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Total

# X043/301

NATIONAL QUALIFICATIONS 2008

MONDAY, 19 MAY 1.00 PM – 3.30 PM

# GEOLOGY HIGHER

**Fill in these boxes and read what is printed below.**

Full name of centre

Town

Forename(s)

Surname

Date of birth
Day Month Year

Scottish candidate number

Number of seat

1 This paper consists of three sections A, B and C. You are advised to spend about 1 hour on Section A, half an hour on Section B and 1 hour on Section C.

2 You should attempt **all** of the questions in Sections A and C and only **one** question in Section B.

3 All answers should be written in the spaces provided in this answer book and should be written clearly and legibly in ink.

4 The marks allocated to each question or part of a question are shown at the end of each question or part of a question.

5 Additional space for answers or rough work will be found at the end of this book. If further space is required, supplementary sheets may be obtained from the invigilator and should be inserted inside the **front** cover of this booklet. You should draw a line through anything which you do not wish the examiner to mark.

6 Before leaving the examination room you must give this book to the invigilator. If you do not, you may lose all the marks for this paper.

Marks

## SECTION A

**All questions in this section should be attempted. Forty marks are allocated to this section.**

**1.** (*a*) Complete the blanks in the table below by selecting from the word box.

| Cross hatched twinning, olivine, pyroxene, quartz, pleochroic, biotite. |
|---|

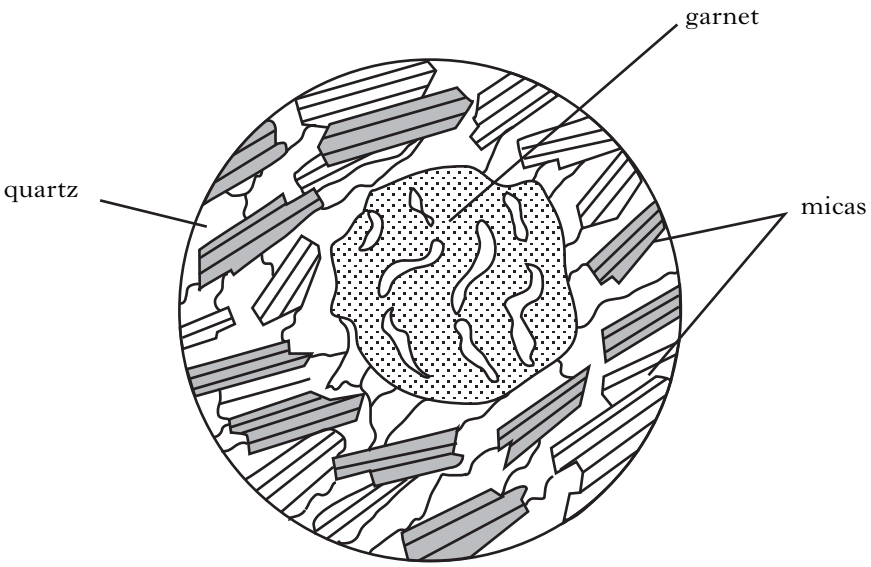
| *Optical properties* | *Name of mineral* |
|---|---|
| Low relief<br>No twinning<br>White to grey polarisation colours | |
| High relief<br>Cracked appearance<br>Colourless in PPL<br>Bright green to blue in XPL | |
| | Amphibole |
| High relief<br>One perfect cleavage<br>Pleochroic brown to yellow | |
| High relief<br>Two cleavages at 90°<br>Bright blue in XPL | |
| | Microcline |

3

*Marks*

**1. (continued)**

The sketch below shows a thin section of a metamorphic rock.




(*b*) (i) Name the rock.

..... **1**

(ii) What term is given to the alignment of platy minerals in this rock?

..... **1**

(iii) Explain how this rock would have been formed.

.....

