OCR
RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE

Unit **F794:** Environmental Geology

Mark Scheme for June 2011

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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Question			Expected Answers	Marks	Additional Guidance
1	(a)	(i)	equatorial / <u>wet</u> or <u>humid</u> tropical	1	**accept** just tropical if wet / high rainfall is referred to in 1a (ii)
		(ii)	delta / delta top / swamp / marsh / bog / floodplain environment abundant trees / high rate of vegetation growth / presence of peat anaerobic / anoxic / reducing / stagnant / low oxygen conditions / vegetation did not decay / decompose (rapid) subsidence / burial / high rates of sedimentation description of compaction or diagenesis due to weight of overlying sediments / coalification giving coal series or detail of volatiles driven off coal seams formed in repeated cyclothems	**any 3**	
	(b)	(i)	**QWC** mark for correct use and spelling of **<u>unconformable / unconformably / unconformity</u>** as the technical term	1	
		(ii)	the rocks were folded into an <u>anticline / antiform</u> the Coal Measures rocks have been eroded off	**any 1**	
	(c)		opencast coal mining – arrow labelled **B** anywhere where the Coal Measures outcrop at the surface concealed coalfield – arrow labelled **C** anywhere where the Coal Measures are overlain by the Permo-Triassic sandstones	1 1	 **C** can be labelled in the Coal Measures or at surface above PT
	(d)		faulting disrupts production / faulting offsets or displaces coal seams faults allow water to enter and cause flooding dips are too steep for mechanised mining	**any 2**	allow seams are not continuous or they are laterally discontinuous so seam thins or washed out – though it is not obvious on the cross section

Question			Expected Answers	Marks	Additional Guidance
	(e)	(i)	overburden is removed / piled up to form spoil heap stripping ratio of less than 20:1 is economic / maximum depth 200m sides of open cut must not be too steep / benches are cut for stability coal and rock may be broken up by blasting / (dragline) excavator used to remove coal restoration or reclamation as site infilled or put back into use / site backfilled with overburden after mining	any 3	**max 1** for coal is extracted / quarried at surface (and hole filled in) **accept** AW
		(ii)	higher rates of coal production can be achieved in opencast mining opencast mining requires a smaller workforce / wages are lower / has lower set up costs / no tunnels or shafts needed opencast mining requires less specialised or high tech equipment / no roof supports has no requirement for pumping / ventilation / thinner seams can be mined at a profit	any 1	**accept** ora allow safety if linked to gas risk and ventilation, flooding and pumping or collapse and tunnels or support
			Total	**14**	

<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>rich in organic matter / contains plankton / high carbon content / contains hydrocarbons or sapropel
dark coloured / black
fine grained / mudstone / shale / clay</td><td>any 2</td><td></td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>
<table>
<tr><th>geothermal gradient (°C / km)</th><th>depth at which 50°C is reached (km)</th><th>depth at which 200°C is reached (km)</th></tr>
<tr><td>10</td><td>5.00</td><td>20.00</td></tr>
<tr><td>20</td><td>2.50</td><td>10.00</td></tr>
<tr><td>30</td><td>1.67</td><td>6.67 / 6.66 / 6.7</td></tr>
<tr><td>40</td><td>1.25</td><td>5.00</td></tr>
<tr><td>50</td><td>1.00</td><td>4.00</td></tr>
<tr><td>60</td><td>0.83</td><td>3.33 / 3.3</td></tr>
</table>
</td><td>2</td><td>2, 3 or 4 correct = 1 mark
5 or 6 correct = 2 marks

accept fractions or numbers to 1 decimal place or more</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>3, 4 or 5 points and line plotted correctly = 1 mark
all 6 points plotted correctly and joined with line = 2 marks</td><td>2</td><td>allow ecf from b (i)</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>2 (+ / -0.5) to 8 (+ / -0.5) <u>km</u></td><td>1</td><td>allow ecf from b (ii)
must have correct units (km)</td></tr>
<tr><td></td><td></td><td>(iv)</td><td>it denatures / is destroyed / breaks down / is carbonised / turns into gas</td><td>any 1</td><td></td></tr>
<tr><td></td><td>(c)</td><td></td><td>oil migrates down pressure gradient / migrates from high pressure to low pressure

oil is less dense than water in pore space so percolates upwards

oil will migrate upwards until it meets a cap rock / impermeable rock</td><td>any 2</td><td></td></tr>
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Question			Expected Answers	Marks	Additional Guidance
	(d)		diagram of fault with labelled permeable rock or reservoir rock or suitable named rock on one side of fault <u>and</u> impermeable rock or cap rock or suitable named rock above reservoir rock <u>and</u> on other side of the fault	**1**	no diagrams = 0 **max 2** if only one diagram drawn mark labels as text
			diagram of salt dome with permeable rock or reservoir rock or suitable named rock adjacent to salt dome and impermeable rock or cap rock or suitable named rock shown above reservoir rock	**1**	shading or symbol acceptable for labelling on just one side
			oil (with gas above) drawn <u>horizontally</u> at top of reservoir rock adjacent to the fault and salt dome **on both diagrams**	**1**	
			Total	**13**	

Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	reserves are the amount of the resource that can be extracted at a profit or with existing technology	1	do not allow accumulation or store as alternatives to amount – must be a quantitative term
		(ii)	180 years	1	
		(iii)	grade – the amount or percentage of metal in the ore concentration factor – the amount or factor or number of times by which the metal is concentrated above its average crustal abundance concentration factor – it is the cut off grade or percentage of metal in an ore deposit divided by its average crustal abundance	1 any 1	**allow** AW 1 for grade; 1 for concentration factor allow word mineral instead of metal for concentration factor only
		(iv)	the deposits cover a large area of the island or there are numerous deposits which cause widespread landscape problems eg spoil heaps or noise/dust pollution or opencast mining operations the bauxite is mined by opencast methods – produces noise or dust from machinery or blasting opencast mining causes landscape degradation or destruction of unique habitats over a large area processing plants / refineries cause atmospheric pollution	any 1	must qualify pollution with discussion answers must qualify the effects to go beyond the question
		(v)	bauxite tailings are alkaline or toxic so cause surface or groundwater contamination bauxite tailings are difficult to dispose of due to high volume or alkaline surface storage ponds may leak / pumping tailings underground pollutes aquifers if tailings dry out they make harmful dust causes hypertension in people or health problems	any 1	must qualify pollution with discussion accept answers from part (iv) if no repetition

Question			Expected Answers	Marks	Additional Guidance
	(b)		reserves could go down because bauxite is being extracted reserves could go up because exploration finds more reserves could go up if technology improves allowing economic extraction of lower grade deposits cut off grade could change – if decreases, lower grade or smaller deposits become economic to mine / if increases, lower grade or smaller deposits become uneconomic to mine OR price of bauxite changes – if becomes more expensive, lower grade deposits become economic to mine / if becomes cheaper, lower grade deposits become uneconomic to mine	any 2	must qualify economics with discussion max 1 for 2 reasons but no statements of reasons up or down
	(c)	(i)	(intense) chemical weathering or carbonation or hydrolysis in hot and humid (tropical) or equatorial climate soluble elements or ions or minerals removed in solution / soluble elements or ions or minerals leached downwards groundwater with a pH of 4 – 10 removes silica leaves insoluble residue of aluminium (oxides and hydroxides) / bauxite at surface	any 3	groundwater must have an effect such as removes silica
		(ii)	more joints means more weathering and more bauxite / joints increase surface area available for chemical weathering or chemical reactions more joints increase permeability / allow water into rock / water is required for chemical reactions variations in clay content – clay is rich in aluminium / clay is the source of aluminium	any 2	must give explanations
			Total	**13**	

Question			Expected Answers	Marks	Additional Guidance
4	(a)	(i)	chalk	1	
		(ii)	sandstone **E**	1	not just sandstone
		(iii)	point correctly marked – porosity less than 5%, permeability less than 1 mD	1	
		(iv)	labelled diagram of sandstone **D** description of sandstone **D** as poorly sorted / cemented / compacted / close packing / no joints / has matrix between grains to show low permeability labelled diagram of sandstone **E** description of sandstone **E** as well sorted / no or poor cement / no matrix between grains / unconsolidated / loose packing / well jointed to show high permeability	1 1 1 1	**max 2** if no diagrams max 1 for unlabelled correct diagrams diagrams must have labels
		(v)	sandstone **E**	1	
	(b)		<u>description</u> – **QWC** mark for correct use and spelling of **<u>cone of depression</u>** as the technical term; <u>explanation</u> – there is a reduction in hydrostatic pressure / a hydraulic gradient is set up / water flows in towards well / water flows from high pressure to low pressure / lowering of water table or draw down / where water is pumped out faster than it is replenished	1 any 1	1 for description; 1 for explanation
	(c)		<u>renewable</u> – must have recharge zone / water is replenished by rainfall / goes round the water cycle / rainwater percolates down through pore space of rocks to water table; <u>sustainable</u> – provided rate of use / extraction does not exceed rate of recharge / provided natural systems are able to clean the water fast enough / provided aquifer does not become polluted	any 1 any 1	**allow** AW 1 for renewable; 1 for sustainable general answer but with correct ideas max 1
			Total	12	

Question			Expected Answers	Marks	Additional Guidance
5			seismically quiet / requires flat lying strata / thick and uniform beds / use of a suitable ready made hole in ground – old quarry / brick pit is common	1	mark diagrams as text
			leachate may pollute groundwater or aquifers / definition of leachate as (toxic) fluid formed by water dissolving soluble chemicals from the waste	1	
			high water table / water table level may vary – pollution more likely	1	
			porous and permeable rocks such as sandstone allow leachate migration	1	
			fine-grained, **impermeable** rocks (clays) / crystalline igneous rocks / metamorphic rocks (unless affected by jointing) / cementation all **act as a barrier to leachate**	1	
			limestone is generally unsuitable – may be dissolved by acidic leachate / may contain cavities / has beds and joints	1	
			weathering increases porosity and permeability – allows leachate migration	1	
			faults or joints or fractures increase permeability or allows leakage of leachate	1	
			tilted or folded beds allow lateral or down dip escape of leachate / anticlines may have tension joints on crests	1	
			collapse of rock faces can occur in clay / slippage along bedding planes causes landslips	1	
			clay lining / geomembrane lining / grouting can make the landfill site impermeable	1	
			drainage, collection and treatment of leachate can stop pollution	1	
			methane generated by decomposing waste requires venting or burning can be dangerous / cause explosions	1	
			correct labelled diagram showing leachate plume below landfill site		
			Total	**8**	

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