RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE **A2 H487**

Advanced Subsidiary GCE **AS H087**

Mark Schemes for the Units

June 2009

HX87/MS/R/09

Oxford Cambridge and RSA Examinations

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Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

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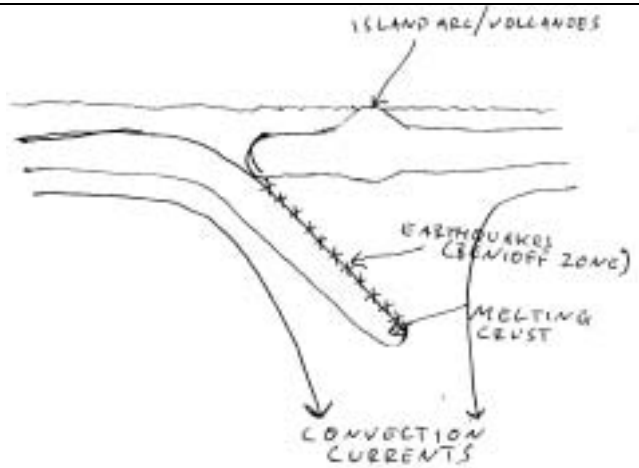
Advanced Subsidiary GCE Geology (H087)

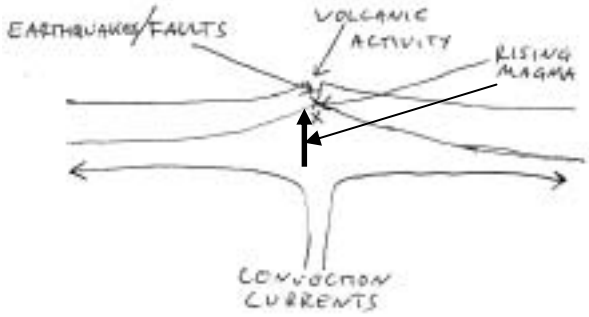
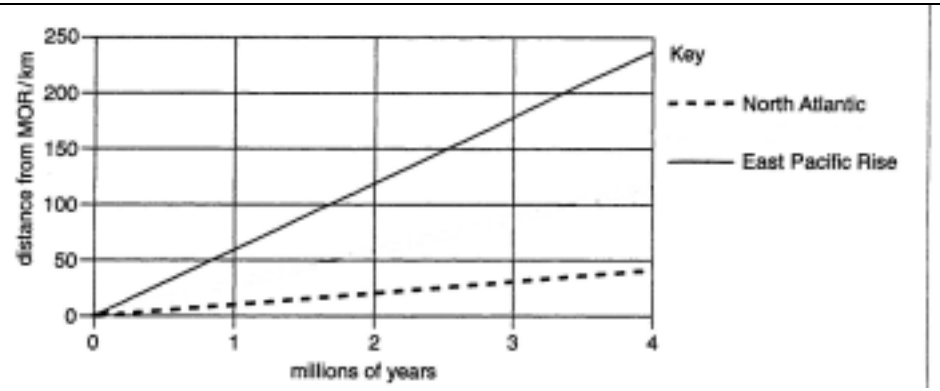
MARK SCHEMES FOR THE UNITS

F791 Global Tectonics

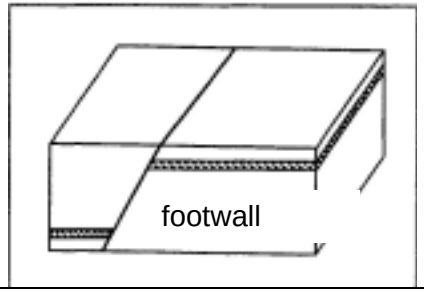
Question			Expected answers	Marks	Additional guidance
1	a	i	South American trench / Caribbean trench / New Zealand / Aleutian trench Rockies / Andes / Appalachians	1 1	Majority within 2 mm of the coastline (use the overlay) no part on land Parallel to coast and majority within correct zone
		ii	New Zealand / Hawaii / Caribbean arc / Aleutian Islands / Rockies / Andes / East Pacific Rise / Mid Atlantic Ridge	1	
		iii	**convergent** partial melting (of the subducted plate) / volcanic activity / rising magma / friction causing partial melting **divergent** 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 **hot spots** partial melting (of the mantle) / volcanic activity / rising magma / rising mantle plume	any 1	'subduction' insufficient on its own because it is a MOR / divergent plate boundary is too vague allow 'hotspot' on its own
		iv	Brazil / Canadian Shield / Greenland / top of subduction zones / ocean trench / abyssal plain	1	
		v	away from plate margin / centre of plate / cold convection currents / thick crust / descending convection currents / old (stable) crust / no igneous activity / no rising magma	1	

