



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 22 May 2023 Morning

Time allowed: 3 hours

At the top of the page, write your surname and forenames, your centre number, your candidate number and add your signature.

[Turn over]



J U N 2 3 7 4 4 7 1 0 1

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 additional 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.

01

FIGURE 1, on the opposite page, shows part of the phosphorus (P) cycle.

01.1

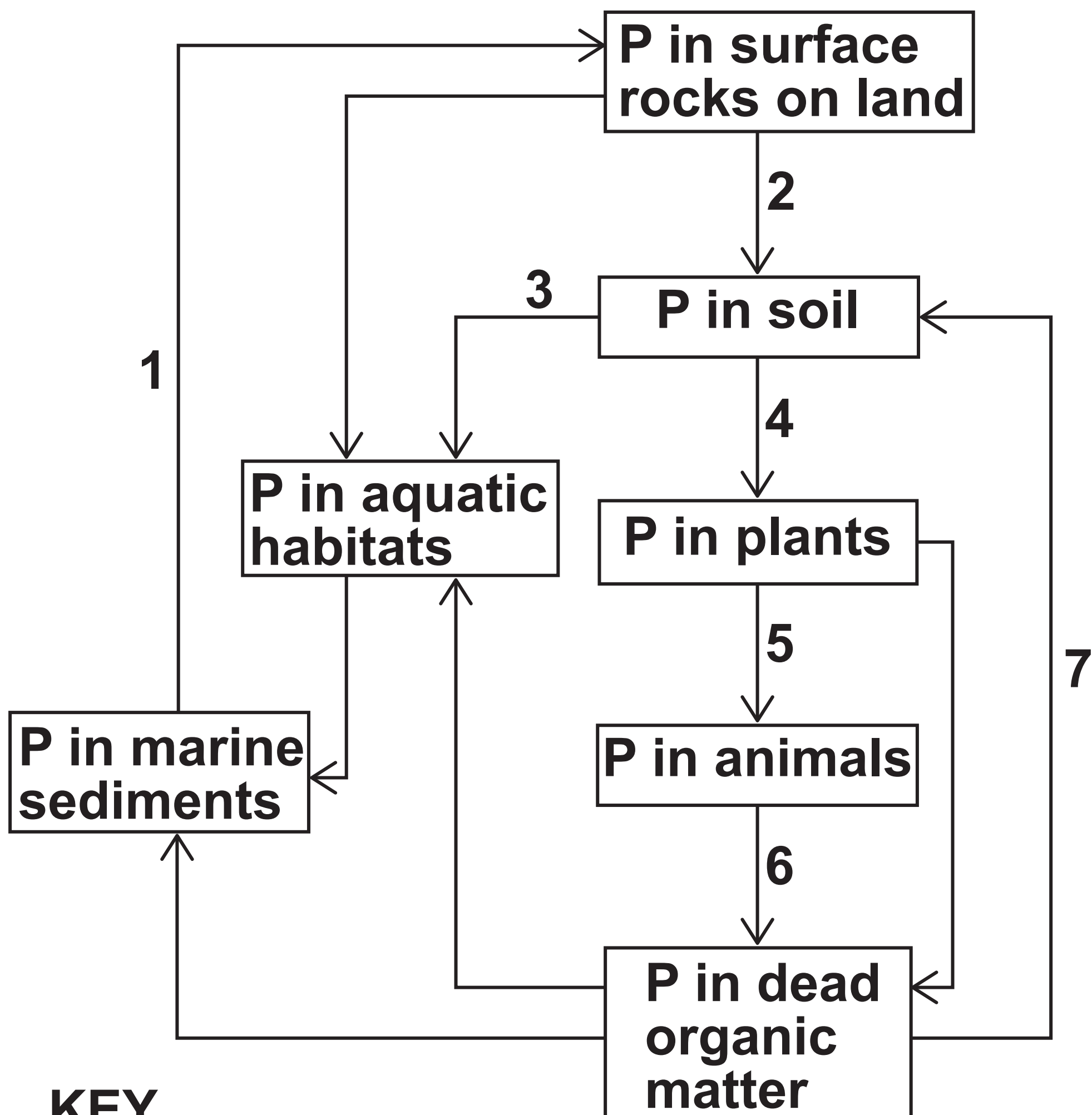
Use FIGURE 1 to complete TABLE 1 by writing in the appropriate number or name of process.

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

TABLE 1

NAME OF PROCESS	NUMBER
Weathering	2
	4
	7
Runoff	
Mountain building	

FIGURE 1



KEY



Store / reservoir of P



Process

[Turn over]



01.2

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

5

BLANK PAGE

[Turn over]



0	2
---	---

Locating mineral deposits involves a range of exploratory techniques.

0	2	.	1
---	---	---	---

**Complete TABLE 2, on the opposite page, 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

[Turn over]



02.2

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 _____



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 _____

[Turn over]



Impact 2 _____

How it may be reduced _____

Impact 3 _____

How it may be reduced _____



Impact 4 _____

How it may be reduced _____

Impact 5 _____

How it may be reduced _____

[Turn over]



