SPECIMEN MATERIAL

Please write clearly, in block capitals.

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

Surname _____

Forename(s) _____

Candidate signature _____

A-level
ENVIRONMENTAL SCIENCE

Paper 1

Date of Exam | Morning | Time allowed: 3 hours

Materials

For this paper you may have:

- 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** parts in 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.
- 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.
- 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.

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

0 1 **Table 1** shows the features of different energy resources.

Complete **Table 1** by putting **one** tick in the appropriate box in each row.

[5 marks]

Table 1

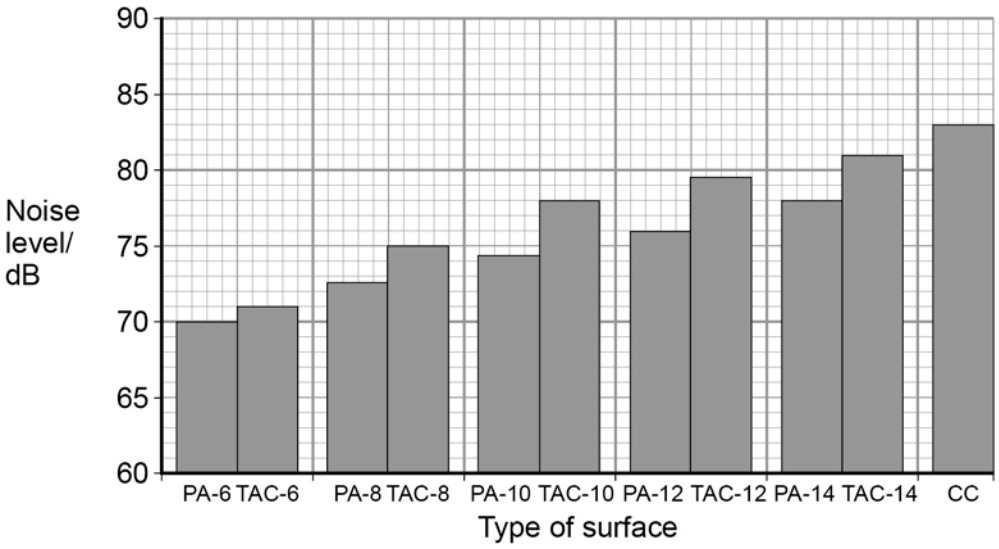
	Energy resource				
	Biomass	**Solar**	**HEP**	**Hydrogen**	**Instream Tidal Power**
Releases CO_2 on combustion but overall use can be carbon neutral					
Can be used to store gravitational potential energy					
Renewable but not solar derived					
Supply is unpredictable					
Secondary fuel					

0 2 . 0 The number of vehicles using motorways in the UK has continued to increase since they were introduced in the 1960s. They are an important source of noise nuisance to people in residential areas close to motorways.

Some materials used to cover the road surface reduce the level of noise produced by vehicles.

Figure 1 shows the results of an experiment where noise levels were measured as vehicles moved over roads with different types of surfaces.

Figure 1



Key to type of surface

PA = Porous asphalt **TAC** = Thin asphalt and concrete **CC** = Concrete

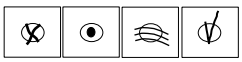
Numbers refer to particle size in mm

0 2 . 1 Use data from **Figure 1** to assess the effectiveness at reducing noise from a concrete road by using PA compared with TAC.

[2 marks]

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

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

CORRECT METHOD  WRONG METHODS 

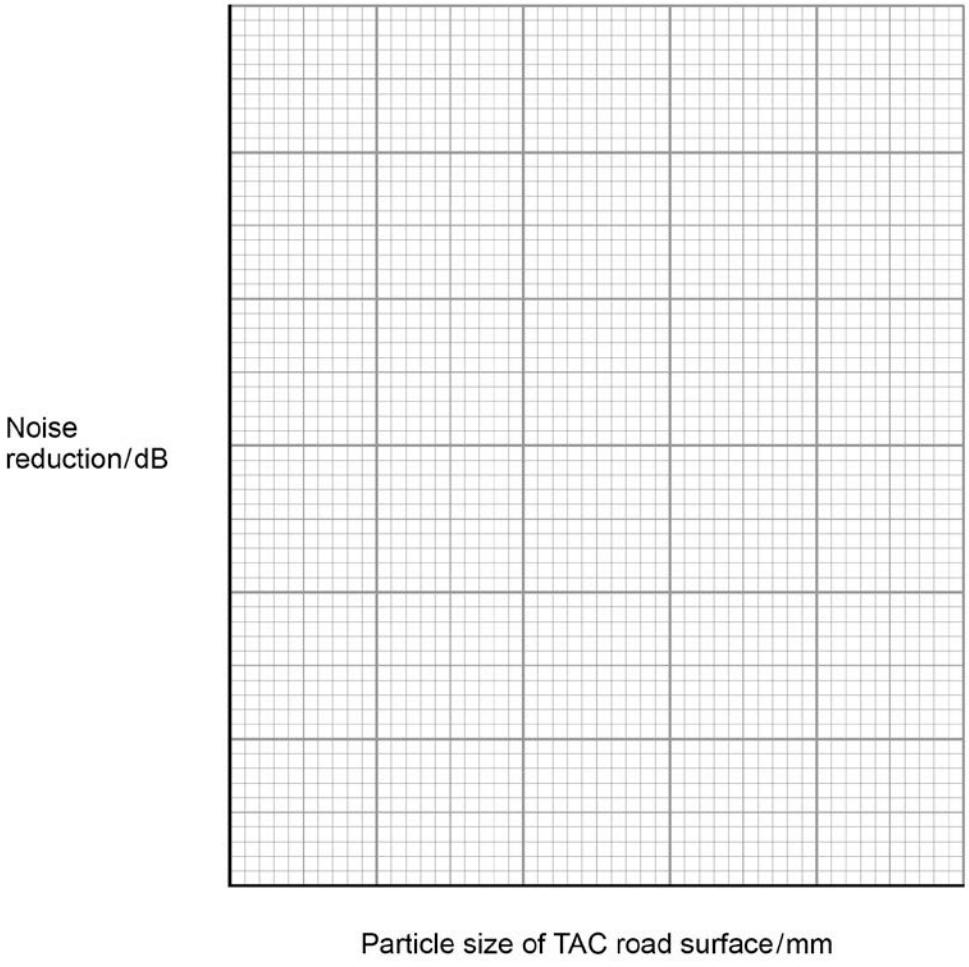
If you want to change your answer you must cross out your original answer as shown. 

