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AS and A LEVEL

Candidate Style Answers

GEOLOGY

H014, H414
For first teaching in 2017

Exemplar learner responses to level of response questions

Version 2

Contents

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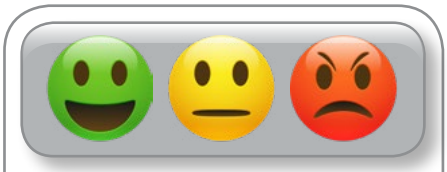

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Introduction – General Commentary

Traditional extended response in A level Geology was assessed through 10 to 15 mark questions which focused on describe and explain, rewarded quality of written communication (QWC) through the correct use of specific technical terms and used mark-schemes based on 'point marked' criteria. From June 2018 extended response questions in AS Geology (H014) will be assessed with mark-schemes based on 'Level of Response' (LoR) criteria, and from 2019 onwards both AS (H014) and A level (H414) Geology exams will contain LoR questions. LoR questions have been used in OCR GCSE science exams for a number of years and teachers may also be familiar with this approach from GCSE and A level geography exams.

LoR questions are indicated in question papers with an asterisk (*) after the question number. These questions are generally less structured than most other questions in the papers and allow candidates to choose their own route through an answer. Candidates may be asked to draw from geological knowledge across the course and apply familiar content in unfamiliar contexts rather than straight recapitulation of knowledge. The use of level of response allows more flexible credit to be given when candidates have answered in a slightly different way or done much better in one part of an answer than another. This resource has been designed to aid teachers and students in preparing for this style of question in their examinations.

LoR questions allow students to be credited for both

- their scientific knowledge, understanding and ability to apply these to familiar and unfamiliar situations, and
- their ability to communicate in a clear, coherent and logical manner.

Mark schemes for LoR questions therefore detail both the 'geological content' and the 'communication' aspects of expected answers. The communication criteria cover the ability to maintain a sustained line of argument rather than just the use of specific technical language.

Examiners are told to read through an answer once to decide which of four 'Levels' (including zero) it matches on a 'best fit' basis. There are descriptors on the left-hand side of the mark-scheme corresponding to each level. The 'indicative geological points' on the right-hand side of the mark-scheme are used here. They then read the answer again to decide whether the 'quality of written communication' statement (in italic on the left-hand side for each scoring level) is matched. This often refers to a logical presentation of the points made. If the statement is matched, the higher mark in the level is awarded, eg 6 marks for Level 3, 4 marks for Level 2, etc. Otherwise the lower mark in the band is awarded.

The indicative geological points that are included in mark schemes are neither exhaustive nor a list of all of the geological points that have to be included in an answer to gain a particular mark. Indeed, the mark schemes that are used to assess candidates' responses in live examinations are finalised only after examiners have looked at and discussed a wide range of candidates' responses. This is a key aspect of ensuring that all candidates are awarded marks and final grades in a fair and credit-worthy manner. The senior examiner commentary included within this resource should therefore be seen within this context.

Further senior examiner commentary and guidance on answering all styles of questions is made available in Examiner's Reports (via www.ocr.org.uk, under 'Past papers, mark schemes and reports' on the qualification pages) and in CPD materials published following each series of examinations (available securely to teachers via www.cpdhub.ocr.org.uk under 'GCE Geology', or www.ocr.org.uk/interchange under 'Resources and Materials'/'Past Papers and Mark Schemes').

For this resource, student style responses to eight LoR questions have been marked and commented on by two experienced examiners. The student responses are composite answers composed from the replies of one or more students to the sample assessment papers available on:

http://www.ocr.org.uk/Images/322113-unit-h014-01-as-geology-sample-assessment-material.pdf and http://www.ocr.org.uk/Images/322107-unit-h414-01-fundamentals-of-geology-sample-assessment-material.pdf.

As can be seen from these questions, a variety of different geological concepts can be assessed by LoR question. For example sedimentary processes, field work and laboratory practical activities, and stratigraphy are covered in these papers. Additionally, the demand of the questions can vary across the range from medium low demand to high demand.

For each question, four responses have been selected, exemplifying a Level 3, a Level 2 and a Level 1 response,

and one that would gain no marks. Commentary is provided on why the Level was selected and the mark awarded, and what extra was needed in the response to move to the next Level.

For each question, three composite responses have been composed from actual student answers, exemplifying a Level 1, a Level 2 and a Level 3 response. Commentary is provided on why the level was selected and the mark awarded, and the mark awarded within the level.

When answering LoR questions, students are advised to approach the writing of their response systematically. Students may find these tips useful:

- Read the question carefully (including any accompanying data) to make sure your answer will address the question asked – underlining/circling command words can be helpful.
- Does the question include any accompanying data to use in your answer? This could include a photograph, map, drawing, graph or data table – analyse and/or interpret accompanying data in the context of the question asked, for example the reasons for patterns/trends seen within the data, and geological structures in photographs – annotation of the data can be helpful.
- Re-read the question, and identify the key aspects of geology that the question is asking about – underlining/circling keywords and phrases can be helpful.
- Think about the knowledge of geology required and the understanding that needs to be used to answer the question – making brief notes, the points can then be arranged in a logical order.
- Write a clear and logical answer to the question, thinking carefully about the order in which points are presented, and how the answer links to the aspects of geology asked about in the question – bullet points can be used if they help communicate a sustained line of reasoning.
- Use diagrams especially where a blank space is given, diagrams should complement and enhance your written response to help to communicate your answer(s) more clearly in fewer words – use labels to make it obvious why you have included the drawing(s).
- Re-read the question and the answer, checking that the question has been fully answered, and that the answer doesn't contain contradictions.

The number of dotted lines given in examination papers for the answers is indicative of the length of answer expected for the question. Students can use the extra space provided within a paper if necessary. They should, however, be cautious about writing very long answers, as this can increase the possibility of contradicting themselves and can reduce the clarity and coherence of their answers.

Question 1 – H014/01 Question 24(c)

AS Level Geology

24 Sediment transport processes not only affect the characteristics of the sediments themselves, but can also produce structures which suggest the nature of the sedimentary environment.

Some students investigated sedimentary processes from two points in a river by systematically sampling clasts across the river bed.

(c)* The students then studied a nearby cliff section of sedimentary rock. Their geological guide book said that the sedimentary rocks may have been deposited by a river flowing into a playa lake, and that later tectonic processes had turned the whole sequence upside down.

Discuss possible sedimentary structures that might be recognised in the outcrop which would support the proposed environment of deposition and also possible evidence for the sequence being overturned.

Explain your decisions. You may find the use of diagrams helps your answer

6 marks – Level of Response – **Medium/low demand**

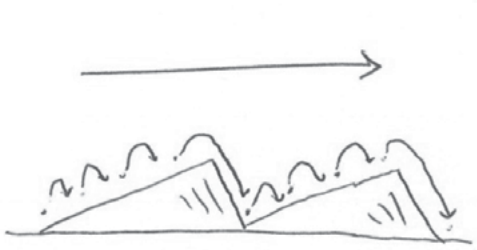
Question			Answer	Marks	Guidance
24	(c)*		*Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.* **Level 3 (5–6 marks)** Full analysis of the information provided discussing most of important geology (i.e. most of potential sedimentary structures) **AND** explanation **AND** discussion of way-up evidence *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and detailed.* **Level 2 (3–4 marks)** Good analysis of the information provided. Some of structures described **AND** explanation **OR** discussion of way-up evidence *There is a line of reasoning presented with some structure. The information presented is relevant.* **Level 1 (1–2 marks)** A limited treatment providing either a description of some structures **OR** information which may lead to attempt at interpretation of way-up evidence *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0 (0 marks)** *No response or no response worthy of credit.*	6	**Indicative geological points may include** **Evaluation of scenario** sediment brought down by river, settles in low energy conditions of playa lake; hot conditions cause rapid evaporation, this environment leads to…… **determine possible sedimentary structures** • Salt pseudomorphs • Asymmetrical ripple marks • Graded bedding • Desiccation cracks • Imbrication **explanation of decisions** • *Salt pseudomorphs:* form when lake dries and halite crystals form; redissolving of these and infilling with sediment form pseudomorphs • *Asymmetrical ripple marks*: are formed by currents that flow in one direction, or formed in desert environments where the wind acts in the same way as water • *Graded bedding:* largest particles are on the bottom of the bed and the smaller particles are at the top / the grains become finer towards the top / there is an abrupt change in size at each bedding plane / larger particles are heavier and settle out first so are found at the bottom of the bed / can be formed when sediment tips into lake and gravity settling occurs • *Dessication (mud)* cracks: form when fine sand/mud dries, shrinks and cracks; cracks become infilled later with sediment • *Imbrication:* forms when long pebbles become tilted in roughly the same direction by transporting river • *Evidence for overturned sequence:* dessication: cracks are wider at bottom than top; graded bedding: sequence gets coarser upwards; geopetal structures.

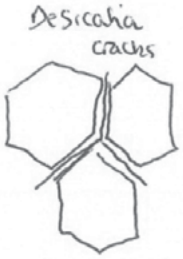
The layout and structure of LoR Mark Schemes is shown in the first example above. The lefthand column details each of the three Level descriptors (starting with Level 3 and proceeding down to 0 marks). The marks available in each Level are shown in brackets. There is a quality of written communication statement incorporated into each Level, which is shown in italics.

The right-hand column of the mark scheme lists relevant scientific information that may be present in a good response. Underlined words indicate that terms must be present in an answer to score a mark (i.e. asymmetrical ripples but not symmetrical ripples or other nonspecific ripples that are not indicative of environment of deposition). These points do not all have to be present to achieve full marks and they are not marking points. They are simply an indication of the type of information and detail that could be expected.

Question 1, sample answer 1

Explain your decisions. You may find the use of diagrams helps your answer.





Sedimentary structures that may be recognised in the outcrop which would support deposition in a river having into a playa lake are asymmetrical ripple marks on the ground, they are asymmetrical due to the current flowing in one direction. Furthermore imbricate structures may also form due to this, as a series of clasts stack up against each other dipping upstream. Another sedimentary structure is desiccation cracks, these will be by playa lakes which form in hot, arid environments. As mud dries when water evaporates it shrinks to form cracks. As the water contained dissolved salt pseudomorphs may form. When mud flows into a playa lake, energy is lost which means sediment is deposited as there is it enough energy to carry it forward. [6]

Evidence for the whole sequence being overturned would be the sedimentary structures, for example 'V' shaped dessicatia cracks will have their smaller point at the top when inverted, but the top should be wider, closer to the surface where mud evaporation takes place

Commentary on Question 1, sample answer 1 of 4

This is a Level 3 response and has been awarded 5 marks.

The candidate has analysed the information provided and has identified most of the sedimentary structures that might be found in the environment described.

They have included explanations of the formation of some sedimentary structures, but not all of them. The diagram of the asymmetrical ripple implies a process of formation however this can only be credited if it is explicit, for example by annotation.

The candidate has also discussed way-up evidence provided by one of the sedimentary structures (desiccation cracks). It is the inclusion of both these sections that makes this response level 3.

This is a very good response that is concise, clear and logically structured throughout. Better use could have been made of the drawings by labelling and linking them in the text to avoid repeating the same information in two places. To improve the response the candidate could have described an additional sedimentary structure (e.g. graded bedding), both in terms of its formation and use to identify way-up.

Question 1, sample answer 2

Explain your decisions. You may find the use of diagrams helps your answer.

Desiccation cracks occur when water evaporates from a playa lake in the hot, arid conditions of a desert. These can be used as way-up evidence as the cracks should be wider at the top, due to more evaporation and greater contraction of the mud. If the 'V' shape points upward, then the bed has been inverted.

Another sedimentary structure that could be found is graded bedding. This is also useful as a way-up structure because the large clasts are found at the base and smaller clasts at the top of a bed. This means that if a bed is found with large clasts at the top, then it must have been overturned.

Ripple marks could be found from the river, but are not as useful for way-up. [6]

Commentary on Question 1, sample answer 2

This is a Level 2 response and has been awarded 3 out of 6 marks.

The candidate has analysed the information provided and identified the conditions found in a desert and has been able to discuss sedimentary structures found in both rivers and playa lakes.

They have correctly described the use of desiccation cracks and graded bedding as way-up indicators, although they could have written more about the ripple marks (for example – named them as asymmetrical). Their use of non-technical terms such as large/small for clast sizes rather than coarse/fine indicates more limited familiarity with sedimentary processes, while their clear diagrams imply a knowledge of way-up that could not be credited because it was not made explicit either in the text or through using more explicit annotations.

They have not been awarded higher than level 2 as they have not attempted to provide any information about the formation of these sedimentary structures. The response is not sufficient to warrant 4 marks and 3 marks have been awarded.

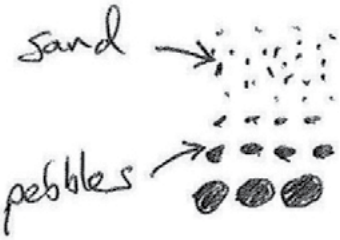
The answer could be improved by using a clearer structure that would allow the candidate to demonstrate a sustained line of argument including all relevant observations:

- what are rivers and lakes in an arid like as depositional environments
- how could sedimentary structures recognised in an outcrop give evidence for an arid depositional environment (flashy river and/or playa lake)
- how could these sedimentary structures provide information on way-up
- how can I use drawings to reduce and enhance what I have to write

The command word 'discuss' requires students to give an account that addresses a range of ideas and arguments, in this case the candidate has mostly covered way-up and not addressed evidence for depositional environment.

Question 1, sample answer 3

Explain your decisions. You may find the use of diagrams helps your answer.



Playa lakes occur in hot and arid desert environments so the river was probably a high energy wadi channel. In wadis there is graded bedding, this is where coarser clasts are deposited at the bottom and finer clasts deposited on top in a fining upwards sequence. Water from the playa lakes evaporates in the hot, arid environment causing V-shaped desiccation cracks to occur as the mud shrinks.

[6]

Commentary on Question 1, sample answer 3

This is a Level 1 response and has been awarded 2 out of 6 marks.

The candidate has evaluated the scenario and given a limited treatment of the conditions expected in the depositional environment and they have identified more than one sedimentary structure that could form in the river and playa lake using information from the stem of the question.

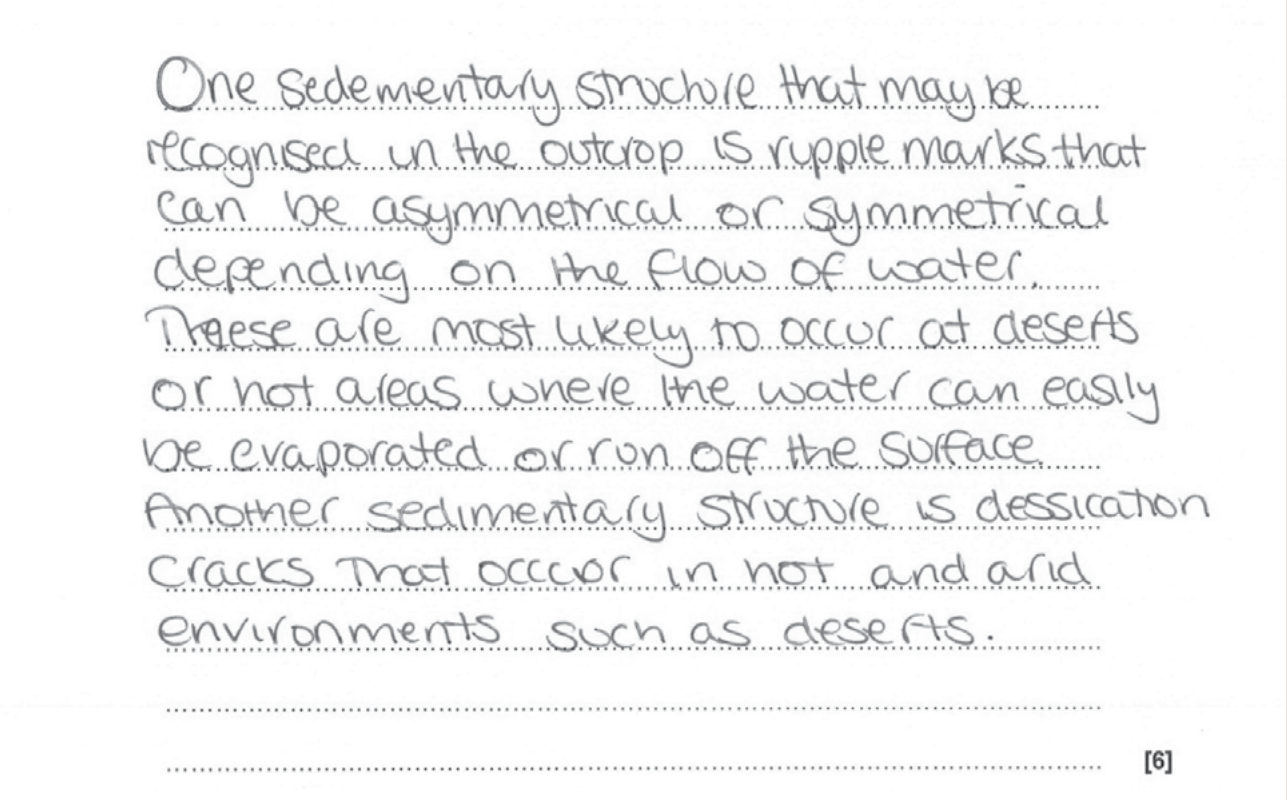
They have described how both graded bedding (including a clearly labelled sketch) and desiccation cracks (lacking detail) form. The formation of desiccation cracks is used as evidence to support the environmental interpretation but the formation of graded bedding in wadis is implied so cannot be credited as evidence.

