GCE

Geology

H414/01: Fundamentals of geology

Advanced GCE

Mark Scheme for Autumn 2021

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

Annotations

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	Ignore
BP	Blank page

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	AO element	Guidance
1			**A**	1	1.1a	**A** – arkose
2			**C**	1	1.1a	**C** – rock 1 = metamorphic, rock 2 = igneous, rock 3 = sedimentary
3			**C**	1	1.1a	**C** – medium grade metamorphic
4			**C**	1	2.1b	**C** – sub-angular, 45, 35, 20
5			**B**	1	2.1a	**B** – greywacke
6			**C**	1	2.1a	**C** – melting point = 2446°C
7			**C**	1	1.1c	**C** – the density of the Earth
8			**B**	1	1.1c	**B** – the magnetic field is axial – aligned with the spin axis of the Earth
9			**B**	1	1.1a	**B** – the Great Oxidation Event
10			**A**	1	1.1c	**A** – Chalk = aquifer; Gault Clay = aquiclude; silts and clays = aquitard
11			**B**	1	2.1a	**B** – +100m
12			**A**	1	1.1a	**A** – formation and break up of major continents
13			**C**	1	2.1b	**C** – a measure of the spread of the data about the mean
14			**C**	1	1.1c	**C** – it calculates the ground motion caused by an earthquake at a given site.
15			**C**	1	2.1b	**C** – 6525 years
16			**C**	1	2.1b	**C** – 3.98 MPa
17			**D**	1	2.1a	**D** – slab pull at subduction zones
18			**D**	1	2.1b	**D** – plagioclase 45%, pyroxene 35%, olivine 20%
19			**D**	1	1.1c	**D** – magma << dense than the surrounding rock
20			**B**	1	1.1d	**B** – the Sun and chondrites are made from the same original material
21			**A**	1	2.1b	**A** – 1445^{o}C
22			**B**	1	1.1c	**B** – 70% An 30% Di
23			**A**	1	1.1c	**A** – partial melting of those minerals with higher melting points produces magma
24			**D**	1	2.1b	**D** – synsedimentary faulting
25			**A**	1	2.1b	**A** – anticline

Question			Answer	Marks	AO element	Guidance
26	(a)	(i)	sheets **OR** 3 oxygen atoms shared in one plane ✓	1	1.1a	
	(a)	(ii)	**Any one from:** the bonding between sheets is weak leading to one perfect cleavage✓ the spaces between sheets contain hydroxyl (OH) ions which results in low density ✓	1	1.1c	
	(b)	(i)	pyroxene / augite / any other correct named pyroxene **OR** amphibole / hornblende / any other correct named amphibole ✓	1	1.1a	
	(b)	(ii)	**Any two from:** chains of tetrahedra result in a negative charge ✓ this is balanced by cations linking the chains together ✓ bonds between chains are weaker resulting in cleavages ✓ in a single chain (pyroxene) there are 2 cleavages at 90^{o} ✓ in a double chain (amphibole) there are 2 cleavages are at 60^{o} / 120^{o} to each other ✓	2	2.1a	
	(c)	(i)	framework **OR** each of the 4 oxygens in the tetrahedron are shared with other Si atoms ✓	1	1.1a	
	(c)	(ii)	**Any two from:** frameworks are isotropic / have the same properties in all directions ✓	2	2.1a	

