2011 Geology

Higher

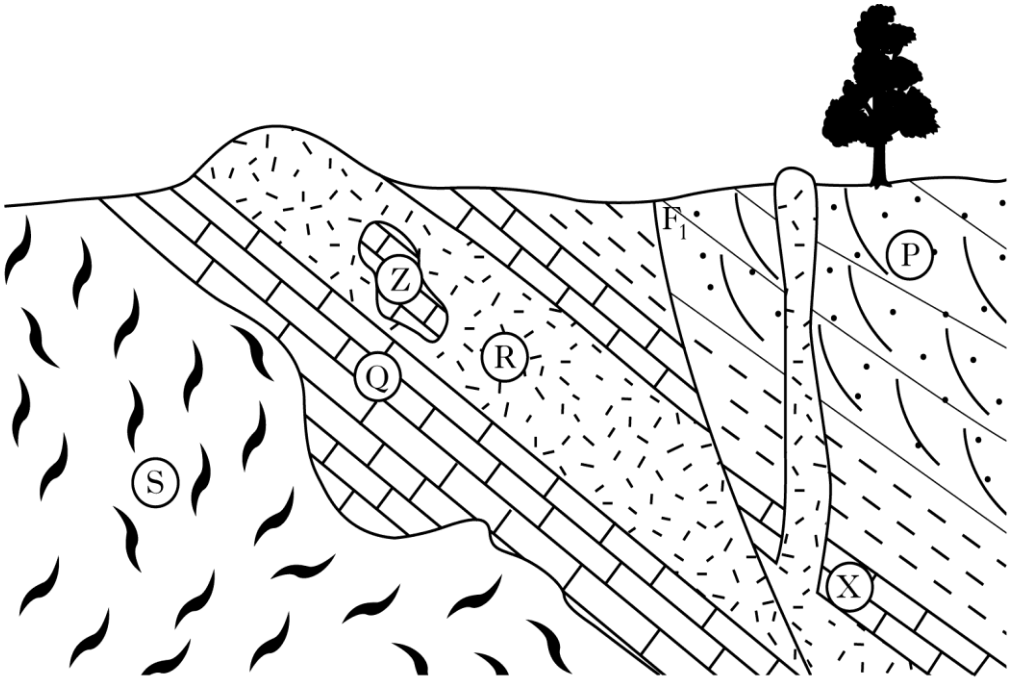
Finalised Marking Instructions

Marks

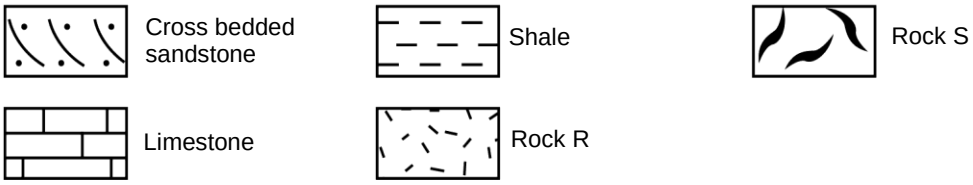
Section A

All questions in this section should be attempted. Forty marks are allocated to this section.

1. **(a)** Examine the diagram below.



Key



Which **one** of the following statements is correct?

A Igneous intrusion R is a dyke.

B Igneous intrusion R is a sill.

C Fault F1 is a reverse fault.

D Fault F1 is a thrust fault.

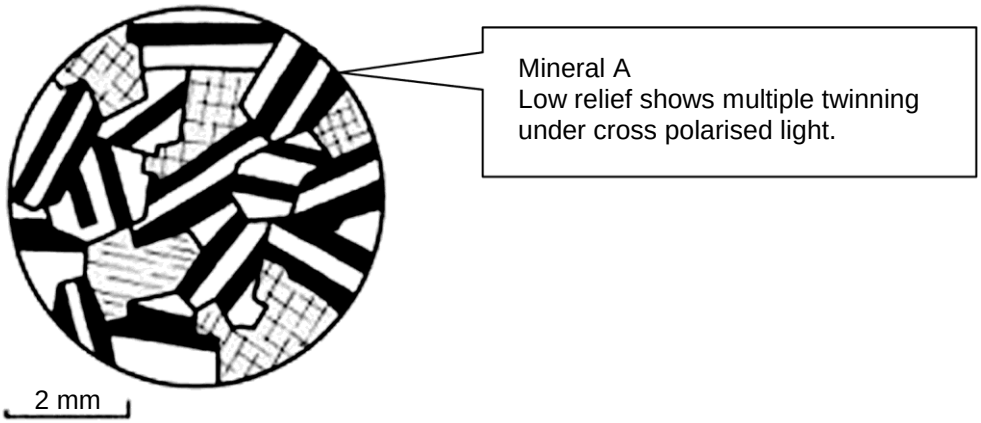
Give only the letter **B** **1**

		Marks
(b)	Which **one** of the following statements is correct?	
	A Rock P formed in a lower energy depositional environment than Rock Q.	
	B Rock Z is a fault breccia.	
	C There is a conformable relationship between rocks S and Q.	
	D Rock R is the youngest rock on the diagram.	
	Give only the letter **D**	**1**
(c)	What rock would you expect to find at X?	
	A Hornfels.	
	B Marble.	
	C Mylonite.	
	D Migmatite.	
	Give only the letter **B**	**1**

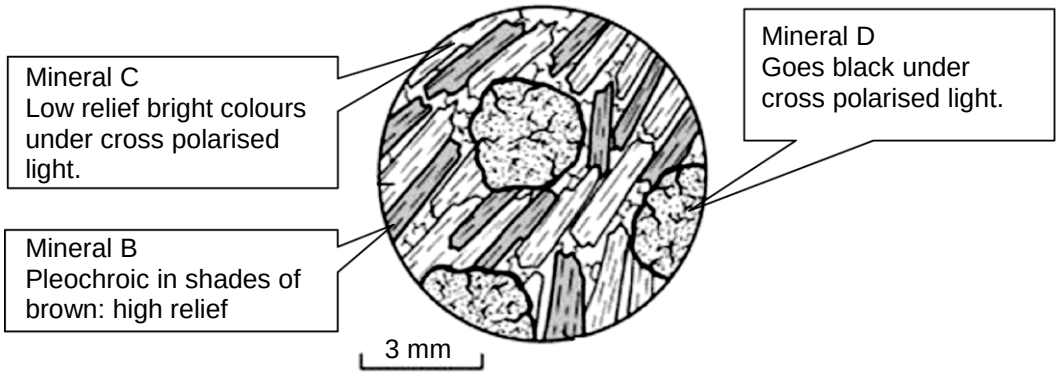
	Marks

(d) Samples of rocks R and S from the previous diagram are shown below in thin section.