The candidate has not referred to way-up interpretation or how either graded bedding or desiccation cracks could be used as evidence for way-up.

To be a Level 2 response the candidate would need to provided more detail (such as through a well annotated sketch) on the formation of desiccation cracks (e.g. in desiccation cracks the mud dries and shrinks more at the top). The answer could be improved by checking that all aspects of the question have been answered. While the answer given matches the Level 2 communication statement, for example it is "presented with some structure. The information presented is relevant", the incompleteness of the answer in terms of the science content limits this answer to a Level 1.

Question 1, sample answer 4

Explain your decisions. You may find the use of diagrams helps your answer.



One sedementary structure that may be recognised in the outcrop is ripple marks that can be asymmetrical or symmetrical depending on the flow of water. These are most likely to occur at deserts or hot areas where the water can easily be evaporated or run off the surface. Another sedimentary structure is dessication cracks that occcur in hot and arid environments such as deserts.

[6]

Commentary on Question 1, sample answer 4

This is a Level 0 response and has been awarded 0 out of 6 marks.

No marks awarded, as candidate has only named sedimentary structures that might be found in rivers or playa lakes, but has not discussed these structures as evidence of either the depositional environment or way-up.

The candidate has some implied knowledge of arid sedimentary environments however their very vague response neither states nor explains why ripples (symmetrical or asymmetrical) and desiccation cracks are evidence of an arid river or lake deposition. This response fails to meet any of the criteria for Level 1 and is not worthy of any credit.

This is an example of a candidate answering the question they expected rather than the one they were asked. It is insufficient in a level of response question to list 'facts', the candidate does need to make some attempt to answer the question they were asked.

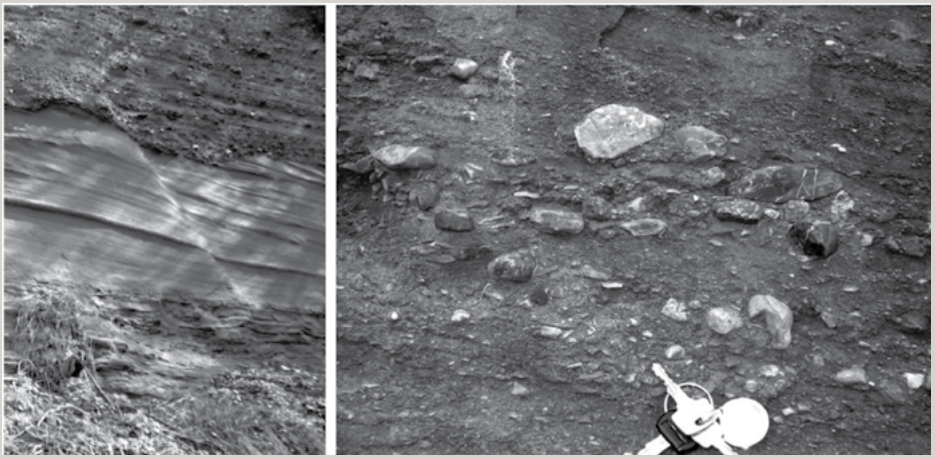
Had the candidate circled the command words (*i.e. discuss and explain your decisions*) and underlined the critical terms in the stem of the question (*ie support the proposed environment* and evidence for … being overturned) it would have been clearer to them how to apply their geological knowledge. The answer could be improved by attempting a logical structure that either describes the formation of the sedimentary structures support deposition in an arid environment OR by describing how the sedimentary structures could be used to interpret the way-up of the sequence.

Question 2 – H014/01 Question 28(a)(iii)

AS Level Geology

28 The geology of South Devon has often been characterised by the 'red beds' frequently seen in coastal sections, notably in the Torbay area.

(a) A group of geology students decide to investigate these 'red beds'. They choose an outcrop near Paignton Harbour which appears to show large scale cross bedded sandstones but interspersed with lenses of a coarser sediment. See photographs 28A and 28B below.



Photograph 28A
Cross bedded sandstones in centre of photo

Photograph 28B
Lens of coarser material

The students decided to do a grain analysis on a weakly cemented block of the coarser sediment in order to plot a cumulative weight percent frequency curve.

(iii)* The students use their cumulative weight percent frequency curve to calculate the sorting coefficient of the coarser material to be 1.9. From the geological guide, they know value for the sorting of the sandstones is 0.3.

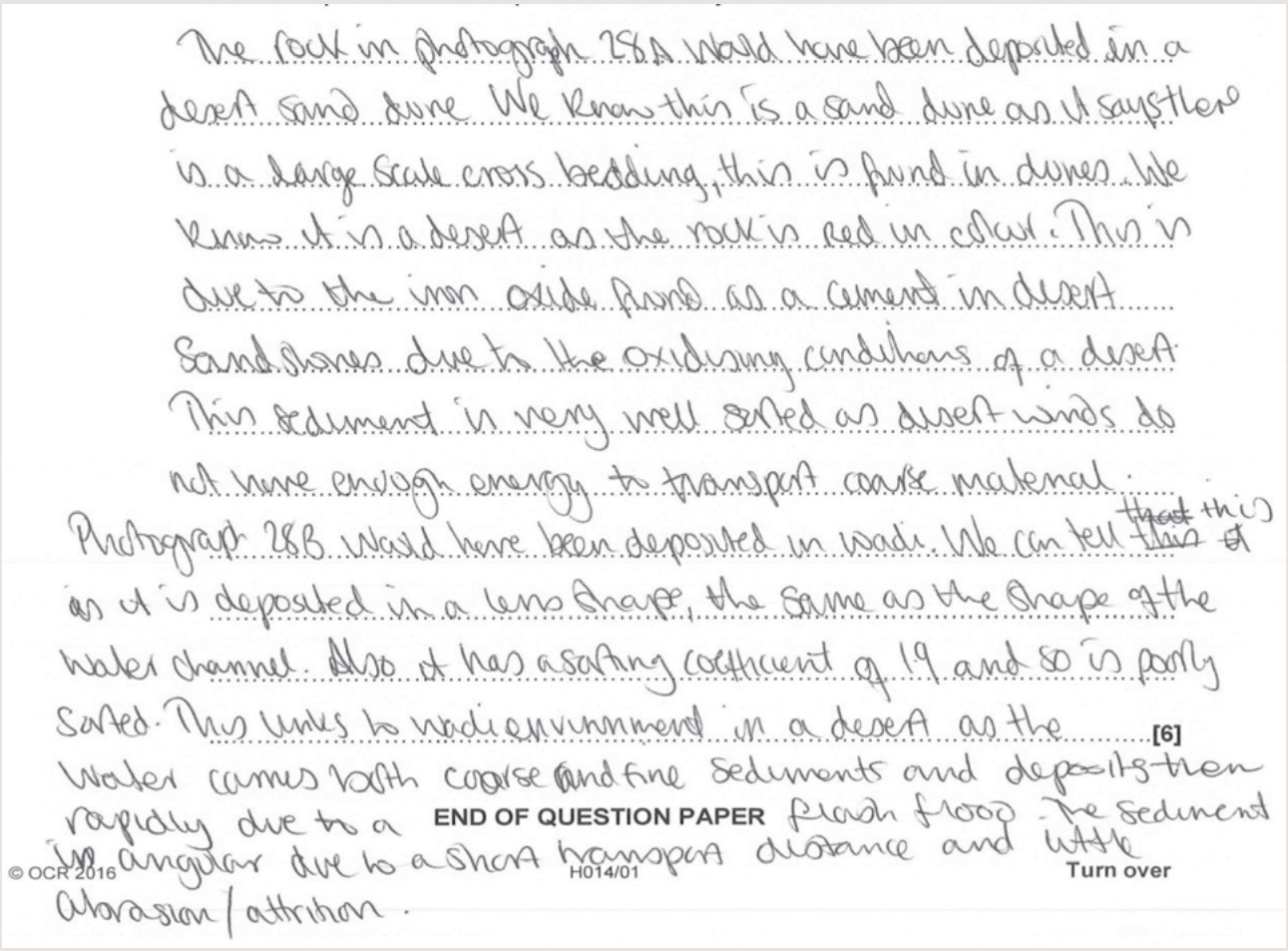
Use the values above, along with the photographs and information given in the earlier parts of this question, to suggest the environment of deposition of the rocks found in this outcrop. You should explain the basis of your decisions.

6 marks – Level of Response – **Medium demand**

Question			Answer	Marks	Guidance
28	(a)*	(iii)*	*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)** Full analysis of the information provided discussing most of important geology **AND** a sound overall conclusion. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and detailed.* **Level 2 (3–4 marks)** Good analysis of the information provided **AND** an attempt at an overall conclusion of the environment at the time **OR** interpretation of information *There is a line of reasoning presented with some structure. The information presented is relevant.* **Level 1 (1–2 marks)** A limited treatment providing incomplete analysis of information which may lead to attempt at interpretation or conclusion. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0 (0 marks)** *No response or no response worthy of credit.*	6	**NB:** A labelled diagram may illustrate some of the observations and/or interpretation. **Indicative geological points may include** **analyse geological information, ideas and evidence** Pictures • angular fragments • badly sorted • imbricate structures dip to west • coarse material interspersed with finer cross bedded sands Grain analysis • coarser material poorly sorted • sandstones well-sorted and finer sand Text • red colour suggest oxidising conditions (surface deposition) **interpret geological information, ideas and evidence** • red large-scale cross bedded sands suggest desert environment • breccia/badly sorted angular fragments showing imbrication suggests rapid water borne deposition **draw conclusions** • overall desert environment with periodic flash floods depositing eroded material from higher ground to west of desert

Question 2, sample answer 1

Use the values above, along with the photographs and information given in the earlier parts of this question, to suggest the environment of deposition of the rocks found in this outcrop. You should explain the basis of your decisions.



The rock in photograph 28A would have been deposited in a desert sand dune We know this is a sand dune as it says there is a large scale cross bedding, this is found in dunes. We know it is a desert as the rock is red in colour. This is due to the iron oxide found as a cement in desert sandstones due to the oxidising conditions of a desert. This sediment is very well sorted as desert winds do not have enough energy to transport coarse material.

Photograph 28B would have been deposited in wadi. We can tell this as it is deposited in a lens shape, the same as the shape of the water channel. Also it has a sorting coefficient of 1.9 and so is poorly sorted. This links to wadi environment in a desert as the water carries both coarse and fine sediments and deposits them rapidly due to a flash flood. The sediment is angular due to a short transport distance and little abrasion / attrition. [6]

END OF QUESTION PAPER

Commentary on Question 2, sample answer 1

This is a Level 3 response and has been awarded 5 of 6 marks.

This response is detailed and contains most of the information possible from the photographs, text and grain analysis data. The candidate has analysed the evidence provided and used it to correctly identify the environment of deposition as a desert, demonstrating how they have drawn conclusions from the evidence available in their answer.

The previous part to the question – 28(a)(ii) – dealt with imbricate structures which are also in photograph 28B, however because the candidate did not identify these structure they were unable to use them as further evidence of wadi deposition. Although the candidate's content and interpretation is very good their written response is quite disjointed and they treat each source of information in isolation; the text makes it clear that the two photographs are linked and both part of the same larger environment.

This answer could be improved by more clearly linking the various data in a more logically structured way. The candidate would have been well advised to:

- note down the points in the margin before starting
- arrange the points in a logical sequence before commencing the answer.

Although this candidate's response addresses all of the science content required for the Level 3 descriptor in the left hand column of the mark scheme their line of reasoning is not at an AS/A level standard and only just meets the guidelines in the communication statement in the left hand column of the mark scheme – information presented is relevant and detailed but although a line of reasoning is present it is disjointed rather than well developed. There is an expectation that AS students can communicate scientific concepts and ideas clearly rather than as a series of unlinked points.

Question 2, sample answer 2 of 3

Use the values above, along with the photographs and information given in the earlier parts of this question, to suggest the environment of deposition of the rocks found in this outcrop. You should explain the basis of your decisions.

I think that because the cross bedded sandstone is on a large scale, it will be a desert environment with large sand dunes ~~and~~ because there is lensing of coarse sediment, which is poorly sorted, that it will be an alluvial fan at the base of a wadi channel. This forms as a result of flash floods in deserts. The red colour is due to iron oxide, found as a result of hot and arid conditions.

[6]

Commentary on Question 2, sample answer 2

This is a Level 2 response and has been awarded 3 out of 6 marks.

This candidate has analysed a variety of information from both the text and the photographs to identify key features of the sedimentary deposits. They have then gone on to link these features with those found in desert environments/sediments and therefore concluding the environment of deposition.

A more detailed response would apply basic knowledge and understanding to discussing the grain size and shape and relating this to the sorting and rapid deposition that occurs in the wadis.

To achieve Level 3 the candidate would have to justify and explain rather than merely stating facts (i.e. why is the red colour the result of hot and arid conditions?). Clearer links also need to be made between data and conclusions rather than relying on implied understanding and assuming geological understanding in the reader; no reference is made to data sources for example how do we know that the sediment is poorly sorted?

Question 2, sample answer 3

Use the values above, along with the photographs and information given in the earlier parts of this question, to suggest the environment of deposition of the rocks found in this outcrop. You should explain the basis of your decisions.

I think this environment is desert because there is cross-bedded sandstone which would suggest that the sand has been sorted and transported by the wind, the coarser material was deposited, probably due to a river because there is coarse material and very poor sorting.

[6]

Commentary on Question 2, sample answer 3

This is a Level 1 response and has been awarded 1 out of 6 marks.

The candidate has used some of the information available in the question to attempt an analysis of the environment of deposition. They have used both photographs, but not the text within the question, or prior to it.

The response could be improved by indicating the scale of the cross bedding and linking it to the scale of sand dunes or discussion of the coarse deposit being poorly sorted due to rapid deposition. Because only a limited amount of the available data has been treated and conclusions are presented with no justification this is a Level 1 response. Geology is more than description and classification.

To improve to Level 2 the candidate would need to explicitly consider and interpret all three data sources: text, grain size analysis and photographs.

Question 2, sample answer 4

Use the values above, along with the photographs and information given in the earlier parts of this question, to suggest the environment of deposition of the rocks found in this outcrop. You should explain the basis of your decisions.

the photograph on the right was deposited in water.
The other photograph 28A shows sands deposited in a desert environment to create sand dunes.

[6]

Commentary on Question 2, sample answer 4

This is a Level 0 response and has been awarded 0 out of 6 marks.

This response is very limited, it does not include any analysis of information in photograph 28B (or does not identify it as such) and while there is an attempt at deducing the environment of deposition for photograph 28A, the student offers no explanation indicating why they think it could be a desert.

To achieve Level 1 the candidate needs to attempt to interpret more than one data source and offer some explanation as to why they believe this to be a former desert environment. For example they could discuss the large scale cross bedding as evidence for sand dunes, or the sorting coefficient data or sizes of clasts in 28B as indicators of flashy/high energy river/wadi deposition.

Question 3 – H414/01 Question 31(b)

A Level Geology

31 (b)* Finer sediments such as silts are difficult to analyse using sieves. However Stokes' Law shows a relationship between the radius and the terminal velocity of a particle falling through a fluid.

Design an experiment a student could carry out to measure the mean grain size in a well-sorted sample of silt-sized sediment. Include details of the steps they would carry out and how they would process their results.

6 marks – Level of Response – **Medium/high demand**

Question			Answer	Marks	Guidance
31	(b)*		*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)** Coherent experimental procedure suggested including a high level of detail and a clear understanding of the objective. Includes clear details of how to process the results. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and detailed.* **Level 2 (3–4 marks)** A workable experimental procedure suggested, although some key aspects have been missed. Includes clear details of how to process the results. *There is a line of reasoning presented with some structure. The information presented is relevant.* **Level 1 (1–2 marks)** An attempt is made to construct a procedure for the experiment although it does not contain enough detail to be reproducible. Some suggestion of how to process the results has also been made. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0 (0 marks)** *No response or no response worthy of credit.*	6	**Indicative geological points may include** **development of practical design and procedures** • Support a tall cylinder of water that can be viewed from the side • Measure water temperature as it affects viscosity • Arrange a scale or two marks at a measured distance apart on the cylinder • Carefully place grains beneath the surface with a moistened fine brush to break surface tension • Shake and release grains, time passage between two marks • Calibration with grains of known size • Repeat and record results to obtain a mean time **ALLOW** the pipette or the hydrometer methods Variables (in Stokes' law) • Water temperature • Viscosity of the fluid • Mass of grain sample • Distance between marks Limitations • limited range of grain sizes in the well-sorted sample *Mention of controlled variables and limitations is not required to achieve Level 3, but may be indicative of a clear understanding of the objective.* **demonstrate knowledge of geological skills and techniques** Apparatus • Tall cylinder with support • Measuring cylinder • Fine brush • Thermometer • Timer Processing results • Repeats • Mean data • Use of Stokes' law • Appropriate table of results • Appropriate graph of results

Question 3, sample answer 1

Design an experiment a student could carry out to measure the mean grain size in a well-sorted sample of silt-sized sediment. Include details of the steps they would carry out and how they would process their results.

