OCR
RECOGNISING ACHIEVEMENT

GCE

Geology

Advanced GCE

Unit **F794:** Environmental Geology

Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

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Question			Answer	Mark	Guidance
1	(a)	(i)	the percentage of carbon in the coal **OR** the amount of carbon in the coal **OR** the maturity of the coal **OR** the amount of energy produced when burnt **OR** the calorific value	1	any 1
		(ii)	peat → **lignite** → bituminous coal → **anthracite** lignite; anthracite	 1 1	
		(iii)	**description** the weight of accumulating sediment **OR** weight of overlying rocks **OR** load pressure **OR** compaction **OR** coalification **OR** diagenesis **OR** pressure causes thickness of the coal decreases **explanation** water **OR** volatiles are forced out causing the <u>carbon</u> content to increase	1 1	DO NOT ALLOW just temperature / pressure increases ALLOW volatiles squeezed out OR reduced
		(iv)	**physical properties** black colour; banded with dull and shiny layers **OR** powdery layers; low density **OR** specific gravity **OR** density in range 1.1 to 1.5 g/cm^3 **;** reflectance in range 0.5 to 1.5. **chemical properties** carbon content in range 45-85%; calorific value in range 20 to 35 kJ/g; total volatile content in range 45 to 25% **OR** volatiles present are a mixture of oxygen, hydrogen and nitrogen; contains layers of macerals **OR** vitrain **OR** fusain **OR** durain **OR** clarain.	1 1	any 1 any 1 allow 1 mark if 2 general points without values are made eg high carbon content <u>and</u> high calorific value OR low volatiles
		(v)	sulfur **OR** pyrite **OR** clay (minerals) **OR** mud **OR** silt **OR** sand **OR** quartz **OR** silica **OR** iron **OR** aluminium **OR** trace elements	1	accept sulfur spelled sulphur
	(b)	(i)	overburden	1	QWC mark for correct spelling

Question			Answer	Mark	Guidance
		(ii)	strength of the rock being removed – will affect angle of cutting sides **OR** cost and ease of removing overburden stability of the sides – may need to use geotextile or drains (as a ground improvement strategy) **OR** reduce angle of sides to stop slipping **OR** may have to cut benches permeable rock – may cause flooding **OR** pumping may be needed depth to water table – risk of flooding if high **OR** pumping may be needed **OR** could be contamination of groundwater water thickness of coal seam too thin **OR** lateral variation in thickness of coal seam **OR** seam splitting where coal seam splits into thinner seams – disrupts production **OR** makes it uneconomic to mine dip of coal seams **OR** beds – machinery cannot cope with steep dips faults displace the coal seam – disrupts production **OR** makes it uneconomic to mine presence of washouts **OR** where coal is replaced by channel sands and gravels – disrupts production **OR** coal seam is lost	3	any 3 max 1 for a description of 2 factors with no evaluation each point must have the description of the factor and the evaluation of the effect on mining
		(iii)	noise and dust from machinery **OR** noise pollution from blasting **OR** landscape degradation **OR** deforestation before mining **OR** destruction of habitats **OR** surface water pollution **OR** acid mine drainage water	1	any 1 must be a description
	(c)		open cut is backfilled with overburden **OR** landfill; contaminated soil is removed **OR** top soil is replaced and seeded with grass **OR** planted with trees **OR** planted with vegetation; polluted water **OR** acid mine drainage water can be treated – using settlement ponds **OR** reed beds **OR** active chemical treatment; re-contouring of slopes to a lower / stable angle.	2	any 2 max 1 for a list
			Total	**15**	

Question			Answer	Mark	Guidance
2	(a)	(i)	chilled margin	1	QWC mark for correct spelling
		(ii)	outer part of the intrusion cooled first **OR** cooled in contact with cold country rock as the intrusion cooled it contracted tensional forces were set up **OR** cooling joints formed joints opened at 90° to the tensional forces **OR** at 90° to the cooling surface	2	any 2
		(iii)	the source of the ore is hydrothermal fluids from the intrusion **OR** metals in the intrusion are in the hydrothermal fluid **OR** hot aqueous fluids contain metal ions in solution **OR** hydrothermal fluids accummulate at the top of the intrusion **OR** hydrothermal fluid with ore mineral dissolved in it the hydrothermal fluids moved out along the joints **OR** the hydrothermal fluids filled the joints **OR** the joints are zones of permeability **OR** the joints allow fluid circulation	1 1	
	(b)	(i)	**description** the ore minerals were precipitated out along joints; the limestone is porous and/or permeable; veins of ore formed along joints and bedding planes in the limestone; **explanation** the limestone is chemically reactive **OR** chemical reactions occurred between the limestone and the fluid; the ore minerals replaced the limestone; disseminated ore formed where ore minerals were precipitated in the pore space of the limestone;	1 1	any 1 for each part
		(ii)	shale and sandstone are chemically unreactive **OR** shale is impermeable and sandstone is well cemented **OR** both sandstone and shale are impermeable **OR** sandstone and shale do not show joints	1	ALLOW correct combinations of both sandstone and shale answers