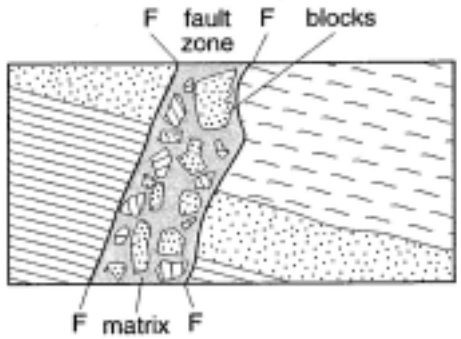
Question			Expected answers	Marks	Additional guidance
	b	i	 1 mark for each correct label	5	earthquakes need to be in a descending zone <u>not just a point</u> and <u>top</u> of descending plate island arcs need to be drawn as islands and <u>not on continental crust</u> island arc and volcanoes need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

Question			Expected answers	Marks	Additional guidance
			absorbs energy / allows building to sway base isolation / rubber / Teflon / ball bearings / rollers between building and foundations to absorb ground vibrations / separate building from ground / building stationary while ground moves building on a solid concrete raft / pumping liquid cement / deeper / wider / piled foundations / strengthen building foundations / reinforced foundations to provide greater support / stops shearing from foundations	2	‘shock absorbers’ max =1 ‘rubber foundations’ max =1 general comments about reinforced concrete with steel rods = 1
			Total	**15**	

Question			Expected answers	Marks	Additional guidance
2	a	i	 axial rift in centre labelled diverging convection currents magma rising labelled volcanoes in rift area labelled	any 4	needs indication of rising magma volcanoes within 2mm of edge of rift
		ii	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> / <u>pulling</u> plates <u>apart</u>	any 2	allow description of ridge push or slab pull do not accept extrusive activity general comment about convection currents=0
	b	i			use the overlay allow one small square of error 1 / 2 points correct = 1 3 / 4 points correct = 2 correct line through origin and joining points = 1

Question			Expected answers	Marks	Additional guidance
				3	
		ii	5.88 cm per year +/- 0.5cm per year (ecf) correct working	1 1	20 = 5.88 50 = 6.25 3.4 0.8 if distance over time suggested then 1 mark for working do not allow just 'd/t'
		iii	steeper gradient / steeper angle	1	answer must refer to the gradient of the line
	c		mafic / basic / basaltic	1	spelled correctly do not accept basalt / dolerite / gabbro on its own
			Total	**13**	

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

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

Question			Expected answers	Marks	Additional guidance
4	a	i	hydrogen helium	1 1	both spelled correctly for 2 marks
		ii	Mercury / Venus / Mars	any 2	
		iii	similar mass / density / (relatively) high density similar composition / rocky / metallic core / NiFe core similar size / relatively small closest to the Sun / inner planets similar structure / solid crust / solid surface / rocky surface	any 2	do not accept 'solid' on its own
			Total	**6**	

Question			Expected answers	Marks	Additional guidance
5			**mantle** 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 Low Velocity Zone / LVZ for asthenosphere
			mantle starts between 7 and 90 km / 30 km depth on average Moho forms the crust mantle boundary asthenosphere 70 – 250 km / 70km from 670 – 2900 km is lower mantle / 670 km Gutenberg discontinuity between core and mantle (give once) any 2 = 1 mark	1	need 2 marking points for 1 mark credit Gutenberg once only (mantle or core)
			lithosphere is solid asthenosphere is (5%) partially molten / rheid rest of mantle is solid / mantle is mainly solid any 2 = 1 mark	1	need 2 marking points for 1 mark
			all ultramafic / ultrabasic / peridotite / silicate / olivine rich / mafic minerals / ferromagnesian minerals	1 max 4	
			core Gutenberg discontinuity between core and mantle (give once) / Lehman discontinuity between outer and inner core	any 1	need depth, state and composition for 4 credit Gutenberg once only (mantle or core)
			liquid outer core and solid inner core (need both)	1	
			2900 – 5000-5150 km for the outer core / 2900 km 5000-5150 – 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 sulfur / silicon as additional elements
			Total	**8**	

