



Please write clearly in block capitals.

Centre number

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Candidate signature

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I declare this is my own work.

# A-level ENVIRONMENTAL SCIENCE

## Paper 1

Monday 20 May 2024

Morning

Time allowed: 3 hours

### Materials

For this paper you may use:

- a calculator.

### Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions 1 to 10 and **one** essay from question 11.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

### Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 120.
- All questions should be answered in continuous prose.
- You will be assessed on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.

| For Examiner's Use |      |
|--------------------|------|
| Question           | Mark |
| 1                  |      |
| 2                  |      |
| 3                  |      |
| 4                  |      |
| 5                  |      |
| 6                  |      |
| 7                  |      |
| 8                  |      |
| 9                  |      |
| 10                 |      |
| 11                 |      |
| <b>TOTAL</b>       |      |



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7447/1

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

Do not write  
outside the  
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0 1

**Table 1** shows technologies used to control some atmospheric pollutants.

Complete **Table 1** by adding **one** technology or pollutant in each row.  
The first row has been completed.

**[5 marks]**

**Table 1**

| Pollution control technology                        | Pollutant       |
|-----------------------------------------------------|-----------------|
| Flue gas desulfurization                            | SO <sub>x</sub> |
| Cleaning electronic equipment with alcohol solvents |                 |
|                                                     | Carbon monoxide |
| Recovery of gas from coal mines                     |                 |
|                                                     | PM10            |
| Urea sprays                                         |                 |

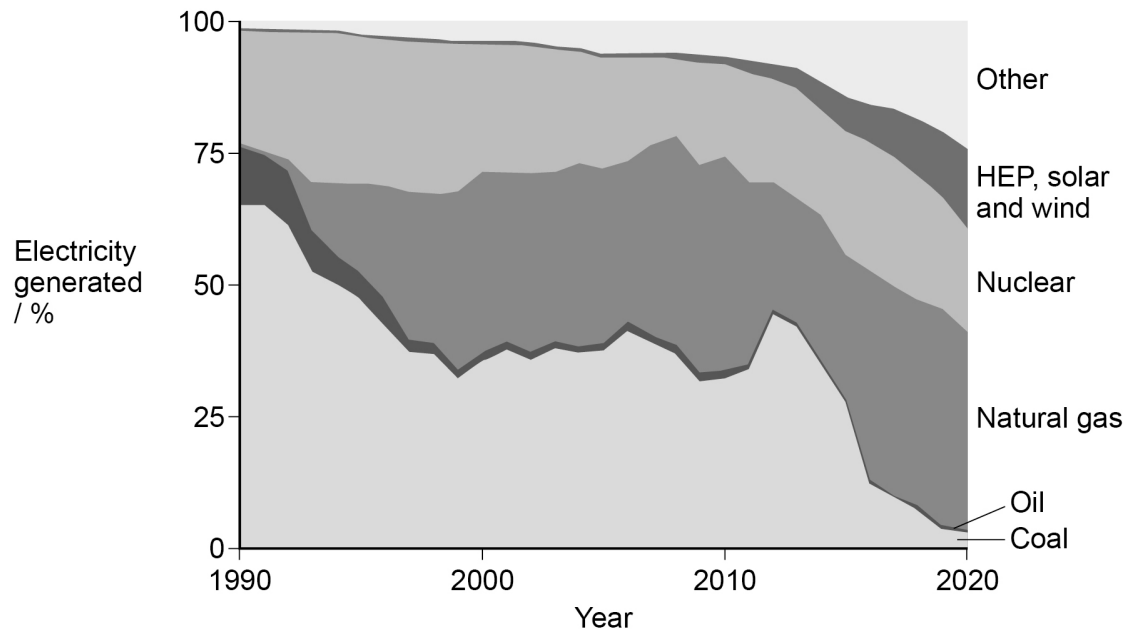
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0 2

**Figure 1** shows how the UK's electricity has been generated from 1990 to 2020.

**Figure 1**



0 2 . 1

Suggest **two** reasons for the change in the percentage of electricity generated by HEP, solar and wind after 2005 as shown in **Figure 1**.

**[2 marks]**

- 1 \_\_\_\_\_
- \_\_\_\_\_
- 2 \_\_\_\_\_
- \_\_\_\_\_

**Question 2 continues on the next page**

**Turn over ►**



0 2 . 2

In 2020, 75.6 TWh of electricity was produced by UK onshore and offshore wind power.

The maximum amount of electricity that could have been produced in 2020 was 216 372 GWh.

Calculate the capacity factor for UK wind power, where:

$$\text{Capacity factor (\%)} = \frac{\text{Actual production}}{\text{Maximum possible production}} \times 100$$

Give your answer to **three** significant figures.

Show your working.

[2 marks]

Answer \_\_\_\_\_ %

0 2 . 3

Outline **two** advantages of using vertical axis wind turbines (VAWTs) over horizontal axis wind turbines (HAWTs).

[2 marks]

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_



The problem of energy intermittency has led to the development of storage technologies, such as batteries.

**0 2 . 4**

Give the names of **two other** storage technologies and describe how they work.

