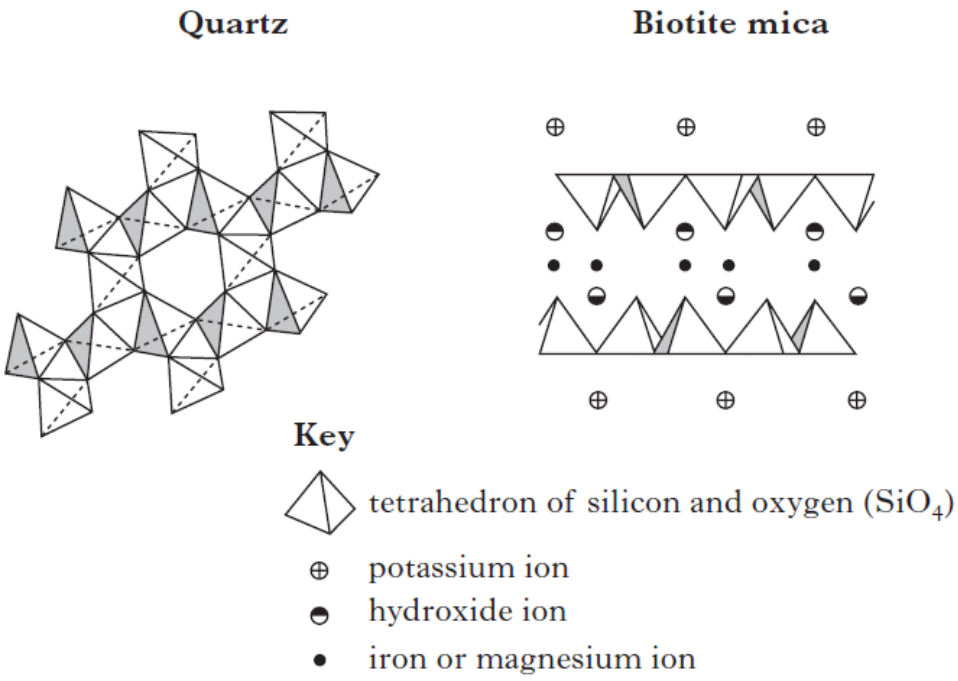
2012 Geology

Higher

Finalised Marking Instructions

			Marks
		Section A	
		All questions in this section should be attempted. Forty marks are allocated to this section.	
1.	**(a)**	Use the diagram below to explain the following observations.	



	(i)	Biotite mica can split easily into thin flexible sheets.	
		One cleavage, weak bond between silica sheets.	**1**
	(ii)	Quartz is less dense than biotite mica.	
		Contains no iron or magnesium.	**1**
	(iii)	Quartz has no cleavage.	
		No cleavage planes.	**1**
	(b)	Give **one** similarity and one difference between biotite and muscovite.	
		Similarity **both have one cleavage.**	
		Difference **biotite is plechroic, biotite is black/muscovite is silvery.**	**2**

Marks

(c) Put the following minerals into their correct chemical groups in the table below:

Garnet, Barite, Dolomite, Fluorite, Galena, Vassiterite

Halides	Sulphides	Carbonates	Silicates
fluorite	**galena**	**dolomite**	**garnet**

2

(d) Complete the table below by selecting the correct mineral from the word box.

Chalcopyrite, gypsum, malachite, calcite, talc, haematite, olivine

Colour	**Relative Density**	**Hardness**	**Name of mineral**
Dark and light green stripes	4	3	**malachite**
Grey/white	2.7	1	**talc**
Usually colourless or white	2.7	3	**calcite**
Black or browny red	5	6	**haematite**

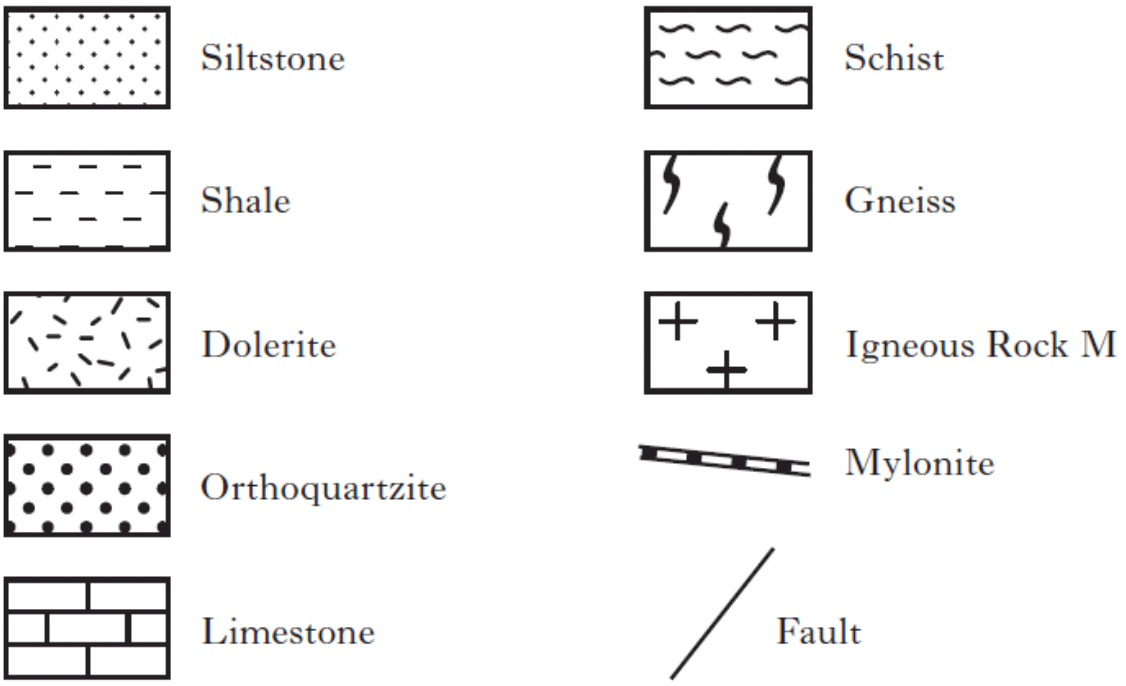
2

Marks

2. Study the diagram below of quarry face and answer the question based on it below.

-

Key (Rocks not in order of age)



	Marks

2. (continued)

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

A The siltstone is the youngest rock in the quarry face.
B The dolerite is the youngest rock in the quarry face.
C Three unconformities are present in the quarry face.
D three different sedimentary rocks are present in the quarry face.

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

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

A Fault F1 is a reverse fault.
B The rock at A is hornfels.
C Mylonite is formed by contact metamorphism.
D New minerals will have formed at B as a result of contact metamorphism.

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

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

A Two different types of fault are evident in the quarry face.
B Dolerite is a fine grained basic igneous rock.
C Gneiss is a metamorphic rock formed at low temperatures and high pressure.
D The limestone rests conformably on the schist.

