OCR
RECOGNISING ACHIEVEMENT

GCE

# Geology

Advanced GCE

Unit **F794:** Environmental Geology

# Mark Scheme for January 2012

Oxford Cambridge and RSA Examinations

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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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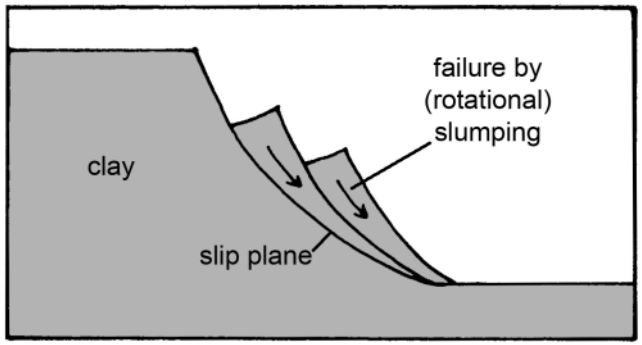
## Annotations

| Annotation | Meaning |
|---|---|
|  | Benefit of doubt given |
|  | Incorrect response |
|  | Error carried forward |
|  | Ignore |
|  | Reject |
|  | Benefit of doubt not given |
|  | Omission mark |
|  | Correct response |
| SEEN | Point has been noted, but no credit has been given |