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

0 2 . 2 Use data from **Figure 1** to plot a line graph on **Figure 2** to show the effect of particle size on noise reduction on roads surfaced with TAC.

[2 marks]

Figure 2



0 2 . 3 Which decibel level has 10 times the sound pressure of a sound at 70 db?

A 73 dB ⬭

B 80 dB ⬭

C 90 dB ⬭

D 170 dB ⬭

E 700 dB ⬭

[1 mark]

0 2 . 4 As part of a noise reduction programme near a residential area, a section of concrete motorway was resurfaced with 8 mm porous asphalt.

A calibrated sound meter was used in an experiment to assess whether the noise reduction achieved by the new road surface was the same at all distances from the motorway.

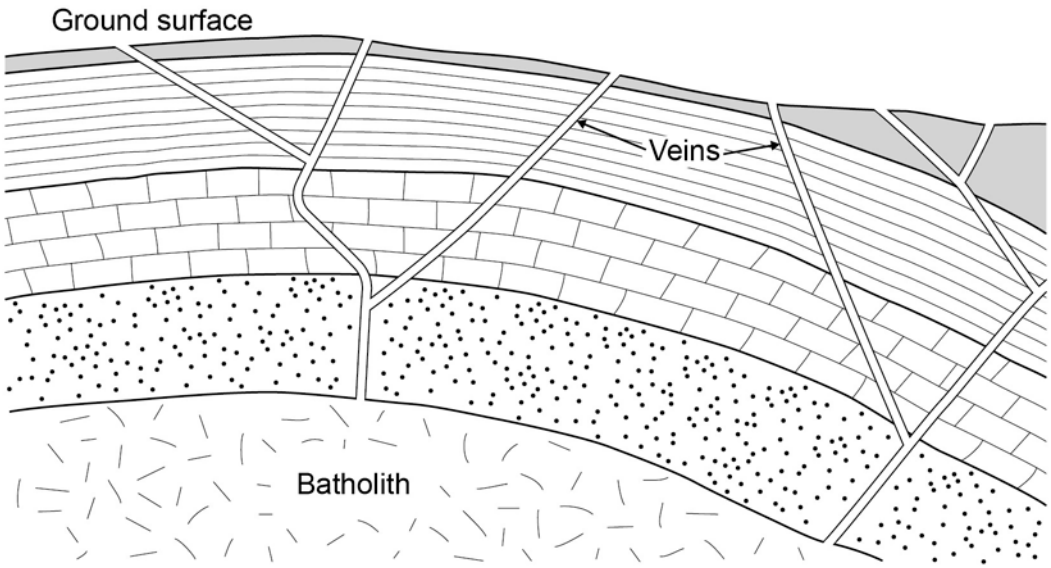
Describe how the investigation could have been planned to make sure valid results were obtained.

[5 marks]

Turn over for the next question

0 3 . 1 **Figure 3** shows a cross section of a granite batholith and its associated geological structures.

