

## **Mark Schemes for the Units**

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**June 2009**

**3884/7884/MS/R/09**

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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.

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## **CONTENTS**

### **Advanced GCE Geology (7884)**

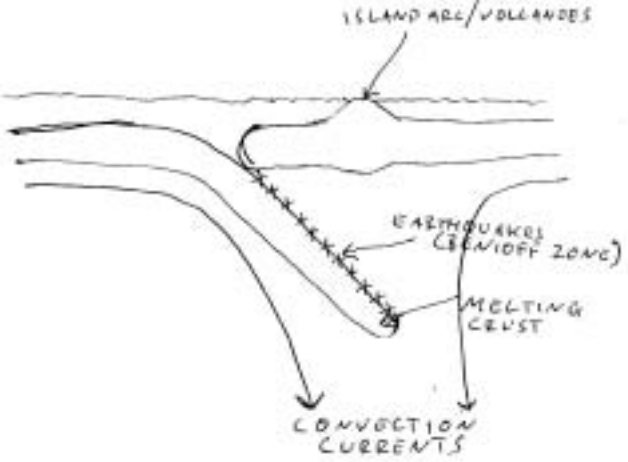
### **Advanced Subsidiary GCE Geology (3884)**

## **MARK SCHEMES FOR THE UNITS**

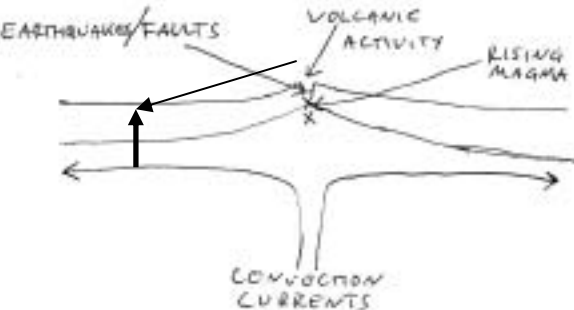
<b>Unit/Content</b>	<b>Page</b>
2831 Global Tectonics and Geological Structures	1
2832 The Rock Cycle – Processes and Products	10
2833 Economic and Environmental Geology	18
2834 Palaeontology	25
2835 Petrology	32
2836 Geological Skills	40
Grade Thresholds	46

## 2831 Global Tectonics and Geological Structures

Question			Expected Answers	Marks	Additional Guidance
1	a	i	New Zealand / Hawaii / Caribbean arc / Aleutian Islands / Rockies / Andes / East Pacific Rise / Mid Atlantic Ridge	2	any 2
		ii	<b>ocean v ocean</b> partial melting (of the subducted plate) / volcanic activity / rising magma / friction causing partial melting <b>ocean v continental</b> partial melting (of the subducted plate) / volcanic activity / rising magma / friction caused partial melting <b>constructive</b> partial melting (of the mantle) / volcanic activity / rising magma / convection currents bringing hot mantle close to the surface / where sea floor spreading is taking place <b>hot spots</b> partial melting (of the mantle) / volcanic activity / rising magma / rising mantle plume / allow because it is a hot spot	any 2	one mark max for each shaded area  because it is a MOR / divergent plate boundary is too vague  because it is a subduction zone is too vague  allow hot spot on its own
		iii	Brazil / Canadian Shield / Greenland / top of subduction zones / ocean trench / abyssal plain	1	
		iv	away from plate margin / centre of plate / <u>cold</u> convection currents / thick crust / descending convection currents / old (stable) crust / no igneous activity / no rising magma	1	

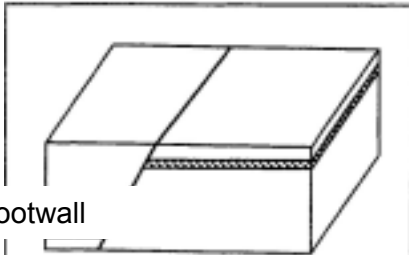
Question	Expected Answers	Marks	Additional Guidance
b i	 <p>1 mark for each correct label</p>	5	<p>earthquakes needs to be in a descending zone not just a point earthquakes need to be at the top of the subducting plate</p> <p>island arcs need to be drawn as islands and not on continental crust</p> <p>island arc and volcanoes need to be away from the trench</p> <p>if divergent drawn zero marks</p> <p>allow if one convection current <u>parallel</u> to subducting plate and sinking</p> <p>plan view max = 2</p>
	<p>ii</p> <p>friction between plates (oceanic) crust is <u>subducting</u> build up of pressure / stress (but not tension) stored (friction) energy / stress is released / pressure is released reverse (thrust) faults</p>	any 2	<p>accept build up of pressure do not accept "sinks" do not accept "tension"</p>
c	<p>cross-bracing / bird caging / <u>shear</u> walls to strengthen building / reduces torsion / reduces twisting</p> <p>flexible pipelines / electricity cables stops pipes from fracturing / stops fires</p> <p>weight on roof of tall buildings / passive damping / pendulum acts as a counterbalance as the building sways</p> <p>pyramid like structure</p>		<p>accept the name as part of the explanation</p> <p>name = 1 mark description / explanation / recognisable diagram = 1 mark max 2 for each method</p>


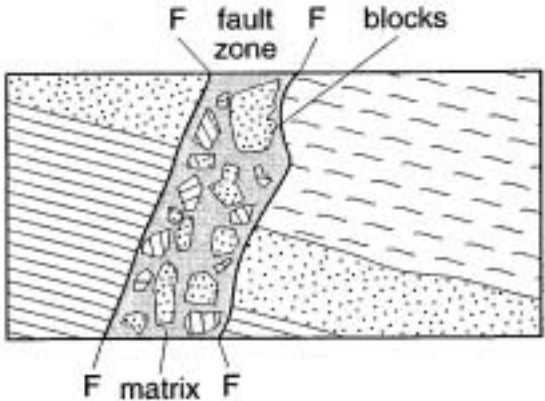
Question			Expected Answers	Marks	Additional Guidance
			<p>more stable / wider base</p> <p>flexible structure to absorb energy / allow building to sway</p> <p>base isolation / rubber / Teflon / ball bearings / rollers between building and foundations to absorb ground vibrations / to separate building from the ground / building stationary whilst ground moves</p> <p>building on a solid concrete raft / pumping in liquid cement / deeper / wider / piled foundations / strengthen building foundations / reinforced foundations provide greater support / stops shearing from foundations</p>	4	<p>shock absorbers vague so max 1 rubber foundations max 1</p> <p>general comments about reinforced concrete with steel rods = 1</p>
			<b>Total</b>	<b>17</b>	

Question	Expected Answers	Marks	Additional Guidance
2 a i	 <p>axial rift in centre labelled diverging convection currents magma rising labelled volcanoes in rift area labelled</p>	any 4	not just magma chamber within 2 mm of the rift
ii	<p>sea floor spreading ridge push slab pull injection of magma / intrusion of new material <u>pushes / forces</u> plates apart convection currents <u>diverging</u> / currents <u>pulling</u> plates <u>apart</u></p>	any 2	<p>allow description of ridge push or slab pull</p> <p>do not accept extrusive activity</p> <p>don't allow general comment on convection currents</p>

Question			Expected Answers	Marks	Additional Guidance
	<b>b</b>	<b>i</b>	<p>1 / 2 points correct = 1 3 / 4 points correct = 2 correct line = 1</p>	3	<p>use the overlay allow 1 small square in error</p> <p>line must go through the origin and join up points</p>
		<b>ii</b>	5.88 cm per year +/- 0.5cm / year (ecf) correct working	1 1	$\frac{200}{3.4} = 5.88$ $\frac{50}{0.8} = 6.25$ if distance over time suggested then 1 mark for working not just d/t
		<b>iii</b>	<u>steeper</u> gradient / <u>steeper</u> angle	1	answer must refer to the line
	<b>c</b>		ooze / chert / fine grained sediment basalt / pillow lava dolerite / dykes (sheeted) gabbro (layered)	any 3	incorrect order max=2
<b>Total</b>				<b>15</b>	



