OCR
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AS Level Geology
H014/01 Geology
Sample Question Paper

Date – Morning/Afternoon
Version 2.1

Time allowed: 2 hours 30 minutes

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

You may use:
- a scientific or graphical calculator

First name	
Last name	
Centre number	
Candidate number	

INSTRUCTIONS
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

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

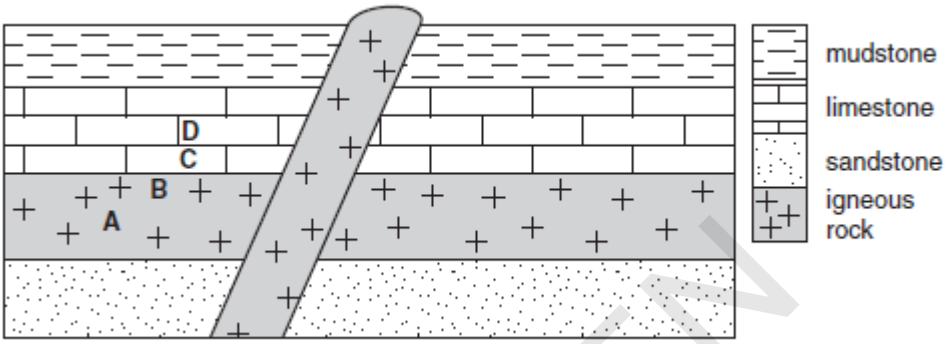
Section A

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

Write your answer to each question in the box provided.

Answer **all** the questions.

1 The diagram below shows two igneous intrusions.



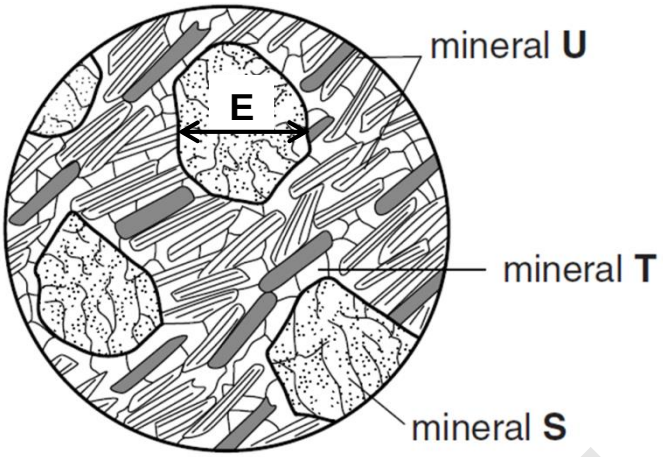
The thin section of rock below is taken from rock shown on the diagram.

magnification ×5
crystals of calcite

Which rock shown on the diagram, **A**, **B**, **C** or **D**, does the thin section come from?

Your answer ☐ **[1]**

2 The diagram below shows a thin section drawing of a metamorphic rock containing garnet crystals.



magnification ×4

What is the actual diameter of the garnet crystal labelled **E**?

A 0.43 mm

B 6.80 mm

C 0.24 mm

D 4.25 mm

Your answer ☐ **[1]**

3 Which factor provides evidence that igneous rocks were once molten?

A The presence of a crystalline texture.

B The presence of quartz.

C The presence of mica.

D The presence of feldspar.

Your answer ☐ **[1]**

4 Carbonate minerals react with hydrochloric acid.

A geologist tested the mineral strontianite ($SrCO_3$) with a 10% aqueous solution of cold hydrochloric acid.

What would the result of this test be?

A bubbling observed

B precipitation formed

C colour change observed

D no reaction

Your answer ☐ **[1]**

5 Which texture best describes obsidian?

A smooth

B flow banded

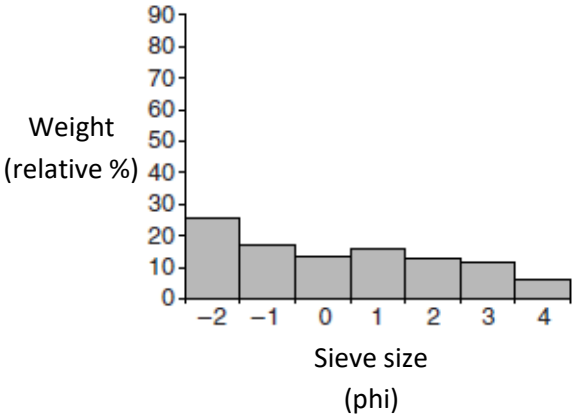
C glassy

D ropey

Your answer ☐ **[1]**

6 The graph below shows data for a sediment that has been sieved.

The –2 (phi) sieve contains the coarsest particles.



Which statement best describes the degree of sorting shown?

A very well sorted

B well sorted

C poorly sorted

D moderately sorted

Your answer ☐ **[1]**

7 Where would you expect to find sediment showing this grain size distribution?

A glacial till

B river deposits

C aeolian sands

D beach deposits

Your answer ☐ **[1]**

8 The elements gold (Au), silver (Ag) and platinum (Pt) are known as the noble metals. They have low crustal abundance.

Which statement about the noble metals is correct?

A They are lithophile elements because they oxidise easily.

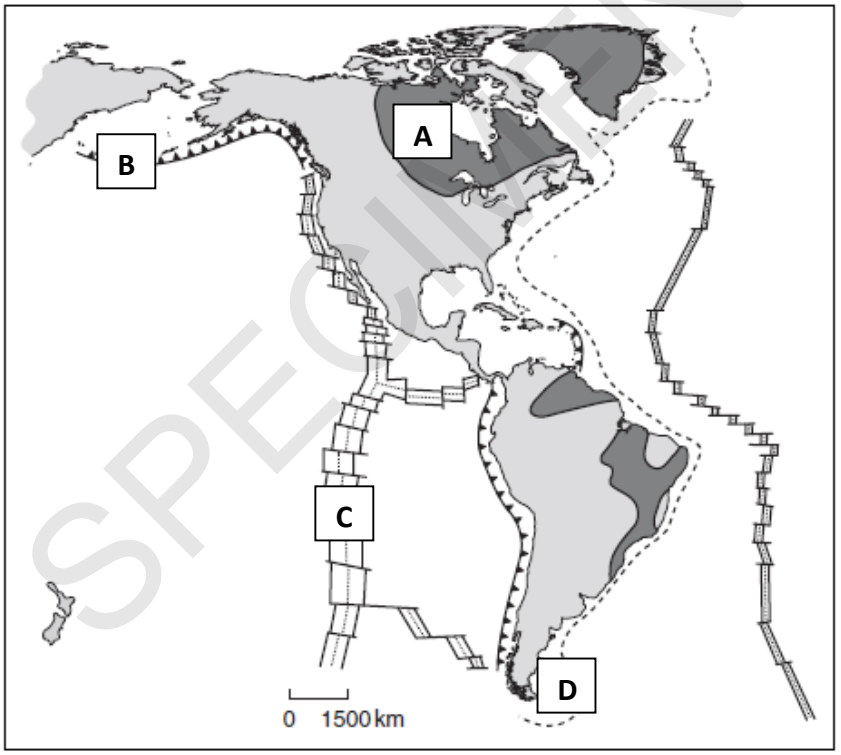
B They are chalcophiles which form strong bonds with sulfur and are found in the mantle.

C Their crustal concentration factor is 1.0 compared with chrondite meteorites.

D They are resistant to oxidation, and while they form sulfides they prefer to alloy with other metals.

Your answer ☐ **[1]**

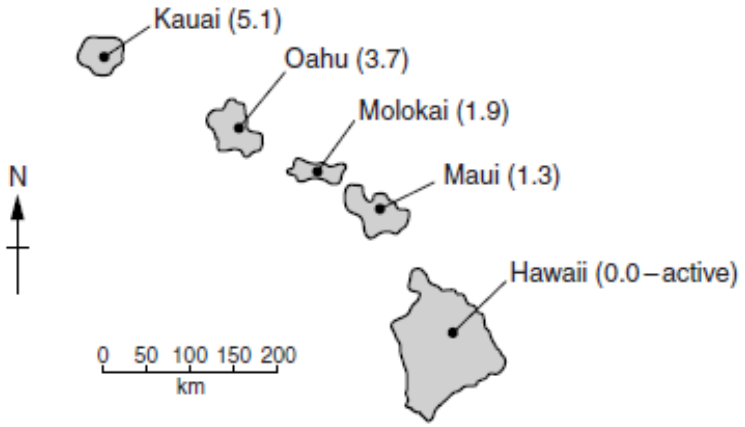
9 The map below shows some tectonic features in the North and South American regions.



Which letter, **A**, **B**, **C** or **D**, is located at a deep ocean trench?

Your answer ☐ **[1]**

10 The map below shows a number of islands in the Hawaiian chain. The age of the island (Ma) is shown in brackets.



With reference to the islands of Hawaii and Kauai, which of the following represents the average rate of plate movement during the last 5.1 Ma?

