Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

C480UA0-1

S23-C480UA0-1

MONDAY, 15 MAY 2023 – AFTERNOON

GEOLOGY – Component 1

Geological Principles (Paper version of on-screen assessment)

1 hour 15 minutes

For Examiner's Use Only		
Question	Maximum Mark	Mark Awarded
1.(a)(i)	**2**	
1.(a)(ii)	**2**	
1.(a)(iii)	**2**	
1.(a)(iv)	**1**	
1.(b)(i)	**1**	
1.(b)(ii)	**1**	
1.(c)	**4**	
2.(a)(i)	**1**	
2.(a)(ii)	**2**	
2.(a)(iii)	**3**	
2.(b)	**1**	
2.(c)	**2**	
2.(d)	**2**	
2.(e)	**4**	
3.(a)(i)	**1**	
3.(a)(ii)	**2**	
3.(b)(i)	**2**	
3.(b)(ii)	**2**	
3.(b)(iii)	**6**	
4.(a)(i)	**1**	
4.(a)(ii)	**1**	
4.(a)(iii)	**2**	
4.(a)(iv)	**2**	
4.(b)	**2**	
4.(c)	**3**	
5.(a)(i)	**4**	
5.(a)(ii)	**2**	
5.(a)(iii)	**2**	
5.(a)(iv)	**2**	
5.(b)	**6**	
6.(a)(i)	**2**	
6.(a)(ii)	**1**	
6.(b)(i)	**1**	
6.(b)(ii)	**1**	
6.(b)(iii)	**2**	
6.(b)(iv)	**1**	
6.(c)	**4**	
Total	**80**	

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ADDITIONAL MATERIALS

In addition to this examination paper you will need:

- the Data Sheet
- a calculator
- a ruler.

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.

INFORMATION FOR CANDIDATES

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 **3** and **5**.

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Answer **all** questions.

1. **Figure 1a** shows a rock outcrop on the west coast of Portugal.

