OCR
Oxford Cambridge and RSA

Monday 13 May 2024 – 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

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 **36** pages.

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

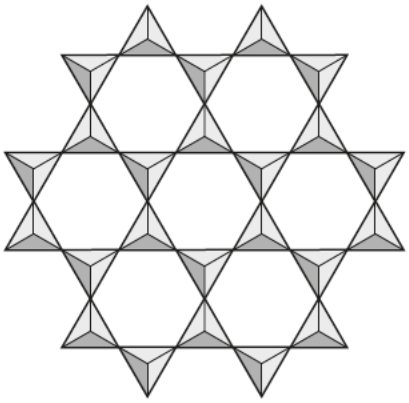
Section A

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

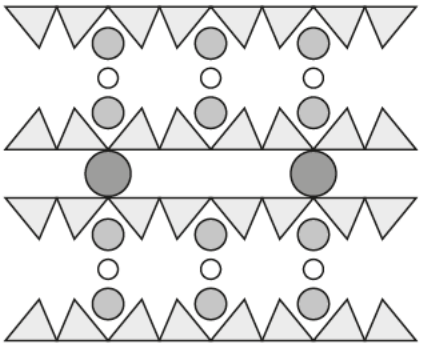
For each question write the letter in the box.

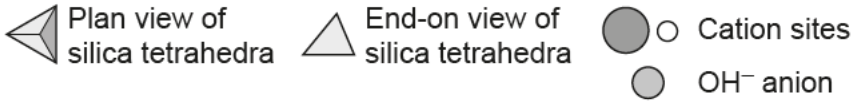
The diagrams show the atomic structure of the silicate mineral mica.
Questions **1** and **2** refer to these diagrams.

Plan view of mica's structure



End-on view of mica's structure





1 Which type of silicate structure is shown?

A Chain

B Framework

C Isolate

D Sheet

Your answer ☐ **[1]**

2 How many directions of cleavage does mica have?

A 0

B 1

C 2

D 3

Your answer ☐ **[1]**

3 Which of these minerals is **not** a silicate?

A Calcite

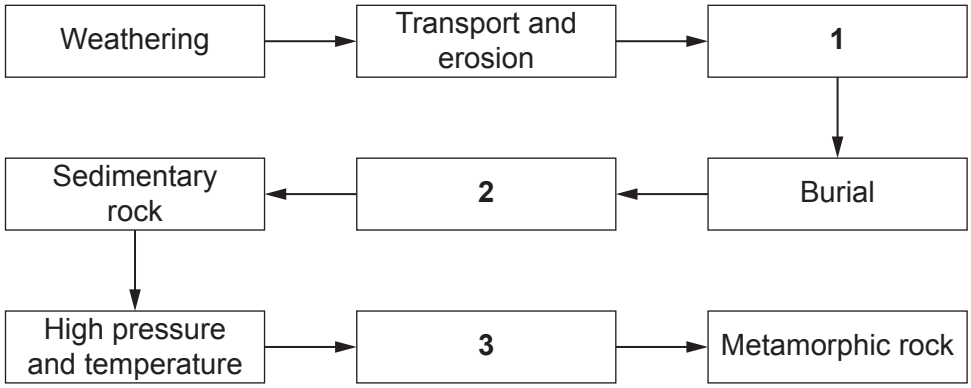
B Feldspar

C Mica

D Quartz

Your answer ☐ **[1]**

4 The diagram shows part of the rock cycle with three stages in the sequence shown as numbered boxes.



Which option correctly completes the numbered boxes in the sequence?

A **1** = deposition, **2** = lithification, **3** = recrystallisation

B **1** = deposition, **2** = recrystallisation, **3** = lithification

C **1** = lithification, **2** = deposition, **3** = recrystallisation

D **1** = lithification, **2** = recrystallisation, **3** = deposition

Your answer ☐ **[1]**

5 The original rock cycle that Hutton proposed was later changed by the addition of which process?

A Intrusion

B Melting

C Plate tectonics

D Uplift

Your answer [ ] **[1]**

6 Chemical weathering of pre-existing rocks produces sediments that go on to form sedimentary rocks.

What is the most common mineral produced by chemical weathering of pre-existing rocks?

A Clay

B Feldspar

C Olivine

D Quartz

Your answer [ ] **[1]**

7 Carbonate sedimentary rocks (limestones) can be classified using the Dunham classification scheme. The thin section diagram shows one type of limestone.

What name is given to this type of limestone using the Dunham classification scheme?

A Grainstone

B Mudstone

C Packstone

D Wackestone

Your answer [ ] **[1]**

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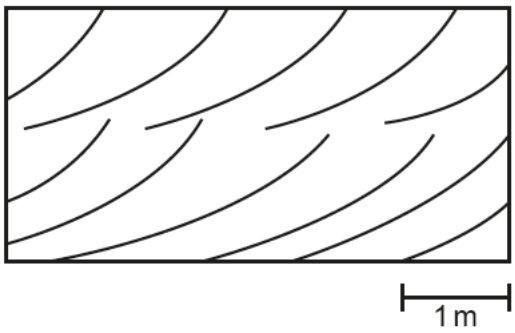
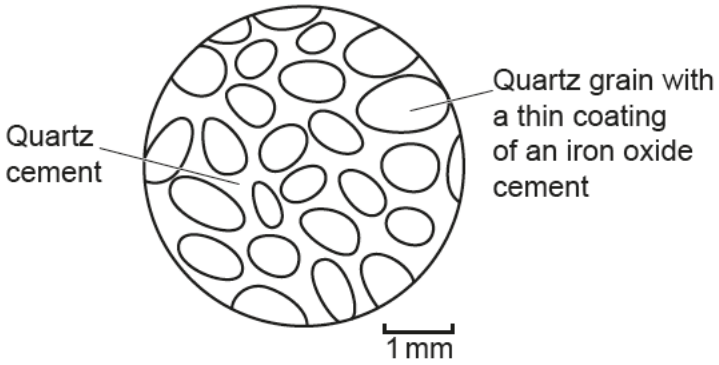
The diagrams show a sedimentary structure and a thin section from one sedimentary facies. The sedimentary rock has a complete absence of fossils.

Questions **8**, **9**, **10** and **11** refer to these diagrams.

