

Mark Schemes for the Units

January 2010

HX87/MS/R/10J

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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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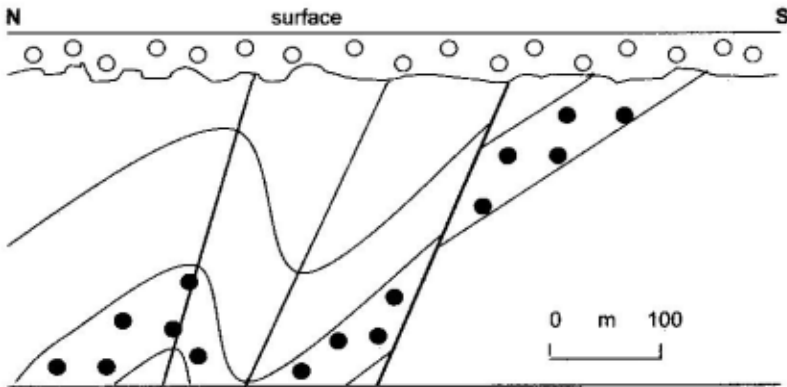
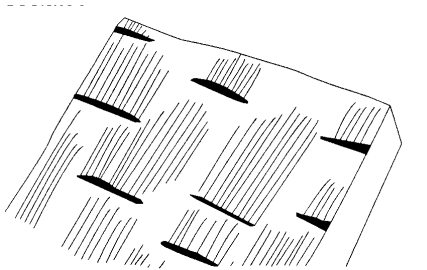
F791 Global Tectonics

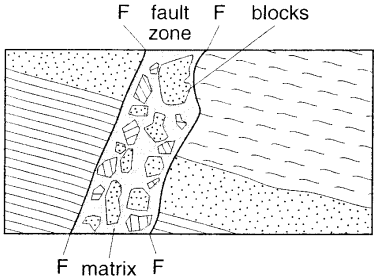
Question			Expected Answers	Marks	Additional Guidance
1	a	i	<p>3-6 correct points = 1 mark 7-8 correct = 2 marks</p>	2	<p>ignore any curves that may be drawn</p> <p>use the template on SCORIS allow within 1mm</p>
		ii	Mars and Jupiter	1	
	b	i	<p>iron meteorite / metallic meteorite / iron-nickel meteorite stony meteorite / rocky meteorite / silicate meteorite / achondrite stony iron (carbonaceous) chondrite</p>	<p>1 1 1 1 max 2</p>	allow <i>irony</i>
		ii	<p>iron meteorite specific layer - the core Fe and Ni / right density for core / greater than 10 g/cm³ / explains how the magnetic field occurs</p> <p>stony meteorite / rocky meteorite / silicate meteorite / achondrite specific layer - the mantle / asthenosphere silicates / olivine, (pyroxene and plagioclase) / peridotite / more dense silicate in the lower mantle</p>	<p>1 any 1 any 1 any 1</p>	<p>not just <i>iron</i> make sure that 1 mark is for description of the composition and 1 mark is for the layer represented</p> <p>the composition and evidence must tie in with the appropriate meteorite</p>

Question	Expected Answers	Marks	Additional Guidance
	stony iron specific layer – core-mantle boundary iron and olivine (carbonaceous) chondrite specific layer – mantle / whole Earth composition composition of Sun minus some volatiles with water and carbon has organic molecules / brings in viruses / bacteria / contains olivine / peridotite	1 1 1 1 max 4	max 4 for two pairs of answers
c	impact craters / Meteor Crater / Chicxulub crater tilted strata / inverted strata iridium layer / shocked quartz / melted quartz / shocked crystals (glass) spherules / tektites ejecta material around the crater / brecciated material / debris from meteorite	1 1 1 1 1 max 2	<i>shocked minerals</i> not enough needs to be <i>crystals</i>
	Total	11	

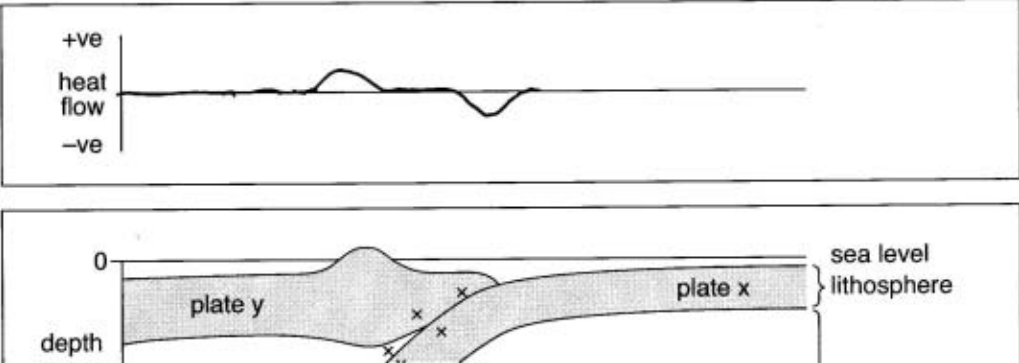
Question			Expected Answers	Marks	Additional Guidance
2	a	i	lithosphere	1	needs the correct spelling
		ii	solid / rigid / brittle	1	
		iii	(5%) partially molten / rheid / plastic / solid that flows / ductile	1	not <i>semi molten</i>
		iv	asthenosphere / low velocity zone / LVZ	1	
	b	i	base of the crust / line between A and B	1	dashed line at base of crust on the diagram
		ii	use of P / S waves / body waves reflection / refraction timing of wave arrivals / seismic waves speed up in the mantle / two sets of waves incompressibility / density / rigidity controls velocity changing composition of the layers causes refraction / reflection	1 1 1 1 1 any 2	not <i>diffraction</i> or <i>deflection</i> but not <i>slow down</i>  mark diagram as text