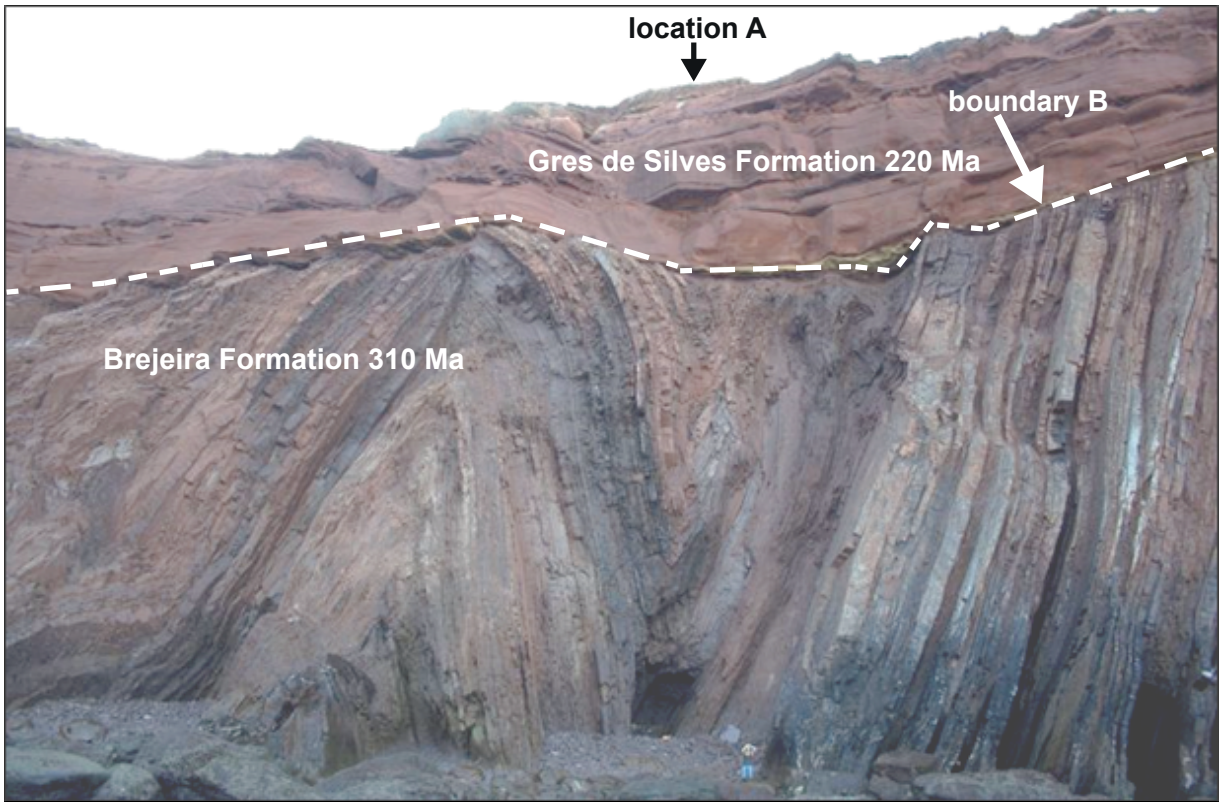

Figure 1a

Refer to **Figure 1a**.

(a) (i) Using **Figure 1a**:

- Estimate the height of the cliff at location **A**
- Calculate the time gap in millions of years (Ma) between the Brejeira Formation and the Gres de Silves Formation. [2]

Height of cliff ..... metres

Time gap: ..... Ma

(ii) Using the Data Sheet, state the geological **era** to which the Gres de Silves Formation belongs and the geological **period** to which the Brejeira Formation belongs. [2]

Gres de Silves Formation: ..... era

Brejeira Formation: ..... period

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(iii) State the geological processes that must have taken place between the deposition of the Brejeira Formation and the Gres de Silves Formation. [2]

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.....

(iv) State the most appropriate name for boundary **B**. Tick (✓) only **one** box. [1]

baked margin ☐ fault ☐ joint ☐ lamination ☐ unconformity ☐

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Figure 1b

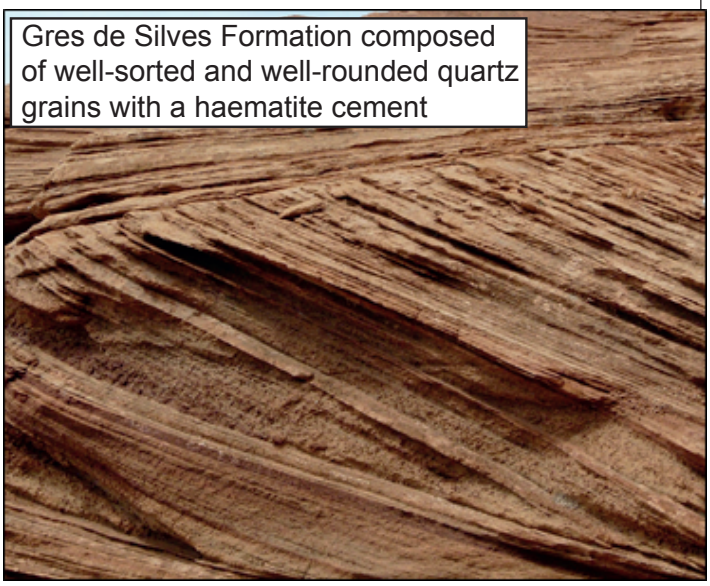

Figure 1c

(b) **Figure 1b** and **Figure 1c** show typical sedimentary structures found in the rocks of the Brejeira Formation and Gres de Silves Formation.

(i) State the name of the sedimentary structures shown in **Figure 1b** and **Figure 1c**. Tick (✓) only **one** box. [1]

desiccation cracks and laminations ☐

graded bedding and cross bedding ☐

ripple marks and graded bedding ☐

cross bedding and trace fossils ☐

bedding planes and ripple marks ☐

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(ii) State the name of the rock types shown in **Figure 1b** and **Figure 1c**.
Tick (✓) only **one** box. [1]

breccia and black shale ☐

conglomerate and limestone ☐

turbidite and desert sandstone ☐

tillite and gypsum ☐

coal and halite ☐

(c) Refer to **Figure 1b** and **Figure 1c**.