0	3
---	---

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

FIGURE 2

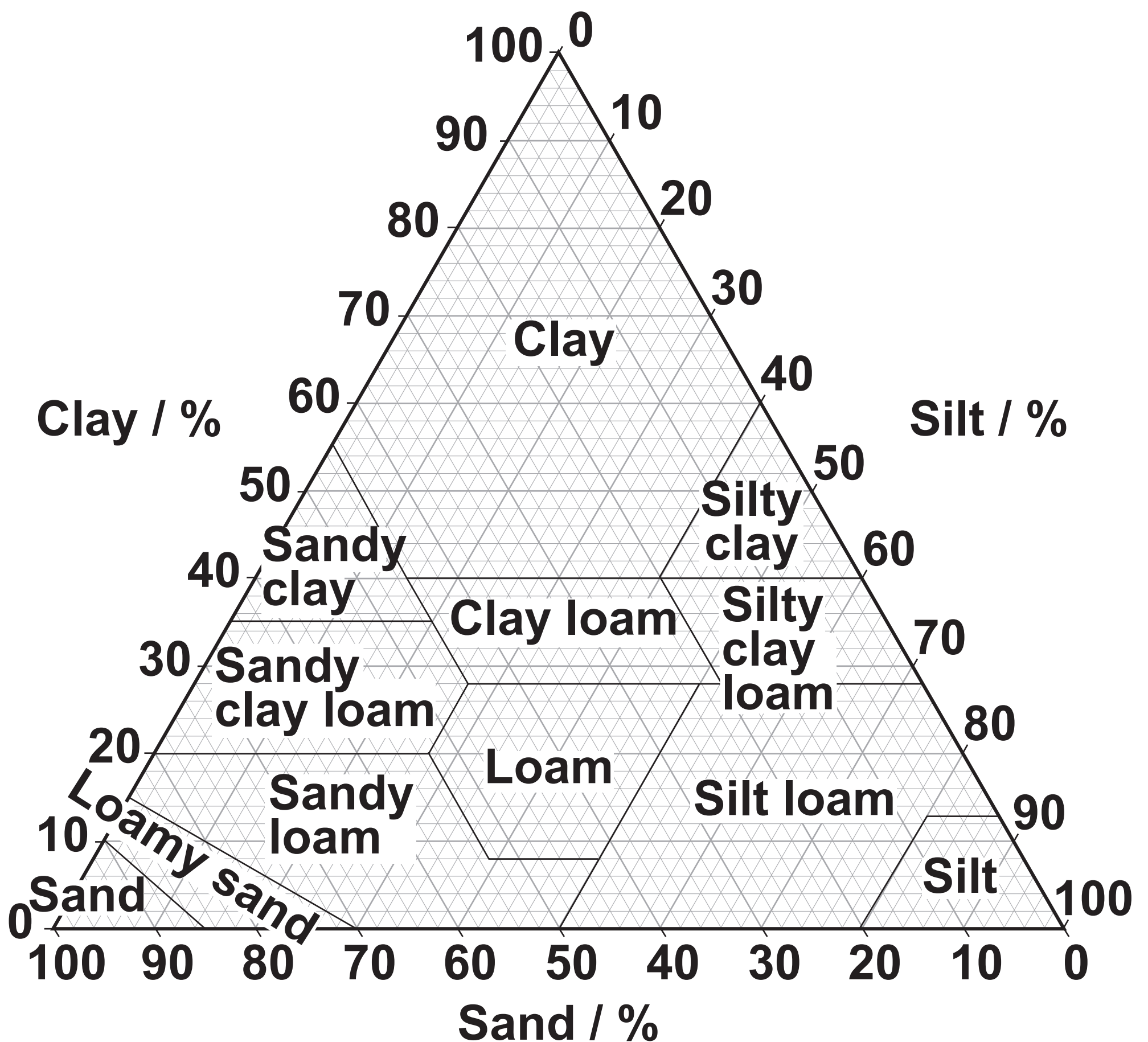


TABLE 3 shows the textural composition of four soil samples A, B, C, and D.

TABLE 3

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

03.1

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

[Turn over]



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

Explain why soil sample B in TABLE 3, on page 15, is likely to have the highest permeability. [2 marks]

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

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



[Turn over]



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 _____

[Turn over]



03.5

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

10



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 pages 22 and 23, shows the annual mass of sediment collected (soil loss) as the slope gradient increases at different land use sites.

[Turn over]



