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National  
Qualifications  
2021 ASSESSMENT RESOURCE

Mark

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**X826/76/02****Environmental Science  
Paper 2**

Duration — 2 hours 30 minutes



Fill in these boxes and read what is printed below.

Full name of centre

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Town

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Forename(s)

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Surname

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Number of seat

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Date of birth

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Month

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Year

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Scottish candidate number

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**Total marks — 100**

Attempt ALL questions.

Questions 8 and 9 each contain a choice.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. You should score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

Before leaving the examination room you must give this booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

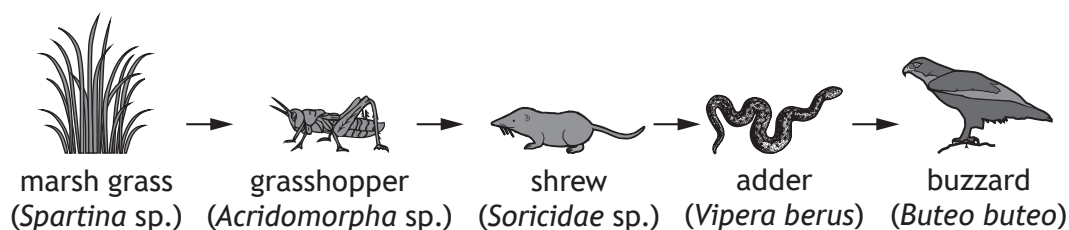


Total marks — 100 marks

Attempt ALL questions

Questions 8 and 9 each contain a choice

1. A typical Scottish marshland food chain is shown.



(a) Marsh grass is a green plant that produces biomass.

(i) A green plant that can produce its own biomass can be referred to as a producer.

State one other term that describes such an organism.

1

(ii) Suggest the season in which green plants will produce the most biomass.

Explain your answer.

3



\* X 8 2 6 7 6 0 2 0 2 \*

1. (continued)

(b) The ecological efficiency in a food chain can be calculated.

(i) Define *ecological efficiency*.

1

(ii)  $5\,000\,000\text{ kJ m}^{-2}$  of energy falls on the marshland ecosystem.

8% of this energy is assimilated by marsh grass.

The grasshopper then consumes the marsh grass, assimilating 6% of the available energy.

Calculate how much energy the grasshopper assimilates from the marsh grass.

2

*Space for working*

\_\_\_\_\_  $\text{kJ m}^{-2}$

(iii) Explain why only a small percentage of energy passes to the next trophic level.

1



\* X 8 2 6 7 6 0 2 0 3 \*

## 1. (continued)

- (c) Areas of Scottish marshland are under threat from human activities.

Rewilding practices, such as the reintroduction of native species, have been used to initiate or accelerate the recovery of habitats or ecosystems.

State two other activities used in rewilding.

2



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\* X 8 2 6 7 6 0 2 0 5 \*

2. The Earth's internal heat drives the system of currents circulating in both the mantle and the core.

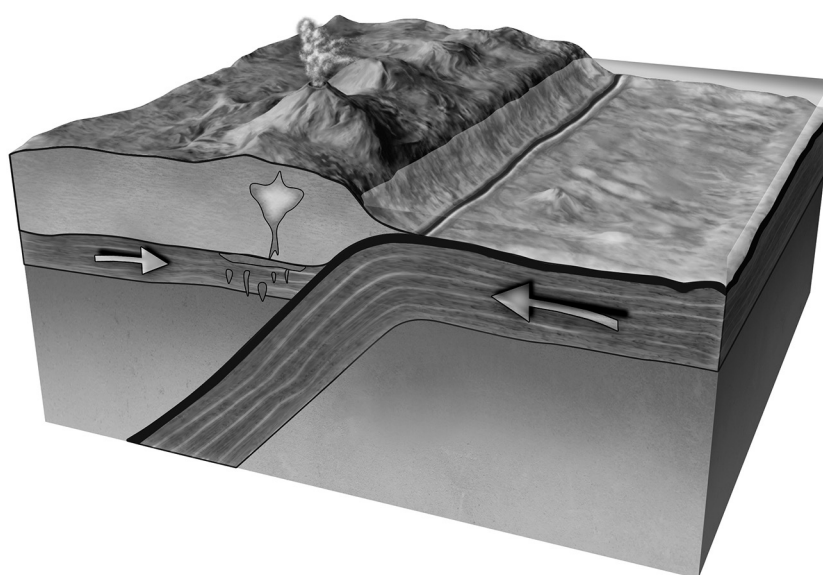
(a) (i) State the term given to describe these circulation currents.

