

Mark Scheme for January 2013

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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

Annotation	Meaning
	Unclear
	Benefit of doubt given
	Contradiction
	Incorrect response
	Error carried forward
	Ignore
	Benefit of doubt not given
	Poor Diagram
	Reject
	Point has been noted, but no credit has been given
	Correct response
	Omission mark
	Maximum (marks available for) Response

Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

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

Question		Answer	Marks	Guidance
1	(a)	(i)	1	ALLOW <u>Speeton Clay</u> OR <u>Brent Group shales / clay</u> OR <u>Jurassic / Lias shales / mudstones / clays</u>
		(ii)	1	QWC mark for correct use and spelling of <u>unconformity / stratigraphic / stratigraphical</u> as the technical term
		(iii)	2	MAX 1 for 2 correct points without any reference to rocks shown on diagram DO NOT ALLOW oil is less dense than <u>rock</u>
		(iv)	1	DO NOT ALLOW escaped <u>down</u> the fault

Question		Answer	Marks	Guidance
	(b) (i)	<p><u>any three from</u></p> <ul style="list-style-type: none"> a (production) well OR borehole is drilled into the <u>reservoir rock / trap / through the cap rock</u>; directional / deviation / slant drilling techniques are used to withdraw oil from a large area; the well needs to be capped off to prevent blowouts OR the well needs to be capped off to prevent oil spills; the oil comes to the surface under natural pressure OR forms a gusher OR release of pressure causes oil to rise; the pressure is the result of gases coming out of solution OR the result of expansion of the gas above OR the result of water pushing up from under the oil OR the result of hydrostatic pressure; as the pressure reduces the oil is pumped out using <u>nodding donkeys</u> OR using <u>submersible pumps</u>; 20–30% of the oil can be recovered OR 70–80% of oil is left in the reservoir 	3	<p>ALLOW correct named rocks from diagram in part (a)</p> <p>MUST describe how the blowout is prevented</p> <p>ALLOW one correct number within the range</p>
	(ii)	to increase OR maintain the pressure	1	ALLOW oil is pushed up by water
	(iii)	<p>use of detergents reduces the surface tension of the oil OR loosens the oil from the grains which makes it easier to recover;</p> <p>use of bacteriological techniques bacteria / microbes digest oil OR breakdown oil OR metabolise large hydrocarbon molecules which lowers the viscosity of the oil OR lower viscosity oil flows better</p>	1 1	<p>MUST explain how each technique works</p> <p>MAX 1 if not clear which technique is described</p>
		Total	11	

Question		Answer	Marks	Guidance
2	(a)	(i) definition a rock with (high) porosity and permeability OR porous rock in which water can be stored OR permeable rock into which water can flow and be extracted from OR a rock that can store AND yield groundwater;	1	ALLOW joints / fractures increase water flow
		explanation limestone is well-jointed which increases permeability OR fractures increase permeability	1	
		(ii) QWC mark for correct use and spelling of recharge zone as the technical term	1	
		(iii) allows rain water / surface water to enter / refill the aquifer OR is the area of the aquifer open to the atmosphere OR is the area of the aquifer allowing replenishment of <u>(ground)water</u>	1	ALLOW ECF for correct function if technical term given in part (ii) is a spring
		(iv) hydraulic gradient – difference in hydrostatic pressure divided by the distance between two points OR difference in hydrostatic head divided by the distance between two points	1	ALLOW hydraulic pressure / head for hydrostatic pressure / head
		(v) $(120 - 100) / 200 = \underline{0.1}$	1	ALLOW ratio 1:10 OR <u>10%</u>
	(b)	(i) description water is removed from the pore space OR water is removed from between the grains OR the pore fluid pressure is reduced;	1	
		explanation grains are no longer supported OR weight of overlying rocks causes the rock to collapse downwards OR compaction occurs	1	

Question		Answer	Marks	Guidance
	(d)	water is pumped into the ground for storage until needed OR controlled flooding spreads water over the ground so it can infiltrate into the ground for storage OR stored groundwater is pumped into rivers to maintain river flow in dry periods OR sediment traps are used to ensure the groundwater is free of sediment prior to discharge into river OR weirs are used to ensure the groundwater is oxygenated prior to discharge into river	1	
		Total	13	

