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AQA

A-level
ENVIRONMENTAL SCIENCE

Paper 1

7447/1

Monday 22 May 2023   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]

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.**

- **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.**

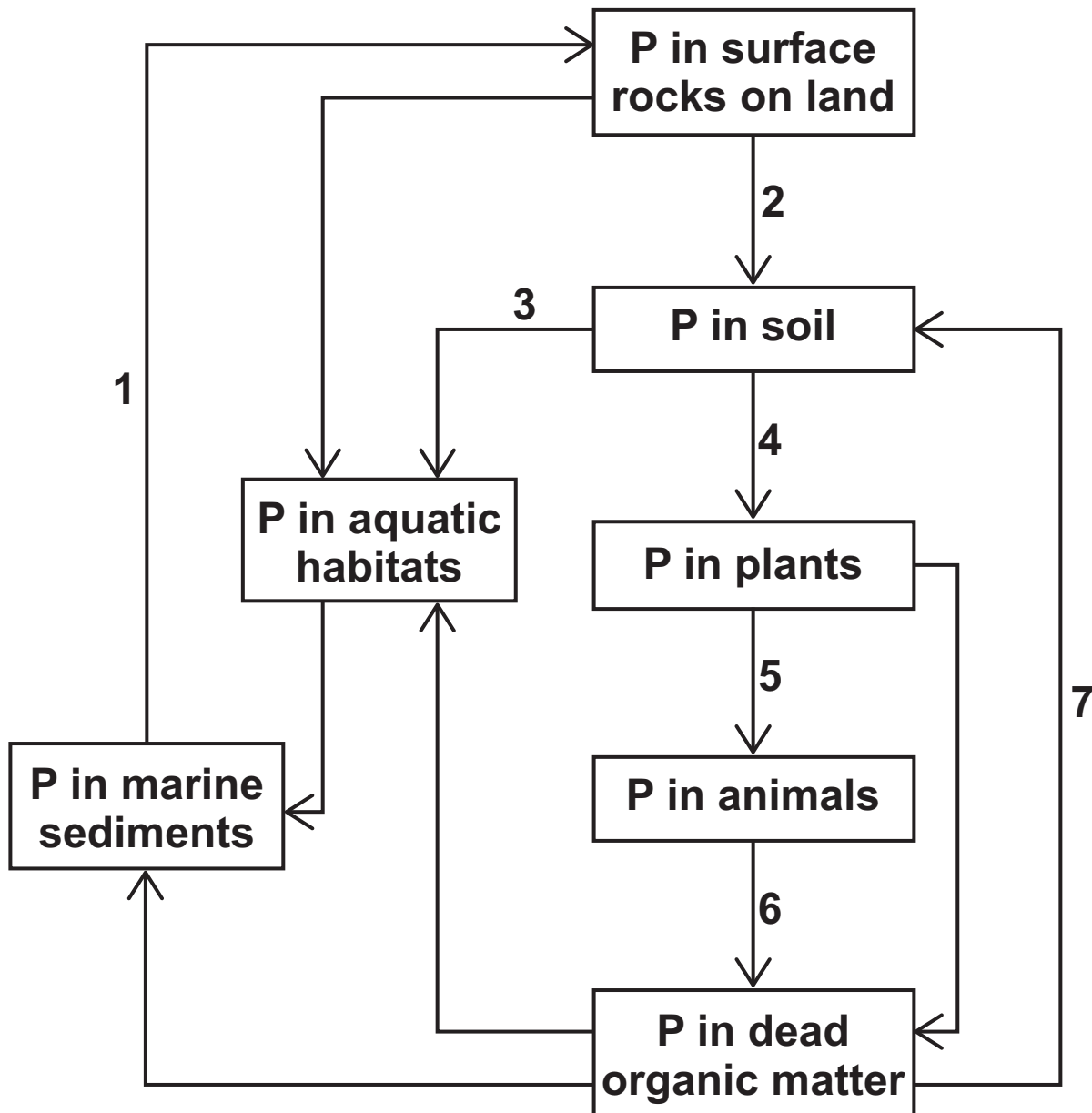**DO NOT TURN OVER UNTIL TOLD TO DO SO**

Answer ALL questions in the spaces provided.

0	1

FIGURE 1 shows part of the phosphorus (P) cycle.

FIGURE 1

KEY

☐ **Store / reservoir of P**

⟶ **Process**

0 1 . 1

Use FIGURE 1, on the opposite page, to complete TABLE 1 by writing in the appropriate number or name of process.

The first row has been completed for you. [4 marks]

TABLE 1

NAME OF PROCESS	NUMBER
Weathering	2
	4
	7
Runoff	
Mountain building	

0 1 . 2

Suggest how the amount of phosphorus compounds in the soil may be increased sustainably by human activity. [1 mark]

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[Turn over]

0 5

0	2

Locating mineral deposits involves a range of exploratory techniques.

0	2	.	1

Complete TABLE 2 by adding the name of the survey technique or description of how it works.
[3 marks]

TABLE 2

NAME OF SURVEY TECHNIQUE	DESCRIPTION OF HOW IT WORKS
	The use of reflected sound waves to produce data about the density and shape of rock strata at great depth
Resistivity	
	Technique used to measure or map variations in density of crustal rocks

| 0 | 2 | . | 2 |

Some remote sensing techniques use drones to carry sensors that obtain survey data on a mineral deposit.

Trial drilling involves a ground-based survey to obtain these data.

Suggest ONE advantage of drones and ONE advantage of trial drilling to obtain data on a mineral deposit.
[2 marks]

Drones _____

_____

_____

Trial drilling _____

_____

_____

[Turn over]

0 2 . 3

Mineral ore extractions at an operational mine can have local environmental impacts.