1

(ii) Explain how the Earth's internal heat drives the movement of material within the mantle.

2

- (b) The circulation patterns are responsible for plate tectonics. The diagram shows the interaction of tectonic plates at a subduction zone.



(i) Name the type of plate boundary shown in the diagram.

1



## 2. (b) (continued)

- (ii) Describe the processes occurring at a subduction zone that result in volcanic activity.

4

- (c) Ores rich in aluminium oxide are found in extractable quantities in areas associated with subduction zones.

- (i) Name an ore that is rich in aluminium oxide.

1

- (ii) Smelting is a process by which metal is obtained from its ore by heating it beyond the melting point.

Explain one environmental issue associated with the smelting of aluminium-rich ores.

2



\* X 8 2 6 7 6 0 2 0 7 \*

2. (continued)

- (d) Villarrica, a volcano located in a glaciated area in Chile, erupted in 2015. The eruption had a major impact on the hydrosphere and other Earth systems.



Suggest one possible impact of a volcanic eruption on

- (i) the hydrosphere

1

- (ii) natural climate change.

1

- (e) Natural climate change has both long-term and short-term impacts. Explain a social impact of a prolonged period of hot, dry weather.

2





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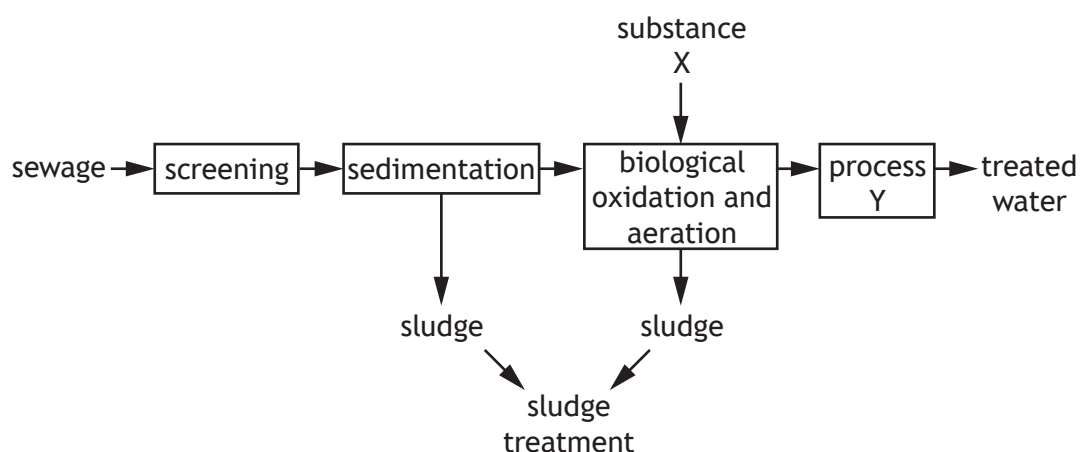
3. A town in India has built a sewage treatment facility to reduce the volume of untreated sewage being released into waterways.

(a) State the term used to describe the liquid part of the waste material.

1

- (b) At the sewage treatment facility, sewage goes through a series of processes before being released back into the environment.

The processes are shown in the flow diagram.



## 3. (b) (continued)

- |  |   |
|--|---|
| (i) Using the information in the flow diagram, identify  |   |
| (A) substance X  | 1 |
| (B) process Y.   | 1 |
| (ii) The preliminary stage involves the screening process.<br>Describe what happens to the sewage during this process. | 1 |
| (iii) Describe how the sludge can be treated in order to produce a<br>named resource.                                  | 2 |

[Turn over]