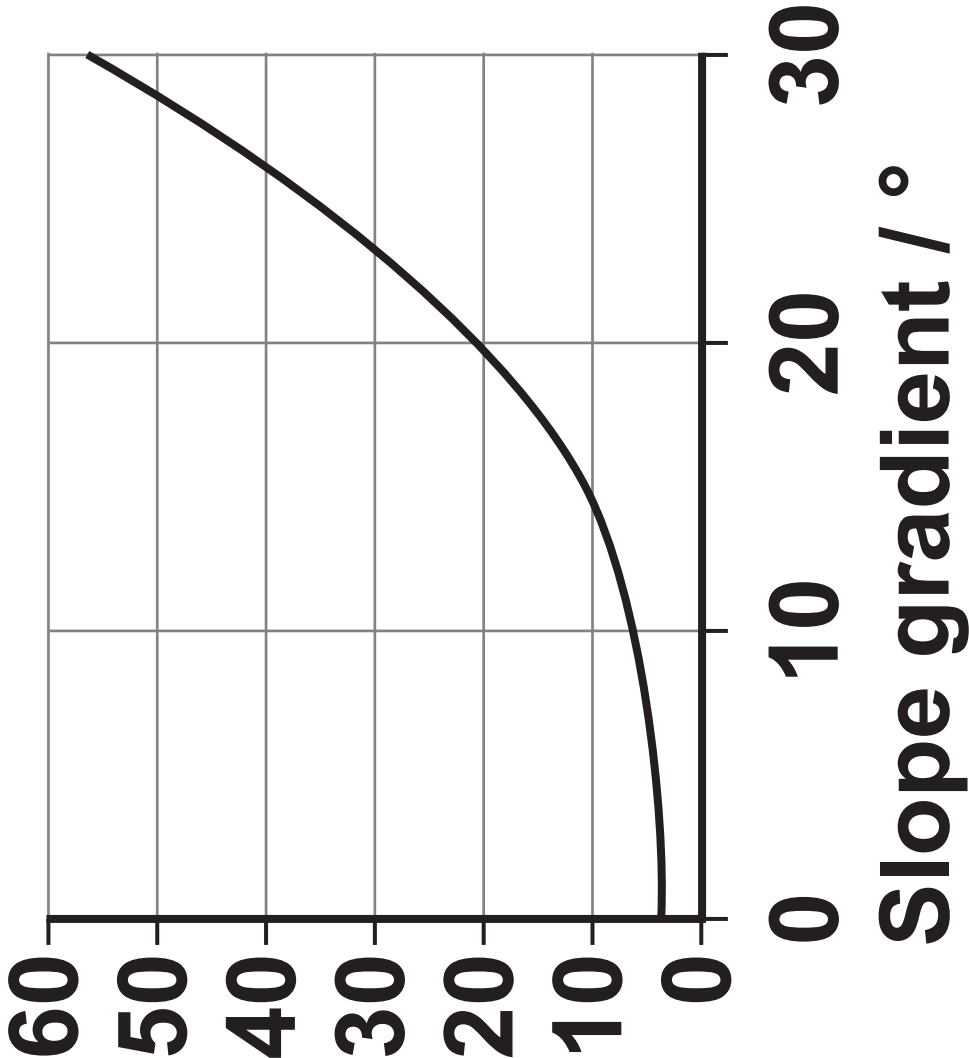


2 2

FIGURE 3

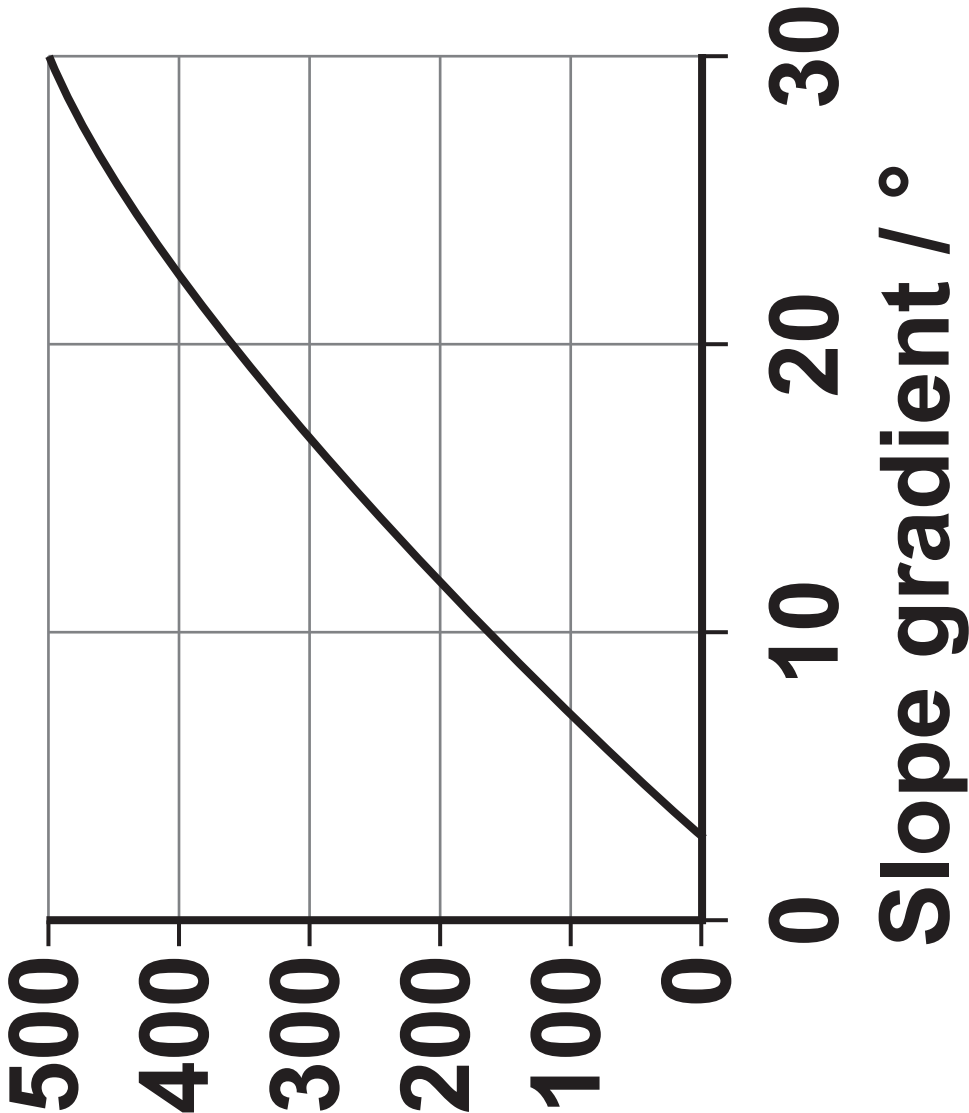
FOREST LAND

Mass of sediment collected / t ha⁻¹ yr⁻¹



FARMLAND

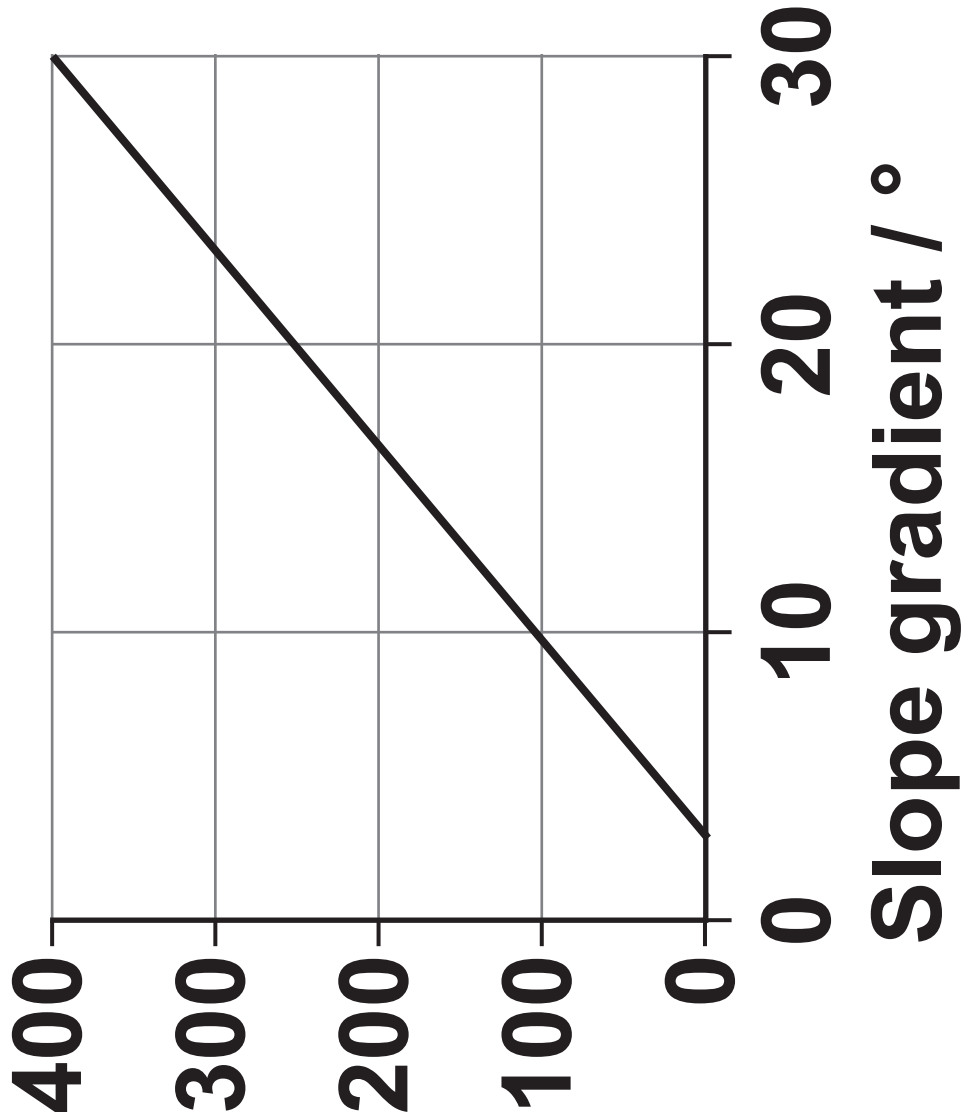
Mass of sediment collected / t ha⁻¹ yr⁻¹





BARE SOIL

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



[Turn over]



**Describe and explain TWO trends shown by the data in
FIGURE 3, on pages 22 and 23. [4 marks]**

1



2 5

2

[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 _____

[Turn over]



04.3

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

1 _____

2 _____

10

BLANK PAGE

[Turn over]





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