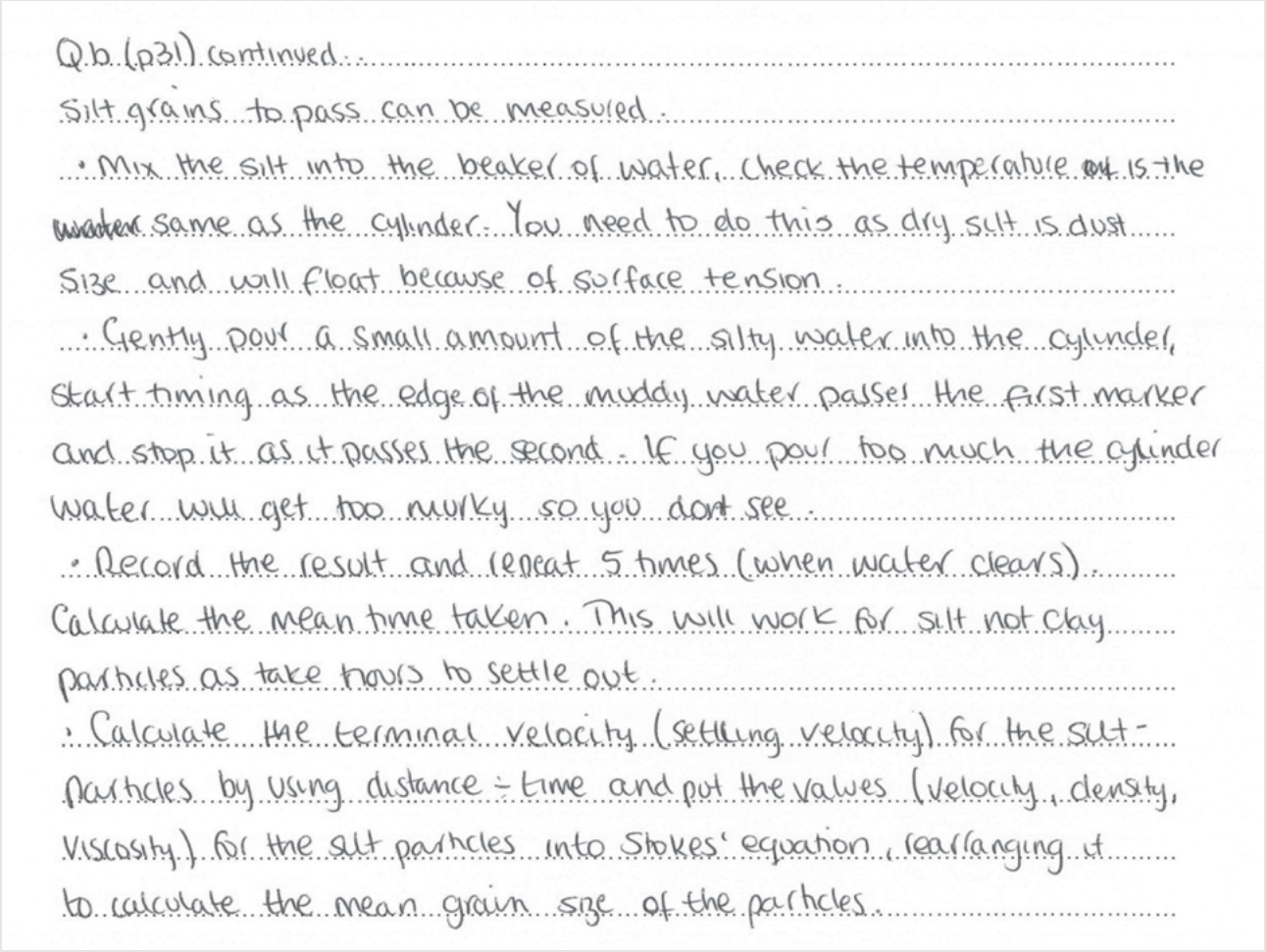
The student could carry out this practical experiment:
- Find out the density as well as the viscosity of water from tables on the internet (and the density of silt)
- Set up a measuring cylinder of water. Measure the temperature of the water with a thermometer to calculate the density as well (for a known, constant temperature and volume).

Pour some of the water into a beaker (same temperature)
- mark on the sides of the cylinder two points near the top (one above ~~the~~ another of a certain distance eg 2cm) between which ~~time~~ the time taken for the sediment

[6]

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following page(s). The question number(s) must be clearly shown in the margin.



Q.b.(p3!) continued.....
silt grains to pass can be measured.....
• Mix the silt into the beaker of water. Check the temperature of is the water same as the cylinder. You need to do this as dry silt is dust size and will float because of surface tension.
• Gently pour a small amount of the silty water into the cylinder, start timing as the edge of the muddy water passes the first marker and stop it as it passes the second. If you pour too much the cylinder water will get too murky so you dont see.
• Record the result and repeat 5 times (when water clears). Calculate the mean time taken. This will work for silt not clay particles as take hours to settle out.
• Calculate the terminal velocity (settling velocity) for the silt-particles by using distance ÷ time and put the values (velocity, density, viscosity) for the silt particles into Stokes' equation, rearranging it to calculate the mean grain size of the particles.

Commentary on Question 3, sample answer 1

This is a Level 3 response and has been awarded 5 out of 6 marks.

This candidate has set out a clear detailed sustained method which is reproducible. The step by step instructions using bullet points make it clear to follow and indicate an understanding of some of the potential issues they could face (surface tension) and that a silt particle will sink slowly, therefore need a short distance to be timed over.

They have shown the calculations needed, why Stokes' Law must be rearranged and indicated other data required to complete the calculation. The method could be improved by indicating the specific volume of measuring cylinder, sediment and water required and names of some of the equipment to be used.

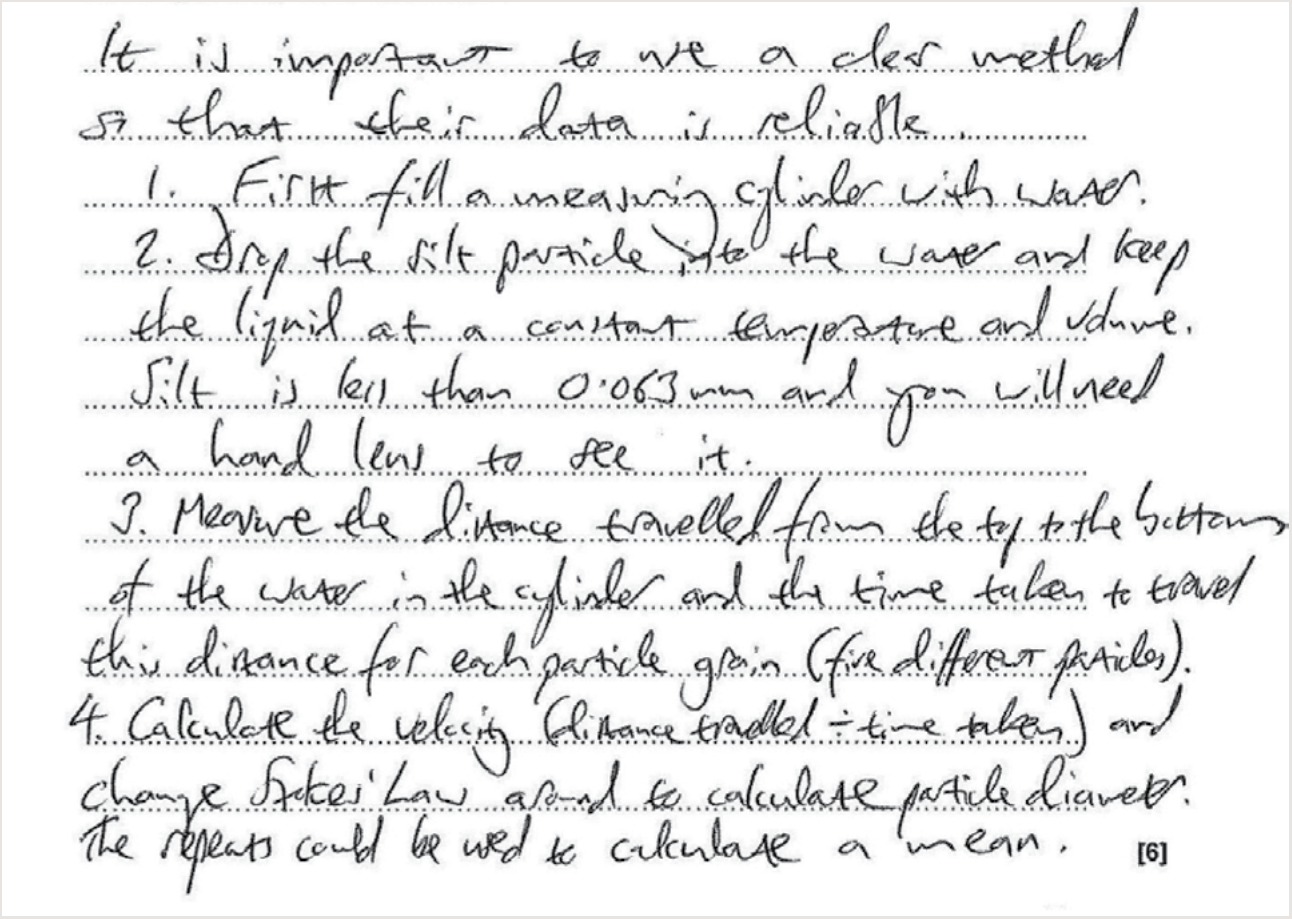
This answer matches most of the indicative geological points in detail for practical design and procedure, and apparatus; however there is only a basic treatment of data processing. Therefore it matches the criteria for Level 3, but lacks detail required on data processing to be awarded 6 marks.

The candidate would have been well advised to:

- note down the points in the margin before starting
- arrange the points in a logical sequence before commencing the answer.

Question 3, sample answer 2

Design an experiment a student could carry out to measure the mean grain size in a well-sorted sample of silt-sized sediment. Include details of the steps they would carry out and how they would process their results.



It is important to use a clear method so that their data is reliable.

1. First fill a measuring cylinder with water.
2. Drop the silt particle into the water and keep the liquid at a constant temperature and volume. Silt is less than 0.063 mm and you will need a hand lens to see it.
3. Measure the distance travelled from the top to the bottom of the water in the cylinder and the time taken to travel this distance for each particle grain (five different particles).
4. Calculate the velocity (distance travelled ÷ time taken) and change Stokes' Law around to calculate particle diameter. The repeats could be used to calculate a mean. [6]

Commentary on Question 3, sample answer 2

This is a Level 2 response and has been awarded 3 out of 6 marks.

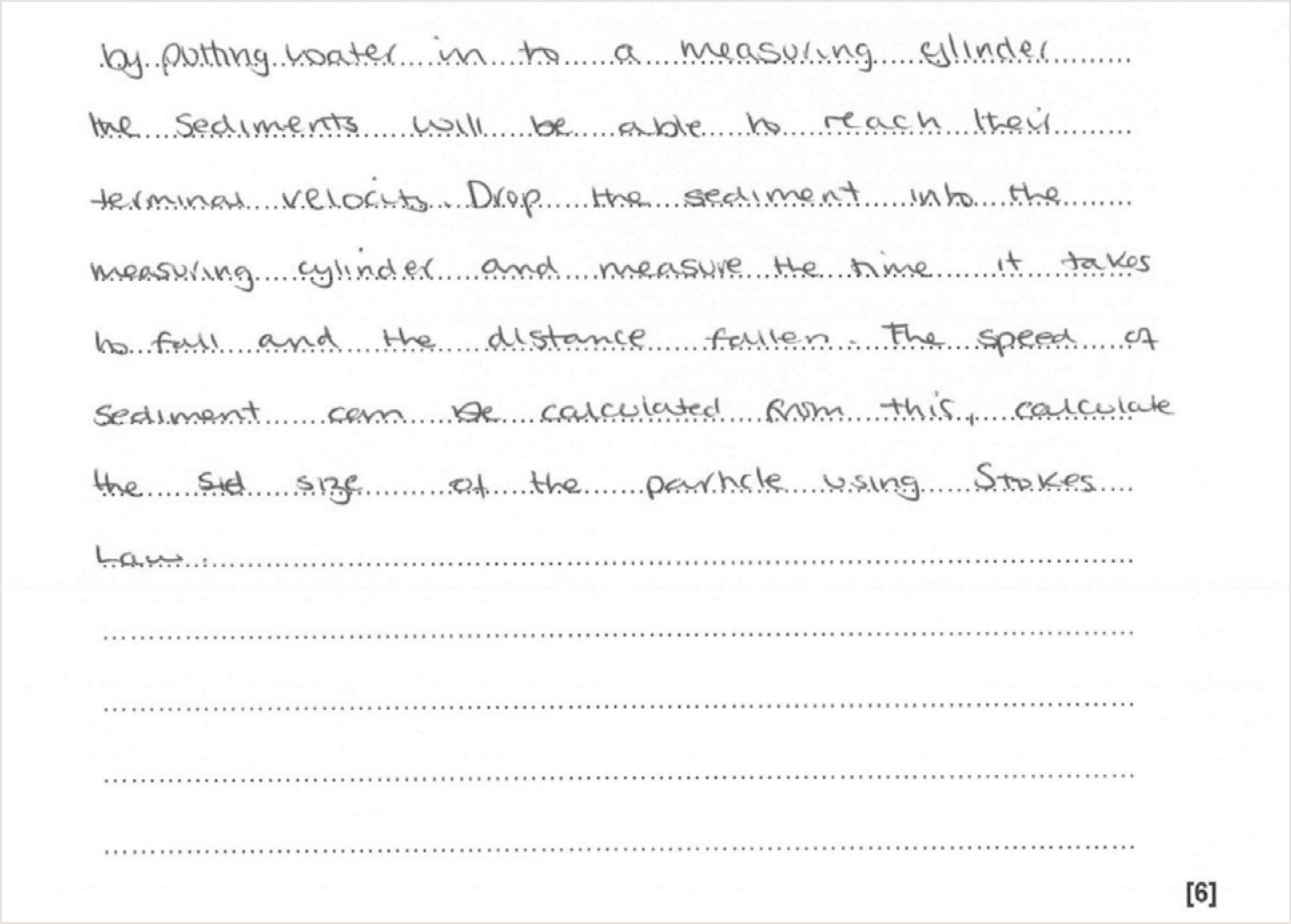
The candidate has described a procedure that could be used and has included some variables that should be controlled, recognising that temperature could affect the results. They have shown how to calculate the velocity of the particles and that this will be used in Stokes' Law. In addition to this, the candidate has indicated the use of repeats in order to calculate a mean. However their procedure for dropping silt into water would not work.

Their answer could be improved by considering how long it would take for silt to travel the length of the cylinder, therefore suggesting there are two markers on the cylinder between which they will time. They could also describe how to get the silt particle into the water.

To move to Level 3, the candidate would have needed to provide clearer relevant detail and explanation. The use of an annotated diagram(s) could reduce the amount of writing required and help to clarify their method.

Question 3, sample answer 3

Design an experiment a student could carry out to measure the mean grain size in a well-sorted sample of silt-sized sediment. Include details of the steps they would carry out and how they would process their results.



by putting water in to a measuring cylinder the sediments will be able to reach their terminal velocity. Drop the sediment into the measuring cylinder and measure the time it takes to fall and the distance fallen. The speed of sediment can be calculated from this, calculate the sed size of the particle using Stokes Law.

