GCE A LEVEL

eduqas
Part of WJEC

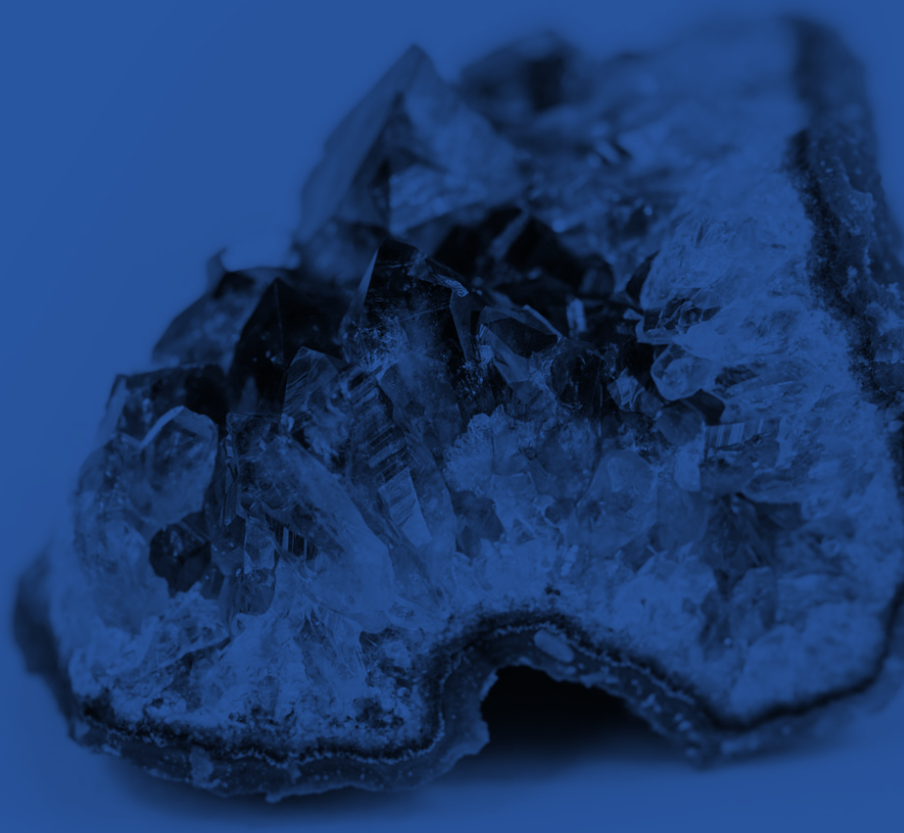
WJEC Eduqas GCE A LEVEL in

GEOLOGY

ACCREDITED BY OFQUAL
DESIGNATED BY QUALIFICATIONS WALES

SAMPLE ASSESSMENT MATERIALS

Teaching from 2017
For award from 2019



wjec
cbac

For teaching from 2017
For awards from 2019

GCE A LEVEL GEOLOGY

SAMPLE ASSESSMENT MATERIALS

Contents

Candidate Name	Centre Number					Candidate Number				
						0				

A LEVEL

GEOLOGY

COMPONENT 1

Geological Investigations

SAMPLE ASSESSMENT MATERIALS

2 hours 15 minutes

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- the Resource Sheet
- Specimens **A**, **B**, **C** and **D**
- geological equipment for testing specimens
- the Mineral Data Sheet
- a calculator

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	16	
	2.	15	
Section B	**3.**	11	
	4.	12	
	5.	6	
	6.	22	
	7.	14	
	8.	9	
	Total	**105**	

INFORMATION FOR CANDIDATES

This paper is in 2 sections, **A** and **B**.
Section **A**: 31 marks. Answer **both** questions. You are advised to spend about 35 minutes on this section.
Section **B**: 74 marks. Answer **all** questions. You are advised to spend about 1 hour 40 minutes on this section.

The geology is **not** designed to represent any particular area.
The Mineral Data Sheet and **Map 1** and **Photographs 1** and **2** are provided on separate resource sheets.
Strips of plain paper may be obtained from the supervisor on request.
Four specimens, **A**, **B**, **C** and **D**, are provided for use.
All except specimen D may be tested with the equipment specified by the supervisor.
The number of marks is given in brackets at the end of each part-question.
The assessment of the quality of extended response (QER) will take place in questions 4 and 8.

*Answer **all** questions.*

Section A

1. **Figure 1a** and **Figure 1b** show two species of marine molluscs. **Figure 1a** are fossils representative of a sample from a single bedding plane (**species A**) while **Figure 1b** represents shells collected from a modern beach (**species B**).

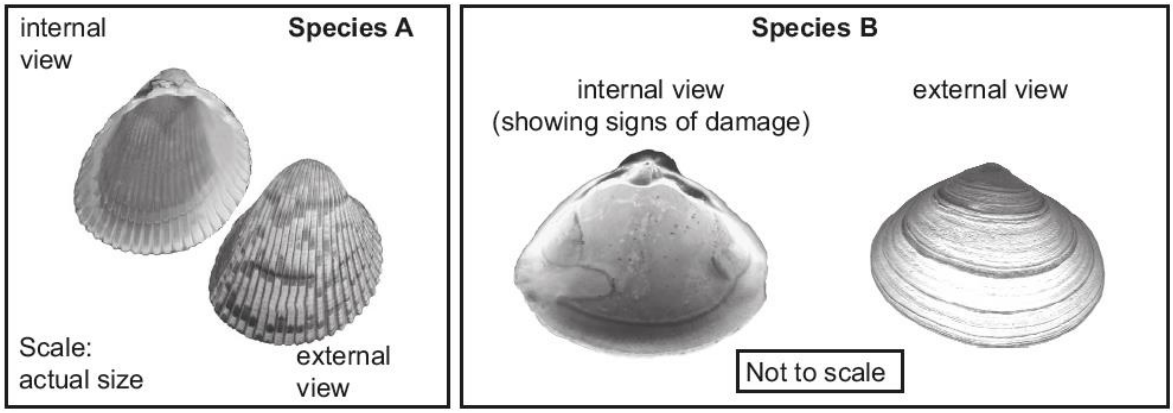


Figure 1a **Figure 1b**

Refer to **Figures 1a** and **1b**.

(a) (i) State the type of marine mollusc represented by species **A** and **B**. [1]

.....

(ii) Describe **two** morphological differences between species **A** and **B**. [2]

Difference .....

Difference .....

(iii) State the former modes of life of species **A** and **B**. Explain **one** piece of evidence for each of your answers. [4]

Species A Mode of life .....

Explanation of the evidence .....

.....

Species B Mode of life.....

Explanation of the evidence.....

.....

(b) **Figure 1c** is a scatter graph of the size variation of **species A** on the bedding surface compared with the beach assemblage of **species B.**

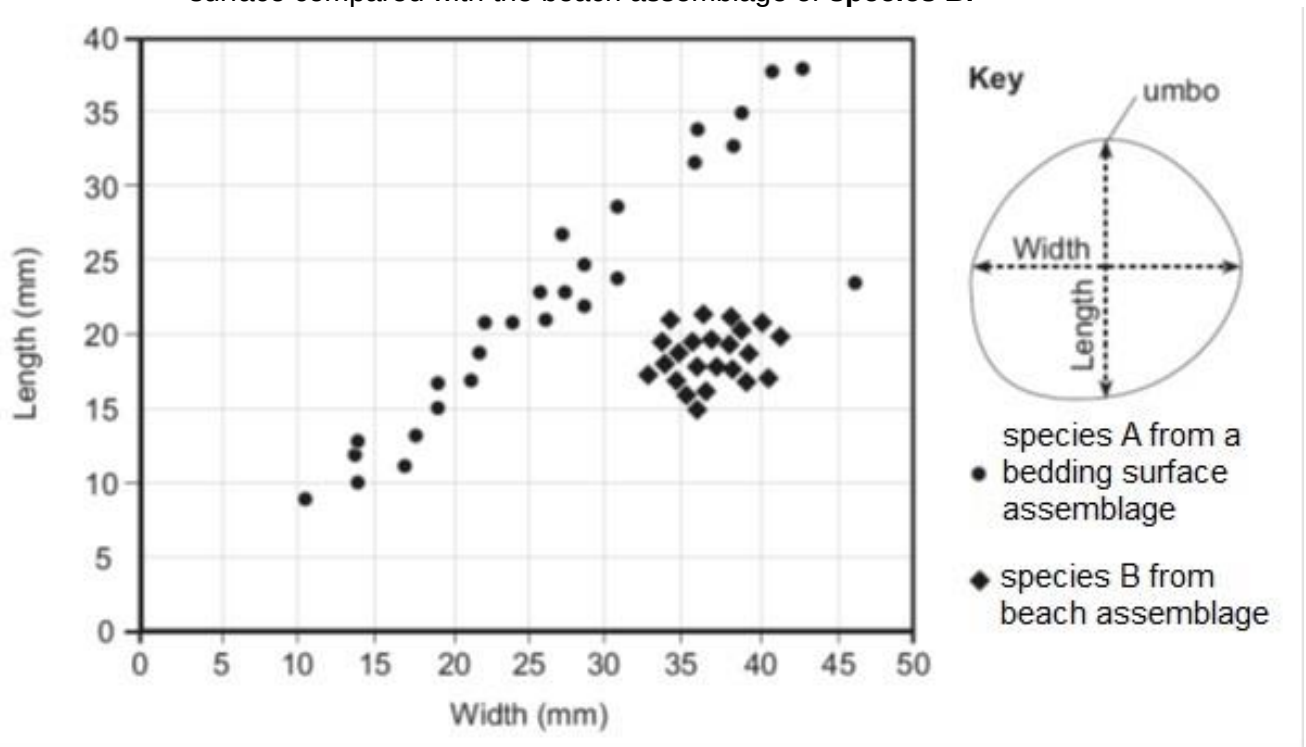


Figure 1c

(i) Refer to **Figure 1c.**

- State the length of the smallest valve within **species A**
- State the width of the widest valve within **species A** [2]

Length of the smallest valve within **species A** …… mm

Width of the widest valve within **species A** …….. mm

(ii) Describe and explain the distribution of the data for **species A** on **Figure 1c**. [4]

……

……

……

……

……

……

(iii) A student correctly concluded from the data that the beach assemblage (**species B**) represented a death (transported) assemblage. Explain this statement with reference to the evidence. [3]

……

……

……

……

……

……

16

2. **Figure 2a** shows temperature and pressure conditions with depth in the Earth.

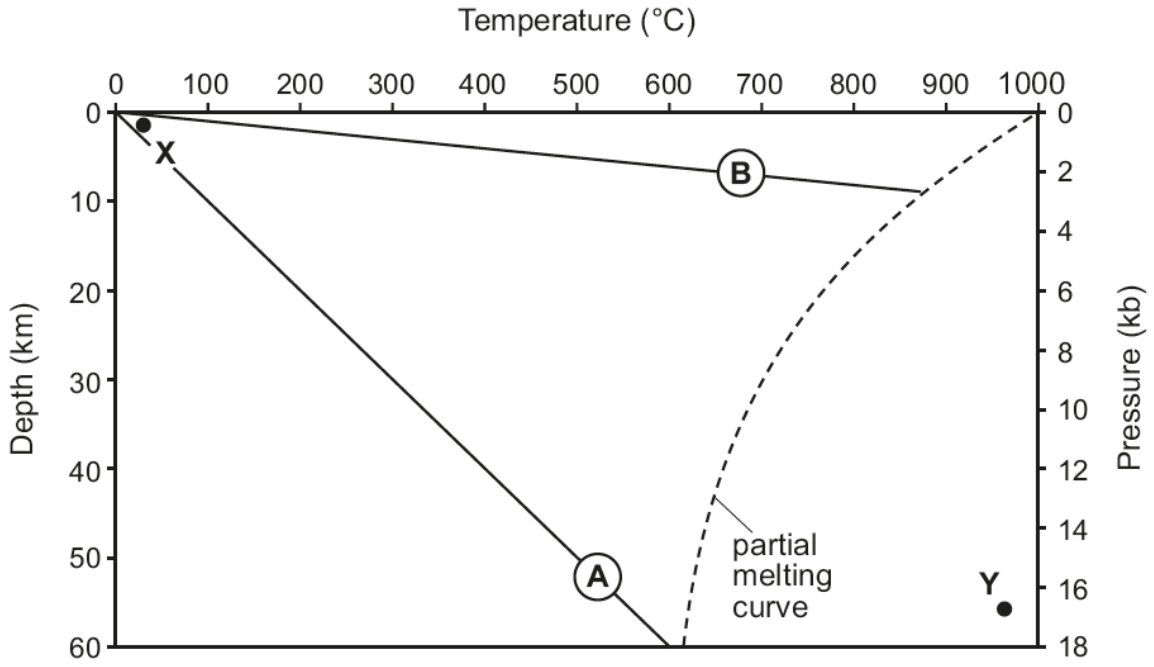


Figure 2a

Refer to **Figure 2a**.

(a) State the main geological processes (**igneous, sedimentary** or **metamorphic**) operating under the temperature and pressure conditions at locations **X** and **Y**. [2]

X…… **Y**.....

(b) (i) Calculate the geothermal gradient of the line **A**. *Show your working*. [2]

……

(ii) Draw a line on **Figure 2a** to represent the geothermal gradient of 25°C km^{-1}. Label it **C**. [1]

(iii) State along which geothermal gradient (**A**, **B** or **C**) the metamorphic rock **hornfels** is most likely to form. Explain your answer. [3]

Geothermal gradient (**A**, **B** or **C**) ☐

Explanation

……...

……...

……...

Figure 2b is a photomicrograph of a metamorphic rock with a porphyroblastic texture.

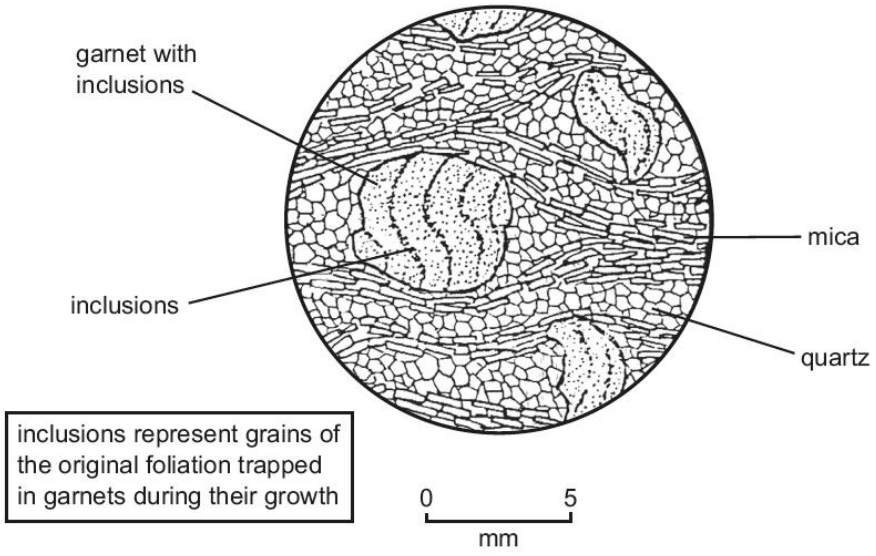


Figure 2b

(c) (i) On **Figure 2b**, label a porphyroblast with an arrow (← **P**). [1]

(ii) Explain the meaning of the term porphyroblastic texture. [3]

……..

……..

……..

……..

(d) (i) On **Figure 2b**, draw a line (labelled **F**) to show the most recent foliation direction. [1]

(ii) Outline the evidence from **Figure 2b** to suggest that the principal stress directions have changed during the metamorphism of this rock. [2]

……..

……..

……..

Section B

3. Specimens **A** and **B** were collected from **Rock Units A** and **B** on **Map 1**.

(a) (i) Describe the texture of **Specimen A**. [3]

……

……

……

……

(ii) **Specimen A** is mafic. Name **one** of the minerals in **Specimen A**. [1]

……

(iii) State the name of **Specimen A**. [1]

……

(b) State the name of **Specimen B**. Give **two** reasons for your answer. [3]

Name……

Reason 1……

……

Reason 2……

……

(c) With reference to **Specimen A** and the outcrop pattern of **Rock Unit A** on **Map 1**, identify the type of igneous body formed by **Rock Unit A**.
Give **two** reasons for your answer. [3]

Type of igneous body ……

Reason 1……

……

Reason 2……

……

4. **Specimen C** is a plaster cast of a fossil of Carboniferous age collected from **Rock Unit C** at the position indicated on the graphic log shown in **Figure 4**.

(a) (i) In the space below draw a diagram of **Specimen C**. Add a scale for your diagram. [4]

(ii) State how features seen in **Specimen C** indicate that it could represent a fossil of Carboniferous age. [2]

.....

.....

.....

(b) **Figure 4** is a simplified graphic log typical of **Rock Unit C** on **Map 1**. **Photographs 1** and **2** on page 4 of the resource sheet were taken at the positions indicated on the log.

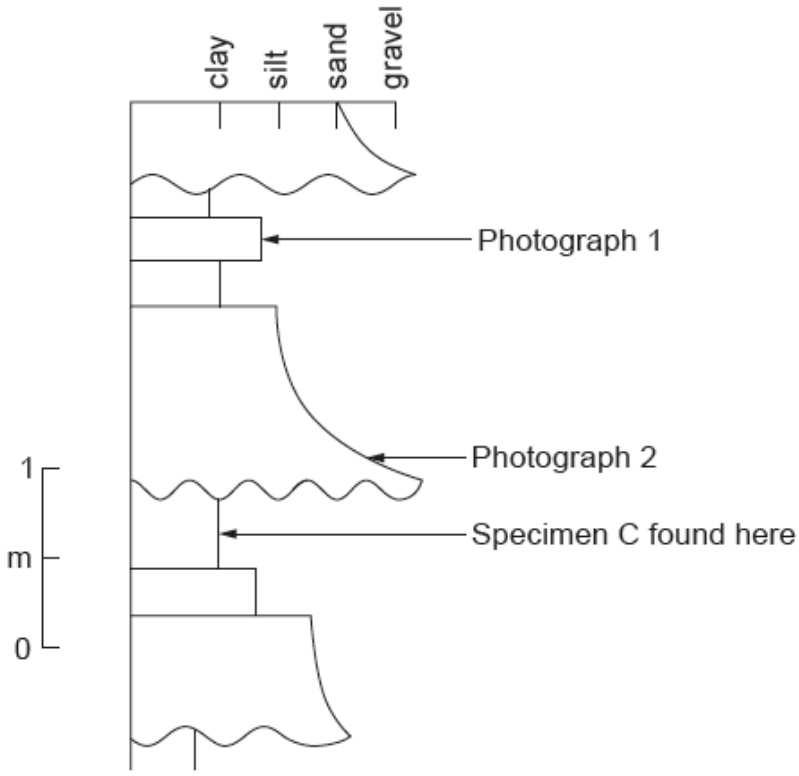


Figure 4

Analyse the information in **Figure 4**, **Specimen C** and **Photographs 1** and **2**. Suggest the changes in the environments of deposition of **Rock Unit C**, giving reasons for your answer. [6 QER]

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

12

5. **Specimen D** is a mineral typically found in **Rock Unit D** on **Map 1**.

(a) State the name of mineral **Specimen D**. Give **two** pieces of evidence for your answer.
You may wish to refer to the **Mineral Data Sheet**. [3]

Name ……

Evidence 1……

……

Evidence 2……

……

(b) With reference to **Specimen D** suggest the probable environment of deposition of **Rock Unit D**. Give a reason for your answer. [3]

.....

.....

.....

.....

6

6. (a) For any **one** fold you can identify on **Map 1**, complete **Table 4** below to describe the fold characteristics. [3]

fold characteristics	description
trend of the axial plane trace	•
attitude of the axial plane	•
direction of plunge of the axis	•

Table 4

(b) **Map 1** shows two faults **F1** and **F2.**
Fault **F1** is a normal fault which dips at 80º towards the east.
Refer to **Map 1**.

(i) Evaluate the following statement, giving reasons for your answer. [3]

- Fault **F1** is younger than fault **F2**.

……
……
……
……
……

(ii) Evaluate the following statement, giving reasons for your answer. [4]

- Fault **F1** and the folds were both produced at the same time by compression from the East and West.

……
……
……
……
……

(c) The following is a description, taken from a student's field notebook, of fault **F2** on **Map 1**.

> "The fault plane had a mean dip of 70º towards the west. Slickensides on the fault plane indicate that the fault moved vertically."

(i) Using evidence from **Map 1** and the description above, name the type of fault represented by fault **F2**. Explain your answer. [3]

Type of fault ……..

Explanation ……..

…….

……..…….

……..……..

……..…….

(ii) Justify the measurements you would make in the field in order to plot the orientation of a fault on a map. Describe how you would collect this data. You may use a diagram if you wish. [4]

……..……

……...

……

……..……..

……..……

……...

……

……..……..

(iii) Explain how slickensides can be used to indicate the direction of fault movement. [2]

……

……

……

(iv) Explain why slickensides cannot be used to determine that a fault might have moved **only vertically**. [3]

……

……

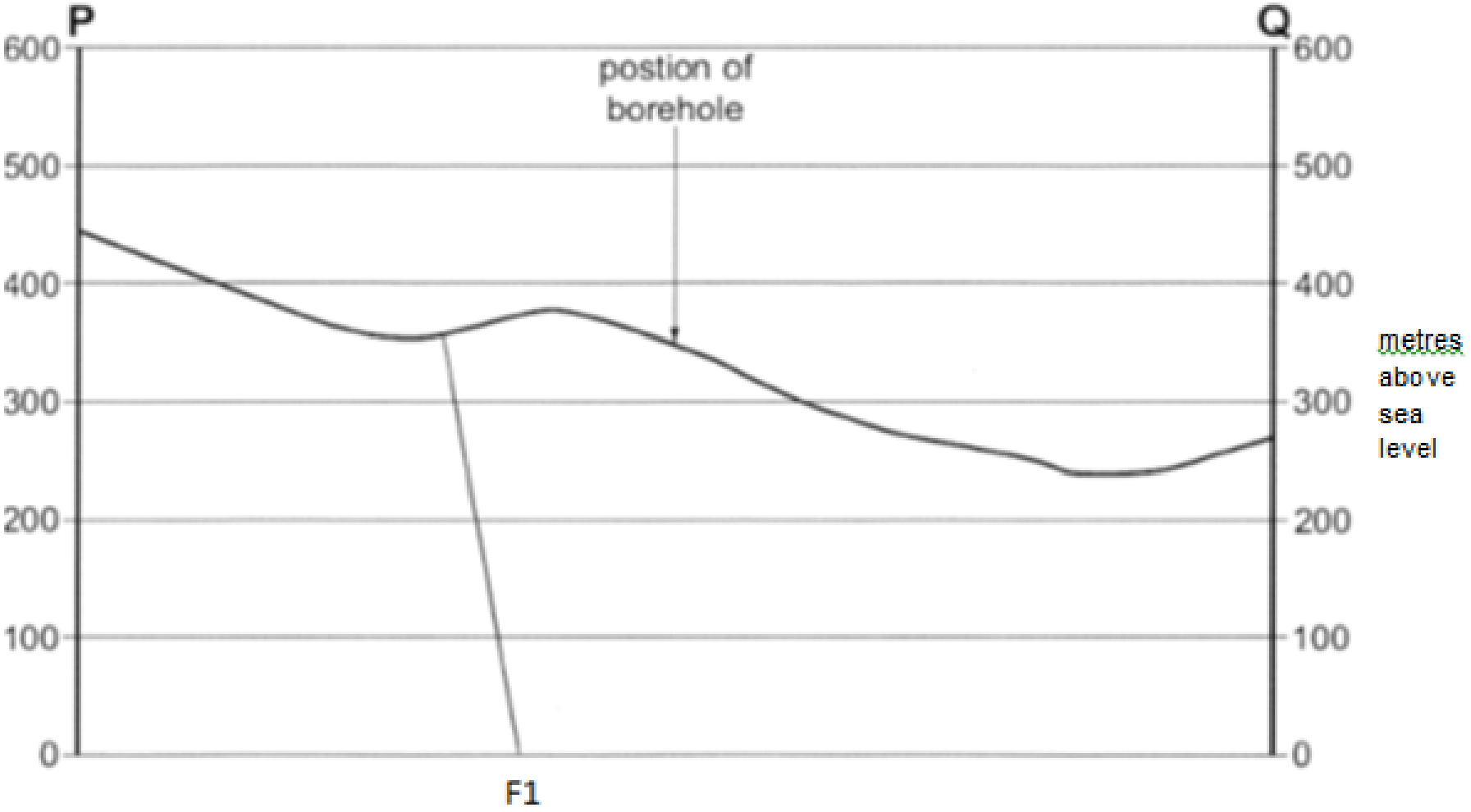
……

……

22

7. The topographic profile below was taken along the line P-Q on **Map 1**. Complete the sketch of the geological cross-section along this line using Map 1 and the borehole data found in the key.

