Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Level Examination
January 2013

Biology BIOL4

Unit 4 Populations and environment

Friday 11 January 2013 1.30 pm to 3.00 pm

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

Time allowed
- 1 hour 30 minutes

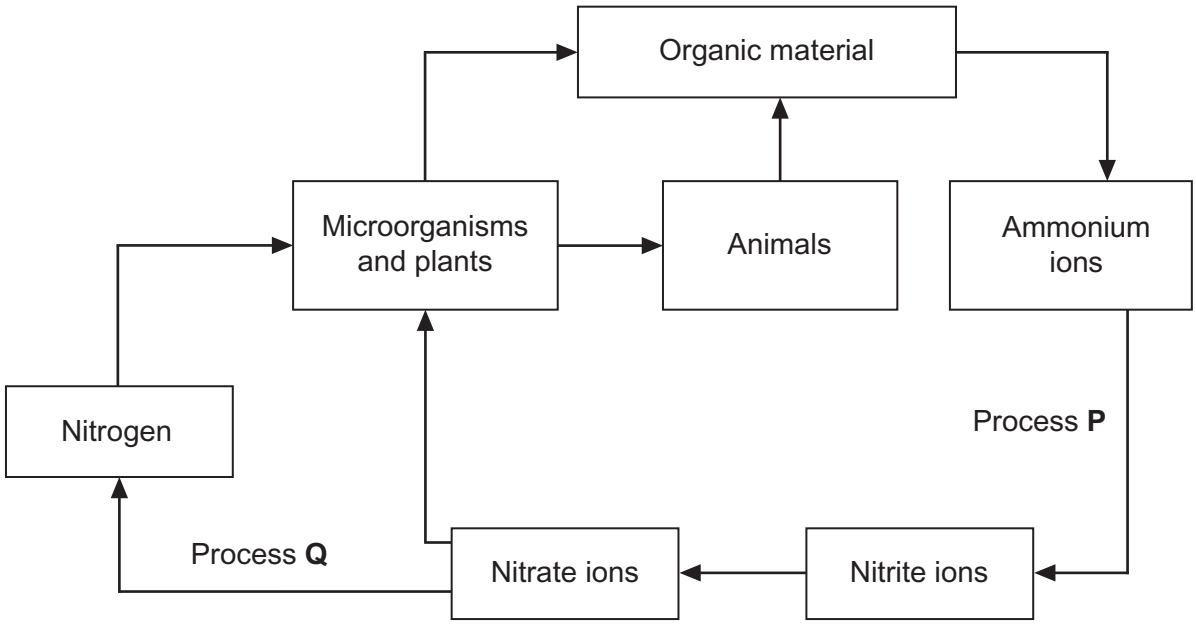
Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- You may ask for extra paper. Extra paper must be secured to this booklet.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this paper is 75.
- The marks for questions are shown in brackets.
- Quality of Written Communication will be assessed in all answers.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Do not write outside the box

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

1 The diagram shows the nitrogen cycle.



1 (a) (i) Name process **P**.

.....

(1 mark)

1 (a) (ii) Name process **Q**.

.....

(1 mark)

1 (b) Leguminous crop plants have nitrogen-fixing bacteria in nodules on their roots. On soils with a low concentration of nitrate ions, leguminous crops often grow better than other types of crop. Explain why.

.....

.....

.....

.....

.....

(2 marks)

Do not write outside the box

1 (c) Applying very high concentrations of fertiliser to the soil can reduce plant growth. Use your knowledge of water potential to explain why.

.....

.....

.....

.....

.....

(2 marks)

6

Turn over for the next question

Do not write outside the box

2 (a) Explain what is meant by the term population.

.....

.....

