Qualification Accredited

Examiners' report

A LEVEL

GEOLOGY

OCR Level 3 Advanced GCE in Geology

H414

For first teaching in 2017

H414/02 Summer 2025 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Paper 2 series overview

The H414/02 GCE Geology A Level paper is synoptic in nature and assesses content from all of the modules 1-7. There is an emphasis on scientific literacy – the ability to comprehend a passage of text of A Level standard, to extract information from it, and to use the information to answer the questions posed.

Most candidates were well prepared and were able to plan their time to answer all the with no evidence that any ran out of time. The answer lines given in the examination booklet should provide more than enough space to attain the maximum marks available for each question.

Candidates appeared confident in how to approach answering the two six mark level of response questions. The list of indicative points given in the guidance column of the mark scheme for these questions are not exhaustive and candidates do not have to include all the points in order to attain the highest level. Centres are reminded that the answer to a question worth 6 marks should, on average, be only twice as long as an answer to a question worth 3 marks. Responses that continue at length often struggle to retain enough coherence or relevance to achieve the communication aspects of a given level. What candidates have to do to attain Level 3 is to make sure that they fulfil all the requirements of the question.

Candidates coped well with the first parts of Question 3 which assessed practical skills and laboratory experiments to investigate the purity of haematite ore samples, which may have been an unfamiliar context to many.

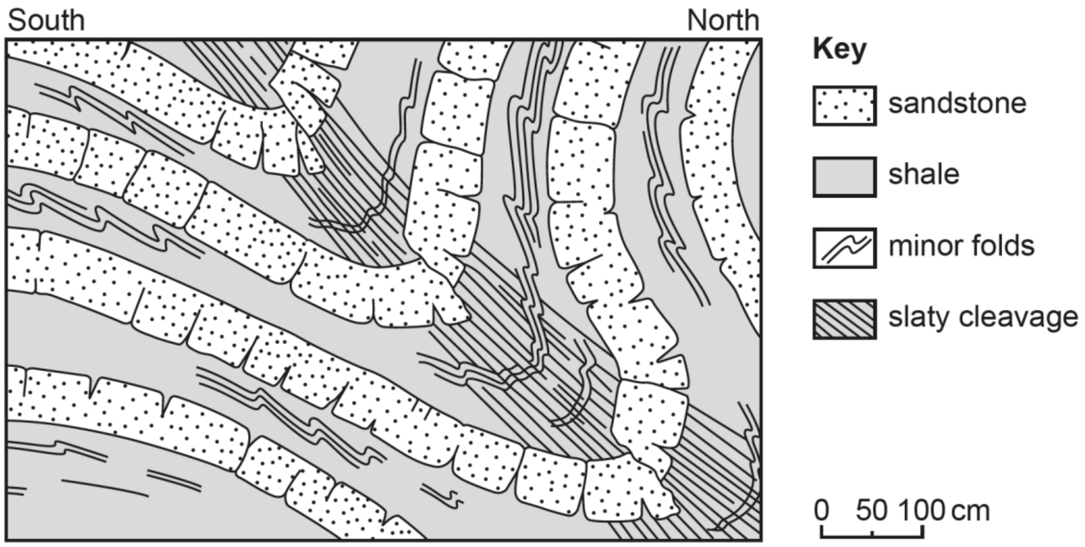
Most candidates dealt well with the mathematical requirements of the paper. Those candidates who had been given opportunities to practise the required mathematical skills (Appendix 5e of the specification) over the two years of the course were able to demonstrate their proficiency and performed well on the mathematical skills questions.

Handwriting was an issue for some candidates, making it difficult for examiners to read and decipher what they had written. If answers are illegible, candidates run the risk of losing credit worthy marks.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• read the questions carefully, took note of the command words given and utilised all the information supplied when constructing their answer • used their knowledge and understanding from different areas of the specification when answering individual questions • had good command of correct geological terminology and knowledge and were able to apply what they had learnt to unfamiliar contexts • produced clear and concise answers to the level of response questions which included sufficient detail and addressed all the requirements of the questions • performed mathematical calculations with confidence, following the required rubric, e.g. clearly laid out working, use of correct units and significant figures.	• wrote under-developed answers which either repeated the questions or did not clearly address what the questions asked • did not have the depth and breadth of geological understanding required to answer the mainly synoptic questions on this paper • produced unstructured responses to the level of response questions which were lacking in depth and explanation or contained incorrect and contradictory information • did not extract and use information provided. For example, when answering the level of response Questions 2 (b) and 6 (a) (i), analysing the graph in Question 2 (a), or comparing the two trilobites in Question 5 (a) • were inaccurate when plotting graphs and labelling diagrams, which often gained little or no credit.

Question 1 (a) (i)

1
(a) The diagram shows some folded sedimentary rocks in a cliff face.



(i) Label the diagram to show:

- hinge line
- joints
- limb

[3]

The features of a fold were familiar to most candidates and nearly all were able to access some credit for their labelling. The position of the fold limbs were well-known, although only a few indicated the entire length of a limb. The positions of joints were also known by most, although some were not precise enough with their labelling lines to attain the mark. A minority thought the slaty cleavage or the minor folds were joints. Some missed the mark for the position of the hinge line as they labelled a point, rather than a line running through the points of maximum curvature in each bed.

Question 1 (a) (ii)

(ii) Name the type of force that formed this fold.

.... **[1]**

This question was done well with virtually all candidates attaining the mark for recognising that folds are the result of compressional forces.

Question 1 (a) (iii)

(iii) Draw arrows on the diagram of the cliff face to indicate the maximum stress directions. **[1]**

Just over half the candidates accessed this mark for drawing two arrows at 90º to the hinge line, pointing inwards. Some candidates only drew one arrow, while others drew a horizontal arrow on the north side of the fold.

Question 1 (a) (iv)

(iv) Describe the distribution of the slaty cleavage shown in the diagram **and** explain how this structure formed.

....

....

....

.... **[2]**

Not all candidates answered both the describe and explain parts of the question, limiting their mark to a maximum of one. Although credit was given for stating the slaty cleavage is located along the hinge line/axial plane, not many stated parallel to the hinge line/fold axis. A few candidates suggested it is only found in the shale.

Many candidates had some knowledge of the formation of slaty cleavage, but they did not always give the two halves of the explanation required for the mark – alignment of minerals AND at 90º to the maximum pressure.

Question 1 (a) (v)

(v) Explain why the minor folds are only found in the shale.

....

....

....

.... **[2]**

Successful responses often cited the incompetent nature and ductile behaviour of shale. However, a significant number of candidates got their explanations the wrong way round and stated shale is competent, or sandstone is incompetent. To attain the mark for ductile behaviour, correct terminology needed to be used, so statements such as 'shale bends easily' were insufficient. Others incorrectly referred to shale as having elastic behaviour.