Rock R



Rock S



Complete the table below by naming the minerals and the rocks.

Mineral or rock	*Name of mineral or rock*
Mineral A	**plagioclase**
Mineral B	**biotite**
Mineral C	**muscovite**
Mineral D	**garnet**
Rock R	**dolerite**
Rock S	**garnet mica schist**

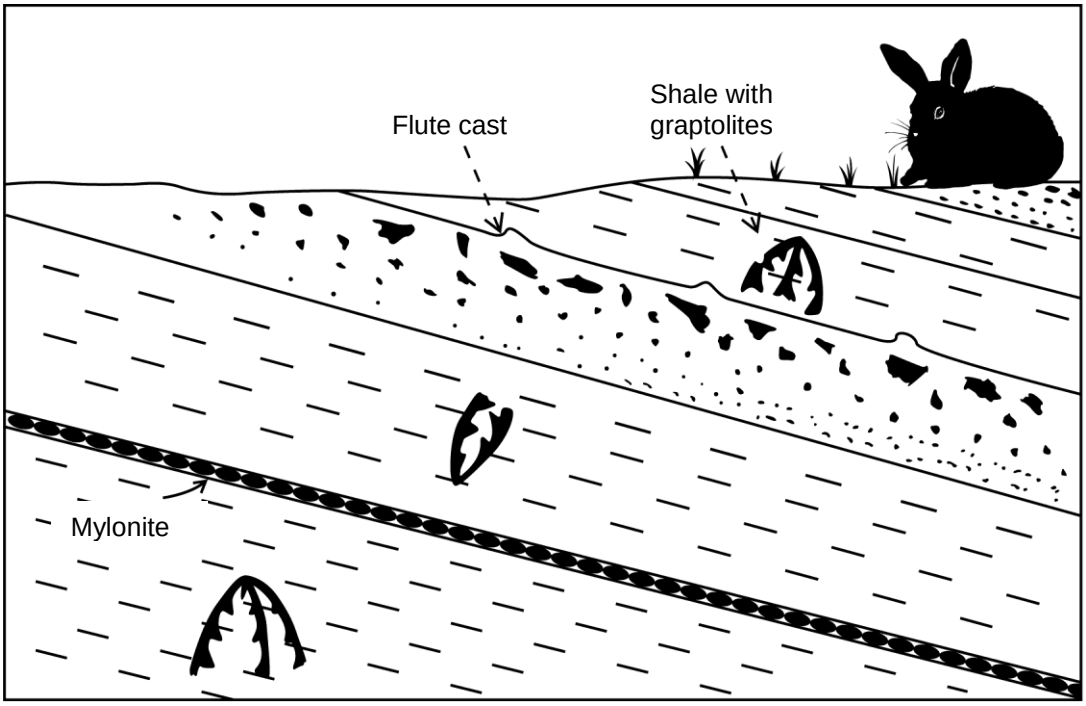
3

(e) **Explain** the term ‘contact metamorphism’:

The recrystallisation of rocks surrounding an igneous intrusion in response to the heat released by the intrusion. **1**

	Marks

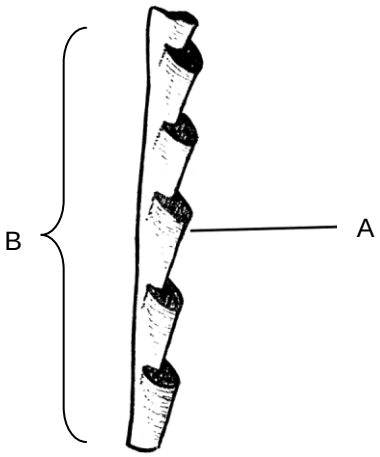
2. Study the diagram of the rock quarry face below.



(a) What **three** pieces of evidence suggest that the rocks are upside down?

1. Graded bedding inverted.
2. Flute casts inverted.
3. As graptolites evolved reduction in number of stipes and change from pendent to scandent stipes. **3**

(b) Study the diagram of a graptolite below and identify features A and B.



A Theca.
B Stipe. **2**

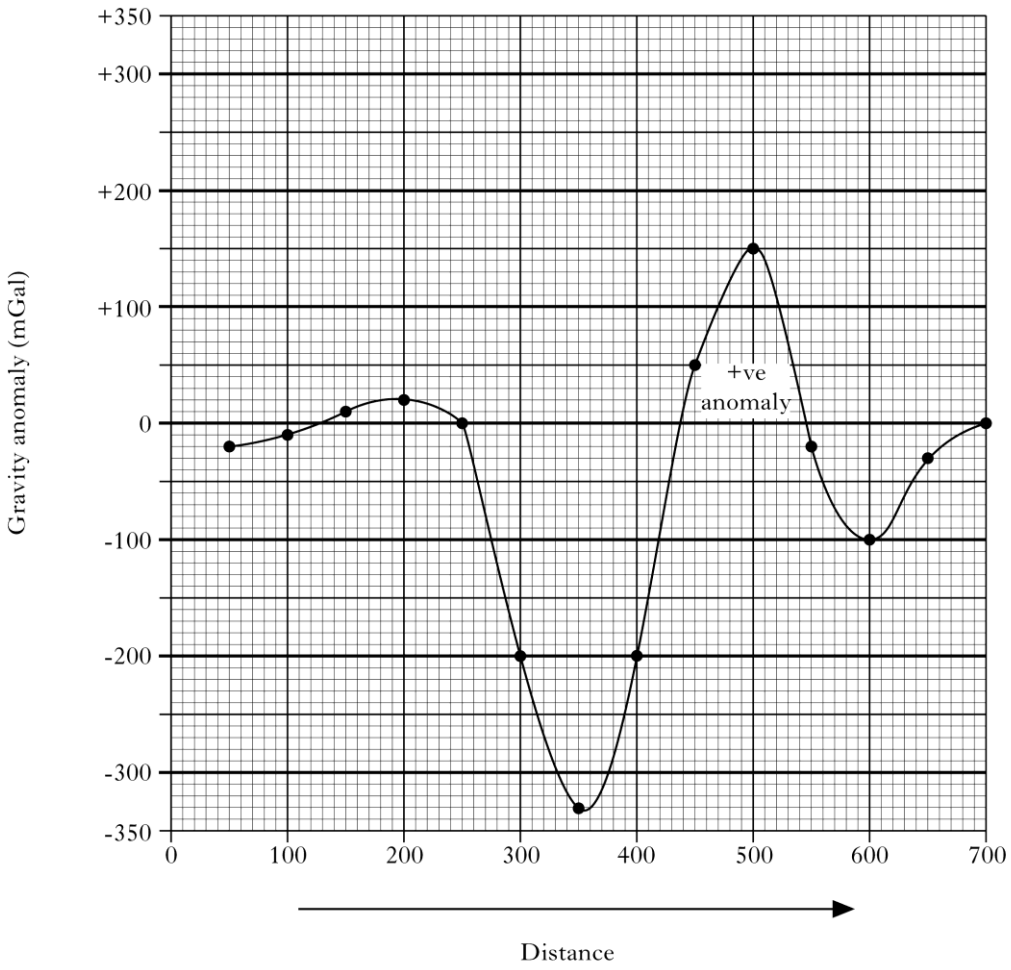
		Marks
(c)	Which **one** of the following statements is correct?	
	A Graptolites are used to zone late Palaeozoic and Mesozoic rocks.	
	B Graptolites are usually found in a life assemblage.	
	C Graptolites are planktonic freshwater organisms.	
	D Graptolites are used to zone lower Palaeozoic rocks.	
	Give only the letter **D**	**1**
(d)	Which **one** of the following statements is correct?	
	A Turbidite and greywacke are different terms for the same rock type.	
	B Greywackes are well sorted sandstones containing only rounded quartz grains.	
	C Turbidity currents flow rapidly down the continental slope or submarine canyons.	
	D Turbidity currents flow slowly along the continental shelf.	
	Give only the letter **C**	**1**