A 8 cm year^{-1}

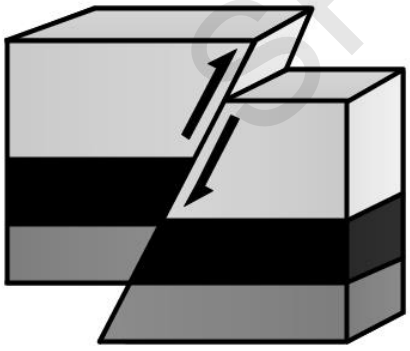
B 10 cm year^{-1}

C 12 cm year^{-1}

D 14 cm year^{-1}

Your answer ☐ **[1]**

11 What type of fault is shown in the diagram below?



A normal

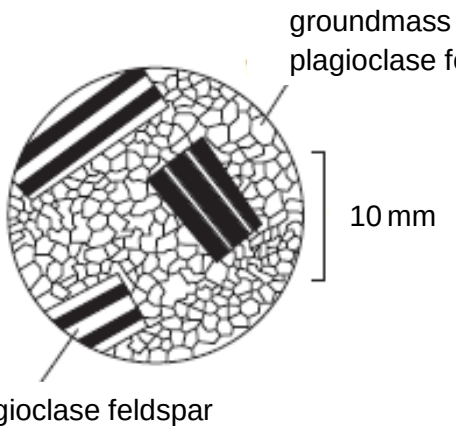
B reverse

C thrust

D strike-slip

Your answer ☐ **[1]**

12 What type of rock is shown below?



A intrusive igneous

B extrusive igneous

C metamorphic

D sedimentary

Your answer ☐ **[1]**

13 The temperature of lava within a volcano varies with depth.

A reading of 1323 K was taken at the surface of the lava lake in a volcano. 13 m below the surface at the bottom of the lake, a second reading of 1443 K was taken.

Calculate the percentage decrease in temperature from the bottom to the top of the lava lake.

A 9.1%

B 8.3%

C 12.0%

D 15.6%

Your answer ☐ **[1]**

14 A diagnostic property of the rock-forming mineral quartz is the absence of cleavage.

Which statement about quartz best explains this property?

A Silicon–oxygen tetrahedra are very strong.

B The quartz lattice contains Si–O covalent bonds in all directions.

C The quartz lattice contains Si–O ionic bonds in all directions.

D Quartz is a framework silicate mineral.

Your answer ☐ **[1]**

15 Gold is a highly desirable mineral used in the production of jewellery and coins as well as in other fields including electronics and dentistry.

The density (ρ) of gold is ~1.9×10^4 kg m^{-3}. A jeweller has 20 g of pure gold.

Calculate the volume of the gold.

A 0.001 m^3

B 1.053 m^3

C 1.05×10^{-6} m^3

D 0.011 m^3

Your answer ☐ **[1]**

16 What term is used to describe an ancient ocean crust?

A oolites

B ophiolites

C xenolith

D kimberlite

Your answer ☐ **[1]**

17 What is a rheid?

A An ultramafic igneous rock composed of the mineral olivine.

B An area of partial melting deep within the lithosphere.

C A less dense stony meteorite similar to the mantle.

D A solid material that flows.

Your answer ☐ **[1]**

18 About 80% of the copper mined today is extracted from sulfide ores.

The mineral chalcocite (Cu_2S) is a copper sulfide ore. If the molar mass of copper is 63.5 g mol^{-1} and the molar mass of sulfur is 32.1 g mol^{-1}, what is the percentage by mass of copper in chalcocite?

A 63.5%

B 79.8%

C 66.4%

D 50.6%

Your answer ☐ **[1]**

19 Which of the following **could not** be found in an ancient desert deposit?

A Red colour formed by iron oxide.

B Evaporites and clays formed in lakes.

C Well sorted and well-rounded sand grains.

D Bands of flint formed by diagenesis.

Your answer ☐ **[1]**

20 The environment in which sediments are deposited is a major factor in the resulting sedimentary rock. Fossils are of value to the oil and gas industry as indicators of rocks which may be potential reservoirs of hydrocarbon deposits.

Which of the following features of a fossil **does not** give information about its palaeoenvironment?

A thickness of shell

B shell ornamentation

C stratigraphic age

D detail of preservation

Your answer ☐ **[1]**

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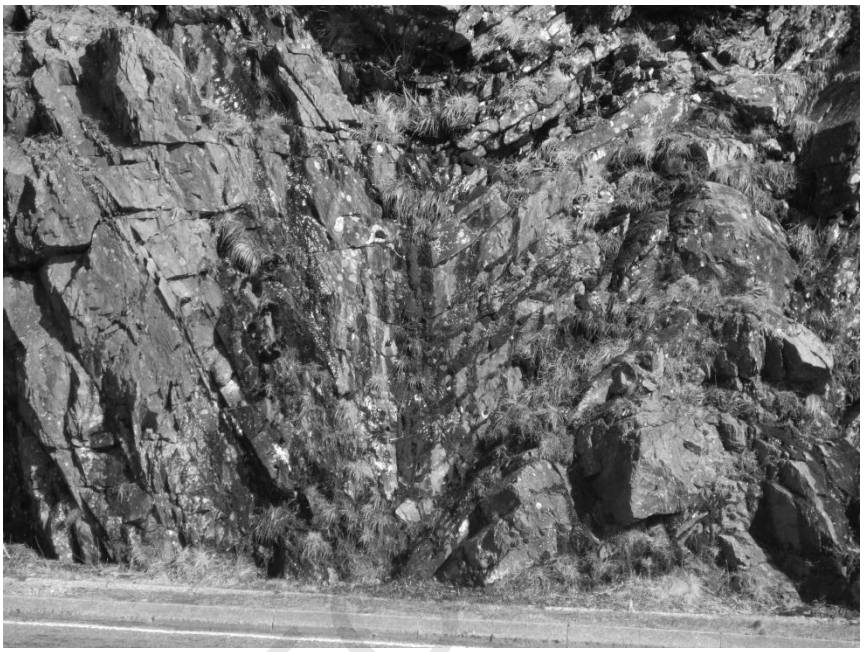
SECTION B STARTS ON THE NEXT PAGE

Section B

Answer **all** the questions.

21 This question is about geological structures.

(a) The photograph below shows a geological feature exposed in a roadside cutting in Cumbria.



In the space below draw a labelled sketch to show the main features of the geological structure.

[3]

(b) Explain in detail how an **angular** unconformity is formed.

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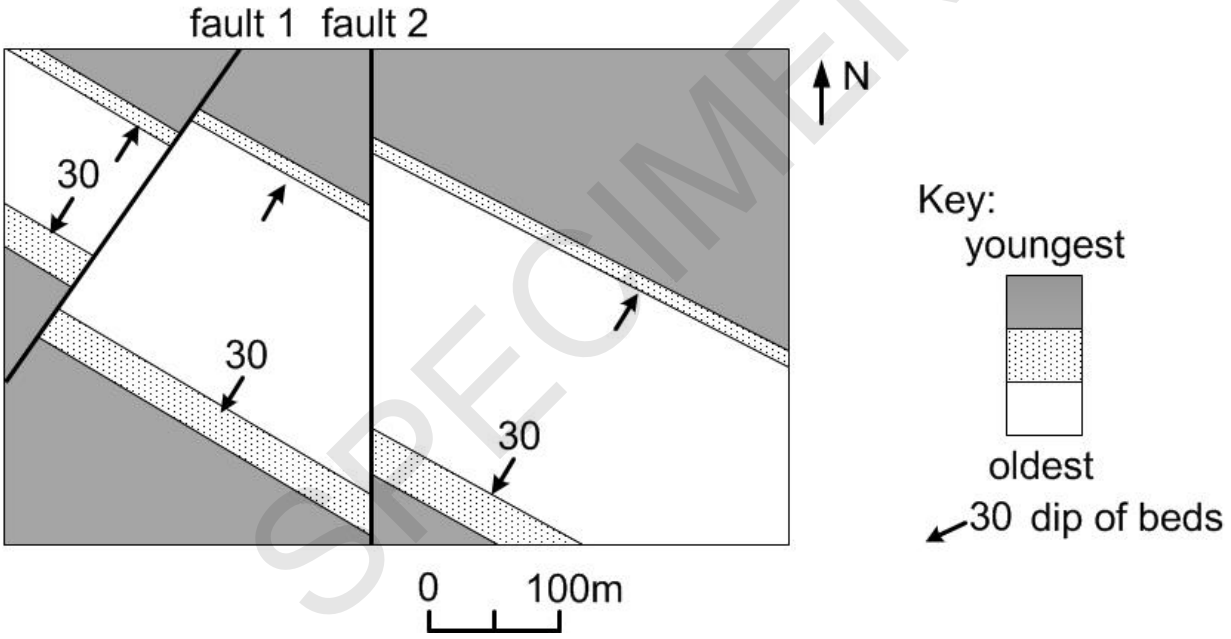
…… **[3]**

(c) Below is a geological sketch map. The land is flat.



(i) How can you tell from the geological map that **fault 1** is a dip-slip fault?

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…… **[1]**

(ii) Which side of **fault 1** is the downthrow side. Explain your answer.

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……..……**[2]**

(iii) Use the scale to measure the displacement of **fault 2**.

