AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

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	
TOTAL	

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

Do not write outside the box

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_x
Cleaning electronic equipment with alcohol solvents	
	Carbon monoxide
Recovery of gas from coal mines	
	PM10
Urea sprays	

5

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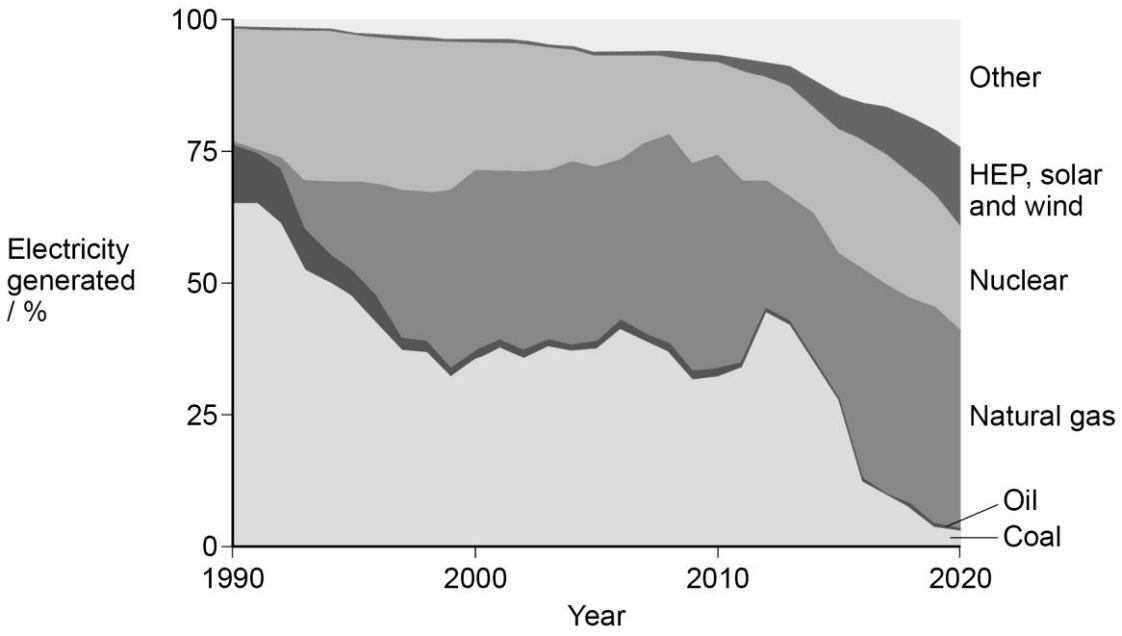
0 2 **Figure 1** shows how the UK's electricity has been generated from 1990 to 2020.