- Draw the rock units. Use similar ornament or letters for these as used on **Map 1**.
- Draw and label any fold axes.
- Draw and label fault **F2**.
- Project the rock units and structures above the ground surface to illustrate any cross cutting relationships. [14]



8. **Photograph 3** on page 4 of the resource sheet is a photograph (looking north-east) of a coastal cliff section in a limestone area.

State and give reasons for the observations you would make in a field investigation to determine the past geological processes that have happened in the area shown in **Photograph 3**.

You may wish to use an annotated diagram(s) in your answer. [9 QER]

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

A LEVEL

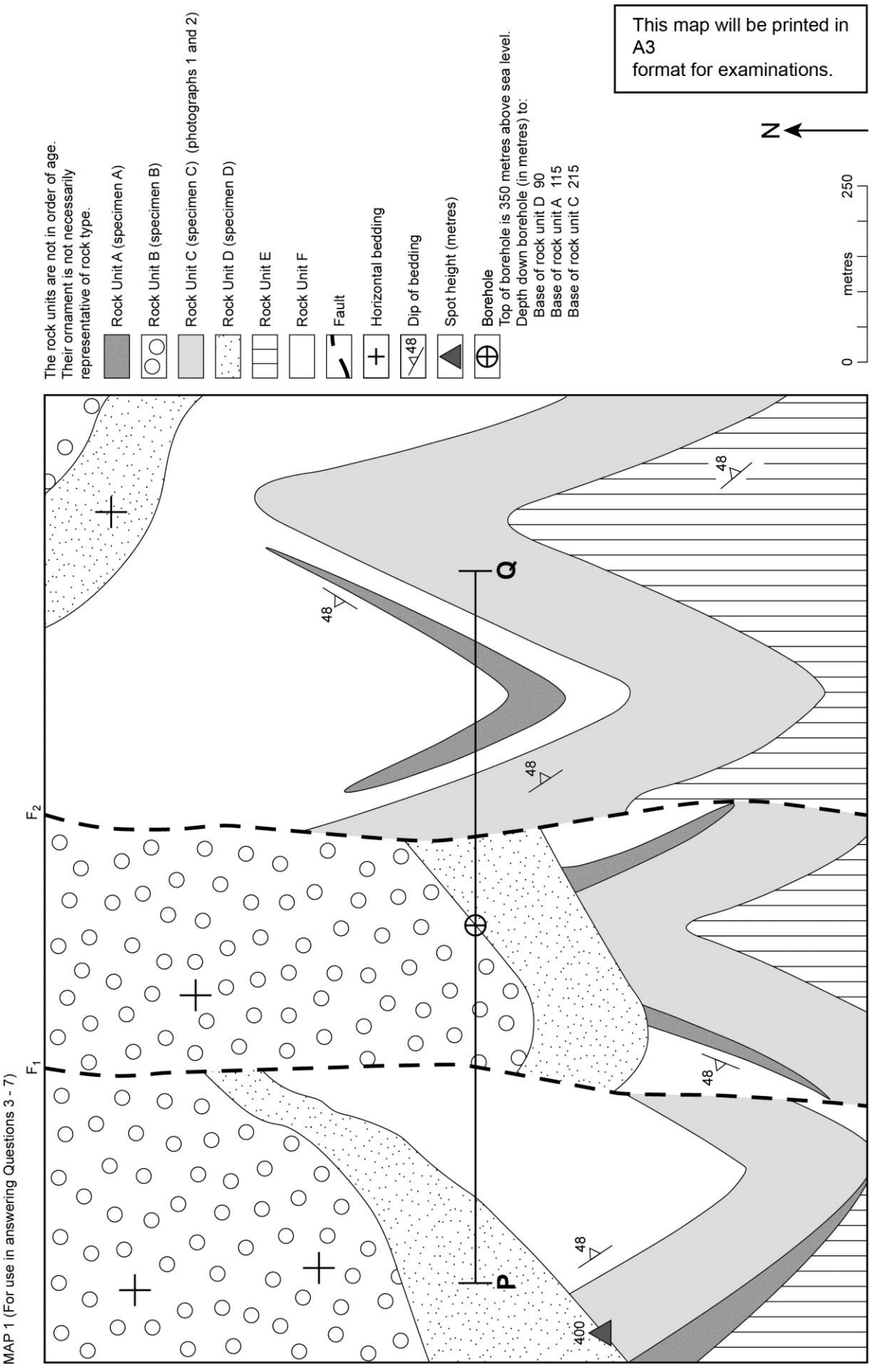
GEOLOGY

COMPONENT 1

Geological Investigations

RESOURCE SHEET

SAMPLE ASSESSMENT MATERIALS



Photograph 1 For use in Question 4

© T.Travis Brown x 1

Photograph 2 For use in Question 4

© Pelex – Wikimedia Commons

Photograph 3 For use in Question 8

GEOLOGY

MINERAL DATA SHEET

Name	Cleavage/Fracture	Hardness	Density (gcm^{-3})	Streak	Lustre	Colour	Other diagnostic properties
Quartz RF	*none/conchoidal	7	2.65	scratches streak plate	vitreous	colourless, milky but variable	hexagonal prisms terminated by pyramids
Orthoclase Feldspar RF	*2 good, 90	*6	2.6	scratches streak plate	vitreous	flesh, pink, white	*simple twin
Plagioclase Feldspar RF	*2 good, 90	*6	2.7	scratches streak plate	vitreous	creamy-white, grey, colourless	*repeated multiple twin
Muscovite Mica RF	*1 perfect (basal)	*2.5	2.7-3.1	white	pearly	colourless or pale yellow, green or brown	*flaky
Biotite Mica RF	*1 perfect (basal)	*2.5-3	2.7-3.1	white	pearly	brown/black	*flaky
Hornblende RF	*2 good, 60/120	*5-6	3.0-3.5	scratches streak plate	vitreous	black, dark green	prismatic crystals
Augite RF	*2 good, 90	*5-6	3.2-3.5	scratches streak plate	vitreous	greenish black	prismatic crystals
Olivine RF	none/conchoidal	*6-7	3.2-4.3	scratches streak plate	vitreous	*olive green	
Chiastolite/ Andalusite	poor 1/ uneven fracture	7.5	3.1-3.3	scratches streak plate	vitreous	pearly grey/pink	needle crystals with square x-sections, black centre
Garnet	none	*6.5-7.5	3.5-4.3	scratches streak plate	vitreous	red/brown	*12 sided crystals - each face rhomb shaped
Calcite RF	*3 good, not at 90, perfect rhombs	*3	2.71	white	vitreous	colourless, white, tints	*effervesces with 0.5M HCl, rhombic shape
Fluorite	*4 good, parallel to octahedron	*4	3.0-3.2	white	vitreous	colourless purple/green/yellow	fluoresces in uv light, cubic or octahedral crystals
Halite	3 good, 90 cubic	*2.5	2.2	white	vitreous	colourless, white, often stained	*salty taste cubic crystals, often stained
Gypsum	1 good (basal)	*1.5-2	2.3	white	silky, pearly	colourless, white, often stained	fibrous or twinned crystals
Barites	2 good, 90	*3-3.5	*4.5	white	vitreous, resinous	white, pink	bladed crystals
Chalcopyrite	poor/conchoidal	4	4.2	*black	metallic	bronze yellow	*tarnished to peacock colours
Pyrite	none/conchoidal	*6	5.0	*greenish black	metallic	brass yellow	crystals often striated cubes
Galena	*3 good, 90 cubic	*2.5	*7.5	*lead grey	metallic	lead grey	cubic crystals
Haematite	poor/subconchoidal	*5.5-6.5	4.9-5.3	*cherry red	metallic-dull	red/black skin/steel grey	kidney shaped masses, fibrous

* - Useful property for diagnosis RF - Common rock-forming mineral

This table should <u>not</u> be memorised.

Marks in the examinations will be awarded for description of the outcomes of tests on minerals and, on some occasions, identification from test results.

WJEC Eduqas A Level Geology

Mark scheme for use with Component 1

Geological Investigations

SAMPLE ASSESSMENT MATERIALS

Instructions for examiners of A Level Geology when applying the mark scheme

1 Positive marking

It should be remembered that candidates are writing under examination conditions and credit should be given for what the candidate writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Worthwhile answers that meet the requirements of the question, but do not appear on the mark scheme are to be given credit.

2 Tick marking

Low tariff questions should be marked using a points-based system. Each credit worthy response should be ticked in red pen. The number of ticks must equal the mark awarded for the sub-question. The mark scheme should be applied precisely using the marking details box as a guide to the responses that are acceptable. Do not use crosses to indicate answers that are incorrect.

3 Annotated diagrams

Where a candidate has answered a question wholly or partly by use of an annotated diagram, credit must be awarded to the annotations which form credit-worthy responses as outlined in the marking details box. Candidates must be credited only once for valid responses which appear both as annotations to diagrams and within a section of prose in the answer to the same question.

4. Banded mark schemes

Banded mark schemes are divided so that each band has a relevant descriptor. The descriptor for the band provides a description of the performance level for that band. Each band contains marks. Examiners should first read and annotate a learner's answer to pick out the evidence that is being assessed in that question. **Do not use ticks** on the candidate's response. Once the annotation is complete, the mark scheme can be applied. This is done as a two stage process.

Stage 1 – Deciding on the band

When deciding on a band, the answer should be viewed holistically. Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptor for that band. Examiners should look at the descriptor for that band and see if it matches the qualities shown in the learner's answer. If the descriptor at the lowest band is satisfied, examiners should move up to the next band and repeat this process for each band until the descriptor matches the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content.

Examiners should not seek to mark candidates down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark

Once the band has been decided, examiners can then assign a mark. During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Indicative content is also provided for banded mark schemes. Indicative content is not exhaustive, and any other valid points must be credited. In order to reach the highest bands of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that is contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)	• Bivalve (1)	1			1		
		(ii)	**Any two x (1) from:** Species A — Species B • Ribs/crenulated ridges/ corrugations — Smooth • No pallial sinus — Pallial sinus • More rounded — More oval Do not credit reference to size	2			2		
		(iii)	Species A : Surface plougher/vagrant (1) **Any one x (1) from:** • Rough outer shell – higher energy of surface • Pallial Line entire (no siphon) Species B : Burrower (1) **Any one x (1) from:** • pallial sinus for large siphons • Smooth shell for burrowing		4		4		

	(b)	(i)	Length within range 8 - 9 mm (1) Width within range 46 - 47 mm (1)	2			2		2
		(ii)	Describe: Directly proportional/positive correlation (**Reserved mark**) (1) Also accept **up to one x (1) more** description mark from: • range of specimen sizes (width 10-43 mm or length 8-38mm) • reference to the anomaly Explain **Any two x (1) from:** • life assemblage (not transported) • young and old specimens together • not sorted by currents • shells not broken	2	2		4	1	1
		(iii)	**Any three x (1) from:** • from high energy beach • small range of sizes/clustered thus moderately sorted • by beach/wave transport • chipped but not broken • burrowing bivalve now on beach hence transported			3	3		
			Question 1 total	**7**	**6**	**3**	**16**	**1**	**3**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)		X = Sedimentary (1) Y = Igneous (1)		2		2		
	(b)	(i)	10 (1) ºCkm^{-1} (ie correct units) (1)		2		2	1 1	2
		(ii)	Line at 25ºCkm^{-1} (1)		1		1		1
		(iii)	B (mark C if erroneously drawn higher than B) (1) Hornfels – contact metamorphism (1) High Temperature/low pressure (1)		3		3		
	(c)	(i)	Garnet porphyroblast correctly labelled (1)	1			1		
		(ii)	**Any three x (1) from:** • larger crystals • in a finer groundmass • in metamorphic rocks • mica (foliations) wrapped around the porphyroblast (garnet)	3			3		
	(d)	(i)	Horizontal line (left to right) (1)		1		1		
		(ii)	**Any two x (1) from:** • schistosity different orientation to inclusions in the garnet • indicates that sigma max has changed over time • s-shaped nature of inclusions (suggesting continuing change) • porphyroblasts may have rotated		2		2		
			Question 2 total	**4**	**11**	**0**	**15**	**2**	**3**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)	**Any three x (1) from:** • crystalline/interlocking etc • medium or value within range 1 - 3mm • equicrystalline • random alignment	3			3		3
		(ii)	**Any one x (1) from:** • plagioclase • augite or pyroxene • olivine	1			1		
		(iii)	Dolerite (1)		1		1		
	(b)		Dark colour or mafic (1) Fine grained/fine crystals/value less than 1 mm (1) Basalt (1)		3		3		3
	(c)		Sill (**Reserved mark**) (1) **Any two x (1) from:** • concordant • transgressive or intruded into different rock units • medium crystal size or value within range 1 - 3mm		3		3		3
			Question 3 total	**4**	**7**	**0**	**11**	**0**	**9**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)	Correct shape ie not too elongate length ways or width ways (1) Shows correct number of whorls (1) Shows correct detail of the suture line (1) Drawn to a correct scale (1)		4		4	1	4
		(ii)	**Any two x (1) from:** • reference to suture line • goniatite or goniatitic/simple (suture line) • rounded saddle • angular lobe		2		2		
	(b)		**Indicative content** Answers should make use of analysis of a balance of evidence using information from the four sources (figure 4, specimen C, photograph 1 and photograph 2). **Analysis and judgements using Figure 4** Upward fining showing decrease in energy Repeated cycles of higher to lower energy Erosive bases showing high energy events **Analysis and judgements using Specimen C** Marine Low energy because complete Found in low energy finer sediment on figure 4 **Analysis and judgements using Photograph 1** Plant shows land/terrestrial/close to land/fluvial/delta Low energy because complete Found in low energy finer sediment on figure 4 **Analysis and judgements using Photograph 2** Coarse grained high energy Current bedding is small scale indicates unidirectional current/fluvial etc			6	6		6

			5–6 marks There is a clear response which draws upon analysis of a **minimum of three** of the four sources of information (figure 4, specimen C, photograph 1 and photograph 2). Most or all of the sources of evidence are analysed coherently. Judgements regarding the environments of deposition are drawn that include all of the following: variation in energy levels, identification of marine conditions, identification of deltaic/fluvial/near shore conditions. All judgements are consistent with the information as analysed. *There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant.* **3–4 marks** The response draws upon analysis of a **minimum of two** of the four sources of information (figure 4, specimen C, photograph 1 and photograph 2) and comments with relevance on their contribution to the environments of deposition. Judgements regarding the environments of deposition include reference to variation in energy levels and identification of marine conditions. Most judgements are drawn that are consistent with the information as analysed. *There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included but there may be some irrelevant information or minor errors.* **1–2 marks** The response makes use of **one or two** of the four sources of information (figure 4, specimen C, photograph 1 and photograph 2) only with rather superficial comment. There may be a lack of relevance in places and judgements drawn concerning the environments of deposition are rather						

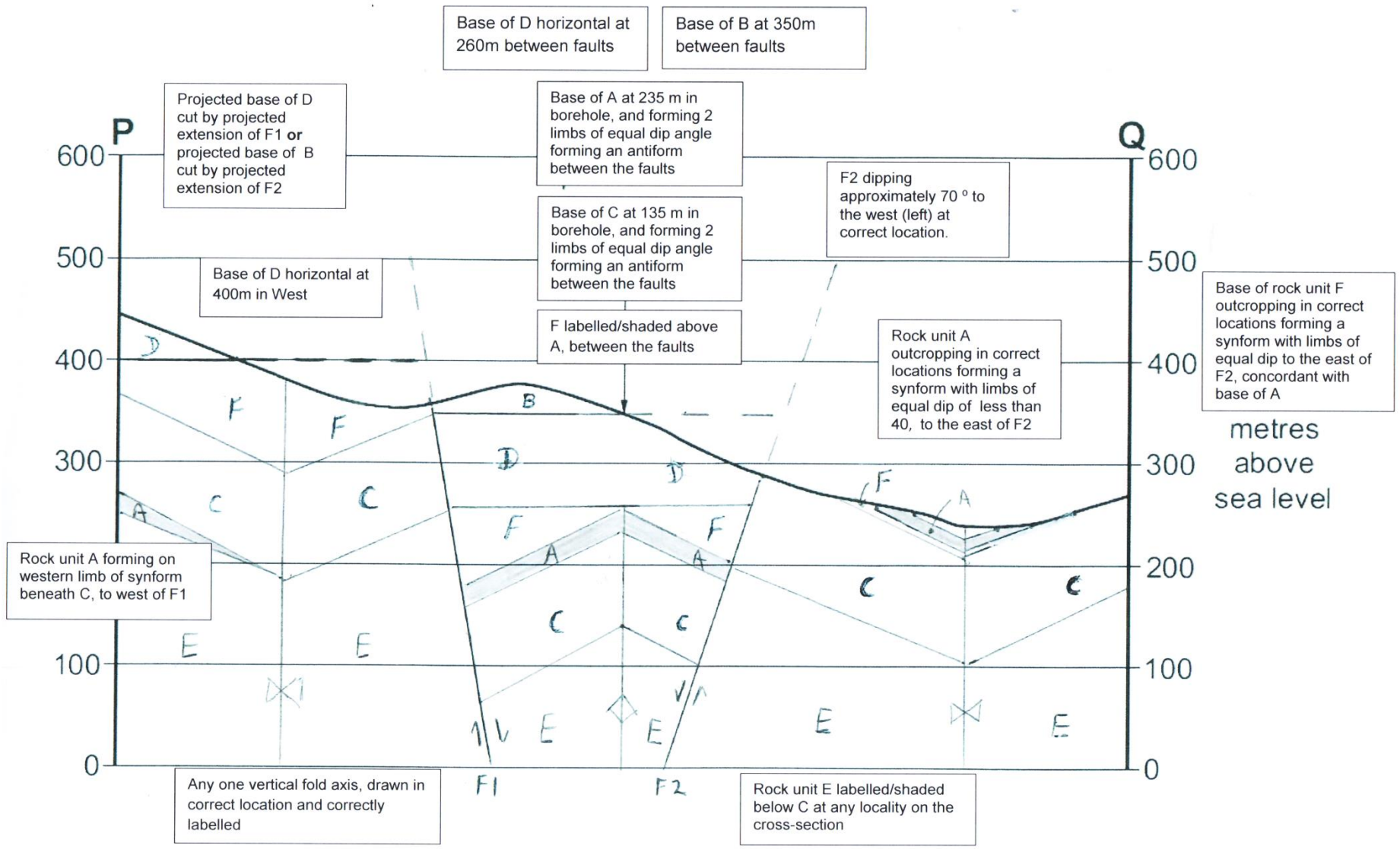
			superficial, with simple comments on variation of energy levels and/or marine conditions *There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure*. *There may be significant errors or the inclusion of much irrelevant information.* **0 marks** *No attempt made or no response worthy of credit.*						
			Question 4 total	**0**	**6**	**6**	**12**	**1**	**10**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Gypsum (1) **Any two x (1) from:** • scratched with a finger nail • white • fibrous habit • 1 good cleavage • silky or pearly lustre		3		3		3
	(b)		Hot/arid/desert (1) Lake/shallow water (1) Mineral D is formed by evaporation/drying out (1)		3		3		
			Question 5 total	**0**	**6**	**0**	**6**	**0**	**3**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)		North – south (or north or south) (1) Upright or vertical (1) North (1)		3		3		3
	(b)	(i)	There is no evidence for the relative ages of the faults (1) They both cut the same rocks (or unconformity) (1) They do not cross-cut/meet (1)			3	3		3
		(ii)	**Any four x (1) from:** • the fault cuts the folds so fault younger/not produced at same time or the fault cuts the unconformity/horizontal beds so younger/not produced at same time • they did both form by E-W stress • F1 is normal so tension, • folding formed by compression • cannot have compression and tension at the same time			4	4		4
	(c)	(i)	Normal (1) Downthrow side is to the west/younger rock on west outcrops against older rock on east (1) Dips to the downthrow side or footwall up normal (1)			3	3		3
		(ii)	To plot an orientation a strike direction is required because the orientation is the strike direction **Reserved mark** (1) **Any three x (1) from:** • the strike direction is where dip angle is zero or description of how to determine a dip angle of zero • point compass in direction of strike along the fault plane • line up 2 red arrows or equivalent and read off strike direction/bearing on outer scale or equivalent • Reference to repeat of measurements to gain a more accurate reading **to a maximum of 4 marks for the question, but must include the reserved mark**			4	4		4

		(iii)	Grooves/slickensides are parallel to fault movement (1) Feel smooth in direction of fault movement or feel rough against direction of fault movement (1)	2			2		
		(iv)	**Any three x (1) from:** • vertical movement shown by vertical slickensides • these only show the most recent movement on the fault plane • due to fault movement destroying slickensides showing previous evidence of fault movement • reference to fault re-activation	3			3		
			Question 6 total	**5**	**3**	**14**	**22**	**0**	**17**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
7									
			The following points should all appear on the cross-section. • Base of D horizontal at 400m in West • Base of B at 350m between faults • Base of D horizontal at 260m between faults • Base of A at 235 m in borehole, and forming 2 limbs of equal dip angle forming an antiform between the faults • Base of C at 135 m in borehole, and forming 2 limbs of equal dip angle forming an antiform between the faults • F labelled/shaded above A, between the faults • F2 dipping approximately 70-75º to the west (right) at correct location • Base of F forming a synform with limbs of equal dip west of F1 • Rock unit A forming on western limb of synform beneath C, to west of F1 • E labelled/shaded below C at any locality on the cross-section • Rock unit A outcropping in correct locations forming a synform with limbs of equal dip to the east of F2 • Base of rock unit F outcropping in correct locations forming a synform with limbs of equal dip of less than 40º, to the east of F2 • Projected base of rock unit D cut by projected extension of F1 **or** projected base of rock unit B cut by projected extension of F2 • Any one vertical fold axis, drawn in correct location and correctly labelled		1 1 1 1 1 1 1 1 1 1	1 1 1 1	14	14	14
			Question 7 total	**0**	**9**	**5**	**14**	**14**	**14**



