

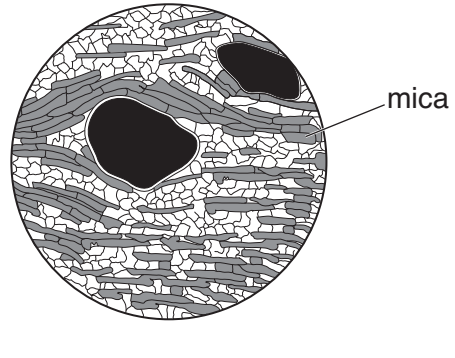
Answer **all** the questions.

1 Descriptions and thin section drawings of different rocks **A** to **F** are shown below.

thin section drawing of rock B

description of rock A

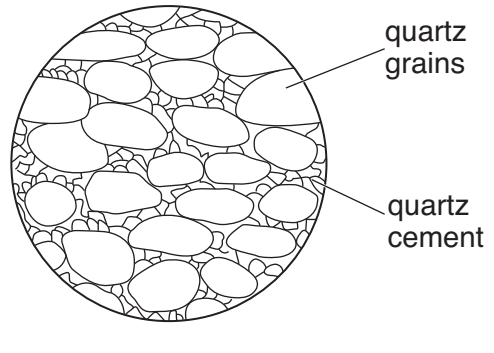
- coarse grained crystalline texture
- quartz is prominent
- contains K feldspar with some mica



thin section drawing of rock D

description of rock C

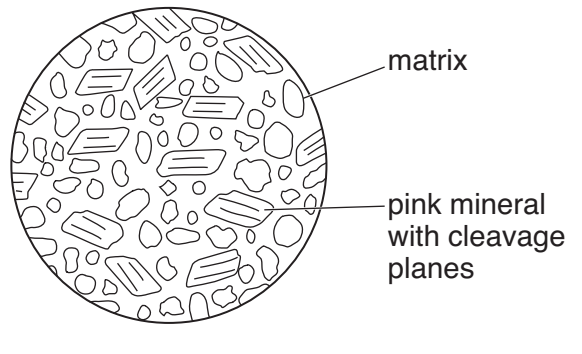
- coarse grained crystalline texture
- quartz is prominent
- mainly plagioclase feldspar with some K feldspar
- some mafic minerals



thin section drawing of rock F

description of rock E

- fragmental texture
- fine grained (<0.0625 mm)
- layering is visible



(a) (i) Identify the six rocks **A** to **F**.

A

B

C

D

E

F

[6]

(ii) Name the texture shown in **rock B**.

..... [1]

(iii) Describe the grain shape and sorting in **rock D**.

grain shape.....
 sorting [2]

(iv) Describe the environment in which **rock F** was deposited.

.....

 [2]

(b) (i) State the silica content of mafic and silicic igneous rocks.

mafic % silicic % [2]

(ii) The data table below shows the characteristics of some rock forming minerals.

name	composition	specific gravity	colour
hornblende	$\text{Ca}_2(\text{MgFeAl})_5(\text{SiAl})_8\text{O}_{22}(\text{OH})_2$	3–3.5	black, often greenish
calcite	CaCO_3	2.7	white or colourless
K feldspar	KAlSi_3O_8	2.6	often pink, may be white or grey
plagioclase feldspar	$\text{NaAlSi}_3\text{O}_8$ to $\text{CaAl}_2\text{Si}_2\text{O}_8$	2.6–2.8	white or grey
garnet	$\text{Fe}_3\text{Al}_2\text{Si}_3\text{O}_{12}$	3.6–4.2	usually red or brown
muscovite mica	$\text{KA}l_2(\text{AlSi}_3)\text{O}_{10}(\text{OH})_2$	2.8–2.9	colourless, white or silvery
biotite mica	$\text{K}(\text{FeMg})_3(\text{AlSi}_3)\text{O}_{10}(\text{OH})_2$	2.8–2.9	black or dark brown
olivine	$(\text{MgFe})_2\text{SiO}_4$	3.2–4.4	green, yellow or brown
augite	$(\text{CaMgFeAl})_2(\text{SiAl})_2\text{O}_6$	3.4	black or greenish black
quartz	SiO_2	2.65	usually white or colourless

Complete the table below with ticks to classify the minerals as mafic or felsic. Two have been done for you.

mineral	mafic	felsic
augite		
biotite mica		
K feldspar		
muscovite mica		
olivine	✓	
quartz		✓

[3]

(iii) Using the data table, name **one** mineral that forms limestone.