Question			Answer	Mark	Guidance
	(b)	(iii)	**B** = cassiterite **C** = galena **OR** sphalerite temperature falls away from intrusion **OR** minerals precipitate out in order of temperature – high temperature ones first **OR** minerals precipitate out in order of solubility – least soluble first; point B is closer to the intrusion so higher temperature **OR** less soluble ore minerals will precipitate here; point C is further from the intrusion so lower temperature **OR** more soluble ore minerals will precipitate here	1 1	accept any other hydrothermal minerals correct for the locations any 1
	(c)		**magnetic survey** using a magnetometer **OR** detects variations in Earth's magnetic field strength may be done as a map or transect survey **OR** lines joining points of equal magnetic field strength are plotted on a map **OR** magnetic anomaly map is drawn **OR** ore minerals have a higher magnetic susceptibility so give a positive magnetic anomaly; **gravity survey** using a gravimeter **OR** detects variations in Earth's gravitational field strength; data are corrected for latitude **OR** altitude **OR** topography to give density of underlying rocks **OR** lines joining points of equal gravitational field strength are plotted on a map **OR** gravity anomaly map is drawn **OR** dense ore minerals give a positive gravity anomaly; **electrical resistivity** is measured by passing an electric current through the rock and using two probes **OR** electrodes to detect it; lines joining points of equal resistivity are plotted on a map **OR** metals are good conductors so give a positive anomaly **OR** ore minerals have a lower resistance (than surrounding rocks)	3	1 mark for method and 1 mark for additional detail of how method is used if only one method described – max 2 if more than two methods described – accept the best two descriptions if 2 methods are given with no detail max 1
			Total	**13**	

Question			Answer	Mark	Guidance
3	(a)	(i)	oil and gas are less dense <u>than the water</u> in the pore space **OR** oil and gas migrate upwards until they encounter an impermeable cap rock	1	
		(ii)	rounded <u>and</u> well sorted grains large pore spaces between grains holding oil **OR** high porosity high permeability **OR** good interconnections between pores **OR** indication of oil flow between grains little or no cement **OR** no matrix suitable grain size **OR** scale – grains 0.5 – 2 mm size	3	any 3 mark labels on diagram as text max 2 if no diagram
	(b)	(i)	top of gas field = <u>400</u> to <u>410</u> atmospheres base of sandstone directly beneath oil well = <u>600</u> to <u>610</u> atmospheres	1 1	ecf base of sandstone is 200 atmospheres more than top of gas field
		(ii)	**primary recovery** the oil initially flows to the surface due to this pressure difference; if the well is not capped off securely the pressure can cause a blow out **OR** gusher; as the oil is extracted the pressure reduces so it then has to be pumped out, **secondary recovery** involves injecting <u>gas above</u> the oil to maintain pressure; pumping <u>water below</u> the oil to maintain the pressure	3	any 2 for primary recovery any 2 for secondary recovery ALLOW general description of secondary recovery using both gas and water for 1 mark max 3

Question			Answer	Mark	Guidance
	(c)		the older rocks produce less oil because: older rocks are likely to be buried deeper so oil lost **OR** older rocks more compacted so less oil held **OR** older rocks have a lower porosity or permeability so less oil held; older rocks are more likely to have suffered metamorphism **OR** high temperatures (above 200°C) so the oil will have denatured / been destroyed; older rocks are more likely to have been deformed **OR** affected by tectonic movements **OR** faulting so the oil will have escaped **OR** oil has migrated to younger rocks; older rocks are more likely to have suffered weathering and erosion of cap rocks so the oil will have escaped; there may have been less plankton **OR** marine micro-organisms to form the oil in source rocks in the older rocks;	3	any 3 no mark for stating older rock produces less oil – must give reasons ora ALLOW 2 descriptions with no explanation for 1 mark
			Total	**12**	