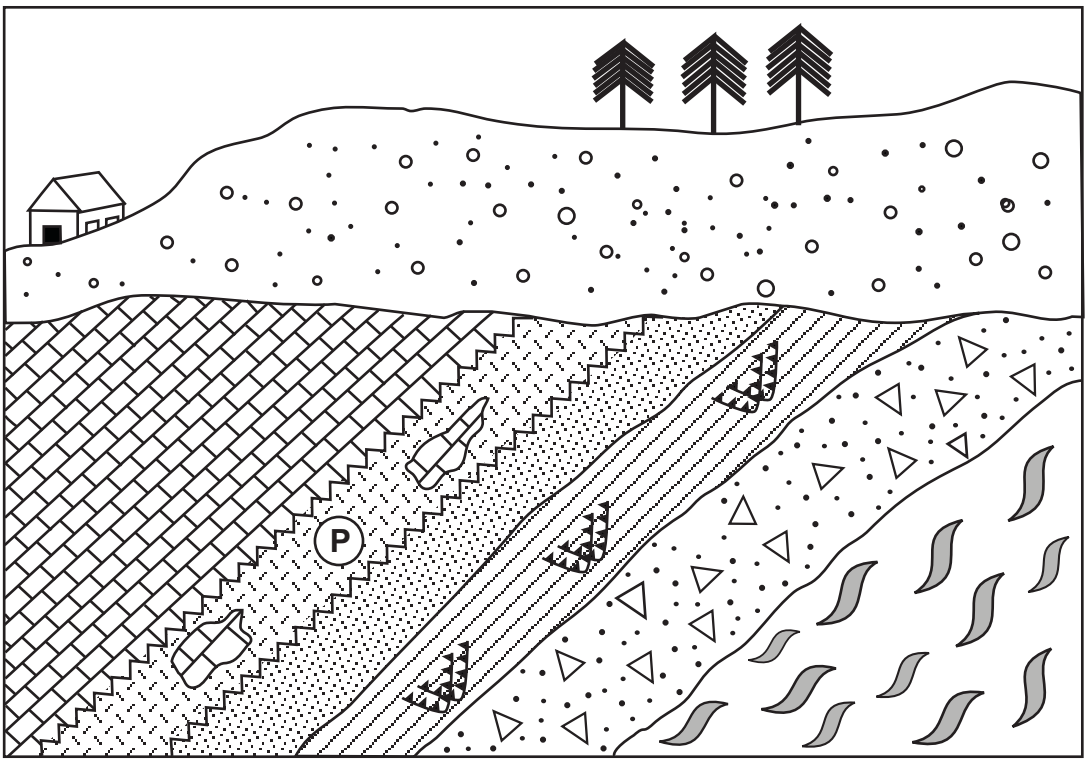
.....

.....

..... **2**

**[Turn over**

**2.** The field sketch below shows an exposed section in a road cutting.




**Key**

 gneiss

 chilled margin

 breccia

 rock P

 shale with graptolites

 limestone

 sandstone

 conglomerate

*Marks*

**2. (continued)**

Which **three** of the following statements are correct?

A Corals are more reliable zone fossils than graptolites.

B The shale was deposited on a lake bed.

C There are two unconformities shown, one of which is angular.

D Rock P is a sill.

E Rock P is a lava flow.

F Conglomerate is the youngest.

G Breccia is the oldest.

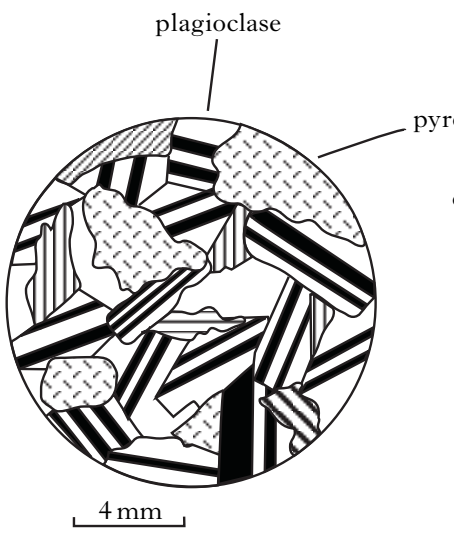
Give only the letters: ....., ..... and ..... **3**

**[Turn over**

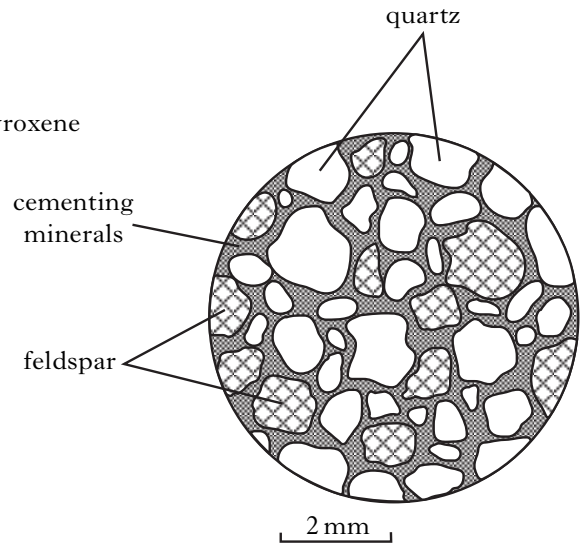
*Marks*

**3.** Look at the two thin sections below.

**Rock P**




**Rock Q**




(*a*) Name rock P.

Rock P is .....

Give **two** reasons for your answer.

Reason 1 .....

.....

Reason 2 .....

..... **3**

(*b*) Name rock Q.

Rock Q is .....

Give **a reason** for your answer.

