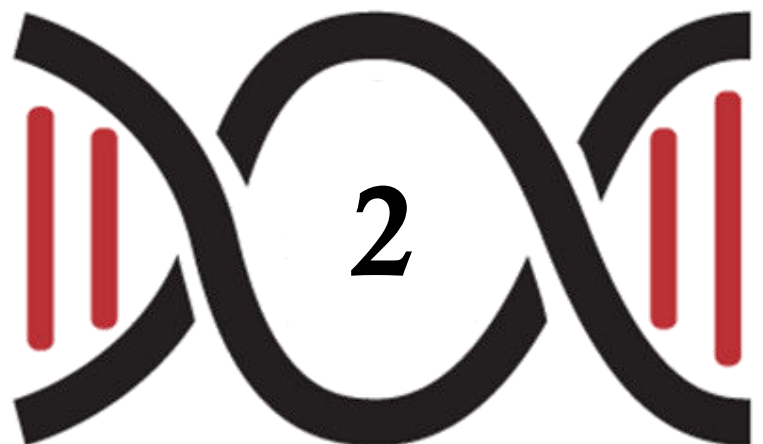


AQA A2 BIOLOGY

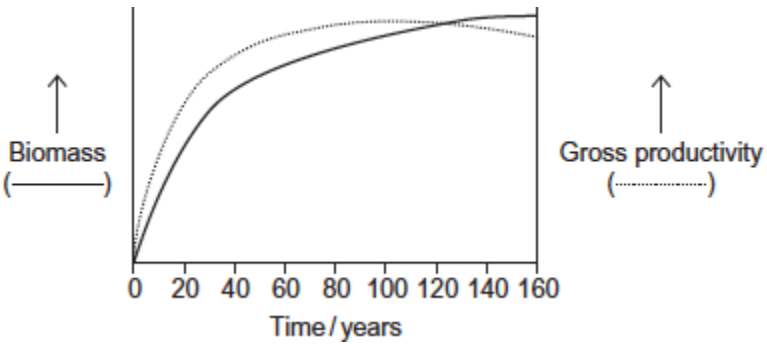
# TOPIC 5

ENERGY TRANSFER IN + BETWEEN ORGANISMS



1

The graph shows how gross productivity and biomass in an area changed with time in the succession from bare soil to mature woodland.



(a) (i) Suggest appropriate units for gross productivity.

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(1)

(ii) Explain the decrease in gross productivity as the woodland matures.

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(2)

(b) Use your knowledge of succession to explain the increase in biomass during the first 20 years.

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(3)

- (c) Use the information in the graph and your knowledge of net productivity to explain why biomass shows little increase after 100 years.

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(2)

- (d) Suggest **one** reason for conserving woodlands.

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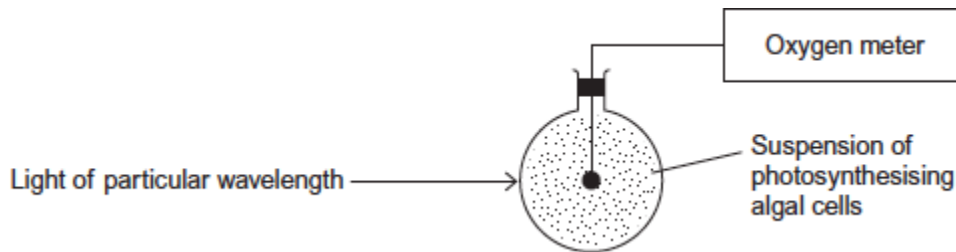
(1)

(Total 9 marks)

2

A student investigated the effect of different wavelengths of light on the rate of photosynthesis. She used the apparatus shown in **Figure 1**.

**Figure 1**



- (a) What measurements should the student have taken to determine the rate of photosynthesis?

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(1)

- (b) Other than temperature and pH, give **two** factors which should be kept constant during this investigation.

1 .....

2 .....