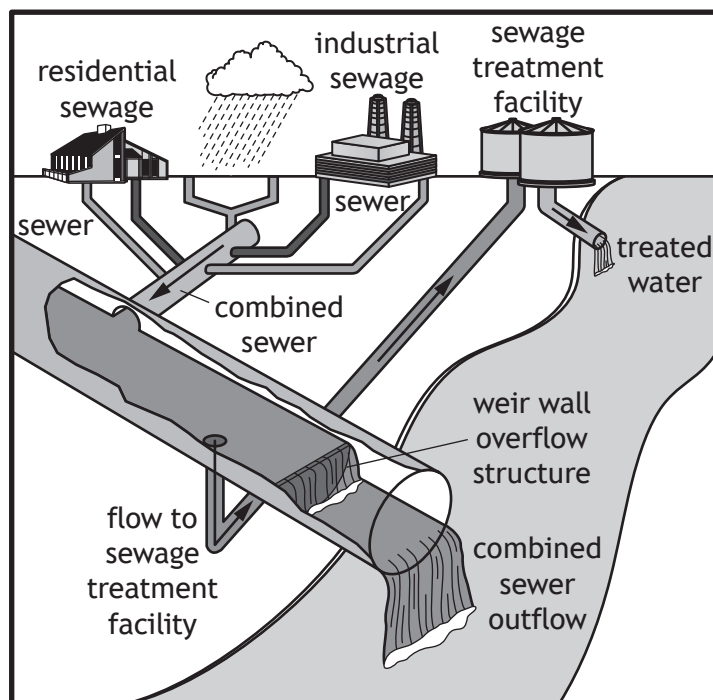


\* X 8 2 6 7 6 0 2 1 1 \*

3. (continued)

- (c) During periods of heavy rainfall the sewage system occasionally overflows, leading to high volumes of untreated waste being released into the river.

The sewage system during heavy rainfall is shown in the diagram.



- (i) The diagram shows liquid waste material being discharged from the combined sewer outflow into the river.

State whether this is an example of point or diffuse pollution.

Justify your response.

1

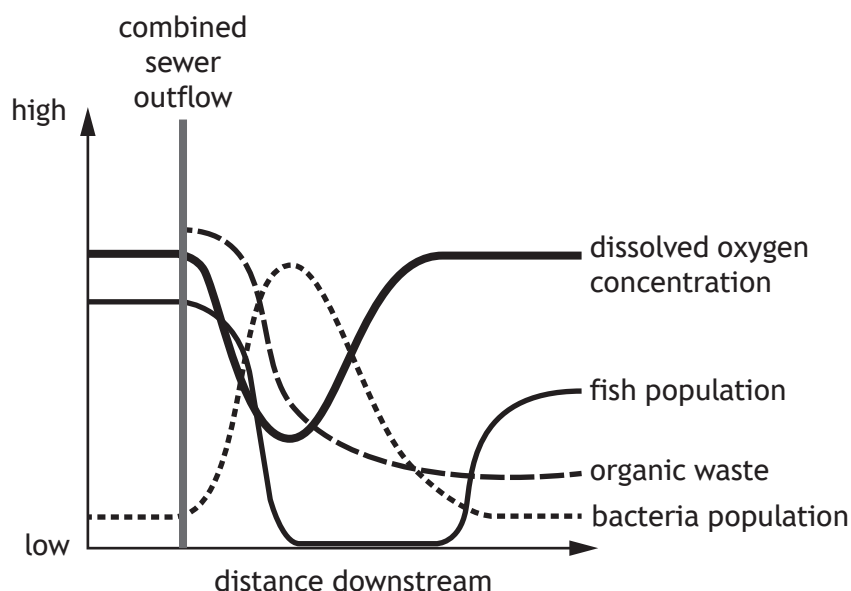
Type of pollution

Justification

3. (c) (continued)

- (ii) Untreated waste was discharged into the river during a period of heavy rainfall.

Environmental scientists measured four factors along the river: dissolved oxygen concentration, fish population, organic waste, and bacteria population. The trends are shown in the diagram.



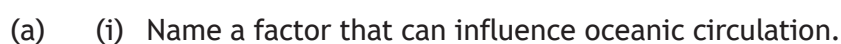
Using all the information in the diagram, explain the reasons for the trend in fish population.

4



\* X 8 2 6 7 6 0 2 1 3 \*

- The map shows the path the tracker travelled.



1

- (ii) Explain the effect the factor named in (i) has on oceanic circulation.

2



\* X 8 2 6 7 6 0 2 1 4 \*

## 4. (continued)

(b) The table shows the distance the GPS tracker travelled each month.

Month	Distance travelled (km)
1	1653
2	1448
3	1428
4	1135
5	883
6	841
7	879
8	892
9	1097
10	1536
11	1096
12	1727

Calculate the mean distance travelled by the tracker each month.