Describe the most likely environments of deposition of the Brejeira Formation and the Gres de Silves Formation. [4]

Brejeira Formation .....

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Gres de Silves Formation .....

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2. **Figure 2** shows the plate tectonic setting of Montserrat in the Caribbean and the variation in heat flow across the region.

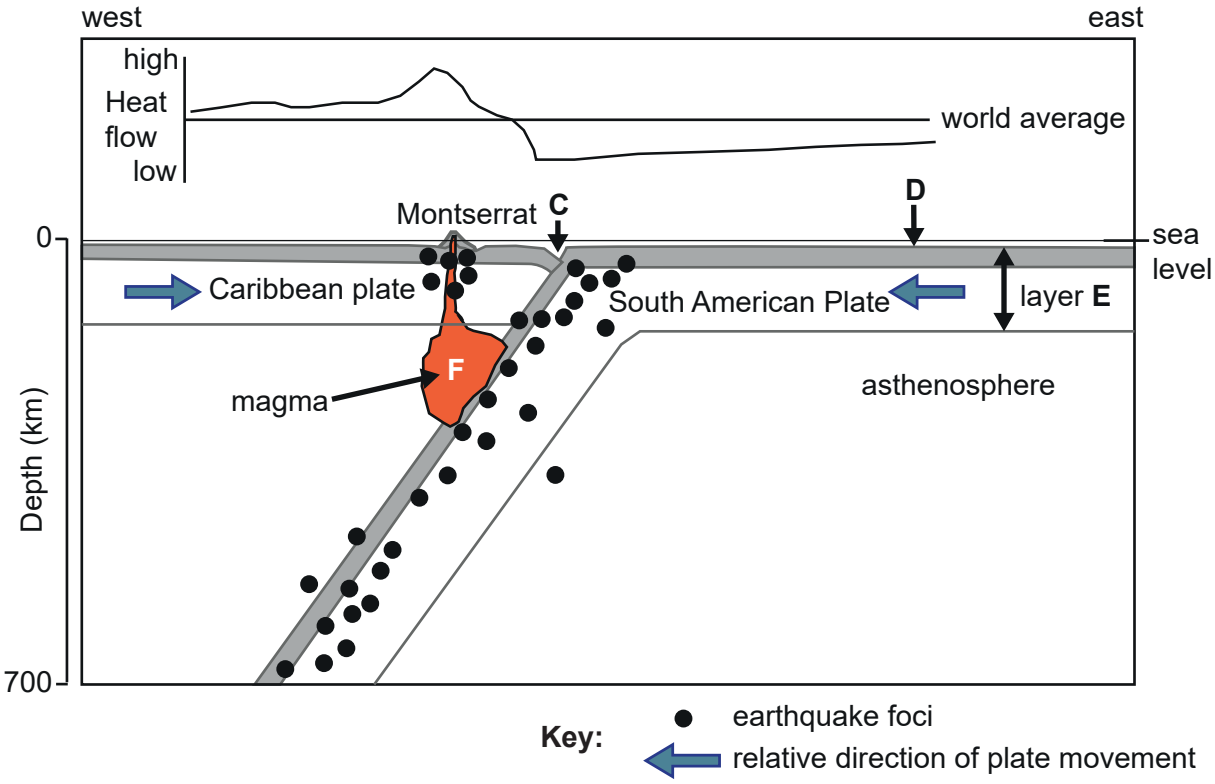

Figure 2

(a) Refer to **Figure 2**.

(i) State the type of plate boundary shown. Tick (✓) only **one** box. [1]

conservative ☐

convergent oceanic-continental ☐

divergent ☐

convergent oceanic-oceanic ☐

convergent continental-continental ☐

(ii) Identify features labelled **C** and **D**. Choose **two** from the following options. [2]

transform fault meteorite impact crater rift valley

abyssal plain fold mountains ocean trench

C ..... **D** .....

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(iii) Refer to layer **E**.

- State the name of layer **E**
- State which **two** of the statements in the list below are **correct** regarding layer **E**. [3]

Name of layer **E**

.....