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 ►

Do not write outside the box

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 _____

_____

Do not write outside the box

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 _____

_____

_____

_____

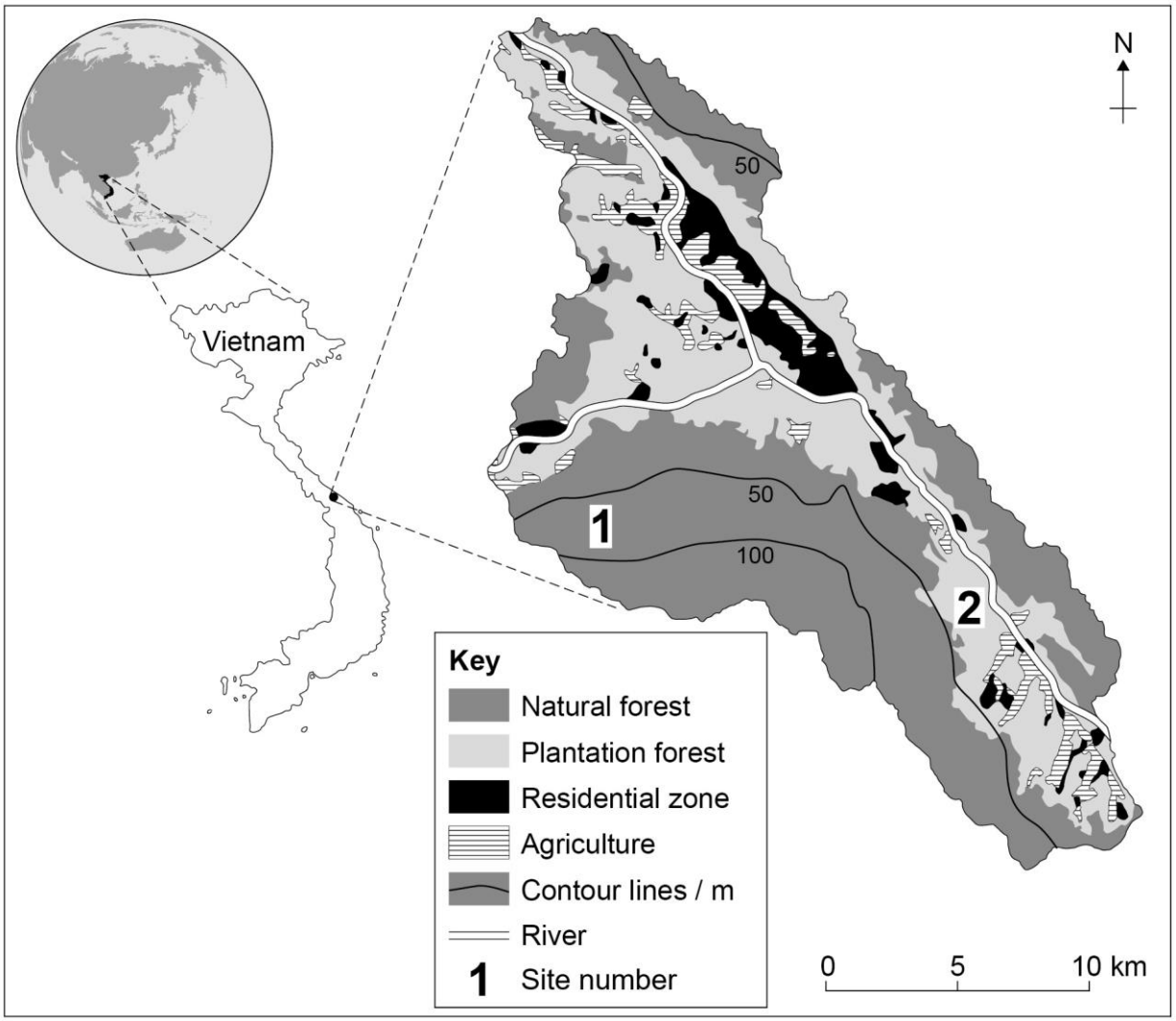
10

Turn over for the next question

Do not write outside the box

0 3 **Figure 2** shows land use information for the Sap drainage basin, Vietnam.

Figure 2



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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

Do not write outside the box

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

Table 2

	A	**R**	**K**	**LS**	**C**	**P**
Site 1 – Natural Forest	19.35	1680	0.30	0.16		1.00
Site 2 – Plantation Forest		1670	0.28	0.07	0.25	0.79

The USLE can be used to estimate soil erosion rates.

$$\mathbf{A = R \times K \times LS \times C \times P}$$

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]

Do not write outside the box

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]

