Surname	Centre Number	Candidate Number
Other Names		2

GCE A Level

1214/01

S17-1214-01

GEOLOGY – GL4
Interpreting the Geological Record

TUESDAY, 6 JUNE 2017 – AFTERNOON

2 hours

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	**15**	
	2.	**15**	
	3.	**15**	
	4.	**15**	
Section B	**5.**	**9**	
	6.	**7**	
	7.	**13**	
	8.	**11**	
	Total	**100**	

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ADDITIONAL MATERIALS

- the Geological Map Extract (Settle);
- a hand-lens or magnifier to study the map (optional);
- a calculator;
- a protractor.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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 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.

Candidates are reminded that marking will take into account the quality of communication used in their answers.

Examiner only

SECTION A

Answer **all** *questions in the spaces provided.*

This section should take approximately 1 hour to complete.

1. **Figure 1a** shows the mineralogy and texture of Shap granite.

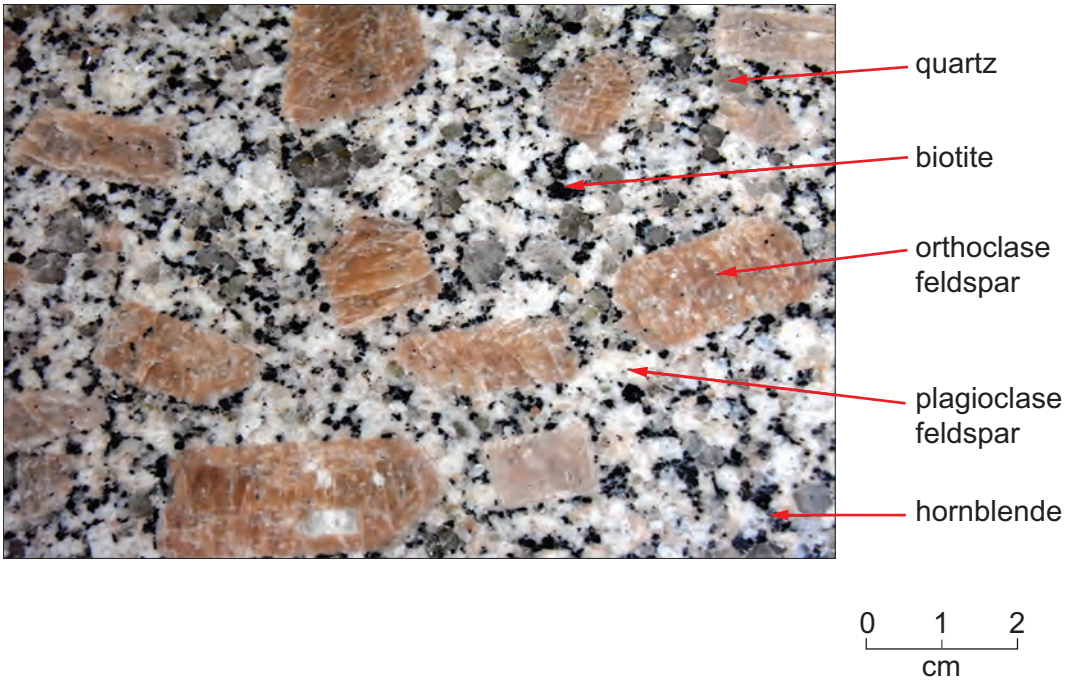

Figure 1a

(a) Refer to **Figure 1a**.

(i) State **two** reasons why this rock is correctly identified as a *granite*. [2]

1. .....

2. .....

(ii) Explain the evidence from **Figure 1a** which might suggest that Shap granite formed by a process of *two stages of cooling*. [4]

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(b) **Figure 1b** is a phase diagram showing the results of experiments to determine crystallisation temperatures for minerals in a granitic magma at different pressures.

