Geology 12

June 2000 Provincial Examination

ANSWER KEY / SCORING GUIDE

Topics:
1. Earth Materials
2. Time and Fossil Record
3. Internal Structures and Processes
4. Surficial Processes
5. Comparative Planetology

Part A: Multiple Choice

Q	K	C	T	PLO	Q	K	C	T	PLO
1.	C	U	1	B2	29.	B	U	3	K4
2.	B	U	1	B2	30.	C	U	3	K3
3.	A	U	1	B3	31.	D	H	3	K3
4.	A	H	1	B3	32.	A	U	3	K7
5.	C	H	1	C3	33.	D	U	3	K6, 7; C6
6.	D	U	1	C4	34.	C	H	3	K7, 2; A7
7.	B	H	1	C5	35.	A	K	3	K6
8.	A	U	1	C6	36.	D	H	3	L4
9.	A	K	1	D1, 3	37.	D	U	3	L1, 6
10.	D	U	1	D1, 3	38.	C	U	3	L2, 5
11.	A	U	1	D4	39.	B	K	3	M1
12.	B	U	1	E1	40.	D	U	3	N1
13.	A	U	1	E1, 4	41.	A	U	3	O3
14.	C	U	1	F1, 3	42.	B	H	3	O7, 9
15.	D	H	1	F3	43.	D	U	3	O7
16.	B	U	1	F1, 4	44.	D	U	3	O4
17.	C	K	1	F5	45.	C	K	4	R1
18.	A	U	2	G2; C7, 8	46.	A	K	4	R1
19.	C	U	2	J4	47.	D	U	4	R2
20.	C	H	2	G2	48.	D	U	4	Q4
21.	C	U	2	J6	49.	A	U	4	P4, 5
22.	C	K	2	I1	50.	D	H	4	P4, 5
23.	C	H	2	H3, 1	51.	C	U	4	Q3
24.	C	U	2	G5	52.	D	H	4	Q3
25.	C	U	2	H1	53.	C	H	5	T4
26.	D	H	2	H1, 3	54.	A	U	5	T3; D1; F8
27.	A	H	2	J7	55.	D	U	5	T2
28.	A	U	2	G2					

Multiple Choice = 55 marks

Part B: Written Response

Q	B	C	T	S	PLO
1.	1	U	1	8	A4; C2, 3, 4; D1, 3; E2
2.	2	H	1	3	D4
3.	3	U	1	2	F7
4.	4	U	2	3	J1
5.	5	U	2	3	G2, 4, 5; J5; O5
6.	6	U	2	3	G2; J4; A6
7.	7	U	3	2	K1
8.	8	U	3	1	K1, 7
9.	9	U	3	3	K1, 2, 6
10.	10	H	3	4	L4; N1, 3
11.	11	U	3	4	O4, 5, 6, 7; P2
12.	12	U	4	4	S1, 2, 4
13.	13	H	4	3	P1, 2
14.	14	U	5	2	T1, 2

Written Response = 45 marks

Multiple Choice = 55 (55 questions)
Written Response = 45 (14 questions)
EXAMINATION TOTAL = 100 marks

LEGEND:

Q = Question Number **K** = Keyed Response **C** = Cognitive Level
B = Score Box Number **S** = Score **T** = Topic
PLO = Prescribed Learning Outcome

PART B: WRITTEN RESPONSE

Value: 45 marks **Suggested Time: 55 minutes**

INSTRUCTIONS: Answer each question in the space provided. You may not need to use all of the space given.

1. A geologist collected four rock samples in the land area shown in diagram 1. Unfortunately, the labels fell off each sample. All that was left to identify each sample were field-note descriptions and a magnified view showing the microscopic make-up of each rock.