(2)

- (c) The student did **not** use a buffer to maintain the pH of the solution.  
Explain what would happen to the pH of the solution during this investigation.

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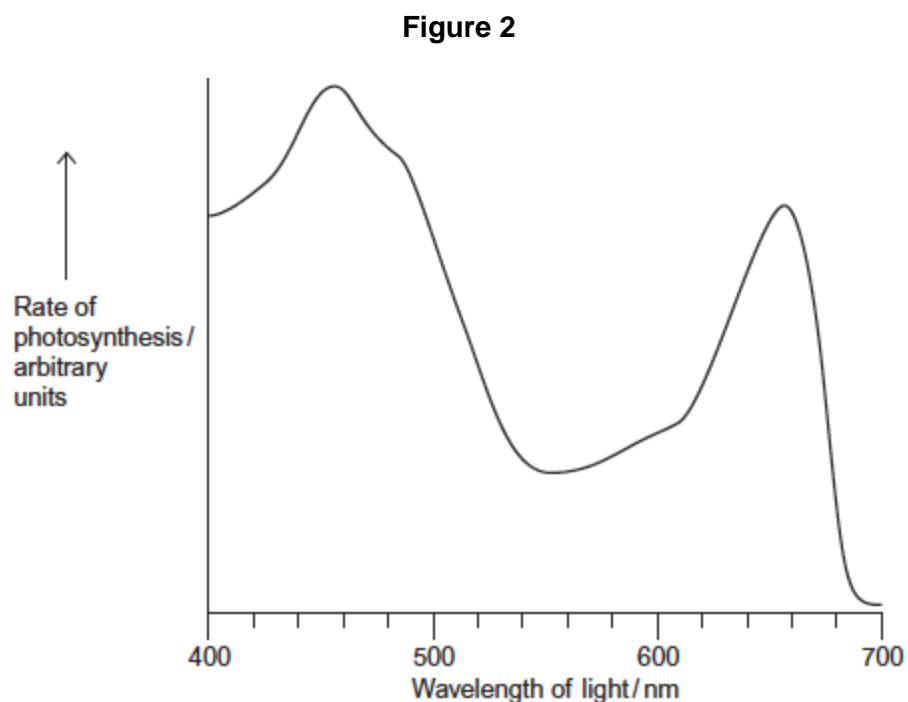
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(2)

- (d) **Figure 2** shows the student's results.



Suggest and explain why the rate of photosynthesis was low between 525 nm and 575 nm wavelengths of light.

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**[Extra space]** .....

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(2)  
(Total 7 marks)

**3**

(a) Describe how acetylcoenzyme A is formed in the link reaction.

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**(2)**

(b) In the Krebs cycle, acetylcoenzyme A combines with four-carbon oxaloacetate to form six-carbon citrate. This reaction is catalysed by the enzyme citrate synthase.

(i) Oxaloacetate is the first substrate to bind with the enzyme citrate synthase. This induces a change in the enzyme, which enables the acetylcoenzyme A to bind.

Explain how oxaloacetate enables the acetylcoenzyme A to then bind to the enzyme.

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**(2)**

(ii) Another substance in the Krebs cycle is called succinyl coenzyme A. This substance has a very similar shape to acetylcoenzyme A.

Suggest how production of succinyl coenzyme A could control the rate of the reaction catalysed by citrate synthase.

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**(2)**

- (c) In muscles, pyruvate is converted to lactate during anaerobic respiration.
- (i) Explain why converting pyruvate to lactate allows the continued production of ATP during anaerobic respiration.

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(2)

- (ii) In muscles, some of the lactate is converted back to pyruvate when they are well supplied with oxygen. Suggest **one** advantage of this.

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(1)

(Total 9 marks)

4

- (a) On islands in the Caribbean, there are almost 150 species of lizards belonging to the genus *Anolis*. Scientists believe that these species evolved from two species found on mainland USA. Explain how the Caribbean species could have evolved.

