OCR
Oxford Cambridge and RSA

GCE

Geology

Unit **H014:** Geology

Advanced Subsidiary GCE

Mark Scheme for June 2018

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

Annotations

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

Annotation	Use
BP	Blank page
BOD	Benefit of Doubt
CON	Contradiction
	Cross
	Tick
L1	Level 1 answer in Level of Response question
L2	Level 2 answer in Level of Response question
L3	Level 3 answer in Level of Response question
I	Ignore
ECF	Error Carried Forward
^	Omission mark
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
MR	Maximum Response

Subject Specific Marking Instructions

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

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

You should ensure that you have copies of these materials.

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

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

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

Question			Answer	Mark	Guidance	AO
21	(a)	(i)	3.0 g cm^{-3} **OR** 2.99 g cm^{-3} **OR** 2.98 g cm^{-3} ✓	2	**ALLOW** calculations of mean mass and mean volume to provide density. e.g. {(210.2/70.3)+(267.6/89.2)+(183.9/61.7)+(80.5/27.2)} ÷ 4 = (2.99+3.00+2.98+2.95) ÷ 4 = 2.98 g cm^{-3} (2 dp) or 3.0 g cm^{-3} (1dp) e.g. (210.2+267.6+183.9+80.5) ÷ (70.3+89.2+61.7+27.2) =2.99 g cm^{-3} (2dp) 3.0 g cm^{-3} (1dp) **ALLOW** one mark for working if incorrect answer given **DO NOT ALLOW** 3 dp answers **DO NOT ALLOW** 3 g cm^{-3}	2.1b
		(ii)	3000 kg m^{-3} **OR** 2990 kg m^{-3} **OR** 2980 kg m^{-3} ✓	1	**ALLOW** ecf from part (i)	2.1b
	(b)		gabbro ✓ slow cooling **AND** cooled at depth **OR** plutonic **OR** in a batholith ✓	2	**ALLOW** diorite **ALLOW** any correct tectonic setting such as ocean ridges. **ALLOW** any appropriate specific depth	2.1a 3.1a
	(c)		answer between 2.25% and 2.35% ✓ Any **two** from: density of Rock B is 135.5÷48.4= 2.80 (student 2) and 88.9÷32.7= 2.71 (student 4) ✓ difference in observations is 3.000 – 2.949 = 0.051 (A), 2.800 – 2.719 = 0.081 (B) ✓ average percentage difference is the mean of 0.051÷3.000 = 1.700% and 0.081÷2.800=2.893% ✓	3	**max 2** if not 3 sf **ALLOW** one mark for working. e.g. Method involving calculating density for A and B for both students; calculating % difference between students' results	2.1b

Question			Answer	Mark	Guidance	AO
	(d)		Any **three** from: first measurement rock is dry / contains no water ✓ subsequent measurements rock contains some water in pore spaces ✓ over time more water enters the rock ✓ air is being displaced by water ✓ density of water is greater than that of air ✓	3		3.1e
	(e)		Any **two** from: repeats of measurements ✓ balances calibrated ✓ balances with higher resolution ✓ vacuum immersion of samples (**E**) ✓ leave to soak for a long time before displacement measured ✓ larger specimens and displacement vessels ✓	2	**AW** **ALLOW** drying out samples before repeating test	3.1f
	(f)		Any **two** from: mineral composition variation ✓ decreased porosity due to compaction / diagenesis **OR** metamorphism / recrystallization ✓ increased porosity due to fractures / joints / foliation / vesicles / amygdales / weathering ✓	2	**max 1** mark for general statement about porosity **max 1** mark for any two factors listed, with no link to porosity changes **DO NOT ALLOW** changes in sample size again	3.1a
	(g)	**(i)**	rhyolite ✓	1	**ALLOW** pumice	1.1a