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

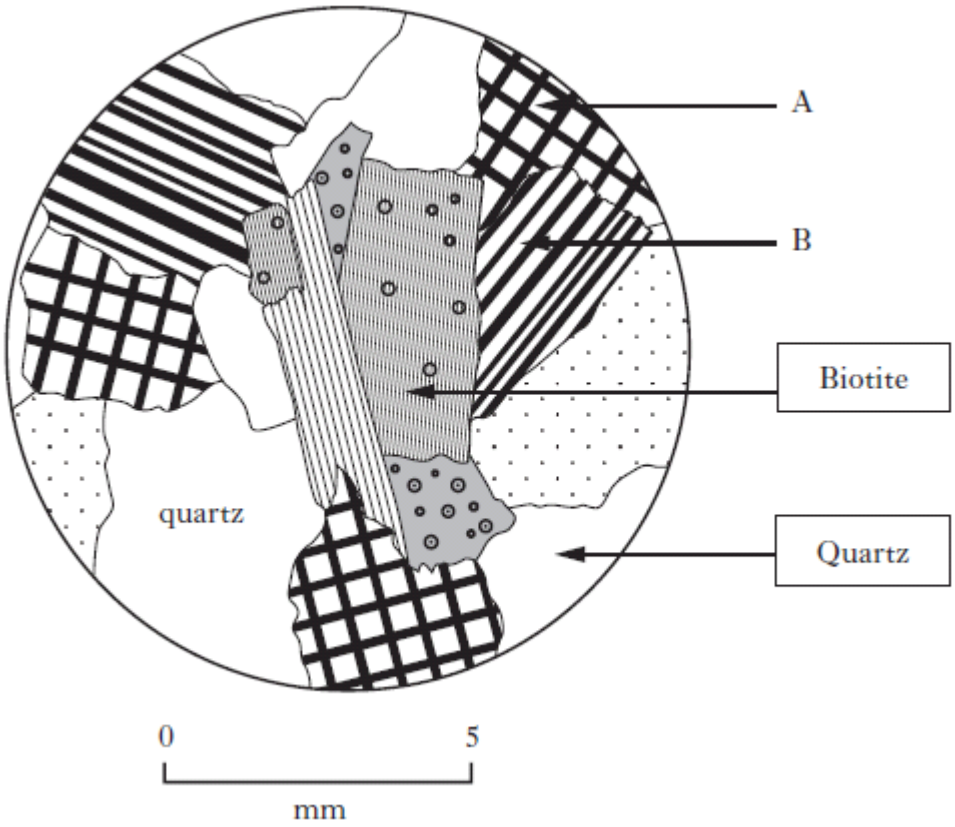
(d) Chalcopyrite is found at **'C'** in the quarry face. Explain how it was formed.

Heat/volatiles from microgranite: chemical reaction;
limestone dissolved – mineralization of limestone.
Credit metosomatism – using joints and bedding planes. **2**

Marks

2. (continued)

(e) Study the thin section from igneous rock **M** shown under crossed polarised light.



(i) Identify minerals

A **microline feldspar** B **plagioclase** **2**

(ii) Name rock **M**

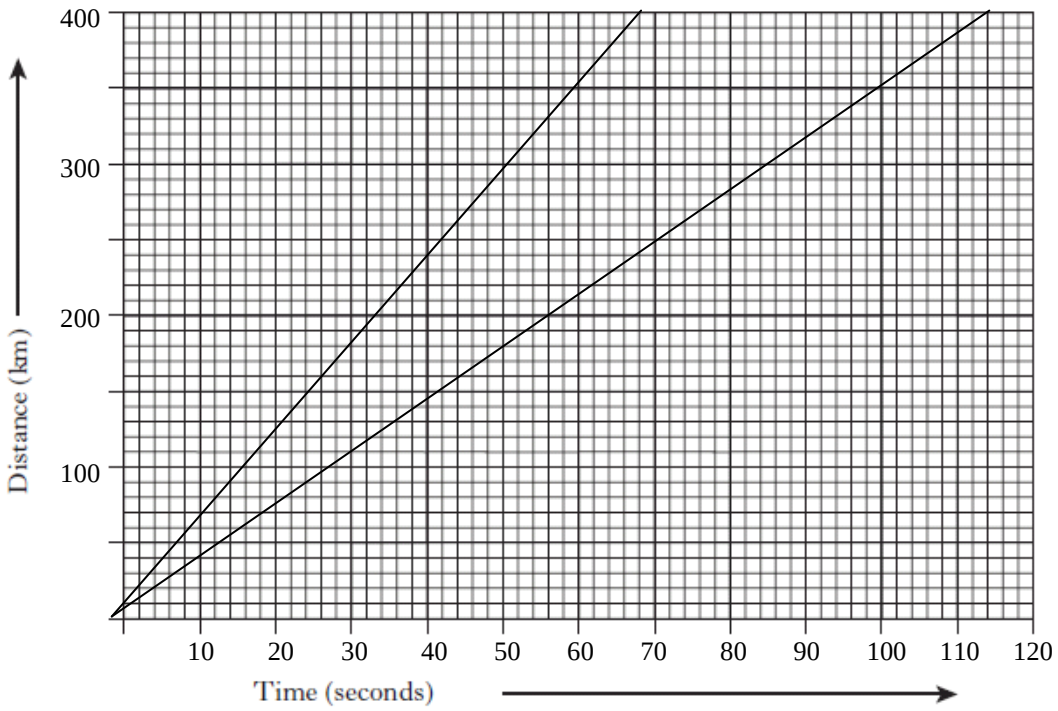
Granite/microgranite/syenite **1**

Marks

3. The table below shows information about earthquake waves near to the surface of the Earth.

P-Waves		S-Waves	
Distance from epicentre	Travel time (seconds)	Distance from epicentre	Travel time (seconds)
100km	18	100km	29
200km	36	200km	58
300km	54	300km	87
400km	72	400km	116

(a) Draw travel time lines on the graph paper below for P- and S-waves.



1 mark for each line drawn correctly **2**

(b) Calculate the difference between P- and S-wave velocities.

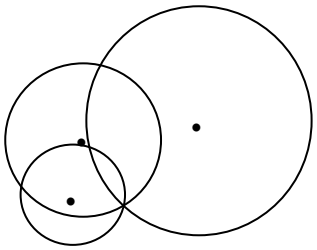
Space for working

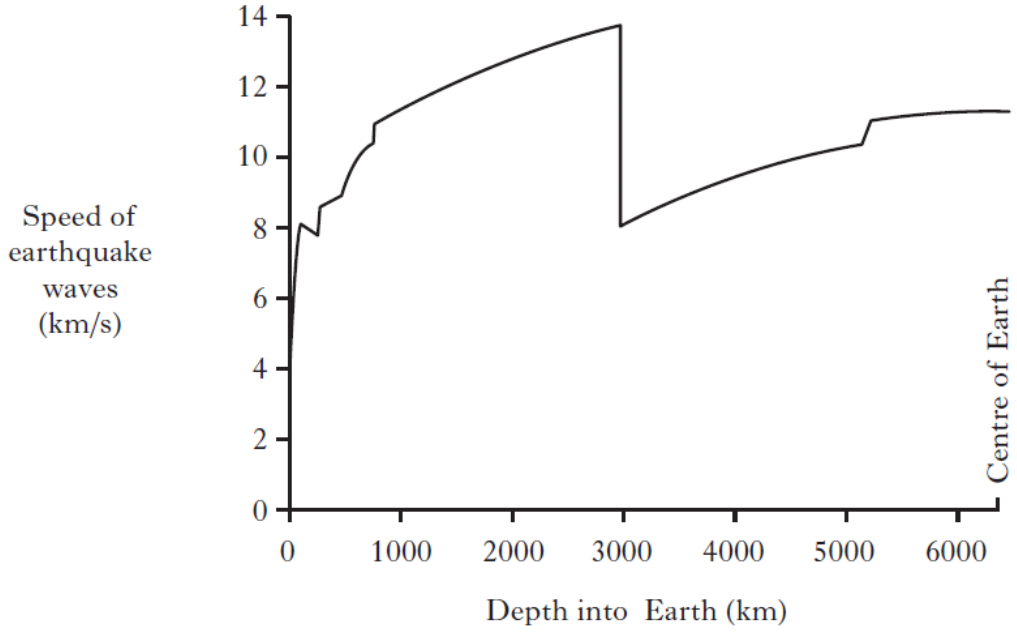
P – 400/72 = 5.55 km/sec S = 400/116 = 3.45 km/sec