Sketch of **sedimentary structure** in a vertical cliff face



Thin section diagram of a **sedimentary rock**



8 Which **sedimentary structure** is shown in the sketch diagram?

A Cross-bedding

B Graded bedding

C Imbricate structure

D Ripple marks

Your answer ☐ **[1]**

9 Which type of **sedimentary rock** is shown in the thin section diagram above?

A Arkose

B Conglomerate

C Desert sandstone

D Greywacke

Your answer ☐ **[1]**

10 Which environment is this sedimentary facies most likely to have been deposited in?

A Deep sea

B Desert

C Fluvial

D Shallow sea

Your answer ☐ **[1]**

11 Which other sedimentary facies can be grouped with the facies in **Question 10** to form a facies association that was deposited in the same sedimentary environment?

A Beach sandstones

B Continental slope cherts

C Flood plain siltstones

D Wadi breccias

Your answer ☐ **[1]**

12 Trace fossils preserve the activity of an organism, not the organism itself.

Which of these is **not** a valid use of trace fossils?

A To provide evidence of the diet of an organism

B To provide evidence of the locomotion of an organism

C To provide evidence of the palaeoenvironment in which the organism lived

D To provide evidence of the precise numerical age of an organism

Your answer ☐ **[1]**

13 Body fossils preserve the hard parts of an organism, such as the skeleton or shell. Geopetal structures are sometimes preserved within the hard parts of organisms.

For what purpose are geopetal structures commonly used?

A To indicate the maturity of a sequence of sedimentary rocks

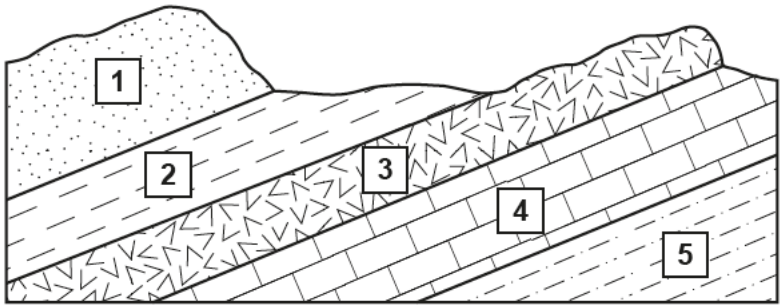
B To indicate the numerical age of a sequence of sedimentary rocks

C To indicate the palaeoenvironment of a sequence of sedimentary rocks

D To indicate the way up of a sequence of sedimentary rocks

Your answer ☐ **[1]**

14 The cross-section shows the geology of an area, with the rocks shown the right way up.



Rock units **1**, **2**, **4** and **5** are sedimentary. Rock unit **3** is igneous.

What deduction can be made regarding the relative age of rock unit **3** compared to rock unit **4**?

A Rock unit **3** is the same age as rock unit **4**

B Rock unit **3** is younger than rock unit **4**

C Rock unit **4** is younger than rock unit **3**

D The relative age of rock unit **3** and rock unit **4** cannot be determined

Your answer ☐ **[1]**

15 Which boundary corresponds to a **distinct** change in both physical state **and** chemical composition within the layered Earth?

A Boundary between the crust and mantle

B Boundary between the lithosphere and asthenosphere

C Boundary between the mantle and outer core

D Boundary between the outer and inner core

Your answer ☐ **[1]**

16 The table shows information on the mean density of the Earth's crust, mantle and whole Earth.

	Density ($g\,cm^{-3}$)
Crust	~ 2.8
Mantle	~ 4.4
Whole Earth	~ 5.5

Which option best describes the density of the Earth's core?

A $< 2.8\,g\,cm^{-3}$

B $\geq 2.8\,g\,cm^{-3}$ and $< 4.4\,g\,cm^{-3}$

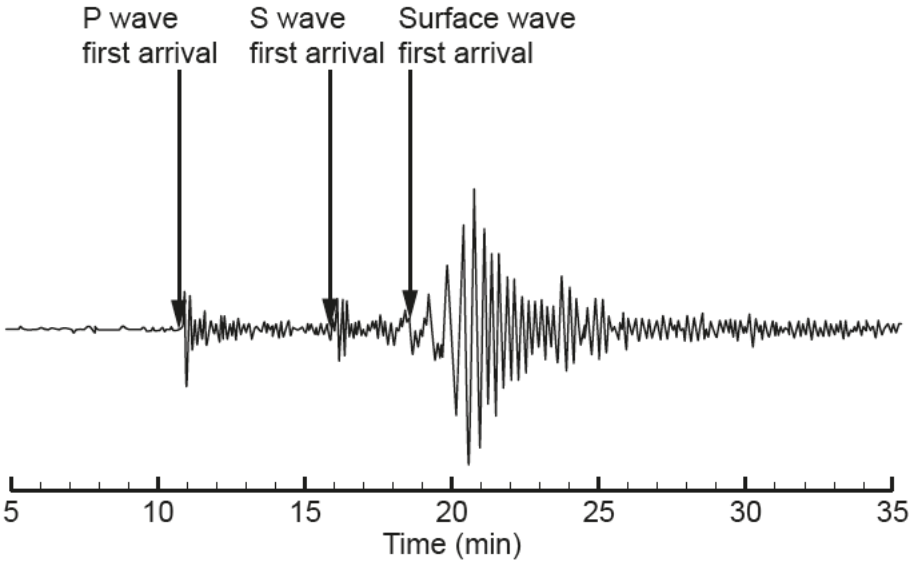
C $\geq 4.4\,g\,cm^{-3}$ and $< 5.5\,g\,cm^{-3}$