Question			Answer	Marks	AO element	Guidance
			only contains strong Si-O bonds ✓ there are no planes of weakness therefore no cleavage ✓ there are no planes of weakness so has conchoidal fracture ✓ this makes the mineral structure strong therefore hardness is 7 / high ✓			
	(c)	(iii)	**Any one from:** each silicon atom is covalently bonded with 4 oxygen atoms (forming the silica tetrahedron) ✓ each of the 4 oxygen atoms is shared with other silicon atoms in the framework ✓ **Any one from:** the silicon has a half share of each of the oxygen atoms giving the silica formula ✓ there must be a ratio of 2:1 oxygen to silicon atoms to balance the overall charge ✓ silicon ions have a 4+ charge and oxygen ions have a 2- charge ✓	**1** **1**	**1.1a** **2.1a**	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>AO element</th><th>Guidance</th></tr>
<tr><td>27</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>Experiment</th><th>Sand length L (m)</th><th>Head $h_2 - h_1$ (m)</th><th>Hydraulic gradient</th><th>Flow rate Q ($m^3 s^{-1}$ x 10^{-3})</th></tr>
<tr><td>1</td><td>0.58</td><td>1.11</td><td>1.9</td><td>0.60</td></tr>
<tr><td>2</td><td>0.58</td><td>2.36</td><td>4.1</td><td>1.28</td></tr>
<tr><td>3</td><td>0.58</td><td>4.00</td><td>6.9</td><td>2.00</td></tr>
<tr><td>4</td><td>0.58</td><td>4.90</td><td>8.4</td><td>2.38</td></tr>
<tr><td>5</td><td>0.58</td><td>5.02</td><td>8.7</td><td>2.53</td></tr>
<tr><td>6</td><td>0.58</td><td>7.63</td><td>13.2</td><td>3.63</td></tr>
</table>
</td><td>1</td><td>1.1b</td><td>Both hydraulic gradients calculated correctly and recorded in table to a maximum of 2 decimal places for 1 mark</td></tr>
<tr><td>27</td><td>(a)</td><td>(ii)</td><td>axes plotted to make best use of the available graph AND axes labelled correctly, including units for flow rate Q ✓

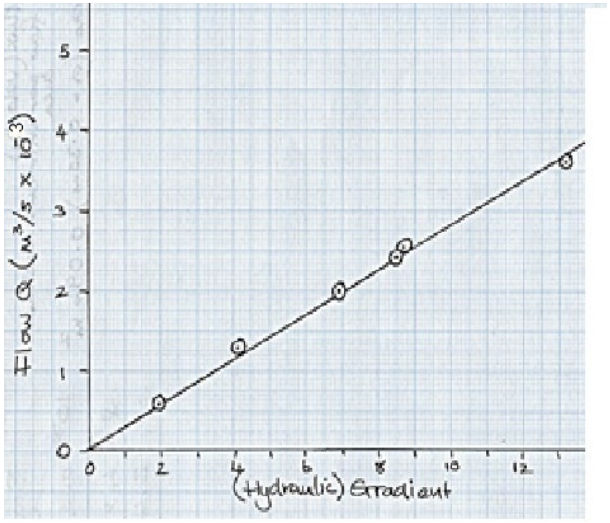
5 or more points plotted correctly (within a mm) ✓

line of best fit passes through zero AND has approximately equal points above and below the line ✓</td><td>1

1

1</td><td>1.1a

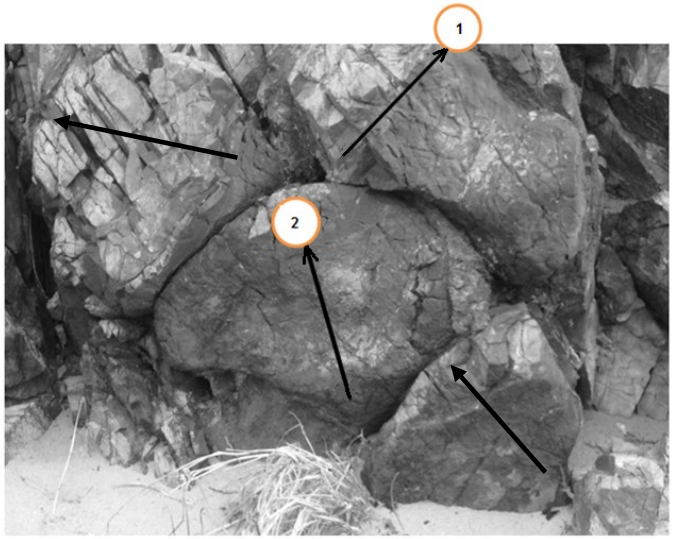
1.1c

1.1d</td><td> 
</td></tr>
<tr><td>27</td><td>(a)</td><td>(iii)</td><td>the relationship is linear
OR there is a direct correlation between Q and the hydraulic gradient
OR there is a positive correlation between Q and gradient
OR the relationship is directly proportional ✓</td><td>1</td><td>3.1a</td><td>ALLOW description of relationship e.g. as the hydraulic gradient increases the flow rate increases</td></tr>
</table>