(1 mark)

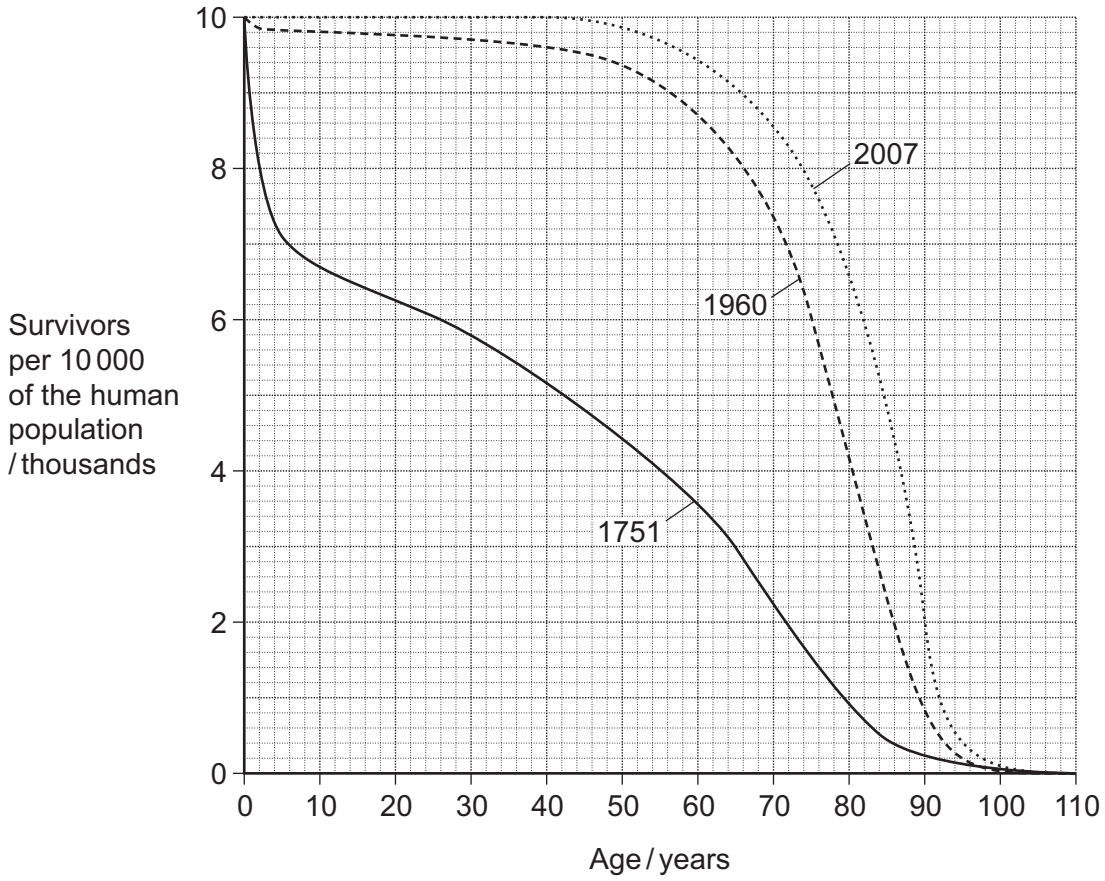
2 (b) Give **two** factors which could lead to a decrease in the death rate in a human population.

1 .....

2 .....

(1 mark)

The graph shows survival curves for human populations of the same country in different years.



Do not write outside the box

2 (c) Calculate the percentage increase from 1751 to 2007 in the number of people who survived to 70 years of age. Show your working.

Answer = ... %

(2 marks)

2 (d) The changes in the survival curves between 1751 and 1960 show that a demographic transition has taken place in this country. Explain how the changes show this.

.....

.....

.....

.....

.....

(2 marks)

6

Turn over for the next question

Do not write outside the box

3 The fruit fly is a useful organism for studying genetic crosses. Female fruit flies are approximately 2.5 mm long. Males are smaller and possess a distinct black patch on their bodies. Females lay up to 400 eggs which develop into adults in 7 to 14 days. Fruit flies will survive and breed in small flasks containing a simple nutrient medium consisting mainly of sugars.

3 (a) Use this information to explain **two** reasons why the fruit fly is a useful organism for studying genetic crosses.

1 .....

.....

2 .....

.....

(2 marks)

3 (b) Male fruit flies have the sex chromosomes XY and the females have XX. In the fruit fly, a gene for eye colour is carried on the X chromosome. The allele for red eyes, **R**, is dominant to the allele for white eyes, **r**. The genetic diagram shows a cross between two fruit flies.

3 (b) (i) Complete the genetic diagram for this cross.