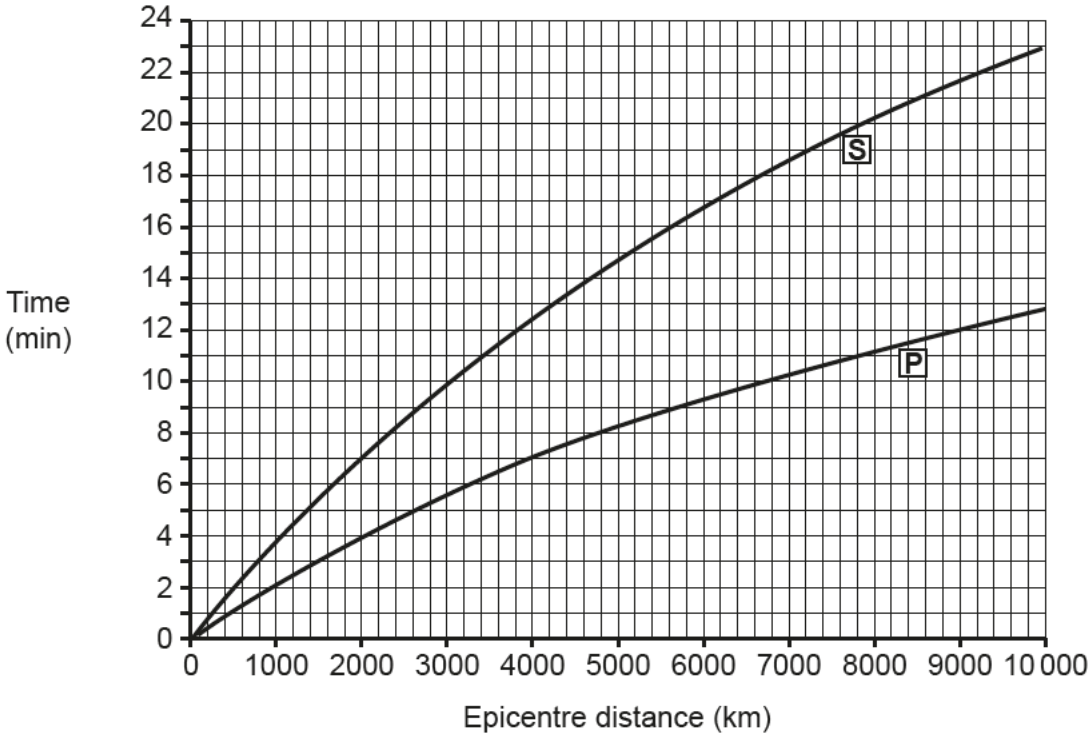
D $\geq 5.5\,g\,cm^{-3}$

Your answer ☐ **[1]**

17 The difference between the first arrival times of P and S waves on seismograms can be used by seismologists to locate the distance to the epicentre of an earthquake.

What is the most likely distance between the seismograph station, which recorded the seismogram below, and the epicentre of the earthquake that it detected? Use the P and S wave time-distance curves to help you.





A 2000 km

B 3000 km

C 4000 km

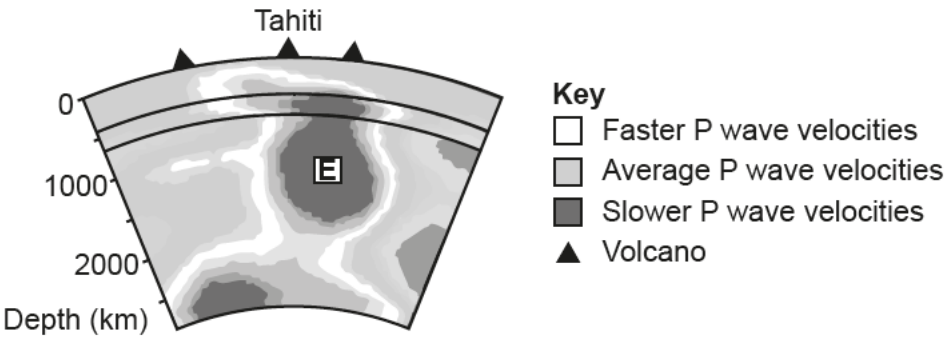
D 5000 km

Your answer ☐ **[1]**

18 The image below shows a 2D seismic tomographic cross-section beneath the island of Tahiti in the Pacific Ocean with slower than average and faster than average P wave velocities highlighted.

Identify the geological feature labelled **E** shown in this cross-section.

P wave Tomography



A Hot spot

B Kimberlite pipe

C Mantle plume

D Subduction zone

Your answer ☐ **[1]**

19 Which geophysical observation is **most likely** to indicate active subsurface intrusion and ascent of magma?

A An increase in magnetic field strength

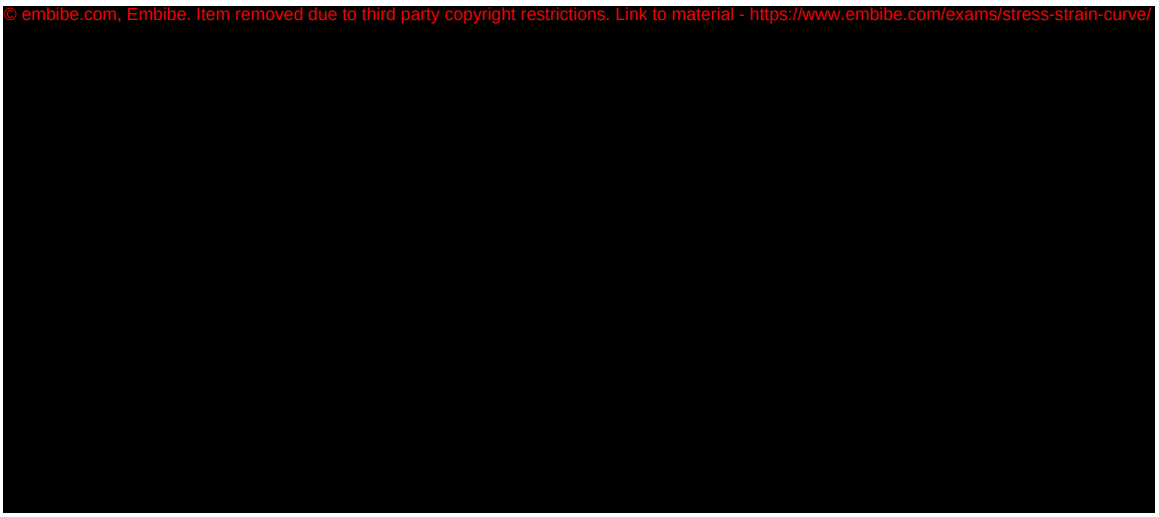
B An increase in volcanic gas emissions

C A reduction in geothermal gradient

D A reduction in seismic P wave velocities

Your answer ☐ **[1]**

20



Which of the four stress-strain curves on the graph (**1**, **2**, **3** or **4**) best shows how a competent rock would deform when compressed?