**[4 marks]**

Storage technology \_\_\_\_\_

Description \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Storage technology \_\_\_\_\_

Description \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**10**

**Turn over for the next question**

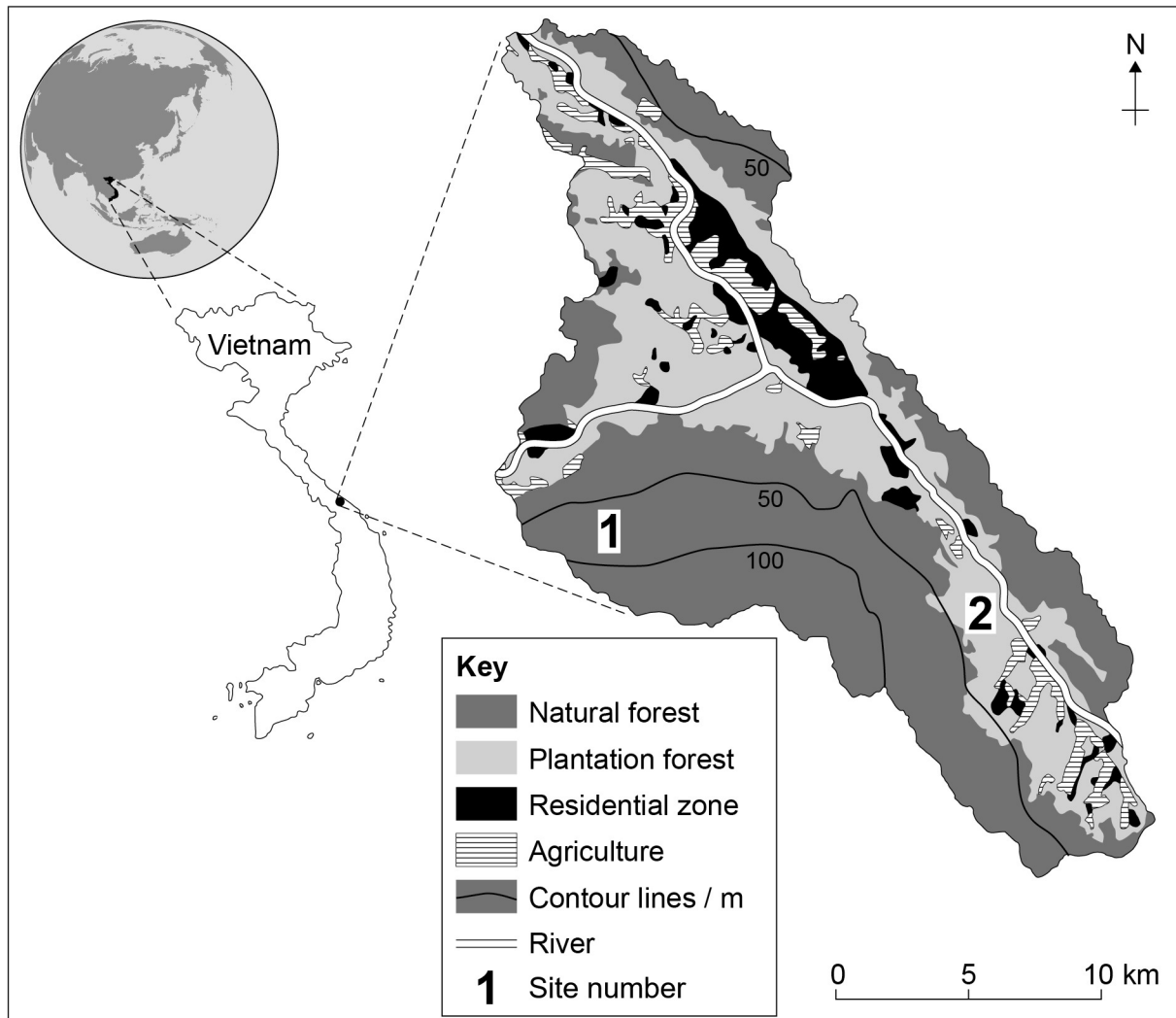
**Turn over ►**



0 3

Figure 2 shows land use information for the Sap drainage basin, Vietnam.

Figure 2



|   |   |   |   |
|---|---|---|---|
| 0 | 3 | . | 1 |
|---|---|---|---|

Rates of soil erosion vary with land use.

Suggest **two** physical reasons why soil erosion rates could be different at **site 1** and **site 2**.

Use information from **Figure 2** and your own knowledge.

**[4 marks]**

Reason 1 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Reason 2 \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Question 3 continues on the next page**

**Turn over ►**



**Table 2** shows erosion factors from the Universal Soil Loss Equation (USLE) for **sites 1** and **2**.

**Table 2**

|                                   | <b>A</b> | <b>R</b> | <b>K</b> | <b>LS</b> | <b>C</b> | <b>P</b> |
|-----------------------------------|----------|----------|----------|-----------|----------|----------|
| <b>Site 1 – Natural Forest</b>    | 19.35    | 1680     | 0.30     | 0.16      |          | 1.00     |
| <b>Site 2 – Plantation Forest</b> |          | 1670     | 0.28     | 0.07      | 0.25     | 0.79     |

The USLE can be used to estimate soil erosion rates.

$$A = R \times K \times LS \times C \times P$$

A = Average annual soil loss

R = Rainfall erosivity factor

K = Soil erodibility factor

LS = Slope factors (length and gradient combined)

C = Cover (crop) management factor

P = Erosion prevention factor.