Question 1 (b)

(b) Draw lines to connect each **term** to the correct **description** of structures that are found in deformed rocks.

Term	**Description**
Boudinage	Ductile flow when subjected to stress and strain
Buckling	Striations resulting from friction
Plunge	Cylinder or lens-like structures forming layers
Slickensides	A fold that has an axis tilted from the horizontal

[4]

Most candidates accessed some credit for this match the terms to their correct descriptions exercise. Slickensides and plunge were most commonly correct, but candidates were less sure of the correct descriptions for boudinage and buckling.

Question 1 (c) (i)

(c) Stress and strain result in folding and faulting of rocks.

(i) Define the term **strain**.

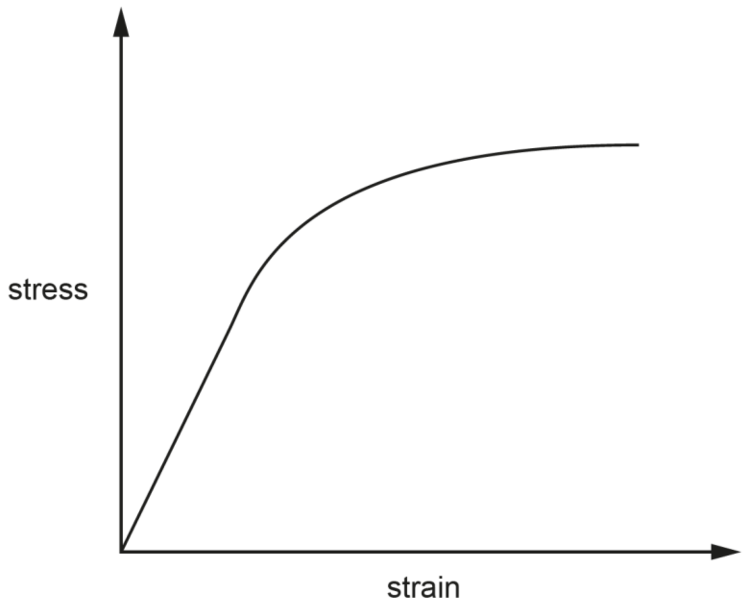
....

.... **[1]**

This question was done well. However, some candidates gave a definition of stress rather than strain. Others thought it is the amount of stress a rock can withstand before failure, while a small number thought strain is an alternative term for tensional forces, when a rock is pulled apart.

Question 1 (c) (ii)

(ii) The graph shows the behaviour of a metamorphic rock that has been subjected to stress and strain.



Label the graph to show:

- elastic deformation
- elastic limit
- rupture or faulting **[3]**

Most candidates gained marks for correct labelling. However, a significant number labelled elastic deformation beyond the elastic limit, in the region where plastic deformation takes place. An elastic material obeys Hooke's Law, so strain is proportional to stress, producing a straight-line graph. Others did not gain marks as their labelling of the points of elastic limit or rupture/faulting were imprecise. A few thought the point of rupture/faulting was within the plastic deformation part of the curve.

Question 1 (c) (iii)

(iii) This metamorphic rock was deformed at 350 °C.

Sketch a line on the graph to indicate the behaviour of the rock if it had been deformed at 600 °C. **[1]**

The effect of increased temperature on rock deformation was not well understood and less than half of the candidates gained this mark. At higher temperatures rocks become more ductile, so the line for the behaviour at 600 ºC should have been drawn below the line for 350 ºC to show more and earlier plastic deformation.

Question 1 (c) (iv)

(iv) Describe how confining pressure can affect the deformation of rocks.

....

....

....

.... **[2]**

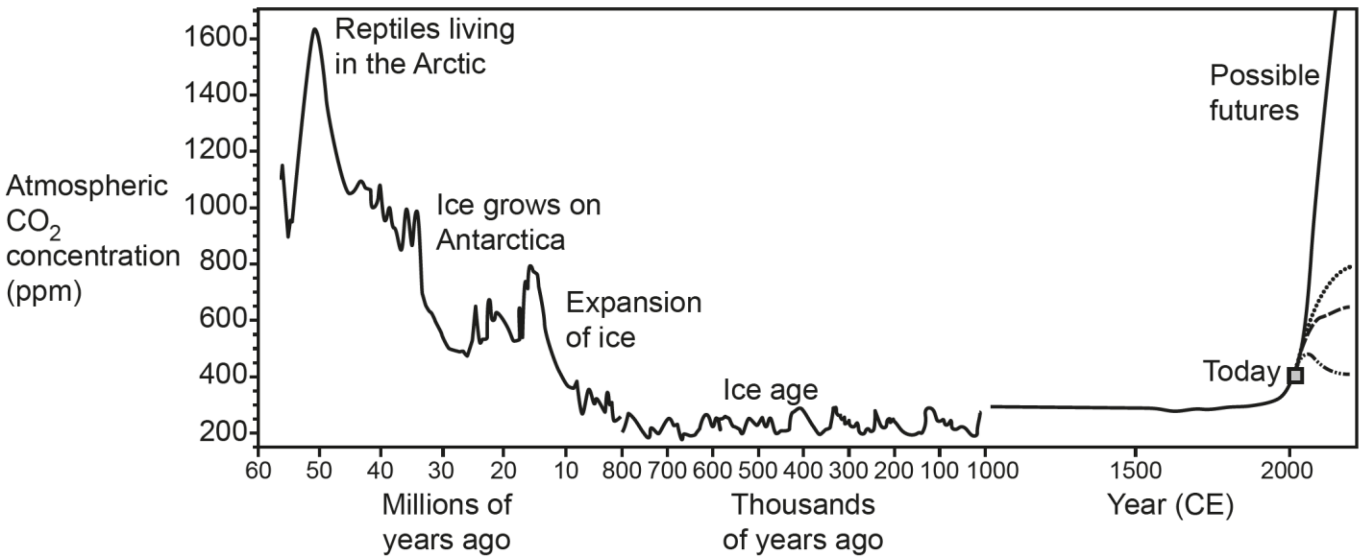
Candidates found it difficult to describe the effect of confining pressure on rock deformation and few gained marks on this question. Most were not aware that confining pressure increases the strength of rocks, so they take longer to deform and become strained. A small number of candidates knew that confining pressure is experienced uniformly from all directions and that, as a result, changes occur on all sides of a rock.

Question 2 (a) (i)

2

(a) Scientists have used microfossils to reconstruct the atmospheric composition of the last 60 million years. Deep sea sediment cores were taken from different parts of the ocean floor. The microfossils were extracted and chemically analysed using several methods, including isotope analysis.

The results are shown in the graph.



(i) Describe and explain the changes in atmospheric CO_2 concentration on the part of the graph labelled 800 to 100 thousand years ago.

....

....

....