Diagram 1

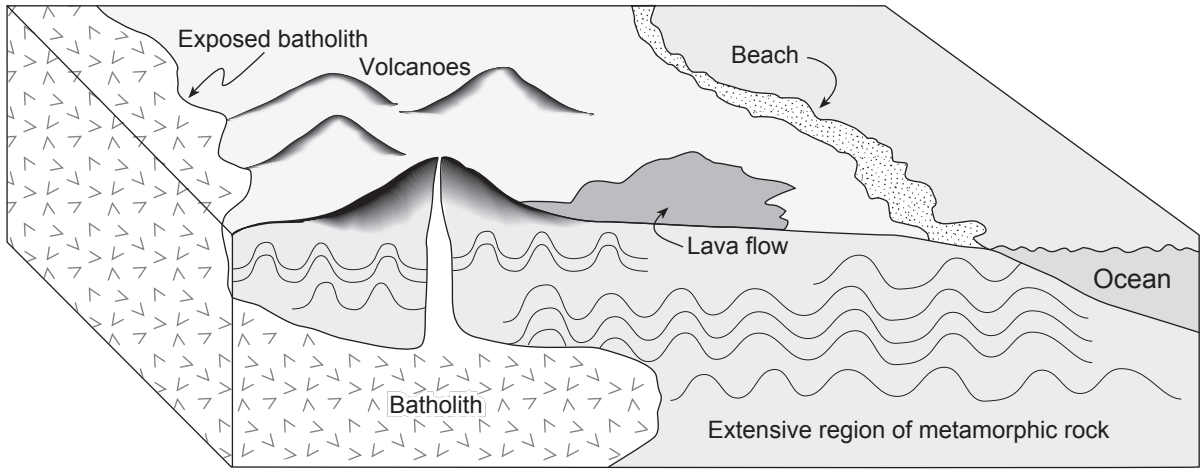
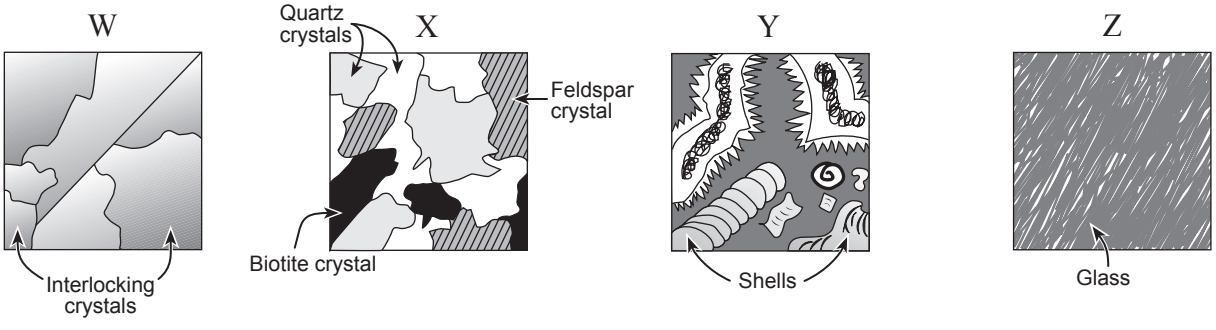


Diagram 2

Magnified view (× 30) of rock samples

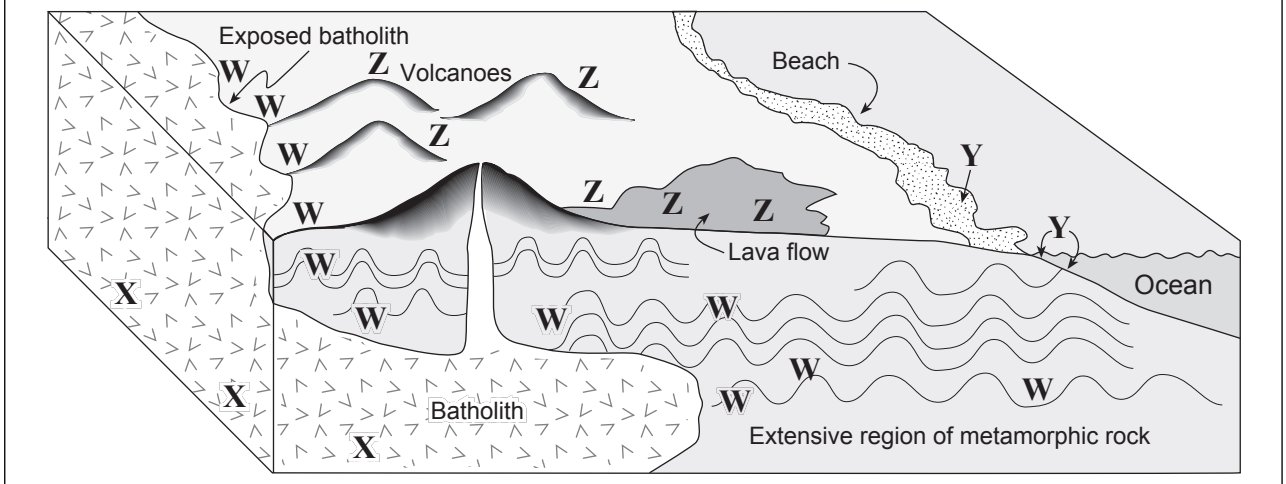


a) Complete the following table using information from diagram 2 and the description of each rock sample below. **(4 marks)**

