

**GCE**

**Geology**

Unit **F792**: Rocks – Processes and Products

Advanced Subsidiary GCE

**Mark Scheme for June 2017**

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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.

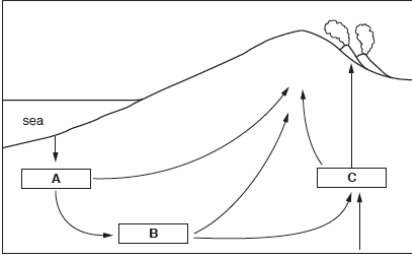
Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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## Annotations

Annotation	Meaning
	Unclear
	Benefit of doubt
	Contradiction
	Cross
	Error carried forward
	Ignore
	Benefit of doubt not given
	Poor diagram
	Reject
	Noted but no credit given
	Tick
	Omission mark
	Maximum response

Question			Answer	Marks	Guidance								
1	(a)	(i)	<table border="1"> <thead> <tr> <th>Processes</th> <th>Rock group</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>Sedimentary</td> </tr> <tr> <td>B</td> <td>metamorphic</td> </tr> <tr> <td>C</td> <td>Igneous</td> </tr> </tbody> </table>	Processes	Rock group	A	Sedimentary	B	metamorphic	C	Igneous	1	Must have all 3 rock groups correct for 1 mark
		Processes	Rock group										
A	Sedimentary												
B	metamorphic												
C	Igneous												
(ii)	<p>correctly labelled uplift close to volcanic activity ; correctly labelled burial close to surface ;</p> 	1	<p>Must have both correct for 1 mark</p> <p><b>ALLOW</b> any of the three upward arrows on left hand side for uplift</p> <p><b>ALLOW</b> any location close to surface above <b>A</b> for burial</p>										
		(iii)	correctly positioned sedimentary at 200°C, 200MPa ; correctly labelled metamorphic in middle zone on graph ;	1 1									
	(b)	(i)	<u>20cm/s</u>	1									
		(ii)	<u>20cm/s</u>	1									
		(iii)	weathering is the breakdown of rocks in-situ / without transport ;  erosion is the wearing away (denudation) of rock by transport ; erosion is the wearing away (denudation) of rock by named method of erosion ;	1  1									
		(iv)	saltation – clast drawn and labelled bouncing / skipping along the bed ;	1	<b>ALLOW</b> max 1 for correct diagrams without named processes								
			traction – clast drawn and labelled rolling / sliding / in contact with the bed ;	1									
		(v)	solution – transport of ions <b>OR</b> solutes <b>OR</b> soluble minerals <b>OR</b> named ions ;	1									
			suspension – transport of material in water or air without touching the Earth’s surface ;	1									
	(c)	(i)	<b>ANY</b> 1 point from: is the process by which sediments are lithified into sedimentary rocks ; is the process by which sediments undergo compaction <b>AND</b> cementation ; changes that take place in sediments at low temperature and pressure, at or near the Earth’s surface ;	1	<b>DO NOT ALLOW</b> changes to rocks								
		(ii)	groundwater / water containing ions / solutes / minerals in solution flowing through the	2	<b>ALLOW</b> oxidation of Fe								

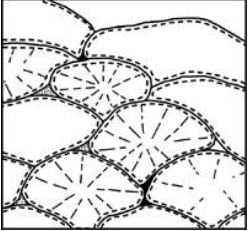
Question			Answer	Marks	Guidance
			sediment / pore spaces ; minerals / quartz are precipitated forming a cement ; cement binds the grains together to form the sandstone / cement infills pores ;		
		(iii)	Correctly plotted rose diagram	3	6 or above correct = 3 4 - 5 correct = 2 3 correct = 1  Max 2 if opposite sector of diagram shaded
		(iv)	NW / 300- 330 / from SE to NW	1	
			<b>Total</b>	<b>19</b>	