Question			Answer	Mark	Guidance	AO
		(ii)*	**Level 3 5 – 6 marks** Applies detailed knowledge and understanding of geophysical and surface measurements to the prediction of eruptions. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated* **Level 2 3 – 4 marks** Demonstrates knowledge and understanding of a geophysical and a surface measurement relevant to the prediction of eruptions. Explains how measurements are relevant to the prediction of eruptions. *There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence* **Level 1 1 – 2 marks** Demonstrates knowledge of geophysical or another surface measurement relevant to the prediction of eruptions. *There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.* No response or no response worthy of credit **0 marks**	6	**Diagrams marked as text** **Indicative points include:** *A01.1b Demonstrate knowledge of geological skills and techniques* **Geophysical measurements:** • harmonic tremors, magma movement in conduits and vents • microseismic short-period events, intruding magma fracturing rock • geodetic measurements such as GPS or tiltmeters, ground surface changes • satellite remote sensing such as SLAR, thermal infrared multispectral scanner and spectrometry *A01.1c Demonstrate understanding of geological ideas* **Surface measurements:** • composition of erupting material, such as phreatic to magmatic • composition and volumes of gases (at fumaroles) • chemistry of surface runoff or groundwater • volumes and frequency of steam emissions • infrared photometers • ground surveys such as levelling or tiltmeters *A02.1a Apply knowledge and understanding of geological ideas* **Predicting volcanic eruptions:** • changes in seismic activity indicating change from filling magma chamber to active upward intrusion • changes in surface slow swelling and sudden drops associated empting of magma chamber • changes in composition gasses/erupted material/chemistry associated with magma front	1.1b 1.1c 2.1a

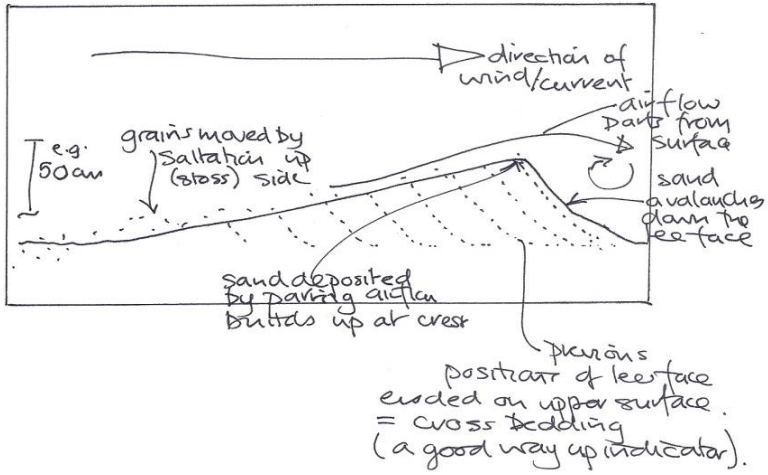
Question			Answer	Mark	Guidance	AO
					• possible case study examples such as Bárðarbunga 2014-15 or Kilauea 2018	
			Total	**24**		

Question			Answer	Mark	Guidance	AO
22	**(a)**	**(i)**	shadow zones ✓	1		1.1a
		(ii)	Any **two** from: seismic wave velocity changes due to changing incompressibility / rigidity / density ✓ changes in velocity result in wave refraction ✓ at the liquid outer core there is a decrease in wave velocity ✓ waves are focussed inwards / refracted more steeply resulting in the shadow zones ✓	2	**IGNORE** answers based on S-wave shadow zones **max 1** for general statement linking refraction to change in state from solid to liquid	1.1c
		(iii)	change of state from liquid (outer core) to solid (inner core) ✓	1	**ALLOW** increase in incompressibility **OR** rigidity	2.1b
	(b)	**(i)**	0.125 **OR** 12.5% **OR** $^1/_8{}^{th}$ ✓ correct working ✓	2	volume of core is $^4/_3 \times \pi \times (^r/_2)^3 = (^4/_3 \times \pi \times r^3) \, /_8 = \, ^1/_8{}^{th}$ of whole Earth volume of Earth is $^4/_3 \times \pi \times 6371^3 = 1.08 \times 10^{12}$ km^3, **AND** volume of core is $^4/_3 \times \pi \times 3185.5^3 = 1.35 \times 10^{11}$ km^3 $\frac{1.35 \times 10^{11}}{1.08 \times 10^{12}} = 0.125$ **ALLOW** 17% / 16.7% / $^1/_6{}^{th}$ using depth to Gutenberg Discontinuity (i.e. core radius = 6371km – 2900km = 3471km = is $^4/_3 \times \pi \times 3471^3 = 1.75 \times 10^{11}$ km^3) **ALLOW** one mark for evidence of correct working if incorrect answer given	2.1a
		(ii)	Any **two** from: low surface density suggests high density for the interior ✓ density of interior must be greater than 5500 kg m^{-3} ✓ mantle rocks increase in density with depth / as	3	**ALLOW** any attempt to calculate it e.g. .125(x) + 0.875 (3000) = 5500 x = 23 000 kg m^{-3} **OR** x = 18 625 kg m^{-3}	3.1a