SAMPLE	EXAMPLE	W	X	Y	Z
Description	• *large pebbles in a fine-grained matrix* • *rounded pebbles*	• tightly interlocking crystals • hardness of 7 • crystalline • granular texture	• large, interlocking crystals • light-coloured • clear, beige, pink and black crystals	• made from shells and shell fragments cemented together • reacts with dilute acid	• glassy texture • dark • slightly opaque • conchoidal fracture
Type of rock	*sedimentary*	**metamorphic**	**igneous**	**sedimentary**	**igneous**
Specific rock name	*conglomerate*	**quartzite**	**granite**	**limestone (fossiliferous)**	**obsidian**

b) For each rock sample, place its corresponding **letter** on diagram 1 in a location where it would **most likely** form. **(2 marks)**

Diagram 1



$\frac{1}{2}$ **mark** for each of the following:

W: anywhere in the metamorphosed zone
X: in the batholith area
Y: in the beach area or ocean bottom
Z: in the lava area

c) The texture of a rock tells a great deal about how that rock was formed. Pick **two** of the rocks from a) and, with reference to **texture**, describe how each rock was formed. **(2 marks)**

Any **two** for **2 marks:**

W: ***Quartzite:*** **was formed from the metamorphism of sandstone, i.e., sandstone was subjected to sufficient heat and pressure to recrystallize it as quartzite. The porosity of the original sandstone was reduced.**

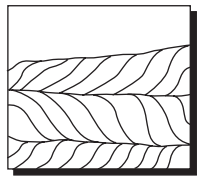
X: ***Granite:*** **the large crystals suggest a magma cooled and crystallized over a long period of time under the earth's surface.**

Y: ***Limestone:*** **shells and shell fragments were subjected to lithification which caused dissolved calcite (probably from the shells) to cement the shells together.**

Z: ***Obsidian:*** **magma reached the surface of the earth and cooled extremely rapidly, resulting in its glassy texture. On the other hand, a glassy texture may result from slow cooling of a silicic magma that is too viscous to allow the nucleation and growth of crystals. (In this situation, the rate of cooling is less significant.)**

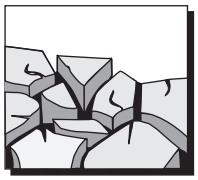
Select two of the features in Diagram 1 below to answer question 2.

Diagram 1



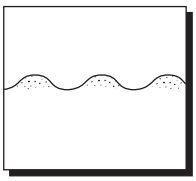
Cross bedding

Feature C



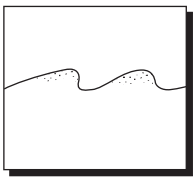
Mud cracks

Feature M



Symmetrical ripple marks

Feature S



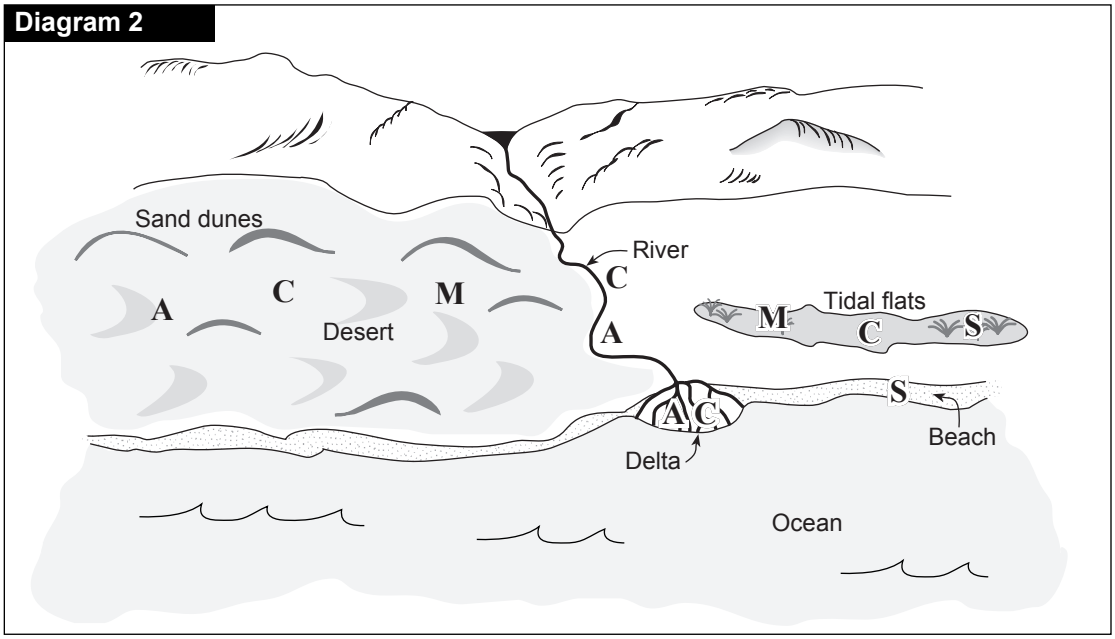
Asymmetrical ripple marks

Feature A

I have chosen feature _____ and feature _____ .