Marks

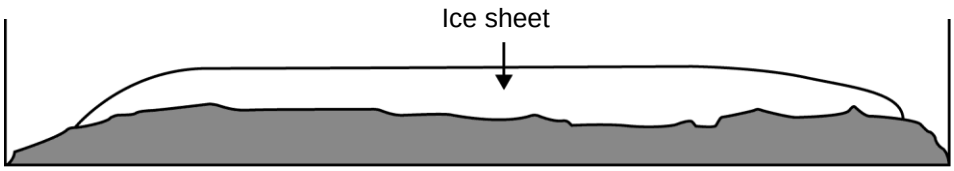
3. The table below shows distance across an oceanic destructive plate margin and the associated gravity anomalies.

Distance (kilometres)	*Gravity anomaly (mGal)*
50	-20
100	-10
150	10
200	20
250	0
300	-200
350	-330
400	-200
450	50
500	150
550	-20
600	-100
650	-30
700	0

(a) On the graph paper below, plot gravity anomaly against distance.

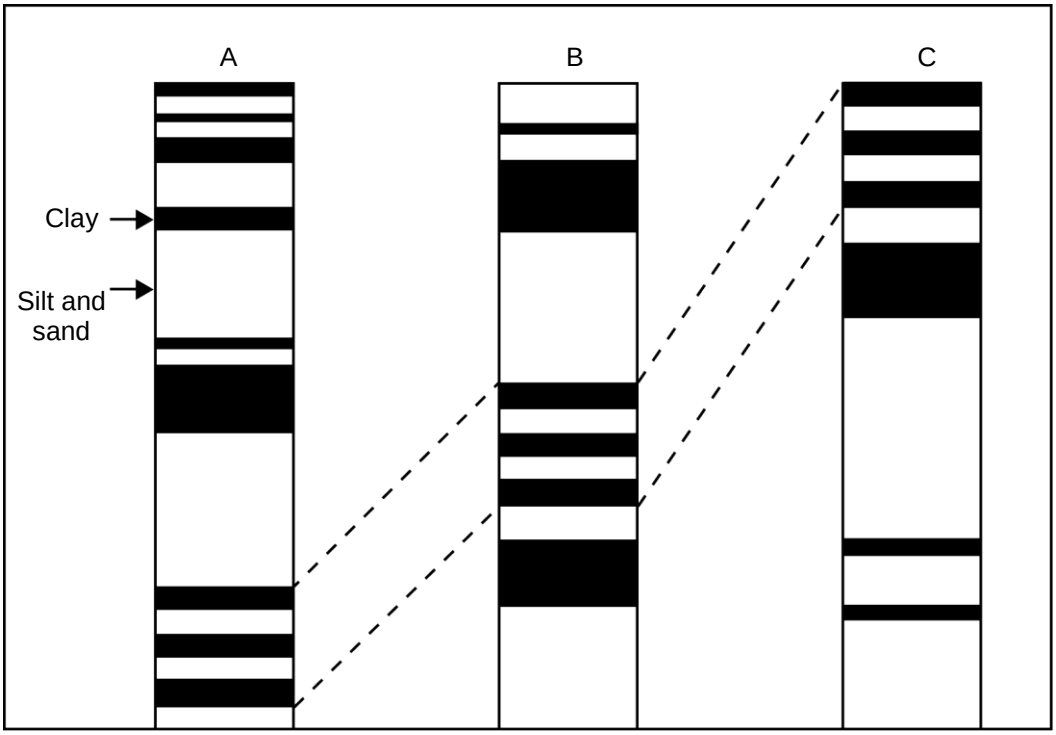


2

			Marks
(b)	**(i)**	Label the largest positive gravity anomaly. **On graph**	**1**
	(ii)	**Explain** the presence of the major negative anomaly and major positive anomaly. **Gravity anomaly profile typical of destructive margin. Negative anomaly exists where oceanic plate subducts and marks the position of the ocean trench. The positive anomaly marks the presence of an island arc.**	**2**
(c)		Using the diagram, **explain** why a positive gravity anomaly exists over the continent shown.  Explanation **Ice sheet has added extra mass to the continent.** **Build up of ice sheet makes continent sink normally.** **Ice sheet must have formed rapidly, and continent has not had time to sink and displace mantle.**	**1**

	Marks

4. The bore holes below show varves from three lake beds in Sweden.



(a) **(i)** Draw lines on the diagram above to match up the sequences in the different lakes.

Half mark for each line correlating part of the sequences correctly. **1**

(ii) **Explain** the term 'varve'.

A banded layer of clay and silt/sand deposited annually in lakes, especially near ice sheets. **1**

(iii) How many years of deposition are represented by the sediments in the boreholes?

