



**GCE**

**Geology**

**H414/03: Practical skills in geology**

Advanced GCE

**Mark Scheme for June 2019**

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

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

















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

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## Annotations

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

## Marking Annotations

Annotation	Use
	Benefit of Doubt
	Contradiction
	Cross
	Error Carried Forward
	Given Mark
	Extendable horizontal wavy line (to indicate errors / incorrect science terminology)
	Ignore
	Large dot (various uses as defined in mark scheme)
	Highlight (various uses as defined in mark scheme)
	Benefit of the doubt not given
	Tick
	Omission Mark
	Blank Page
	Level 1 answer in Level of Response question
	Level 2 answer in Level of Response question
	Level 3 answer in Level of Response question

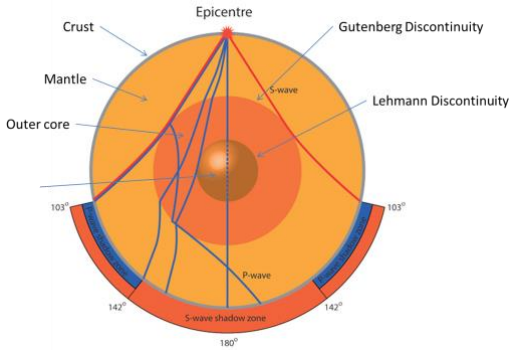
Question			Answer	Mark	Guidance	AO															
1	(a)	(i)	All 4 lines plotted correctly ✓✓✓	3	<p><b>ALLOW</b> a maximum of one incorrect point plotted per curve</p> <p><b>ALLOW</b> 3 lines plotted correctly = 2 marks</p> <p><b>ALLOW</b> 1 or 2 lines plotted correctly = 1 marks</p>	1.1b 1.1d															
1	(a)	(ii)	<table border="1"> <thead> <tr> <th></th> <th>Sample A</th> <th>Sample B</th> <th>Sample C</th> <th>Sample D</th> </tr> </thead> <tbody> <tr> <td>Coefficient of sorting (p)</td> <td></td> <td>0.90</td> <td>0.5</td> <td>0.4</td> </tr> <tr> <td>Degree of sorting</td> <td></td> <td>Moderately sorted</td> <td>Well/moderately sorted</td> <td>well sorted</td> </tr> </tbody> </table>		Sample A	Sample B	Sample C	Sample D	Coefficient of sorting (p)		0.90	0.5	0.4	Degree of sorting		Moderately sorted	Well/moderately sorted	well sorted	3	<p>Correct answer within +/- 0.2 of calculation for coefficient of sorting</p> <p><b>ALLOW</b> ECF for degree of sorting.</p> <p><b>ALLOW</b> any two correct degrees of sorting for 1 mark if calculations are incorrect</p>	1.1b 2.1b
	Sample A	Sample B	Sample C	Sample D																	
Coefficient of sorting (p)		0.90	0.5	0.4																	
Degree of sorting		Moderately sorted	Well/moderately sorted	well sorted																	

			✓✓✓		<b>ALLOW</b> any two correct calculations for 1 mark if degrees of sorting are incorrect	
1	(a)	(iii)	<p>sample C <b>OR</b> D ✓</p> <p>Any <b>one</b> from:</p> <p>dune sand is transported in a high energy / wind environment ✓</p> <p>dune sand usually has fine to medium grains (due to being transported for a long time) / wind does not transport very coarse grains ✓</p> <p>lower coefficient / more well sorted / sorted than the other samples ✓</p> <p>as wind loses energy sediment is sorted by grain size / coarsest deposited first and finest last ✓</p>	<p>1</p> <p>1</p>	<p>D has the best co-efficient of sorting</p> <p>C has the highest concentration of sediment into sieves</p> <p><b>ORA</b></p> <p>For example....</p> <p>The other sediments will be transported in lower energy environments</p>	<p>3.1a</p> <p>3.1b</p> <p>3.1d</p>
2	(a)		<p>(electrical) resistivity survey ✓</p> <p>if underlying rock contains copper it will be a good conductor / and will have low resistance ✓</p> <p><b>OR</b></p> <p>gravity survey ✓</p> <p>if underlying rock contains copper it will have a positive gravity anomaly ✓</p> <p><b>OR</b></p> <p>electromagnetic / EM survey ✓</p> <p>magnetic field induces a current in conducting materials such as copper ore ✓</p>	2	<p><b>DO NOT ALLOW</b> magnetic survey or vegetation sampling</p> <p>Must consider either conductivity or resistance</p> <p>Copper is denser and gives a higher reading</p> <p>Must consider anomaly</p>	2.1 a