VP – VS = 2.1 km/sec

Answer **2.1 km/s** **1**

Margin of error +/- 0.3 km/s

			Marks
(c)	**(i)**	A difference of 40 seconds is recorded between the arrival times of P- and S-waves. What distance is this seismometer from the epicentre?	
		360 km ± 30 km (using graph)	**1**
	(ii)	**Using a diagram**, explain why it is necessary to use seismic records from more than one place to locate the epicentre of an earthquake.	
		Space for diagram	
		Intersection of 3 circles marking the radius of distance from the epicentre of these 3 seismometers.	
		 epicentres pinpointed and labelled	**2**
(d)		The graph below shows how the speed of P-Waves change with depth within the earth.	**2**

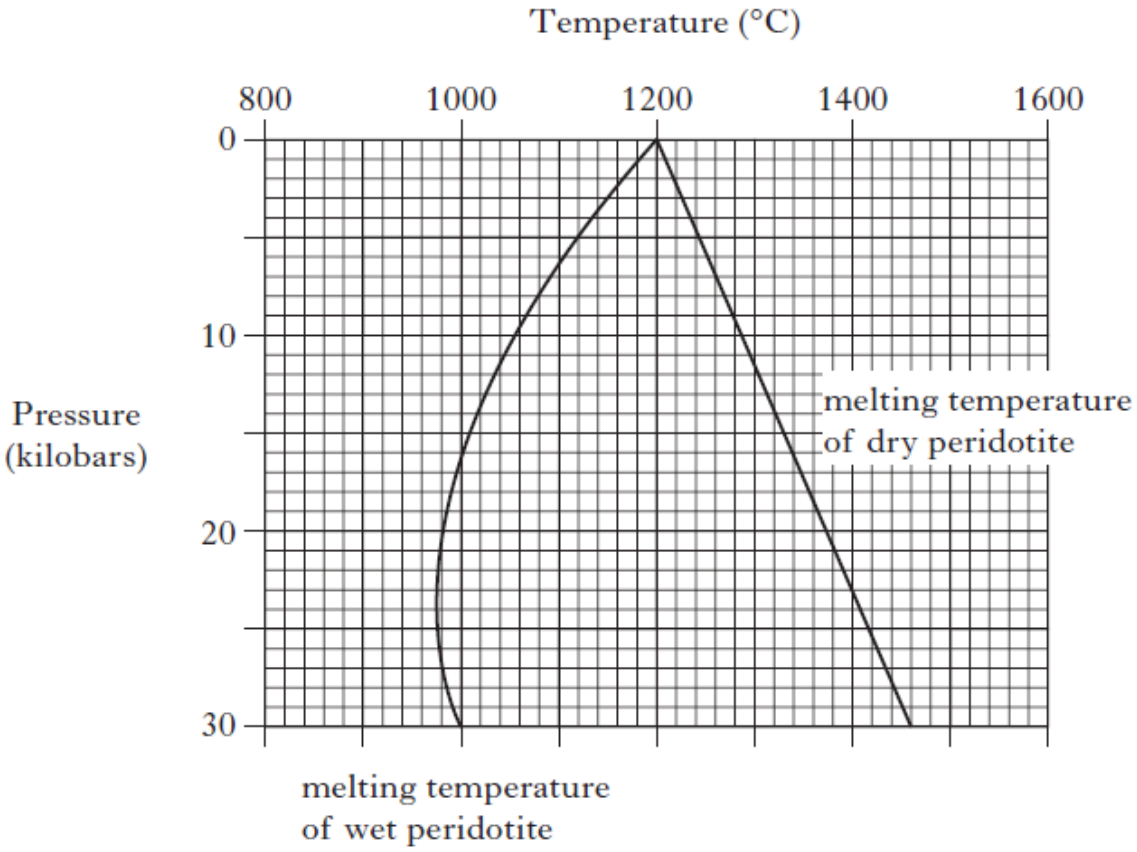


Explain the changes in P-wave velocity shown.

3000km slows down as it enters the liquid outer core; liquid is less compressible.
Near surface, velocity is low due to low density rock.
Mantle dominated by mafic minerals – high density but compressibility is reduced which more than compensates for this.
Core is FeN alloy – very dense – high velocity. **3**

Marks

4. The graph below shows how pressure affects the melting temperature of wet and dry peridotite.



Which **two** of the following statements are correct?

A At a pressure of 20 kilobars the difference between the melting temperatures of wet and dry peridotite is greatest.

B There is a positive relationship between pressures up to 23 kilobars and the melting temperature of wet peridotite.

C Basaltic magma produced at constructive plate boundaries is formed by the partial melting of peridotite.

D For a one kilobar increase in pressure the melting temperature of dry perodotite rises by 8.7ºC.

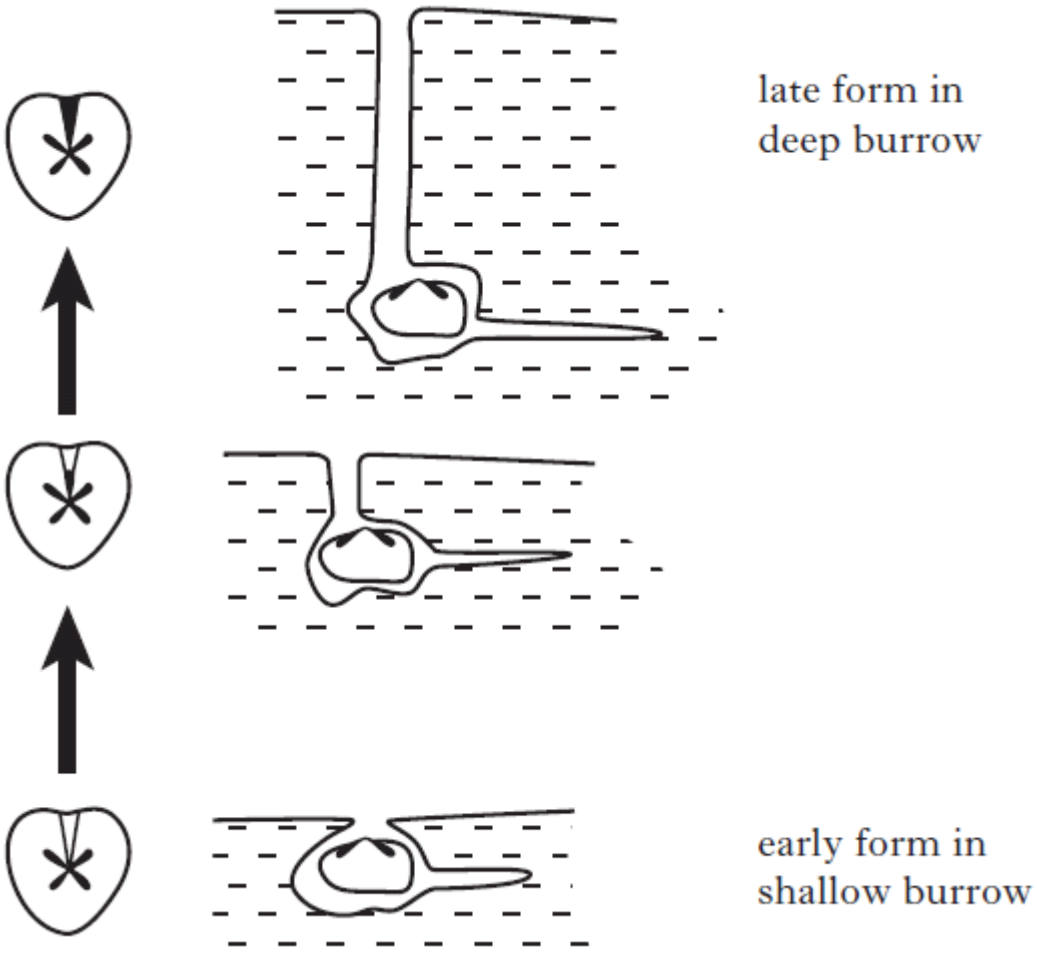
E Oceanic crust is composed of peridotite.