Question			Answer	Marks	AO element	Guidance
27	(a)	(iv)	k within range 2.84 x 10^{-3} to 3.24 x 10^{-3} ✓	1	2.1b	**ALLOW** positive or negative value for k.
27	(a)	(v)	pressure in the water supply could change during measurement ✓	1	3.1f	
27	(a)	(vi)	**Any one from:** a constant head supply / reservoir would improve the accuracy / precision ✓ Maintaining a constant water pressure / flow rate would improve accuracy / precision✓ Use a longer column of sand which would improve accuracy / precision✓	1	3.1f	**ALLOW AW**
27	(b)		flow rates should increase (for the same gradient) **OR** permeability / k will be higher ✓ finer grains fill up pore space / pore throats between coarser grains **OR** there is less resistance to flow around coarse grains **OR** there is less friction as water flows between coarse grains **OR** the pore spaces between coarse grains are larger allowing easier flow **OR** coarser grains increase the amount of interconnected pore space ✓	1 1	1.1c 2.1a	 **ORA**
27	(c)	(i)	**Any one from:** lower permeability allows more time for grains to act as a natural filter✓ lower permeability / longer residence time allows time for bacteria to remove organic matter in suspension ✓ lower permeability / longer residence time allows time for clay minerals to remove organic matter in suspension ✓	1	1.1c	**ORA**

Question			Answer	Marks	AO element	Guidance
	(c)	(ii)	**Any two from:** calcium / Ca^{2+} **AND** limescale problems **OR** soap lather difficulties **OR** may be beneficial for bone growth / teeth ✓ sulfate / SO_4^{2-} **AND** bad taste **OR** diarrhoea ✓ magnesium / Mg^{2+} **AND** describes a hard water problem ✓ hydrogen carbonate / HCO_3^- **AND** describes a hard water problem ✓ chloride / Cl^- **AND** bad taste ✓ nitrate / NO_3^- **AND** methaemoglobinemia / blue baby syndrome **OR** cancer risk (when reduced to nitrite) ✓ Fe^{2+} / Fe^{3+} / iron gives a discolouration to the water✓ H^+ / hydrogen could lead to acidic water✓ F^- / fluoride can improve dental health / can be toxic✓	2	1.1a x 1 1.1c x 1	**MUST** link correct stated ion to a correct affect for 1 mark **ALLOW** any correct named ion found in drinking water linked to a correct affect note: SiO_2 and $CaCO_3$ are **not** ions

Question			Answer	Marks	AO element	Guidance
28	(a)	(i)	sediments **OR** calcareous ooze **OR** siliceous ooze **OR** fine clays **OR** chert ✓	1	1.1a	**ALLOW** ooze
	(a)	(ii)	it is unconsolidated **OR** contains a high proportion of water **OR** the layers beneath are igneous / crystalline rock **OR** low incompressibility **OR** low rigidity ✓	1	3.1b	
	(a)	(iii)	**Any two from:** ridges are spreading centres **OR** new oceanic crust forms at ridge ✓ oceanic crust increases in age with distance from the ridge ✓ older crust has more time to accumulate sediment ✓ sediment is deposited slowly as marine "snow" ✓	2	2.1a	**ALLOW AW**
	(a)	(iv)	**formation of sheeted dykes** **Any one from:** form in an extensional / tensional regime ✓ resulting from ridge push / gravity acting on the ridge flanks ✓ **Any one from:** magma moves towards the surface up long fissures ✓ fissures form parallel to the ridge axis / within the axial rift ✓ the original dyke has two chilled margins✓ relatively quick cooling of magma forms dolerite / medium textured mafic rock ✓	1 1 1	2.1a 3.1b 3.1d	**ALLOW** joints and fractures