Phenotypes of parents	red-eyed female	×	white-eyed male
Genotype of parents	.....		.....
Gametes	..... and		..... and .....
Phenotypes of offspring	red-eyed females	and	red-eyed males
Genotype of offspring	.....		.....

(3 marks)

Do not write outside the box

3 (b) (ii) The number of red-eyed females and red-eyed males in the offspring was counted. The observed ratio of red-eyed females to red-eyed males was similar to, but not the same as, the expected ratio. Suggest **one** reason why observed ratios are often **not** the same as expected ratios.

.....

.....

.....

(1 mark)

3 (c) Male fruit flies are more likely than female fruit flies to show a phenotype produced by a recessive allele carried on the X chromosome. Explain why.

.....

.....

.....

.....

.....

(2 marks)

8

Turn over for the next question

Do not write outside the box

4 A student investigated an area of moorland where succession was occurring. She used quadrats to measure the percentage cover of plant species, bare ground and surface water every 10 metres along a transect. She also recorded the depth of soil at each quadrat. Her results are shown in the table.

	Percentage cover in each quadrat A to E				
	A	**B**	**C**	**D**	**E**
Bog moss	55	40	10	–	–
Bell heather	–	–	–	15	10
Sundew	10	5	–	–	–
Ling	–	–	–	15	20
Bilberry	–	–	–	15	25
Heath grass	–	–	30	10	5
Soft rush	–	30	20	5	5
Sheep's fescue	–	–	25	35	30
Bare ground	20	15	10	5	5
Surface water	15	10	5	–	–
Soil depth / cm	3.2	4.7	8.2	11.5	14.8

– Indicates zero percentage cover.

4 (a) Explain how these data suggest that succession has occurred from points **A** to **E** along the transect.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

Do not write outside the box

4 (b) The diversity of animal species is higher at **E** than **A**. Explain why.

.....

.....

.....

.....

.....

(2 marks)

4 (c) The student used the mark-release-recapture technique to estimate the size of the population of sand lizards on an area of moorland. She collected 17 lizards and marked them before releasing them back into the same area. Later, she collected 20 lizards, 10 of which were marked.

4 (c) (i) Give **two** conditions for results from mark-release-recapture investigations to be valid.

1 .....

.....

2 .....

.....

(2 marks)

4 (c) (ii) Calculate the number of sand lizards on this area of moorland. Show your working.

Answer = ...

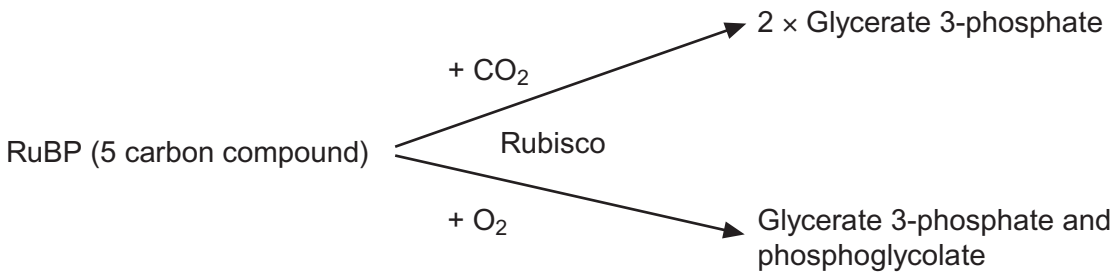
(2 marks)

9

Do not write outside the box

5 During photosynthesis, carbon dioxide reacts with ribulose bisphosphate (RuBP) to form two molecules of glycerate 3-phosphate (GP). This reaction is catalysed by the enzyme Rubisco. Rubisco can also catalyse a reaction between RuBP and oxygen to form one molecule of GP and one molecule of phosphoglycolate. Both the reactions catalysed by Rubisco are shown in **Figure 1**.

Figure 1



5 (a) (i) Where exactly in a cell is the enzyme Rubisco found?

.....