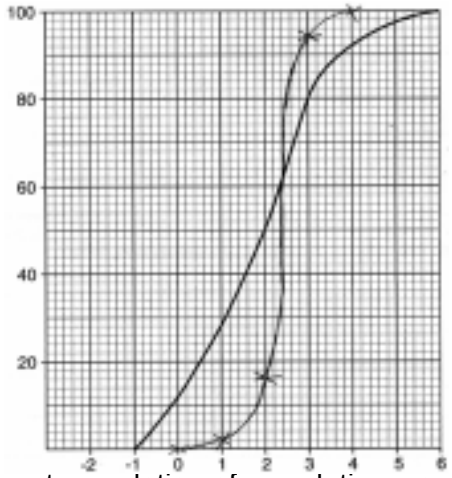
F792 Rocks – Processes and Products

Question			Expected answers	Marks	Additional guidance
1	(a)		A= sedimentary B= metamorphic C= metamorphic / sedimentary D = igneous 4 or 3 correct = 3, 2 correct = 2, 1 correct = 1	3 max	A allow correct clastic rock conglomerate / breccia / sandstone B allow slate / schist / gneiss C allow marble / limestone / orthoquartzite / meta quartzite / quartzite D allow any named igneous rock NOT contradictory rock types
	(b)	(i)	clastic = composed of clasts / particles / pieces / grains / of pre existing rocks / other rock / containing broken shells / fragments / fragmentary crystalline = composed of (interlocking) crystals	1 1	Not 'bits'
		(ii)	made of grains or crystals sediment that has hardened or magma that has cooled an aggregate of minerals a mixture of minerals naturally occurring substance composed of mineral/s	any 1	
		(iii)	minerals subjected to directional stress / pressure during folding / mountain building / at a convergent plate boundary / during regional metamorphism minerals recrystallise due to effect of stress / pressure minerals align with long axis perpendicular / 90^{o} to stress direction / pressure minerals must be flat / platy / tabular / not equidimensional / mica burial beneath great thicknesses of overlying rocks / stresses applied to minerals due to mass of overlying rocks	any 2	Not just 'pressure' must have reason for pressure
	(c)	(i)	E = igneous F= sedimentary	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 / cement only occurs in sedimentary rocks fragmental / clastic	any 2	ecf on (c)(i)
			Total	**14**	

Question			Expected answers	Marks	Additional guidance
2	(a)	(i)	sediment carried by (turbulent) flow / current sediment does not contact the river bed carried in the water column very fine sand or sediment particles or silt or clay or small grains / light grains	any 2	Allow if suspension defined as carried in the air
		(ii)	energy of transporting medium may vary seasonal variation in river discharge / variable wind velocity high energy allows suspension of fine or light grains / particles lower energy leads to saltation of grains / particles large grain becomes smaller by attrition / abrasion	any 2	Allow velocity / speed for energy (allow discharge)
		(iii)	**difference** ice poorly sorted, wind well sorted ice angular grains, ice not well rounded, wind well rounded grains ice mixed composition of rock fragments, wind composed of sand / quartz ice coarse grained > 2 mm, wind medium grained approx 1 mm ice no frosted grains, wind grains are frosted **reason / explanation** wind energy insufficient to transport coarse grains / wind does not pick up coarse grains / wind blows finest grains further than sand grains more attrition with wind transport reduces size and makes it well sorted and all quartz / ice transport has less attrition because grains not in contact / ice deposits wide range of grain sizes and composition and sorting	any 1 any 1	difference must include both ice and wind or comparative term (e.g. more than / less than) reason must match difference read difference and reason together
	(b)	(i)	west bank of river (small part of steep bank symbol on east bank at lower edge)	1	on left on outside of the meander label must be on the bank of the river where slope marked or below water level
		(ii)	cross bedding ripple marks (asymmetrical) graded bedding imbricate structure	any 2	Do not allow *symmetrical* ripple marks

Question			Expected answers	Marks	Additional guidance
		(iii)	as channel moves / meanders sediments are deposited on the inside of the meander bend / river is at 1 first then moves to 2 forms point bar / sand bar deposit so beds are dipping towards the river youngest sediments are down dip	any 2	Allow 1 mark for concept of superposition with sediment 2 on top of sediment 1 so younger
	(c)		when the river floods, the suspended load is deposited on the flood plain as mud - low velocity sand deposited in channel under high / medium energy gravel deposited in channel when velocity drops from very high or high velocity produces coarse gravels at the bottom of the sequence as velocity decreases sediment gets finer (sand / clay)	1 1 1 1 1	2 marks for statements of mud on flood plain, sand and gravel in channel description of coarse first, then sand, then mud max 1
			Total	**14**	

