

Mark Scheme for January 2011

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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) | surface separating <u>unsaturated</u> rock above / <u>saturated</u> rock below / rock below has 100% water filling pore space / joints / fractures | any 1 | do not accept simplistic descriptions of level of water in rock |
| | (b) | (i) there is <u>permeable rock</u> / <u>an aquifer</u> (above) and <u>impermeable rock</u> / <u>an aquiclude</u> (below); at an <u>unconformity</u> ; the water table intersects the topographic/land surface at this point | any 2 | |
| | | (ii) water table meets the topographic/land surface at the spring and water table rises into hillside (below shale lens) | 1 | must be within 1mm of spring must not go through shale ignore anything above shale |
| | (c) | well rounded and well sorted grains / large pore spaces between grains / high porosity and permeability / little or no matrix / good interconnections between pores / indication of groundwater flow between grains; suitable grain size 0.0625 – 2 mm indicated <u>filtering</u> of water as it passes between the grains | 1 1 1 | max 1 if no relevant labels on diagram poorly cemented is neutral |
| | (d) | (i) QWC mark for correct use and spelling of <u>perched/unconfined</u> as the technical term | 1 | |
| | | (ii) the water will drain /move <u>downwards</u> | 1 | |
| | (e) | (i) draw down = <u>7m</u> +/- 1 | 1 | |
| | | (ii) hydraulic gradient = difference in hydrostatic pressure/hydrostatic head ÷ distance between two points = $7 \div 40$ – formula stated or correct working; = <u>0.175</u> allow between 0.15 and 0.20 (ratio from 1:7 to 1:5) | 1 1 | award 2 if correct answer given with no working allow ecf from (i) accept correct fractions |
| | | (iii) as water is abstracted a cone of depression forms; there is a reduction in hydrostatic pressure in the vicinity of the well; this causes a hydraulic gradient to be set up and water flows in towards well / water flows from high pressure (at C) to low pressure (at D) / the hydraulic gradient <u>increases</u> | any 2 | |
| | | Total | [14] | |

| Question | | | Expected Answers | Marks | Additional Guidance |
|----------|-----|-------|--|---------------------|---|
| 2 | (a) | (i) | Northern basin/Viking Graben/Central Graben of North Sea/west of Shetland for oil and/or gas / Southern basin of North Sea or Morecambe Bay/Kinsale Head in Irish Sea for gas only | any 1 | must shade and label oil and/or gas |
| | | (ii) | correct vertical sequence (bottom source rock / Kimmeridge Clay – middle reservoir rock / fractured chalk – top cap rock / clay); structure of <u>reservoir and cap</u> rock shown as an anticline; oil (and gas above) shown <u>horizontally</u> at top of reservoir below cap rock | 1 1 1 | |
| | | (iii) | maturation occurred due to increased temperature and pressure; compaction due to load pressure during burial; temperatures of 50 to 200°C (oil window); involvement of anaerobic <u>bacteria</u> ; plankton / marine micro-organisms are converted to sapropel / kerogen / hydrocarbons | any 2 | |
| | | (iv) | QWC mark for correct use and spelling of <u>migration</u> as the technical term | 1 | |
| | (b) | | oil spillages /oil slicks (from pipes/tankers/rigs/blowouts) / leakage of pipelines under sea / disposal of old oil rigs cause damage to marine ecosystems / marine habitats / marine life / birds / pollution of sea water / coastlines/ oil fires / flares causing <u>atmospheric</u> pollution/ ground subsidence / may increase seismic activity | any 1 | must qualify leakage / pollution with discussion of impact do not accept blowout unless linked to an oil spill |