Question			Expected Answers	Marks	Additional Guidance
3	a		<b>stress</b> the <u>forces</u> acting upon a rock / the force per unit / area / pressure applied	1	if an example of tension, shear or compression = 1 unless also given for strain in which case = 0 accept example folding, faulting effect on the rock = 0
			<b>strain</b> the resultant <u>deformation</u> / <u>change in shape</u> of the rock	1	
	b	i	the rock does not change thickness when folded or deformed / likely to fracture / rocks stronger / more resistant to forces / brittle / forms joints when folded  sandstone / limestone / basalt / any igneous rocks	1  1	accept more likely to break do not accept hard  no metamorphic rocks
		ii	rock changes thickness when deformed / tends to flow rather than fracture / tends to fold rather than fracture / weaker and less resistant to forces / tends to form cleavage  shale / mudstone / clay / claystone	1  1	accept more plastic or ductile not elastic
	c	i	<b>D</b> = strike slip / tear / wrench / sinistral <b>F</b> = normal <b>G</b> = reverse / thrust	1 1 1	not transform / shear not just dip slip
		ii	 <p>footwall</p>	1	the footwall needs to be clearly on the right hand side, arrows that point to the fault gain no mark
		iii	<b>stress type</b> compression shear tension	<b>fault D, F or G</b> <b>G</b> <b>D</b> <b>F</b>	1 correct = 1 2 / 3 correct = 2
				2	

Question	Expected Answers	Marks	Additional Guidance
d i	 <p>correct diagram with at least 1 correct label = 1</p> <p>scratches / striations / grooves / gouges / gashes formed mineral growth caused by movement along the fault (plane) / in direction of movement any 2</p>	3	labels on diagram marked as text
ii	 <p>correct diagram with at least 1 correct label = 1</p> <p>brittle deformation / close to surface rocks fractured as <u>fault moves</u> / broken as the <u>fault moves</u> angular fragments finer material (matrix) forms as rock is crushed any 2</p>	3	labels on diagram marked as text diagram not just a breccia
	<b>Total</b>	<b>18</b>	

Question			Expected Answers	Marks	Additional Guidance
4			<b>mantle</b> upper part of upper mantle is part of the lithosphere asthenosphere within the upper mantle / below the lithosphere rest of upper mantle below the asthenosphere lower mantle below the upper mantle any 2 = 1 mark	1	need depth, state and composition for 4 need 2 marking points for 1 mark  accept LVZ / low velocity zone for asthenosphere
			mantle starts between 7 and 90 km / 30 km depth on average moho forms the crust mantle boundary asthenosphere 70 – 250 km / 70 km from 670–2900 km is lower mantle / 670 km Gutenberg discontinuity between core and mantle any 2 = 1 mark	1	need 2 marking points for 1 mark  accept LVZ / low velocity zone for asthenosphere  credit Gutenberg once in mantle or core section
			lithosphere is solid asthenosphere is (5%) partially molten / rheid rest of mantle is solid / mantle is <u>mainly</u> solid any 2 = 1	1	need 2 marking points for 1 mark  accept LVZ / low velocity zone for asthenosphere
			all ultrabasic / peridotite / silicate / olivine rich / ultramafic / mafic minerals / ferromagnesian minerals	1 max 4	
			<b>core</b> Gutenberg discontinuity between the mantle and outer core Lehman discontinuity between outer and inner core	any 1	need depth, state and composition for 4 credit Gutenberg once only
			liquid outer core and solid inner core (need both)	1	
			2900–5000 km for the outer core / 2900 km 5000–6371 km for the inner core / 5000–5150 km	any 1	allow between 5000 and 5150 km for outer core / inner core boundary
			core mainly Ni, Fe,	1 max 4	accept S and Si as additional elements
			<b>Total</b>	<b>8</b>	

**Quality of Written Communication**

- 2 marks      **(technical terms)** Answers are structured clearly and logically, so that the candidate communicates effectively, uses a wide range of specialist terms with precision and spelling, punctuation and grammar are accurate.
- 1 mark      **(organisation)** There are shortcomings in the structure of the answer, however, the candidate is able to communicate knowledge and ideas adequately, a limited range of specialist terms are used appropriately and spelling, punctuation and grammar are generally accurate with few errors.
- 0 marks      There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar, which makes the candidate's meaning uncertain.

**[quality of written communication max 2]**

				<b>Total</b>	<b>10</b>	
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## 2832 The Rock Cycle – Processes and Products

Question		Expected answers	Marks	Additional Guidance
1	(a)	<p><b>A</b> = sedimentary</p> <p><b>B</b> = metamorphic</p> <p><b>C</b> = metamorphic / sedimentary      <b>D</b> = igneous</p> <p>4 or 3 correct = 3, 2 correct = 2, 1 correct = 1</p>	3 max	<p><b>A</b> allow correct clastic rock conglomerate / breccia / sandstone</p> <p><b>B</b> allow slate / schist / gneiss</p> <p><b>C</b> allow marble / limestone / orthoquartzite / metaquartzite / quartzite</p> <p><b>D</b> allow any named igneous rock</p> <p>NOT contradictory rock types</p>
	(b) (i)	<p>clastic = composed of clasts / particles / pieces / grains / of pre existing / other rock / containing broken shells / fragments / fragmentary</p> <p>crystalline = composed of (interlocking) crystals</p>	1 1	Not 'bits'
	(ii)	<p>made of grains or crystals</p> <p>sediment that has hardened or magma that has cooled</p> <p>an aggregate of minerals</p> <p>a mixture of minerals</p> <p>naturally occurring substance composed of mineral/s</p>	any 1	
	(iii)	<p>minerals subjected to directional stress / pressure during folding / mountain building / at a convergent plate boundary / during regional metamorphism</p> <p>minerals recrystallise due to effect of stress / pressure</p> <p>minerals align with long axis perpendicular / 90° to stress direction / pressure</p> <p>minerals must be flat / platy / tabular / not equidimensional / mica</p> <p>burial beneath great thicknesses of overlying rocks / stresses applied to minerals due to mass of overlying rocks</p>	any 2	Not just 'pressure' must have reason for pressure
	(c) (i)	<p><b>E</b> = igneous</p> <p><b>F</b> = sedimentary</p>	1 1	

Question		Expected answers	Marks	Additional Guidance
	(ii)	crystalline porphyritic texture / finer groundmass / two stage cooling crystals not aligned / randomly orientated interlocking crystals / plagioclase phenocrysts / / no cement made of mafic minerals	any 2	ecf on c(i)
	(iii)	contains fossils / bioclastic cement between grains / calcite cement fragmental / clastic	any 2	ecf on c(i)
	(d)	from top to bottom on the diagram, the correct labels are: igneous metamorphic sedimentary	max 2	three correct=2 one or two correct=1
<b>Total</b>			<b>16</b>	

Question	Expected Answers		Marks	Additional Guidance																								
2 (a) (i)		<table><thead><tr><th>grain size (phi)</th><th>mass (%)</th><th>cumulative mass %</th></tr></thead><tbody><tr><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>2</td><td>2</td></tr><tr><td>2</td><td>14</td><td>16</td></tr><tr><td>3</td><td>78</td><td>94</td></tr><tr><td>4</td><td>6</td><td>100</td></tr><tr><td>5</td><td>0</td><td>100</td></tr><tr><td>6</td><td>0</td><td>100</td></tr></tbody></table>	grain size (phi)	mass (%)	cumulative mass %	0	0	0	1	2	2	2	14	16	3	78	94	4	6	100	5	0	100	6	0	100		Allow full marks even if points 5 and 6 are not plotted
grain size (phi)	mass (%)	cumulative mass %																										
0	0	0																										
1	2	2																										
2	14	16																										
3	78	94																										
4	6	100																										
5	0	100																										
6	0	100																										
	correct completion of cumulative mass all points plotted correctly / ecf for points plotted if calculation wrong joined with a smooth 's' shaped curve		1 1 1																									
	(ii) degree to which particles are the same size spread of grain size around the mean / measure of variation in grain size well sorted = all same size poorly sorted = wide range of grain sizes		any 2	accept 'same size and shape' for max 1 diagram can act as text																								
	(iii) $\frac{3.2 - 0.2}{2}$ ( $\frac{2.8 - 2.0}{2}$ ) <b>G</b> = 1.5 (+/- 0.1) <b>H</b> = 0.4 (+/- 0.1) method = 1 and answers = 2		1 2	correct method shown 1 mark even if calculations are incorrect correct answers 1 for each sediment even if no working allow e.c.f for sediment <b>H</b>																								
	(iv) <b>H</b> is better sorted than <b>G</b> <b>H</b> is well sorted and <b>G</b> is poorly sorted <b>G</b> has coefficient of 1.5 compared with 0.4 for <b>H</b> <b>G</b> has wider range of grain sizes than <b>H</b>		any 1	Allow e.c.f. from iii) If coefficient for <b>H</b> is 0.5 allow 'moderate sorting'																								