Tick (✓) only **two** boxes.

comprises oceanic crust and upper mantle ☐

it is relatively hot, weak and ductile ☐

comprises continental crust and upper mantle ☐

it is cool, rigid and brittle ☐

its maximum thickness is 35 km ☐

earthquakes rarely occur in this layer ☐

(b) State which **one** of the following statements best accounts for the formation of andesitic magma at location **F**. Tick (✓) only **one** box. [1]

boiling of seawater in the subduction zone ☐

partial melting of the oceanic crust and overlying mantle ☐

complete melting of the mantle due to increased pressure ☐

intense earthquake activity resulting in frictional melting of mantle rock ☐

high levels of radioactive minerals in the core causing melting here ☐

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(c) Describe **one** possible mechanism that may drive plate movement. [2]

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(d) State which **two** of the following statements are **false** regarding the earthquake epicentres shown on **Figure 2**. [2]

the earthquake foci range in depth from approximately 5 km to 680 km	
there is a cluster of shallow foci earthquakes below Montserrat	
there are no earthquake foci in the asthenosphere	
the majority of earthquake foci occur in the upper part of the South American plate	
subduction related earthquake foci increase in depth from west to east	
some earthquakes occur in the oceanic crust	

(e) With reference to the heat flow graph in **Figure 2**, describe and explain the difference in heat flow over Montserrat and location **C**. [4]

Description .....

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Explanation .....

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3. **Figure 3a** shows the tsunami travel times in hours for the Valdivia earthquake that occurred in Chile on May 22nd 1960.