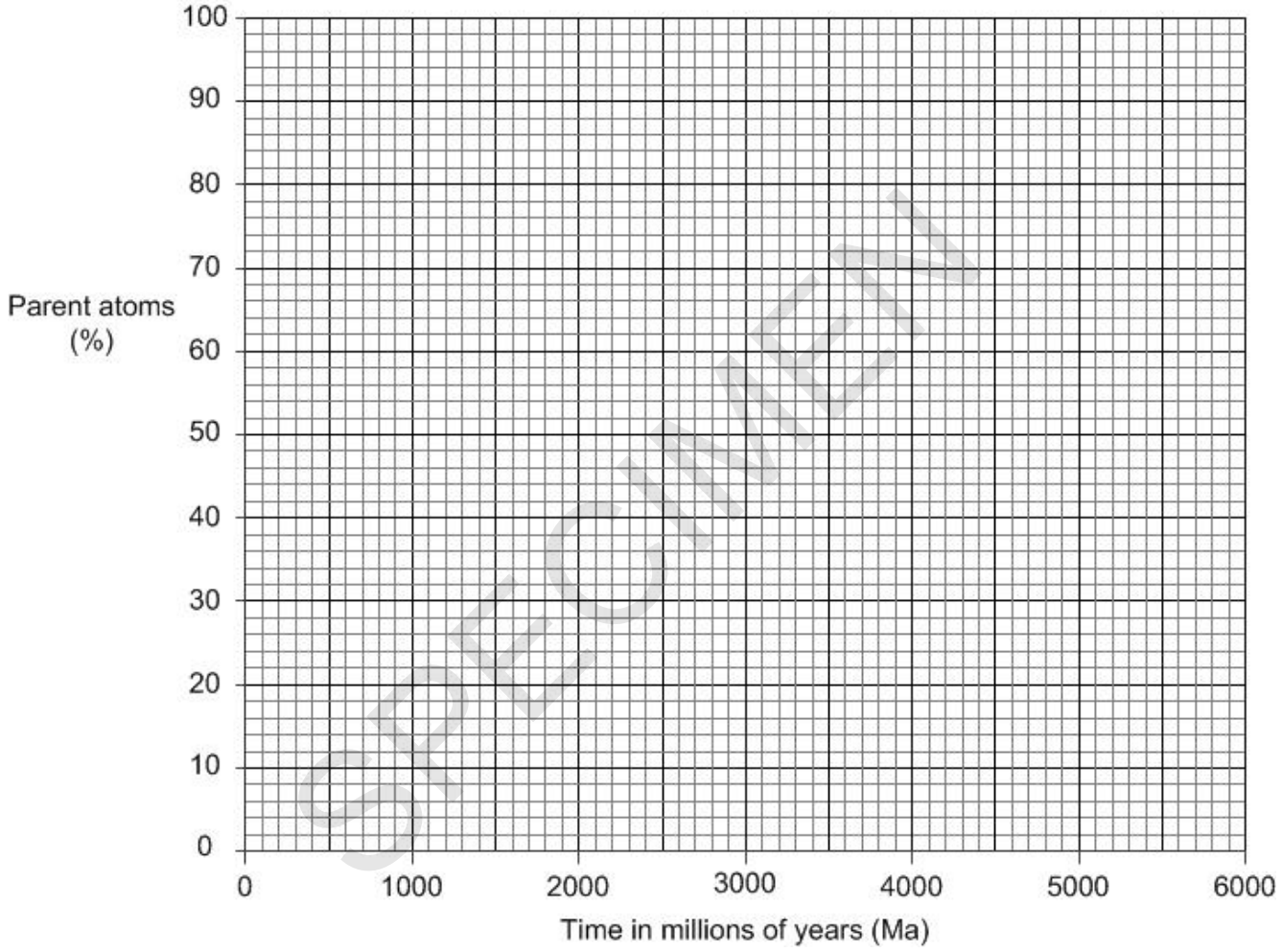
…….. **[1]**

22 Geologists need to be able to date the formation of different rocks in order to understand the processes that shaped the Earth.

Methods include numerical dating and relative dating.

(a) Numerical dating methods use the radioactive decay of certain elements found in some minerals in rocks.

The radioactive isotope ^{40}K, found in many minerals, decays to ^{40}Ar and has a half-life of 1250 million years.



(i) Plot the decay of the parent ^{40}K on the graph for four half-lives and draw the decay curve. **[2]**

(ii) A whole rock analysis was found to have a ratio of $^{40}K : {}^{40}Ar$ of 1 : 4. Use your graph to describe and explain how this radiometric decay can be used to calculate the age of this rock.

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…… **[4]**

(iii) The discovery of radioactivity in 1896 led to major changes in Earth science in the twentieth century.

Explain the ways in which the discovery and use of radioactivity led to the development of geological understanding over the last 100 years.

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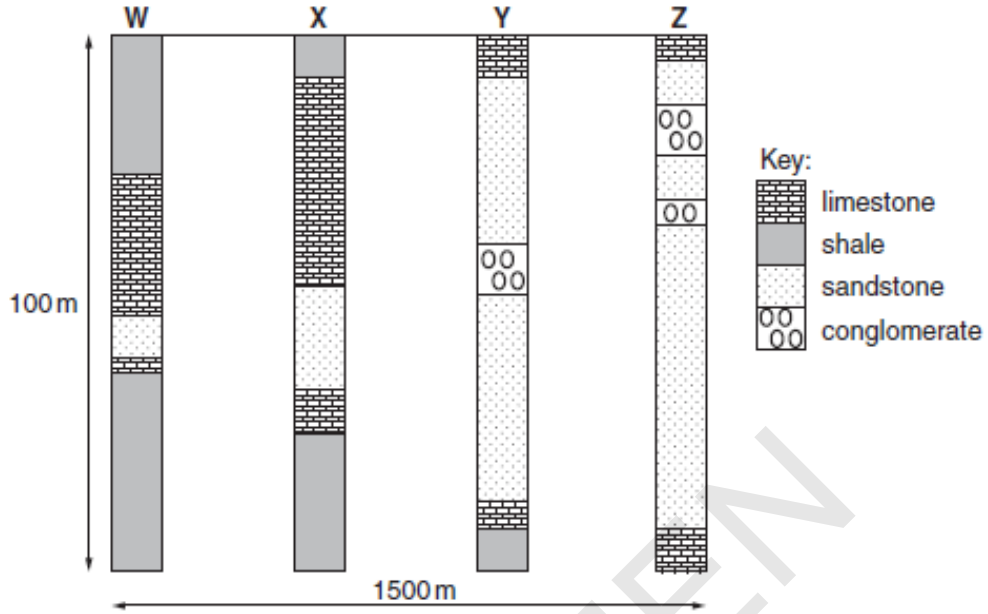
…… **[3]**

(b) One method of relative dating uses *lithostratigraphic correlation*, comparing and matching rock formations.

Boreholes, **W**, **X**, **Y** and **Z**, were logged and are shown in the diagram below.



(i) On the diagram, correlate the beds by drawing lines between the four boreholes. **[3]**

(ii) Describe the advantages and disadvantages of lithostratigraphic correlation.

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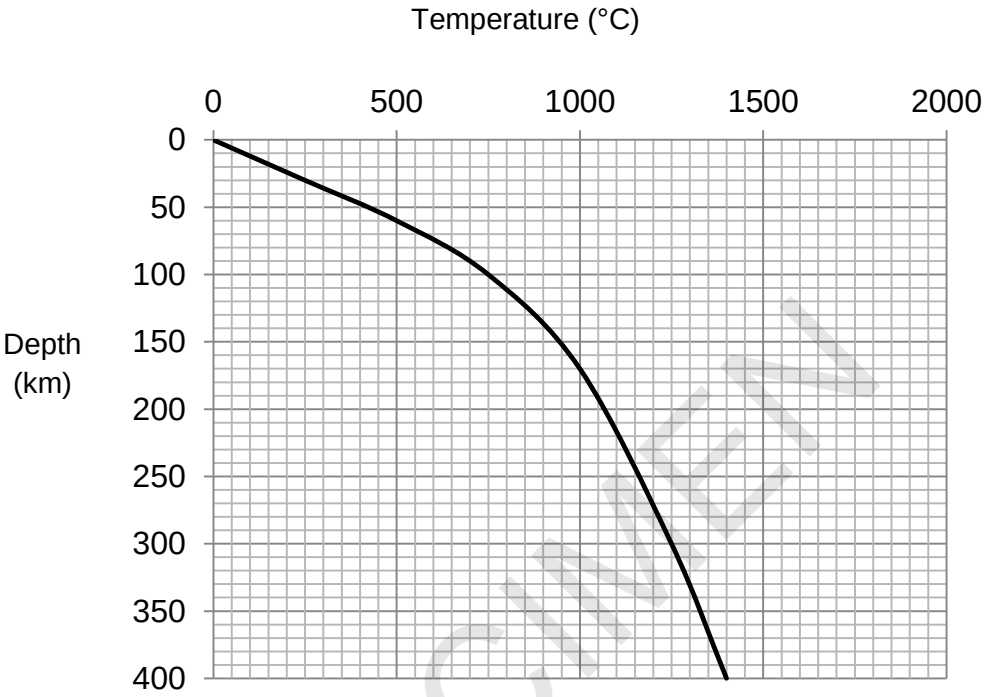
……**[3]**

(c) Temperature measurements down the boreholes in part **(b)** showed that the temperature increased with depth.

Geothermal gradient describes how temperature changes with depth inside the Earth.

The geothermal gradient for a region, **Q**, has been plotted on the graph below.



(i) Calculate the geothermal gradient between 100 km and 400 km for region **Q**. Include units in your answer.

geothermal gradient…… units…… **[2]**

(ii) Explain why geothermal gradient changes with depth.