A Curve **1**

B Curve **2**

C Curve **3**

D Curve **4**

Your answer ☐ **[1]**

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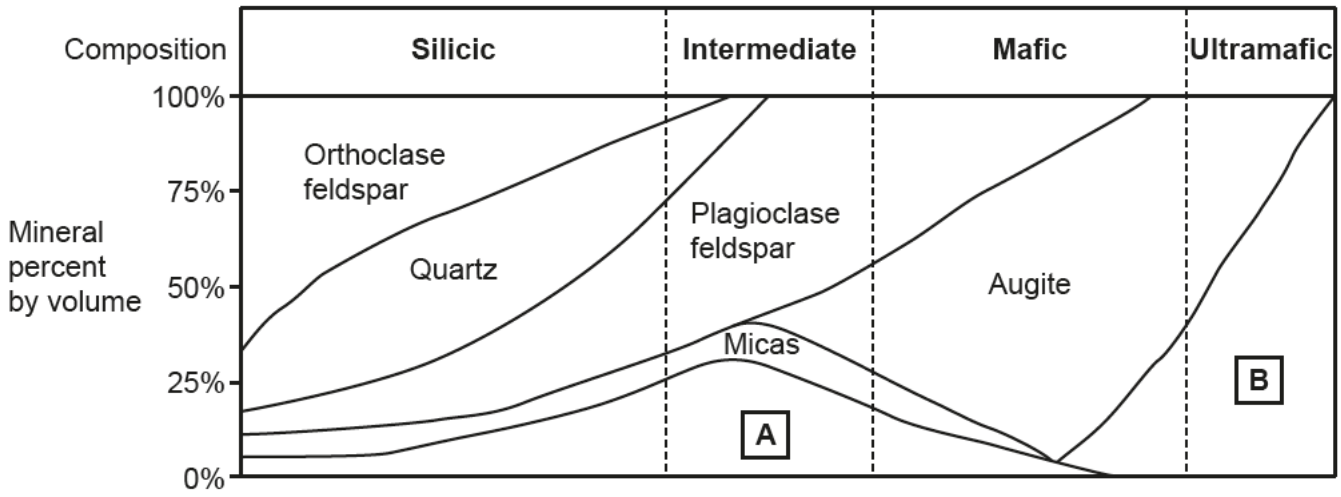
Section B

21 Igneous rocks can be classified based on their mineralogy and texture as shown in the classification diagram.



Texture	Rock Name			
Coarse	Granite	Diorite	D	Peridotite
Medium	C	Microdiorite	Dolerite	
Fine	Rhyolite	Andesite	Basalt	
Glassy	Obsidian			

(a)

(i) Name the correct minerals **and** igneous rocks labelled **A**, **B**, **C** and **D** on the classification diagram.

A .....

B .....

C .....

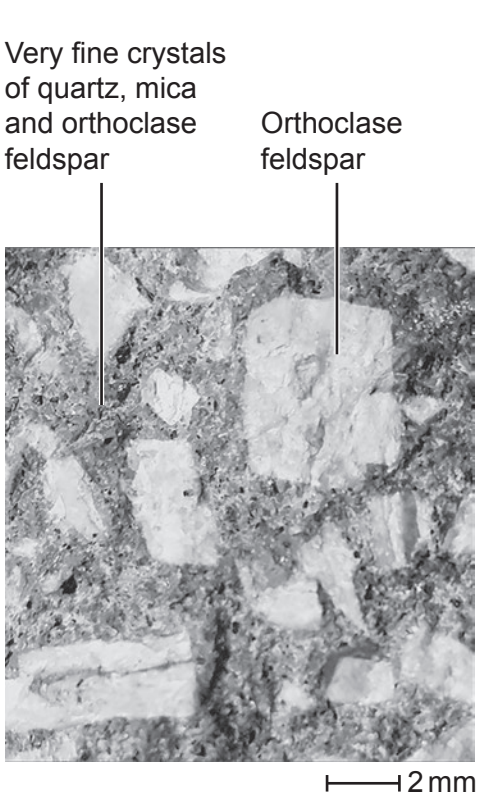
D .....

[4]

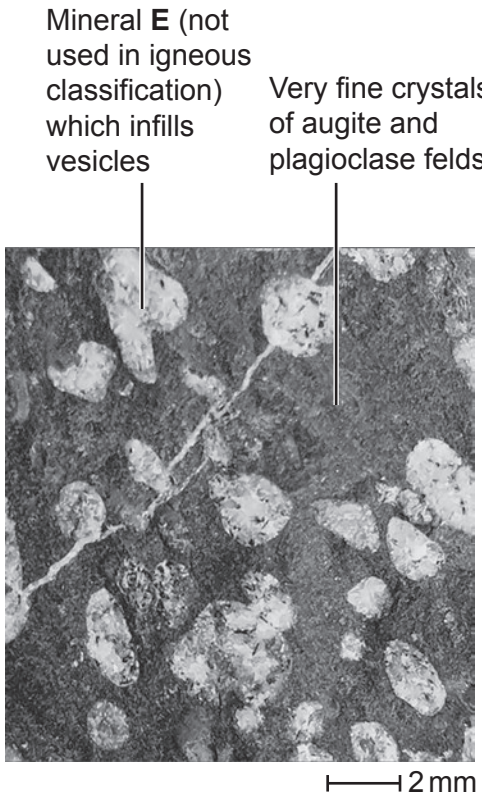
(ii) State the range used to define medium-crystal size in igneous rocks.

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

(b) The photographs show the mineralogy and texture of two different igneous rock types, **Y** and **Z**.



Rock **Y**



Rock **Z**

(i) Use the classification diagram to name the two igneous rocks, **Y** and **Z**.

Rock **Y** .....

Rock **Z** .....

[2]

(ii) State the name of the texture displayed by Rock **Z and** explain its origin.

Texture of Rock **Z** .....

Origin .....

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[3]

(iii) Compare and contrast the cooling histories of igneous rocks **Y** and **Z**. Explain your answer.

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

(c) Mineral **E** can be mistakenly identified as quartz or calcite during fieldwork.

Use the table and your knowledge of standard field equipment to describe how you could distinguish mineral **E** from quartz and calcite in the field.