.... **[2]**

This was a low scoring question. Although many candidates recognised that atmospheric carbon dioxide levels fluctuated during this time, they often did not appreciate that the changes were cyclical and periodic in nature, or that the total concentration of carbon dioxide stayed low. Some candidates could have improved their answers by quantifying the range or the highest value of carbon dioxide over the time 800,000 to 100,000 time period.

Candidates were even less successful in their explanations. Some gave incorrect explanations suggesting the changes were the result of volcanic activity or due to carbon dioxide being trapped in ice.

Question 2 (a) (ii)

(ii) Explain why the chemical composition of the microfossils could be used to determine the atmospheric CO_2 concentration.

....

.... **[1]**

While some candidates correctly stated the shells are composed of calcium carbonate or can be used for carbon or oxygen isotope analysis, many did not gain this mark. Vague statements such as 'CO_2 is trapped in the shells' or 'the higher the atmospheric CO_2 content the higher the CO_2 content in the shell' did not gain the mark.

Question 2 (a) (iii)

(iii) Name a microfossil group that the scientists may have used in their study to determine the atmospheric CO_2 concentration.

.... **[1]**

Candidates needed to name a microfossil with a shell made of calcium carbonate. About half the candidates correctly cited foraminifera or coccoliths.

Question 2 (a) (iv)

(iv) Explain why it is **not** usual to go back further than 60 million years by analysing deep sea sediment cores.

....

....

....

.... **[2]**

Candidates found this question demanding. Rather than giving a simple explanation that oceanic crust and the sediment on it is rarely older than 60 million years old because it is subducted and recycled into the mantle by plate tectonic movements, many gave elaborate answers about the technical difficulties of deep-sea drilling which did not answer the question.

Question 2 (b)*

(b)* Several scientific models have been developed that can predict the likely changes in atmospheric CO_2 concentration in the future.

Some schemes for carbon capture may be successful in offsetting the carbon emissions of industry. These schemes include burying CO_2 in a suitable underground location.

The current concentration of CO_2 in our atmosphere is around 422.8 ppm.

Describe and explain the potential impact of an increase in atmospheric CO_2 concentration on planet Earth if the increases cannot be offset.

Include the following ideas in your answer:

- impact on the environment
- the scale of the potential changes
- comparison with changes from geological history

....

....

....

....

....

.... **[6]**

Successful Level 1 answers made use of the information provided to give descriptions of the likely impacts on the environment such as global warming, ice caps melting, sea level rises, loss of habitat and faunal extinctions. However, some went off-topic and started describing impacts on humans such as coastal flooding of cities which are not relevant to impacts on planet Earth.

Some described how climate change and global warming come about due to increased concentrations of carbon dioxide in the atmosphere, which was tangential to the question asked, while others were confused with the ozone layer and ozone depletion. Some suggested that increased carbon dioxide levels in the atmosphere would trigger an icehouse, rather than a greenhouse, Earth event.

Fewer candidates attained Level 2 for either giving creditable descriptions of the scale of the change or providing comparisons with changes from geological history, alongside the impacts on the environment. For the scale of the change, candidates needed to refer to eustatic sea level changes or transgressions, a mass extinction event, or the creation of a new epoch, the Anthropocene, producing a golden spike in the geological record. A good explanation of a positive feedback loop resulting in a runway global warming was also worthy of Level 2.

Those who attained Level 3 were in the minority. To access credit for comparisons with changes in geological history, candidates needed to give correct named greenhouse Earth periods or named past mass extinction events such as Cretaceous-Tertiary, rather than merely stating the Earth has been hotter or that mass extinctions have happened in the past.

Exemplar 1

If atmospheric CO_2 increases, then ~~more~~ increased amounts of re-emitted infra-red radiation is absorbed. This causes an increase in atmospheric temperature. This can then lead to melting ice sheets, rising sea levels, and ~~increased~~ ~~freq~~ unpredictable weather patterns, removing species from their range of tolerance. ~~There~~ Rising sea levels will occur due to land ice melting and running off into the sea and thermal expansion. The potential changes caused will be on a global scale*. A similar event in geological history is the Permian-Triassic mass extinction event, where the Siberian Traps released large volumes of CO_2 into the atmosphere, removing species such as corals from their range of tolerance as rising sea levels ~~prevented them from~~ reduced light penetration. **[6]**

*→ however sea level rise can have impacts on a local scale

Exemplar 1 is typical of a response that attained Level 2, 4 marks. The candidate has given a detailed account of the increased impacts in atmospheric carbon dioxide concentration could have on planet Earth, including an increase in atmospheric temperatures, melting ice sheets, rising sea levels, unpredictable weather patterns and the removal of species from their range of tolerance. They have also referenced the Permo-Triassic mass extinction event so have made a valid comparison to a named change in geological history. However, they have not provided sufficient detail of the scale of the potential changes to attain Level 3.

Question 2 (c) (i)

(c)
(i) Describe how Pangaea formed.

....

....

....

.... **[2]**

Most candidates attained at least one mark for describing how the supercontinent Pangaea formed by continental collisions. However, few went beyond this to discuss orogenic mountain building events, or the ocean closure stage of the Wilson Cycle being dominant at the time.

Question 2 (c) (ii)

(ii) Explain how Pangaea influenced global climate after its formation.

....

....

....

.... **[2]**

The desert conditions in the centre of Pangaea were well-known and a few referred to reduced albedo due to the large land mass. However, few cited the influence Pangaea had on ocean or atmospheric circulation. Some candidates were confused in their discussion of the albedo effect. The presence of a dark coloured supercontinent at low latitudes would reduce albedo, whereas a supercontinent at high latitudes could result in increased albedo from snow and ice accumulation.

Question 3 (a) (i)

3

(a) A student investigated **three** hematite ore samples (**A**, **B** and **C**) to determine which sample was purest with the highest hematite content.

The formula for hematite is Fe_2O_3.

The student used **two** experiments to investigate the hematite samples:

- Loss on Ignition (LOI)
- Determination of Acid Insoluble Material

Experiment 1 – Loss on Ignition (LOI)

1. Using a pestle and mortar grind sample **A** until it resembles flour.
2. Place a crucible onto a **three** decimal place digital balance and tare the balance so that it reads zero.
3. Carefully measure 5 g of the ground sample **A** into the crucible.
4. Using tongs, heat the crucible in the hottest part of a Bunsen burner flame for five minutes, then put aside on a heatproof mat to cool.
5. Once cool, record the mass of the crucible contents.
6. Record the loss of mass in the table.
7. Repeat this procedure twice more, to gain three values for sample **A**.
8. Repeat steps 1–7 for samples **B** and **C**.

The results are shown in the table.