F Wet peridotite is associated with constructive plate boundaries.

Give only the letters **C** and **D** **2**

Marks

5. The diagram below shows changes in the living positions of micraster over time.



Which **two** of the following statements are correct?

A Micraster is a regular echinoid.

B The anterior groove is found at the back of Micraster.

C As Micraster evolve the anterior groove got deeper.

D Micraster is an important zone fossil for dating Jurassic rocks.

E Micraster was a planktonic organism.

F As micraster evolved, the mouth moved further forward to allow better collection of food from the current.

Give only the letters **C** and **F** **2**

Marks

6. The table below gives information about the temperatures and viscosity of different magmas.

Magma	Temperature ºC	Viscosity (dry) magma Measured in poises	Viscosity (wet) magma Measured in poises
Rhyolite	785	10^{12}	10^{6}
Andesite	1000	10^{4}	$10^{3.5}$
Basalt	1250	10^{2}	10^{2}

(a) Explain the term viscosity

Ability of lava to flow freely; measure of the resistance of a fluid to flow. **1**

(b) What effect does the addition of water to a magma have on its viscosity?

Lowers the viscosity/no effect for basalt. **1**

(c) The table below gives information about the viscosity of two lava flows

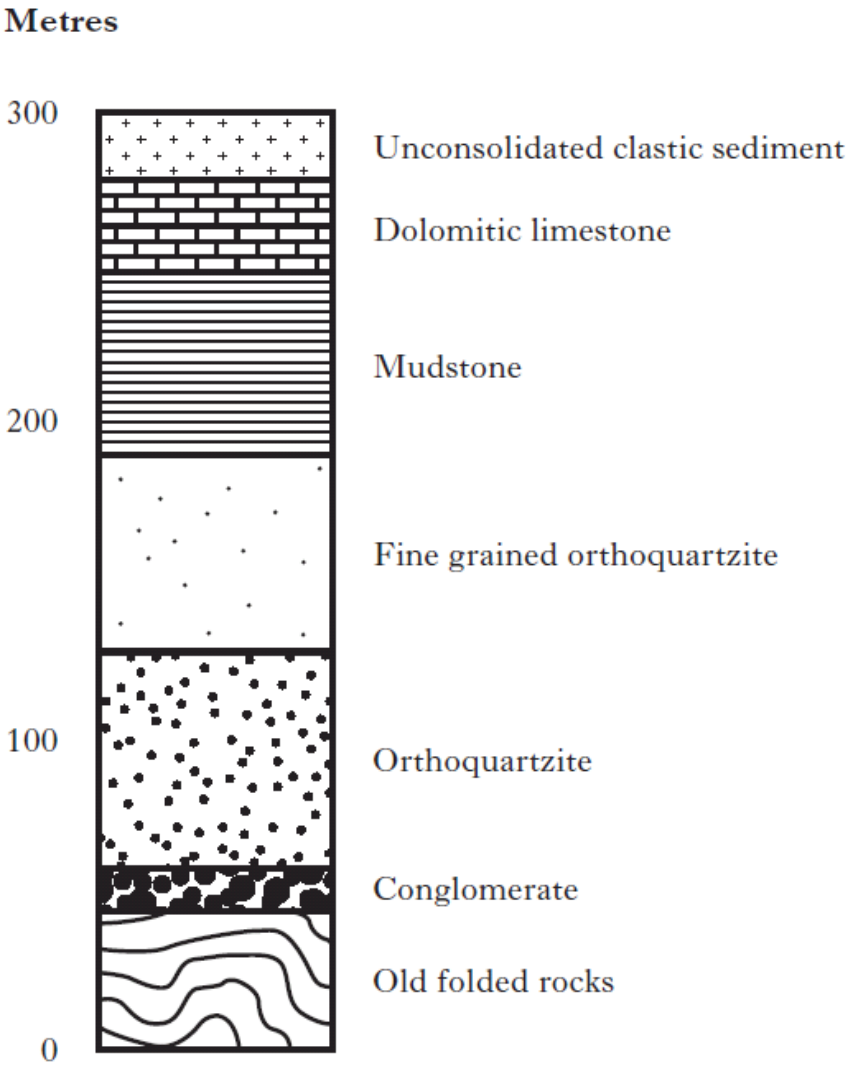
Lava flow	Distance travelled from vent (km)	Increase in viscosity of lava flow over distance travelled
Mauna Loa – Hawaii	17	2×
Mount Etna – Sicily	0.5	375×

Provide possible explanations for the difference between the two lavas.

Volume ejected could be different.
One lava silica richer than the other – chemistry of lavas different.
Lower/higher temperatures.
Gradient different between the two volcano flanks.
Water content may be different.
One eruption may be supraglacial and thus cooled quickly. **2**

	Marks

7. The diagram below shows a sequence of rocks obtained from a borehole.



(a) Chose the correct statement that best describes the sequence.

A Turbidite facies.
B Cyclothem.
C Deltaic facies.
D Marine transgression.

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

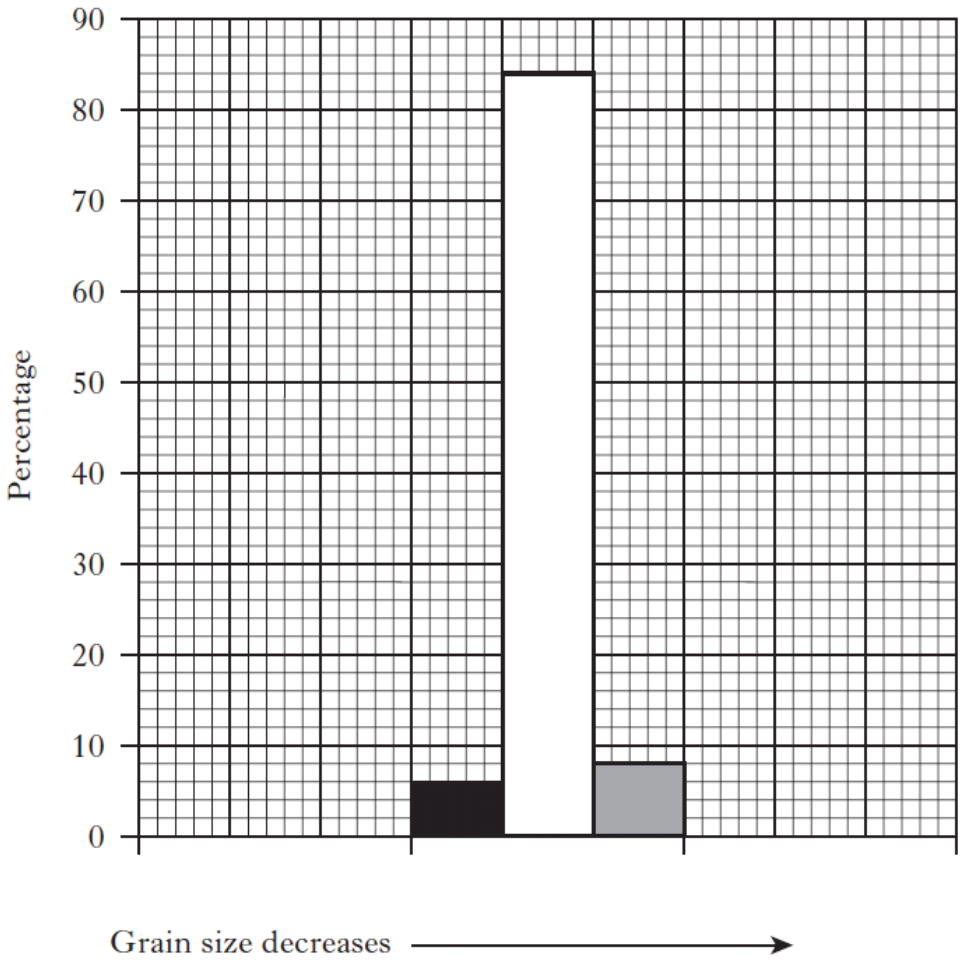
(b) Which rock is most likely to have been deposited as an evaporate?

