OCR
Oxford Cambridge and RSA

Tuesday 20 June 2023 – Afternoon

A Level Geology

H414/03 Practical skills in geology

Time allowed: 1 hour 30 minutes

You must have:
- the Insert (inside this document)

You can use:
- an HB pencil
- a scientific or graphical calculator
- a protractor
- a ruler (cm/mm)
- A4 plain paper

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **16** pages.

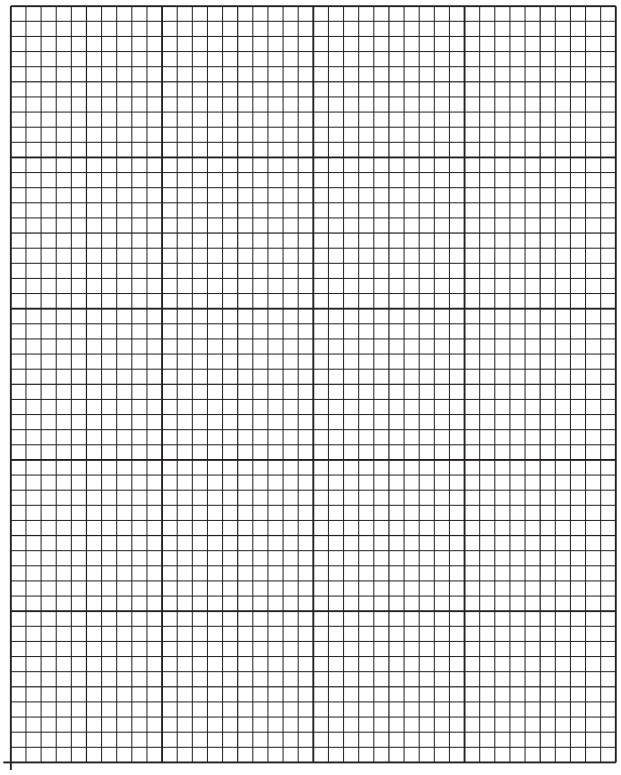
ADVICE
- Read each question carefully before you start your answer.

1 A student has collected a sediment sample for analysis in the laboratory using a sieve stack. This is a stack of sieves arranged with the biggest mesh at the top (4 mm or –2Φ) and the smallest at the bottom (0.0625 mm or 4Φ).

The student's results are shown in the table.

Phi Φ	% of Sample
–2	0
–1	3
0	23
1	64
2	8
3	2
4	0

(a) Plot the results from the table as a cumulative frequency curve on the grid.



[3]