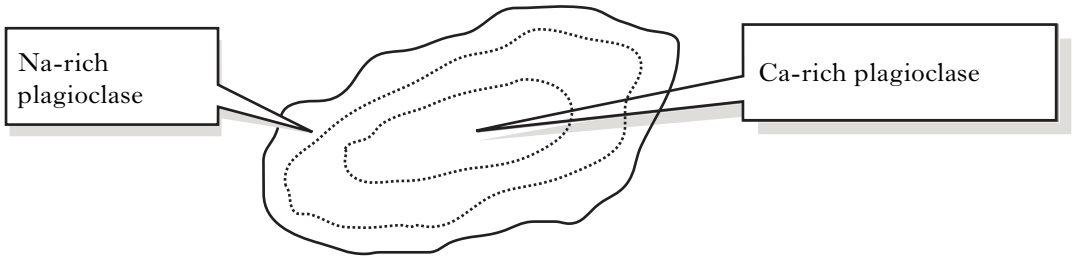
Reason .....

..... **2**

*Marks*

**3. (continued)**

(*c*) Detailed examination of the plagioclase in rock P shows it to be zoned as shown in the diagram below.




**Explain** how this zoned crystal formed.

Explanation .....

.....

..... **2**

**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**4.** The oxide contents of four **igneous rocks** are shown in the table below.

| *Mass % oxide* | *Rock P* | *Rock Q* | *Rock R* | *Rock S* |
|---|---|---|---|---|
| $SiO_2$ | 70 | 60 | 50 | 43 |
| $Al_2O_3$ | 15 | 16 | 14 | 4·0 |
| $Fe_2O_3$ + FeO | 3·0 | 7·2 | 12 | 12 |
| MgO | 0·8 | 3·0 | 8·5 | 34 |
| CaO | 2·0 | 10 | 11 | 3·5 |
| $Na_2O$ | 3·2 | 2·2 | 2·7 | 0·5 |
| $K_2O$ | 5·0 | 1·6 | 0·3 | 0·25 |
| Others | 1·5 | 0 | 1·5 | 2·75 |

(*a*) Which rock contains the most quartz?

Rock ..... **1**

(*b*) Which rock will contain the most olivine?

Rock ..... **1**

(*c*) Explain why rock S has the highest density.

.....

..... **1**

(*d*) Explain how rock R could be formed from rock S.

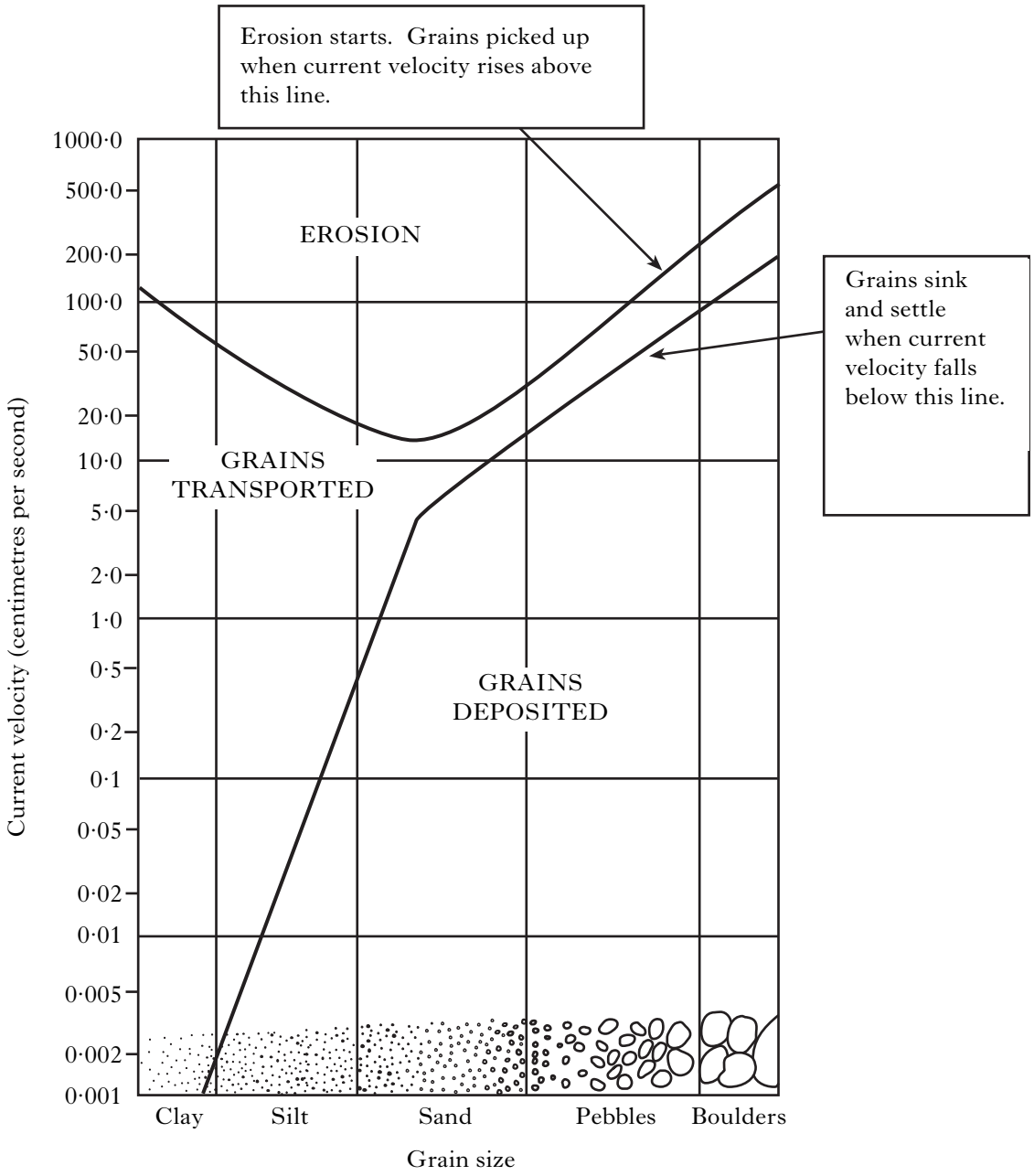
.....