Dolomitic limestone. **1**

(c) Why is it difficult to date sedimentary rocks using radiometric dating methods?

Contains mineral/rock fragments from a variety of other rocks of different origin/age. **1**

		Marks
(d)	The histogram below shows sediment analysis by grain size of the unconsolidated clastic sediment in the borehole.	



Describe the methods used to obtain such a sediment analysis.

Weigh the sample after drying it.
Sieve the sediment through sieve of declining mesh size.
Weigh the contents of each sieve. **2**

(e) Which statement best describes the sorting of the unconsolidated clastic sediment?

A Poorly sorted.

B Random sorted.

C Well sorted.

D Unevenly sorted.

Give only the letter **C** **1**

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 15, 16 and 17.	
	Additional space for answers may be found at the end of this book.	
8.	Write an essay on geological fieldwork.	
	Credit will be given for the use of maps and diagrams.	
	Give details as follows.	
	(a) Testing and identifying rocks and minerals in the field.	
	Colour – acid/basic igneous rock; grain size indicator of cooling rate for igneous rock, acid test for calcite; scratch test, cementing agent like iron oxide identified by red colour, hand lens to magnify minerals; foliation/ lineation of metamorphic rock.	**3**
	(b) Different methods of recording and processing information in the field.	
	Photograph exposures/macro photograph small features; field sketching; measuring dip and stike by clinometer and compass; mapping boundaries/ dykeintrusions/faults; measuring fault displacement and hade of fault; measuring clast alignment/roundness.	**3**
	(c) Using **sketch maps and diagrams**, give an account of the geology of an area you have studied. This could include: • location of the area • rock types and how they were formed • geological features and structures, eg folds, faults, fossils, igneous and sedimentary structures • methods of establishing the relative ages of the rocks, eg cross cutting relationships, way – up criteria, unconformity.	**9**
	Mark as a whole. All bullet points should be covered to gain full marks.	**(15)**
	Maximum possible (15)	

		Marks
9.	Write an essay on metamorphism.	
	Credit will be given for the use of sketch maps and diagrams.	
	Give details as follows.	
	(a) Contact metamorphism around large igneous intrusions and the changes to country rocks which may occur.	
	Hornfels/spotted rock/mudstone – structural and mineralogical change; sandstone/metaquartzite; limestone/marble – skarn – metasomatism.	**6**
	(b) Textural and mineralogical changes which may occur within sedimentary rock when they are subject to regional metamorphism. Mention rock types, metamorphic grades and metamorphic zones.	
	Limestone/foliation; pelitic rock change – slate/phylite/schist/gneiss/ migmatite; basic rock – amphibolite. Barrovarian zones – chlorite/ biotite/garnet/kyanite/sillimanite.	**6**
	(c) Dynamic metamorphism, mentioning fault breccias, slickensides and mylonite.	
	Broken rock along fault plane; polished surface/grooved; thrust fault association 'chewing gum appearance'.	**3**
		(15)

Maximum possible (15)

		Marks
10.	Write an essay on resources and reserves. **Credit will be given for the use of diagrams.** Give details as follows.	
(a)	How oil and coal are formed and extracted. **Organic origin, partial decomposition in anaerobic conditions of planktonic marine organisms. The presence of plant pigments (porphyrins) suggests petroleum has formed from algae. Potroleum forms at relatively low temperatures (porphyrins) decompose at temperatures around 200c. Planktonic remains accumulate in low energy environments to form an organic mud (sapropel).** **Anticlines Faults Unconformities Salt plugs/domes Facies/lateral variation/ wedge – edge.** **Reefs Reference should be made to source rocks/reservoit rocks/cap rocks.** **Extraction eg North Sea could include production platforms where oil is piped ashore or via tankers. Reference may be made to secondary recovery.** **For coal – burial and compaction of peat following anaerobic decay of tropical swamp vegetation.** **Mention of carboniferous, palaeo-latitude, different types of coal, grade and rank – ratio of carbon to volatiles.** **Adit mines/shaft/opencast removal of overburden.**	**8**
(b)	Factors affecting the lifetime of reserves. **Changing rates of use and/or extraction** **changes in price** **improvements in technology leading to increased discovery and/or recovery.**	**3**
(c)	Cut off grades and place value. **Explanation of the concept of how much transport costs add to the price of a mineral deposit. Diamonds have a low place value since transport costs add relatively little to their price whereas sand or gravel has a high place value and must be worked near the place of use.** **Lowest grade of ore that will recover cost of mining,**	**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 of a glassy rock taken on land after a recent eruption in south west Iceland.

Choose **three** correct statements from the list below about **rock A**.

A The rock has a glassy appearance because it has cooled quickly.

B Rocks like this are normally found in deep oceans near conservative plate margins.

C The rock has a glassy appearance because it may have been erupted underneath a glacier.

D Rocks like this are normally found in deep oceans near destructive plate margins.

E The correct term to describe this rock is a pillow lava.

F The correct term to describe this rock is a vesicular basalt.

G A possible name for this rock is obsidian.

H Rocks like this are normally associated with granitic intrusions.

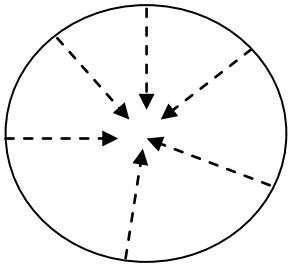
Give only the letters **A, C** and **G** — **3**

Marks

12. The photograph below shows students conducting geological fieldwork in front of an ancient volcanic vent.

Using diagrams explain why the cooling cracks form this particular pattern.

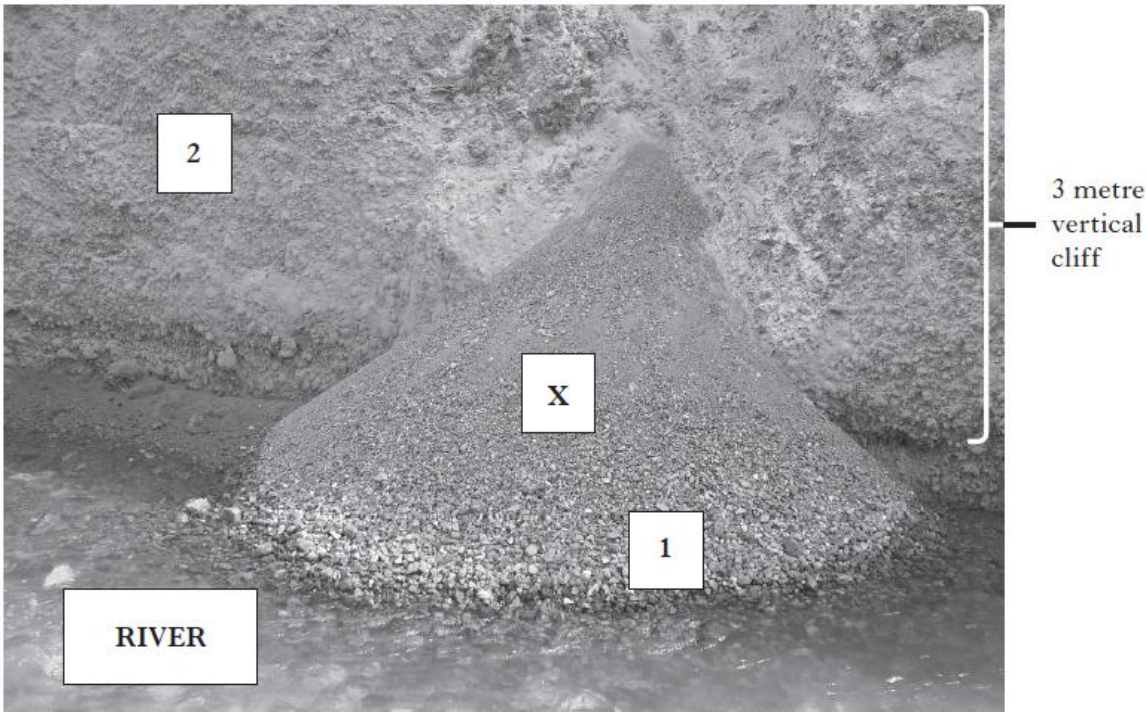
Columnar joints form at right angles to the cooling surface.
This is a cylindrical intrusion and would have had a circular contact with the country rock.
It would cool inward from the edges towards a central point.