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……**[2]**

23 The table below shows temperature readings measured in a sandstone country rock around two igneous intrusions of the same composition but of different size.

Distance from intrusion (m)	Temperature of rocks (°C)	
	Intrusion E	Intrusion F
0	650	650
100	420	520
200	250	390
300	150	280
400	100	190
500	100	120
600	100	100

(a) Using data from the table, identify which is the larger intrusion and suggest why the temperature change in the country rock may vary with the size of the intrusion.

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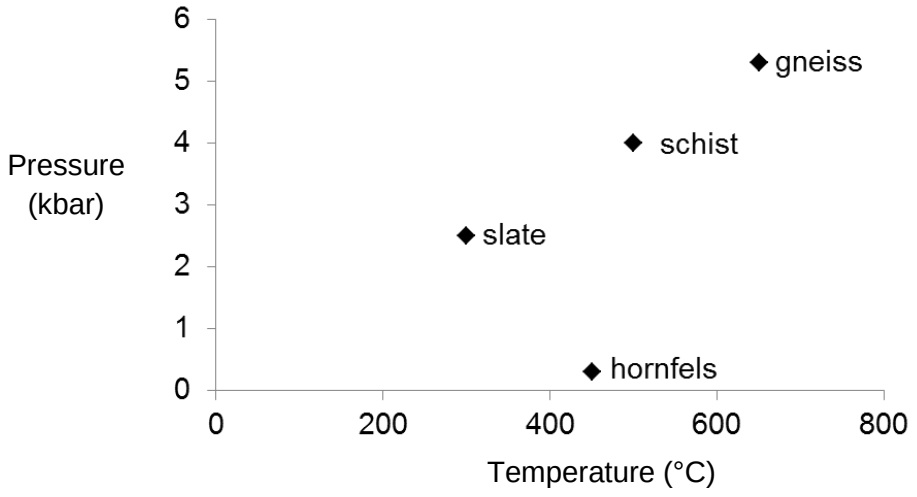
..... **[3]**

(b) The diagram below shows a pressure/temperature plot for four different rocks.



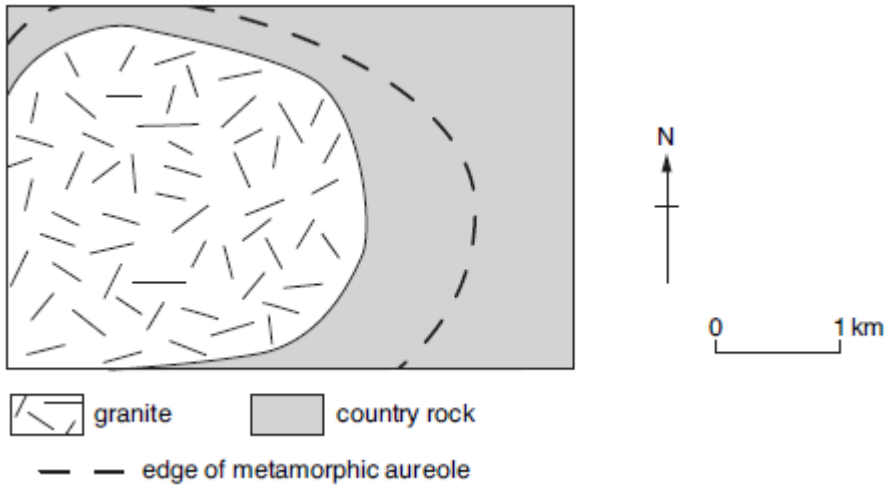
(i) On the diagram, shade the area where regional metamorphism takes place. **[1]**

(ii) The table below lists some properties of the four rocks.
Complete the table below with the names of the four rock types shown on the diagram. You may use each rock type once, more than once or not at all.

Formed at the greatest depth	.....
Been re-crystallised by contact metamorphism	.....
Has a cleavage	.....
A coarse banded texture	.....
No preferred orientation of its minerals	.....
Parallel alignment of muscovite mica crystals	.....

[2]

(c) The diagram below shows a metamorphic aureole around a granite intrusion.



Explain why the width of the metamorphic aureole may vary.

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..…… **[3]**

(d) When geologists reconstruct the conditions of contact and regional metamorphism, they concentrate on pelitic (fine grained siliciclastic) rocks. Explain why geologists prefer to investigate some types of metamorphosed sedimentary rocks and not others.

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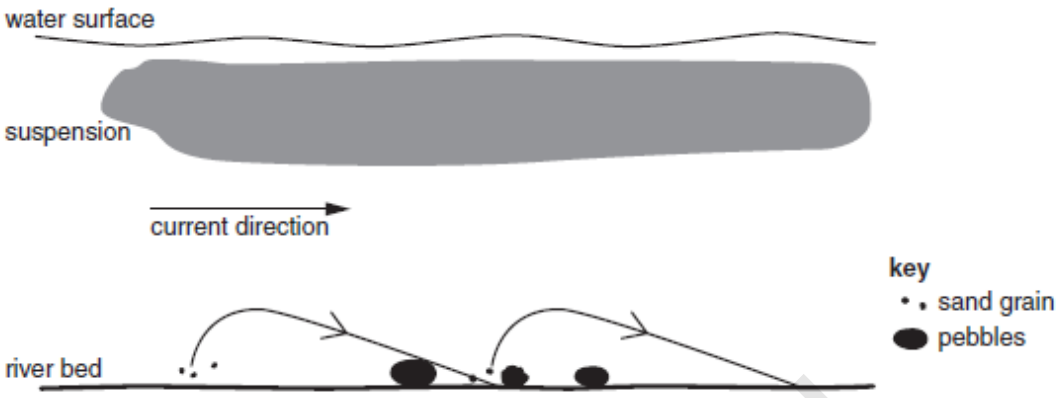
……**[2]**

24 Sediment transport processes not only affect the characteristics of the sediments themselves, but can also produce structures which suggest the nature of the sedimentary environment.

The diagram below shows how sediments are transported by a river.



(a) Describe the importance of river velocity in determining the method by which sediment is transported downstream?

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……**[2]**

(b) The photograph below shows sediment in a river bed.

Some students collected 15 clasts from two points in a river by systematically sampling across the river bed. They measured the length and width (to the sharpest point) of each clast to investigate how sediment changes as it is transported downstream.

The table on the next page shows the data they collected.

	Downstream			Upstream		
Clast	**Length (mm)**	***Running mean of length (mm)***	**Width (mm) (to sharpest point)**	**Length (mm)**	***Running mean of length (mm)***	**Width (mm) (to sharpest point)**
1	32	32	14	56	56	15
2	27	30	20	39	48	14
3	45	35	34	98	64	35
4	58	41	42	78	68	39
5	60	44	39	108	76	40
6	40	44	20	64	74	20
7	52	45	22	78	74	22
8	42	45	25	56	72	15
9	52	45	29	87	74	31
10	30	44	23	92	76	24
11	23	42	12	36	72	12
12	45	42	33	78	73	35
13	43	42	27	68	72	28
14	56	43	34	92	74	35
15	39	43	26	71	73	27
Mean	**43**		**27**	**73**		

(i) Calculate the mean width of the upstream clasts.

mean = …… mm **[1]**

(ii) An approximate measure of the roundness of the clasts can be calculated using the formula

$$R = \frac{2b_r}{a} \times 1000$$

Where b_r is half the clast width (measured to the sharpest point) and a is the clast length.

The mean roundness of the downstream clasts is 628.

Using the formula, calculate the mean roundness of the **upstream clasts**.

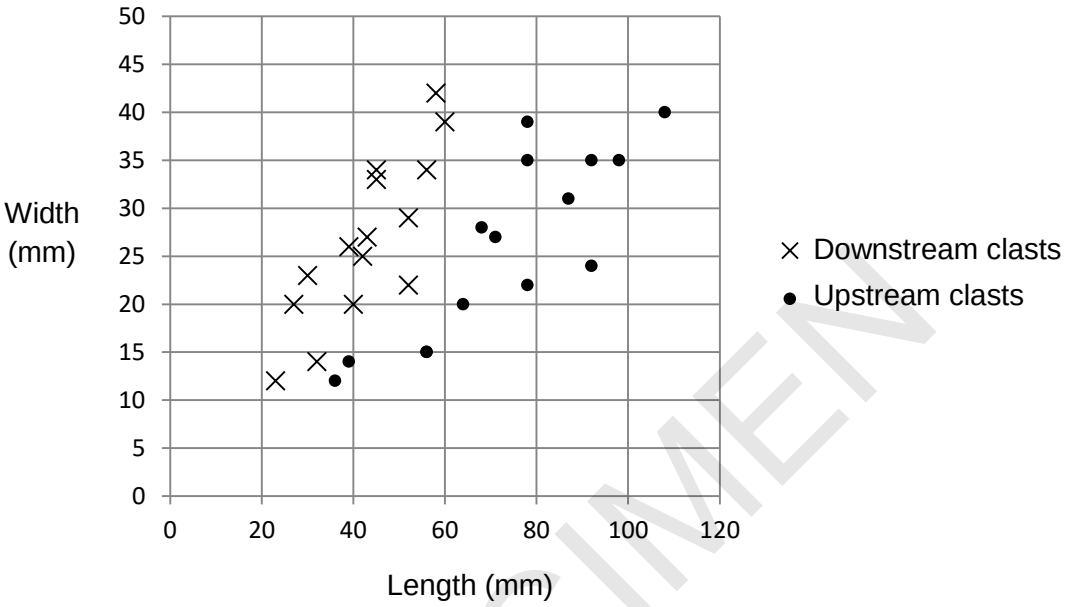
R = …… **[2]**

(iii) Comment on the validity of the samples the students collected.