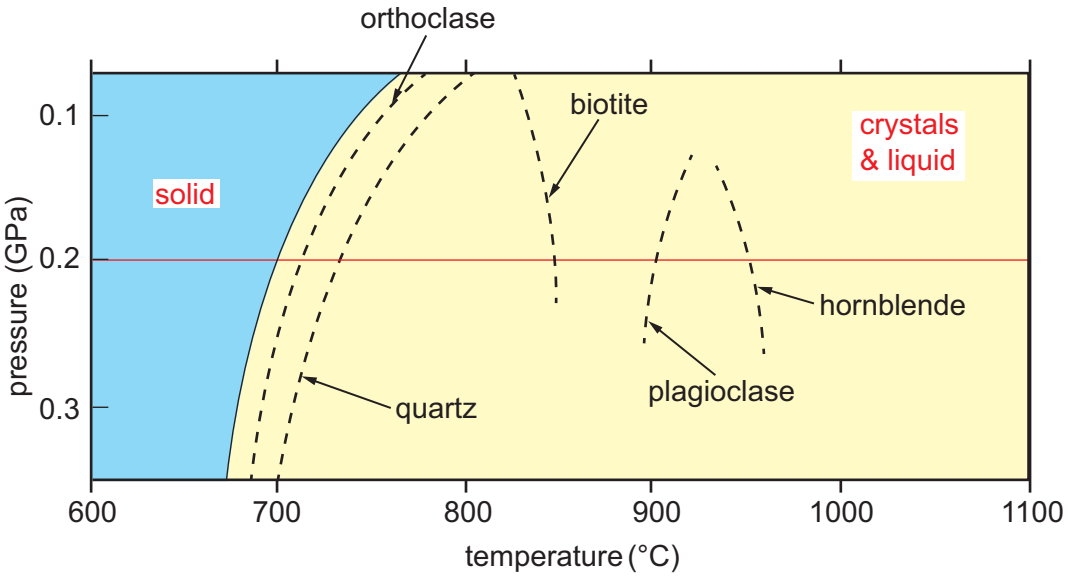

Figure 1b

Refer to **Figure 1b**.

(i) Complete **Table 1** to show the order of crystallisation of minerals from the magma at a pressure of 0.2 GPa. [4]

order of crystallisation	minerals crystallising (at 0.2 GPa)	crystallising temperature (°C) (at 0.2 GPa)
first to crystallise	•	•
	•	845
last to crystallise	orthoclase feldspar	•

Table 1

(ii) Describe the effects of pressure on the crystallisation temperatures of the minerals in **Figure 1b**. [2]

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(c) Explain how the experimental data (**Figure 1b**) conflicts with the evidence for the order of crystallisation of the minerals in Shap granite (**Figure 1a**). [3]

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2. **Figure 2a** shows a skeleton of the bird-hipped dinosaur, *Stegosaurus*. **Figure 2b** shows details of the skull of *Stegosaurus*.

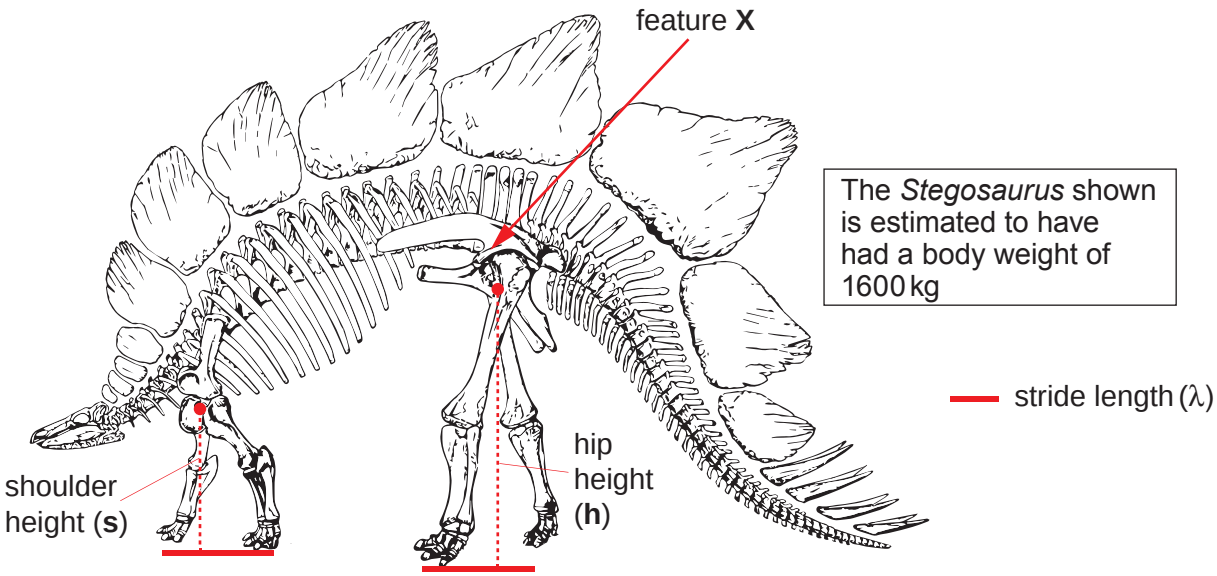

Figure 2a

Figure 2b

Examiner only

(a) Complete **Table 2a** by stating the level of classification (order, phylum or species) represented by the term *ornithischian*. [1]

Classification level	Classification
Class	Reptile
	ORNITHISCHIAN (bird-hipped)
Family	Stegosaurid
Genus	*Stegosaurus*

Table 2a

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

(i) Name the morphological feature **X** and suggest its function. [2]

feature **X** .....

function .....