.....

..... **1**

**[Turn over for Question 5 on *Page ten***

**5.** Look at the diagram below. It shows how different grain sizes are transported, eroded and deposited by a river.



*Marks*

**5. (continued)**

Choose the correct **three** statements from the list below. Give only the letters in the spaces at the bottom.

A Clay-sized particles are transported over a wide range of velocities and are deposited in very low energy conditions.

B Clay particles are eroded at higher velocities than boulders.

C Pebble-sized particles are transported over a wider velocity range than silt-sized particles.

D Sand-sized particles are eroded at the lowest velocities.

E As velocity decreases, sediment is deposited with the largest grain size first.

F Clay-sized particles are eroded at lower velocities than sand-sized particles.

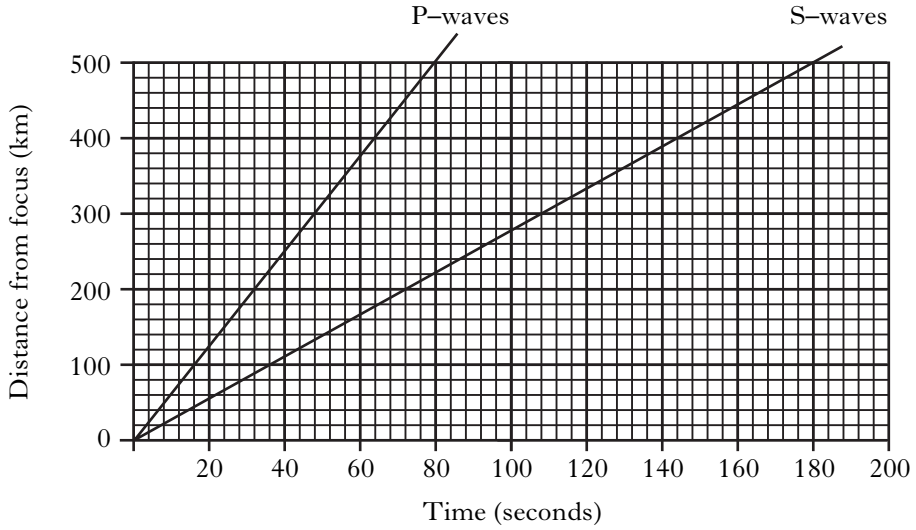
G As velocity decreases, clay-sized particles are deposited before silt and sand.

Give only the letters: ....., ..... and ..... **3**

**[Turn over**

**6.** Look at the graph below.

**Travel time lines for P– and S–waves**




Choose **three** correct statements about the graph above.

A The graph shows that S–waves travel faster than P–waves.

B P–wave velocity is approximately 6 km/sec.

C The graph shows that S–waves travel slower than P–waves.

D S–wave velocity is approximately 0·3 km/sec.

E The difference between the arrival of P–waves and S–waves is called the lag time.

F The focus of an earthquake is above the epicentre.

G S–wave velocity is higher at 200 km from the focus than at 100 km from the focus.