2. a) Indicate a location **where** each of the two features that you have chosen could form, by placing the letter of the feature on diagram 2. **(1 mark)**

Diagram 2



See diagram above.

1 mark for any **two** placed in the correct location:

C: desert, delta, river
M: tidal flats, desert
S: beach, tidal flats
A: river, desert, delta, tidal flats

b) Describe **how** the features you have chosen were formed. **(2 marks)**

Any **two** features for **2 marks:**

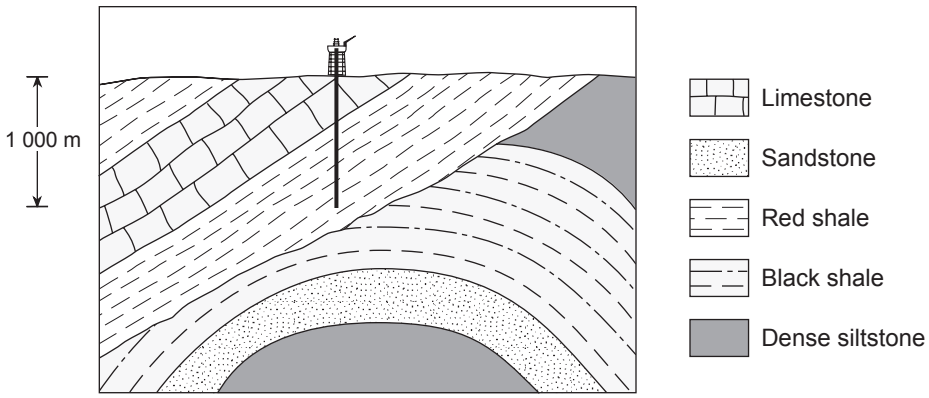
C: ***Cross bedding:*** **formed by the direction of sediment-carrying currents (water or wind).**

M: ***Mud cracks:*** **formed by the desiccation and contraction of water-saturated, clay-rich sediments.**

S: ***Symmetrical ripple marks:*** **formed by the oscillation of current motion, back and forth, as with tides coming in and out.**

A: ***Asymmetrical ripple marks:*** **formed by currents moving in one particular direction.**

Use the following cross section to answer question 3.
The well has been drilled to a depth of 1 000 m.



3. a) Referring to the cross section above, explain why this well would **not** produce oil. **(1 mark)**

This well would not produce any oil because the shale is impermeable. ← **1 mark**
No trap ← **$\frac{1}{2}$ mark**

b) Name a more appropriate layer to drill to, and explain the reason for your choice. **(1 mark)**

A porous and permeable sandstone; anticlinal trap. ← **1 mark**
Sandstone only ← **$\frac{1}{2}$ mark**

4. Paleontologists have estimated that of all the different species that ever lived on Earth, less than 1 in 5 000 left any fossil remains to show that they ever existed. Describe **three** reasons why a modern-day woodland slug is unlikely to become part of the fossil record. **(3 marks)**

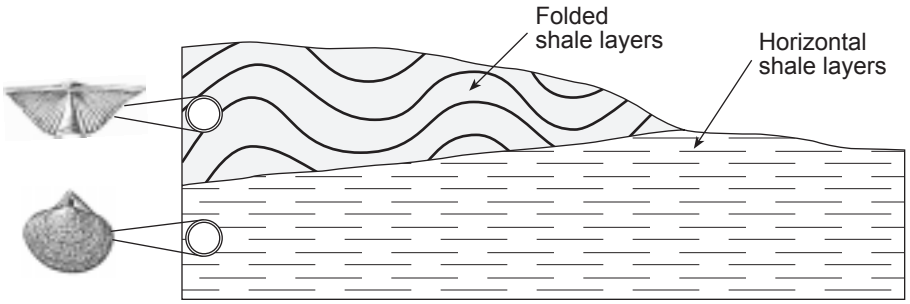
Any **three** for **3 marks:**

- **They are composed of soft material that will eventually decay and leave no trace.**
- **As the slug lives on land, it is very susceptible to the processes of weathering and erosion.**
- **The slug is likely to be consumed by predators or scavengers.**
- **It is unlikely that the slug will be rapidly buried.**
- **Slugs are not common enough to have a high chance of preservation.**
- **High oxygen → fast decomposition**
- **Need fine material burial as in a marine environment.**

REFERENCE DATA BOOKLET

Refer to pages ii and iii of the Data Booklet.

Use the Geological Time Scale and the Fossil Samples chart, along with the following geological cross section showing folded and horizontal shale layers, to answer question 5.