(ii) Explain how the morphological features of the *Stegosaurus* skeleton suggests it was **unlikely** to have been a carnivorous predator. [4]

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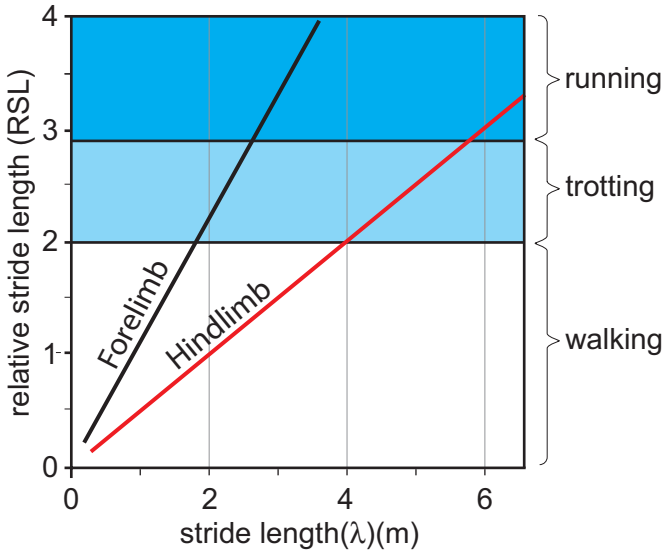
(c) **Figure 2c** shows how the stride length and **relative** stride length of the forelimbs and hindlimbs of *Stegosaurus* (**Figure 2a**) can be used to determine the dinosaur's gait (i.e. whether it walked, trotted or ran).



Stride length (λ) = the distance travelled by a forelimb or hindlimb during each stride.

Relative stride length (RSL) = the stride length (λ) relative to the shoulder or hip height ($\frac{\lambda}{\mathbf{s}}$ **or** $\frac{\lambda}{\mathbf{h}}$).

Running involves all 4 limbs being in the air at the same time.

Figure 2c

Refer to **Figure 2a** and **Figure 2c**.

(i) Using **Figure 2c**, complete **Table 2b** by inserting the appropriate relative stride length and gaits. [3]

Stride length (λ) of forelimb and hindlimb (m)	Relative stride length of limbs (RSL)		gait (walking, trotting or running)
	forelimb ($\frac{\lambda}{\mathbf{s}}$)	hindlimb ($\frac{\lambda}{\mathbf{h}}$)	
1	1.1		walking
		•	walking
2	2.2		•
		1.0	walking
3	3.3		•
		1.5	walking

Table 2b

Examiner only

(ii) Using the data in **Table 2b**, complete **Table 2c** below by calculating the shoulder height (**s**) for *Stegosaurus* from the formula;

[Relative stride length (RSL) = $\frac{\lambda}{\mathbf{s}}$]

Show your working. [2]

shoulder height (**s**)	Working: ..... m

Table 2c

(iii) Explain why the data (**Figure 2a**, **Figure 2c** and **Table 2b**) might suggest that *Stegosaurus* was unable to run fast. [3]

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3. **Figure 3a** is a partially completed geological map of an area of folded strata.