Give only the letters: ....., ..... and ..... **3**

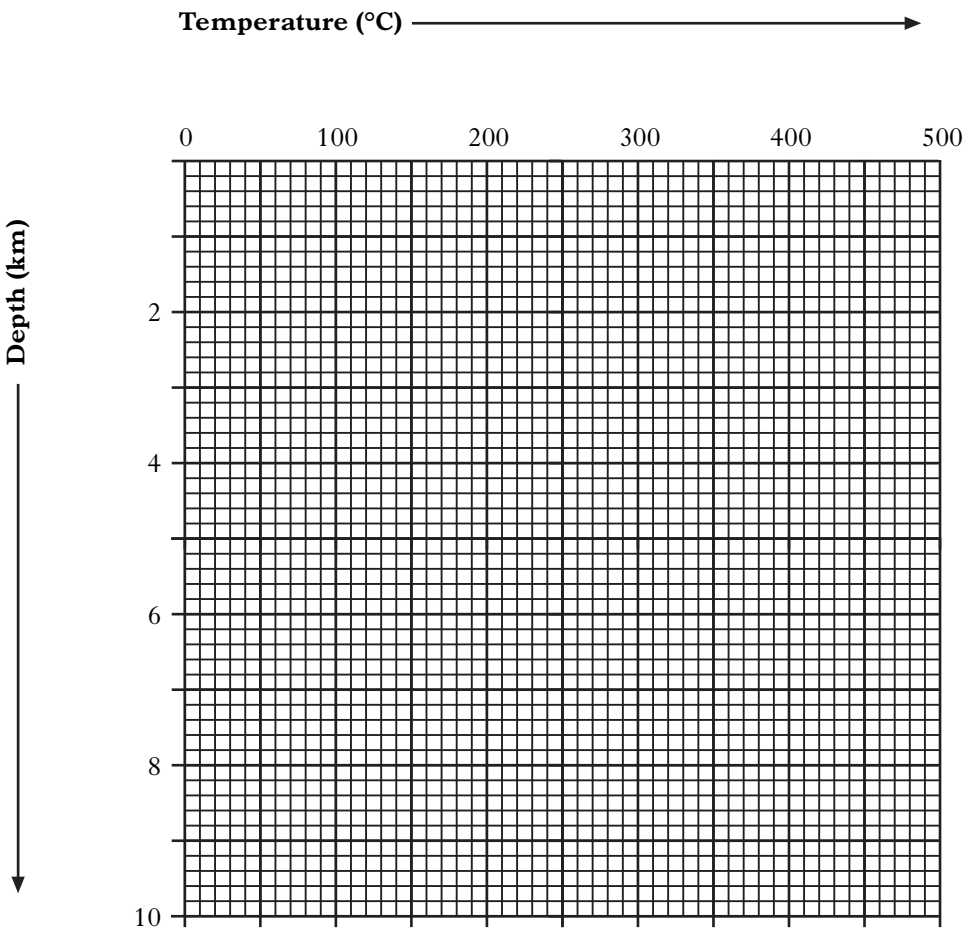
**[Turn over for Question 7 on *Page fourteen***

*Marks*

**7.** The temperature has been measured in 3 boreholes. The data recorded is shown in the table below.

| *Depth* (km) | *Borehole 1 Temperature* (°C) | *Borehole 2 Temperature* (°C) | *Borehole 3 Temperature* (°C) |
|---|---|---|---|
| 1 | 30 | 50 | 20 |
| 2 | 60 | 100 | 40 |
| 3 | 90 | 150 | 60 |
| 4 | 120 | 200 | 80 |
| 5 | 150 | 250 | 100 |
| 6 | 180 | 300 | 120 |
| 7 | 210 | 350 | 140 |
| 8 | 240 | 400 | 160 |
| 9 | 270 | 450 | 180 |
| 10 | 300 | 500 | 200 |

(*a*) Plot the data for **borehole 1** on to the graph below.




2

*Marks*

**7. (continued)**

(*b*) Calculate the geothermal gradient for **borehole 3** in degrees Celsius/metre.

Answer ..... °C/m

*Space for working*

**1**

(*c*) A geothermal power station is planned for a site close to **borehole 2**.

Such a power station is economic in locations where the geothermal gradient exceeds 0·1 °C/m. Calculate whether the planned power station should go ahead.

Explain your decision.

.....

.....

.....

*Space for working*

**2**

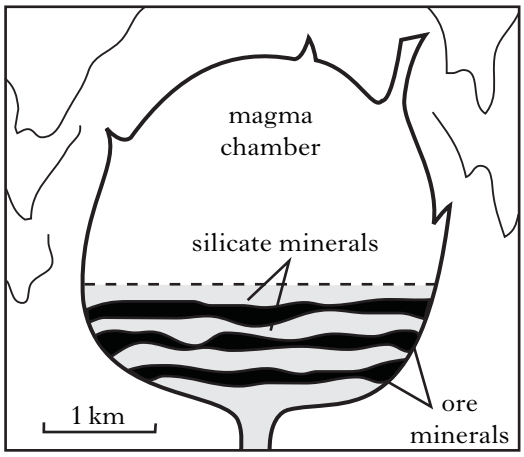
**[Turn over**

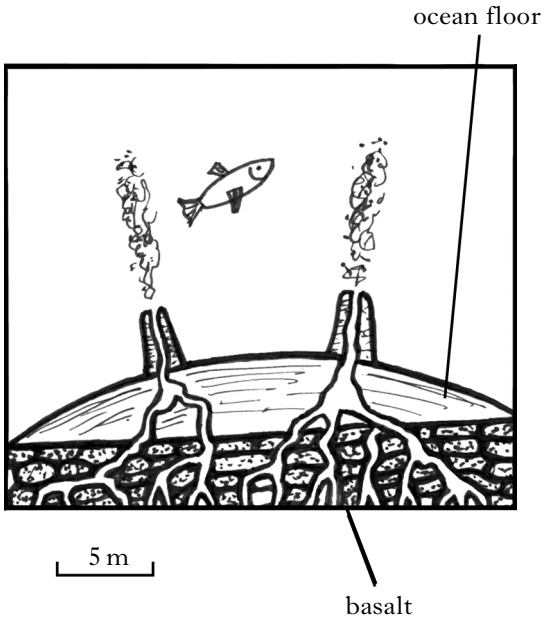
*Marks*

**8.** (*a*) The diagrams below show four ways in which ores are formed.

Choose the correct name for each ore formation from the word box below.