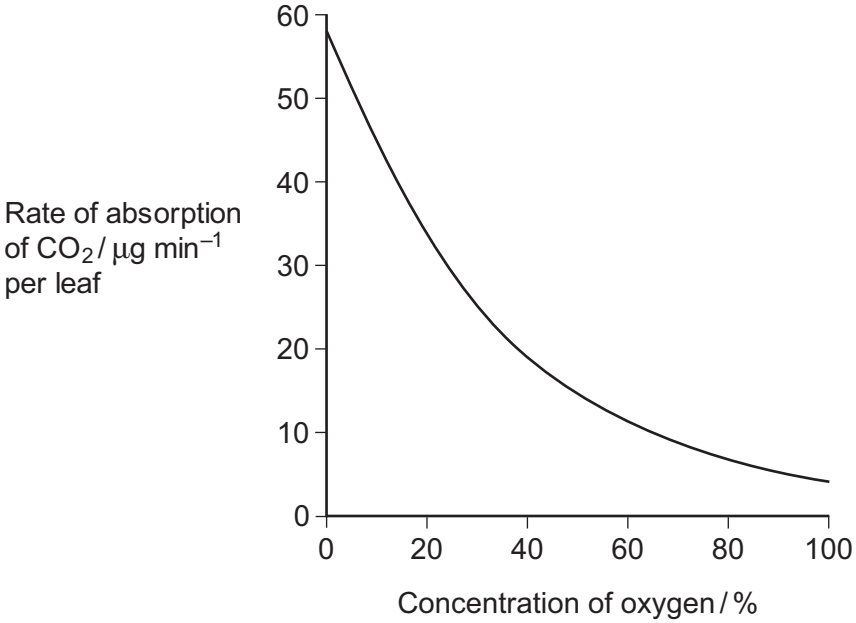
(1 mark)

5 (a) (ii) Use the information provided to give the number of carbon atoms in **one** molecule of phosphoglycolate.

(1 mark)

5 (b) Scientists investigated the effect of different concentrations of oxygen on the rate of absorption of carbon dioxide by leaves of soya bean plants. Their results are shown in **Figure 2**.

Figure 2



Do not write outside the box

Use **Figure 1** to explain the results obtained in **Figure 2**.

.....

.....

.....

.....

.....

(2 marks)

5 (c) Use the information provided and your knowledge of the light-independent reaction to explain why the yield from soya bean plants is decreased at higher concentrations of oxygen. Phosphoglycolate is not used in the light-independent reaction.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

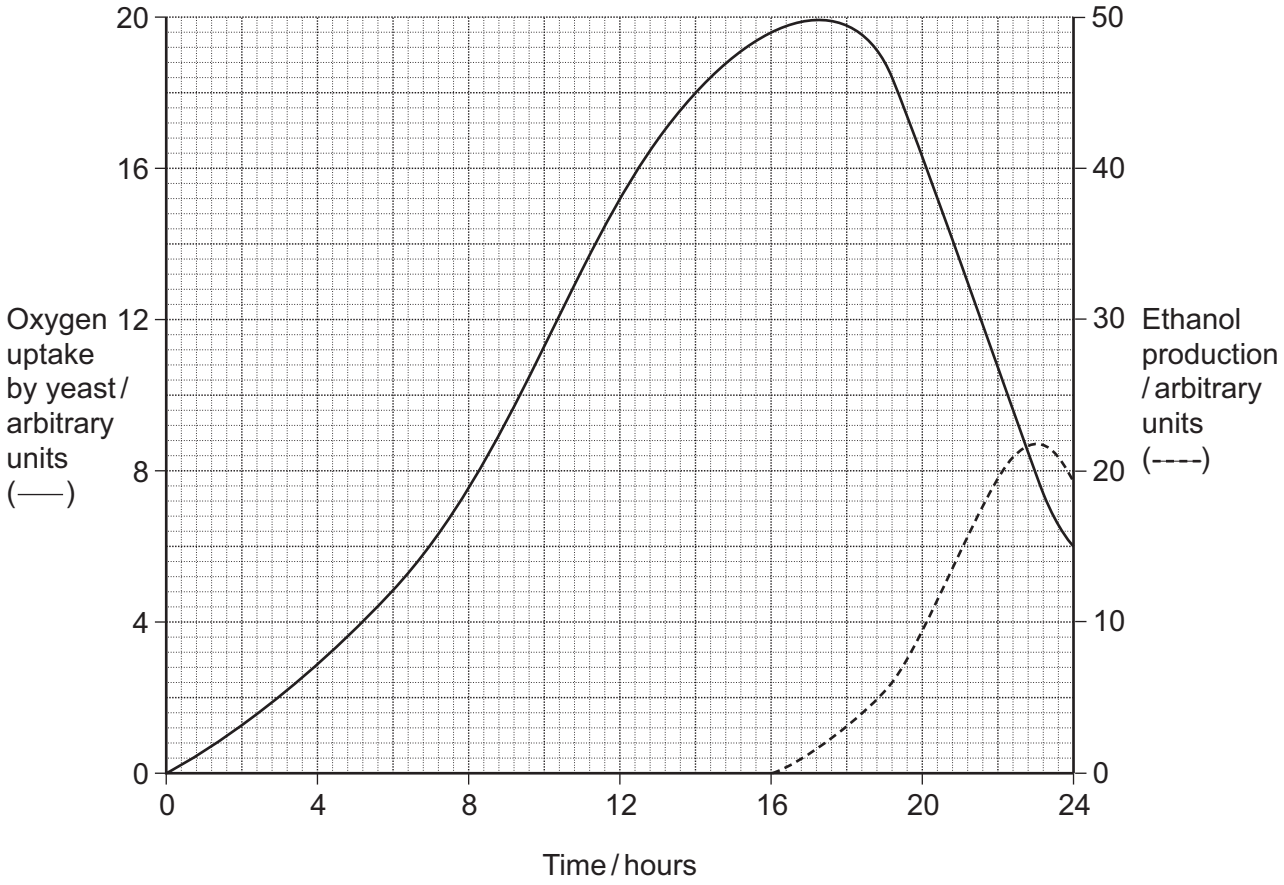
.....

