

GCE

Geology

H414/01: Fundamentals of geology

Advanced GCE

Mark Scheme for November 2020

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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 available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore
	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

Subject-specific Marking Instructions**INTRODUCTION**

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

Section A

			Answer	Mark	AO	Guidance
1			B - Euhedral	1	2.1a	
2			B – (M – Ol – P – Ne – Or)	1	2.1b	
3			C - fine , equicrystalline	1	1.1a	
4			D – separation of minerals in a lava	1	1.1a	
5			C - silicic	1	2.1c	
6			B – greater safety	1	2.1b	
7			C – the negative gravity anomaly over Scandinavia	1	2.1a	
8			C – a process by which thermal energy is transferred through a medium by a fluid	1	1.1c	
9			B – 1/2	1	2.1a	
10			C - Lithophile	1	1.1a	
11			C – they were in meteorites	1	1.1c	
12			B - lateral compression is caused by the contraction of the Earth as it cools	1	1.1c	
13			D - Chi squared	1	2.1b	
14			C – a sheet-like body dipping 45° to the west	1	2.1b	
15			C – depth of overburden	1	1.1c	
16			B – a lack of physical and mathematical evidence	1	1.1d	
17			D – there is a 2% chance that an earthquake will occur this year	1	1.1c	
18			C – the yolk sac	1	1.1a	
19			D - enhanced calcium carbonate concentrations and depletion of oxygen and sulfate	1	1.1c	
20			B - conodonts	1	2.1a	
21			A - High porosity, high resistivity, high gamma ray count	1	2.1a	
22			D – E, F and G	1	2.1b	
23			D – 88.6	1	2.1a	
24			C - CuFeS ₂ = Chalcopyrite	1	1.1a	
25			A - Erosion	1	2.1a	

Section B

Question		Answer	Mark	AO element	Guidance
26	(a)	Morphology ✓ Taphonomy ✓ Life assemblages ✓	3	2.1a	
26	(b)	ANY two from Most fossils are fossilised hard parts OR many organisms lack hard parts / teeth / skeletons ✓ The fossil record is biased / incomplete ✓ They could be derived fossils / eroded out of the original sedimentary rock ✓ Many fossils are not preserved in their original environment OR many fossils are in death assemblages ✓ Soft parts decay OR are scavenged on death ✓ Particular conditions are needed for preservation (taphonomy) ✓ Most preservation is in marine environments OR most preservation is in depositional environments OR lack of terrestrial fossils OR lack of fossils in erosional environments ✓	2	1.1a 1.1c	
26	(c)	ANY two from Bedding would have been laid down horizontally OR bedding disrupted by burrowing / bioturbation ✓ Bottom suitable for life OR oxygen in sediment suitable for burrowing (aerobic) OR oxygen in water suitable for life (oxic) OR bottom has organic rich sediment ✓ U-shaped burrows show evidence of erosion OR high energy indicated by need for protective burrows OR low / medium energy	2	3.1b	

Question		Answer	Mark	AO element	Guidance
		indicated by (fine-grained) sediment suitable for burrowing OR burial of burrows shows a depositional environment ✓			
26	(d)	<p><i>Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5-6 marks) Good discussion of both internal and external morphology of both brachiopods and bivalves. Morphology discussed is linked to mode of life. Terminology used is correctly applied to the function / form / mode of life the fossil when it was alive.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</i></p> <p>Level 2 (3-4 marks) Gives a clear account comparing the external morphology of both fossil types and uses the terminology correctly throughout OR Gives a clear account comparing either mode of life or internal morphology of both bivalves and brachiopods but with some minor inconsistencies</p> <p><i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>Level 1 (1-2 marks) Describes and compares the external gross morphology of both types of organism shown but may not use all the correct technical terms and may make minor errors OR Discusses the mode of life of each fossil but answer lacks clear coherence / points not linked to each fossil type explicitly, but more general discussion regarding mode of life / feeding.</p>	6		<p>AO2.1a Apply knowledge and understanding of geological ideas May include hard parts:</p> <ul style="list-style-type: none"> • Shell shape: two different sized valves (inequivalve) for brachiopods and equal sized valves (equivalve) for bivalves. • Shell symmetry: median plane for brachiopods and along hinge line for bivalves. • Two teeth within hinge of brachiopod whilst teeth and sockets along hinge plate of bivalve. • Spirallia, cardinal process in brachiopods. • 2 or 3 sets of muscle scars in brachiopods (adductor and diductor), 1 set for bivalves (adductor). <p>May include soft parts:</p> <ul style="list-style-type: none"> • Comparison of shell opening and closing devices (using diductor and adductor muscles in brachiopods and adductor and ligaments in bivalves). • Bivalves have a foot, whilst brachiopods have a pedicle. • Bivalves have pallial line and sinus, brachiopods do not have this structure. • Brachiopods have a lophophore, bivalves have gills. <p>AO3.1b Interprets geological information, ideas and evidence May include:</p>

