Surname	Centre Number	Candidate Number
First name(s)		2

GCE A LEVEL

A480U10-1

S23-A480U10-1

MONDAY, 5 JUNE 2023 – MORNING

GEOLOGY – A level component 1
Geological Investigations

2 hours 15 minutes

ADDITIONAL MATERIALS
In addition to this examination paper, you will need:
- the Resource Sheet
- **specimens B**, **C** and **K**
- geological equipment for testing specimens
- the Mineral Data Sheet
- a calculator
- a ruler
- a protractor

INSTRUCTIONS TO CANDIDATES
Use black ink or black ball-point pen. Do not use gel pen or correction fluid.
You may use a pencil for graphs and diagrams only.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** questions.
Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

	For Examiner's use only		
	Question	Maximum Mark	Mark Awarded
Section A	1.	18	
	2.	12	
Section B	3.	12	
	4.	10	
	5.	15	
	6.	9	
	7.	10	
	8.	13	
	9.	6	
	Total	105	

INFORMATION FOR CANDIDATES
This paper is in 2 sections, **A** and **B**.
Section **A**: 30 marks. Answer **both** questions. You are advised to spend about 35 minutes on this section.
Section **B**: 75 marks. Answer **all** questions. You are advised to spend about 1 hour 40 minutes on this section.
The geology is **not** designed to represent any particular area.
The Mineral Data Sheet and **Map 1** are provided on separate resource sheets.
Strips of plain paper may be obtained from the supervisor on request.
Three specimens, **B**, **C** and **K**, are provided for use.
The number of marks is given in brackets at the end of each question or part-question.
The assessment of the quality of extended response (QER) will take place in questions **6** and **9**.

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Section A

Answer **all** questions.

1. **Figure 1a** is a map of Iceland (located on a divergent plate margin) showing selected volcanoes and rift zones.
Figure 1b shows a cross-section of the Hekla volcano.
Table 1 contains information about two Icelandic volcanoes (Hekla and Katla).