_____

_____

10

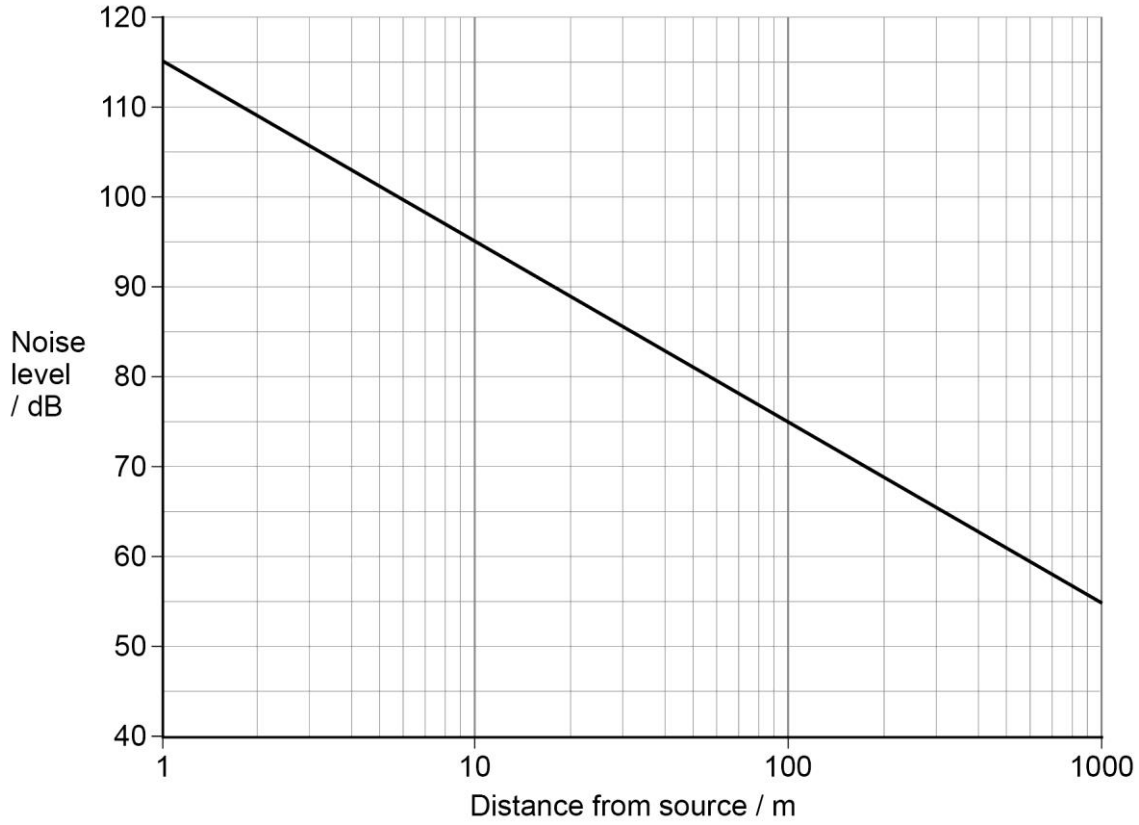
Turn over for the next question

Do not write outside the box

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

Do not write outside the box

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

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.

Figure 4

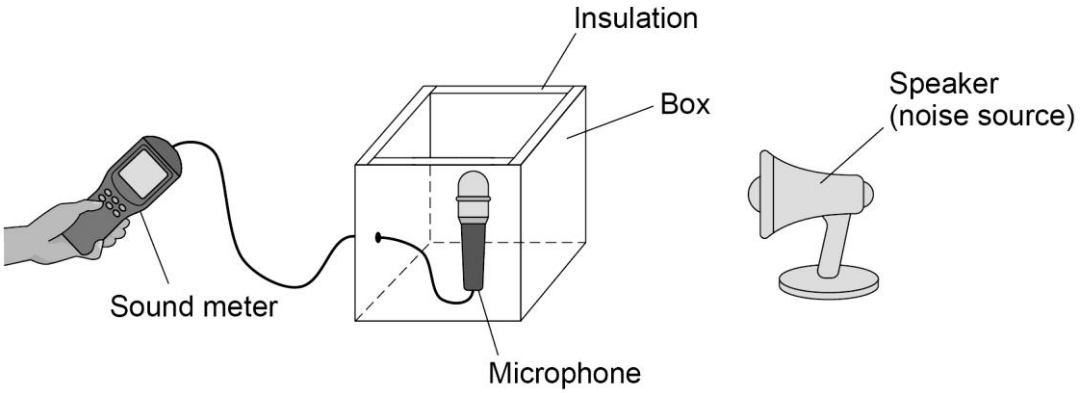


Table 3 shows the results of this investigation.

Table 3

Insulation thickness / mm	**Noise level / 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

Do not write outside the box

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

Do not write outside the box

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]

_____

_____

_____

_____

Do not write outside the box

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

Graph showing actual world population and estimated world population without the use of artificial fertilisers (no Haber Bosch nitrogen) from 1900 to 2020.