Explain how FIVE environmental impacts may be reduced. [5 marks]

Impact 1 _____

_____

How it may be reduced _____

_____

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Impact 2 _____

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How it may be reduced _____

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Impact 3 _____

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How it may be reduced _____

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Impact 4 _____

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How it may be reduced _____

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Impact 5 _____

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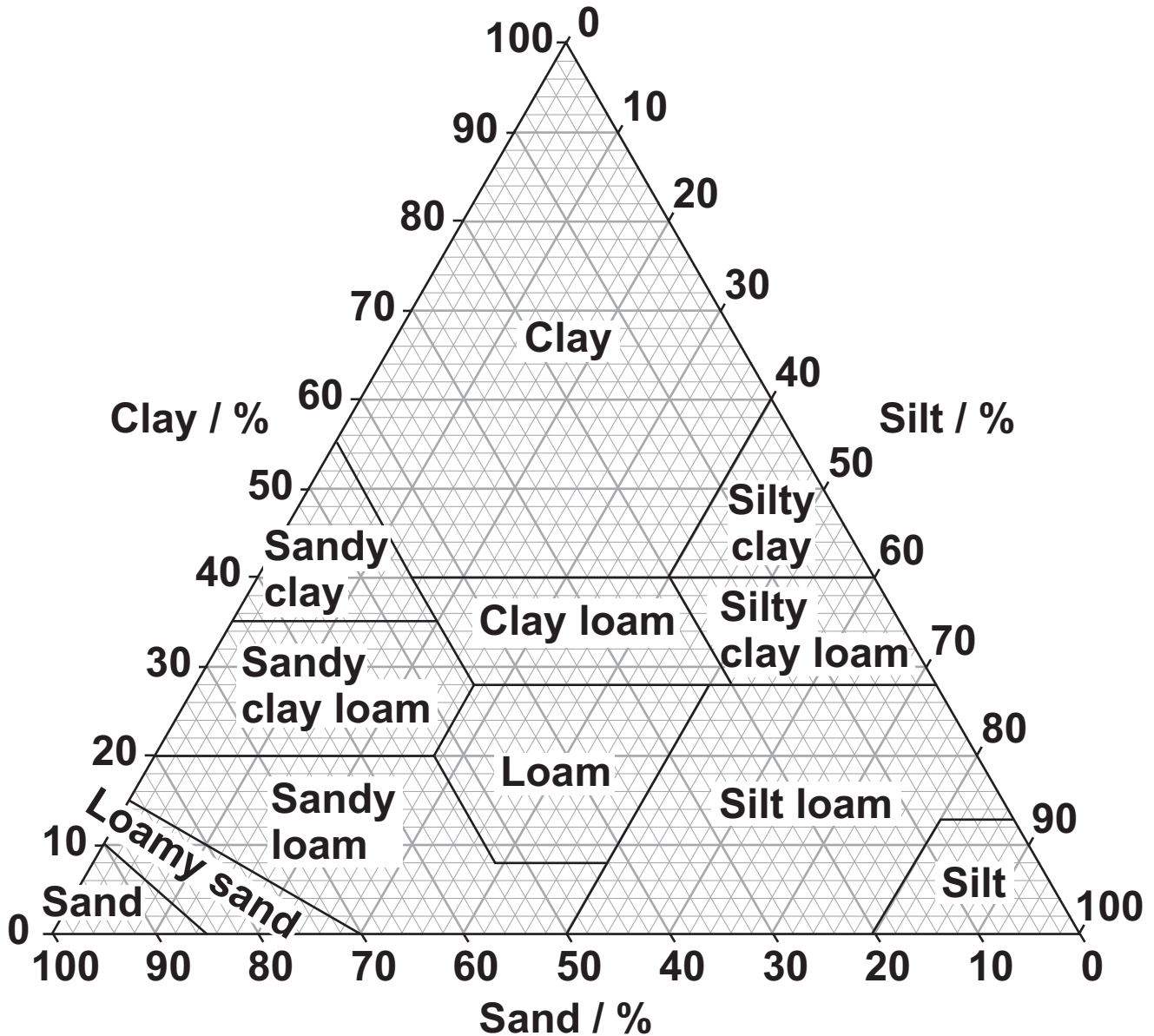**How it may be reduced** _____

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_____ **10**

[Turn over]

0	3

FIGURE 2 shows a soil triangle used to identify the textural class of a soil sample.

FIGURE 2

TABLE 3 shows the textural composition of four soil samples A, B, C, and D.

TABLE 3

SOIL SAMPLE	SAND / %	SILT / %	CLAY / %
A	50	10	40
B	60	35	5
C	35	40	25
D	10	35	55

| 0 | 3 | . | 1 |

Use FIGURE 2, on the opposite page, to identify the textural class of soil sample A in TABLE 3. [1 mark]

_____

_____

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[Turn over]

| 0 | 3 | . | 2 |

Explain why soil sample B in TABLE 3, on page 11, is likely to have the highest permeability. [2 marks]

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| 0 | 3 | . | 3 |

Explain how soil texture affects nutrient levels in soil. [4 marks]

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Soil sieving using different mesh sizes is used to determine soil texture.

TABLE 4 shows the results of sieving 450 g of dry soil.

TABLE 4

FRACTION	MESH SIZE DIAMETER / mm	MASS OF SOIL FRACTION / g
Sand	1.0	1.5
	0.2	7.5
	0.1	76.5
	0.04	58.5
Silt	0.02	76.5
	0.01	49.5
	0.005	32.0
	0.002	5.0
Clay	Base pan	130.0

0	3	.	4

Use information in the text and TABLE 4, on the opposite page, to calculate the percentage (%) soil loss in this soil sieving.