2	b	(i)	Mean	606.18	73.06	2	Mean must be to 2 d.p and rounded up correctly	1.1b
			Mode	61	62			
			Median	76	64			
2	b	(ii)	<p>Any <b>three</b> from:</p> <p>mode / median show little variation in copper ppm (between the two data sets) so not useful ✓</p> <p>mean copper ppm differs greatly so is a useful indicator of difference (between the two data sets) ✓</p> <p>Mann-Whitney U-test shows a significant difference in copper ppm (between the two data sets) so is useful ✓</p> <p>the Mann-Whitney U-test was performed on 17 sets of data / more than 5 sets of data and resulted in a confidence level higher than 95% so can be trusted and is useful ✓</p>			3	<p><b>ALLOW</b> one mark maximum if candidate does not compare the two sets of data but demonstrates understanding of <b>two</b> from: mode / mean / median and Mann-Whitney U-test</p>	3.1c

2	(c)*	<p><b>Level 3 (5-6 marks)</b> Detailed method given including how to control variables and collect numerical data <b>AND</b> links method clearly to the characteristics of a placer ore.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</i></p> <p><b>Level 2 (3-4 marks)</b> Outline method is given with some detail <b>AND</b> explanation of the purpose of the method.</p> <p><i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1-2 marks)</b> Describes a basic method, which may be flawed. Links to geological reasons may not be clear.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i></p> <p><b>0 marks</b> No response or no response worthy of credit</p>	6	<p><b>Experimental set up:</b></p> <ul style="list-style-type: none"> <li>• Uses a flume tank / elongate container / drainpipe or other suitable equipment to allow one-way flow of water</li> <li>• Inclines the set up where necessary eg drainpipe</li> <li>• Controls flow of water and volume of water / volume described</li> <li>• Setting up barriers to slow water described</li> <li>• Discusses sources of experiment error and how to minimise this.</li> </ul> <p><b>Data collection:</b></p> <ul style="list-style-type: none"> <li>• Explains how to collect data qualitative</li> <li>• Explains how to collect data quantitative</li> <li>• Repeat measurements</li> </ul> <p><b>Characteristics of placer ore:</b></p> <ul style="list-style-type: none"> <li>• Chemically stable or relatively inert</li> <li>• Dense</li> <li>• Lack cleavage</li> <li>• Low fragmentation</li> </ul> <p><b>Composition:</b></p> <ul style="list-style-type: none"> <li>• Sand particles less dense than placer so tend to be deposited for example in a depression in the riverbed</li> <li>• Bigger sand / gravel are denser and can act as the placer deposit</li> </ul> <p><b>Location of placer:</b></p> <ul style="list-style-type: none"> <li>• Reference to inside of meander bends</li> <li>• Plunge pools</li> <li>• River confluence</li> <li>• River bed projections</li> <li>• Beaches</li> </ul>	<p><b>1.1c</b> <b>2.1b</b> <b>3.1c</b> <b>3.1f</b></p>
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<p>3</p>	<p>(a)</p>	<p>(i)</p>	 <p>✓✓</p>	<p>2</p>	<p>Arrows <b>must</b> touch exact lines for: crust; Gutenberg Discontinuity; Lehmann Discontinuity</p> <p><b>ALLOW</b> mantle / inner core / outer core if written within the correct zone</p> <p><b>ALLOW</b> one incorrect label for full marks</p> <p><b>ALLOW</b> 3 or 4 correct = 1 mark</p>	<p>1.1a</p>
	<p>(a)</p>	<p>(ii)</p>	<p>path of S wave confined to mantle and does not appear beyond 103°</p> <p><b>AND</b></p> <p>P waves must show refraction at discontinuities passing through the core ✓</p>	<p>1</p>	<p><b>ALLOW</b> straight line directly from 0 to 180° for the P wave</p> <p>Lines must be labelled</p>	<p>2.1a</p>
	<p>(a)</p>	<p>(iii)</p>	<p><b>Any 2 from:</b></p> <p>P and S waves arriving up to 103 degrees directly pass through the mantle / as mantle is rigid or incompressible / as mantle is plastic / as mantle behaves as a solid ✓</p> <p>P waves are refracted at the Gutenberg Discontinuity / Gutenberg and Lehmann discontinuities as they pass through the core to emerge beyond 142° ✓</p> <p>S waves cannot pass through the outer core as it is a liquid / has zero rigidity ✓</p>	<p>2</p>	<p><b>DO NOT ALLOW</b> P waves arriving between 142° either side of the epicentre</p>	<p>3.1a</p> <p>3.1b</p>