5. a) Both fossils shown in the cross section above belong to the same fossil group. Name the group to which they belong. **(1 mark)**

Fossil Group: **Brachiopods, Brachiopoda** ← **1 mark**

Use the following list to answer question 5b).

Types of geological boundaries

i) Unconformity
ii) Fault
iii) Undisturbed sedimentary contact

b) Three types of geological boundaries are given in the list above. Which of these boundaries **most likely** exists between the folded and horizontal shale layers? **(1 mark)**

ii) Fault ← **1 mark**

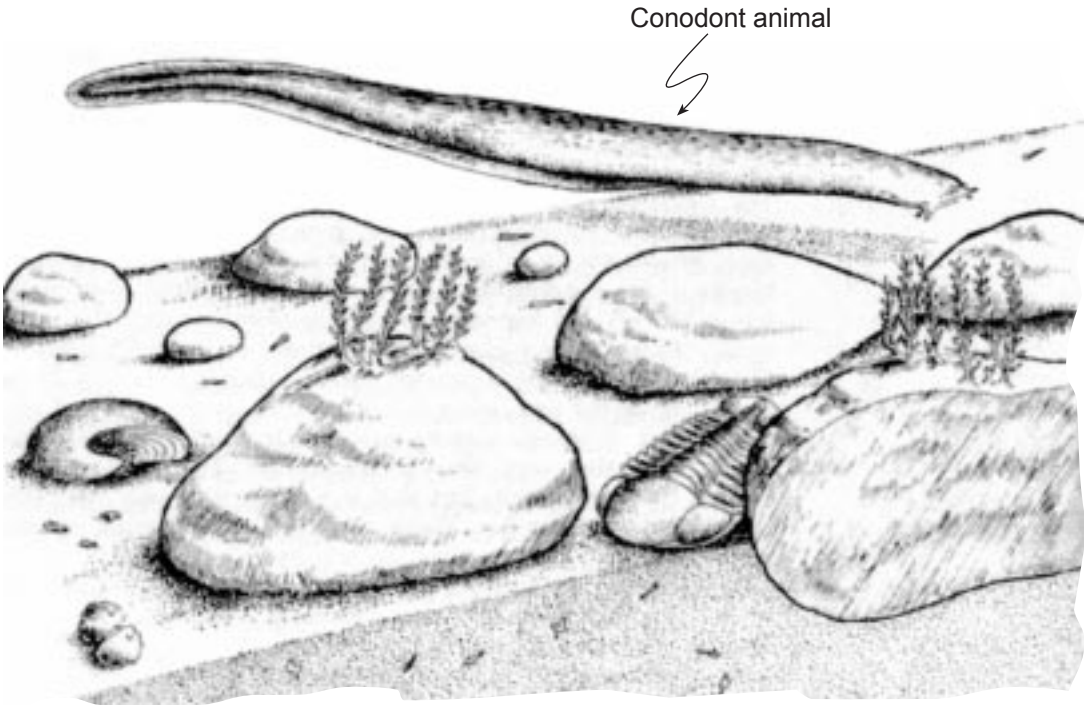
c) Give **one** reason that justifies your answer to part b). **(1 mark)**

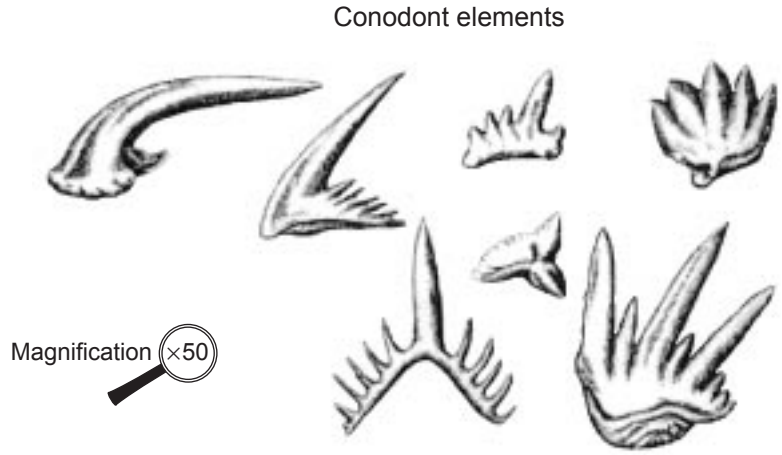
Either one for **1 mark:**

- **Older rocks are on top of younger rocks as shown by the ages of the fossils. Must be faulted.**
- **Folded rocks are on top of flat rocks, therefore the rocks on top must have been faulted on top of the flat rocks.**

Use the following description and diagrams of a conodont animal and conodont elements to answer question 6.