Accessed via:
https://www.researchgate.net/figure/Changes-in-world-human-population-as-compared-with-estimated-changes-in-the-absence-of_fig1_259294081

Figure 5 not reproduced here due to third-party copyright restrictions.

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

Do not write outside the box

0 5 . 4 Explain **one** advantage and **one** disadvantage of artificial fertiliser use in food production.

[4 marks]

Advantage

Disadvantage

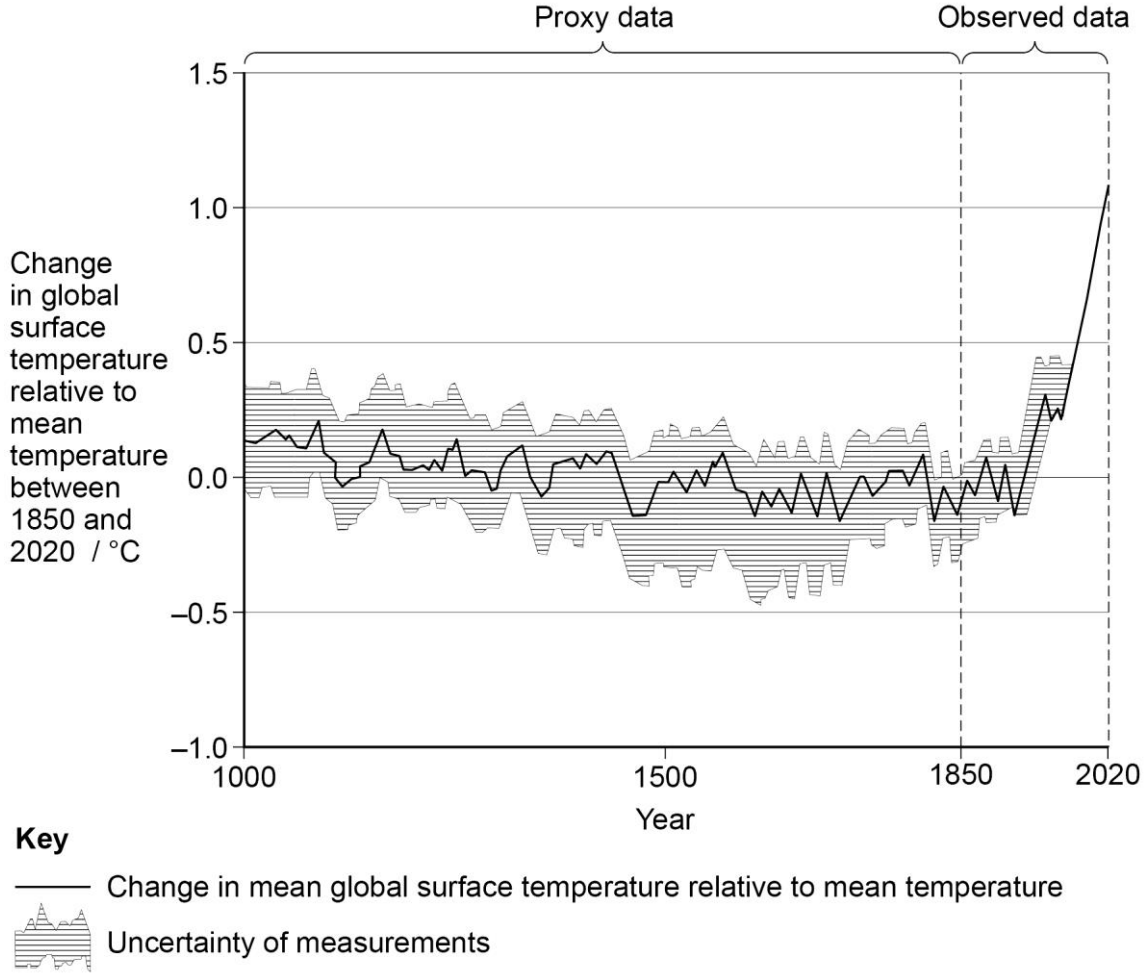
10

Do not write outside the box

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



0 6 . 1 Use data from **Figure 6** to describe the trend in uncertainty of the measurements.

