OCR
Oxford Cambridge and RSA

Monday 12 May 2025 – Morning

AS Level Geology

H014/01 Geology

Time allowed: 2 hours 30 minutes

You must have:
- a ruler (cm/mm)
- a protractor

You can use:
- a scientific or graphical calculator
- an HB pencil
- A4 plain paper

Please write clearly in black ink. **Do not write in the barcodes.**

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

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **120**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **40** pages.

ADVICE
- Read each question carefully before you start your answer.

Section A

You should spend a **maximum** of **30 minutes** on this section.

For each question write the letter in the box.

1 Which element would be considered ‘atmophile’ under the Goldschmidt classification?

A Copper

B Hydrogen

C Iron

D Silicon

Your answer ☐ **[1]**

2 In which Earth layer are siderophile elements the most abundant?

A Atmosphere

B Core

C Crust

D Mantle

Your answer ☐ **[1]**

3 Which groups of elements are igneous rocks mainly composed of?

A Atmophile

B Chalcophile

C Lithophile

D Siderophile

Your answer ☐ **[1]**

4 Which mineral commonly found in igneous rocks is the **least** susceptible to chemical weathering?

A Mica

B Olivine

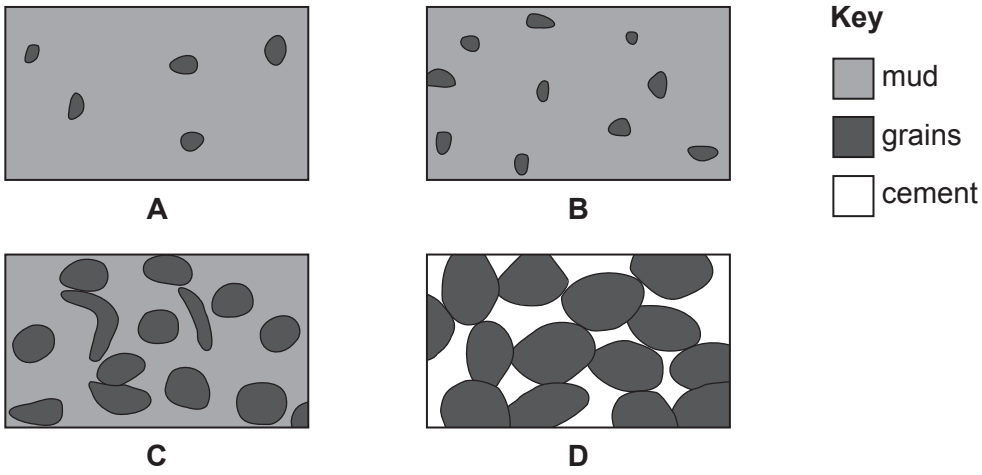
C Pyroxene

D Quartz

Your answer [ ] **[1]**

The diagrams (**A**, **B**, **C** and **D**) show the four main types of limestone according to the Dunham classification scheme.

Questions **5**, **6** and **7** refer to these diagrams.



5 Which diagram shows a limestone with <10% grains in a mud supported matrix?

A Diagram **A**

B Diagram **B**

C Diagram **C**

D Diagram **D**

Your answer ☐ **[1]**

6 Which diagram shows a packstone?

A Diagram **A**

B Diagram **B**

C Diagram **C**

D Diagram **D**

Your answer ☐ **[1]**

7 Which diagram shows the limestone which was deposited in the highest energy sedimentary environment?

A Diagram **A**

B Diagram **B**

C Diagram **C**

D Diagram **D**

Your answer ☐ **[1]**

8 Which fundamental principle of geology uses modern-day sedimentary processes to interpret ancient sedimentary rocks?

A Correlation

B Geochronology

C Superposition

D Uniformitarianism

Your answer ☐ **[1]**

9 In a practical investigation to model how the temperature of flowing lava affects its viscosity, a student poured syrup down an inclined board and timed its progress to calculate its speed.

Which of the following options is **not** a control variable in this experiment?

A Angle of board

B Temperature of syrup

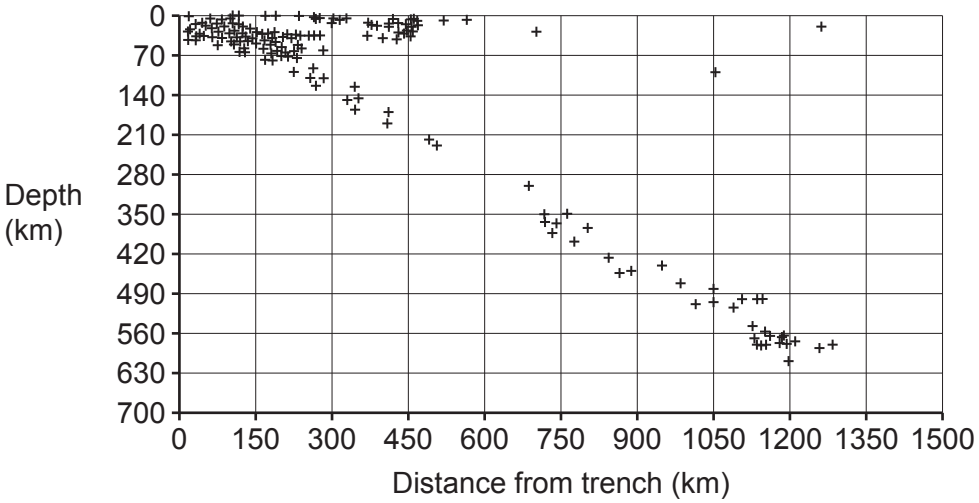
C Type of syrup

D Volume of syrup

Your answer ☐ **[1]**

The scatter diagram shows how the depth of earthquake foci changes with distance from an ocean trench in Japan.

Questions **10**, **11** and **12** refer to this diagram.



10 What is the name given to the area of inclined earthquake foci on the scatter diagram?

A Asthenosphere

B Benioff zone

C Bouguer anomaly

D Lithosphere

Your answer ☐ **[1]**

11 Which geological process can be explained by the pattern of earthquake foci on the scatter diagram?

A Passive upwelling

B Polymerisation

C Seafloor spreading

D Subduction

Your answer ☐ **[1]**

12 Which of these best describes the correlation between the depth of earthquake foci and distance from the trench on the scatter diagram?