**0 3 . 2** Use the USLE to complete **Table 2**.

**[2 marks]**



0 3 . 3

A management technique was applied for 9 years to reduce erosion at **site 1**.

After 9 years, the **LS** factor had reduced by 20%.

After each 3-year period the **K** factor had reduced by 5%.

All other factors stayed the same.

Calculate the **LS** and **K** factors at **site 1** after 9 years of management.

Use the information above and in **Table 2**.

Give your answers to **two** decimal places.

Show your working.

[3 marks]

**LS** factor = \_\_\_\_\_

**K** factor = \_\_\_\_\_

0 3 . 4

Changes to soil management practices can lead to changes in the **C** factor.

Suggest how a change in crop management practice could reduce the **C** factor value.

[1 mark]

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10

Turn over for the next question

Turn over ►

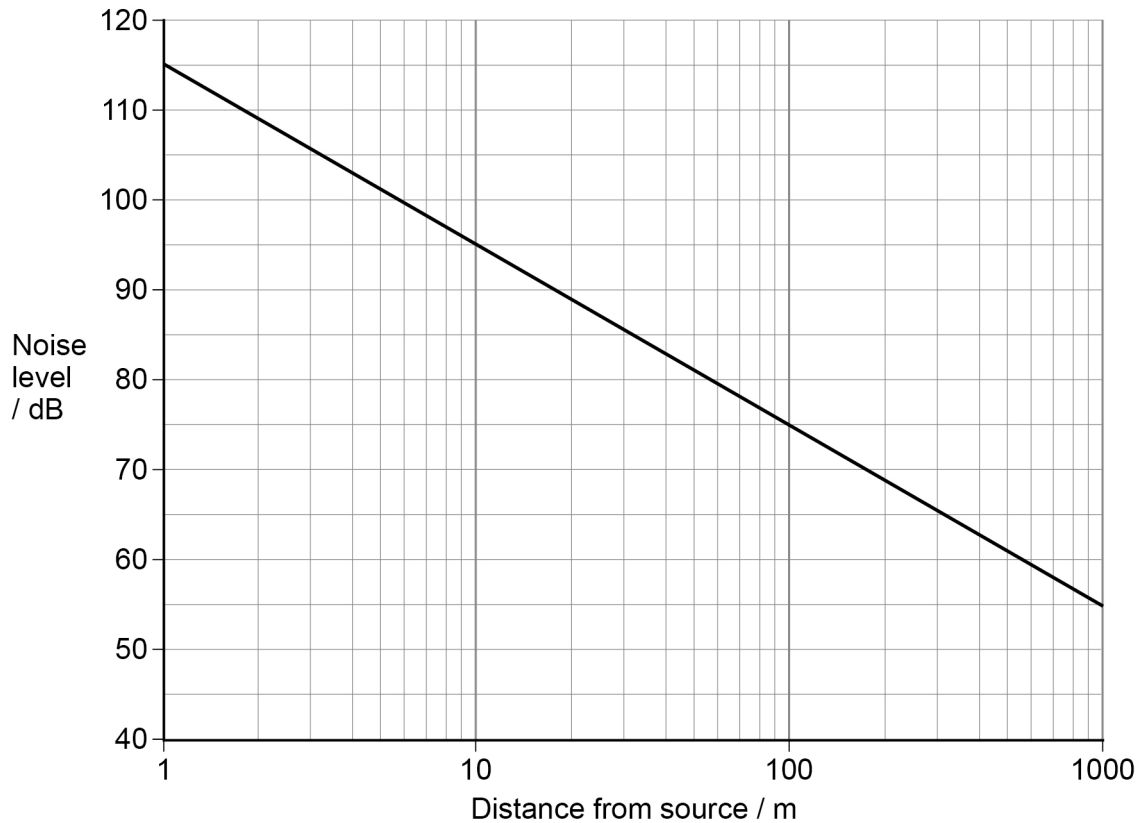


0 4

High Speed 2 (HS2) is a new railway system. It is predicted that the level of noise reaching houses within 300 m (metres) of the railway will increase.

**Figure 3** shows the predicted change in noise levels with distance from a source of noise under controlled test conditions.

**Figure 3**



0 4

. 1

Using **Figure 3**, state the noise level at 300 m from the source.

[1 mark]

Answer \_\_\_\_\_ dB



0 4 . 2

Suggest how **two** environmental factors could affect the level of noise reaching houses from the HS2 railway line.

[2 marks]

1 \_\_\_\_\_

\_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

0 4 . 3

Identify **two** sources of railway noise and describe how each can be controlled using railway or train design.