[illegible]



Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	recrystallisation/metamorphism	1	
			recrystallisation/metamorphism	1	
			magma accumulation	1	
			crystallisation	1	
		(ii)	mass / weight of overlying sediment / hydrostatic pressure / load pressure / compression fluids squeezed from pore spaces / from sediment porosity reduced / no pore spaces / close packing of grains volume reduced / thickness of sediment reduced / density increased more effective on platy / clay minerals ORA	any 2	Not just 'pressure'
		(iii)	fluids pass through pore spaces / through sediment carry minerals in solution / calcite or quartz or haematite in solution minerals precipitate in pore spaces / crystallise out / come out of solution / minerals deposited in pore spaces porosity reduced grains glued/stuck together by a named mineral most effective in sandstones	any 2	Not 'evaporated' instead of 'precipitated'
	(b)	(i)	both occur at Earth's surface / surface processes / both related to climate/ both produce rock fragments / both related to breakdown of rock	any 1	
			erosion involves transport but weathering does not / weathering occurs in place / in situ but erosion occurs due to transport / weathering is breakdown of material erosion is removal of material	any 1	
		(ii)	diagram(s) to show frost shattering / freeze–thaw weathering climate where freezing occurs at night and thaw during day water enters fractures in rock / in confined space water expands (9% by volume) on freezing / forces crack to open further when ice melts water penetrates further into fracture / repeated process cause fragments to break off	1  any 3	  diagrams marked as text
		(iii)	humid tropical / equatorial	1	NOT just tropical

Question	Expected Answers	Marks	Additional Guidance
	<p>(iv) hydrolysis = decomposition of silicate minerals and reaction with water / carbonic acid / reaction between water / carbonic acid and silicate minerals / feldspars / end products include a clay mineral / silica in solution / carbonate or bicarbonate (K, Na, Ca)</p> <p>hydration = H<sub>2</sub>O molecule added to mineral structure/ minerals expand/ clays/ feldspars often affected</p> <p>oxidation = loss of electrons / dissolved O<sub>2</sub> in rainwater / combines with metallic iron / rusty surface on oxidised rock / ferrous iron / Fe<sup>2+</sup> becomes ferric / Fe<sup>3+</sup></p> <p><b>carbonation = rainwater containing dissolved CO<sub>2</sub> becomes carbonic acid / acid water reacts with / dissolves carbonates / limestone forms soluble hydrogen carbonates /</b>  <math display="block">\text{CaCO}_3 + \text{H}^+ + \text{HCO}_3^- \rightarrow \text{Ca}^{2+} + 2\text{HCO}_3^-</math></p>	<p>any 2</p> <p>any 2</p> <p>any 2</p> <p>any 2</p>	
	<b>Total</b>	<b>17</b>	

Question			Expected Answers	Marks	Additional Guidance
4			<b>sill</b>		
			2 baked margins	1	
			2 chilled margins	1	
			medium / coarse crystal grain size	1	
			fragments of country rock included (xenoliths)	1	
			olivine rich layer at base	1	
				<b>Max 4</b>	
			<b>lava flow</b>		
			1 baked margin	1	
			1 chilled margin likely below – if cooling by air above allow 2 chilled margins	1	
			fine crystal grain size	1	
			igneous material found in overlying rocks	1	
			weathered / irregular upper surface / red colour	1	
			vesicles concentrated towards upper surface	1	
			alignment of phenocrysts by flow / flow structures	1	
			pillow structure	1	
			fragments of country rock included (xenoliths) rare and only at base	1	
				<b>Max 4</b>	
			diagrams to be marked as text		
			correct comparison diagrams only max 2		
			points should be in pairs		
			<b>Total</b>	<b>8</b>	

		Answers are structured clearly and logically, so that the candidate communicates effectively, uses a wide range of specialist terms with precision and spelling, punctuation and grammar are accurate.	2	QWC
		There are shortcomings in the structure of the answer, however, the candidate is able to communicate knowledge and ideas adequately, a limited range of specialist terms are used appropriately and spelling, punctuation and grammar are generally accurate with few errors.	1	
		There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar which makes the candidate's meaning uncertain.	0	
		<b>Total</b>	<b>10</b>	

## 2833 Economic and Environmental Geology

Question			Expected Answers	Marks	Additional Guidance
1	a	i	amount / factor / number of times by which the metal is concentrated to make an (economic) ore deposit / above its average crustal abundance / cut off grade or percentage of metal in an ore deposit divided by its average crustal abundance	any 1	<b>accept</b> alternative wording <b>not</b> concentration of metal in ore
		ii	concentration factor = $(8/0.002 =)$ <u>4000</u>	1	
	b	i	bauxite	1	allow 1 letter incorrect in spelling
		ii	(intense) <u>chemical</u> weathering / hydrolysis; requires hot and humid / tropical / equatorial climate; requires rocks (rich in aluminium and) poor in iron / granite / impure limestone; soluble elements / ions / minerals removed in solution; groundwater with a pH of 4 – 10 removes silica; leaves insoluble residue of aluminium (oxides and hydroxides) / bauxite; joints increase permeability / allow water into rock for hydrolysis / increase surface area available for chemical weathering	any 2	
	c	i	chalcopyrite / any other valid copper mineral	1	allow 1 letter incorrect in spelling
		ii	suitable labels/text: rainwater causes <u>chemical</u> weathering; iron oxide / gossan capping is left at surface; copper / ore is depleted above the water table / near the surface / there is zone of leaching above water table / near surface; copper / ore is taken into solution / dissolved; groundwater containing copper in solution percolates downwards; copper / ore is concentrated at / immediately below the water table; oxides / carbonate / any correct named copper mineral above the water table and sulphides / any correct named copper mineral below water table; copper / ore is re-precipitated due to change in conditions / from oxidising above to reducing conditions below the water table; copper / ore is concentrated into a smaller volume; unaltered / unweathered / unaffected / original / primary copper ore is at depth	any 3	max 2 if no diagram
1	d		metals / ores are a non-renewable resource / they are finite geological processes that form metals / ores are very slow / take millions of years; the rate of extraction exceeds the rate of renewal / the rate of extraction cannot	any 2	<b>accept</b> thousands

Question			Expected Answers	Marks	Additional Guidance
			continue into the future / there will be nothing left for future generations; not all the metal / ore present can be extracted at a profit / using existing technology; high grade deposits are being worked out / only low grade deposits remain / costs remain the same regardless of the grade of the ore being extracted; demand for (rare / precious) metals (for new technologies) is outstripping their reserves / supply; pollution may be too great / irreversible;		
			<b>Total</b>	<b>11</b>	

Question			Expected Answers	Marks	Additional Guidance
2	a	i	<b>advantage</b> – less material needs to be removed (so cheaper) / less excavation needs to be made (so cheaper) / cutting wall is not as high / less chance of rockfalls / landslips onto roadway / no waste – cut material is used as fill; <b>disadvantage</b> – <u>fill material / outer part of road</u> may be unstable / weak / have low load-bearing strength / unconsolidated / different materials underlying roadway may lead to differential subsidence / 2 types of sub base may be unstable / steeper slope on outside of roadway / outer part of road liable to slope failure / landslips / slumping / fill material may need support	any 1  any 1	must be specific as to <u>where</u> the risk of rock falls, landslips, etc, will be reduced  must be specific as to <u>where</u> landslips, slumping, etc, will take place
		ii	<b>rock bolts</b> – to prevent rock falls / to prevent loose blocks falling out / used to pin loose rock to sound rock / used to stabilise competent rocks;  <b>retaining wall</b> – to prevent slope failure / slumping / slipping / sliding by <u>giving support</u> (lateral toe);  <b>rock drains</b> – to remove water which adds weight / acts as a lubricant / decreases likelihood of slope failure / landslips / slumping due to addition of water / to reduce pore fluid pressure;  <b>gabions</b> - to prevent slope failure / slumping / slipping / sliding by <u>giving support</u> (lateral toe)	1  1  1  1	if merely repeat to prevent rock failure for retaining wall and gabions with no description = 1mark    must give reason for drainage – not just remove water
	b		weathered rock is crumbly / very weak / low load-bearing strength; some strategies can't be used e.g. rock bolts; there are no secure attachment points in weathered rock / rock is loose; weathered rocks have a high permeability / are porous / are difficult to drain; slopes of road cutting will need to be at a very shallow angle to be stable	any 2	do not allow expensive
2	c	i	<b>granite</b> = class I <b>shale</b> = class V or IV	1 1	
		ii	<b>limestone</b> – high permeability / jointed so possibility of flooding / jointing may cause problems of loose blocks and/or rock falls / may contain caves / cavities / chemically reactive / bedding planes are a weakness / dipping beds may be unstable / cause collapse;  <b>granite</b> – (engineering) problems of overbreak / underbreak / expensive tunnelling / rate of tunnelling will be slow / difficult / hard rock so difficult	any 1  any 1	must give correct geological reasons