……

……**[1]**

(iv) The students' data is plotted on the graph below.



Using the graph and your answer to **(ii)**, discuss the data collected and draw a conclusion about how river bedload changes as it is transported downstream. Explain your answer.

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……**[4]**

(c)* The students then studied a nearby cliff section of sedimentary rock. Their geological guide book said that the sedimentary rocks may have been deposited by a river flowing into a playa lake, and that later tectonic processes had turned the whole sequence upside down.

Discuss possible sedimentary structures that might be recognised in the outcrop which would support the proposed environment of deposition and also possible evidence for the sequence being overturned.

Explain your decisions. You may find the use of diagrams helps your answer. **[6]**

Additional answer space if required.

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25 Minerals help geologists distinguish between igneous, sedimentary and metamorphic rocks.

(a) **(i)** For each rock group, name a mineral that is found in that rock group only.

Igneous …….....

Sedimentary ……....

Metamorphic ……..…..

[2]

(ii) Give **two** reasons why the mineral quartz is common in all three groups of rock.

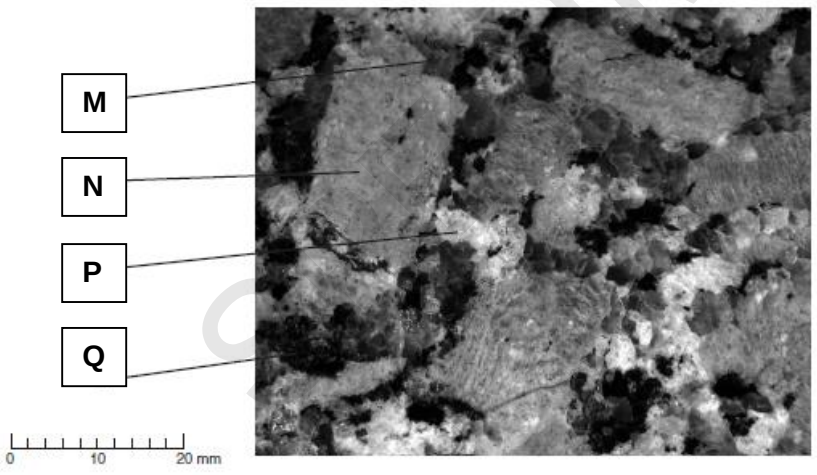
1……

...……..…

2……

...……**[2]**

(b) The photograph below is of a granite.



Identify two minerals in the photograph from their descriptions below.

Black, with perfect cleavage that forms flakes:

Letter …… Name ……...……

Pink phenocrysts of hardness 6:

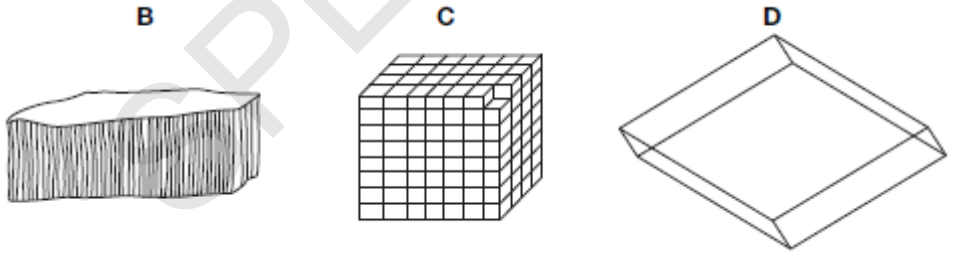
Letter …… Name ……..…

[2]

(c) The table below gives information relating to minerals found in the Zechstein salt deposits of northern Europe.

Specific gravity	Crystal system and cleavage	Hardness	Composition	Colour	Name
2.0	Varies	2	K salts	White	Potash salts
2.3	Massive or cubic with excellent cleavage so cleaves into smaller cubes	2.5	NaC*l*	White	Halite
2.9	Massive layers	3	$CaSO_4$	White	Anhydrite
2.2	Fibrous layers	2	$CaSO_4 \cdot 2H_2O$	White or pink	Gypsum
2.8	Massive or rhombohedral but faces are often curved	3.5	$CaMg(CO_3)_2$	White	Dolomite
2.7	Massive or rhombohedral with three planes of cleavage so cleaves into smaller rhombs	3	$CaCO_3$	White	Calcite

Using information from the table, identify minerals **B**, **C** and **D.**



Mineral **B** ……

Mineral **C** ……..

Mineral **D** ……..……...

[2]

(d) (i) A student needed to distinguish between three metallic ore samples.

Using colour, the student decided that the first sample, a dark red, was hematite, the second sample, a grey sample, was galena and the third sample, a pale brass-yellow sample, was iron pyrites.

Evaluate the student's decision.

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…… **[1]**

(ii) Suggest **two** ways to improve the validity of the identifications the student has made.

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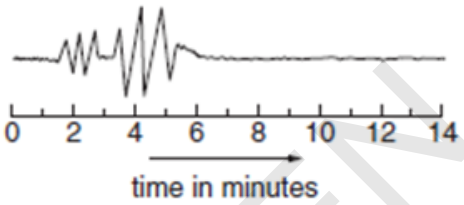
…… **[2]**

26 Geologists use seismograms to investigate earthquakes.

(a) **(i)** The table shows arrival times to the nearest half minute for the P and S waves shown on three seismograms.

	P wave arrival time (min)	S wave arrival time (min)
Seismogram A	6	10
Seismogram B	1.5	6.5
Seismogram C		



Complete the table for seismogram **C**, using the data above. Give the arrival times to the nearest half minute.

[1]

(ii) Using the P wave arrival time data from the seismograms and assuming that P waves travel at 5×10^2 km min^{-1}, calculate the distance from the epicentre for stations **A**, **B** and **C**.

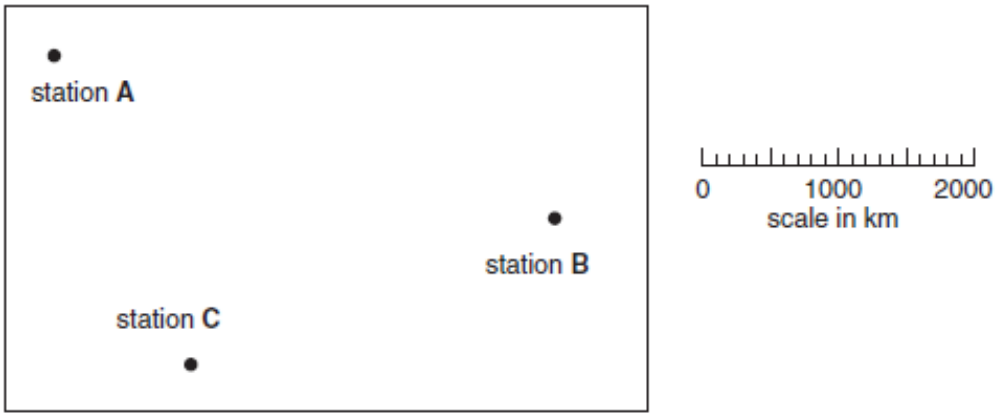
Station **A** distance ..... km

Station **B** distance ..... km

Station **C** distance ..... km

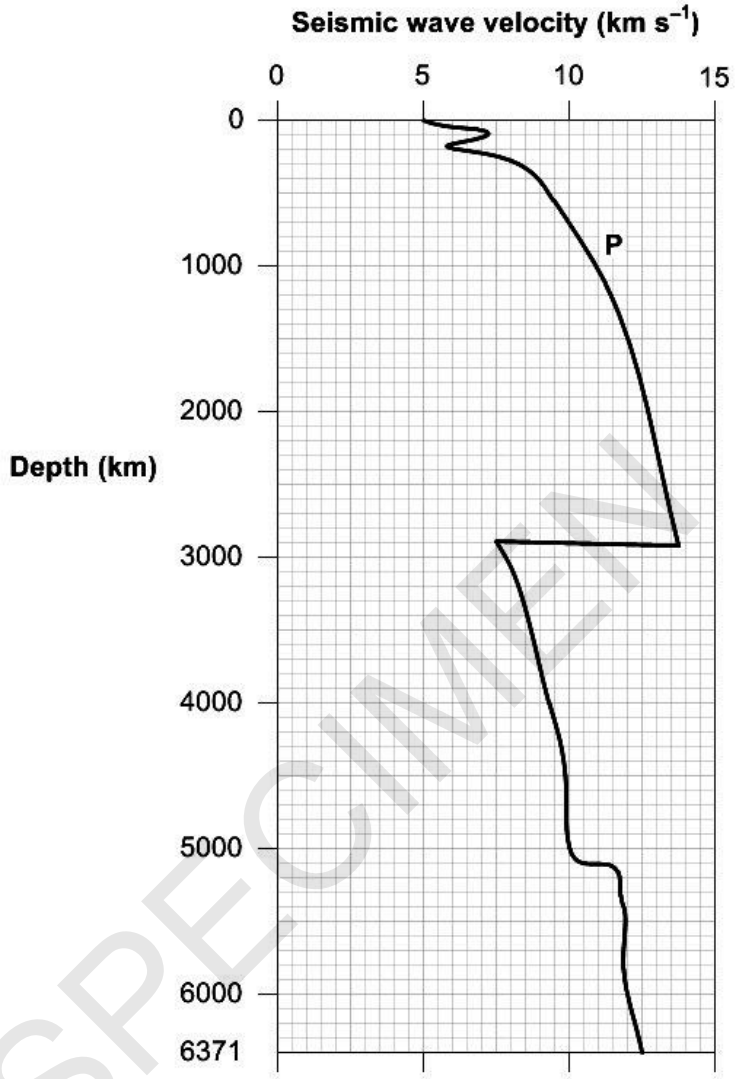
[1]

(b) Use the distance from the epicentre for all three stations to locate the epicentre of the earthquake on the diagram below.