12 years (+1/-1 tolerance). **1**

(b) Which **one** of the following statements about stratigraphy is correct?

A Correlation is the matching up of sequences in different areas on the basis of lithology only.

B Diachronous beds can only contain fossils from one zone.

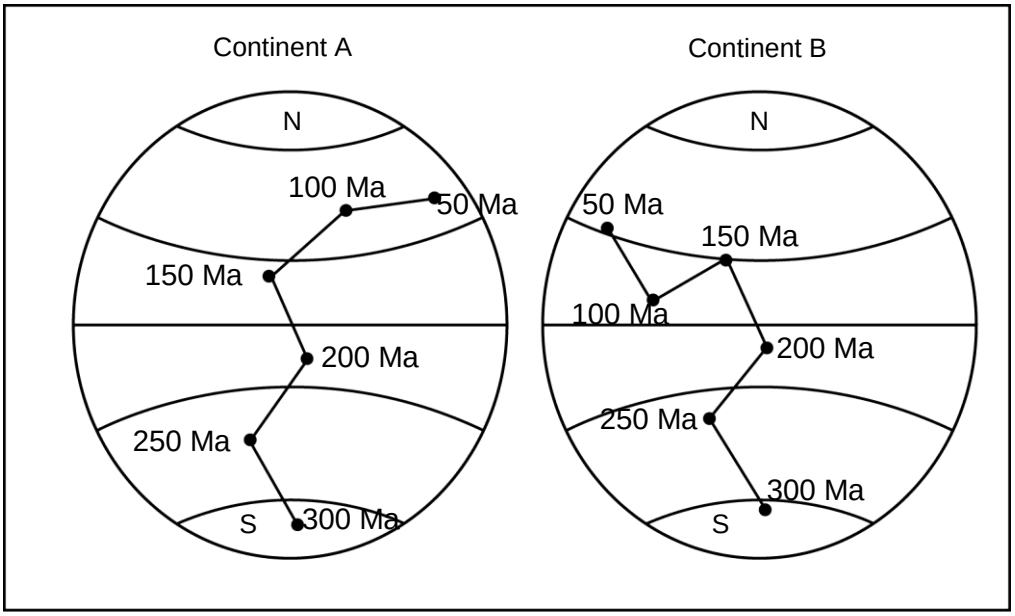
C Time marker horizons are often locally distributed and are capable of being traced over a small geographical area.

D Overlap is a type of unconformable relationship.

Give only the letter **D** **1**

	Marks

5. Study the diagram of the apparent polar wandering curves for continents A and B.



(a) Describe how the continents have moved over the last 300 million years in relation to each other.

Continents drifted together as part of a larger continent from 300 to 150 Ma (1 mark).
Continents separated at 150 Ma and followed different paths (1 mark). **2**

(b) Polar wandering curves provide evidence for the relative movement of continents.

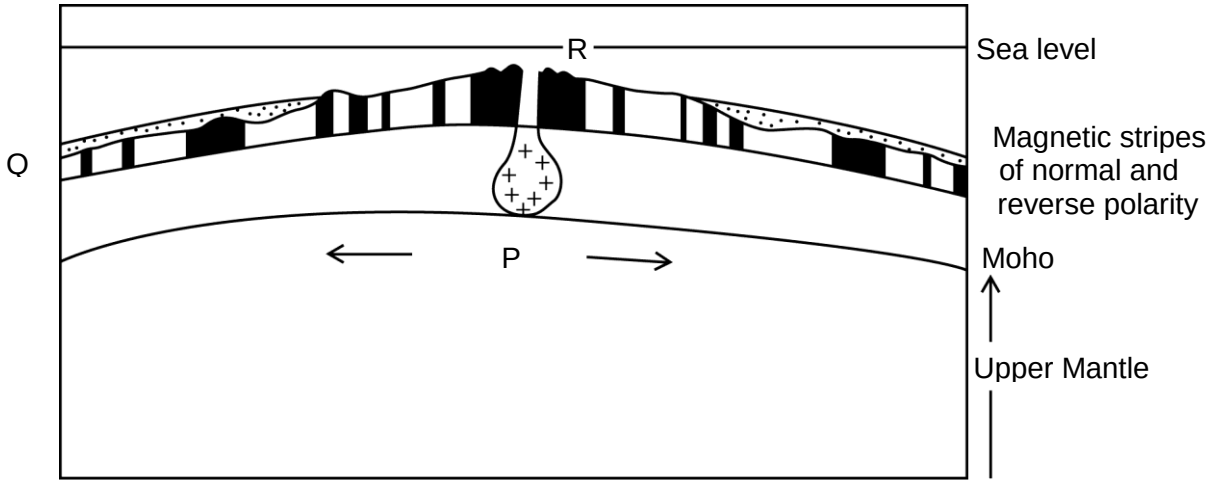
Give **three** other pieces of evidence for continental drift.

1. Match of continents along 1000m depth contour.
2. Matching cratons, geology, and orogenic belts.
3. Fossils such as Mesosaurus.
4. Eratic.
5. Ancient mountain belts. **3**

			Marks
(c)	**(i)**	65 million years ago India lay 30 degrees south of the equator. Today it is 20 degrees north. One degree of latitude is 110km. Calculate the minimum drift rate of India over the last 65 million years. *Space for working.* **1^0 = 110 km** **50 × 110 km = 5500 km** **5500 × 1000 = 5500000 metres** **5500000/65000000 years = 0.08 metres per year** **= 80mm/year** Answer: 80 mm/year	**2**
	(ii)	Why might the drift rate be greater than that calculated above? **India might not have drifted in a straight line.**	**1**

	Marks

6. Study the diagram of a plate boundary below.



(a) Which **one** of the following statements is correct?

A The earth's magnetic field is axial and dipolar.

B The earth's magnetic field is biaxial and polar.

C The earth's magnetic field is produced by electrical currents flowing in the inner core.

D The earth's magnetic field reverses every 5 million years.

Give only the letter **A** **1**

(b) Which **one** of the following statements is correct?

A Sea floor spreading occurs at ocean trenches.

B Reverse faulting occurs at mid ocean ridges.

C Oceanic crust contains the Earth's oldest rocks.

D Basaltic volcanism occurs at constructive plate boundaries.

Give only the letter **D** **1**

(c) Which **one** of the following statements is correct?

A Basaltic magma is formed by the partial melting of peridotite at P.