3

	Marks

13. Look at the photograph below taken of the foot of a steep cliff face.



Choose **three** correct statements from the list below about **feature X**.

A The largest clasts are found at the foot of this feature.

B Rocks in zone 1 are older than those in zone 2 because they lie below those in zone 2.

C The rock clasts in this feature will be less rounded than the rocks in the river.

D The rock clasts in this feature will be more rounded than the rocks in the river.

E The correct term for this feature is a river cone.

F The correct term for this feature is an alluvial fan.

G The correct term for this feature is a scree slope.

H The largest clasts are found at the top of this feature.

Give only the letters **A, C** and **G** — **3**

	Marks

14. Study the map (on the **separate worksheet**) and answer the questions based on it.

(a) How many unconformities are shown?

2 **1**

(b) **(i)** What type of fault is F1?

tear fault **1**

(ii) How much movement has there been on F1?

100 metres **1**

(c) What type of igneous intrusion is the diorite?

sill **1**

Give a reason for your answer.

Follows bedding in the limestone and is folded with it.

(d) Place a letter **H** on the map where hornfels will be found. **1**

(e) On the topographic profile, (**on the separate worksheet**), complete the geological section between points X and Y on the map. **7**

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

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

(Give only the letters)

A	Formation of Gneiss
B	Folding
C	Granite intrusion
D	Faulting at F2
E	Micro diorite intrusion
F	Intrusion of basalt
G	Deposition of conglomerate, shale, limestone, sandstone
H	Micro granite dyke intrusion

(Give only the letters)