TABLE 5, on page 31, 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			

[Turn over]



05.1

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 page 31, 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]

_____ %

[Turn over]

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]



This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



0	5	.	3
---	---	---	---

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

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 page 38, shows how the efficiency of a helical low head turbine varies as the flow rate of the water increases.

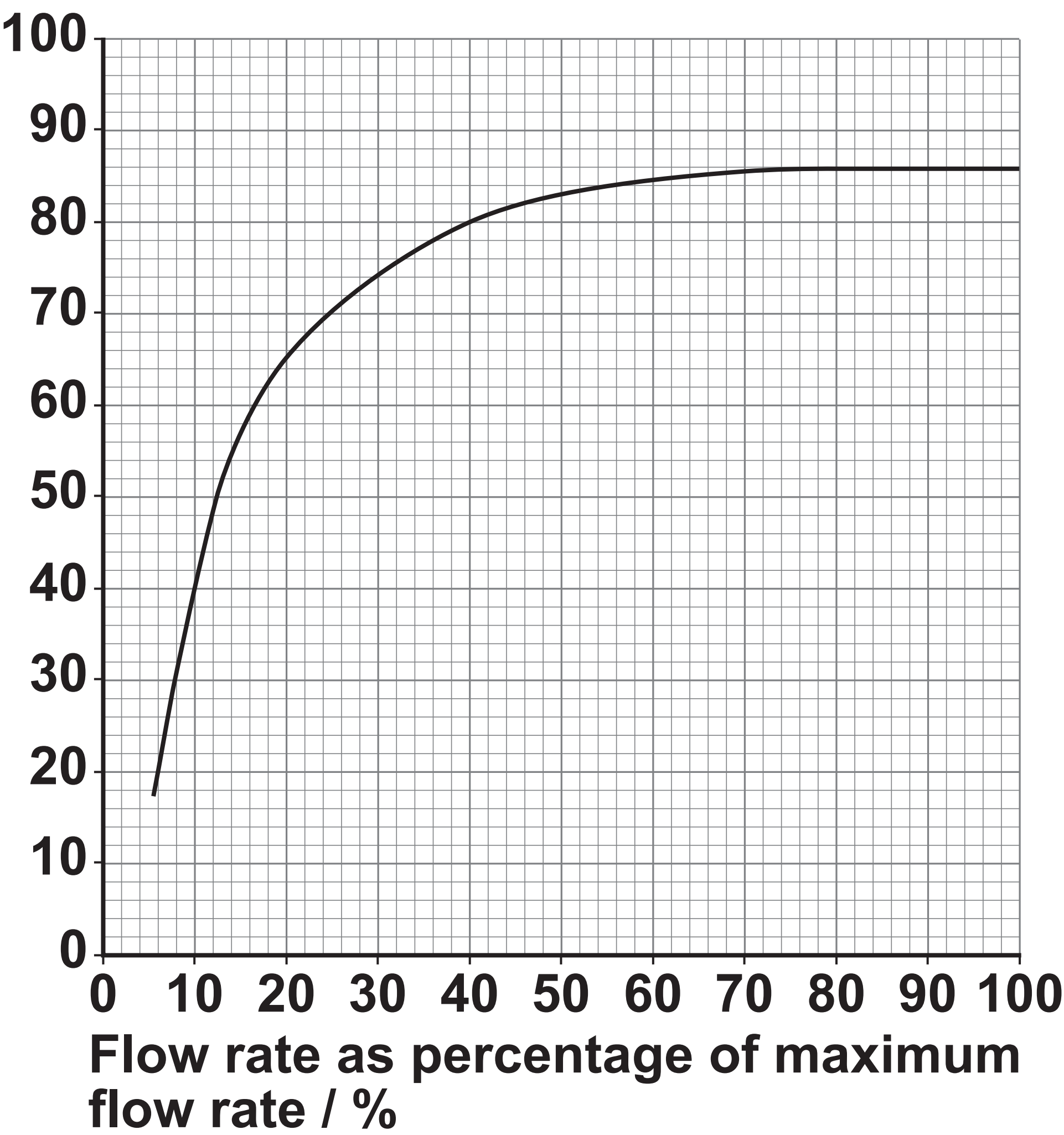
The flow rate is shown as a percentage (%) of the maximum flow rate recorded at the site.