Conodont elements are very common, microscopic, tooth-like fossils made of the same material as vertebrate teeth. They occur in a large range of marine sedimentary rocks, ranging in age from the late Precambrian to the Triassic, and are found all over the world. Conodonts evolved rapidly into distinct forms through time. The three specimens of the conodont animal that have been found are about five centimetres long and contain the conodont elements in the head area. The elements are likely to be part of a food processing device.





6. a) The form and lifestyle of the conodont animal shown in the diagram was created by comparing its fossil remains with modern creatures. When paleontologists engage in this sort of activity, which geological principle are they applying? **(1 mark)**

Uniformitarianism ← **1 mark**

b) Give **two** reasons why conodont elements are such useful index (guide) fossils. **(2 marks)**

Any **two** for **2 marks:**

- **They are found in lots of different types of rock.**
- **They are geographically widespread.**
- **As they evolved rapidly, rocks of a particular age will likely contain different and distinct conodonts.**
- **They are distinctive – easy to recognize.**
- **The material they are made of makes them suitable for preservation.**
- **Abundant.**
- **Short time range.**

7. The continents of South America and Africa contain many features which suggest that they were once joined together and have since drifted apart. Describe **two** of these features. **(2 marks)**

Any **two** for **2 marks:**

- **The coastlines of both continents fit together quite well.**
- **The same rock types are found in matching locations on both continents.**
- **Identical fossils, widely separated, are found on both continents that could not have crossed the Atlantic.**
- **Glacial deposits and glacial striations on areas of both continents match when joined.**

(Page 67 Geology 12 IRP—Software Learning Resource: *The Theory of Plate Tectonics*.)

8. Describe a major geological feature which suggests that the Indian subcontinent has drifted into Asia. **(1 mark)**

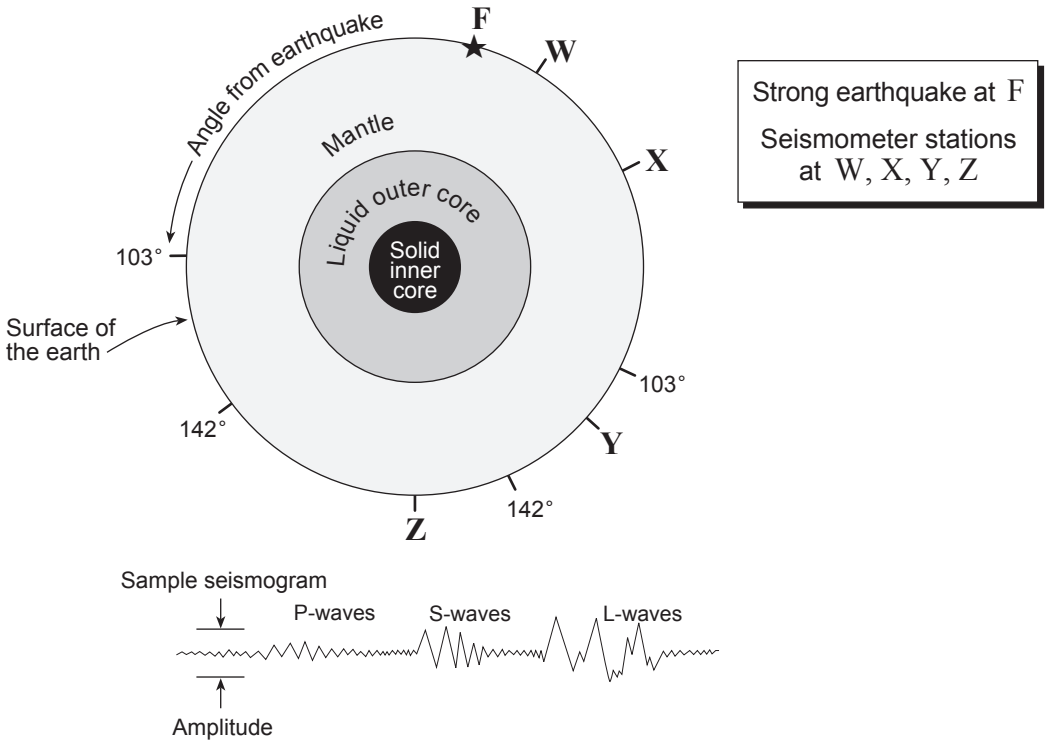
The Himalayan fold mountains in North India, South China and Tibet. ← **1 mark**

9. Describe **three** pieces of evidence which demonstrate that sea-floor spreading is occurring. **(3 marks)**

Any **three** for **3 marks:**

- **The linear patterns of shallow earthquakes along the oceanic rift and transform faults.**
- **The age of rock across the sea floor (younger at the ridge – getting older moving away).**
- **Thin sediments at the ridge – they are thicker away from the spreading centre.**
- **Higher heat flow at the spreading centre.**
- **Active volcanism or new rock at the ridge.**
- **Symmetrical magnetic strips.**
- **Increasing size of the Atlantic ocean.**
- **Satellite measurements.**

Use the following sketch of the cross section of the earth to answer question 10.