[6]

Commentary on Question 3, sample answer 3

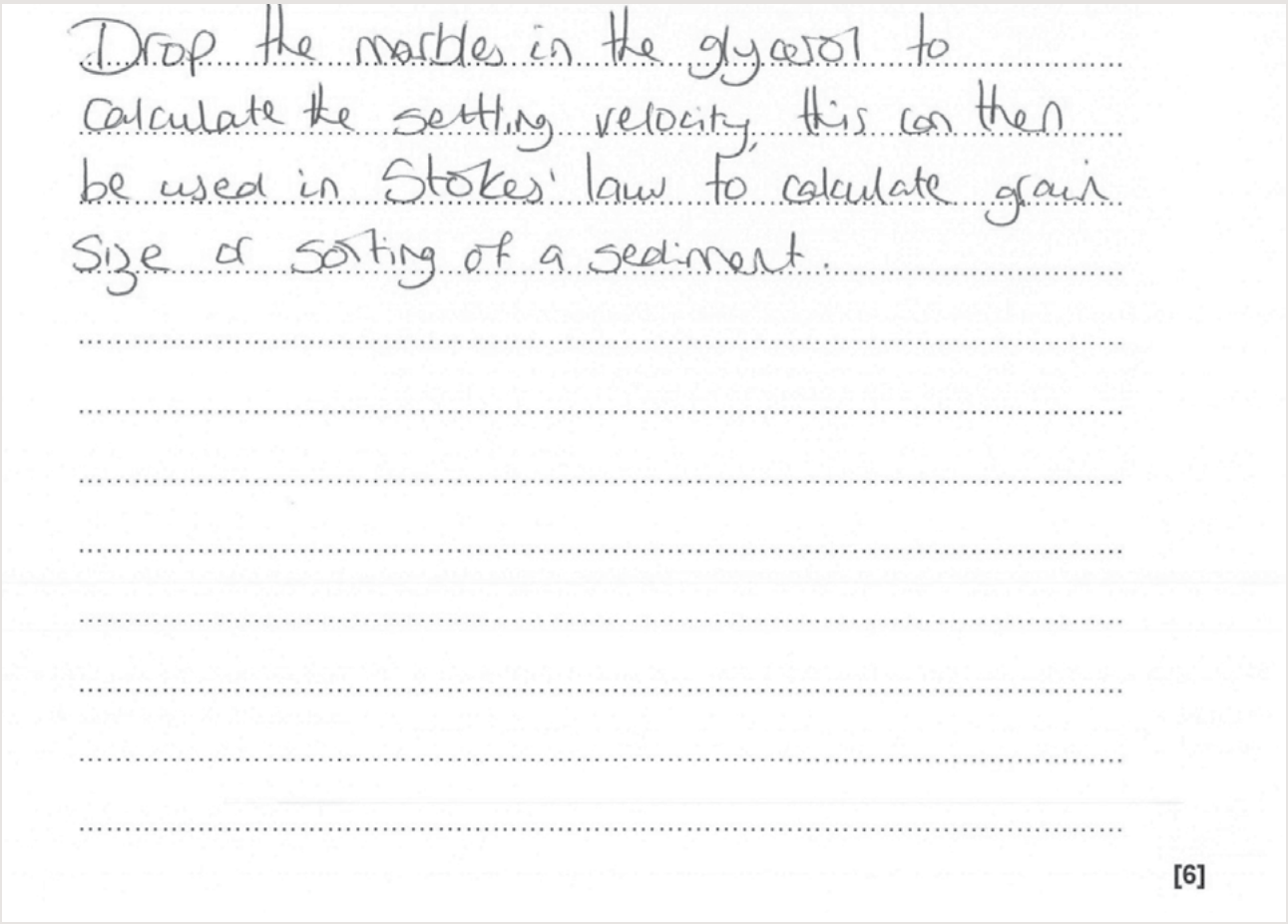
This is a Level 1 response and has been awarded 1 out of 6 marks.

This candidate has described a procedure that would potentially enable them to calculate the velocity of a sediment particle however it is not reproducible. They have not indicated how large the measuring cylinder should be, how much water should be in it, there is no discussion of what the sediment could be or how to record their results, all of which would improve their answer. Therefore it is Level 1.

In order to be considered for Level 2, the answer would have had to present a method with a clear series of steps and some explanation. The processing of results needs to contain more detail than just rewording information from the stem of the question – how would you use Stoke's Law.

Question 3, sample answer 4

Design an experiment a student could carry out to measure the mean grain size in a well-sorted sample of silt-sized sediment. Include details of the steps they would carry out and how they would process their results.


Drop the marbles in the glycerol to calculate the settling velocity, this can then be used in Stokes' law to calculate grain size or sorting of a sediment.

[6]

Commentary on Question 3, sample answer 4

This is a Level 0 response and has been awarded 0 out of 6 marks.

This response is not worthy of credit, as it has no detail of how to conduct the experiment: it contains no steps to describe how to set it up, or how to use the results.

It is a common misconception with students that the practical questions are based on activities from the Practical Endorsement rather than specification content (i.e. 5.1.1a). In this case the candidate appears to be reporting a GCSE physics practical using marbles and glycol to calculate terminal velocity.

To be considered for Level 1 the answer would need to contain content relevant to the question asked. For example: 'by dropping silt grains into a measuring cylinder of water and measuring how long it takes the grains to fall a measured distance you can calculate the settling velocity, this can then be used in Stokes Law to calculate the diameter of the silt grains.'

Question 4 – H414/01 Question 33

A Level Geology

33* We have already lost 27% of the world's coral reefs. If present rates of destruction are allowed to continue, 60% of the world's coral reefs will be destroyed over the next 30 years.

The Great Barrier Reef is the largest living structure on the planet, 2300 km long, extending over 14° of latitude, from shallow estuarine areas to deep oceanic waters.

Current threats include increased sedimentation and elevated levels of mineral nutrients in the marine ecosystem (eutrophication) caused by forestry and agricultural practices, increased exposure to ultraviolet light, climate change, and damage by dredging and tourists.

Decide whether these threats are likely to produce geological evidence at the Great Barrier Reef for the start of the Anthropocene epoch. You should explain how these threats will affect carbonate sedimentation, and may be expressed in the future geological record.

6 marks – Level of Response – **High demand**

Question			Answer	Marks	Guidance
33*			*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)** Interprets the evidence to reach a clear decision on whether the geological record would represent the start of the Anthropocene epoch **AND** provides a detailed discussion of the effects on carbonate sedimentation on the Great Barrier Reef **AND** suggests of how the changes in sedimentation might appear in the future geological record. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and detailed.* **Level 2 (3–4 marks)** Uses the evidence to reach a decision on whether the geological record would represent the start of the Anthropocene epoch **AND** provides a discussion on the effects on carbonate sedimentation on the Great Barrier Reef **AND/OR** makes an attempt to suggest how the evidence of these effects might appear in the future geological record. *There is a line of reasoning presented with some structure. The information presented is relevant.* **Level 1 (1–2 marks)** Indicates whether the start of the Anthropocene epoch may/may not be present linked to the geological record **AND** attempts to discuss the effects of the threats on carbonate sedimentation on the Great Barrier Reef, though this may be lacking in detail **AND/OR** makes some suggestion of how the evidence of these effects might appear in the future geological record. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0 (0 marks)** *No response or no response worthy of credit.*	**6**	**Indicative geological points may include** **applies knowledge and understanding of the threats to carbonate sedimentation on the Great Barrier Reef** • Sediment and microorganisms cloud water, reducing the light available • Sediment e.g. from increased run-off from deforested areas deposited on corals blocks the sun and harms the polyps • Agricultural run-off contains mineral nutrients that promote seaweed growth and cover the reef • Sea levels rise increase depth of water at reef • Increase in CO2 causes acidification, reacting with calcium carbonate of calices • Warmer water causes corals to expel algae • Dredging physically destroys corals • Tourists touching sensitive polyps harms them. **applies knowledge and understanding of changes in sedimentation to the future geological record** • Erosion surfaces (from dredging) with broken coral • Higher energy sediments, bioclastic limestone/oolitic limestone as reef floods • High energy sedimentary structures such as crossbedding • Disappearance of species from fossil record Corals killed at the same time over a wide area due to rapid sea level rise / acidification • Peak of detritivores/fungal spores and non-carbonate mud/clay/marl • Eventual appearance of new species adapted to new conditions • First appearance of plastic and metals such as aluminium, steel in deposits. **ALLOW** other Anthropocene evidence e.g. appearance of concrete, fly ash and fall out from nuclear tests across the planet, elevated greenhouse gas emissions trans-global species invasions. **interprets geological record as representing a stratotype** • Continuous marine deposit • Synchronous over the Great Barrier Reef • Index fossils • Numerical dating possible (nuclear tests) • Isotopic carbon and oxygen evidence. **makes judgement on whether start of the Anthropocene** • Comparison of changes in fossil record to studied mass extinction events • Rate of change of sea level, and of temperature from isotopic record • Change in style of sedimentation of sufficient magnitude.

Question 4, sample answer 1

Decide whether these threats are likely to produce geological evidence at the Great Barrier Reef for the start of the Anthropocene epoch. You should explain how these threats will affect carbonate sedimentation, and may be expressed in the future geological record.

The Athropese epoch should start, as there have been many big changes in the world recently: the use of nuclear weapons which will show up in the rock record in the future as a sudden increase in radioactive elements, rise in sea levels from ice caps melting, due to an increase in global temperatures, man made materials which are often dumped in the sea (such as plastic) may show up as fossils in the future and then there is the extinction of animals and coral reefs which is happening at a high rate. These will have an effect on carbonate sedimentation as some of these issues will be preserved in the rocks (plastic/radioactive elements etc.), altering the usual carbonate deposited.

[6]

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following page(s). The question number(s) must be clearly shown in the margin.

33) Carbonate rocks in reefs contain many corals, but if the dredging and tourism continue they will damage the corals so less will be preserved in the rock. What corals are preserved will be fragmented and so would produce bioclastic limestone when usually it would be reef limestone. Coral extinction could also occur due to changes to the ocean temperatures (higher temperatures cause coral bleaching: when corals expel the algae) and acidification of the seas which damages the calcium carbonate coral skeletons. This would result in large areas suffering loss of corals and noticeable impact on the rock record.

Commentary on Question 4, sample answer 1

This is a Level 3 response and has been awarded 5 of 6 marks.

This candidate has interpreted the evidence and clearly noted which threats to the Great Barrier Reef would leave evidence in the geological record for the start of the Anthropocene epoch and the effect of these threats on carbonate sedimentation. They have looked at the ways corals could be affected and have discussed potential ways the sedimentation might appear/ be preserved; for example replacement of reef limestones by bioclastic limestone in the sedimentary record.

The answer contains relevant information, but doesn't always flow as a 'well developed line of reasoning'. It would have been better if the candidate had linked each threat to carbonate sedimentation and the geological record in turn. Some planning notes would have helped to focus on the most important threats to geological change (for example, climate change, eutrophication and the impact of agriculture/forestry and UV light exposure) rather than more peripheral issues such as nuclear testing dredging and beach litter. It is important to be aware of the time and answer space constraints and focus on a clear line of reasoning rather than a comprehensive listing of every conceivable effect on carbonate sedimentation.

This candidate's response considered five different areas in assessing whether each would be preserved in the geological record however little attempt is made to integrate them into one coherent argument. Therefore although this answer meets the criteria for Level 3 it would only score 5 marks.

To achieve full marks the candidate could assess the relative importance of the different threats to produce geological evidence and how this evidence compares to comparable evidence used to define other epochs in the geological record. To score a maximum of 6 marks it is important that the line of reasoning meets the guidelines in the communication statement in the left hand column of the mark scheme – it is well-developed, clear and logical flow so that it reads well, with clarity. Quality of content is more important than overall quantity.

Question 4, sample answer 2

Decide whether these threats are likely to produce geological evidence at the Great Barrier Reef for the start of the Anthropocene epoch. You should explain how these threats will affect carbonate sedimentation, and may be expressed in the future geological record.

The changes that have occured have been increased CO_2 levels which have caused the water to become more acidic and global temperatures to rise because of this the warmer ~~weather~~ water expands and global sea levels are rising and the warmer water and lower pH causes bleaching of the corals in the reef. Tourism on the Queensland Gold coast and modern industrial agriculture increases sediment in the coastal zone (like construction of hotels + deforestation of the rainforest for pineapple farms) and dredging for the expansion ports to export iron ore, bauxite and coal, and tourist beach recharge has caused an increase [6] amount of sediment in the Great Barrier Reef meaning less light is able to

END OF QUESTION PAPER

get through to the corals The result of this is a lack of photosynthesis causing coral reefs to die. This sediment increase and pollution from beach tourism will be trapped in the limestone allowing it to be preserved in the future geological record These changes will be detectable as the beginning of the ~~Apo~~ Anthropocene epoch.

Commentary on Question 4, sample answer 2

This is a Level 2 response and has been awarded 3 of 6 marks.

The candidate has considerable knowledge of the environmental issues threatening the Great Barrier Reef however they have used their knowledge in a very geographical way rather than answering the geological questions asked. Where concepts such as the Anthropocene may be covered in different subjects in different ways it is important that students can contextualise their cross curricular knowledge and understanding in subject appropriate ways.

The candidate has covered a number of points from the information provided in a superficial way for a geological response and they have implied rather than explicitly stated how the evidence might appear in the rock record. They briefly discuss how the hazards can be used to identify the start of the Anthropocene now but the only representations in the geological record they suggest are a break in sedimentation marked by terrestrial sediment and pollution, and anthropogenic/man made erosion.

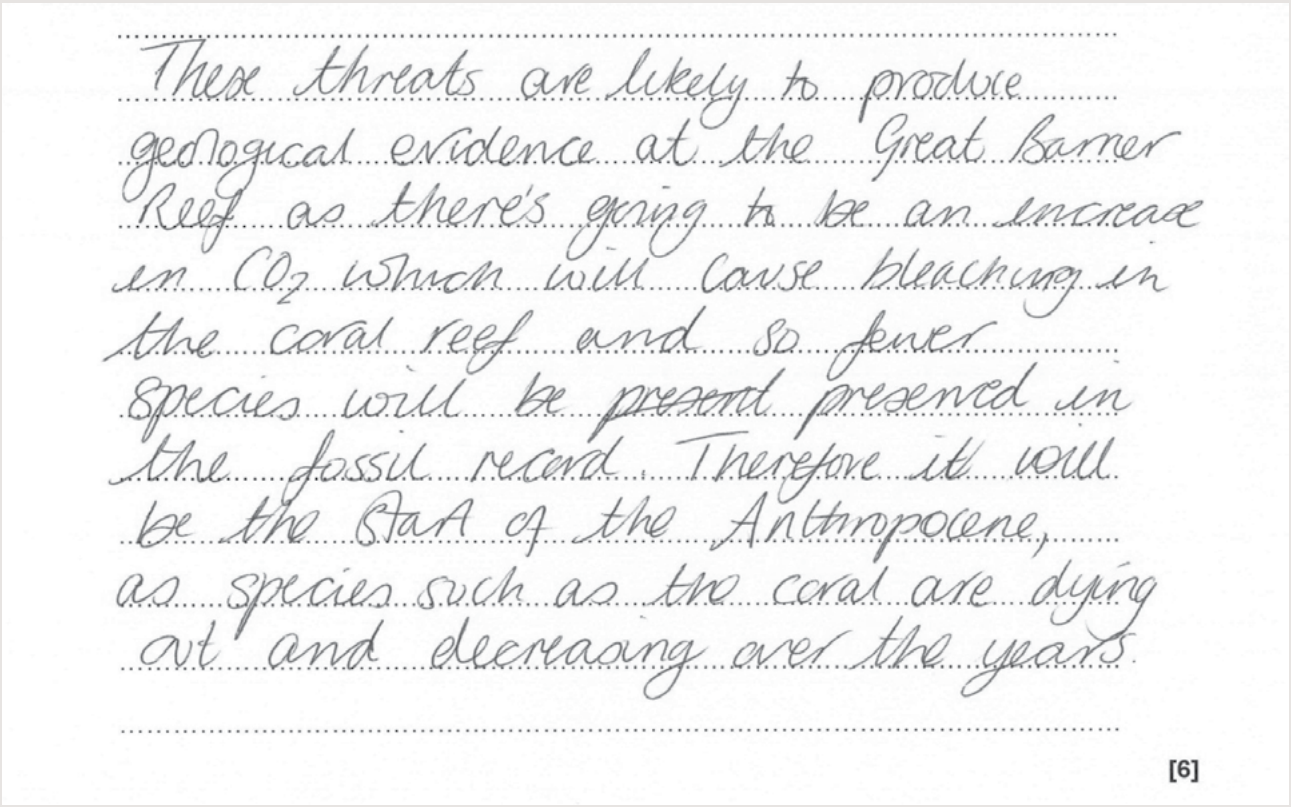
The response is fairly basic, but covers the areas specified in the mark scheme for Level 2. The answer could be improved by including further information about the effects on corals and discussing more of the issues given in the question.

To reach 4 marks, the candidate would have had to provide a more structured response, remove the general environmental content that has a geographical rather than geological impact, focus on how their evidence might appear in the geological record and whether this would characterise the start of a new geological epoch.

To reach Level 3, analysis of how the hazards together may affect carbonate sedimentation and how any changes in the reef ecosystem would express themselves in the geological record. Finally, a clear statement of how these changes compare to other type sections indicating the start of a new epoch would have been needed.

Question 4, sample answer 3

Decide whether these threats are likely to produce geological evidence at the Great Barrier Reef for the start of the Anthropocene epoch. You should explain how these threats will affect carbonate sedimentation, and may be expressed in the future geological record.


These threats are likely to produce geological evidence at the Great Barrier Reef as there's going to be an increase in CO_2 which will cause bleaching in the coral reef and so fewer species will be present preserved in the fossil record. Therefore it will be the start of the Anthropocene, as species such as the coral are dying out and decreasing over the years.

