GCE

Geology

H414/02: Scientific literacy in geology

A Level

Mark Scheme for June 2024

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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.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

   Rubric Error Responses – Optional Questions
   Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
    - there is nothing written in the answer space

Award Zero '0' if:
    - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

Levels of response questions on this paper are **2(c)** and **5(a)(v)**.

11. **Annotations**

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

12. **Subject Specific Marking Instructions**

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

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
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

INTRODUCTION

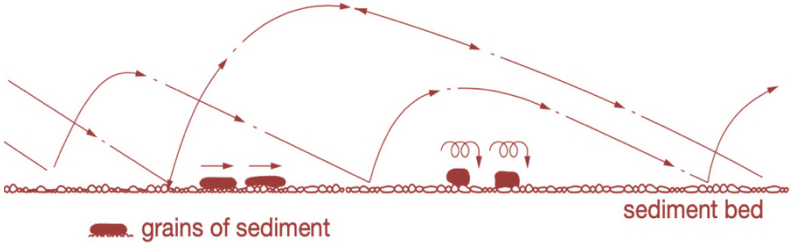
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- 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.

Question			Answer	Marks	AO Element	Guidance
1	(a)	(i)	Grain labelled saltating (bouncing or hopping) ✓ Grain labelled in traction (rolling or sliding) ✓  	1 1	1.1a	**MAX 1** if river bed is not drawn **MAX 1** if two correct diagrams not labelled saltation and traction **MUST** label or indicate movement of grains **IGNORE** reference to grain size
1	(a)	(ii)	Different grain shapes (could allow the same size grains to be transported by either saltation or suspension) ✓ Different densities / weights (could allow the same size grains to be transported by either saltation or suspension) ✓ Turbulence during transport could hold a grain in suspension whereas laminar flow would cause the grain to saltate ✓	**Max 1**	2.1a	**ALLOW AW** for density / weight **ALLOW** different compositions
1	(b)		**MAX any two** descriptions of differences from: Texturally mature sediment will have: • More / well rounded **OR** more spherical / high sphericity grains ✓ • Better / well sorted **OR** has grains all the same size ✓ • Finer (average) grain size ✓ **MAX any two** explanations from: • During transport / higher energy (transport) ✓ • Undergoes erosion / abrasion / attrition ✓	**Max 3**	2.1a	**ORA** for texturally immature **MUST** use correct descriptive terminology **IGNORE** weathering

Question			Answer	Marks	AO Element	Guidance
1	(c)	(i)	36 cm s^{-1} (Allow 33 to 39) ✓	1	3.1a M3.11	**MUST** include units for the mark **ALLOW** cm/s for units
1	(c)	(ii)	0.3 mm (Allow 0.27 to 0.33) ✓	1	3.1a M3.11	**MUST** include units for the mark
1	(c)	(iii)	• Allows for a wide range of velocities / grain sizes **OR** the range of velocities / sizes is too large ✓ • The axes would be too large if linear scales were used **OR** to fit on a suitable graph size ✓ • Can present data over a very large range ✓ • Shows data as a straight line when values increase exponentially ✓	Max 1	2.1b M3.6	**ALLOW** AW
1	(d)	(i)	Name: Compaction / compacted ✓ Explanation: During burial **OR** overlying sediment accumulates **OR** weight from overburden **OR** caused by (load) pressure **OR** grains move closer / fuse together **OR** beds become thinner **OR** dewatering occurs ✓	1 1	1.1a	**ALLOW** burial as named process **MARK first** process and explanation only
1	(d)	(ii)	Name: Pressure solution **OR** (pressure) dissolution ✓ Explanation: (Load pressure creates stress) at contact between grains **AND** quartz / grain dissolves **OR** dissolved minerals move laterally **OR** minerals are (re)precipitated / (re)crystallised **OR** grains become fused together ✓	1 1	1.1c 3.1c	**ALLOW** stylolitisation / stylolite **DO NOT ALLOW** melting **DO NOT ALLOW** discussion of sediment movement / deposition