Question			Answer	Mark	AO element	Guidance
			<p><i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i></p> <p><i>No response or no response worthy of credit 0 marks.</i></p>			<ul style="list-style-type: none"> • Interprets diagrams and discusses mode of life of bivalves and brachiopods. • Links hard and soft parts to mode of life and method of feeding eg. siphons and pallial sinus or muscles to open and close valves. <p>AO3.1e Draws conclusions May include:</p> <ul style="list-style-type: none"> • Relates morphology to mode of life in both bivalves and brachiopods. •
26	(e)	(i)	<p>Ornithischian hip bones / pubis point backwards (bird hipped) AND Saurischian hip bones / pubis point forwards (reptile hipped) ✓</p> <p>Ornithischian hip bones / pubis point backwards (bird hipped) allowed a more upright posture OR enabled organisms to exploit different niches ✓</p> <p>Saurischian have long S shaped necks OR ornithischian have shorter necks ✓</p> <p>Saurischian neck allows rapid / precise movement OR allows access to higher vegetation ✓</p> <p>Saurischian have asymmetrical digits ✓</p> <p>Saurischian asymmetrical digits allowed grasping ✓</p> <p>Some ornithiscians have bony plates ✓</p> <p>Ornithiscian bony plates could be for heat exchange ✓</p>	Max. 2	1.1a 1.1c	<p>ALLOW alternative wording to describe the hip configuration</p> <p>DO NOT ALLOW non-skeletal differences</p>

Question			Answer			Mark	AO element	Guidance
26	(e)	(ii)		Feature	Characteristic?	3	1.1a 1.1c	5 or 6 lines correct = 3 marks 3 or 4 lines correct = 2 marks 2 lines correct = 1 mark
				Large olfactory lobes				
				Gastroliths	✓			
				Peg like teeth	✓			
				Thumb spike				
				Short neck				
				Laid amniotic eggs	✓			
		✓✓✓						
26	(e)	(iii)	ANY one from Asteroid impact OR meteorite impact ✓ Major volcanic activity OR Deccan Traps described ✓			1	1.1c	
Total						20		

Question			Answer	Mark	AO element	Guidance
27	(a)	(i)	Shear	1	1.1a	
		(ii)	<p>ANY four from</p> <p>Shear strain / deformation results as crust moves in opposing directions OR shear strain results from frictional resistance ✓</p> <p>Elastic strain energy builds up over many years ✓</p> <p>Stress builds until it exceeds the strength of the faulted rock ✓</p> <p>Sudden release of the stored strain energy results in earthquake ✓</p> <p>Energy released as seismic waves ✓</p> <p>Some permanent strain remains ✓</p>	4	1.1a 1.1c	Max 2 if pressure, stress, friction used instead of strain energy or shear strain
	(b)	(i)	<p>ANY three from</p> <p>Earthquakes occur at shallow depths ✓</p> <p>Subduction zones are in the ocean margins ✓</p> <p>Rapid relative convergence of plates ✓</p> <p>Large magnitude / magnitude above 6.5 earthquakes common ✓</p> <p>Convergence occurs in a series of sudden movements ✓</p> <p>Convergence results in vertical movement of the seabed ✓</p> <p>Deformation / drag of the overriding plate by the subducting plate ✓</p>	3	2.1a 3.1c	
		(ii)	<p>ANY two from</p> <p>Mapping of high risk / low-level ground OR mapping the effects of previous tsunamis ✓</p> <p>Overlay with population density ✓</p> <p>Show communication links at risk ✓</p> <p>Plan responses for emergency services ✓</p> <p>Show installations needing particular protection e.g. power stations, hospitals ✓</p> <p>Data available for all coasts ready for update with epicentre position ✓</p> <p>Track wave heights in the ocean ✓</p> <p>Show areas liable to liquefaction ✓</p>	2	2.1a	
		(iii)	3.33 Ma ✓✓✓✓	4		DO NOT ALLOW full marks for result in years or more than 3 significant figures