Question			Expected Answers	Marks	Additional Guidance
			<p>to tunnel through drilling and blasting will need to be used / possibility of rock bursts / jointing may cause problems of loose blocks and/or rock falls;</p> <p><b>shale</b> – low load bearing strength / incompetent / weak rock so likelihood of collapse / tunnel will need lining / fissile / contains planes of weakness / dipping beds may slide</p>	any 1	
			<b>Total</b>	<b>13</b>	



Question			Expected Answers	Marks	Additional Guidance
3	a	i	trap is a salt dome; negative gravity anomaly; salt / halite / evaporites have a low density / lower density than surrounding rocks / density of salt / halite / evaporite is 2.3–2.2 g/cm <sup>3</sup> ; surrounding rocks have higher density / density 2.5–3.0 g/cm <sup>3</sup>	1 any 2	
		ii	close to the 0 milligal line – accept anywhere outside / above the -10 milligal line	1	Allow ecf if anticline trap – D inside -30 milligal line
	b	i	rock type / composition; permeability of rock / interconnections between pores / effective porosity; grain size / roundness / sorting of grains / amount of matrix; presence of structures / joints / fractures; degree of cementation / compaction / lithification / diagenesis / consolidation; viscosity of oil / temperature of oil; (hydrostatic) pressure oil is under / volume of gas in solution	any 2	
		ii	water is pumped into rock (below oil); maintains pressure / forces oil up borehole(s) to surface / oil is less dense than water; OR gas is injected into rock (above oil); maintains pressure / forces oil up borehole(s) to surface; OR use of steam / detergents / chemicals / surfactants / bacteria; to reduce surface tension / viscosity of oil	any 1+1	description must match named method
	c		oil spillages / oil slicks (from pipes / tankers / rigs / blowouts) leakage of pipelines under sea / damage to marine ecosystems / marine habitats / marine life / birds pollution of sea water / coastlines / oil fires / flares causing (atmospheric) pollution / disposal of old oil rigs ground subsidence / may increase seismic activity	any 1	must qualify pollution with discussion

Question			Expected Answers	Marks	Additional Guidance
3	d	i	delta / delta top / swamp / marsh / bog / floodplain environment; hot and humid / tropical / equatorial climate; abundant trees / high rate of vegetation growth / presence of peat; anaerobic / anoxic / reducing / stagnant / low oxygen conditions / vegetation does not decay / decompose; (rapid) subsidence / burial / sedimentation / vegetation covered in (fine) sediment / compaction occurs; coal forms as part of a cyclothem	any 3	do not accept named environments if contradictions
		ii	the percentage of carbon in the coal / the position of the coal in the coal series / the maturity of the coal / the amount of energy produced when burnt / the calorific value	any 1	
		iii	anthracite has higher carbon content / higher rank / produces more heat energy when burnt / has a higher calorific value / produces less smoke / ash when burnt anthracite is harder / shinier / iridescent / vitreous / glassy / darker in colour bituminous coal has dull bands / is banded / anthracite has higher density / higher reflectance / anthracite contains less impurities / less sulphur / less pyrite / less volatiles	any 1	accept reverse argument

Question			Expected Answers	Marks	Additional Guidance
3	e		1 requires presence of (confined) aquifer / suitable named rock; 2 requires (highly) porous rock / (highly) permeable rock 3 extra detail of porosity / permeability, e.g. has well rounded/well sorted grains / has little or no cementation / is poorly consolidated / unlithified / has good interconnections between the pores / jointed rock; 4 artesian basin is a <u>confined</u> aquifer / overlain by <u>impermeable</u> rocks / sandwiched between <u>impermeable</u> rocks (accept suitable named rock type); 5 artesian basin has a <u>syncline</u> / <u>synform</u> structure; 6 water is under (high hydrostatic) pressure; 7 (hydrostatic) pressure will be greatest in the centre of the artesian basin / where the hydrostatic head is highest; 8 needs recharge zones / water percolates into aquifer at edges of basin; 9 London Basin is an example - chalk with clay above and below 10 if well is artesian / sunk into an artesian basin the water will rise up the well / flow out onto surface; 11 rocks act as natural filter / purifies water / water does not require treatment / chlorination; 12 no loss of water through evaporation / less seasonal than surface water supplies; 13 as water is extracted the level of water table falls / a cone of depression forms / well becomes dry; 14 as water is extracted a hydraulic gradient is set up / water flows in towards the well / the (hydrostatic) pressure drops 15 discussion of problems – salt water encroachment / long residence time of pollutants, etc. 16 suitable labelled diagram(s)	any 7	mark labels on diagrams as text
			<b>Total</b>	<b>21</b>	

# 2834 Palaeontology

## Question Expected Answers

## Marks

1 (a) (i)

fossil	Phylum	Group
<b>A</b>	hemichordata	graptolite / graptolithina /graptoloidea
<b>B</b>	mollusca / mollusc	gastropod
<b>C</b>	mollusca / mollusc	belemnite
<b>D</b>		plant / fern

Max 4

1 mark per row

If all groups correct = 2 marks

If all phyla correct = 2 marks

- (ii) 1 = apex / top of spire  
 2 = growth line / ornamentation / last whorl  
 3 = outer lip  
 4 = guard

1  
1  
1  
1

- (iii) jet propulsion/ expelling water;  
*moving backwards;*  
*funnel muscles contract squeezing water out;*  
 using tentacles;  
 use siphuncle to control water levels in chambers;  
 chambers control water or air to go up and down

Any 2

(iv)A

1

fragile colonies / too fragile for high energy / found only in deep water  
 shales / must have occupied surface waters / *small sized so they can float*  
*/ sometimes seen with floatation device / not streamlined*

Any 1

- (b) (i) low energy environment / deltaic / *terrestrial*;  
 marsh / bog / swamp;  
*tropical / equatorial*;  
 description of cyclothem development;  
 rapid sedimentation to cover plant remains;  
 buried in fine sediments / low energy;  
 plants fall into anoxic / anaerobic environment;  
 low amount / no bacterial action;  
*ecf for 2 marks*

Any 3

- (ii) *modern rainforests are not found in temperate latitudes (UK);*  
*fossils now found in temperate latitudes (UK);*  
*UK must have moved northward/ away from the equator;*  
*can't have lived where found;*  
*fossil D existed in a warmer climate;*

Any 2

Question Expected Answers  
2 (a) (i)

## Marks

Fossil	Description	mode of life
<b>F</b>	many thoracic segments/ legs; enrolment to protect; large size; streamlined for bottom dwelling; eyes allow all round vision;	benthonic / scavenger / <i>vagrant</i> / <i>epifaunal</i>
<b>G</b>	small; no eyes / blind; few thoracic segments / legs; inflated glabella	planktonic / <i>pelagic</i> / floater
<b>H</b>	no eyes / blind; pitted cephalon / sensory hairs; shovel shaped cephalon / <i>streamlined</i> ; <i>genal spines</i>	benthonic / infaunal / burrower

6 max  
3 max

2 marks for description of each  
1 mark for mode of life of each

- (ii) two or three trilobites correct = 2 marks  
one correct = 1 mark 2
- (iii) 11 1
- (b) (i) recognisable *labelled* diagrams of trace fossils; 1
- description and detail of how one trace fossil was formed (eg resting or walking);  
description and detail of how another trace fossil was formed (eg resting or walking);  
description of *two trace* fossils (eg resting or walking);  
*detail* of how trace fossils were formed (eg impressions of legs, gills etc)/  
*infilled later by sediment* Any 2
- (ii) jointed appendages;  
*segmented thorax or exoskeleton*;  
has a (chitinous) exoskeleton;  
*moulting or ecdysis* Any 2
- (iii) not found where they lived;  
transported after death and then deposited;  
winnowed or disarticulated any 2