Sample	**Loss of mass (g)**			**Mean loss of mass (g)**	**Mean percentage change in mass (%)**
	1	**2**	**3**		
A	0.100	0.104	0.146	0.117	
B	0.086	0.090	0.088	0.088	–1.76
C	0.107	0.103	0.108		–2.12

(i) Calculate the mean loss of mass for sample **C**.

Mean loss of mass = ... g **[1]**

This was a high scoring question, and all candidates calculated the mean loss of mass for sample **C** correctly.

Question 3 (a) (ii)

(ii) Calculate the mean percentage change in mass for sample **A**.

Mean percentage change in mass = ... % **[2]**

This question was also done well with the majority arriving at the correct answer. All candidates remembered to give their answer as a negative number to match the other results provided in the table as it is loss of mass.

A small number did not realise that the mean loss of mass is the percentage change so instead of dividing 0.117 by 5.000, they subtracted 0.117 from 5.000 before dividing by 5.000 which gave an incorrect answer.

Question 3 (a) (iii)

(iii) Suggest **one** improvement that could be made to the design of this experiment.

....

.... **[1]**

Although the experiment may have been unknown to them, candidates coped well with suggesting an improvement to the loss on ignition experiment. The most common correct answers given were either to increase the number of repeat measurements done on each sample or to use a balance with more decimal places. Other valid improvements suggested included heating the samples until there is no more loss of mass or attaining better temperature control during the heating. A small number suggested using more samples which is different from increasing the number of repeat measurements and did not attain credit.

Question 3 (b) (i)

(b) Experiment 2 – Determination of Acid Insoluble Material

1. Carefully measure 10 g of the ground sample **A** into a beaker.
2. Add 10 cm^3 of 1M nitric acid to the sample and allow the reaction to occur to completion (the reaction has stopped).
3. Transfer the solution into an evaporating dish and place on a tripod over a Bunsen burner in a fume cupboard.
4. Gently heat the solution until all of the liquid has evaporated.
5. Scrape the contents into a weighing boat and place on a **two** decimal place digital balance and record the results.
6. Repeat steps 1–5 for samples **B** and **C**.

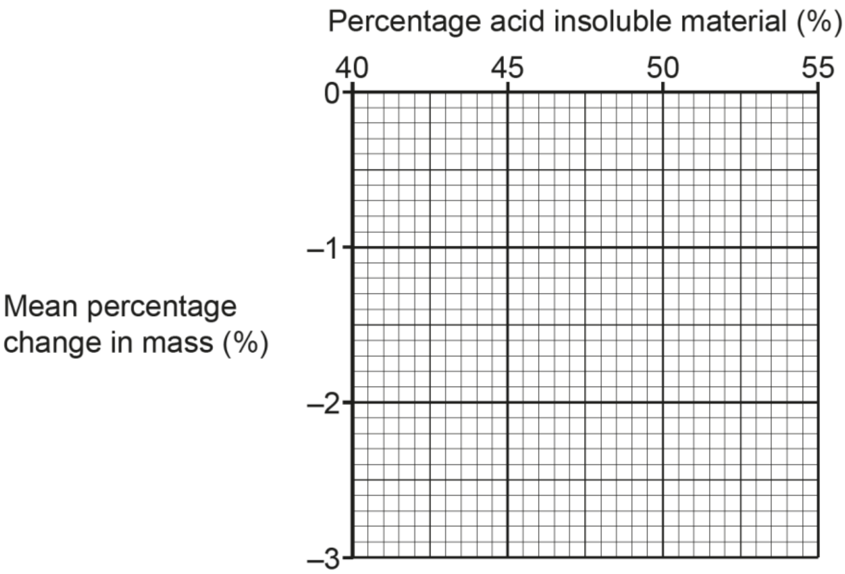
The symbol equation for the initial reaction is:

$Fe_2O_3 + 6HNO_3 \rightarrow 2Fe(NO_3)_3 + 3H_2O$

The results gained were used to calculate the percentage residue of acid insoluble material. The results are given in the table.

Sample	Percentage Acid Insoluble Material (%)
A	44.92
B	53.77
C	47.55

(i) Plot a chart to show the **percentage acid insoluble material (%)** against the **mean percentage change in mass (%)** for samples **A**, **B** and **C**. Draw a line of best fit through the data points.



[2]

Most candidates were able to plot at least two of the three data points correctly and draw a straight-line of best fit through the points to attain both marks. A few candidates made plotting errors, and it was clear some had difficulties dealing with the negative numbers, below zero, for the mean percentage change in mass.

Question 3 (b) (ii)

(ii) Which type of relationship is shown on the graph you have plotted? Tick (✓) **one** box.

linear ☐ logarithmic ☐ non-linear ☐

[1]

Most who had drawn a straight-line of best fit knew the relationship must therefore be linear.

Question 3 (b) (iii)

(iii) Name a statistical test that could be used to determine if there is a relationship between the percentage acid insoluble material and the percentage change in mass. Explain your answer.

....

....

....

.... **[2]**

Answers were evenly split between those who correctly suggested using either the Spearman's Rank or the Pearson correlation coefficient, and those who incorrectly suggested the Chi squared, Mann-Whitney U-test or the t-test.

The Chi squared test is not applicable as the data are not in classes. The Mann-Whitney U-test and the t-test are used to establish whether the data are from two different populations, so not applicable to testing whether there is a relationship between two data sets.

Not all who suggested using the Spearman's Rank or the Pearson correlation coefficient tests attained the second mark for a correct explanation that they compare two data sets to determine if there is a correlation between them.

Question 3 (c)

(c) Evaluate the **two** experiments to assess which of the samples **A**, **B** or **C** is the purest. Give reasons for your answer.

....

....

....

....

....

.... **[4]**

Responses to this question were variable. Successful answers often scored 3 marks for suggesting sample **B** is the purest with explanations that in experiment 1 it had the lowest loss of mass on heating and that in experiment 2 it had the largest percentage of acid insoluble material. However, few attained a fourth mark, which was usually for suggesting that the loss of mass on ignition was due to loss of volatiles or impurities.

A significant number of candidates got the evaluation the wrong way around and suggested **A** was the purest as it had highest loss of mass on heating and the lowest percentage of acid insoluble material. Others thought the tests showed two different things and concluded one sample was the purest for one test and then contradicted themselves by suggesting a different sample was the purest for the other test. Some seemed to think the haematite decomposed in the two tests, so that the oxygen was given off during the loss of ignition test and that only iron remained after the reaction with acid.

Others misunderstood the question completely and gave evaluations of the experimental methods. There were also some cases where candidates produced no response to this question.

Question 3 (d) (i)

(d) Deposits of metal ore minerals often occur in low concentrations within waste minerals of no economic value.

(i) State the name given to non-economic waste minerals.

.... **[1]**

The term gangue was well-known, but not all could spell it correctly. If the word was recognisable, incorrect spelling was given the benefit of the doubt.