.....

7

Do not write outside the box

6 Yeast is a single-celled organism. A student investigated respiration in a population of yeast growing in a sealed container. His results are shown in the graph.



6 (a) Calculate the rate of oxygen uptake in arbitrary units per hour between 2 and 4 hours.

Answer ..... arbitrary units per hour

(1 mark)

6 (b) (i) Use the information provided to explain the changes in oxygen uptake during this investigation.

.....

.....

.....

.....

.....

.....

(3 marks)

Do not write outside the box

(Extra space) .....

.....

.....

6 (b) (ii) Use the information provided to explain the changes in production of ethanol during this investigation.

.....

.....

.....

.....

.....

(2 marks)

6 (c) Sodium azide is a substance that inhibits the electron transport chain in respiration. The student repeated the investigation but added sodium azide after 4 hours. Suggest and explain how the addition of sodium azide would affect oxygen uptake and the production of ethanol.

.....

.....

.....

.....

.....

.....

(3 marks)

(Extra space) .....

.....

.....

9

Do not write outside the box

7 Scientists investigated the effect of a pesticide called malathion on the survival of tadpoles of species of toads found in the USA. The scientists determined the LC50 for the tadpoles of each species over a 16-day period in an aquarium. The LC50 is the concentration of malathion that killed 50 percent of a population of tadpoles. The scientists also investigated whether the presence of a predator of tadpoles changed the effect of malathion.

7 (a) Suggest **two** advantages of using the LC50 to determine the effect of a pesticide.

1 .....

.....

2 .....

.....

(2 marks)

The scientists looked at previous studies on the effects of various pesticides on tadpoles.

They found that most of these studies:

- were carried out on tadpoles of the African clawed toad
- measured the LC50 of each pesticide over 1 to 4 days in the absence of any biotic factor.

7 (b) The scientists concluded that these previous studies were of limited use when trying to assess the effects of malathion on the tadpoles of toads found in the USA. Suggest why the scientists reached this conclusion.

.....

.....

.....

.....

.....

.....