[Turn over]



FIGURE 4

Efficiency
of turbine / %



0	5	.	4
---	---	---	---

The maximum flow rate recorded was $6.5 \text{ m}^3 \text{ s}^{-1}$. This generated a maximum output of 100 kW.

Use information in FIGURE 4, opposite, and the text to calculate the output in kW generated if the flow rate of water was $0.67 \text{ m}^3 \text{ s}^{-1}$.

Give your answer to ONE decimal place.

Show your working. [3 marks]

_____ kW

[Turn over]



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]

1 _____

2 _____



0	6
---	---

FIGURE 5, on pages 42 and 43, 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.

[Turn over]





Advantage

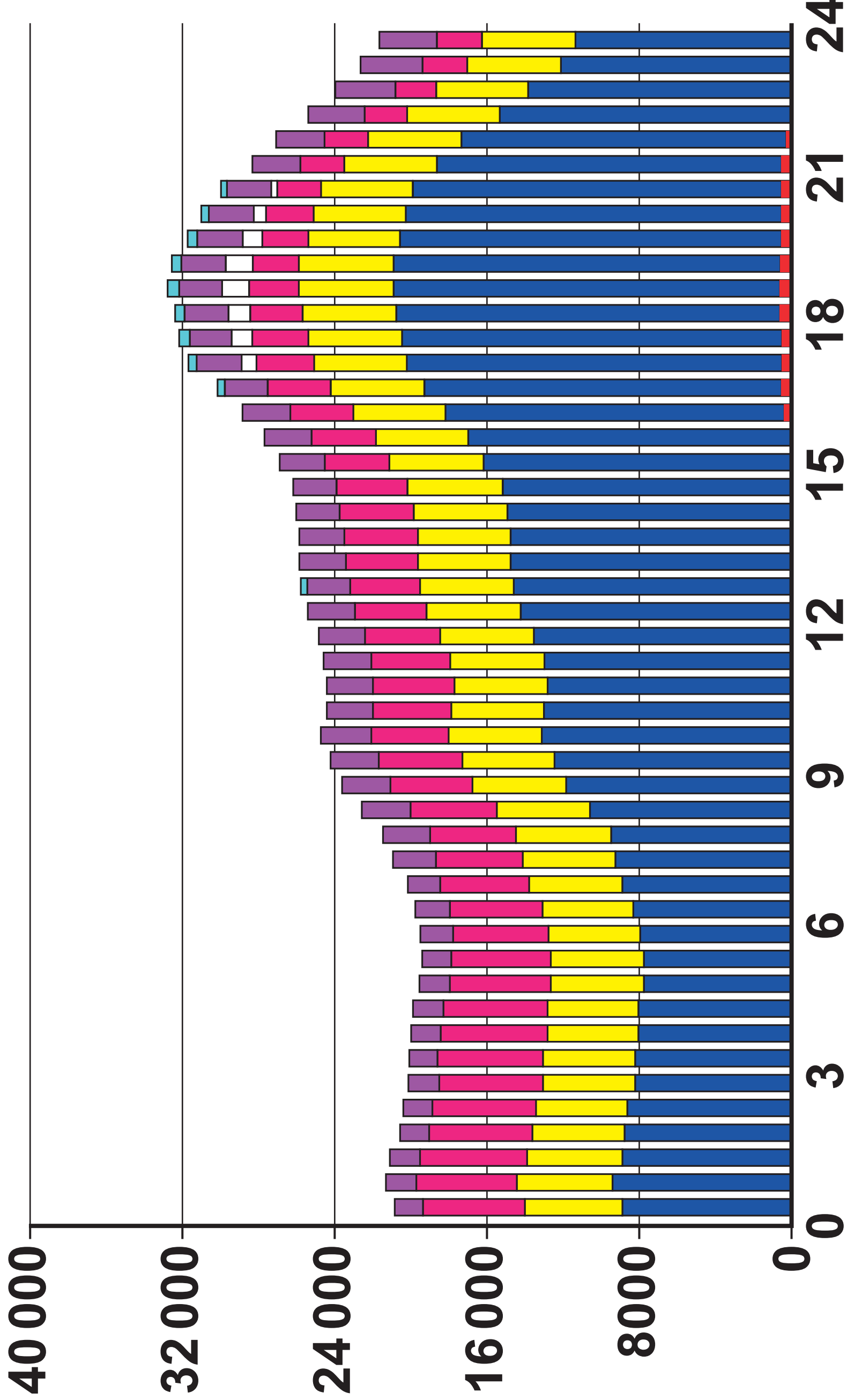
42

KEY

Other
 Wind
 Biomass
 Coal
 Nuclear
 Pumped storage
 HEP



Electricity demand / MW



Hours

[Turn over]