<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks Available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>8</td><td></td><td></td><td>

Indicative content

<table>
<tr><td></td><td>Observations suggested</td><td></td><td>Justification given</td></tr>
<tr><td>Dark near vertical feature

ie igneous processes</td><td>Texture: crystalline or granular

Crystal size

Crystal shape

equicrystalline or porphyritic

Random or orientated crystals</td><td></td><td>crystalline more likely to be igneous (granular sedimentary)

Cooling speed

Cooling history

1 or 2 stage cooling history

Random cooled from a melt</td></tr>
<tr><td></td><td>Colour or seek to identify minerals</td><td></td><td>To determine the composition
dark = mafic
pale = silicic
olivine pyroxene plagioclase = mafic
quartz plag orthoclase = silicic</td></tr>
<tr><td></td><td>Heft of a fragment</td><td></td><td>To determine if iron or silica-rich</td></tr>
<tr><td></td><td>Concordant or discordant</td><td></td><td>Discordant = dyke
Concordant = sill or lava flow</td></tr>
</table>

</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

			ie metamorphic processes	Chilled margins		2 chilled margins = dyke or sill 1 = lava flow						
				Columnar joints		indicate that it is igneous indicates the "cooling surfaces", at 90 degrees to cooling surfaces dyke = at right angle to walls						
				Baked margins (crystalline or granular)		indicates contact metamorphism, marble 2 = dyke or sill 1 = lava flow						
			Limestone ie sedimentary processes	Texture Grain size Graphic log		energy level variation link between grain size and energy level defined upward fining = decreasing energy or *vice versa*						
				Texture: oolitic, skeletal (fossiliferous) or not		explanation of cause of oolitic/skeletal (fossilierous) texture						
				Effect of adding dil HCl		composition confirms limestone = warm shallow seas deposition						
				Fossil content		e.g. corals = shallow warm tropical sea brachopiods marine						

				Broken or complete fossils		energy levels of depositional environment explained. Life or death assemblage				
				Fossils in life positions		Life assemblage				
				Cement present		cementation during diagenesis				
				Fossil limestone pavement		would indicate rock had been exposed between one bed being deposited and the next				
				Structural processes	Orientation of dark feature		Determine trend to determine stress field at time of intrusion (tension at right angles)			
					Dip and strike of limestone bedding planes		To determine if folding has occurred /stress conditions after limestone deposited			
					joint orientations		control of intrusion			
			7–9 marks The response is well-structured and justifies a range of observations to investigate processes **from all four** categories of igneous, sedimentary, metamorphic and structural. Most or all of the observations are well justified showing that the candidate has a clear rationale for most of the observations that have been proposed. *There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant.*					9	9		9

			4–6 marks The response is quite well-structured and includes a range of observations to investigate **a minimum of two** of the four sets of processes (igneous, sedimentary, metamorphic, structural). Many but not all of the observations are justified appropriately, showing that the candidate has a reasonable rationale for many of the observations that have been proposed. *There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included but there may be some irrelevant information or minor errors.* **1–3 marks** The response makes use of a few observations only with superficial comments. Only **one or two** of the processes (igneous, sedimentary, metamorphic, structural) are considered. Justification for the observations is limited revealing that the candidate has a limited rationale for the observations proposed. *There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure*. *There may be significant errors or the inclusion of much irrelevant information.* **0 marks** No attempt made or no response worthy of credit.						
			Question 8 total	**0**	**0**	**9**	**9**	**0**	**9**

Candidate Name	Centre Number					Candidate Number				
						0				

A LEVEL

GEOLOGY

COMPONENT 2

Geological Principles and Processes

SAMPLE ASSESSMENT MATERIALS

1 hour 45 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	15	
2.	14	
3.	15	
4.	12	
5.	14	
6.	20	
Total	**90**	

ADDITIONAL MATERIALS
In addition to this examination paper you will need a calculator.

INSTRUCTIONS TO CANDIDATES
Answer **all** questions.
Use black ink or black ball-point pen. Do not use gel pen. Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets alongside each question or part-question.
The assessment of the quality of extended response (QER) will take place in questions **5** and **6**.

*Answer **all** questions.*

1. **Figure 1a** is a geological map showing two localities from where samples of river sediment (**A** and **B**) were obtained. Sediments **A** and **B** were sieved and the results plotted in **Figures 1b** and **1c** respectively.

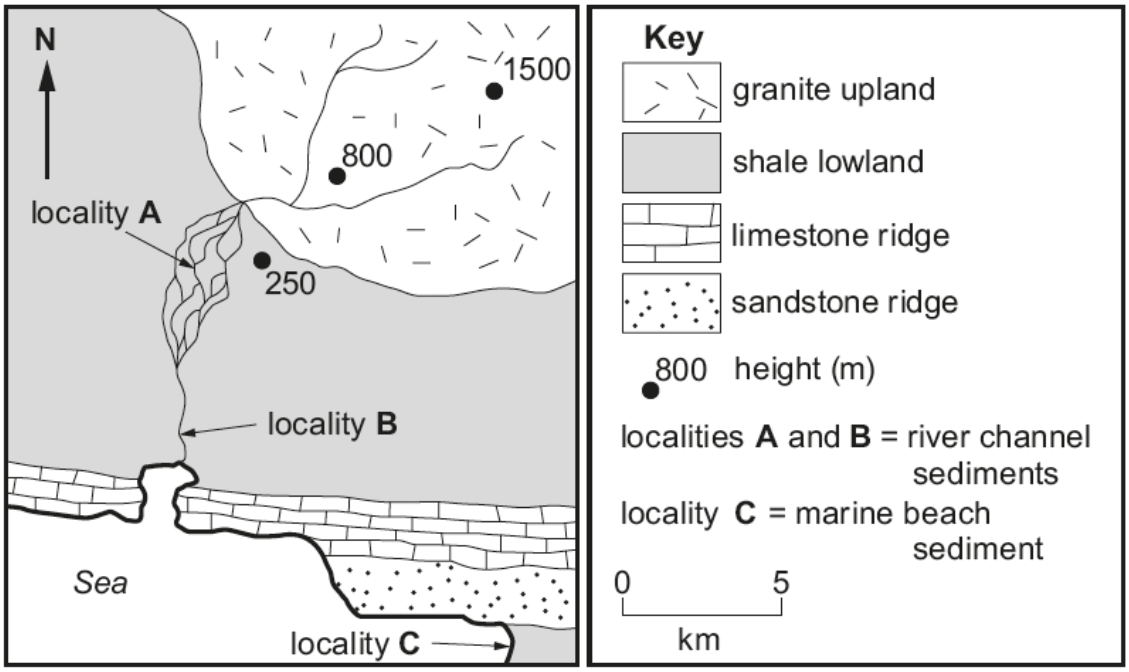


Figure 1a

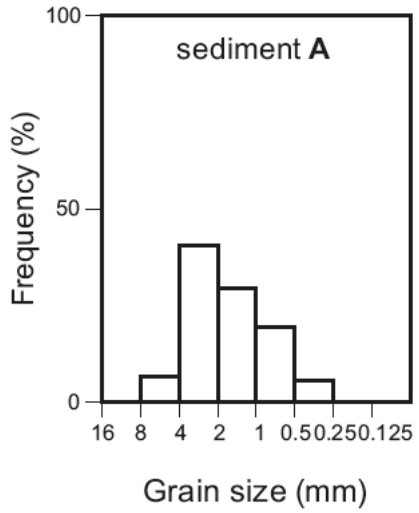


Figure 1b

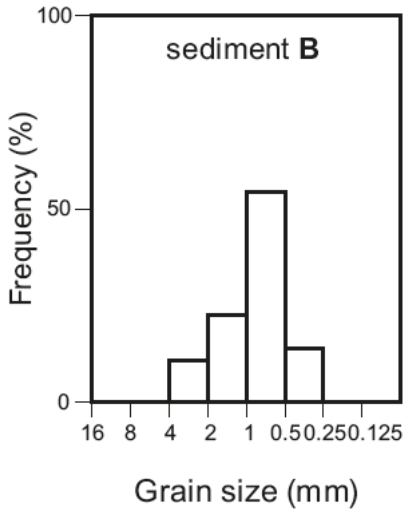


Figure 1c

Refer to **Figures 1a**, **1b** and **1c**.

(a) (i) Describe the sorting of sediment **A**. [2]

……..

……..

……..

(ii) Give reasons for the difference in sorting between sediments **A** and **B**. [2]

……..

……..

……..

(b) Describe, **with reasons**, the **mineral composition** of the sedimentary grains you might expect to find in sediments **A** and **B**. [4]

Sediment **A**

……

Sediment **B**

……..

Reasons

……..

……..

……..

……..

(c) A sample of beach sediment **C** was obtained from locality **C** on **Figure 1a**. **Table 1** outlines details of a chemical experiment on sediments **A**, **B** and **C**.

Table 1

20 gram samples of sediments A, B and C were placed in hydrochloric acid (HCl) until any reaction was complete. The results of weighing the dried residues were as follows.

	Sediment A	Sediment B	Sediment C
Mass of original sample (g)	20	20	20
Mass of sample after treatment with HCl (g)	20	20	15

Refer to **Table 1** and **Figure 1a**.

(i) Suggest what conclusion can be drawn about the composition of sediment **C** from the results of this experiment. [2]

……

……

……

(ii) Suggest why the beach at locality **C** has the composition shown by sediment **C** in **Table 1**. [2]

……

……

……

(d) **Figure 1d** is a photograph of an exposure of sedimentary rock.

Figure 1d

A student correctly concluded that the original sedimentary environment in which the beds in **Figure 1d** were deposited was similar to the depositional conditions found at locality **A** on **Figure 1a**. Explain why this conclusion was drawn with reference to the evidence in **Figures 1a**, **1b** and **1d**. [3]

……

……

……

……

……

15

2. **Figure 2a** shows a block diagram of a shale and sandstone sequence that has deformed at one time under stress.

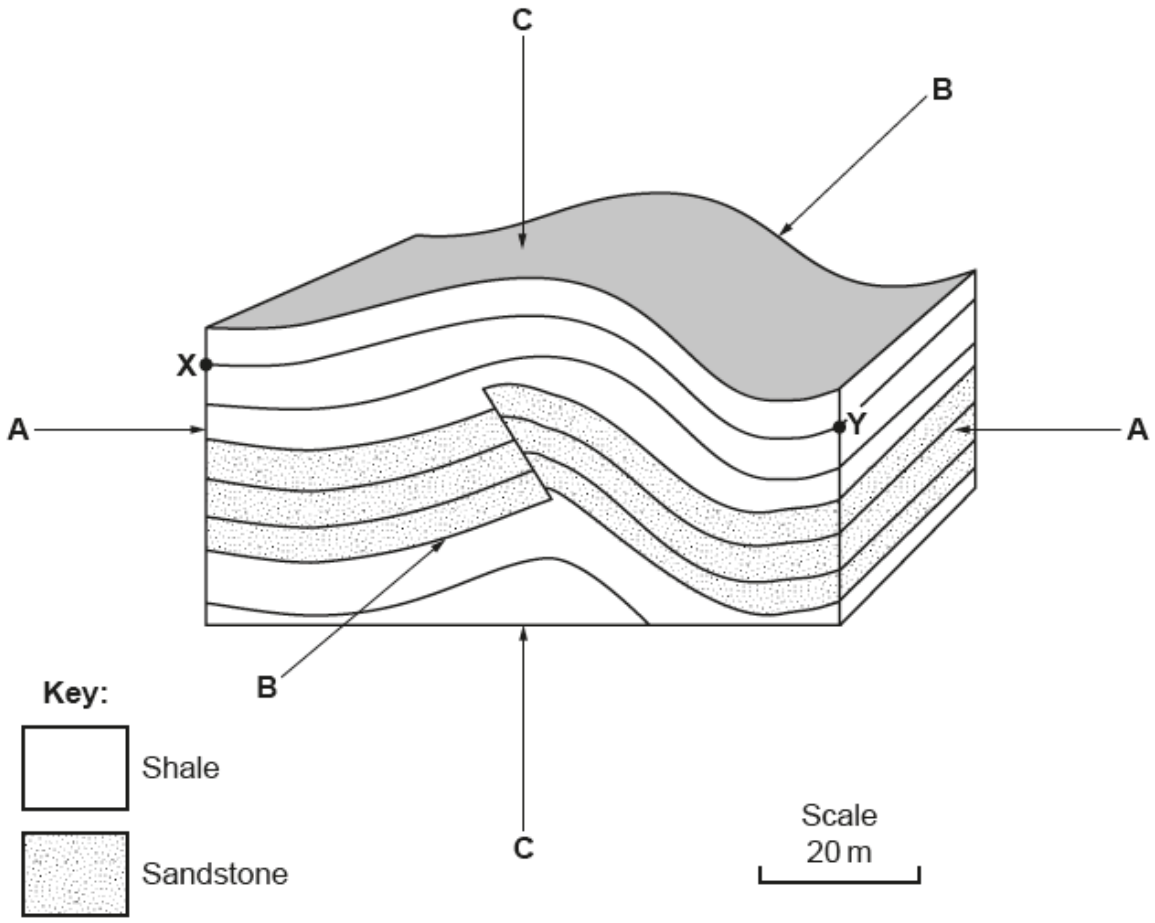


Figure 2a

Refer to **Figure 2a**

(a) (i) State which of the arrows labelled A, B or C show the directions of principal stresses **σ max** and **σ min** during deformation. [2]

Directions of **σ max** are shown by arrows labelled with the letter ……

Directions of **σ min** are shown by arrows labelled with the letter ……

(ii) Give one reason for your choice of direction for the maximum principal stress **σ max**. [1]

……

(iii) Compare and contrast how the shale and sandstone layers have responded to the stress. [3]

……

……

……

……

……

……

(iv) The original length of the shale bed between Points **X** and **Y** on **Figure 1a** was 85 m. Calculate the percentage shortening of the shale bed following deformation. *Show your working*. [2]

……..%

(b) **Figure 2b** shows a stress-strain curve obtained in the laboratory for a specimen of the sandstone.

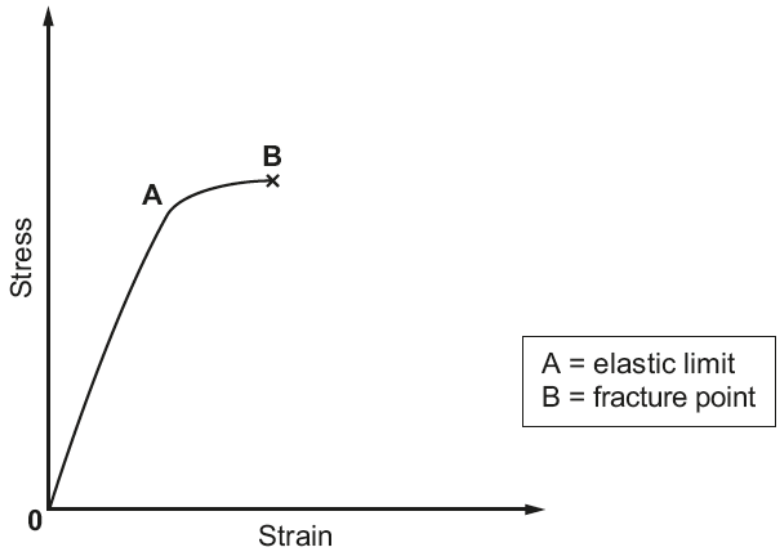


Figure 2b

Refer to **Figures 2a** and **2b.**

(i) Draw, on **Figure 2b**, a stress-strain curve to show the likely behaviour of the shale tested under the same conditions as the sandstone. Explain any differences between the sandstone stress-strain curve and the shale stress-strain curve you have drawn. [3]

……

……

……

(ii) Explain how the rocks in **Figure 2a** would deform if they were subject to the same stress at a higher temperature. [3]

……

……

……

……

BLANK PAGE

3. **Figure 3** is a partly drawn coastal cliff section, part of which has been obscured by a landslip.

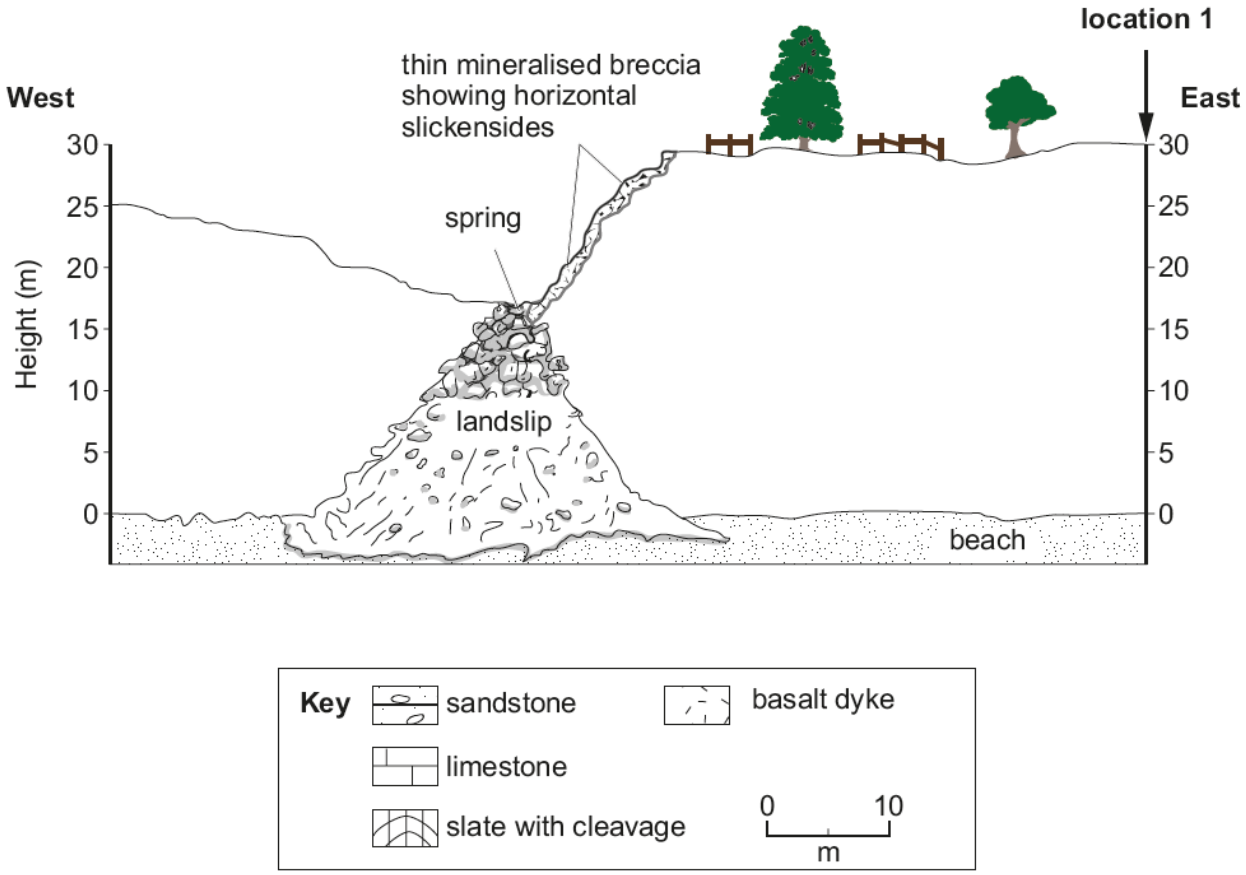


Figure 3

Location	**West of landslip**	LANDSLIP	**East of landslip**	
Geology	A series of folded slates with an axial planar cleavage dipping 80°E		A vertical section (showing vertical thicknesses) measured at **location 1** on the eastern edge of the cliff section (in stratigraphic order – **oldest at the base**)	
	Cut by a 2 metre thick vertical, basaltic dyke (10 m from the western margin)		Youngest ↑ Oldest	5 m bedded sandstone, dipping 10° N
				Irregular unconformity, dipping 10° N
				10 m well-bedded limestone, dipping 15° W
				Unconformable junction, dipping 15° W
				15 m folded slates with an axial planar cleavage, dipping 80° E

Table 3

(a) Complete **Figure 3** by sketching in the geological features described in **Table 3**. Use the appropriate shading provided in the key. [8]

Refer to **Figure 3**

(b) A student concluded that the difference in geology to the east and west of the landslip could best be explained by:

- a fault
- showing normal movement
- that had been reactivated.

Evaluate these statements explaining the evidence for your conclusions.

(i) a fault [2]

……

……

……

……

(ii) showing normal movement [3]

……

……

……

……

(iii) that had been reactivated [2]

……

……

……

……

15

4. **Figure 4** is a cross section through a limestone area showing 3 wells (shading shows the level of water).

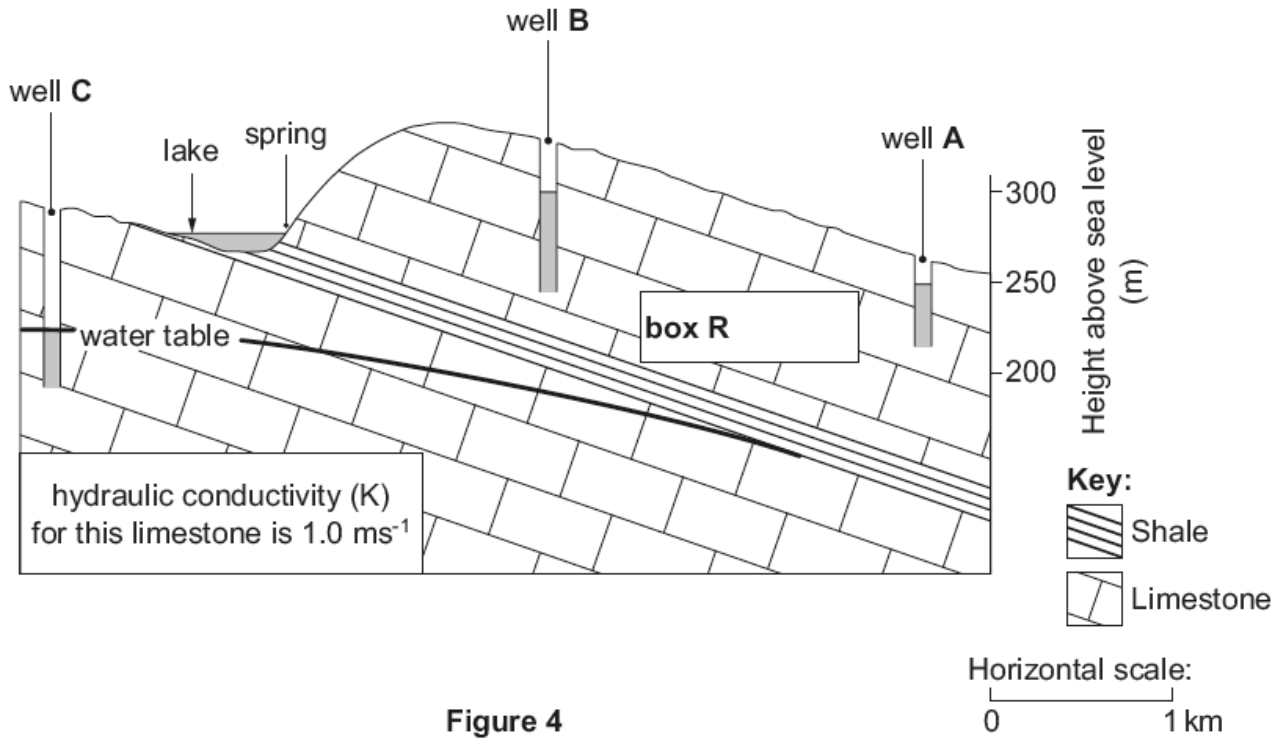


Figure 4

Refer to **Figure 4**

(a) (i) Mark on **Figure 4** the level of the water table above the shale. [2]

(ii) Give reasons for the presence of the water table **above** the shale. [2]

……

……

(b) Refer to **Figure 4**.