**Question Expected Answers****Marks**

3 (a) (i) J = orthocone nautiloid / tabulate coral

K = rugose coral

L = scleractinian coral

M = goniatite

N = ammonite

5 / 4 correct = 4 marks

3 correct = 3 marks

2 correct = 2 marks

1 correct = 1 mark

4 max

(ii) record where fossils are present in rocks;  
fossils together will indicate specific dates;  
combine other information about rock types to draw time scale;  
*zone fossils described*;  
fossils used for biostratigraphic correlation /AW

Any 2

(b) (i) ash contains minerals that can be radiometrically dated;  
*method discussed such as potassium*;  
*half lives discussed*;  
dating which gives a number / numerical value;  
laid down instantly (geologically) / cover a large area (globally);  
chronostratigraphic correlation

Any 2

(ii) seasonal lake deposits;  
counting which gives a number;  
seasonal variation;  
*layers can be counted*;  
numerical value is one year / one double layer is one year;  
*relative thicknesses can be correlated*

Any 2

(c) (i) 65 Ma before present + / - 5Ma

1

(ii) any suitable example (eg dinosaurs, belemnites, foraminifera)

1

(iii) high levels of iridium in boundary clays;  
element able to withstand high pressure or temperature / rare on Earth;

shocked grains of quartz;  
strain inside seen as evidence of high pressure;

tektites;  
formed from silica as evidence of high pressure;

sedimentary evidence for widespread tsunamis;  
as aftermath of impact in water

Chicxulub meteor crater / Yucatan peninsula, Mexico;  
detected off shore as circular depression

Max 4

Any two with explanation

Question	Expected Answers	Marks
4 (a) (i)	growth line on either fossil	1
	hinge line between two different valves	1
	pedical valve on either fossil	1
	<b>(ii) lophophore function</b>	
	used for feeding;	
	used for respiration;	
	cilia trap food particles;	
	cilia waft to create a current to bring food in or expel waste	Any 1
	<b>brachidium</b>	
	supports the lophophore / <i>soft tissue</i> ;	Any 1
	<b>(iii)</b> diductor muscles contract to open valves	1
	adductor muscles contract to close valves	1
(b) (i)	marks division between chambers / septum position / edge of septa visible when shell is eroded away	Any 1
	<b>(ii)</b> suitable diagram of ammonite suture;	1
	suitable diagram of ceratite suture;	1
	<i>saddle and lobe labelled on either diagram</i>	1
(c)	tube interconnecting chambers;	
	controls gas or water in chambers;	
	affects buoyancy;	Any 2

13

Question	Expected Answers	Marks
5 (a) 1	<i>regular – radial or five fold symmetry</i> <i>irregular – bilateral or two fold symmetry</i>	1
2	<i>regular – hemispherical or rounded</i> <i>Irregular – highest point towards posterior / streamlined</i>	1
3	<i>regular – circular shape</i> <i>irregular - anterior groove deepens / development of heart shape;</i>	1
4	<i>regular – anus central on top aboral surface</i> <i>irregular - anus moves posteriorly;</i>	1
5	<i>regular – anus central in apical system</i> <i>irregular - anus moves out of apical system / apical system no longer radial;</i>	1
6	<i>regular – no sub anal fasciole / fasciole not needed</i> <i>irregular – has sub anal fasciole / more cilia for waste;</i>	1
7	<i>regular – mouth central on oral surface</i> <i>irregular - mouth moves anteriorly / away from anus;</i>	1
8	<i>regular - mouth has jaws / Aristotle's lantern</i> <i>irregular – no jaws;</i>	1
9	<i>regular – no labrum</i> <i>irregular - labrum to protect mouth;</i>	1
10	<i>regular – ambulacra extend from mouth to anus</i> <i>irregular - ambulacra form petal shapes / petaloid</i>	1
11	<i>regular – tube feet over whole test surface (on ambulacra)</i> <i>irregular – tube feet restricted to petaloid ambulacra on aboral surface / for respiration in burrow</i>	1
12	<i>regular – tube feet used for attachment not just respiration</i> <i>irregular – tube feet used to generate currents for feeding and sanitation</i>	1
13	<i>regular – no plastron</i> <i>irregular - plastron develops on underside;</i>	1
14	<i>regular – may have large spines all over test</i> <i>irregular – may have spines only on plastron / test lacks spines;</i>	1
15	<i>regular – spines for movement and defence</i> <i>irregular – spines for digging burrow;</i>	1
16	<i>regular – test may have tubercles</i> <i>irregular – may have tubercles on plastron / test lacks tubercles</i>	1

diagrams to illustrate

Max 4

no diagrams Max 8



Question	Expected Answers	Marks
5 (b)	<b><u>adaptations of burrowers</u></b>	
1	elongate valves / smooth valves allows easy movement through sediment / allows burrowing;	1
2	large foot / strong muscle allows burrowing / pulls organism into sediment;	1
3	pallial sinus or long siphons allows gas exchange and / feeding to occur out of the burrow;	1
4	gapes present and allows extension of foot and siphons for burrowing; thin shells or valves;	1
5a	<i>thin shells</i> to move through sediment / thick shells not needed (protection);	1
5b	<i>muscle scars or muscles small as no need to open and close valves;</i>	1
6	suitable diagram of form eg <i>Solen</i> or <i>Cardium</i>	1
	<b><u>adaptations for swimming forms</u></b>	
7	thin shells or hydrodynamic shape allows 'swimming' / flapping of shells;	1
8	corrugated or ribbed shells allows high strength;	1
9	monomyarian / single strong muscle allows control rapid flapping of valves;	1
10	ears or wings to direct currents to control direction of movement; large surface area to weight ratio for efficient displacement of water	1
11	when swimming;	1
12	suitable diagram of form eg <i>Pecten</i>	1
	<b><u>adaptations of attached forms</u></b>	
13	byssus or cement to attach to rocks or substrate (prevent being swept away);	1
14	streamlined or hydrodynamic / unornamented shells lessens damage due to impact or high energy;	1
15	may have thick, heavy shells or strong growth lines for strength;	1
16	<i>large muscles or muscle scars needed to keep shells closed;</i>	1
17	suitable diagram of form eg <i>Ostrea</i> or <i>Mytilus</i>	1
18		1
19	<b><u>adaptations for free lying forms</u></b>	1
20	thick, <i>ribbed</i> or heavy shells allows protection from high energy (ora);	1
21	Inequivalve allows a lower centre of gravity and so more stable / not moved by currents;	1
22	curved lower surface / snowshoe shaped / <i>spines</i> prevents sinking in soft sediment / stability in high energy;	1
	strong growth lines allows animal to grip the sediment; suitable diagram of form eg <i>Gryphea</i>	

List with no explanation max 3 marks

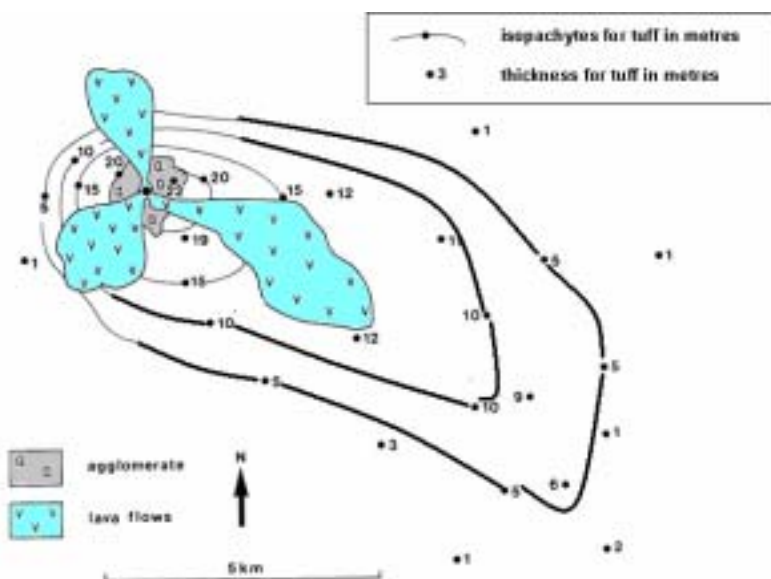
- 2 marks    Answers are structured clearly and logically, so that the candidate communicates effectively, uses a wide range of specialist terms with precision and spelling, punctuation and grammar are accurate.
- 1 mark     There are shortcomings in the structure of the answer, however, the candidate is able to communicate knowledge and ideas adequately, a limited range of specialist terms are used appropriately and spelling, punctuation and grammar are generally accurate with few errors.
- 0 marks    There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar which makes the candidate's meaning uncertain.