[2 marks]

Question 6 continues on the next page

Turn over ►

Do not write outside the box

0 6 . 2 Explain **one** disadvantage of using proxy data to estimate past global temperature.

[2 marks]

0 6 . 3 Suggest **two** difficulties faced by scientists in predicting future climate change.

[2 marks]

1

2

0 6 . 4 Explain how future climate change could lead to increased **ocean acidification** and increased **forest fires**.

[4 marks]

Increased ocean acidification

Increased forest fires

10

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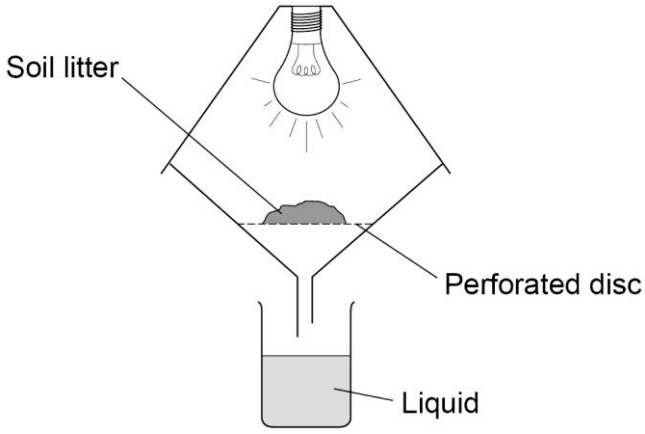
0 7 **Figure 7** shows a Tüllgren funnel.

Figure 7



0 7 . 1 Using **Figure 7**, explain how a Tüllgren funnel is used to investigate soil organisms from a soil litter sample.

[3 marks]

0 7 . 2 Explain **two** ways that soil organisms can increase soil fertility.

[2 marks]

1

2

5

Turn over ►

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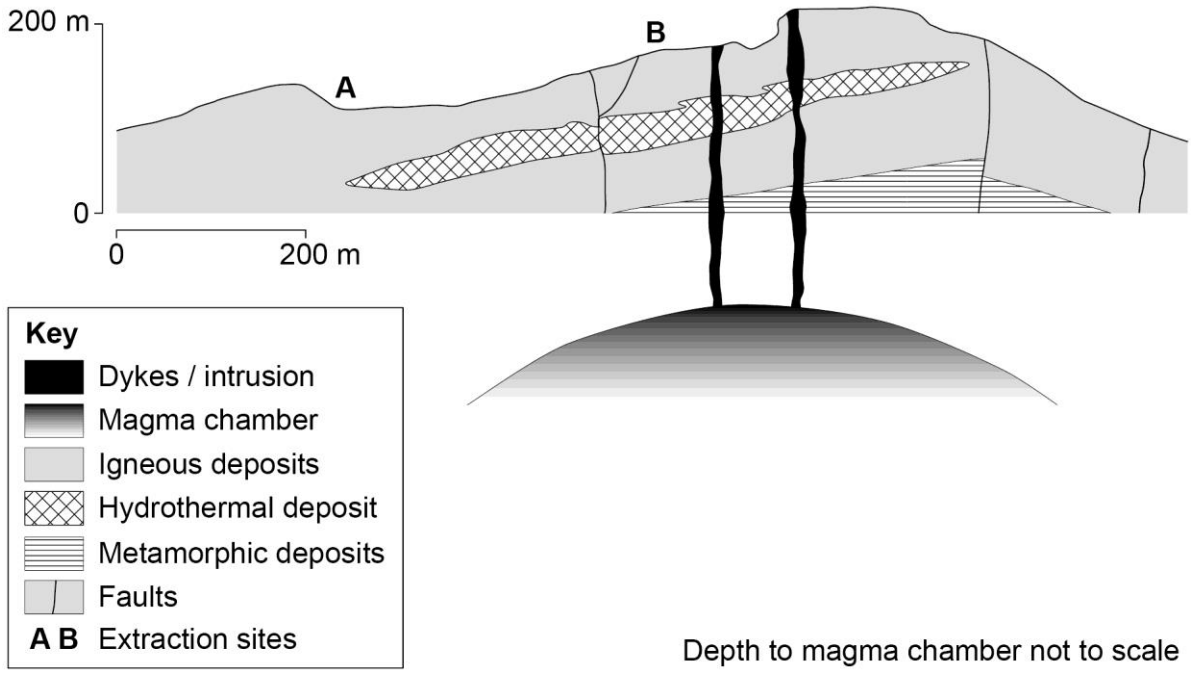
0 8 **Figure 8** shows a geological cross section, composed of mineral deposits and the location of two possible extraction sites (**A** and **B**).