(6)

- (b) *Anolis sagrei* is a species of lizard that is found on some of the smallest Caribbean islands. Describe how you could use the mark-release-recapture method to estimate the number of *Anolis sagrei* on one of these islands.

(4)

- (c) Large areas of tropical forest are still found on some Caribbean islands. The concentration of carbon dioxide in the air of these forests changes over a period of 24 hours and at different heights above ground.

Use your knowledge of photosynthesis and respiration to describe and explain how the concentration of carbon dioxide in the air changes:

- over a period of 24 hours
- at different heights above ground.

(5)

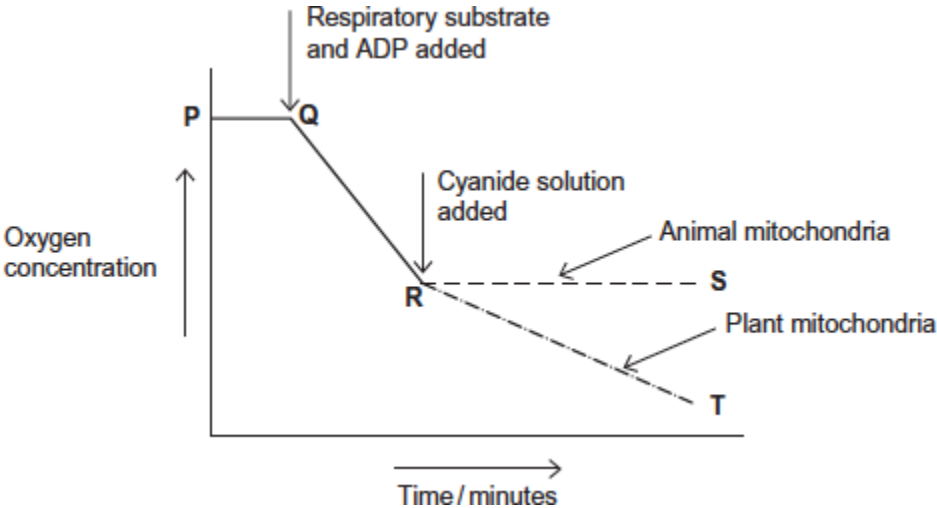
(Total 15 marks)

5

Researchers investigated the effect of cyanide on oxygen uptake by mitochondria. They prepared a suspension of mitochondria from animal cells and a suspension of mitochondria from plant cells. They placed the suspensions in separate flasks containing isotonic solution, started the timer and began recording the concentration of oxygen in each flask.

- After 5 minutes, they added a respiratory substrate and ADP to each flask.
- After 13 minutes, they added cyanide solution to each flask.

The graph below shows their results. From **P** to **R** the curves for animal and plant mitochondria overlap.



(a) Explain the line between **P** and **Q**.

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(2)

(b) (i) Explain the line between **Q** and **R**.

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(2)

- (ii) The respiratory substrate and ADP added after 5 minutes (**Q**) were part of a buffered isotonic solution.

What other substance would the buffer or solution have to contain?

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(1)

- (c) Describe and explain the difference between line **R** to **S** (animal mitochondria) and line **R** to **T** (plant mitochondria).

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(4)

(Total 9 marks)

**6**

Upwelling is a process where water moves from deeper parts of the sea to the surface. This water contains a lot of nutrients from the remains of dead organisms.

- (a) (i) Nitrates and phosphates are two of these nutrients. They provide a source of nitrogen and phosphorus for cells.

Give a biological molecule that contains:

1. nitrogen .....
2. phosphorus.....

(2)



(ii) Describe the role of microorganisms in producing nitrates from the remains of dead organisms.

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*(Extra space)* .....  
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**(3)**

(b) Upwelling often results in high primary productivity in coastal waters.  
Explain why some of the most productive fishing areas are found in coastal waters.

