



Surname _____

Forename(s) _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

I declare this is my own work.

A-level

ENVIRONMENTAL SCIENCE

Paper 1

7447/1

Monday 20 May 2024 Morning

Time allowed: 3 hours

At the top of the page, write your surname and forename(s), your centre number, your candidate number and add your signature.

[Turn over]



JUN247447101

MATERIALS

For this paper you must have:

- **a calculator**
- **the insert (enclosed).**

INSTRUCTIONS

- **Use black ink or black ball-point pen. Pencil should only be used for drawing.**
- **Answer ALL questions 1 to 10 and ONE essay from question 11.**
- **You must answer the questions in the spaces provided. Do not write 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.**

**DO NOT TURN OVER UNTIL TOLD
TO DO SO**



Answer ALL questions in the spaces provided.

0	1
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TABLE 1, on the opposite page, 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	

[Turn over]



0	2
---	---

FIGURE 1, on page 2 of the insert, shows how the UK's electricity has been generated from 1990 to 2020.

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



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[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.



9

Show your working. [2 marks]

Answer _____ %

[Turn over]



0 9

0	2	.	3
---	---	---	---

Outline TWO advantages of using vertical axis wind turbines (VAWTs) over horizontal axis wind turbines (HAWTs). [2 marks]

1 _____

2 _____



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[Turn over]



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 _____

[Turn over]



0	3
---	---

FIGURE 2, on page 3 of the insert, shows land use information for the Sap drainage basin, Vietnam.

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 _____

[Turn over]



Reason 2



BLANK PAGE

[Turn over]





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.

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

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.

03.2

**Use the USLE to complete TABLE 2, on the opposite page.
[2 marks]**

[Turn over]

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, on page 18.

Give your answers to TWO decimal places.



21

Show your working. [3 marks]

LS factor = _____

K factor = _____

[Turn over]



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



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[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, on page 4 of the insert, shows the predicted change in noise levels with distance from a source of noise under controlled test conditions.

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

[Turn over]



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 _____



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, on page 5 of the insert, shows the investigation.

[Turn over]



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



0	4	.	4
---	---	---	---

Suggest THREE variables that should have been controlled to ensure reliable results. [3 marks]

Variable 1 _____

Variable 2 _____

Variable 3 _____

[Turn over]



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]



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[Turn over]





TABLE 4

<i>n</i>	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	1.000
8	0.524	0.643	0.738	0.833	0.881	0.952	0.952
9	0.483	0.600	0.700	0.783	0.833	0.917	0.917
10	0.455	0.564	0.648	0.745	0.794	0.879	0.879
11	0.427	0.536	0.618	0.709	0.755	0.845	0.845
12	0.406	0.503	0.587	0.678	0.727	0.818	0.818
13	0.385	0.484	0.560	0.648	0.703	0.791	0.791



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.

0 4 . 6

Using TABLE 3, on page 28, and TABLE 4 on page 32, identify the highest level of significance (p -value) for these results. [1 mark]

33

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]**

[Turn over]



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

FIGURE 5, on page 6 of the insert, compares the actual world population and the estimated world population without the use of artificial fertilisers.



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[Turn over]



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.



39

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 _____

Disadvantage _____



[Turn over]



0	6
---	---

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

FIGURE 6, on page 7 of the insert, shows the change in mean global surface temperature (1000–2020) relative to the mean temperature between 1850 and 1900.

0	6	.	1
---	---	---	---

Use data from FIGURE 6 to describe the trend in uncertainty of the measurements. [2 marks]



06.2

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

[Turn over]



0	6	.	3
---	---	---	---

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

1

2



BLANK PAGE

[Turn over]