Marks

YOUNGEST

F
H
C
D
B
E
G
A

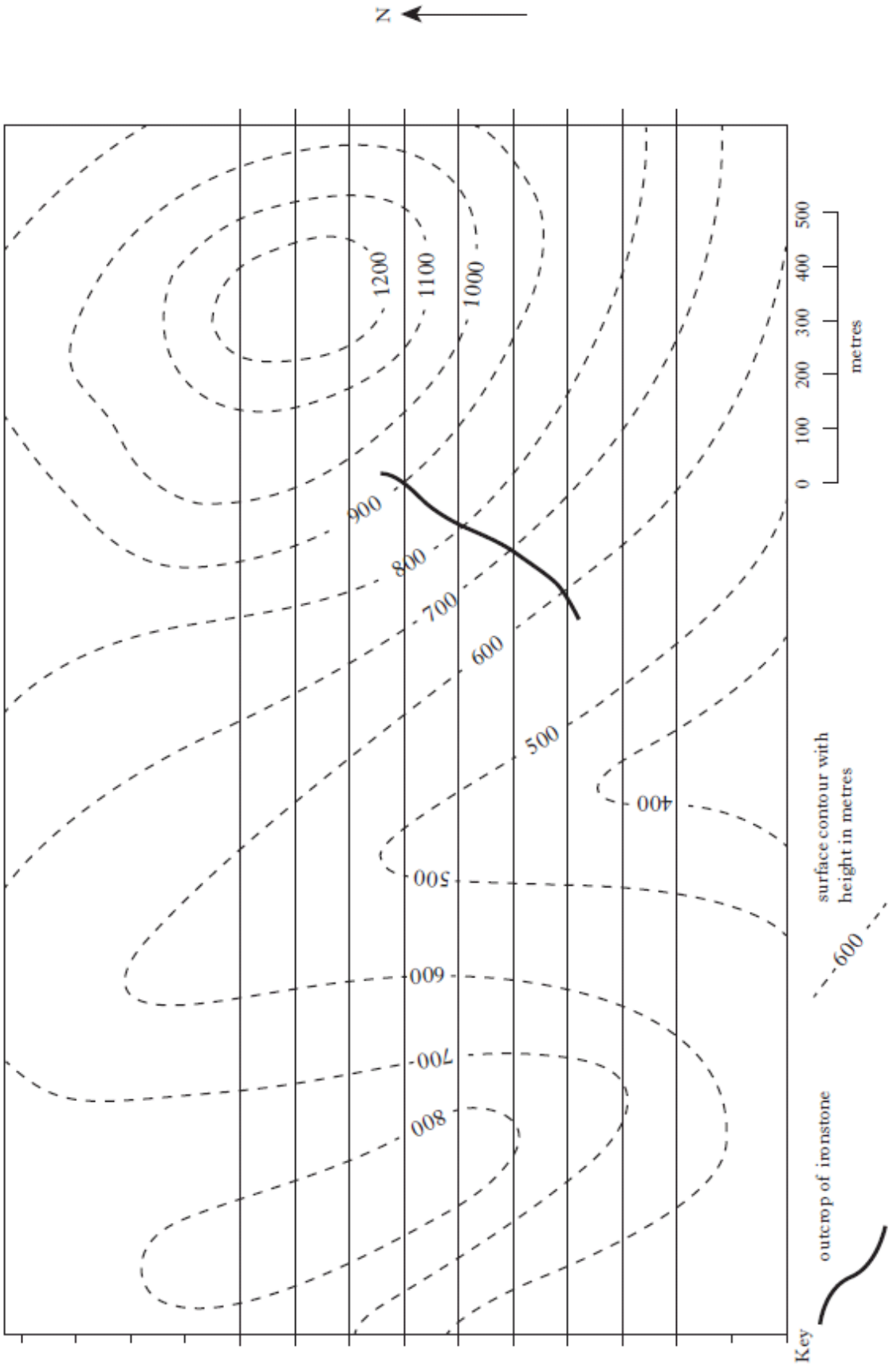
OLDEST

3 marks

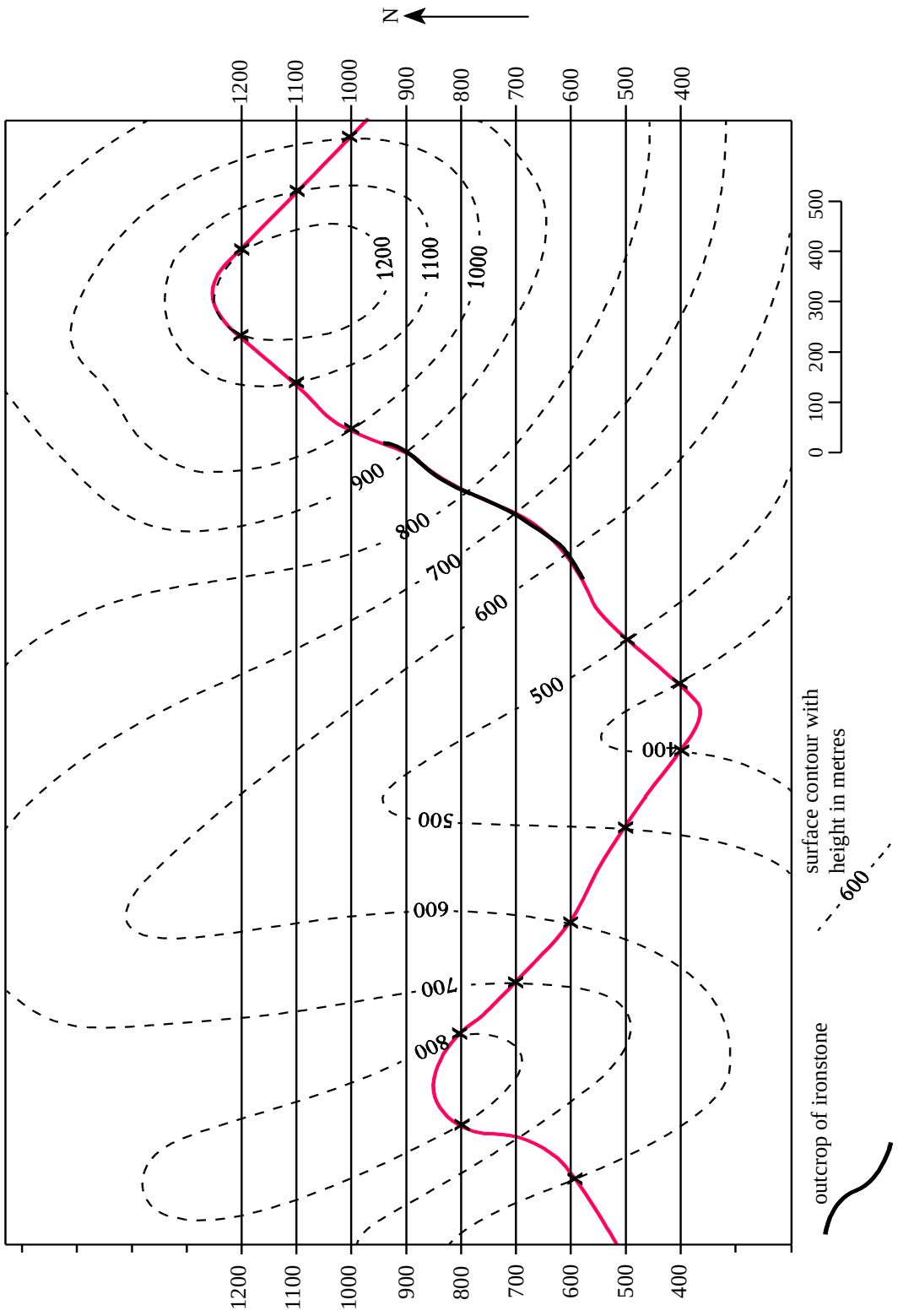
1 – 2 CORRECT = 1 MARK
3 – 4 CORRECT = 2 MARKS
5 – 6 CORRECT = 3 MARKS

Marks

15. Study the map below then answer the questions on the next page.



	Marks
The map on page 23 shows ironstone outcropping at the positions shown.	
(a) Number the structure contours for the ironstone.	**1**
(b) Draw the outcrop of the ironstone across the map.	**2**



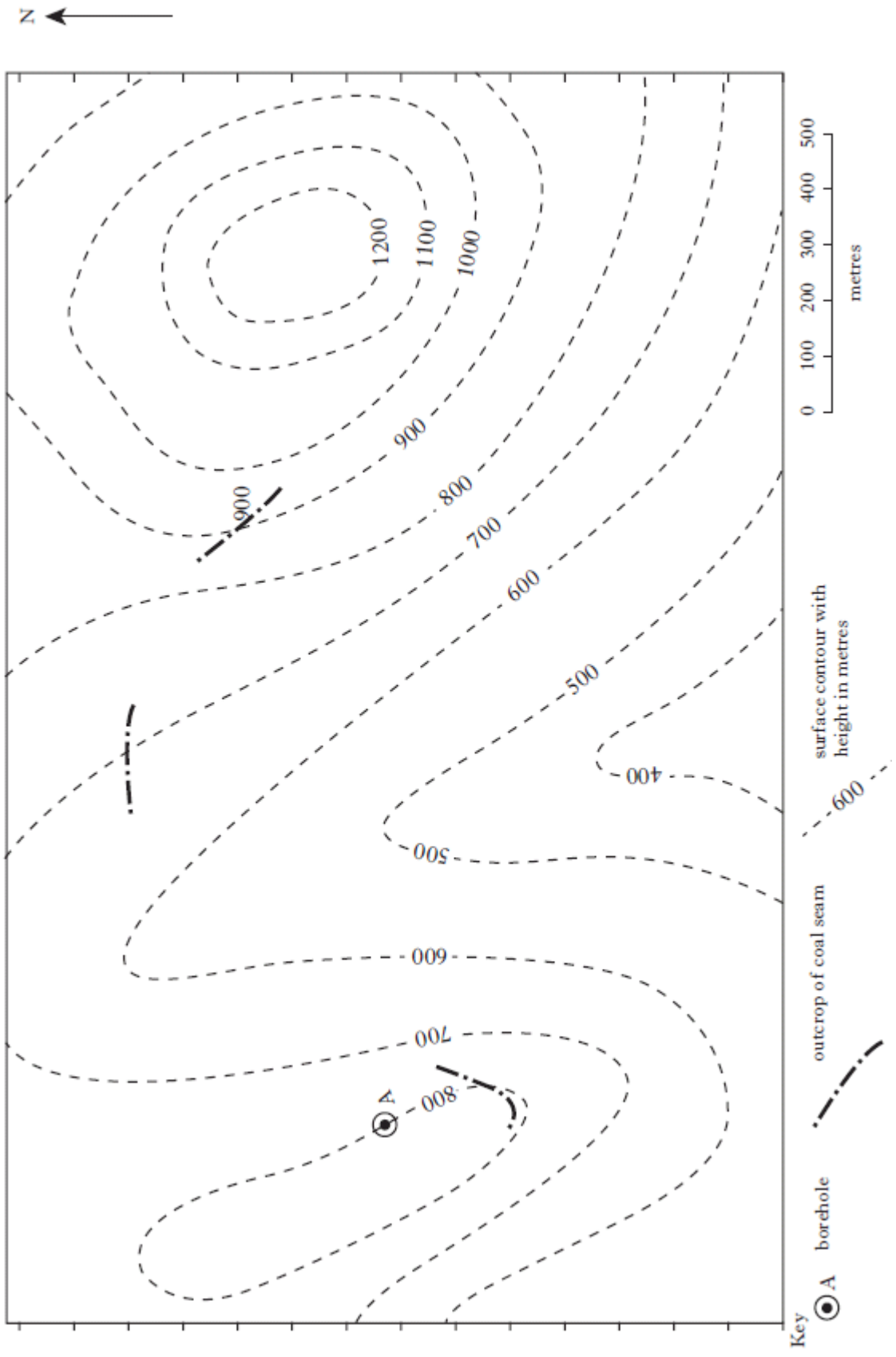
Marks
2

(c) Calculate the angle of dip of the ironstone.