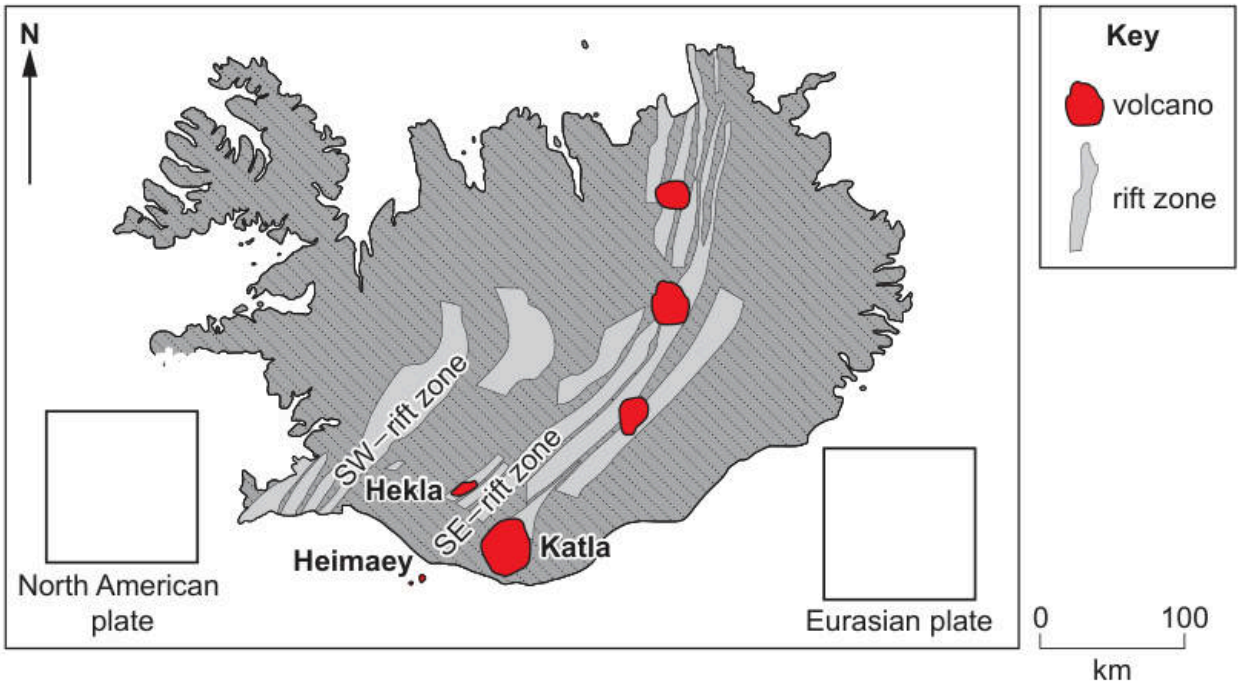


Figure 1a

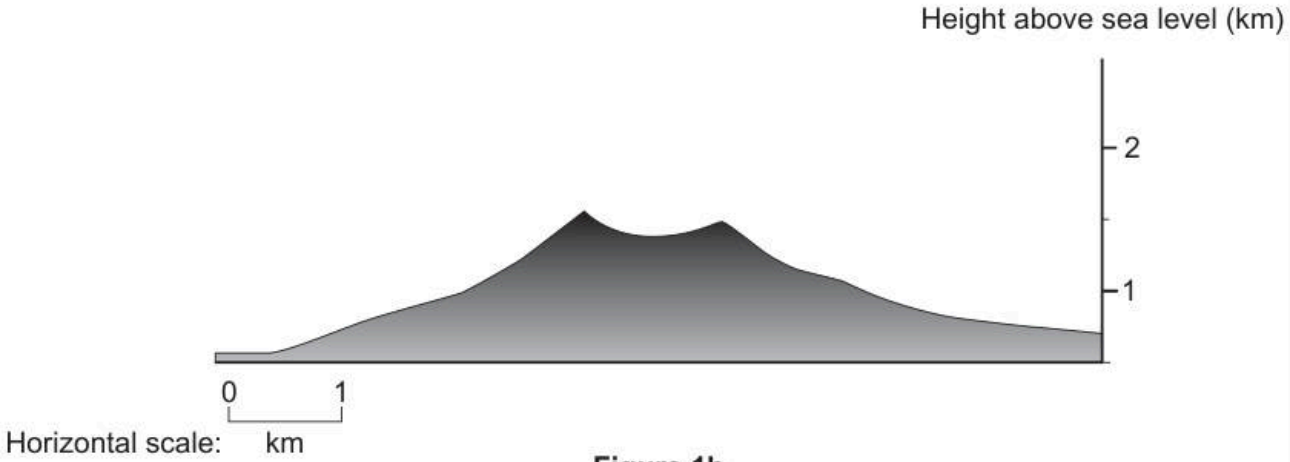


Figure 1b

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Volcano	Composition of lavas	Height (km)	Area (km^2)
Hekla	ranges from andesitic to basaltic	•	131
Katla	basaltic	1.51	☐ 260 ☐ 800 ☐ 2600 ☐ 8000

Table 1

(a) (i) Add arrows in the **two** boxes on **Figure 1a** to show the relative direction of movement for the:

- North American plate
- Eurasian plate. [2]

(ii) Complete **Table 1** by:

- using **Figure 1b** to determine the height above sea level of the summit of Hekla
- using **Figure 1a** and the information in **Table 1** to **estimate** the area of Katla. Tick (✓) **one** box in **Table 1**. [2]

(iii) Refer to **Table 1**. **Hekla** has a steeper slope angle than **Katla**. Give a possible geological explanation for this difference. [4]

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(b) **Figure 1c** shows a map of Heimaey, a volcanic island to the south of Iceland. It shows the impact of the 1973 eruption on the island.

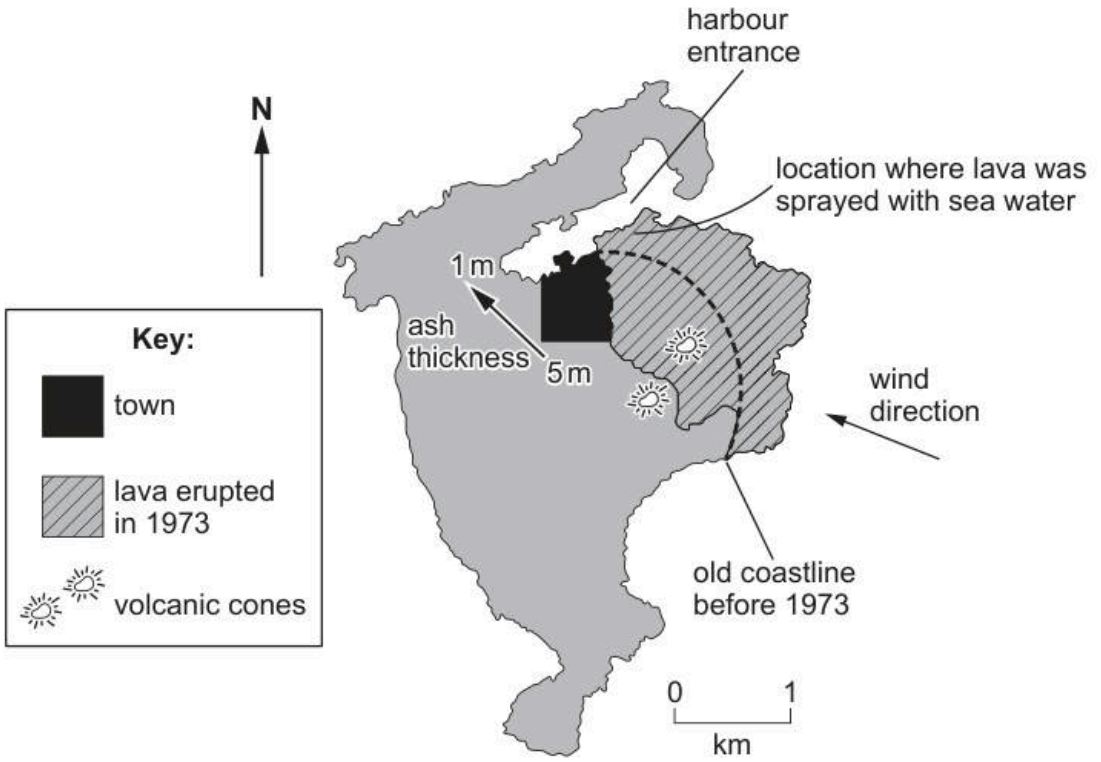


Figure 1c

(i) State **two** possible impacts of the ash fall. [2]

1. .....

.....

2. .....

.....

(ii) Suggest **one** factor responsible for the distribution and thickness of the ash shown on **Figure 1c**. [1]

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(c) Explain why spraying the lava with seawater might have prevented the lava closing off the harbour entrance. [3]

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(d) Describe **two** methods that could be used to monitor potential future eruptions of Icelandic volcanoes. Explain how each method would indicate that an eruption was imminent. [4]

Method 1 .....

Explanation .....

.....

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Method 2 .....

Explanation .....

.....

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2. **Figure 2a** shows the range of crystallisation temperatures of some silicate minerals. **Table 2** provides data for ions often found in silicate minerals.