Question		Answer	Mark	AO element	Guidance
		<p>Calculation of length of subducted slab using appropriate trigonometry; $\sin 30^\circ = 150 \text{ km} / h$ $h = 150 / 0.5 \text{ km}$ $h = 300 \text{ km}$</p> <p>Calculation of time taken to subduct and conversion of units</p> $300 \text{ km} / 90 \text{ mm a}^{-1}$ $= 300 \times 10^3 \text{ m} / 90 \times 10^{-3} \text{ m a}^{-1}$ $= 3.33 \text{ Ma}$		2.1b	<p>Max 3 for working if incorrect answer</p> <p>ALLOW ecf from slab length above</p>
	(iv)	<p>ANY two from Marine deposit in a continental environment OR marine deposit above sea-level at that time ✓</p> <p>Layer of coarse sand OR rip-off clasts OR broken shells in otherwise fine succession OR erosive base OR poorly sorted OR graded bedding OR boulders in finer sediment ✓</p> <p>Massive beds OR very thick layers ✓</p>	2	2.1a	
Total			16		

Question			Answer	Mark	AO element	Guidance
28	(a)	(i)	<p>ANY two from</p> <p>The ridge axis is the site of spreading / creation of new lithosphere ✓</p> <p>It is a tensional tectonic environment / regime ✓</p> <p>Normal faulting results ✓</p> <p>Paired normal faults may form rift valleys OR form horsts and grabens ✓</p>	2	1.1c	
		(ii)	<p>Slow-spreading ridge</p> <p>AND</p> <p>ANY one of</p> <p>It has an axial rift ✓</p> <p>It has rugged topography ✓</p> <p>The ridge is steep-sided ✓</p>	1	2.1a	As slow or fast is a 50/50 guess there must also be a valid reason for the choice.
		(iii)	<p>ANY two from</p> <p>Basalt lava flows at the surface ✓</p> <p>Intrusion of dolerite dykes forces the crust apart ✓</p> <p>(High-angle) normal faults result from the extension ✓</p> <p>Uplift of the footwall brings lower crust / gabbro and upper mantle / peridotite to the surface ✓</p> <p>Gabbro is added (to the uplifted footwall) from the magma chamber ✓</p> <p>Spreading lowers the angle of fault dip (to around 30°) ✓</p> <p>Movement on the fault contributes to lateral spreading ✓</p> <p>Seawater and talc lower friction on the fault plane ✓</p>	2	1.1a 1.1c	
	(b)		<p>Asthenosphere close to the surface OR</p> <p>Hotter mantle / partial melting close to the surface ✓</p> <p>Melt / hotter mantle / asthenosphere is lower density ✓</p>	2	2.1a	
	(c)	(i)	<p>$t^x = w/k$</p> <p>$x (\log t) = \log (w/k)$</p> <p>e.g. $x(\log 5) = \log (2.236)$ OR $\log (726.7/325)$</p> <p>$x = 0.5$ ✓✓✓</p>	3	3.1a	

Question		Answer	Mark	AO element	Guidance
	(ii)	Plot a graph of w against t^x AND k is given by the gradient of the straight line ✓	1	2.1b	Must say <i>what</i> is plotted for the gradient mark ALLOW negative gradient
	(iii)	ANY two from Higher spreading rate results in greater displacement in the same time ✓ Therefore slope / gradient of ridge is less steep for fast spreading ridges ✓ Fast-spreading means there will be no axial rift OR there will be a dome like topography OR the topography will be smoother ✓	2	3.1f	
(d)	(i)	gravity acting on the ridge slopes (is a mechanism for spreading) OR gravity has a greater effect on taller / higher / steeper ridges ✓	1	2.1c	
	(ii)	Ridges only rise 3 km above abyssal plain OR Ridge gradient is very low / 1.5° OR Subduction zones can be steep / up to 45° OR Descending slab can be 100s km long OR Lithosphere can be pulled without deformation / compression usually taken up by thrusting OR gravity has a greater effect on the large mass of the subducting slab OR gravity has a lesser effect on the smaller mass of the ridge ✓ The Pacific is fringed by subduction zones acting on the plates OR The Atlantic ocean has no subduction zones ✓	2	2.1a	ALLOW plates of Atlantic Ocean are partly continental lithosphere