1

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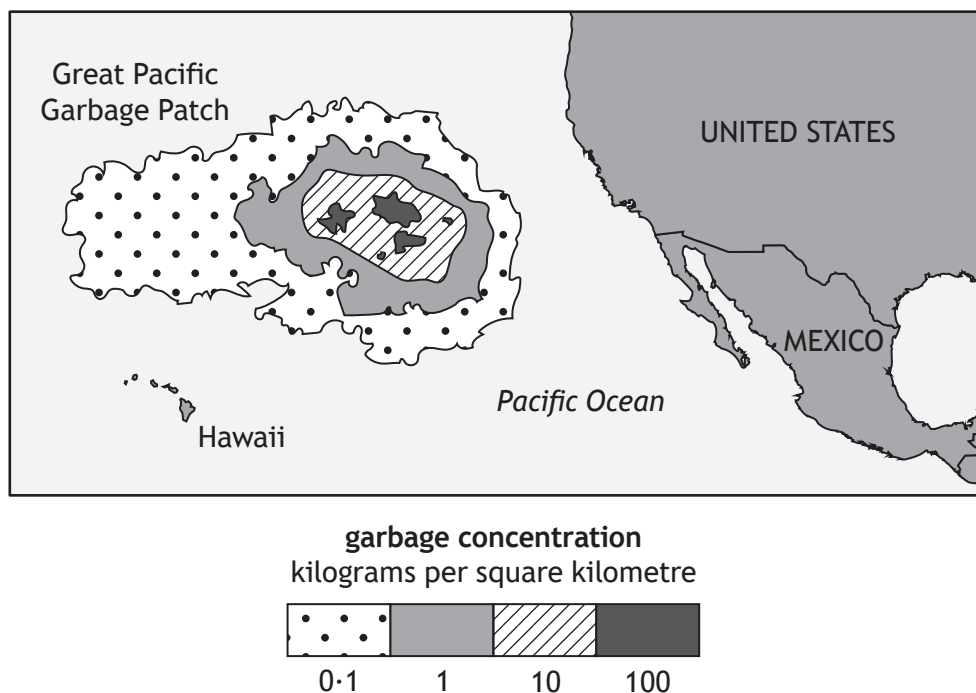


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4. (continued)

- (c) Ocean gyres often trap and accumulate large volumes of waste. The Great Pacific Garbage Patch located off the west coast of North America is the largest of these.

The diagram below shows the approximate location and size of the Great Pacific Garbage Patch.



- (i) Define the term *ocean gyre*.

1

- (ii) Suggest why there is a greater concentration of garbage towards the centre of the patch.

1



4. (c) (continued)

- (iii) A study in 2018 investigated plastic waste circulating in the Great Pacific Garbage Patch. The estimated composition of this waste is shown in the table.

Type of plastic	Size (cm)	Number of items per km <sup>2</sup>
Micro-plastics	<0.50	678 000
Meso-plastics	0.50–5.00	22 000
Macro-plastics	5.01–50.00	690
Mega-plastics	>50.00	4

Calculate the percentage of the total waste per km<sup>2</sup> made up by plastics less than 5.01 cm in size.

1

*Space for working*

- (iv) Plastics in the Great Pacific Garbage Patch have been assessed since the 1970s, and the research shows that the proportion of micro-plastics is increasing.

Suggest why marine micro-plastics are increasing over time.

1

- (v) Explain an impact that plastics accumulating in a marine environment will have on biodiversity.

2



5. Crop production depends on physical factors, including availability of arable land, as well as consumer demand and economics.