Question			Answer	Mark	Guidance	AO
			pressure rises ✓ density increase due to a change in composition / change from silicates to iron ✓ the small volume of the core implies a very high density to account for the average density of the Earth ✓			
	(c)		**Level 3 5 – 6 marks** Shows a detailed knowledge and understanding of the properties of the asthenosphere clearly described and explained clearly linked to plate tectonics. Makes a clear evaluation of the evidence important to plate tectonics. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 3 – 4 marks** Demonstrates knowledge and understanding of the properties of the asthenosphere and explains the links to plate tectonics. Shows understanding of the terms and gives some evidence for the properties. Makes some evaluation of the evidence important to plate tectonics. *There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.* **Level 1 1 – 2 marks** Demonstrates knowledge of the properties of the asthenosphere and describes some evidence for this **OR** outlines the limited relevance to plate tectonics.	6	**Indicative scientific points include:** *A01.1a Demonstrate knowledge of geological ideas* **Asthenosphere as a rheid layer:** • deforms as a plastic solid in response to stress • viscous non-molten solid, below its melting point • deforms at a rate at least three times that of an elastic solid *A01.1c Demonstrate understanding of geological ideas* **Evidence for rheid behaviour of the Asthenosphere:** • postglacial isostatic rebound of Scandanavia / Scotland • gravity anomalies indicating mountains chains in isostatic equilibrium • gravity anomalies indicating oceanic islands (such as Hawaii) are not in isostatic equilibrium • Low Velocity Zone (LVZ) operates between 5 and 300 km depth (depths vary and are not critical) • geotherm close to / overlap the peridotite melting curve. • 1-5% melt is enough to slow P-waves and (especially) S-waves *A02.1a Apply knowledge and understanding of geological ideas* *A03.1c* Evaluate geological information, ideas and evidence **Importance of rheid behaviour to plate tectonics:** • ductile 'weak' zone allows relative movement of the rigid lithospheric plates. • allows slab pull and (a minor amount of) ridge push • 5% partial melting acts as source of magma for oceanic crust production by intrusion, extrusion and eruption at	1.1a 1.1c 2.1a 3.1c

Question			Answer	Mark	Guidance	AO
			There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant. **0 marks** *No response or no response worthy of credit*		Oceanic Core Complexes (OCC) and Mid-Ocean Ridges (MOR) • negative density contrast with Lithosphere important for allowing subduction to take place	
			Total	**14**		