..... [1]

[Total: 17]

Turn over

2 The list and the table below contain information about igneous processes and products.

(a) Complete the table by writing the **correct number**, 1 to 9, chosen from the list.

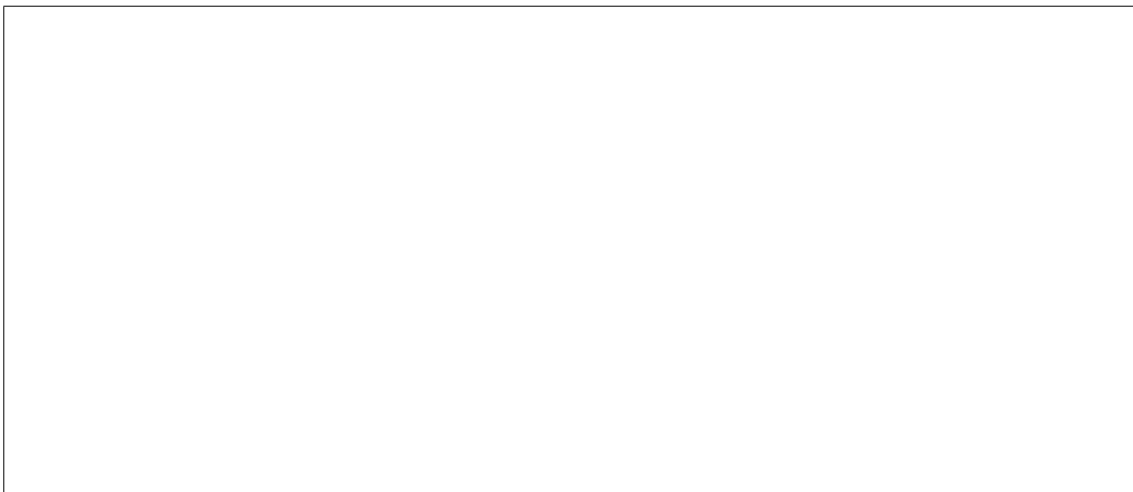
list

- 1 vesicles
- 2 the incorporation of country rock into a magma by melting
- 3 xenolith
- 4 plutonic
- 5 hypabyssal
- 6 some of the minerals in a rock melt to form a magma
- 7 the emission of magma onto the Earth's surface where it forms a lava flow
- 8 fluid non-explosive lava
- 9 a layer of dense early formed minerals at the base of an intrusion

processes and products	definitions
extrusion	
	piece of country rock that is detached and settles into the magma
assimilation	
	igneous rocks formed at relatively shallow depths below the surface
effusive, low viscosity	
	holes formed by gases trapped in lava
partial melting	

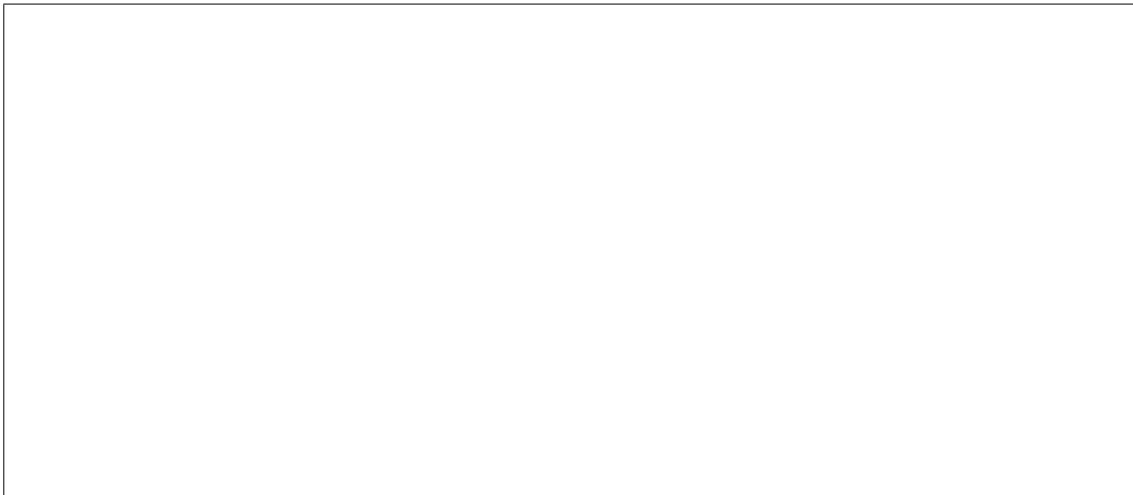
[6]

(b) (i) Draw and label a cross section diagram to show a shield volcano.