Residual deposit, hydrothermal ore formation, pegmatite ore formation, sea floor sulphide deposition, magmatic segregation, porphyry ore formation, secondary enrichment.



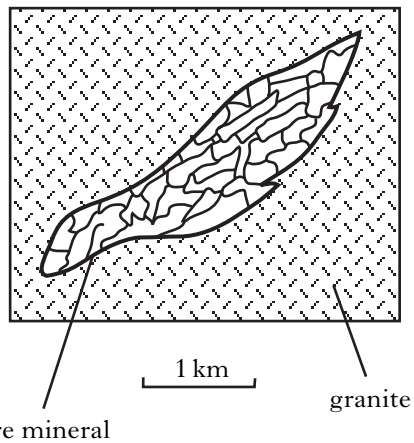



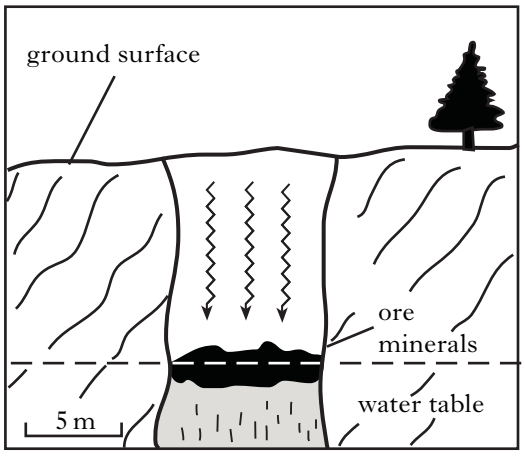

Ore formation .....

.....

Ore formation .....

.....




Ore formation .....

.....

Ore formation .....

.....

**2**

*Marks*

**8. (continued)**

(*b*) Choose **one** method of ore formation from the word box and explain how that ore is formed.

Name of ore formation .....

Explanation .....

.....

.....

.....

..... **2**

(*c*) Silver needs to be concentrated 1250 times from its average crustal abundance of 0·000008% in order to reach its cut-off grade.

Calculate the cut-off grade of silver.

*Space for working*

Answer .....% **1**

**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

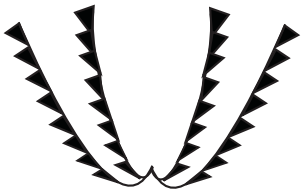
**9.** Look at the Graptolites shown below.

(*a*) Place the graptolites in their correct evolutionary order from **oldest to youngest**.

A

B

C



D

Give only the letters:

..... , ..... , ..... , ..... **2**

**oldest** ⟶ **youngest**

(*b*) Explain why graptolites form a death assemblage.

.....

.....

..... **1**

**Section A: Total (40) marks**

**[Turn over for SECTION B on *Page twenty***

## SECTION B

*Marks*

**This section consists of three questions. Only ONE question should be attempted. Fifteen marks are allocated to this section.**

**Candidates should write their answer on pages 21, 22 and 23.**

**Additional space for answers may be found at the end of this book.**

**10.** Write an essay on sedimentary rocks.

**Credit will be given for the use of maps and diagrams.**

Give details as follows.

| | | |
|---|---|---|
| (*a*) | The classification of sedimentary rocks | **6** |
| (*b*) | The use made of sedimentary structures | **3** |
| (*c*) | Way up criteria | **3** |
| (*d*) | Diagenesis | **3** |
| | | **(15)** |

**11.** Write an essay on plate tectonics.

**Credit will be given for the use of maps and diagrams.**

Give details as follows.

| | | |
|---|---|---|
| (*a*) | Sea floor spreading and magnetic anomalies | **6** |
| (*b*) | Transform faults | **2** |
| (*c*) | Gravity anomalies and geological processes associated with destructive plate margins | **5** |
| (*d*) | Mechanisms for plate movement | **2** |
| | | **(15)** |

**12.** Write an essay on fieldwork techniques.

**Credit will be given for the use of maps and diagrams.**

Give details as follows.

| | | |
|---|---|---|
| (*a*) | Geological and safety equipment required in the field | **4** |
| (*b*) | Different methods of recording and processing information in the field | **4** |
| (*c*) | Testing and identifying rocks and minerals in the field | **4** |
| (*d*) | Measurements made in the field, eg strike and dip, throw of a fault | **3** |
| | | **(15)** |

**Section B: Total (15) marks**

**NOW GO TO SECTION C ON PAGE TWENTY-FOUR**

SPACE FOR ANSWERS

DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWERS

DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWERS

## SECTION C

**All questions in this section should be attempted. Forty marks are allocated to this section.**

*Marks*

**13.** Look at the photograph below of a lava flow.

Choose **two** correct statements from the list below.