A Strong negative

B Strong positive

C Weak negative

D Weak positive

Your answer ☐ **[1]**

13 Which of these is **not** a mechanism of heat transfer within the Earth?

A Advection

B Conduction

C Contraction

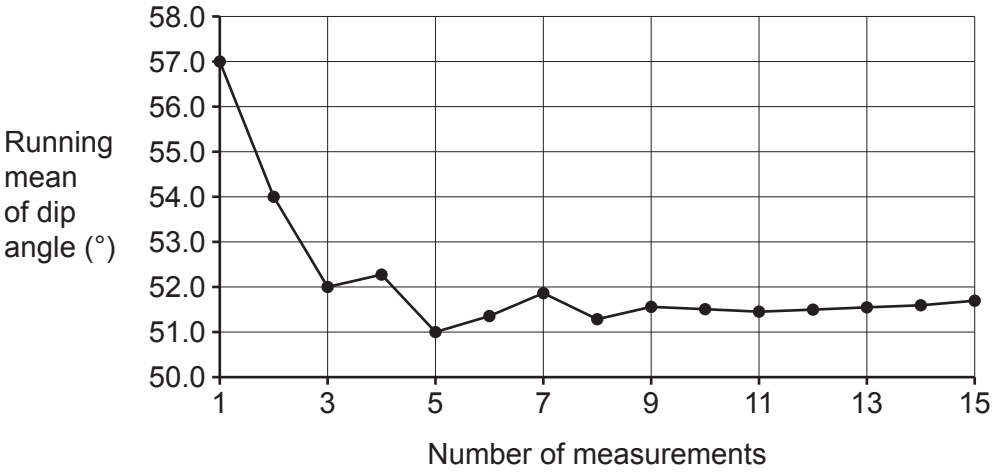
D Convection

Your answer ☐ **[1]**

To determine the mean dip angle of a bedding plane, a student collected measurements at 1 m intervals along a tape measure positioned parallel to the strike of the bedding plane.

The graph shows the running mean of their results and the number of measurements made.

Questions **14**, **15** and **16** refer to this graph.



14 Which option describes the sampling technique that the student used?

A Cone and quartering

B Random

C Stratified

D Systematic

Your answer ☐ **[1]**

15 What was the optimum number of measurements to determine the mean dip angle of the bedding plane?

A 1

B 5

C 9

D 13

Your answer ☐ **[1]**

16 What was the value of the third dip measurement made by the student?

A 48°

B 50°

C 52°

D 54°

Your answer ☐ **[1]**

17 Which of these is **not** an ethical issue which needs to be considered when undertaking fieldwork?

A Collecting geological samples

B Gaining permission to access field locations

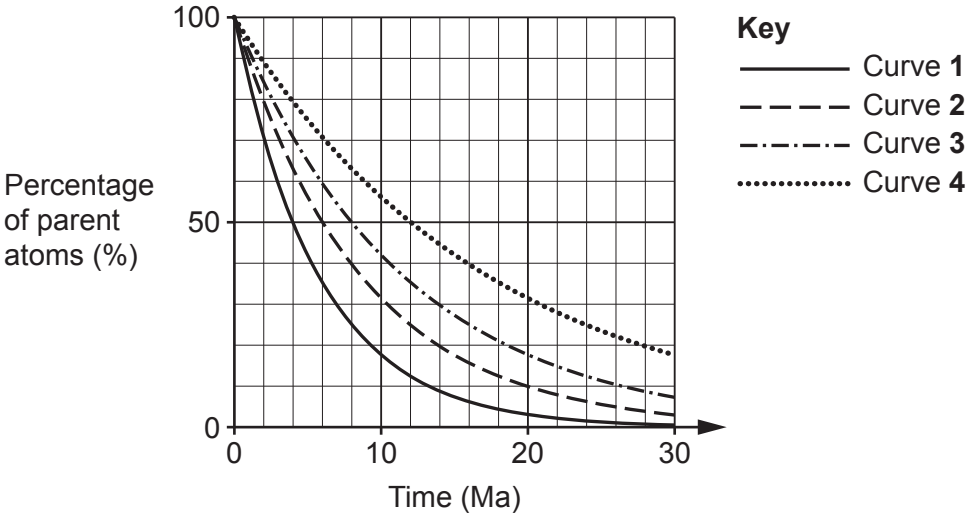
C Polluting field locations

D Sampling technique

Your answer ☐ **[1]**

The graph shows half-life curves for four different radioactive decays.

Questions **18**, **19** and **20** refer to this graph.



18 Which half-life curve shows the radioactive decay with the longest half-life?

A Curve **1**

B Curve **2**

C Curve **3**

D Curve **4**

Your answer ☐ **[1]**

19 What is the half-life of the radioactive decay shown by Curve **2**?

A 6 Ma

B 8 Ma

C 10 Ma

D 12 Ma

Your answer ☐ **[1]**

20 What would the age of a mineral be if it had passed through three half-lives and followed the radioactive decay path shown by Curve **3**?

A 8 Ma

B 16 Ma

C 24 Ma

D 32 Ma

Your answer ☐ **[1]**

Section B

21 Minerals are the basic components of geology and most rocks contain one or more minerals.

The table shows the properties of three minerals.

Mineral	Chemical composition	Density ($g\,cm^{-3}$)	Hardness
Calcite	$CaCO_3$	2.7	3
Orthoclase feldspar	$KAlSi_3O_8$	2.6	6
Plagioclase feldspar	$CaAl_2Si_2O_8$	2.7	6

(a)

(i) Define the geological term **mineral**.

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..... **[2]**

(ii) State which **one** of the minerals in the table is **not** a silicate mineral. Explain your answer.

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..... **[2]**

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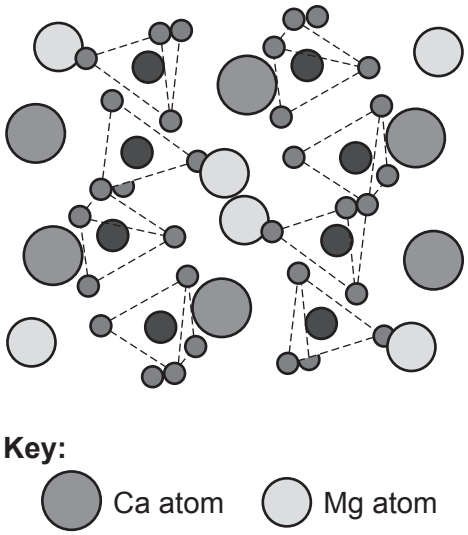
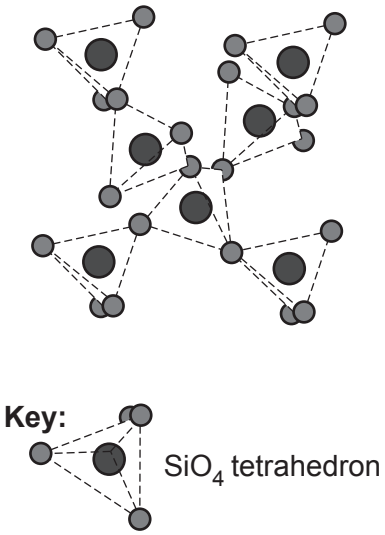
(b) The table shows information on two silicate minerals.

Mineral	Diopside (a pyroxene)	Quartz
Composition	$MgCaSi_2O_6$	SiO_2
Si:O ratio	.....	1:2
Atomic structure		
Silicate structure	.....	framework
Hardness	6	7
Density ($g\,cm^{-3}$)	3.3	2.7

(i) State the **Si:O ratio** and **silicate structure** for the mineral diopside. Write your answers in the table. **[2]**

(ii) Use the information in the table to explain the differences in hardness and density between diopside and quartz.

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..... **[2]**

(iii) Draw a diagram to show the atomic structure of the olivine mineral forsterite (Mg_2SiO_4), a silicate mineral made of isolated SiO_4 tetrahedra.

Your sketch diagram should contain at least **two** SiO_4 tetrahedra. Use the key in the table for your sketch.