[2 marks]

Source \_\_\_\_\_

Control \_\_\_\_\_

\_\_\_\_\_

Source \_\_\_\_\_

Control \_\_\_\_\_

\_\_\_\_\_

**Question 4 continues on the next page**

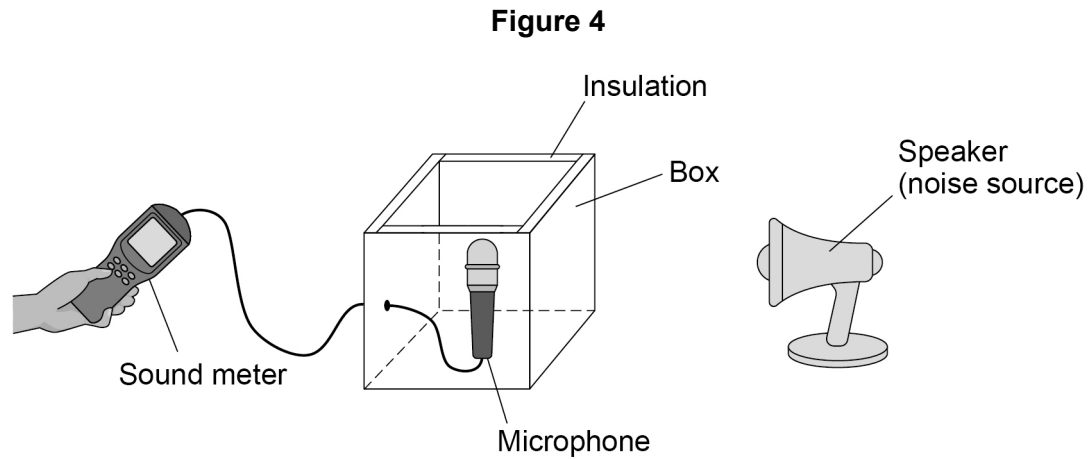
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Acoustic insulation can be installed in buildings to reduce railway noise for residents.

Students conducted a laboratory investigation to compare the effectiveness of different building insulation thicknesses to reduce noise.

**Figure 4** shows the investigation.



**Table 3** shows the results of this investigation.

**Table 3**

| Insulation thickness<br>/ mm | Noise level<br>/ dB |
|------------------------------|---------------------|
| 50                           | 90                  |
| 55                           | 91                  |
| 60                           | 89                  |
| 65                           | 90                  |
| 70                           | 87                  |
| 75                           | 78                  |
| 80                           | 75                  |
| 85                           | 69                  |
| 90                           | 69                  |
| 95                           | 57                  |
| 100                          | 55                  |

$n$  (number of pairs of data) = 11



0 4 . 4

Suggest **three** variables that should have been controlled to ensure reliable results.

[3 marks]

Variable 1 \_\_\_\_\_

\_\_\_\_\_

Variable 2 \_\_\_\_\_

\_\_\_\_\_

Variable 3 \_\_\_\_\_

\_\_\_\_\_

A statistical test was carried out to see if there was a correlation between the thickness of insulation and reduction in noise level.

0 4 . 5

State an appropriate statistical test that could have been used.

[1 mark]

\_\_\_\_\_

The results of the investigation gave a test statistic of 0.73.

**Table 4** shows the critical values for different values of  $n$ , where  $n$  = the number of pairs of data.

**Table 4**

| $n$ | Level of significance ( $p$ -value) |       |       |       |       |       |
|-----|-------------------------------------|-------|-------|-------|-------|-------|
|     | 0.10                                | 0.05  | 0.025 | 0.01  | 0.005 | 0.001 |
| 4   | 1.000                               | 1.000 | -     | -     | -     | -     |
| 5   | 0.800                               | 0.900 | 1.000 | 1.000 | -     | -     |
| 6   | 0.657                               | 0.829 | 0.886 | 0.943 | 1.000 | -     |
| 7   | 0.571                               | 0.714 | 0.786 | 0.893 | 0.929 | 1.000 |
| 8   | 0.524                               | 0.643 | 0.738 | 0.833 | 0.881 | 0.952 |
| 9   | 0.483                               | 0.600 | 0.700 | 0.783 | 0.833 | 0.917 |
| 10  | 0.455                               | 0.564 | 0.648 | 0.745 | 0.794 | 0.879 |
| 11  | 0.427                               | 0.536 | 0.618 | 0.709 | 0.755 | 0.845 |
| 12  | 0.406                               | 0.503 | 0.587 | 0.678 | 0.727 | 0.818 |
| 13  | 0.385                               | 0.484 | 0.560 | 0.648 | 0.703 | 0.791 |

0 4 . 6

Using **Tables 3** and **4**, identify the highest level of significance ( $p$ -value) for these results.

[1 mark]

$p$ -value \_\_\_\_\_

10

Turn over ►



**0 5**

Human activities can change the dynamic equilibrium of the nitrogen cycle locally and globally.

**0 5 . 1**

Identify and describe **one** technique for measuring nitrate concentrations in water samples.

**[2 marks]**

Technique \_\_\_\_\_

\_\_\_\_\_

Description \_\_\_\_\_

\_\_\_\_\_

**0 5 . 2**

Students want to investigate how nitrate concentrations in one river location change over the year.

Describe **one** sampling strategy that could be used to collect reliable nitrate concentration data for this investigation.