Mineral	**Colour**	**Lustre**	**Streak**	**Cleavage**	**Density ($g\,cm^{-3}$)**	**Hardness**
E	White/ colourless	Vitreous/ silky/pearly	None	1	2.25	5
Quartz	White/ colourless	Vitreous	None	None	2.65	7
Calcite	White/ colourless	Vitreous/ pearly	White	3	2.71	3

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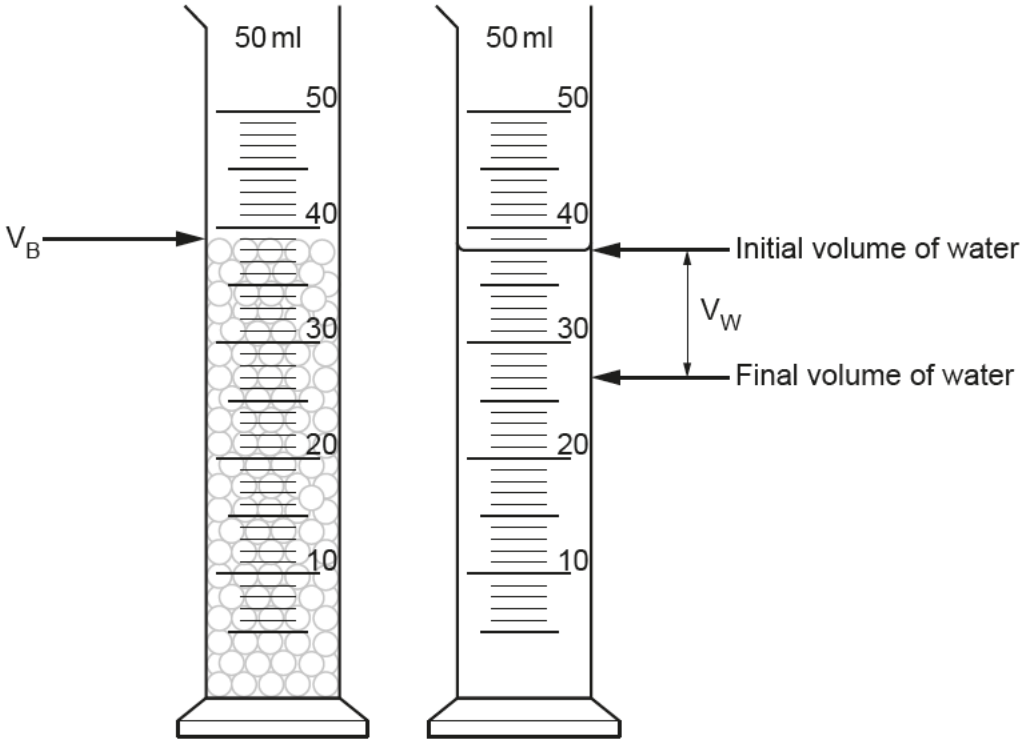
22 A student performed an experiment to investigate how porosity is influenced by sorting.

This is the method they followed:

- They used glass spheres of diameter 8 mm and 4 mm to represent grains of quartz.
- They mixed different proportions of these glass spheres to vary the sorting.
- They placed each mixture of glass spheres into a measuring cylinder.
- They measured the combined volume of the glass spheres and pore space (V_B).
- They poured water from a second measuring cylinder up to the level of the top of the glass spheres.
- They determined the volume of water required to fill the pore space between the glass spheres (V_W).
- They calculated the porosity of each mixture of glass spheres.

The apparatus used to perform the experiment and the student's results when using 50% 8 mm glass spheres are shown in the diagram. All results are shown in the table.



Sorting – Proportion of 8 mm glass spheres in the total population of glass spheres (%)	Porosity (%)
0	39
10	35
20	32
30	31
40	29
50	

(a)

(i) Use the diagram to determine the combined volume of the glass spheres and pore space (V_B) and the volume of water required to fill the pore space (V_W) when using 50% 8 mm glass spheres.

V_B = …… ml

V_W = …… ml **[2]**

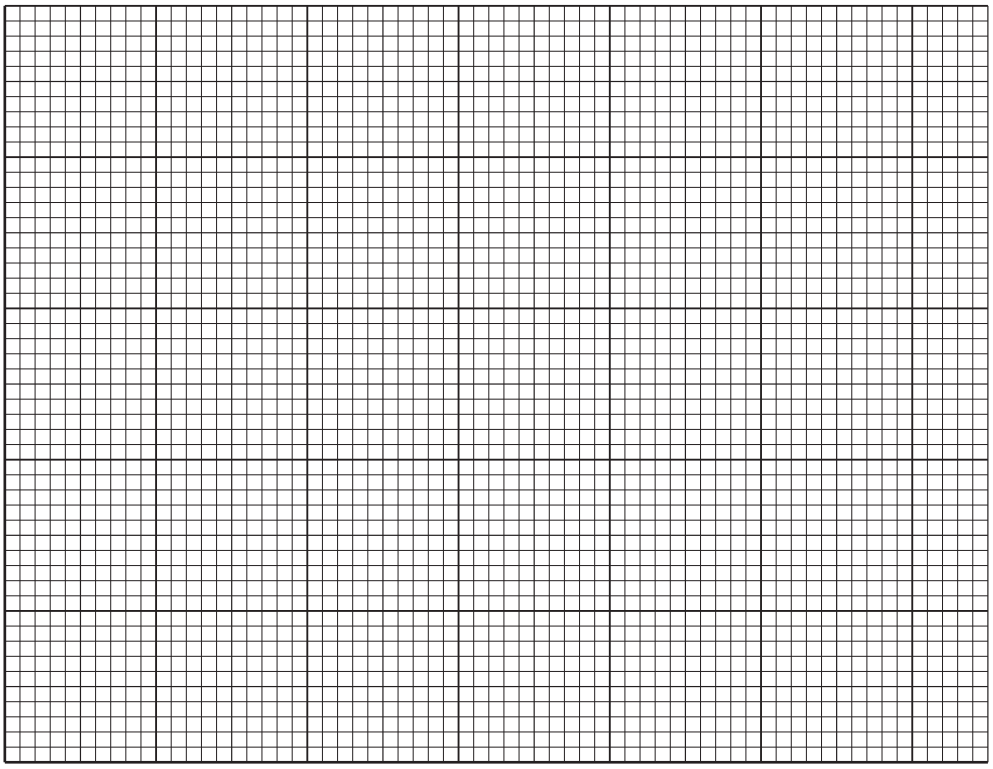
(ii) Calculate the porosity of the glass sphere mixture in the diagram.
Use the formula:

$$\text{Porosity (\%)} = \frac{V_W}{V_B} \times 100$$

Write your answer to **2** significant figures.