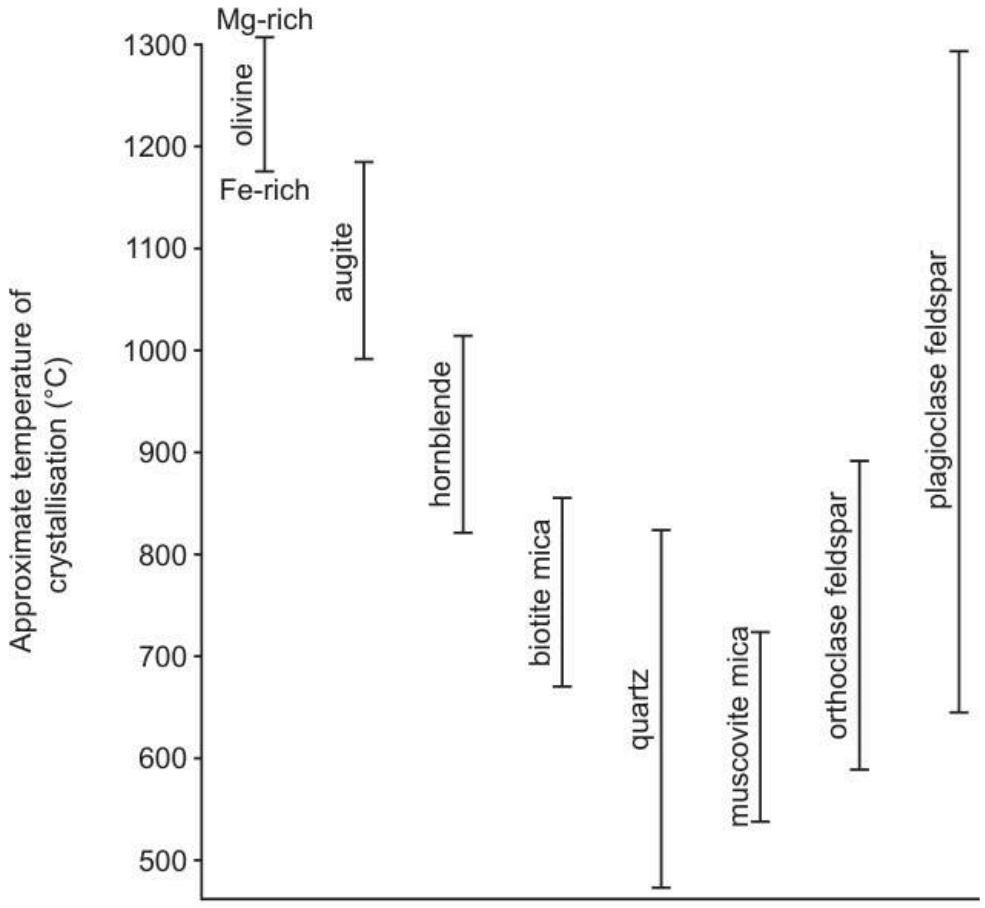


Figure 2a

Ion	Fe^{2+}	Mg^{2+}	Na^{+}
Ionic charge	+2	+2	+1
Ionic radius (nm)	0.74	0.66	0.97

Table 2

(a) State which mineral on **Figure 2a** has the largest range of crystallisation temperatures. [1]

.....

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(b) Refer to **Figure 2a** and **Table 2**. Olivine forms a solid solution series.

(i) Explain what is meant by the term 'solid solution series'. [2]

.....

.....

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(ii) Explain why Mg^{2+} and Fe^{2+} can substitute for each other in olivine. [2]

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(c) A student suggested that the data in **Figure 2a** explains why some silicate minerals are more resistant to chemical weathering than others. Evaluate this suggestion. [3]

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(d) **Figure 2b** shows an environment found at the Earth's surface.



Annual temperature range = 22 °C to 34 °C

Mean annual rainfall = 5000 mm

Figure 2b

Describe the products produced and the processes involved when an arkose sandstone undergoes weathering in the environment shown in **Figure 2b**. [4]

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Section B

Answer **all** questions.

Study **Map 1** on the **Resource Sheet**.

3. (a) **Specimen C** was collected from within **Rock Unit C** on **Map 1**. **Specimen C** contains three main rock forming minerals, each identified by a characteristic colour.

(i) Complete **Table 3** below by:

- briefly describing how you would test or observe the named physical property
- recording the results of your tests/observations. [6]

Characteristic colour of the mineral	Physical property	Description of test/observation	Results of test/observation
white	hardness	•	•
colourless	lustre	•	•
black/brown	cleavage	•	•

Table 3

(ii) With reference to **Table 3** and the Mineral Data Sheet, name the following rock forming minerals in **Specimen C**. [2]

White mineral .....

Black/brown mineral .....

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(b) (i) Describe the texture of **Specimen C**. [2]

.....

.....

.....

(ii) Suggest the probable cooling history of **Specimen C**. [2]

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.....

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4. A student measured the orientation of the long axis of phenocrysts within **Rock Unit C** at **Locality 1** and **Locality 2** on **Map 1**.
Figure 4a shows phenocryst **J** identified on a horizontal surface at **Locality 2**.
Figures 4b and **4c** are rose diagrams of phenocryst orientations at **Localities 1** and **2**.