Quality of Written Communication

QWC 2

## 2835 Petrology

Question	Expected Answers	Marks
1 (a) (i)	tuff is consolidated volcanic ash / fine grained ash/ <i>consolidated pyroclastic material</i> agglomerate is consolidated volcanic bombs / blocks / coarse grained/ large fragments OR 1 mark for fine and coarse + 1 mark for ash and bomb	1 1
(ii)	10 m line 5 m line	1 1



- (iii) tuffs extends to the SE/ *wind from North West*  
 extended by wind direction at the time of ash fall / *prevailing wind direction*  
 gets thinner away from the volcano  
 possible lateral eruption  
 any 2
- (b) (i) youngest lava flow  
 agglomerate  
 oldest ash / tuff  
 reason cross cutting relationship of lava flow across other layers means it  
 is younger/ *lava going over other layers*  
 1  
 1
- (ii) K/Ar<sub>40</sub> or U/ Pb method named / radiometric dating  
*half life is fixed period of time / or actual half life time given / K/Ar 1260Ma*  
*or U/Pb 4500Ma*  
*parent to daughter breakdown*  
 half of parent decays in one half life / time for half of the parent to decay  
 stable daughter product forms  
 measure amount of decay product  
 age is ratio of parent / daughter isotopes / relative %s of isotopes  
 any 3

Question	Expected Answers	Marks
(c) (i)	destructive oceanic continental / oceanic oceanic / island arc / <i>destructive</i> / <i>convergent</i>	1
(ii)	magma acid / intermediate / andesitic / <i>silicic</i> / <i>rhyolitic</i>	1
	type of activity violent, infrequent / strombolian / vesuvian / plinian / <i>explosive</i>	1
<b>Total</b>		<b>14</b>

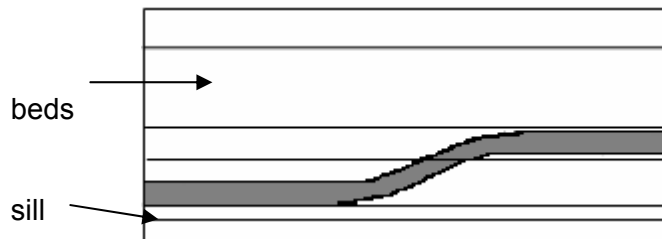
Question	Expected Answers	Marks
2 (a) (i)	D – schist	1
	E – metaquartzite / quartzite	1
	F – spotted rock / spotted slate	1
(ii)	crystalline minerals feldspar, micas / kyanite garnet porphyroblast shown and labelled / garnet porphyroblast described alignment of micas to show schistosity drawn	any 3
	<i>Allow ecf if gneiss given in D</i>	
		max 1 if no diagram
(iii)	interlocking crystals of quartz equigranular crystals <i>suitable scale</i>	any 2
		max 1 if no diagram
(b) (i)	biotite is black / <i>dark</i> and muscovite is silvery / <i>light</i> / <i>white</i> biotite is rich in Mg Fe and muscovite is rich in K Al / <i>muscovite is lacking in Mg and Fe</i> / <i>reference to position in Bowens Reaction Series</i>	1
(ii)	garnet	1
(c)	needs high pressure which is not found in thermal met / thermal met is only at low pressure kyanite is an $Al_2SiO_5$ polymorph kyanite forms at high pressure andalusite forms at low pressure	any 2
(d) (i)	high pressure <u>AND</u> low temp belt close to trench due to compression at subduction zone	1
	high temp <u>AND</u> low pressure belt away from trench due to heat from rising magma	1
	diagram of subduction zone	1
		labelled diagram max 3 no diagram max 2
(ii)	high pressure (compressive stress) due to collision of plates / formation of fold mountains <i>crust thickens under high temps and pressures</i> high temperatures in centre of orogenic belt due to batholiths / rising magma / from partial melting due to geothermal gradient	any 2
<b>Total 17 marks</b>		

Question	Expected Answers	Marks
3 (a) (i)	G – laccolith H – cone sheets / dykes	1 1

- (ii) *J will be coarser grained / larger / deeper / cooled more slowly than H*  
*Ora*  
*H has 2 chilled margins and J has 1*

any 1  
1

- (iii) sill crossing from one bed to another



- (b) most acidic (*silicic*) part of the magma / rich in K feldspar, quartz and mica/ *silica rich melt*  
 trace elements / metals dissolved in fluid  
 watery fluids contain fluorine / boron / volatile rich  
 fluid moves out along cracks / faults in outer part of batholith / country rock  
 saturated solution allows large crystals to grow  
 repeated pulses of fluids from intrusion
- any 2
- (c) (i) original composition of magma in chilled margins at boundary with country rock
- 1
- (ii) cumulate / *cryptic layering*
- 1
- (iii) each layer is heavier mafic minerals at base and lighter felsic minerals above  
*high temperature minerals form first / denser*  
 gravity settling occurs in each layer/ *sinking*  
 convection currents may cause repeated layers
- any 2
- (iv) iron and magnesium used in augite / olivine at base  
 due to gravity settling  
 rest of magma depleted in Fe and Mg  
*early formed crystals Ca rich magma becomes richer in Na*  
 richer in felsic minerals at end of crystallisation  
 fractional crystallisation
- any 3

**Total 13 marks**

Question	Expected Answers	Marks
4 (a) (i) K	bioclastic / reef / <i>shelly</i> / <i>fossiliferous</i> / <i>biosparite</i> Corals / brachiopod / bivalve / shell fragments	1 1
(ii) L	crinoidal stem sections / ossicles / broken stem sections / hole in centre for soft tissue / <i>randomly orientated</i>	1 1
(iii)	high energy marine shallow, clear seas / tropical / warm <i>carbonate rich seas</i>	any 1
(iv) M	round ooliths of concentric rings of $\text{CaCO}_3$ around a nucleous nucleus of shell fragment or sand grain tidal / wave action rolling the particles / fragments on the sea floor carbonate precipitated from sea water <i>sea water saturated in <math>\text{CaCO}_3</math></i> <i>OR if M identified as a coral limestone</i> <i>Corals and shell fragments present</i> <i>Algae encrust reef cementing it together</i> <i>High energy conditions at fore-reef</i> <i>Form talus at foot of slope</i> <i>Cemented together by calcite cement</i>	any 2           any 2
(b)	high bearing strength / <i>strong</i> / <i>competent</i> resistant to weathering (hard but) can be carved / cut / joints allow easy quarrying <i>reference to colour / decorative / appearance</i>	any 2
(c) (i)	clay needed (as source of aluminium) / gypsum (5%) / alumina added to control setting rate (chalk and) clay crushed and mixed and heated any other correct points such as volcanic ash	any 2
(ii)	quarry uses large area non renewable material quarrying causes dust / <i>noise pollution</i> / <i>air pollution</i> / <i>visual pollution</i> / <i>habitat loss</i> lowering of water table / contamination of groundwater / <i>changing drainage patterns</i>	any 2
(d)	coccoliths / foraminifera / <i>calcareous algae</i> / plankton in the surface layers of the ocean (die and)sink to the deep sea floor to accumulate <i>has to be above carbonate compensation depth</i>	any 2

Question	Expected Answers	Marks
(e) (i)	<i>reference to evaporation</i> calcite then dolomite precipitated out first / carbonates least soluble gypsum / anhydrite / calcium sulphate next halite / sodium chloride more soluble K salts / <i>sylvite</i> most soluble so last <i>replenishment of salts leads to cycles</i>	any 3
	<i>3 correct mineral names in correct order Max 1</i> if no link to solubility max 2	
(ii)	desiccation cracks / mud cracks / salt pseudomorphs	1
(iii)	evaporites require hot arid conditions / <i>rate of evaporation exceeds rate of precipitation</i> UK must have been in tropical latitudes / 20°N	any 2
		<b>Total 21 marks</b>

#### Quality of Written Communication

2 marks	Answers are structured clearly and logically, so that the candidate communicates effectively, uses a wide range of specialist terms with precision and spelling, punctuation and grammar are accurate.
1 mark	There are shortcomings in the structure of the answer, however, the candidate is able to communicate knowledge and ideas adequately, a limited range of specialist terms are used appropriately and spelling, punctuation and grammar are generally accurate with few errors.
0 marks	There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar which makes the candidate's meaning uncertain.



