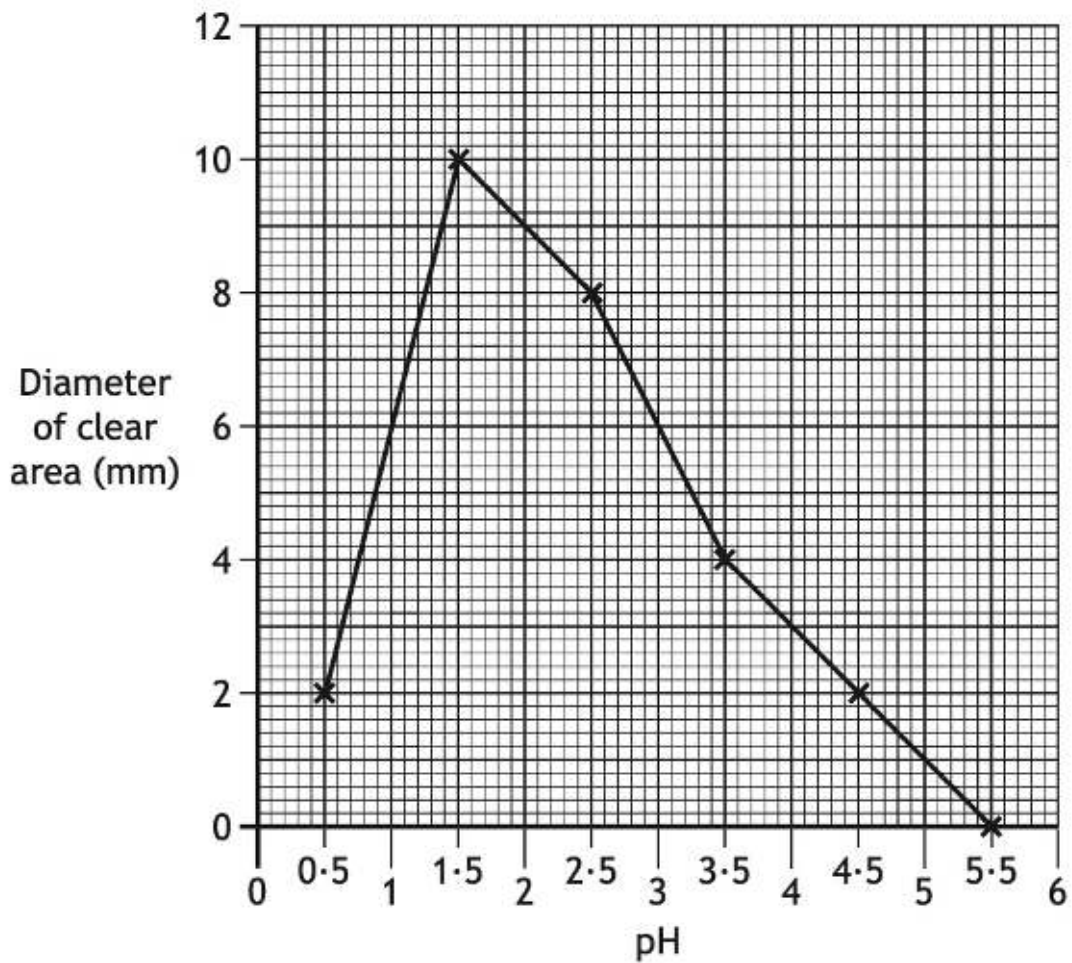
(a) (i) Identify the optimum pH for pepsin in this experiment.   1

pH _____

(ii) Calculate how many times more active the enzyme is at pH 2·5
than at pH 4·5.   1

Space for calculation

_____ times

12. (continued)

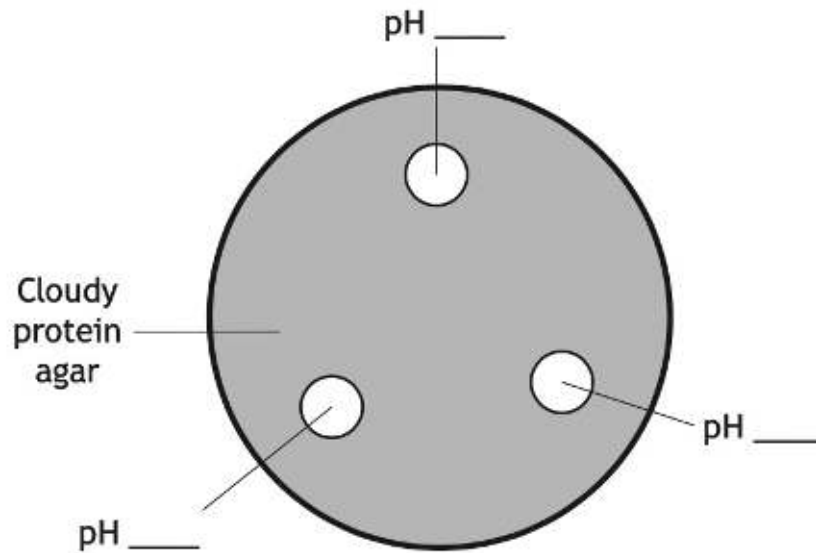(b) State two variables which should be controlled to make this experiment valid. **2**

1 _____

2 _____

(c) As a follow-up to this investigation, students were asked to design an experiment using the same apparatus to identify a more exact optimum pH value.