	<b>(b)</b>	<p><b>Correct labelled diagram of P wave</b> ✓  compression to (propagate) the wave  longitudinal movement of particles (rock) labelled  propagation of wave labelled  rarefaction described</p> <p><b>Correct labelled diagram of S wave</b> ✓  up and down / side to side movement to propagate the wave  transverse movement of particles (rock) labelled  vibrates at right angles / 90° to direction of travel  propagation of wave labelled</p>	2	<p>Likely to be two separate diagrams, one for P waves and one for S waves</p> <p>Requires two correct points for P waves AND two correct points for S waves to receive 2/2 marks</p> <p><b>ALLOW</b> 1 mark max for one point on P waves <b>AND</b> one point on S waves</p>	2.1b 3.1b
	<b>(c)</b>	<p>Any <b>three</b> from the following:</p> <p>labels correct layers on graph for <b>three</b> zones from: crust / mantle / lithosphere / outer core / inner core ✓  labels low velocity zone / asthenosphere ✓  labels states of matter for <b>three</b> different layers ✓  labels composition of three layers ✓  two discontinuities labelled correctly ✓  labels <b>three</b> of the following: rigid / zero rigidity / more rigid / less rigid / more incompressible / less incompressible ✓</p>	3	ORA	3.1b 2.1a

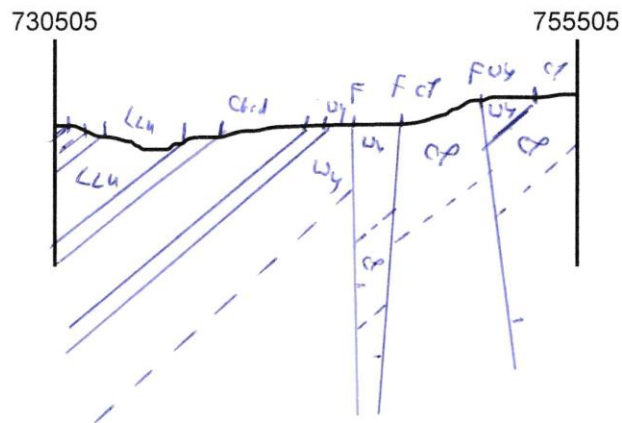
<p>4</p>	<p>(a)</p>	<p>(i)</p>	<p>bed thicknesses plotted correctly ✓</p> <p>correct lithology symbol and grain size ✓</p> <p>completed description section to include at least three rock names and their features ✓</p>	<p>3</p>	<p><b>ALLOW</b> one incorrect plot for thickness <b>OR</b> grain size for maximum marks</p> <p>Basalt grain size should be medium sand or finer</p> <p><b>ALLOW</b> a max of 2 marks if the log is drawn 'upside down'</p>	<p>1.1b</p> <p>2.1b</p>
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	(a)	(ii)	labelled diagram showing pebbles all leaning in same direction ✓	1	Must show the correct label for current direction for 1 mark Must have three or more fragments in the diagram	2.1a
	(a)	(iii)	identify the direction the majority of pebbles are leaning as this is the current direction / reference to a large clast causing a build-up of pebbles due to the current ✓  describes how to use a compass-clinometer to measure compass direction (flow direction) ✓	2	<b>DO NOT ACCEPT</b> references to clasts lying parallel to flow	2.1b
	(b)	(i)	death assemblage = X ✓	1		1.1a
	(b)	ii)	Any <b>two</b> from:  <b>Good/High preservation potential due to:</b> rapid burial prevents predation ✓ rapid burial creates anaerobic conditions /prevents aerobic conditions / inhibits life ✓ hypersaline conditions restricts life ✓ low energy preserves hard parts / lack of disarticulation ✓ short transport / low amounts of abrasion / attrition / erosion ✓ fine sediment size preserves/infills details / indicates low energy ✓ high energy increases fragmentation (due to collisions) ✓ preservation potential on land is poor OR preservation potential in marine environments is high ✓ robust / presence of hard parts ✓ anaerobic / anoxic conditions preserve hard parts ✓	2	<b>ORA</b>  <b>ALLOW MAX 1 mark</b> if palaeoenvironment is not mentioned	2.1a

	(c)	(i)	lava flow ✓	1		1.1c
	(c)	(ii)	Any <b>two</b> from the following:  reddish-brown top (due to erosion) ✓ vesicles present (towards the top of the flow) ✓ broken eroded top surface / pieces of lava flow (xenoliths / amygdales) in overlying bed ✓ presence of a fossil soil ✓ contact zone or chilled margin at the base and top ✓ one baked margin in the underlying rock ✓ alignment of crystals / flow banding ✓	2		2.1a
	(d)		<b>Shale</b> Any <b>one</b> from: re-crystallised rock forms as hornfels / andalusite slate (rock) / spotted rock ✓ chemical changes may result in porphyroblasts of metamorphic minerals e.g. mica / biotite / andalusite / sillimanite aluminum silicates can be reorganised to form many different minerals ✓  <b>Limestone</b> Any <b>one</b> from: re-crystallised limestone forms marble ✓ original calcite crystals grow larger and interlock / forms equidimensional calcite crystals / granoblastic texture / sugary ✓ any impurities may allow the formation of porphyroblasts such as garnet / wollastonite ✓	2	<b>MUST HAVE</b> one mark max for each rock type  <b>ALLOW</b> 1 mark max if no reference to re-crystallisation but marble AND hornfels / andalusite slate (rock) / spotted rock referred to	2.1a 3.1b