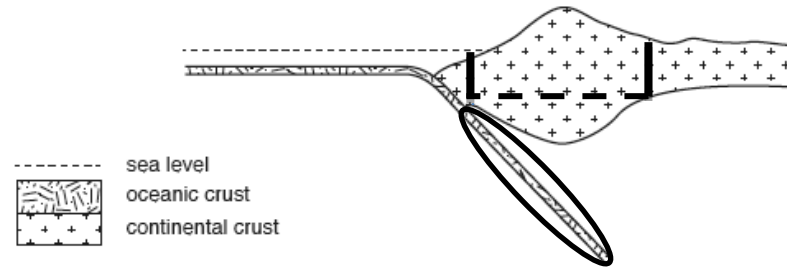


		<b>Answer</b>	<b>Marks</b>	<b>Guidance</b>
	<b>(d)</b>	<b>(i)</b> weathered / eroded / detritus / cliff collapse / land based sediment ;  rivers carry sediment ; wind carries dust / finest particles ; longshore drift <b>OR</b> rip currents move sediment to other locations ;	1	<b>ALLOW</b> rare shell fragments  Max 1 for stating transport
			1	
		<b>(ii)</b> symmetrical ripple mark drawn accurately <b>AND</b> asymmetrical ripple mark drawn accurately	1	<b>ALLOW</b> asymmetrical and symmetrical drawn accurately with one label for each diagram for 1 mark  <b>DO NOT ALLOW</b> overhang on slope
		<b>(iii)</b> bidirectional movement of water by tides / swash and backwash leads to the formation of symmetrical ripple ; unidirectional movement by ocean currents or longshore drift ;	1	
			1	
			<b>Total</b>	<b>15</b>

Question			Answer	Marks	Guidance
3	(a)	(i)	radiate from Mauna Loa / to the south west / south  low viscosity flows (basalt) are fluid and travel further ; lava flows on the steepest gradient travel further ; lava flows into the sea ; ; more lava flows to the SW of the island / protrudes to the SW ; multiple vents to the SE / Kilauea ; flow down valleys ; more activity at Mauna Loa ; stated distance of lava flow < 75km	1  2	<b>ALLOW AW</b> for radiate
		(ii)	Pahoehoe	1	
		(iii)	<u>Diagram</u> Accurate diagram with correct scale and vesicles labelled ;  <u>Explanation</u> gases come out of solution / bubbles formed due to drop in pressure ; gas bubbles are trapped in lava as it cools (rapidly) ; hole/vesicles are usually oval or ellipsoid in shape ; hole/vesicle is elongate parallel to direction of flow ; gas rises so hole/vesicle is found nearer to the top of the lava flow ;	1  2	
	(b)	(i)	Mafic	1	
		(ii)	J = dolerite K = gabbro	2	
		(iii)	<b>ANY</b> 3 points from: a hotspot is stationary column of heat / high heat flow / surface expression of mantle plume ; mantle plumes rise from deep within the mantle ; partial melting of peridotite forms mafic / basaltic magma ; partial melting of plume is caused by decompression ; partial melting in the upper mantle ; convection transports heat to the Earth's surface in rising columns ; hot material spreads when the plume head meets the base of the rigid lithosphere ;	3	

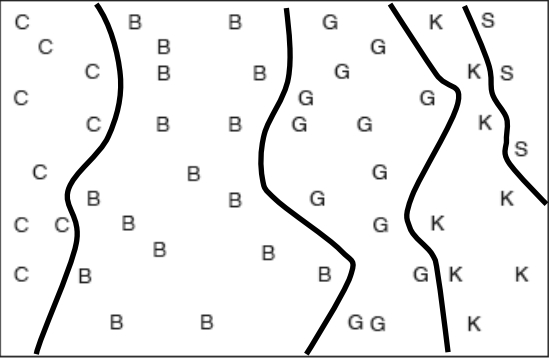


Question		Answer	Marks	Guidance	
	(c)	(i)			
		<p><u>Diagram</u> Correctly drawn pillow lava – bulbous / spherical / tubular lobes of lava / Draw in plan or cross section</p> <p><u>Explanation</u> form underwater ; Glassy exterior due to cooling in water / rapid cooling ; form during eruptions with relatively low effusion rates ; forms a lobe, which breaks when magma pressure rises and breaks through the skin creating a new lobe ; slow extrusion gives time for a thick crust to form on all sides of a pillow lobe ; pillows often have lineation or scrape marks on their sides ; as a pillow flow forms, the newest pillows are erupted from the top of the stack and flow outward / pile up on top of each other to form pillows ;</p>		<p>1</p> <p>2</p>	<p><b>ALLOW</b> any relevant label</p> <p><b>ALLOW</b> saggy bottom</p>
			<b>Total</b>	16	