Figure 4a

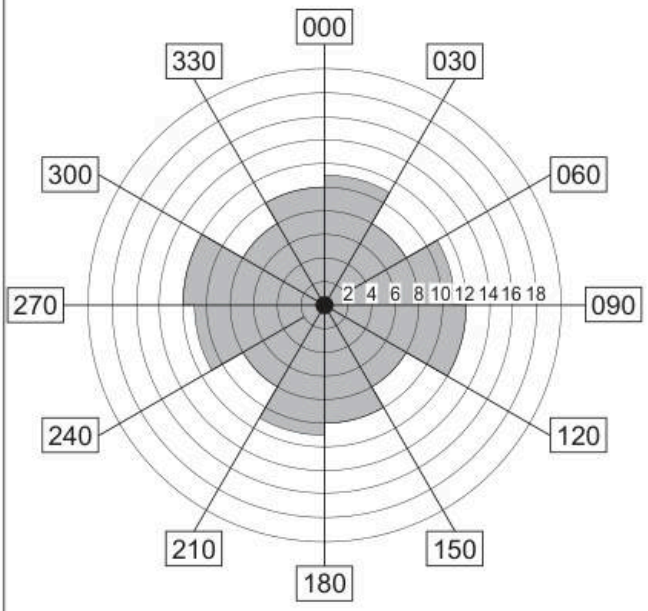


Figure 4b

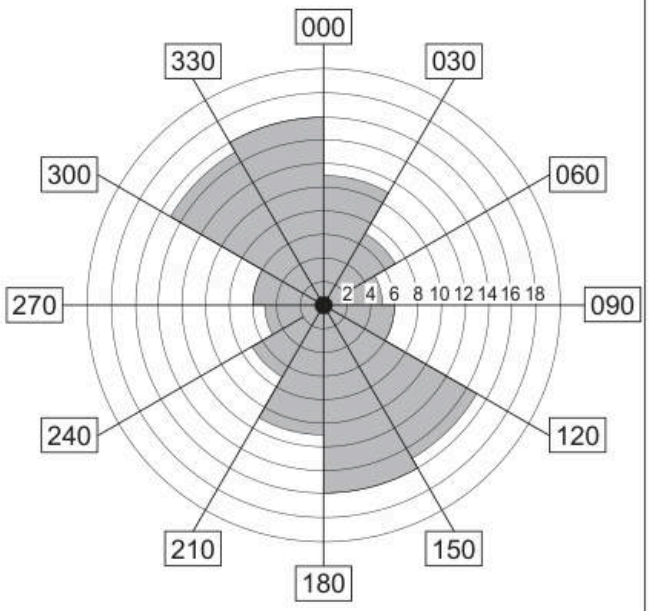


Figure 4c

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(a) (i) Measure and record the orientation of the long axis of phenocryst **J** shown in **Figure 4a**. [1]

Orientation of phenocryst **J** ..... ° to ..... °

(ii) Describe the orientation of phenocrysts at **Locality 2** shown in **Figure 4c**. [2]

.....

.....

.....

(b) **Table 4** is a partly completed chi-squared test at **Locality 2**, used to test the null hypothesis (H_0) that 'there is no significant alignment of the phenocrysts'.

Phenocryst alignment in degrees (class)	Observed frequency (O)	Expected frequency (E)	(O–E)	$(O–E)^2$	$\frac{(O–E)^2}{E}$
000–029	11	10	1	1	0.1
030–059	7	10	–3	9	0.9
060–089	5	10	–5	25	2.5
090–119	6	10	–4	16	1.6
120–149	15	10	5	25	2.5
150–179	•	10	•	•	•
Total	60	60	chi-squared value		11.2

Table 4

(i) Using data from **Figure 4c** complete the blank cells for the 150°–179° class in. **Table 4** [2]

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(ii) **Figure 4d** is a chi-squared significance chart.

Degrees of Freedom	Probability										
	0.95	0.90	0.80	0.70	0.50	0.30	0.20	0.10	0.05	0.01	0.001
1	0.004	0.02	0.06	0.15	0.46	1.07	1.64	2.71	3.84	6.64	10.83
2	0.10	0.21	0.45	0.71	1.39	2.41	3.22	4.60	5.99	9.21	13.82
3	0.35	0.58	1.01	1.42	2.37	3.66	4.64	6.25	7.82	11.34	16.27
4	0.71	1.06	1.65	2.20	3.36	4.88	5.99	7.78	9.49	13.28	18.47
5	1.14	1.61	2.34	3.00	4.35	6.06	7.29	9.24	11.07	15.09	20.52
6	1.63	2.20	3.07	3.83	5.35	7.23	8.56	10.64	12.59	16.81	22.46
7	2.17	2.83	3.82	4.67	6.35	8.38	9.80	12.02	14.07	18.48	24.32
8	2.73	3.49	4.59	5.53	7.34	9.52	11.03	13.36	15.51	20.09	26.12
9	3.32	4.17	5.38	6.39	8.34	10.66	12.24	14.68	16.92	21.67	27.88
10	3.94	4.86	6.18	7.27	9.34	11.78	13.44	15.99	18.31	23.21	29.59
	Non-significant								Significant		

Degrees of freedom (df) = number of categories – 1

Figure 4d

Using the significance chart (**Figure 4d**) explain the reason why the chi-squared value of these data means the null hypothesis (H_0) can be rejected at the **95%** confidence level. [2]

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(c) At **Locality 1** on **Map 1** the chi-squared value was 1.14 and the null hypothesis was accepted.

With reference to the chi-squared data, suggest a geological explanation for orientation of the phenocrysts found at **Locality 1** and **Locality 2**. [3]

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5. Study **Specimen B** which is representative of **Rock Unit B** and **Specimen K** which shows a fossil found within **Rock Unit B**.

(a) Describe the texture and composition of **Specimen B**. [3]

.....

.....

.....

.....

(b) In the space below draw a diagram of **Specimen K**. Add a scale to your drawing. [4]

(c) Name the fossil group represented by **Specimen K**. Give a reason for your answer. [2]

Fossil group .....

Reason .....

.....

(d) A student suggested that, '**Rock Unit B** was deposited in a shallow, tropical, marine environment'. Evaluate this statement with reference to **Specimen B** and **Specimen K**. [4]

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(e) **Figure 5** shows a photomicrograph of a marine sandstone forming **Rock Unit E**.