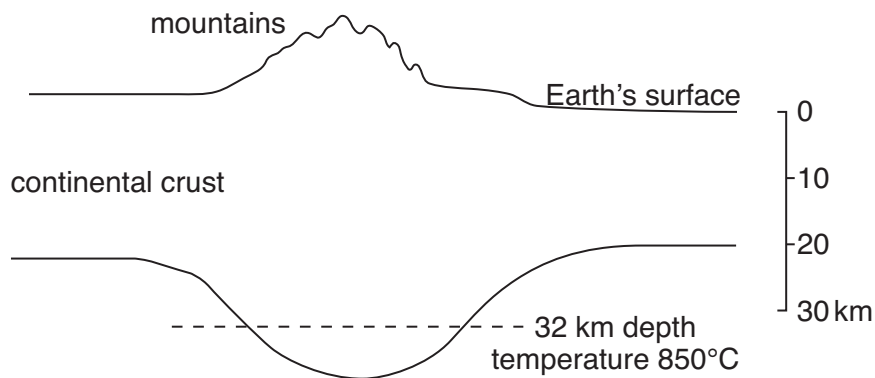
[2]

(ii) Draw and label a cross section diagram to show a strato volcano.



[2]

(c) The diagram below shows a cross section through a convergent plate boundary where two continents moved towards each other.



(i) On the diagram:

- shade the area where partial melting occurs
- draw the likely position of a batholith.

[2]

(ii) Calculate the geothermal gradient at this boundary in °C/km. Show your working.

.....°C/km [2]

(d) Describe how a metamorphic aureole forms around a batholith.

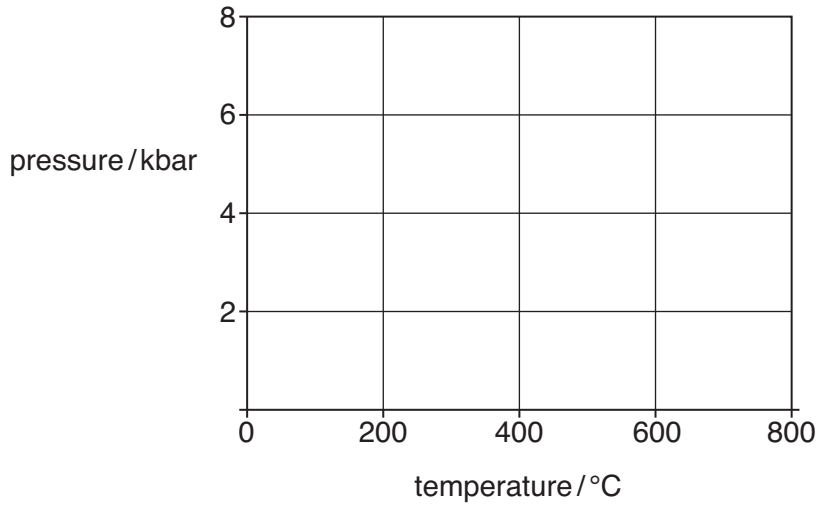
.....

 [2]

[Total: 16]

Turn over

- 3 (a) (i) On the diagram below, shade and label where the following types of metamorphism take place:
- contact
 - regional
 - burial



[3]