Question 3 (d) (ii)

(ii) Describe **one** method of geochemical exploration that can be used to locate a metal ore deposit.

....

....

....

.... **[2]**

There were some very good answers which gave clear details of a suitable named geochemical exploration method. However, a significant number of candidates named and described a geophysical exploration method which did not answer the question. Marks could be gained for describing drilling and analysis of drill core or chips, but those who referred to analysing boreholes did not attain credit.

Misconception

?

Candidates need to be clear about the difference between the process of drilling a borehole and the drill core or chips which are the materials extracted from the borehole that can be tested and analysed.

Question 3 (d) (iii)

(iii) Deposits of banded iron-formations (BIFs) are an example of a metal ore deposit formed by sedimentary processes.

Describe and explain how these metal deposits were formed.

....

....

....

.... **[2]**

Candidates were evenly split between those who knew how banded iron-formation deposits formed and those who didn't, leading to a distribution of marks of either 0 or 2.

Those who knew how banded iron-formations formed often gave detailed descriptions using correct terminology of ferrous ($Fe^{2+)}$ and ferric (Fe^{3+}) iron and knew the role of photoferrotrophic bacteria in the oxidation of dissolved iron during the Great Oxidation Event, about 2300 Ma. Many of these were also familiar with the cyclical deposition of bands of light-coloured chert and dark coloured iron oxide minerals.

A small number wrote Fe_2 and Fe_3 rather than Fe^{2+} and Fe^{3+} but were given the benefit of the doubt if their meaning was clear. Some incorrect answers described placer deposition or gravity settling processes.

Question 3 (e) (i)

(e) Geohazards pose a risk to the mining industry, especially when mines are sited in areas known for earthquakes.

(i) Explain what the term **return period** means when applied to earthquakes.

....

.... **[1]**

About half the candidates were able to give a correct explanation of the meaning of an earthquake return period but some struggled to articulate a creditworthy response. Incorrect responses included that it is time taken for a seismic wave to return to the surface, clearly confused with two-way travel times, while others stated it is the time taken for aftershocks to arrive, or the lag time between P and S wave arrivals.

Question 3 (e) (ii)

(ii) Describe **one** method and **one** limitation of predicting a tectonic geohazard.

Method ....

....

Limitation ....

....

[2]

Candidates found this question difficult. Rather than describing a named method of prediction such as seismic gap theory, a specific change in ground conditions close to a fault, micro seismics as an eruption predictor or tsunami warming systems, they wrote vague descriptions of predicting tectonic geohazards in general which limited their marks.

Question 3 (e) (iii)

(iii) Explain how geographical information systems (GIS) can be used to improve disaster planning.

....

.... **[1]**

This was a low scoring question. Answers often referred to unspecified hazards, risks and damage. Such answers were too general and vague to attain the mark. Candidates needed to refer to mapping the positions of specific geological features such as faults, rock types, steep ground or areas where liquefaction would be likely, or use in the construction of hazard risk maps.

There was confusion with prediction rather than planning, so some gave answers that would have been better reserved for Question 3 (e) (ii). For example, suggesting that GIS allows planning of suitable evacuation routes was creditworthy, but suggesting that they give warning to allow people to evacuate was not.

Question 4 (a) (i)

4
(a)
(i) Describe how magnitude can be determined from a seismogram. You may use a labelled diagram in your answer.

....

.... **[1]**

Few used the correct technical term amplitude when referring to the size of the seismic waves on a seismogram.

Some candidates misread or misunderstood the question and explained how a seismometer works, rather than how to determine the magnitude from the seismogram recording produced.

Misconception

?

A common misconception is that the terms seismometer/seismograph and seismogram are synonymous.

A seismometer or seismograph is the instrument that detects seismic waves, whereas a seismogram is the paper or electronic record made. The maximum amplitude recorded on the seismogram is used to determine the magnitude of an earthquake.

Question 4 (a) (ii)

(ii) Explain how seismograms can be used to identify shadow zones.

....

....

....

....

....

.... **[2]**

The concept of seismic shadow zones was well understood with candidates frequently gaining one mark for explaining that they are areas on the Earth's surface where seismic waves are not recorded. However, few gained a second mark for correctly defining the extent of the P or the S wave shadow zone. Furthermore, rather than explaining how shadow zones can be identified, some candidates explained how shadow zones are produced, which was allowed for a maximum of one mark.

Question 4 (b) (i)

(b)
(i) Describe the **three** mechanisms that drive the movement of tectonic plates.

1 ....

....

2 ....

....

3 ....

....
[3]

This question was attempted by most candidates, but only about half achieved the maximum marks available for suitable descriptions of all three mechanisms of slab pull, ridge push and convection currents in the mantle. Some did not gain marks by not including the names of the mechanisms, so it was unclear which mechanism they were describing, while others mixed up the locations and mechanisms of slab pull and ridge push.

Question 4 (b) (ii)

(ii) State which mechanism is considered by scientists to be the most important.

.... **[1]**

Those who knew the three mechanisms from Question 4 (b) (i), were usually correct in stating slab pull as the most important mechanism.

Question 4 (c)

(c) Explain how the pattern of magnetic anomalies at mid-ocean ridges form.

....

....

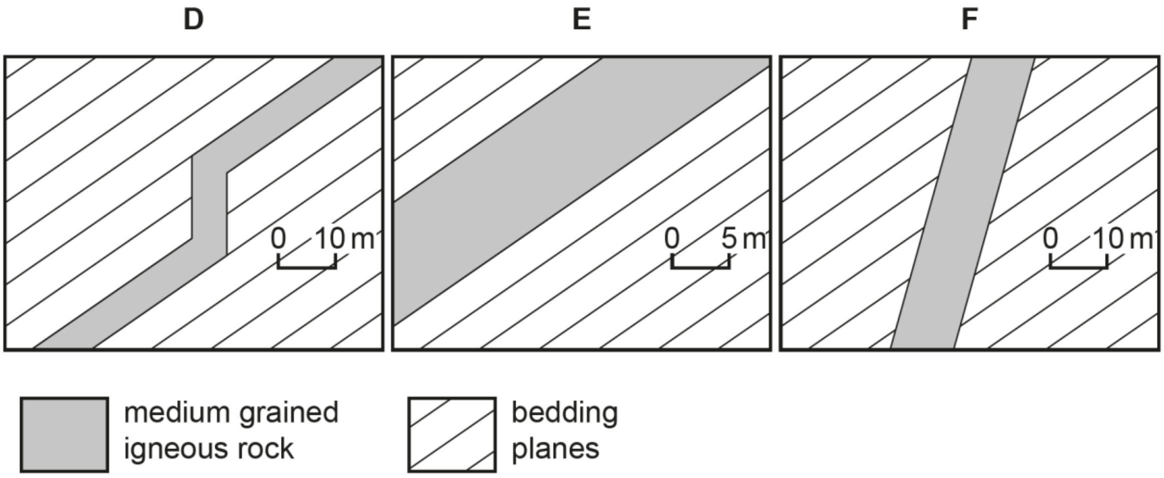
....