Question			Answer	Marks	Guidance
3	(a)	(i)	granite areas / 40°C/km – geothermal gradient plotted correctly as a straight line (0km=10°C, 1km=50°C, 2km=90°C, 3km=130°C, 4km=170°C, 5km=210°C); sedimentary basins / 30°C/km – geothermal gradient plotted correctly as a straight line (0km=10°C, 1km=40°C, 2km=70°C, 3km=100°C, 4km=130°C, 5km=160°C)	1 1	MAX 1 if both lines are correct but not labelled MAX 1 if both lines are correct but start at 0°C OR points are 10°C out MAX 1 if all points plotted correctly for both but not joined with lines ALLOW two correct points plotted and joined with a straight line for each gradient
		(ii)	granite areas = 2.2 km + / - 0.1 km AND sedimentary basins = 3 km + / - 0.1km	1	BOTH must be correct for 1 mark ALLOW ECF from graph
		(iii)	granite contains (a higher proportion of) <u>radioactive</u> minerals OR granite contains (a higher proportion of) <u>radioactive</u> elements OR granite contains (a higher proportion of) uranium / thorium / potassium (sedimentary rocks do not); radioactive decay produces heat OR granite is heated by radioactivity	1 1	ALLOW correct comparison of granite areas and sedimentary basins

Question	Answer	Marks	Guidance
(b)	<p><u>any three</u> from granite <u>batholith</u> drawn and labelled;</p> <p><u>two</u> boreholes drawn OR cold water is pumped down one borehole OR hot water / steam rises up second borehole;</p> <p>granite is artificially fractured using explosives OR granite is artificially fractured using high pressure water;</p> <p>granite is <u>impermeable</u> OR fractures increase <u>permeability</u>;</p> <p>water is passed through heat exchanger OR steam used to drive a turbine</p>	3	<p>MARK labels as text</p> <p>MAX 2 for drawing and labels without explanation one label must include enough detail to explain for MAX marks</p> <p>MAX 2 if the diagram shows a volcanic source or a geothermal aquifer</p>
(c)	<p>advantages</p> <ul style="list-style-type: none"> • renewable OR sustainable as there is a continuous supply of heat from the Earth OR magma is continually rising OR water can be re-injected to maintain pressure / get rid of waste; • reduces reliance on fossil fuels OR does not produce carbon dioxide OR does not produce greenhouse gas emissions; • can work continually day and night OR is not affected by changing weather conditions; • in the right location geothermal energy can be cost effective; <p>disadvantages</p> <ul style="list-style-type: none"> • if it is a <u>low enthalpy system</u> OR a <u>geothermal aquifer</u> it cannot be used to drive turbines OR it cannot be used to generate electricity; • requires suitable geology OR geographical areas are limited OR each geothermal well is only viable for 20-30 years OR needs to be near an area of population; • extraction of water / steam can cause subsidence OR trigger earthquakes; • groundwater is saline OR groundwater is corrosive / toxic OR salts may precipitate out and block pipes 	3	<p>MUST discuss, not list MAX 2 for advantages only MUST have an explanation for renewable / sustainable</p> <p>MAX 2 for disadvantages only</p>
	Total	11	

Question		Answer	Marks	Guidance										
4	(a)	<table border="1"> <tr> <td>description</td> <td>term</td> </tr> <tr> <td>the amount by which a metal is concentrated to make an ore deposit</td> <td><u>concentration factor</u></td> </tr> <tr> <td>a useful and valuable material</td> <td><u>resource</u></td> </tr> <tr> <td>the amount of metal present in the ore</td> <td><u>grade</u></td> </tr> <tr> <td>the amount of ore that can be extracted at a profit</td> <td><u>reserves</u></td> </tr> </table>	description	term	the amount by which a metal is concentrated to make an ore deposit	<u>concentration factor</u>	a useful and valuable material	<u>resource</u>	the amount of metal present in the ore	<u>grade</u>	the amount of ore that can be extracted at a profit	<u>reserves</u>	4	
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	(b) (i)	(ocean – ocean) convergent plate margin OR subduction zone OR island arc	1	ALLOW (ocean – ocean) destructive plate margin IGNORE ocean – continent										
	(ii)	<p><u>any two from</u></p> <ul style="list-style-type: none"> • source of magma is (partial) melting of subducted plate / subducted crust OR dewatering of subducted plate / subducted crust causes (partial) melting of overlying mantle wedge / base of crust; • magma rises as low density diapirs (on island arc side) OR (partial) melting increases the silica content of magma OR the magma becomes intermediate / silicic OR magma mixing occurs OR magma rises up the faults; • (some) magma cools at depth / within the crust to form granite intrusions; • (some) magma reaches the surface to form volcanoes / magma is erupted to form volcanic rocks 	2	ALLOW Indonesia is an island arc / convergent plate margin if not given in part (i)										