10. A strong earthquake occurred at location **F**.

a) The time difference between the arrival of P- and S-waves is known as the P- and S-wave interval. Describe how the P- and S-wave interval varies between stations **W** and **X**. **(1 mark)**

There is a greater P- and S-wave interval at station X than at Station W. ← **1 mark**

b) Describe the difference in amplitude between direct path P-waves at station **W** and at station **X**. **(1 mark)**

There is less amplitude at station X than at station W. ← **1 mark**

c) Explain why no direct path S-waves would be recorded at station **Z**. **(1 mark)**

S-waves are absorbed by the liquid outer core before they reach station Z. ← **1 mark**

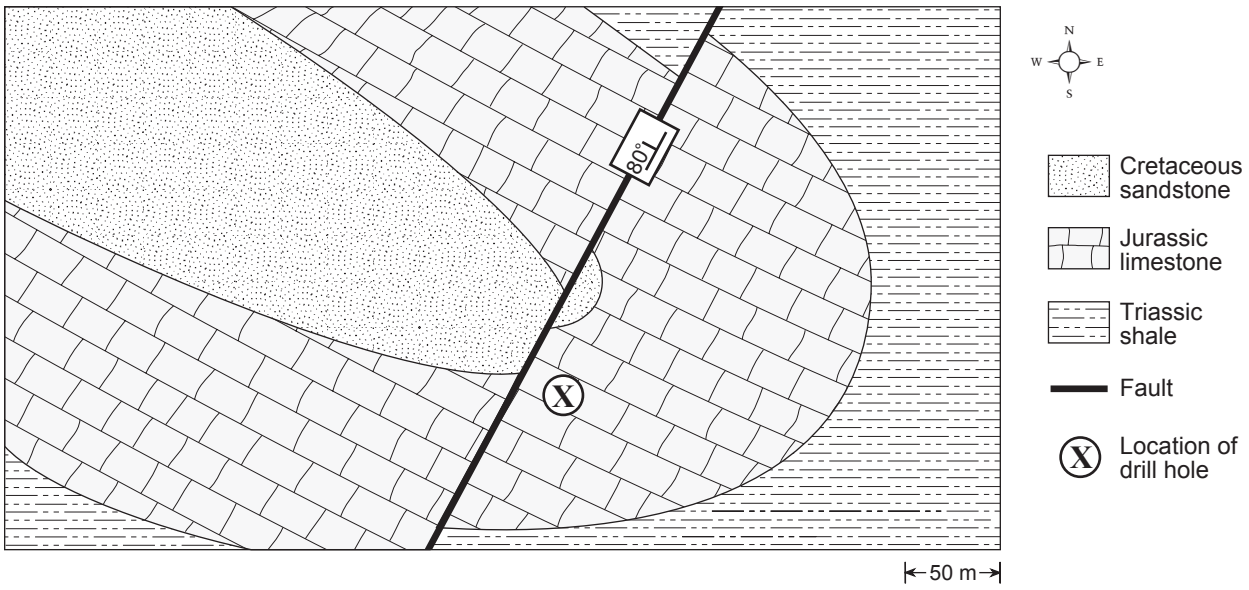
d) Explain why no direct path P-waves would be recorded at station **Y**. **(1 mark)**

P-waves are refracted away as they cross the core boundary, therefore they are not recorded at station Y. } ← **1 mark**

REFERENCE DATA BOOKLET

Refer to page ii of the Data Booklet.

Use the Geological Time Scale and the following map to answer question 11.
The map shows outcrops of rocks in a generally flat area.
A slight depression occurs along the fault trace.



11. a) A geologist has determined that the fold structure shown above is a syncline. Describe the evidence that helped her come to this conclusion. **(1 mark)**

The youngest rocks are in the centre of the structure. ← **1 mark**

b) Describe the type of plate tectonic situation where a fold of this type would **most likely** be formed. **(1 mark)**

This type of fold is usually formed by compression and is therefore most likely to be produced where plates are converging/subducting. } ← **1 mark**