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**(2)**

**(Total 7 marks)**

**7**

Farmland previously used for growing crops was left for 30 years and developed into woodland. During this period, ecologists recorded an increase in the diversity of birds in the area.

(a) Name the process that resulted in the development of woodland from farmland.

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**(1)**

(b) Explain the increase in the diversity of birds as the woodland developed.

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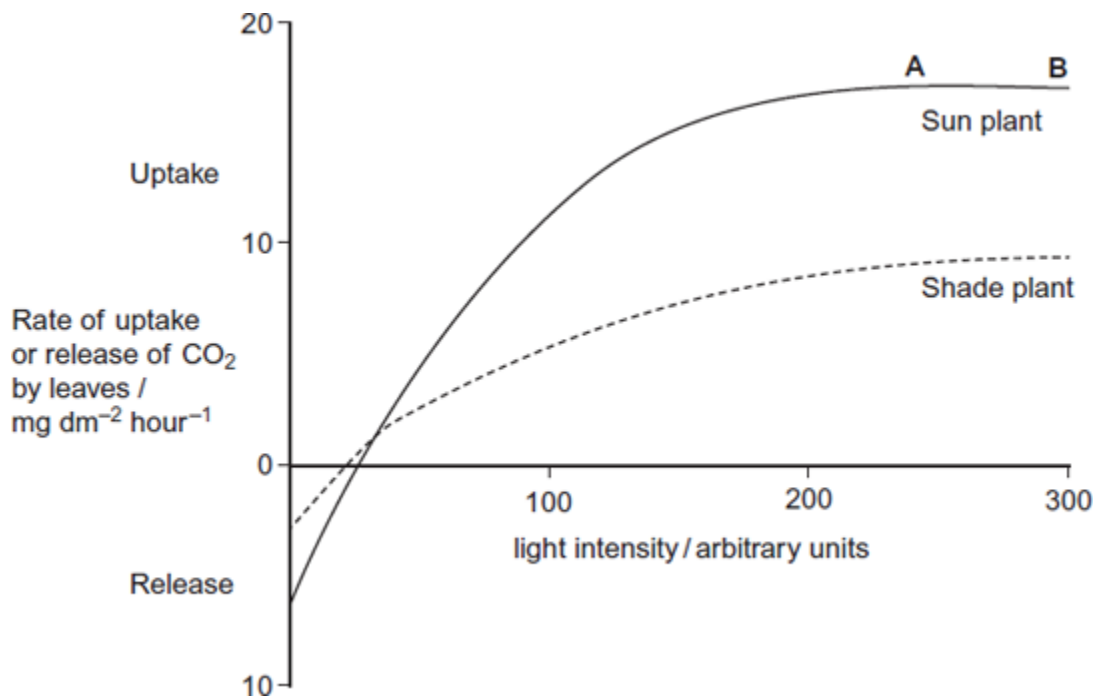
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(3)

(c) The ecologists also investigated photosynthesis in two species of plant found in the woodland. One of the species was adapted to growing in bright sunlight (sun plant) and the other was adapted to growing in the shade (shade plant). The ecologists' results are shown in the figure below.



(i) Give **two** factors which could be limiting the rate of photosynthesis in the sun plant between points **A** and **B** on the figure.

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2.....

(1)

(ii) Explain why CO<sub>2</sub> uptake is a measure of net productivity.

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(Extra space) .....  
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(1)

(iii) Use the information in the figure to explain how the shade plant is better adapted than the sun plant to growing at low light intensities.