(i) Mark in **box R** on **Figure 4** an arrow to show the most likely direction of natural groundwater flow. [1]

(ii) Determine the horizontal distance in metres between well **B** and well **A**. [1]

……metres

(iii) Using **Darcy's Law**, calculate the flow of ground water between well **B** and well **A** per $1m^2$ of limestone. *Show your working*. [2]

Darcy's Law

$$Q = -KA\frac{(h_1 - h_2)}{L}$$

Where:
Q is rate of flow
K is hydraulic conductivity
A is cross-sectional area
(h_1-h_2) is change in height
L is horizontal distance

.....$m^3\ s^{-1}$

(iv) Well **A** has been interpreted as highly suitable for the extraction of water for public water supply. State and explain the evidence which supports this interpretation. [4]

……

……

……

……

……

……

……

……

……

……

……

5. **Figure 5a** is a graph showing estimated changes in mean global surface temperature during a typical Snowball Earth event. **Figure 5b** is a simplified section from Namibia used as evidence in support of the Snowball Earth hypothesis. **Figure 5c** shows further detail from the Namibian section.

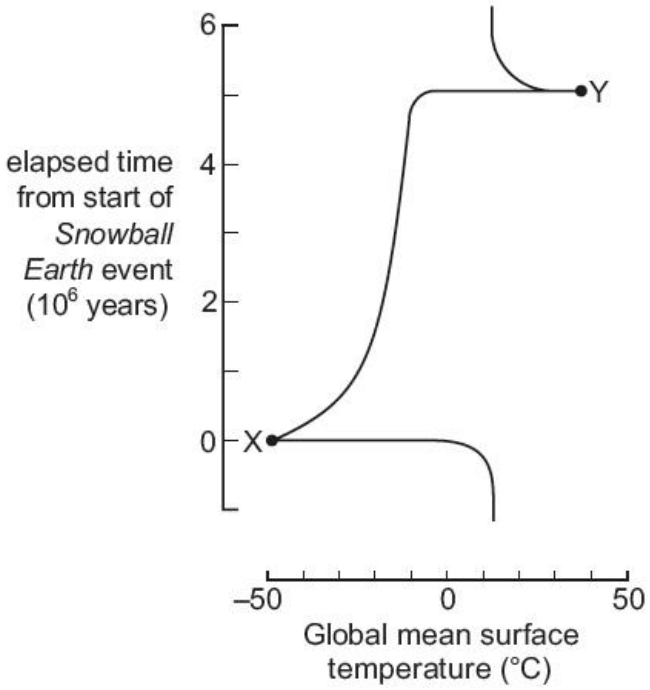


Figure 5a

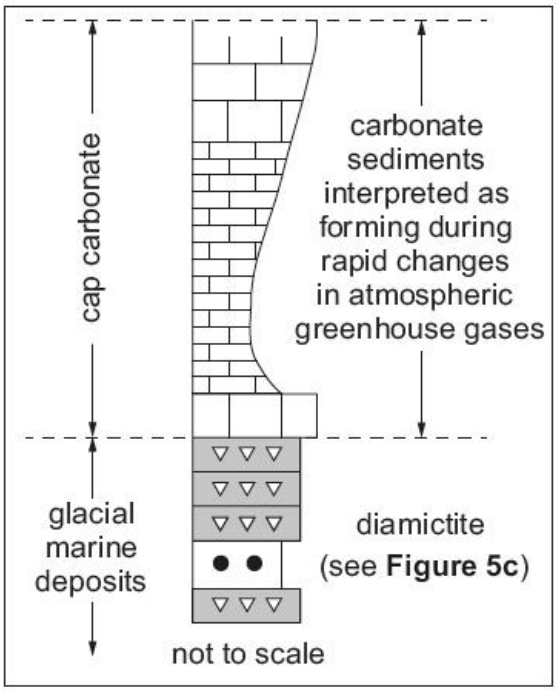


Figure 5b

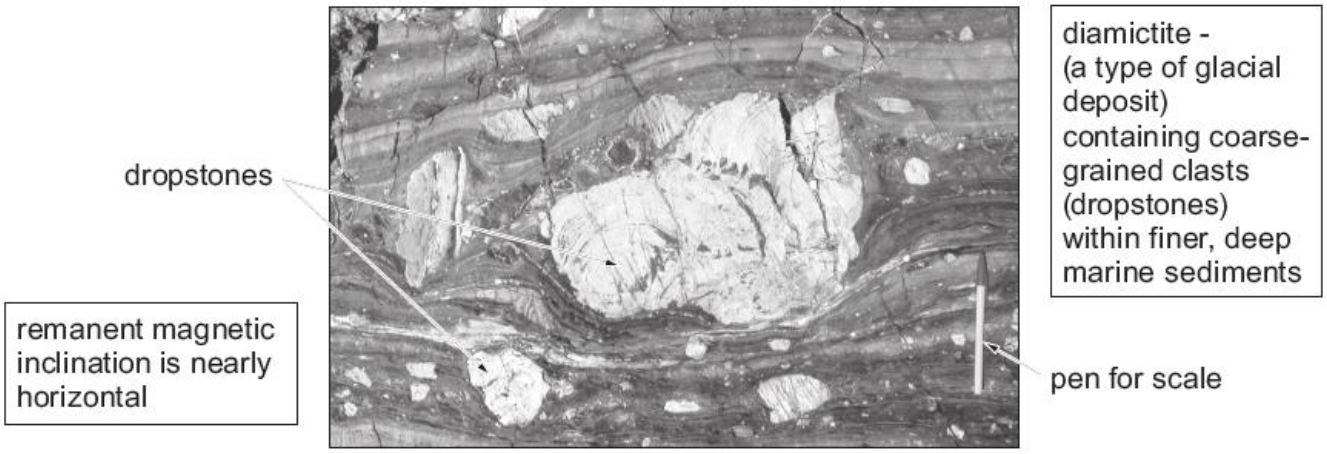


Figure 5c

www. snowballearth.org

(a) Refer to **Figure 5a**

(i) Calculate the mean rate of global surface temperature change between Point **X** and Point **Y**. *Show your working*. [2]

……°C Ma^{-1}

(ii) Explain why the mean global surface temperature change you have calculated may not reflect the rate of climatic changes during a Snowball Earth event. [2]

……

……

……

(b) Refer to **Figure 5b** and **Figure 5c**. Explain how evidence from the following supports the theory that ice once extended from the poles to the Equator during a Snowball Earth event.

(i) Inclination of the remnant magnetism [2]

……

……

……

(ii) Dropstones in fine-grained, deep marine sediments [2]

……

……

……

(c) The cap carbonate in **Figure 5b** may provide evidence of rapid changes in atmospheric greenhouse gases at the end of a Snowball Earth event. Explain how natural processes may have contributed to the rapid changes in atmospheric greenhouse gases that ended a Snowball Earth event and produced cap carbonates. You should refer to:

- volcanic activity
- methane hydrates
- rock weathering [6 QER]

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

14

6. **Figure 6a** shows the changes in diversity of marine fauna (Sepkoski's curves) during the Phanerozoic. **Figure 6b** shows data obtained at the K-Pg boundary in New Zealand.

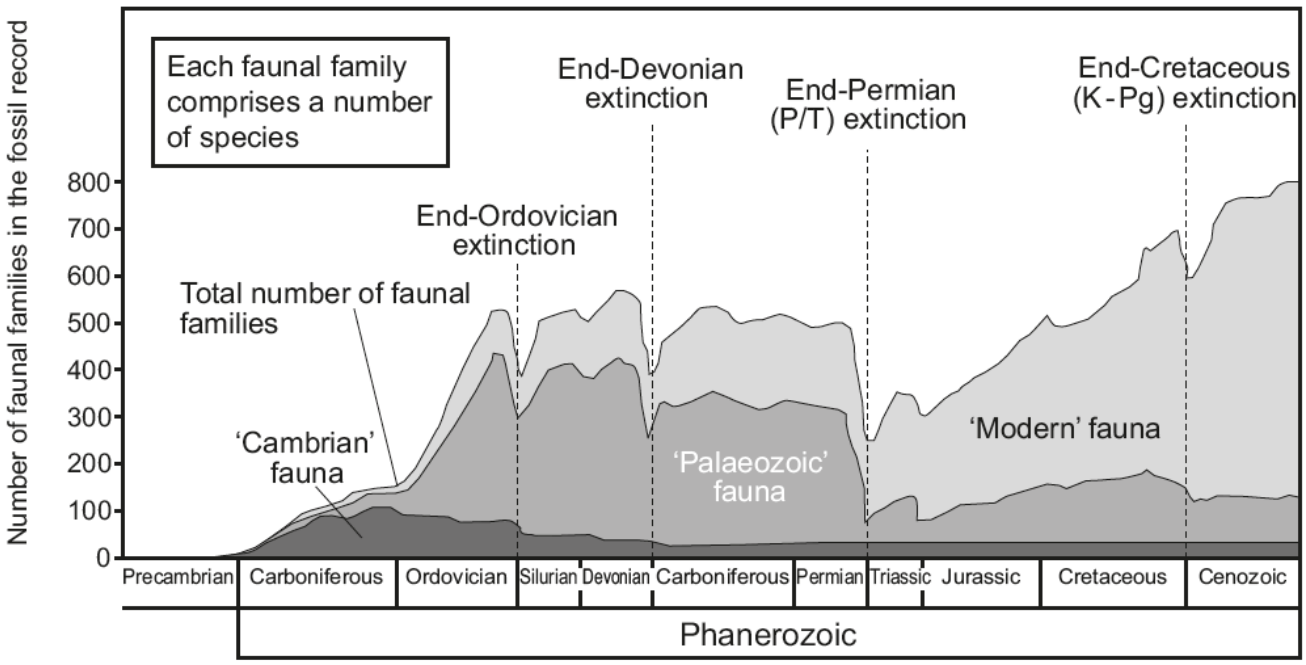


Figure 6a

Refer to **Figure 6a.**

(a) (i) State the number of faunal families at the end of the Permian. [1]

……

(ii) Describe the changes in relative abundance of Phanerozoic faunas between the end-Permian (P-T) and end-Cretaceous (K-Pg) mass extinction events. [3]

……

……

……

……

(b) (i) Using **Figure 6a**, calculate the percentage of faunal families that became extinct during the end-Cretaceous mass extinction (K-Pg). *Show your working*. [2]

…….. %

(ii) It is estimated that 75% of faunal species became extinct at the K-Pg mass extinction. Explain the discrepancy between this figure and the percentage of faunal families that became extinct. [2]

……

……

……

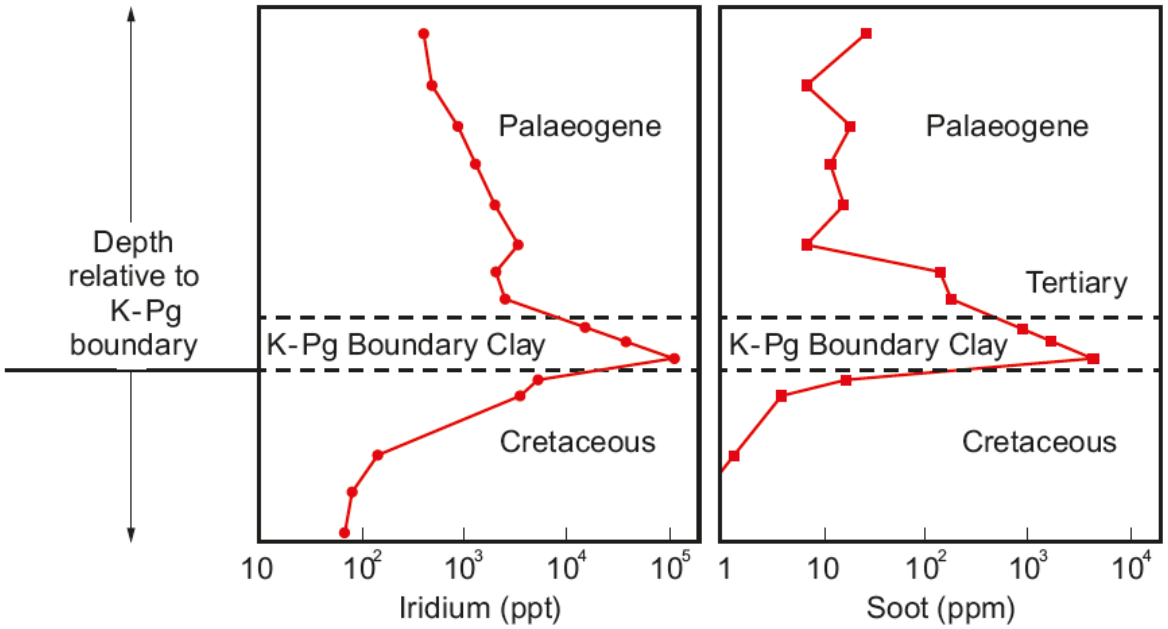


Figure 6b

Modified after Wolbach et al., 1990

Refer to **Figure 6b**

(c) (i) Calculate the maximum relative enrichment of iridium in the K-Pg Boundary Clay compared to the oldest Cretaceous sediment shown. *Show your working*. [2]

……times more iridium

(ii) Describe the degree of correlation between iridium and soot. [2]

……

……

……

(iii) Suggest reasons to explain the high levels of iridium and soot at the K-Pg boundary. [2]

……

……

……

(d) "Volcanic activity is thought to be the main cause of the K-Pg mass extinction".
Discuss this statement with reference to the interpretation of evidence related to:

- volcanic activity
- asteroid impact
- the fossil record. [6 QER]

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

……..

20

WJEC Eduqas A Level Geology

Mark scheme for use with Component 2

Geological Principles and Processes

SAMPLE ASSESSMENT MATERIALS

Instructions for examiners of A Level Geology when applying the mark scheme

1 Positive marking

It should be remembered that candidates are writing under examination conditions and credit should be given for what the candidate writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Worthwhile answers that meet the requirements of the question, but do not appear on the mark scheme are to be given credit.

2 Tick marking

Low tariff questions should be marked using a points-based system. Each credit worthy response should be ticked in red pen. The number of ticks must equal the mark awarded for the sub-question. The mark scheme should be applied precisely using the marking details box as a guide to the responses that are acceptable. Do not use crosses to indicate answers that are incorrect.

3 Annotated diagrams

Where a candidate has answered a question wholly or partly by use of an annotated diagram, credit must be awarded to the annotations which form credit-worthy responses as outlined in the marking details box. Candidates must be credited only once for valid responses which appear both as annotations to diagrams and within a section of prose in the answer to the same question.

4 Banded mark schemes

Banded mark schemes are divided so that each band has a relevant descriptor. The descriptor for the band provides a description of the performance level for that band. Each band contains marks. Examiners should first read and annotate a learner's answer to pick out the evidence that is being assessed in that question. **Do not use ticks** on the candidate's response. Once the annotation is complete, the mark scheme can be applied. This is done as a two stage process.

Stage 1 – Deciding on the band

When deciding on a band, the answer should be viewed holistically. Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptor for that band. Examiners should look at the descriptor for that band and see if it matches the qualities shown in the learner's answer. If the descriptor at the lowest band is satisfied, examiners should move up to the next band and repeat this process for each band until the descriptor matches the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content.

Examiners should not seek to mark candidates down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark

Once the band has been decided, examiners can then assign a mark. During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

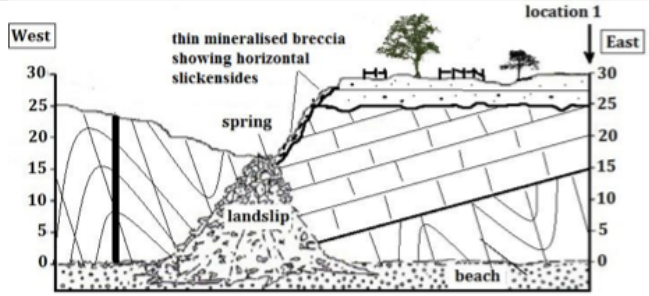
When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Indicative content is also provided for banded mark schemes. Indicative content is not exhaustive, and any other valid points must be credited. In order to reach the highest bands of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that is contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)	(i)	**Any two x (1) from:** • wide range of sizes/poorly sorted/coarse and fine • use of numbers (e.g. 0.25-8 mm) • modal group / 40% is 2-4 mm	2			2		2
		(ii)	A = less mature/less attrition (accept erosion/abrasion) (1) shorter distance of transport than B (1) or B = more mature/more attrition (accept erosion/abrasion) (1) longer distance of transport than A (1)		2		2		
	(b)		A = rich in quartz **and** feldspar /micas/ hornblende (more than just quartz) (1) B = rich in quartz (1) (and mica, accept feldspar remaining if explained) – not clay Reasons **Any two x (1) from:** • derived from granite parent • B - more (chemical) weathering (hydrolysis /oxidation) • B - feldspar has cleavages so more easily broken down • quartz/muscovite chemically more stable / resistant to weathering/erosion or quartz/mica are more stable (lower on Bowen's reaction series)		4		4		

	(c)	(i)	**Any two x (1) from:** • partly /25% /5g) composed of • limestone /CaCO3 /shelly material • quartz non-reactive with acid			2			
		(ii)	Weathering/marine erosion of **limestone**/sandstone/shale to **west** (1) Transport of sediment by sea along the coast from west to east/ Longshore drift from west to east (1) or Beach shells from marine animals (1) washed up/broken (1)		2				
	(d)		**Any three x (1) evaluative** statements consistent with a braided stream environment at A (Fig 1a) **from**: • high energy – large, rounded pebbles in Fig 1d • lower energy sand lenses shown in Fig 1d • suggests variation in energy with time – river e.g. flash flood • channels/sand bars of limited lateral extent – migrating channels • sudden drop in gradient – braiding • both Fig 1a and Fig 1d have range of grain sizes (coarse and fine/poorly sorted) • sediment A does not show the same range of sediment size Credit other acceptable answers			3			3
			Question 1 total	**2**	**8**	**5**	**15**	**0**	**5**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)	σ_{max} – A (1) σ_{min} – C (1)	2			2		
		(ii)	**Any one x (1) from:** • displacement of reverse fault • perpendicular to fold axis		1		1		
		(iii)	Both are folded (1) Shale shows some change in thickness/incompetent but sandstone does not/competent (1) Sandstone faulted but shale is not (1)	3			3		
		(iv)	$\frac{(85-80)}{85} \times 100$ (1) 6 [%] (accept 5.8-6.2) (1)		2		2	2	2
	(b)	(i)	**Any three x (1) from:** • sketch to show lower elastic limit • sketch to show longer ductile strain • shale less competent that sandstone • more likely to flow that fracture		3		3		
		(ii)	**Any three x (1) from:** • peak stress reduces with increased temperature • rocks less competent • greater ductile flow • less likely to fault • less stress to reach elastic limit	3			3		
			Question 2 total	**8**	**6**	**0**	**14**	**2**	**2**

<table>
<tr><th colspan="3" rowspan="2">Question</th><th rowspan="2">Marking details</th><th colspan="6">Marks Available</th></tr>
<tr><th>AO1</th><th>AO2</th><th>AO3</th><th>Total</th><th>Maths</th><th>Prac</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td>
<table>
<tr><th>Geology</th><th>Marks</th></tr>
<tr><td>Folded slates with an axial planar cleavage dipping 80°E</td><td>1 – folds drawn
1 – axial planar cleavage dipping at ~80°E (either on west or east)</td></tr>
<tr><td>Cut by a 2 metre thick vertical, basaltic dyke</td><td>1 – drawn vertical (thickness not important)</td></tr>
<tr><td>5m bedded sandstone, dipping 10°N</td><td>1 – marked in 5m thick (regardless of dip)</td></tr>
<tr><td>Irregular unconformity, dipping 10°N</td><td>1 – horizontal
1 – irregular</td></tr>
<tr><td>10m well-bedded limestone, dipping 15°W</td><td>1 – limestone – 10m thick</td></tr>
<tr><td>Unconformable junction, dipping 15°W</td><td>1 – dipping 15°W</td></tr>
<tr><td>15m folded slates with an axial planar cleavage dipping 80°E</td><td>1 – 15m marked in fold/cleavage dipping 80°E (credit here if not previously)</td></tr>
</table>


</td><td></td><td>8</td><td></td><td>8</td><td></td><td>8</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Any two x (1) evaluative statements consistent with a fault from:
• displacement of beds
• fault scarp
• spring
• fault breccia
• slickensides
(Note, the evidence must be explained not simply stated)</td><td></td><td></td><td>2</td><td>2</td><td></td><td>2</td></tr>
</table>

		(ii)	**Any three x (1) evaluative** statements that disagree that there has been normal movement **from:** • fault is reverse • hangingwall block upthrown/footwall block downthrown • faultplane dips towards older rocks/upthrow side • slickensides horizontal show strike-slip movement (Note, the evidence must be explained not simply stated)			3	3		3
		(iii)	Slickensides show last movement horizontal not vertical (1) Fault has upthrow and downthrow side so fault must have moved more than once in different directions (1)			2	2		2
			Question 3 total	**0**	**8**	**7**	**15**	**0**	**15**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)	line connecting water levels in boreholes (1) extended to spring (1)	2			2		
		(ii)	**Any two x (1) from:** • shale is impermeable/low permeability • shale is an aquiclude • water can't flow down to the water table below (1) • perched aquifer (1)		2		2		
	(b)	(i)	Arrow pointing to right (1)	1			1		
		(ii)	2,000 metres (1) (accept 1,950 – 2,050 metres)		1		1		1
		(iii)	$-1.0 \times 1 \times \frac{50}{2000}$ (1) 0.025 [$m^3 s^{-1}$] (accept 0.024) (1)		2		2	2	2
		(iv)	**Any four x (1) from:** • Limestone moderately permeable (1) • water flows through joints (1) • widened by erosion (or solution) of limestone (1) • unconfined aquifer (1) • recharges easily (1) • Water flows towards wells (1) • can pump at 25 litres per second ($0.025 m^3 s^{-1}$) without reducing water table (1) Credit other acceptable answers			4	4		
			Question 4 total	**3**	**5**	**4**	**12**	**2**	**3**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)	(i)	$\frac{90°C}{5\,Ma}$ (1) 18 [°C Ma^{-1}] (1)		2		2	2	2
		(ii)	**Any two x (1) from:** • temperature change not constant (1) • two phases of rapid increase (1) • long period of relative stability (1) • most change occurred within 1 Ma (1) • 50°C increase 'geologically instantaneous' (1)		2		2		
	(b)	(i)	Magnetic inclination indicates horizontal magnetic field (1) Suggests sedimentation at the Equator Ice at Equator (1)	2			2		
		(ii)	**Any two x (1) from:** • dropstones coarse-grained = not deposited in a low energy environment (1) • marine sediments fine-grained = low energy (1) • glaciation/glacial debris (1) • falls/dropped from melting ice/icebergs (1)	2			2		