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^2 ⬭

B 12 000 m^2 ⬭

C 21 000 m^2 ⬭

D 30 000 m^2 ⬭

Do not write outside the box

0 8 . 2 Other than trial drilling, state **one** exploration technique used to locate mineral deposits.

[1 mark]

0 8 . 3 Explain the geological processes which could have led to the formation of the hydrothermal deposit shown in **Figure 8**.

[4 marks]

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]

10

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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^2.

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]

_____

Do not write outside the box

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 _____

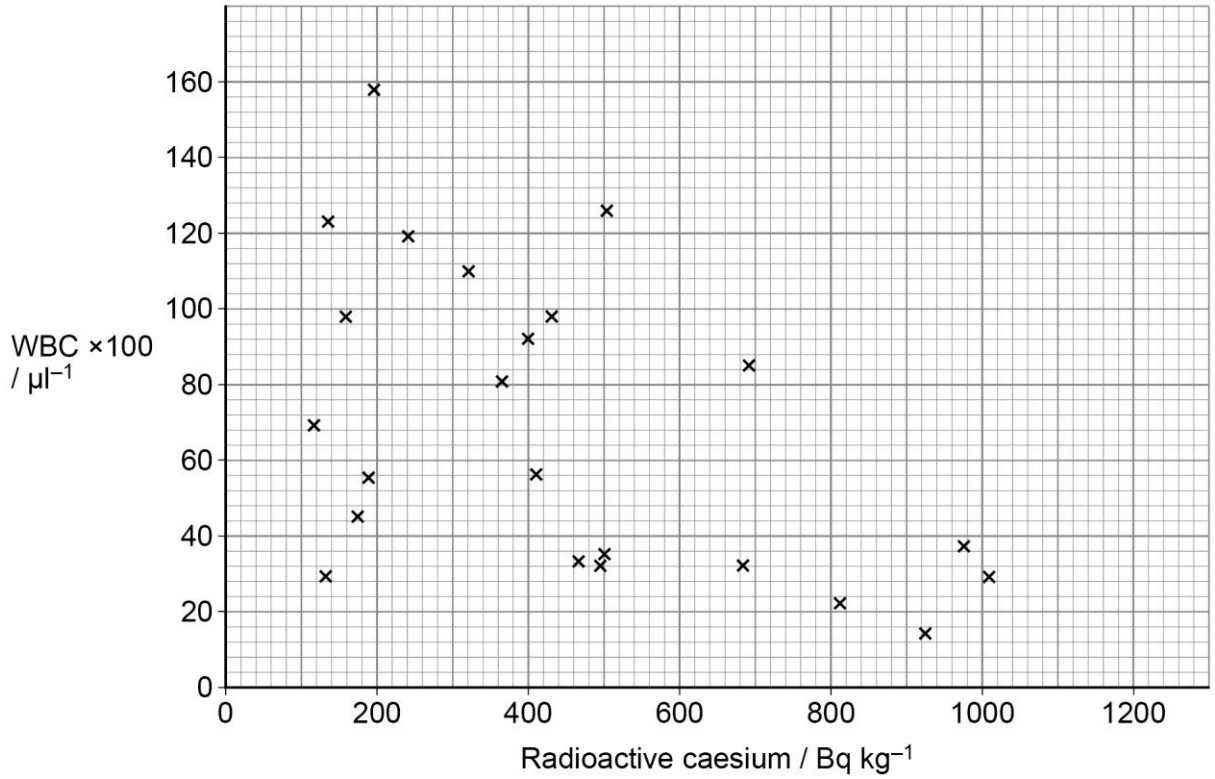
_____

Question 9 continues on the next page

Do not write outside the box

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]

