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Candidate number

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Surname

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I declare this is my own work.

# A-level ENVIRONMENTAL SCIENCE

## Paper 1

Wednesday 13 May 2020

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	
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11	
<b>TOTAL</b>	



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

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**0 1**

**Table 1** shows some features of greenhouse gases.

Complete **Table 1** by adding information to the boxes that are blank.

**[5 marks]**

**Table 1**

Gas	Mean residence time / yrs	Human activity that increases atmospheric concentration of greenhouse gas	Global warming potential / relative to CO <sub>2</sub>	Method to reduce atmospheric concentration of greenhouse gas
	12	Food waste sent to landfill	25	Collection of gas from landfill sites
CFC-11	45	Use of old aerosols, foam plastics and refrigerator disposal	4660	
	114	High-temperature fossil fuel combustion in vehicle engines	265	Catalytic converters
Carbon dioxide	Variable	Combustion of fossil fuels		Carbon sequestration
	Weeks/ months	Primary pollutant released by combustion in vehicle engines undergoes photochemical reactions to produce the gas	2000	Catalytic converters

**5**



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ANSWER IN THE SPACES PROVIDED**

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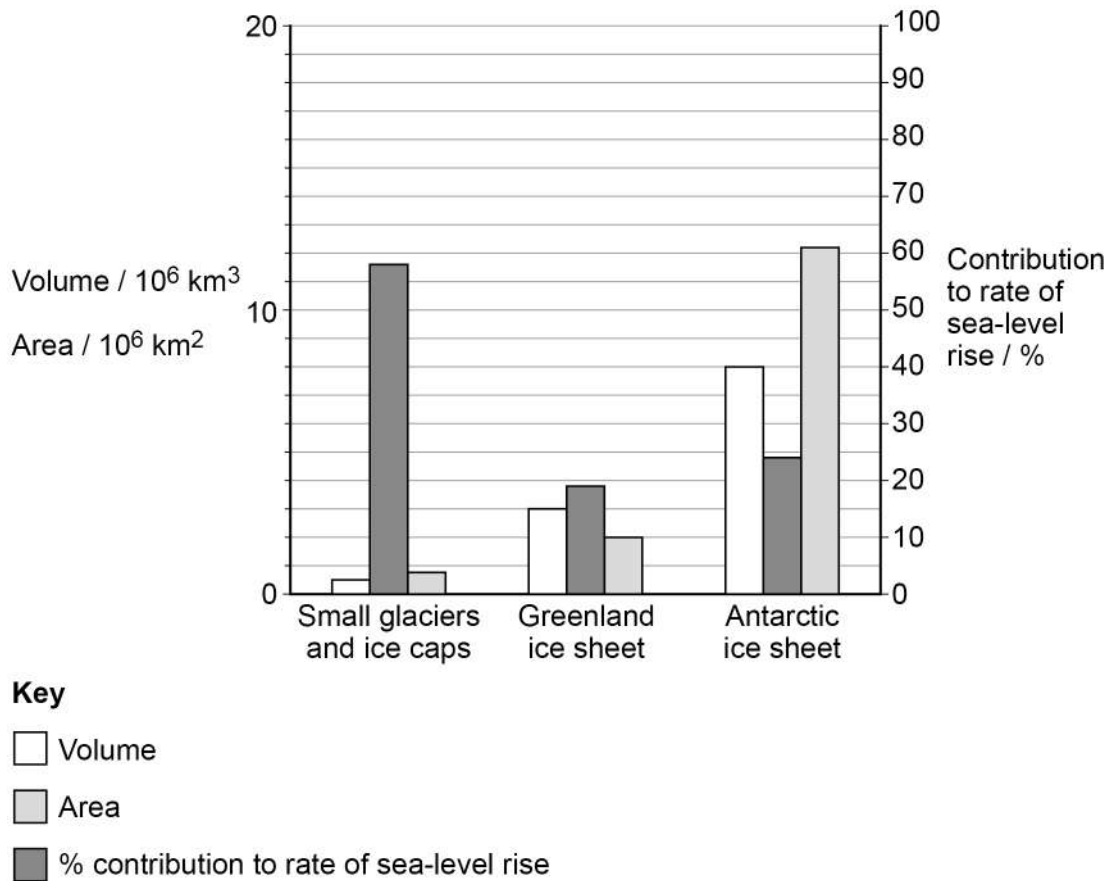


0 2

The amount of land ice is affected by increasing global temperatures. A range of methods can be used to estimate the volume of ice.