Complete the diagram below to show the pH values the students could use. **1**

pH ____

Cloudy
protein —
agar

pH ____

pH ____

13. To investigate the effect of competition on the growth of cress seeds, five Petri dishes, labelled A–E, were set up and left for six days. Each dish contained a layer of moist cotton wool with different numbers of cress seeds sown evenly across its surface.

Dish A is shown in the diagram.
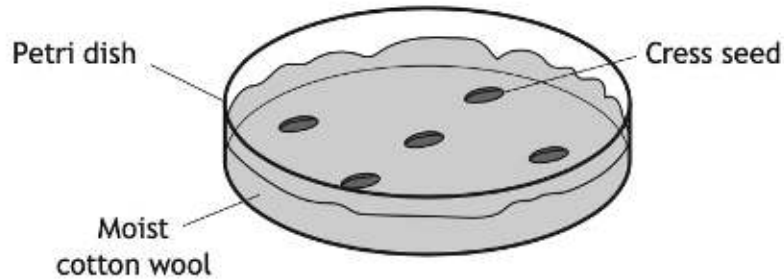
The results are shown in the table.

Dish	Number of seeds sown	Number of seedlings surviving after six days	Percentage of seedlings surviving after six days
A	5	5	100
B	10	10	100
C	20		95
D	40	34	85
E	80	60	75

(a) (i) Complete the table by calculating the number of seedlings surviving in Dish C.   1

Space for calculation

(ii) Describe the relationship between the number of seeds sown and the percentage of seedlings surviving after six days.   1
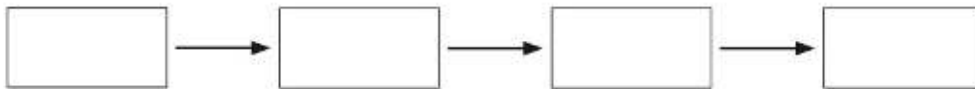
_____

_____

13. (continued)

    (iii) Explain why the type of competition shown in this investigation is described as being intraspecific.   **1**

_____

_____

(b) The diagram represents positions of organisms in a food chain.

Tick one of the boxes to show the position cress would occupy in the food chain.   **1**

$$\boxed{} \longrightarrow \boxed{} \longrightarrow \boxed{} \longrightarrow \boxed{}$$

14. A student set up an investigation into the effect of temperature on the rate of photosynthesis in a green plant, by measuring the volume of oxygen released in one hour.

The results are shown in the table.

Temperature (°C)	Volume of oxygen released in one hour (cm^3)		
	Experiment 1	Experiment 2	Average
10	0·7	0·5	0·6
20	1·6	1·4	1·5
30	2·7	1·9	2·3
40	2·0	2·6	2·3
50	0·3	0·5	0·4

(a) On the grid, plot a line graph to show the effect of temperature on the average volume of oxygen released in one hour.　　　　2

Average volume of oxygen released in one hour (cm^3)
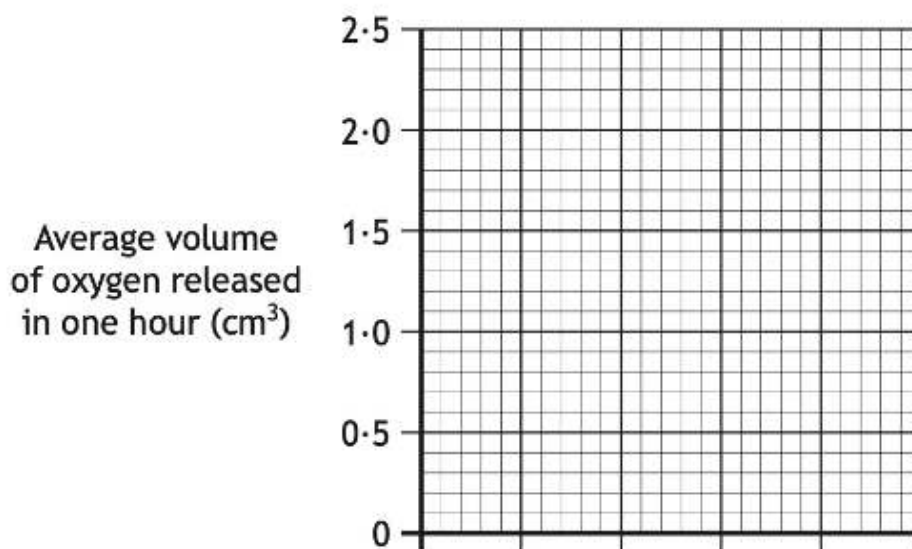
14. (continued)