Question			Answer	Marks	Guidance
4	(a)	(i)	<p>Correctly labelled diagram</p> <p>arrows in each plate pointing towards each other ;</p> <p>batholith in the thickened section of continental crust between vertical lines;</p> <p>partial melting of continental crust in region below dashed line ;</p> <p>partial melting of oceanic crust in region indicated by ellipse ;</p>	2	2-3 correct for 1 mark 4 correct for 2 marks
		(ii)	 <p>high silica / <math>\geq 66\%</math> silica / high quartz content / light in colour / viscous / Na plagioclase / potash feldspar / muscovite and biotite mica / high gas content / density of <math>\sim 2.7 \pm 0.1 \text{ g/cm}^3</math> / low temperature magma / immiscible / high percentage felsic minerals ;</p>	1	<b>DO NOT ALLOW</b> incorrect minerals  IGNORE reference to explosivity
		(iii)	<p>oceanic crust (subducting) partially melts ;</p> <p>mafic magmas partially melt continental crust ;</p> <p>partial melting of the lower crust / continental crust as a result of deep burial / tectonic thickening ;</p> <p>partial melting produces silicic magma ;</p> <p>magma rises because it is less dense ;</p> <p>silicic magma is viscous and therefore does not reach the surface ;</p> <p>assimilation of crust / country rock / contamination of magma ;</p> <p>fractional crystallisation / magmatic differentiation of mafic magma ;</p>	2	ALLOW AW for assimilation eg melts and incorporates
		(iv)	<p>high heat / high temperatures causes recrystallisation ;</p> <p>batholiths are major intrusions, heating large zone of country rock ;</p> <p>formed by contact metamorphism ;</p> <p>closest to the intrusion there is total recrystallization / high grade rocks <b>OR</b> further away from the intrusion recrystallisation is partial / low grade rocks ;</p> <p>width of aureole will depend on size / temp of batholith / dip / composition of country rock / composition of magma ;</p>	2	

		(v)	metamorphic rock	parent rock	2	1-2 correct for 1 mark 3 correct for 2 marks  <b>ALLOW</b> Mudstone / Clay / Slate and Ash for Spotted Rock <b>ALLOW</b> ANY other Limestone for Marble <b>ALLOW</b> ANY other Sandstone for Quartzite
			spotted rock	shale		
			marble	limestone		
			quartzite	Orthoquartzite		
	(b)	(i)	bomb (lava)		1	<b>ALLOW</b> Agglomerate
		(ii)	<p><b>ANY</b> 2 points from: ash / tuff / lapilli / pumice / agglomerate / ignimbrite / blocks / pyroclasts / CO<sub>2</sub> / N<sub>2</sub> / SO<sub>2</sub> / water vapour / sulphur / andesite <b>OR</b> rhyolite <b>OR</b> lava ;</p>		1	<p><b>IGNORE</b> pyroclastic flow / nuee ardentes / lahar</p> <p><b>ALLOW</b> bomb if not used in 4(b) (i)</p>
		(iii)	<p>ground level swelling indicates rising magma <b>OR</b> accumulating magma <b>OR</b> increasing gas pressure ; swelling is measured using tiltmeters <b>OR</b> GPS ;</p>		1	<p><b>DO NOT ALLOW</b> micro fracture opening up</p>
			<p>groundwater increased gas pressure will cause water levels to rise and suddenly drop before an eruption ; groundwater will be warmer ; groundwater pH will drop ; borehole <b>OR</b> well measurements are used to monitor changes ; increased local heat flow can reduce flow in aquifers ;</p>		1	
			<p>seismicity earthquake swarms immediately precede most eruptions ; short-period earthquakes are caused by fracturing of brittle rock ; long-period earthquakes are caused by increased gas pressure in volcano's magma chamber ; harmonic tremours result from magma vibrating in the vent as it moves upwards ; decrease in P and S wave velocities indicate accumulation of magma ;</p>		1	
<b>Total</b>					<b>14</b>	

Question			Answer	Marks	Guidance
5	(a)	(i)	L = gneiss M = (meta) quartzite N = schist P = slate	4	
		(ii)	M <b>OR</b> (meta) quartzite  does not contain platy minerals such as mica ; grains (quartz) rotate therefore cannot align ;	1  1	
		(iii)	<u>Name</u> garnet porphyroblasts / porphyroblastic <b>OR</b> schistosity / schistose texture  <u>Explanation</u> porphyroblasts grow during metamorphism and are surrounded by a finer grained groundmass ; porphyroblasts grow during metamorphism and the groundmass forms first ; garnet porphyroblasts grew before / during / after the foliation ;  foliation/schistosity wraps around the porphyroblasts ; alignment of platy minerals perpendicular / 90° to directed stress ;	1  1	Name must match explanation of corresponding texture
	(b)	(i)	<u>grade</u> measure of intensity / extent of metamorphism / amount of change / temperature and pressure conditions of which metamorphic rock forms ;  <u>index mineral</u> (metamorphic) mineral which is stable over a particular temperature and pressure range ;  <u>isograd</u>  <u>line</u> on a map joining points of equal metamorphic grade <b>OR</b> a <u>line</u> separating zones of different metamorphic grade <b>OR</b> <u>line</u> separating different index minerals ;	1  1  1	