Question	Expected Answers	Marks
5 (a)	Describe the rocks and sedimentary structures formed in fluvial environments. Refer in your answer to alluvial fans, river channels and flood plains. You may use diagrams to illustrate your answer.	
	<b>Alluvial fans</b>	
	rocks all texturally and mineralogically immature	1
	Conglomerates / <i>breccias</i>	1
	badly sorted, coarse grained, sub rounded, polymict	1
	arkose	1
	contains K feldspar, rock fragments, quartz	1
	massive beds / crude beds / lenticular beds / lateral variation	1
	no sedimentary structures	1
	fan at base of mountains / at change in slope / rapid deposition	1
	<i>coarse grained clasts at wadi mouth or reverse argument</i>	
	diagram	1
		<b>max 5</b>
	<b>River channels</b>	
	sand with gravel / sand with pebbles at the base / conglomerates / <i>lag gravels</i>	1
	<i>description of named deposit</i>	1
	erosional base / fining up sequence	1
	point bar sand shows cross bedding / <i>finer sediment on inside of meander</i>	1
	sand is moderately sorted, medium grained, quartz and mica	1
	assymmetrical ripple marks in sands	1
	<i>imbricate structures / sole structures</i>	1
	lense shape of channel deposit / channel sand is cross cutting	1
	diagram	1
		<b>max 5</b>
	<b>Flood plains</b>	
	fine silt / clay deposited (from suspension)	1
	clay minerals form mudstone or shale	1
	deposited over a (large) flat area	1
	laminated / finely bedded	1
	plant fossils	1
	desiccation cracks	1
	diagram	1
		<b>max 4</b>
	diagrams as text	<b>11</b>

**Question Expected Answers****Marks**

- 5 (b)** Explain how you would classify igneous rocks using mineral composition, silica percentage and crystal grain size.

**Mineral composition**

Acid = quartz, potash feldspar, plagioclase, muscovite, biotite (*3 minerals required*)

Intermediate = potash *feldspar*, plagioclase, quartz, hornblende, biotite (*3 minerals required*)

Basic = plagioclase and pyroxene (augite) / *olivine*

Ultrabasic = pyroxene / *olivine*

Plagioclase, acid = Na rich / basic = Ca rich

Potash feldspar only in acid / intermediate

*Quartz essential mineral in acidic rocks*

Pyroxene basic/possibly intermediate/possibly ultrabasic

Olivine ultrabasic/basic

Acid = felsics/basic more mafics

Leucocratic (light coloured)/mesocratic/melanocratic (dark coloured) (only given once)

Max 6

**Silica content**

- acidic - >66% SiO<sub>2</sub> +/- 1%

- intermediate = 52-66% SiO<sub>2</sub> +/- 1%

- basic = 45-52% SiO<sub>2</sub> +/- 1%

- ultrabasic <45% SiO<sub>2</sub> - +/- 1%

*Allow ecf for incorrect values Max 3*

Leucocratic (light coloured)/mesocratic/melanocratic (dark coloured) (only given once)

Max 4

**Crystal grain size**

>5mm = coarse grained

- 1-5mm = medium grained

<1mm = fine grained

no crystals glassy

those cooled slowly at depth / coarse = - e.g. granite / plutonic igneous rocks/batholiths

hypabyssal igneous rocks /at intermediate depths / medium - e.g.

dolerite/sills/dykes

fast cooled at surface / fine / Volcanic/extrusive e.g. basalt lavas / *super cooling into water leads to glass*

OR

General statement linking grain size with cooling rate

1  
Max 4

*Table showing silica content and crystal grain size*

Max 7

**Total 12**  
**QWC 2**

**Total 25**

## 2836 Geological Skills

Question	Expected Answers	Marks
1 (a) (i)	7 cm measured is 175 m +/- 5	1
(ii)	identification - tear fault / strike-slip / wrench / <u>not</u> transform; fault trends NE – SW / movement horizontal / sinistral / left lateral / north side moved to SW; reason: axial plane of the fold is displaced / width of outcrop of the beds either side of the fault is the same / granite is displaced / features on either side are displaced laterally / horizontally / opposite side has moved to left	1 1 1
	allow AW	
(b)	1 beds of siltstone then shale laid down; 2 beds intruded by dolerite <u>sill</u> (could be after 3 or after siltstone but before shale); 3 beds folded into <u>syncline</u> / <u>synform</u> ; 4 detail of fold as symmetrical / limbs dipping (west and east) at 50° / axial plane trace trends NW – SE; 5 granite <u>intruded</u> – allow AW; 6 faulted – allow ecf for fault type; 7 erosion / unconformity then sandstone laid down; 8 sandstone tilted 10° (W) – allow folding with a dip of 10°; 9 dolerite <u>dyke</u> intruded (could be before 8); 10 erosion / unconformity 11 conglomerate / limestone laid down <u>horizontally</u> ; 12 erosion to form <u>outlier</u> ;	any 8 If reverse order or list max 4 QWC1

13

### Quality of Written Communication

1 mark	The candidate is able to communicate knowledge and ideas adequately, specialist terms are used appropriately and spelling, punctuation and grammar are generally accurate with few errors.
0 marks	There are severe shortcomings in the organisation and presentation of the answer, leading to a failure to communicate knowledge and ideas. There are significant errors in the use of language, spelling, punctuation and grammar which makes the candidate's meaning uncertain.

Question	Expected Answers	Marks
2	(a) (i) baked margins in country rock on both sides of intrusion accept if only intrusion's baked margins drawn do not accept contradictions	1
	(ii) 40 cm +/- 5 – accept if 0.4 m	1
	(iii) left / west side downthrown	1
(b)	(i) accuracy affected by experimental / lab techniques / dealing in very small amounts / accuracy of equipment / uncertainty of half life data / analytical method not very accurate must give reason for inaccuracy accept if analytical inaccuracy discussed in part (ii)	any 1
	(ii) argon (gas) escaping; gives a <u>younger</u> age if argon has escaped; metamorphism / heating causes resetting of geological clock; weathering allows argon to escape / groundwater percolating through rock alters it / porous/permeable rocks can cause problems; may not be a closed system / may become open system accept AW accept if argon loss discussed in part (i)	any 2
	(iii) series/sequence of sedimentary rocks / sandstone, limestone and shale are older than intrusion / older than 167 Ma or any stated date older than 167 Ma; fault is older than intrusion / older than 167 Ma or any stated date older than 167 Ma; conglomerate is younger than intrusion / younger than 167 Ma or any stated date younger than 167 Ma	any 2
(c)	rock is <u>basalt</u> ; rock formed from crystallisation of basic magma; fine grained / glassy rock formed by rapid cooling on surface; vesicular texture formed by gases escaping / exsolving from magma / high gas pressure; gas escapes at low pressure / gas rises to top; vesicles preserved as cooled rapidly	1     any 2

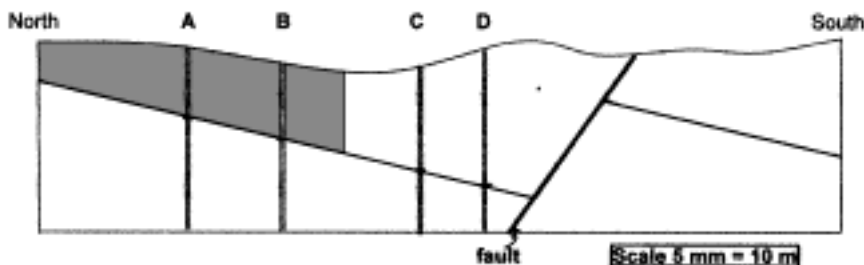
Question	Expected Answers	Marks
(d) (i)	Jurassic / Cretaceous / accept correct <u>range</u> in Ma anywhere from 200 to 65 Ma	1
(ii)	bullet-shaped belemnite guard drawn – labels not required accept if guard drawn inside belemnite	1
(iii)	sea floor was anoxic / reducing / anaerobic; low energy / ammonites not broken up; idea of sulphur / involvement of bacteria; requires iron-rich / organic sediment / requires iron-rich water; atom by atom replacement of shell material by pyrite; fossilised ammonites were weathered / eroded out of shale; transported / (re)deposited in younger conglomerate / form derived fossils max 2 if no discussion of process of pyritisation any 4 max 3 if no discussion of occurrence in conglomerate	4