	(c)		**Indicative content** *Volcanic activity* Under Snowball ice, increase in greenhouse gases (greenhouse gas/CO2 release), rapid melting of the ice with runaway global warming. *Methane hydrates* methane gas locked in frozen sediment/ice, rapid thawing methane released to atmosphere, adds to runaway global warming (most powerful greenhouse gas). *Rock weathering* Greenhouse gas/CO2 released - washed from atmosphere when hydrological cycle restarts as acid rain, rapid chemical weathering of silicate rocks and deposition of carbonates washed into sea. **5–6 marks** There is a clear response which draws upon explanations from **each of the three** aspects (volcanic activity, methane hydrates and rock weathering). The ideas are relevant and well explained throughout. *There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant.* **3–4 marks** The response draws upon explanations from a **minimum of two** of the three aspects (volcanic activity, methane hydrates and rock weathering). The ideas are generally reasonably well explained and mostly relevant. *There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included but there may be some irrelevant information or minor errors.* **1–2 marks** The response develops explanations from only **one or two** aspects (from volcanic activity, methane hydrates and rock weathering) with rather superficial comment. There may be significant lack of relevance in places. *There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure*. *There may be significant errors or the inclusion of much irrelevant information.* **0 marks** *No attempt made or no response worthy of credit.*	6			6		
			Question 5 total	**10**	**4**	**0**	**14**	**2**	**2**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)	(i)	250 (accept 230-270) (1)	1			1		
		(ii)	**Any three x (1) from:** • Cambrian fauna static – low • Palaeozoic fauna increases slightly • modern fauna increase rapidly • Palaeozoic and Modern affected by extinction at end of Triassic • relevant use of values	3			3		3
	(b)	(i)	$\frac{(700-600)}{700}\times 100$ (1) 14.2 [%] (accept 13.5-15.5) (1)		2		2	2	2
		(ii)	**Any two x (1) from:** • family is a higher taxonomic group than species (1) • families can consist of many species (1) • all species in the family must become extinct for the family to become extinct (1) • one surviving species ensures the continuation of the family (1)		2		2		

	(c)	(i)	$\frac{10^5}{10^2}$ (1) 10^3 or 1000 (1)		2			2	2
		(ii)	**Any two x (1) from:** • excellent / very good / strong (1) • positive correlation / both peak at K-Pg boundary / as iridium increases so does soot (or vice versa) (1) • use of values (1) • Tertiary less good correlation, iridium decreases but soot fluctuates (1)		2		2	2	2
		(iii)	Iridium related to asteroid / impact (1) Heat from impact caused wildfires creating soot (1)	2			2		
	(d)		**Indicative content** **Interpretation of evidence related to volcanic activity** Deccan plateau basalts would have blocked sunlight to prevent photosynthesis Loss of primary producers from food webs Volcanic activity occurred over a long period of time and would have had a long period of effects on life Correlation of Large Igneous Provinces with other mass extinction events **Interpretation of evidence related to asteroid impact** Well dated and correlated event with asteroid impact Would have same effects as volcanicity over shorter time period Gypsum deposits on Yucatan Peninsula related to super acid rain However may have occurred just after extinction event **Interpretation of evidence related to the fossil record** Fossil evidence ambiguous, may have been extinction event occurring just before the impact Loss of marine life may be related to effects of the Maastrichtian regression			6	6		

			5–6 marks There is a clear response which draws on the interpretation of evidence provided by **each of** the three aspects (volcanic activity, asteroid impact and the fossil record). Most or all of the evidence is interpreted coherently and a judgement regarding the statement is drawn suggesting that the mass extinction is most likely to be the result of a combination of events rather than one sole cause. Contrasting aspects provided by the evidence are raised such as the relative length of time of the effects of volcanic activity compared with meteorite impact. *There is a sustained line of reasoning which is coherent, substantiated and logically structured. The information included in the response is relevant* **3–4 marks** The response draws on the interpretation of evidence provided by a **minimum of two** of the three aspects (volcanic activity, asteroid impact and the fossil record). Some of the evidence is interpreted coherently. A judgement regarding the statement is drawn suggesting that the mass extinction is most likely to be the result of a combination of events rather than one sole cause. Discussion of contrasting evidence is not developed. *There is a line of reasoning which is partially coherent, supported by some evidence and with some structure. Mainly relevant information is included but there may be some irrelevant information or minor errors.* **1–2 marks** The response makes use of the interpretation of evidence provided by **one or two** of the three aspects (volcanic activity, asteroid impact and the fossil record). The evidence is interpreted with only rather superficial comment or the evidence may be stated but not interpreted (e.g. the answer might state the evidence for asteroid impact without interpreting the effects of this on the K-Pg mass extinction). There may be a lack of relevance in places and either no judgement or a very simplistic judgement concerning one line						

			of evidence. *There is a basic line of reasoning which is not coherent, supported by limited evidence and with very little structure. There may be significant errors or the inclusion of much irrelevant information.* **0 marks** *No attempt made or no response worthy of credit.*						
			Question 6 total	**6**	**8**	**6**	**20**	**6**	**9**

Candidate Name	Centre Number					Candidate Number				
						0				

A Level

GEOLOGY

COMPONENT 3

Geological Applications

SAMPLE ASSESSMENT MATERIALS

2 hours

ADDITIONAL MATERIALS
In addition to this examination paper you will need a calculator.

INSTRUCTIONS TO CANDIDATES
Answer **all** questions in sections **A** and **B**.
Answer all the questions in **one** option only in section **C**.
Write your answers in the spaces provided in this booklet.
Use black ink or black ball-point pen.
Do not use gel pen.
Do not use correction fluid.
Write your name, centre number and candidate number in the spaces at the top of this page.

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	15	
	2.	15	
Section B	**3.**	14	
	4.	15	
	5.	6	
	6.	10	
Section C option		12	
		12	
		6	
	Total	**105**	

INFORMATION FOR CANDIDATES

This paper is in 3 sections **A, B** and **C**.
Section **A**: 30 marks. Answer **both** questions. You are advised to spend about 35 minutes on this section.
Section **B**: 45 marks. Answer **all** questions. You are advised to spend about 50 minutes on this section.
Section **C**: 30 marks. Answer all the questions in **one** option only. You are advised to spend about 35 minutes on this section.

The number of marks is given in brackets alongside each question or part-question.
The assessment of the quality of extended response (QER) will take place in questions **9**, **12** and **15.**

SECTION A

*Answer **all** questions.*

1. **Table 1a** shows data on the relationships between Moment magnitude (Mw), seismic energy and the frequency of occurrence of earthquakes.

Moment magnitude (M_w)	Seismic energy released (metric tons TNT equivalent)	Approximate frequency of occurrence
<2	<1	8,000 per day
2.0	1	1,000 per day
3.0	32	49,000 per year
4.0	1,000	6,200 per year
5.0	32,000	800 per year
6.0	1 million	120 per year
7.0	•	18 per year
8.0	1 billion	1 per year
>9.0	32 billion	1 per 20 years

Adapted from the U.S. Geological Survey

Table 1a

Refer to **Table 1a.**

(a) Describe the general relationships between Moment magnitude, seismic energy released and frequency of occurrence of earthquakes. [2]

……

……

……

(b) (i) Estimate the seismic energy (in equivalent metric tons of TNT) released in a **magnitude 7** earthquake. Mark on **Table 1a.** [1]

(ii) Explain why large magnitude earthquakes are infrequent. [2]

……

……

……

(c) **Figure 1a** is a seismogram of an earthquake (**B**). **Figure 1b** is a diagram that calculates earthquake magnitude using data from a seismogram.

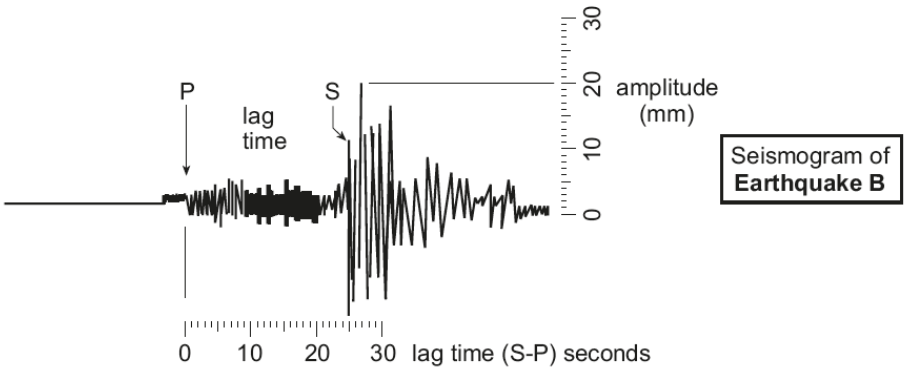


Figure 1a

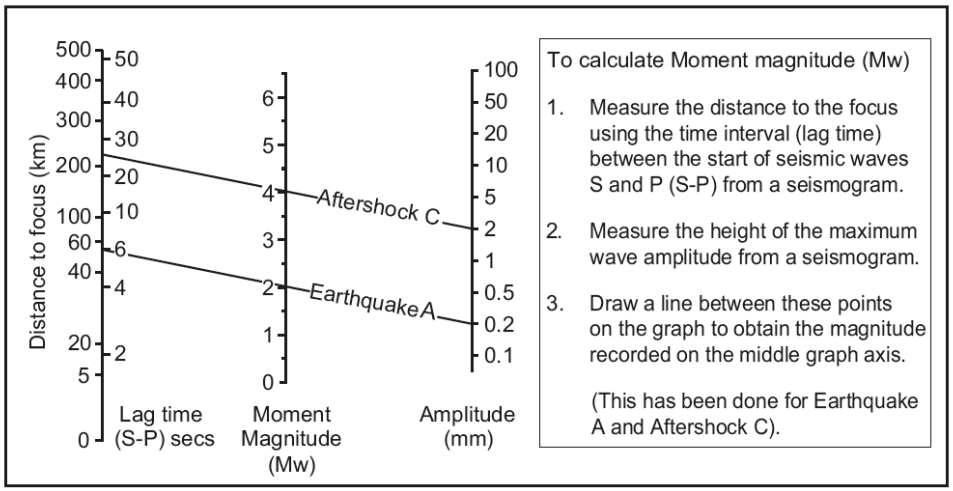


Figure 1b

(i) Complete **Table 1b** below by measuring the lag time and amplitude for the seismogram in **Figure 1a** (**earthquake B**) and establishing the Moment magnitude using **Figure 1b**. (This method is illustrated in **Figure 1b** for another earthquake, **A**, and an aftershock event **C**). [3]

Name	Distance (km)	lag time (S-P) seconds	Amplitude (mm)	Moment Magnitude (M_w),
Earthquake A	50	6	0.2	2
Earthquake B	225	•	•	•
Aftershock C			2	4

Table 1b

(ii) Using **Table 1a** and **Table 1b**, calculate how many times bigger **earthquake B** is than **aftershock C** in terms of:

1. the energy released …….. times [1]

2. the maximum amplitude ……times [1]

(d) Using your knowledge explain how **one** aseismic building design may successfully reduce the impact of ground accelerations during a major earthquake. [2]

……

……

……

(e) Using your knowledge evaluate the use of seismic monitoring in the attempt to predict earthquakes. [3]

……

……

……

……

……

……

15

2. **Figure 2a** shows the rise in groundwater levels beneath Central London since 1905**.**

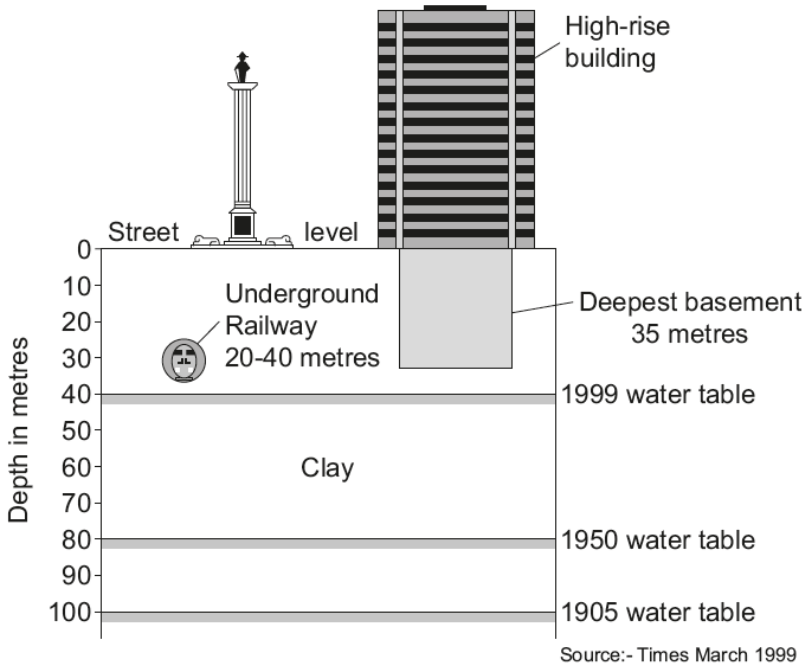


Figure 2a

Refer to **Figure 2a**:

(a) (i) Compare the average rate of rise in the water table before and after 1950. [2]

……

……

(ii) In 1999 groundwater levels were rising at a rate of 3 m yr^{-1}.
Calculate the year in which the water table would have reached street level (zero metres) if the 1999 rate were maintained.
Show your working. [2]

Year……..

(b) State two possible geohazards associated with an increase in each of the following: [4]

- saturation of the clay
- groundwater (pore) pressure.

Clay saturation

1……..

2……..

Groundwater (pore) pressure

1……..

2……..

(c) A network of boreholes was planned to reduce the water table levels in the London basin. **Figure 2b** shows a borehole situated near to the Thames estuary.

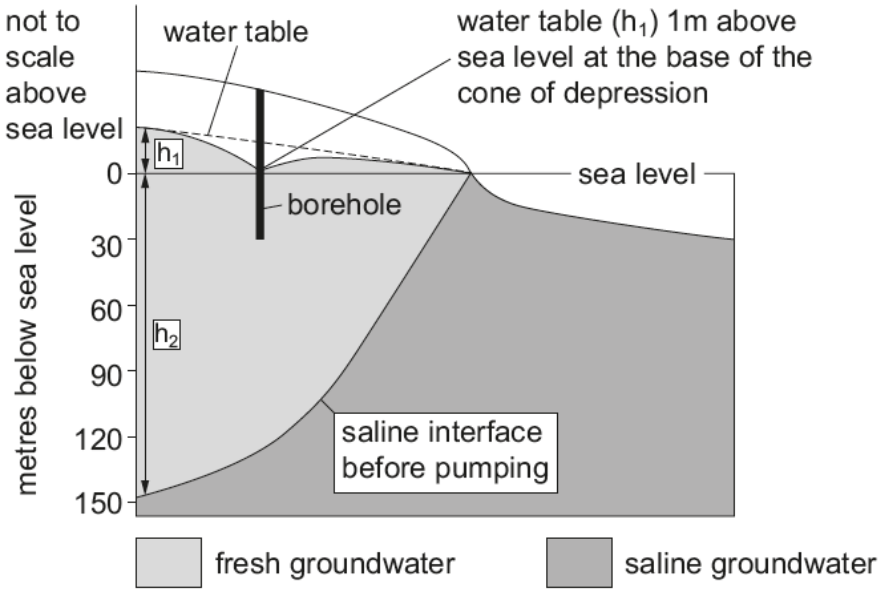


Figure 2b

Refer to **Figure 2b**

(i) Explain why a cone of depression has developed in the water table around the borehole. [2]

……

……

……

(ii) Refer to the information in **Figure 2b** and the information in the box below. Draw on **Figure 2b** the probable depth of the saline interface (h2) associated with this cone of depression. [2]

The depth of the saline interface between fresh and saline groundwater (h_2) is approximately 40 times the height of the water table (h_1) above sea level.

(d) Using your knowledge, explain how the stability of the area around a borehole can be affected by the over-pumping of an aquifer. [3]

……..

……..

……..

SECTION B

*Answer **all** questions.*

*Questions **3 – 6** relate to the **British Geological Survey 1:25 000 geological** map extract from the **Clitheroe and Gisburn** Sheet.*

3 (a) (i) State the superficial (drift) deposit overlying the Pendle Grit (**PG**) on Pendle Hill (**grid square 7941**). [1]

……

(ii) Account for the irregular outcrop pattern of this deposit in **grid square 7940**. [1]

……

(b) (i) Using the **generalised geological column**, calculate the maximum vertical thickness of the Pendleside **Sandstone** unit (**PdS**) within the Lower Bowland Shales (**LBS**). *Show your working.* [2]

Maximum vertical thickness ..... (m)

(ii) Account for the “v shape” in the outcrop pattern of the Pendleside Sandstone (**PdS**) around **GR 810 430**. [2]

……

……

……

(c) **Figure 3** is a **sketch** section along part of the line of section (**X-Y**) on the **geological map**. It includes the part of the line coloured red on the **geological map** between **grid reference** (**GR**) **827419** and **GR 830416**)

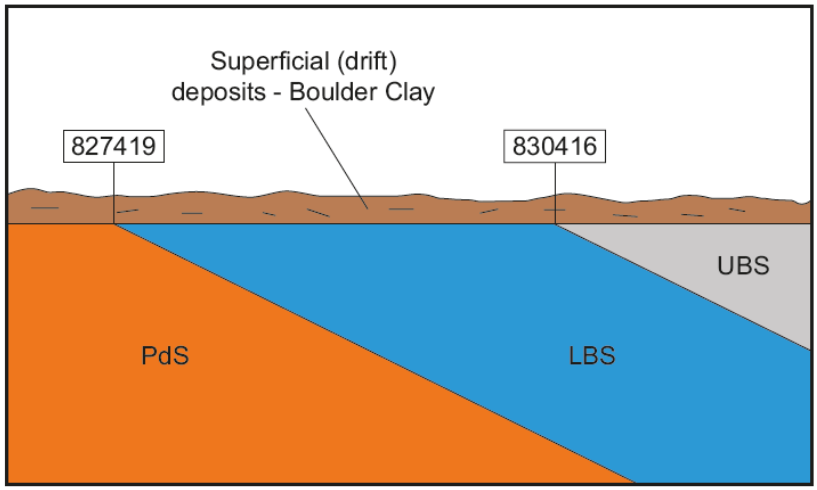


Figure 3

Using the **geological map**, complete **Table 3a** below by calculating the width of outcrop from the top of the Lower Bowland Shales (**LBS**) to the top of the Pendleside Sandstone (**PdS**) illustrated in **Figure 3**.
Show your working. [2]

Width of outcrop (m) of the Lower Bowland Shales (**LBS**) between **GR 827419** and **GR 830416**
Working. Answer ..... (m)

Table 3a

(d) A student undertook a statistical study into the relationship between the width of outcrop of the Lower Bowland Shales (LBS) and dip angle from geological map and field data. These data were analysed using the Spearman Rank correlation coefficient method as follows:

- the null hypothesis (H0) was stated as 'there is no significant relationship between outcrop width and dip angle other than could have occurred by chance'
- the student chose 30 pairs of data
- the Spearman's Rank Correlation Coefficient (rs) = 0.23

Spearman's Rank Correlation Significance Graph and Table

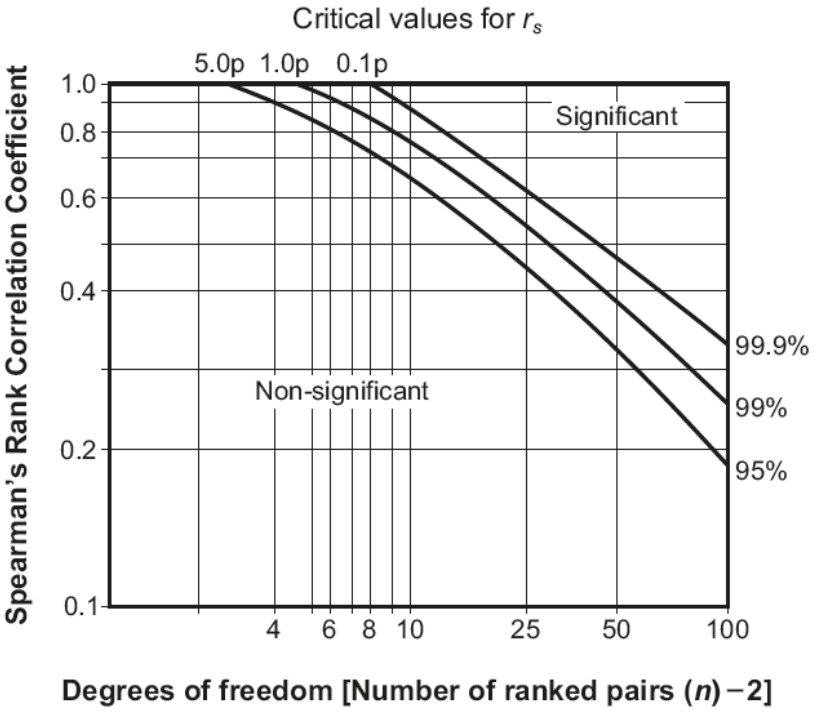


Table 3b

(i) Using the graph in **Table 3b**, comment on the statistical significance of the result of the Spearman's Rank Correlation Coefficient (rs). [2]

……

……

……

(ii) With reference to the **geological map** and the **generalised geological column** explain **two** factors that may influence the width of outcrop of the Lower Bowland Shales (**LBS**) other than dip angle.[4]

……

……

……

……

……

4. **Table 4** and **Figure 4a** show the results of an investigation of three different rock samples from the map area.