[2]

(c)

(i)* Describe how you would determine the density of an unknown mineral in a school science laboratory. You should:

- state the equipment that you would use
- describe your method
- outline how you would attempt to minimise the effect of anomalous results.

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Extra answer space if required.

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(ii) Use the table to explain whether density and hardness would be sufficient to distinguish calcite, orthoclase feldspar and plagioclase feldspar.

Mineral	Density ($g\,cm^{-3}$)	Hardness
Calcite	2.7	3
Orthoclase feldspar	2.6	6
Plagioclase feldspar	2.7	6

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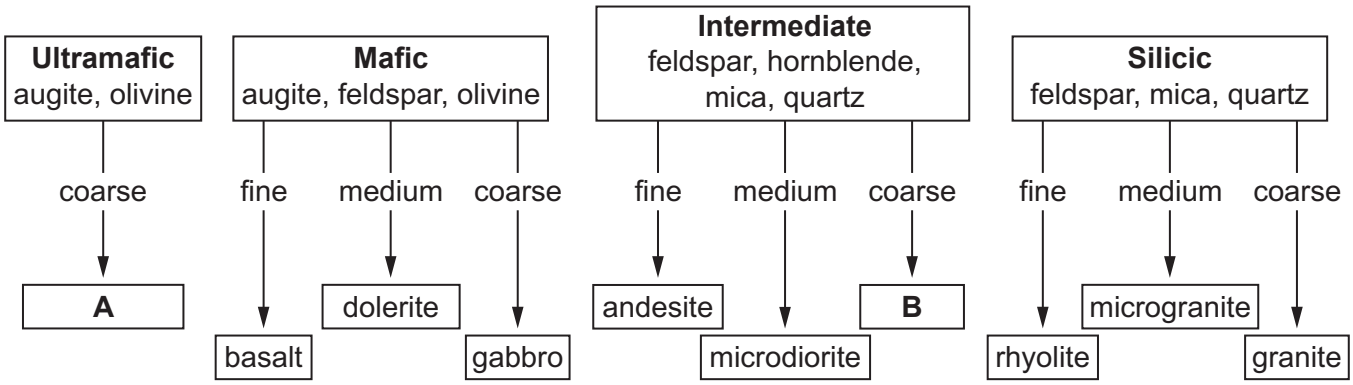
..... **[2]**

22 Igneous rocks can be classified based upon their composition and crystal size as shown by the identification key.



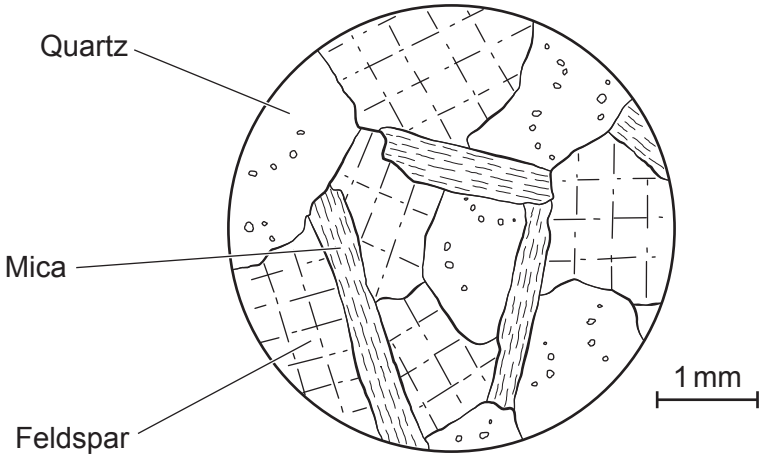
(a) Name the igneous rocks **A** and **B** in the identification key.

A .....

B .....

[2]

(b) The diagram shows a sketch made by a student of an igneous rock collected on a field trip.



(i) Use the identification key to name the igneous rock in the diagram.

..... **[1]**

(ii) Explain what the texture suggests about the cooling history and depth of formation of the igneous rock in the diagram.

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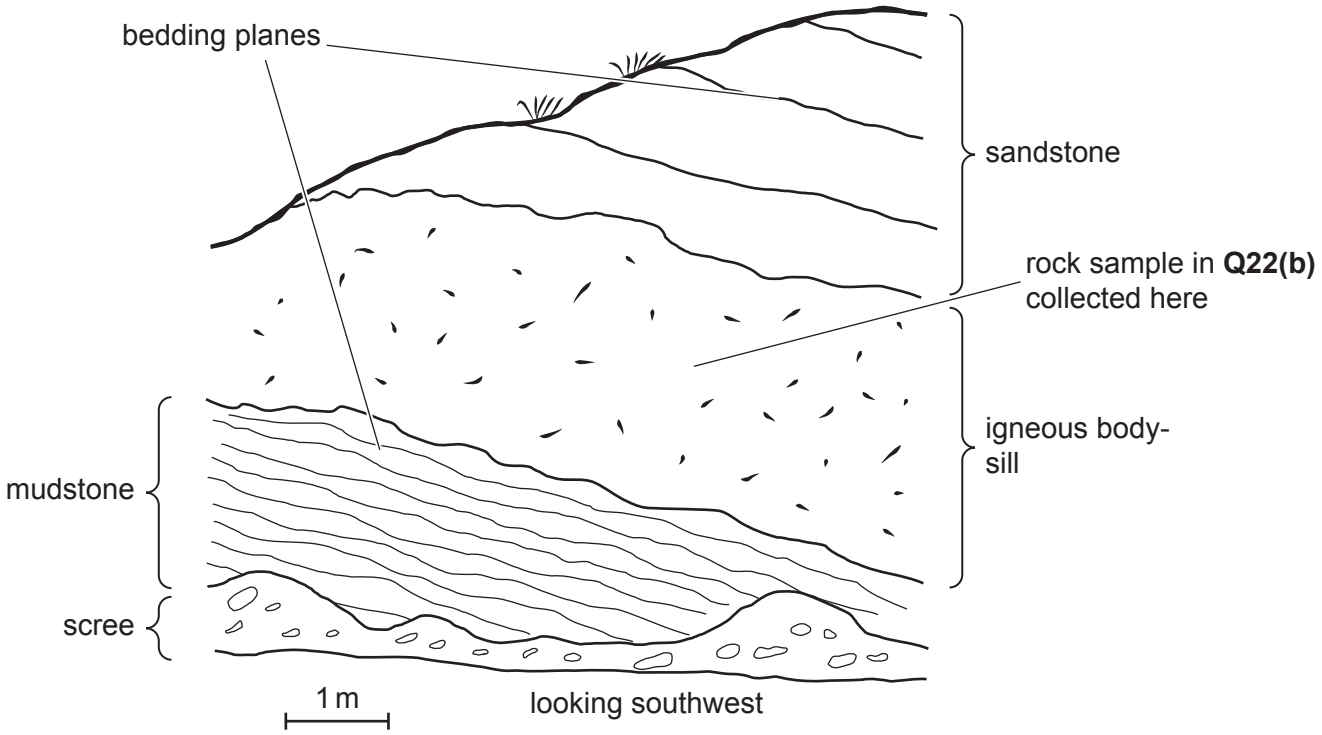
(c) The student's field sketch of part of the igneous body from where the igneous rock was collected is shown below.