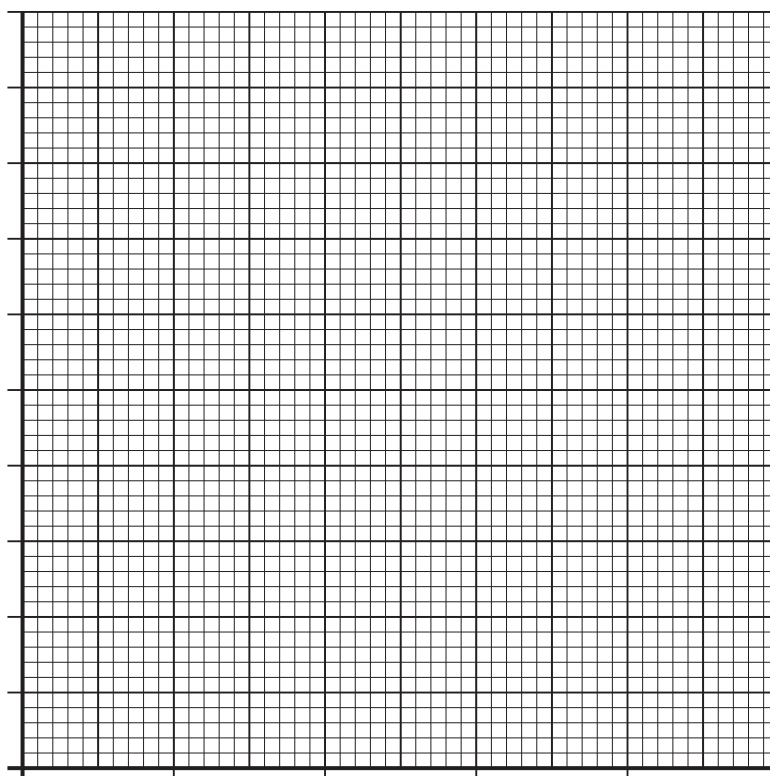
The table shows global yields of major crops by year.

Crop	Global crop yield by year (million tonnes)				
	2010	2012	2014	2016	2018
Wheat	275	273	292	300	267
Maize	418	375	482	499	477
Soybean	97	90	116	127	137

- (a) Using information from the table, draw a line graph to show the crop yield for maize between 2010 and 2018.

3

(Additional graph paper, if required, can be found on *page 34*.)



5. (continued)

- (b) Suggest a reason for the change in global wheat yield between 2016 and 2018.

1

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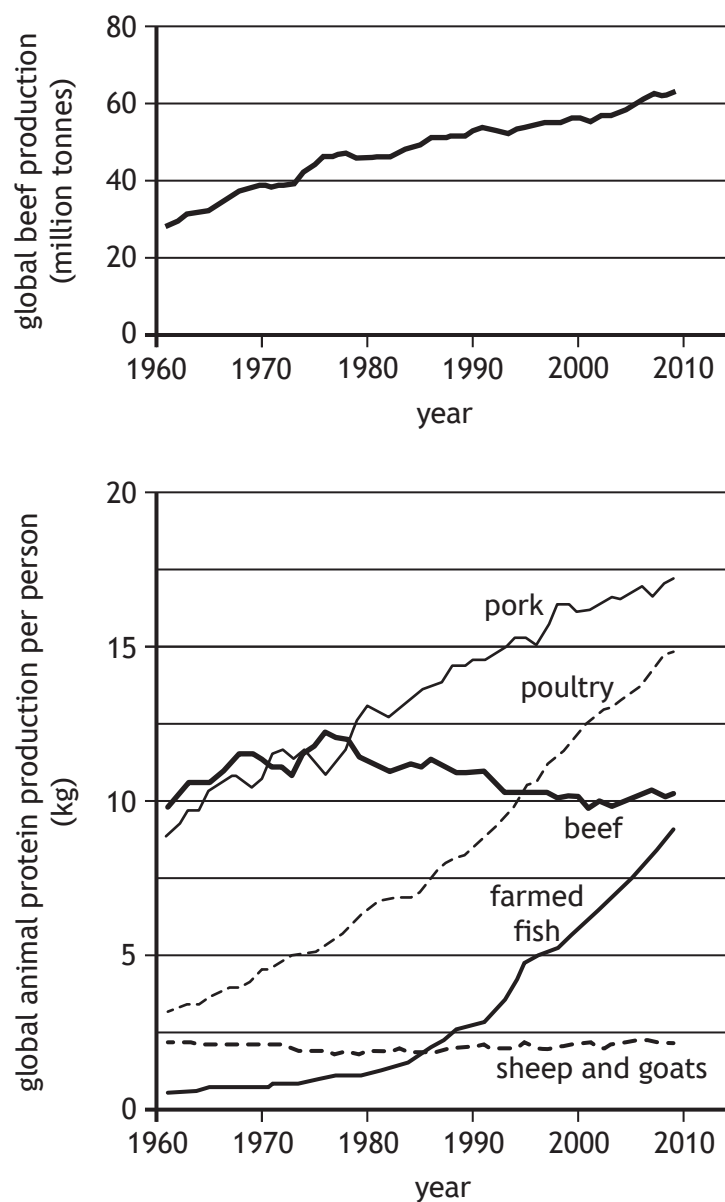


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## 5. (continued)

- (c) Global consumption of animal protein is on the rise.