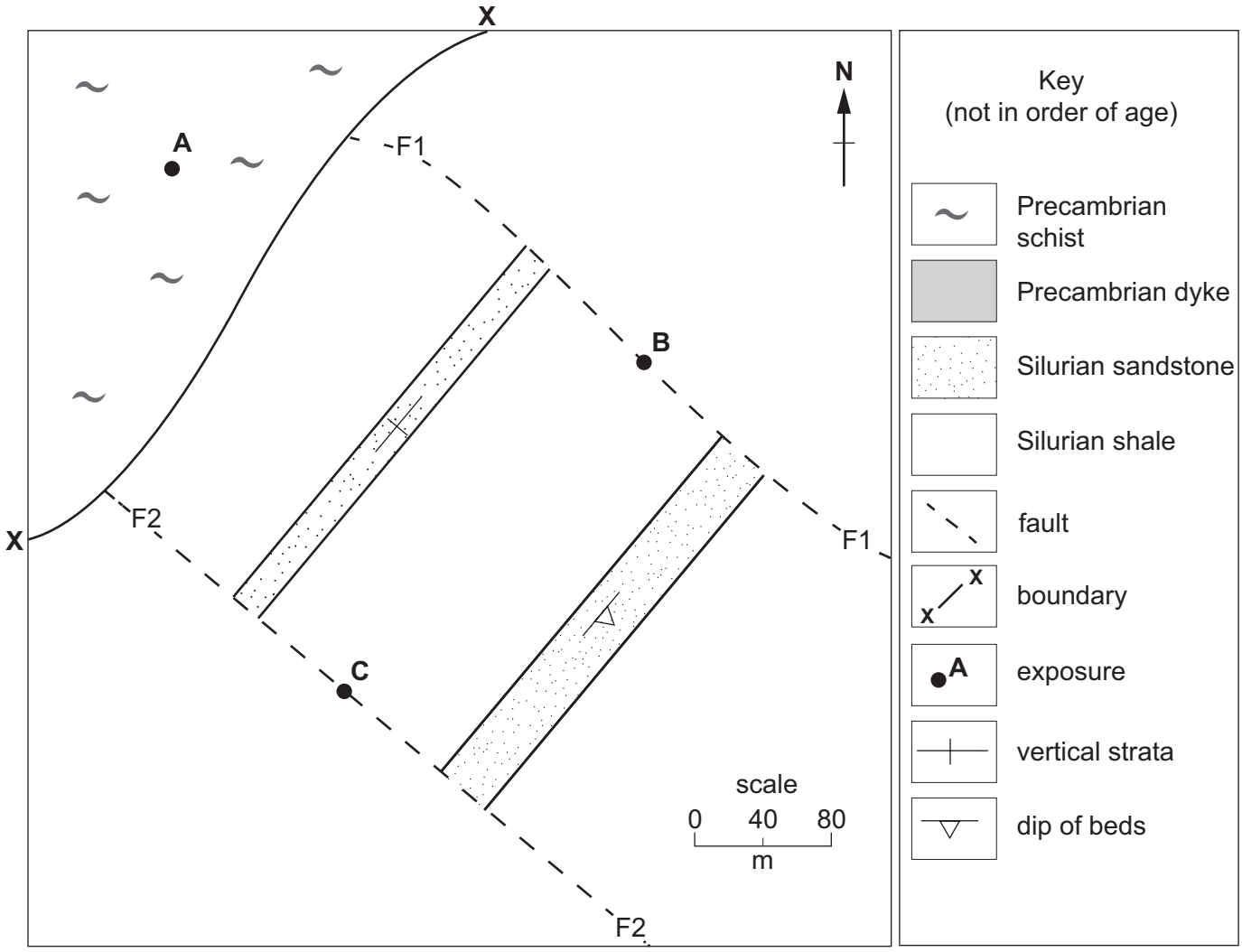

Figure 3a

exposure	description
A	20 m wide, NW-SE trending dyke of Precambrian age.
B	NW-SE normal fault (F1) dipping 75 degrees to SW. The Silurian sandstone outcrop on the southern limb of the anticline is offset by 40 m.
C	NW-SE vertical strike-slip fault (F2) formed as a result of the direction of the principal stress, σ **max**, from west – east. The Silurian sandstone outcrop on the southern limb of the anticline is offset by 40 m.

Table 3

Examiner only

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

(i) Suggest a reason for the difference in the width of outcrop of the Silurian sandstone on the limbs of the anticline. [1]

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(ii) State the true thickness of the Silurian sandstone. [1]

Thickness ..... m

(b) Refer to **Table 3**. Using the appropriate shading from the key, complete **Figure 3a** by marking on:

1. the Precambrian dyke
2. the Silurian sandstone outcrops NE of F1
3. the Silurian sandstone outcrops SW of F2 [6]

(c) The following rock description of the schist in **Figure 3a** was recorded in the field.

"... a garnet-mica schist showing 5mm euhedral garnet porphyroblasts surrounded by finer crystals of mica."

Draw a **scaled**, **labelled** diagram of the schist, in **Figure 3b**, to illustrate the main mineralogical and textural features described. [4]

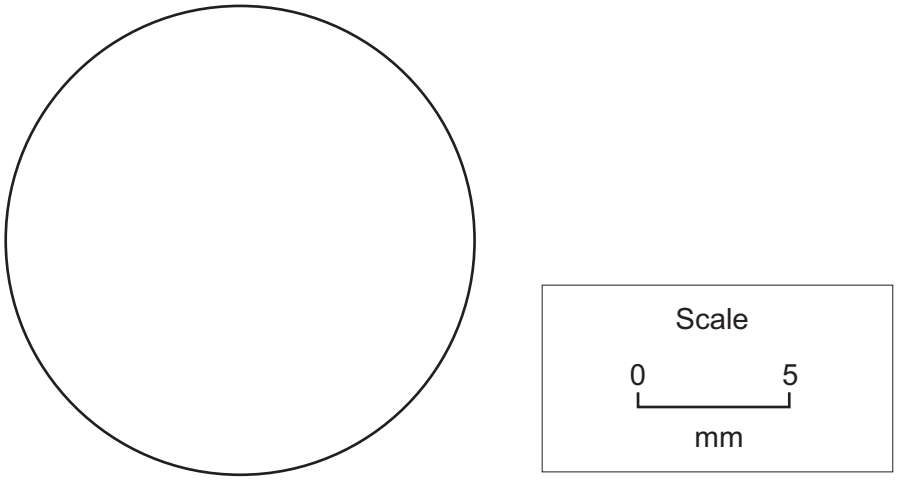

Figure 3b

(d) A student suggested the boundary labelled **X-X** on **Figure 3a** was an angular unconformity. Critically evaluate this statement, explaining the **evidence** for your conclusions. [3]

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4. **Figure 4a** shows the change in mean global temperature through geological time. **Figure 4b** is a palaeogeographic reconstruction of the distribution of continents in the late Carboniferous.