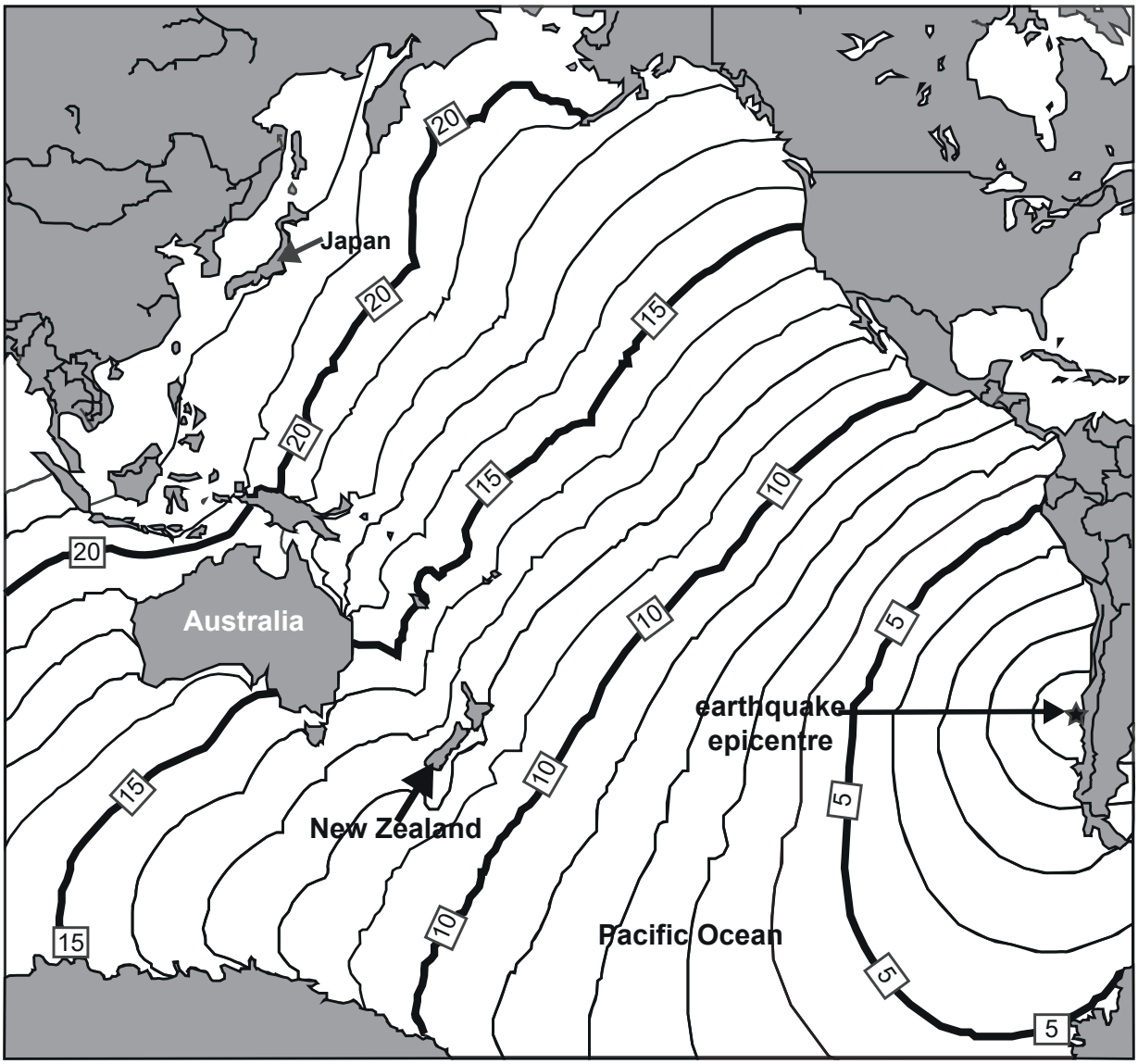

Figure 3a

(a) Refer to **Figure 3a**.

(i) State how long it took a tsunami wave to reach New Zealand. [1]

..... hours

(ii) Japan is 17,320 km from the earthquake epicentre. Calculate the mean speed of the tsunami reaching Japan across the Pacific Ocean. Show your working. [2]

..... km hr^{-1}

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(b) **Figure 3b** shows two types of faults associated with the generation of submarine earthquakes.

Table 1 compares the 1960 Chilean event in the Pacific Ocean with two events in the Indian Ocean in 2004 and 2012.

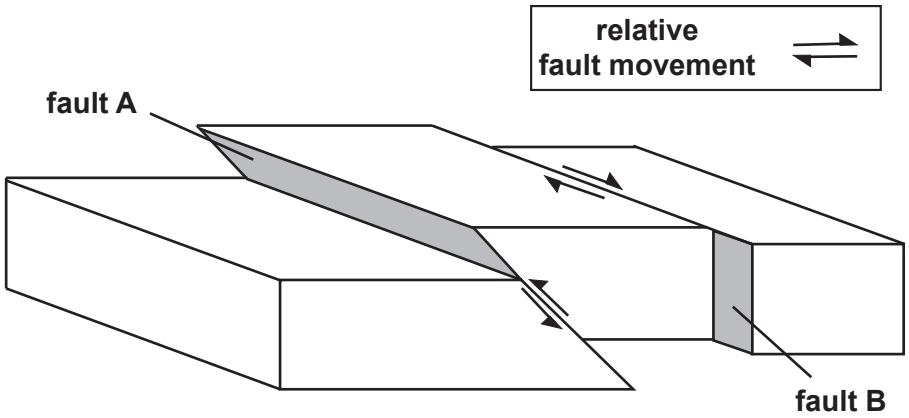

Figure 3b

Date of earthquake	Magnitude	Depth of focus (km)	Distance of epicentre from shore (km)	Tsunami wave height (m)	Worldwide deaths and damage due to tsunami	Fault type
Chile 1960	9.5	33	160	30	1655 killed, widespread damage	**A**
Indonesia 2004	9.0	30	160	30	227,898 killed, widespread damage	**A**
Indonesia 2012	8.6	33	640	0	No reported injury or damage	**B**

Table 1

(i) State the types of fault represented by fault **A** and fault **B** in **Figure 3b**. [2]

A .....

B .....

(ii) With reference to **Figure 3b**, explain why movement along fault type **B** in 2012 in Indonesia failed to generate a life-threatening tsunami. [2]

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(iii) Refer to **Table 1**.

- Compare the characteristics of the Chilean event of 1960 with the Indonesian event of 2004.
- Suggest reasons to explain the significant difference in the numbers of deaths. [6 QER]

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4. **Figure 4** is a geological cross-section showing the route of the Channel Tunnel between England and France.