The graphs show global beef production and global animal protein production per person between 1960 and 2010.



5. (c) (continued)

- (i) Explain the difference in the trends in beef production shown in these two graphs.

2

- (ii) Between 1960 and 1980, the trends for beef and pork production per person were similar.

Suggest a reason for the change in the trends of global beef and pork production per person after 1980.

1

- (d) Meat production per person is predicted to increase significantly in developing countries.

Suggest two reasons for this prediction.

2

1

2

- (e) Meat production accounts for an estimated 15% of anthropogenic greenhouse gas emissions, including methane and nitrous oxide.

Other than meat production, name an anthropogenic source of

- (i) methane

1

- (ii) nitrous oxide.

1



\* X 8 2 6 7 6 0 2 2 1 \*

6. Alternative sources of energy are being explored to replace fossil fuels. Hydrogen is one such fuel.

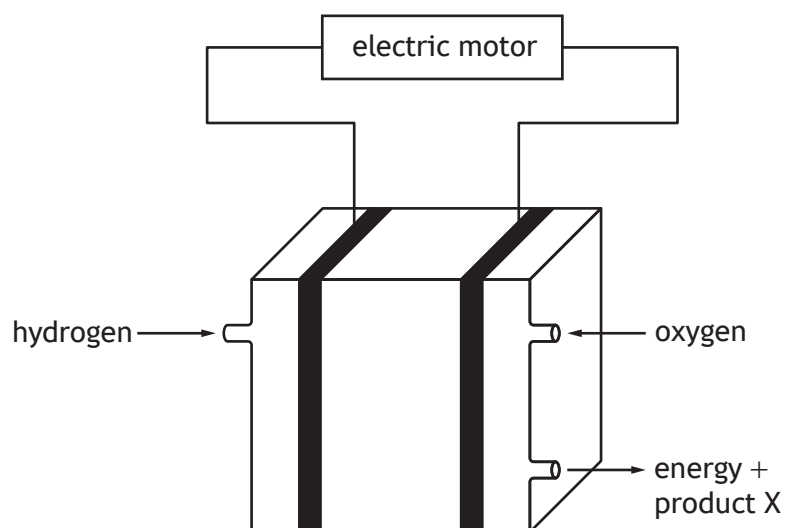
(a) (i) Name one method of producing hydrogen for use in fuel cells.

1

(ii) Describe this method of producing hydrogen.

2

- (b) Energy can be generated from hydrogen using a fuel cell, as shown in the diagram.



- (i) Name the substance represented by product X in the diagram.

1



\* X 8 2 6 7 6 0 2 2 2 \*

## 6. (b) (continued)

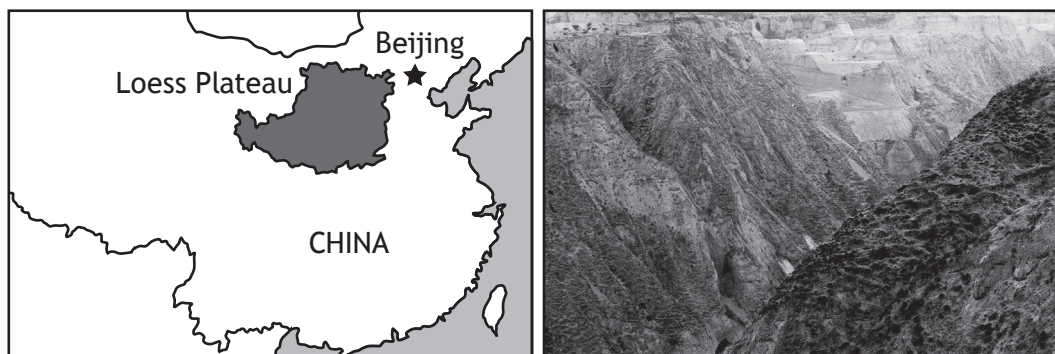
- |   |   |
|---|---|
| (ii) Describe how a fuel cell generates electricity.  | 1 |
|   |   |
| (c) Explain why generating electricity from hydrogen may not be considered environmentally sustainable.   | 2 |
|   |   |
| (d) A fuel company is considering installing fuelling stations throughout the UK for hydrogen-powered vehicles.<br>Describe two advantages of using hydrogen as a fuel. | 2 |

[Turn over



\* X 8 2 6 7 6 0 2 2 3 \*

7. The Loess Plateau in China is one of the most severely eroded areas in the world.



Around 80% of the area has been affected by exposure to strong winds and heavy precipitation, deforestation, uncontrolled grazing, and agricultural cultivation on the steep slopes.