[3]

(c) Seismic wave velocity can be used to help determine the nature and depth of the earth's interior. The graph below shows how the velocity of P waves change as they travel through the Earth.



(i) From the graph, calculate the average velocity of P waves between depths of 1200 and 1800 km.

average velocity =……km s^{-1} **[1]**

(ii) Explain why the P wave velocity increases between 200 and 2900 km depth.

……

…… **[1]**

(iii) The table below shows changes in the velocity of S waves. Plot the data on the axes in part **(c)** and draw the line on the graph.

S wave velocity (km s^{-1})	3.0	5.0	4.0	5.0	7.0	0.0	0.0	4.0	4.5
Depth (km)	0	100	150	250	2900	2900	5100	5100	6371

[2]

(iv) Suggest the geological reason for the difference between the graphs for P waves and S waves between 2900 and 5100 km depth.

……

…… **[1]**

(v) Use the graph to describe the role of P and S waves in identifying layers within the Earth.

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…… **[3]**

27 In 1812 Friedrich Mohs devised a hardness scale for identifying mineral specimens.

(a) Why are there usually 9 minerals supplied in a laboratory Mohs Hardness Scale kit, rather than the 10 minerals originally suggested?

……

…… **[1]**

(b) A student found two minerals, **Specimen A** and **Specimen B**, from an old hardness kit which had lost their labels.

Using a laboratory Mohs Hardness Scale kit, describe a procedure the student could use to identify **Specimen A** and **Specimen B**.

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…… **[3]**

(c) **Specimen A** does not scratch **Specimen B**. The student observed that a third specimen, **Specimen C**, had a grey appearance similar to **Specimen B** and was able to scratch **Specimen A**.

What does the information suggest about the identity of **Specimen C**?

……

…… **[1]**

(d) Common objects can be used in the place of minerals for a quick hardness test.

The table below shows some of the common objects used to test the hardness of **Specimen C**.

Common object	**Mohs hardness**	**Specimen C scratched?**
fingernail	2–2.5	X
nail	4	✓
knife blade	5–6.5	✓
quartz	7	✓

The table below shows the appearance and hardness of a number of minerals.

Mineral	**Appearance**	**Mohs hardness**
Gypsum	White colour, translucent	2
Anhydrite	White/grey colour, sugary appearance	3–3.5
Calcite	White/pink colour, sugary appearance	3
Quartz	White/pink colour, translucent	7

The student concluded that **Specimen C** was anhydrite.

Evaluate the student's judgement.

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…… **[2]**

28 The geology of South Devon has often been characterised by the 'red beds' frequently seen in coastal sections, notably in the Torbay area.

(a) A group of geology students decide to investigate these 'red beds'. They choose an outcrop near Paignton Harbour which appears to show large scale cross bedded sandstones but interspersed with lenses of a coarser sediment. See photographs **28A** and **28B** below.

Photograph 28A
Cross bedded sandstones in centre of photo

Photograph 28B
Lens of coarser material

The students decided to do a grain analysis on a weakly cemented block of the coarser sediment in order to plot a cumulative weight percent frequency curve.

(i) Outline a practical procedure that the students could follow.

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……..……..**[4]**

(ii) Several of the elongated clasts in photograph **28B** are tilted in a similar direction.

Name the sedimentary structure represented by the tilted clasts and explain how this tilting occurs.

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...……..……..**[3]**

(iii)* The students use their cumulative weight percent frequency curve to calculate the sorting coefficient of the coarser material to be 1.9. From the geological guide, they know value for the sorting of the sandstones is 0.3.

Use the values above, along with the photographs and information given in the earlier parts of this question, to suggest the environment of deposition of the rocks found in this outcrop. You should explain the basis of your decisions. **[6]**

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Additional answer space if required.

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END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following page(s). The question number(s) must be clearly shown in the margin.

Oxford Cambridge and RSA

…day June 20XX – Morning/Afternoon

AS Level Geology

H014/01 Geology

SAMPLE MARK SCHEME

Duration: 2 hours 30 minutes

MAXIMUM MARK 120

This document consists of 26 pages

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit.

3. Log-in to RM assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM assessor 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM assessor messaging system.

5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question.

   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The RM Assessor comments box is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. Do not use the comments box for any other reason.
   If you have any questions or comments for your Team Leader, use the phone, the RM Assessor messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:
Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative geological content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and geological content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.
Once the level is located, award the higher or lower mark:
The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.
The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.
In summary:
The skills and geological content determine the level.
The communication statement determines the mark within a level.

Level of response questions on this paper are **24c** and **28(a)(iii).**

11. **Annotations**

Annotation	Meaning
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

12. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

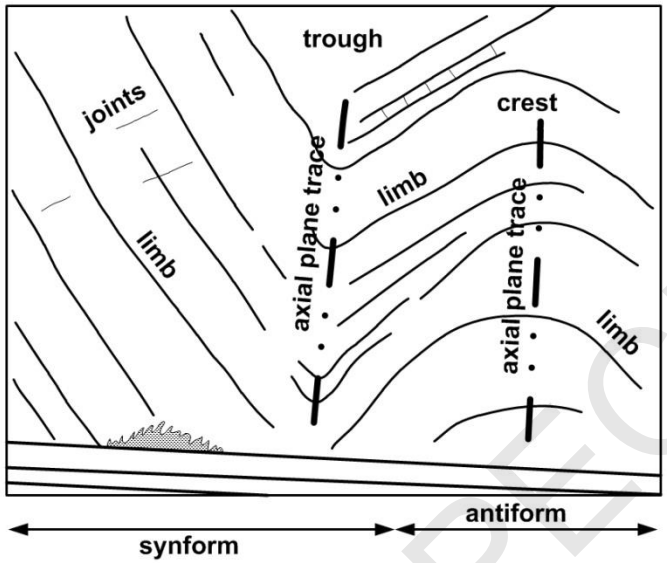
You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCE Geology:

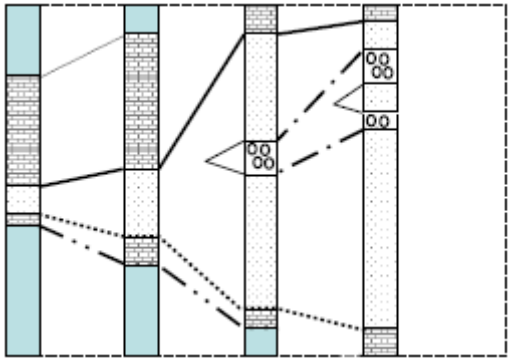
	Assessment Objective
AO1	**Demonstrate knowledge and understanding of geological ideas, skills and techniques**
AO1.1a	Demonstrate knowledge of geological ideas
AO1.1b	Demonstrate knowledge of geological skills and techniques
AO1.1c	Demonstrate understanding of geological ideas
AO1.1d	Demonstrate understanding of geological skills and techniques
AO2	**Apply knowledge and understanding of geological ideas, skills and techniques**
AO2.1a	Apply knowledge and understanding of geological ideas
AO2.1b	Apply knowledge and understanding of geological skills and techniques
AO3	**Analyse, interpret and evaluate geological information, ideas and evidence to make judgements, draw conclusions, and develop and refine practical design and procedures**
AO3.1a	Analyse geological information, ideas and evidence
AO3.1b	Interpret geological information, ideas and evidence
AO3.1c	Evaluate geological information, ideas and evidence
AO3.1d	Make judgements
AO3.1e	Draw conclusions
AO3.1f	Develop and refine practical design and procedures

Question			Answer	Marks	AO element	Guidance
1			C✓	1	2.1a	
2			D✓	1	2.1b	
3			A✓	1	1.1a	
4			A✓	1	1.1d	
5			C✓	1	1.1a	
6			C✓	1	2.1a	
7			A✓	1	1.1c	
8			D✓	1	2.1a	
9			B✓	1	2.1a	
10			B✓	1	2.1b	
11			B✓	1	2.1a	
12			A✓	1	1.1c	
13			B✓	1	2.1b	
14			B✓	1	1.1c	
15			C✓	1	2.1b	
16			B✓	1	1.1a	
17			D✓	1	1.1a	
18			B✓	1	2.1b	
19			D✓	1	1.1c	
20			C✓	1	1.1c	
			TOTAL	**20**		