	(ii)	lines correctly drawn		2	4 lines correct for 2 marks 1-3 lines correct for 1 mark  <b>DO NOT ALLOW</b> lines cutting through letters
	(iii)	towards NE / E / from SW to NE / from W to E		1	
	(iv)	Gneiss <b>OR</b> Hornfels Gneiss - high temp and high pressures <b>OR</b> Gneiss - Max temp 600 - 800 and max pressure 6 – 8 MPa <b>OR</b> Hornfels - high temp and low pressure <b>OR</b> Hornfels - 550-900 and 2- 4.5 kb		1 1	Temperature and Pressure must match rock stated
<b>Total</b>			<b>16</b>		

Question	Answer	Marks	Guidance
6	<p>(magmatic differentiation) causes a magma to change in composition <b>OR</b> produces different igneous rocks from a single parent magma ;</p> <p><b><u>fractional crystallisation</u></b>            olivine forms at high temperatures / early formed ;            olivine and pyroxene use the iron and magnesium from the magma / deplete magma ;            remaining liquid becomes enriched in silica / potassium / sodium / water ;            as temp falls pyroxene (augite), amphibole (hornblende), biotite form ;            crystallisation of plagioclase feldspar, Ca rich at high temps becoming Na rich at low temps ;            at lower temperature K feldspar, muscovite and quartz form ;</p> <p><b><u>Gravity settling</u></b>            early forming minerals <b>OR</b> olivine <b>OR</b> augite have a high density / denser than magma ;            early forming minerals <b>OR</b> olivine <b>OR</b> augite sinks ;            early forming minerals <b>OR</b> olivine <b>OR</b> augite form a <u>cumulate layer</u> at the base of intrusion ;            gravity settling removes the crystals from the remaining liquid so they do not react with the remaining magma ;</p> <p><b><u>Filter pressing</u></b>            during crystallisation there is a point where crystals and liquid exist together ;            due to weight of overlying crystals, liquid gets squeezed out ;            liquid forms a separate layer above ;</p>	10	<p>MAX 2 for Bowens Reaction Series diagram with correct sequence of minerals and temperature indicated</p> <p><b>DO NOT ALLOW</b>            repetition of mineral sequence</p> <p>If only two processes are discussed MAX 8</p>
	<b>Total</b>	<b>10</b>	

Question	Answer	Marks	Guidance
7	<p><b><u>boulder clay</u></b></p> <p>ice plucks rocks and transports them within the ice ;  glacier transports <b>OR</b> deposits poorly sorted material ;  deposition occurs when ice melts ;  angular fragments due to no erosion during transportation ;  clasts may be striated ;  abrasion during transport produced fine grained crushed rock fragments / rock flour ;  may contain erratics ;</p>		<p><b>max 4</b></p> <p>Mark labelled diagrams as text</p>
	<p><b><u>varves</u></b></p> <p>deposited in (glacier) lakes ;  sediment transported to lake in spring / summer thaw <b>OR</b> by melt water streams ;  fine sand / silt deposited in summer / spring / higher energy ;  mud / clay remains in suspension until winter ;  mud / clay deposited in winter (when lake freezes) / in low energy ;  laminated (fine grained) sediments are produced ;  each varve / pair of layers / light and dark layer represents one year's deposition ;</p>		<p><b>max 4</b></p> <p>Mark labelled diagrams as text</p>
	<p><b><u>sands and gravels</u></b></p> <p>transported by glacial melt water streams ;  deposited on the outwash plain ;  deposited by braided streams / reduction in velocity ;  moderate / poorly sorted ;  sub rounded / sub angular ;  immature composition / varied mineralogy ;  may show cross bedding / graded bedding / imbrication</p>		<p><b>max 4</b></p> <p>Mark labelled diagrams as text</p>
		<b>Total</b>	<b>10</b>

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