Question		Expected Answers		Marks	Additional Guidance
c			oceanic areas	continental areas	allow composition of sedimentary, metamorphic and igneous for continental mafic rocks = basalt, dolerite, gabbro single figure age must be a range ending at the Present / Quaternary allow periods or numeric answer single figure 1 – 2 correct = 1 3 – 4 correct = 2 5 – 6 correct = 3 7 – 8 correct = 4
		average composition	mafic / basic / basaltic / any mafic rock	silicic / acid / intermediate / granite / granodiorite / felsic / andesite / rhyolite any appropriate silicic or intermediate rock	
		average density (g/cm ³)	2.9 +/- 0.1 g/cm ³	2.7 +/- 0.1 g/cm ³	
		age range	Present / Quaternary to Jurassic 0 – 200 Ma +/- 20 Ma	Present / Quaternary to Precambrian 0 – 4000 Ma +/- 200 Ma	
		average thickness (km)	7 km +/- 3 km	35 km +/- 5 km	
d		definition	feature		
		deep ocean basin with a depth of between 3 and 5 km	abyssal plain	1	
		line of volcanic mountains rising 2 to 3 km above the ocean basin. Has an axial rift valley.	mid-ocean ridge	1	
		very deep, linear valley in the ocean parallel to fold mountains and island arcs	deep sea trench	1	
Total				14	

Question	Expected Answers		Marks	Additional Guidance
3 a i	antiform / anticline overfold / overturned / asymmetric / dip measurements / closed / rounded		1 any 1	if candidates describe the syncline they can still get 1 mark for describing other features asymmetric etc
	ii		1	1 for both correct labelled axes as shown on the diagram allow if no labelling
b i	normal fault / dip slip		1	
	ii	tension / tensional / pulling apart		allow arrows
	iii	 <p data-bbox="309 1246 1227 1278">grooves / striations / scratches / lines parallel to direction of movement</p>	1 1 1	needs to be spelled correctly diagrams need labels or a description beneath name = 1 diagram = 1 label or describe =1

Question	Expected Answers	Marks	Additional Guidance
	<p>OR</p> <p>fault breccia</p>  <p>angular blocks / rotated blocks / clay matrix / gouge matrix / broken area / fragmented area between blocks</p>	<p>1</p> <p>1</p> <p>1 max 3</p>	<p>needs to be spelled correctly</p> <p>name = 1 diagram = 1 (needs fault label) label or describe =1</p> <p>accept mylonite between faults with an appropriate diagram</p> <p>marks only given for one of the structures so max 3</p>
<p>c</p>	<p>i</p> <p>line at base of coarse sandstone</p>	<p>1</p>	
	<p>ii</p> <p>deposition of clay, conglomerate, sandstone and mudstone rocks folded fault forms erosion / uplift / formation of the unconformity / time gap deposition of coarse sandstone</p>	<p>any 1</p> <p>4</p>	<p>2 correct = 1 3 correct = 2 4 correct = 3 5 correct = 4</p> <p>If two points are the wrong way round then ignore one and one out of the two is correct If upside down max 2 check for labels / numbers on the diagrams</p>
	<p>Total</p>	<p>13</p>	

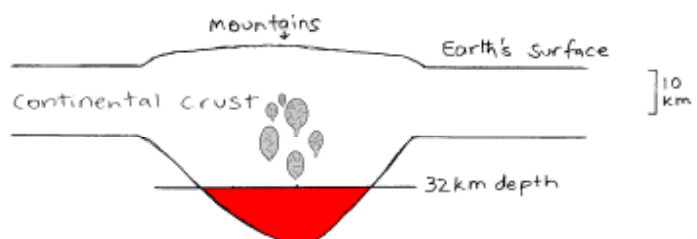
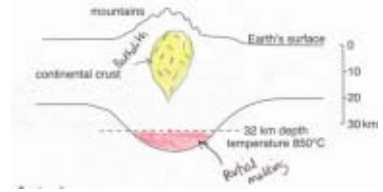
Question			Expected Answers	Marks	Additional Guidance
4	a	i	<p>island arc</p> <p>sea level</p> <p>plate y</p> <p>plate x</p> <p>lithosphere</p> <p>depth</p> <p>150</p> <p>300km</p> <p>asthenosphere</p> <p>Benioff zone</p> <p>x x earthquake foci</p> <p>correct Benioff zone = 1 correct island arc = 1</p>	2	<p>as on the diagram</p> <p>Benioff zone must be a zone and not a point even if only a small zone</p> <p>island arc could be a point anywhere in the raised area</p>
		ii	2 correct arrows = 1	1	see diagram above – must be converging
		iii	rising magma below the island arc	1	<p>must be labelled on the diagram above</p>
		iv	convergent / destructive / ocean v ocean collision	1	