A This sort of structure is common in lavas with high silica content.

B This sort of structure is common in lavas with low silica content.

C Lava like this is called pillow lava.

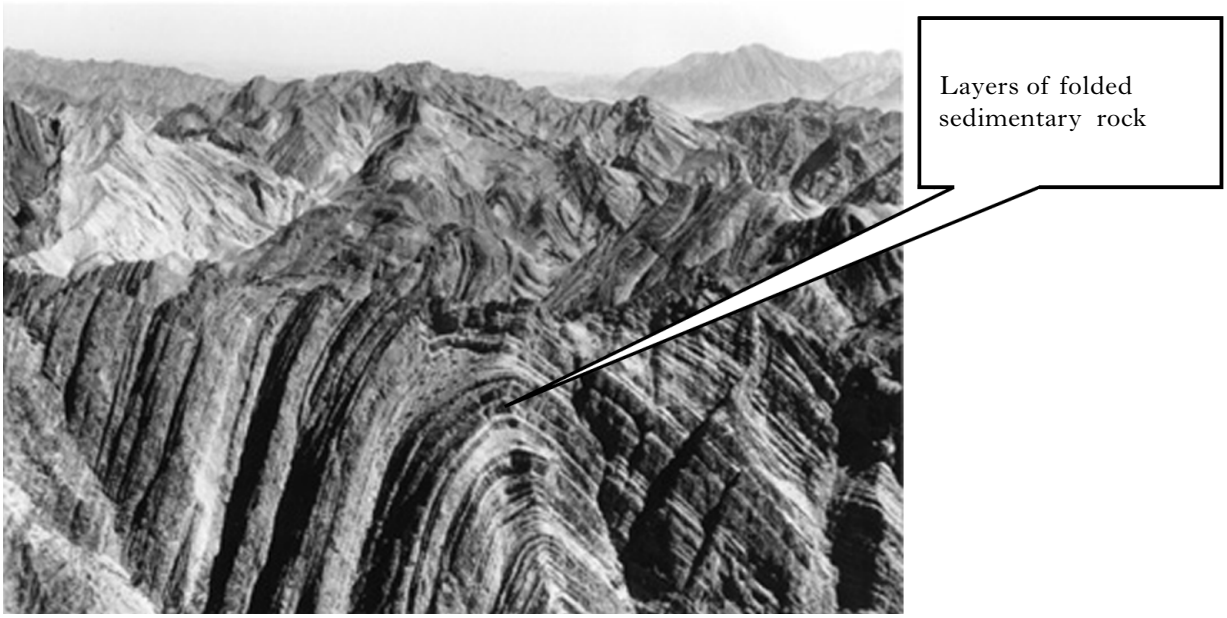
D Lava like this is called aa lava.

E Lava like this is called pahoehoe lava.

Give only the letters: ..... and ..... **2**

*Marks*

**14.** Look at the photograph below of this mountain range in Iran.




(*a*) What is the name given to this kind of geological structure?

..... **1**

(*b*) Annotate the photograph using the following labels.

- Hinge line
- Steeply dipping limb
- Axial plane **3**

**[Turn over**

*Marks*

**15.** Examine the annotated photograph below of a quarry face.


(*a*) What is the name of the geological feature marked by line A?

.....

**1**

(*b*) Explain the sequence of geological events that would have produced this feature.

**3**

DO NOT WRITE IN THIS MARGIN

*Marks*

**16.** Study the map (on the **separate worksheet**) and answer the questions based on it.

(*a*) How many unconformities are present?

Answer .....  **1**

(*b*) On which side of fault F1 have the rocks been downthrown? Give **one** reason.

Answer .....

Reason .....

.....

.....  **1**

(*c*) What type of fault is F2? Give **one** reason to explain your answer.

A Normal

B Reverse

C Tear

D Thrust

Letter: .....  **1**

Reason .....

.....

.....  **1**

(*d*) How can you tell that movement has taken place twice along fault F2?

.....

.....

.....  **1**

**[Turn over**

DO NOT WRITE IN THIS MARGIN

*Marks*

**16. (continued)**

(*e*) Place an "M" on the map to show one place where marble would be found. **1**

(*f*) The horizontally bedded mudstone in the centre of the map is known as

A an outlier

B an inlier

C a cone sheet

D a sill.

Letter: ..... **1**

(*g*) On the topographic profile (on the **separate worksheet**), draw a geological section between points X and Y on the map. **5**

*Marks*

**16. (continued)**

(*h*) Place the geological events of this map area in the correct order by inserting the correct letters from the box at the bottom of the page. (Give only the letters.)