06.2

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

5



BLANK PAGE

[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 / $10^{15} \text{ dm}^3 \text{ yr}^{-1}$	Volume of water transferred out of reservoir by process / $10^{15} \text{ dm}^3 \text{ yr}^{-1}$
Atmosphere	over land	precipitation		107
		evaporation and transpiration	71	
	over oceans	precipitation		398
		evaporation	434	



Oceans	1 400 000	precipitation	398		
		evaporation			434
		groundwater flow			
		river runoff	19		
Land	43 762	precipitation	107		
		evaporation and transpiration			71
		river runoff			19
		groundwater flow			

[Turn over]

07.1

Use TABLE 6, on pages 46 and 47, to calculate the annual volume of water transferred between reservoirs by groundwater flow. [1 mark]

_____ × 10¹⁵ dm³ yr^{−1}

07.2

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 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]



07.3

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

5

0	8
---	---

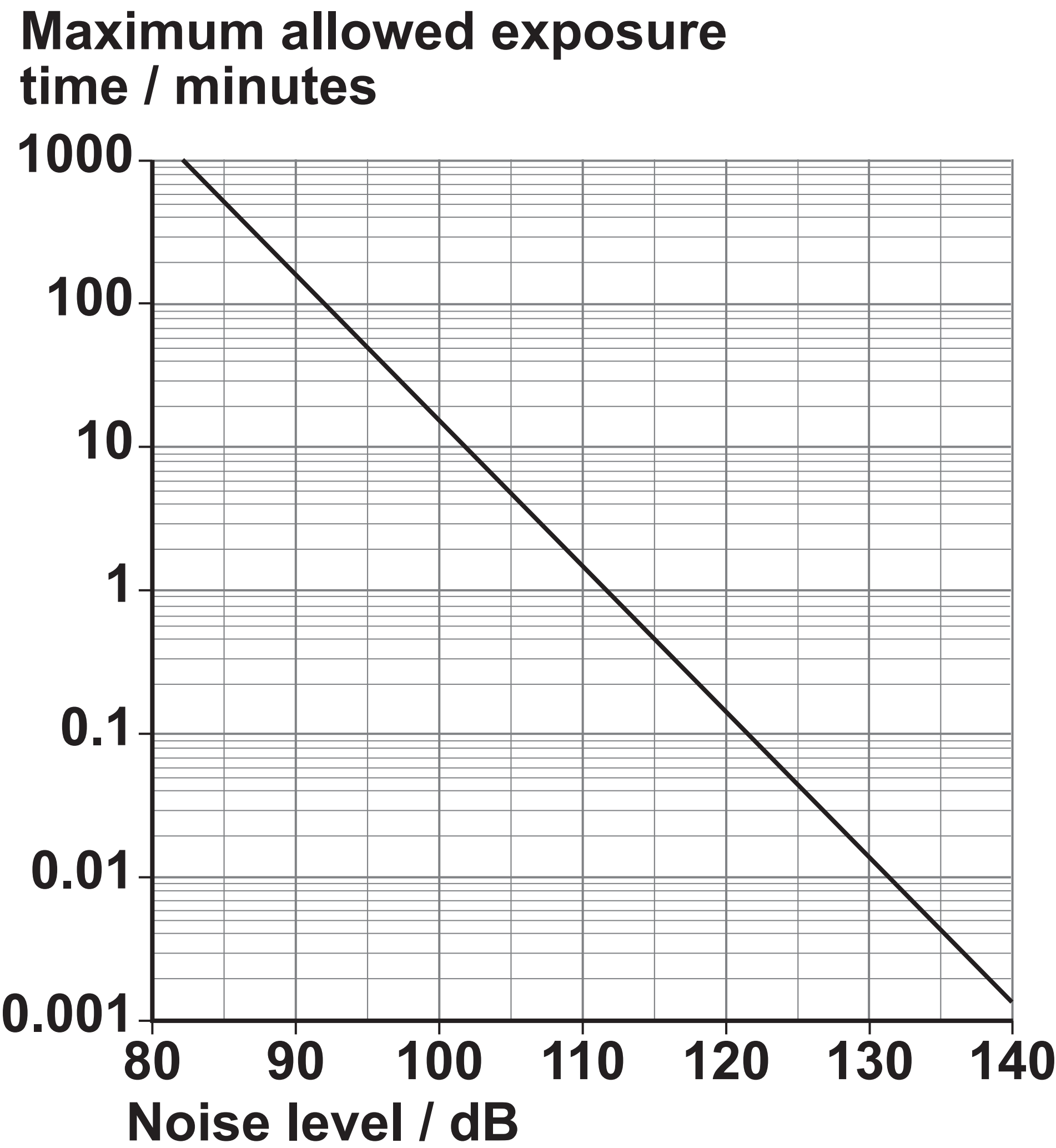
Noise pollution may have negative impacts on human health.

FIGURE 6, on page 52, shows the relationship between maximum allowed exposure time without hearing protection and noise level in an industrial setting.

[Turn over]



FIGURE 6



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]



08.2

State TWO health impacts on humans, other than hearing loss, that can be caused by continued exposure to noise. [2 marks]

1 _____

2 _____

Motor-racing venues have strict noise limits.