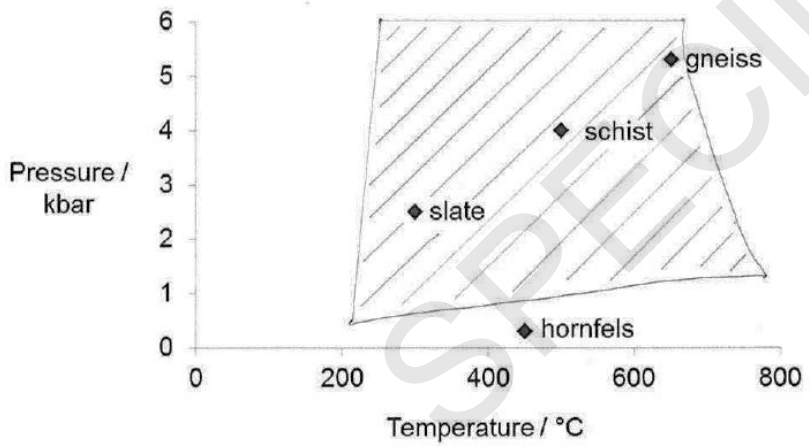
Question			Answer	Marks	AO element	Guidance
21	(a)		clear sketch showing in the correct proportions: synform ✓ antiform ✓ e.g.  labels to include: antiform; synform; limb; axial plane trace; crest; trough ✓	3	2.1b × 3	Minimum of three labels required
	(b)		• sediments laid down horizontally ✓ • sedimentation stops as rocks are uplifted and eroded ✓ • new deposits laid down unconformably on erosion surface ✓	3	1.1c × 3	**ALLOW** labeled diagrams showing stated points

Question			Answer	Marks	AO element	Guidance
	(c)	**(i)**	the distances between the two limbs of the fold are different on either side of the fault / the outcrop is displaced in opposite directions on each side of the axial plane / axial plane trace not displaced ✓	**1**	**2.1a**	**ALLOW** alternative wording
		(ii)	left / NW / W ✓ the outcrop of the beds are closer on the downthrown side of an antiform / beds are younger on the downthrown side / **ORA** ✓	**2**	**1.1c** **2.1a**	
		(iii)	50 m ± 5 m ✓	**1**	**2.1b**	
			Total	**10**		

Question			Answer	Marks	AO element	Guidance
22	(a)	(i)	points plotted correctly at, 100% – 0 Ma 50% – 1250 Ma 25% – 2500 Ma 12.5% – 3750 Ma 6.25% – 5000 Ma ✓ curve plotted correctly ✓	2	2.1b × 2	
		(ii)	• at formation of rock only ^{40}K present ✓ • over time (unstable) ^{40}K decays to (stable) ^{40}Ar ✓ • half-life is a measure of this decay and the ratio of ^{40}K to ^{40}Ar will be related to the age of the rock ✓ • this ratio and the half-life graph can be used to estimate the age of the rock at about 2900 million ✓	4	2.1a × 4	**DO NOT ALLOW** unless answer is linked to specific details from the graph
		(iii)	**Any three from** • Radioactivity allowed Precambrian rocks to be dated and the age of the Earth to be extended beyond 100 Ma✓ • Numerical dating allows a time scale to be given to the geological column / relative dating history (**AW**) ✓ • The heat released by radioactive decay in the mantle (an additional source of geothermal energy) led to a better explanation of the shape of the geotherm✓ • Release of heat in the mantle from radioactive decay provided a plausible mechanism for the theory of continental drift ✓ • Radioactive decay provided an explanation for mantle convection allowing the general acceptance of the theory of plate tectonics in the 1970s✓	3	2.1a ×3	

Question			Answer	Marks	AO element	Guidance
	(b)	(i)	 top and bottom of the top limestone ✓ top and bottom of conglomerate ✓ top and bottom of bottom limestone ✓	3	2.1b × 3	
		(ii)	***Advantages*** • recognises lithostratigraphic as using rocks / identify sequences in rocks • has immense economic importance in identifying beds of economic value such as coal ***Disadvantages*** • without fossil evidence lithostratigraphic correlation is difficult	3	1.1c × 3	**ALLOW** the presence of rare minerals such as iridium can greatly enhance correlation
	(c)	(i)	2.2 (±0.2) ✓ °C km^{-1} ✓	2	2.1b × 2	(1400 – 750)/(400 – 100) = 650/300 = 2.2

Question			Answer	Marks	AO element	Guidance
		(ii)	heat transfer in the lithosphere (0 – 100 km) is by conduction, which is less efficient, therefore the geothermal gradient is higher ✓ heat transfer in the asthenosphere (> 100 km) is by convection, which is more efficient, therefore the geothermal gradient is lower ✓	**2**	**1.1a × 2**	**ALLOW** some areas have much higher heat flows because of deep fault zones, rifting, magmatic intrusions, or active tectonic forces
			TOTAL	**19**		

Question			Answer	Marks	AO element	Guidance
23	(a)		***F** is the larger intrusion (no mark)* the temperature gradient is less steep around **F OR** the rate of cooling is lower around **F** ✓ **F** has a smaller surface area to volume ratio **OR** has a greater thermal mass **OR** has a greater volume of magma ✓ because larger intrusions retain heat for longer they can heat up a greater volume of country rock **OR** the heat can travel a greater distance from the intrusion ✓	**3**	**3.1a × 3**	
	(b)	**(i)**	shaded area must include slate, schist and gneiss and begin above 200°C ✓ e.g.  	**1**	**AO2.1b**	
		(ii)	gneiss hornfels slate gneiss hornfels schist / slate	**2**	**1.1a × 2**	5–6 correct = 2 marks 1–4 correct = 1 mark

Question			Answer	Marks	AO element	Guidance
	(c)		***Any three from*** • dip of sides / contact of intrusion varies ✓ • narrow if side is dipping steeply / wide if shallow dip ✓ • country rock type varies – heat is absorbed / conducted differently / some are more reactive ✓ • presence of water – increases amount of metamorphism / carries heat further ✓ • size / volume of magma – large intrusion produces wider aureole / will retain heat longer ✓ • initial temperature of magma / temperature difference – higher temperature will produce wider aureole ✓ • composition of magma – silicic magmas may contain more volatiles so can produce wider aureoles ✓	**3**	**1.1c × 3**	max 1 if general statement width varies because the intrusion / country rock varies max 1 for list of factors with no explanation
	(d)		***Any two from*** • pelites/shale(**AW**) is the parent of different low, medium and high grade metamorphic rocks **OR** slate, phyllite, schist and gneiss as metamorphic grade increases✓ • limestone is the parent of one metamorphic rock marble **OR** sandstone is the parent of one metamorphic rock metaquartzite **OR** limestone is only composed of $CaCO_3$/Calcite **OR** sandstone is only composed of SiO2/Quartz ✓ • the <u>clay minerals</u> in pelites/shale(**AW**) have a complex chemical composition so they can be the produce a wide variety of different <u>index minerals</u> as, metamorphic grade/the intensity of metamorphism, increases ✓	**2**	**1.1c × 2**	**ALLOW** intensity of metamorphism for metamorphic grade **DO NOT ALLOW** general comments about ‘minerals’
			TOTAL	**11**		

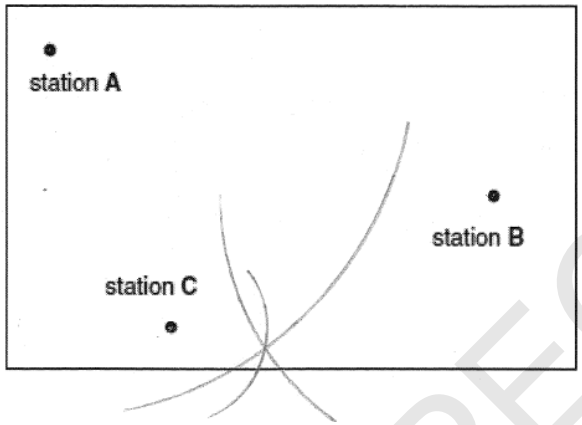
Question			Answer	Marks	AO element	Guidance
24	(a)		***Any two from*** • greater the velocity the larger particles that can be transported ✓ • takes greater amount of energy to lift the particles ✓ • clay particles require large amounts of energy to be picked up ✓ • velocity is fastest in the centre of the river ✓	2	1.1c × 2	**ALLOW** reference Hjulstrom curve **ALLOW** reference to reduction in velocity **ALLOW** velocity may increase during flood conditions
	(b)	(i)	mean = 392/15 = 26 (mm) ✓	1	1.1b × 1	
		(ii)	Mean roundness = [(2 × 13)/73] × 1000 ✓ = 356 ✓	2	2.1b × 2	**ALLOW ECF from part (b)(i)**
		(iii)	sample size is valid, because it is larger than optimum sample size determined using running means of length / larger than optimum sample size of 12 ✓	1	3.1c	**ALLOW** 11 for optimum sample size
		(iv)	***Discussion of data*** Positive correlation of data but gradients different, data sets don't overlap ✓ ***Conclusions*** Suggests significant difference between pebble sizes upstream and downstream ✓ Suggests pebbles are smaller/smoother/more rounded ✓ ***Explanation*** smaller clasts, travel further / can travel over a wider range of velocities, and are therefore subjected to more erosion by abrasion and attrition ✓	4	3.1a x1 3.1e x2 2.1a ×1	