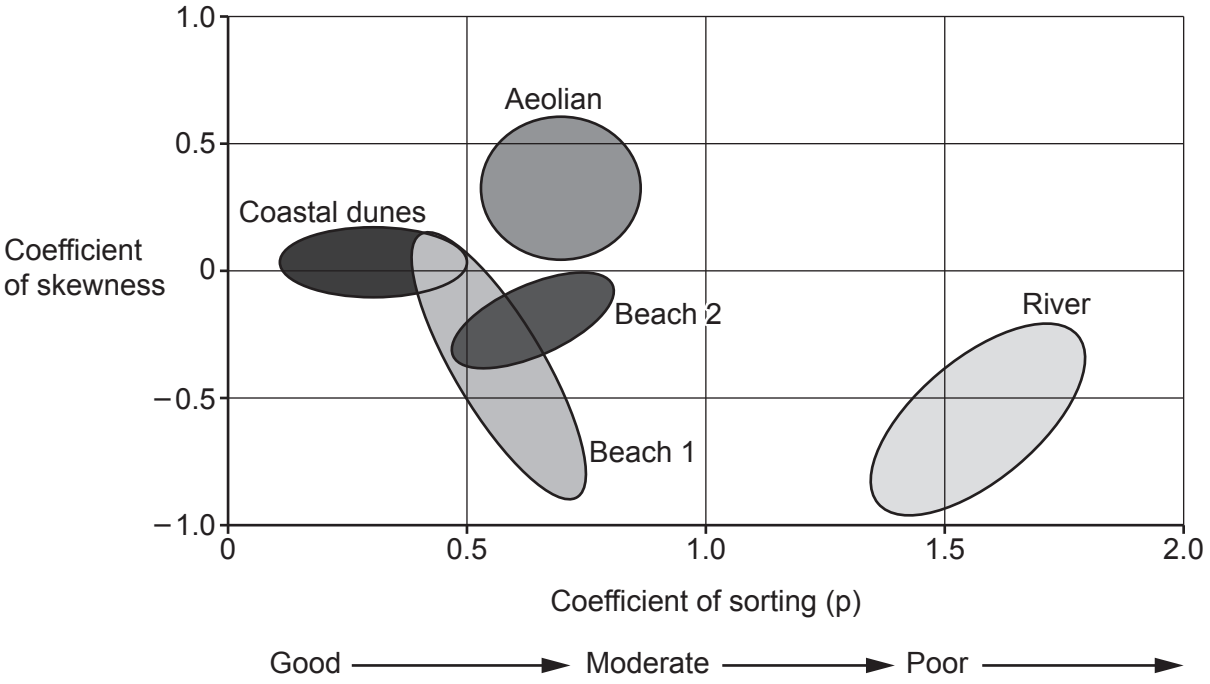
(b) The coefficient of skewness can be calculated using the equation:

$$\text{Coefficient of skewness} = \frac{(\Phi_{84} + \Phi_{16}) - 2\Phi_{50}}{2}$$

Calculate the coefficient of skewness for this sample.

Coefficient of skewness = ... **[2]**

(c) The bivariate plot shows the likely origin of sediment based on the coefficient of skewness against the coefficient of sorting (p).



The coefficient of sorting for the sediment was calculated as 0.65.

Use the value you have calculated for the coefficient of skewness in **part (b)** to suggest a likely origin for this sediment sample.

..... **[1]**

(d) Other than skewness and sorting, suggest **three** characteristics of sediment found in this environment of deposition.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(e) Evaluate the method used by the student to interpret the environment of deposition for this sediment sample.

.....

.....

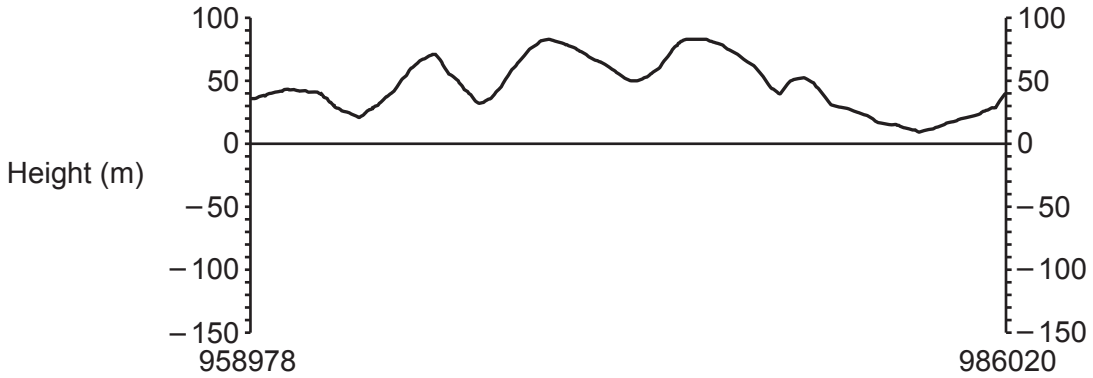
.....

.....

..... **[2]**

2 The 1:50 000 geological map excerpt (Pembroke and Linney Head), **in the Insert**, should be used for this question.

(a) (i) On the topographic sketch profile below draw and label a cross section of the solid geology from grid reference 958978 in the South West to 986020 in the North East.