B Q is depleted in silica and enriched in ferromagnesian minerals relative to P.

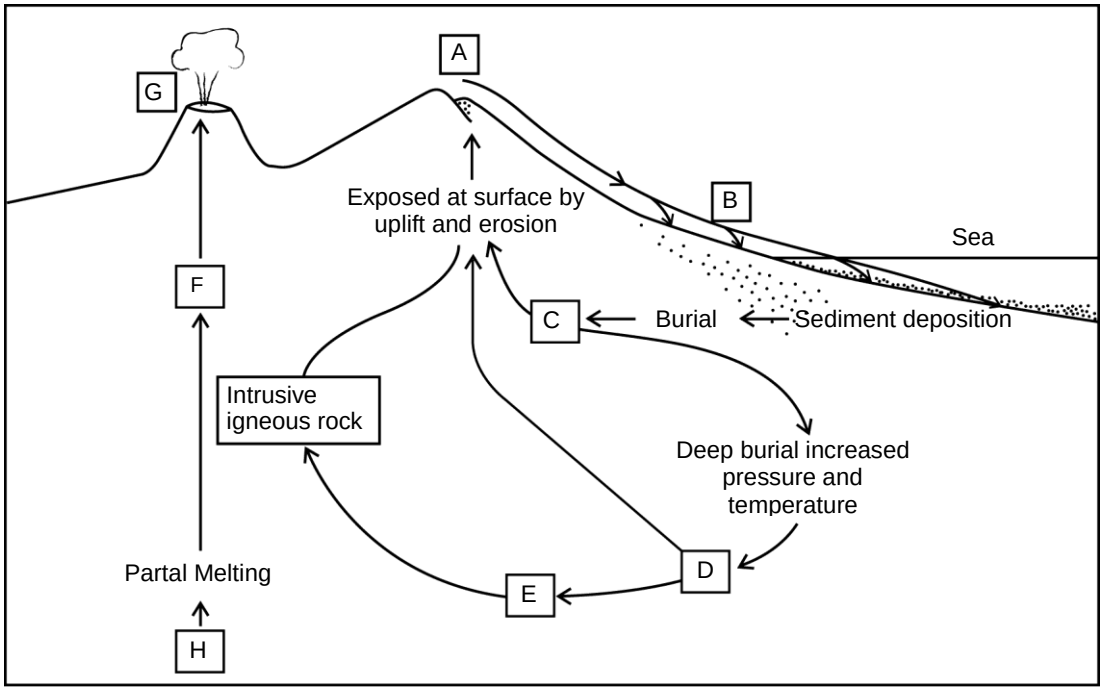
C Pillow lavas found at R have coarsely crystalline skins.

D Partial melting of Q creates P.

Give only the letter **A** **1**

	Marks

7. Study the diagram of the rock cycle below.



Glaciofluvial, extrusive rocks, mantle, pegmatite, weathering and erosion, biochemical precipitation, melting, transportation, magma, cone sheet, metamorphic rock, sedimentary rock.

A **Weathering and erosion.**

B **Transportation.**

C **Sedimentary rock.**

D **Metamorphic rock.**

E **Melting.**

F **Magma.**

G **Extrusive rocks.**

H **Mantle.** **4**

Section A: Total (40) marks

		Marks
	Section B	
	This section consists of three questions. Only ONE question should be attempted. Fifteen marks are allocated to this section.	
	Candidates should write their answers on page 17, 18, 19 and 20.	
8.	Write an essay on ores.	
	Credit will be given for the use of diagrams.	
	Give details as follows.	
	(a) The formation of ores by internal processes, eg magmatic, hydrothermal and contact metasomatic processes.	
	Concentration of metal bearing minerals at base of magma chamber due to settling of denser early formed crystals; role of volatiles especially from granitic intrusions associated with dolomitic limestones.	**6/7**
	(b) The formation of ores by surface processes eg placer deposits, secondary enrichment.	
	Transported ore bearing minerals will sink where water current slows eg inside meander loops. Soluble ores will be carried down to the water table and precipitate out leaving non soluble ore minerals at surface.	**6/7**
	(c) Methods of exploration to find and extract ore deposits.	
	Credit should be given for mentioning remote sensing, geophysical, geochemical and geological techniques. **Extraction of ores.** **Credit should be given for mentioning open cast mining, especially in connection with low grade ores. Underground mining of high grade/high value ores.**	**3/4** **(15)**

Maximum possible (15)

		Marks
9.	Write an essay on sedimentary rocks. **Credit will be given for the use of diagrams.** Give details as follows.	
(a)	The formation of rocks from sediments. **Credit should be given to any reference to lithifaction, compaction and cementation eg types of cement, and an explanation of these processes.**	**3/4**
(b)	The use of sedimentary structures in determining way upness and environments of deposition. **Reference should be made to way upness and how sedimentary structures are used to determine environments of deposition.**	**6/7**
(c)	The classification of sedimentary rocks. **Credit should be given for mentioning classification according to grain size; rudaceous, arenaceous and argillaceous. Classification in terms of composition and mode of formation – limestone – evaporites – precipitates formed other than by evaporation eg banded ironstone.**	**6/7** **(15)**

Maximum possible (15)

		Marks
10.	Write an essay on earthquakes and the internal structure of the Earth. **Credit will be given for the use of diagrams.** Give details as follows.	
(a)	Causes of earthquakes and types of earthquakes waves. **Credit should be given for reference related to plate tectonics and any mention of earthquakes that do not fit into theory eg glacial earthquakes, intra plate earthquakes.**	**6/7**
(b)	How the study of earthquakes is used to determine the internal structure of the Earth. **Credit should be given for reference to earthquake depth, Benioff Zone, mapping plate boundaries, Moho, Conrad, core – mantle, Taylor – Guttenburg discontinuities, shadow zones…**	**6/7**
(c)	The composition and structures of the crust, mantle and core. **Credit should be given to any reference to the composition of the mantle, outer and inner core. Any reference to how the study of earthquake waves, meteorites, volcanic activity etc has helped to further our knowledge of the composition of the Earth should be credited.**	**3/4** **(15)**