## Subject-specific Marking Instructions

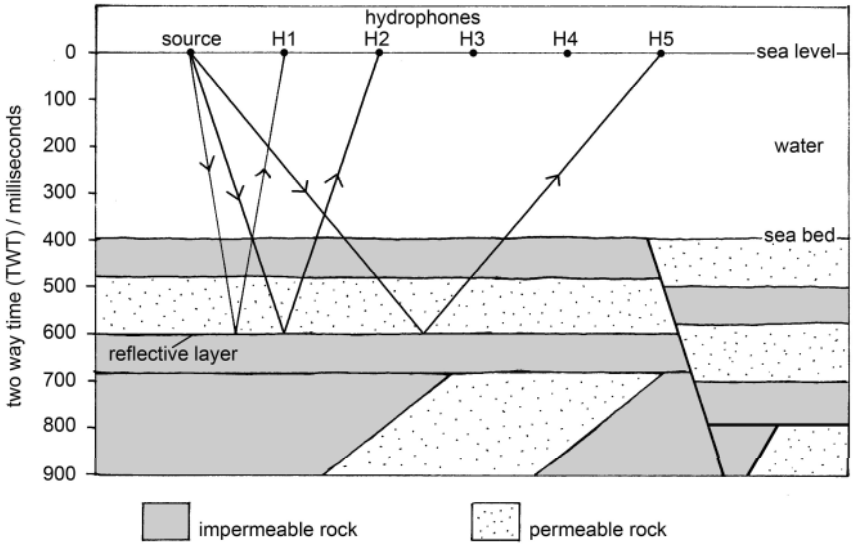
| Annotation | Meaning |
|---|---|
| **DO NOT ALLOW** | Answers which are not worthy of credit |
| **IGNORE** | Statements which are irrelevant |
| **ALLOW** | Answers that can be accepted |
| ( ) | Words which are not essential to gain credit |
| __ | Underlined words must be present in answer to score a mark |
| **ECF** | Error carried forward |
| **AW** | Alternative wording |
| **ORA** | Or reverse argument |
| **MAX** | Maximum mark allowed |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 1 | (a) | (i) | diagram showing <u>clay</u> moving downwards<br>  <br> | 1 | allow arrow as label<br>mark labels as text<br>max 1 if no diagram<br>accept diagram showing a flow type of failure<br>do not credit repetition on diagram and in text |
| | | | explanation – clay fails by slumping /<br>clay is weak / incompetent / has low load bearing strength /<br>clay absorbs water / becomes saturated | any 1 | |
| | | (ii) | rock will be strong / competent – less likely to fail (1)<br><br>sandstone is permeable – allows water into the rock making failure more likely (1)<br><br>bedding planes are lines of weakness / bedding planes form slip planes / rock will be affected by land slipping along the bedding planes (1)<br><br>direction / angle of bed <u>dip</u> is important – if dipping towards valley or has steep dip it will be unstable / if dipping away from valley or horizontal it will be stable(1)<br><br>degree of lithification / diagenesis important – if well-cemented / well-lithified it will be stronger and more stable / less permeable (1)<br><br>sandstone may be jointed / faulted – these are planes of weakness leading to rock falls (1)<br><br>degree of weathering – weathering weakens the rock making failure more likely (1) | any 2 | max 1 if factors stated with no evaluation<br><br>do not allow discussion of porosity on its own<br><br>ORA<br><br>ORA |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 1 | (b) | (i) | water adds weight (1)<br>water increases the pore fluid pressure (1)<br>rocks become saturated / waterlogged (1)<br>water acts as a lubricant / causes loss of friction / loss of cohesion / allows slippage (1) | any 2 | do not allow reference to weathering<br><br>allow absorbs water |
| | | (ii) | building on or at top of slope / removing material from base of slope / cuttings steepen slope / leaking water mains or sewage pipes / removing vegetation / creating impermeable surfaces / vibrations caused by traffic, machinery or blasting / agricultural methods such as ploughing | any 1 | |
| | (c) | | **wire netting** = to fix surfaces in place and catch small rock falls;<br>**shotcrete** = to protect the sides of a road cutting from weathering;<br>**retaining wall** = to support the sides of a road cutting | 1<br>1<br>1 | |
| | | | **Total** | **10** | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 2 | (a) | (i) | QWC mark for correct use and spelling of **<u>metamorphic aureole</u>** as the technical term | 1 | do not accept baked margin because of scale on diagram |
| | | (ii) | marble / calc-silicate rock | 1 | |
| | | (iii) | <u>use</u><br>statues / gravestones / kitchen surfaces / flooring / building (stone) / dimension stone / in cement<br><br><u>properties</u><br>crystalline / interlocking crystals / crystals make it impermeable (1)<br>strong / competent / has high load bearing strength (1)<br>soft / H = 3 / can be cut / can be carved (1)<br>attractive in appearance / can be polished (1)<br>uniform composition (1)<br>if used for cement – composed of calcium carbonate (1)<br>if used for cement – can be crushed (1) | any 1<br><br>any 2 | allow ecf from part (ii) for max 2, unless limestone is given for max 3<br>accept any other correct use for marble<br>if limestone is given allow aggregate<br><br>properties described must match use given<br>if limestone is given allow joints aid extraction |
| | (b) | (i) | dredging;<br>loose material is scraped / sucked up (from river bed)<br>OR<br>opencast / open pit mining;<br>overburden is removed / loose material is excavated using a dragline excavator or digger / benches cut for stability | 1 + 1 | description must match named method<br><br>allow hydraulic mining and use of high pressure water jet to wash material out |
| | | (ii) | noise and dust / landscape degradation / silt in water affects aquatic ecosystems / loss of habitat / reduces biodiversity / alters river's route / alters patterns of erosion or deposition / pollution from increased traffic / pollution from equipment e.g. oil spills / improved habitats for water fowl / use for recreation / country parks | any 1 | do not allow pollution without qualification |
| | | (iii) | <u>sand and gravel for concrete</u><br>clean with no impurities / no clay / low fines value /<br>needs high or moderate crushing strength / clasts must be strong / pebbles must be rounded (to allow concrete to be poured) or broken pebbles (allow interlocking of fragments) /<br>poorly sorted (so there are no gaps between pebbles) | any 1 | 1 for description of sand and gravel for concrete; 1 for description of aggregate for roadstone |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| | | | <u>aggregate for roadstone</u><br>must be strong / needs high crushing strength / high impact strength/ resistant to abrasion / durable / resistant to mechanical weathering / resistant to chemical weathering / resistant to corrosion / impermeable / skid resistant / does not polish / made of a mixture of minerals of different hardness / must bond well with bitumen | any 1 | |
| | (c) | | <u>rock types</u><br>granite is hard / resistant / crystalline / strong / competent rock so erodes slowly or most slowly (1)<br><br>limestone is strong / competent so erodes slower than mudstone / limestone is chemically reactive so weathers / erodes at a faster rate than granite (1)<br><br>mudstone is less resistant / soft / weak / incompetent so will erode quickly or most quickly / mudstone will be subject to landslips and slumping / mudstone will be carried away in suspension (1)<br><br>sands and gravels are loose / unconsolidated so will erode quickly or most quickly (1)<br><br>rocks in metamorphic aureole will be more resistant to erosion than mudstone / less resistant to erosion than granite (1)<br><br><u>geological structure</u><br>rocks of alternating resistance / hardness strike at an angle / at 90° to the coast producing the headlands and bays (1)<br><br>joints / bedding planes are lines of weakness so easily eroded (1)<br><br>faults are lines of weakness so easily eroded (1)<br><br>joints / faults / bedding planes will be enlarged to form caves / arches / stacks / inlets / blowholes / or detail of their formation(1) | 4 | max 1 for rock type if state hard / strong / named rocks form headlands and soft / weak / named rocks form bays with no explanation<br><br>max 1 for rock type if state hard / strong rocks erode slower than soft / weak rocks with no rock names<br><br>max 3 if only assess rock types<br>max 3 if only assess geological structure<br><br>accept comparison of strength of aureole rocks to the north and south of intrusion<br><br>accept discussion of formation by hydraulic action |
| | | | **Total** | **14** | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 3 | (a) | (i) | straight lines drawn on diagram from source to reflective layer to hydrophones H2 and H5 with arrows showing correct direction for both (1)<br><br>angle of reflection equal to angle of incidence for both H2 and H5 (1)<br><br>  <br> | 1<br><br>1 | must be within 3mm of mid point on reflective layer between source and hydrophone |
| | | (ii) | TWT through water = 400 milliseconds<br>TWT through rock = 200 milliseconds | 1 | both measurements must be correct for mark |
| | | (iii) | depth / distance = velocity x time OR shows understanding of this through working OR<br>depth of water = 1500 x (400÷1000) ÷ 2 = 300 metres OR<br>depth of rock = 5000 x (200÷1000) ÷ 2 = 500 metres (1)<br><br>total depth = 800 metres (1) | 1<br><br>1 | allow ecf from (ii)<br>max 1 if total depth given is 800,000 (answer in millimetres)<br>max 1 if total depth given is 1600 m (failed to divide answer by 2 as TWT) unless ecf of 800 and 400 milliseconds in working<br>award 2 marks if correct answer given with no working |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **3** | (b) | (i) | a cylindrical rotating drill is used / drill bit is studded with diamonds to cut through rock (1)<br><br>drill bit is cooled / lubricated by drilling mud / density of drilling mud is controlled by adding barite / barite is added so drilling mud reaches the bottom of the hole (1)<br><br>rock chips and drill core can be recovered (1)<br><br>recovered material is examined by geologists / mud loggers to identify rock types (1)<br><br>microfossils are used to find the age of rocks / correlate the geology between boreholes (1)<br><br>down-hole logging or wire-line logging can be carried out / geophysical instruments are mounted on a sonde and lowered into the borehole (1)<br><br>measurements of porosity / gamma ray spectroscopy / resistivity can be made (1)<br><br>correct extra detail of porosity / gamma ray spectroscopy / resistivity survey (1) | any 3 | |
| | | (ii) | vertical borehole drawn through the unconformity into the permeable rock below | 1 | borehole does not need to be drawn extending to sea level |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| **3** | (b) | (iii) | the unconformity makes a suitable trap structure (1)<br><br>the impermeable rock above the unconformity could be a suitable cap rock / impermeable rocks on either side concentrate the oil in one place (1)<br><br>the permeable rock below the unconformity could be a suitable reservoir rock or oil and gas could be stored in it (1)<br><br>any oil and gas will be found at the top of the reservoir rock due to its low density (1)<br><br>the fault is not a suitable trap because the oil and gas could escape through permeable rocks (on the other side) (1)<br><br>the rocks above the unconformity would not be suitable as they are horizontal / the oil and gas would not be concentrated in one place(1) | any 3 | allow ecf from (ii) for max 2<br>must explain not just describe |
| | | | **Total** | **12** | |