Porosity = ... % **[1]**

(iii) Plot a line graph of the data from the table to show the relationship between porosity and sorting.



[3]

(iv) Describe and explain the data that you have plotted.

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

(b)

(i) Use the diagram of the measuring cylinders to calculate the percentage error (uncertainty) in your value of V_W.

Percentage error (uncertainty) = ... % **[2]**

(ii) Explain how the percentage uncertainty in your value of V_W could be reduced.

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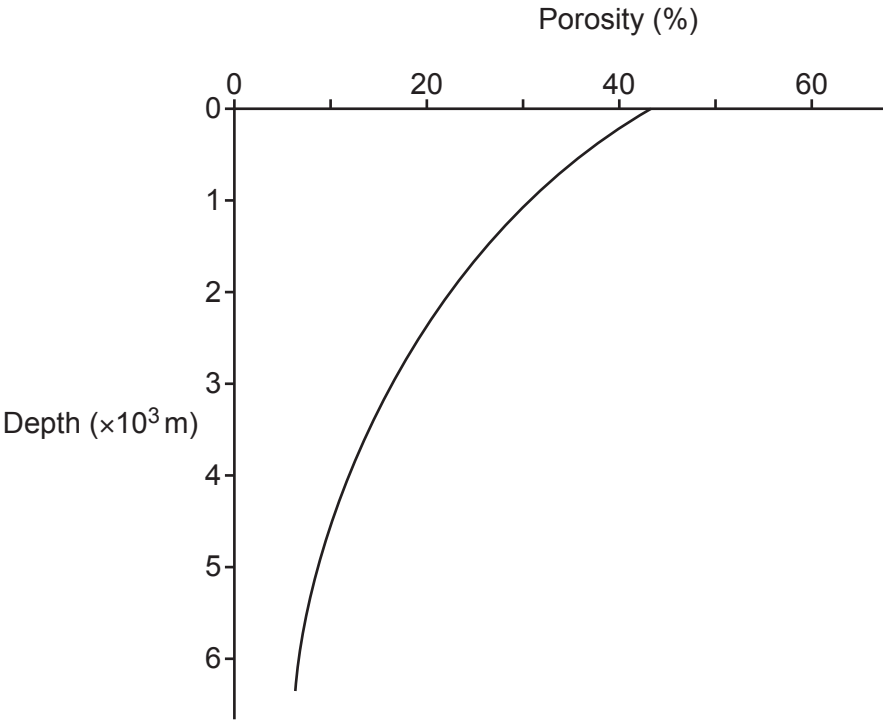
..... **[2]**

(c) The graph below shows how porosity changes as a sand is buried and lithified to form a sandstone.



(i) Use the graph to describe how porosity changes with depth.

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

(ii)* Explain how diagenetic processes result in the changes in porosity shown on the graph as a sand is buried and lithified to form a sandstone.

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Extra answer space if required

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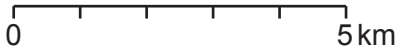
23 Despite being located at a divergent plate boundary, the island of Iceland displays a wide range of volcanic landforms and lava types. Data on two contrasting types of Icelandic volcano, Volcano **W** and Volcano **X**, are shown in the table below.

Volcano **W**

Description of volcanic rocks: primarily mafic lavas with rare pyroclastic deposits of volcanic ash.

Cross-section:

Horizontal scale = vertical scale



Type of volcano: Shield

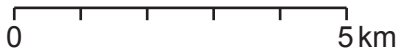
Slope angle: ~ 9°

Volcano **X**

Description of volcanic rocks: alternating layers of silicic, intermediate and mafic lavas and pyroclastic deposits including volcanic ash and pumice.

Cross-section:

Horizontal scale = vertical scale



Type of volcano: .....

Slope angle: .....°

(a)

(i) Complete the table for Volcano **X**.

- State the type of volcano.
- Estimate the slope angle. **[2]**

(ii) Lavas from volcanoes like Volcano **W** are usually erupted at higher temperatures than those like Volcano **X**.
Describe **one** technique used to measure the temperature of the lavas erupting from a volcano.

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

(iii)* Explain the geological reasons why the hazards of volcanoes like Volcano **W** generally present less risk to local buildings and people than volcanoes like Volcano **X**.
In your answer you must discuss the geological reasons and hazards for both volcanoes.

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Extra answer space if required

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(b) One reason for the variety of lava types in Iceland is a process called **gravity settling**.

During gravity settling, silica-poor minerals sink to the bottom of a magma chamber, making magma at the top of the magma chamber and any associated erupted lavas more silica-rich.

Practical investigations to model gravity settling can be carried out in a school science laboratory using:

- sweets such as Skittles^{TM} to represent sinking minerals
- sugar solution in a boiling tube to represent magma.

Write a brief plan for a practical investigation to show how the speed of sinking minerals (Skittles^{TM}) is influenced by the density of magma (sugar solution).

Your plan should include:

- any additional equipment that you will need
- how you will obtain your data
- which variable you will change
- how you will numerically process this data.