Sample characteristics	Pendleside Sandstone (**PdS**) (within **LBS**)	Upper Bowland Shale (**UBS**)	Pendle Grit (**PG**)
Fossil groups	trilobites	goniatites, bivalves	plant fragments
Sedimentary structures	bedding	laminations	channels, erosion surfaces, flute and groove casts. Some lateral and vertical grading of sediments
Sand percentage	60	0	•
Silt percentage	25	5	•
Clay percentage	15	95	10

Table 4

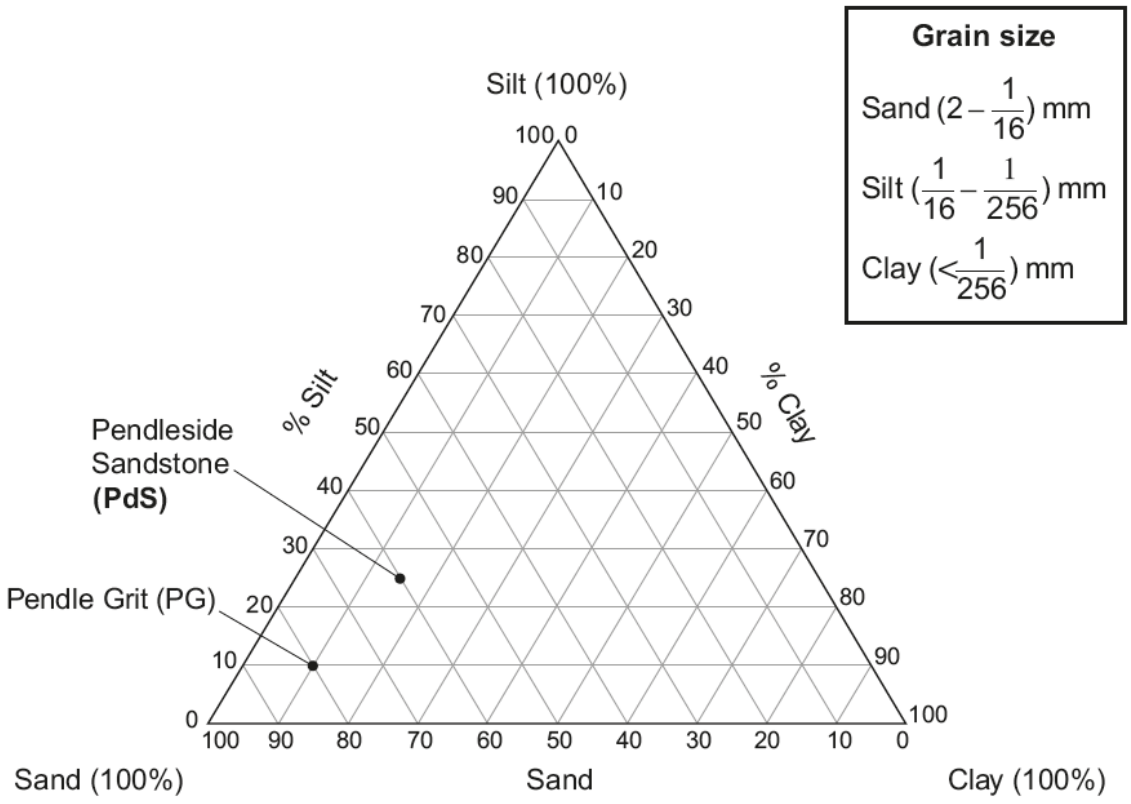


Figure 4a

(a) Using **Table 4** and **Figure 4a** as appropriate:

(i) complete **Table 4** to show the percentage of sand and silt in the Pendle Grit (**PG**) [1]

(ii) plot the percentage of sand, silt and clay in the Upper Bowland Shale (**UBS**) on **Figure 4a**. Label your plot with an arrow (← **UBS**) [1]

(iii) state which of the three rock samples (Pendle Grit, Pendleside Sandstone or Upper Bowland Shale) is the **most** poorly-sorted. Explain your reasoning. [2]

Rock sample ……

Explanation …….

.....

(b) Refer to the **generalised geological column**, and data in **Table 4** and **Figure 4a**. Describe the environments of deposition of the Upper Bowland Shale (**UBS**) and the overlying Pendle Grit (**PG**). Explain the evidence for your answers. [4]

Upper Bowland Shale ……..

……

……

Pendle Grit ……...

……

……

(c) Explain why a spring has formed at Deep Clough (**GR 805 405**). [2]

……

……

……

……

(d) **Figure 4b** illustrates one of the fossil groups identified in **Table 4**.

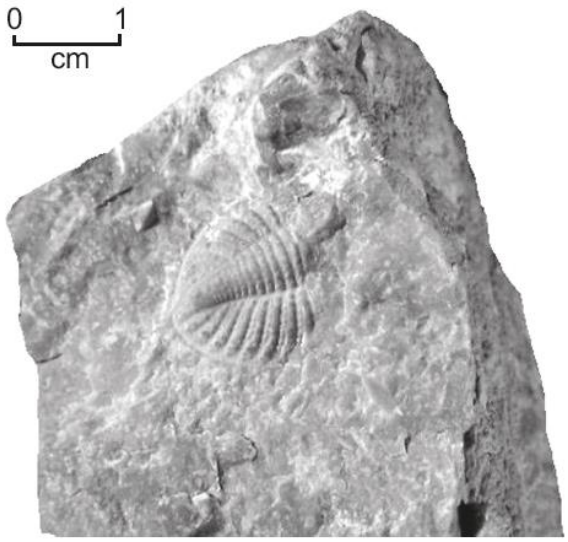


Figure 4b

(i) State the fossil group to which this specimen belongs. [1]

Fossil group……

(ii) Assess how useful this fossil alone would be in determining:

- the mode of life of the original organism and
- the environment of deposition of the rock in which it is found.

[4]

……

……

……

……

……

……

……

15

5. **Figure 5** is a copy of part of the **geological map**. From the outcrop pattern and dip directions a student identified **two** plunging folds on the **geological map**.

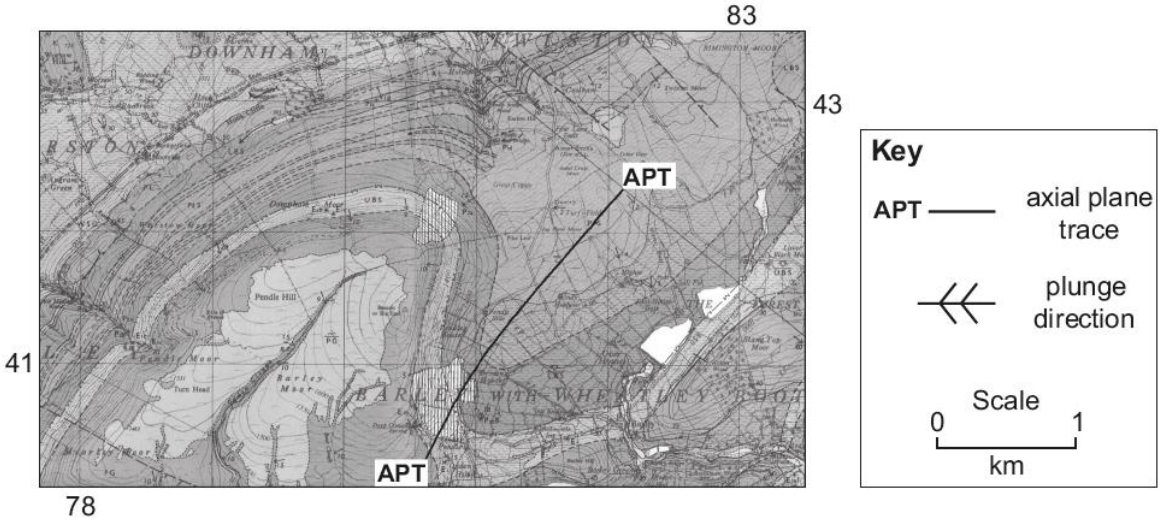


Figure 5

(a) The axial plane trace of one plunging fold is marked on **Figure 5**. For this marked fold, name the type of fold and state the direction of plunge. [2]

type of fold	•
direction of plunge	•

(b) **On Figure 5**, draw the axial plane trace of another plunging fold. Use the symbols in the key to indicate the direction of plunge of this fold. [2]

(c) The student described these plunging folds as having *"...a wavelength of approximately 1 km..."*.

Critically evaluate this statement. [2]

……

……

……

6

6. (a) Suggest probable geological explanations for the location of the two reservoirs (shaded white) **in** **grid square 8241**. [4]

……..

……..

……..

……..

……..

……..

(b) Two landslips have developed on Pendle Hill. With reference to evidence from the **geological map**, evaluate the likelihood that the following factors were responsible for the landslides at these locations. [6]

- Rock type
- Dip (angle and direction) of beds
- Steepness of the slope

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

BLANK PAGE

SECTION C

*Answer the questions from only **one** option.*

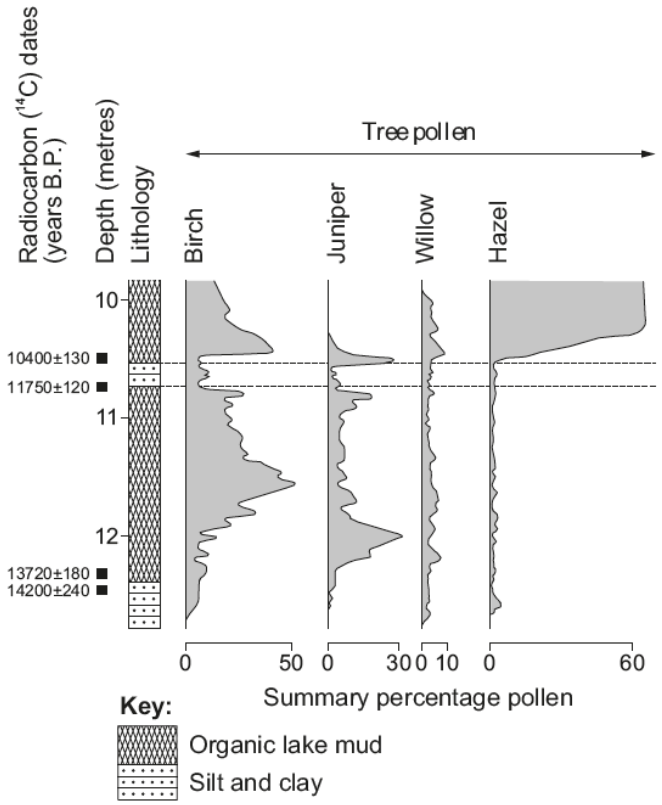
*Tick one of the boxes below to indicate which **one** option you have selected.*

☐ Quaternary geology ☐ Geological evolution of Britain ☐ Geology of the lithosphere

Option 1 Quaternary Geology

If you have chosen this option, answer **all** the questions within this option.

7. **Figure 7** is a pollen diagram from a sediment core from Llyn Gwernan, a lake in North Wales.



Adapted from: Geological Conservation Review, Quaternary of Wales

Figure 7

Refer to **Figure 7**.

(a) It is thought that the climate in Wales warmed approximately 14,000 years B.P (before present).

(i) Describe the evidence from the **lithology** of the lake sediments that suggests the climate warmed approximately 14.000 years B.P. [1]

……

……

(ii) Describe the changes in the **tree pollen** assemblage between the radiocarbon (14C) dates of 13,720 and 11,750 years B.P. [3]

……

……

……

……

(iii) Suggest reasons for the variations in the percentage of **Birch** and **Juniper pollen** between the radiocarbon (14C) dates of 13,720 and 11,750 years B.P. [2]

……

……

……

(b) (i) Calculate the percentage uncertainty in the radiocarbon ^{14}C date of 11750 ± 120 year B.P. obtained from a depth of 10.8 m in the sediment core on **Figure 7**. *Show your working.* [3]

…… %

(ii) "Radiocarbon (^{14}C) dating is the best method for providing a timescale for the climatic fluctuations suggested in **Figure 7**."
Discuss the validity of this statement. [3]

……

……

……

……

……

……

……

8. **Figure 8a** is a Quaternary landform map of the Cadair Idris area in Wales. **Figure 8b** is a cross section along the line **X-Y** on **Figure 8a**.

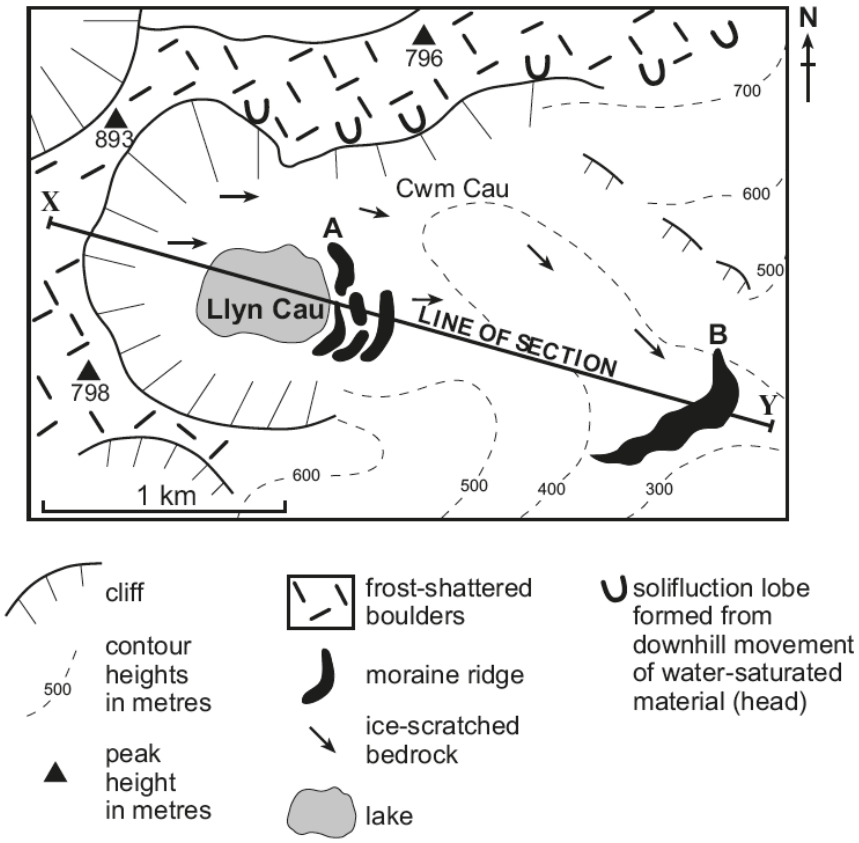


Figure 8a

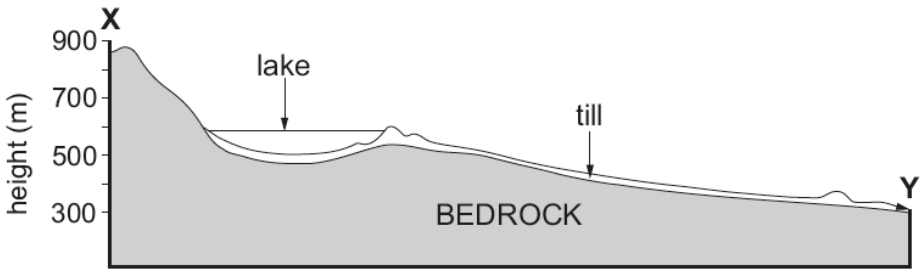


Figure 8b

(a) State two pieces of evidence in **Figure 8a** which indicate that this area has been glaciated. [2]

1. ……

2. ……

(b) Refer to **Figures 8a** and **8b**.

(i) Give a geological reason for the depression in which the lake (Llyn Cau) formed. [2]

……

……

……

(ii) Suggest reasons for the presence of moraines at two localities in Cwm Cau (labelled **A** and **B**). [2]

……

……

……

(c) Solifluction lobes can develop in periglacial conditions.
Refer to **Figure 8a**.
Describe the distribution of solifluction lobes in the Cadair Idris area. [3]

……

……

……

……

(d) The Cadair Idris area has been interpreted as experiencing glacial and periglacial conditions at the same time. Discuss the validity of this interpretation. [3]

……

……

……

……

……

……

12

9. Explain how Milankovitch Cycles are believed to cause climatic fluctuations in the Quaternary.

You may wish to use an annotated diagram(s) in your answer. [6 QER]

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

6

Option 2 Geological Evolution of Britain

If you have chosen this option, answer **all** the questions within this option.

10. **Figure 10a** shows the variation in the angle of inclination of the Earth's magnetic field in relation to latitude at the present day.

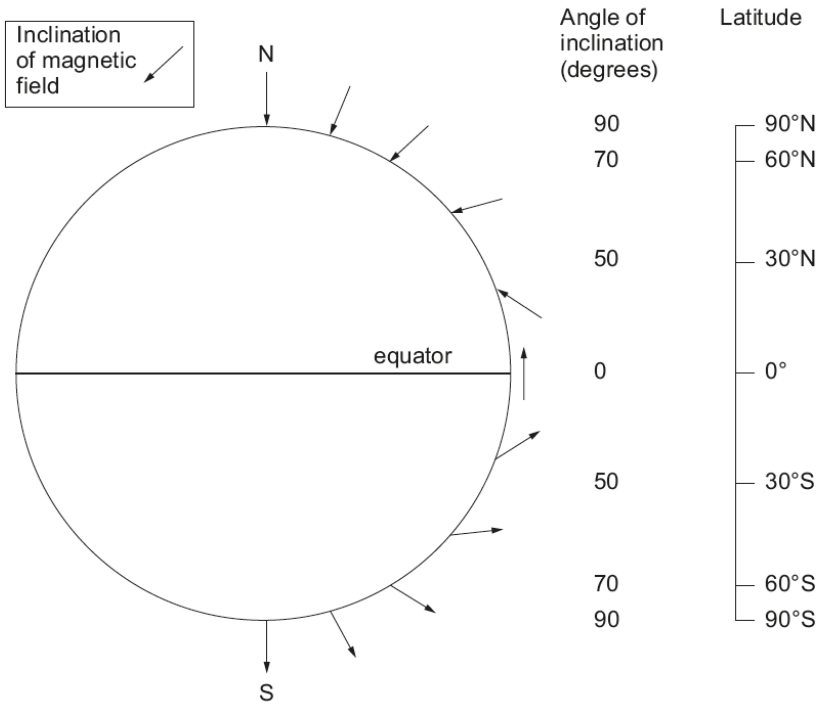


Figure 10a

(a) Describe how the angle of magnetic inclination in **Figure 10a** varies between the northern and southern hemispheres and between the equator and the poles. [2]

……..

……..

……..

……..

(b) **Table 10** shows data on palaeomagnetic inclination and palaeolatitude for rocks in Wales and Scotland during the Early Palaeozoic.

Location	Palaeomagnetic inclination (degrees)	Palaeolatitude
Wales	70	54°S
Scotland	50	•

Table 10

Assuming that geographic and magnetic poles have always been close together, palaeolatitude can be determined using the equation:

Tan L = 0.5 Tan I

where L is the palaeolatitude and
I is the palaeomagnetic inclination

Complete **Table 10** by calculating the palaeolatitude of Scotland during the Early Palaeozoic. *Show your working.* [3]

……..

……..

Figure 10b is a map of the British area showing the distribution of Early Palaeozoic fossils and the location of two graphic logs of Early Palaeozoic age. These graphic logs are shown in **Figures 10c** and **10d**.

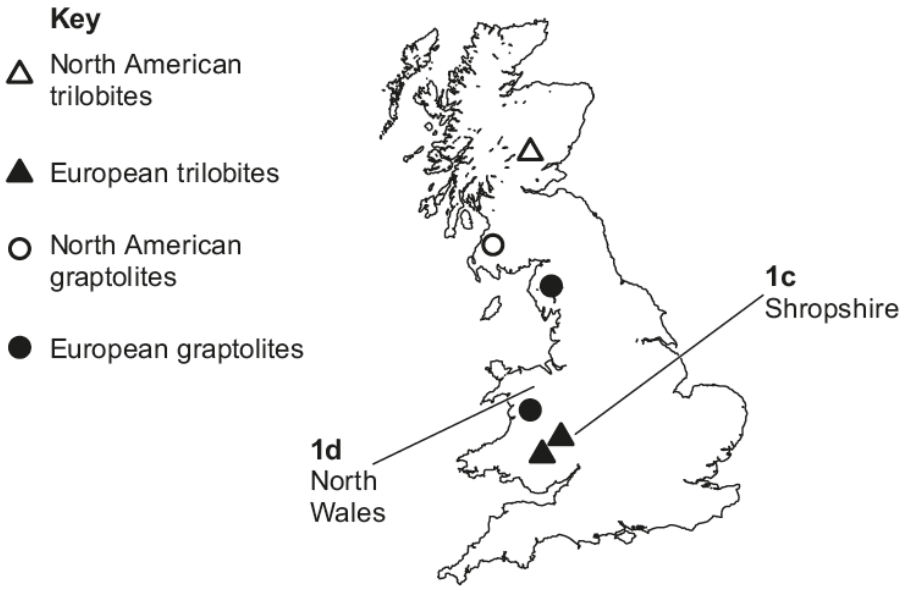


Figure 10b

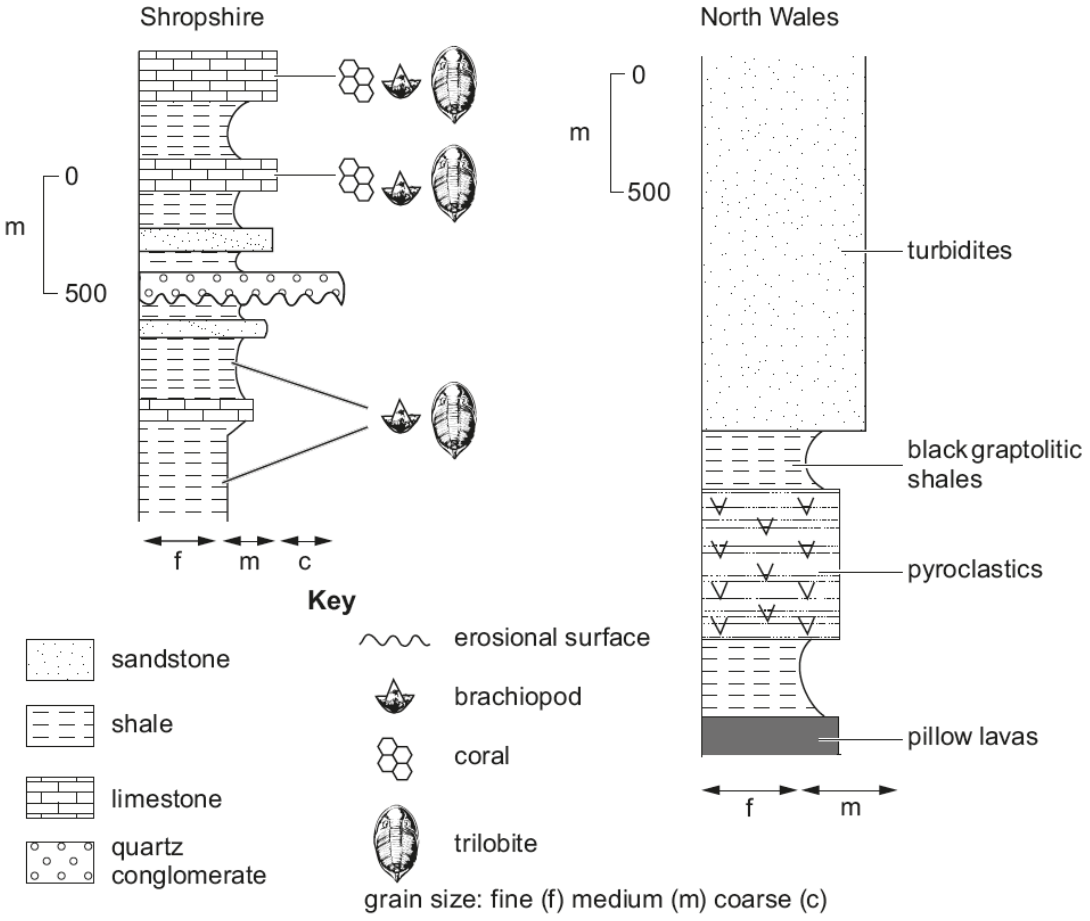


Figure 10c

Figure 10d

(c) Use **Figures 10c** and **10d** to compare and contrast the depositional environments in which the sedimentary rocks of Shropshire and North Wales were deposited during the Early Palaeozoic. Give reasons for your answers. [3]

……..