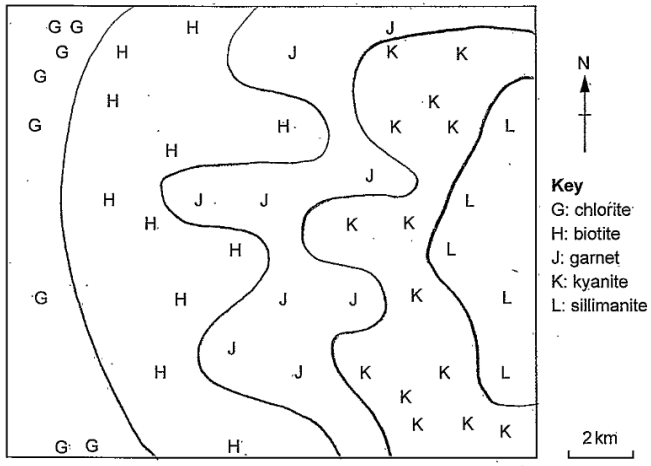
Question			Answer	Mark	Guidance	AO
23	(a)	(i)	Rock **Y**: mean grain size 0.25 – 0.5 mm ✓ (very) well sorted ✓ (well) rounded ✓ Rock **Z**: largest grain diameter >3.5mm – 5mm ✓ (very) poorly sorted ✓ (sub-) angular ✓	max 3	2 / 3 correct = 1 4 / 5 correct = 2 6 correct = 3 **DO NOT ALLOW** other descriptive terms for sorting and grain shape **DO NOT ALLOW** any measurements without units	1.1a 2.1b
		(ii)	glacial ✓	1	**ALLOW** fault plane **OR** talus / scree slope **OR** wadi **OR** alluvial fan **OR** river / alluvial **OR** deep marine / abyssal plain	2.1a
	(b)		Any **two** from: immature sediment results from lack of weathering **OR** has not been transported far ✓ mature sediments result from prolonged weathering / transport ✓ In immature sediments (chemically) unstable minerals **OR** (physically) weak minerals can be found ✓ mature sediments only contain resistant minerals (e.g. quartz) ✓ Any **two** from: rock **Z** contains clay minerals which are weak and easily broken down ✓ rock **Z** contains rock fragments which will breakdown into smaller / mono-mineralic fragments ✓ rock **Z** grains are angular and show little evidence of transport ✓ rock **Y** has well rounded grains, evidence of prolonged transport ✓ rock **Y** only has strongest/chemically stable minerals (quartz) as other minerals break down during transport ✓	4		1.1a 2.1a
	(c)	(i)	(continental) <u>desert</u> ✓	1	**ALLOW** aeolian / wind-blown	1.1c

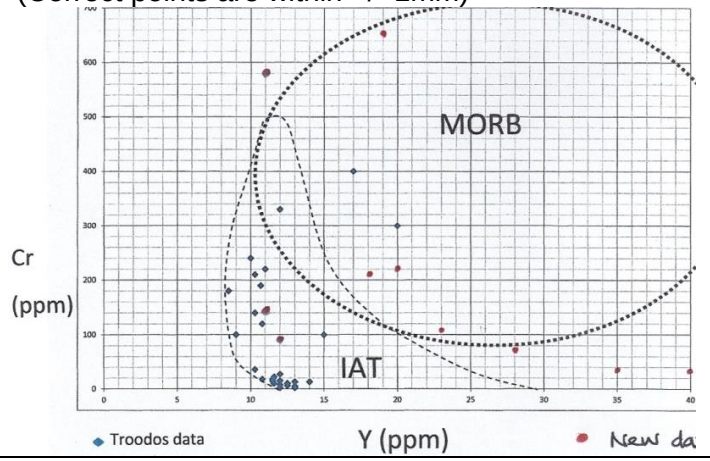
Question			Answer	Mark	Guidance	AO
		(ii)	Recognisable diagram with min **two** labels ✓ Diagram fully labelled including: asymmetrical dune profile at appropriate angles **AND** wind/current direction **AND** indication of cross bedding correctly orientated at correct angle ✓ **ANY** 4 points from: sand carried (by saltation) up stoss / windward / gently inclined face ✓ sand eroded from stoss / windward / gently inclined face ✓ sand deposited / avalanches down lee/steep face ✓ coarser grains on surface of the flow mark out the cross beds ✓ cross beds show former position of lee slope / face of dune ✓ cross bedding is steep / angle of rest in air / 37^{o} at top ✓ cross-bedding is concave up / flattens out at base ✓	1 1 2	 2 / 3 points = 1 mark 4 points = 2 marks **ALLOW** annotation as text for explanation 2 / 3 explanatory points = 1 mark 4 explanatory points = 2 marks	1.1a 1.1c
	(d)	**(i)**	Any t**wo** from: desiccation cracks result from drying out of mud ✓ formed in playa / ephemeral lakes ✓ require high rates of evaporation ✓ mud contracts as it dries forming (polygonal) cracks ✓ v-shaped as evaporation taking place at surface ✓ preserved by infilling with sediment ✓	2		1.1a 1.1c
		(ii)	Any **one** from: graphic log shows this as a mudrock ✓ mudrocks contain high proportion of clay minerals ✓ only clay minerals shrink as they dry ✓	1		3.1a