Figure 3

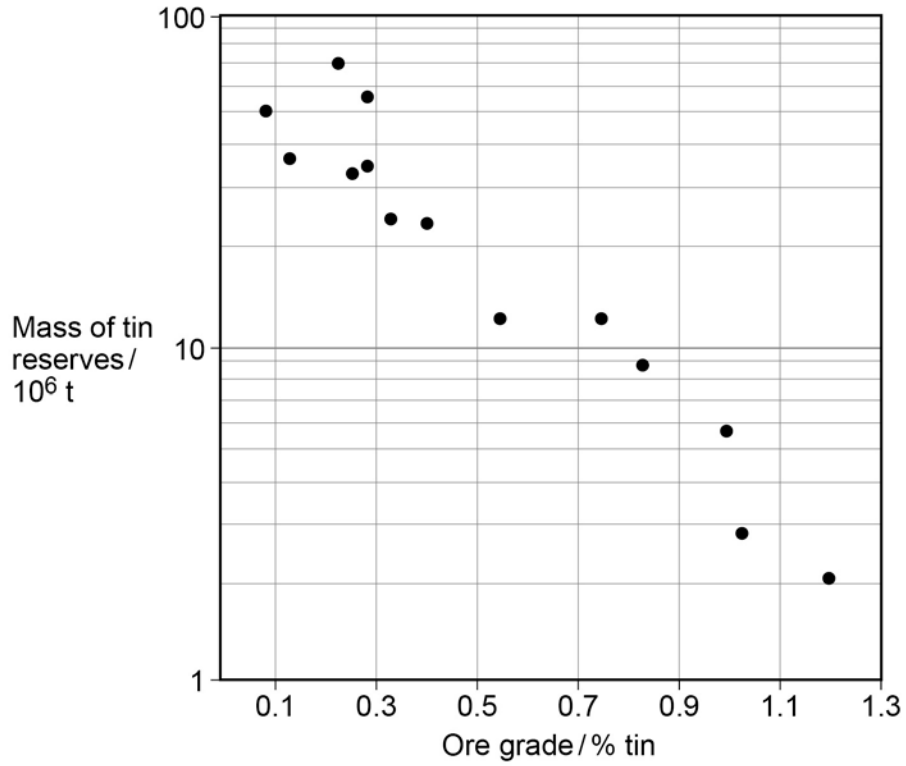


Explain how hydrothermal processes produced economically recoverable metal ore deposits.

[3 marks]

0 3 . 2 **Figure 4** shows the mass of tin reserves that occur at different ore grades.

Figure 4



Draw a line of best fit and use it to estimate the mass of tin ore that would exist in ores of 0.35% purity.

[1 mark]

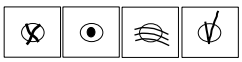
_____ /10^6 t

0 3 . 3 Explain why a reduction in the market price for tin would change the 'cut-off ore grade'.

[2 marks]

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

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

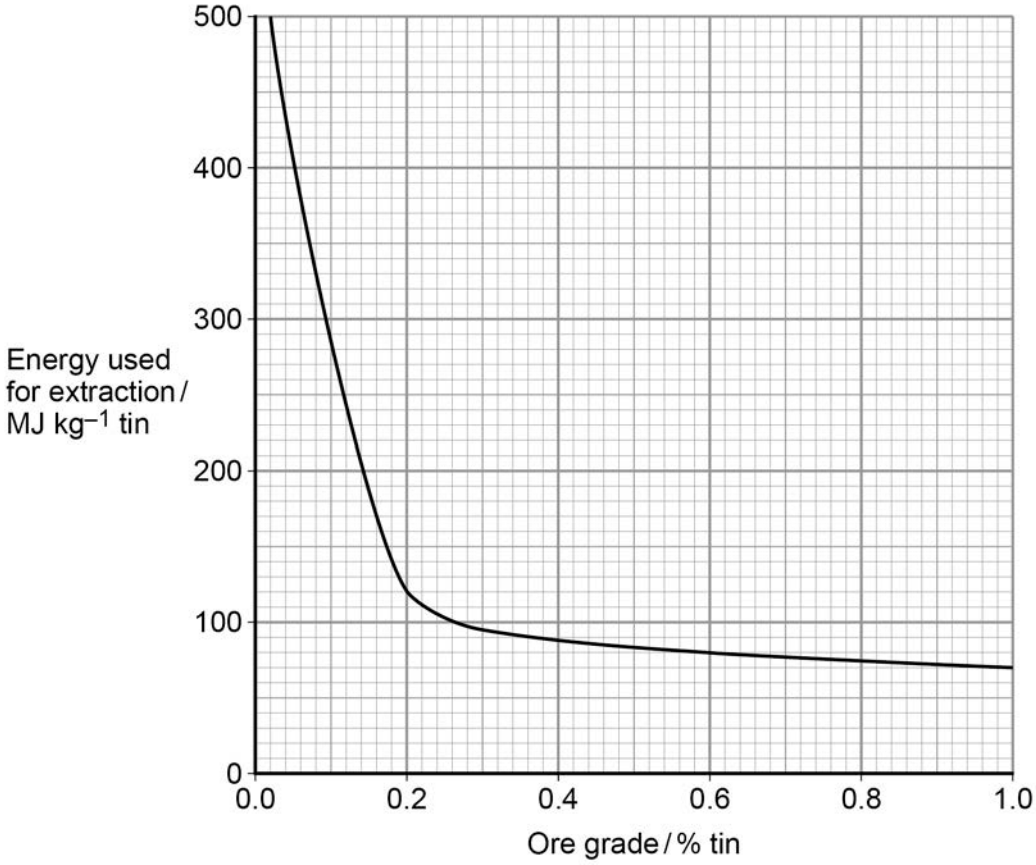
CORRECT METHOD  WRONG METHODS 

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 3 . 4 **Figure 5** shows the amount of energy needed to extract tin from different grades of ore.

Figure 5



Use information from **Figure 5** to calculate the percentage change in the energy used to extract tin if the 'cut-off ore grade' changed from 0.6% to 0.2%.

A 40 ⬭

B 50 ⬭

C 125 ⬭

D 180 ⬭

E 225 ⬭

[1 mark]

0 3 . 5 Give **one** reason why the energy required for extraction increases as the ore grade declines.