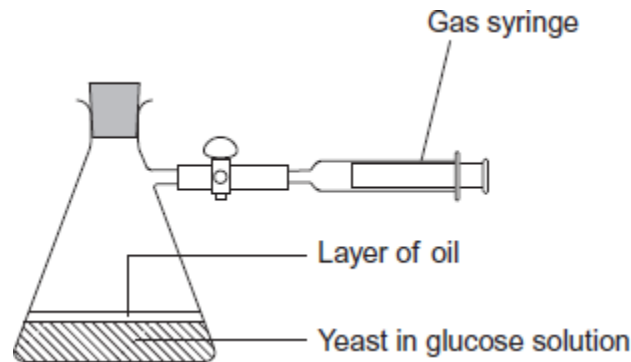
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(2)

(Total 8 marks)

8

A student investigated the rate of anaerobic respiration in yeast. She put 5 g of yeast into a glucose solution and placed this mixture in the apparatus shown in the figure below. She then recorded the total volume of gas collected every 10 minutes for 1 hour.



(a) Explain why a layer of oil is required in this investigation.

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(1)

(b) The student's results are shown in the following table.

Time / minutes	Total volume of gas collected / cm <sup>3</sup>
10	0.3
20	0.9
30	1.9
40	3.1
50	5.0
60	5.2

(i) Calculate the rate of gas production in cm<sup>3</sup> g<sup>-1</sup> min<sup>-1</sup> during the first 40 minutes of this investigation. Show your working.

Answer = ..... cm<sup>3</sup> g<sup>-1</sup> min<sup>-1</sup>

(2)

(ii) Suggest why the rate of gas production decreased between 50 and 60 minutes.

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(1)

(iii) Yeast can also respire aerobically. The student repeated the investigation with a fresh sample of yeast in glucose solution, but without the oil. All other conditions remained the same.

Explain what would happen to the volume of gas in the syringe if the yeast were only respiring aerobically.

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(2)

- (c) Respiration produces more ATP per molecule of glucose in the presence of oxygen than it does when oxygen is absent. Explain why.

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**(2)**  
**(Total 8 marks)**



10

CREB is a transcription factor in the mitochondria of neurones.

(a) What is a **transcription factor**?

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(2)

(b) CREB leads to the formation of a protein that removes electrons and protons from reduced NAD in the mitochondrion.

Huntington’s disease (HD) causes the death of neurones. People with HD produce a substance called huntingtin. Some scientists have suggested that binding of huntingtin to CREB may lead to the death of neurones.

Suggest how binding of huntingtin to CREB may lead to the death of neurones.

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*(Extra space)* .....

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(3)

- (c) CREB is a protein synthesised in the cytoplasm of neurones. Transport of CREB from the cytoplasm into the matrix of a mitochondrion requires two carrier proteins.

Use your knowledge of the structure of a mitochondrion to explain why transport of CREB requires **two** carrier proteins.

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(2)  
(Total 7 marks)

11

Scientists measured the rate of respiration in **three** parts of an ecosystem.

They did this by measuring carbon dioxide released into the air by:

- leaves of plants
- stems and roots of plants
- non-photosynthetic soil organisms.



The table below shows the scientists' results for these three parts of the ecosystem.

Part of ecosystem	Mean rate of carbon dioxide production / $\text{cm}^3 \text{m}^{-2} \text{s}^{-1}$	Percentage of total carbon dioxide production measured by the scientists
Leaves of plants	0.032	25.0
Stems and roots of plants	0.051	
Non-photosynthetic soil organisms	0.045	

- (a) Complete the table to show the percentage of total carbon dioxide production by each part of the ecosystem.

Show your working.

(2)

- (b) A student who looked at the data in the table concluded that plants carry out more respiration than non-photosynthetic organisms in the ecosystem.

Use the information provided to suggest why these data may **not** support the student's conclusion.

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(2)

(c) What measurements would the scientists have made in order to calculate the rate of carbon dioxide production?

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(2)

(d) The scientists calculated the mean rate of carbon dioxide production of the leaves using measurements of carbon dioxide release in the dark.

Explain why they did **not** use measurements taken in the light.