Question			Answer	Mark	Guidance	AO
	(e)		Any **one** from: flash flood event (in mountains / wadis) ✓ flash floods move a range of material✓ Any **one** from: large pebbles / cobbles / boulders are supported in muddy suspension ✓ material kept in suspension by rapid flow in mountain valley / wadi ✓ poorly sorted material as rapidly deposited ✓ as water spreads out / slows down / loses energy ✓ referred to as wadi gravels / conglomerates ✓ these deposits create an alluvial fan ✓	2	**MAX** 1 for coherent description of turbidite deposition if environment taken as deep water marine.	2.1a
			Total	**18**		

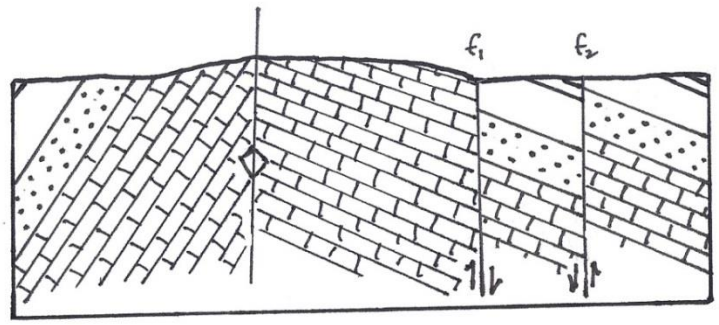
Question			Answer	Mark	Guidance	AO
24	(a)	(i)	it must be a lava (flow) **OR** extrusive **OR** erupted at the surface ✓	1		1.1c
		(ii)	vesicles ✓ Any **two** from: pressure decreases / drops (as magma is erupted) causing exsolution of gases / volatiles ✓ gases rise as bubbles to the top ✓ rapid cooling 'freezes' / traps some of the vesicles in this upper surface ✓	3	**ALLOW** gas comes out of solution AW	1.1a 1.1c
	(b)	(i)	1. It is a <u>sill</u> **AND** it is injected between beds at depth/not exposed at the surface to be weathered **OR** It is a <u>sill</u> **AND** it is injected between beds at depth/under pressure so no vesicles can form ✓ 2. It is a <u>sill</u> **AND** in the forceful injection of magma between beds, pieces of both beds can be ripped off and incorporated in the magma **OR** reverse argument that a lava flow can only incorporate xenoliths from the rock beneath it as there is no rock above it before cooling ✓	1 1	**ALLOW** 1 max if two good points, but no mention of "sill".	1.2a 2.1a
		(ii)	Any **four** from: at the contacts with the cold sedimentary rocks cooling would be rapid ✓ rapid cooling of magma caused <u>fine</u> crystal formation ✓	4	**DO NOT ALLOW** small / smaller **OR** big / bigger for crystal grain size	2.1a

Question			Answer	Mark	Guidance	AO
			there are chilled margins in rock K at the contacts ✓ the centre of the igneous body cools more slowly than the margins ✓ slower cooling of magma results in <u>coarser</u> crystals ✓ the sill/rock **K** is insulated by the depth at which it is intruded ✓			
	(c)		the sedimentary rock may change colour **OR** be harder/indurated **OR** be less permeable **OR** be crystalline ✓ baked margins have resulted from the heat of the igneous rock **OR** the sedimentary rock has been metamorphosed/re-crystallised by the heat of the igneous rock ✓	2	**ALLOW** formation of hornfels / andalusite slate / spotted rock / metaquartzite	2.1a
			Total	**12**		

Question			Answer	Mark	Guidance	AO
25	(a)	(i)	4 smooth, sub-parallel contours drawn around first appearances ✓✓	2	2 / 3 contours correct = 1 mark 4 contours correct = 2 marks **1 max** if drawn contours just join points  	2.1a 2.1b
		(ii)	Any **two** from: index minerals only exist at certain temperatures and pressures / are stable under specific pressure and temperature conditions ✓ metamorphism / recrystallization of clay minerals forms index minerals ✓ the <u>first appearance</u> of the index mineral is mapped ✓	2	**ALLOW 1 max** for idea that chlorite is lowest grade and sillimanite is highest grade	1.1c
		(iii)	east of map area ✓	1	**DO NOT ALLOW**: (from the) right	3.1b
			Total	**5**		