**[2 marks]**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

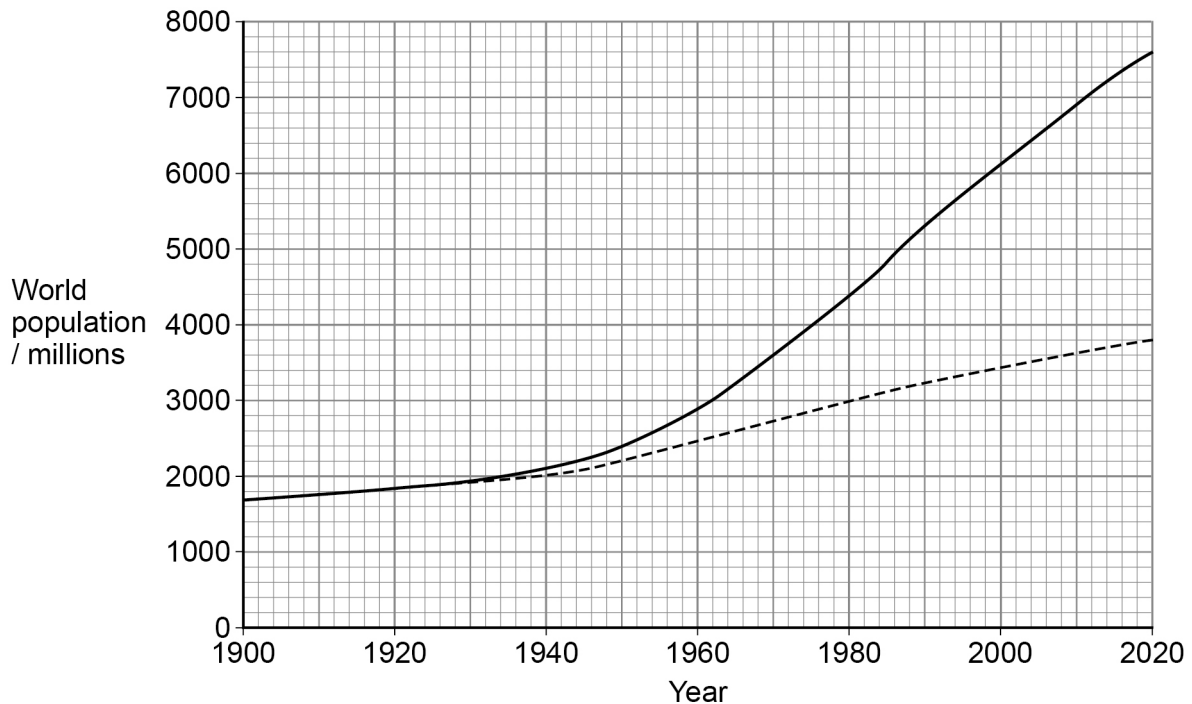
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The Haber process fixes nitrogen that can be used to make artificial fertilisers for agriculture.

**Figure 5** compares the actual world population and the estimated world population without the use of artificial fertilisers.

**Figure 5**



**Key**

— Actual world population

---- Estimated world population without use of artificial fertilisers

**0 5 . 3** The annual rate of increase in the estimated world population from 1950 to 2020, without the use of artificial fertilisers, is **22 857 143**.

Calculate the difference in the annual rate of increase for the actual world population and the estimated world population without the use of artificial fertilisers from 1950 to 2020.

Give your answer to **two** significant figures.

Show your working.

**[2 marks]**

\_\_\_\_\_ people per year

**Turn over ►**



0

5

4

Explain **one** advantage and **one** disadvantage of artificial fertiliser use in food production.

**[4 marks]**

Advantage \_\_\_\_\_

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Disadvantage \_\_\_\_\_

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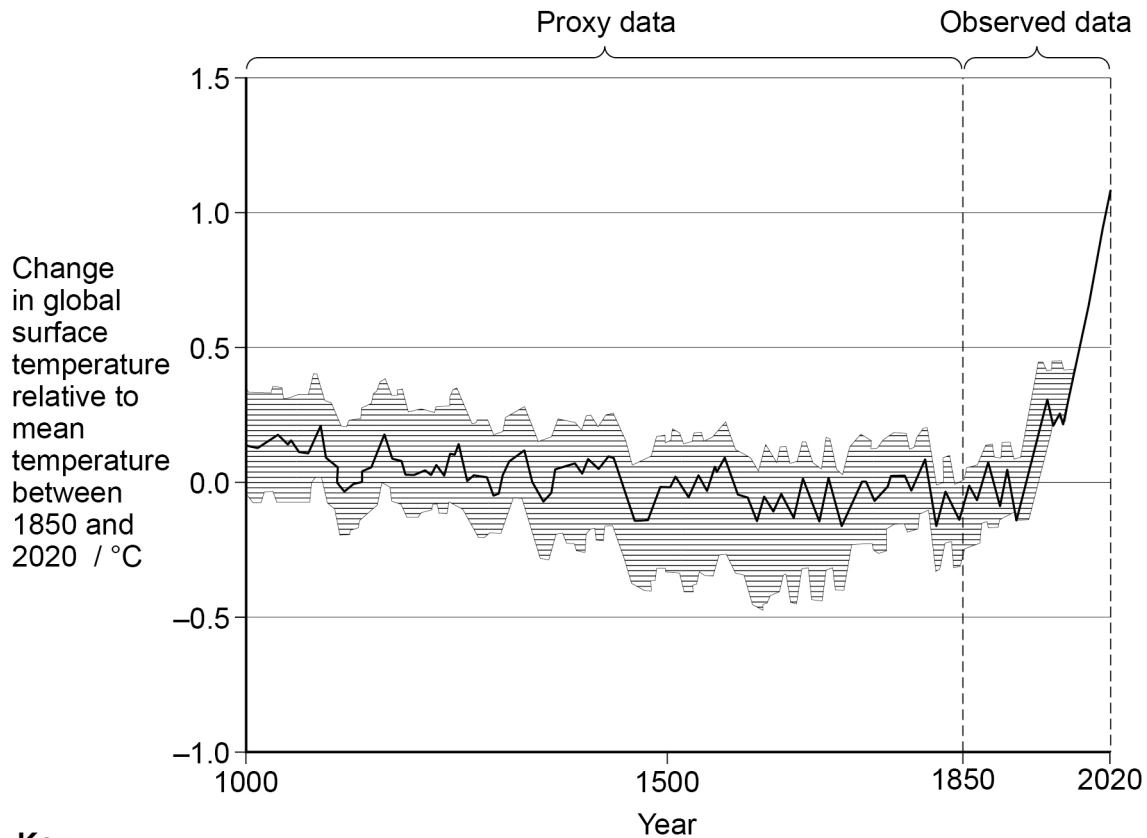
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**10**