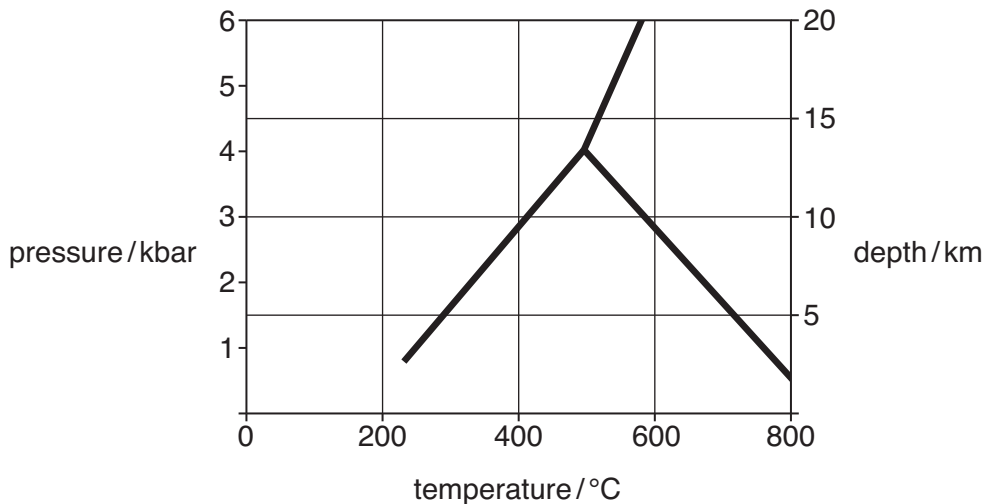
- (ii) Shade and label where diagenesis takes place.

[1]

- (b) (i) Define the term *polymorph*.

.....
 [1]

The graph below shows an Al_2SiO_5 polymorph phase diagram.



- (ii) Complete the diagram by writing the names of the **three** polymorph minerals in the correct places. [2]

- (iii) If all three minerals are found together in the same rock at equilibrium, state the temperature and pressure at which metamorphism of the rock occurred.

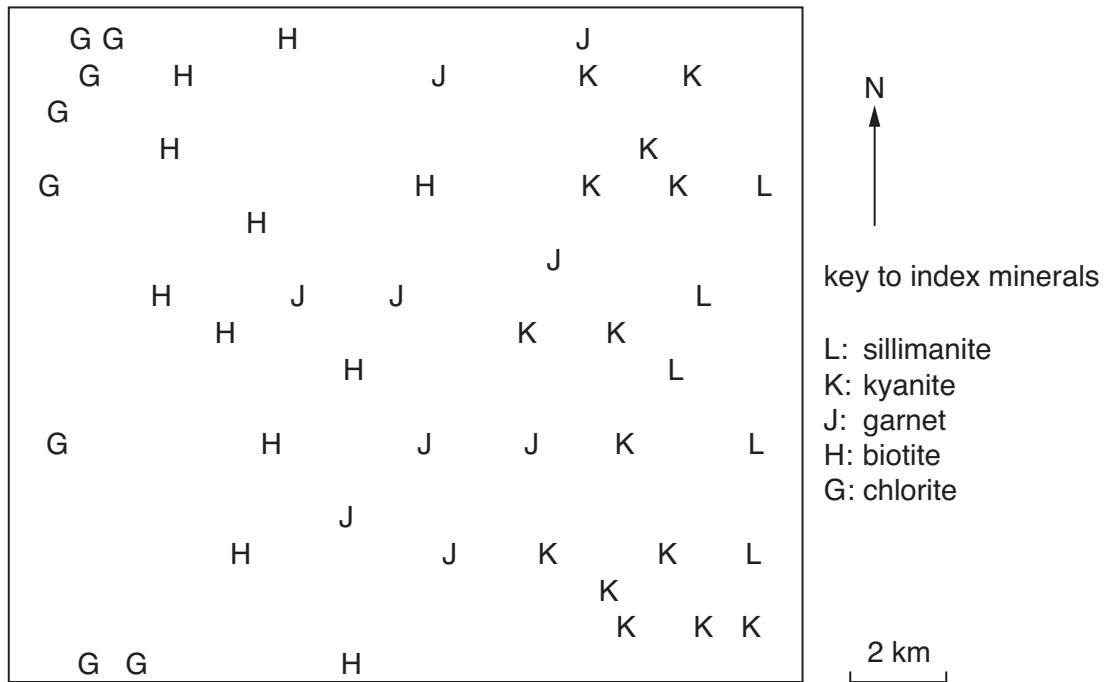
temperature pressure [2]

(c) (i) Define the term *index mineral*.

.....
 [1]

The map below shows index minerals in an area of shales that have undergone regional metamorphism.

(ii) Complete the map by drawing isograds to show the metamorphic zones.