Question			Answer	Mark	Guidance
4	(a)		NW receives more rainfall than the SE; NW has more lakes or reservoirs and rivers while the SE has more aquifers; NW is mainly underlain by impermeable rocks while SE is mainly underlain by permeable rocks NW made of crystalline **OR** igneous **OR** metamorphic rocks while SE made of sedimentary rocks **OR** has chalk **OR** limestone **OR** sandstone;	2	any 2
	(b)	(i)	porous <u>and</u> permeable rock capable of storing and /or yielding water; porous <u>and</u> permeable rock from which water flows relatively easily; a water bearing permeable rock.	1	any 1
		(ii)	it must be confined **OR** overlain by impermeable rocks **OR** overlain by an aquiclude	1	
	(c)	(i)	in a valley at a dyke **OR** intrusion at an unconformity at a fault	1	any 2 for 1 mark
		(ii)	permeable **OR** suitable named rock <u>and</u> impermeable **OR** suitable named rock in correct situation water table drawn and labelled in correct position <u>and</u> spring labelled in correct position	1 1	max 1 if diagram does not match the name of the spring type given

Question			Answer	Mark	Guidance
	(d)	(i)	hydroelectric power **OR** flood protection **OR** improved navigability for shipping **OR** irrigation for agriculture **OR** land reclamation	1	any 1 important use refers only to reason the dam was built so does not include recreational
		(ii)	flooding **OR** filling of reservoir **OR** construction of reservoir causes – loss of agricultural land **OR** villages drowned **OR** loss of archaeological sites **OR** loss of habitat submerged forests decay and release <u>methane</u> aquatic ecosystems are harmed due to changes in water depth **OR** water volume **OR** water temperature **OR** dissolved oxygen content **OR** fish cannot swim upstream to reach their spawning grounds over time the reservoir silts up **OR** accelerated (clear water) erosion downstream of dam risk of downstream flooding if engineers miscalculate how much water to release **OR** unexpected weather events may mean there is not enough time to draw down the reservoir before it overflows	2	max 1 for a list any 2
		(iii)	water adds weight **OR** increases load pressure **OR** increases pore fluid pressure **OR** crust has to adjust to increased load water acts as a lubricant **OR** water causes loss of friction **OR** water causes loss of cohesion **OR** water causes reduces brittle failure limit **OR** water causes movement on a fault **OR** reactivation of a fault	1 1	 The mark for fault must have movement / dislacement – not just presence of fault
			Total	**12**	

Question			Answer	Mark	Guidance
5			**rock type** • foundation rock (any suitable named) must have high load-bearing strength **OR** be competent – to support weight of dam and water; • underlying rock should be <u>impermeable</u> – to prevent leakage; • if constructed on permeable rocks – leakage will occur unless cutoff curtain or grouting is carried out **OR** dam will collapse; • clay / mudstone are unsuitable as weak rocks **OR** incompetent **OR** have low load-bearing strength – so may collapse **OR** slip; • limestone is unsuitable if it has solution features **OR** caves – may collapse or leak; • foundation rock should be uniform – to prevent problem of differential subsidence of the dam; • large depth of weathered rock – weakens rock **OR** increases permeability **OR** makes a poor foundation; • mineral veins containing toxic elements, eg lead, arsenic – contaminate water; **geological structures** • horizontal and/or strata dipping upstream – are stable; • strata dipping downstream – are unstable **OR** potential for slippage and collapse of dam **OR** could cause leakage; • beds on sides of reservoir could slip if dip down to reservoir – cause flooding **OR** collapse; • faults – form zones of permeability **OR** zones of weakness **OR** old faults may be reactivated **OR** juxtapose different rock types **OR** allow leakage; • joints – form zones of permeability **OR** weakness **OR** allows leakage; • synclines – may permit leakage **OR** allow water to bypass dam; • anticlines – may have slippage on limbs; • anticlines – may have <u>tension joints</u> on crest allowing leakage		max 5 marking points may be shown as labels on diagram(s) or described in text must describe and explain, not list ALLOW 2 descriptions with no explanation for 1 mark max 5 do not allow vague terms of dip away or towards unless made clear on a diagram
			Total	**8**	

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