Question			Expected answers	Marks	Additional guidance
3	(a)	(i)	 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	Allow full marks even if points 5 and 6 are not plotted
		(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' max 1 diagram can act as text
		(iii)	$\frac{3.2 - 0.2}{2}$ $\left(\frac{2.8 - 2.0}{2}\right)$ G =1.5 (+/-0.1) H = 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 ecf for sediment H
		(iv)	H is better sorted than G H is well sorted and G is poorly sorted G has coefficient of 1.5 compared with 0.4 for H G has wider range of grain sizes than H	any 1	Allow ecf from (iii) If coefficient for H is 0.5 allow 'moderate sorting'

Question			Expected answers	Marks	Additional guidance
		(v)	G = river / alluvial fan / glacial / wadi H = aeolian dune/ desert / beach dunes	1 1	ecf if moderately sorted in part (iv) allow beach / river / shallow sea / deltaic
	(b)	**(i)**	J greywacke deep sea / turbidite due to angular / poorly sorted grains with rock fragments and matrix OR J arkose Alluvial fan / river / wadi due to angular / poorly sorted grains with rock fragments and matrix with feldspar	1 1 1 1	1 mark for identification 1 for explanation
		(ii)	cement is calcite / calcium carbonate precipitated from sea water	1	
		(iii)	K is angular so little transport compared to L well rounded lots of transport OR K is angular so short time of transport compared to L well rounded long time of transport	1	
		(iv)	well rounded grains due to saltation / abrasion / wind transport / high energy all quartz grains so long period of weathering / mature / extreme chemical weathering iron oxide cement forms in oxidising desert conditions well sorted as wind only picks up one size	any 2	
			Total	**17**	

Question			Expected answers	Marks	Additional guidance
4	(a)	(i)	1 recrystallisation / metamorphism 3 magma accumulation 2 recrystallisation / metamorphism 4 crystallisation	1 1 1 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 / permeability reduced grains glued / stuck together by a named mineral most effective in sandstones	any 2	Not 'evaporated' instead of 'precipitated'
	(b)	(i)	1 hornfels contains sillimanite / andalusite rock is crystalline / unfoliated / granoblastic / crystal size medium or coarse 2 andalusite / chiastolite rock / slate rock has porphyroblasts of andalusite / unfoliated / crystal size medium 3 spotted rock / rock contains chlorite / biotite / muscovite / mica fine crystal size / spots of recrystallised minerals OR 2 marks max for any 2 correct rock names (hornfels, andalusite rock / slate, spotted rock) 2 marks max for index minerals (sillimanite, andalusite, chlorite / biotite) 2 marks max for descriptions of crystal size, texture etc	1 1 1 1 1 1	

Question			Expected answers	Marks	Additional guidance
		(ii)	Drawing of granoblastic crystals crystals of quartz (crystal grain size any) rock is white / grey in colour / crystalline / hard / interlocking crystals / metaquartzite / granoblastic texture	1 1 1	1 mark for drawing 1 mark for description / label 1 mark for additional detail for other label on diagram drawings must show **no foliation**
		(iii)	metamorphic aureole – large scale 100's m to km / around a batholith baked margin - small scale cm to m / around sills and dykes / below lava flow	1 1	1 mark max if size is not quantified (e.g. aureole larger than baked margin)
			Total	**19**	

Question			Expected answers	Marks	Additional guidance
5	(a)	(i)	arrow from bottom to top	1	Accept correct temperatures
		(ii)	olivine augite / pyroxene muscovite quartz	3 max	4 or 3 correct = 3, 2 correct = 2. 1 correct = 1
		(iii)	Ca rich crystallises at high temperature / first Na rich crystallises at low temperature / last variable mix from 100% Ca to 50:50 to 100% Na Ca is depleted as crystallisation takes place so more Na plagioclase forms	any 2	Allow anorthite as Ca and albite as Na suitable description of changing composition
	(b)	(i)	olivine – forms at high temp / rich in Mg Fe / first to crystallise pyroxene / augite - forms at high temp / rich in Mg Fe / second to crystallise / dark colour Ca rich plagioclase - forms at high temp / first to crystallise	any 2	mark is for the reason not just the name max 1 mark for 2 correct minerals named
		(ii)	quartz H 7 so will scratch glass plagioclase H 6 will not scratch glass / quartz is harder / feldspar can be scratched by steel nail but quartz can't quartz has no cleavage compared to plagioclase with 2 good cleavages / quartz will not split but will fracture plagioclase may cleave quartz is composed of silica and plagioclase feldspar is a Na or Ca rich aluminium silicate	Any 2	Do not accept data not provided in table Max 1 if no explanation
	(c)	(i)	Q black crystals as biotite N large phenocrysts as K feldspar	1 1	 Allow orthoclase feldspar Not just 'feldspar'
		(ii)	muscovite / plagioclase feldspar / quartz any 2	1	Not 'mica' or 'feldspar' as already used