Question		Expected Answers	Marks	Additional Guidance
b	i	 <p>rise over island arc and fall at the trench</p>	1	need both elements to be correct
	ii	high over the arc because of rising magma / volcanic activity low over the trench because of cold sinking convection currents / cold (subducting) plate	1 1	must be an explanation not just a description
c	i	Caribbean / Nazca / Pacific / Juan de Fuca / Cocos / Scotia / Phillipines	1	capital not required
	ii	Arabian	1	capital not required
d	i	fixed point of high heat flow / surface expression of a mantle plume / area of intra plate volcanic activity / volcanic activity not near a plate boundary	1	
	ii	volcanic activity at a fixed point / above a mantle plume / stationary mantle plume eruption of magma forms volcanic islands plate moves over the hot spot / plate moves over the mantle plume volcanoes removed from source / idea of islands moving away from the hotspot produces a line of increasingly old volcanoes away from the hotspot seamounts are old eroded volcanoes / sunken volcanic islands	1 1 1 1 1 1 any 3	mark diagrams as text allow annotations on map
Total			14	

Question	Expected Answers	Marks	Additional Guidance
5	fit of the continents fit along the coastlines (can be a diagram) edge of continental shelf / 500m / 1000m / 2000m / on continental slope few overlaps due to younger rock deposited few gaps due to erosion	1 1 1 1	only allow if mentioned in text mark diagrams as text if mentions erosion or deposition affects the fit then = 1 max 3
	rock types rocks have same characteristics / types / matching sequences (across the join) same age of rocks (across the join) example – (Precambrian) cratons (can be a diagram) example (Carboniferous) glacial deposits / tillites (can be a diagram)	1 1 1 1	mark diagrams as text max 1 if not Africa or South America max 3
	mountain chains same trend of mountain belts across the join of the continents (can be a diagram) structures such as folds / faults match up same rock types in the mountain belt across the join same age of mountains across the join	1 1 1 1	mark diagrams as text max 1 if not Africa or South America max 3
	Fossils outcrops of fossils match up / same fossils on different continents (could be a diagram) fossils that could not have crossed an ocean the same on both continents / could cross when joined eg reptiles / <i>Mesosaurus</i> / <i>Cynognathus</i> / <i>Lystrosaurus</i> eg plants / <i>Glossopteris</i>	1 1 1 1	mark diagrams as text does it need to say land based max 1 if not Africa or South America max 3
	Glaciations direction of striations shows movement of ice / striations match up erratics on both continents glacial rocks match up across the join Carboniferous ice sheet across Africa and South America / at poles together (could be a diagram)	1 1 1 1	mark diagrams as text max 1 if not Africa or South America max 3
			marks can only be gained from 3 of the categories
	Total	8	