(i) The student has correctly identified the igneous body in their field sketch as a sill. Explain the evidence from the sketch of the igneous rock in **Q22(b)** and the field sketch of the igneous body in **Q22(c)** that supports the student's conclusion.

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(ii) Describe what other evidence the student could look for in the exposure shown in the field sketch to further confirm that the igneous body is a sill.

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(d) In a nearby exposure the sill is transgressive. In the box draw a labelled field sketch to show the field relationships of the transgressive sill to the country rock. **[2]**

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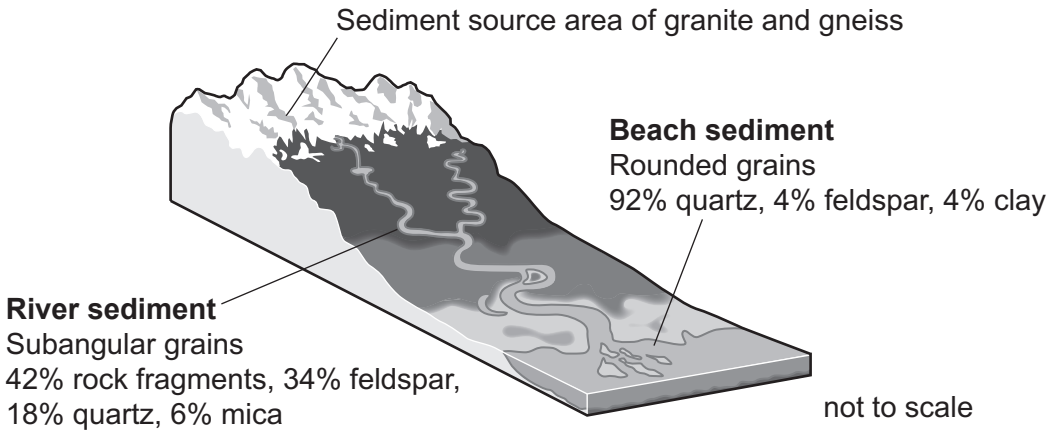
23 The grain size distribution of sediments can be determined by sieving.
The diagram shows the location of two sites where sediment samples were collected to compare the grain size distribution of river and beach sediments.



(a) Outline how the grain size distribution of a sediment sample can be measured using a stack of sieves in a school laboratory.

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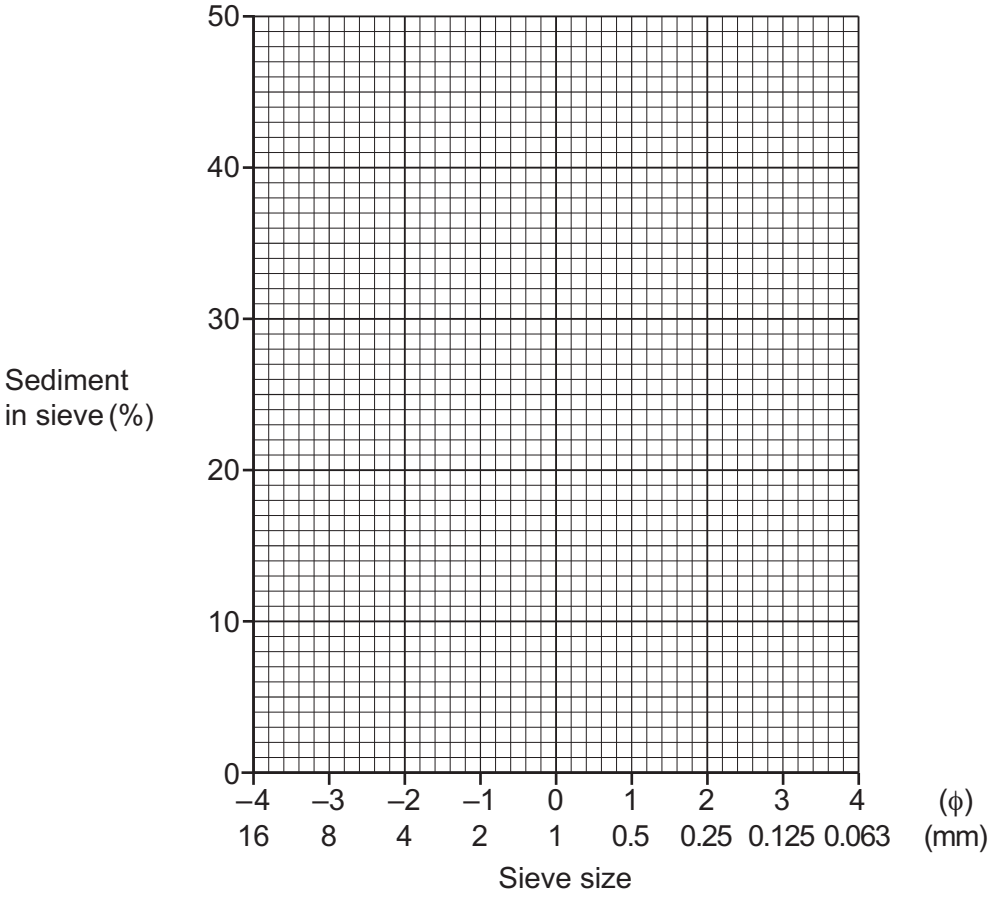
..... **[4]**

(b) The table shows grain size data for the **river sediment** on the diagram.

Grain size (mm)	**Grain size (ϕ)**	**Sediment in sieve (%)**
8 ≤ mm < 16	$-3 \geq \phi > -4$	0
4 ≤ mm < 8	$-2 \geq \phi > -3$	28
2 ≤ mm < 4	$-1 \geq \phi > -2$	42
1 ≤ mm < 2	$0 \geq \phi > -1$	13
0.5 ≤ mm < 1	$1 \geq \phi > 0$	8
0.25 ≤ mm < 0.5	$2 \geq \phi > 1$	5
0.125 ≤ mm < 0.25	$3 \geq \phi > 2$	4
0.063 ≤ mm < 0.125	$4 \geq \phi > 3$	0

(i) Plot a bar chart on the grid to show the grain size distribution of the **river sediment**. **[2]**



(ii) Describe the grain size distribution of the **river sediment** shown by the bar chart and table.