[1 mark]

0 3 . 6 Explain how **one** property of a named mineral resource or mineral group may make it possible to detect its presence with a geophysical technique.

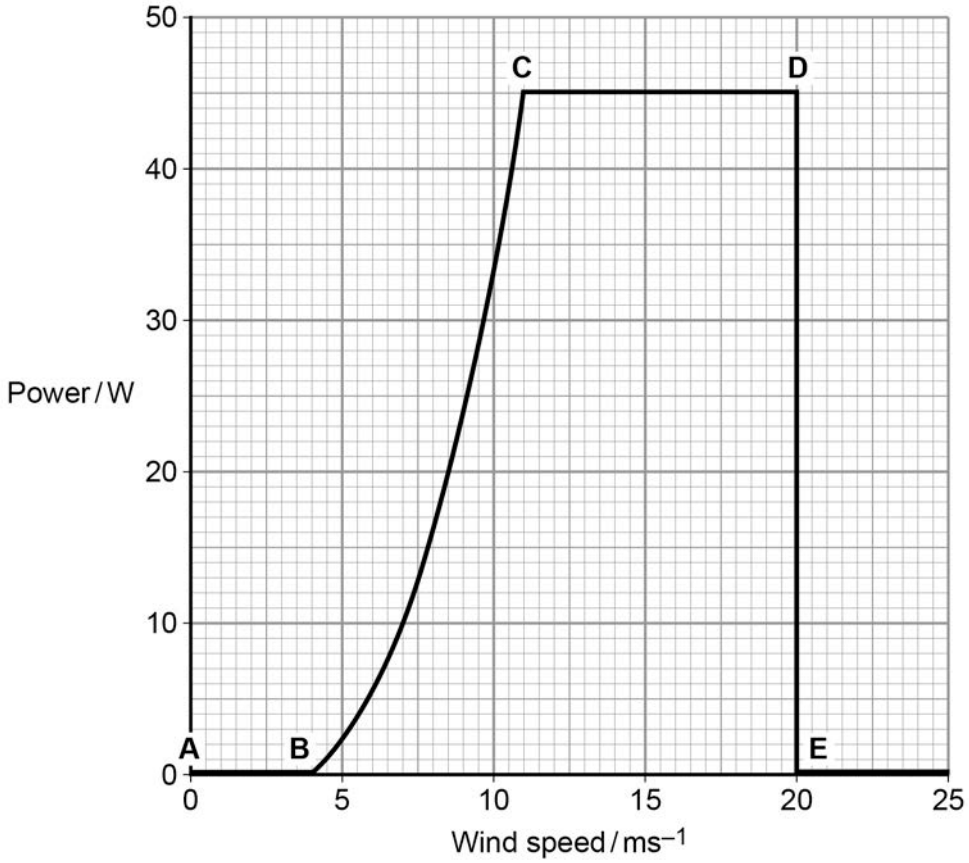
[2 marks]

Turn over for the next question

0 4 . 1 The design of a wind turbine affects the proportion of the energy that can be harnessed from the wind.

Figure 6 shows the power output of a wind turbine at different wind velocities.

Figure 6



Explain the power outputs shown for A – B and C – D.

[2 marks]

A – B

C – D

0 4 . 2 The maximum power in watts produced by a wind turbine can be calculated using the formula:

$$KE = 0.5\ \pi\ r^2\ v^3\ d$$

where

KE = kinetic energy available /j

π = 3.142

r = radius of area swept by turbine blades /m

v = wind velocity /ms^{-1}

d = density of air (at sea level) = 1.2 kg m^{-3}

Use the formula to calculate the power in MW produced by a wind turbine if the blade radius is 25 m and the velocity of the air flowing over its blades is 20 ms^{-1}. Assume the turbine is 45% efficient at converting kinetic energy into electricity.

[2 marks]

MW

Question 4 continues on the next page

Table 2 shows the power outputs of wind turbines of different blade diameters with a wind velocity of 8 km hr^{-1}.