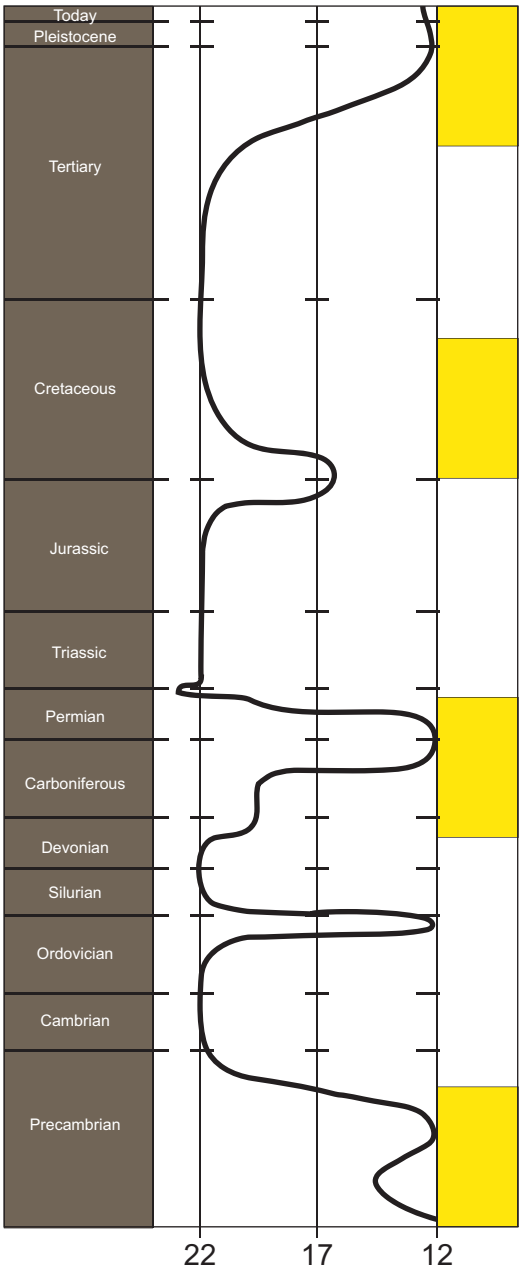

Figure 4a

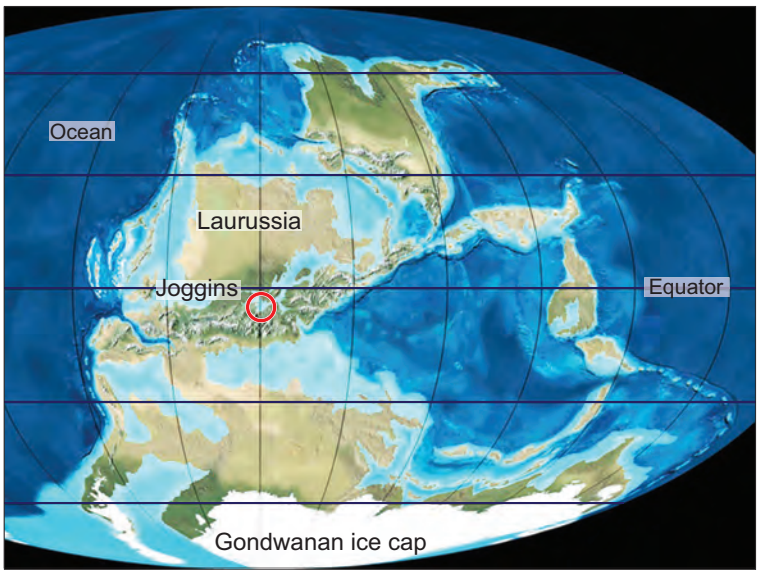

Figure 4b

Refer to **Figure 4a** and **Figure 4b**.

(a) (i) On **Figure 4a** mark **one** box (coloured yellow) with the letter **G**, to indicate a time when the Earth experienced a *greenhouse* climate. [1]

(ii) On **Figure 4a** mark **one** box (coloured yellow) with the letter **S**, to indicate the time when it is suggested the Earth experienced a *Snowball Earth* event. [1]

Examiner only

(b) (i) Using **Figure 4b**, explain how the distribution of oceans and continents in the late Carboniferous may have influenced whether ice developed at the North or South poles. [4]

North Pole .....

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South Pole .....

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(ii) Using your knowledge, describe and explain **one** other mechanism that might account for fluctuations in global temperature in the geological past. [3]

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(c) **Figure 4c** is a photograph of a cliff section at Joggins, Nova Scotia (shown on **Figure 4b**), showing a late Carboniferous plant in life position. This section is interpreted as representing a flood plain deposit within a tropical rainforest.