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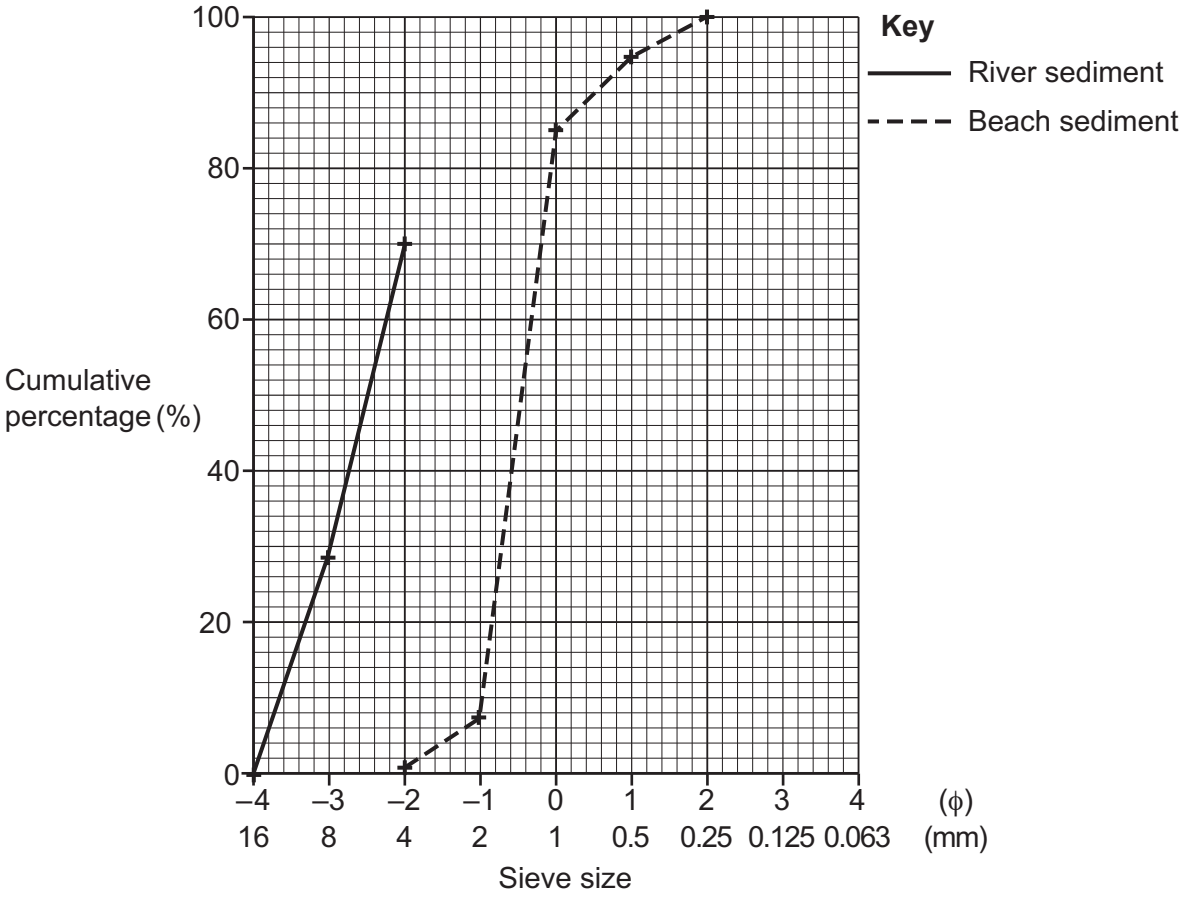
(c) The graph shows a cumulative frequency curve of the grain size distribution for the **beach sediment**.



(i) The median grain size of this sediment is the 50th percentile value ($\phi 50$) from the cumulative frequency curve. State the median grain size of the **beach sediment** in ϕ units.

Median grain size = ... ϕ **[1]**

(ii) Using the cumulative frequency curve state the modal class interval of the **beach sediment** in ϕ units.

Modal grain size = ... ϕ to ..... ϕ **[1]**

(iii) Calculate the mean grain size of the **beach sediment** in ϕ units using results taken from the cumulative frequency curve.

Use the formula mean grain size = $\frac{1}{3}(\phi 16 + \phi 50 + \phi 84)$

Mean grain size = ... ϕ **[1]**

(d) The table showing grain size data for the **river sediment** is repeated again here for reference.

Grain size (mm)	Grain size (ϕ)	Sediment in sieve (%)
8 ≤ mm < 16	$-3 \geq \phi > -4$	0
4 ≤ mm < 8	$-2 \geq \phi > -3$	28
2 ≤ mm < 4	$-1 \geq \phi > -2$	42
1 ≤ mm < 2	$0 \geq \phi > -1$	13
0.5 ≤ mm < 1	$1 \geq \phi > 0$	8
0.25 ≤ mm < 0.5	$2 \geq \phi > 1$	5
0.125 ≤ mm < 0.25	$3 \geq \phi > 2$	4
0.063 ≤ mm < 0.125	$4 \geq \phi > 3$	0

(i) Use the data in the table to plot a second cumulative frequency curve on the graph to show the grain size distribution for the **river sediment**.

The first three points have been plotted for you. **[2]**

(ii)* Describe and explain the differences in the texture and composition of the river and beach sediments found at the two sites.

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Extra answer space if required.

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24 Metamorphism is a solid state isochemical process that changes the characteristics of a parent rock.

(a) A chemical reaction that may occur between two minerals during metamorphism is shown.

Calcite + Quartz ⟶ Wollastonite ($CaSiO_3$) + Carbon dioxide

(i) Write a balanced **symbol equation** for this chemical reaction.

..... **[1]**

(ii) Suggest the name of a likely parent rock for this metamorphic chemical reaction.

..... **[1]**

(iii) Explain what the term **isochemical** means.

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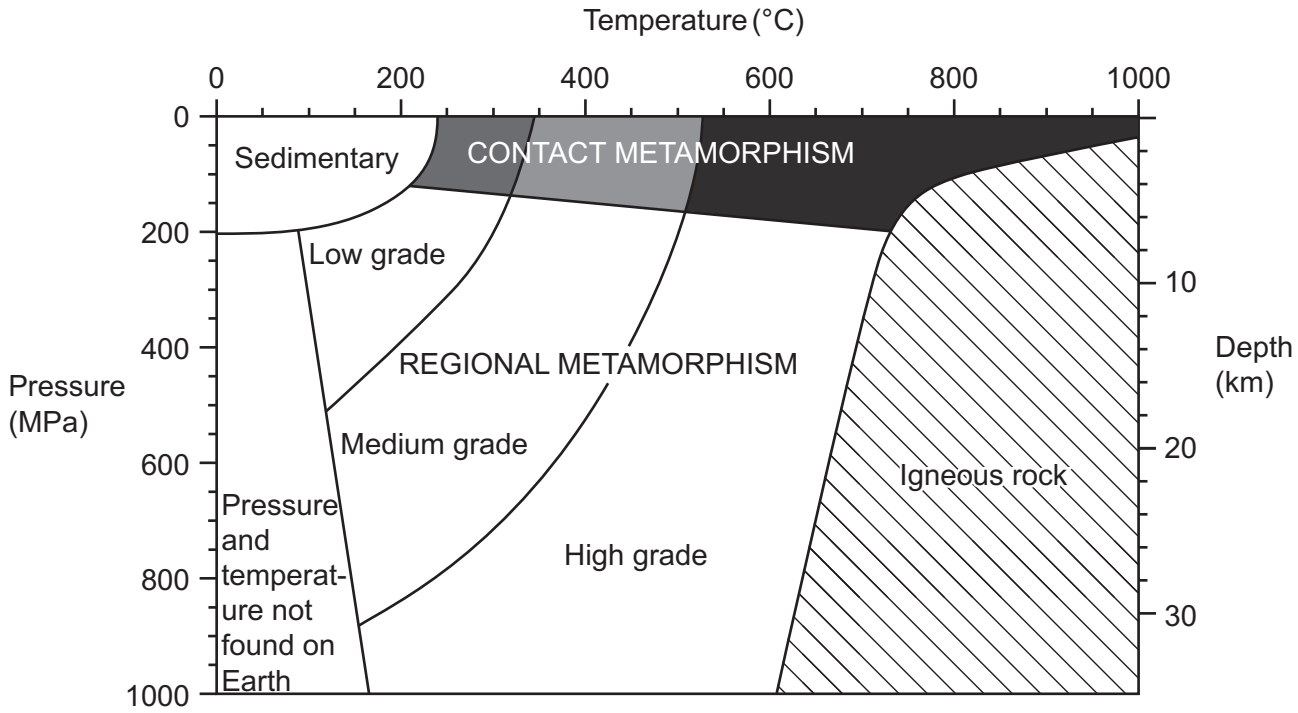
..... **[1]**

(b) The diagram shows the pressure and temperature conditions under which sedimentary, metamorphic and igneous rocks form.