YOUNGEST

| | |
|---|---|
| H | Volcanic vent |
| | |
| E | Second movement on F2 |
| | |
| I | First movement on F2 |
| | |
| D | Faulting on F1 |
| | |
| B | Folding |
| | |
| J | Erosion of gneiss |
| | |

OLDEST

**6**

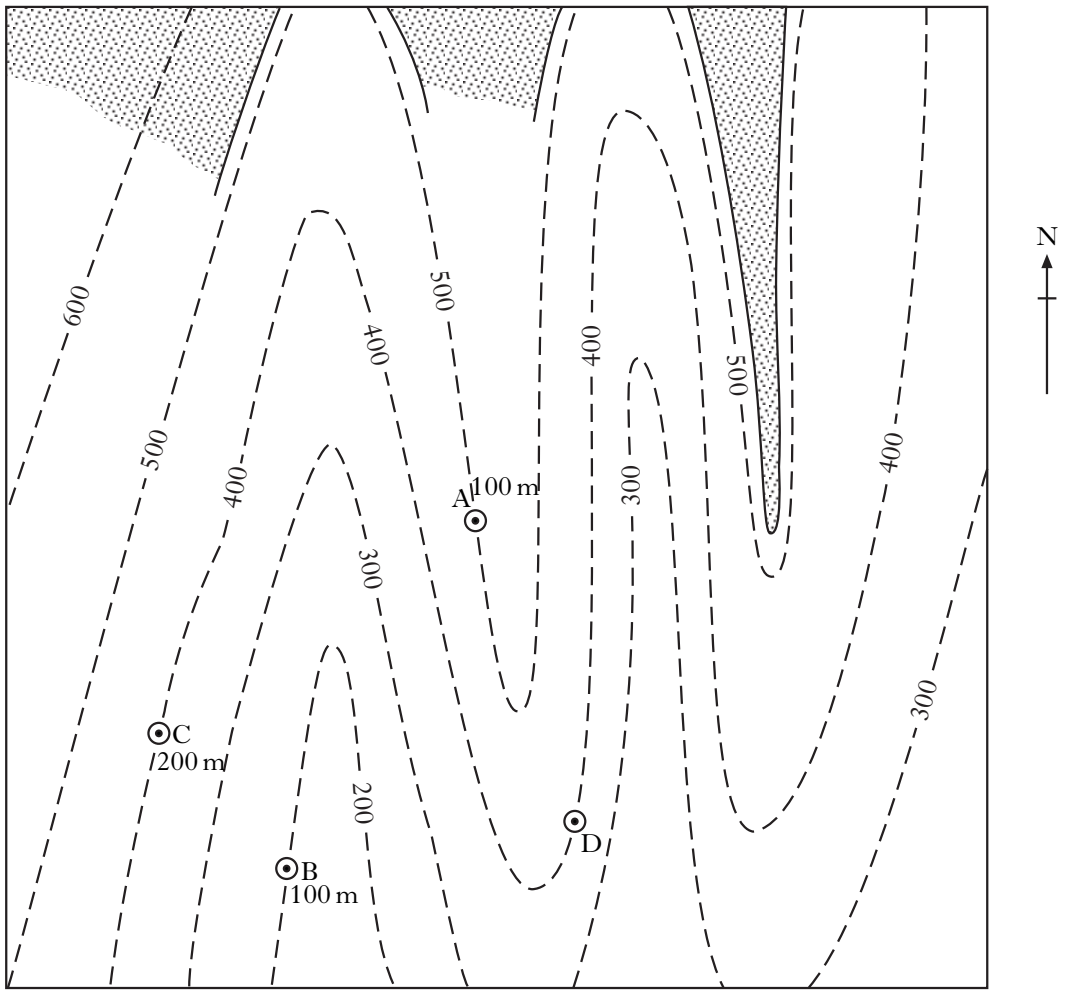
**The events in this table are not in the correct order**.

| | |
|---|---|
| **A** Limestone deposited unconformably on gneiss | **G** Intrusion of dolerite dyke |
| **C** Intrusion of diorite dyke | **K** Deposition of mudstone |
| **F** Intrusion of felsite dyke | **L** Formation of gneiss |

**[Turn over**

**17.** The map below shows an outcrop of sandstone and an underlying coal seam.

Study the map carefully and answer the questions on the page opposite.



DO NOT WRITE IN THIS MARGIN

*Marks*

**17. (continued)**

(*a*) Part of the outcrop of a bed of sandstone is shown. Complete the outcrop of the sandstone. **1**

(*b*) A coal seam of uniform dip is found in boreholes A, B and C, at the **depths** shown.

(i) Draw structure contours for the coal seam over the whole area of the map. **4**

(ii) Draw in the outcrop of the coal seam. **3**

(iii) What is the angle and direction of dip of the coal seam?

Angle of dip .....

Direction of dip .....

*Space for working*

**2**

(iv) At what depth from the surface will the coal seam be found in borehole D?

..... **1**

(*c*) Why can you not draw structure contours for the sandstone?

.....

..... **1**

**Section C: Total (40) marks**

[*END OF QUESTION PAPER*]

DO NOT WRITE IN THIS MARGIN

SPACE FOR ANSWERS OR FOR ROUGH WORK