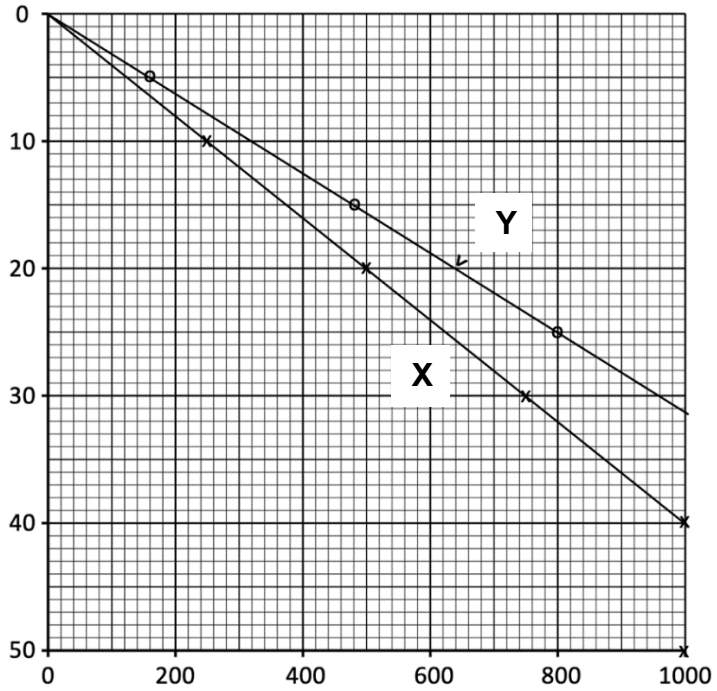
Question			Answer	Marks	AO Element	Guidance
1	(d)	(iii)	Name: Precipitation / precipitate ✓ Explanation: Dissolved minerals / minerals in solution / minerals in groundwater move through sediment **OR** dissolved minerals form in pore spaces between grains ✓	**1** **1**	1.1c 3.1c	**ALLOW** crystallisation / recrystallisation / cementation **ALLOW** correct named mineral **DO NOT ALLOW** discussion of sediment movement / deposition
1	(d)	(iv)	• Less water can be stored **OR** capacity of aquifer reduces ✓ • Porosity reduces **OR** volume of pore space reduces ✓ • Cement fills the pores **OR** grains are closer together **OR** interconnections between pores reduces ✓ • Permeability reduces **OR** less water can pass through **OR** flow of water reduces ✓ • Takes longer for aquifer to recharge **OR** takes longer to extract the water ✓ • Dolomitisation **OR** atomic substitution of Mg^{2+} for Ca^{2+} **OR** any valid atomic substitution may have occurred ✓	**Max 3**	2.1a 3.1e	**ALLOW** Porosity / permeability can increase due to further solution **OR** dolomitisation **OR** any valid atomic substitution for 1 mark

Question			Answer	Mark	AO Element	Guidance
2	(a)	(i)	Rigid / brittle / broken into (tectonic) plates ✓	1	1.1c	**ALLOW** solid
2	(a)	(ii)	Seismic waves / seismic surveys / seismic tomography / EM surveys ✓	1	1.1a	**ALLOW** crosses 1300°C isotherm
2	(a)	(iii)	Description: Rheid **OR** plastic layer **OR** is 1-5% melted **OR** partially / partly melted ✓ Explanation: Allows (lithospheric / tectonic) plates to float / move / slide (over asthenosphere) **OR** the asthenosphere can flow ✓	1 1	2.1a	**ALLOW** convection cells / convection currents **OR** allows ridge push or slab pull for explanation mark
2	(b)	(i)	• State of equilibrium / balance between Earth's lithosphere and asthenosphere ✓ • The lithosphere is buoyant / floats at a height that depends upon its thickness / density / weight / mass **OR** less dense continents rise to a higher elevation than more dense ocean floors ✓ • Pressure exerted by the lithosphere on the underlying asthenosphere is the same everywhere (irrespective of elevation) ✓ • Isostatic adjustment / isostatic rebound occurs where the lithosphere and asthenosphere are out of equilibrium **OR** the asthenosphere flows sideways to compensate for any extra weight / mass of the lithosphere above ✓	**Max 2**	1.1a 1.1c	**ALLOW** discussion of crust and mantle **ALLOW** named example of where this occurs, e.g., ice sheets