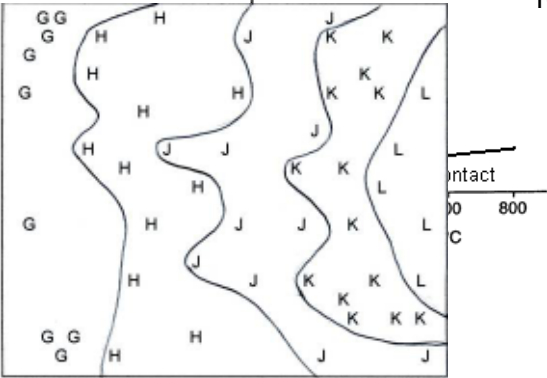
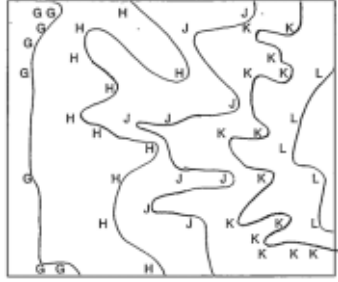
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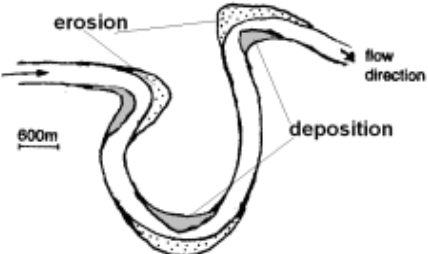
Question			Expected Answers	Marks	Additional Guidance																
1	a	i	A = granite; B = (garnet mica) schist; C = granodiorite; D = orthoquartzite / quartzite / (quartz) sandstone / <i>quartz arenite</i> E = shale; F = arkose/ greywacke	1 1 1 1 1 1	Allow <i>granite</i> for C if not given in A																
			ii	schistose / porphyroblastic / foliated / schistosity/ crystalline	1	e cf allow <i>gneissose banding</i> if B identified as gneiss above															
			iii	grain shape: rounded sorting: well sorted	1 1	If <i>sub</i> or <i>well</i> precede rounded, ignore															
			iv	alluvial fan / fluvial / high energy / flash floods / <i>wadi</i> close to source / before weathering causes K feldspar to break down / arid transport for short time / distance; rapid deposition	any 2	e cf. If F identified as <i>greywacke</i> allow <i>deposition from turbidity currents</i> as first marking point															
	b	i	45 – 52% >66% / 66%	1 1	Any figure(s) between and including 45-52 Any number from 66-78 <i>If out by 1% on BOTH max 1</i>																
			ii	<table style="width: 100%; border: none;"> <tr> <td></td> <td style="text-align: center;">mafic</td> <td style="text-align: center;">felsic</td> </tr> <tr> <td>augite</td> <td style="text-align: center;">✓</td> <td></td> </tr> <tr> <td>biotite mica</td> <td style="text-align: center;">✓</td> <td></td> </tr> <tr> <td>K feldspar</td> <td></td> <td style="text-align: center;">✓</td> </tr> <tr> <td>muscovite mica</td> <td></td> <td style="text-align: center;">✓</td> </tr> </table>		mafic	felsic	augite	✓		biotite mica	✓		K feldspar		✓	muscovite mica		✓	3 max	mafic minerals contain Fe and Mg 1 mark for 2 or 1 correct 2 marks for 3 correct 3 marks for 4 correct
				mafic	felsic																
augite	✓																				
biotite mica	✓																				
K feldspar		✓																			
muscovite mica		✓																			
iii	calcite	1																			
Total				17																	

Question		Expected Answers	Marks	Additional Guidance
2	a	7 ;3; 2; 5; 8; 1; 6	6	7 correct = 6: 6/5 correct = 5: 4 correct = 4 3 correct = 3: 2 correct = 2: 1 correct = 1 There is no need to write out descriptions.
	b i	sides at a very low angle <math><10^\circ</math> central crater / vent / layers of lava / lava flows labelled/ mafic / non viscous / runny lava	1 1	accept if angle is steeper but labelled as <math><10</math> Allow if comparison made between the two e.g gentle sides wide base / steep sides /narrow base <i>Max 1 if no labels</i>
	ii	sides at a steeper angle 30 – 50° layers of lava and pyroclasts / ash alternating and labelled silicic / viscous lava flow	1 1	accept if angle is steeper but labelled as between 30-50 Allow if comparison made between the two e.g gentle sides wide base / steep sides /narrow base <i>Max 1 if no labels</i>
	c i	 <p>area below 32km depth shaded below mountains above 32 km</p>	1 1	<p>Batholiths should be similar size to those shown in ms. Allow up to 28mm high and 15mm wide as shown below.</p> 
	ii	$\frac{850}{32} =$	1 1	calculation (even if figures incorrect) =1 correct answer =1 (allow 26.6)

Question		Expected Answers	Marks	Additional Guidance
		26.56°C/km <i>Allow 26.6 or 27</i>		If surface temperature is subtracted from 850. e.g. 20, then allow correct calculation 25.9
	d	heat from intrusion / by contact / thermal metamorphism / distance determines amount of heat; altered / changed / recrystallised / baking in country rock.	1 1	NOT <i>metamorphosed</i> as <i>altered</i> because <i>metamorphic</i> is already given in the question.
		Total	16	

Question		Expected Answers	Marks	Additional Guidance	
3	a	i	<p>contact regional contact</p>	<p>1 1 1</p>	<p>lines between areas need to be broadly correct – can vary in angle. must be drawn correctly on the axes</p> <p>1 mark if shown in correct relationship to each other</p> <p><i>Can go slightly above area</i></p>
		ii	<p><i>shaded area below 2kb and less than 200°</i></p>	<p>1</p>	
	b	i	<p>polymorph a mineral that has a fixed / the same composition; but occurs in different forms / shapes / has different habit</p>	<p>1</p>	
		ii		<p>2</p>	<p>3 correct = 2 1 or 2 correct = 1</p>
		iii	<p>500°C (+/- 10); 4kb (+/- 0.1 i.e. 3.9 - 4.1)</p>	<p>1 1</p>	<p>units not needed</p>
	c	i	<p>index mineral a (metamorphic) mineral that is stable under specific pressure and temperature conditions; indicate the metamorphic grade <i>mineral that defines a specific zone</i></p>	<p>1</p>	