[6]

Commentary on Question 4, sample answer 3

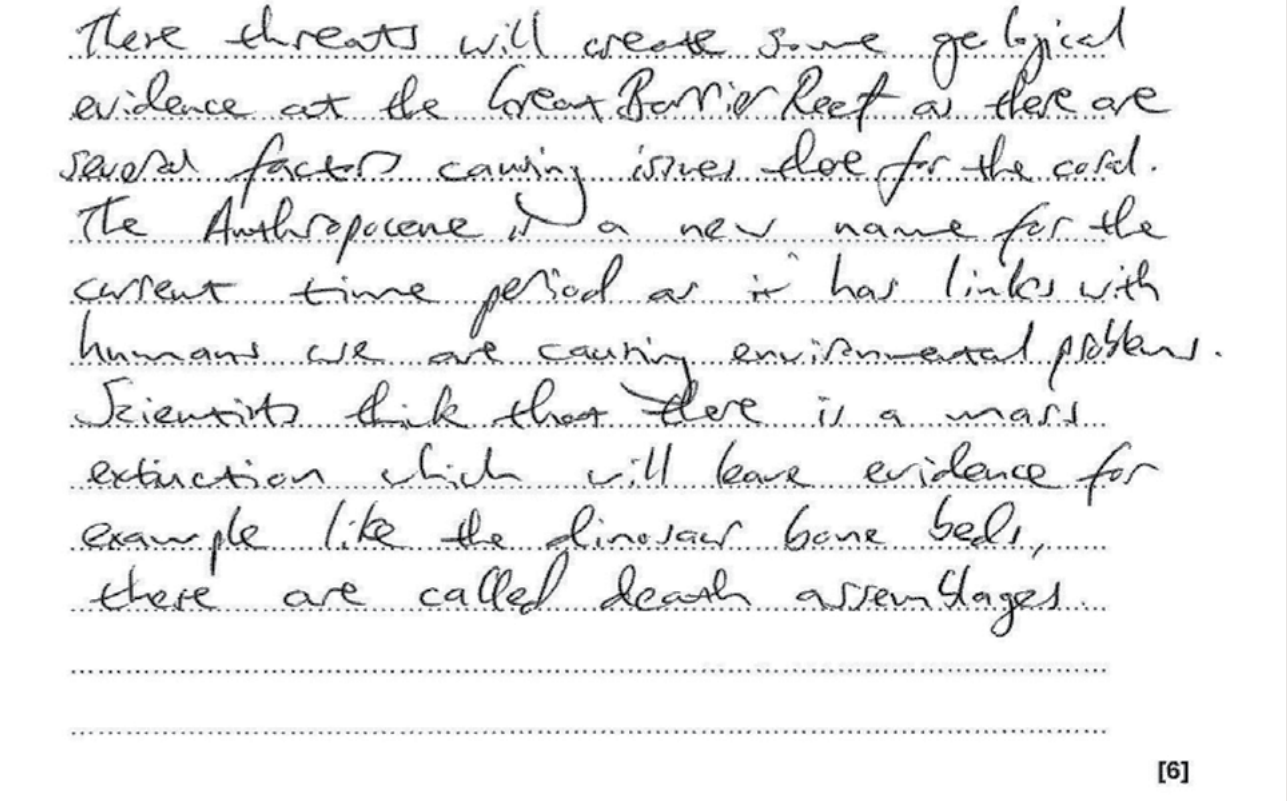
This is a Level 1 response and has been awarded 1 of 6 marks.

The candidate has indicated that the Anthropocene can be identified by a change in species preserved as fossils. They have also discussed increasing CO2 levels and the bleaching of coral, but with no other detail beyond the effect on preservation in the fossil record; for example they could have discussed the effect on carbonate sedimentation.

To be considered for Level 2 they could clarify the link between CO2 and global warming, including the physical and chemical changes in the oceans which result in the expulsion of algae resulting in bleaching. How coral bleaching would impact on carbonate sedimentation and the geological record would need to be clarified: this could include a break in sedimentation (unconformity), change in limestone (reef top bioclastic), changes in fossil record, or changes in the O and C isotope ratios. They need to also include some concept of large scale of change occurring presently and what is needed for the delineation of the Anthropocene

Question 4, sample answer 4

Decide whether these threats are likely to produce geological evidence at the Great Barrier Reef for the start of the Anthropocene epoch. You should explain how these threats will affect carbonate sedimentation, and may be expressed in the future geological record.


There threats will create some geological evidence at the Great Barrier Reef as there are several factors causing issues doe for the coral. The Anthropocene is a new name for the current time period as it has links with humans we are causing environmental problems. Scientists think that there is a mass extinction which will have evidence for example like the dinosaur bone bed, there are called death assemblages

[6]

Commentary on Question 4, sample answer 4

This is a Level 0 response and has been awarded 0 out of 6 marks.

The candidate has attempted the question, but with no clear understanding of what the issues and threats are and how coral reefs and geological record could be affected, despite some being named in the question.

To reach Level 1 the candidate needs to consider the stem of the question and make some quick notes to guide the focus for their answer. For example discuss the geological impact of eutrophication or damage by tourists on the Great Barrier Reef as a carbonate depositional system, followed by some indication of how this might be evidenced in the fossil record.

To be considered for Level 2, the candidate would have needed to select the most important threats to the reef (those causing long term dieback rather than cosmetic damage) and consider their geological impact before suggesting how this might appear in the geological record. The response would also need a clear structure which sets out the scenario, considers the evidence and finally reaches a decision on whether the rock record would constitute the start of the Anthropocene epoch.

Question 5 – H414/02 Question 1(d)

A Level Geology

1(d)* Fig. 1.2 shows a sketch of a sequence found in a borehole 2 km inland from a low-lying coast.

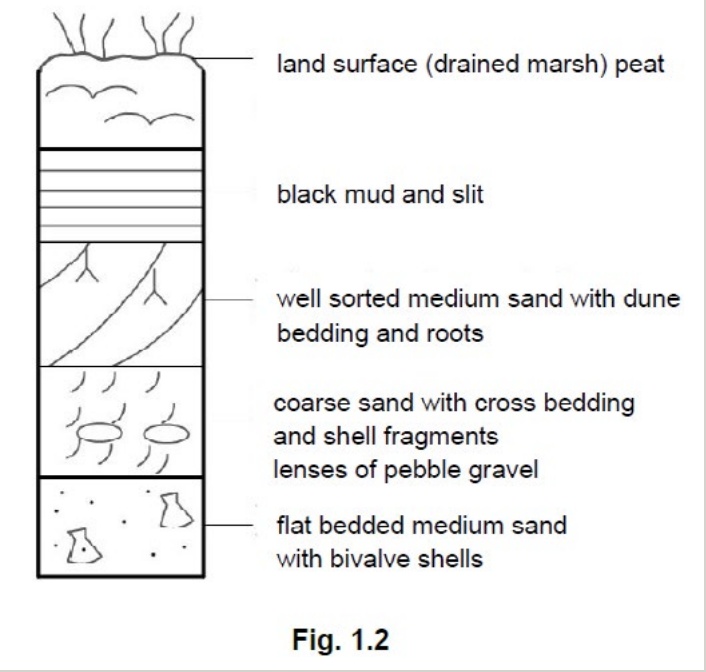


Fig. 1.2

Critically apply Walther's Law to interpret the facies observed in the borehole and draw conclusions about the geology of the area.

6 marks – Level of Response – **Medium demand**

Question			Answer	Marks	Guidance
1	(d)*		*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)** Clear recognition of situations where Walther's Law applies. Correctly interprets all facies / environments in the section and draws appropriate conclusions. *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)** Sound interpretation of the majority of the layers in the section. Concludes, with reference to Walther's law, that there is a horizontal as well as vertical component involved. *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)** Attempt at interpretation of the section. Walther's Law is mentioned, but not linked to evidence and no conclusion drawn. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0 (0 marks)** *No response or no response worthy of credit.*	6	**Indicative geological points may include** **apply knowledge and understanding of Walther's Law** • Walther's Law applies to facies that are superimposed without a break • There are no unconformities in the sequence so Walther's Law can be applied **interpret geological information, ideas and evidence** • bottom layer was shallow marine environment /facies • cross bedded layer was beach facies • gravels in cross bedded layer are storm beach environment • dune bedded layer with roots was coastal dunes • black mud and silt from marsh (fresh or salt water) • peat shows land environment with woody plants **draw conclusions** • Walther's Law states that such facies once existed beside one another • the strata in the borehole represent environments that exist side by side now • Walther's Law enables diachronism to be explained • the beach /coast is now 2 km further away so this is a depositional / prograding coast

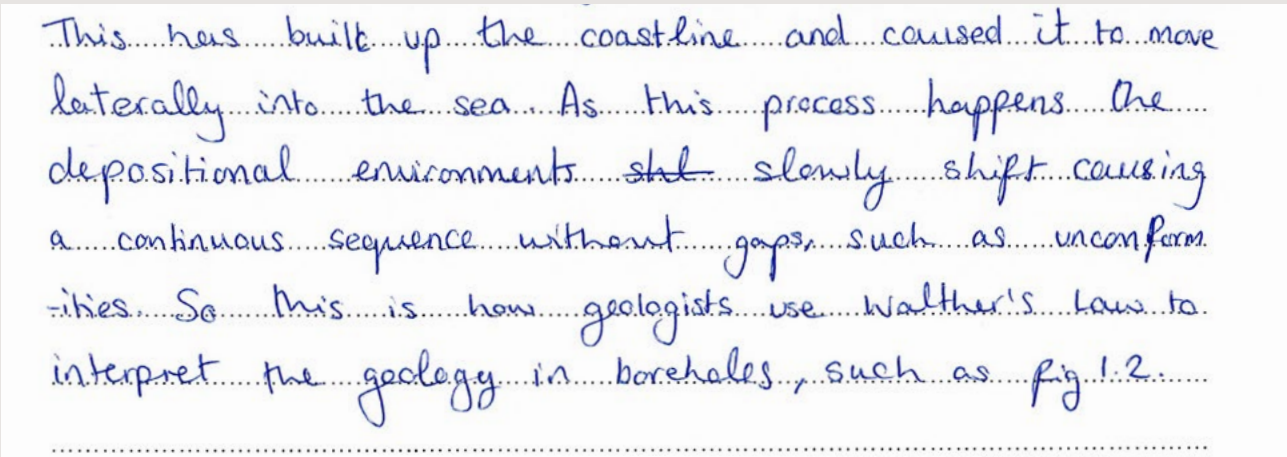
Question 5, sample answer 1

Critically apply Walther's Law to interpret the facies observed in the borehole and draw conclusions about the geology of the area.

Walther's Law can be applied to the facies observed in Fig 1.2 because the borehole sequence describes a vertical change in facies from the bottom to the top which is the same as the horizontal change in depositional environments at the coast 2km away. This is because Walther's Law states when sedimentation is continuous you will see the same sequence down a borehole as you see laterally on the ground. The facies in Fig 1.2 could be found arranged laterally in a deltaic setting;

- at the base ~~of~~ marine sands contain shells
- adjacent to this beach deposits are found with broken shells, the higher energy storm beach includes the gravels. [6]
- The next environment laterally are the coastal dune beds
- Behind the dunes is a low energy swamp where muds and silts deposit, in areas where sediment builds up and out of the water plants allow peats to form.

The dynamic nature of the delta is shown in the sequence as the coastline has moved from the borehole location to 2km away as more sediment has been added.


This has built up the coastline and caused it to move laterally into the sea. As this process happens the depositional environments ~~shal~~ slowly shift causing a continuous sequence without gaps, such as unconformities. So this is how geologists use Walther's Laws to interpret the geology in boreholes, such as fig 1.2.

Commentary on Question 5, sample answer 1

This is a Level 3 response and has been awarded 6 of 6 marks.

The response links the vertical and horizontal components in a clear way, using the technical term 'facies'. This is then linked to Walther's law, stating sedimentation is continuous (no unconformities or breaks in sedimentation). The expected response was to interpret the borehole as a transgressive coastal sequence. However, the candidate has offered an alternative plausible interpretation of the borehole as a prograding delta sequence.

The candidate further exemplifies their reasons behind interpretation. Marine sands, sand dunes and areas of swamp conditions are identified, mostly linked to the energy levels in those environments. They also explain why the sequence in the bore hole is present vertically, due to changing sea levels.

This is an excellent answer and the candidate shows a deep understanding of the concept of Walther's Law. To improve their response the candidate could avoid repeating parts of the question stem in their response 'Walther's Law can be applied to the facies described in fig 1.2 because.' Many candidates believe that longer responses are better but it is more important to concentrate on a concise clear response that answers all parts of the question.

Question 5, sample answer 2

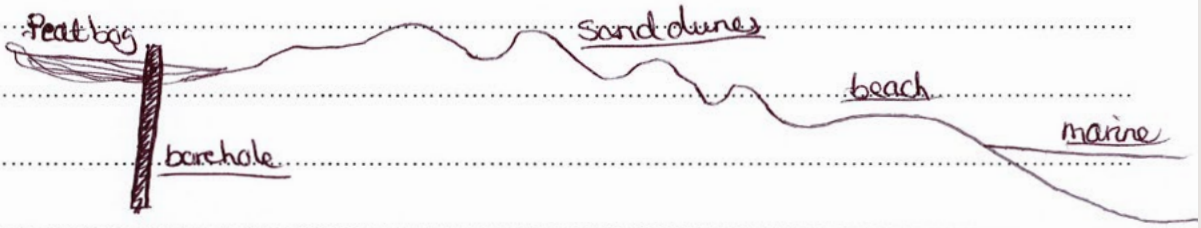
Critically apply Walther's Law to interpret the facies observed in the borehole and draw conclusions about the geology of the area.

The diagram below shows how the sequence in the borehole shows how the environments are changing. At the bottom of the borehole a shallow marine environment is by flat bedded medium sandstone and bivalves. Moving up the strata the energy increases to a beach where broken shell ~~fom~~ are found. Above this layer are dune bedding formed by sand dunes in a coastal location. Above this a peat bog environment causes black anoxic mud and then plants to grow. At the coast the environments are found side by side but in the borehole they are recorded on top of one another.

[6]

1(d)

The diagram shows the borehole as described.



Commentary on Question 5, sample answer 2

This is a Level 2 response and has been awarded 4 of 6 marks.

This candidate has drawn a diagram to show how the horizontal component links together to form a coastal environment, in the correct order. Had they added annotations to explain how the information in the borehole links with their diagram this could have reached Level 3 particularly if they had drawn layers connecting the environment on the diagram to the borehole to show their interpretation. Using diagrams can be very helpful in geology exams and a clearly annotated diagram can replace a lot of text and save candidates time.

In the response the candidate's discussion centres around moving up the borehole (strata). There is a conclusion which discusses the horizontal as well as the vertical component, but they do not mention Walther's Law itself. It is clear that they understand of the concept of Walther's Law in their discussion. However before a candidate can gain credit their understanding must be stated – implying understanding requires the reader to provide the interpretation rather than the candidate.

To be considered for Level 3 the candidate would have to provide a clear explanation as to why the horizontal component is translated into a vertical one by ways of the regression of the sea. This could have been done by drawing layers connecting environments to the borehole on their diagram as explained above. Although the candidate has some understanding they imply their understanding rather than stating it and a clearly stated response that covers all parts of the question is required to meet the Level 3 criteria.

Question 5, sample answer 3

Critically apply Walther's Law to interpret the facies observed in the borehole and draw conclusions about the geology of the area.

The facies in the borehole tell about the different environment found at the coastal area. There are different environments as the sea level can change at the coast. Bivalves live in shallow conditions under the sea, the energy level is medium shown by flat bedded medium sand. The energy level is higher on the beach where the waves are breaking, this is why the grain size is larger with gravels found and shelly fragments. Away from the sea land plants are able to grow peat such as in the top borehole layers. These environments are found close together at the coast.

[6]

Commentary on Question 5, sample answer 3

This is a Level 1 response and has been awarded 2 of 6 marks.

The response links the borehole to the environments found at the coast in a very general way. The candidate makes a link between the beach environment and the energy level within this environment including an explanation of why waves breaking on a beach lead to larger grain size and fragmented shells. As the candidate has only provided this detailed interpretation for a single borehole facies this response could only be credited as Level 1.

The discussion of land plants is is presented as a standalone comment about the top of the borehole. The final sentence suggests an understanding of the key concepts but does not explicitly link changes in horizontal and vertical facies–environments. Walther's Law is not specifically mentioned at all and the answer is not detailed enough nor does the candidate draw a conclusion.

To be considered for Level 2 the candidate would have to interpret at least three of the sedimentary layers in the borehole and make a clear statement about the links between changes in the position of the coast and the sequence in the borehole.

Question 5, sample answer 4

Critically apply Walther's Law to interpret the facies observed in the borehole and draw conclusions about the geology of the area.

The borehole shows 5 different rock types and conditions found. Some layers have shells and some do not. Dune bedding show the current direction there are different to the crosr bedding. The shell fragments could be broken bivalves because the energy level is different for each layer, silts are low energy but fragments in high.

[6]

Commentary on Question 5, sample answer 4

This is a Level 0 response and has been awarded 0 of 6 marks.

This is a basic answer which lacks any detail. There is a limited statement linking shell fragments and silts to energy levels but no attempt at interpreting any of the facies is made. The candidate does not explain the vertical and horizontal variations that are present nor mention Walther's Law. Therefore the response does not meet the criteria for Level 1.

To be considered for Level 1 the candidate would have to make some attempt at interpreting the borehole sequence and show at least a limited understanding of Walther's Law.

Question 6 – H414/02 Question 6(a)iii

A Level Geology

6 Read the text below, then answer the questions that follow.

The North African country Morocco is located at a plate boundary. Outcrops range from Precambrian to Cenozoic and from sedimentary basins to fold belts. At present, there is active exploration for oil and gas fields offshore.

In the north, the Rif Range extends along the Mediterranean coast. South of this a domain of plateaux and intermontane basins occurs. Then the NE–SW trending Atlas (early Cenozoic) and Anti-Atlas (Caledonian) fold mountains rise up, providing a northern boundary to the extended and generally low elevation Saharan platform domain.

Geophysical data confirm that the elevated topography is related to a hot mantle anomaly. The anomaly is also outlined by the pattern of recent alkaline volcanoes.

The Upper and Lower Fezouata formations in the Saharan platform domain fill an important preservational window between the Cambrian and late Ordovician. In the Fezouata Lagerstätten the fossilized fauna contain numerous forms thought to have become extinct by the mid Cambrian.

Over 1500 non-mineralised specimens have been recovered together with some shelly fauna. The sediment contains burrows that are between 1 and 3 cm wide, but it is not extensively bioturbated. High biodiversity of echinoids indicates normal salinity. The fossils are often coated with a small amount of pyrite and their preservation is similar in many ways to those found at Chenjiang. Non-mineralised soft appendages are often preserved.

(a)iii* Suggest in what type of environment the Fezouata formations were deposited, and evaluate the significance of these formations to geological understanding.

Use evidence from the text to support your answer.

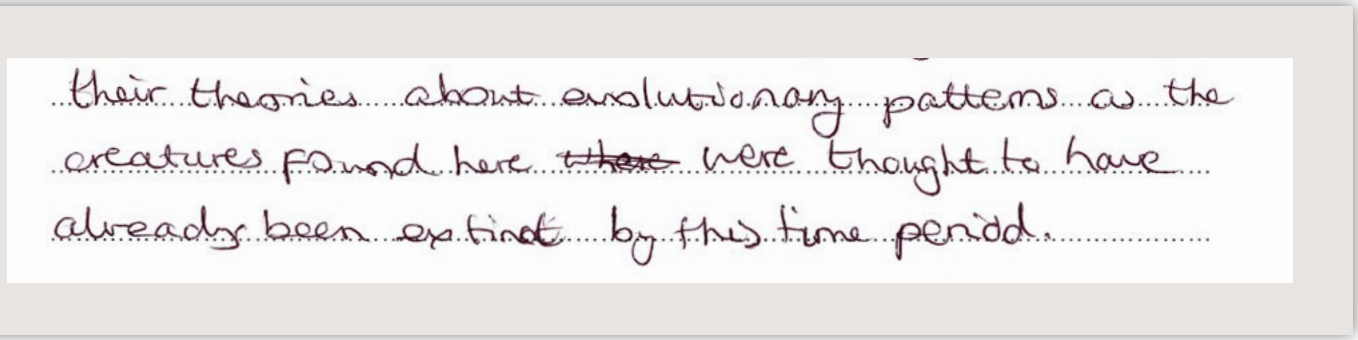
6 marks – Level of Response – **High demand**

Question			Answer	Marks	Guidance
6	(a)	iii*	*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)** Provides evidence, based on analysis of information from the text and the course, and makes environmental interpretation and detailed evaluation of the value of the Fezouata Lagerstätten. *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)** **EITHER** Detailed environmental interpretation **OR** detailed evaluation of significance, in either case using evidence from the text **OR** Limited environmental interpretation **AND** limited evaluation of significance with some evidence from the text. *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 relevant information lifted from the article, with an attempt at environmental interpretation **OR** evaluation of significance. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0 (0 marks)** *No response or no response worthy of credit.*	6	**Indicative geological points may include** **analyse information from the article for evidence** • Fezouata Formation (Fm) is part of a sedimentary basin • has some similarities with Chenjiang and with the Burgess Shale • soft parts that are normally destroyed by mineralisation / petrifaction are preserved **interpret evidence for environmental interpretation and nature of the Fezouata Fm** • marine with normal salinity water • lack of burrowing suggests environment unsuitable for benthonic fauna • small burrows may suggest benthonic infauna stunted • presence of pyrite suggests sea floor conditions may have been anoxic **evaluates the significance of Fezouata Fm** • Lagerstätten relatively uncommon in Ordovician • both Chenjiang and Burgess shales are from an earlier period than Fezouata Fm • extends range of some Cambrian faunas • there are no other deposits of this type from this period • Lagerstätten have produced landmark discoveries (e.g. Archaeopteryx) • study of soft parts may reveal unknown features

Question 6, sample answer 1

Suggest in what type of environment the Fezouata formations were deposited, and evaluate the significance of these formations to geological understanding. Use evidence from the text to support your answer.

The Fezouata formation can be analysed to understand the sedimentary environment where it is formed. The Fezouata formation was deposited in a sedimentary basin where subsidence allowed a huge vertical thickness of sediment layers to build up. The Fezouata Lagerstätten provides evidence for evolution from Cambrian to late Ordovician and is very important as there is a lack of geological evidence to back up theory in this time. Other Lagerstätten I have 6a)iii) studied include the Burgess Shale and Chenjiang which contain soft bodied fauna from the middle and early Cambrian. The exceptionally preserved fossils in the Fezouata Lagerstätten is due to the environment of deposition allowing many soft appendages to preserve, like in the Burgess shale. The creatures sank into low oxygen conditions before decay had occured (pyrite is evidence of anoxic condition, which is where it forms), allowing details to be preserved. Other conditions which made preservation of a wide range 6a)iii) of organisms likely is the normal salinity which allowed many organisms to thrive. The results found in this unit has allowed geologists to improve


their theories about evolutionary patterns as the creatures found here ~~there~~ were thought to have already been extinct by this time period.

Commentary on Question 6, sample answer 1

This is a Level 3 response and has been awarded 5 of 6 marks.

This is a very long response (194 words) and shows several of the problems associated with over long responses. The first sentence is only a restatement of the question and the second sentence may be true, but is not relevant to the question. It is only in third sentence that the candidate's response contains relevant information about the significance of the Fezouata Lagerstätten. However it is unclear what the candidate is thinking, and which 'theory' they mean.

It is only from line 10 that they suggest similarities between these deposits to other well-known Lagerstätten deposits that they have studied. The candidate then correctly links low-oxygen conditions to pyrite formation and subsequently links this to preserved detail and lack of decay. But they also state that normal salinity conditions would have allowed many organisms to thrive, or live in the environment. This contradicts their previous sentence regarding pyrite formation in anoxic conditions. It is possible that they are thinking more about the Burgess Shale rather than the conditions for preservation in the Chenjiang Lagerstätten.

Finally the candidate shows that they do understand the importance of the fossils in the Fezouata formations in showing that these species occupied longer time zones than had previously been thought.

This candidate split their response across three separate pages with the final section in an additional answer booklet. In the live question papers candidates will have 15 answer lines with some blank space below which they can use to complete their response or draw any supporting diagrams. Where possible candidates are recommended to keep their response together or make use of the additional answer lines at the end of the question booklet. Analysis of the 2018 AS Geology candidate responses showed that under exam conditions most candidates who achieved full marks for level of response questions were writing between 90–130 words.

To achieve full marks the candidate could have explained the apparent contradiction between evidence for normal salinity and pyrite formation using the Chenjiang model where preservation occurred during short periods of restricted conditions (anoxic and possibly high salinity) on what was otherwise a normally oxygenated shallow shelf with normal salinity.

Question 6, sample answer 2

Suggest in what type of environment the Fezouata formations were deposited, and evaluate the significance of these formations to geological understanding. Use evidence from the text to support your answer.

These rocks must have been deposited in a sedimentary basin with normal salinity which gave suitable conditions for many different creatures to thrive. The burrows are 1-3cm which shows the size of the animals in them. Bioturbation is when sediment is mixed by burrowing animals, as there ~~are~~ is not a lot of bioturbation there must be not be many worm organisms in the sediment. The Fezouata formation may give geologists information about evolution between the Cambrian - and late Ordovician because they are younger then the Chenjiang. It may give evidence for a geological idea that does not have proof. Most often only hard parts are preserved but in a Lagerstätten you find soft parts preserved too.

Commentary on Question 6, sample answer 2

This is a Level 2 response and has been awarded 4 of 6 marks.

The first sentence links normal salinity to many different creatures thriving. The description of the burrows is linked to sizeable animals that lived within them. But they could have suggested the environment that could support such relatively large animals in the Cambrian. The candidate discusses bioturbation, linking it to the presence of few infaunal organisms, and could also have mentioned the burrows which were also bioturbation. The response does not demonstrate an awareness of the evolution of infaunal organisms which were few in number at this point in evolution. This could have allowed the response to access Level 3 if they had explained the importance of Fezouata evidence of infaunal organisms.

The significance of providing evidence of evolution between the Cambrian and the Ordovician is a good point but it is made in a quite generalised way. The last sentence is a definition of the Lagerstätten to the fossil record and only demonstrates a limited evaluation of significance. It would have been more effective had it been written as an evaluation of the importance of the Fezouata formations linked to the previous sentence.

To be considered for Level 3 the candidate would have to provide a more focussed response which could have been achieved by using a less discursive writing style. The content of the candidate's response implies that they probably could meet the Level 3 criteria if they were to be more explicit in their evaluations and use evidence from the resource to justify their argument in a more effective way. For example:

The Fezouata was deposited on a shallow marine platform with normal salinity. The evidence for this is:

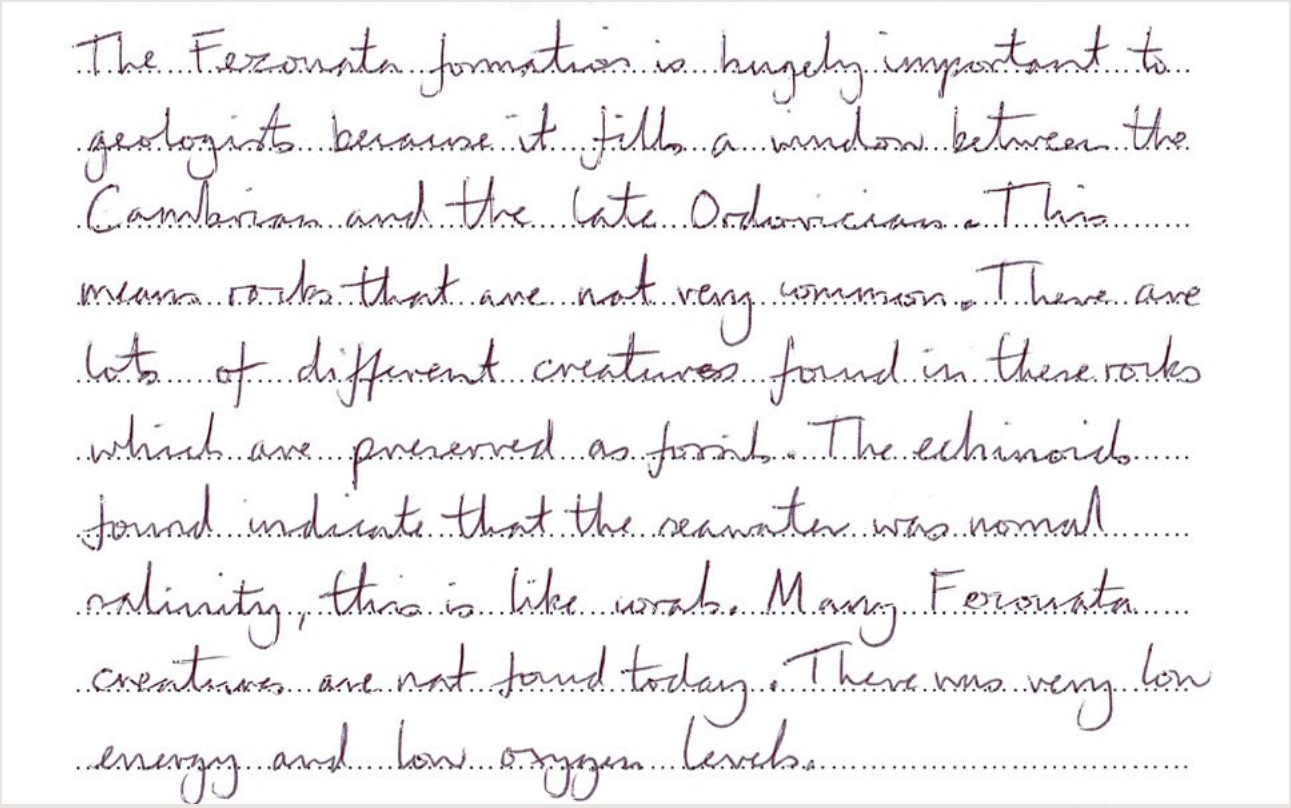
- *High biodiversity of echinoids – normal salinity*
- *Burrows that are 1-3 cm – shows size of the animals in them*
- *Not a lot of bioturbation – few burrowing worms in the sediment*
- *1500 non-mineralised fossils and a shelly fauna – high biodiversity of other animals*

As the Fezouata is younger than the Chenjiang it gives geologists information about evolution between the mid Cambrian and late Ordovician, because:

- *Fills gap in the detailed fossil record after the Burgess Shale*
- *Lots soft parts preserved (Lagerstätten) for species that geologists thought were extinct so gives a way to test theories about evolution that do not have proof otherwise*

Question 6, sample answer 3

Suggest in what type of environment the Fezouata formations were deposited, and evaluate the significance of these formations to geological understanding. Use evidence from the text to support your answer.



The Fezouata formation is hugely important to geologists because it fills a window between the Cambarian and the late Ordovician. This means rocks that are not very common. There are lots of different creatures found in these rocks which are preserved as fossil. The echinoids found indicate that the seawater was normal salinity, this is like usual. Many Fezouata creatures are not found today. There was very low energy and low oxygen levels.

Commentary on Question 6, sample answer 3

This is a Level 1 response and has been awarded 1 of 6 marks.

The response starts by quoting the question but does not explain the meaning of the words 'window' or 'fills' in this context. The second sentence suggests that the candidate understands the rarity, but phrases this badly. The comment about the salinity is true, but does not link this with the exceptional preservation nor make any other links with the environment.

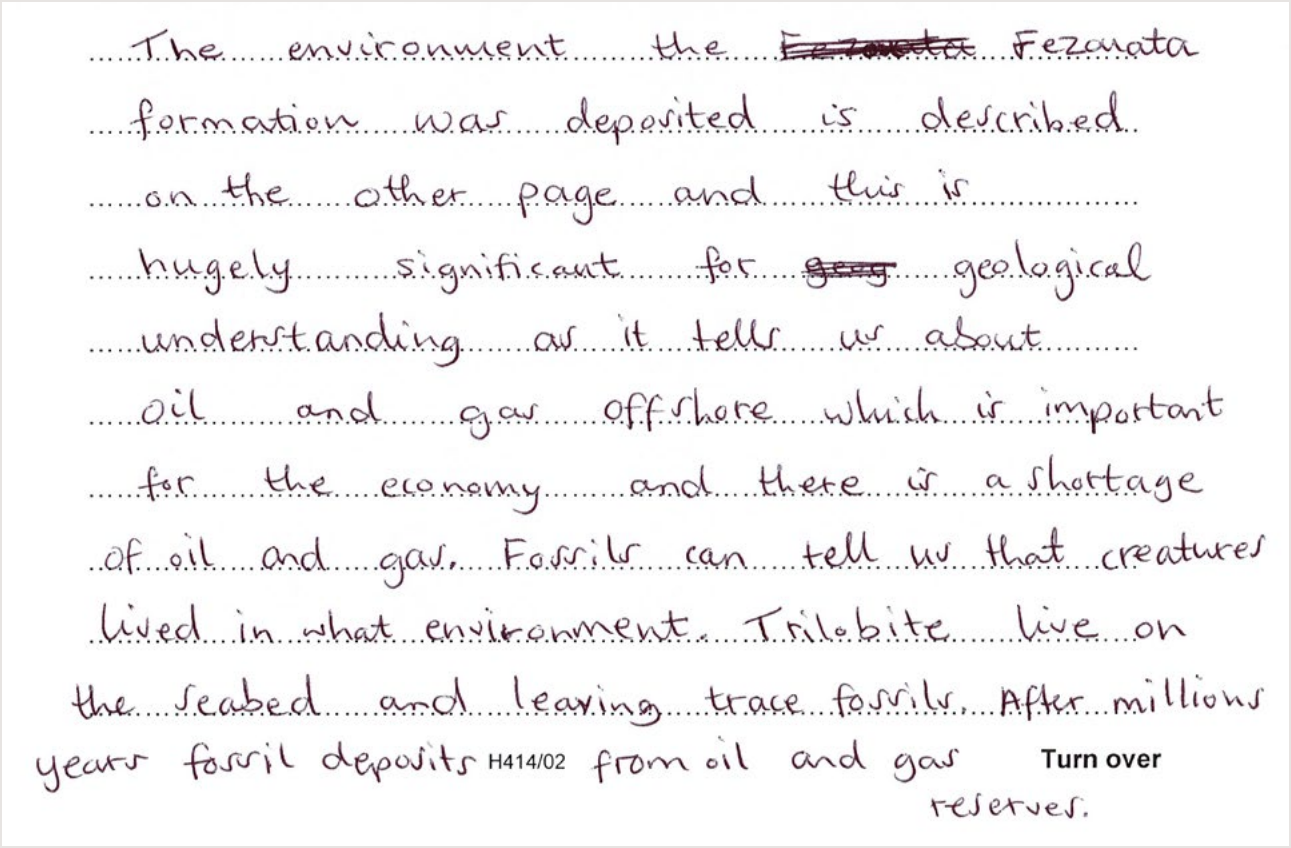
The low energy comment is true, but it needs to be linked to a context to gain credit (e.g. such as low energy prevented fragmentation). The low oxygen level may be true, but it has not been linked to pyrite formation and / or sulfur bacteria which lived in the lower-oxygen environment.

This is a low level answer where the candidate has picked out some information with a basic line of reasoning. To move to the top of Level 1 they would need to suggest a possible environment of deposition or make an evaluative comment about why the Fezouata Formation is important.

To be considered for Level 2 the candidate would have to give some interpretation of the environment of deposition/fossil formation, show how a piece of evidence from the resource page supports this interpretation and make a relevant comment about why the fossil evidence from Fezouata is important to understanding the history of life.

Question 6, sample answer 4

Suggest in what type of environment the Fezouata formations were deposited, and evaluate the significance of these formations to geological understanding. Use evidence from the text to support your answer.


The environment the ~~Fezouata~~ Fezouata formation was deposited is described on the other page and this is hugely significant for ~~geog~~ geological understanding as it tells us about oil and gas offshore which is important for the economy and there is a shortage of oil and gas. Fossils can tell us that creatures lived in what environment. Trilobite live on the seabed and leaving trace fossils. After millions years fossil deposits H414/02 from oil and gas reservers. Turn over

Commentary on Question 6, sample answer 4

This is a Level 0 response and has been awarded 0 of 6 marks.

The formation of oil and gas is not relevant to the question which is about the environment of deposition and its significance. The candidate states that trilobites live on the seabed, which could be interpreted as 'marine', but little else of relevance to the question is offered in the response.

The candidate may have practiced with or revised questions on oil and gas and used this as an opportunity to answer the question they wanted to rather than the question asked. The taphonomy of trilobite carapaces is unlikely to be a significant source rock for hydrocarbon resources in Morocco. At A Level there is not enough here for the candidate to gain any marks.

To be considered for Level 1 the candidate needed to be more explicit about the mode of life of trilobites or link the presence of soft bodied remains as being geologically unusual.

Question 7 – H414/03 Question 5(b)

A Level Geology

5 A geology student is collecting data on the rock types and geological structures present on a small Scottish island.

There are various types of metamorphic rocks and some small silicic igneous intrusions on the island. The metamorphic rocks cover most of the island. There is evidence that there has been more than one phase of metamorphism.

The following photographs were taken on the island.

(b)* The geology student designed an investigation to test the hypothesis that there is more than one phase of metamorphism on the island. They carried out stratified sampling and field measurements of each rock type in proportion to its cover on the island (psammitic 45%, pelitic 25%, carbonate 20% and igneous 10%). The student mapped the isograds from chlorite to biotite, and biotite to garnet zones using the *Photo Guide to Minerals* to confirm their mineral identification. Where possible the student measured dip and strike of the country rock and finally they carried out a detailed transect across the exposed contact between the country rock and the largest intrusion, in the bed of a stream.

Evaluate the method that the geology student has used.

Suggest modifications to this method that would enable you to gain more accurate data. Assume that you have access to the standard equipment available to a student in a school or field study centre

6 marks – Level of Response – **Medium/high demand**

Question			Answer	Marks	Guidance
5	(b)*		*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)** Gives detailed evaluation and judgement on method provided. **AND** Proposes relevant refinements and additions to practical procedure that allow identification of multiple phases of metamorphism **AND** wider conclusions re geological environment or history *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Gives evaluation and judgement on method provided. **AND** Proposes relevant refinements and additions to practical procedure that allow identification of more than one phase of metamorphism **OR** wider conclusions re geological environment or history. *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 identification of shortcomings in method provided. **AND** Attempt at increase in data collection for identification of contact and regional metamorphism **OR** wider conclusions, which may lack detail. *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **Level 0 (0 marks)** No response or no response worthy of credit.	6	**Indicative geological points may include** **evaluate given method** • sampling strategy poor as undersamples pelitic rocks which are most informative, other types less useful for identifying multiple phases • only index minerals within rock samples identified • photo guides are ambiguous in the absence of a systematic key • other minerals would show evidence for multiple phases (garnet with trails / rims / inclusions / shadows) • transect across contact is good • if silicic intrusion after regional metamorphism may not be hot enough to produce contact metamorphism • method does not provide detail of cleavage and jointing • method does not provide details of geological structures or location of samples taken **make judgement on method** • method is poor • insufficient data to enable a conclusion for more than one phase of metamorphism • no data to allow conclusions on geological structures / phases of folding / orogenic history **evaluates the significance of Fezouata Fm** • refine selection criteria for stratified sampling to increase pelitic rocks • record additional data on minerals in rock samples / collect samples to observe/test in the lab • systematic approach to identifying minerals using a classification scheme / key, and tests • record measurements of geological structures (e.g. trends, folds, dips, cleavage, lineations, crenulations) using compass clinometer • record locations • propose systematic approach to research (e.g. classification of minerals, approach to sampling, identification of structures allowing multiple phases of metamorphism and folding to be concluded)

Question 7, sample answer 1

Evaluate the method that the geology student has used. Suggest modifications to this method that would enable you to gain more accurate data.

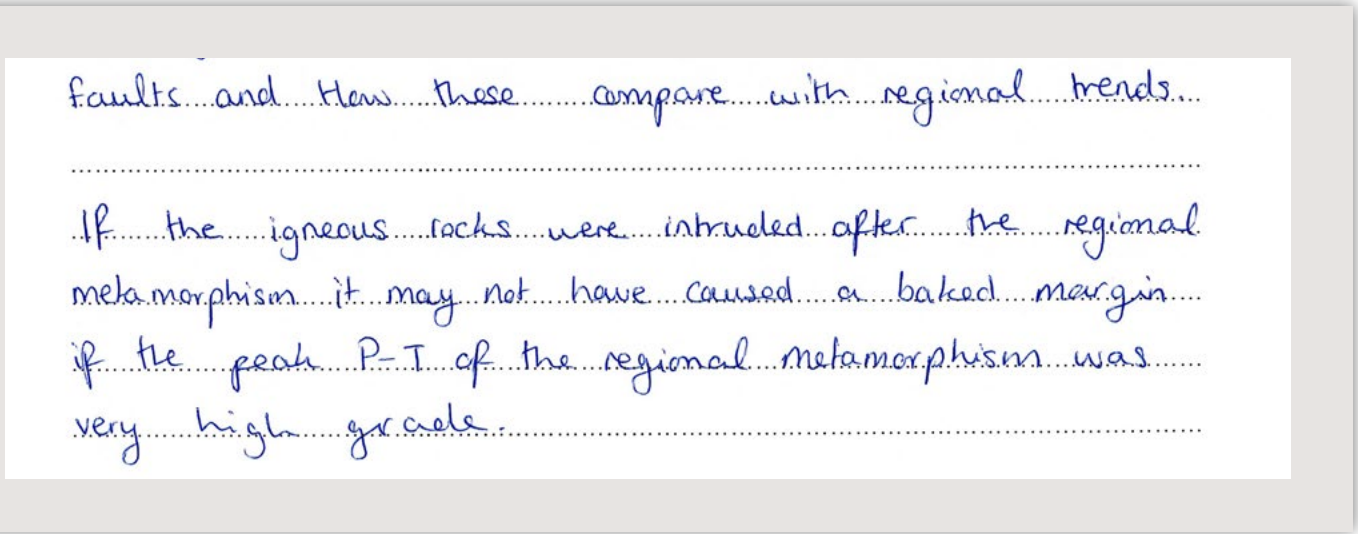
The use of stratified sampling as a method attempted to represent all rock types, however this was not suitable for identifying if more than one phase of metamorphism took place. The pelitic rocks which made up 25% of those sampled are the only ones to give detailed index mineral information. Using pelitic rocks ~~of~~ as the temperature and pressure increased the clay minerals change to more stable forms to suit the conditions, the clays change to Chlorite, biotite, garnet, kyanite and sillimanite which indicate increasing metamorphic grade. → P.T.O. **[6]**

> The student should increase the number of minerals identified to include kyanite and sillimanite ~~that~~ and in doing so can add additional isograds to their map.

> identify minerals in hand specimens could be improved by using a hand lens and identification key. this will give much more accurate identification as the perfect examples in photo guides never look like real minerals in rocks.

> Using a hand lens she could also see if there are inclusions in garnet porphroblasts which would be evidence that than one ~~phase~~ phase had occured.

> She could collect more structural data, measuring cleavage and orientations of fold hinges and limbs,


faults and How these compare with regional trends.

If the igneous rocks were intruded after the regional metamorphism it may not have caused a baked margin if the peak P-T of the regional metamorphism was very high grade.

Commentary on Question 7, sample answer 1

This is a Level 3 response and has been awarded 6 of 6 marks.

This is a long response (226 words) although the use of bullet points has allowed the candidate to be quite focused and has ensured that the candidate has covered every part of the question.

The response identifies that the sampling method was not suitable for the aim of the fieldwork: to identify different phases of metamorphism. They explain why more pelitic rocks need to be sampled, as index minerals only form in these rocks, demonstrating the candidate's detailed understanding of metamorphism. Both increasing the number of index minerals to be identified and using a key rather than a photo guide are examples of specific improvements that would reduce error and improve the accuracy of the results.

Identifying inclusions in the garnet porphyroblasts as an attempt to identify an earlier phase of metamorphism is a good idea and probably comes from their experience of practical activities such as PAG 3.2. Spotting inclusions in a hand sample using a lens is quite difficult compared to identifying them in a thin section, but this was an excellent example of synoptic thinking by the candidate.

The use of structural data as an independent set of evidences to mineral changes is a good idea and strengthens an answer which had already met the Level 3 criteria. The candidate's final observation about baked margins in high grade metamorphic rocks is valid for an A Level candidate. Detailed knowledge of retrograde metamorphism is beyond the specification. Candidates will always be rewarded for correct geology in context and are not expected to have higher education knowledge of exceptions to their on specification understanding.

Here is example of how the candidate could have presented their response more concisely:

Stratified sampling was not suitable because only pelitic rocks (25% of the sample) contain index minerals which indicate metamorphic grade. Also if the igneous intrusions happened after the regional metamorphism it may not have caused a baked margin if the peak P-T of the regional metamorphism was very high grade.

The accuracy of the results could be improved by:

- *Including index minerals kyanite and sillimanite to additional isograds.*
- *Using a key hand and lens identify minerals as photo guides never look like real minerals in rocks.*
- *Look for inclusions in garnet porphroblasts as evidence of more than one phase of metamorphism.*
- *Measure cleavage and orientations of fold hinges and limbs – refolding could indicate another phase of metamorphism.*

Question 7, sample answer 2

Evaluate the method that the geology student has used. Suggest modifications to this method that would enable you to gain more accurate data.

Stratified sampling was a good choice of method as all the rocks have an equal chance of being measured. A disadvantage is that index minerals only form in Pelitic rocks like shale when regional metamorphism makes chlorite, biotite and garnet from clay and muscovite mica. Measuring the other types of rocks may have wasted time and stopped the student collecting more data. Metamorphism of sandstone/carbonate to marble/quartzite are not as accurate as geoclataloggers (as good minerals). The transect would be useful as all the rocks are affected by contact metamorphism. The sandstone/carbonate bleach make a => [6]

5b) => granoblastic texture in the contact zone and shale will become a spotted rock. The width of each metamorphic rock could be measured along the transect to work out the effect of the intrusion

Commentary on Question 7, sample answer 2

This is a Level 2 response and has been awarded 4 of 6 marks.

This candidate has identified that evaluation does involve a consideration of both positive and negative point. They identify that in general stratified sampling is a good approach but in this case some of the rocks sampled would not be able to form the index minerals needed due to their composition. They state correctly that looking for index minerals in unsuitable rocks is a waste of time and indicate that this method was flawed.

The discussion of the transect across the contact and the limited usefulness of named sediments and resultant metamorphic rocks shows that this candidate has a good knowledge of metamorphism. They also suggest specific additional measurements that could be taken to improve the accuracy of their results. By assessing more than one of the fieldwork techniques and reaching conclusions about one (prevented collection of more valid data) and an improvement to the other, the response meets the criteria for the top of Level 2.

At 125 words this response was of an appropriate length and would have fitted on the answer lines available in a geology A Level paper (from June 2019 there will be 15 answer lines for a level of response question plus an additional 6 answer lines). To be considered for Level 3 the candidate would have to provide specific improvements to the fieldwork methods used that would improve the ability of the student to answer their hypothesis that there is more than one phase of metamorphism on the island.

Question 7, sample answer 3

Evaluate the method that the geology student has used. Suggest modifications to this method that would enable you to gain more accurate data.

The geologist has carried out fieldwork on a Scottish island, there are advantages and disadvantages to fieldwork methods.

- There may have been more than one stage of metamorphism. Contact metamorphism was investigated in the stream, I think a transect here was a good idea as you can see change along the line from granite to hornfels, to spotted rock to shale.
- To improve another transect could be done to confirm the results.
- If there was not enough results collected to see if another metamorphic event happened, so maybe collect more data. [6]
- It may have been difficult for the geologists to know their location.

Commentary on Question 7, sample answer 3

This is a Level 1 response and has been awarded 2 of 6 marks.

The first relevant content is on line 6 of the response where the candidate offers their opinion that a transect was a good idea to see specific named changes in mineralogy. The suggested improvement (a second transect) would improve the precision of the results (reproducibility) but not the accuracy the results. To improve the accuracy of results a source of error needs to be identified and reduced/eliminated. Collecting more data (or repeats) are not enough to improve the accuracy of the results on their own.

The candidate is correct in stating that it might have been difficult for the geologists to know their location, but again they have not suggested how to improve the student's fieldwork method. The general comments about the data collected, although they lack of detail are enough to reach the top of Level 1.

To be considered for Level 2 the candidate would have to suggest specific improvements to the fieldwork methods used. For example collect more samples of pelitic rocks as these are more helpful in identifying stages of metamorphism. Marking positions of sampling sites onto a base map or making detailed notes to overcome the problem of locating the samples.

Question 7, sample answer 4

Evaluate the method that the geology student has used. Suggest modifications to this method that would enable you to gain more accurate data.

I have considered what data was collected to evaluate the method used by the student. Stratified sampling is a very good method because all the main rock types are measured making it a fair test which will make the results very reliable. The sandstones would be metamorphosed into metaquartzite, limestone into marble, igneous into gneiss and the shale into slate and metamorphic zones found all over the island. In conclusion by looking at rocks all over the island it will make the data most accurate.

[6]

Commentary on Question 7, sample answer 4

This is a Level 0 response and has been awarded 0 of 6 marks.

This is a simplistic answer which does not identify the many flaws in the method. The candidate states parent and metamorphic rocks and discusses zones in a very basic way but does not link this to the fieldwork program. Because there is no explicit link made it cannot be considered as 'wider conclusions which lack lacks detail.'

To be considered for Level 1 the candidate needed to identify at least one shortcoming of the fieldwork method used by the student and suggest a plausible improvement to the method.

Question 8 – H414/03 Question 6(c)

A Level Geology

6(c)* A mining company have applied for planning permission to site a quarry in the Hotwells Limestone, at grid reference 485535. The overall size of the quarry would cover around 2 km^2.

Analyse the potential geohazards that may occur around the area of extraction.

Conclude whether you think that this quarry should be given planning permission for limestone extraction.