**Figure 1** shows the area and volume of land ice, and its percentage (%) contribution to sea level rise in 2012.

**Figure 1**



0 2

1

In 2012, the melting of land ice was estimated to raise sea level by  $1.8 \text{ mm yr}^{-1}$ .

Use **Figure 1** to calculate Antarctica's contribution to sea-level rise in  $\text{mm yr}^{-1}$ .

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

Show your working.

**[1 mark]**

\_\_\_\_\_  $\text{mm yr}^{-1}$



0 2 . 2

The melting of  $395 \text{ km}^3$  of land ice is estimated to raise global sea level by 1.0 mm.

Use **Figure 1** to calculate the sea-level rise in metres if all the land ice melted from the small glaciers and ice caps, Greenland ice sheet and Antarctic ice sheet.

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

Show your working.

[2 marks]

\_\_\_\_\_ m

0 2 . 3

Give **one** factor, other than the melting of land ice, that may contribute to sea-level rise.

[1 mark]

\_\_\_\_\_  
\_\_\_\_\_

0 2 . 4

State **one** remote sensing system that may be used to estimate the volume of ice in Antarctica.

[1 mark]

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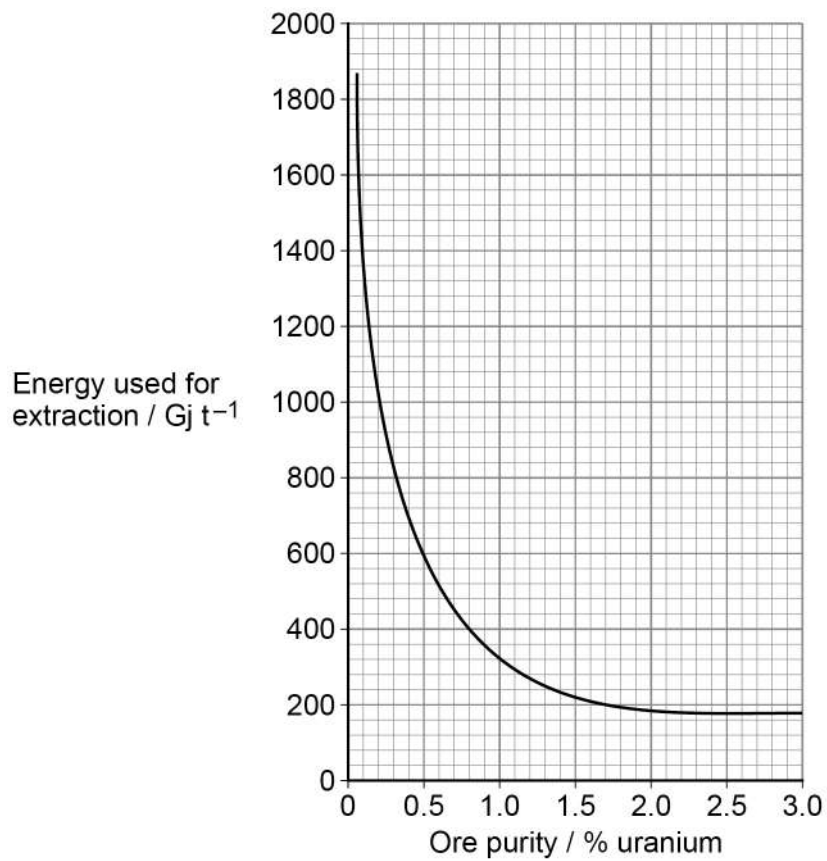


0 3

Uranium occurs in low concentration in the Earth's crust.

**Figure 2** shows the energy used to extract uranium from ores of different grades.

**Figure 2**



**Table 2** shows the energy density of the fuel used to extract uranium and the emissions of CO<sub>2</sub> caused.

**Table 2**

Energy density of fuel	42 GJ per tonne
CO <sub>2</sub> emissions when fuel is burnt	2.8 tonnes CO <sub>2</sub> / tonne fuel



0 3 . 1

Use **Figure 2** and **Table 2** to calculate the **difference** in CO<sub>2</sub> emissions if uranium is extracted from **5 tonnes** of 0.5% ore grade instead of **5 tonnes** of 2% ore grade.

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

Show your working.

[2 marks]

\_\_\_\_\_ t of CO<sub>2</sub>

0 3 . 2

Describe **one** method that may be used to locate uranium ore deposits.