Section B: Total (40) marks

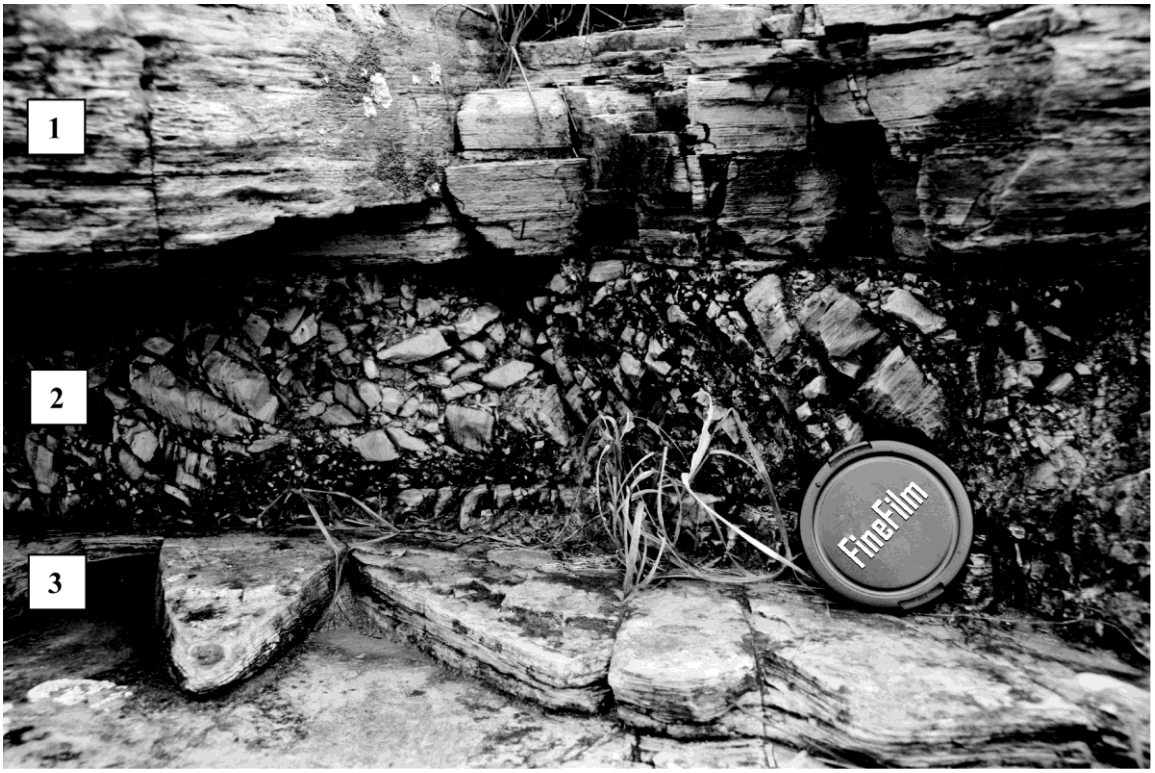
Maximum possible (15)

Marks

Section C

All questions in this section should be attempted. Forty marks are allocated to this section.

11. Look at the photograph below.



Layer 1: fine grained sandstone
Layer 2: consists of broken fragments from layer 3
Layer 3: fine grained sandstone

(a) Describe the depositional environment that would have led to the formation of rock layers one and three.

Fine laminae suggests very slow moving water, possibly lacrustrine but this more likely to produce massive bedding. No evidence of current bedding and fine grains more indicative of middle to lower course river flowing over a gentle gradient and/or with low discharge. **2**

(b) Why would it be unlikely to find fossils in layer two?

Layer two appears to be brecciated or indicative of physical weathering processes. The destruction applied prior to the deposition of the rock fragments would have almost certainly destroyed hard animal or plant parts. **1**

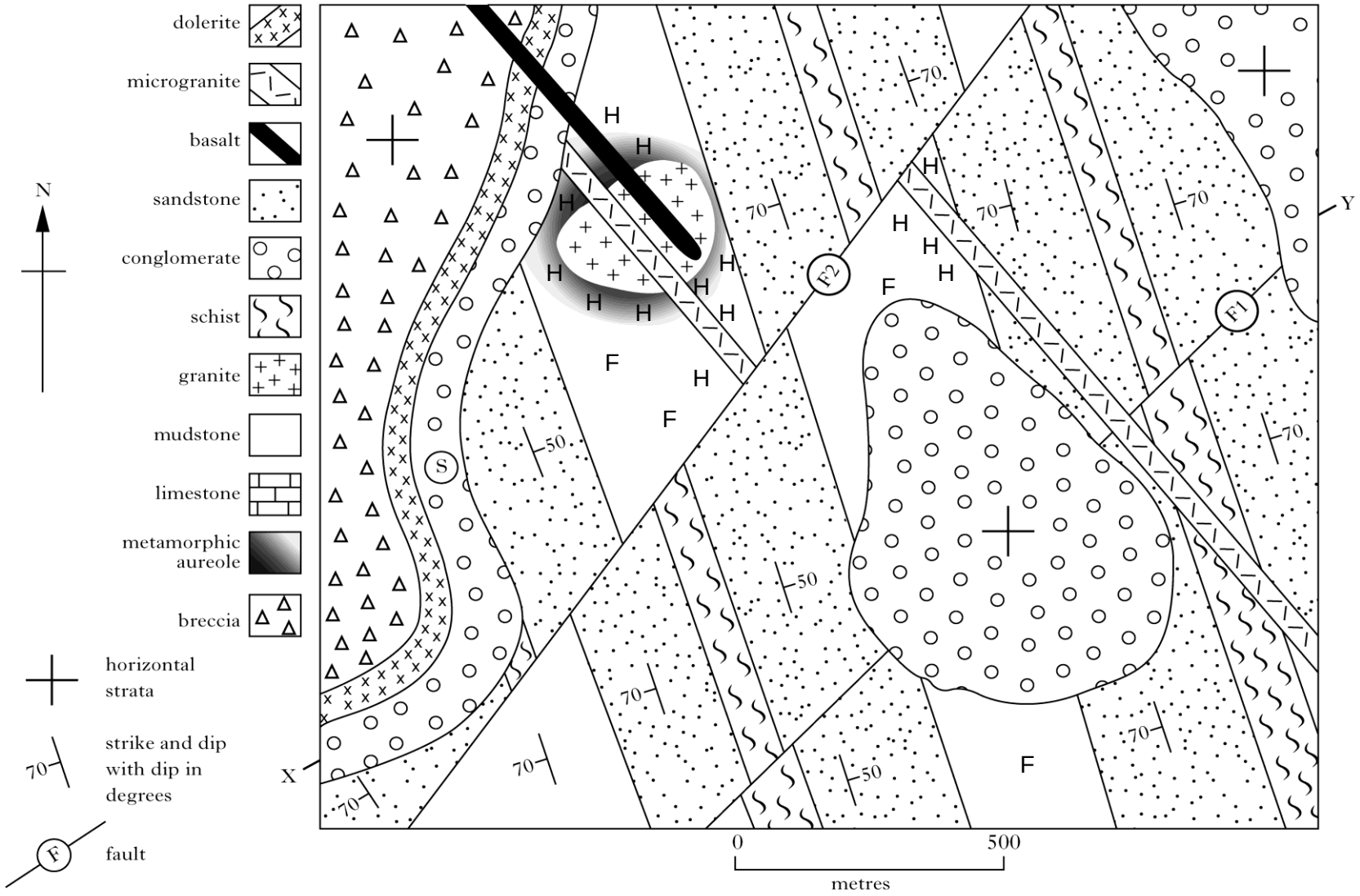
			Marks
	(c)	**Explain** how the three rock layers have been formed. Diagram may be used.	
		No obvious solution. Accept any reasonable explanation that has validity. Eg slow moving river deposits layer one. Landslide from river side cliff deposits rock fragments onto river bed. River does not have the capacity to move the fragments. Layer three represents a resumption of normal deposition on top of the breccicated layer. **OR** **Middle layer appears brecciated. Possibly fault breccia suggesting that photograph view is parallel to the fault plane. The fault plane could be near horizontal with layer one or three having been pushed towards the camera. Unlikely to be a low angle thrust fault as middle layer is not mylonite.**	**3**
12.	Study the map (on the **separate worksheet**) and answer the questions based on it.		
	(a) **(i)**	Which **one** of the following statements correctly describes the movement of the rocks on the north west side of **fault F1**?	
		A They have moved to the north west. B They have moved to the south east. C They have moved upwards. D They have moved downwards.	
		Give only the letter: **D**	**1**
	(ii)	Give a reason for your answer.	
		Younger rock on downthown side underlying schist more exposed in south	**1**
	(iii)	The fault plane of **F1** dips 72° north west. What type of fault is **F1**?	
		Normal	**1**
	(b)	Which **three** of the following statements are correct?	
		A Two unconformities are shown on the map. B Three unconformities are shown on the map. C Fault **F2** cuts through the granite. D Fault **F2** is a tear fault. E Fault **F2** is a thrust fault. F Fault **F2** is older than the microgranite dyke. G The granite intrusion is younger than the conglomerate. H The microgranite dyke is older than the basalt dyke. I The metamorphic aureole around the granite is of constant width. J There are three anticlines shown on the map. K There are three synclines shown on the map. L The breccia rests uncomformably on the dolerite.	
		Give only the letters: **A, D and H**	**3**