[5]

(ii) On your cross section, sketch the axial plane of the fold shown in the North East of the area. **[1]**

(iii) Identify and fully describe **two** geological structures shown in your cross section.

.....

.....

.....

.....

..... **[2]**

(b) (i) **Fig. 2**, **in the Insert**, is a photograph of a locality close to the area shown on the geological map.

Draw a sketch of this geological outcrop and label **two** geological features.

[2]

(ii) The angle and direction of dip is often measured at geological localities.

Describe how to find and measure the strike of a bedding plane using a compass clinometer.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(c)* Evaluate the potential geological problems that could be encountered by a company aiming to quarry the Carboniferous Limestone d^1 and d^2 shown on the geological map.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

Additional answer space if required.

.....

.....

.....

.....

.....

3 **(a)** Describe the difference between porosity and permeability in a hydrocarbon reservoir rock.

.....

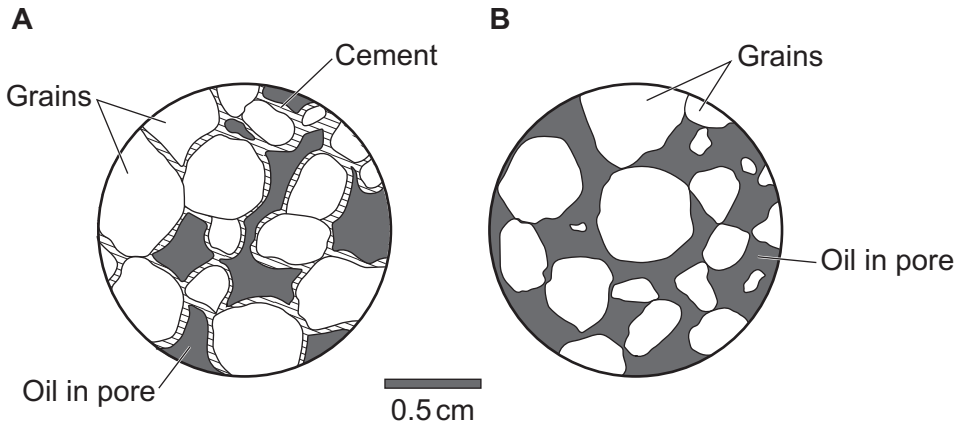
.....

.....

.....

..... **[2]**

(b) **(i)** Diagrams **A** and **B** show two sandstone samples, collected from two boreholes in a hydrocarbon field.



Explain which sample would yield a greater value of hydrocarbons.

.....

.....

.....

.....

.....

.....

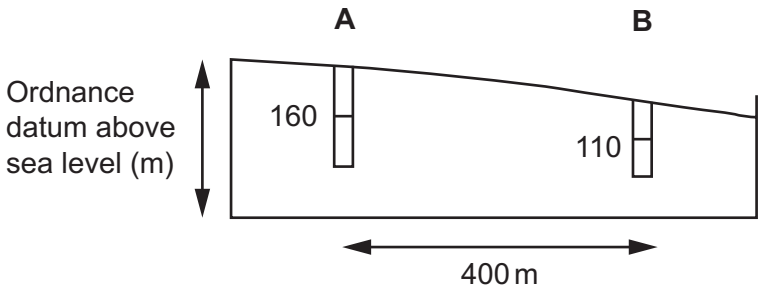
.....

.....

.....

..... **[4]**

(ii) The diagram shows the location of the two boreholes, **A** and **B**.



The two boreholes can be used to calculate the permeability of the sandstones using Darcy's Law.

The hydraulic conductivity (k) of the sandstones was found to be 1×10^{-3} cm sec^{-1} and the area of the hydrocarbon field was 1500 m^2.

Calculate the permeability (Q) of the sandstones.