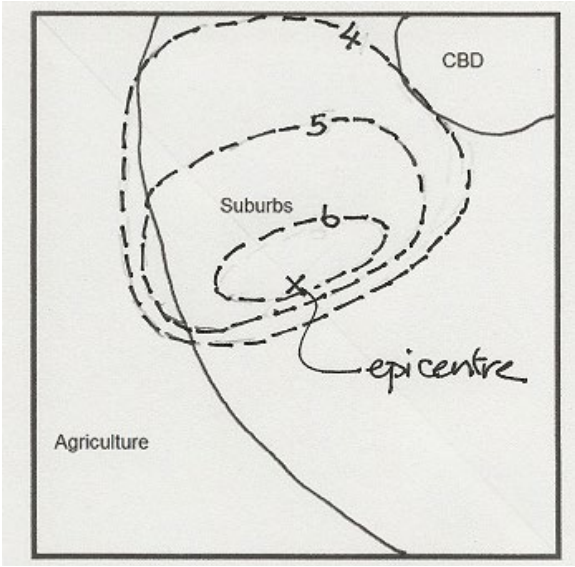
Question			Answer	Marks	AO element	Guidance
			as spreading continues new dykes follow the line of weakness of previous intrusions ✓ **explanation of chilled margins** **Any one from:** the previous dyke is split forming a half dyke with a single chilled margin✓ one side of each dyke was in contact with hot magma, so each dyke only has one chilled margin✓ statistical analysis of the sides the chills are on gives the direction of the ridge axis ✓			
28	**(b)**	**(i)**	**EITHER** arrow as shown ✓  	**1**	**2.1a**	**ALLOW** +/- 20º **1** is the actual direction of younging **2** is the direction of younging using the most obvious 'neck' in the photograph
28	**(b)**	**(ii)**	**formation of pillow lavas** **Any two from:** lava is extruded onto the seafloor / lava erupts underwater✓ rapid cooling by the water forms a glassy 'skin' ✓	**2**	**2.1 a**	

Question			Answer	Marks	AO element	Guidance
			lava continues to be extruded inflating the pillow ✓ lava is extruded as a tube and may roll down slope ✓ settles onto previous pillows but is still plastic ✓ **explanation of younging direction** fills space between previous pillows to make a 'neck' downwards / dome upwards / convex upwards ✓	**1**	**1.1c**	**DO NOT ALLOW** vesicles as a way-up indicator as they are not visible in the photograph **AW** "pinched" for "neck"
28	**(c)**		**Any one from:** radioactive decay within the Earth✓ decay of heat producing elements / K / U / Th✓ unstable parent atoms / isotopes changing to stable daughter atoms / isotopes release heat✓ **Any one from:** heat left over / residual / primordial from formation of the Earth ✓ gravitational potential energy of formation of the Earth✓ (kinetic energy from) early bombardment / collisions during formation of the proto-Earth✓ (potential energy from) the process of differentiation of the core, mantle and crust✓ the change in state at the outer – inner core boundary from liquid to solid✓ latent heat of crystallisation as inner core crystallises ✓	**1** **1**	**1.1a** **2.1a**	
28	**(d)**		*Refer to marking instructions on page 5 of mark scheme for guidance on marking this question.*	**6**	**1.1a x 2** **1.1c x 2**	**Indicative points may include:**

Question			Answer	Marks	AO element	Guidance
			Level 3 (5 – 6 marks) Gives a detailed description and explanation of how hydrothermal processes result in the formation of sulfide ores, including the principles of convective circulation of seawater within the fractures of the upper oceanic crust. **AND** Describes how the discharge of fluids / brines and the precipitation of sulfide ore minerals are the final stage in the concentration of metals from low crustal abundance. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3 – 4 marks)** Gives a description and explanation of how hydrothermal processes result in the formation of sulfide ores, including the principles of convective circulation of seawater within the fractures of the upper oceanic crust. **OR** Describes ow the discharge of fluids / brines and the precipitation of sulfide ore minerals are the final stage in the concentration of metals from low crustal abundance. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1 – 2 marks)** There is an attempt at a description and/or explanation of how hydrothermal processes result in the formation of sulfide ores. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*		**2.1a x 2**	• reasons why upper oceanic crust is fractured • temperatures attributed to the hot brine, e.g. 380°C • water heated by the presence of magma at high crustal levels • depths to which fluids circulate or volume of crust involved in the circulation may be estimated • the fluids / brines are extremely reactive at high temperatures, e.g. have a low pH • there is evidence of metasomatism of crustal rocks • the fluids / brines circulate becoming increasingly charged / concentrated and escape at the sea floor. • occurs at black smokers • reduction in temperature when the fluid meets cold seawater results in the formation / precipitation of sulfide ores • changes in chemistry (combining with H_2S) may result in the formation / precipitation of sulfide ores • dense sulfide minerals are deposited local to the vent • correct named examples of ore minerals may be given – galena, sphalerite, chalcopyrite, pyrite • may form chimneys • if the minerals are subsequently buried (by lavas or sediments) they will not dissolve into the seawater