Give your answer to ONE decimal place.

Show your working. [2 marks]

% soil loss _____

0 3 . **5**

Suggest ONE limitation of the soil sieving technique that may have contributed to the percentage (%) soil loss.
[1 mark]

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0	4

Erosion by water is a major cause of soil loss.

Field experiments investigated the relationship between slope gradient, land use and soil loss in a hilly region of southern China.
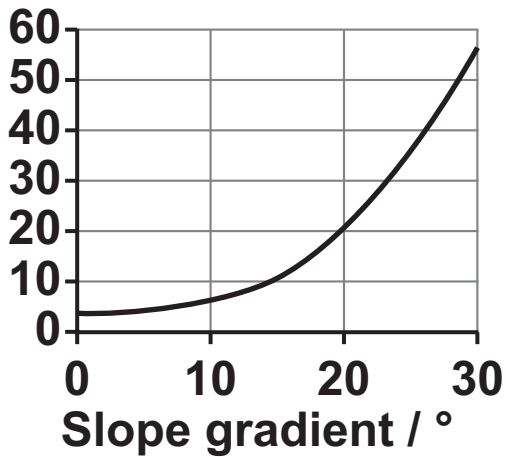
Data were collected monthly from each land use area at different slope gradients over the period of one year.

FIGURE 3, on the opposite page, shows the annual mass of sediment collected (soil loss) as the slope gradient increases at different land use sites.
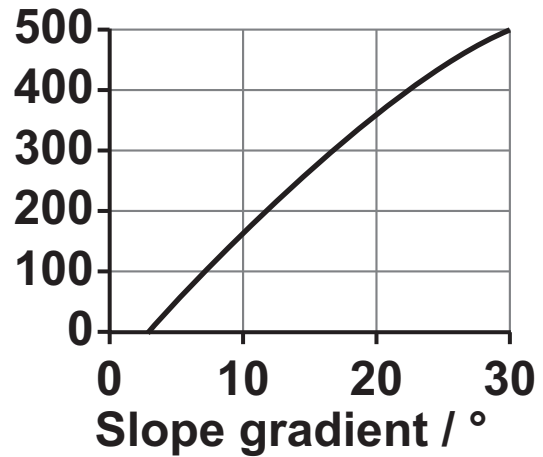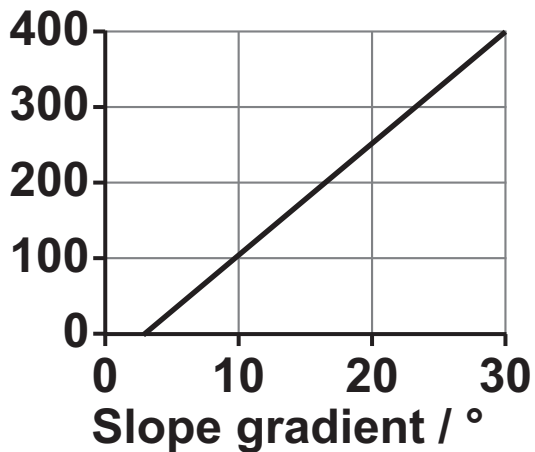
FIGURE 3

FOREST LAND

Mass of sediment collected / t ha^{-1} yr^{-1}

FARMLAND

Mass of sediment collected / t ha^{-1} yr^{-1}

BARE SOIL

Mass of sediment collected / t ha^{-1} yr^{-1}

[Turn over]

| 0 | 4 | . | 1 |

Describe and explain TWO trends shown by the data in FIGURE 3, on page 19. [4 marks]

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[Turn over]

0 4 . 2

Variables that could affect the validity of the results in the field experiments were investigated.

The results from preliminary studies helped decide the location of the test plots in the three different land use areas.

Name TWO variables that would need to be investigated in the preliminary studies.

Explain why each variable should be investigated.
[4 marks]

Variable 1 _____

_____

Explanation _____

_____

_____

_____

Variable 2 _____

_____

Explanation _____

_____

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| 0 | 4 | . | 3 |

Outline TWO potential environmental impacts of eroded soil entering a nearby river. [2 marks]

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0	5

In 2019, Pakistan's demand for electricity was greater than the electricity it generated. This caused electricity shortages, especially in rural areas.

TABLE 5 shows electricity generation by energy source in Pakistan in 2019 and projected electricity demand in 2050.

TABLE 5

	ENERGY SOURCE			
	Nuclear power	Fossil fuels	Renewables – wind, biofuels, solar PV	HEP
Electricity generated in 2019 / MW	1005	16 305	684	7172
Projected electricity demand in 2050 / MW	49 078			

0	5	.	1

An expansion in HEP alone could generate an extra 60 000 MW of electricity.

This expansion in HEP would be from new sites across Pakistan.

Use TABLE 5, on the opposite page, to calculate the percentage (%) of the 60 000 MW of electricity that would be needed from new HEP sites across Pakistan to meet the projected demand in 2050. The electricity generated by other energy sources remains the same.

Give your answer to ONE decimal place.

Show your working. [4 marks]

_____%

0 5 . 2

Low head turbines are suitable for installation at many of these new, rural sites in Pakistan.

Suggest why low head turbines are more suitable for use in rural areas than high head HEP schemes. [5 marks]

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| 0 | 5 | . | 3 |

Suggest ONE reason why low head turbine schemes may NOT be installed at suitable sites in rural areas. [1 mark]

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[Turn over]

The amount of electricity generated from low head helical turbines depends on a number of factors.