Question	Expected Answers	Marks	Additional Guidance
ii	 <p>1-2 correct isograds= 3 correct isograds= 4 correct isograds=</p>	<p>1 2 3</p>	<p>If points joined max 1 If lines very wiggly (see below) max 2</p> 
iii	<p>L= gneiss J= schist G= slate / <i>phyllite</i></p>	<p>1 1 1</p>	
Total		16	

Question			Expected Answers	Marks	Additional Guidance
4	a	i	meander bend in south migrates further south / point bar deposition builds out meander bend in west migrates east meander bend in east migrates west 	any 2	ALT correct movement of a meander bend =1 correct labels =1 <i>If labelled erosion and deposition correct implies movement</i> Max 1 labels are on incorrect map
		ii	erosion / bank undercutting on outside of meander bend: deposition / point bars form on inside of meander bend	1 1	
	b	i	imbricate structure / imbrication	1	
		ii	Pebbles moved by traction / rolled along stream bed / flat pebbles stack / are deposited next to each other / when current reduces / <i>stacked against object / projection</i> long axes parallel provides maximum resistance to movement / pebbles dipping upstream / leaning downstream current flowing from left to right	any 2	arrow showing current direction on diagram = 1 <i>Allow ecf if flute casts = Max 1</i>
	c	i	have gentle windward slope /upstream slope / concave upwards; dip measurements can be taken/ direction of dip indicates palaeocurrent direction	1 1	ALT diagram = 1 label = 1

Question		Expected Answers	Marks	Additional Guidance
	ii		3	8 or 7 accurate =3 5-6 accurate =2 3-4 accurate =1 (allow +/- 2mm on diagram)
	iii	NE / 31° - 60° / from SW to NE	1	
d	i	river channel asymmetric beach symmetric; detail and accuracy of drawing	1 1	<i>pointed crests and rounded troughs</i>
	ii	unidirectional current in river and /two/ bi-directional on beach	1	only direction of arrows relevant must have both for 1 mark
Total			16	

Question			Expected Answers	Marks	Additional Guidance
5	a	i	M= suspension N= saltation P= traction	1 1 1	
		ii	solution	1	eef if <i>solution</i> stated for M above allow <i>suspension</i>
		iii	M= clay/ silt / <0.0125mm / <1/16mm / <i>argillaceous</i> N= sand / 0.01-2mm / 1/16 -2mm / <i>arenaceous</i>	1 1	very fine/ fine medium max 1
	b	i	angular boulders / fragments as they are protected by ice from attrition / fragments from freeze thaw weathering fall on ice poorly sorted as all sizes transported together fine clay / rock flour common as grinding rock flour at base / crushing at base	any 3	must have explanations for full marks 1 mark for description and 1 for explanation 2 marks for explanation 1 mark for description or vice versa accept <i>erosion</i> for <i>attrition</i>
		ii	boulder clay / moraine / till / erratics / breccia	1	
	c	i	angular	1	if very precedes angular ignore
		ii	sediment with mixed sizes	1	scale not essential can be any shape
		iii	transported grains are affected by attrition/ collide with other grains/ become abraded by contact with other grains; attrition / collisions round the grains; the longer the transport the more attrition/ greater rounding	any 2	<i>accept erosion for attrition</i>
		iv	quartz is harder/ survives attrition better than mica / mica is softer/ may be crushed / mica has cleavage / quartz has no cleavage	any 1	
Total				15	

Question		Expected Answers	Marks	Additional Guidance
6				weathering processes must be linked to rocks
		<p>burrowing <i>is a biological weathering process</i> carried out by animals / worms / reptiles/ sea creatures / invertebrates /mammals; activity brings rock material to surface more weathering can affect it near surface physically breaks up rock burrows allow gases / water to penetrate/ facilitates chemical weathering</p>	<p>1 1 1 1 1 1 1 max 4</p>	
		<p>carbonation <i>is a chemical weathering process</i> rainwater containing CO₂ becomes carbonic acid / acid rain ; it reacts with carbonates; dissolves limestone; to form soluble hydrogen carbonates / $\text{Ca CO}_3 + \text{H}^+ + \text{HCO}_3^- \rightarrow \text{Ca}^+ + 2\text{HCO}_3^-$</p>	<p>1 1 1 1 1 1 max 4</p>	
		<p>exfoliation <i>is a physical / mechanical weathering process</i> separation of surface layers of rock ; by thermal expansion and contraction / expansion due to pressure release environments with wide diurnal temperature range/ most common in hot arid environments / pressure release on erosion of overlying strata; onion skin weathering</p>	<p>1 1 1 1 1 1 1 max 4</p>	<p>diagram showing concentric layers = 1 mark</p>
		<p>hydrolysis <i>is a chemical weathering process</i> decomposition and reaction with water feldspars break down to form clay; silica in solution / insoluble residue; carbonate / bicarbonate /salts (of K, Na or Ca) in solution fastest in tropical / hot humid climates</p>	<p>1 1 1 1 1 1 max 4</p>	
		Total	10	