[2 marks]

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0 3 . 3

State **two** methods that may be used to reduce the radiation dose received by workers exposed to radioactive materials, such as uranium.

[2 marks]

1 \_\_\_\_\_

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**[9 marks]**

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[illegible]

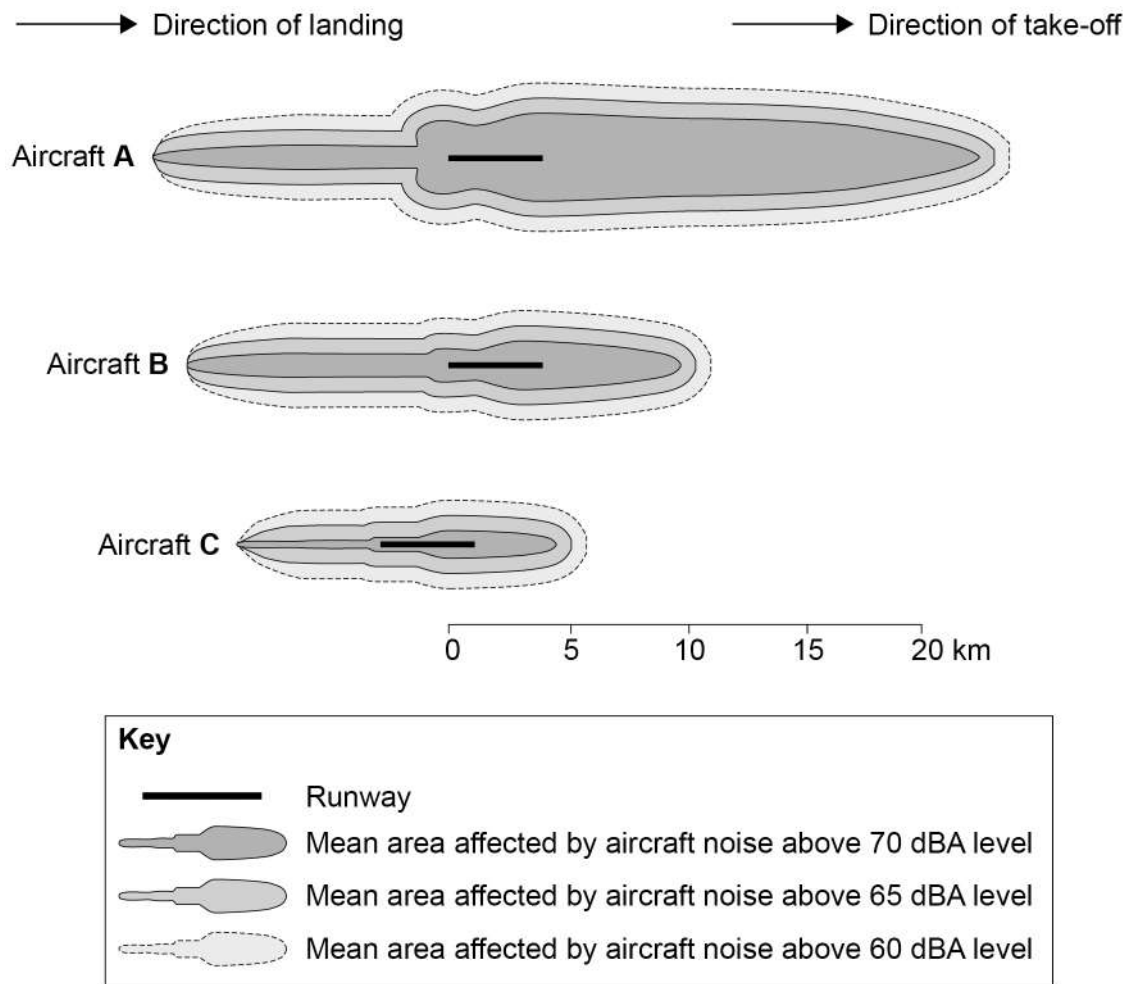
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0 4

**Figure 3** shows information about three different versions of Boeing 737 aircraft and ground-level noise contour lines around an airport. Each line surrounds an area where noise levels exceed the stated dBA levels. Noise contour lines are shown for the landing and take-off of these three different versions of Boeing 737 aircraft.