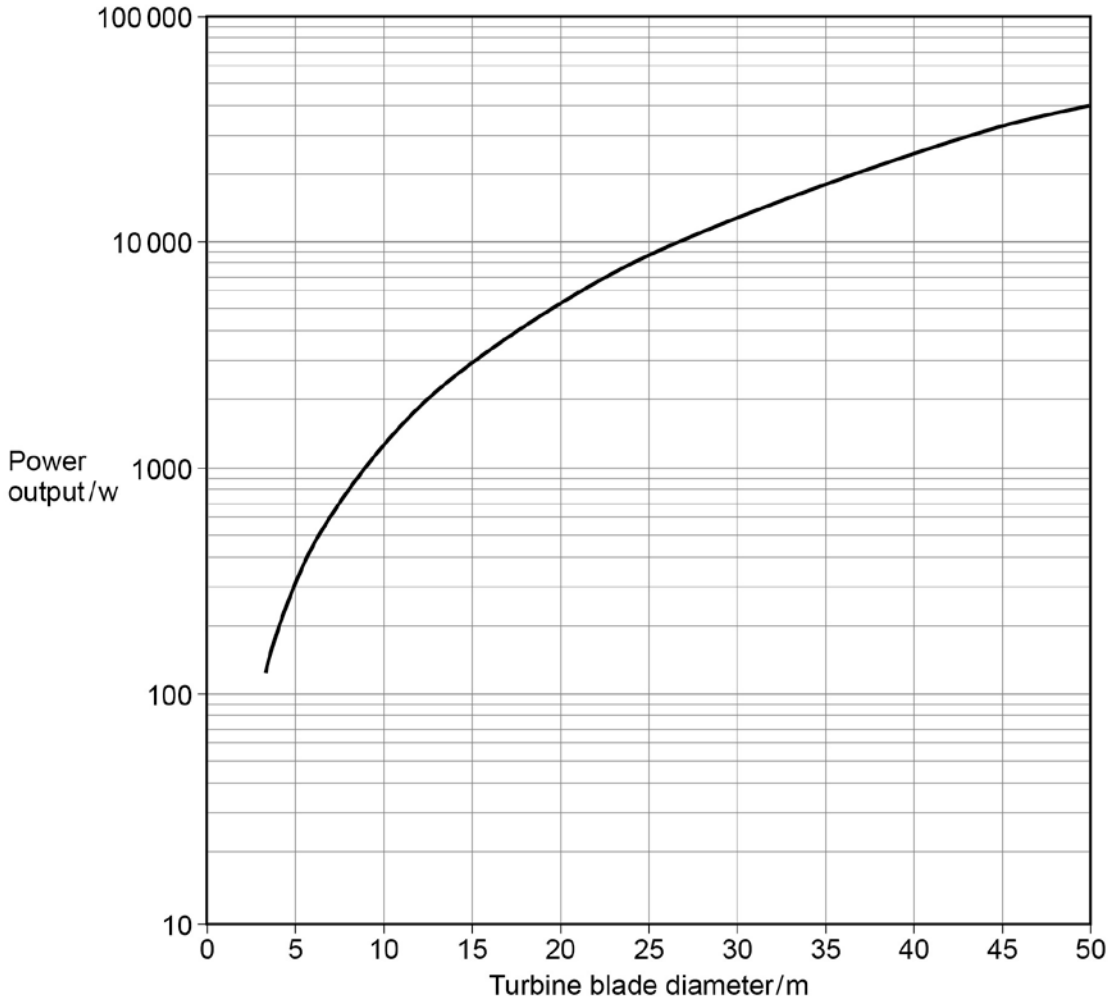
Table 2

Blade diameter / m	Power output / w
50	5000
40	3000
30	1500
20	650
10	150
5	37

Unit of power = watts

Figure 7 shows a graph of power output for wind turbines of different blade diameters when the wind velocity is 16 km hr^{-1}.

Figure 7



0 4 . 3 Use data from **Figure 7** to estimate the increase in power output if the wind velocity is 16 km hr^{-1} and blade diameter is increased from 5 m to 40 m.

[1 mark]

0 4 . 4 Use the data in **Table 2** to plot a graph on **Figure 7** of the effect of blade diameter on power output when the wind velocity is 8 km hr^{-1}.

[2 marks]

0 4 . 5 Use data from **Figure 7** to calculate the effect of doubling the blade diameter on the power output of wind turbines.

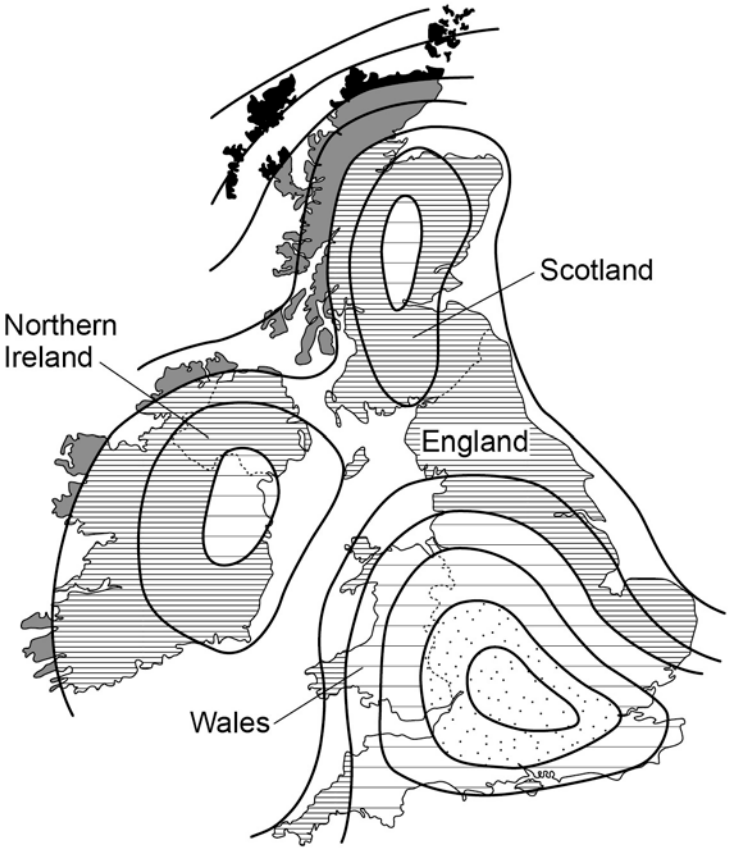
Show your working.

[1 mark]

Question 4 continues on the next page

0 4 . 6 **Figure 8** shows the maximum wind speeds for the UK and Ireland.