Question	Answer	Mark	AO element	Guidance
(e)*	<p><i>Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question.</i></p> <p>Level 3 (5-6 marks) Shows and records an understanding of the cause and effects of decompression melting at divergent margins AND gives detailed explanations for the chemistry of the magma.</p> <p><i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated</i></p> <p>Level 2 (3-4 marks) The principles of decompression melting are presented logically AND gives some explanation of the chemistry.</p> <p><i>There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.</i></p> <p>Level 1 (1-2 marks) Decompression melting is given as the explanation of magma generated at margins but other descriptive evidence is not relevant to the explanation. There is a basic explanation of the chemistry.</p> <p><i>There is an attempt at a logical structure with a line of reasoning. The information is, in the most part, relevant.</i></p> <p><i>No response or no response worthy of credit 0 marks.</i></p>	6	2.1a 2.1c 3.1b	<p>May include</p> <ul style="list-style-type: none"> • Upwelling of the mantle • Lithosphere under tension thins • Asthenosphere close to the surface • Pressure is reduced but mantle is still hot • Partial melting results • Called decompression or adiabatic melting • Pressure drop lowers melting point • Allows geotherm to cross solidus <p>AND</p> <ul style="list-style-type: none"> • Partial melting of ultramafic peridotite produces mafic magma • Rapid transit to the surface does not allow magmatic differentiation • No addition of silicic melt from continental crust / no assimilation • Lower melting point minerals melt first. • These minerals are relatively rich in S and Fe / Mg poor.
	Total	22		

Question			Answer	Mark	AO element	Guidance
29	(a)	(i)	Secondary enrichment ✓ Due to chemical weathering of deposit and leaching of copper sulfate in oxidation zone above a water table OR insoluble sulfide deposited in reducing zone / below water table ✓ OR Placer deposit ✓ Dense material accumulation described where water energy has dropped ✓	2	2.1a	1 mark for identified process 1 mark for the description. ALLOW copper porphyry deposit described correctly ALLOW any correct placer, e.g. behind projections on sea bed, plunge pools etc.
	(a)	(ii)	ANY two from: High grade deposits have already been extracted so need to exploit lower grade deposits ✓ Methods of ore processing have improved / been developed so that lower grade deposits can be mined ✓ Methods of mining have improved / been developed so that lower grade deposits can be mined ✓ Metal is now more valuable due to its scarcity, so lower grade extraction possible ✓	2	3.1a 3.1b	ALLOW 1 mark if correct method used but incorrect dates used from the table.
	(a)	(iii)	Using equation : Final grade - original / original grade X 100 $1.10 - 1.98 = -0.88$ $0.88/1.98$ $= -0.44$ $-0.44 \times 100 = -44.4\%$ OR -44% ✓✓	2	2.1b	DO NOT ALLOW values beyond 3 significant figures. ALLOW 44% as only change is asked for
	(a)	(iv)	Geochemical Stream / vegetation / soil / water sampling AND comparison of values of metals from samples from different locations to build up map of anomalies to locate deposit ✓ Geophysical Magnetic / gravity / EM survey / resistivity AND changes in Earth's magnetic field measured with positive anomalies representing ore minerals / increase in gravity represents denser minerals which could be ore minerals /	2	2.1b	If both names correct but incorrect explanation then 1 max