6 marks – Level of Response – **Medium**

Question			Answer	Marks	Guidance
6	(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)** Gives reasoned conclusion based on identification of relevant features from the map and evaluation of risk, linking to detailed application of understanding of geological hazards relating to faults **AND** dipping beds, including the effect of water. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Gives conclusion based on identification of relevant features from the map and linking to application of understanding of geological hazards relating to faults **AND** dipping beds. *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)** Identifies faulting **OR** dipping beds as potential hazard with some link to understanding. **There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.** **Level 0 (0 marks)** *No response or no response worthy of credit.*	6	**Indicative geological points may include** **analyse geological information on map** • faults / dipping beds near site identified **apply understanding of geological hazards** • cross cutting / multiple faults are linked with earthquakes / indication of tectonic stress • dipping beds identified as geohazard as slope failure may occur • identification of water as a potential issue in mining relating to swelling clays **evaluate geological information, ideas and evidence** • moderate risk of movement along faults, if blasting occurs in the quarry • dipping strata may be lubricated along boundaries causing slope failure during extraction **draw conclusions** • gives geological reasons why the quarry should or should not be allowed planning permission, matched with reasoned observations

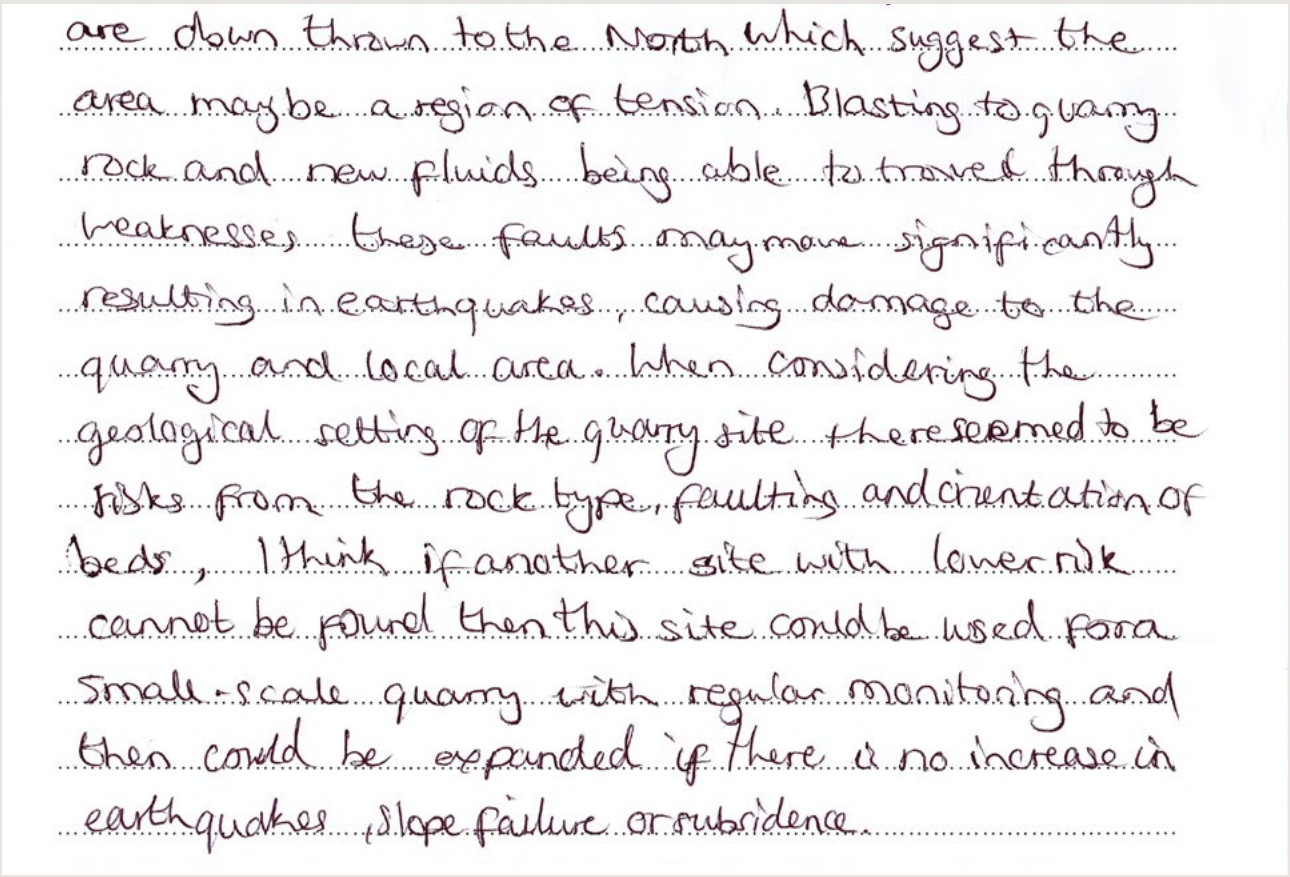
Question 8, sample answer 1

Analyse the potential geohazards that may occur around the area of extraction. Conclude whether you think that this quarry should be given planning permission for limestone extraction.

6c) A desk study and monitoring are required to determine whether planning should be allowed for any civil engineering project such as the new quarry at GR 485535. Geologists ~~should~~ could look at existing quarries of a similar size and geological setting to help them make a decision. The Hotwell Limestone is Carboniferous and below it in the geological column are the calcite mudstones which are exposed on the surface to the North of the proposed site. The calcite mudstones ('chinastone') may cause an increased risk of hazard to the site because as rocks are removed by quarry, water may find a pathway to seep into the mudstones and would cause clay particles to swell and then ~~sink~~ shrink when they dry, this would cause instability in the ground close to the quarry and in the local area and may result in subsidence. The mudstone and limestone beds -

6c) continued ..... are dipping at 20° to the South so the quarry walls cut into these dipping beds section may become unstable and cause blocks to slide into the quarry causing high risk of damage to life and machinery, the orientations of the quarry walls could be carefully planned so bedding planes don't dip down into the quarry.

In the South part of the site (within 300m of GR 485535) there are number of faults on the map, these faults



are down thrown to the North which suggest the area may be a region of tension. Blasting to quarry rock and new fluids being able to travel through weaknesses these faults may move significantly resulting in earthquakes, causing damage to the quarry and local area. When considering the geological setting of the quarry site there seemed to be risks from the rock type, faulting and orientation of beds, I think if another site with lower risk cannot be found then this site could be used for a small-scale quarry with regular monitoring and then could be expanded if there is no increase in earthquakes, slope failure or subsidence.

Commentary on Question 8, sample answer 1

This is a Level 3 response and has been awarded 6 of 6 marks.

This is a very long answer (332 words) and it is clear that the candidate intended to write an essay style response as they ignored the answer lines below the question and turned to the additional answer pages at the back of the booklet. It may have been that the candidate had practiced using the extended response questions from the legacy Past Papers (H487). However there is a difference between 10 mark extended response questions in the legacy geology A-level and level of response questions in the new geology A-level. The legacy questions assessed breadth of knowledge but the new level of response questions assess both geological understanding, and communication skills. So 6 marks does not imply that six different areas must to be covered to gain full marks.

This candidate considers the use of evidence from existing quarries in the area. They have identified from the ecological column in the map key that the mudstones contain clays which could cause swelling linked to stability and water. They discuss the dipping beds, and the issues of stability and slides within the quarry. They identify the faults in the area to the south, although this is linked to simple ideas about earthquakes, rather than slope stability.

The response meets the criteria for Level 3 by giving a reasoned conclusion that suggests allowing the quarry on a smaller scale, which may or may not be economically viable.

Although it is a good answer it could have been improved by using a more appropriate concise and focused style. For example:

I noted the following evidence on the map:

- *Below the Hotwell Limestone are the calcite mudstones. Quarrying may allow water to seep into the mudstones which could cause the clay particles to swell and shrink, causing instability and subsidence in the quarry.*
- *Hotwell Limestone beds dip at 30° to the south. The quarry walls may become unstable and blocks slide into the quarry risking workers and machinery.*
- *300m south of GR 485535 there are number of faults down thrown to the north suggesting the rock may be under tension. Blasting and water leaking into cracks may cause these faults to move and damage the quarry.*

If there is no alternative then this site could be used for a small-scale quarry with regular monitoring. I recommend that:

- *The orientations of the quarry walls be planned so bedding planes don't dip into the quarry.*
- *If there is no increase in slope failure or subsidence then the quarry could be expanded.*

Question 8, sample answer 2

Analyse the potential geohazards that may occur around the area of extraction. Conclude whether you think that this quarry should be given planning permission for limestone extraction.

To decide if the quarry should be given planning permission I will analyse the risks caused developing a quarry at 2 km² site (485,535) to excavate the Hotwells limestone.

> The beds in the limestone dip 30° in general. After blasting and removing rock these tilting bedding planes will be the wall of the quarry and could make the steep quarry walls to be unstable and slide and collapse causing denger to the workers.

> Nearby are a number of faults could also be a problem as many things may cause them to move, they may already be active, the manmade explosions in the quarry could make them unstable and they start to move again.

> New faults may form because of the increased stress in the side of the quarry which is like a massive road ~~crossing~~ cutting. These are pressure release joints caused by excavating out all the lime stone.

In conclusion I would recommend that the company find another site where there are fewer faults in the limestone.

[6]

Commentary on Question 8, sample answer 2

This is a Level 2 response and has been awarded 4 of 6 marks.

The response is probably twice as long as it needed to be (172 words) and as a result the candidate introduced lines of argument which were not relevant and so could gain no credit despite being good geology.

The use of bullet points is a good strategy and after an introductory sentence that simply reiterates the question. The response identifies the two main potential geohazards associated with quarrying the dipping limestone (slide and collapse after blasting) and the (re)activation of faults due to explosions (blasting).

The discussion regarding pressure release jointing caused by quarrying, while good geology, is not based on analysis of the map information and so it could not be credited as it is knowledge in isolation. The candidate already knows about pressure release jointing but this cannot be interpreted from data on the map.

The candidate concludes that the location is not suitable on the basis of the structures discussed. This response fully meets the criteria for a top Level 2 response.

To be considered for Level 3 the candidate would have to provide a more detailed analysis of the possible geohazards that demonstrated that both human activity (quarrying) and natural processes (such as the increased seepage of water into the rock) could increase the risks associated with the steep bedding and faulting.

An example of a more concise (96 words) focused Level 2 response using the same content could be:

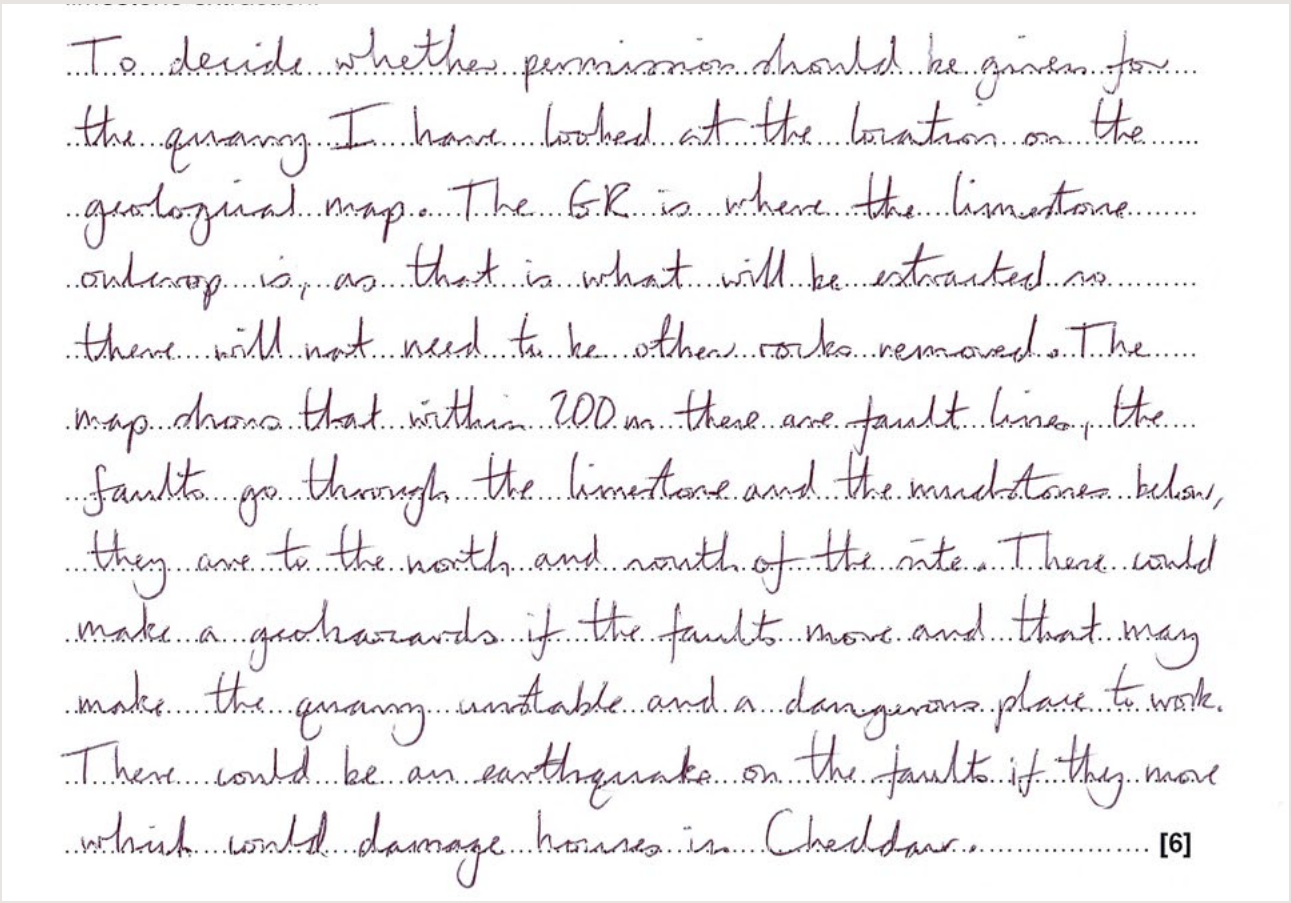
I identified two potential geohazards within the proposed2km2 area on the geological map.

- *The beds in the limestone dip at 30°. These tilting bedding planes will be the wall of the quarry and could make the quarry walls unstable and slide or collapse on the quarry workers.*
- *There are a number of faults which show different directions. These faults may already be active, or the manmade explosions in the quarry could make them unstable and start to move again.*

I would recommend that the company find another site where there are fewer faults in the limestone.

Question 8, sample answer 3

Analyse the potential geohazards that may occur around the area of extraction. Conclude whether you think that this quarry should be given planning permission for limestone extraction.



To decide whether permission should be given for the quarry I have looked at the location on the geological map. The GR is where the limestone outcrop is, as that is what will be extracted so there will not need to be other rocks removed. The map shows that within 200m there are fault lines, the faults go through the limestone and the mudstones below, they are to the north and south of the site. There could make a geohazards if the fault move and that may make the quarry unstable and a dangerous place to work. There could be an earthquake on the fault if they move which would damage houses in Cheddar. [6]

Commentary on Question 8, sample answer 3

This is a Level 1 response and has been awarded 2 of 6 marks.

The first half of the candidate's response mostly rewords the question to set the scene. There is no requirement for candidates to set out their response using a traditional essay format (i.e. introduction > body >conclusion). No credit was gained for this introduction and a more concise geology report style would have been more appropriate and saved time.

The second half of the response identifies multiple fault lines as potential hazards that have been interpreted from the map. This is linked to stability within the quarry and earthquake risk. By identifying map evidence for a single geohazard, and demonstrating some understanding of the risk, this response meet the criteria for the top of Level 1.

To be considered for Level 2 the candidate would have to both identify map evidence for more than one geohazard and offer a conclusion relevant to this map evidence. It is important to answer the question that has been asked; underlining the keywords can help (i.e. analyse, geohazards and conclude). Alternatively the candidate could have written the key words down in the margin and used this as a mini plan which could then be checked to make sure that you have answered all parts of the question. A response that attempts to answer the full question will in general achieve at least Level 2.

Question 8, sample answer 4

Analyse the potential geohazards that may occur around the area of extraction. Conclude whether you think that this quarry should be given planning permission for limestone extraction.

A quarry at the Hotwell Limestone, could cause geohazards but also many geological resources too. Limestone is used for construction such as buildings, steps, road aggregate. So it is a hugely important resource for the company. The map shows there is a vast amount of limestone here for the company. Quarrying may cause geohazards such as more lorries, and pollution like noise and dust. But many permanent jobs will be created in Cheddar, this is better than seasonal employment in tourist jobs in Goatchurch Cavern and Cheddar Gorge. [6]

Commentary on Question 8, sample answer 4

This is a Level 0 response and has been awarded 0 of 6 marks.

This candidate's response demonstrates many of the misconceptions found in weaker responses:

- There is no evidence that the candidate has used the map to identify the geohazards.
- The first sentence is a reworded version of the question being asked.
- The response is not relevant to the question such as the description of the uses of limestone and the importance to quarrying to the economy.
- Many of the observations are geographical, such as the general discussion about noise pollution and dust. The question requires specific geological interpretation of map evidence.

This answer does not meet the Level 1 criteria. To be considered for Level 1 the candidate needed to identify at least one potential geohazard based on information on the map, such as the faults or steeply dipping bedding.

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