10

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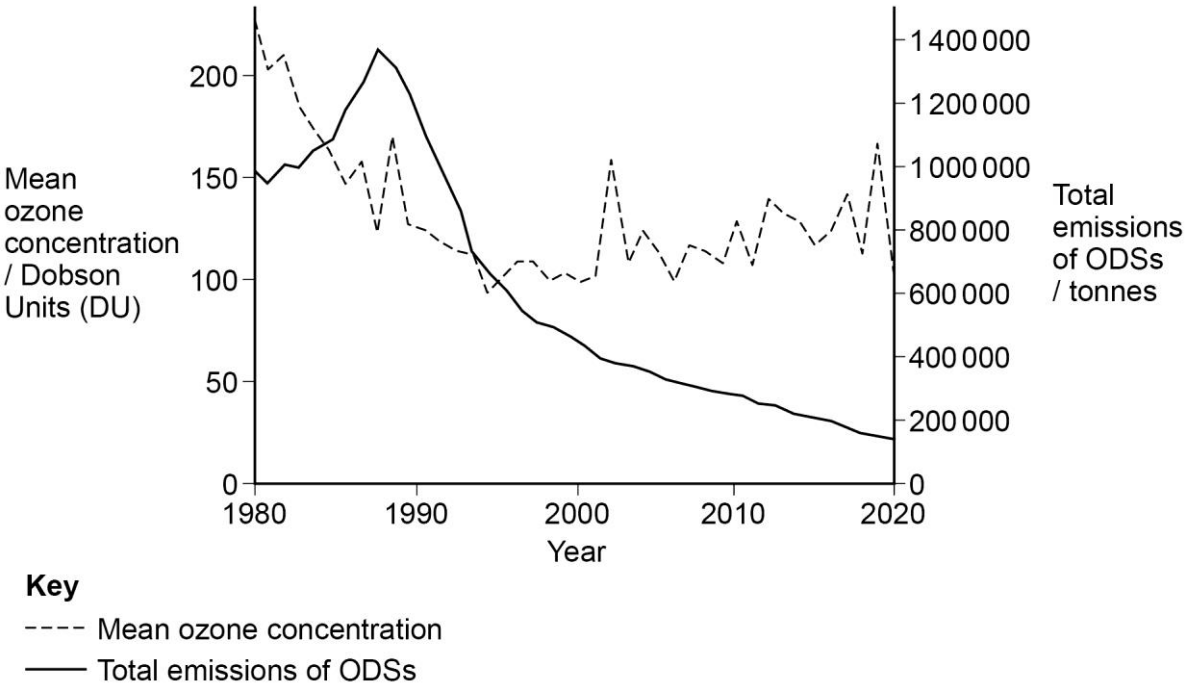
1 0 **Figure 10** shows the global mean ozone concentration and total emissions of ozone-depleting substances (ODSs) from 1980.

Figure 10



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]

Question 10 continues on the next page

Do not write outside the box

1 0 . 2 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 _____

_____

_____

_____

Do not write outside the box

1 0 . 3 Evaluate the methods used to restore the ozone layer.

[9 marks]

15

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Write an essay on **one** of the following topics.

1 1 . 1 Evaluate the extent to which anthropogenic and environmental factors affect the dispersal and severity of pollution.

[25 marks]

OR

1 1 . 2 Evaluate the extent to which anthropogenic and environmental factors affect the choice and use of energy resources.

[25 marks]

Shade the lozenge below to indicate which optional question you have answered.

Question **1 1 . 1** ⬭ Question **1 1 . 2** ⬭

CORRECT METHOD ⬬ WRONG METHODS ⊘ ⦿ ≋ ∅

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Turn over ►

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END OF QUESTIONS

25

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There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**
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