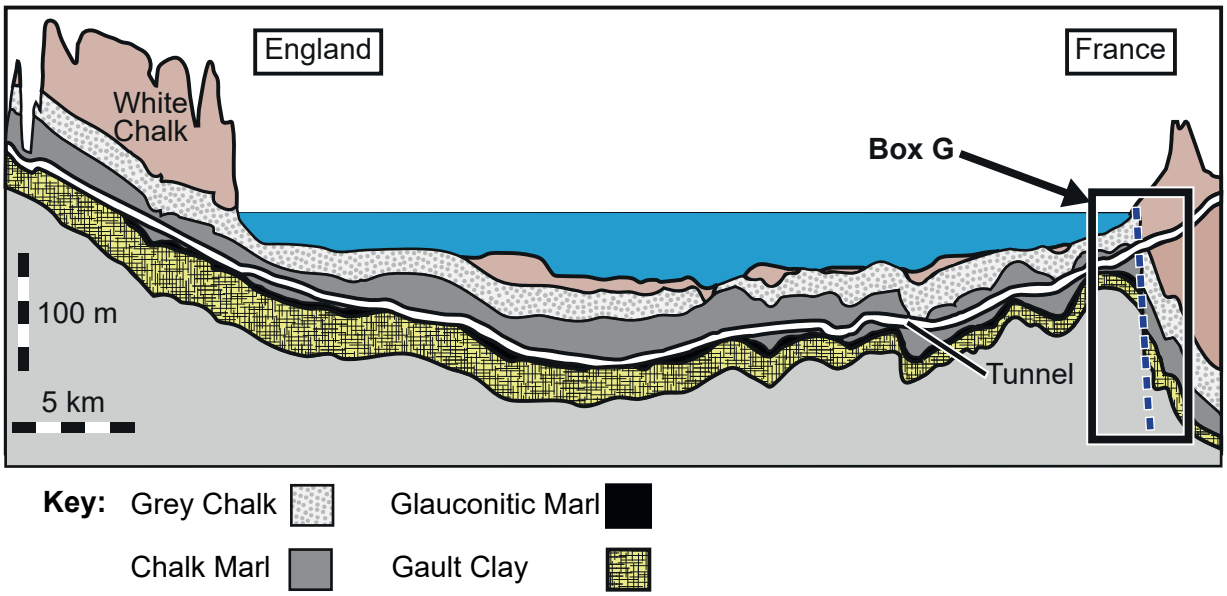

Figure 4

(a) Refer to **Figure 4**.

(i) State the name of the geological structure through which most of the Channel Tunnel is built. Tick (✓) only **one** box. [1]

antiform ☐

horizontal beds ☐

strike-slip fault ☐

synform ☐

unconformity ☐

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(ii) State the name of the rock through which most of the Channel Tunnel was constructed. Tick (✓) only **one** box. [1]

Gault Clay ☐

Grey Chalk ☐

Glauconitic Marl ☐

White Chalk ☐

Chalk Marl ☐

(iii) State which **two** rock properties would result in the most stable conditions for the construction of the Channel Tunnel. Tick (✓) only **two** boxes. [2]

high fossil content ☐

impermeable ☐

well jointed ☐

high porosity ☐

absence of faults and bedding planes ☐

strong foliation ☐

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(iv) State the **two** survey methods most likely to have been used to plan the route of the Channel Tunnel. Tick (✓) only **two** boxes. [2]

geochemical soil analysis	☐
ground penetrating radar	☐
seismic survey	☐
magnetic survey	☐
geological mapping	☐
geochemical river sediment analysis	☐

(b) The total length of the Channel Tunnel is 50 450 metres and cost £9×10^9 to construct.

Calculate the average building cost per metre length of the tunnel. Show your working. [2]

£ ..... per metre length of tunnel

(c) Refer to **Box G** on **Figure 4** where the cost of building the tunnel was affected by geological problems.

Describe and explain potential geological problems that could affect the tunnel in this area. [3]

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5. **Figures 5a**, **5b**, **5c** and **5d** show four different fossils that are useful to geologists.