.... **[2]**

Most candidates accessed at least a mark for their answers. The process by which magnetic minerals in magma align in the direction of Earth's magnetic field and retain this palaeomagnetism when the rock cools below the Curie point was well understood, as was the formation of 'magnetic stripes' due to periodic reversals of Earth's magnetic field. The creation of a symmetrical pattern on either side of the mid-ocean ridge due to seafloor spreading was cited less often. A small number of candidates appeared to be confused with magnetic surveys of mid-ocean ridges.

Question 4 (d) (i)

(d) The diagrams show a variety of igneous intrusions that can be associated with plate boundaries.



(i) Use information from the diagrams to identify the type of igneous intrusion.

D ....

E ....

F ....
[3]

Candidates were very familiar with concordant sills (**E**) and discordant dykes (**F**) but did not always know the technical term transgressive sill (**D**) for a sill that steps up a layer.

Question 4 (d) (ii)

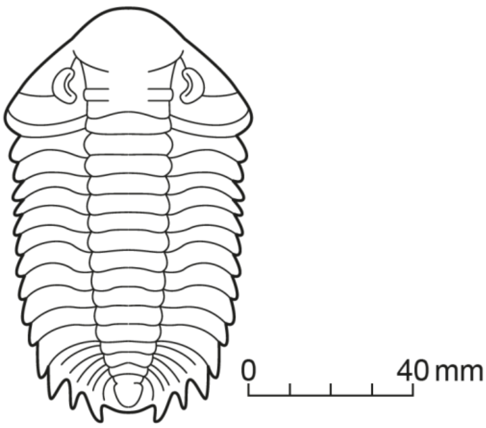
(ii) Shade the areas on diagram **F** where baked margins will occur. **[1]**

The position of the baked margins within the country rock on either side of the dyke was well-known and this was a high scoring question. The majority of candidates remembered to shade the whole length of the baked margins on either side, and only a handful shaded incorrectly within the dyke (the chilled margins).

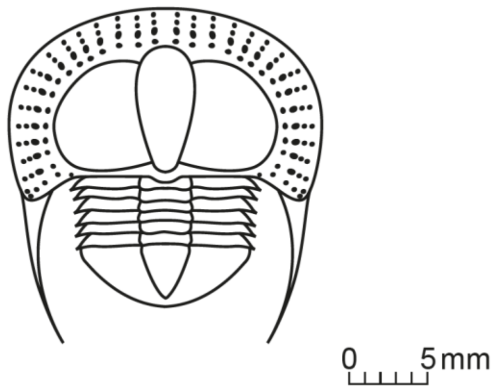
Question 5 (a) (i)

5
(a) Fossils **G** and **H** are both arthropods.

Fossil G



Fossil H



(i) To what group of Arthropoda do both fossils **G** and **H** belong?

.... **[1]**

Most candidates identified the two fossils as trilobites. Cephalopods was the most common incorrect answer seen.

Question 5 (a) (ii)

(ii) Fossils **G** and **H** had different modes of life.

Describe **two** morphological differences between fossils **G** and **H**. Explain how these morphological differences can be used to infer different modes of life.

....

....

....

....

....

.... **[2]**

Successful answers gave point by point correct comparisons of the morphological differences between the two trilobites to arrive at the conclusion that fossil **G** would have been epifaunal and fossil **H** infaunal. However, only about a quarter of the candidates gained both marks as often a mistake was made in the mode of life of one or other of the trilobites, or insufficient details of morphology were provided. Candidates need to use correct morphological terms such as cephalon and thorax, rather than head and body.

Question 5 (a) (iii)

(iii) Measure the maximum width of fossil **H** and calculate the magnification.

Width ....

Magnification ....
[2]

Most candidates gained the mark for correct measurement of the maximum width of fossil **H**. However, a small number forgot to give units so lost the mark.

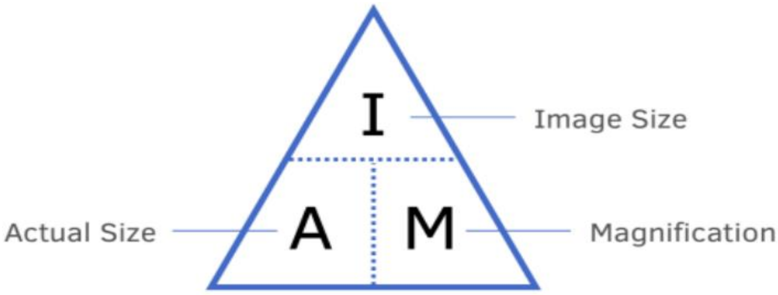
Candidates were less successful in working out the magnification – ×0.5, ×4 and ×5 were common incorrect answers.

Assessment for learning

As stated in the specification, candidates are expected to be able to recall the formula for calculating magnification:

$$\text{Magnification} = \frac{\text{Size of image}}{\text{Actual size of real object}}$$

Use of a 'triangle formula' and 'I AM' as a memory aid might help some candidates:



Question 5 (a) (iv)

(iv) The group to which fossils **G** and **H** belong became extinct at the Permo-Triassic boundary.

Suggest **one** piece of evidence for the cause of the Permo-Triassic mass extinction event.

....

.... **[1]**

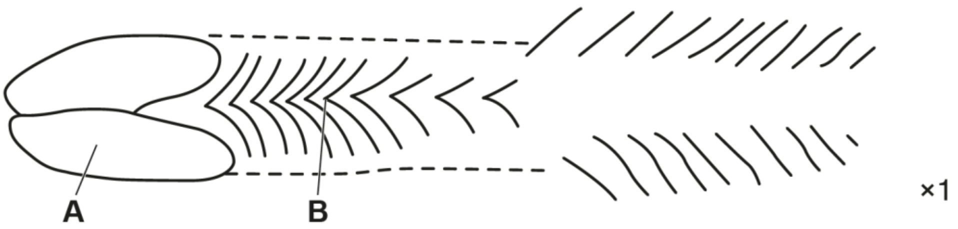
Less than half of candidates were able to suggest a creditworthy piece of evidence for the cause of the 252 Ma Permo-Triassic mass extinction events. The mark was most commonly given for naming the Siberian Traps.

Few if any, quoted plate tectonic or stratigraphic reconstructions showing the existence of the supercontinent Pangaea, or the lithological evidence of desert sandstones and evaporites indicating harsh, desert conditions at the time.

A number of candidates gave incorrect answers such as the Chicxulub impact crater or the Deccan traps, which are evidence for the cause of the more recent 66 Ma Cretaceous -Tertiary mass extinction event.