**0 6**

Changes in the Earth's surface temperature can be determined using both proxy data and observed data.

**Figure 6** shows the change in mean global surface temperature (1000–2020) relative to the mean temperature between 1850 and 1900.

**Figure 6****Key**

— Change in mean global surface temperature relative to mean temperature

Uncertainty of measurements

**0 6****. 1**

Use data from **Figure 6** to describe the trend in uncertainty of the measurements.

**[2 marks]**


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**Question 6 continues on the next page**

**Turn over ►**



0 6 . 2

Explain **one** disadvantage of using proxy data to estimate past global temperature.**[2 marks]**


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0 6 . 3

Suggest **two** difficulties faced by scientists in predicting future climate change.**[2 marks]**

1 

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2 

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0 6 . 4

Explain how future climate change could lead to increased **ocean acidification** and increased **forest fires**.**[4 marks]**

Increased ocean acidification 

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Increased forest fires 

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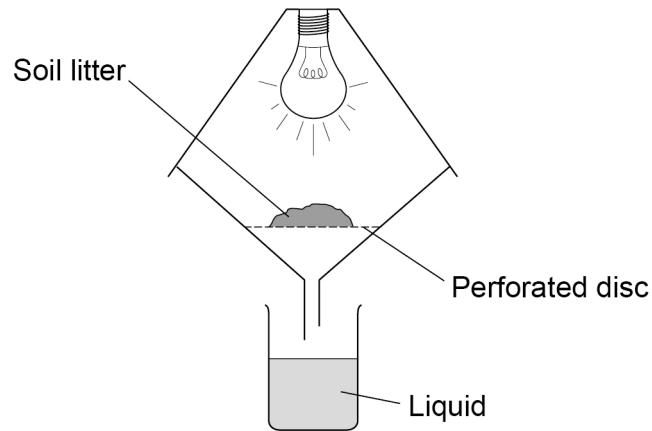
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07

Figure 7 shows a Tüllgren funnel.

Figure 7



07.1

Using **Figure 7**, explain how a Tüllgren funnel is used to investigate soil organisms from a soil litter sample.

[3 marks]

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07.2

Explain **two** ways that soil organisms can increase soil fertility.

[2 marks]

1 

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2 

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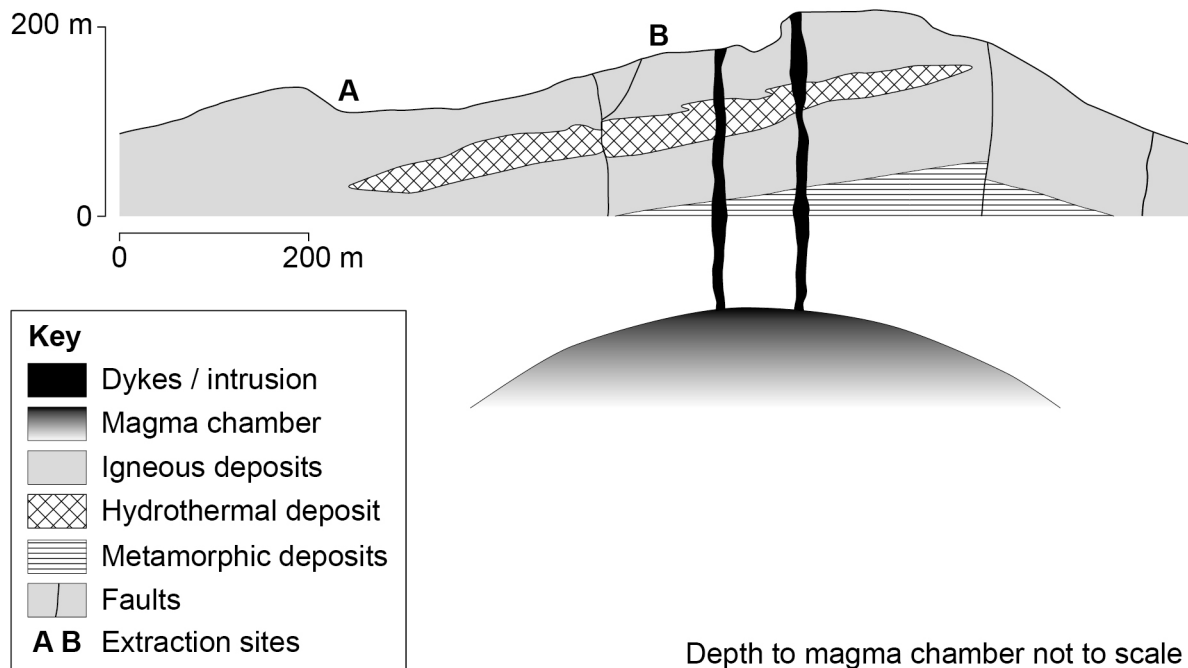
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0 8