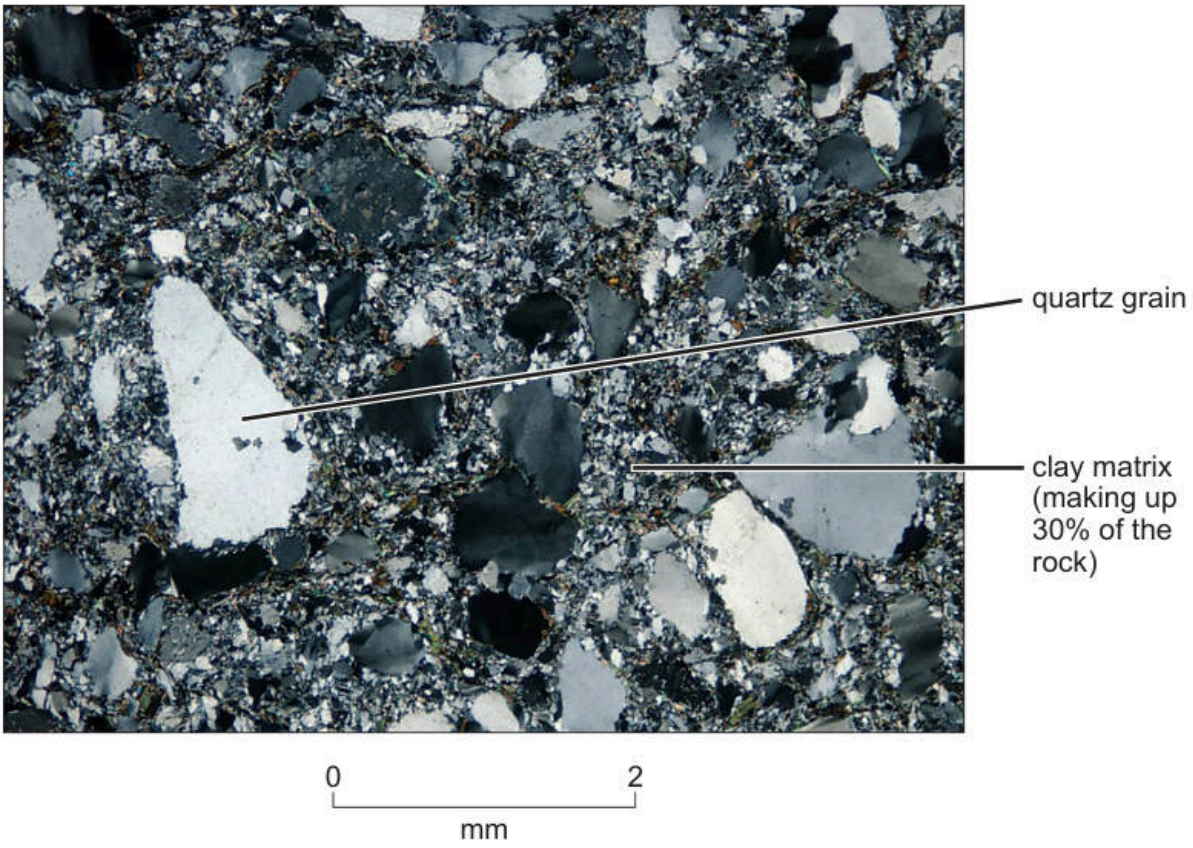


Figure 5

State, giving a reason, the type of sandstone represented by **Rock Unit E**. [2]

Type of sandstone .....

.....

Reason .....

.....

.....

15

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6. State and give reasons for the observations you would make in a **field investigation** to confirm the age relationships of the **Rock Units A**, **B**, **C** and **E** within the area of **box A** on **Map 1.**

You may wish to use an annotated diagram(s) in your answer. [9 QER]

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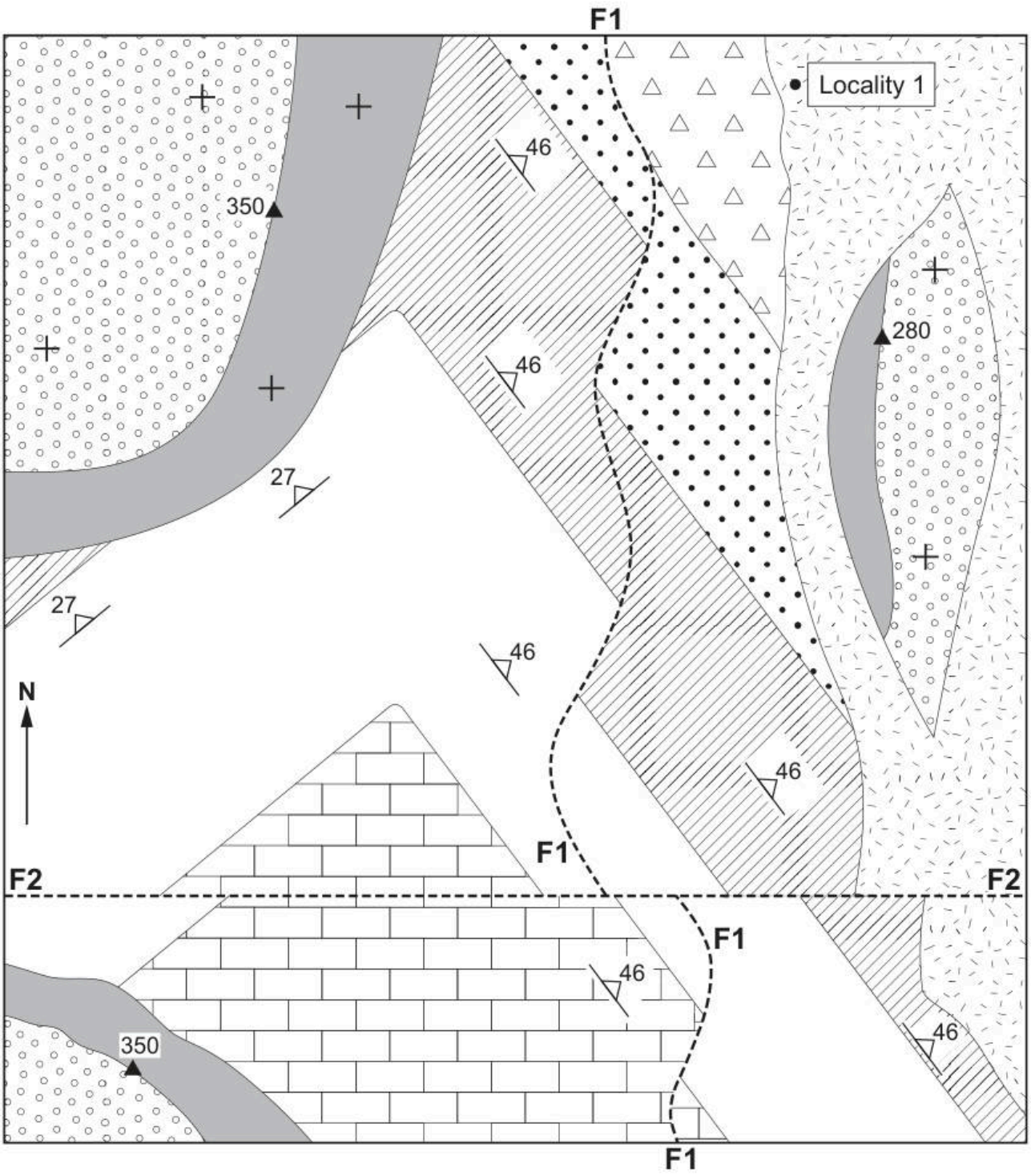
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7. **Map 2** shows an area of **Map 1**.