Question			Answer	Marks	AO element	Guidance
			0 marks *No response or no response worthy of credit.*			

Question			Answer	Marks	AO element	Guidance
29	**(a)**	**(i)**	**Any three from:** choose height of building so natural frequency does not match seismic wave frequencies ✓ avoid irregular designs which are susceptible to twisting forces ✓ avoid ornamentation and fascias which may be dislodged ✓ avoid large open spaces, such as atria ✓ use steel-framed buildings (more ductile and able to deform without collapse) ✓ resist shear forces by using diagonal beams / cross bracing / cables ✓ isolate foundations / base isolation systems – able to distort or slide in response to horizontal forces ✓ absorb sway, e.g. with active mass damping, hydraulic systems ✓ use of flexible structures / flexible pipes✓ use a building code to prevent building on unsuitable ground✓	**3**	**1.1a x 1** **2.1a x 2**	**ALLOW** construction of deep foundations / piles to solid geology **ALLOW** any other correct civil engineering strategy that can reduce the impact of seismic events

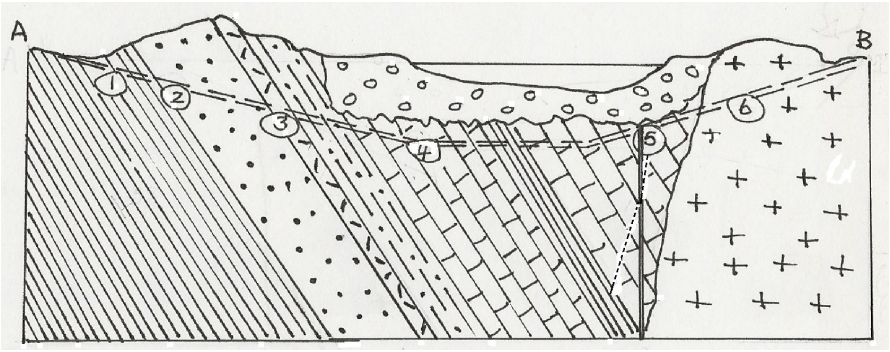
Question			Answer	Marks	AO element	Guidance
29	(a)	(ii)	liquefaction ✓ **Any two from:** vibrations / shaking cause the sediment to behave as a (viscous) liquid ✓ (pressure builds and) water forces the grains apart to liquefy the sediment / water separates from the grains and rises to the surface ✓ P-wave / seismic wave pulses / vibrations raise the pore pressure of water between the sediment grains ✓ the pores are small so there is insufficient opportunity for the pressure to drop between pulses / vibrations ✓	**1** **2**	**1.1a** **1.1c**	**ALLOW AW**
29	(a)	(iii)	3 closed, concentric isolines drawn ✓ isolines have realistic intensity values labelled, e.g., highest between 5 and 8 ✓ highest isoline encloses epicentre ✓ isolines drop away more quickly to the south (over the granite) ✓ isolines are 'squeezed' by competent buildings in the CBD **OR** by lack of apparent damage in the agricultural areas ✓	**5**	**3.1a x 1** **3.1b x 2** **3.1d x 1** **3.1e x 1**	**ALLOW** labelling in roman or arabic numerals e.g., of possible answer 
29	(b)		**First check answer on answer line**	**3**	**2.1b**	