Figure 8



Key

Maximum wind velocity

- More than 27 m s^{-1}
- 25 – 27 m s^{-1}
- 23 – 25 m s^{-1}
- 21 – 23 m s^{-1}
- Less than 21 m s^{-1}

Windfarm generating capacity in each country in the UK / MW

Scotland	1293
England	616
Wales	498
Northern Ireland	213

Use information from **Figure 8** and your own knowledge to explain why the windiest areas in a region are not always chosen for new wind farms.

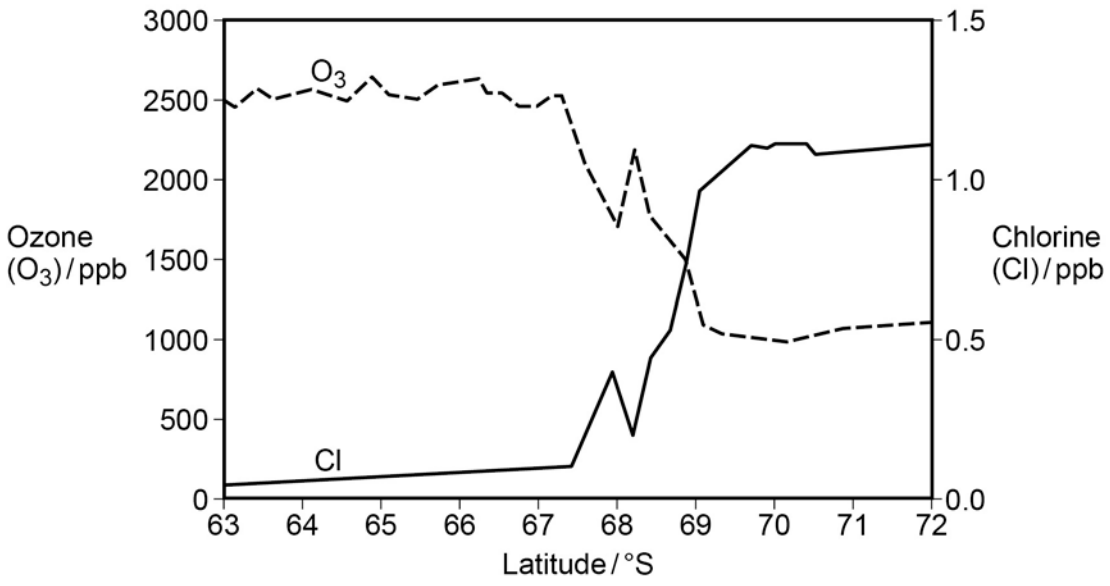
[2 marks]

0 5 . 1 Explain the role of chlorofluorocarbons (CFCs) in the depletion of stratospheric ozone (O_3).

[3 marks]

0 5 . 2 **Figure 9** shows the concentration of ozone and chlorine in the stratosphere of the Southern Hemisphere during September 1994.

Figure 9



Use information from **Figure 9** and your own knowledge to explain why the concentration of chlorine (Cl) in the stratosphere is higher at 70°S than at 65°S.

[2 marks]

0 6 . 1 A brewery abstracts water from a borehole for use in its brewing process. Before it can be used, the water is treated to reduce the salt content.

Table 3 shows the results of water tests before and after treatment.

Table 3

Parameter / mg l^{-1} (excluding pH)	**Before treatment**	**After treatment**
pH	7.4	6.1
Ca^{2+}	429.0	2.0
NO_3^-	16.0	1.6
PO_4^{3-}	0.3	0.2
Na^+	135.0	0.0
K^+	3.7	0.0
Cl^-	359.0	8.5

Describe how **one** named method may have been used to treat the water.

[3 marks]

0 6 . 2 Describe how the nitrate concentration of the water could have been measured.

[1 mark]

0 6 . 3 Give **two** advantages of using aquifer water rather than water from a reservoir for public supply.

[2 marks]

0 6 . 4 Water is a renewable resource but unsustainable exploitation may reduce its availability.

Describe how unsustainable abstraction of water from rivers may cause environmental problems.

[4 marks]

Turn over for the next question

0 7 Minamata Bay is on the west coast of Japan. The bay is largely enclosed by headlands and islands and has few rivers flowing into it.

Between 1932 and 1968, industrial wastewater from the Chisso factory was discharged directly into Minamata Bay via the Hyakken outlet. This waste water contained low levels of inorganic mercury compounds.

The population living around Minamata Bay ate fish and shellfish from the bay as part of their diet. In the late 1950s, cats and humans began to develop a neurological disorder, which became known as Minamata disease. Children in the area were born with congenital disorders such as paralysis, blindness and brain damage.

Methyl mercury was detected in fish from the bay. Tissue samples from the diseased cats and humans were tested and found to contain even higher levels of methyl mercury than in the fish. Core sediment samples were analysed from the bottom of the bay and the highest levels of methyl mercury were found in the top few centimetres near the Hyakken outlet. Samples analysed from Minamata Bay in 2015 still contained methyl mercury.

Use the information in the text and your own knowledge to explain why the discharge of low levels of inorganic mercury compounds caused such serious health effects.