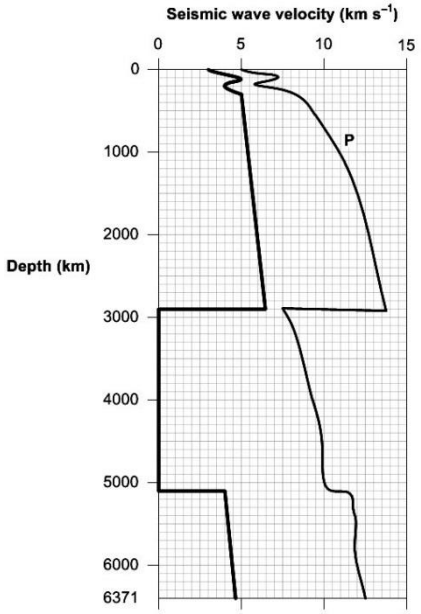
	(c)		Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Full analysis of the information provided discussing most of important geology (i.e. most of potential sedimentary structures) **AND** explanation **AND** discussion of way-up evidence *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and detailed.* **Level 2 (3–4 marks)** Good analysis of the information provided. Some of structures described **AND** explanation **OR** discussion of way-up evidence *There is a line of reasoning presented with some structure. The information presented is relevant.* **Level 1 (1–2 marks)** A limited treatment providing either a description of some structures **OR** information which may lead to attempt at interpretation of way-up evidence. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	**2.1a ×4** **3.1c x1** **3.1d x1**	**Indicative geological points include:** ***AO3.1c Evaluate geological ideas, information and evidence – Evaluation of scenario*** sediment brought down by river, settles in low energy conditions of playa lake; hot conditions cause rapid evaporation, this environment leads to…… ***AO3.1d Make judgements – determine possible sedimentary structures*** Salt pseudomorphs Asymmetrical ripple marks Graded bedding Desiccation cracks Imbrication ***AO2.1a Apply knowledge and understanding of geological ideas – explanation of decisions*** ***Salt pseudomorphs*** form when lake dries and halite crystals form;redissolving of these and infilling with sediment form pseudomorphs. ***Asymmetrical ripple marks*** are formed by currents that flow in one direction, or formed in desert environments where the wind acts in the same way as water ***Graded bedding***, largest particles are on the bottom of the bed and the smaller particles are at the top / the grains become finer towards the top ***/*** there is an abrupt change in size at each bedding plane

						larger particles are heavier and settle out first so are found at the bottom of the bed / can be formed when sediment tips into lake and gravity settling occurs ***Dessication (mud) cracks*** form when fine sand/mud dries, shrinks and cracks; cracks become infilled later with sediment. ***Imbrication*** forms when long pebbles become tilted in roughly the same direction by transporting river ***Evidence for overturned sequence*** Dessication: cracks are wider at bottom than top; Graded bedding: sequence gets coarser upwards Geopetal structures
			TOTAL	**16**		

Question			Answer	Marks	AO element	Guidance
25	(a)	(i)	***igneous*** olivine ***sedimentary*** clay ***metamorphic*** garnet ✓✓	2	1.1a × 2	All correct for 2 marks 1–2 correct for 1 mark
		(ii)	quartz is SiO_2 and Si and O are the most abundant elements in the crust (~75%) / are lithophiles so are enriched in the crust ✓ continental crust is formed of granitic rocks, quartz is a common mineral in granite (~25%) and through the rock cycle granites erode to form quartz sandstone and metamorphose to form gneiss ✓	2	1.1a × 2	**ALLOW** quartz is resistant to physical weathering (hardness 7) and chemical weathering (chemically inert)
	(b)		**Q** black crystals as biotite ✓ **N** large phenocrysts as K feldspar ✓	2	3.1b × 2	 **ALLOW** orthoclase feldspar **DO NOT ALLOW** 'feldspar'
	(c)		**B** gypsum **C** halite **D** calcite ✓✓	2	3.1c × 2	All 3 for 2 marks 1–2 for 1 mark

	(d)	**(i)**	most ores/minerals have a range of colours so this is not a reliable form of identification ✓	**1**	**3.1c**	**ALLOW** red could be a copper ore, grey could be an iron mineral/magnetite, yellow could be gold
		(ii)	***Any two from*** streak ✓ lustre ✓ hardness ✓	**2**	**3.1f × 2**	**ALLOW** density or specific gravity **IGNORE** details of the results you would see for the three metallic ore samples mentioned
			TOTAL	**11**		

Question			Answer	Marks	AO element	Guidance
26	(a)	(i)	P wave arrival time = 1.5 (min) S wave arrival time = 3.0 **OR** 3.5 (min) ✓	1	1.1d	
		(ii)	**A** = 3×10^3 / 3000 (km) (6×500) **B** = 2.25×10^3 / 2250 (km) (4.5×500) **C** = 7.5×10^2 / 750 (km) (1.5×500) ✓	1	2.1b	**ALLOW ECF** from **(i)** for **C** **All** three needed for one mark
	(b)		 ✓✓✓	3	2.1b × 3	**ALLOW ECF** from **(ii)** 1 mark for 1 correct arc 2 marks for 3 correct arcs 1 mark for locating the epicentre / can be in the centre of a triangle
	(c)	(i)	12.00 (km s^{-1}) ✓	1	1.1d	
		(ii)	As pressure increases with depth, particles become closer so waves (energy) transmitted faster ✓	1	1.1c	
		(iii)	Correctly plotted points ✓ Line drawn correctly ✓	2	2.1b × 2	

Question			Answer	Marks	AO element	Guidance
						
		(iv)	S waves are transverse waves which cannot travel through liquids as liquids will not shear ✓	**1**	**3.1b**	

		(v)	***Any three from*** • P and S wave velocities change markedly at the boundary of two layers/at a discontinuity ✓ • P and S waves both slow down in the asthenosphere ✓ • P and S waves both speed up in the mantle ✓ • P waves slow down at the Gutenberg Discontinuity/outer core whilst S waves stop completely ✓ • P waves speed up at the Lehmann Discontinuity/inner core ✓ • S waves reappear at the Lehmann Discontinuity/inner core ✓	**3**	**2.1a × 3**	**ALLOW** Velocity of seismic waves increases with depth as rock becomes more rigid/more incompressible **ALLOW** P and S waves do not pass through the shadow zone
			Total	**13**		

Question			Answer	Marks	AO element	Guidance
27	(a)		because diamond is so expensive it is usually left out of the kit ✓	1	1.1d	
	(b)		Locate (unscratched smooth) surface on unknown specimen and take one of the standard minerals and drag its point against the unknown specimen ✓ (Re-examine the unscratched /smooth surface to) determine if a scratch (a distinct groove not a mark that wipes away) has been made ✓ Repeat using other standard minerals in the hardness kit and use key to identify possible mineral ✓	3	1.1b × 2 2.1b x 1	
	(c)		**Specimen C** could be the same mineral as **Specimen B** (because it has a similar appearance and because both **Specimen C** and **B** are harder than **Specimen A**) **AND** further tests would be needed to confirm this ✓	1	3.1a	
	(d)		*Could be anhydrite because* Can't be gypsum because could not be scratched with fingernail / Mohs hardness above 2.5 **AND** Grey colour / appearance points towards anhydrite ✓ However, not enough information/data collected, would need to test hardness between 2.5 and 4 to validate conclusion ✓	2	3.1c × 2	
			Total	7		

Question			Answer	Marks	AO element	Guidance
28	(a)	(i)	block / sample needs to be broken up ✓ mass of sample weighed / 100 g used ✓ use sieve bank / stack to sort sample ✓ weigh proportion of sediment in each sieve ✓	4	3.1f x 4	
		(ii)	imbrication / imbricate structure ✓ water flow knocks over elongated flat pebbles ✓ b-axis tilts in the direction of flow ✓	3	1.1c x 3	
		(iii)*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Full analysis of the information provided discussing most of important geology **AND** a sound overall conclusion *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and detailed.* **Level 2 (3–4 marks)** Good analysis of the information provided **AND** an attempt at an overall conclusion of the environment at the time **OR** interpretation of information *There is a line of reasoning presented with some structure. The information presented is relevant.*	6	3.1a x 3 3.1b x 2 3.1e x 1	**NB: A labeled diagram may illustrate some of the observations and/or interpretation.** **Indicative geological points include:** **AO3.1a Analyse geological information, ideas and evidence** **Pictures:** • angular fragments • badly sorted • imbricate structures dip to west • coarse material interspersed with finer cross bedded sands **Grain analysis:** • coarser material poorly sorted • sandstones well-sorted and finer sand **Text:** Red colour suggest oxidising conditions (surface deposition)

			Level 1 (1–2 marks) A limited treatment providing incomplete analysis of information which may lead to attempt at interpretation or conclusion. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*			**AO3.1b Interpret geological information, ideas and evidence** • red large-scale cross bedded sands suggest desert environment • breccia/badly sorted angular fragments showing imbrication suggests rapid water borne deposition **AO3.1e Draw conclusions** • overall desert environment with periodic flash floods depositing eroded material from higher ground to west of desert
			Total	**13**		

Summary of updates

Date	Version	Change
January 2019	2.1	Minor accessibility changes to the paper: i) Additional answer lines linked to Level of Response questions ii) One addition to the rubric clarifying the general rule that working should be shown for any calculation questions