Question			Answer	Marks	AO element	Guidance
			If answer = 1.41 x10^{18} **award 3 marks** correct rearranging of equation, e.g., Log E = $^3/_2$ Mw + $^3/_2$ 6.1 ✓ use of logarithms to calculate correct answer of 1.41 x10^{18} Joules / J ✓ answer given to no more than 3 sig figs ✓			
29	**(c)**	**(i)**	**Any two from:** as waves spread from the focus the energy is spread over a larger area / dissipated ✓ energy is absorbed as seismic waves travel through rocks ✓ waves are scattered as they pass through the rock ✓ imperfect elastic response leads to attenuation ✓ some energy is converted to heat ✓	**2**	**2.1a**	**ALLOW AW**
29	**(c)**	**(ii)**	**Any two from:** ground conditions may amplify movement / amplitude **OR** ground movement / amplitude depends on competence of (bed)rock / soil ✓ faults may not be visible at the surface / blind faults ✓ fault failure may occur infrequently **OR** many faults move frequently with little energy released ✓ sections of faults may be locked increasing risk **OR** sections of faults may creep reducing risk ✓	**2**	**1.1c**	**ORA**

Question			Answer	Marks	AO element	Guidance
			risk depends on magnitude **OR** magnitude is poorly predictable **OR** earthquake magnitude varies for individual faults ✓ risk may be affected by tsunami or landslide potential✓			

Question			Answer	Marks	AO element	Guidance
30	(a)	(i)	degree to which repeated measurements under unchanged conditions are the same **OR** how close repeated measurements are to each other ✓	1	3.1d	**ALLOW AW** **DO NOT ALLOW** how accurate the measurements are
30	(a)	(ii)	eastward = –10.5 (mm y^{-1}) ✓ northward = 21.0 (mm y^{-1}) ✓	2	3.1b	**ALLOW** 9.0 to 12.0 (mm y^{-1}) for eastward **ALLOW** 19.5 to 22.5 (mm y^{-1}) for northward
30	(a)	(iii)	**Any one from:** divergent plate boundary passes through Iceland **OR** Mid-Atlantic Ridge / mid-ocean ridge passes through Iceland ✓ **Any one from:** North American plate separates from Eurasian plate **OR** relative overall separation is approximately West – East ✓ western Iceland is on North American plate **OR** is moving NW away from the ridge axis ✓ Mid-Atlantic Ridge in western Iceland is NE- SW so separation of NW – SE is expected ✓	1 1	3.1a 3.1b	
30	(b)		correctly named example of a fossil used as evidence for continental drift / plate movements, e.g. *Mesosaurus* / *Lystrosaurus* / *Cynognathus* / *Glossopteris* / land plants / corals / trilobites ✓ **Any two from:** matching fossils of the same type and age are found on different continents ✓ the organisms could not have swum / moved / spread across former oceans suggesting the continents were joined at the time ✓	3	2.1a	**ALLOW** any correct named fossil example explanation **MUST** match named fossil(s)

Question			Answer	Marks	AO element	Guidance
			(the same species) suggests different continents were joined at the time and have moved apart due to plate movements ✓ (different species) suggests different continents were separated at the time and have moved together due to plate movements ✓ (assuming uniformitarianism) fossils are found in different climatic zones / latitudes to where they were alive ✓ suggests the continents were in a different climatic zone / latitude than they are today so must have moved to present day positions ✓			

Question			Answer	Marks	AO element	Guidance
31	(a)		**Any five from:** dipping beds are correctly drawn using ornament / rock names in key ✓ dipping beds have dip of approx. 50° east (less than 60°) ✓ concordant dolerite sill is drawn in correct position ✓ fault is drawn at correct position below river ✓ fluvio-glacial drift deposits with steep sides and flat base / u-shaped valley are correctly drawn **OR** base of fluvio-glacial drift deposits is **above** the tunnel profile ✓ river drawn with an asymmetric profile to correct approx. max depth of 10 m ✓ steep margin to granite intrusion correctly drawn ✓ metamorphic aureole correctly drawn parallel to the granite contact ✓  	**5**	**1.1d x 1** **2.1a x 2** **2.1b x 1** **3.1a x 1**	