……..

……..

……..

……..

……..

……..

(d) (i) The trilobites and graptolites located on **Figure 10b** belong to one of two different faunal provinces (North American and European), each of which is characterised by distinct faunal assemblages. Using your knowledge, draw a line on **Figure 10b** to separate the two faunal provinces. [1]

(ii) State the evidence from **Figures 10a, 10b, 10c** and **10d** for a convergent plate boundary in the British area during the Early Palaeozoic. [3]

……

……

……

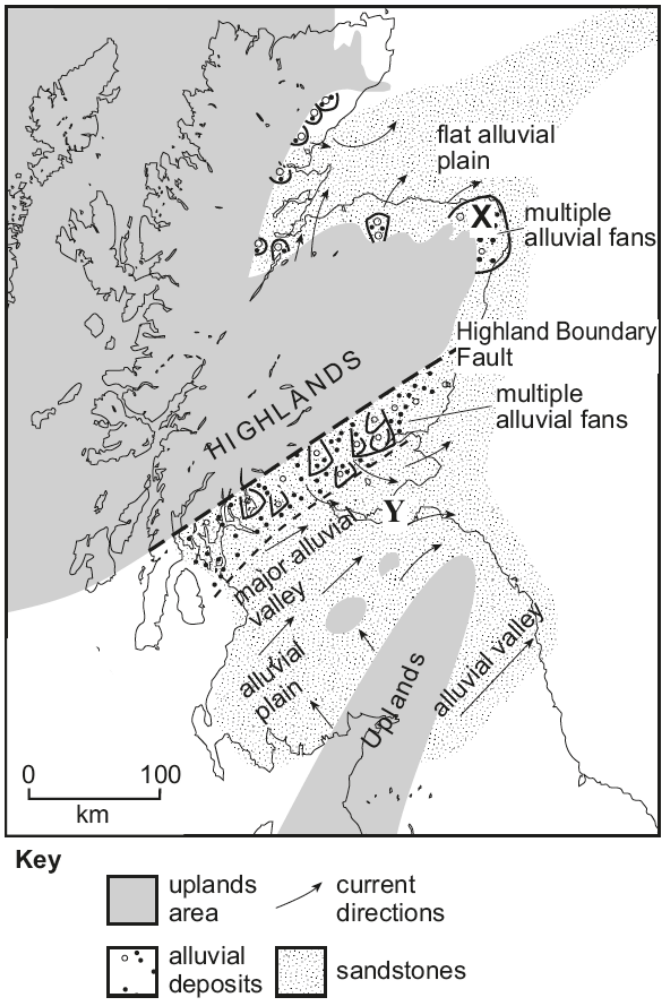
……

……

……

12

11. **Figure 11a** is a palaeogeographical map of Northern Britain during the Devonian Period.
Figures 11b and **11c** are graphic logs recorded at localities **X** and **Y** on **Figure 11a**.



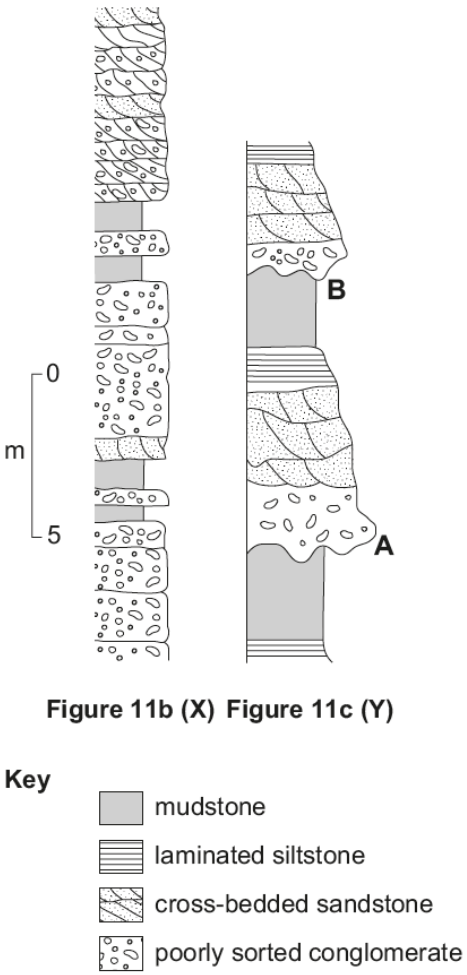


Figure 11b (X) Figure 11c (Y)

Figure 11a

(a) Alluvial fans as shown in **Figure 11a** are produced when fast flowing rivers flowing out from mountainous areas deposit their sediments on a flat plain.

(i) Describe the distribution and size of the alluvial fans on **Figure 11a**.
[3]

……

……

……

……

(ii) Explain how **one** piece of evidence from the sedimentary rocks in **Figure 11b** could be used to interpret their origin as part of an alluvial fan deposit. [2]

Evidence……..

Explanation……

……

……

……

……

(iii) Use a labelled diagram to show how one piece of field evidence might be used to confirm the current directions shown in **Figure 11a**. [2]

(b) (i) Describe and explain the pattern of grain size variation between **A** and **B** in **Figure 11c**. [2]

……

……

……

……

……

(ii) A student incorrectly concluded that the sedimentary rocks in **Figure 11c** were deposited under aeolian conditions. Explain why this conclusion is incorrect with reference to the evidence in **Figure 11c**.[3]

……

……

……

……

……

……

12. Explain the range of igneous bodies and their associated rock types found in the Paleogene Igneous Province of north-west Britain.

You may wish to use an annotated diagram(s) in your answer. [6 QER]

Option 3: Geology of the Lithosphere

If you have chosen this option, answer all the questions within this option.

13. **Figure 13a** is a generalised block diagram across an active orogenic belt. **Figure 13b** is a detailed cross section of the accretionary prism on the margin of the ocean trench seen in **Figure 13a**.

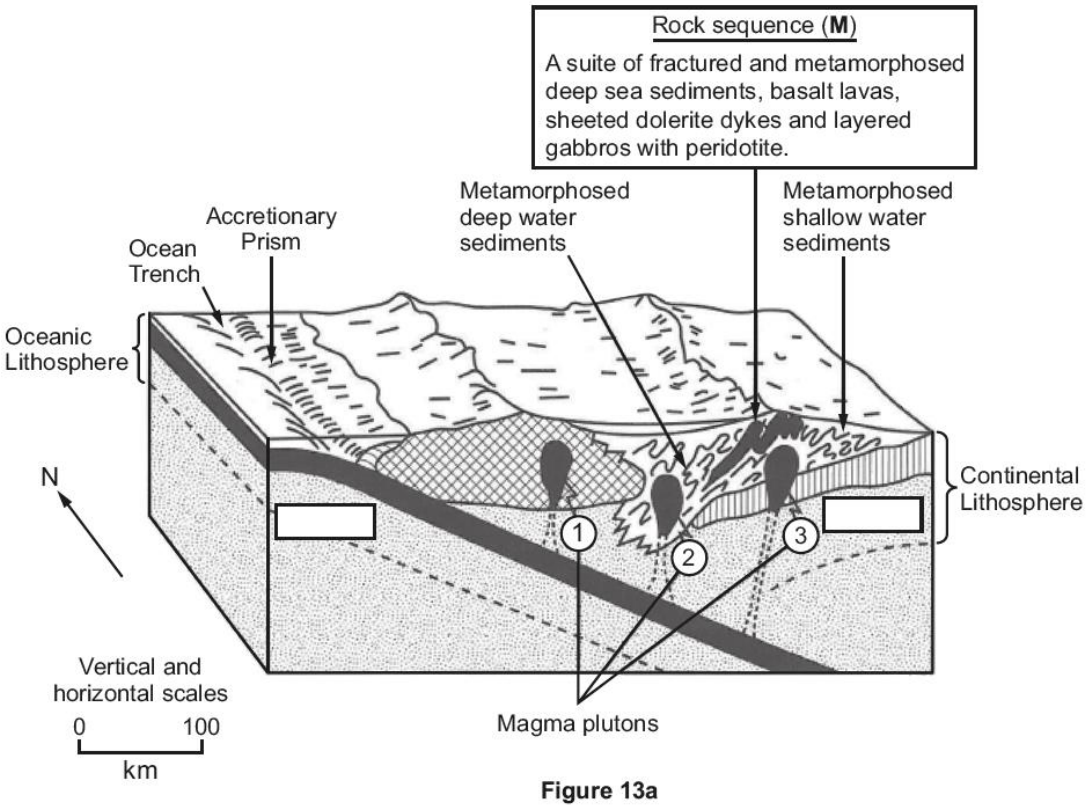


Figure 13a

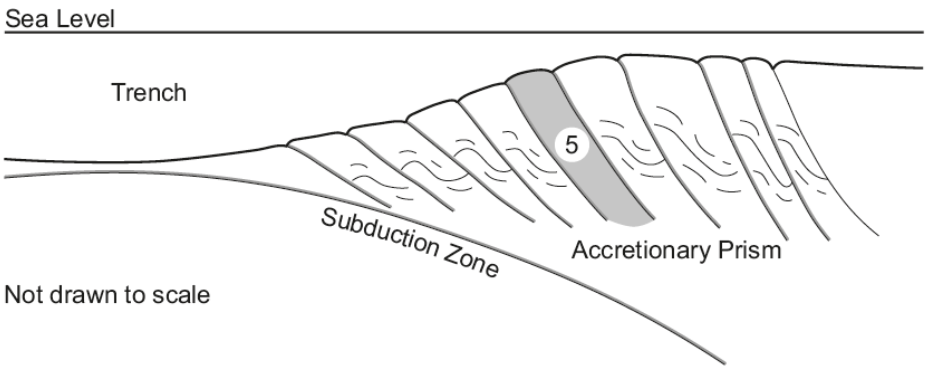


Figure 13b

(a) Draw two arrows **in the boxes** on **Figure 13a** to show the present day relative movement of the continental and oceanic lithosphere. [1]

(b) Refer to the sequence of rocks marked (**M**) on **Figure 13a**.

(i) State the name given to such a sequence. [1]

...

(ii) Account for the presence of this rock sequence (**M**) within the active orogenic belt. [2]

.....

.....

.....

.....

(c) Refer to **Figure 13b** and your knowledge.

(i) Number the sediment wedges in the accretionary prism on **Figure 13b** that are **older** than sediment wedge 5 (shaded), in the order in which they formed, (1 being the oldest). [1]

(ii) Describe the mechanism by which an accretionary prism forms. [2]

.....

.....

.....

(iii) Describe the structural geology of an accretionary prism. [2]

.....

.....

.....

(d) A student concluded that the magma plutons at locations **1**, **2** and **3** in **Figure 13a** were all likely to be intermediate (andesitic) in composition. Discuss the validity of this conclusion. [3]

.....

.....

.....

.....

.....

14. **Figure 14a** is a time-distance graph showing data collected from a seismic survey designed to calculate the local thickness of the continental crust. **Figure 14b** illustrates a two layer ray path model to explain the results of this seismic survey.

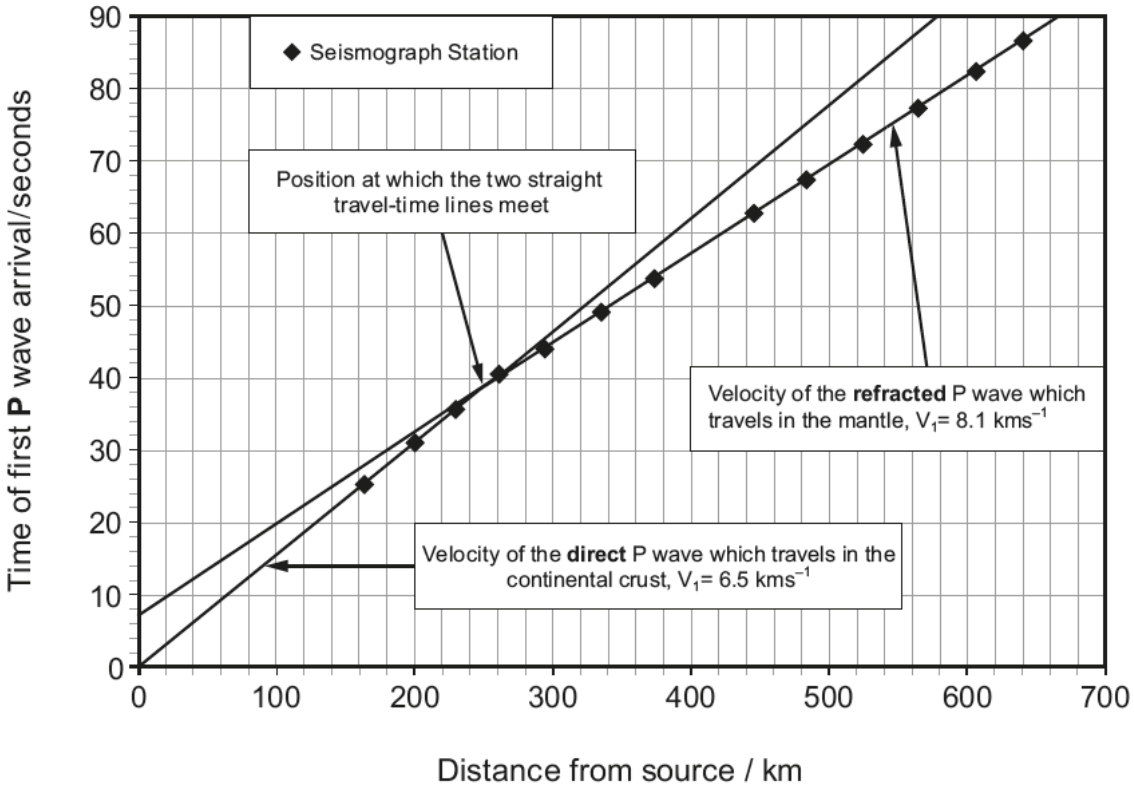


Figure 14a

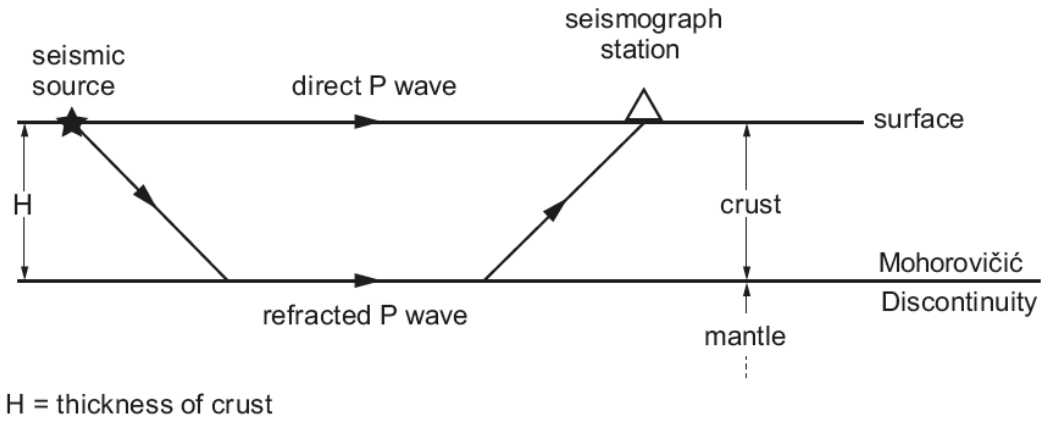


Figure 14b

(a) Use **Figure 14a** to complete **Table 14** to determine the time of the first P wave arrivals at seismograph stations positioned **200 km** and **565 km** from the seismic source. [2]

Distance from seismic source / km	Time of the first P wave arrivals
200	•
565	•

Table 14

(b) Using **Figures 14a** and **14b** explain the path of the refracted P wave as it travels from the seismic source to and along the Mohorovičić Discontinuity and to the seismograph station. [3]

……..

……..

……..

……..

……..

(c) It is possible to calculate the thickness of the crust by using data from **Figure 14a** and the formula below.

$$H = \frac{D}{2}\sqrt{\frac{(V_2 - V_1)}{(V_2 + V_1)}}$$

H is the thickness of the crust in km

D is the distance in km at which the two straight travel-time lines meet

V_1 is the velocity in kms^{-1} of the P waves in the crust

V_2 is the velocity in kms^{-1} of the P waves in the mantle

(i) Measure on **Figure 14a** the distance D at which the two straight travel-time lines meet.

D = ...km [1]

(ii) Show that the thickness of the crust in this area is approximately 40 km by substituting all relevant values from **Figure 14a** into the formula above. *Show your working.* [3]

(d) With reference to all the data available (given and calculated) and your own knowledge, suggest which one of the locations (A-D) in **Figure 14c**, would most likely be underlain by the crust identified in **Figures 14a** and **14b**.

Give a reasoned explanation for your choice of location. [3]

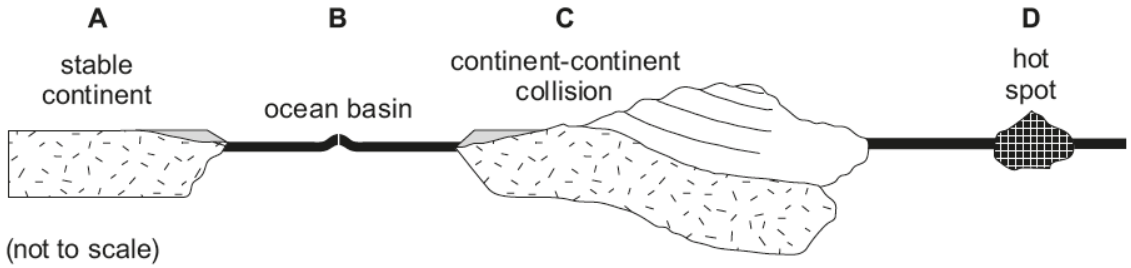


Figure 14c

Location .....

Explanation ……

……..

……..

……..

……..…

…….....

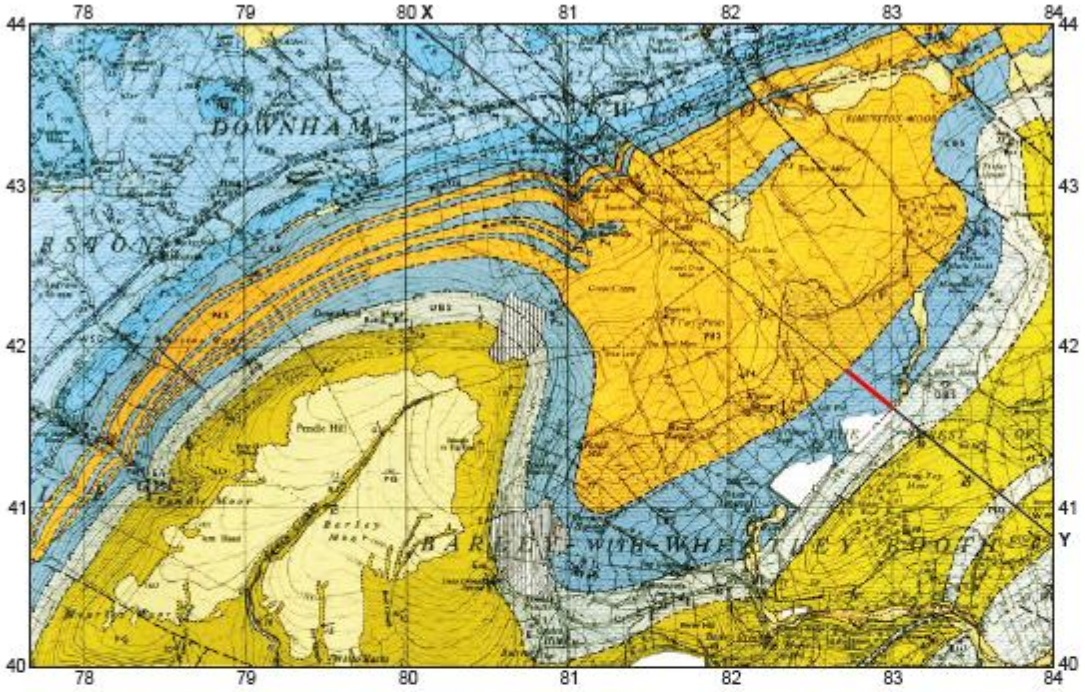
15. Explain why oceanic lithosphere varies in thickness across oceanic regions.

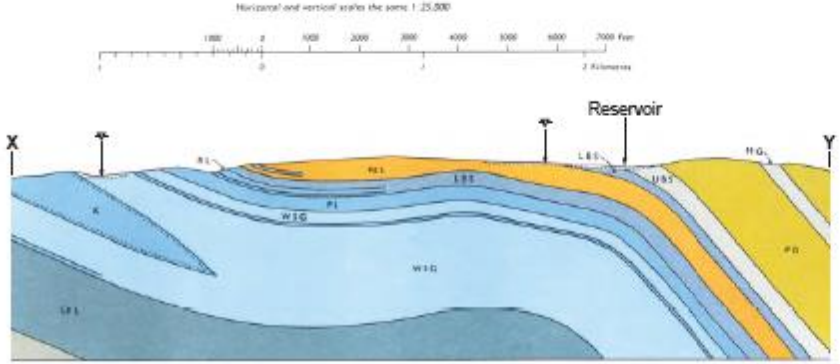
You may wish to use an annotated diagram(s) in your answer. [6 QER]

……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……
……

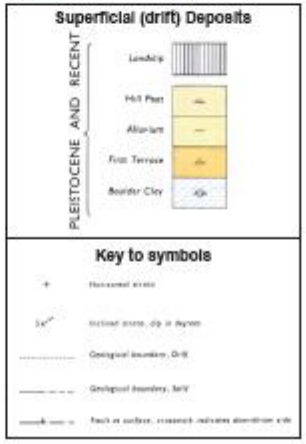
This map will be printed in A3 format for examinations

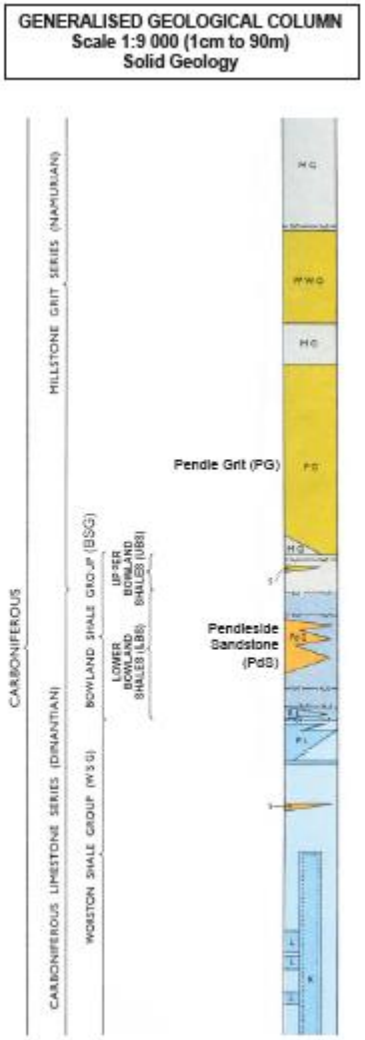
A Level sample paper Component 3 Geological Application Section B
Extract from Clitheroe and Gisburn (Solid and Drift) 1:25 000 (1cm to 250m)





CROSS-SECTION SHOWING THE GENERAL RELATIONS OF ROCKS ALONG THE LINE X–Y





BLANK PAGE

WJEC Eduqas A Level Geology

Mark scheme for use with Component 3

Geological Applications

SAMPLE PAPER

Instructions for examiners of A Level Geology when applying the mark scheme

1 Positive marking

It should be remembered that candidates are writing under examination conditions and credit should be given for what the candidate writes, rather than adopting the approach of penalising him/her for any omissions. It should be possible for a very good response to achieve full marks and a very poor one to achieve zero marks. Worthwhile answers that meet the requirements of the question, but do not appear on the mark scheme are to be given credit.

2 Tick marking

Low tariff questions should be marked using a points-based system. Each credit worthy response should be ticked in red pen. The number of ticks must equal the mark awarded for the sub-question. The mark scheme should be applied precisely using the marking details box as a guide to the responses that are acceptable. Do not use crosses to indicate answers that are incorrect.

3 Annotated diagrams

Where a candidate has answered a question wholly or partly by use of an annotated diagram, credit must be awarded to the annotations which form credit-worthy responses as outlined in the marking details box. Candidates must be credited only once for valid responses which appear both as annotations to diagrams and within a section of prose in the answer to the same question.

4 Banded mark schemes

Banded mark schemes are divided so that each band has a relevant descriptor. The descriptor for the band provides a description of the performance level for that band. Each band contains marks. Examiners should first read and annotate a learner's answer to pick out the evidence that is being assessed in that question. **Do not use ticks** on the candidate's response. Once the annotation is complete, the mark scheme can be applied. This is done as a two stage process.

Stage 1 – Deciding on the band

When deciding on a band, the answer should be viewed holistically. Beginning at the lowest band, examiners should look at the learner's answer and check whether it matches the descriptor for that band. Examiners should look at the descriptor for that band and see if it matches the qualities shown in the learner's answer. If the descriptor at the lowest band is satisfied, examiners should move up to the next band and repeat this process for each band until the descriptor matches the answer.

If an answer covers different aspects of different bands within the mark scheme, a 'best fit' approach should be adopted to decide on the band and then the learner's response should be used to decide on the mark within the band. For instance if a response is mainly in band 2 but with a limited amount of band 3 content, the answer would be placed in band 2, but the mark awarded would be close to the top of band 2 as a result of the band 3 content.

Examiners should not seek to mark candidates down as a result of small omissions in minor areas of an answer.

Stage 2 – Deciding on the mark

Once the band has been decided, examiners can then assign a mark. During standardising (marking conference), detailed advice from the Principal Examiner on the qualities of each mark band will be given. Examiners will then receive examples of answers in each mark band that have been awarded a mark by the Principal Examiner. Examiners should mark the examples and compare their marks with those of the Principal Examiner.

When marking, examiners can use these examples to decide whether a learner's response is of a superior, inferior or comparable standard to the example. Examiners are reminded of the need to revisit the answer as they apply the mark scheme in order to confirm that the band and the mark allocated is appropriate to the response provided.

Indicative content is also provided for banded mark schemes. Indicative content is not exhaustive, and any other valid points must be credited. In order to reach the highest bands of the mark scheme a learner need not cover all of the points mentioned in the indicative content but must meet the requirements of the highest mark band. Where a response is not creditworthy, that is contains nothing of any significance to the mark scheme, or where no response has been provided, no marks should be awarded.

Section A

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
1	(a)		As Moment magnitude increases energy increases (1) As Moment magnitude increases or energy increases frequency decreases (1) (Credit use of numbers)	2			2		
	(b)	(i)	32 million (1)		1		1	1	1
		(ii)	Build-up of strain takes time (1) Rare for energy to build up so high without slipping (1)	2			2		
	(c)	(i)	S-P lag time = 25 (23-27) (1) Amplitude = 20 (1) Magnitude = 5 (1)	1 1	 1		 3	 1	 1
		(ii)	1 = 32 (1) 2 = 10 (1)		2		2	2	2
	(d)		One aseismic design stated (1) Success of the chosen aseismic design explained (1) e.g. • cross bracing (1) withstands lateral and vertical stresses (1) • use of flexible materials e.g wood, metal (1) absorbs energy and does not fracture/shatter (1) • firm attachments of fixings (1) so that they do not fall during an earthquake (1) • foundations composed of rubber or steel (1) absorb the energy of the earthquake (1) • safety cut-off valves/reinforced tanks for oil, gas and water (1) reduce the chance of leakage and fire or flooding (1) • buildings designed with a low centre of gravity (1) reduce the extent of swaying of building (1) Credit other acceptable answers	2			2		

	(e)		**Any three x (1) from**: • evaluation that there is limited success in terms of prediction of size or timing of earthquakes • evaluation that there may be some success in terms of location of earthquakes • using increase/decrease in background rate of minor quakes • using seismic gap • using measurement of P and S velocities passing through fault zone • reduction indicates influx of water into rock as micro-fractures open • on returning to normal, pore pressure rises = quake • duration of anomaly = predicted magnitude of quake Credit other acceptable answers			3	3		
			Question 1 total	**8**	**4**	**3**	**15**	**4**	**4**

Question			Marking details	Marks Available					
				AO1	AO2	AO3	Total	Maths	Prac
2	(a)	(i)	**Any two x (1) from**: • greater increase after 1950 • twice as fast after 1950 • Accept numbers - 0.4 & 0.8 myr^{-1}		2		2		2
		(ii)	$\frac{40}{3}$ = ~13 years (1) Year 2012 (1)		2		2	2	2
	(b)		Clay saturation: **Any two x (1) from**: • Flooding underground/basements • Shorting of electrical equipment • Effect of acid groundwater on foundations • Building subsidence/heave as clay becomes ductile/swells Credit other acceptable answers Groundwater pressure: **Any two x (1) from**: • "Popping"(on building foundation) • Tube tunnels, foundations become distorted Credit other acceptable answers	2 2			4		

	(c)	(i)	abstraction (1) is greater than recharge (1)	2			2		
		(ii)	Sketch to show that: • depth of interface is ~40m below sea level below borehole (1) • deeper on each side of borehole to form a cone shape (1)		2		2		2
	(d)		**Any three x (1) from**: • reduction in pore water pressure • compaction/readjustment/repacking of sediment • shrinking clays • reduction in pore space/rock volume • subsidence	3			3		
			Question 2 total	**9**	**6**	**0**	**15**	**2**	**6**

Section B

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
3	(a)	(i)	Hill Peat (1)	1			1		
		(ii)	Erosion by rivers/streams (1)		1		1		
	(b)	(i)	1.3 (accept 12.5 – 13.5) x 90 or equivalent e.g. 13mm measured on the geological column (12.5 - 13.5mm) x 90 (1) 117 [m] (Accept range 112 -122) (1)		2		2	2	2
		(ii)	Beds dip to south (1) In a valley (1)		2		2		
	(c)		1.5 cm (1.4 - 1.6 cm) x 25,000 (1) 375 [m] (Accept range 350 – 400m) (1)		2		2	2	2
	(d)	(i)	Not significant (1) At the 95% level (1)		2		2	2	2
		(ii)	Factor 1: Gradient of topography (1) Explanation: Steeper gradient the narrower the width of outcrop (1) Factor 2: Variation in bed thickness (1) Explanation: Width of outcrop narrower where bed thinner (1)	4			4		
			Question 3 total	**5**	**9**	**0**	**14**	**6**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
4	(a)	(i)	Sand 80 and Silt 10 (1) (1 correct = 0 marks)	1			1	1	1
		(ii)	Sand - 0%, Silt – 5%, Clay – 95% correctly plotted (1)	1			1	1	1
		(iii)	Pendleside Sandstone (1) Most evenly spread of data (1)		2		2		2
	(b)		1. Upper Bowland Shale Low energy because fine grained/shale (1) Marine because of marine fossils (1) 2. Pendle Grit **Any two x (1) from**: • associated with land because plants washed in • high energy/fast moving currents/turbidites because graded beds/flute casts/coarse grains • submarine flow/river channel with lateral grading from meandering channel			2 2	4		4
	(c)		**Any two x (1) from**: • impermeable (Bowland Shale) beneath permeable (Pendle Grit) • water forced to the surface at interface between shale and overlying grits • proximity of a small fault		2		2		

	(d)	(i)	Trilobite (also accept pygidium but not tail) (1)	1			1		
		(ii)	1. Mode of life Use of this specimen is poor because only pygidium preserved (1) Could be benthonic, pelagic/planktonic, swimmer/ burrower/ walker (1) 2. Environment **Any two x (1) from**: • extinct group • no living relatives to compare (uniformitarianism) • only can tell that it is marine • May be a moult or broken fragment • difficult to determine energy level • may be a derived fossil			2 2	4		
			Question 4 total	**3**	**4**	**8**	**15**	**2**	**8**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
5	(a)		Anticline/Antiform/Monocline (1) Plunging SW (1)		2		2		2
	(b)		Syncline drawn to west (1) Plunging SW (1)		2		2		2
	(c)		**Any two x (1) from**: • incorrect • 1 km = half wavelength measured between APT shown • wavelength approximately 2km • need 2 peaks or 2 troughs to measure distance			2	2		2
			Question 5 total	**0**	**4**	**2**	**6**	**0**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
6	(a)		**Any four x (1) from**: • underlain by Bowland Shale Group (1) • Bowland Shale Group impermeable (1) • underlain by Boulder Clay (1) • Boulder Clay impermeable (1) • reference to dam foundations (1) • bedrock is strong (1) • stable area (1) • very little faulting in area (1) Credit other acceptable answers		4		4		
	(b)		1. Rock type Map interpretation: Permeable Pendle Grit overlies impermeable Upper Bowland Shale (1) Evaluation: High likelihood that rock type is responsible for landslide (1) 2. Dip (angle and direction) of beds Map interpretation: Beds dip into the hill/ beds have dip angle that is too shallow (1) Evaluation: Low likelihood that dip of beds is responsible for landslide (1) 3. Steepness of the slope Map interpretation: Contours close together so steep slope or Material can flow more easily down over steepened slope. (1) Evaluation: High likelihood that steepness of slope is responsible for landslide (1)			6	6		6
			Question 6 total	**0**	**4**	**6**	**10**	**0**	**6**

Section C Option 1 Quaternary Geology

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
7	(a)	(i)	Sediment changes from clastic (silt and clay) to organic rich (1)		1		1		
		(ii)	**Any three x (1) from**: • Juniper increase followed by decrease • Birch increase followed by decrease • Willow and hazed constant values • Any quantification of % • Any quantification of depth	3			3		
		(iii)	**Any two x (1) from**: • Climate warmed therefore trees could grow in greater abundance • Longer growing season • Juniper- pioneer species • Soils/cover improved birch takes over • Vegetation succession		2		2		
	(b)	(i)	$\frac{120}{11750}$ (1) x 100 (1) 1.0 or 1.02 [%] (1)		3		3	3	3

		(ii)	**Any three x (1) from**: • ^{14}C dating accurate • small ~ 1% uncertainty • short half-life (5,730 year) • within the age limits of dating by this technique • plenty of organic material to date • limitations – contamination, variations in production of ^{14}C by cosmic rays • not useful for silt/clay- no organic material			3	3		
			Question 7 total	**3**	**6**	**3**	**12**	**3**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
8	(a)		**Any two x (1) from**: • Moraine / till present • corrie • ice-scratched rocks • arête • pyramidal peak	2			2		
	(b)	(i)	In the base of a corrie/cirque/cwm (1) Eroded/overdeepend (1)		2		2		
		(ii)	**Any two x (1) from**: • two periods of glacial deposition • terminal • recessional moraine	2			2		
	(c)		**Any three x (1) from**: • high on the mountains • above 700 m contour • south-facing slope • edge of frost-shattered boulders • E-W trend • northern part of area	3			3		
	(d)		**Any three x (1) from**: • ice in Cwm Cau with periglacial conditions higher than ice limit • at the same time • periglacial conditions may have existed after glacial conditions • when ice had melted as climate ameliorated			3	3		3
			Question 8 total	**7**	**2**	**3**	**12**	**0**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
9			**Indicative content:** • Eccentricity ~ 40k cycle relating to shape of Earth's orbit around the Sun • Obliquity ~ 40k cycle relating to angle of Earth's axial tilt • Precession ~ 26K cycle relating to the direction of Earth's axis of rotation • Cycles combine to vary the insolation/ total solar radiation received on Earth's surface • Cycles combine to vary the extremeness of seasonality • Low seasonality causes summer insolation minima and vice-versa • Low seasonality tends to generate cooler climates (glacials) and vice-versa • Summer insolation minima favoured by low obliquity, high eccentricity with northern hemisphere summers at aphelion • Summer insolation maxima favoured by high obliquity, high eccentricity with northern hemisphere summers at perihelion **5-6 marks:** A thorough understanding of the **three** Milankovitch cycles including an explanation of how **each of** eccentricity, obliquity and precession are caused. Explanations of how **each of** the three causes of Milankovitch cycles trigger climatic fluctuations. *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.*	6					

			3-4 marks: A sound understanding of **at least two** of the Milankovitch cycles including some explanation of how **two** of eccentricity, obliquity and precession are caused. Explanations of how **at least two** of the causes of Milankovitch cycles trigger climatic fluctuations. *The candidate constructs a coherent account including many of the key elements of the indicative content and little irrelevant material. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.* **1-2 marks:** A partial understanding of **one or more** of the Milankovitch cycles including some explanation of how **one or more** of eccentricity, obliquity and precession are caused. Explanation of how **at least one** of the causes of Milankovitch cycles trigger climatic fluctuations. *The candidate attempts to link at least two relevant points related to at least one Milankovitch cycle in the indicative content. Coherence is limited by omission and/or inclusion of irrelevant material. There is some evidence of appropriate use of scientific conventions and vocabulary.* **0 marks:** *The candidate does not make any attempt or give an answer worthy of credit.*						
			Question 9 total	**6**	**0**	**0**	**6**	**0**	**0**

Section C Option 2 Evolution of Britain

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
10	(a)		Inclination gets steeper towards the poles or vive-versa (1) In the northern hemisphere inclination direction is into the ground whereas in the southern hemisphere inclination direction is out of the ground (1)	2			2		
	(b)		Tan L = 0.5 Tan 50 (1) L = Tan^{-1} (0.5 x Tan 50) (1) 31^{o} S (1)		3		3	3	3
	(c)		Sequences are both marine because they contain marine fossils (1) North Wales sequence is deep marine because of the presence of turbidites/ graptolites/ black shales/ pillow lavas (1) Shropshire sequence is shallow marine because of the presence of limestone/ coral/ brachiopod/ trilobite (1)			3	3		
	(d)	(i)	Correct position of line approximate NE-SW trend (1)	1			1		
		(ii)	Palaeomagnetism – Wales and Scotland once separated but now together (1) Fossils - separate provinces / benthos cannot cross but now together(1) Deep ocean sediments – deep oceanic area existed between continental shelves (1)		3		3		
			Question 10 total	**3**	**6**	**3**	**12**	**3**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
11	(a)	(i)	**Any three x (1) from**: • adjacent to upland/highland areas • majority located adjacent to HBF • located in alluvial plain • 10-50 km in length/width	3			3		
		(ii)	Credit up to two marks from **one** piece of evidence: Conglomerates (1) - high energy / flash floods / high degree of erosion (1) or Poorly sorted (1) - indicates rapid deposition on losing energy (1) or Cross bedded sandstones (1) - deposited by currents (1) or Few mudstones (1) - high energy (1) or Absence of fossils (1) - low preservation potential/ hostile environment (1) or Cyclic sedimentation (1) - wet-dry seasons/ flash foods (1)		2		2		
		(iii)	Use of cross bedding/ asymmetric current ripples/ imbrication (1) Correct identification of current direction (1)	2			2		

	(b)	(i)	Fining upwards/ A is coarser than B (1) Decrease in depositional energy (1)	2			2		
		(ii)	**Any three x (1) from**: • conglomerate too coarse to be aeolian • cross bedding may be aeolian or fluvial (difficult to determine in approx 1m thick beds • fine grained sediments too fine to accumulate under aeolian condtions • erosive base likely to be caused by river channel erosion • fining-upward likely to be due to migration of river channel • fine-grained sediments due to deposition on flood plain			3	3		3
			Question 11 total	**7**	**2**	**3**	**12**	**0**	**3**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
12			**Indicative content:** • Extrusion of plateau basalts • Intrusion of gabbroic plutonic complexes • Intrusion of dyke swarms (with NW-SE trend) • Ring complexes • Intrusion of much rarer granite plutons • Prodigious igneous activity associated with opening of Atlantic/ hot spot/ new spreading centre • Decompressional partial melting of mantle peridotite • Tensional stress field trending NE-SW • Origin of more silicic magma due to fractionation or partial melting of basement rocks by large volumes of mafic melt **5-6 marks:** A thorough understanding of **at least three** of the Paleogene igneous bodies and associated rock types (plateau basalts, gabbroic plutons, dyke swarms, ring complexes, granite plutons) in NW Britain. A clear explanation of the various modes of generation of **at least three** of the Paleogene igneous bodies and associated rock types as the Atlantic Ocean opened. *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.* **3-4 marks:** A sound understanding of **at least two** of the Paleogene igneous bodies and associated rock types (plateau basalts, gabbroic plutons, dyke swarms, ring complexes, granite plutons) in NW Britain. Some attempt at an explanation of the mode of generation of **at least two** of the Paleogene igneous bodies and associated rock types with	6					

			some understanding of their link to the opening of the Atlantic Ocean. *The candidate constructs a coherent account including many of the key elements of the indicative content and little irrelevant material. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.* **1-2 marks:** A partial understanding of **at least two** of the Paleogene igneous bodies or rock types (plateau basalts, gabbroic plutons, dyke swarms, ring complexes, granite plutons) in NW Britain and their link to the opening of the Atlantic Ocean. Some attempt at an explanation of **at least one** of the Paleogene igneous bodies. *The candidate attempts to link at least two relevant points from the indicative content. Coherence is limited by omission and/or inclusion of irrelevant material.* **0 marks:** *The candidate does not make any attempt or give an answer worthy of credit.*						
			Question 12 total	**6**	**0**	**0**	**6**	**0**	**0**

Section C Option 3 Geology of the Lithosphere

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
13	(a)		→ ← (1)		1		1		
	(b)	(i)	Ophiolite (1)	1			1		
		(ii)	**Any two x (1) from**: • previous oceanic lithosphere/crust • ocean closed • oceanic lithosphere/crust subducted/obducted • thrusted/uplifted onto marine sediments/continental crust	2			2		
	(c)	(i)	1 being located in the furthest eastern wedge; 4 adjacent to wedge 5 (1)		1		1		
		(ii)	**Any two x (1) from**: • sediment from ocean floor/trench • too low density to subduct/'chokes' subduction zone • scraped off subducting plate • onto overriding continental plate margin	2			2		
		(iii)	**Any two x (1) from**: • wide range of folds • reverse/thrust faults • nappes	2			2		

	(d)		**Any three x (1) from**: • all magmas appear to originate in oceanic crust • partial melting of oceanic crust could produce andesite • assimilation of country rock by primary magma could change composition • magma 3 more likely to be affected by this process • fractional crystallisation of primary magma could change composition • magma 1 partial melt possibly more silicic and vice-versa			3	3		
			Question 13 total	**7**	**2**	**3**	**12**	**0**	**0**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
14	(a)		200km: 30s (accept 28-32s) (1) 565 km: 77s (accept 74-78s) (1)	2			2		2
	(b)		**Any three x (1) from**: • velocity increases as P waves enter mantle • velocity increases from 6.5 to 8.1 km/s • mention of total internal reflection/ critical angle • velocity increase due to increased rigidity/incompressibility (*cf.* density) • reverse holds true as P wave refracts up to seismograph station		3		3		
	(c)	(i)	260 [km] (accept 234-286) (1)	1			1		1
		(ii)	Use the candidates answer to c (i) Use of velocities 8.1 and 6.5 (1) Substitution correct= 260/2.√[(8.1-6.5)/(8.1+6.5)] (1) Correct answer to 2 or 3 sig fig i.e. 43 or 43.0 [km] (1)		3		3	3	3
	(d)		Location A (1) Credit statements which justify A or discount other locations as follows **Any two x (1) from**: • A is a craton/ weathered-eroded continental crust and is expected to be approximately 40 km • too thick to be oceanic crust so not B (5-10km)/too thick to be oceanic crust at hot spot D (10-20km) • too thin for orogenic belt/ continental-continental collision/ crustal thickening/ average expected to be 50-70 km			3	3		
			Question 14 total	**3**	**6**	**3**	**12**	**3**	**6**

Question			Marking details	Marks available					
				AO1	AO2	AO3	Total	Maths	Prac
15			**Indicative content:** • Oceanic lithosphere thinnest at oceanic ridges and thickens progressively to plate margins • Oceanic lithosphere defined at 1300^{o}C isotherm • Oceanic lithosphere increases in age away from ocean ridge • Heat transferred from oceanic lithosphere to oceans leading to cooling of oceanic lithosphere • Conduction of heat energy through the lithosphere • Older oceanic lithosphere has lost more heat energy to the oceans • Leading to depression of the 1300^{o}C isotherm • Hence the thickening of the older oceanic lithosphere away from the oceanic ridge **5-6 marks:** A thorough understanding of the reasons for the variation in the thickness of the oceanic lithosphere including explanations that relate to **all** three causes of thickness variation (thermal structure, cooling history, age). *The candidate constructs a relevant, coherent and logically structured account including all key elements of the indicative content. A sustained and substantiated line of reasoning is evident and scientific conventions and vocabulary are used accurately throughout.*	6					

			3-4 marks: A sound understanding of the reasons for the variation in the thickness of the oceanic lithosphere including explanations that relate to **at least two** of the three causes of thickness variation (thermal structure, cooling history, age). *The candidate constructs a coherent account including many of the key elements of the indicative content and little irrelevant material. Some reasoning is evident in the linking of key points and use of scientific conventions and vocabulary is generally sound.* **1-2 marks:** A partial understanding of the reasons for the variation in the thickness of the oceanic lithosphere including explanations that relate to **at least one** of the three causes of thickness variation (thermal structure, cooling history, age). *The candidate attempts to link at least two relevant points from the indicative content. Coherence is limited by omission and/or inclusion of irrelevant material. There is some evidence of appropriate use of scientific conventions and vocabulary.* **0 marks:** *The candidate does not make any attempt or give an answer worthy of credit.*						
			Question 15 total	**6**	**0**	**0**	**6**	**0**	**0**