Question			Answer	Mark	Guidance	AO
26	(a)	(i)	Any **three** from: divergent margins are associated with upwelling of mantle ✓ hot rising convection currents cause partial melting ✓ temperature of mantle approaches solidus / melting point ✓ slab pull **OR** diverging plates reduces pressure on rocks below✓ pressure release / lower pressure causes partial melting ✓ low density of melt and hot mantle holds up ridge ✓	3		1.1c
		(ii)	Any **two** from: they offer easy inspection/sampling of oceanic lithosphere / crust / plate ✓ ophiolites show the structure / composition of oceanic lithosphere ✓ oceanic lithosphere is usually destroyed by subduction ✓ oceanic lithosphere is difficult / impossible to sample by drilling✓ ophiolites help in the understanding of the sea-floor spreading process ✓ ophiolites form from obduction / thrusting onto land ✓	2		2.1b
	(b)	(i)	Points correctly plotted ✓✓	2	8 or more points correct = 2 marks 5 to 7 points correct = 1 mark (Correct points are within +/- 1mm) 	2.1b

Question			Answer	Mark	Guidance	AO
		(ii)	most of the Troodos data lie in the IA field ✓	1	**ORA**	3.1d
		(iii)	MOR field = 40% ✓ IA field = 20% ✓	2		3.1a
26	(b)	(iv)	Any **two** from: the new ophiolite setting is different / distinguishable from the Troodos setting ✓ new data generally lies outside the IA field / is not wholly island arc **OR** new data has more association with the MOR field / more ocean ridge setting ✓ new data has generally higher Y concentrations ✓ Troodos data lie principally within the IA field ✓ Any **three** from: the Troodos data show the method to be worthwhile ✓ 40% of new data lie outside either field ✓ there is a limited range of Y values/only 10 to 40 ppm so ✓ there is a very large range of Cr values ✓ experimental error has not been stated ✓ errors at such low concentrations could lead to mis-interpretation of setting ✓ there are only 10 values for the new ophiolite ✓ the new data may not be representative of the ophiolite / no information on samples used ✓ points for the new ophiolite have a greater spread / lower precision / no apparent trend ✓ there is overlap between the two sets of data so can't be distinguished ✓	2 3	ORA **ALLOW** these data would be better plotted on a log-log graph;	3.1b 3.1c 3.1d
			Total	**15**		

Question			Answer	Mark	Guidance	AO
27	(a)	(i)	downthrows correctly marked on both faults (E of f1 and W of f2) ✓	1		3.1a
		(ii)	graben ✓	1	**ALLOW** rift **OR** rift valley **ALLOW** horst as ecf from a(i)	3.1a
	(b)	(i)	2 faults showing correct downthrow to allow coal outcrops ✓ antiform with steeper dip on western limbs ✓ constant thickness of beds on W and E limbs of fold ✓	3	 Beds must be recognisable/contain decoration similar to map otherwise **MAX** 1 mark for dips **OR** faults correct	3.1a 3.1d
		(ii)	unconformable / unconformity ✓ Any **two** from: dips are steeper in underlying rocks ✓ dips are in a different direction in underlying rocks ✓ contact cuts across more than one rock type **OR** Triassic cuts across the Carboniferous ✓ contact cuts off / across faults ✓	1 2	**ALLOW** correct explanation of unconformity without use of term **ORA**	2.1a 3.1a
		(iii)	tensional ✓	1	**ALLOW** extensional **OR** tension **ALLOW** compressional **OR** compression	1.1c
		(iv)	compressional ✓	1	**ALLOW** compression	1.1c
		(v)	different tectonic forces affected the area at different times ✓	1	**DO NOT ALLOW** ecf from (b) (iii) and (iv) if both are the same	2.1a

Question			Answer	Mark	Guidance	AO
	(c)		Any **two** from: plunging (to the north) ✓ antiform ✓ asymmetrical ✓ N-S axial plane **OR** limbs dipping East and West ✓ overfold **OR** axial plane dipping east ✓ open **OR** inter-limb angle is 96º / 95º ✓	2	**ALLOW** anticline for antiform	1.1c 2.1a
			Total	**12**		

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