**Figure 8** shows a geological cross section, composed of mineral deposits and the location of two possible extraction sites (**A** and **B**).

Figure 8



Only **one** answer per question is allowed.

For each question completely fill in the circle alongside the appropriate answer.

CORRECT METHOD



WRONG METHODS



If you want to change your answer you must cross out your original answer as shown.



If you wish to return to an answer previously crossed out, ring the answer you now wish to select as shown.



0 8 . 1

Estimate the area of the hydrothermal deposit in **Figure 8**.

Shade **one** box only.

[1 mark]

A 7000 m<sup>2</sup>
☐
B 12 000 m<sup>2</sup>
☐
C 21 000 m<sup>2</sup>
☐
D 30 000 m<sup>2</sup>
☐


0 8 . 2

Other than trial drilling, state **one** exploration technique used to locate mineral deposits.

[1 mark]

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0 8 . 3

Explain the geological processes which could have led to the formation of the hydrothermal deposit shown in **Figure 8**.

[4 marks]

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0 8 . 4

Extraction of the hydrothermal deposit is more viable at site **B** than at site **A**.

Use **Figure 8** to explain why extraction at site **B** is more viable.

[4 marks]

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**0 9**

In March 2011, a tsunami flooded the nuclear reactors at the Fukushima plant in Japan. The reactors overheated, releasing radioactive isotopes of caesium (Cs-134 and Cs-137) into the environment. High levels of both isotopes were recorded over a contaminated area of 3000 km<sup>2</sup>.

**0 9 . 1**

State **three** features of the environment that would have been sampled in the contaminated area to measure the radiation levels.

**[3 marks]**

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

**0 9 . 2**

Caesium-134 has a half-life of 2 years.

Calculate the **fraction** of the original caesium-134 remaining exactly 10 years after the incident.

Show your working.

**[1 mark]**

\_\_\_\_\_



Scientists investigated the effect of radiation on local populations of wild Japanese monkeys, one year after the incident. Different monkeys were exposed to different levels of radiation in this time.

Two types of data were collected from the monkeys:

- white blood cell (WBC) counts
- radioactivity levels in muscle tissue.

0 9 . 3

Suggest **three** variables that the scientists would have considered in selecting a sample group of monkeys to provide reliable data.

[3 marks]