Question 5 (a) (v)

(v) The trace fossil shown was made by the activities of a different arthropod.



Describe the palaeoenvironmental conditions that enabled this trace fossil to have been formed and preserved.

....

....

....

.... **[2]**

The conditions that allow the preservation of trace fossils were well understood and most candidates gained both marks for their answers. Low energy conditions, a soft substrate and fine-grained sediments were commonly described.

Reference to anoxic conditions was ignored. Although this is a common factor in exceptional preservation, as the organism that made this trace fossil was clearly moving around on the seafloor when it was alive, then the conditions on the seafloor must have been oxygenated at the time.

Question 5 (b) (i)

(b) Lagerstätten deposits are found in basins where specific conditions during deposition provided exceptional preservation of organisms.

The Jurassic Solnhofen Limestone in Germany and the Cambrian Burgess Shale in Canada are examples of Lagerstätten deposits that were produced in different geological settings with different specific sedimentary conditions.

(i) Compare the differences between the geological settings and sedimentary conditions of these **two** Lagerstätten deposits.

....

....

....

.... **[2]**

Candidates found this high-level question challenging. However, those who scored marks often showed detailed knowledge of the two sites and were able to provide sound comparisons of the differences between their geological settings and sedimentary conditions.

The hypersaline lagoonal setting of Solnhofen Limestone was often cited, as were the submarine turbidity currents and slurries that led to the rapid burial and preservation of organisms in the Burgess Shale.

Question 5 (b) (ii)

(ii) Compare the methods of fossil preservation in these **two** Lagerstätten deposits.

....

....

....

....

....

.... **[2]**

Candidates found this question very difficult, and it was low scoring. Many were confused between the conditions that facilitate exceptional preservation and the methods by which the fossils are preserved. This led to some candidates repeating the descriptions of the geological settings or sedimentary conditions they had given for Question 5 (b) (i).

Those who discussed atom-by-atom replacement for either site were in a small minority, as were those who described the preservation of soft parts as aluminosilicate films within the Burgess Shale. There were one or two outstanding answers that referred to the necrolytic features seen in some fossils within the Solnhofen Limestone, possibly the result of preservation in toxic hypersaline conditions.

Some candidates suggested that preservation in the Solnhofen Limestone was by carbonisation, possibly confusing this with replacement by calcite. These candidates would have accessed a mark for describing carbonisation as a method of preservation for the Burgess Shale. Preservation by moulds and casts were incorrectly referred to for both and, in some cases, there appeared to be confusion with the chemical weathering processes of carbonation and hydrolysis.

Question 5 (b) (iii)

(iii) Suggest how fossils from the Burgess Shale Lagerstätten deposit provide evidence for the Cambrian explosion.

....

....

....

.... **[2]**

Knowledge of how fossils from the Burgess Shale provide evidence for the Cambrian explosion was also sparse. Less than half of candidates gained one mark and only a handful gained both marks for their answers. It was clear a significant number of candidates did not understand the term 'Cambrian explosion', and some seemed to think it was a mass extinction event rather than the opposite, an 'explosion' of life.

Successful answers commonly cited the presence of enigmatic fossils with no known modern-day equivalents, possibly suggesting evolutionary experiments. Others gave correct named examples of fossils unique to the Burgess Shale such as *Anomalocaris* or *Hallucigenia*.

Although some candidates described the preservation of large numbers of different organisms, they often did not convey the idea of over a short time period, so did not show understanding that the fossils provide evidence for a period of rapid evolution.

Question 5 (c) (i)

(c)
(i) Explain how ideas about uniformitarianism can be applied to the study of facies.

....

.... **[1]**

Candidates found this high-level question challenging. The phrase 'the present is the key to the past' was often quoted but this was insufficient as the answer had to be in the context of sedimentary facies and environments.

Some high-attaining candidates were able to articulate concise responses to show understanding that the principle of uniformitarianism applied to sedimentary facies assumes that those formed in the past were formed in the same way and environments as they are today.

Question 5 (c) (ii)

(ii) The Welsh Basin contains turbidites and dark shales, thin impure limestones, reef limestones and red sandstones that were deposited throughout the Lower Palaeozoic periods.

Using ideas about facies associations, explain how a whole basin analysis approach (sedimentology and palaeontology) can be used to infer changing palaeoenvironments in the Welsh Basin.

....

....

....

....

....

.... **[4]**

Candidates were more successful at explaining how a whole basin analysis approach can be used to infer changing palaeoenvironments within the Welsh Basin, and this question provided to be a good discriminator.

Those who picked up on the prompts of the different rock types given in the question were able to gain most of the available marks, if they explained what information each of the rock types listed provided about the palaeoenvironment in the Welsh Basin at the time.

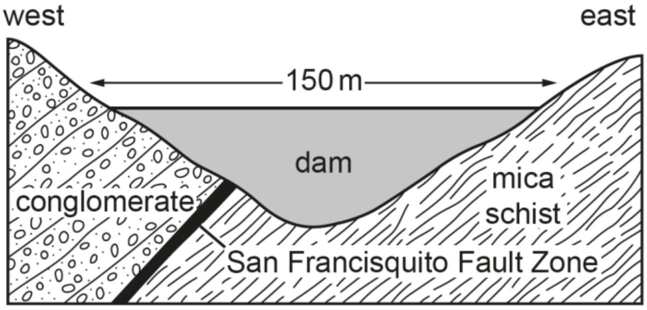
Some knew that the basin transitioned from deep marine to terrestrial over the Lower Palaeozoic time scale. However, those who correctly used ideas about facies associations, or described the use of lithostratigraphy or biostratigraphy were in the minority.

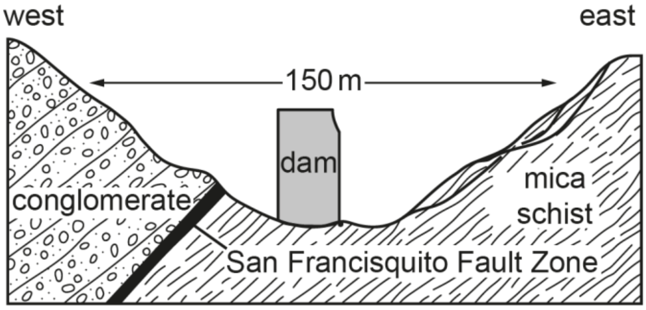
Question 6 (a) (i)*

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

Geological factors play a critical role in the planning and construction of dams and tunnels. In the case of the St. Francis Dam, Santa Clarita, California, a series of human errors and poor engineering judgement led to its failure in March 1928.

The diagrams show the 56 m tall concrete gravity arch dam before and after failure.