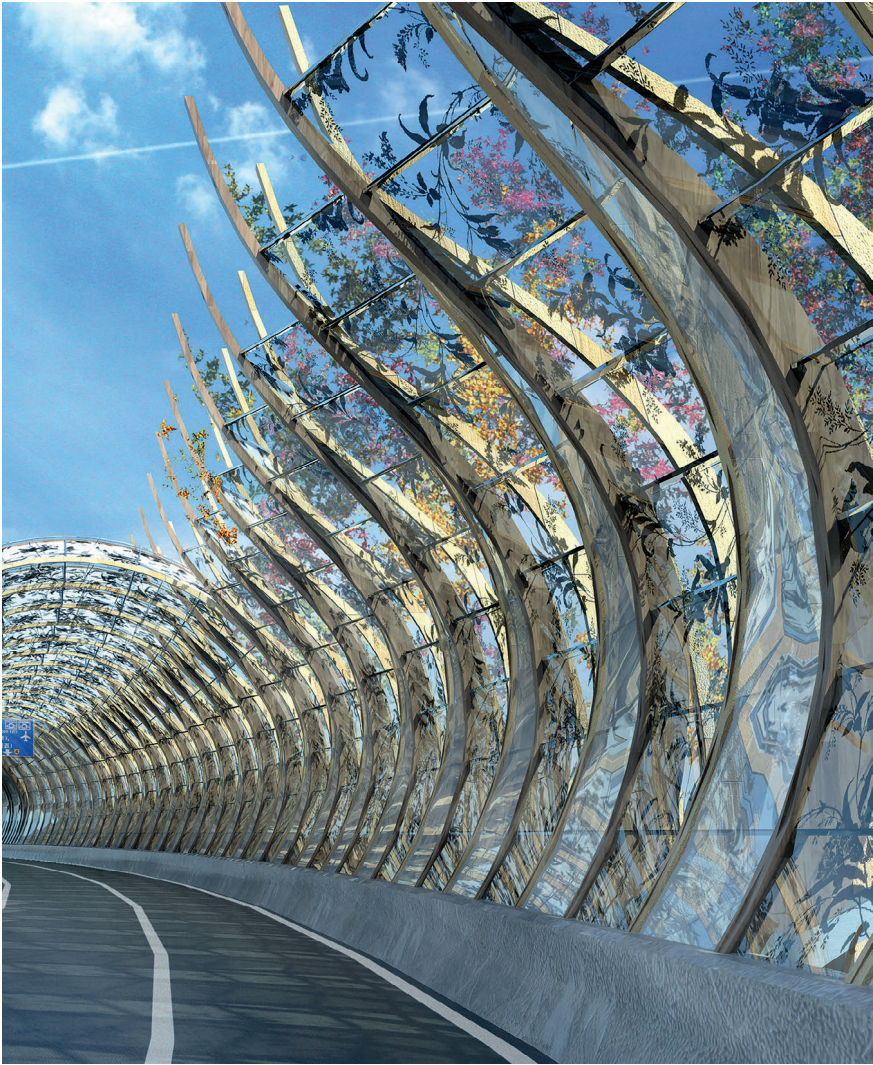
Noise from the track may be a source of pollution to local residents, some of whom may live within 500 m of the venue.

FIGURE 7, on page 56, shows two examples of different types of acoustic barrier that may be used to reduce noise pollution to local residents.

[Turn over]



FIGURE 7



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]

[Turn over]



[illegible]

[Turn over]



08.4

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

10

BLANK PAGE

[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 km², 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

[Turn over]



0	9	.	2
---	---	---	---

Data obtained from satellites recorded how the oil spill had increased in area to 27 km² after six days.