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

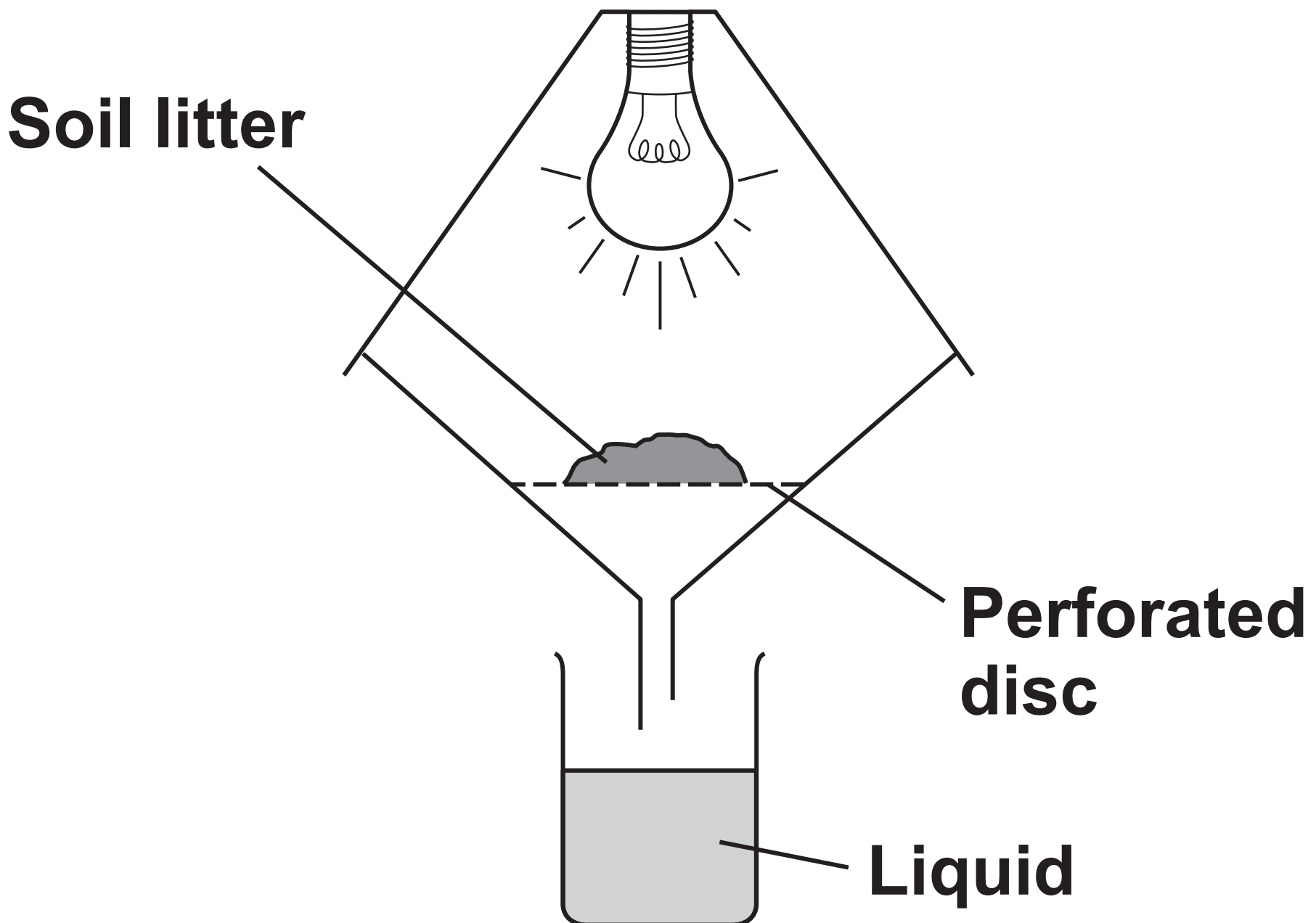
[Turn over]



07

FIGURE 7 shows a Tüllgren funnel.

FIGURE 7



07.2

Explain TWO ways that soil organisms can increase soil fertility. [2 marks]

1 _____

2 _____

5



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[Turn over]



0 8

FIGURE 8, on page 8 of the insert, shows a geological cross section, composed of mineral deposits and the location of two possible extraction sites (A and B).

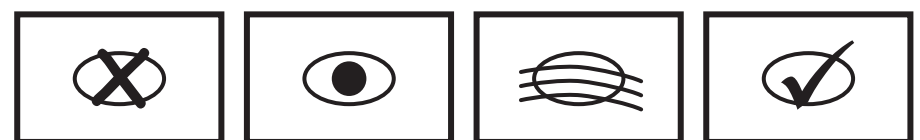
Only ONE answer per question is allowed.

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

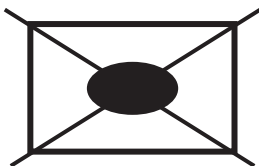
CORRECT METHOD



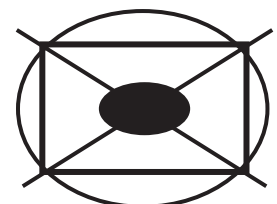
WRONG METHODS



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 m²

B 12 000 m²

C 21 000 m²

D 30 000 m²

0 8 . 2

Other than trial drilling, state ONE exploration technique used to locate mineral deposits. [1 mark]

[Turn over]



[Turn over]



08.4

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

[Turn over]



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 km².



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 _____

[Turn over]



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]



BLANK PAGE

[Turn over]



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 _____

[Turn over]



FIGURE 9, on page 9 of the insert, shows WBC counts and radioactive caesium in muscle tissue of Japanese monkeys sampled in the contaminated area.



1	0
---	---

FIGURE 10, on page 10 of the insert, shows the global mean ozone concentration and total emissions of ozone-depleting substances (ODSs) from 1980.

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]



[Turn over]



10.2

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 _____



1 0 . 3

Evaluate the methods used to restore the ozone layer. [9 marks]

[Turn over]





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[Turn over]



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 circle below to indicate which optional question you have answered.

Question

1	1
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1	<input type="radio"/>
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Question

1	1
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 .

2	<input type="radio"/>
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CORRECT METHOD

<input checked="" type="radio"/>

WRONG METHODS

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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[Turn over]



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For Examiner's Use	
Question	Mark
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9	
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TOTAL	

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9 2



2 4 6 A 7 4 4 7 / 1