Question			Answer	Mark	AO Element	Guidance
2	(b)	(ii)	• (Gravity anomalies) result from density differences in crustal rocks **OR** roots of mountains / continental crust is less dense **OR** oceanic crust is denser **OR** MOR can have an excess or mass / are hot and less dense ✓ • Negative gravity anomalies show rocks are less dense (than expected) **OR** positive gravity anomalies show rocks are denser (than expected) ✓ • (Strong) negative gravity anomalies occur across mountain ranges **OR** positive gravity anomalies occur over ocean basins **OR** gravity anomalies over MORs can be positive or negative ✓ • (Gravity anomalies) show where the crust and mantle are not in equilibrium **OR** show where isostatic adjustment / isostatic rebound is occurring ✓ • Negative gravity anomalies occur over areas where isostatic rebound is occurring **OR** show continental crust extends further into mantle than expected (because isostatic rebound hasn't occurred) ✓	**Max 2**	2.1b 3.1c	**ALLOW** discussion of lithosphere and asthenosphere

Question			Answer	Mark	AO Element	Guidance
2	(c)	*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Describes the geodynamo theory in a detailed and well understood way **AND** explains the indirect evidence for processes operating within the Earth's core. *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)** Describes the geodynamo theory in a moderate level of detail **AND** explains some of the indirect evidence for processes operating within the Earth's core. *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)** Describes the geodynamo theory in a basic way **OR** describes a property / process operating within the Earth's core. *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 2.1a 3.1c HSW1	AO2.1a Apply knowledge and understanding of geological ideas AO3.1c Evaluate geological information ideas and evidence **Indicative points may include:** Geodynamo theory: • The Earth's core is made of iron / nickel • Outer core is liquid and inner core is solid • Forms a permanent magnet • Has the appearance of a bar magnet / magnetic field lines are oriented N-S • The outer core acts like an electromagnet / self-exciting (dynamo) • Flow of molten iron produces electrical currents • The electrical currents generate magnetic field lines (perpendicular to them) • Variations in magnetic field strength / magnetic reversals occur • Reversals occur approx. every 100,000 to 400,000 years • The position of magnetic north changes over time • Magnetic inclination preserved in rocks provides evidence for the Earth's magnetic field in the past

Question			Answer	Mark	AO Element	Guidance
						<u>Evidence for processes:</u> • Inner / solid part of core is above the Curie point / too hot to be a permanent magnet • Without a liquid outer core movement / convection would not be possible • Changes in Earth's magnetic field strength / magnetic reversals are evidence that convection in the core changes / the self-exciting dynamo runs down • Movement is caused / energy comes from formational heat / radioactive decay • Heat moves outward in all directions from centre of the Earth • The temperature difference between the hot inner and cooler outer core creates convection currents • The Coriolis force / the Earth's spin twists the convection currents or aligns the magnetic field N-S • Reversals are recorded as remanent magnetism in rocks • Magnetic anomalies on the seafloor provide evidence the Earth's magnetic field has changed over time

Question			Answer	Mark	AO Element	Guidance
2	(d)	(i)	 Region **X** data plotted correctly ✓ Region **Y** data plotted correctly ✓ Lines drawn through both sets of points ✓	3	1.1b 2.1b M3.8	**IGNORE** extrapolation beyond 800°C for Region **Y**
2	(d)	(ii)	640 (°C) ✓	1	3.1a M3.8	
2	(d)	(iii)	32 ✓ °C km^{-1} ✓	2	3.1a M3.10	**ALLOW** °C/km for units **ALLOW** ratio for 1 mark