QWC1

18

**Question Expected Answers****Marks**

- 3 (a) (i) vein plotted correctly in boreholes  
(depths: **A** = 12.5 $\pm$ 2mm; **B** = 14 $\pm$ 2mm; **C** = 19 $\pm$ 2mm; **D** = 25 $\pm$  2mm)  
1 mark if 1 or 2 boreholes correct  
2 marks if 3 or 4 boreholes correct  
Max 1 if vein not joined up from **A** to **D**



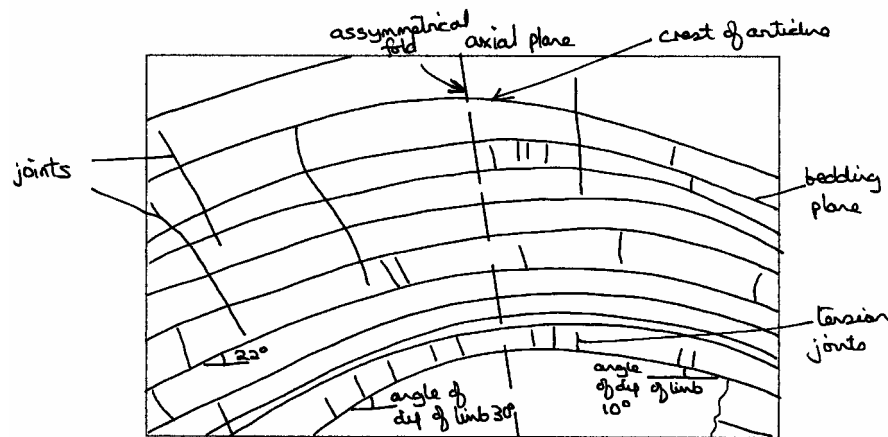
- (ii) 13°  $\pm$  2 (allow ecf) 1
- (iii) correct displacement measured vertically for throw of 40 m = 20mm on cross section (allow 25mm along fault  $\pm$ 2) 1  
vein drawn with same dip as on north side of fault 1
- (b) (i) grey area shaded to a depth of 15 mm on cross section (allow any horizontal distance) 1
- (ii) galena is dense / has specific gravity of 7.5  
calcite has specific gravity of 2.7 / fluorite has specific gravity of 3.2;  
heavy minerals / galena will sink to the bottom (if panned) / allowed to settle in large volume of water;  
lighter minerals / calcite / fluorite could be floated off;  
could use froth flotation / shaking table;  
if liquid of suitable density used – galena would sink and calcite / fluorite would float any 2
- (iii) galena contains lead / is toxic;  
pollution of surface runoff and rivers;  
pollution of groundwater / acid mine drainage water from mine;  
galena is soluble in water / kills plants / poisons animals;  
waste tips contaminate soil / cover large area (causes destruction of habitat) / causes landscape degradation;  
noise / dust during mining operation from machinery/ dump trucks/ blasting; any 2  
max 1 if general discussion of environmental consequences  
not specific to galena
- (c) calcite rhombic crystals / H = 3 / reacts with acid / 3 cleavages any 1  
fluorite cubic crystals / H = 4 / 4 cleavages / variable colour / often purple/green / is fluorescent any 1  
do not accept contradictions

12

## Question Expected Answers

## Marks

4 (a)



dip on left limb between 20 - 30°;

dip on right limb 10 - 20°;

anticline / antiform with descriptor e.g. asymmetrical / open / gentle /

interlimb angle 150° +/- 5°;

crest / axial plane within error labelled;

joints / tension joints labelled / fault with displacement shown;

bedding plane correctly labelled / bed with measured thickness;

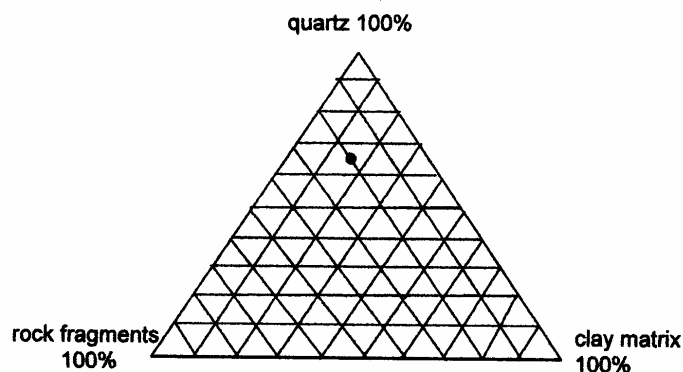
thick and thin beds / interbedded competent and incompetent rocks /

laminations

any 4

max 3 if no dip measurements

(b)



point as shown on diagram – accept 3 lines intersecting at correct point

1

(c)(i) ripple marks (asymmetrical)

1

- (ii) wind blows sediment (up sides of dunes) / sediment transported by saltation / aeolian transport;  
 unidirectional wind / current (makes asymmetrical ripples) / upwind / up current side is gentle and downwind / down current side is steep;  
 sediment deposited on downwind / down current side of ripple / ripple migrates downwind / down current

any 2

max 1 ecf if identified as flute casts / tool marks

- (iii) 1 = G / river  
 2 = E / beach / shallow marine  
 3 = F / dune

all 3 correct = 2, 1 or 2 correct = 1

2

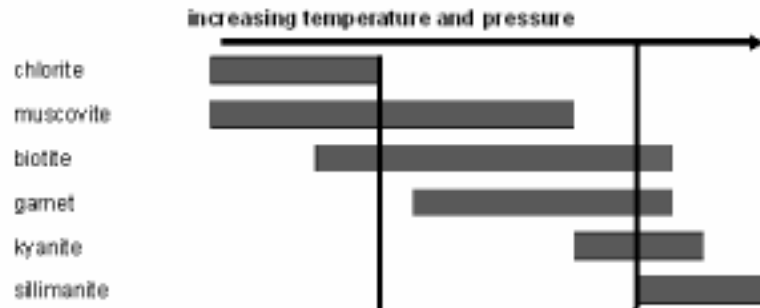
10

**Question Expected Answers****Marks****5 (a)(i)** regional / Barrovian

1

(ii) from anywhere between end of chlorite / start of garnet to anywhere between beginning of kyanite / beginning of sillimanite

1



(iii) low = slate / phyllite  
 medium = schist  
 high = gneiss / migmatite

3

allow ecf max 1 for spotted slate, andalusite slate, hornfels all correct if answer to (i) contact / thermal

(b) both are polymorphs / same composition but different form / shape / crystal structure;  
 composition is  $\text{Al}_2\text{SiO}_5$  / aluminosilicates;  
 kyanite is high pressure, (low temperature) (polymorph);  
 sillimanite is high pressure, high temperature (polymorph);  
 as metamorphism proceeds kyanite breaks down and forms sillimanite / they are stable at different P/T conditions

any 2

max 1 if only diagram

7



# Grade Thresholds

Advanced GCE (Geology) (3884, 7884)  
June 2009 Examination Series

## Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2831	Raw	60	46	41	36	31	26	0
	UMS	90	72	63	54	45	36	0
2832	Raw	60	50	45	40	36	32	0
	UMS	90	72	63	54	45	36	0
2833	Raw	120	98	86	74	62	50	0
	UMS	120	96	84	72	60	48	0
2834	Raw	90	68	59	50	41	33	0
	UMS	90	72	63	54	45	36	0
2835	Raw	90	62	54	46	38	30	0
	UMS	90	72	63	54	45	36	0
2836	Raw	120	96	85	74	64	54	0
	UMS	120	96	84	72	60	48	0

## Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3884	300	240	210	180	150	120	0
7884	600	480	420	360	300	240	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	B	C	D	E	U	Total Number of Candidates
3884	20.8	51.6	77.7	91.5	99.5	100	185
7884	25.7	52.0	73.4	90.1	97.2	100	818

## 1003 candidates aggregated this series

For a description of how UMS marks are calculated see:  
[http://www.ocr.org.uk/learners/ums\\_results.html](http://www.ocr.org.uk/learners/ums_results.html)

Statistics are correct at the time of publication.

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