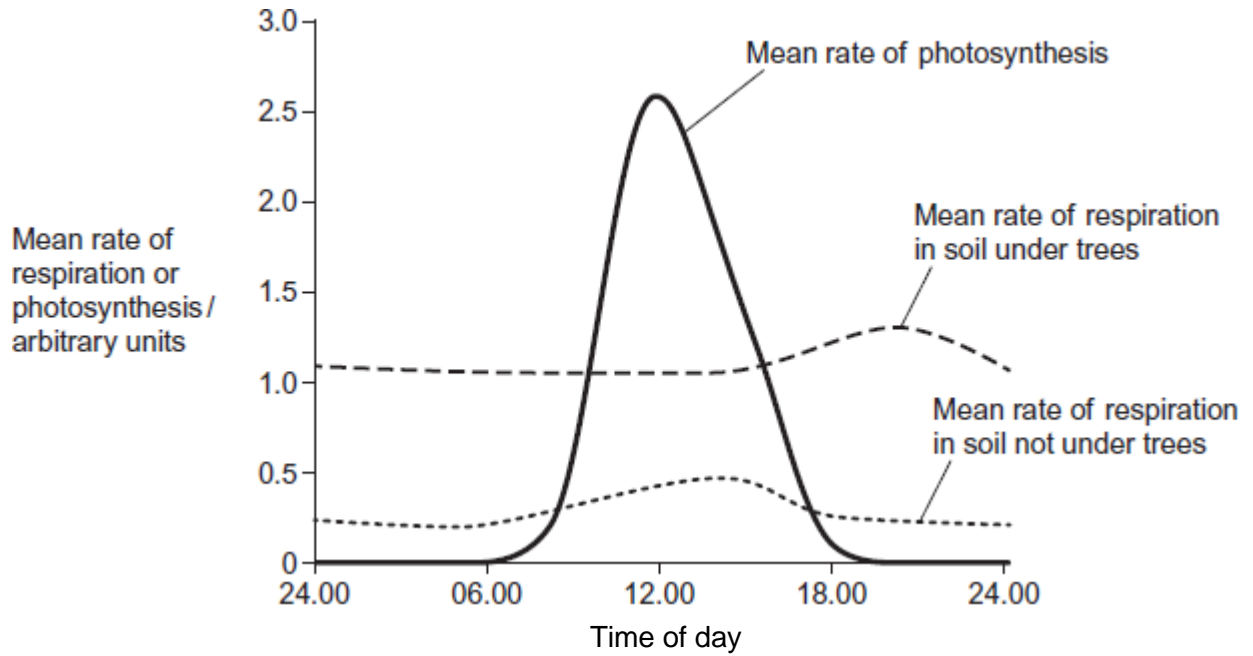
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(2)

Another group of scientists measured the mean rate of respiration in soil under trees and soil not under trees in the same wood. They also measured the mean rate of photosynthesis in the trees.

They took measurements at different times of day during the summer.

The figure below shows the scientists' results.



(e) (i) Describe **two** ways in which the mean rate of respiration in soil under trees is different from soil not under trees.

- 1 .....
- .....
- 2 .....
- .....

(2)

(ii) Suggest **one** explanation for the differences in the mean rate of respiration in soil under trees and soil not under trees between 06.00 and 12.00.

- .....
- .....
- .....
- .....

(2)

(f) The scientists suggested that the rise in the mean rate of photosynthesis was the cause of the rise in the mean rate of respiration in soil under trees.

(i) Suggest how the rise in the mean rate of photosynthesis could lead to the rise in the mean rate of respiration in soil under trees.

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**(2)**

(ii) Suggest why there is a delay between the rise in the mean rate of photosynthesis and the rise in the mean rate of respiration.