Map 2

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(a) Draw on **Map 2** the position of a fold axial plane trace to the north and south of **Fault F2**. Using symbols in the key, label your fold axial plane trace to show:

- the type of fold present
- the direction of plunge of the fold. [3]

(b) Label on **Map 2**, using an arrow labelled **U** (**U →**), the position of an unconformity to the **west** of **Fault F1**. [1]

(c) **Map 1** shows two faults, **F1** and **F2**.

(i) Complete **Table 5** to compare **Fault F1** and **Fault F2**. [4]

	Fault F1	Fault F2
Vertical displacement	•	0 m
Dip amount and dip direction of the fault plane	75° towards the west	•
Type of fault	•	•

Table 5

(ii) State the evidence for your choice of the type of fault for **Faults F1** and **F2**. [2]

Fault F1

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Fault F2

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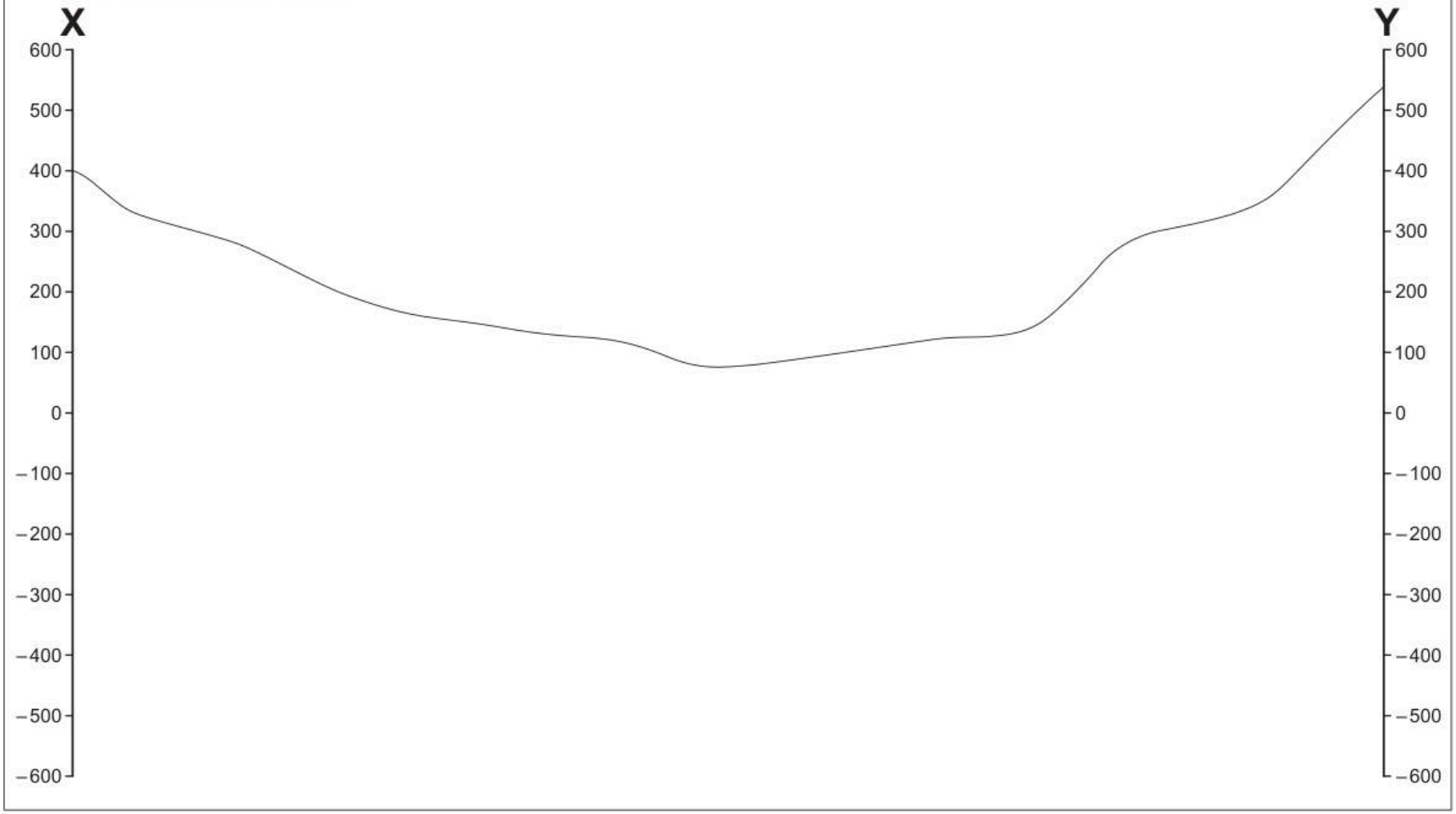
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8. The topographic profile below was taken along the line **X–Y** on **Map 1**.
Complete the geological cross-section along this line using **Map 1**.