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 4 | (a) | (i) | amount / factor / number of times by which the metal is concentrated above its average crustal abundance to make an (economic) ore deposit OR<br>grade / percentage / concentration of metal in an ore deposit divided by its average crustal abundance | any 1 | accept AW<br>not concentration of metal in ore<br>must be a comparison with the average amount |
| | | (ii) | QWC mark for correct use and spelling of **cut-off grade** as the technical term | 1 | accept spelling with or without hyphen |
| | | (iii) | placer deposits – cassiterite / gold;<br><br>residual deposits – bauxite (accept: gibbsite / diaspore / boehmite);<br><br>secondary enrichment – chalcopyrite (accept: bornite / chalcocite / covellite / malachite / azurite / chrysocolla / native copper) | 1<br><br>1<br><br>1 | accept diamond for placer deposit<br>accept any correct named ore mineral that could be found in the deposit type<br>not metal names except gold |
| | (b) | | diagram showing ore deposits in plunge pool at the base of waterfall;<br><br>plunge pool is scoured out /eroded by turbulent water / boulders (1)<br><br>dense ore minerals are trapped in the plunge pool (1)<br><br>current velocity drops in the plunge pool / water leaving the plunge pool has a lower velocity (1)<br><br>ore minerals must be hard / physically resistant / chemically unreactive to withstand erosion and transport / abrasion and attrition (1) | 1<br><br>any 2 | max 2 if no diagram |