Question	Expected answers	Marks	Additional guidance
(d)	Olivine forms layer at base due to gravity settling denser / early formed minerals sink to the bottom Mg and Fe depleted as used to form olivine and augite mafic rocks form early so mafic minerals depleted Ca depleted as used for plagioclase feldspar magma enriched in Na, K and silica last / low temperature minerals make intermediate / more silicic rock	any 3	
		16	

Question	Expected answers	Marks	Additional guidance
6	Describe the grades of regional metamorphism and the rocks produced at each grade		
	limestone as parent rock forms marble at all grades sandstone as parent rock forms metaquartzite at all grades	1 1 1	**Regional metamorphism forms slate, schist and gneiss in sequence max 1 for general statement not given in detail below**
	regional metamorphism needs both temperature and pressure	1	**can be shown on P/T diagram**
	description of Barrovian zones	1	
	low grade regional metamorphism– slate / low temperatures **and** pressures	1	
	index mineral chlorite muscovite formed by recrystallisation formation of slaty cleavage minerals aligned at 90° to pressure fine crystals / crystals <1 mm / pyrite porphyroblasts grey / black / green colour	1 1 1 1 1 1	diagrams to be marked as text if features are clearly seen or labelled
	medium grade regional metamorphism – schist / medium temp **and** pressures	1	
	schistose texture / schistosity, foliation index mineral biotite and garnet minerals grow porphyroblasts of garnet index mineral kyanite as Al_2SiO_5 polymorph medium crystals / crystals 1-5 mm silvery colour / sheen / shiny / appearance	1 1 1 1 1 1	diagrams to be marked as text if features are clearly seen or labelled
	high grade regional metamorphism – gneiss / high temperatures **and** pressures	1	
	rich in quartz, biotite and K feldspar gneissose banding index mineral sillimanite as Al_2SiO_5 polymorph coarse crystals / crystals >5 mm black and white bands	1 1 1 1 1	diagrams to be marked as text if features are clearly seen or labelled
		10	

Question	Expected answers	Marks	Additional guidance
7	**Describe and explain the essential features of strato-volcanoes and shield volcanoes.**		
	magma viscosity		
	Lava is fluid / non-viscous for shield because it is mafic in composition	1	1 mark for strato viscous and shield non-viscous
	Viscous / non-fluid for strato because it is silicic / felsic in composition	1	
	lava type		
	mafic / basaltic in composition for shield	1	
	pahohoe (ropey) / aa (blocky) appearance to lava surface	1	
	intermediate / andesitic / felsic / silicic / rhyolitic in composition for strato	1	
	short / thick / ropey flows / in domes	1	
	gas content		
	effusive / quiet eruptions / gas escapes easily for shield	1	Allow Hawaiian / fissure for quiet
	explosive / violent eruptions / gas held in lava for strato	1	Allow Plinian / Pelean for explosive
	shape and structure of the volcanoes		suitable examples of each 1 mark
	wide base 100s km	1	wide and shallow with no quantitative
	shallow sides 2-10 degrees	1	detail max 1
	primarily lava little pyroclastics	1	mark labelled diagrams as text
	central crater	1	
	labelled diagram	1	If volcanoes described separately max 6 for each volcano
	steeper sides > 30 degrees	1	steep and small with no quantitative
	narrow base 10s km	1	detail max 1
	made of alternating layers of lava and ash / pyroclasts/ tuff / agglomerate	1	
	may have parasitic cones / diagram / calderas	1	Max 1 for 2 unlabelled diagrams
	labelled diagram for strato	1	showing correct shape / size
		10	

Grade Thresholds

Advanced GCE Geology (H487)
Advanced Subsidiary GCE Geology (H087)
June 2009 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
F791	Raw	60	43	37	31	26	21	0
	UMS	90	72	63	54	45	36	0
F792	Raw	100	76	66	56	46	37	0
	UMS	150	120	105	90	75	60	0
F793	Raw	40	32	28	25	22	19	0
	UMS	60	48	42	36	30	24	0

Specification Aggregation Results

Overall threshold marks in UMS (ie after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
H087	300	240	210	180	150	120	0

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

	A	B	C	D	E	U	Total Number of Candidates
H087	17.1	36.1	57.8	75.8	89.6	100	1046

1046 candidates aggregated this series

For a description of how UMS marks are calculated see:
http://www.ocr.org.uk/learners/ums_results.html

Statistics are correct at the time of publication.

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

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