- Draw the rock units. Use similar ornament or letters for those as used on **Map 1**.
- Draw and label any **fold axes**.
- Project the rock units and structures above the ground surface to illustrate any cross-cutting relationships. [13]

Metres relative to sea level



20

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9. A student concluded the following:

'The rocks on **Map 1:**

- have **all** been subjected to **three** episodes of deformation which
- occurred at different times
- with different types of stress
- acting in the same direction.'

Evaluate this conclusion with reference to the evidence shown on **Map 1**. [6 QER]

6

END OF PAPER

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Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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Acknowledgements

Figure 2b Getty images
Figure 4a J. Speed
Figure 5 https://www.earth.ox.ac.uk. Acknowledgement not found

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GCE A LEVEL

A480U10-1C

S23-A480U10-1C

MONDAY, 5 JUNE 2023 – MORNING

GEOLOGY – A Level component 1
Geological Investigations

INSTRUCTIONS FOR EXAMINATIONS OFFICERS

Examinations Officers may share this information with technicians and Geology teaching staff, upon receipt.

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Eduqas A Level Geology Component 1 (A480U10-1) is an examination involving the use of geological specimens, geological equipment, a Question Paper, a Resource Sheet, and a Mineral Data Sheet. For further information, see the relevant page in the Examinations Requirements booklet.

1. The Geological Specimens

These will be despatched to centres prior to the examination in a box or boxes.

In addition, you will receive one colour photograph sheet per candidate to confirm which letter relates to which specimen. The specimens themselves will not be labelled with a letter.

A member of the Geology Department must open the box(es) on receipt and check the contents to confirm that the correct number of specimens of each type is present as per the accompanying photographs. The opening and checking of the specimens must take place under secure conditions within the examinations office. Details of the contents must remain confidential.

Once the specimens have been checked, they and the accompanying photographs should be securely stored, as for the Question Paper, until the start of the examination.

The box(es) include labelled bags containing multiple examples of a specimen, for example, one bag containing 10 samples of specimen **A**, a second bag containing 10 samples of specimen **T**, etc.

Your centre will be allocated enough specimens to create one set of specimens per two candidates entered.

If you have not received the correct number of boxes/specimens you should immediately contact Matthew Roberts (geology@eduqas.co.uk).

2. The Geological Equipment

Each candidate will need to be issued with the following equipment for use in the examination. The equipment will need to be provided by the centre.

- hand lens
- streak plate/unglazed tile
- steel pin/needle, for example, biology dissection pin or steel nail (5.5 on Mohs Scale)
- copper coin
- dilute hydrochloric acid (0.5 M) and a means of adding it dropwise to a sample, for example, dropping bottle, teat pipette, etc.
- water and a means of adding it dropwise to a sample, for example, dropping bottle, teat pipette, etc.
- a strip of plain paper in order to assist with the construction of a geological cross-section.

Please note: only the materials indicated above are permitted for use by candidates and that sheets of glass or files/knives are not to be used for the determination of hardness.

It is recommended that spare equipment is made available at the front of the examination room in case of technical issues with equipment.

Candidates are not permitted to use their own geological equipment, only that which is provided by the centre.

3. The Question Paper, Resource Sheet and Mineral Data Sheet

These will be despatched by WJEC and must be kept in secure storage until the day of the examination, as with any other confidential assessment materials.

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4. Instructions for invigilators and/or technicians

These will be provided in the box with the specimens for use on the day of the examination. This document is now available to centres via the WJEC secure website under 'Today's Question Papers'.

5. Persons permitted to be present in the Examination Room

Geology teaching staff are **not** permitted in the exam room at the start of or during the examination. This represents a change from the legacy specification in which the GL2a was an NEA and was marked and externally moderated.

In addition to the invigilator(s), a science technician or other suitably qualified person must be in attendance throughout the examination in order to offer assistance with issues related to the functioning of geological equipment. This person is not an invigilator and must not count as one when determining numbers of invigilators required to conduct the examination.