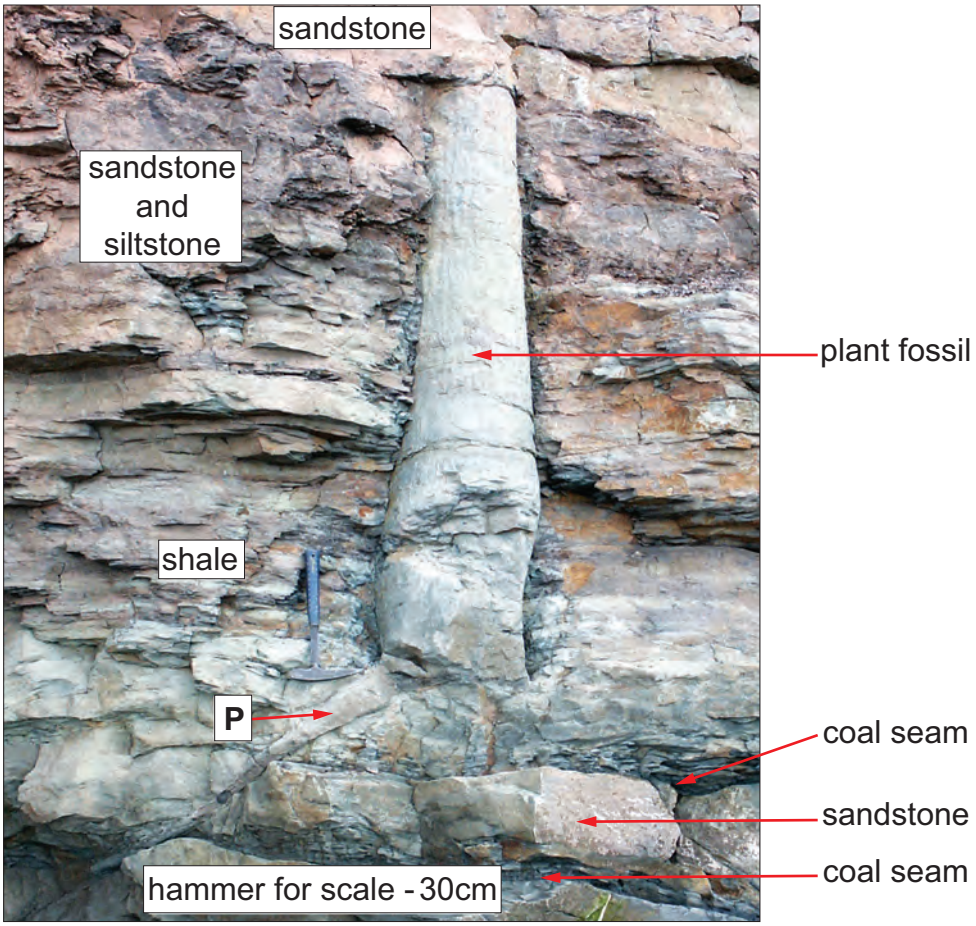

Figure 4c

(i) Identify the fossil part labelled **P**. [1]

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(ii) Explain the evidence from **Figure 4c only** to suggest these deposits were deposited
- fairly quickly
- within the tropics
- in a fluvial environment. [3]

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(d) Explain why the Carboniferous period is described as having an *icehouse* climate when the evidence from areas, like Joggins, indicates tropical rainforest conditions. [2]

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Turn over.

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SECTION B

*Questions **5 - 8** relate to the **British Geological Survey 1:50 000 geological map** extract of **Settle**.*

*Answer **all** questions in the spaces provided.*

This section should take approximately 1 hour to complete.

5. *(a)* The **generalised geological column** shows that the **Worston Shales (WrSh)** are made up of a number of different rock types, some of which appear as wedge-shaped units.

(i) State **one** additional rock type included within the **Worston Shales (WrSh)** by completing **Table 5**. [1]

	Rock type
Worston Shales (WrSh)	*shale*
	•
	mudstone

Table 5

(ii) Explain why some of these beds appear as *wedge-shaped units* on the **generalised geological column**. [2]

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(b) Using the **generalised geological column** only, calculate the total combined thickness of the **Worston Shales (WrSh)** and overlying **Lower Bowland Shales (LBS)**. Show your working. [2]

Thickness .....

Examiner only

(c) The **generalised geological column** shows that the boundary between the **Worston Shales (WrSh)** and the **Thornton Limestone (ThtL)** is marked by a knoll-reef limestone (**K**). **Figure 5** is a photograph showing this boundary which crops out in **Box A** on the **geological map (grid reference 718532)**.

Figure 5

(i) Refer to the **generalised geological column**.

State the type of boundary that locally marks the junction between the **Worston Shales (WrSh)** and the **Thornton Limestone (ThtL)**. [1]

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(ii) Refer to **Figure 5** and the **geological map**.

1. Label on **Figure 5**
   - the knoll-reef limestone (**K**→)
   - the Thornton Limestone (**ThtL**→)

2. Draw a line on **Figure 5** to indicate the position of the boundary between the knoll-reef limestone (**K**) and the **Thornton Limestone (ThtL)**.

3. State the direction in which the camera was pointing.

Camera direction ..... [3]

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6. **Figure 6** is a simplified sketch of the structural features of the **geological map**.