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

1 _____

2 _____



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 _____

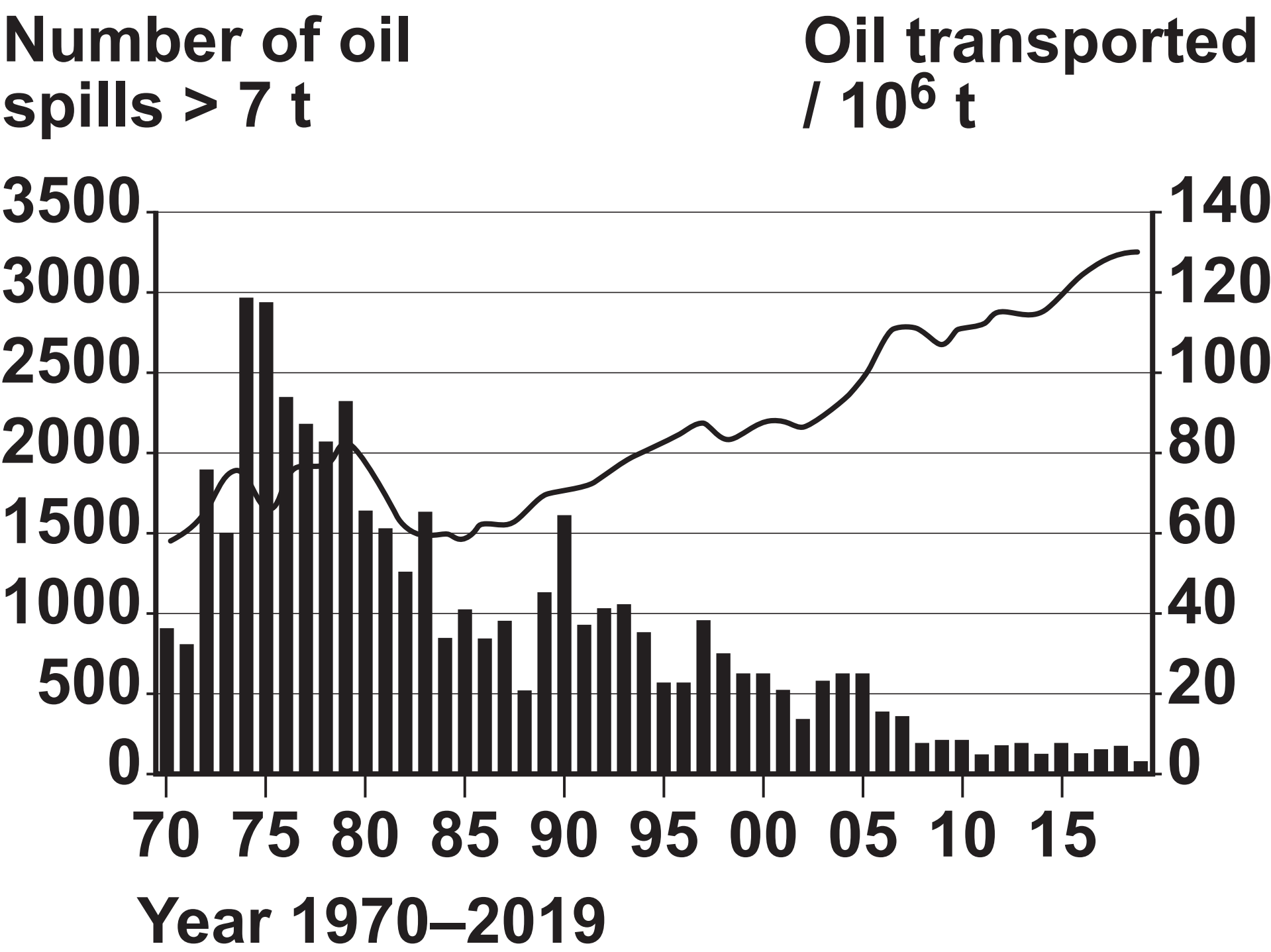
2 _____

[Turn over]



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



KEY

- Number of oil spills > 7 t**
- Oil transported**



09.4

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

1 _____

2 _____

3 _____

[Turn over]



1	0
---	---

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

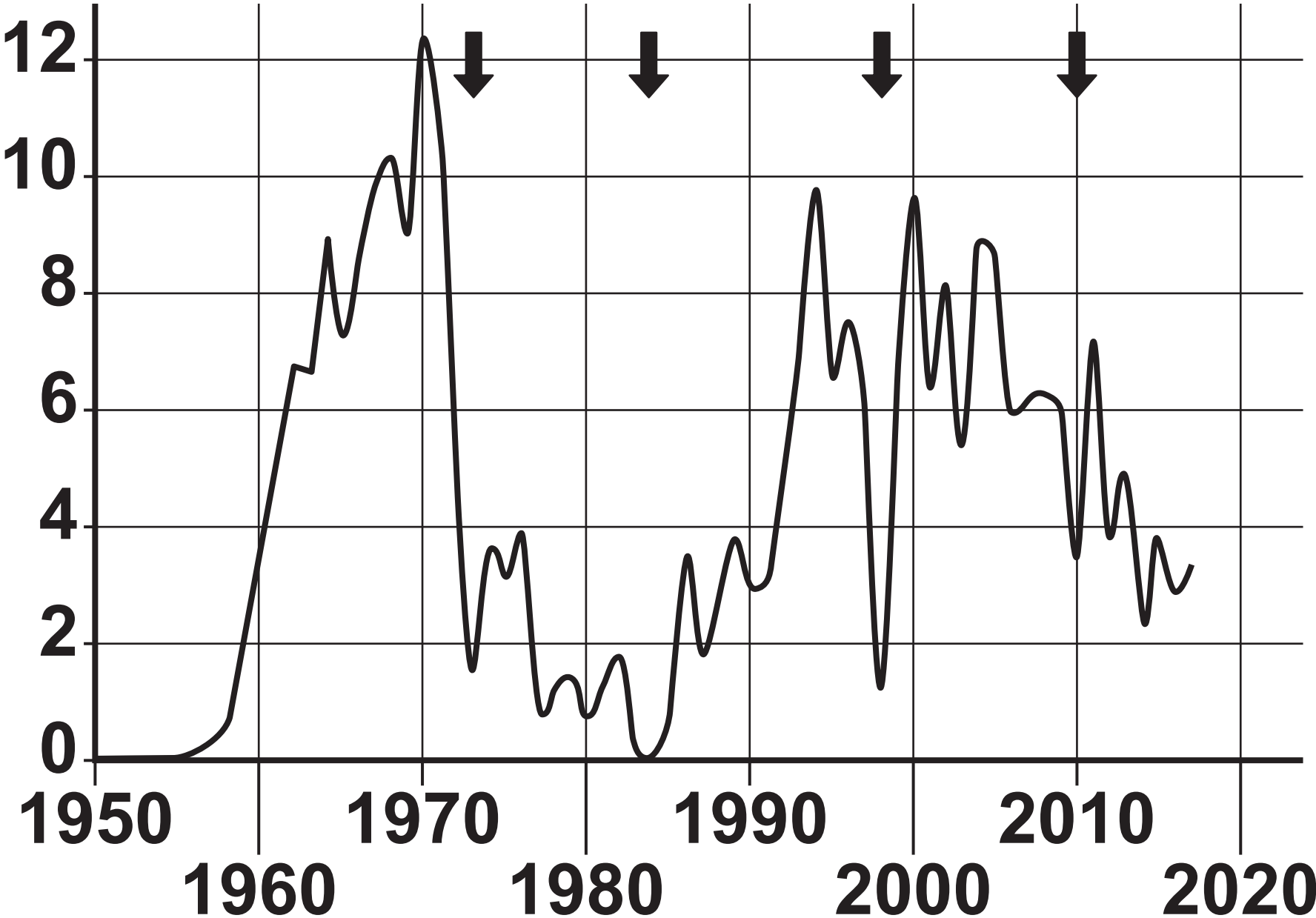
Since 1950, there has been a greater frequency of major El Niño events in the Pacific Ocean.

FIGURE 9, on the opposite page, shows the annual catch of Peruvian anchovies, ‘Peruvian anchoveta’, in the Pacific Ocean, 1950–2018.



FIGURE 9

Annual catch
/ 10⁶ t



Year

KEY

↓ Major El Niño events

[Turn over]



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

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



[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]

1 _____

2 _____



1	0	.	3
---	---	---	---

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

[Turn over]



This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

15

[Turn over]



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

[illegible]

[Turn over]



80

[illegible]

[illegible]

[Turn over]



[illegible]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

[Turn over]



This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

END OF QUESTIONS



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

[illegible]

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

[illegible]

BLANK PAGE

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
TOTAL	

Copyright information

For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from www.aqa.org.uk.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.

Copyright © 2023 AQA and its licensors. All rights reserved.

G/KL/Jun23/7447/1/E3