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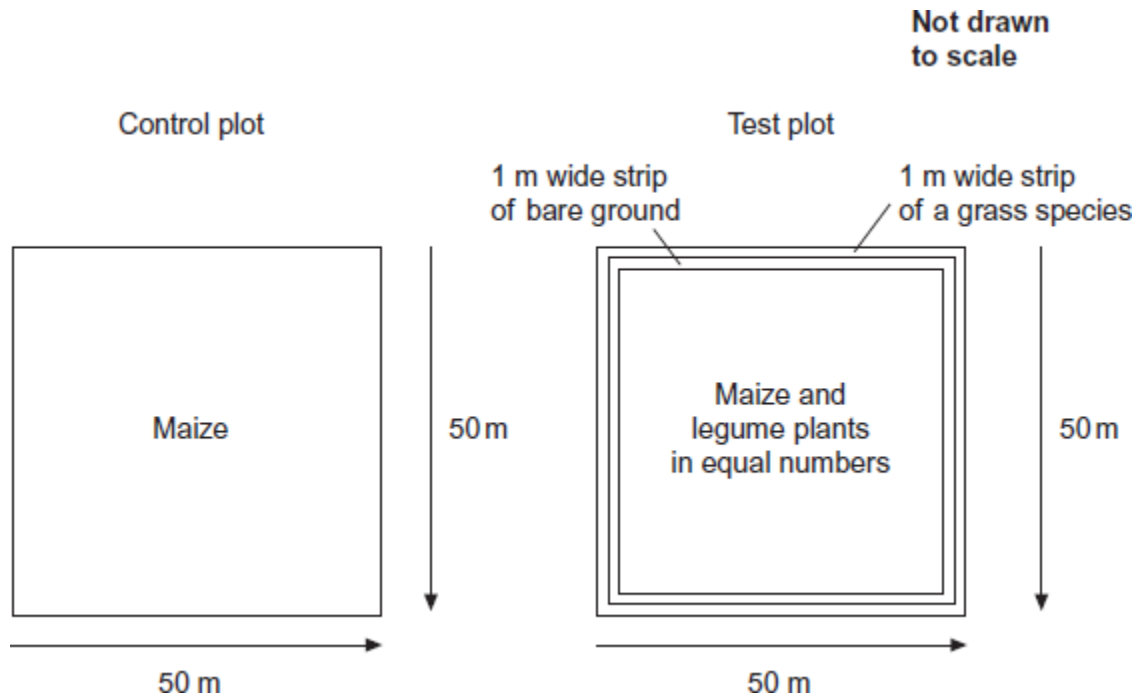
**(1)**

**(Total 15 marks)**

12

Stemborers are insect pests that feed on maize plants. Scientists investigated the effect of **push-pull** stimuli on the control of these pests.

For this investigation, the scientists divided a large field into plots measuring 50 m × 50 m. They then designated each plot as a control plot or a test plot. The following figure shows what they planted in each type of plot.



The legumes planted with the maize drive stemborers away.  
The grass species attracts stemborers.

The table below shows the scientists' results.

Plots	Mean percentage damage to maize plants	Mean maize grain yield / tonnes per hectare ( $\pm$ standard deviation)	Mean production costs per farmer / \$ per hectare ( $\pm$ standard deviation)	Mean total income for farmer / \$ per hectare ( $\pm$ standard deviation)
Control	29.6	1.5 ( $\pm 0.2$ )	250 ( $\pm 0.7$ )	329 ( $\pm 5.9$ )
Test	6.7	3.7 ( $\pm 0.3$ )	278 ( $\pm 1.1$ )	679 ( $\pm 10.2$ )

(a) In the test plot of land, identify the push stimulus and the pull stimulus.

Push stimulus .....

Pull stimulus .....

(1)

(b) When measuring the mean percentage damage to maize plants, 60 plants from each test plot were selected at random and examined.

Describe how the maize plants could be selected at random.

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**(3)**

(c) In the test plot, bare ground was left between the maize and the grass species. Suggest an explanation why.

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**(2)**

(d) The legume plants have nodules containing nitrogen-fixing bacteria on their roots. Explain how nitrogen-fixing bacteria could increase the growth of the maize.

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**(2)**

(e) A year after this investigation, the government of one country decided that their farmers should use these **push-pull** stimuli.

How do these data support this decision?

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**(3)**  
**(Total 11 marks)**