Question			Answer	Mark	AO Element	Guidance
3	(a)	(i)	Loss of energy **OR** transfer of energy from seismic waves to rock **OR** reduction in amplitude (of a wave as it propagates / travels through a material) ✓	1	1.1a	**ALLOW** AW
3	(a)	(ii)	Higher frequency waves have more oscillations (per second) **OR** energy is dissipated / transferred / absorbed faster ✓	1	2.1a	**ORA**
3	(a)	(iii)	<u>Description:</u> Competent / strong rocks have lower intensity / less ground shaking / less damage occurs ✓ **<u>Any one</u>** <u>explanation from:</u> Competent rocks allow vibrations to pass through easily **OR** attenuation is low / negligible **OR** absorb less energy (per unit area) ✓ Incompetent rocks absorb some / more energy ✓ Unconsolidated rocks / sediments vibrate more easily **OR** have high attenuation **OR** amplify ground shaking **OR** undergo liquefaction ✓	1 1	2.1a 3.1b	**ORA** for incompetent / weak rocks **OR** unconsolidated rocks / sediments

Question			Answer	Mark	AO Element	Guidance
3	(b)		**Any two** limitations from: • Shows what happened in the past, not what will happen in future **OR** does not allow prediction of where next earthquake will happen ✓ • Next earthquake could occur on a different fault / different section of fault / different depth / not all faults are known / stress can move position after each earthquake ✓ • Next earthquake / event could be a different magnitude **OR** does not allow prediction of magnitude ✓ • Information may not be understood by non-specialists / members of the public ✓ **Any two** strengths from: • Shows geological features, e.g., faults / rock type / soil type / steep ground ✓ • Areas where earthquakes have happened in the past can be matched up with similar areas where they have not, so can expect similar impact ✓ • Shows areas likely to suffer high intensity / landslides / liquefaction / tsunamis ✓ • Show areas unsuitable for building **OR** where building codes need to be enforced **OR** where built structures need strengthening **OR** where earthquake-proofing of buildings / infrastructure is needed ✓ • Show areas suitable for locating emergency services **OR** evacuation routes **OR** places of safety (muster points) ✓ • Visual / easy to understand **OR** helps non-specialists prepare **OR** helps decision making of government bodies **OR** allows non-specialists to decide whether to get earthquake insurance / earthquake-proofing ✓	**2** **2**	1.1b 2.1b	**ALLOW** reference to other specific named geological hazard(s), e.g., landslide **ALLOW** reference to other specific named geological hazard(s)

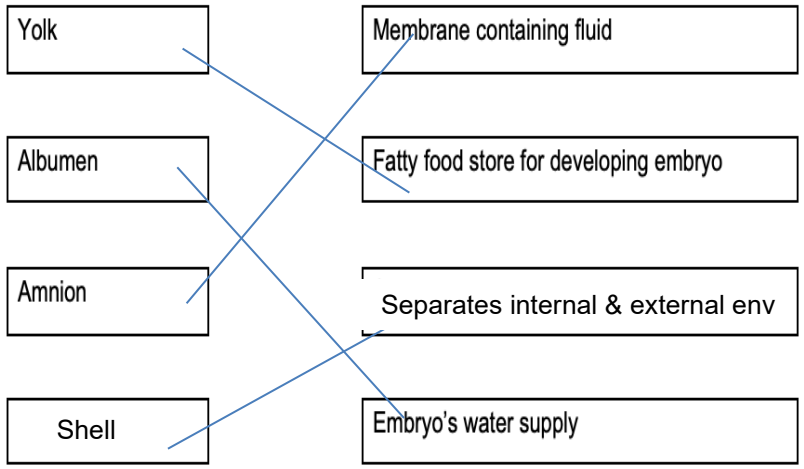
Question			Answer	Mark	AO Element	Guidance
3	(c)		• Lacks a physical **OR** mathematical basis **OR** based on probabilities so may not happen ✓ • Social consequences can be positive, e.g., saves lives / allows people to prepare themselves / prepare their property ✓ • Social consequences can be negative, e.g., panic / stress / unnecessary evacuations / loss of business / falling house prices ✓ • Some people will ignore forecast due to false alarms / apathy / complacency ✓ • Seismologists need to work without fear of retribution / litigation (if they get it wrong) ✓ • Can lead to unsafe engineering / building design (not strong enough) ✓ • Can lead to overly conservative / expensive engineering / building design ✓ • Involves a degree of subjectivity / may lead to different interpretations of the same data by different seismologists ✓ • Problems of misunderstandings between civil engineers / non-specialists / the public **AND** seismologists / geologists / scientists ✓	**Max 3**	3.1c 3.1e	

Question			Answer	Mark	AO Element	Guidance
3	(d)	(i)	Kaolinite is 1:1 ✓ Smectite is 2:1 ✓	2	1.1a	
3	(d)	(ii)	<u>Description one:</u> Treat clay with calcium oxide / lime / chloride salt ✓ <u>Explanation one:</u> Reduces ability to expand **OR** substitutes Ca^{2+} in place of Na^{+} **OR** addition of Ca^{2+} reduces the amount of swelling **OR** clays containing Na^{+} can expand up to 1500% compared to ones containing Ca^{2+} which expand to 100% **OR** stops clays becoming hydrated ✓ **OR** <u>Description two:</u> Use bacteria to change chemistry ✓ <u>Explanation two:</u> Reduces ferric / Fe^{3+} to ferrous / Fe^{2+} **OR** increases the negative surface charge **OR** increases interlayer cation fixation **OR** makes the clay retain K^{+} ✓	2	2.1b	**ALLOW any one** description and **one** matching explanation for **1 + 1** **ALLOW** cement

Question			Answer	Mark	AO Element	Guidance
4	(a)	(i)	Both had four fins / limbs ✓ Fins / limbs were in the same position on the body ✓ Skulls / jaws / teeth (morphology) very similar ✓ Early amphibians had some smally bony scales similar to fish ✓	1	1.1c	**ALLOW** both lack claws or nails **ALLOW** both laid eggs in water
4	(a)	(ii)	(Late) Devonian **OR** (early) Carboniferous ✓	1	1.1a	
4	(b)		**Any** descriptions from: • Fossil **A** has longer tail **OR** fossil **B** has a shorter tail • Fossil **A** has longer / thinner body / is more streamlined **OR B** has a shorter / wider body • Fossil **B** has a large girdle (and **A** does not / is smaller) • Fossil **B** has a robust skeleton (and **A** does not) • Fossil **A** has an elongated / narrower skull **OR B** has wider skull • Fossil **B** has longer limbs **OR** Fossil **A** has shorter limbs ✓✓ **Any one** explanation for fossil **A** to support aquatic environment from: • Long tail used for swimming ✓ • Long thin / streamlined body / narrow skull for swimming / gliding through water ✓ • Short limbs reduce drag in water ✓	2 1	2.1a 2.1b	**ANY 2** correct descriptions for **1 MARK** **ANY 3** or more correct descriptions for **2 MARKS** **ALLOW** implicit comparisons **ALLOW** thicker as **AW** for robust / wider **IGNORE** reference to bony tarsals / foot size

Question			Answer	Mark	AO Element	Guidance
			Any one explanation for fossil **B** to support terrestrial environment from: • Short tail used for balance on land ✓ • Short / wide body for stability walking on land **OR** doesn't need to be streamlined ✓ • Wide girdle for strong attachment of limb bones for walking ✓ • Longer limbs for locomotion on land ✓	**1**		
4	**(c)**	**(i)**	Ischium points backwards in both dinosaurs ✓ Ischium is longer in Iguanodon than Tyrannosaurs ✓ Ilium much larger / wider in Tyrannosaurus than Iguanodon **OR** thicker pubis in Tyrannosaurus than Iguanodon **OR** bones more robust in Tyrannosaurus than Iguanodon ✓ Pubis points forward in Tyrannosaurs **OR** is near vertical (reptile hipped) **OR** Pubis slopes backward / is fore-aft (bird hipped) in Iguanodon ✓	**Max 3**	2.1a	**ORA** **ALLOW** implicit comparisons between the dinosaurs, e.g. longer ischium
4	**(c)**	**(ii)**	Ornithischian ✓ Pubis points backwards **OR** is 'bird hipped' ✓	**1** **1**	2.1b	**ALLOW** Ornithipods

Question			Answer	Mark	AO Element	Guidance
4	(c)	(iii)	Horny (toothless) beak / no predatory teeth / lacks teeth in front of jaw ✓ Used to crop vegetation / unable to tear up meat ✓ **OR** Had leaf shaped cheek teeth ✓ For mincing vegetation ✓ **OR** Hinged jaw / jaw moved from side to side ✓ To chew / grind vegetation ✓ **OR** Limbs ending in hooves ✓ Not a feature of a predator **OR** for steady movement ✓ **OR** Thumb spikes ✓ For gathering vegetation ✓ **OR** Heavy skeleton **OR** (mainly) quadrupedal **OR** able to rear up / become bipedal ✓ Able to run from predators **OR** (rear up to) reach vegetation ✓	**2**	1.1c	**ALLOW any one** morphological adaptation and **one** matching explanation for **1 + 1** **MARK first** adaptation and explanation only **ALLOW** Pleurokinetic jaw **OR** lateral movement of maxilla **ALLOW** (thumb spike) used for defence **ALLOW** walked / moved on 4 legs as **AW** for quadrupedal **ALLOW** (bipedal to) rear up for defence
4	(c)	(iv)	Convergent ✓	**1**	2.1a	

Question			Answer	Mark	AO Element	Guidance
4	(d)	(i)	 ✓✓✓✓	4	2.1a	
4	(d)	(ii)	(Amniotic egg) provided an aquatic / watery environment (for development of embryo) **OR** can be laid out of water **OR** did not have to return to water to breed ✓ (Hard shell) provided protection (to the developing embryo) **OR** prevented desiccation / drying out on land ✓ (Porous shell) allowed for diffusion of (respiratory) gases **OR** gaseous exchange **OR** oxygen in **OR** carbon dioxide out ✓ Contained everything the embryo needed to develop into a miniature adult (able to fend for itself on land) **OR** didn't need to go through a larval stage ✓	**Max 2**	1.1d	

Question			Answer	Mark	AO Element	Guidance
5	(a)	(i)	**MAX any two** descriptions from: Clay / **C** always had the lowest % transmission **OR** medium sand / **M** always had the highest % transmission **OR** the finer the sediment, the lower the % transmission ✓ Silt / **S** showed the biggest change in % transmission during the experiment ✓ Clay particles settle out the slowest **OR** medium sand grains settle out the fastest **OR** the coarser the grain size the faster the grains settled out ✓ Medium sand grains had high % transmission even at the start of the experiment ✓ **MAX any two** explanations from: Clay particles are the lightest / most buoyant **OR** medium sand particles are the heaviest **OR** description of Stoke's Law ✓ Clay particles remain in suspension ✓ Most medium sand particles had already settled out prior to the start of measuring ✓ Silt has a mixture of particle sizes between the other two, so settle out at different rates ✓	**Max 3**	2.1b	**ORA** **ALLOW** clay flocculates so blocks out light / has lower % transmission

Question			Answer	Mark	AO Element	Guidance
5	(a)	(ii)	**FIRST CHECK ANSWER ON THE ANSWER LINE. If answer is <u>8.78</u> (%) award 3 marks** Recall of percentage change formula **OR** <u>80.5 – 74.0</u> X 100 ✓ 74.0 = 8.783 ✓ = <u>8.78</u> (%) Answer to 3 sig figs. ✓	**3**	3.1b	% Change = <u>final – initial</u> X 100 Initial **MAX 2** if answer not given to 3 sig. fig.
5	(a)	(iii)	**M** **AND** Largest / coarsest sediment size **OR** energy is high ✓	**1**	3.1b	**ALLOW C OR S** if justified that grains would be held in <u>suspension</u>
5	(a)	(iv)	Care with electrical equipment and water in experiment (electrocution) **OR** electrical burns ✓ Care with glass breakage and cuts ✓ Care taken with breathing in particulates of sediment (at start of experiment) **OR** risk to asthma sufferers ✓ Slip hazard from water / sand spillage ✓	**Max 1**	2.1b	

Question			Answer	Mark	AO Element	Guidance
5	(a)	(v)*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Analyses and evaluates (implicitly or explicitly) the experimental procedures in detail **AND** suggests some improvements with clarity. *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)** Analyses and evaluates (implicitly or explicitly) the experimental procedures **OR** suggests some improvements. *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)** Analyses at least one experimental procedure in a basic way **OR** suggests at least one improvement giving basic reason(s). *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**	3.1a 3.1c 3.1.f M2.4 HSW6	<u>AO3.1a Analyse geological information ideas and evidence</u> <u>AO3.1c Evaluate geological information ideas and evidence</u> **Indicative points may include:** <u>Analysis and evaluation of the experimental procedures</u> • More accurate than estimating transmission by eye • Made 5 measurements of each – allows plotting of line graph • Colorimeter was calibrated at start • Used a colour filter to make the sediment easier to see • Used regular time intervals • Not realistic / representative of environments of deposition • Samples **C**, **S** and **M** will be different masses for the same volume - may influence results • No information if samples have been graded / sieved - may influence results • Does not state if sample **C** has been crushed (if in lumps will not stay in suspension) • Boiling tubes may not all have the same volume (may differ between **C**, **S** and **M**)

Question			Answer	Mark	AO Element	Guidance
						• Sampling (by pipette) at centre of tube is not specific enough • No information about shaking time • Sampling (by pipette) does not specify volume to sample • Any delay in moving cuvette to colorimeter will affect results • Human error starting stopwatch • No evidence that different filters had been trialled to see if the amber filter was best • Time intervals between each measurement were too long <u>AO3.1f Develop and refine practical design and procedures</u> • Use mass rather than volume of samples **C**, **S** and **M** • Grade / sieve samples to ensure uniform grain size within each sample • Try different colorimeter filters to establish most suitable • Recalibrate the colorimeter between each experiment run • Specify volume of water to add to each boiling tube / use measuring cylinder • Shake each boiling tube for the same amount of time / same way • Sample with pipette at a specific marked position on each boiling tube • Specify volume to sample with pipette

Question			Answer	Mark	AO Element	Guidance
						• Repeat experiment several times and find mean / average results • Control transfer time from cuvette to colorimeter • Use different cuvettes or wash cuvette between experiments • Use shorter time intervals between each measurement
5	**(b)**		**MAX any three** descriptions of method: Use (glass or transparent sided) flume tank / circular flume / bowl / tray **AND** line bottom with sand ✓ Coloured sand **OR** dark and light grains will make formation process easier to see ✓ Place tape measure / ruler along / around / up tank ✓ Use protractor / clinometer (to measure dip angles) ✓ Add flow of water **OR** stir the water in one direction (to generate current) ✓ Vary speed of flow / current (for different experimental runs) ✓ An electric motor and paddles would give better control ✓ Use stopwatch to time (migration / formation) ✓ Use photograph(s) / video recording (to show change over time / for measuring purposes) ✓	**Max 4**	1.1b 2.1b 3.1f M2.5 HSW4	Mark labels on any diagrams as text **MAX 3** for description of experiment **ALLOW** description of an experiment using dry sand and a fan / hair dryer to create current

Question			Answer	Mark	AO Element	Guidance
			MAX any three for data: Measure rate of deposition on lee slope **OR** rate of erosion of stoss slope **OR** rate of dune migration ✓ Measure dune height / wavelength ✓ Measure lee slope / foreset dip / angles ✓ Use systematic sampling **OR** measure at set time intervals ✓ Repeat experiment and find mean / average / standard deviation ✓ Analyse any valid correlation, e.g. dune height to current speed **OR** use Spearman's rank correlation ✓			**MAX 3** for data collection, sampling and processing

Question			Answer	Mark	AO Element	Guidance
6	(a)	(i)	Continents appeared to be fixed in position ✓ Evidence showed the Earth was cooling (from a molten state) ✓ Only movement was thought to be due to cooling of the Earth (which caused contraction) ✓ No horizontal crustal movement was thought to occur **OR** only vertical crustal movement was thought to occur ✓ Experiments showed linear ridges form on cooling spheres similar to linear mountain chains ✓ Mountain ranges formed as wrinkles as the Earth cooled / contracted ✓ Trends of mountain chains correspond with the lines of greatest sediment accumulation (in geosynclines) ✓ Rocks in mountain belts contain marine fossils (showing they originated in geosynclines **/** the rocks had moved upwards) ✓ Shrinkage of a few 10s of km could explain mountain building / orogeny ✓	**Max 2**	3.1a	

Question			Answer	Mark	AO Element	Guidance
6	(a)	(ii)	The text shows that over the past 100 years new theories have built on old theories (geosyncline model / continental drift / seafloor spreading / subduction) ✓ Early ideas / Wegener / Du Toit had no mechanism ✓ The mechanism / understanding of processes was provided by later work / Holmes / Hess / Benioff / Tuzo Wilson / Sykes ✓ Basic model of plate tectonics has been solved ✓ Ridge push / slab pull are relatively recent refinements (to the plate tectonics model) and show ideas are still changing ✓ New evidence is being provided by technological advancements such as seismic tomography / deep sea drilling / supercomputer modelling / basalt geochemistry / isotope geochemistry / radiometric dating ✓ Recent discovery of plates being torn apart away from plate boundaries **OR** 2021 work **OR** work by Toronto researchers needs to be explained, so the paradigm isn't completely solved ✓	**Max 4**	3.1a 3.1b 3.1c	

Question			Answer	Mark	AO Element	Guidance
6	(a)	(iii)	Presence of mid / intraplate volcanoes / volcanic islands / atolls / seamounts ✓ Presence of linear chains of volcanic islands (each one younger than the one before) ✓ High heat flow in areas otherwise aseismic / away from plate boundaries ✓ Discovery of core / mantle boundary plumes using seismic tomography / basalt geochemistry ✓	**Max 1**	1.1c	**DO NOT ALLOW** description of island arcs **ALLOW** correct named chain of islands **ALLOW** any correct geotechnical imaging method
6	(b)		Built on the early ideas of catastrophism / gradualism ✓ Neptunist theory / some geologists suggested all rocks were sedimentary in origin / all formed in the oceans **OR** plutonism theory / some geologists suggested all rocks were igneous in origin / all formed from magma ✓ Recognition that processes operating today are the same as those in the past (identified early) **OR** observation of present-day processes allowed development of the theory of uniformitarianism ✓ Processes were linked together to become the rock cycle model **OR** processes that formed sedimentary, igneous and metamorphic rocks were linked together ✓ Much of the modern rock cycle theory was developed by Hutton (and Lyell) ✓	**Max 2**	3.1b	

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