Tan θ = 100/100
θ = 45º

Marks

16. Study the map below then answer the questions on the next page.

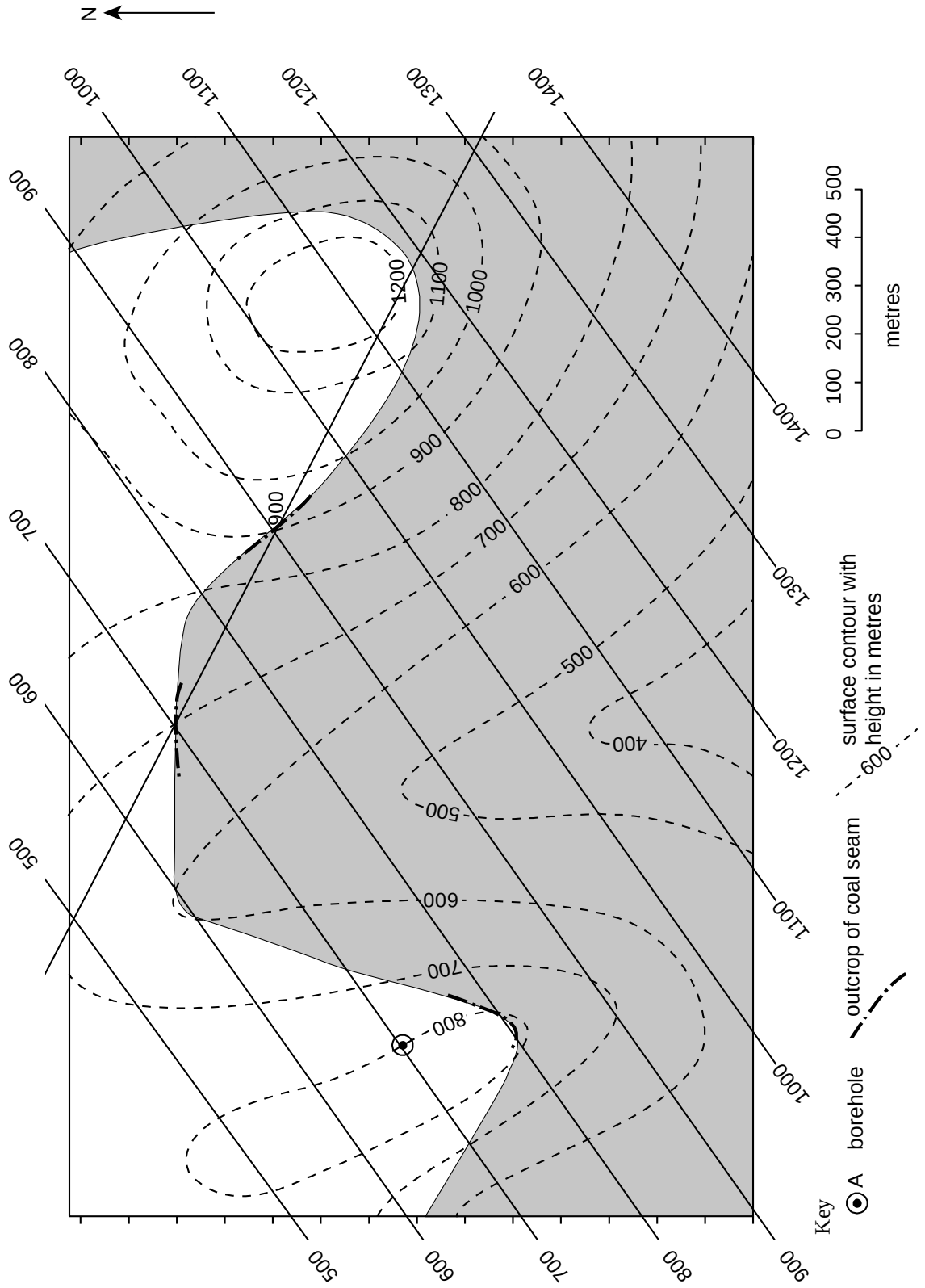


Marks

The map on page 25 shows a coal seam outcropping at the positions shown. The coal seam has a uniform dip.

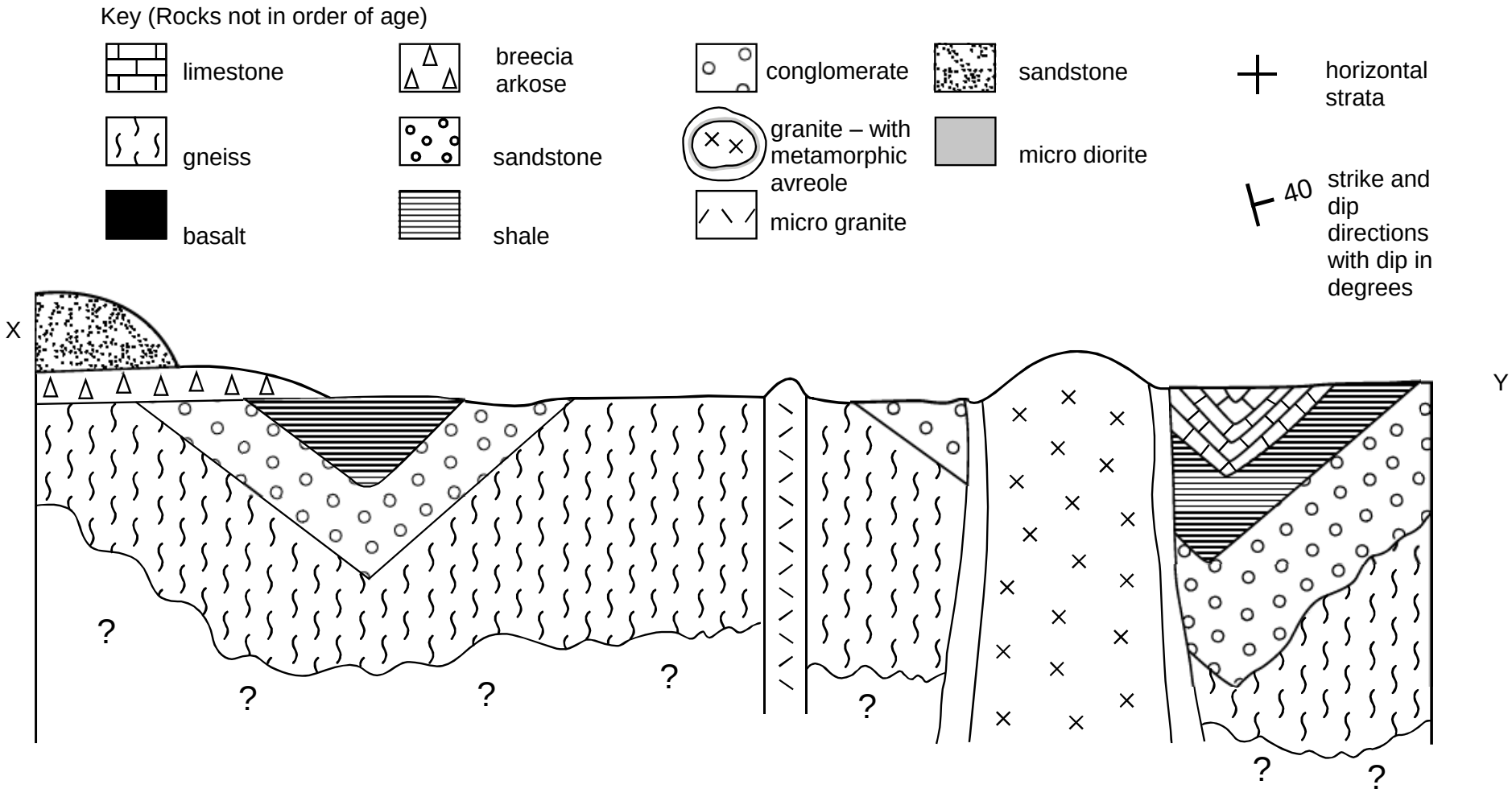
(a) Draw structure contours for the coal seam across the map. **2**

(b) Number the structure contours. **1**



		Marks
(c)	In which direction does the coal seam dip?	
	North west	**1**
(d)	At what angle does the coal seam dip? (working **must** be shown)	
	26.6º	**1**
	Space for working	
	Tan θ = 100/200 **=> = 26.6º**	**2**
(e)	Draw the outcrop of the coal seam.	**2**
(f)	At what depth below the surface will the coal seam be found in borehole A?	
	100 metres	**1**
(g)	Shade in the area not underlain by the coal seam.	**1**
	Section C: Total (40) marks	

Solution to Question 14



[END OF MARKING INSTRUCTIONS]