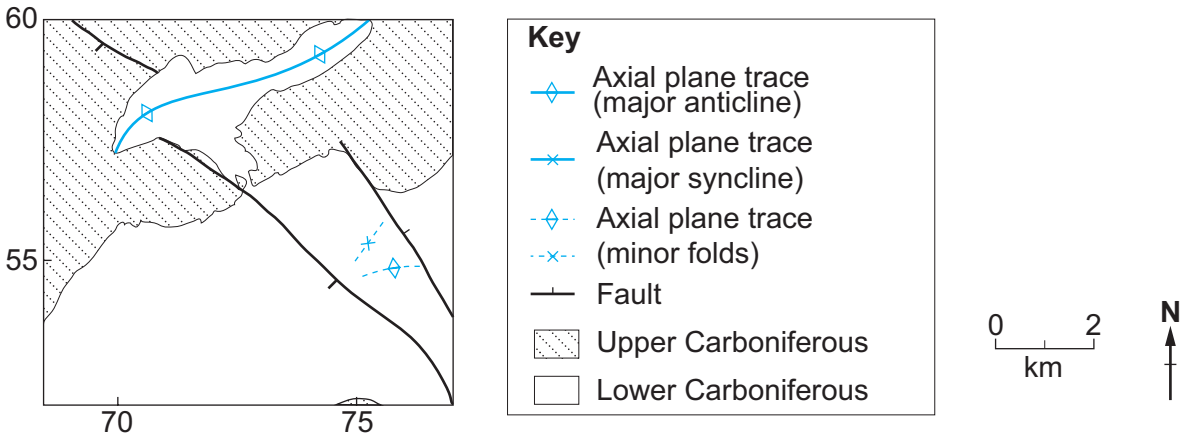

Figure 6

(a) Complete **Table 6** by stating the **evidence** from the **geological map alone** for the fold descriptors of the **major** anticline indicated on **Figure 6**. [2]

Fold descriptors	Evidence
1. an antiform	•
2. an anticline	•

Table 6

(b) On **Figure 6**, draw the axial plane traces of
1. **another** major anticline
2. a major syncline.

Use the symbols in the key to identify the folds. [2]

(c) A student described **both** major **anticlines** as
"…plunging to the NE."
Critically evaluate this statement. [3]

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7. Refer to the line of section **S-T** in **grid square 6952** on the **geological map** and the cross sections (**W**, **X**, **Y** and **Z**) in **Figure 7a**. Faults on the **geological map** are to be considered **normal** faults unless indicated, in the map key, as reversed (**RF**).