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>4</td><td>(c)</td><td></td><td><u>similarities</u><br>both involve chemical weathering / hydrolysis / leaching / soluble substances being removed in solution (1)<br>both involve infiltrating rainwater / permeable rocks (1)
<table>
<tr><th><u>differences</u></th><th>residual</th><th>secondary enrichment</th></tr>
<tr><td>solubility of ore minerals</td><td>insoluble</td><td>soluble</td></tr>
<tr><td>position</td><td>ore is close to surface / gangue minerals transported downwards</td><td>ore transported downwards / gossan left at surface</td></tr>
<tr><td>composition of ore minerals</td><td>oxides / hydroxides</td><td>mainly sulphides</td></tr>
<tr><td>conditions of formation</td><td>oxidising / above water table</td><td>reducing / anoxic / below water table</td></tr>
</table></td><td>any 3</td><td>each point should be a comparison between residual deposits and secondary enrichment<br><br>max 2 if no similarities described<br><br>accept AW</td></tr>
<tr><td></td><td>(d)</td><td>(i)</td><td>heavy metals are toxic / poisonous / harmful / include lead / arsenic / cadmium / mercury (1)<br>heavy metals can contaminate groundwater / aquifers / drinking water in reservoirs (1)<br>heavy metals in soils can be taken up through plant roots / ingested by (grazing) animals (1)<br>plants and animals exposed to heavy metals in soils can be eaten by humans (1)<br>heavy metals bio-accumulate / are not broken down / are not excreted by the human body (1)</td><td>any 2</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>soil samples / stream sediment samples are taken (1)<br>correct extra detail of soil / stream sediment survey method (1)<br>samples are <u>analysed</u> for the heavy metals (1)<br>results are plotted on maps / geochemical atlases are compiled (1)<br>baseline / background values can be established (1)<br><u>geochemical anomaly</u> / concentrations of heavy metals above their normal background values can be identified (1)<br>interpretation requires an understanding of how metals are dispersed / spread out during weathering / erosion / transport (1)</td><td>any 3</td><td>allow any correct named analytical technique</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>16</td><td></td></tr>
</table>

| Question | | | Answer | Mark | Guidance |
|---|---|---|---|---|---|
| 5 | | | components of an artesian basin | max 6 | max 4 for labelled diagram(s) |
| | | | 1 requires an aquifer / suitable named rock; | 1 | max 4 if no diagram(s) |
| | | | 2 aquifer must be porous and permeable; | 1 | |
| | | | 3 extra detail of porosity / permeability, e.g. has well rounded/well sorted grains / has little or no cementation / is poorly consolidated / unlithified / has good interconnections between the pores / jointed rock; | 1 | marking points may be shown as labels on diagram(s) or described in text |
| | | | 4 aquifer must be confined / overlain by aquiclude / impermeable rock / suitable named rock type; | 1 | |
| | | | 5 water is under (high) hydrostatic pressure; | 1 | |
| | | | 6 artesian basin has a syncline / synform structure drawn or labelled; | 1 | |
| | | | 7 has recharge zones / water percolates into aquifer at edges of basin | 1 | |
| | | | how drinking water can be extracted from artesian basins | max 6 | |
| | | | 8 when a well is sunk into an artesian basin the water will rise up the well / flow out onto surface / pumping costs are low; | 1 | |
| | | | 9 (hydrostatic) pressure will be greatest in the centre of the artesian basin / where the hydrostatic head is highest; | 1 | |
| | | | 10 as water is extracted the level of water table falls / a cone of depression forms / water will need to be pumped out; | 1 | |
| | | | 11 as water is extracted a hydraulic gradient is set up / water flows in towards the well / the (hydrostatic) pressure drops; | 1 | |
| | | | 12 rocks act as natural filter / purify water; | 1 | |
| | | | 13 no loss of water through evaporation / less seasonal than surface water supplies; | 1 | |
| | | | 14 discussion of problems – subsidence / salt water encroachment at coast / long residence time of pollutants, etc. | 1 | |
| | | | **Total** | **8** | |

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