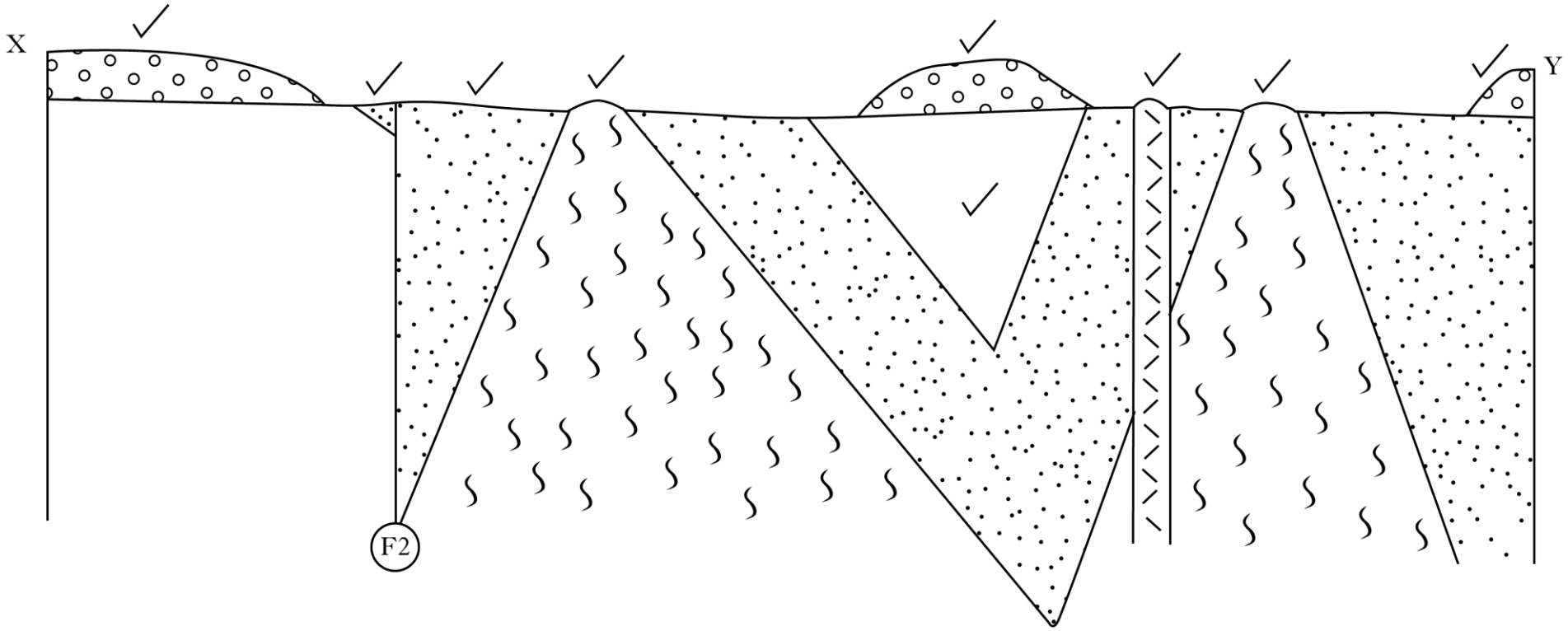
			Marks
(c)	**(i)**	Place an '**F**' on the geological map where you think this photograph of a vertical exposure was taken.	

	(ii)	Using diagrams, **explain** the formation of the structure shown in the photograph above.	
		Compressional force by tectonic movement has been applied from right and left. Structure is a synform but different thickness of bedding would suggest passive flow folding mechanics indicative of folding whilst buried at depth within the crust.	**2**

		Marks
(d)	This photograph was taken at point 'S' looking west.	