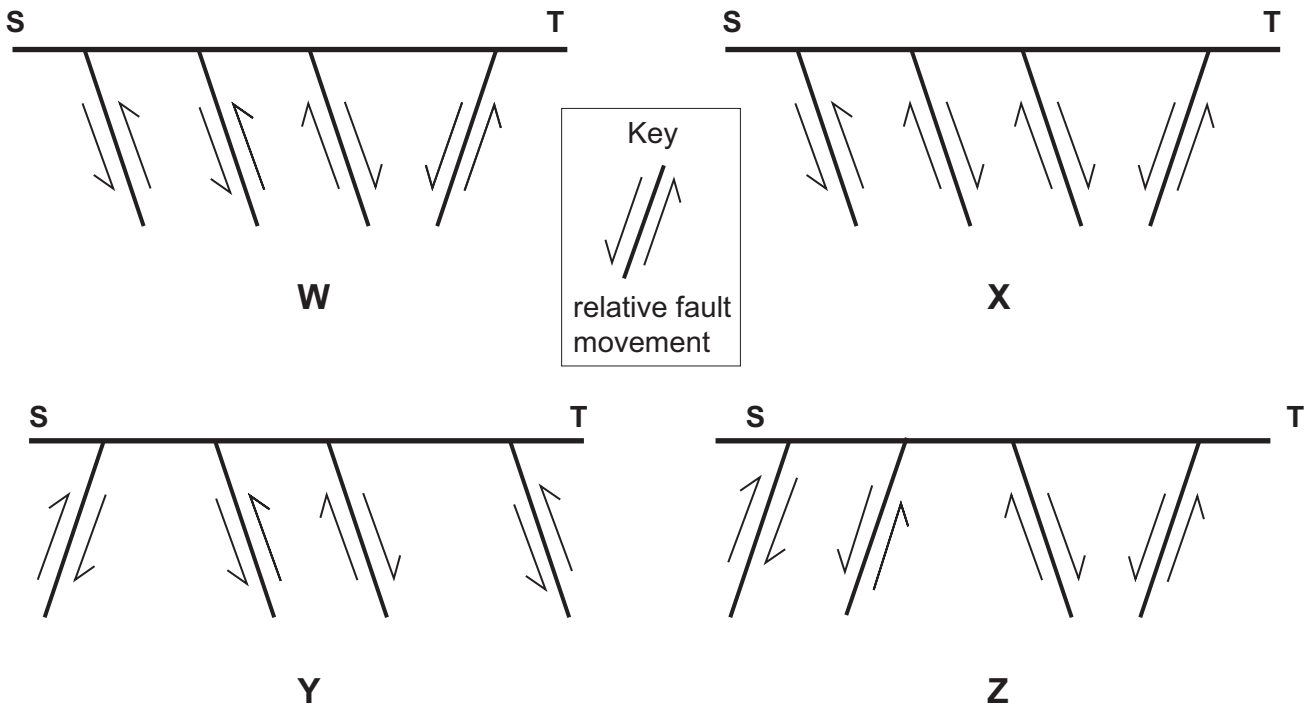

Figure 7a

(a) State which of the sketch cross sections (**W**, **X**, **Y** or **Z**) is most likely to represent the geological structure along the line of section **S-T**. Explain the reasons for your choice. [3]

Choice of section (**W**, **X**, **Y** or **Z**) ☐

Reasons .....

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(b) A student recorded the strike orientation of the major faults on the **geological map** as part of an investigation into stress patterns. **Table 7** is a partly completed chart, and **Figure 7b** a partly completed rose diagram of these data.

Direction	N-S	NE-SW	E-W	NW-SE
Tally	////	𝍸 ///	///	𝍸 𝍸 𝍸 𝍸 𝍸 //
Total number of orientations	•	•	3	

Table 7

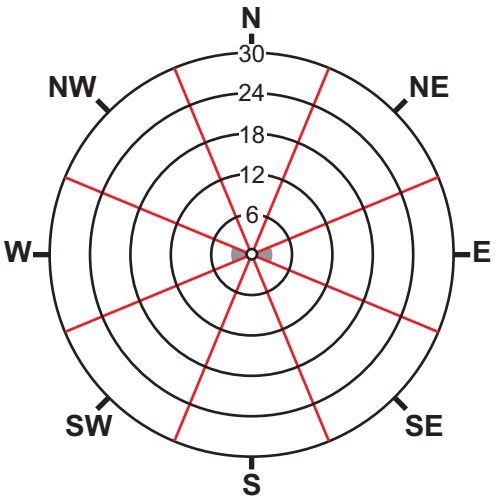

Figure 7b

(i) The tally in **Table 7** does not include the 4 faults in **grid square 6952** and the 3 faults in **grid square 7555**. Add these to the tallies and complete the totals for the data set. [2]

(ii) Complete the rose diagram (**Figure 7b**) to show the distribution of fault orientation totals for the completed data set in **Table 7**. [2]

(c) (i) **Fault F** on the **geological map** dips to the **NE**. A student concluded that **Fault F** and the major folds both formed

- by compression
- at the same time

Critically evaluate this statement. [3]

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(ii) **Figure 7b** shows a significant anomaly to the general fault orientation. Explain the evidence to suggest how some of these anomalous faults might have been formed at the same time as the formation of the major fold structures. [3]

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8. **Figure 8** is a typical exposure of the Worston Shales that underlies Stocks Reservoir (shaded white in **Box B** on the **geological map**). The photograph was taken looking North.

Figure 8

Refer to **Figure 8** and the **geological map**.

(a) (i) State the angle of dip of the beds as seen in **Figure 8**. [1]

..... degrees

(ii) Explain why the dip measurements on the **geological map** in **Box B** might be significantly higher than can be determined in **Figure 8**. [2]

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(b) Describe the **field** observations that might have been obtained at the location shown in **Figure 8** during planning of Stocks Reservoir. [4]

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(c) Explain the geological advantages and disadvantages of developing this site as a reservoir. [4]

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END OF PAPER

Acknowledgements

Figure 1a http://hq-images.com/granite
Figure 1b Glazner, F. A. and Johnson, B. R. 2013. Late crystallisation of K-feldspar and the paradox of megacrystic granites. *Contributions to Mineralogy and Petrology,* 166, 777-799.
Figure 2a https://en.wikipedia.org/wiki/Stegosaurus
Figure 2b http://www.3ders.org/articles/20150220-museum-scientist-uses-3d-scanning-to-discover-secrets-of-rare-stegosaurus.html
Figure 2c D. D. Gillette and M. G. Lockley (eds). Dinosaur Tracks and Traces, Cambridge University Press, 1991
Figure 4a http://www.blackwellpublishing.com/paleobiology/figure.asp?chap=04&fig=Fig4-23&img=c04f023
Figure 4b http://www.slideshare.net/yuriammosov/earth-paleomaps-history-of-continental-drift
Figure 4c https://upload.wikimedia.org/wikipedia/commons/thumb/0/08/Lycopsid_joggins_mcr1.JPG/1280px-Lycopsid_joggins_mcr1.JPG
Figure 5 British Geological Survey (P005661)
Figure 6 adapted from Figure 26 *Geology of the country around Settle* (BGS)
Figure 8 British Geological Survey (P005732)

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For continuation only.