**Figure 3**



Aircraft design	Year of introduction	Area affected by aircraft noise above 70 dBA / km <sup>2</sup>	Maximum weight of aircraft on take-off / tonnes
A	1967	77.0	58
B	1988	25.9	68
C	2017	9.5	82



0 4 . 1

Use information in **Figure 3** to calculate the percentage (%) reduction in the area affected by aircraft noise above 70 dBA achieved by aircraft design **C** compared with aircraft design **A**.

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

Show your working.

[1 mark]

\_\_\_\_\_ %

0 4 . 2

Describe **one** method that may have been used to obtain noise contour data around an airport as shown in **Figure 3**.

[4 marks]

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Question 4 continues on the next page

Turn over ►



0 4 . 3

Explain how **two** named changes in aircraft design have contributed to the reduction in aircraft noise emissions.

[4 marks]

1 \_\_\_\_\_

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0 4 . 4

Outline how **one** change in aircraft flight operation may reduce noise pollution around an airport.

[1 mark]

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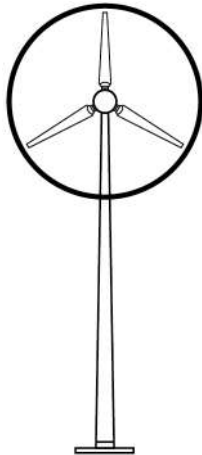
0 5

Research into new wind power technologies has led to the development of a wind lens turbine, which is a Horizontal Axis Wind Turbine (HAWT) with a ring around its blades.

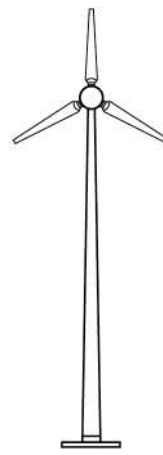
**Figure 4** shows a wind lens HAWT and a conventional HAWT.

**Figure 4**

**Wind lens HAWT**

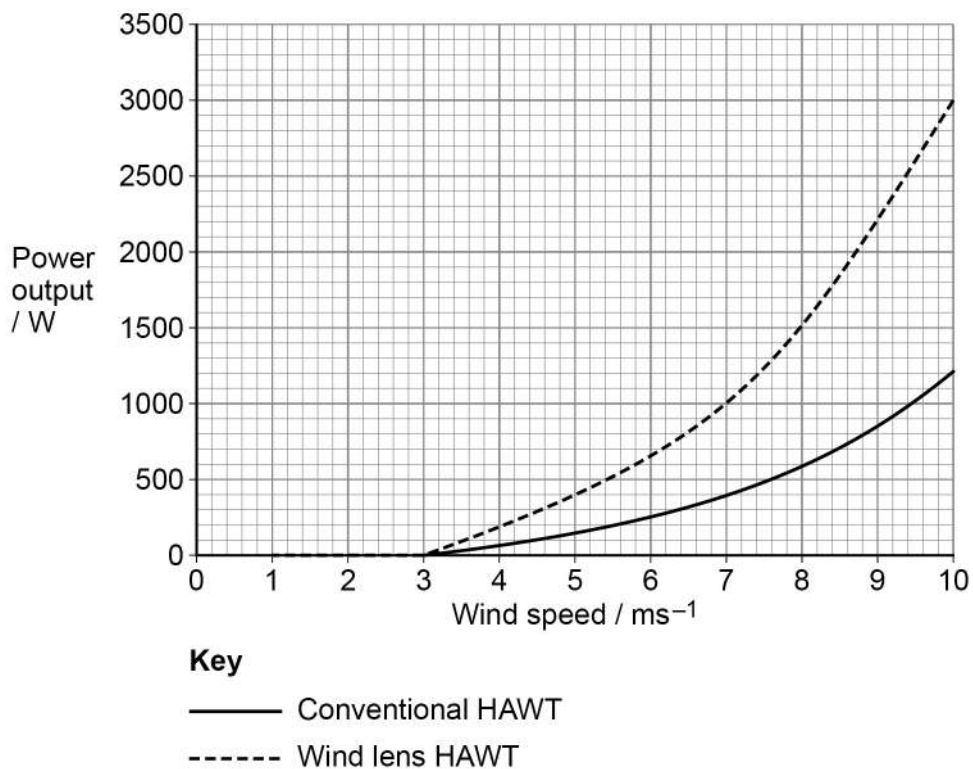


**Conventional HAWT**



**Figure 5** shows the results of an experiment carried out in a wind tunnel where the power output of a wind lens HAWT was compared to the power output of a conventional HAWT as the wind speed was increased.