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

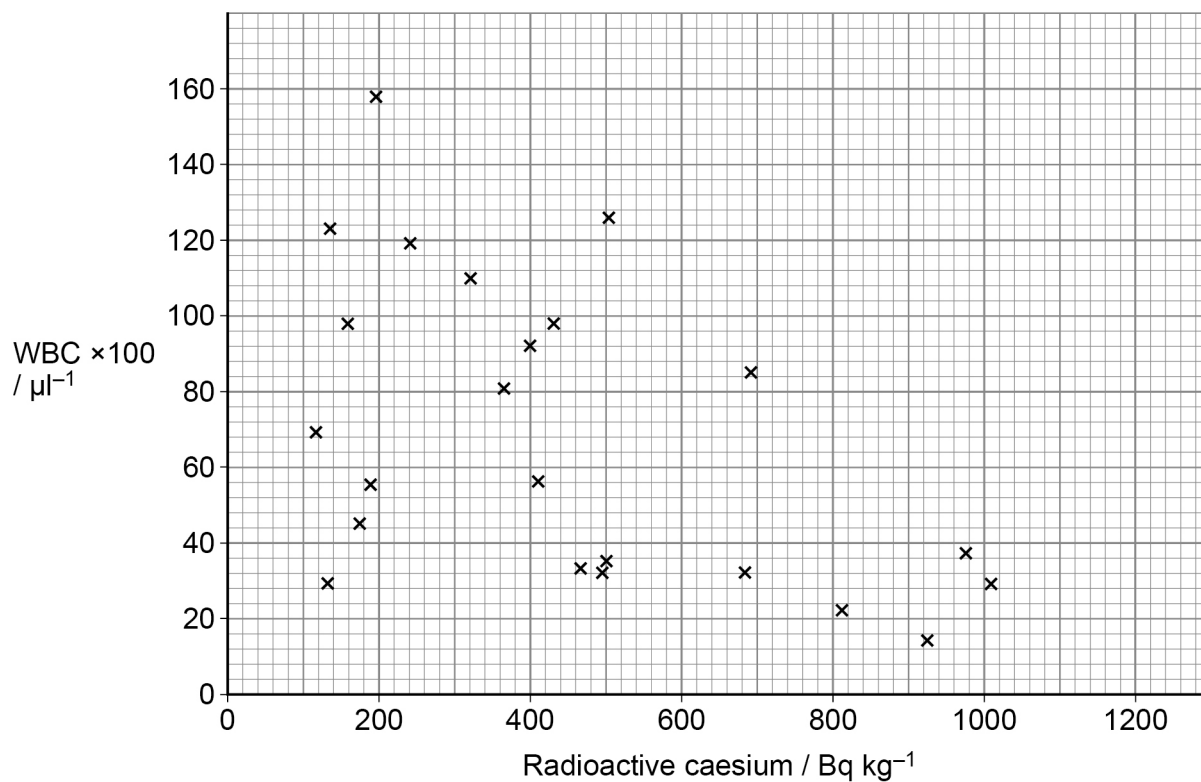
Question 9 continues on the next page

Turn over ►



**Figure 9** shows WBC counts and radioactive caesium in muscle tissue of Japanese monkeys sampled in the contaminated area.

**Figure 9**



0 9 . 4

Analyse the data in **Figure 9**.

**[3 marks]**

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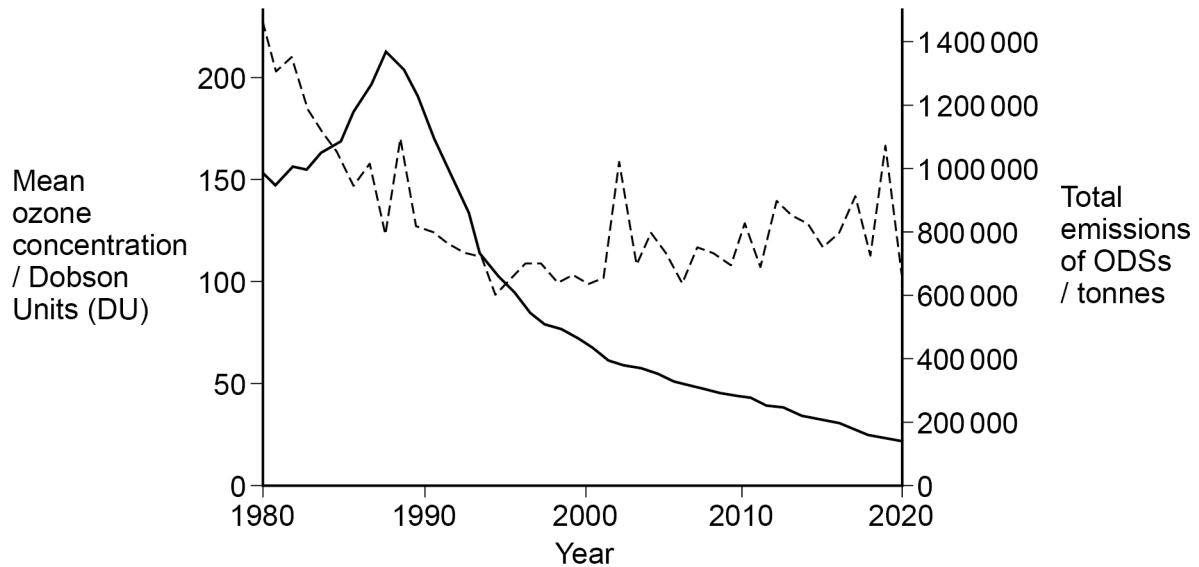
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1 0

**Figure 10** shows the global mean ozone concentration and total emissions of ozone-depleting substances (ODSs) from 1980.

**Figure 10**



**Key**

- Mean ozone concentration
- Total emissions of ODSs

1 0 . 1

'Reductions in ozone depleting substances have had little impact on mean ozone concentration.'

Use **Figure 10** to evaluate this statement.

Use data in your answer.

**[3 marks]**

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**Question 10 continues on the next page**

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|   |   |   |   |
|---|---|---|---|
| 1 | 0 | . | 2 |
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Legislation was introduced in 1987 to help restore the ozone layer.

Students want to conduct a study to determine if there is a statistically significant difference in ozone concentrations (Dobson Units) before and after 1987.

Identify a relevant statistical test and describe how it will determine if there is a statistically significant difference.

**[3 marks]**

Name of test \_\_\_\_\_

\_\_\_\_\_

Description \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



**[9 marks]**

[illegible]

15



11.1

**[25 marks]**

1 1 . 2

**[25 marks]**

Question 

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Question 

|   |   |   |   |                                                                                   |
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☐

## WRONG METHODS

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ANSWER IN THE SPACES PROVIDED**



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[illegible]

| Question number | Additional page, if required.<br>Write the question numbers in the left-hand margin.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
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