Question	Answer	Marks	AO element	Guidance
(b)	*Refer to marking instructions on page 5 of mark scheme for guidance on marking this question.* **Level 3 (5–6 marks)** There is a coherent and logical account of the effects of rocks and structures encountered in locations **1** to **6** which cover properties important to tunnel construction such as permeability and rock strength. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** The effect of some of the rock types and structures are recognised and some relevant properties are explained. *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** The geology at some of the locations **1** to **6** is correctly identified and some relevant properties for each stated. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks** *No response or no response worthy of credit.*	**6**	**1.1a x 2** **1.1c x 1** **2.1a x 2** **2.1b x 1**	**Indicative points may include:** **location 1** • shales are weak / fissile so overbreak / collapse of roof and walls may occur • impermeable so water flow should not be a problem • will require roof support and ground improvement **location 2** • desert sandstones are very well sorted and have well rounded grains • the sandstone could be (relatively) easy to cut through if uncemented **OR** could be hard to cut through if cemented • likely to be porous and permeable forming an aquifer **OR** problems may arise with water flowing into the tunnel • as it is contained between impermeable strata it could be a confined aquifer with the water under pressure • may require roof support and ground improvement and drainage **location 3** • there is a sill / concordant intrusion / minor intrusion / hypabyssal intrusion • surrounding rocks will be baked / indurated / metamorphosed • rocks at this location will be less permeable • hard rock will require a change of excavation method / slow progress • explosives may be needed, requires less support and drainage • competent and easier to drill **location 4** • limestone is characterised by joints and bedding planes

Question			Answer	Marks	AO element	Guidance
						• limestone is a soft rock so easily cut / bored • could encounter high flow rates of groundwater • could be karstic / have voids and caves creating weaknesses **OR** may have joints / bedding planes enlarged by solution • glacial erosion above may lead to weaknesses and changes in rock strength • may require added roof support • may require drainage **location 5** • fault encountered • may allow passage of water / pressurised flows • may cause local weakness • sudden change of rock type may slow tunnelling progress • fault may become active / reactivate causing damage to tunnel / threatening life • will require roof support and drainage **location 6** • granite is hard / crystalline rock so tunnelling will have to be by drilling and blasting • this is a slow / expensive / dangerous process • rockbursts should not be a problem as at a shallow depth • impermeable and so should not require drainage • overall many changes in geology which will require changes in the tunnelling methods which is slower
	(c)		**Any two from:** the major intrusion has created a metamorphic aureole in the country rock / contact metamorphism ✓ fluids from the magma may have escaped into the country rock causing the mineralisation ✓	**2**	**1.1c**	

Question			Answer	Marks	AO element	Guidance
			hydrothermal processes / circulating groundwater can dissolve metals and concentrate / precipitate ore minerals ✓ precipitation occurs as fluids / brines cool / chemistry changes ✓ this may occur in fractures / joints resulting in veins **OR** the ore may be disseminated through the rock ✓ fault may have acted as a conduit for fluids / brines ✓ secondary enrichment may have acted on the ores ✓ placer deposits may form within the river deposits ✓ minerals precipitate as acidic fluids react with the alkaline limestone ✓			
	(d)	**(i)**	**First check answer on answer line** **If answer = 67366 (m^3) award 2 marks** correct recall and use of formula to calculate volume of spoil removed ($V = \pi r^2 l$) ✓ $3.14 \times 5.7^2 \times 660 = 67366$ (m^3) ✓	**2**	**1.1b**	
		(ii)	**Any two from:** cannot be used in the construction of a tunnel ✓ cannot be moved any distance / too expensive to transport ✓ liable to be disposed as spoil heaps **OR** used as infill to local topographic lows **OR** used as landfill in abandoned quarries✓	**2**	**1.1c**	

Question	Answer	Marks	AO element	Guidance
	some could be used as foundations for (tunnel approach) roads ✓ spoil heaps may be unstable ✓ spoil heaps create visual / air pollution ✓ spoil will be a mixture of rock types / chemistry of dump site will vary ✓ will affect surface water / groundwater quality / chemistry / flow ✓			

OCR (Oxford Cambridge and RSA Examinations)
The Triangle Building
Shaftesbury Road
Cambridge
CB2 8EA

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk