GCE

Geology

H414/02: Scientific literacy in geology

A Level

Mark Scheme for June 2023

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.

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.

Level of response questions on this paper are **3(c)** and **6(a).**

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

Annotation	Meaning
I	Ignore
BP	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
I	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

13. **Subject-specific Marking Instructions**

INTRODUCTION

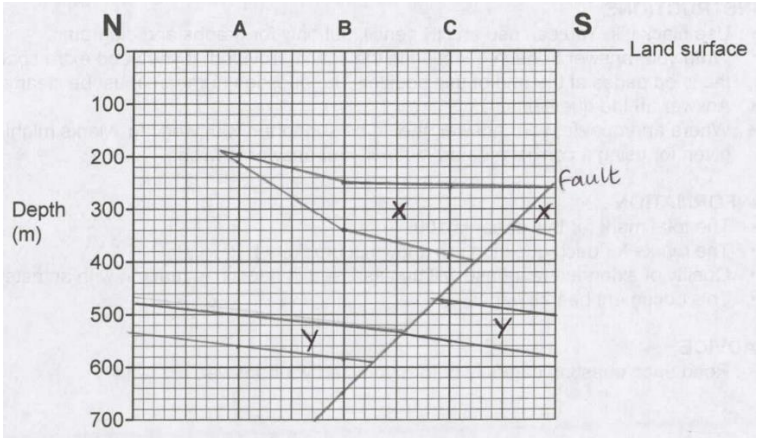
Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- 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.

Question			Answer	Mark	AO Element	Guidance
1	(a)		**Any two** from: • Land which has been built upon **OR** modified by human activity ✓ • Land that has been used for industrial / commercial processes ✓ • Has abandoned factories **OR** has disused buildings / structures **OR** has old infrastructure ✓ • Is derelict / disused land ✓ • May have ground contamination / pollution ✓	2	1.1a	**ALLOW** old landfill site **DO NOT ALLOW** waste disposal / mining unqualified **ALLOW** any correct named contaminant, e.g., asbestos / lead / hydrocarbons / solvents / pesticides
1	(b)	(i)	 ✓✓✓	3	2.1a	Fault plotted correctly for **1 mark** Coal seam **X** plotted widening to the south for **1 mark** Coal seam **Y** plotted displaced by fault for **1 mark**

Question			Answer	Mark	AO Element	Guidance
1	(b)	(ii)	**Any two** from: • Good access to seam **X** using the shaft close to **A** (where seam is close to surface) ✓ • Seam is dipping gently so will be able to construct transport system / machinery will have easy access ✓ • Seam **X** is wide so room to store waste ✓ • Seam **X** is shallow so easily accessible from surface / less likely to suffer roof collapse ✓ • Rocks will absorb radiation ✓ • Ready-made void will reduce costs of excavation ✓ • Stope extraction means unstable roof / may collapse ✓ • Pillars / supports may be in the way (meaning poor access) ✓ • Likelihood of fault reactivation (due to increased load) ✓ • Possibility of leakage / groundwater contamination • Would need lining to contain waste **OR** surrounding rocks need to be impermeable ✓ • Seam **Y** is too deep **OR** is offset by fault so would not be suitable ✓	**2**	**3.1c, 3.1e**	
1	(b)	(iii)	**Any one** description of method from: • Horizontal levels / roadways / trackways are driven out from the shaft ✓ • Coal is removed from the stopes using a shearing / cutting machine **OR** leaves a cavity / void / cavern ✓ • Pillars of coal **OR** supports **OR** props **OR** chocks are left to support the roof ✓	**1**	**1.1d, 3.1d**	

Question			Answer	Mark	AO Element	Guidance
			Any one problem from: • Not all the coal is removed ✓ • Supports fail / wooden supports rot ✓ • Unstable roof / rocks leads to collapse ✓ • Subsidence may occur at the surface ✓	**1**		
1	**(c)**	**(i)**	**Any three** from: • Acid water contaminates drinking water supplies / groundwater / aquifers / surface water ✓ • Free H^+ ions / acidic / low pH water is corrosive **OR** dissolves compounds (as it moves through old mines) ✓ • (Acidified water) contains poisonous / toxic compounds ✓ • (Acidified water) may contain heavy metals / lead / arsenic / mercury / cyanide ✓ • Poisons wildlife / aquatic species in streams / rivers **OR** damages habitats / ecosystems / reduces biodiversity ✓	**3**	**2.1a, 2.1b**	**ALLOW** kills / harms animals / plants
	(c)	**(ii)**	**Any one** from: • Continue pumping out / dewater mine and treat water (after mine closure) ✓ • Seal old mine (concrete or clay) to prevent water leakage ✓ • Use active treatment **OR** add calcium carbonate / limestone / lime / sodium carbonate / sodium hydroxide to increase pH ✓ • Add agents / oxidants to cause precipitation of metals from water ✓ • Use passive treatment / wetlands / shallow ponds / reed beds / phytoremediation ✓	**1**	**2.1a**	**ALLOW** use of (bentonite) clay

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>AO Element</th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>Morphological feature</th><th>Brachiopod
✓ or X</th><th>Bivalve
✓ or X</th></tr>
<tr><td>Pedicle foramen</td><td>✓</td><td>X</td></tr>
<tr><td>A line of symmetry along the hinge line</td><td>X</td><td>✓</td></tr>
<tr><td>Pallial line</td><td>X</td><td>✓</td></tr>
</table>
</td><td>3</td><td>1.1b</td><td>1 mark for each correct row</td></tr>
<tr><td>2</td><td>(a)</td><td>(ii)</td><td>Any three from:
• (Large) pedicle opening / foramen AND supports (large) pedicle for attachment OR pedicle / fleshy stalk AND to attach to substrate ✓
• Strongly ribbed valves AND strengthens shell ✓
• Zigzag / folded margin / commissure AND reduces sediment moving into valves ✓
• Robust / thick / heavy / strong valves AND stable on the substrate / strengthens shell ✓
• Valves may be streamlined AND to prevent damage in high energy OR to align in current ✓</td><td>3</td><td>1.1a</td><td>MAX 1 mark if three adaptations are given with no / incorrect explanations

DO NOT ALLOW attached by pedicle <u>foramen</u> OR attached by pedicle <u>opening</u></td></tr>
</table>

Question			Answer	Mark	AO Element	Guidance
2	(a)	(iii)	**Any two** from: • Only thick shelled fossils preserved **OR** shells show evidence of abrasion ✓ • Broken / disarticulated shells **OR** death assemblage ✓ • (Broken) shells concentrated in layers ✓ • Alignment of shells ✓ • Sorting by size ✓ • Burrowing / infaunal fossils **OR** burrows / trace fossils suggesting burrowing ✓	2	2.1b	**ALLOW** Presence of corals
2	(b)	(i)	Cnidaria **OR** coral ✓	1	2.1a	**ALLOW** Anthozoa
2	(b)	(ii)	**Any three** from: • Fossil **D** has mural pores and **E** does not ✓ • Fossil **E** has a columella and **D** does not ✓ • Fossil **E** has dissepiments / septa and **D** does not ✓ • Both fossils have tabulae ✓ • Both fossils had individual spaces for polyps ✓ • Both fossils are colonial / compound / made of corallites ✓ • Both have radial symmetry in transverse section ✓	3	2.1b	**ALLOW E** is branching and **D** is not **ALLOW AW** **ALLOW** implicit comparisons
2	(b)	(iii)	Palaeozoic ✓	1	2.1b	
2	(b)	(iv)	Brachiopods **OR** bivalves **OR** algal mats ✓	1	2.1a	**ALLOW** any correct named reef-building or reef-dwelling fossil, e.g., crinoid

Question			Answer	Mark	AO Element	Guidance
2	(b)	(v)	**Any four** from: • At or just below sea level / < 30 metres depth ✓ • Clear waters / minimal sediment / low turbidity ✓ • In photic zone / abundant sunlight / have symbiotic algae ✓ • High energy / (well) oxygenated water / nutrient upwelling ✓ • Fully marine / salinity of 30 to 40 parts per thousand ✓ • Temperature between 23 and 29°C / tropical waters ✓ • Sessile / attached / epifaunal / benthonic mode of life ✓ • Filter feeders / have nematoblasts / stinging cells / tentacles to catch food ✓ • May be solitary or colonial / compound ✓	4	2.1a, 3.1b	**ALLOW** any range between 23 and 29°C **OR** optimum temperature 25 / 26 / 27°C
2	(c)	(i)	Pterosaurs **OR** some groups of plants / insects ✓	1	1.1a	
2	(c)	(ii)	Mammals ✓ **Any one** explanation from: • Allowed <u>diversification / radiation</u> into new niches / niches previously occupied by dinosaurs ✓ • Allowed increase in size ✓ • Allowed increase in number of species ✓ • Burrowing / aquatic mammals were not affected as much ✓ • Mammals had a more varied diet ✓	1 1	2.1a	**ALLOW** birds Explanation marking point is dependent on **MP1** **ALLOW** <u>rapid</u> evolution of mammals occurred

Question			Answer	Mark	AO Element	Guidance
2	(c)	(iii)	**Any two** from: • Large crater (offshore) at Chicxulub **AND** is 66 Ma / right age **OR** is site of impact ✓ • Impact site **AND** identified by gravity surveys / inverted sequences / brecciated rock ✓ • Iridium (concentrated in clays at boundary) **AND** originated from outside the Earth / found in meteorites / asteroids ✓ • (Widespread) clay layer **AND** fallout of pulverised meteorite / asteroid / rock from impact ✓ • Shocked quartz grains found at boundary **AND** evidence of impact due to stress / high pressure / shock metamorphism ✓ • Spherules / tektites found near crater **AND** result from melting of rock on impact ✓ • (Widespread) tsunami deposits **AND** as impact caused a tsunami **OR** as a result of impact in ocean ✓ • Soot layer **AND** caused by wildfires triggered by the impact ✓	2	2.1a	**MAX 1** if **two** pieces of evidence listed without explanations **ALLOW** Yucatan Peninsula / Mexico for Chicxulub

Question			Answer	Mark	AO Element	Guidance
3	(a)	(i)	**Any two** from: • Positions of continents have changed <u>over time</u> ✓ • Continents have moved together **OR** have moved apart **OR** supercontinents have existed in past ✓ • Jigsaw fit of continents is evidence ✓ • Wegener's other evidence included matching rocks / fossils / geological structures / evidence of glaciation on different continents ✓ • No explanation **OR** no mechanism was given at the time ✓	2	1.1a	**ALLOW AW**
3	(a)	(ii)	**Any two** from: • Active mantle convection relies on a <u>conveyer belt</u> model where convection cells move plates ✓ • Active convection cells in mantle are not large enough / do not have enough energy to move plates ✓ • No correlation between movement of mantle and movement of plates ✓ • No correlation between plate area and velocity of plate movement ✓ • Good correlation between the edge of the subducting plate and the velocity of plate movement ✓ • Drag of mantle may slow the movement of plates ✓ • Asthenosphere is too plastic / flexible / not enough friction to move the plates along ✓	2	1.1c, 2.1a	

Question			Answer	Mark	AO Element	Guidance
3	(a)	(iii)	Ridge push ✓ Buoyant upwelling of mantle elevates lithosphere at MOR **OR** gravity sliding acts on MOR moving lithosphere away **OR** lithosphere is pushed apart by rising magma at MOR / divergent plate boundaries ✓ **OR** Slab pull ✓ Negative buoyancy pulls subducting oceanic plate into the mantle (at convergent plate boundaries) **OR** cold / dense lithosphere sinks down at ocean trenches / convergent plate boundaries / subduction zones **OR** subducting plate is pulled down by gravity ✓	**2**	**1.1c**	
3	(b)	(i)	Low velocity zone labelled where P and S wave velocities drop close to Earth's surface (approximately 75-250 km depth) ✓ Gutenberg discontinuity labelled at 2900 km, where S waves stop and P wave velocity drops ✓ Outer core marked in area of 2900 – 5100 km depth, where there are no S waves, and the velocity of P waves drops ✓	**1** **1** **1**	**2.1b**	

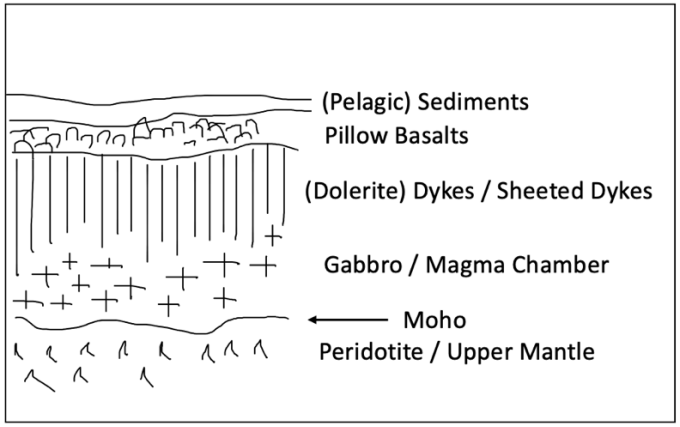
Question			Answer	Mark	AO Element	Guidance
3	(b)	(ii)	**Any one** description from: • S wave velocities generally get faster with depth in mantle ✓ • No S waves are transmitted through outer core **OR** S wave velocity drops to zero at outer core / Gutenberg discontinuity ✓ • S waves reappear in inner core / at inner - outer core boundary / at Lehmann discontinuity ✓ **Any one** explanation from: • S wave velocities are dependent on the rigidity / density of the rock ✓ • Liquids have zero rigidity so S waves cannot be transmitted through liquids / through the outer core ✓ • S waves are generated by P waves in the inner core ✓	**1** **1**	**3.1a**	
3	(b)	(iii)	Correctly read off graph: P wave velocity at 1000km = any value between 11.3 to 11.7 km s^{-1} P wave velocity at 2900km = any value between 13.4 to 13.8 km s^{-1} % change = $\frac{\text{final value – initial value}}{\text{Initial value}}$ x 100 ✓ Correct answer based on correct values used ✓	**2**	**2.1b**	**ALLOW MAX 1** for correct calculation based on incorrect P wave velocities

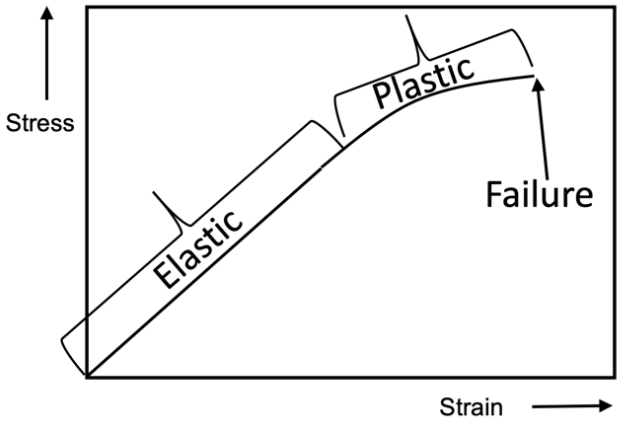
Question			Answer	Mark	AO Element	Guidance
3	(c)*		Refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Uses a good balance of detailed evidence for the structure and composition of the Earth including density **AND** gravity or magnetism *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)** Good evidence for the structure and composition of the Earth is described including density **OR** gravity **OR** magnetism. *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)** Some evidence for the structure or composition of the Earth is described. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*	**6**	**1.1b, 2.1a, 2.1b**	**AO1.1b Demonstrate knowledge and geological skills and techniques** – geophysical surveying **AO2.1a Apply knowledge and understanding of geological ideas** – inferring direct evidence for structure and composition **AO2.1b Apply knowledge and understanding of geological skills and techniques** – inferring indirect evidence for structure and composition **Density** • Gained from rock samples from deep mines / boreholes / deep ocean drilling / ophiolites / mantle xenoliths • Gives density of oceanic crust average 2.9 g cm^{-3} / continental crust average 2.7 g cm^{-3} / Mantle xenoliths average 3.3 g cm^{-3} • Meteorites give evidence for the density of the mantle / core • Mass / density of whole Earth is 5.5 g cm^{-3} / too great to be composed of only crust and mantle rocks, so the core must be higher density or Fe / Ni have correct density

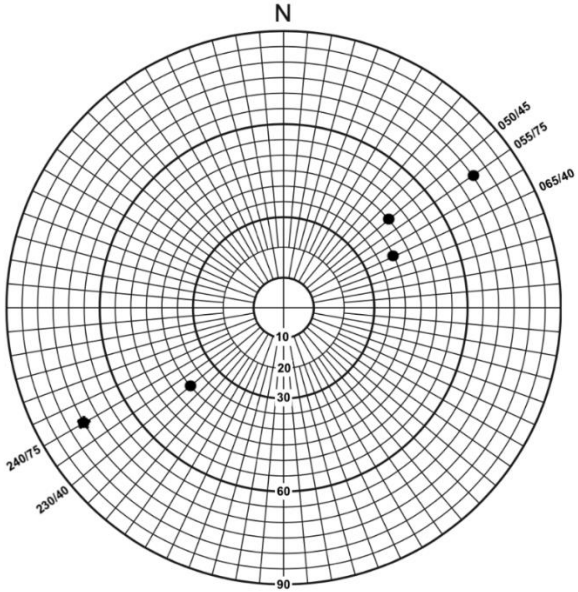
Question			Answer	Mark	AO Element	Guidance
			0 marks *No response or no response worthy of credit.*			**Gravity** • Positive gravity anomalies are produced by high density mafic / ultramafic intrusions • Negative gravity anomalies are produced by low density silicic intrusions • Strong negative gravity anomalies occur across mountain ranges giving evidence that roots of mountains are less dense than mantle • Bouguer gravity anomalies shows less dense continental crust pushes down into mantle / forms roots of mountains • Evidence asthenosphere is a rheid **Magnetism** • Existence of Earth's magnetic field is evidence that part of the core is liquid / Fe / metal / convecting • Electromagnetic (EM) surveys can detect partial melt in upper mantle / below MORs / in the asthenosphere **Other evidence** • Rocks from deep mines and boreholes give evidence continental crust is granitic / silicic / intermediate • Mantle xenoliths / kimberlite pipes give evidence mantle is peridotite / ultramafic

Question			Answer	Mark	AO Element	Guidance
						• Ophiolite complexes / deep ocean drilling give evidence for the layered structure of oceanic crust / oceanic crust is mafic / oceanic core complexes • Iron meteorites contain Fe-Ni / siderophiles and match the core • Stony meteorites contain peridotite / ultramafic rock / olivine and match the mantle / lithosphere
4	**(a)**		Crystal size description: Sills have medium crystals **AND** lava flows have fine crystals **OR** sills have coarser crystals **OR** lava flows have finer crystals ✓ **Any one** crystal size explanation from: Sills cooled (more) slowly / more time for crystals to grow / cooled below the surface **OR** lava flows cooled (more) rapidly / less time for crystals to grow / cooled on the surface ✓ Xenoliths description: Xenoliths found in top and base of sill **AND** xenoliths are only found at base of lava flow ✓ **Any one** xenoliths explanation from: Sills had country rock above and below **OR** lava flows had air / no country rock above **OR** lava flows only had country rock below **OR** xenoliths are older country rock (incorporated into igneous bodies) **OR** country rock above a lava flow is younger ✓	**1** **1** **1** **1**	**1.1a, 1.1c**	

Question			Answer	Mark	AO Element	Guidance
4	(b)		Cuts across / through / not parallel to the original beds ✓	1	1.1a	
4	(c)	(i)	**X** – Olivine ✓ **Y** – Pyroxene / Augite ✓ **Z** – Plagioclase / Feldspar ✓	3	2.1a	**DO NOT ALLOW** Orthoclase **OR** K feldspar
4	(c)	(ii)	(Olivine) Basalt ✓	1	3.1b	
4	(d)	(i)	**FIRST CHECK ANSWER ON THE ANSWER LINE. If answer is T = 28.46 and S = 69.66 award 2 marks** Correct calculation method **OR** formula recall ✓ **T** = 28.46 **AND S** = 69.66 ✓	2	1.1d, 2.1b	**ALLOW** correct answers written on answer lines or in table **ALLOW 1 mark** for one correct answer given to 2 decimal places **ALLOW 1 mark** for 2 correct answers not given to 2 correct decimal places **ALLOW 1 mark** for 2 correct answers to 2 decimal places if distance has not been converted to mm
4	(d)	(ii)	Velocity increases as temperature increases **OR** has a positive correlation ✓	1	3.1e	
4	(d)	(iii)	**V** / vegetable oil **AND any one** reason from: Fast flowing as composed of mafic lava **OR** fast flowing as composed of ferromagnesian minerals **OR** low viscosity so forms shield volcano **OR** low viscosity as low silica content (45-52% SiO_2) ✓	1	3.1c	**ALLOW** basic for mafic

Question			Answer	Mark	AO Element	Guidance
4	(d)	(iv)	**Any two for one mark** from: • Risks of glassware breakage • Scalding / burns from hot water **OR** hot substances **OR** hot glassware • Spilled substances / slipping on substances • Bungs flying out when heated • Danger of electricity (hot water bath) and water mixing ✓	1	3.1f	**ANY two** for **1 mark** **ALLOW** any reasonable answer **DO NOT ALLOW** goggles, lab coats, hair, bags
4	(d)	(v)	**V** flows too fast to time when hot **OR** viscosity too low when hot **OR** unable to start timer before liquid reaches bung ✓	1	3.1c	**ALLOW** any reasonable answer
5	(a)	(i)	Obducted <u>oceanic</u> crust / lithosphere **OR** sections of <u>oceanic</u> crust / <u>oceanic</u> rocks that have been tectonically moved onto continental crust ✓	1	1.1a	**ALLOW AW**
5	(a)	(ii)	 ✓✓✓	3	2.1a, 2.1b	Recognisable sketch showing layered structure through an ophiolite for **1 mark** Any 2 labels for **1 mark** Any 3 **OR** 4 labels for **2 marks** **ALLOW AW** for layer names **MAX 1** for cross-section showing emplacement of an ophiolite complex

Question			Answer	Mark	AO Element	Guidance
5	(b)	(i)	 ✓✓✓	3	3.1b	**1 mark** for each correct label Elastic deformation labelled within bracketed area Plastic deformation labelled within bracketed area Failure point labelled correctly
5	(b)	(ii)	Any **two** from: • Movement along faults is prevented by friction and rock is put under strain / deforms ✓ • Stored stress exceeds the strength of the rock, and it fails ✓ • Energy is released as rock fractures (breaks) and moves **OR** energy released as seismic waves **OR** energy released as vibrations **OR** energy released causes ground movement ✓ • (Elastic) rebound occurs when ground / rocks move back / return to undeformed state ✓	2	1.1c	**ALLOW** stress / pressure instead of energy **DO NOT ALLOW** tension **ALLOW AW** **MAX 1** if explanation uses plates rather than rocks / faults **ALLOW** general statement about stress becomes too much and rocks break releasing energy for **1 mark** **MARK** diagrams as text

Question			Answer	Mark	AO Element	Guidance
5	(c)	(i)	 ✓✓✓	3	2.1b	**ALLOW** ±half a division on stereonet **DO NOT ALLOW** kite plot / rose diagram / circular bar graph 4 points accurate for **3 marks** 2 **OR** 3 points accurate for **2 marks** 1 point accurate for **1 mark**
5	(c)	(ii)	NW to SE ✓	1	3.1b	**ALLOW** correct maximum compressional stress stated from one direction
5	(c)	(iii)	No **AND** Stereonet does not show dip direction **OR** no dip direction information was provided **OR** does not show if the limbs are dipping towards each other or dipping away from each other ✓	1	3.1e	

Question			Answer	Mark	AO Element	Guidance
6	(a)*		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)** Uses a good balance of information / evidence given in the text, map and tables to evaluate and make detailed judgements of the pros / cons of retrofitting. Includes seismic hazards / risk **AND** civil engineering / building code factors. Gives a clear decision as to whether retrofitting existing buildings should be mandatory. *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)** Uses some of the information / evidence given in the text, map and tables to evaluate and make judgements of some of the pros / cons of retrofitting. Includes seismic hazards / risk **OR** civil engineering / building code factors. The decision as to whether retrofitting existing buildings should be mandatory may not be explicit. *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)**	**6**	**3.1c, 3.1d, 3.1e**	**Indicative points include:** **AO3.1c Evaluates information from tables and maps for evidence to help in decision and AO3.1d Makes judgements in terms of pros and cons, and AO3.1e Draws a conclusion. (HSW 9, 10 and 11)** **Seismic hazards / risk** • A hazard exists if there is danger to people or property or Salt Lake City is densely populated • Homes, schools and businesses are at risk • Faults underlie the basin / relative motion on the faults creates a hazard / fault sections underlie most densely urbanised areas • Young / unconsolidated rocks underlie the basin, these absorb (more) energy / amplify seismic waves / ground shaking • Liquefaction hazard is likely in saturated / unconsolidated sediments • Mass movements / landslides may be triggered in mountainous areas • An earthquake prediction could cause a panic evacuation of the city **Civil engineering / building codes** • Earthquakes don't kill people, buildings do

Question			Answer	Mark	AO Element	Guidance
			Some information / evidence is lifted from the text, map and tables to identify some of the pros / cons of retrofitting. A judgement as to whether retrofitting existing buildings should be mandatory may be attempted. *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.*			• Old part / downtown Salt Lake City has many unreinforced / brick buildings • Unreinforced masonry / brick / block buildings are most at risk of damage • Damage to unreinforced buildings will be 40% at intensity VIII / 80% at IX / 100% at X • Damage to reinforced buildings could be as low as 5% at intensity VIII / 13% at IX / 25% at X • Natural frequency of tall buildings can put even modern ones at risk • A retrofitting programme could include cross-bracing to buildings / base isolators • Foundations may be reinforced by pumping in liquid cement • Services (gas, electricity, water) can be earthquake proofed **Retrofitting of existing buildings** **Pros – should be mandatory** • There has been much urban development since 1934 / the last 6.0+ M_W earthquake • A retrofitting programme would significantly reduce the seismic risk • The return period is only an average and a 6.5 to 7.5 M_W earthquake could occur much sooner than predicted

Question			Answer	Mark	AO Element	Guidance
						• Retrofitting does not have to be very expensive • Risk to human life is significant so a retrofit programme is urgently needed **Cons – should not be mandatory** • Return period for a 5.0 M_W or greater is 15 years, but these are not destructive • 6.0 M_W are destructive but only two have occurred in the last 120 years • 6.5 to 7.5 M_W very destructive, but return period is 270 years, there may not be another for well over 100 years • Who is going to pay for retrofitting / people may not be able to afford retrofitting
6	**(b)**		**FIRST CHECK ANSWER ON THE ANSWER LINE. If answer is 15 award 2 marks** Recall of formula: (*n* + 1) / *m (*where *n* is number of years on record and *m* is number of recorded occurrences) **OR** correct method of working ✓ Correct answer: 15 ✓	**2**	**3.1a**	**DO NOT ALLOW** 15.12