**Figure 5**



**0 5 . 1**

Why do the two designs of HAWT produce no power at wind speeds lower than  $3 \text{ ms}^{-1}$ ?

**[1 mark]**

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**0 5 . 2**

Calculate the ratio of the power output of the wind lens HAWT to that of the conventional HAWT at a wind speed of  $10 \text{ ms}^{-1}$ .

Show your working.

**[1 mark]**

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**0 5 . 3**

State **three** variables that would need to be standardised in order to compare power outputs of HAWTs of different designs.

**[3 marks]**

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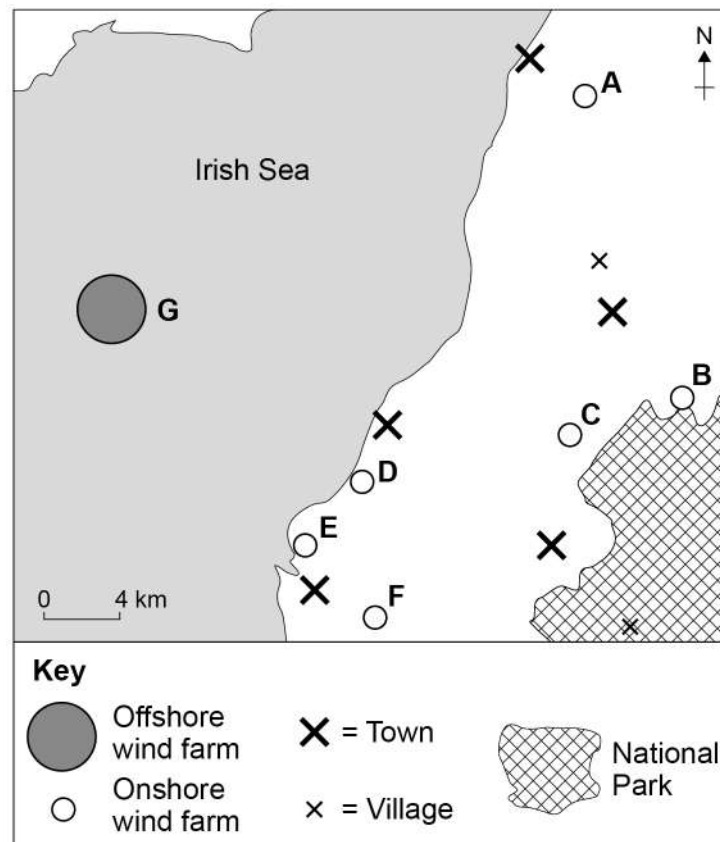
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**Question 5 continues on the next page**

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**Figure 6** and **Table 3** shows the location and data for offshore and onshore windfarms located in an area in the North-West of England.

**Figure 6**



**Table 3**

Wind farm	Height of turbine tower to nacelle (rotor) / m	Blade diameter / m	Number of turbines	Maximum output per turbine / MW	Windfarm maximum output / MW	Mean wind speed at 45 m / ms <sup>-1</sup>
A	80	82	4	2.3	9.2	7.2
B	48	60	8	1.3	10.4	6.8
C	60	80	6	2.0	12.0	6.2
D	69	92	3	2.0	6.0	7.4
E	40	42	9	0.6	5.4	7.2
F	45	47	3	0.7	2.1	7.9
G	80	90	60	3.0	180	8.5



**[5 marks]**

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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 6**

Hydrogen gas is a secondary fuel that is increasingly being used to generate electricity in fuel cells.

**0 6**

**1**

Identify the appropriate energy conversions involved when a fuel cell uses hydrogen gas.

Shade **one** box only.

**[1 mark]**

**A** Chemical energy converted to electrical energy and potential energy

☐

**B** Chemical energy converted to electrical energy and thermal energy

☐

**C** Kinetic energy converted to electrical energy and potential energy

☐

**D** Kinetic energy converted to electrical energy and thermal energy

☐

**0 6**

**2**

Explain how the use of hydrogen storage and fuel cells increases the extent to which solar power can be exploited.

**[2 marks]**

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**Question 6 continues on the next page**

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Waste energy produced by a hydrogen fuel cell may be used to heat stored water for use in a district heating system.

Students investigated the relationship between the volume of cylindrical containers, used to store hot water, and the rate of heat loss.