(i) Calculate the rate of change of pressure with depth in the top 30 km of the Earth. State the units.

Value = ... Unit = ... **[2]**

(ii) Describe and explain the differences you would expect to find in the textures of regional and contact metamorphic rocks.

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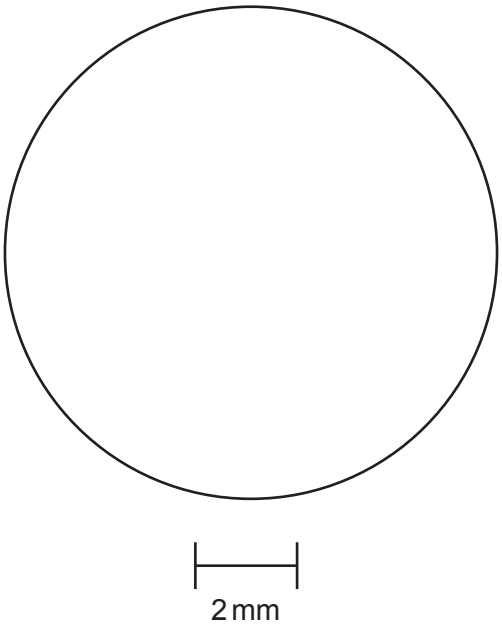
(iii) In the circle sketch the texture of the rock formed when a mudstone has been subjected to medium grade regional metamorphism.

Use the scale provided and label the minerals that are present.



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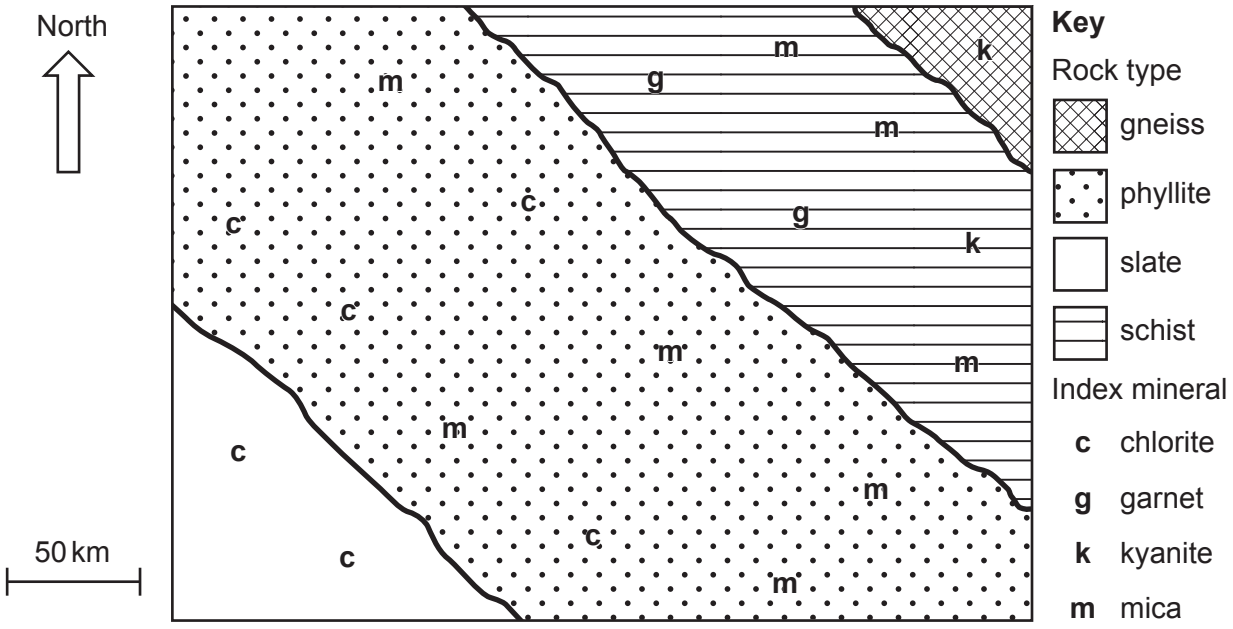
(c) The geological map shows the distribution of rock types and index minerals in an area that has undergone regional metamorphism.



(i) State what the term **index mineral** means.

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..... **[1]**

(ii) State the direction in which metamorphic grade increases on the geological map. Explain your answer.

Direction: .....

Explanation: .....

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..... **[3]**

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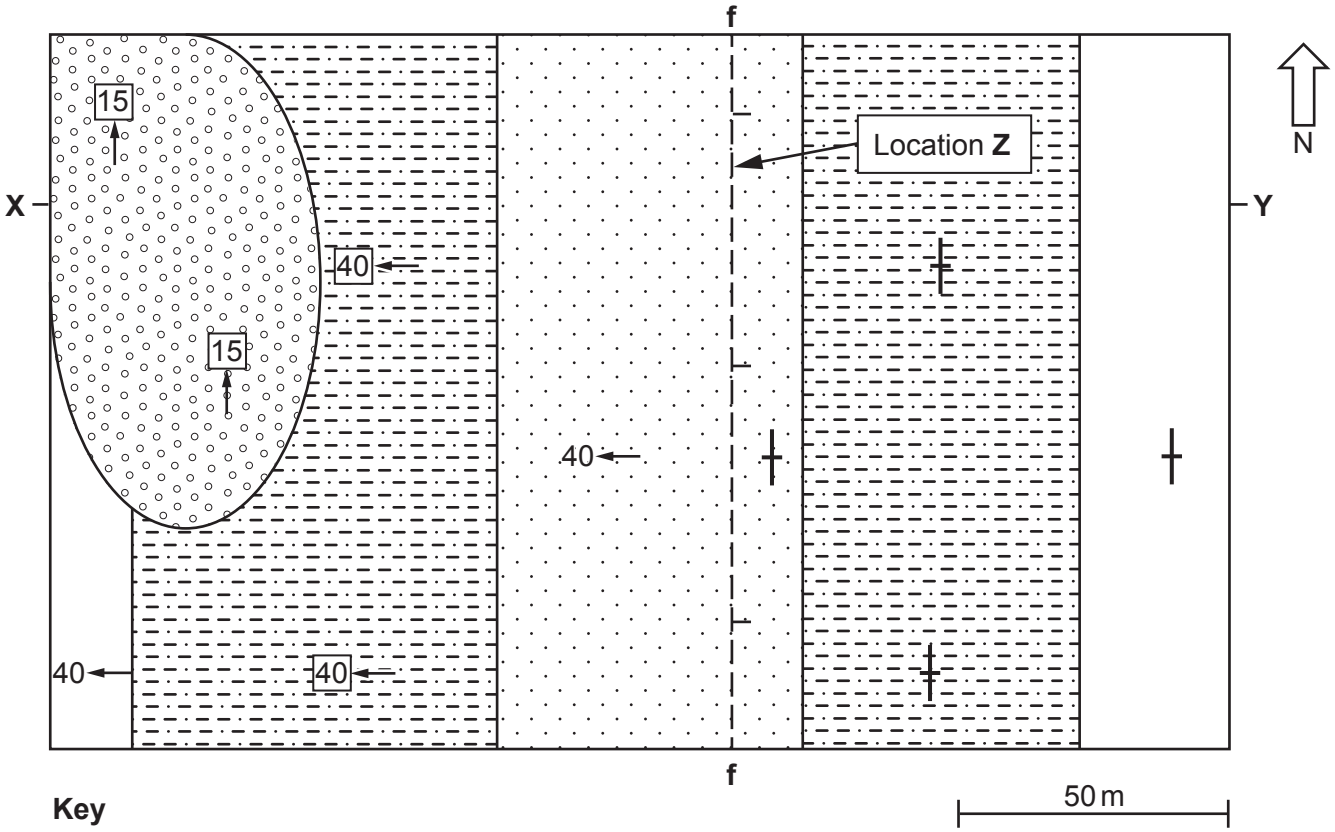
25 The diagram shows a geological map of a small area.



(a)

(i) Label the position of an unconformity on the geological map with an arrow labelled **U** (**U** →). Explain the reasons for your answer.

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..... **[3]**

(ii) The fault was measured in the field as dipping at 45° to the west. Describe how this measurement was made.

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..... **[2]**

(b)

(i) Draw a geological cross-section between **X** and **Y** from the geological map in the space below. Use the key from the geological map to show the beds and the fault which dips 45 °W. **[5]**

(ii) State the type of fault shown on the geological map and cross-section. Explain your answer.

Fault type: .....

Explanation: .....

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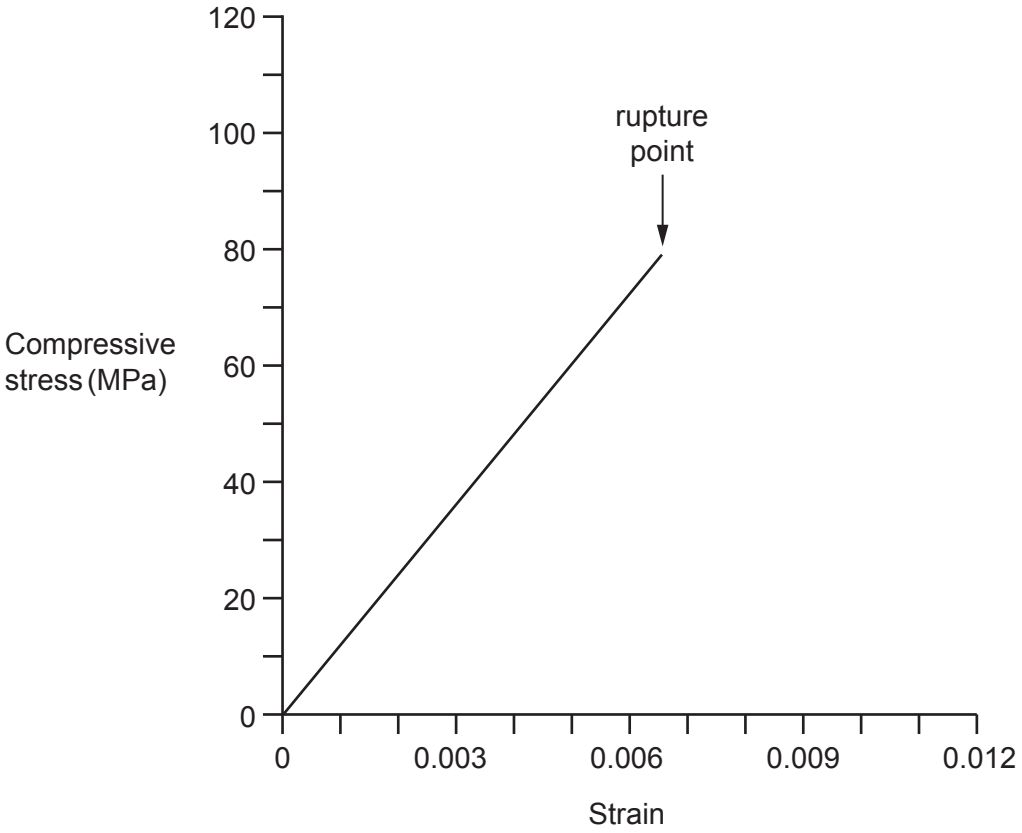
[3]

(c) The graph shows stress-strain for the Ordovician sandstone when subjected to compressive stress.



(i) The gradient of a stress-strain graph is a measure of a rock's stiffness.

Use the graph to calculate the stiffness of the Ordovician sandstone. Write your answer in standard form.

Stiffness = ... MPa **[2]**

(ii) Name the rock type likely to form at location **Z** on the geological map if the Ordovician sandstone was compressed beyond its rupture point as shown on the graph. Explain your answer.

Rock type: .....

Explanation: .....

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[3]

(iii) Sketch a stress-strain curve on the graph to show the effect of increased temperature when compressing the Ordovician sandstone. **[2]**

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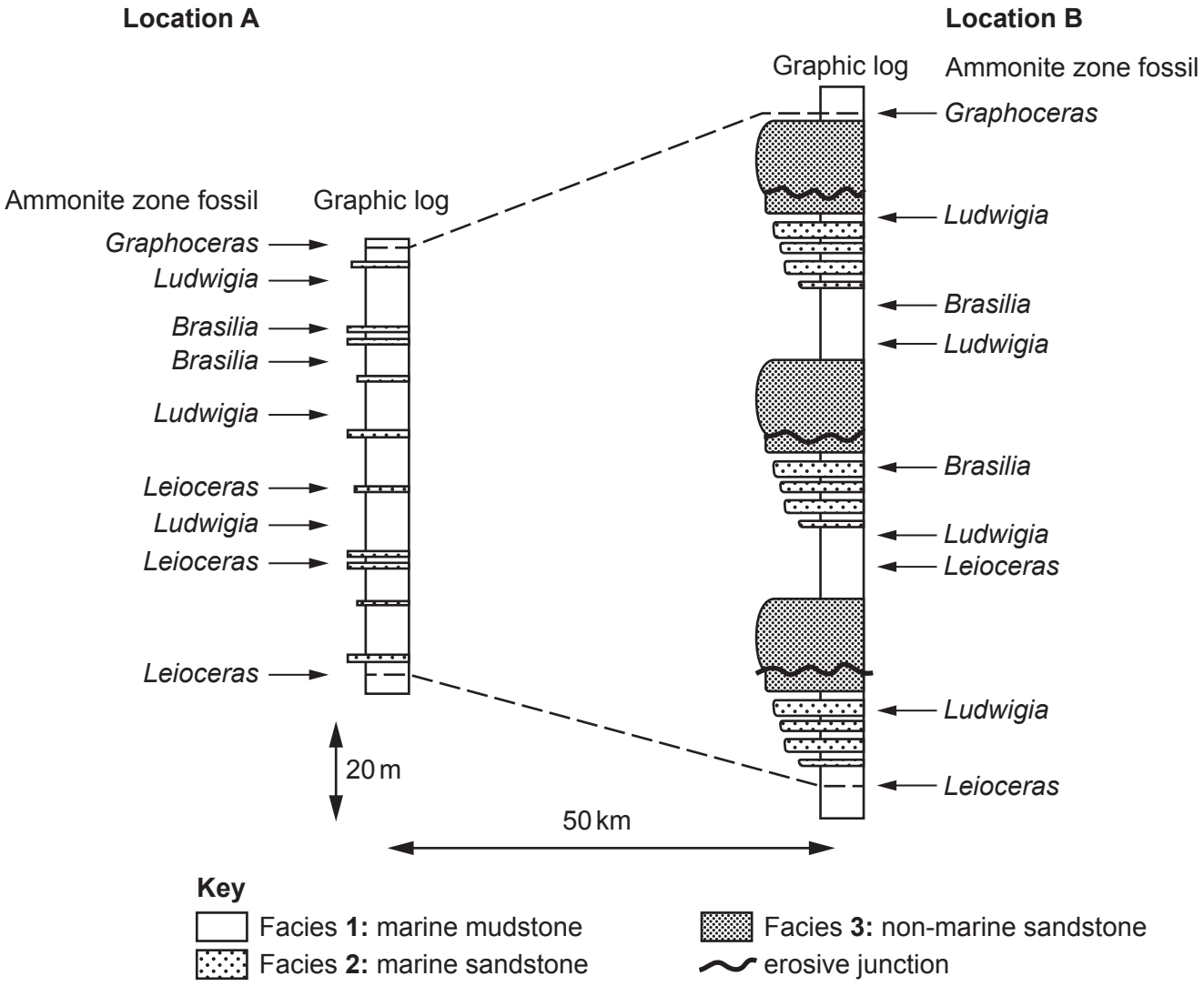
26 The diagram shows graphic logs from two locations (location **A** and location **B**). Ammonite zone fossils show that both sedimentary rock sequences were deposited at the same time in the Jurassic.



(a) Three facies types (**1**, **2** and **3**) are identified in these sedimentary rock sequences.

(i) Explain what the term **facies** means.

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..... **[1]**

(ii) State which **two** of the three facies types can be grouped into a facies association. Explain your answer.

Facies types: .....

Explanation: .....

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..... **[1]**

(iii) State the location (**A** or **B**) of the sedimentary sequence which was deposited furthest offshore. Explain your answer.

Location: .....

Explanation: .....

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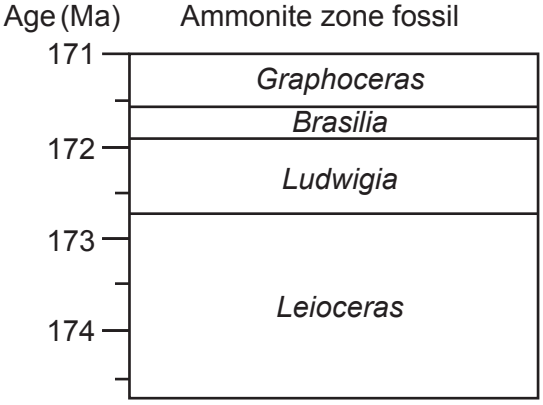
..... **[2]**

(b) The sedimentary rock sequences at locations **A** and **B** can be correlated using the first appearance of ammonites.

A biostratigraphic chart for these ammonite zone fossils is shown.



(i) Using the biostratigraphic chart, state which of the four ammonites in the chart is the best zone fossil. Explain your answer.

Ammonite: .....

Explanation: .....

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..... **[1]**

(ii) Complete the biostratigraphic correlation between locations **A** and **B** on the graphic logs using the first appearance of the ammonite zone fossils in the chart. Lines showing the correlation between locations **A** and **B** using the first appearance of *Leioceras* and *Graphoceras* have been drawn to help you. **[2]**

(iii) A good zone fossil should be found in different rock types and not restricted to a particular environment of deposition. Use the graphic logs to evaluate whether ammonites are good zone fossils.

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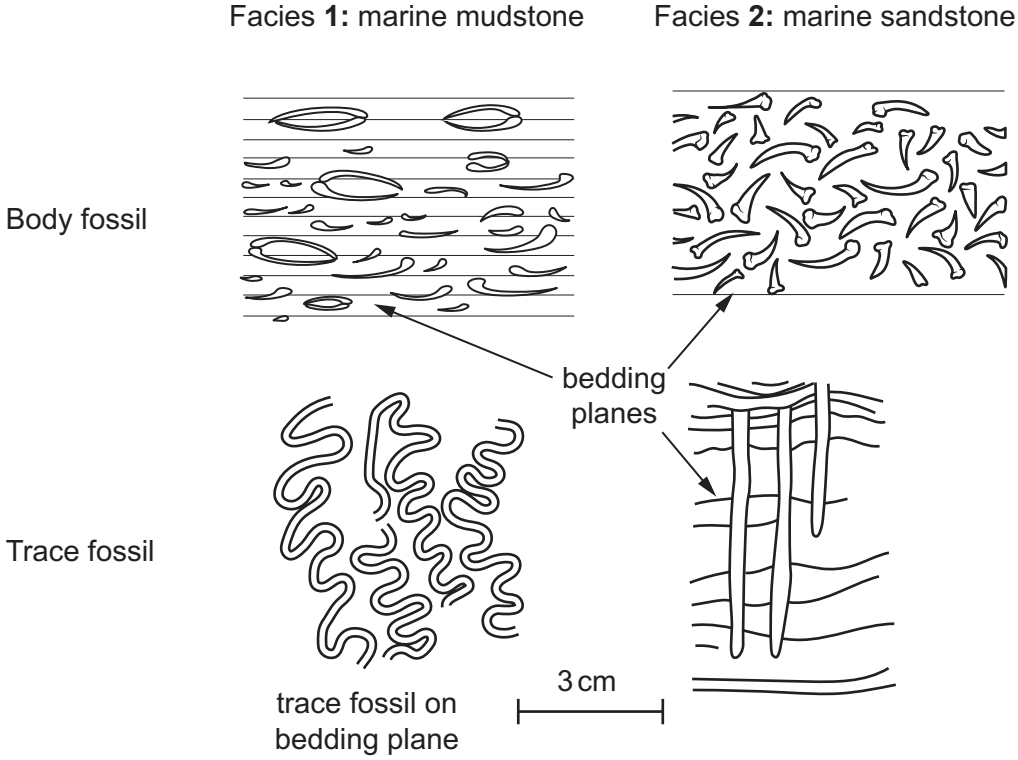
(c) The diagram shows the body and trace fossils found in facies **1** and facies **2** in the graphic logs.



Explain what these fossil assemblages suggest about the palaeoenvironment that operated during the deposition of facies **1** and facies **2**.

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END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.