(i)	**Explain** the formation of the igneous structures shown in the diagram above (**Diagrams may be used**).	
	Combining the map and picture evidence would suggest that this is a sill. Magma has been intruded along the bedding boundary between the conglomerate and breccia. Subsequently, it has cooled downwards and upwards from the colder country rocks and formed columnar joints.	**2**
(ii)	Using diagrams, **explain** why this layer of igneous rock is younger than the breccia.	
	Breccia sitting on top of the dolerite has a baked margin. The breccia would have to predate the dolerite for this to happen.	**2**
(e)	Place a letter **'H'** on the map where you would expect to find hornfels.	**1**
(f)	On the topographic profile, (**on the separate worksheet**), complete the geological section between points X and Y on the map.	
	All correct 4 **6 – 7 3** **4 – 5 2** **2 – 3 1**	**4**


dolerite
microgranite
basalt
sandstone
conglomerate
schist
granite
mudstone
limestone
metamorphic aureole
breccia
horizontal strata
strike and dip with dip in degrees
70
fault
F
N
X
Y
S
F1
F2
H
F
70
50
0
500
metres


X
Y
F2

Marks

(g) Place the geological events of this map area in the correct order by inserting the correct letters from the list below.

The events in this table are not in the correct order.

A	Formation of schist
B	Basalt dyke
C	Microgranite dyke
D	Deposition of sandstone and mudstone
E	Dolerite intrusion
F	Folding
G	Granite intrusion
H	Fault F2
I	Fault F1
J	Deposition of conglomerate and breccia

(Give only the letters)

YOUNGEST

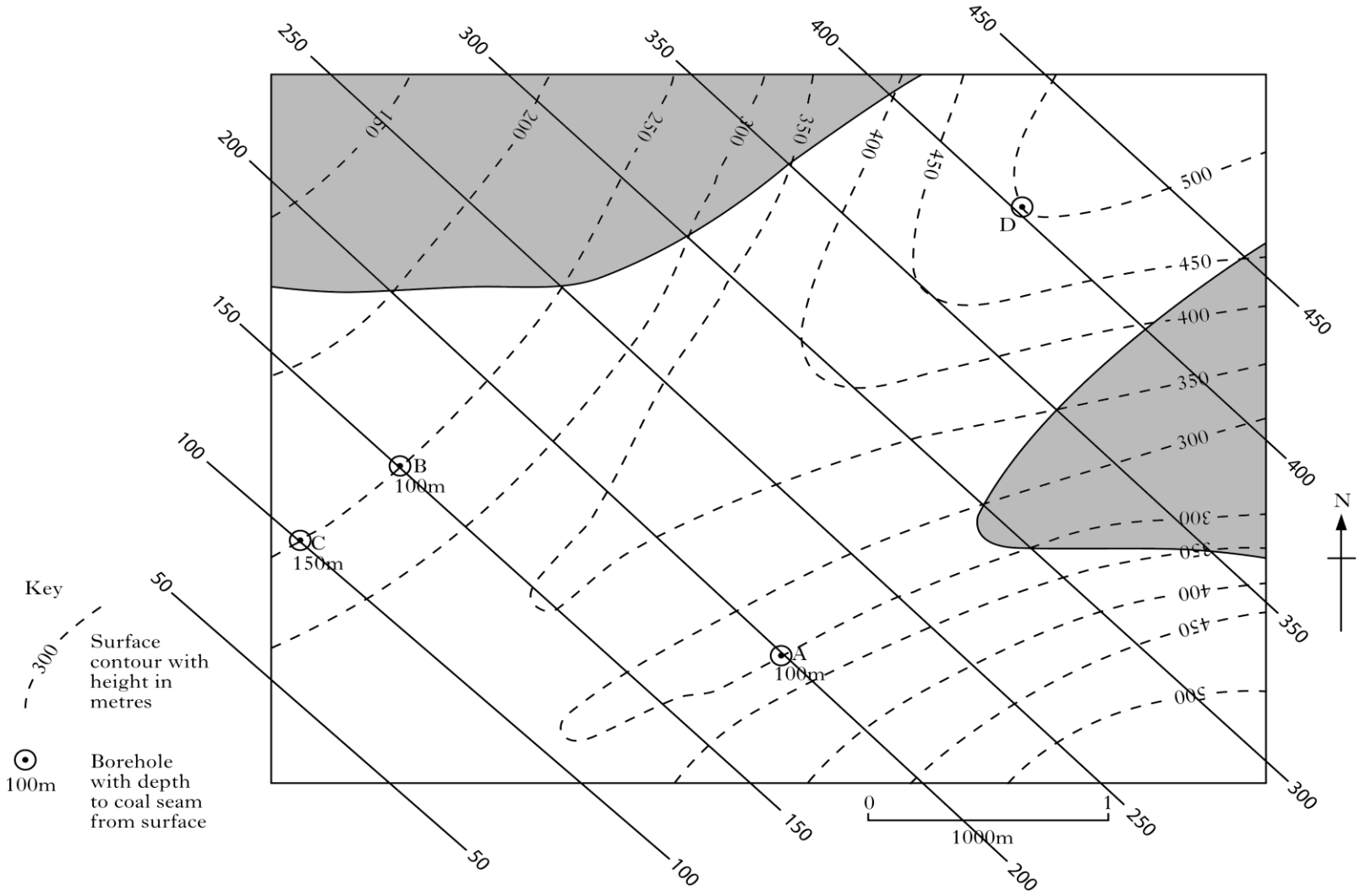
B
E
J
H
C
G
I
F
D
A

OLDEST

All correct	**4**
6 – 7	**3**
4 – 5	**2**
2 – 3	**1**

4

	Marks
13. A constantly dipping coal seam has been found in boreholes A, B and C at depths shown on the map.	
(a) Draw structure contours across the whole map for the coal seam.	**4**
(b) At what angle and direction does the coal seam dip?	
45° degrees to the **south west**	
Space for working.	
$\mathbf{Tan\ \theta} = \frac{150}{150}$ (vertical distance) / (horizontal distance)	
$\mathbf{Tan\ \theta} = 1$	
$\mathbf{\theta = 45^{\circ}}$	**2**
(c) Draw the outcrop of the coal seam.	**3**
(d) At what depth below the surface will the coal seam be found in borehole D?	
Contour at 500 metres – structure contour at 400 metres = 100 metres.	**1**
(e) Shade in the area or areas not underlain by the coal seam.	**2**
Section C: Total (40) marks	



[END OF MARKING INSTRUCTIONS]