[5 marks]

Turn over for the next question

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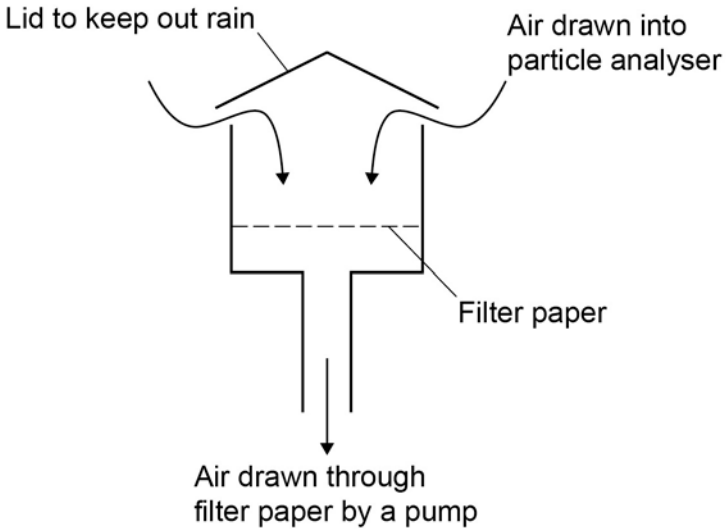
0 8 . 0 Atmospheric smoke levels can be estimated using a particle analyser.

Figure 10 shows the operation of a simple particle analyser.

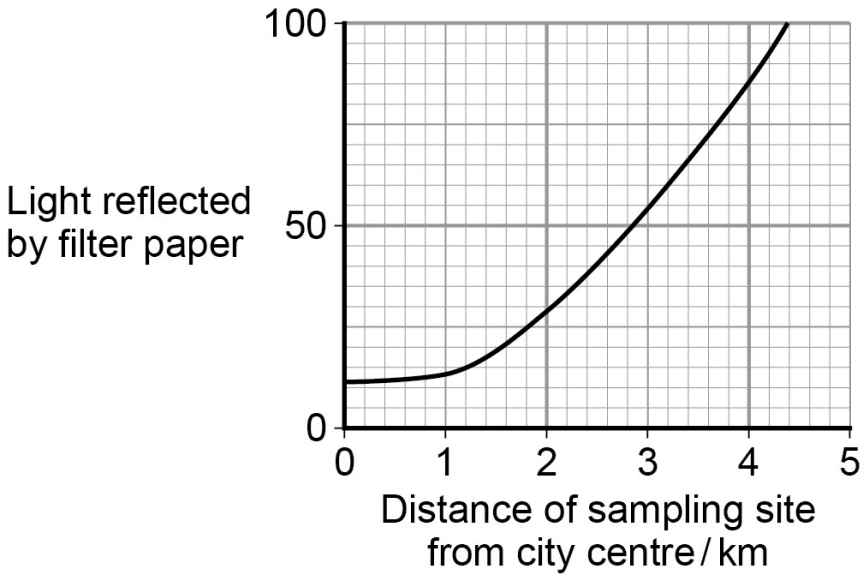
Figure 10



The change in albedo of the filter paper caused by the trapped smoke particles is used to estimate relative smoke levels.

Figure 11 shows the results of a study of smoke levels in a city at different distances from the city centre.

Figure 11



0 8 . 1 Explain why smoke samples collected at different times in the same location during this study may have produced results that show great variability.

[4 marks]

0 8 . 2 Suggest **three** variables, other than the times of collection of samples, that should have been standardised in this study to ensure the results were representative.

[3 marks]

0 8 . 3 Describe the differences between smoke smogs and photochemical smogs.

[3 marks]

0 9 . 0 The formation and erosion of soil are controlled by natural processes.

The overall rate of erosion can be estimated using the Universal Soil Loss Equation (USLE).

Soil erosion rate = R × K × L × S × C × P

Where:
R = Rainfall erosivity factor
K = Soil erodibility factor
L = Slope length factor
S = Slope gradient factor
C = Cropping management factor
P = Erosion prevention factor

Tables 4 to 8 give information about the factors that can be used in the USLE for a particular farm.

The natural rate of soil formation on Newton Farm is 3 t ha^{-1} yr^{-1}. An erosion rate less than this can be considered to be sustainable.

Table 4

Farm name	R factor
Newton farm	90

Table 5

Soil textural class	K factor
Heavy clay	0.38
Loam	0.67

Table 6

Slope length / m	Slope gradient / %	L × S factor
30	5	0.5
	1	0.1
250	5	1.5
	1	0.2

Table 7

Cropping management method	C factor
Wheat	0.35
Salad crops	0.50
Fruit	0.10

Table 8

Erosion prevention method	P factor
Ploughing down the slope	1.00
Contour ploughing	0.75
Contour ploughing and strip cropping	0.25

0 9 . 1 A salad crop field that was contour ploughed had an erosion rate of 4.67 t ha^{-1} yr^{-1}.

In an attempt to have a sustainable erosion rate, the farmer decided to change cultivation to fruit with contour ploughing and strip cropping.

Calculate the new erosion rate.

[2 marks]

Show your working

New soil erosion rate = t ha^{-1} yr^{-1}

Question 9 continues on the next page

0 9 . 2 Explain why contour ploughing reduces soil erosion.