	(e)	<p>(ii)* <b>Level 3 (5-6 marks)</b> A detailed evaluation and judgement of how the pillow lavas formed, with clear links to the observable features in the photograph that allow this conclusion to be drawn. <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i></p> <p><b>Level 2 (3-4 marks)</b> An evaluation of how the pillow lavas formed with an attempt to link this to the observable features in the photograph. <i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.</i></p> <p><b>Level 1 (1-2 marks)</b> Some identification of observable features from the photograph <i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i></p> <p><b>0 marks</b> no response or no response worthy of credit</p>	6	<p>The top of level three should be able to make links between the different factors and make a clear judgement.</p> <p><b>Descriptive features observed:</b></p> <ul style="list-style-type: none"> <li>• pillows are the right way up</li> <li>• pillows rounded at top and less rounded at bottom</li> <li>• formed from basalt OR mafic rock</li> <li>• these layers show finer crystals at edges where they have come into contact with water and quenched</li> <li>• these finer layers are weathering in the pattern of onion layers</li> <li>• coarser centres cooled more slowly</li> <li>• evidence of dark material between pillows, which may be sediment from the sea floor.</li> <li>• evidence of fragmentation and erosion forming soil or debris</li> </ul> <p><b>Type of palaeo-environment:</b></p> <ul style="list-style-type: none"> <li>• marine underwater lava flow</li> <li>• super cooling of outer layers / formation of obsidian / glass</li> <li>• discussion of source of lava as a hotspot or fissure eruption or linked to specific igneous setting</li> <li>• erupted close to MOR / divergent plate margin</li> </ul> <p><b>Transport distance:</b></p> <ul style="list-style-type: none"> <li>• pillows have not flowed far as they are not elongated.</li> </ul> <p><b>Composition:</b></p> <ul style="list-style-type: none"> <li>• basalt / mafic rocks of fine to medium crystal size</li> </ul>	3.1a 3.1b 3.1c 3.1d
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5	(a)	<p>symbols used to show rock type (key not necessary) ✓</p> <p>dip of beds between 31° and 41° dipping towards west ✓</p> <p>3 faults correctly drawn with downthrows marked on the two western faults ✓</p> <p>correct drawing of graben structure ✓</p> <p>(Sample cross section)</p>	4	<p>Allow if there is a dip to the fault.</p>	<p>1.1d</p> <p>2.1b</p> <p>3.1b</p> <p>2.1a</p> <p>3.1a</p>
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	<b>(b)</b>	<b>(i)</b>	Any <b>two</b> from the following:  large WNW – ESE trending faults (running through the Silurian beds (Lower Ludlow Shales, Much Wenlock limestone and Coalbrookdale formation) ✓ smaller NW-SE trending faults truncated by the larger faults allowing relative dates to be established ✓ one of these faults is (dextral) strike slip / tear fault (displaces the Woolhope limestone) ✓ one fault has a downthrow to the south ✓ two dip slip (normal faults) form a graben ✓	<b>2</b>	<b>ALLOW NW-SE</b>	3.1c
	<b>(b)</b>	<b>(ii)</b>	Any <b>three</b> from the following:  fault reactivation by blasting / removal of weight ✓ faults can be a weakness causing collapse ✓ water could enter the fault, lubricating it causing slippage ✓ steeply dipping beds / beds dipping into the quarry increase the possibility of landslides ✓ steep slopes increase the possibility of landslides alluvium cover in the area of mining may become unstable and cause hazards when mining ✓ rock units, such as the overlying shales / limestone could contain water causing stability issues <b>OR</b> less shear resistance ✓	<b>3</b>		2.1a 3.1c
			<b>Total</b>	<b>60</b>		



**OCR (Oxford Cambridge and RSA Examinations)**  
**The Triangle Building**  
**Shaftesbury Road**  
**Cambridge**  
**CB2 8EA**

**OCR Customer Contact Centre**

**Education and Learning**

Telephone: 01223 553998

Facsimile: 01223 552627

Email: [general.qualifications@ocr.org.uk](mailto:general.qualifications@ocr.org.uk)

[www.ocr.org.uk](http://www.ocr.org.uk)

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Head office  
Telephone: 01223 552552  
Facsimile: 01223 552553

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