| Question | | | Expected Answers | Marks | Additional Guidance |
|--------------|-----|------|---|--------------------------|--|
| 2 | (c) | (i) | <p><u>depleted oil/gas/hydrocarbon</u> reservoir; reservoirs /traps where all the recoverable oil/gas has been extracted; <u>reservoir</u> rocks are porous / permeable / capable of storing gas; geology is well known/equipment left over from when reservoir was in production can be used; 50% of the reservoir must be kept filled with gas to maintain pressure / as previously filled with hydrocarbons does not require injection of what will then become unrecoverable gas</p> <p>OR <u>salt caverns / mines</u>; evaporites are impermeable; old salt caverns can be used; new cavities can be created by solution mining/excavation; gas can be replaced/extracted quickly from this type of facility</p> <p>OR <u>aquifers</u>; rocks are porous/permeable (and capable of storing gas); there needs to be an impermeable cap rock / aquiclude above; an artificial gas field is produced by injecting gas into the pore space; the gas will need to be dried prior to use</p> | 1 any 2 | <p>1 for correct named facility, any 2 for description – must match named facility max 2 if more than one type of facility described</p> <p>do not accept salt <u>dome</u> as named facility</p> |
| | | (ii) | <p>danger of gas leaks which result in explosions / fires / gas is highly flammable collapse/surface subsidence (when gas is extracted) overfilling / high pressure could lead to failure</p> | any 1 | do not accept leakage without an explanation of the problem caused |
| Total | | | | [12] | |

| Question | | | Expected Answers | Marks | Additional Guidance |
|----------|-----|-------|---|------------|--|
| 3 | (a) | (i) | 2, 3 or 4 points plotted correctly = 1 mark 5 points plotted correctly = 2 marks | 2 | ignore any lines |
| | | (ii) | form by gravity settling/magmatic segregation/differentiation/fractional crystallisation; magnetite/chromite/ore minerals crystallise early/at high temperatures; mafic magma is fluid/has low viscosity; magnetite/chromite/ore minerals are <u>dense</u> and <u>sink/settle</u> down through the magma; magnetite/chromite/ore minerals form a <u>cumulate</u> layer/metals are concentrated in smaller volume at the base of the intrusion | any 3 | |
| | | (iii) | as density increases melting point increases/there is a positive correlation; the ore minerals/oxides have higher densities and melting points (1) the silicate minerals/gangue minerals have lower densities and melting points (1) OR the ore minerals/oxides have higher densities than the silicate minerals/gangue minerals (1) the ore minerals/oxides have higher melting points than the silicate minerals/gangue minerals (1) | 1 2 | allow ora allow AW/ora eg the oxides have higher densities and melting points than the silicate minerals scores 2 do not accept that Fe bearing minerals are denser / higher melting point than Ca bearing minerals |

| Question | | Expected Answers | Marks | Additional Guidance |
|----------|-----|---|-------------|--|
| 3 | (b) | <p>magnetic survey / use of magnetometer; detects variations in Earth's magnetic field strength caused by presence of magnetic minerals/lines joining points of equal magnetic field strength are plotted on a map/magnetite gives a <u>positive magnetic anomaly</u></p> <p>OR gravity survey / use of gravimeter ; used/detects variations in Earth's gravitational field strength caused by presence of dense minerals/lines joining points of equal gravitational field strength are plotted on a map/magnetite gives a <u>positive gravity anomaly</u></p> <p>OR electrical resistivity; two probes/electrodes are put in ground and electric current passed between them/magnetite has a lower resistance/higher conductivity (than surrounding rocks)</p> | 1 + 1 | description must match named technique |
| | | Total | [10] | |