Figure 5a

Figure 5b

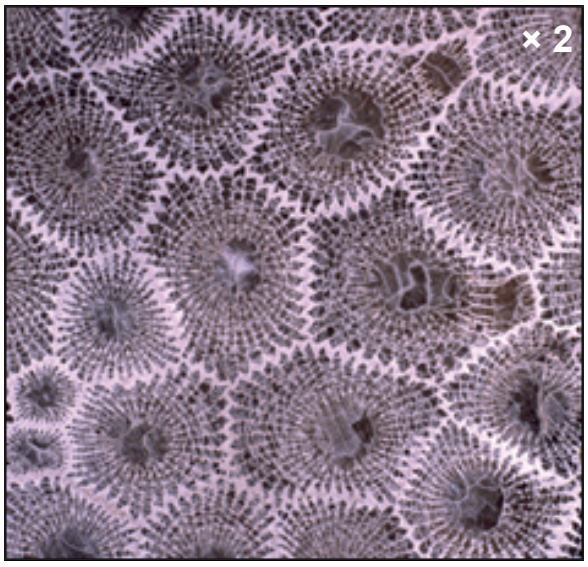

Figure 5c

Figure 5d

Examiner only

(a) Refer to **Figures 5a**, **5b**, **5c** and **5d**.

(i) Draw a line from each of the figures listed on the left to its correct description on the right. [4]

Figure 5a	a trace fossil
Figure 5b	a graptolite from the Silurian
Figure 5c	a fossil from the Burgess Shale
Figure 5d	a fossil of an early hominid
	the best indicator of a warm, shallow, marine environment
	the missing link between reptiles and birds
	disarticulated dinosaur bones

(ii) State the actual size (maximum length) of the fossil shown in **Figure 5a** to the nearest mm. [2]
Show your working.

..... mm

(iii) The fossil shown in **Figure 5a** shows exceptional preservation. State which **two** factors would **not** lead to exceptional preservation of organisms.
Tick (✓) only **two** boxes. [2]

- rapid burial after death of the organism ☐
- a shallow river environment ☐
- covered by very fine sediment ☐
- preservation with no transport after death of the organism ☐
- a deep water, marine environment ☐
- regional metamorphism ☐

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(iv) Explain why fossils such as those seen in **Figure 5b** greatly outnumber those shown in **Figure 5d** in the fossil record. [2]

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(b) The fossil record is largely complete and biased in favour of marine organisms. Evaluate the accuracy of this statement. [6 QER]

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6. **Figure 6a** is a cliff section showing the true dip of the beds.

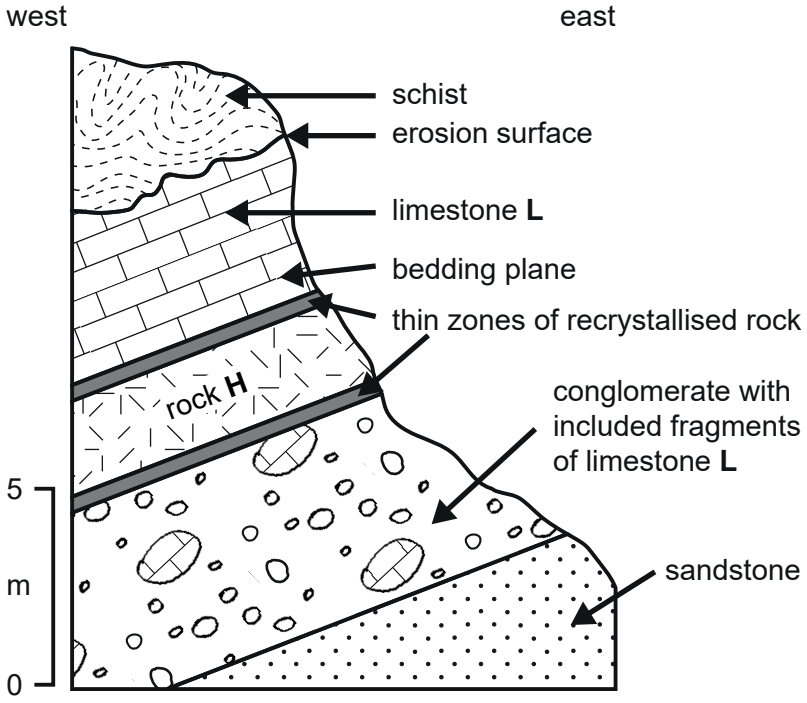

Figure 6a

(a) Refer to **Figure 6a**.