Question	Expected Answers	Marks	Additional Guidance
7			comparisons must be clear
	Differences <ol style="list-style-type: none"> 1. baked zone above and below sill but only below lava flow 2. sills may include xenoliths of overlying rock but lava flows only include underlying rock 3. sills have two chilled margins but lava flows have one 4. lava flows have vesicles or amygdales at the top but sills do not 5. phenocrysts have random orientation in sills but show preferred alignment in lava flows. 6. lava flows may have pillow shapes but sills do not 7. sills have medium sized crystals in the middle but lava flows have fine crystals only/ lava flows have reddened / weathered top 8. sills may have olivine rich layer at base but lavas do not 	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>	Max 4
	Explanations <ol style="list-style-type: none"> 1. Sill intruded between country rocks but lava extruded onto surface 2. there are no rocks overlying lava flows when they are formed 3. sills are cooled by contact with the country rocks at top and base 4. pressures are lower at the surface than at depth allowing gas bubbles to rise to the top of lava flows 5. movement of the lava causes any large elongate crystals to line up in the direction of flow. 6. eruption under water. 7. sills cool more slowly than lava flows / ora / lavas are weathered /oxidised at the surface 8. large sills have time for magmatic differentiation to occur, lava flows don't 	<p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p>	Max 4
	Diagrams (sill; lava flow) which illustrate the differences. Diagrams marked as text	2	
	Total	10	

F794 Environmental Geology

Question			Expected Answers	Marks	Additional Guidance
1	(a)	(i)	normal (1)	1	do not allow contradictions <i>dip slip</i> is insufficient
		(ii)	sandstone is a suitable reservoir rock / is porous and permeable (1) petroleum rises / migrates to the top of the reservoir rock due to low density (1) mudstone is a suitable cap rock / is impermeable / there is a cap rock above (1) the petroleum is concentrated in one place at the top of the reservoir rock adjacent to the fault / there is impermeable rock on the east side of the fault (1) the coal-bearing strata / shale is a suitable source rock (1)	any 2	not a <i>fault trap is present</i> – must explain function of trap
		(iii)	the source rock was coal / there is coal below the trap / methane/gas/volatiles escaped from the coal as it formed / the gas originated from terrestrial vegetation / the source rock did not contain plankton / temperatures were above 100°C in the source rock / high level of maturation / oil has escaped or migrated laterally <i>through the sandstone</i>	any 1	do not allow above 250°C
		(iv)	at top of sandstone adjacent to either side of salt dome (1) at top of sandstone beneath unconformity (1)	1 1	part of the letter must be in the reservoir rock max 1 for both traps shaded correctly with no letters
		(v)	salt dome and unconformity / lithological / stratigraphic (1) QWC mark for correct use and spelling of <i>salt dome and unconformity / lithological / stratigraphic as the technical terms (1)</i>	1 1	names must match labelled traps accept <i>evaporite</i> for <i>salt</i> accept correct named traps if labelling adjacent to salt dome and adjacent to unconformity if incorrect trap(s) allow ecf for correct spelling

Question		Expected Answers	Marks	Additional Guidance	
	(b)	(i)	desert sandstone – well rounded / well sorted grains / texturally mature / iron oxide cement (1)	1	one correct textural feature must be labelled for each diagram
			greywacke – poorly sorted / sub angular grains / texturally immature / (muddy) matrix (1)	1	max one for correct diagrams with no labels
			suitable scales for <u>both</u> – desert sandstone grains 2 – 0.25mm, greywacke grains 2 – 0.0625mm (1)	1	scales must be correct for grains drawn and units must be given
		(ii)	desert sandstone would be a good reservoir rock as <i>well sorted / well rounded grains / poorly cemented</i> give a high porosity / permeability (1)	1	allow ecf from (i) one mark for correct assessment that desert sandstone is better
			greywacke would not be a suitable reservoir rock as <i>poor sorting / matrix / cement</i> gives a low porosity / permeability (1)	1	one mark for reason max one if just compared porosity / permeability and correct assessment
	(c)	(i)	reserves are the <i>amount</i> of the resource that can be extracted (at a profit) / with existing technology / is available	1	
		(ii)	$(173,000,000,000 \div 1,700,000,000,000 \times 100) = 10.18 \% = \underline{10} \%$	1	must be given as correct whole number
	(d)		is difficult / harder / more expensive to extract / refine (1) as has a high viscosity / is extra heavy / energy costs are higher (1) extraction of unconventional petroleum has greater environmental impact / greenhouse gas emissions are greater / causes <i>increased</i> pollution / processing causes surface water pollution / large volume of waste material (1)	any 2	if merely states <i>difficult to extract</i> and <i>causes pollution</i> max one
Total			17		

Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	beds <i>drawn</i> dipping at 20 ° into road cutting on west side (1) slumping / slipping along bedding planes / blocks sliding off / rock falls / arrows indicating movement (1)	1 1	allow west side or both sides of diagram completed – ignore east side allow dip between 10 and 45° do not allow discussion of foliation / cleavage
		(ii)	weathered rock is loose / crumbly / very weak / incompetent some strategies can not be used e.g. rock bolts / there are no secure attachment points in weathered rock / weathered rocks have a high permeability / are difficult to drain / water flowing in saturates the rock / water lubricates the bedding planes	any 1	must explain cause of problem
	(b)	(i)	best choice of site is F because: shale at site F is <i>impermeable</i> so no leakage will occur (1) limestone at site E is <i>permeable</i> so leakage will occur / water will leak from site E through joints in limestone (1) faults at E are zones of weakness / may move / may have earthquakes / seismic activity / zones of permeability / leakage may occur along fault planes (1) shale at site F is incompetent / has low load bearing strength (1)	any 3	no mark for stating which site is best – must give reasons must explain the problem that will occur max one if state F is impermeable and E is permeable do not accept discussion of porosity
		(ii)	cement is a fine grey powder / made of (crushed) limestone (and clay) (1) sand and gravel is added / must be clean / not have impurities / gravel can be rounded so concrete can be poured / local sources used so properties vary (1) OR aggregate is crushed rock / unconsolidated construction material / sand sized and above / needs high or moderate crushing strength (1) gypsum is added to prevent cement setting too quickly (1)	any 2	max one for list of limestone / cement and sand / gravel / aggregate
	(c)		rock bolts (1) shotcrete (1) gabions (1) cut off curtain (1)	1 1 1 1	
			Total	12	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	near surface it is oxidising / copper sulfides are converted to sulfates, carbonates or oxides (1) copper / ore is taken into solution / dissolved / there is zone of leaching above water table (1) rainwater / groundwater percolates downwards (1) copper / ore is precipitated due to change in conditions / (from oxidising above) to reducing conditions immediately below the water table (1) copper sulfates, carbonates or oxides are converted to insoluble copper sulfides (1) unaltered / unweathered / original / primary copper ore is at depth (1)	any 3	accept correct named minerals accept spelling <i>sulphide</i> / <i>sulphate</i>
		(ii)	is more concentrated / enriched ore is concentrated into a smaller volume / enriched ore has a high(er) grade (than rest of deposit) / mining companies often mine the enriched area first to offset cost of exploration and development / less waste material produced	any 1	accept AW
	(b)	(i)	uranium is soluble (in oxidising conditions) (1) dissolved uranium is transported in groundwater / leached / through aquifers / through fossil river channels / through permeable rocks (1) uranium ore is precipitated at redox boundaries / where conditions change from oxidising to reducing / at the water table (1) <i>curved roll-type</i> deposits form (1)	any 2	
		(ii)	the wood may be <i>replaced</i> by uranium minerals / there is a close association between uranium deposits and organic matter / sulfur-reducing bacteria (present in decaying vegetation) may be involved in uranium ore formation / indicates the sandstone and conglomerate unit formed in a terrestrial environment / was a fossil river channel / anoxic conditions so no decay of wood / no decay indicates rapid burial	any 1	accept spelling <i>sulphur</i> do not accept idea of wood becoming the uranium

Question	Expected Answers	Marks	Additional Guidance	
(c)	<p>problem of acid mine drainage water / <i>dissolved</i> / <i>soluble</i> metals (1)</p> <p>metals / chemicals used in mining operations / from spoil heads / pollute aquifers / reach water table / move through permeable rocks (1)</p> <p>metal sulfide minerals / any correct named mineral react with oxygen to form sulfur dioxide / sulfur dioxide dissolves in water to form sulfuric acid / groundwater has a low pH (1)</p> <p><i>toxic</i> / <i>harmful</i> / <i>poisonous</i> metals such as lead / arsenic / cadmium may be present (1)</p> <p>pollutants in aquifer have a long residence time (1)</p>	any 2	accept spelling <i>sulphide</i> / <i>sulphuric</i> do not accept general comments about pollution – must explain	
(d)	(i)	nuclear waste is radioactive / takes a long time to decay / may be thermally hot / radioactive isotopes present have long half lives / waste needs to be isolated for at least 250,000 years	any 1	do not accept “NIMBY” or terrorism comments without explanation
	(ii)	<p>tectonically stable area / aseismic area / away from plate margins / away from faults (1)</p> <p>dry / impermeable rocks / water table needs to be as low as possible (1)</p> <p>crystalline / competent igneous or metamorphic rocks are best option (1)</p> <p>area needs to be free from effects of natural hazards such as flooding / hurricanes (1)</p> <p>waste needs to be isolated for at least 250,000 years (1)</p> <p>needs to be at depth (1)</p>	any 3	do not accept repeat of waste needs to be isolated for at least 250,000 years from part (i)
Total			13	