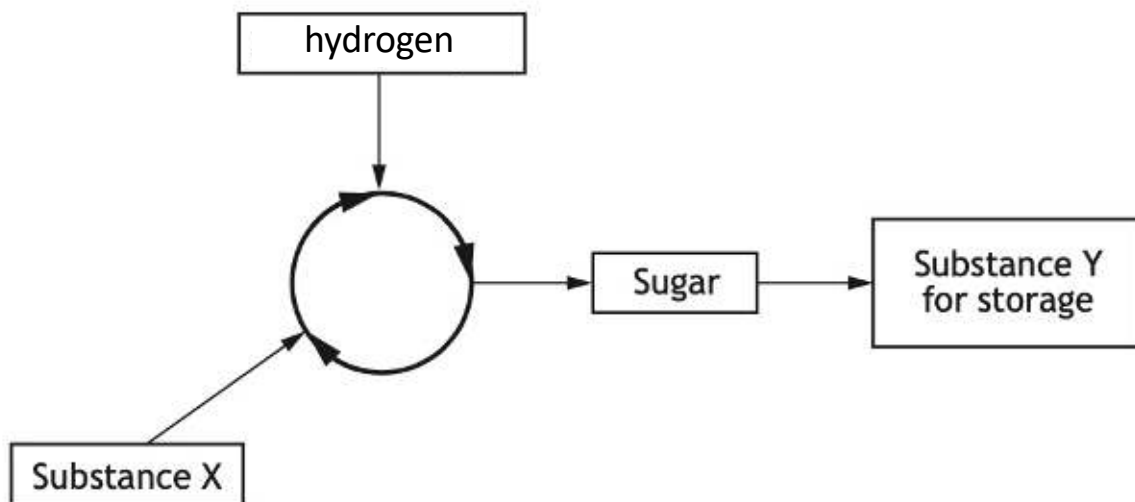(b) Predict the average volume of oxygen released in one hour if the experiment was carried out at a temperature of 60 °C.   **1**

_____ cm^3

(c) State one factor, other than temperature, which can limit the rate of photosynthesis.   **1**

_____

(d) The diagram represents the second stage of photosynthesis.

Name substances X and Y.   **2**

X_____

Y_____

15. A gardener treated the soil in the area where he planted vegetables with a chemical to increase the yield.

(a) When the vegetables were picked and weighed, the total yield was 42 kilograms. The previous year the total yield was 35 kilograms.

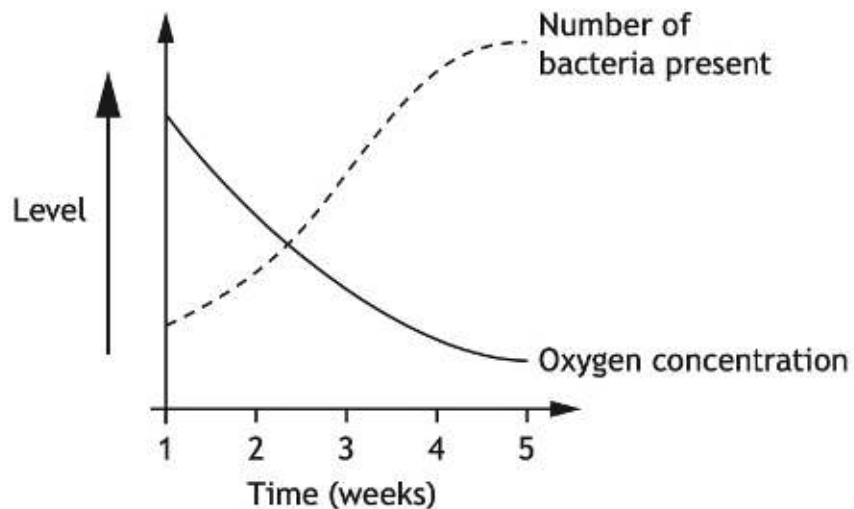Calculate the percentage increase in yield.   **1**

Space for calculation

_____ %

(b) Later in the year the gardener noticed that the algae in his pond had increased and now covered the surface of the water. He sampled the pond water over 5 weeks and measured its oxygen concentration and number of bacteria present.

The results are shown in the graph.

(ii) Explain why the increased growth of algae results in a decrease in the oxygen concentration of the pond water.

_____

_____

_____

_____   **2**

END OF QUESTIONS