During evaluation of the suitability of the site, exploratory tunnels were cut into the rock to test water percolation and samples were taken to test rheological strength. The conglomerate unit was not homogenous, consisting of red sandstones grading into conglomerate with veins of gypsum throughout. The mica schist appeared homogenous but was thinly laminated with weak clay, weathered and cross-faulted in many areas. When dry, the conglomerate performed poorly under compressional stress, relative to the mica schist, and when wet it became soft. The initial survey concluded that the conglomerate was suitable for dam construction but that the mica schist was not. Engineers later contested these findings and asserted that the mica schist was hard and of the same nature throughout. Evidence of previous land slips in the mica schist was not acted upon. The San Francisquito Fault was considered inactive and engineers were not concerned about water ingress through the 2 m wide fault zone as it was sealed with fault gouge. Construction of the dam began in 1924.

During construction, to provide 25% additional reservoir storage, the dam's original planned height was increased by 3 m on two separate occasions, with no change to its basal thickness. No cut-off curtains, grout curtains or contraction joints, which allow concrete to crack in a controlled manner as it cools, were incorporated into the dam's design.

By April 1927, the water level in the reservoir was within 1 m of the spillway near the top of the dam and seepage was minimal. In February 1928 a fracture was observed at the base of the dam discharging around 17 litres of water per second. This was dismissed as a contraction crack and left to drain. Over the course of one month the discharge rate doubled and further leaks appeared along the base of the dam with the runoff having a muddy colour. Engineers concluded that these new leaks were of no concern and the dam was safe. Five days later the dam collapsed.

Post failure, it became clear that the dam had been designed to prevent small foundation stresses only and not to accommodate full support of the dam.

(a)
(i)* Using information from the text and your own knowledge of engineering geology:

- Describe and explain the hydrogeological impacts of the dam construction on the strength and stability of the rocks that underlie the St. Francis Dam.
- Explain the likely reasons for the catastrophic failure of the St. Francis Dam.

....

....

....

....

....

.... **[6]**

Candidates used the information provided in the text about the St. Francis Dam to good effect and many attained Level 2 for applying their knowledge of engineering geology to explain possible reasons for the catastrophic failure of the dam. A successful approach taken by some was to work their way methodically through the information provided about the conglomerate; the mica schist; the fault; and construction considerations, to evaluate the likely causes of the failure.

However, not all went on to discuss the hydrogeological impacts of the dam construction which was required to attain Level 3. There was little appreciation of the role of the water in the reservoir increasing the hydrostatic pressure on the underlying rocks and fault; causing water ingress into permeable rocks; or how water lubricates discontinuities in rocks such as bedding planes, foliation and faults, making slippage and failure more likely.

Exemplar 2

The conglomerate unit was not homogenous meaning areas of different mineralogy would react differently to the weight of the water causing subsidence in some areas. The mica schist was thinly laminated with weak clay which is highly porous and would contract or expand greatly depending on saturation. Water content of the clay would increase as water percolated down from the ~~a dam~~ reservoir causing expension which would move the dam causing it to fail. There were previous land slips showing the rock was unstable and if this had occured while the dam was in place the extra sediment would have decreased the amount of water the resevoir could carry and would build up against the dam, adding pressure. The fault was considered inactive, however the added weight of the water reactivated it which moved the surrounding rock and allowed water to percolate out, lubricating it further. This movement caused the dam it fail. The leaks **[6]**

Extra answer space if required.

that had a muddy colour ~~where~~ containd high levels of sediment which had built up behind the dam and gave the water more ~~fo~~ force to break the dam.

Exemplar 2 is a concise response which includes enough correct content to attain Level 3, 6 marks. The candidate has addressed both the hydrogeological impacts and has used their knowledge of engineering geology to suggest reasons for the dam's failure.

For the hydrogeological impacts they have referred to the weight of the water in the reservoir, water percolating into and saturating underlying rocks, and water lubricating and reactivating the fault.

They have used their knowledge of engineering geology to discuss the problems of the non-homogenous conglomerate, the clay content of the mica schist, the presence of the underlying fault, and the evidence of previous landslips that suggested the rocks were unstable.

Question 6 (a) (ii)

(ii) Explain why there was an increase in seismic activity as the reservoir filled with water.

....

....

....

.... **[2]**

More than half of candidates accessed this question to attain at least one mark. Some responses were limited due to a lack of correct technical terminology such as load, hydrostatic or pore fluid pressure. Rather than explaining fault reactivation or loss of cohesion, many referred vaguely to fault slippage which was insufficient.

Question 6 (b)

(b) A replacement reservoir and dam were constructed in the nearby Bouquet Canyon. This required the cutting of aqueduct tunnels through the same rock units to carry water to the nearby city of Los Angeles.

Describe **one** geological impact of tunnelling and explain how this can be mitigated.

Impact ....

Mitigation ....

....

....
[2]

This question was done well, and responses covered the whole range of mark scheme options. Subsidence or collapse of the overlying rocks was most commonly named as a geological impact of tunnelling and candidates often went on to suggest the use of tunnel supports such as a concrete lining or steel ribs as a suitable mitigation method. However, not all gave a mitigation method that correctly matched the impact they described, which limited their mark to one.

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Access to Scripts

We've made it easier for Exams Officers to download copies of your candidates' completed papers or 'scripts'. Your centre can use these scripts to decide whether to request a review of marking and to support teaching and learning.

Our free, on-demand service, Access to Scripts is available via our single sign-on service, My Cambridge. Step-by-step instructions are on our website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular professional development courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is the exam paper builder platform for a range of our qualifications. Find out more.

Free for all OCR centres with an Interchange account, it allows unlimited users per centre. We require an Interchange username to verify your centre's users for ExamBuilder.

If you do not have an Interchange account, please contact your centre administrator (usually the Exams Officer) to request a username.

Once you have an Interchange username, use the form on this page to sign up for ExamBuilder, or ask an existing user at your centre to create an ExamBuilder account for you.

Active Results

Review students' exam performance with our free online results analysis tool. It is available for all GCSEs, AS and A Levels and Cambridge Nationals (examined units only).

Find out more.

Tell us what you think

Your feedback plays an important role in how we develop, market, support and resource qualifications now and into the future. We want you and your students to enjoy and get the best out of our qualifications and resources, but to do that we need your honest opinions to tell us whether we're on the right track or not.

You can email your thoughts to resources.feedback@ocr.org.uk or visit our feedback page to learn more about how you can help us improve our resources.

Designing and testing in collaboration with you and your students

Helping young people develop an ethical view of the world

Equality, diversity, inclusion and belonging (EDIB) are part of everything we do

Contact the team at:

01223 553998

ocr.org.uk

To stay up to date with all the relevant news about our qualifications, register for email updates at ocr.org.uk/updates

Visit our Online Support Centre at support.ocr.org.uk