6. The Examination Room and its layout

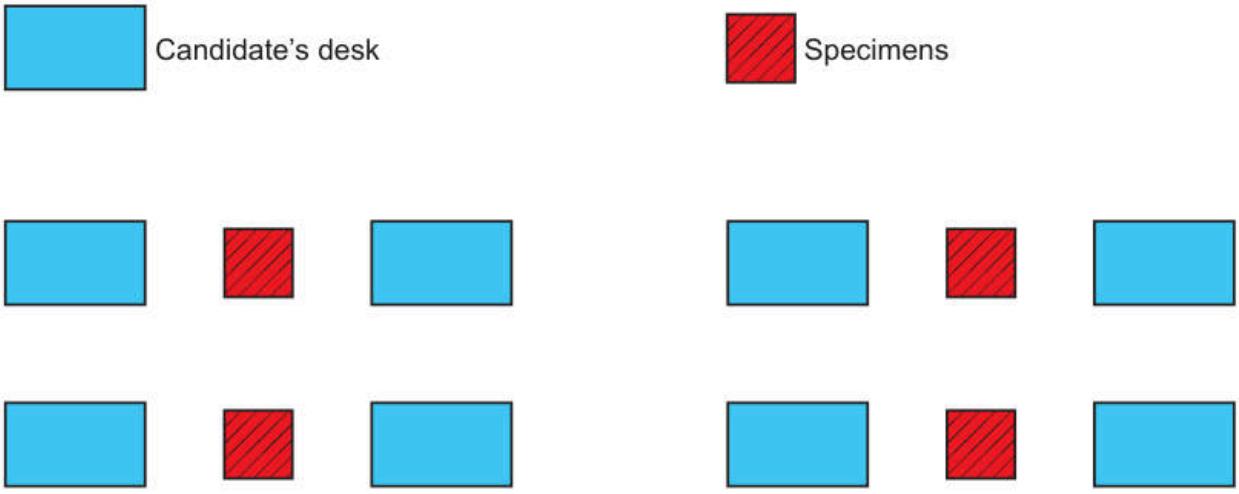
The use of geological specimens by candidates has the potential to disturb other candidates in an examination room. Consequently, this examination must take place in an examination room(s) not used by candidates sitting any other examination. This does not need to be a laboratory but can be any room which complies with the usual JCQ requirements of room suitability for an external examination.

Wall displays should be checked and managed to ensure that they do not contain information potentially relevant to the examination.

The requirements of this examination are such that each candidate must be provided with a desk at least **twice the size** of a standard examination desk.

Candidates must be able to easily access the set of specimens allocated to them in pairs. The specimens should be placed on a small desk or chair/stool between the pair of candidates' desks, such that they can be reached by candidates with the minimum of movement and disruption to other candidates. The layout of the examination room will need careful planning in this regard. An example layout is shown below.

Specimens must be between two candidates. The usual exam rules apply – i.e. that candidates must be a minimum of 1.25 m apart, but are likely to be further apart due to the specimens between them.



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7. Setting up the Examination Room

Prior to the examination commencing, the setting up of the examination room may take quite a long time, up to an hour or more depending on the number of candidates involved.

A geology teacher may be involved in the setting up of the examination room, but must not be present at the start or during the examination.

In addition to any movement of desks, chairs, etc. the following need to be undertaken:

(a) One of each of the listed **geological equipment** is to be placed on each desk.
(b) The geological specimens are to be distributed so that each set of specimens contains one of each specimen, for example, each set contains one specimen **A**, one specimen **B**, one specimen **T** etc. These must remain covered up until the start of the examination.
(c) The Question Paper, Resource Sheet, Mineral Data Sheet and Photographs of Specimens are to be distributed to each candidate.

Candidates must have access to normal drawing instruments, i.e. ruler, protractor, eraser, and a calculator.

A copy of the 'Instructions for candidates' for Eduqas A Level Geology Component 1 (A480U10-1) must be available for invigilators in the examination room.

8. Return of Specimens

As soon as possible after the examination, the individual specimens must be carefully packaged and returned in their original labelled bags and box(es). The specimen box(es) must be packed in the pre-addressed plastic sack and returned to WJEC using the Parcelforce postage label provided. Under no circumstances should postage and address labels be stuck directly onto the box(es). Please note that candidates' completed examination scripts must not be included in the specimen return. These must be despatched to examiners in the usual way, using the specific stationery supplied.

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GCE A LEVEL

A480U10-1D

S23-A480U10-1D

MONDAY, 5 JUNE 2023 – MORNING

GEOLOGY – A level component 1
Geological Investigations

INSTRUCTIONS FOR TECHNICIANS AND INVIGILATORS

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A) Prior to the start of the examination, in addition to all other examination requirements, invigilators must:

1. Familiarise themselves with 'Instructions for candidates' provided to the Examinations Officer.

2. Remind candidates that they have previously been given instructions related to this examination.

3. Inform candidates that they will be sharing a set of geological specimens with another candidate.

4. Indicate to each candidate which set of specimens they have been allocated.

5. Inform candidates that having handled geological specimens, they should wash their hands after the examination.

6. Inform candidates that they must not communicate with other candidates. Candidates must access their allocated set of specimens with the minimum of movement or disturbance to other candidates.

7. Inform candidates that a technician is available in the room to offer assistance with issues related to the specimens and the functioning of geological equipment only.

Just before the start of the examination, the technician/invigilators should uncover each set of specimens.

B) During the examination

The technician must stay in the examination room for the duration of the examination. The role of the technician is **only** to handle any issues related to the functioning of the geological equipment, e.g. a dropper bottle not working properly, a "cloudy" hand lens. Use of spare equipment may be necessary.

Specimens: Invigilators and/or the technician should check that candidates have not forgotten to return the specimens that they have finished using. If a candidate has a specimen(s) that they are not using on their desk, the invigilator/technician should check that the candidate has finished with it and return the specimen where the other candidate of the pair can access it.

In extenuating circumstances, the technician may need to facilitate a candidate being able to view an alternative specimen. In such circumstances the candidate should relinquish their specimen e.g. specimen A, for it to be swapped for a different specimen A which is not being used elsewhere in the room.

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GCE A LEVEL

A480U10-1P

S23-A480U10-1P

MONDAY, 5 JUNE 2023 – MORNING

GEOLOGY – A level component 1
Geological Investigations

PHOTOGRAPHS OF SPECIMENS

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Specimen B



Specimen C



Specimen K

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