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

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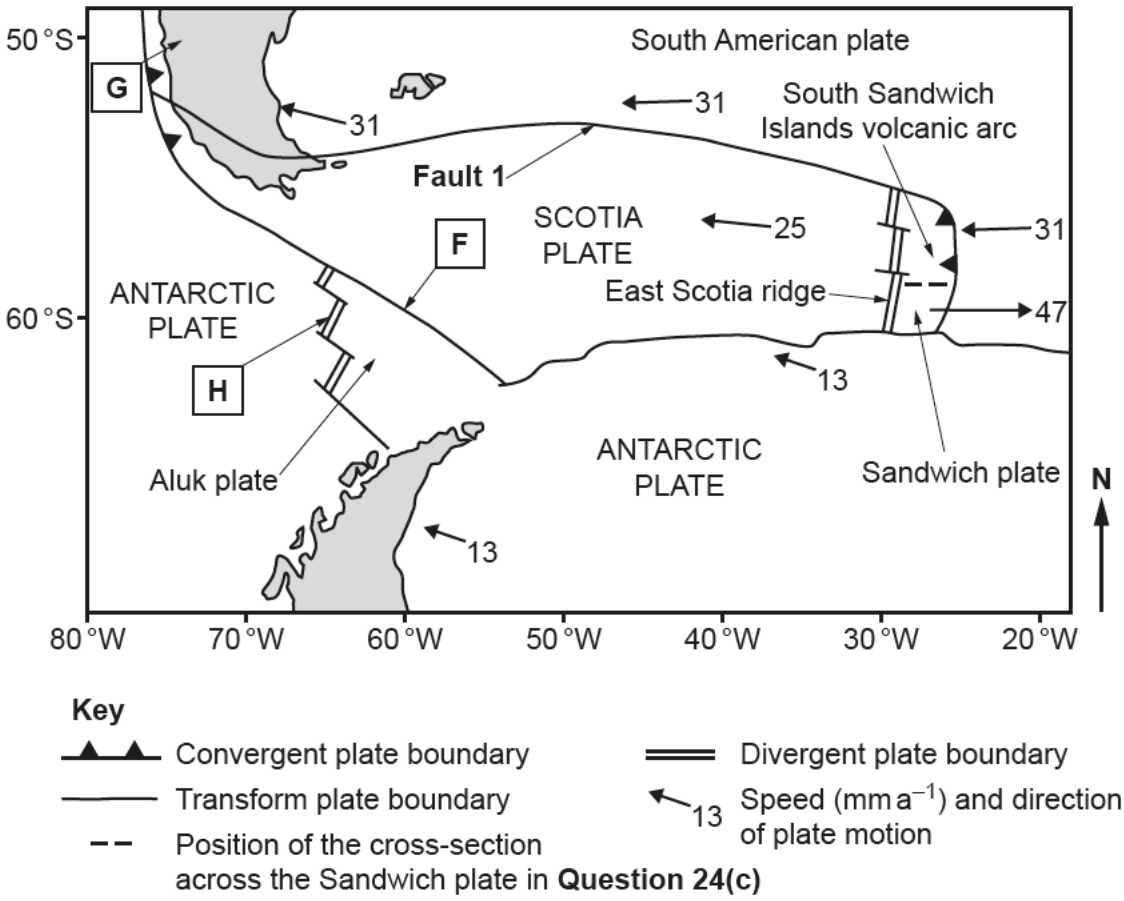
24 The map shows the simplified tectonic setting of part of the South Atlantic and Antarctic Oceans.



(a) Use your knowledge of plate tectonics to identify which of the geological features in the table will be found at locations **F**, **G** and **H** on the map.

Tick (✓) the correct box in the table for each feature.

Geological feature	F	G	H
Graben (rift)			
Fold mountains			
Shear dominated structures			

[2]

(b)

(i) State the name of the method that can be used to accurately measure the speed and direction of current plate motion.

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

(ii) Use the data on the map to calculate the rate of seafloor spreading at the East Scotia ridge.

Rate of seafloor spreading = ... Unit = ... **[1]**

(iii) Using the data on the map only, state the evidence for a convergent plate boundary to the east of the East Scotia ridge.

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

(iv) Determine the speed and direction of movement of the South American plate relative to the Scotia plate across **Fault 1**.

Use your answer to identify the type of fault represented by **Fault 1** on the map.

Relative speed = ... Unit = ...

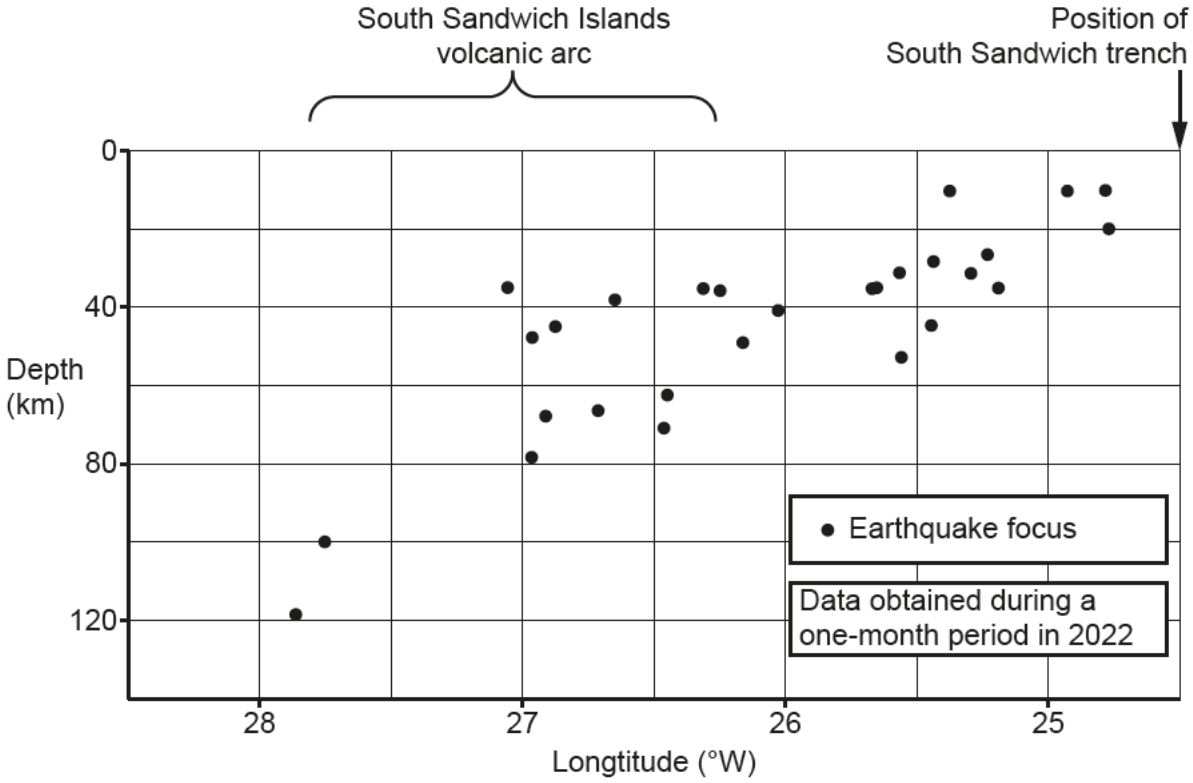
Direction of plate movement .....

Type of fault represented by **Fault 1** .....