| Question | | | Expected Answers | Marks | Additional Guidance |
|----------|-----|-------|---|---|---|
| 4 | (a) | (i) | <p><u>geophysical surveys</u> provide continuous data/provide information about <u>structures</u>/allow interpolation between boreholes/boreholes are spaced out so may miss information/faults/geophysical surveys are cheaper than drilling;</p> <p><u>boreholes/drilling</u> provide actual rock samples/rock samples from boreholes can be testing for strength, etc./boreholes give precise depth information down the hole/down-hole logging can be carried out/microfossils from boreholes can be used for correlation</p> | <p>any 1</p> <p>any 1</p> | <p>max 1 if only give reasons for geophysical survey</p> <p>max 1 if only give reasons for drilling boreholes</p> <p>must state what information is given by each technique</p> |
| | | (ii) | <p>it is impermeable so the tunnel will not flood;</p> <p>it is (fairly) competent / strong so the tunnel will not collapse</p> <p>it is soft / H = 3 so its easy for tunnel boring machine to cut through;</p> <p>it is uniform / homogeneous / has consistent properties for ease of tunnelling</p> | any 2 | must give explanation |
| | | (iii) | syncline/synform | 1 | accept basin |
| | | (iv) | it allowed the tunnel to stay in one rock type / the tunnel could follow the <u>dip</u> of the fold | any 1 | accept stay in one bed |
| | | (v) | <p>faults are planes of weakness/danger of movement/earthquakes/seismic activity/reactivation could cause tunnel to collapse;</p> <p>faults are zones of permeability/may get leakage of water down them</p> | 1 | must give correct geological reasons for problems – not just tunnel may collapse or flood |
| | | | 1 | | |
| | | (vi) | <p>holes are drilled into the rock and <u>liquid cement</u> pumped in / <u>liquid cement</u> is injected into rock;</p> <p>the cement fills pore spaces/joints/fissures;</p> <p>the cement reduces permeability;</p> <p>the cement increases rock strength</p> | <p>1</p> <p>any 2</p> | do not accept discussion of shotcrete (spraying of liquid cement) |

| Question | | Expected Answers | Marks | Additional Guidance |
|----------|-----|--|---|---|
| 4 | (b) | <p><u>argument for</u> – produces large quantities of aggregate needed for construction (cheaply) / aggregate can be transported cheaply by boat / provides employment opportunities in areas where there are few jobs;</p> <p><u>argument against</u> – often situated in areas of outstanding natural scenery/covers large area and causes landscape degradation/destruction of habitats/quarrying operation produces noise/dust from machinery/dump trucks/blasting/local people do not want a quarry nearby/example of “NIMBY” attitude to the environment</p> | <p>any 1</p> <p>any 1</p> | <p>economic argument must be qualified with reason</p> <p>effects / pollutes the environment is insufficient - must give specific details</p> |
| | (c) | <p>1 = F 2 = E 3 = G</p> <p>4 = J 5 = H</p> <p>1 blocks of limestone = F / building stone 2 clay = E / bricks 3 crushed chalk = G / cement 4 crushed dolerite = J / roadstone 5 gravel = H / concrete</p> | 3 | <p>5 correct for 3 marks 3 or 4 correct for 2 marks 1 or 2 correct for 1 mark</p> |
| | | Total | [16] | |

| Question | Expected Answers | Marks | Additional Guidance |
|----------|---|---|--|
| 5 | <p>faults – displace coal seams disrupting production/allow water leakage/may cause collapse</p> <p>folds and steep dips – make mechanised mining impossible/machinery cannot cope with dips greater than 5°;</p> <p>washouts – result from channel switching on delta top; peat is eroded away/coal gives way to river channel sands and gravels;</p> <p>seam splitting – coal seam splits into thinner unworkable seams; result of differential subsidence of delta</p> <p>sandstones within deltaic sequence are permeable / position of water table – may cause flooding / pumping costs may be too high;</p> <p>rocks of different mechanical strength / hardness make mining difficult;</p> <p>possible build up of methane / toxic / poisonous / flammable / explosive gas</p> <p>thin seams/lateral variations in thickness/deep coal seams – make mining uneconomic;</p> <p>rank/quality/carbon content of the coal may be too low – therefore uneconomic</p> <p>correct description of problem caused by long wall mining, eg mined out volume doesn't collapse</p> | <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> <p>1</p> | <p>mark diagrams as text but do not credit repetition only accept discussion of economics once</p> <p>do not accept idea that washout occurs after the coal has formed</p> <p>do not accept discussion of grade</p> |
| | Total | [8] | |

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