[3]

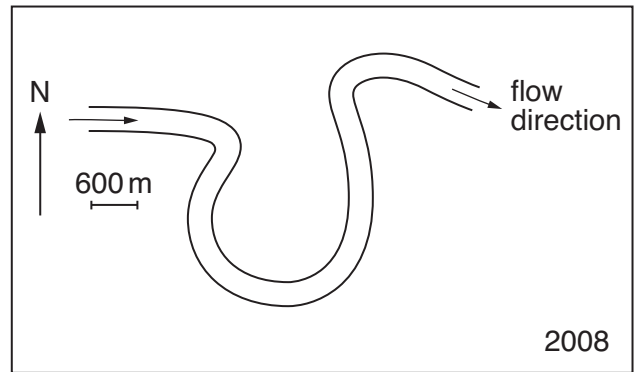
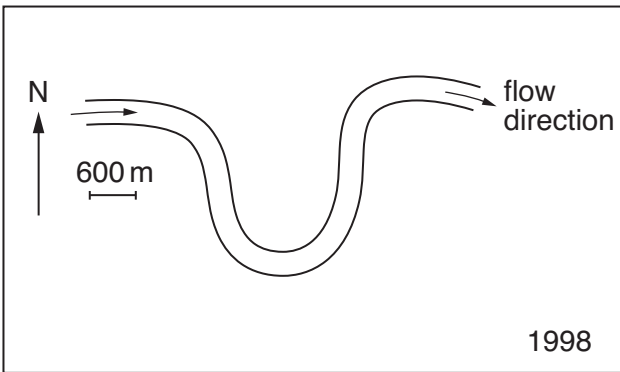
(iii) Complete the table below by writing the name of the rock type in which the index minerals will be found.

index mineral	rock type
sillimanite	
garnet	
chlorite	

[3]

[Total: 16]

4 The maps below show the same part of a meandering river in 1998 and 2008.



(a) (i) Draw and label on the 2008 sketch map where erosion and deposition will have changed the course of the river by 2018. [2]

(ii) Explain the processes that have caused the river channel to change position.

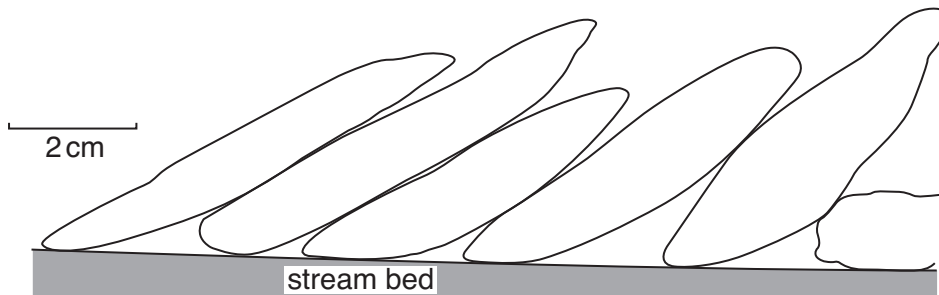
.....

.....

.....

..... [2]

(b) The diagram below shows a sedimentary structure found in a stream bed.



(i) Name the sedimentary structure.

..... [1]

(ii) Describe how it formed.

.....

.....

.....

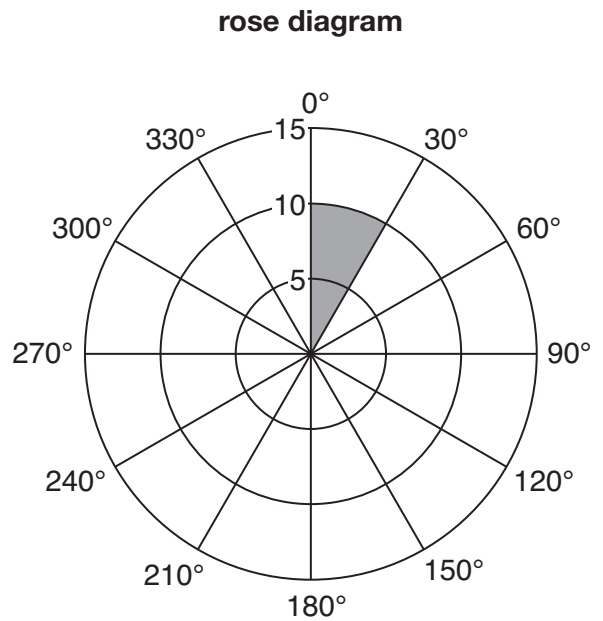
..... [2]

- (c) (i) Use a labelled diagram to explain how cross bedding can be used as a palaeocurrent indicator.