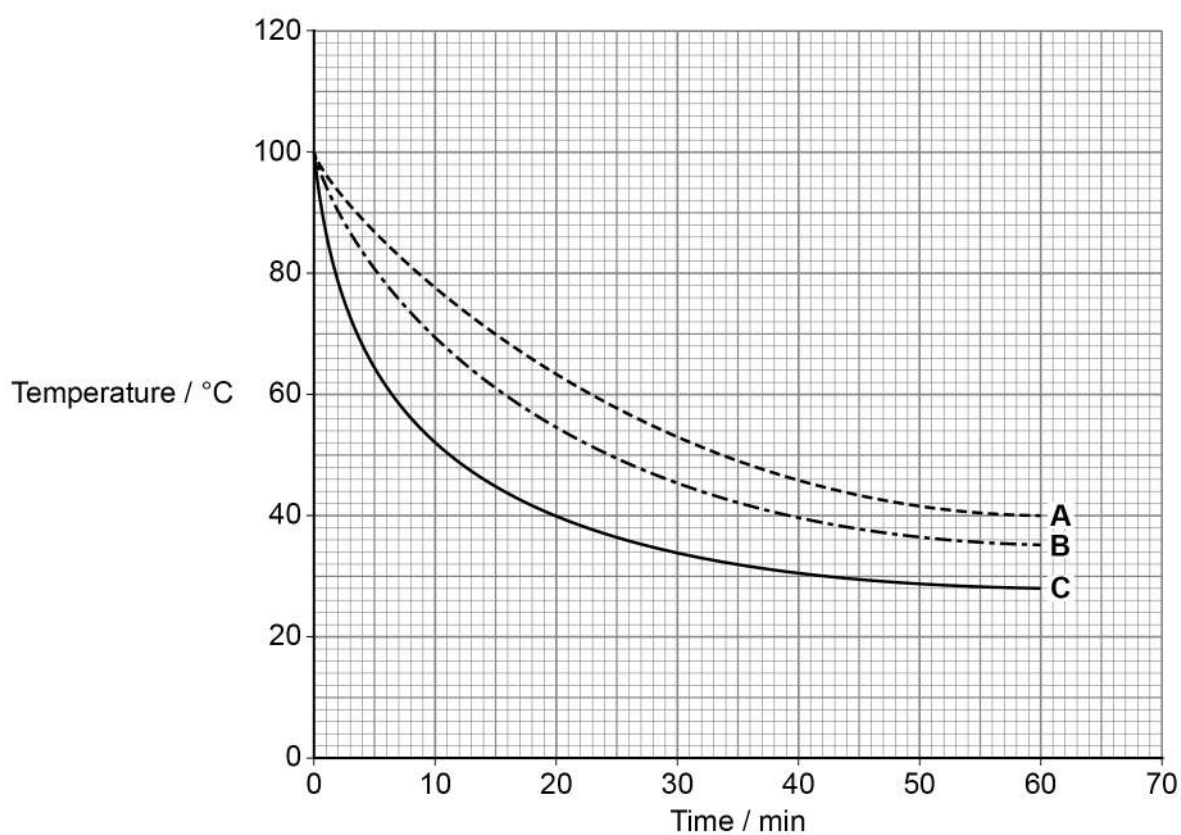
**Table 4** shows features of three cylindrical containers used in the investigation.

**Table 4**

Container	A	B	C
Volume of container / cm <sup>3</sup>	800	300	100
Surface area to volume ratio	0.59:1	0.84:1	1.2:1

**Figure 7** shows the results of the students' investigation into heat loss from the three different-sized cylindrical containers **A–C**.

**Figure 7**



0 6 . 3

Use **Figure 7** to calculate the **difference** in the rate of temperature decline for the first 10 minutes between container **A** and container **C**.

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

Show your working.

[2 marks]

\_\_\_\_\_ °C min<sup>-1</sup>

0 6 . 4

The specific heat capacity of water is 4200 J kg<sup>-1</sup> °C.

Use **Figure 7** to calculate the total energy lost in kilojoules by container **C** during the first 60 minutes.

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

Show your working.

[1 mark]

\_\_\_\_\_ kJ

0 6 . 5

State **two** environmental conditions that should be standardised for this investigation to produce valid results.

[2 marks]

1 \_\_\_\_\_

2 \_\_\_\_\_

\_\_\_\_\_

Question 6 continues on the next page

Turn over ►



0	6	.	6
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Explain the importance of the results of this study for the design of thermal energy stores.

**[2 marks]**

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0 7

A farmer analysed the soil from a field to help decide which crop to grow.

0 7 . 1

Suggest how soil samples may have been collected to ensure that the results represented the normal conditions in the field.

[3 marks]

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0 7 . 2

Describe **one** method that may be used to measure the bulk density of soil from the field.

[2 marks]

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5

Turn over for the next question

Turn over ►



**0 8**

Scientists investigated the biomass and carbon content of pine trees of different ages. Data were collected from different plantations. Trees were planted at the same time within each plantation but each plantation had been planted in a different year.

**0 8****1**

The scientists needed to sample trees to produce data that were representative of each plantation.

Describe **one** sampling method that may have been used.

**[3 marks]**


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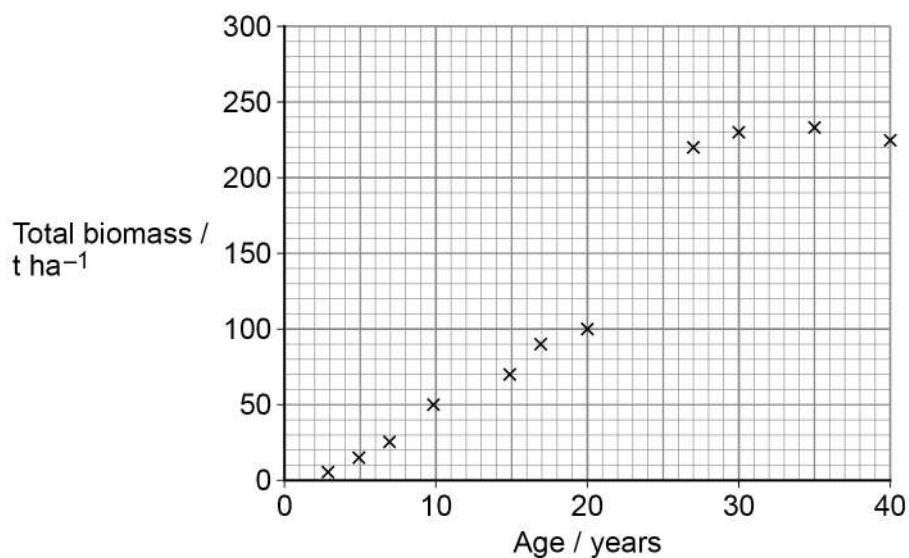


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**Figure 8** shows the biomass per unit area of pine trees in plantations of different ages.

**Figure 8**

**Table 5** shows the ratio of above-ground carbon (AGC) to below-ground carbon (BGC) stored in pine trees of different ages.

**Table 5**

Tree age (years)	Carbon content as % of total biomass	Ratio AGC:BGC
3	45	7.40:1
5	47	9.24:1
7	48	9.22:1
10	50	5.82:1
15	49	5.90:1
17	49	5.67:1
20	50	5.00:1
27	50	5.00:1
30	50	5.00:1
35	50	4.17:1
40	50	4.17:1

**0 8 . 2**

Use **Figure 8** and **Table 5** to calculate the change in AGC between trees with ages of 30 years and 40 years.

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

Show your working.

**[3 marks]**

t ha<sup>-1</sup>

**Turn over ►**



One use of pine trees is as construction timber.

0 8 . 3

Use information from **Figure 8** and **Table 5** to suggest the optimum age of harvesting to maximise the rate of carbon sequestration and explain why this is the optimum age.

**[2 marks]**

Optimum age \_\_\_\_\_

Explanation \_\_\_\_\_

\_\_\_\_\_

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0 8 . 4

Explain how the way timber is used may affect the long-term storage of carbon.

**[2 marks]**

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**0 9**

The Expert Committee on Pesticide Residues in Food (PRiF) tests food in the UK for pesticide residues.

Food items are tested to make sure that they do not exceed the Maximum Residue Level (MRL).

**Table 6** shows five pesticide residues that exceeded the MRL in food samples.

**Table 6**

Food sample	Pesticide	Residue level detected / $\text{mg kg}^{-1}$	MRL / $\text{mg kg}^{-1}$
<b>A</b>	Amitraz	0.12	0.05
<b>B</b>	Diafenthuron	0.04	0.01
<b>C</b>	Dimethoate	1.4	0.02
<b>D</b>	Dithiocarbamates	1.46	0.8
<b>E</b>	Lufenuron	0.05	0.02

A measurement uncertainty is applied to any sample that contains a residue over the MRL.

The sale of the food is prohibited if the residue level is greater than double the MRL.

**0 9 . 1**

Use the information in **Table 6** to identify the food sample that could be sold legally.

Shade **one** box only.

**[1 mark]**

**A** Amitraz

☐

**B** Diafenthuron

☐

**C** Dimethoate

☐

**D** Dithiocarbamates

☐

**E** Lufenuron

☐


Food items are collected and analysed for pesticide residues throughout the year.

0 9 . 2

Suggest **three** other factors that may be considered when selecting food items for testing to ensure that the pesticide residue levels are representative.

[3 marks]

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

0 9 . 3

The food samples collected were individually wrapped before being sent for analysis of pesticide levels.

Why is this **less** important for samples containing systemic pesticides than contact pesticides?

[1 mark]

\_\_\_\_\_

\_\_\_\_\_

0 9 . 4

Suggest why pesticide residue levels in samples of a single type of food may show high variability.

[4 marks]

\_\_\_\_\_

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0	9	.	5
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One common group of pesticides are pyrethroid insecticides.

Describe **three** advantages of using pyrethroids.

[3 marks]

1 \_\_\_\_\_

2 \_\_\_\_\_

3 \_\_\_\_\_

0	9	.	6
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Pesticides may affect living organisms both directly and indirectly.

Describe **three** indirect effects of pesticides on living organisms.

[3 marks]

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1 0

The Dead Sea is a land-locked lake that has a high concentration of salts and other dissolved minerals. There is great concern over the increasing rate at which the Dead Sea is shrinking.

**Table 7** shows the main inputs and outputs of water to and from the Dead Sea.

**Table 7**

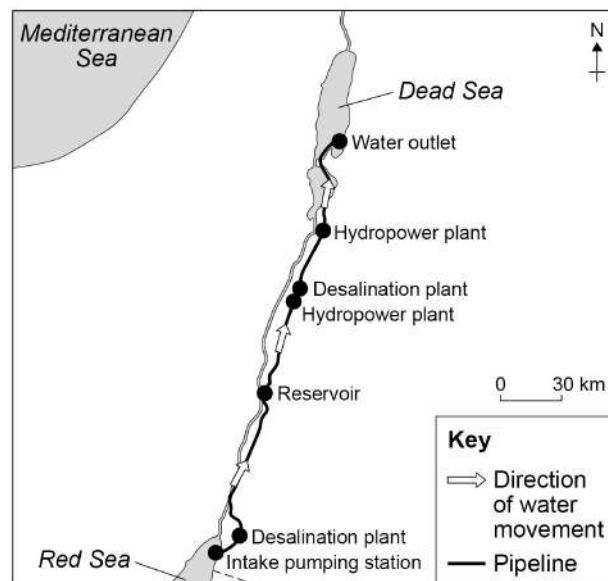
Table 7 cannot be reproduced here due to third-party copyright restrictions.

It is estimated that the water level in the Dead Sea will decrease by  $1.0 \text{ m yr}^{-1}$  under present conditions.

A project to help restore the water level in the Dead Sea involves transferring water along a pipeline from the Red Sea to the Dead Sea. The water will first pass through two desalination plants to provide fresh water supplies to the surrounding regions. The residual saline water will enter the Dead Sea, adding an estimated  $100 \times 10^6 \text{ m}^3$  of saltwater per year.

**Figure 9** shows a map of the proposed pipeline from the Red Sea to the Dead Sea.

**Figure 9**



1 0 . 1

Use information in **Table 7** and the text to estimate the change in water level of the Dead Sea after 10 years following the completion of the pipeline.

Give your answer to an appropriate number of significant figures.

Show your working.

[2 marks]

Change in water level after 10 years \_\_\_\_\_ m

1 0 . 2

Suggest **one** reason why long-term estimates of water-level change may not be accurate.

[1 mark]

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1 0 . 3

The project shown in **Figure 9** includes two new desalination plants.

Describe **one** method to remove salt from water.

[2 marks]

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**Question 10 continues on the next page**

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The effects of mixing water from the Red Sea and the Dead Sea were investigated. One noticeable change was in the colour of the water caused by algal growth leading to increased turbidity.

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Describe **one** technique that may be used for monitoring changes in water turbidity.

**[5 marks]**

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**[25 marks]**

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Question 

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## WRONG METHODS

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