[2 marks]

A study was carried out to find out whether sowing wheat in September would result in lower erosion rates than sowing in April. Both crops are harvested in July.

24 similar fields were chosen, 12 being planted in September and 12 being planted in April.

Table 9 shows the results of the experiment.

Table 9

Annual soil erosion rates /t Ha^{-1}	
Wheat sown in September n_1	**Wheat sown in April** n_2
3.5	3.1
3.2	3.5
3.3	4.0
3.1	4.1
3.5	3.2
3.2	3.4
3.0	3.7
2.9	4.1
2.8	3.5
3.4	4.0
3.2	3.2
3.7	3.7

A t-test was carried out to assess the level of statistical significance of the difference between the two sets of data.

Table 10 shows critical values of t

Degrees of freedom (df)	p values			
	0.10	0.05	0.01	0.001
1	6.31	12.71	63.66	636.00
2	2.92	4.30	9.92	31.60
3	2.35	3.18	5.84	12.92
4	2.13	2.78	4.60	8.61
5	2.02	2.57	4.03	6.37
6	1.94	2.45	3.71	5.96
7	1.89	2.36	3.50	5.41
8	1.86	2.31	3.36	5.04
9	1.83	2.26	3.25	4.78
10	1.81	2.23	3.17	4.59
12	1.78	2.18	3.05	4.32
14	1.76	2.15	2.98	4.14
16	1.75	2.12	2.92	4.02
18	1.73	2.10	2.88	3.92
20	1.72	2.09	2.85	3.85
22	1.72	2.08	2.82	3.79
24	1.71	2.06	2.80	3.74
26	1.71	2.06	2.78	3.71
28	1.70	2.05	2.76	3.67
30	1.70	2.04	2.75	3.65
40	1.68	2.02	2.70	3.55
60	1.67	2.00	2.66	3.46
120	1.66	1.98	2.62	3.37
∞	1.64	1.98	2.58	3.29

0 9 . 3 A t value of 3.01 was calculated.

Use **Table 10** to find the level of significance of this t value.

[1 mark]

Level of significance _____

0 9 . 4 What is the percentage probability that these data occurred by random chance?

[1 mark]

_____ %

0 9 . 5 The field is next to a river.

Outline a plan to collect water samples in the river so that the impact of soil erosion in the field on the turbidity of the river water may be assessed.

[4 marks]

0 9 . 6 Give **two** limitations of using a Secchi disk to monitor the turbidity of water.

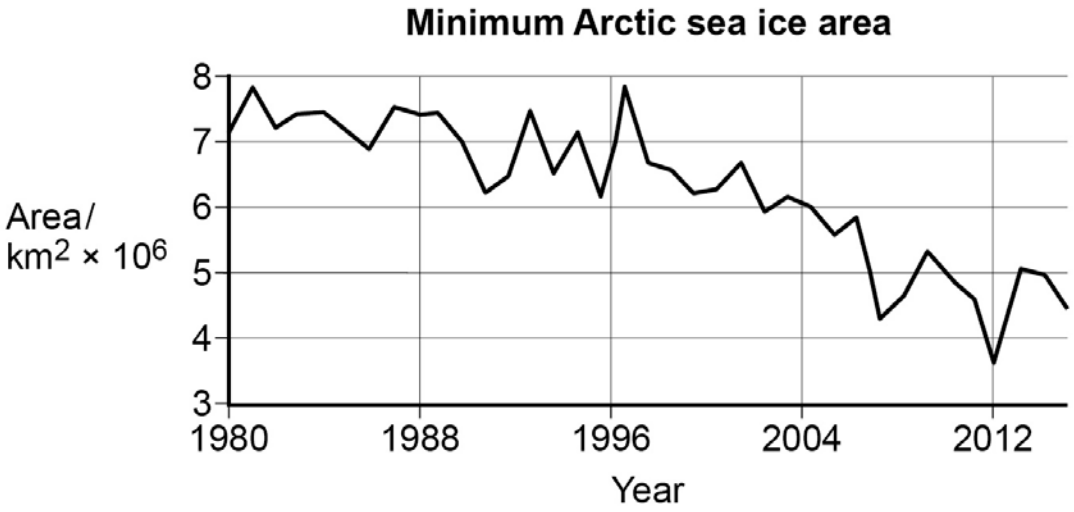
[2 marks]

0 9 . 7 Explain how an increase in the turbidity of water in tropical rivers may affect the ecological process of coral reefs.

[3 marks]

1 0 . 0 **Figure 12** shows changes in the area of Arctic ice in the sea.

Figure 12



1 0 . 1 Use information from **Figure 12** to calculate the difference in mean annual change in ice area between 1980 to 1996 and 1996 to 2012.

[2 marks]

Show your working

Difference = _____

1 0 . 2 Use details of named technologies to explain how satellite surveys are used to collect reliable data about changes in the mass of ice on the Earth's surface.

[4 marks]

1 0 . 3 Explain why it is difficult to accurately predict future changes in the amount of ice on land.

[9 marks]

Extra space

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

1 1 . 1 Discuss the extent to which the development of new technologies has reduced the environmental impacts of the use of energy resources.

[25 marks]

OR

1 1 . 2 Discuss the extent to which new technologies have reduced the environmental impacts caused by pollutants.

[25 marks]

Extra space

There are no questions printed on this page

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