[3]

(c) The cross-section shows the distribution of earthquake foci generated as the South American plate subducts beneath the Sandwich plate.

The location of this cross-section is shown on the previous map.



(i) State the name given to the zone of earthquake foci sloping down from the South Sandwich trench on the cross-section.

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

(ii) Draw a **straight** line on the cross-section to show the likely position of the boundary between the Sandwich and South American plates beneath the Earth's surface. **[1]**

(iii) Explain why there is a high level of uncertainty in drawing in this boundary.

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

(iv) Calculate the gradient of your straight line. State the units.

Gradient = ... Unit = ... **[3]**

(v) Explain how the magma which produces volcanoes in the South Sandwich Islands is generated.

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

(d) During the past few decades, the idea that active mantle convection is the main force driving plate motion has been questioned. Instead, the processes of ridge push and slab pull have been proposed to be more important in driving the motion of tectonic plates.

Explain how the idea of active mantle convection has been developed into the more sophisticated models of ridge push and slab pull.

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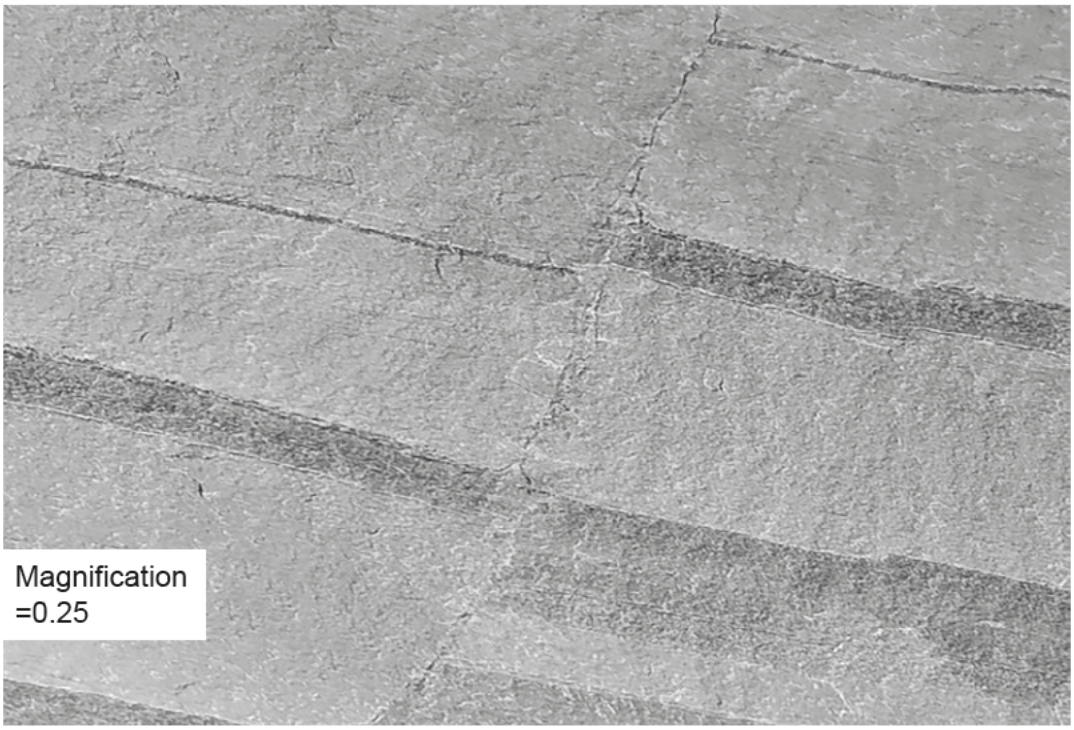
..... **[4]**

25 The photograph shows part of a vertical cliff section of dipping Mesozoic shales and sandstones offset by a fault. The photograph has been taken parallel to both the strike of the bedding planes and the fault plane looking southwards, so that the true dip of the fault plane and bedding planes can be measured.

East West



East West

Magnification
=0.25

(a)

(i) In the blank box, draw a sketch of the geological features displayed in the photograph. **[4]**

(ii) Measure the dip angle and dip direction of the fault plane and bedding planes in the photograph. Write your answers in the table below.

Geological structure	Dip angle and dip direction
Fault plane	
Bedding planes	

[2]

(iii) Use the magnification to estimate the amount of throw across the fault plane.

= ..... cm **[2]**

(iv) State the type of fault shown in the photograph. Explain your answer.

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

(v) Evaluate the statement, 'the fault in the photograph was formed by east-west directed tensile stresses at a convergent plate boundary during the Caledonian orogeny'.

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

(b) Explain how earthquakes are generated when rocks are faulted.

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26 The diagram shows the results of an electromagnetic survey across the Mohns Ridge in the North Atlantic Ocean. The age of the ocean floor rocks with distance from the ocean ridge is indicated.

Resistivity is an electromagnetic surveying technique. It is when a time-varying magnetic field is generated at the surface of the earth that produces a time-varying electrical current in the earth through induction.

(a) Use the data from the diagram to calculate the rate of seafloor spreading in this area of the north Atlantic Ocean. Give your answer in cm a^{-1}.

= .....cm a^{-1} **[3]**

(b)

(i) The Moho discontinuity is positioned where there is a sudden increase in resistivity with depth from the seafloor to values above 3 log Ωm.

Draw a line labelled **M** across the diagram to show the position of the Moho discontinuity. **[1]**

(ii) Tick (✓) the box below that best describes the changes that take place across the Moho discontinuity.

Passing from solid silicic rocks to solid mafic rocks	Passing from solid silicic rocks to partially molten mafic rocks	Passing from solid intermediate rocks to solid mafic rocks	Passing from solid mafic rocks to partially molten ultramafic rocks	Passing from solid mafic rocks to solid ultramafic rocks
☐	☐	☐	☐	☐

[1]

(iii) The base of the lithosphere is positioned where there is a decrease in resistivity with depth from the seafloor to values less than 2.5 log Ωm.

Draw a line labelled **L** across the diagram to show the position of the base of the lithosphere. **[1]**

(iv) Explain why resistivity values decease when passing from the lithosphere to the asthenosphere.

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

(c) Suggest how magma is generated beneath divergent plate boundaries such as the Mohns ocean ridge.

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

END OF QUESTION PAPER

EXTRA ANSWER SPACE

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