Use the formula: $Q = -kA\left(\frac{h_2 - h_1}{L}\right)$

Permeability (Q) = ... Units = ... **[3]**

4 **Fig. 4**, **in the Insert**, is a photograph of a specimen taken from a hydrothermal vein.

Mineral specimens are often identified with the help of diagnostic properties such as colour, density and arrangement of cleavages.

(a) **(i)** Describe the shape and arrangement of cleavage in the mineral shown in **Fig. 4**.

.....

.....

.....

.....

..... **[2]**

(ii) Describe **one** additional test, apart from those listed above, that could be carried out on the mineral shown in **Fig. 4** that would help to identify it.

.....

..... **[1]**

(iii) Describe how a student would measure the **density** of the unknown mineral in **Fig. 4**.

.....

.....

.....

.....

..... **[2]**

(b) Some minerals are found to have relatively high densities.

Describe how this property can lead to accumulations of ore that are economic to extract.

.....

.....

.....

.....

..... **[2]**

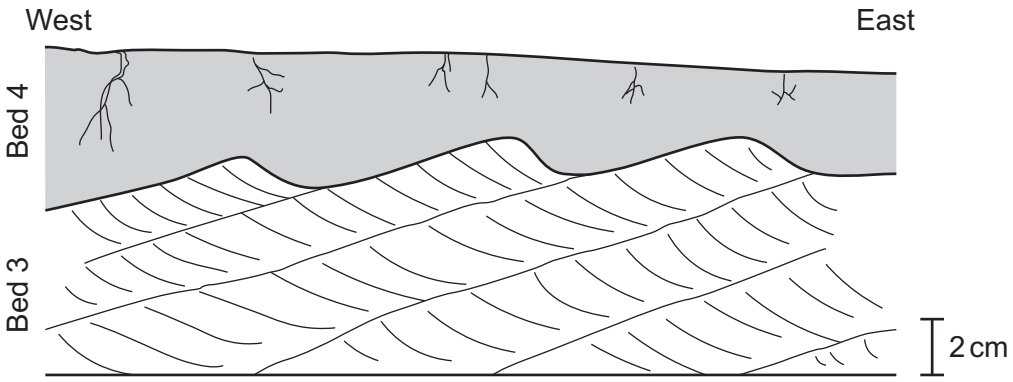
5 Information recorded by students from a cliff section during a field excursion is shown in the table below.

Bed 1 is 3.8 m from the base of the cliff, whilst the base of **bed 5** is 7.8 m from the base of the cliff.

Bed	Thickness (m)	Rock description	Features visible	Energy level (Low, med, high)	Sea level (Low, med, high)
1	1.00	Well-bedded shale Pale grey	Marine brachiopods and bivalves	Low	High
2	1.20	Siltstone Laminated Coarsening upwards from clay to silt	Contains bivalve shells Some bioturbation visible		
3	1.70	Uneven base Coarsening upwards from fine to medium sandstone	Small scale Cross-bedding visible throughout bed Some scattered plant material		
4	0.20	Silty mudstone Reddish-brown colour	Contains plant roots towards the top of the bed		
5	0.10	Black, shiny	None		
6	0.75	Well bedded shale	Marine brachiopods, well preserved and intact		
7	1.00	Laminated siltstones	Bioturbation and trace fossils (burrows)		

(a) Complete the table to identify the energy level and sea level for each bed as either low, medium or high. The first bed has been completed. **[3]**

(b) One of the students produced a field sketch showing the top surface of Bed 3.



Outline how the palaeocurrent direction can be determined.

.....

.....

.....

.....

..... **[2]**

(c) Using the lithological evidence of Bed 5, interpret the palaeoenvironment and climate that must have been present at this time.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

(d)* Depositional cycles such as those recorded in the table can be caused by basin-wide sea-level changes or local tectonic variations.

Describe and compare the processes involved in both sea-level changes and local tectonic variations.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... **[6]**

Additional answer space if required.

.....

.....

.....

.....

.....

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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