Question	Answer	Marks	Guidance
(d)	<p><u>any three from</u> <pre>(pre-existing) mineral veins at surface – are the source;</pre> <pre>weathering – releases the minerals OR allows the minerals to be transported;</pre> <pre>weathering / erosion – separates the ore into individual grains;</pre> <pre>transport – separates ore minerals from gangue minerals OR sorts the minerals OR winnows the minerals;</pre> <pre>tin minerals / cassiterite is hard / has hardness of 6–7 / has no cleavage – so survives abrasion and attrition / erosion / transport;</pre> <pre>tin minerals / cassiterite is insoluble / chemically resistant – so is not dissolved / taken into solution;</pre> <pre>the tin minerals / cassiterite is (preferentially) deposited – because it is dense;</pre> <pre>tin minerals / cassiterite is transported downstream and deposited on <u>inside of</u> meander bends / point bar / in plunge pools of water falls / upstream of projections into river bed / downstream of confluences – where the current velocity slackens</pre> </p>	3	<p>each marking point MUST contain both description and explanation</p> <p>ALLOW heavy</p>
(e)	<p>(i) <u>any two from</u></p> <ul style="list-style-type: none"> • leaching solution is acidic OR leachate contains (dissolved) toxic / poisonous / heavy metals OR leaching solution can contain cyanide which is poisonous; • leakage may cause surface water pollution OR affect aquatic ecosystems OR may cause ground water pollution OR may contaminate aquifers; • wildlife / birds are at risk of poisoning OR habitats could be harmed; • leakage could cause soil contamination 	2	

Question		Answer	Marks	Guidance
	(ii)	<p>crushing ore / tailings crushing produces fine grained tailings which are difficult to dispose of OR tailings may contain toxic metals OR tailings may contain harmful chemicals used in processing OR uranium tailings are radioactive OR bauxite tailings are alkaline OR tailings dams can fail allowing leakage into surrounding areas OR leakage into rivers / groundwater / aquifers OR crushing produces dust</p> <p>smelting ore causes atmospheric pollution / acid rain / releases sulphur dioxide / releases carbon dioxide / releases greenhouse gases OR emissions kill vegetation in surrounding area OR a 'dead zone' forms around the smelter OR emissions cause soil contamination in surrounding area</p>	1	<p>environmental problem described MUST match correct named mineral processing technique</p> <p>ALLOW discussion of environmental consequence of any other correct named mineral processing technique</p>
Total			17	

Question	Answer	Marks	Guidance
5	<p>geological factors <u>any four from</u></p> <ul style="list-style-type: none"> • rocks underlying the road / embankment need to be competent / strong / have high load bearing strength / suitable rock named; • foundations / embankments need to be on stable ground / no caves / no underground mine workings; • hard rocks will be expensive / difficult to cut through; • weathered rock in cuttings will be weak; • permeable rock allows water in which adds weight / lubrication leading to instability in cuttings; • embankments must be made of uniform materials OR cut and fill techniques may be employed; • angle of cutting depends on rock type – competent rock / correct named rock can have steep sides / will be stable OR incompetent rock / correct named rock needs shallow sides / are prone to failure; • if beds <u>dip</u> into cutting may get landslips / slumping / may be unstable; • if rocks are jointed / faulted / unconsolidated may get rock falls; • needs a local / cheap supply of aggregate for roadstone OR needs a local / cheap supply of aggregate for embankment fill; • description of suitable properties of roadstone – at least 2 points; 	4	<p>MARK labelled diagrams as text but DO NOT credit repetition on diagrams</p> <p>ORA for horizontal beds / beds dipping away</p>

Question	Answer	Marks	Guidance
	<p>stabilisation techniques <u>any four from</u></p> <ul style="list-style-type: none"> • slope modification – slope is reduced to lower angle OR benches are cut; • retaining wall – constructed of concrete OR gives toe support; • gabions – wire mesh boxes filled with rocks OR gives toe support OR prevents slumping; • rock bolts – used in competent rocks to prevent rock falls OR to pin loose rock to sound rock behind OR steel rods are cemented into rock faces OR rock bolt plates prevent rocks breaking out along joints; • rock drains – can be used to remove water OR reduce pore fluid pressure; • shotcrete – is sprayed concrete OR increases strength OR reduces permeability OR protects surfaces from weathering; • wire netting – fixes surfaces in places OR catches small rock falls; • vegetation – fixes soil in place OR reduces infiltration of water 	4	<p>MAX 1 for list of stabilisation techniques – MUST have minimum of 3 techniques listed</p> <p>for each MUST describe technique or explain its purpose</p>
	Total	8	

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