The erosion is a constant threat to the livelihoods of rural families and a major problem for the ecosystem and environment.

- (a) Loess is composed of wind-blown silt sediments. Loess deposits in this area can be as much as 330 metres deep.

Name the type of weathering that leads to formation of loess deposits.

1

- (b) In 1986, the Chinese Government introduced a plan to reduce the impacts of erosion on the Loess Plateau and to improve the ecological environment. One way of doing this was the trial planting of different types of trees and shrubs.

- (i) From the information above, identify

(A) a policy

1

(B) a strategy.

1





7. (b) (continued)

- |   |   |
|---|---|
| (ii) Suggest why planting was undertaken rather than allowing natural succession to proceed.  | 1 |
|   |   |
| (c) <i>Caragana korshinskii</i> was found to be one of the most successful plant species in the trials. It is a native desert shrub with strong drought resistance. It is also a leguminous species, able to convert atmospheric nitrogen into a form that can be used by plants. |   |
| (i) Nitrogen content of soil is an edaphic factor.<br>State what is meant by an <i>edaphic factor</i> .   | 1 |
|   |   |
| (ii) Explain why soil nutrients such as nitrogen are important in terms of reducing erosion.  | 2 |
|   |   |
| (d) Slope can directly affect soil condition and the vegetation it can support. Describe a method used for measuring slope.   | 2 |

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7. (continued)

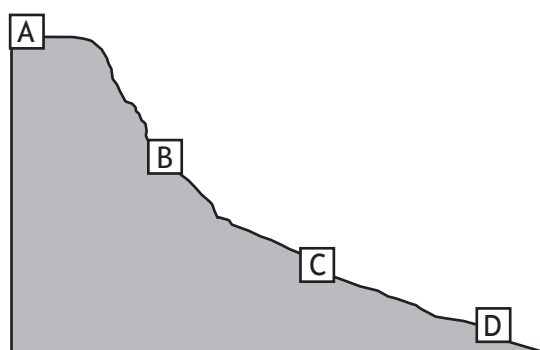
- (e) Researchers assessed the effect of slope on microbial biomass carbon content of soil at four different sites on the Loess Plateau.

Microbial biomass carbon is a measure of the carbon contained within soil bacteria and fungi.

The slope had been planted with *Caragana korshinskii* 35 years ago.

Systematic sampling was used to locate four 100 m × 100 m sites (A, B, C, and D). At each location, random point sampling was used to collect soil samples at three depths: 0–10 cm, 11–30 cm and 31–60 cm.

The diagram shows the location of sites A, B, C, and D.

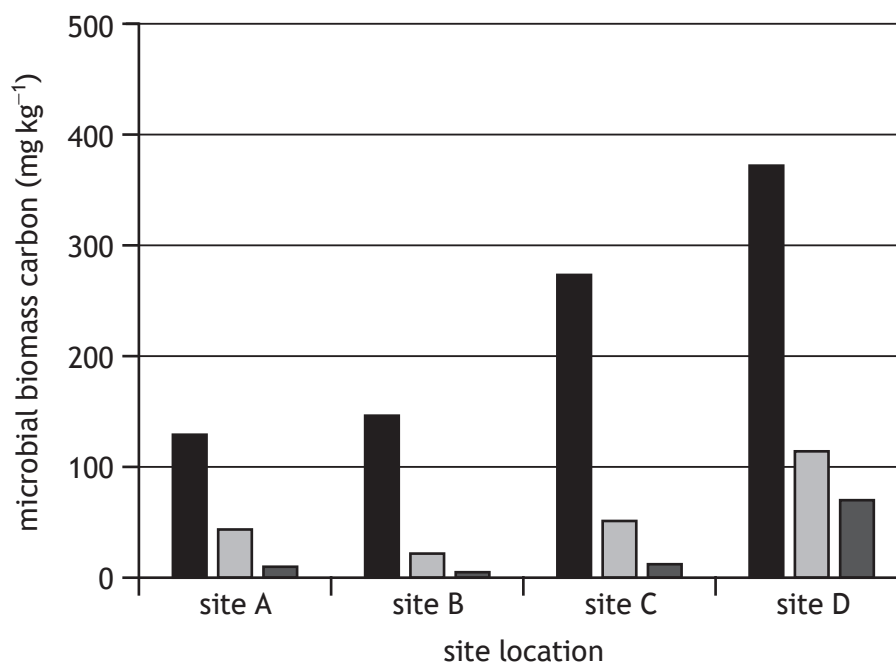


- (i) Suggest why the soil samples were collected at three depths at each sampling point and across each site.