[2]

- (ii) The table below shows measurements of cross bedding taken in sandstones to determine the palaeocurrent direction. Complete the rose diagram by shading the appropriate areas.

orientation (degrees from North)	number of cross bedding readings
1–30°	10
31–60°	15
61–90°	2
91–120°	8
121–150°	6
151–180°	4
181–210°	2
211–240°	0
241–270°	0
271–300°	0
301–330°	0
331–360°	1



[3]

- (iii) State the palaeocurrent direction.

..... [1]

- (d) (i) Draw scale diagrams to show ripple marks formed in a river channel and ripple marks formed on a beach.

river channel

┌ 5mm

beach

┌ 5mm

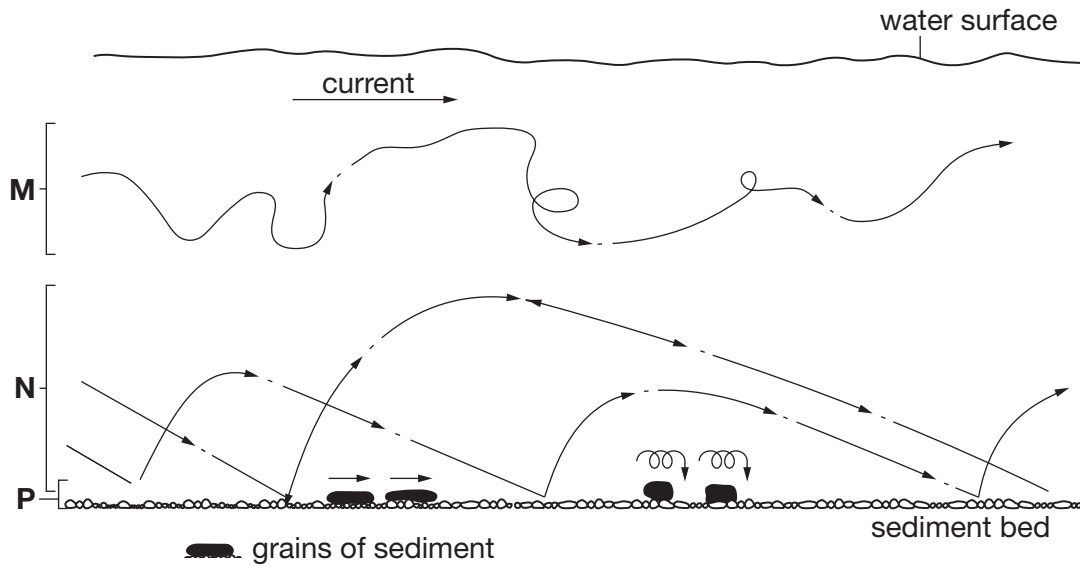
[2]

- (ii) Draw arrows for each diagram to show the current direction.

[1]

[Total: 16]

5 The diagram below shows methods of transport in water.



(a) (i) Name the methods of transport **M**, **N** and **P**.

M **N**

P [3]

(ii) Name **one** method of transport **not** shown on the diagram.

..... [1]

(iii) Name the grain sizes transported by methods **M** and **N**.

method **M**

method **N** [2]

(b) (i) Describe and explain the characteristics of sediments transported by ice.

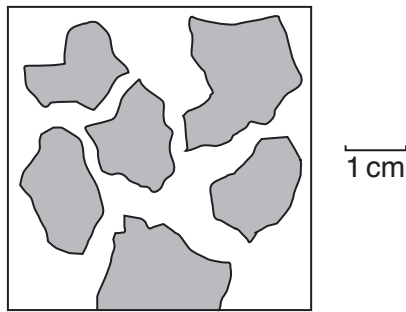
.....

 [3]

(ii) Name a product of deposition by ice.

..... [1]

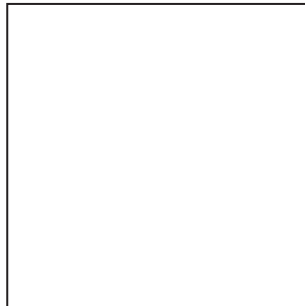
(c) The diagram shows grains in a sediment.



(i) Describe the grain shape.

..... [1]

(ii) Draw in the box below a poorly sorted sediment.



[1]

(iii) Explain how the roundness of grains is related to the length of time they were transported.

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

(iv) Explain why quartz grains survive transport better than mica grains.

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

[Total: 15]

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[Total: 10]

- 7 Describe and explain the differences between sills and lava flows. Use diagrams to illustrate your answer.



In your answer you should make clear the comparison between these two features.

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