Question		Expected Answers	Marks	Additional Guidance
4	(a)	<p>hot <i>and</i> humid / wet tropical / Equatorial climate (1)</p> <p><i>abundant</i> terrestrial vegetation / high rate of tree growth (1)</p> <p>deltaic / delta top / swamp / marsh / bog / floodplain environment (1)</p> <p>low oxygen / anoxic / anaerobic / reducing / stagnant conditions / vegetation does not decay / decompose (1)</p> <p><i>rapid</i> sedimentation / deposition / burial / subsidence (1)</p>	1 any 2	a list given for max one do not accept contradictions e.g. vegetation and plankton
	(b) (i)	<p>2 points plotted correctly = 1 mark</p> <p>all 4 points plotted correctly and joined to form line graph = 2 marks</p>	2	accept line joining from point to point or line of best fit allow one small square tolerance
	(ii)	<p>the weight of accumulating sediment / overburden / load pressure (causes compaction) OR oxygen / water / volatiles are squeezed out / thickness of the seam decreases (1)</p> <p>QWC mark for correct use and spelling of descriptive term - <i>compaction</i> / <i>compacted</i> / <i>diagenesis</i> / <i>lithification</i> / <i>coalification</i> as the technical term</p>	any 1 any 1	must explain the process, not just a description of the graph accept correct spelling of one of the technical terms listed – ignore any others
	(iii)	anthracite has higher carbon content / higher rank / produces more heat energy when burnt / has a higher calorific value / produces less smoke / less volatiles / ash when burnt / contains fewer impurities / less sulfur / less pyrite	any 1	ora
	(c) (i)	takes millions of years to form / coal is burnt / destroyed when used / products are lost as gases (to the atmosphere) / cannot be renewed on human timescales	any 1	allow AW not <i>can only be used once</i> – must give explanation do not accept description of unsustainable
	(ii)	radioactive decay is source of heat / magma is constantly rising / volcanoes erupt repeatedly / (on a human timescale) the heating process is continuous / natural heat will not run out / more water available as rainwater falls and is heated / water is pumped back into ground after use to extend life of geothermal well / maintain pressure	any 1	allow AW not <i>can be used over again</i> – must give explanation
		Total	10	

Question	Expected Answers	Marks	Additional Guidance
5	<p><u>volcanic source</u> magma as source of heat (heats the surrounding groundwater) (1) high geothermal gradient / high enthalpy system (1) pressure at depth prevents the water boiling / water is superheated (1) borehole/s drilled into the rock for hot water to rise up (1) borehole/s drilled into the rock for cooled water / waste water / recycled water to go down (1) reduction in pressure causes the water to flash to steam (1) suitable labelled diagram (1)</p> <p><u>geothermal aquifer</u> occur in sedimentary basins / artesian basins (1) heat source is geothermal gradient / low enthalpy system / groundwater at 60+°C (1) geothermal aquifer is porous / permeable sedimentary rock / sandstone / limestone (1) impermeable rocks / mudstone / shale (above aquifer) act as insulators / prevent heat loss / act as cap rock (1) borehole for hot water to be <i>pumped</i> up (1) second borehole for waste water to be returned / maintain pressure / cold water in (1) suitable labelled diagram (1)</p> <p><u>hot dry rock</u> granite / batholith is heat source (1) contains higher content of radioactive elements / has higher than normal heat flow / has high geothermal gradient / geothermal gradient of ~40°C/km (1) cold water is pumped down one borehole (1) hot water / steam rises up second borehole (1) granite is artificially fractured (1) fractures increase the permeability / fractures created using explosives or high pressure water (1) suitable labelled diagram (1)</p> <p><u>use</u> passed through heat exchanger / is used to drive a turbine (1) used for space heating / swimming pools / greenhouses / hot water supply, etc (1)</p>	<p>max 5</p> <p>max 4</p> <p>max 4</p> <p>max 4</p> <p>max 2</p>	<p>max 5 for general descriptions of geothermal but no specific types</p> <p>any two sources described – if more than two described, award marks for best two</p> <p>two boreholes drilled with no explanation for max 1</p> <p>mark diagrams as text</p>
	Total	8	

Grade Thresholds

Advanced GCE Geology (H487)
 Advanced Subsidiary GCE Geology (H087)
 January 2010 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
F791	Raw	60	47	42	37	32	27	0
	UMS	90	72	63	54	45	36	0
F792	Raw	100	76	67	58	50	42	0
	UMS	150	120	105	90	75	60	0
F794	Raw	60	48	43	39	35	31	0
	UMS	90	72	63	54	45	36	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	5.8	32.7	51.9	82.7	98.1	100.0	55

55 candidates aggregated this series

For a description of how UMS marks are calculated see:

<http://www.ocr.org.uk/learners/ums/index.html>

Statistics are correct at the time of publication.

INSET event for GCE Geology

**An INSET event is being planned for the autumn term 2010
at
the British Geological Survey, Keyworth, Nottingham.**

See the OCR website next term for details.

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