Question		Answer	Mark	AO element	Guidance	
		conductivity increases in EM or resistivity surveys where metallic minerals are present ✓				
	(b)	<p>ANY three from:</p> <p>Separates hydrophobic minerals from hydrophilic ones ✓</p> <p>Fine material mixed with water to form a slurry to separate ✓</p> <p>Target mineral is made hydrophobic by adding chemicals ✓</p> <p>Slurry is agitated and air added to form bubbles to which hydrophobic minerals attach ✓</p> <p>Minerals float to top of cell and are removed ✓</p> <p>Tailings do not float so well and are removed by lower tube ✓</p>	3	2.1a		
	(c)	(i)	<p>ANY two from:</p> <p>Sulfur minerals / sulphides break down due to oxidation (and / or bacterial action) ✓</p> <p>This forms sulfur dioxide (SO₂) and reacts with water to form sulfuric acid (H₂SO₄) ✓</p> <p>This acidic water then leaches out other minerals present in the rock ✓</p> <p>Named minerals / elements (lead, mercury, arsenic) leach into the water ✓</p>	2	2.1a 1.1c	
	(c)	(ii)	<p>Aerobic filters / aerobic wetlands / reed beds AND contain limestone ✓</p> <p>Neutralises acid and oxidation precipitates metal salts / oxides / hydroxides ✓</p> <p>OR</p> <p>Anaerobic filters / anaerobic wetlands AND contain limestone to neutralise acid ✓</p> <p>compost creates reducing conditions to precipitate metals / sulfides OR microorganism / bacteria precipitate metals / sulfides ✓</p> <p>OR</p>	2	1.1a 1.1c	Paired method and brief explanation of how AMD is mitigated for two marks

H414/01

Mark Scheme

November 2020

Question			Answer	Mark	AO element	Guidance
			CaO / CaCO ₃ filters / limestone ponds / limestone channels ✓ CaCO ₃ is dissolved by / reacts with acid / increases pH to precipitate metal sulphides and neutralise acid ✓			
			Total	15		

Question			Answer	Mark	AO element	Guidance									
30	(a)	(i)	<p>ANY two from High / >1% organic content / >0.5% total organic carbon ✓ Marine mudstones OR black shales OR organic shales OR oil shales ✓</p> <p>Deep water (enough to reduce oxidation) / anoxic ✓ Plankton accumulates / algal blooms ✓</p> <p>OR Accumulation of terrestrial vegetation ✓ Low oxygen conditions / swamp ✓ Burial to form coal ✓</p>	2	1.1a 1.1c										
	(a)	(ii)	<p>Burial AND temperatures raised ✓</p> <p>ANY one from: Over time organic matter forms kerogen ✓ Kerogen breaks down to form petroleum ✓ Correct inclusion of oil (50-100°C) OR gas window temperatures (100 - 200°C) ✓</p>	2	1.1a 1.1c										
	(a)	(iii)	<table border="1"> <thead> <tr> <th></th> <th>Property</th> <th>Example</th> </tr> </thead> <tbody> <tr> <td>Caprock</td> <td>impermeable</td> <td>mudstone / shale OR salt / evaporates OR greywacke OR well cemented sandstones OR unjointed limestones</td> </tr> <tr> <td>Reservoir rock</td> <td>(highly) permeable</td> <td>desert sandstone / jointed limestone / deltaic sandstone / poorly cemented sandstone</td> </tr> </tbody> </table> <p>✓✓</p>		Property	Example	Caprock	impermeable	mudstone / shale OR salt / evaporates OR greywacke OR well cemented sandstones OR unjointed limestones	Reservoir rock	(highly) permeable	desert sandstone / jointed limestone / deltaic sandstone / poorly cemented sandstone	2	1.1a 1.1c	<p>one mark for each row</p> <p>4 correct = 2 marks 2 or 3 correct = 1 mark</p> <p>ALLOW high porosity</p> <p>ALLOW named examples</p>
	Property	Example													
Caprock	impermeable	mudstone / shale OR salt / evaporates OR greywacke OR well cemented sandstones OR unjointed limestones													
Reservoir rock	(highly) permeable	desert sandstone / jointed limestone / deltaic sandstone / poorly cemented sandstone													
	(a)	(iv)	<p>Oil in the Upper Jurassic ✓ Oil shown trapped by faults ✓ Reservoir rock labelled in the upper Jurassic ✓ Source rock labelled anywhere in the Jurassic ✓ Cap rock shown in Cretaceous ✓</p>	5	2.1a 1.1c	<p>must have horizontal base but otherwise levels not critical</p> <p>Source is also in U Jurassic but not essential for mark</p>									

Question			Answer	Mark	AO element	Guidance
(b)	(i)	<p>ANY two from Negative gravity anomalies indicate sedimentary rocks deep enough to allow maturation ✓ Negative gravity anomaly could indicate a salt dome trap ✓ Positive anomaly due to anticline OR positive anomaly due to an uplifted block ✓</p>		2	1.1b	
			Total	13		

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