These factors include the head height, flow rate of the water and the efficiency of the turbine.

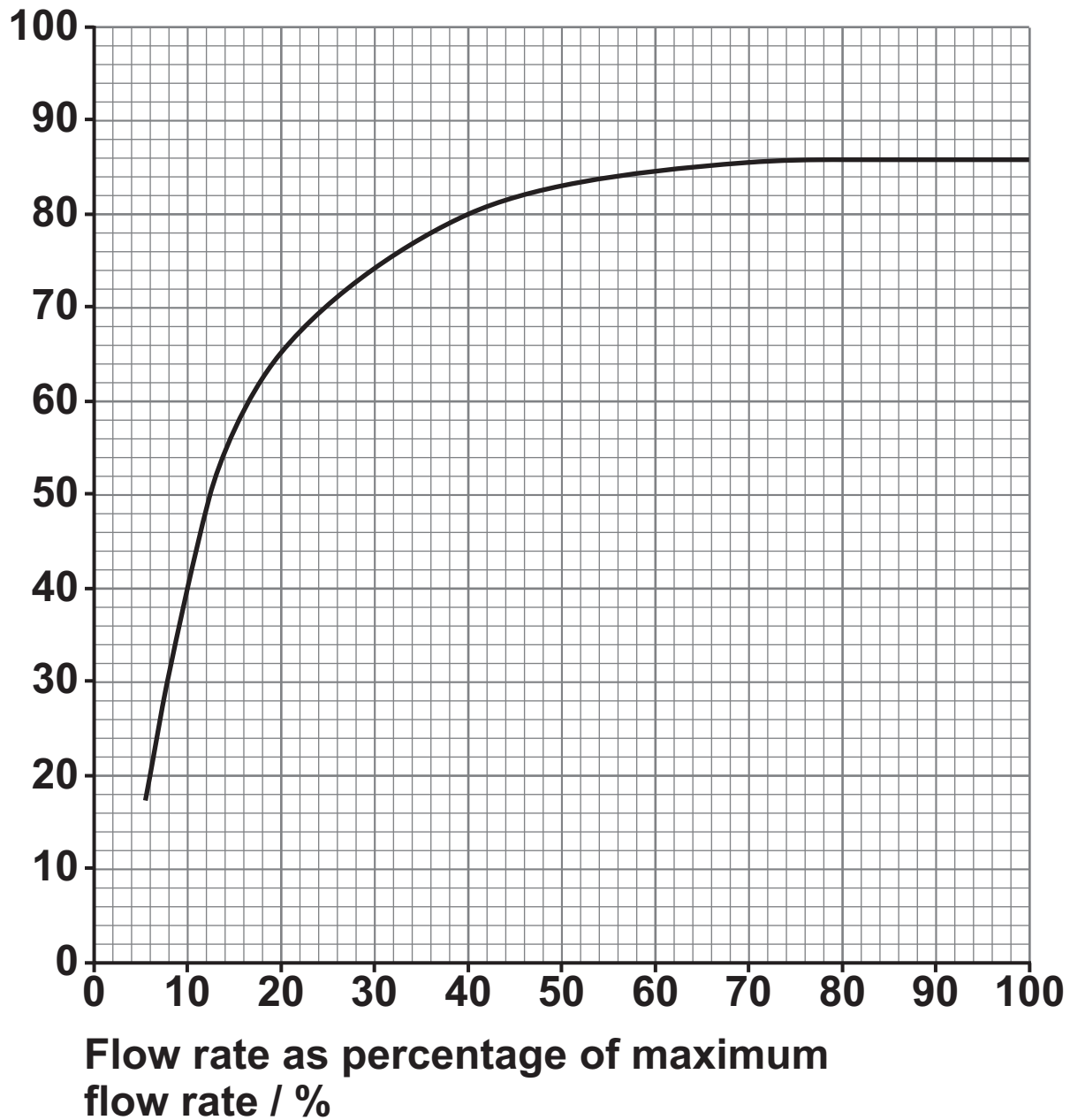FIGURE 4, on the opposite page, shows how the efficiency of a helical low head turbine varies as the flow rate of the water increases.

The flow rate is shown as a percentage (%) of the maximum flow rate recorded at the site.

FIGURE 4

Efficiency of turbine / %

Flow rate as percentage of maximum flow rate / %

[Turn over]

0 5 . 4

The maximum flow rate recorded was 6.5 m³ s⁻¹.
This generated a maximum output of 100 kW.

Use information in FIGURE 4, on page 29, and the text to calculate the output in kW generated if the flow rate of water was 0.67 m³ s⁻¹.

Give your answer to ONE decimal place.

Show your working. [3 marks]

_____ kW

0	5	.	5

Most of the electricity generated from HEP in Pakistan comes from high head HEP systems.

This involves creating a reservoir behind a dam wall.

Outline TWO ways a reservoir may impact the local environment. [2 marks]

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[Turn over]

| 0 | 6 |

FIGURE 5 shows the demand for electricity over a 24-hour period in the UK in March 2021 and the different energy resources used to meet demand.

| 0 | 6 | . | 1 |

Use FIGURE 5, on the opposite page, to suggest ONE advantage and ONE disadvantage of using nuclear power to meet electricity demand over a 24-hour period. [2 marks]
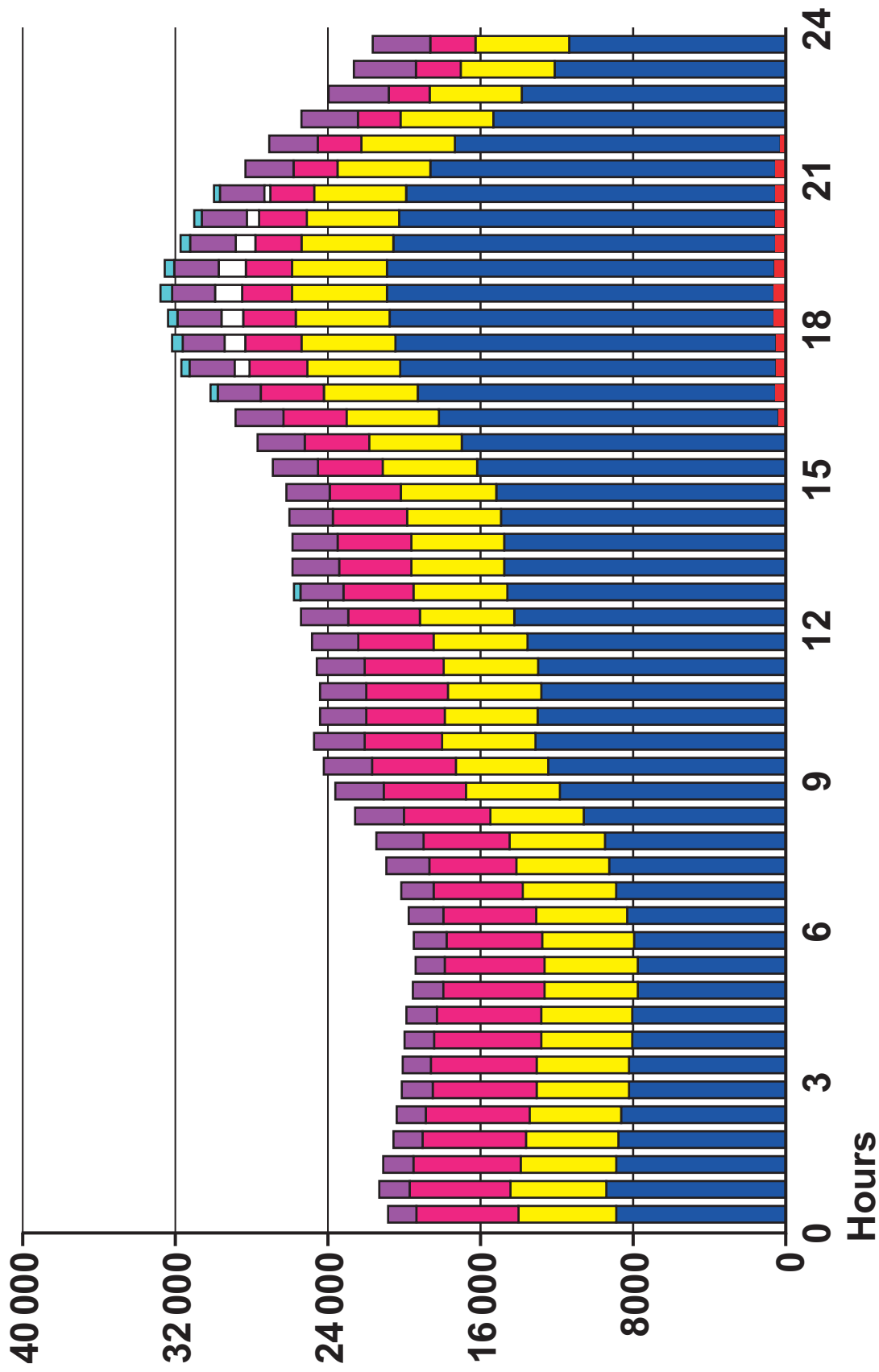
Advantage _____

_____

Disadvantage _____

_____

FIGURE 5

KEY

☐ Other   ☐ Biomass   ☐ Pumped storage HEP   ☐ Coal
☐ Wind   ☐ Nuclear   ☐ Combined-cycle gas turbines

Electricity demand / MW

Hours

33

[Turn over]

0 6 . 2

Explain how pumped storage HEP can be used to meet the demand for electricity during a 24-hour period.
[3 marks]

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[Turn over]

TABLE 6 shows information about the hydrological cycle.

TABLE 6

Reservoir		Volume of water in reservoir / 10^{15} dm^3	Transfer process	Volume of water transferred into reservoir by process / 10^{15} dm^3 yr^{-1}	Volume of water transferred out of reservoir by process / 10^{15} dm^3 yr^{-1}
	over land	4.5	precipitation	////	107
			evaporation and transpiration	71	////
Atmosphere	over oceans	11	precipitation	////	398
			evaporation	434	////

Oceans		**1 400 000**	precipitation	**398**
			evaporation	**434**
			groundwater flow	
			river runoff	**19**
Land	surface	**43 762**	precipitation	**107**
			evaporation and transpiration	**71**
			river runoff	
	under ground	**15 300**	groundwater flow	**19**

| 0 | 7 | . | 1 |

Use TABLE 6, on pages 36 and 37, to calculate the annual volume of water transferred between reservoirs by groundwater flow. [1 mark]

_____ $\times$ **10^{15} dm^3 yr^{-1}**

| 0 | 7 | . | 2 |

The residence time (RT) of water in a reservoir can be calculated using the formula:

$$RT = \frac{\text{volume in reservoir}}{\text{annual rate of inflow or outflow}}$$

Use TABLE 6, on pages 36 and 37, and the formula to calculate the residence time of water in the atmosphere.

Give your answer to the nearest whole day.

Show your working. [3 marks]

_____ **days**

[Turn over]

0 7 . 3

Suggest ONE reason why afforestation may decrease groundwater. [1 mark]

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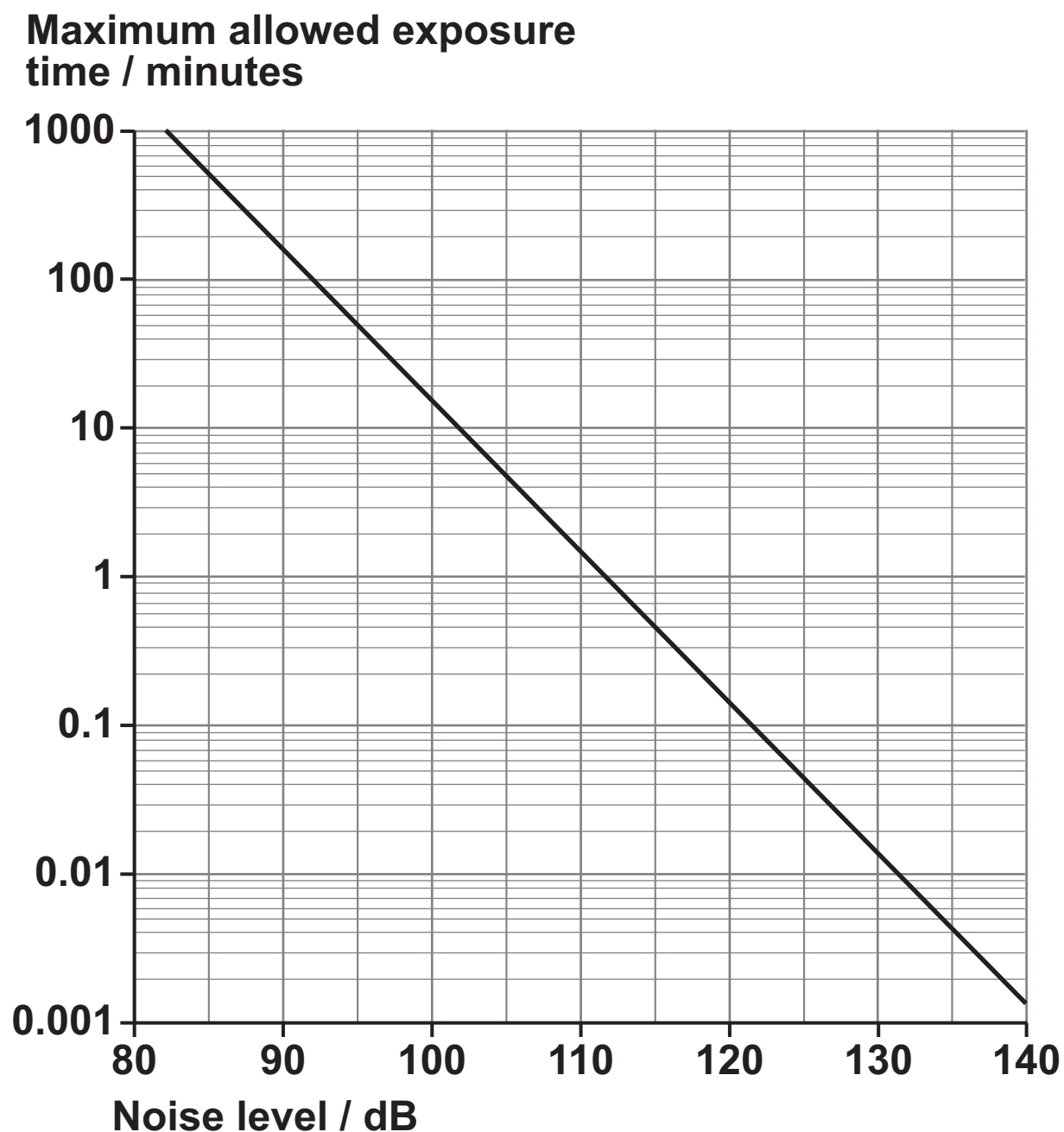
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| 0 | 8 |

Noise pollution may have negative impacts on human health.

FIGURE 6 shows the relationship between maximum allowed exposure time without hearing protection and noise level in an industrial setting.

FIGURE 6

Maximum allowed exposure time / minutes

Noise level / dB

| 0 | 8 | . | 1 |

Use FIGURE 6, on the opposite page, to calculate the maximum allowed exposure time for workers exposed to a noise level of 85 dB.

Give your answer in HOURS and MINUTES.

Show your working. [2 marks]

_____ hours _____ minutes

[Turn over]

| 0 | 8 | . | 2 |

State TWO health impacts on humans, other than hearing loss, that can be caused by continued exposure to noise. [2 marks]
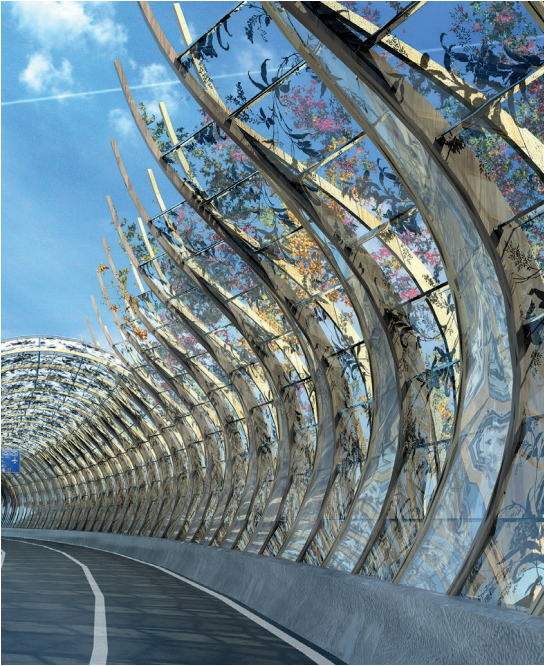
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Motor-racing venues have strict noise limits.

Noise from the track may be a source of pollution to local residents, some of whom may live within 500 m of the venue.

FIGURE 7, on the opposite page, shows two examples of different types of acoustic barrier that may be used to reduce noise pollution to local residents.

FIGURE 7

[Turn over]

0 8 . 3

Describe how to carry out an investigation to measure the effectiveness of different types of acoustic barrier in reducing noise levels from a race track to local residents.
[5 marks]

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0 8 . 4

Outline ONE way in which residential properties could be designed to reduce noise pollution. [1 mark]

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[Turn over]

0	9

In July 2020, the oil tanker MV Wakashio ran aground on a coral reef, south of Mauritius in the Indian Ocean, and began leaking oil.

After one day, the oil had spread over an area of 3.3 km^2, covering the sea surface with a layer 0.38 mm thick.

0	9	.	1

Assuming the density of oil is 950 kg m^{-3}, calculate the mass of oil spilled after one day.

Give your answer in TONNES (t) to TWO significant figures.

Show your working. [3 marks]

_____ t

0	9	.	2

Data obtained from satellites recorded how the oil spill had increased in area to 27 km^2 after six days.

Suggest TWO advantages of using satellite data compared with data obtained from aircraft surveys.
[2 marks]

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[Turn over]

| 0 | 9 | . | 3 |

This oil spill is considered to be the worst environmental disaster in Mauritius because of its effect on local coral reefs.

Describe TWO ways in which an oil spill could affect the survival of the corals. [2 marks]
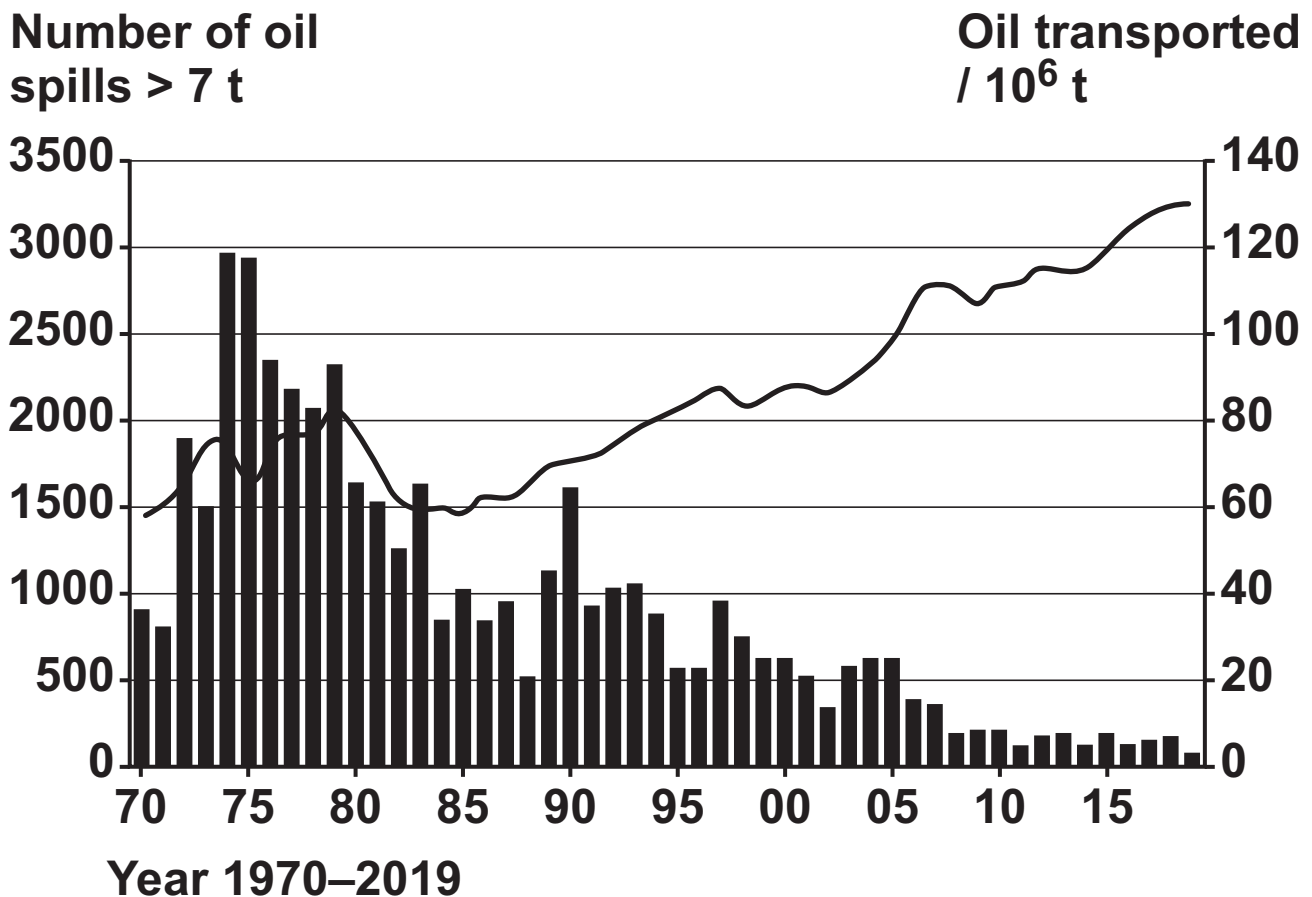
1 _____

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2 _____

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FIGURE 8 shows the decline in number of tanker spills vs growth in crude and other tanker trade loaded 1970–2019 (UNCTAD information not yet available for 2020).

FIGURE 8

Number of oil spills > 7 t

Oil transported / 10^6 t

Year 1970–2019

KEY

▌ **Number of oil spills > 7 t**

— **Oil transported**

[Turn over]

| 0 | 9 | . | 4 |

Suggest THREE reasons for the decline in number of tanker spills despite the growth in oil transported.
[3 marks]

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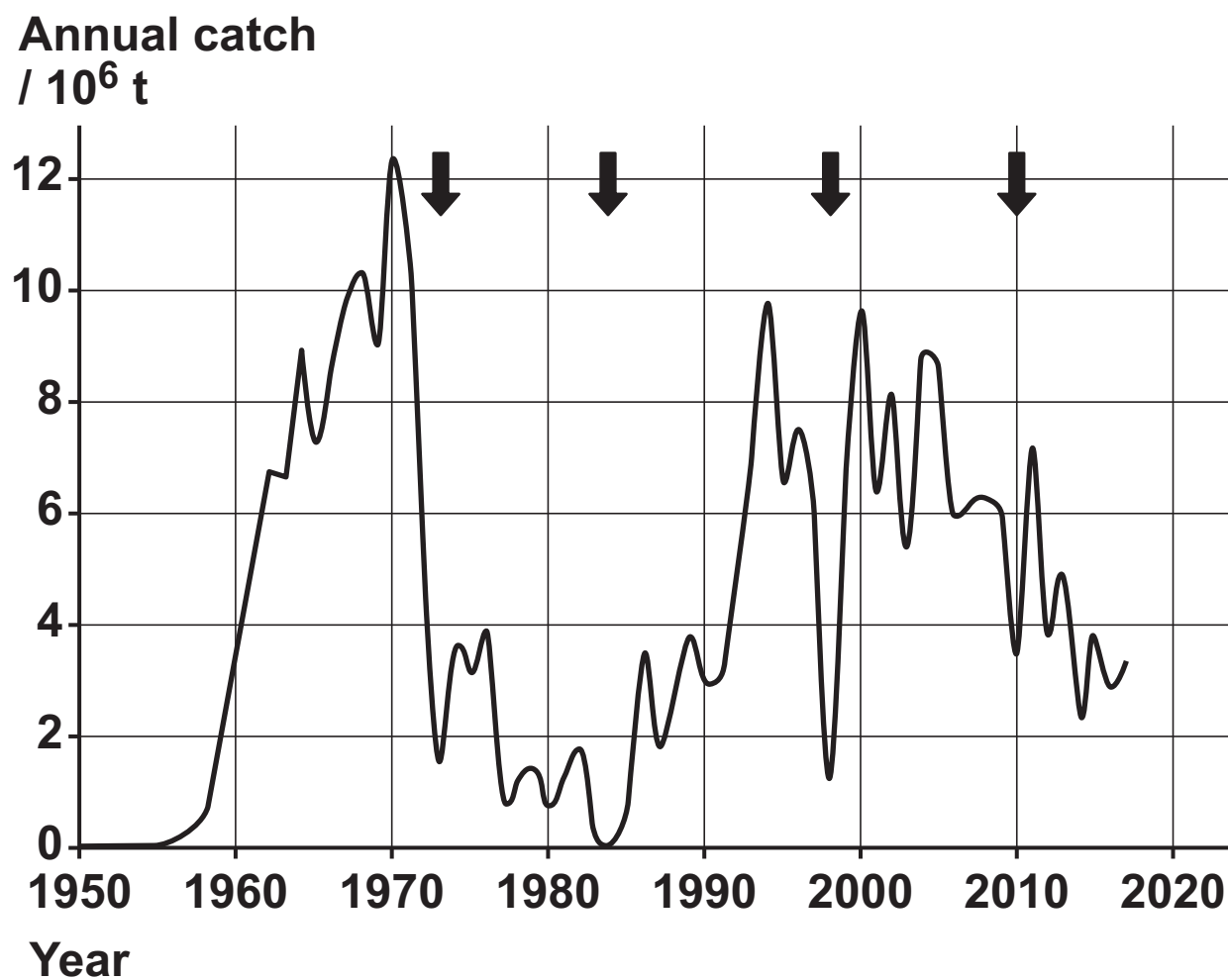
[Turn over]

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There is evidence that global climate change is affecting ocean currents.

Since 1950, there has been a greater frequency of major El Niño events in the Pacific Ocean.

FIGURE 9 shows the annual catch of Peruvian anchovies, 'Peruvian anchoveta', in the Pacific Ocean, 1950–2018.

FIGURE 9

KEY
⬇ Major El Niño events

10 0 . 1

Explain how the changes to ocean currents caused by El Niño affect anchovy catches off the coast of Peru.
[4 marks]

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[Turn over]

1 0 . 2

Suggest TWO ways, other than the impact on the anchovy catch, that El Niño events may affect Peru. [2 marks]

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1 0 . 3

Evaluate the success of the methods and strategies to reduce global climate change. [9 marks]

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15

Write an essay on ONE of the following topics.

1 1 . 1

Discuss how knowledge of the properties of pollutants can be used to reduce the severity of their impact on the environment. [25 marks]

OR

1 1 . 2

Discuss how knowledge of the properties of energy resources can be used to reduce the severity of their impact on the environment. [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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END OF QUESTIONS

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

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

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70

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