(3 marks)

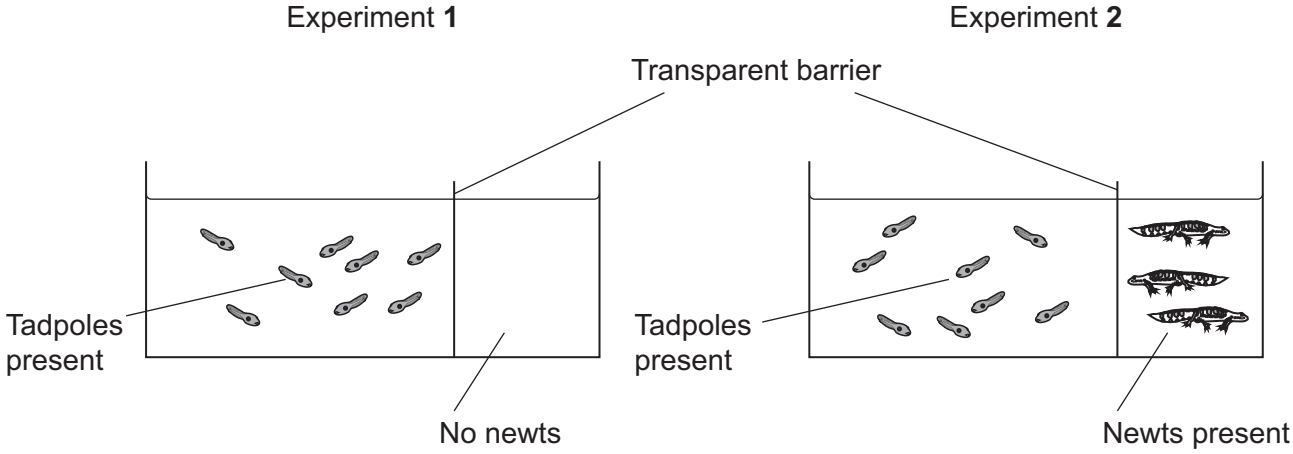
(Extra space) .....

.....

.....

Do not write outside the box

7 (c) Malathion affects the nervous system of tadpoles. The scientists investigated whether the stress caused by the presence of a predator changed the effect of malathion on the tadpoles. The scientists used newts which are predators of tadpoles. They carried out two experiments, as shown in the diagram.



7 (c) (i) Explain why the scientists carried out experiment **1**.

.....

.....

.....

.....

.....

(2 marks)

7 (c) (ii) Explain why the scientists used a transparent barrier in experiment **2**.

.....

.....

.....

.....

(2 marks)

Question 7 continues on the next page

Do not write outside the box

7 (d) Adult toads spend most of their time on land but lay their eggs in water. These eggs hatch into tadpoles, which live in water and develop into adults. The tadpoles are much smaller than adult toads. Use this information to explain why the tadpoles are affected more rapidly by pesticides in water than adult toads.

.....

.....

.....

.....

(2 marks)

7 (e) When malathion is used as a pesticide, it is often sprayed onto aquatic habitats at concentrations of 0.1 to 1.6 mg dm^{-3}. The scientists tested the effect of malathion at concentrations of 0.001 to 10 mg dm^{-3}.
Suggest why.

.....

.....

.....

.....

.....

(2 marks)

7 (f) As a result of this investigation, the scientists concluded that more studies on pesticides should be carried out in natural habitats rather than under laboratory conditions. Suggest **two** advantages of carrying out such investigations in natural habitats.

1 .....

.....

2 .....

.....

(2 marks)

15

Do not write outside the box

8 (a) Energy enters most ecosystems through the light-dependent reaction of photosynthesis. Describe what happens during the light-dependent reaction.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

(Extra space) .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Question 8 continues on the next page

Do not write outside the box

8 (b) Describe the reasons for the low efficiency of energy transfer through ecosystems.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

(Extra space) .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Do not write outside the box

8 (c) Changes in ecosystems can lead to speciation. A high concentration of copper in soil is toxic to most plants. In some areas where the soil is polluted with copper, populations of grasses are found to be growing. These populations of grass belong to a species also found growing on unpolluted soils.

It has been suggested that a new species of grass may evolve on soil that has been polluted with copper. Explain how this new species might evolve.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5 marks)

(Extra space) .....

.....

.....

.....

.....

.....

.....

.....

.....

.....

END OF QUESTIONS

15

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Copyright © 2013 AQA and its licensors. All rights reserved.