1

## 7. (e) (continued)

- (ii) The microbial biomass carbon content of each soil sample was determined. The results are shown in the graph.



Key soil depth

0–10 cm 11–30 cm 31–60 cm

Using the information in the diagram and graph, describe two trends shown.

2

1

2

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\* X 8 2 6 7 6 0 2 2 7 \*

## 7. (continued)

- (f) The loss of sediments from the Loess Plateau into the nearby Yellow River has been reduced by introducing terraces for crop production.



terrace

Explain a benefit to local farmers of using terraces for crop production.

2



\* X 8 2 6 7 6 0 2 2 8 \*

**Questions 8 and 9 each contain a choice**

For each question, attempt either A or B. Write your answers to questions 8 and 9 on the following pages. You may use diagrams where appropriate.

- 8. A** In some soil profiles, distinct horizons are evidence of the translocation of materials.

Discuss the translocation of materials through a podzol soil under the following headings.

- (a) Leaching
- (b) Eluviation
- (c) Illuviation

**10**

**OR**

- B** The global energy budget is the balance between incoming and outgoing solar radiation.

Discuss the impact of the following on the global energy budget.

- (a) Insolation
- (b) Albedo

**10**

- 9. A** It is rarely possible to capture or count all the individuals in a population. Therefore the size and/or distribution of a population must be estimated.

Discuss biotic or biodiversity indices that could be used to estimate the population size and/or distribution of species.

**10**

**OR**

- B** Biotic interactions can act as density-dependent controls, limiting the effects of high populations on ecosystem stability.

Discuss the effects of named biotic interactions on ecosystem stability.

**10**

[Turn over



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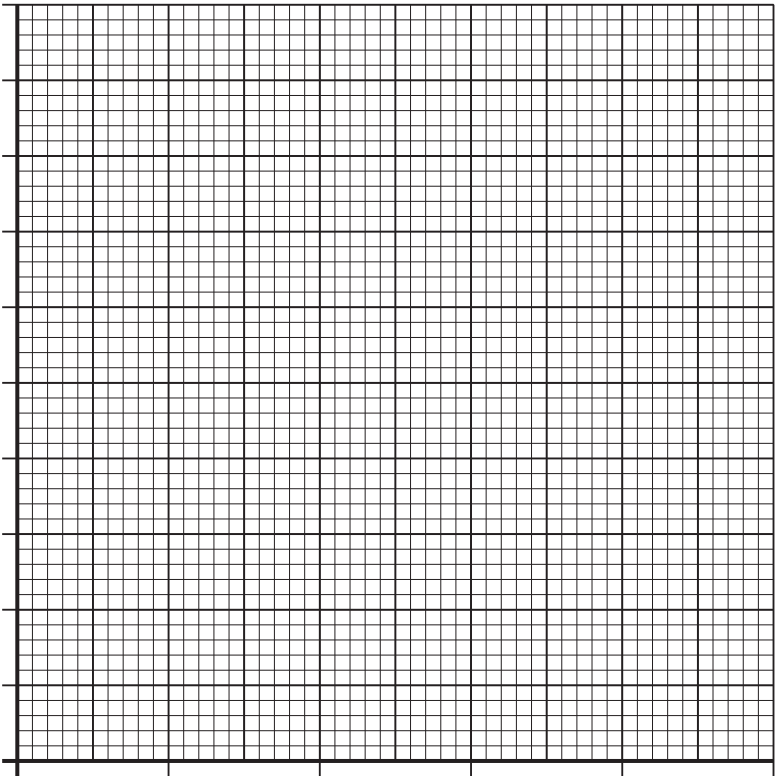
SPACE FOR ANSWERS (continued)

[END OF QUESTION PAPER]



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph paper for question 5



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK



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\* X 8 2 6 7 6 0 2 3 6 \*