Question			Answer	Mark	AO Element	Guidance
6	(c)		Any **three** from: • Epicentre likely to have highest intensity **OR** will be located within the IX isoseismal line ✓ • As energy is absorbed further from epicentre there are concentric successively lower intensities ✓ • Older / unreinforced masonry / brick and block buildings in downtown Salt Lake City are more likely to be damaged / suffer higher intensity ✓ • Highest intensity in downtown Salt Lake City as it is most densely urbanised / has highest population density **OR** undeveloped land has lower intensity ✓ • Newer / reinforced / built to a tighter building code buildings in West Lake City are less likely to be damaged / suffer lower intensity ✓ • Higher intensities above faults **OR** (Buildings in) downtown Salt Lake City have a section of Wasatch fault running below so higher intensity / closer to epicentre ✓ • Higher intensity where there are unconsolidated sediments / gravel / sand / clay / lakebed deposits ✓ • Mass movements / landslides may occur along margins of mountains ✓ • Higher VII zone (within V zone) in the S/SE as the urban area extends to there / there is fault present / landslides may occur ✓	**3**	**3.1b, 3.1d**	**ALLOW AW**
6	(d)	(i)	Resonance amplifies oscillations **OR** sway increases at natural frequency **OR** at natural frequency sway occurs ✓	**1**	**2.1a**	**ALLOW AW**

Question			Answer	Mark	AO Element	Guidance
6	(d)	(ii)	$k = (\boldsymbol{f} \times 2\pi)^2 \times m$ **OR** $(\boldsymbol{f} / 1 / 2\pi)^2 \times m$ **OR** $4\pi^2 \times m \times \boldsymbol{f}^2$ ✓	1	2.1b	**ALLOW** any correct formula rearrangement to give k
6	(d)	(iii)	Any **two** from: • Greater stiffness results in higher natural frequency **OR** greater mass results in a lower natural frequency ✓ • **A** could have most structural integrity as it has greatest stiffness **OR B** could have least structural integrity because it has the lowest stiffness ✓ • **B** has natural frequency furthest away from the earthquake frequency so could have most structural integrity **OR A** could have least structural integrity because its frequency is closest to the earthquake frequency ✓ • **C** could have most structural integrity as it has the greatest mass **OR B** could have least structural integrity because it has the lowest mass ✓	2	3.1c	
6	(d)	(iv)	Taller buildings tend to be more flexible / less stiff / less rigid **OR** taller buildings are likely to have a larger mass (which reduces the natural frequency) ✓	1	1.1c	**ORA** for shorter buildings

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on

01223 553998

Alternatively, you can email us on

support@ocr.org.uk

For more information visit

ocr.org.uk/qualifications/resource-finder

ocr.org.uk

Twitter/ocrexams

/ocrexams

/company/ocr

/ocrexams

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

OCR is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

OCR operates academic and vocational qualifications regulated by Ofqual, Qualifications Wales and CCEA as listed in their qualifications registers including A Levels, GCSEs, Cambridge Technicals and Cambridge Nationals.

OCR provides resources to help you deliver our qualifications. These resources do not represent any particular teaching method we expect you to use. We update our resources regularly and aim to make sure content is accurate but please check the OCR website so that you have the most up-to-date version. OCR cannot be held responsible for any errors or omissions in these resources.

Though we make every effort to check our resources, there may be contradictions between published support and the specification, so it is important that you always use information in the latest specification. We indicate any specification changes within the document itself, change the version number and provide a summary of the changes. If you do notice a discrepancy between the specification and a resource, please contact us.

Whether you already offer OCR qualifications, are new to OCR or are thinking about switching, you can request more information using our Expression of Interest form.

Please get in touch if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.