(i) State the dip direction and strike direction of the labelled bedding plane. [2]

dip direction ..... strike direction .....

(ii) State which rock type is likely to occur in the zone of recrystallised rock in limestone **L**. [1]
Tick (✓) only **one** box.

slate ☐ metaquartzite ☐ marble ☐ schist ☐ andesite ☐

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(b) **Figure 6b** shows a microscope view of rock **H** from **Figure 6a**.

Table 2 shows the mineral composition of rock **H**.

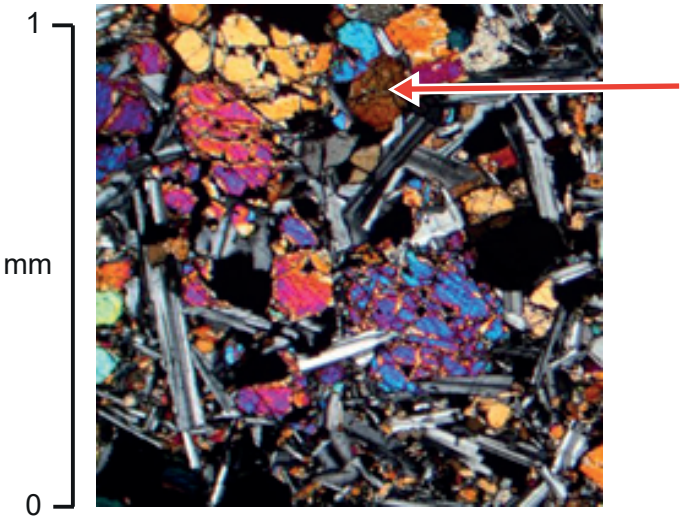

Figure 6b

mineral	% of rock H
feldspar	45
augite	39
olivine	12
mineral **J**	

Table 2

Refer to **Figure 6a**, **Figure 6b** and **Table 2**.

(i) Calculate the percentage of mineral **J** in rock **H**. [1]

..... %

(ii) State the name of mineral **J** in rock **H**. You may wish to refer to the Data Sheet. [1]

Name of mineral **J** .....

(iii) State which **two** statements are **correct** regarding the texture of rock **H**. [2]
Tick (✓) only **two** boxes.

- it has coarse crystals ☐
- it is equicrystalline ☐
- it has formed by two stages of cooling ☐
- it has formed by very slow cooling ☐
- it has fine crystals ☐
- it shows porphyritic texture ☐

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(iv) State the name of rock **H**. Tick (✓) only **one** box. [1]

peridotite ☐ granite ☐ andesite ☐ schist ☐ basalt ☐

(c) A student stated:

- rock unit **H** is a dyke
- the rock sequence is overturned.

Using evidence from **Figure 6a** and **Figure 6b**, evaluate the accuracy of the student's statements. [4]

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END OF PAPER

Acknowledgements:

Figure 1b. https://www.flickr.com/photos/jsjgeology/40920536724/in/photostream/

Figure 1c. https://www.flickr.com/photos/molas/512219839

Figure 3a. http://mapsof.net/chile/tsunami-travel-time-valdivia-1960

Figure 4. https://en.wikipedia.org/wiki/Channel_Tunnel#/media/File:Channel_Tunnel_geological_profile_1.svg

Figure 5a. http://www.fossilmall.com/EDCOPE_Enterprises/

Figure 5b. https://www.telegraph.co.uk/news/worldnews/europe/germany/11812098/

Figure 5c. http://www.geosci.usyd.edu.au/users/prey/FieldTrips/Yass04/

Figure 5d. https://www.britannica.com/science/fossil

Figure 6b. https://www.alexstrekeisen.it/english/

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

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