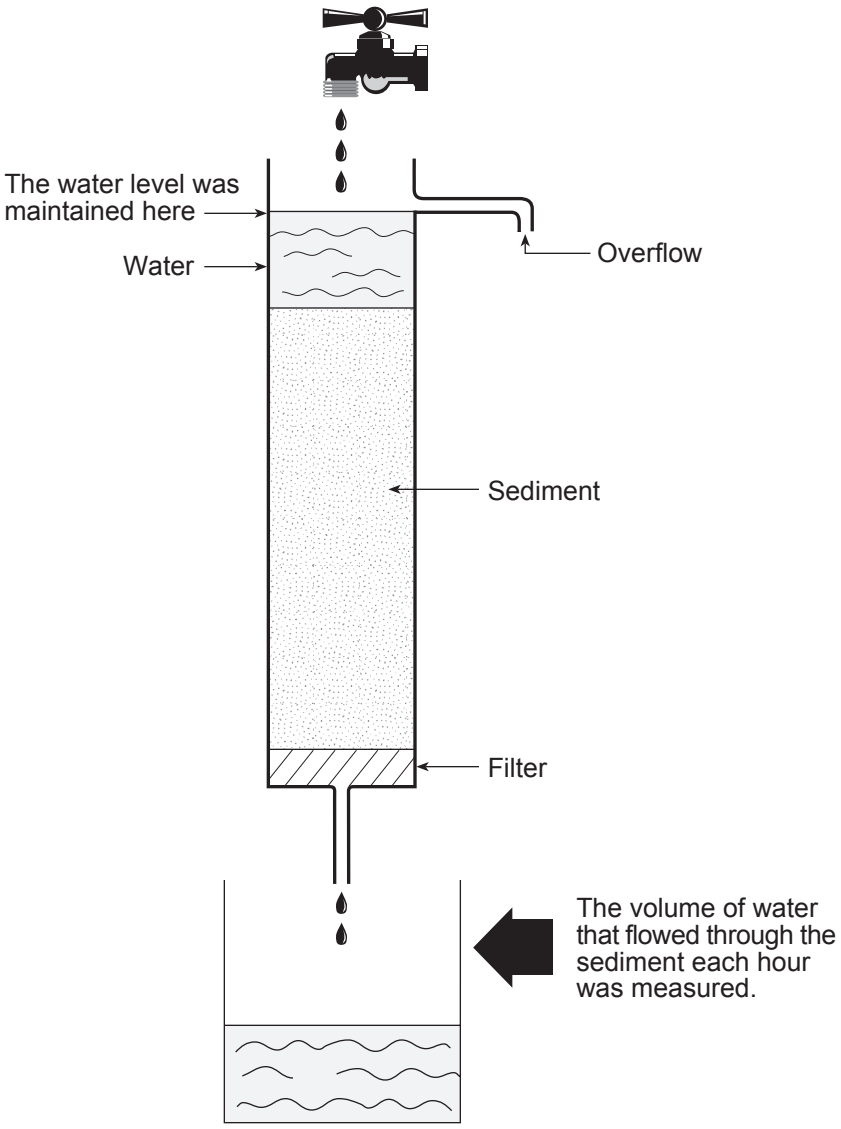
c) Explain why the fault would not be crossed by a vertical drill hole at **X**. **(1 mark)**

The dip of the fault is to the north west and away from the drill hole. ← **1 mark**

d) Explain why there would be a depression in the ground along the fault trace. **(1 mark)**

The rock is fractured by the motion of the fault and is more easily weathered and eroded. } ← **1 mark**

Use the following diagram and table to answer question 12.



Sediment	Flow rate of water (litres per hour)	Porosity (%)
Well-sorted gravel	3 000	30
Well-sorted sand	250	40
Well-sorted silt	0.5	45
Well-sorted clay	0.0001	55
Silty sand	5	20
Glacial till	0.2	10

12. A student used the equipment shown on the previous page to determine the rate of water flow through a variety of sediments. The student also measured the porosity of each material by determining how much water was required to completely saturate the dry sediment.

a) **According to the data** for the well-sorted sediments, what is the relationship between particle size and porosity of the sediments? **(1 mark)**

The smaller the particle size, the greater the porosity, or:
The larger the particle size, the smaller the porosity. } ← **1 mark**

b) Which of the six sediments listed in the table would make the **best** seal to stop toxic waste from leaching from a toxic waste pond? Give a reason for your answer. **(2 marks)**

Sediment: **Clay** ← **1 mark**

Reason: **Clay has the smallest flow rate, and thus the lowest permeability.**
The toxic waste would move through very slowly. } ← **1 mark**

c) Give a reason why the permeability and porosity of the silty sand is so different from the permeability and porosity of the well-sorted sand. **(1 mark)**

The smaller silt particles tend to fill the spaces between the sand particles, therefore reducing both the porosity and the permeability. } ← **1 mark**

REFERENCE DATA BOOKLET

Refer to page ix of the Data Booklet.

Use Photograph 9 which shows vertical alternating layers of light-coloured limestone and dark-coloured shale to answer question 13.

13. a) Referring to the photograph, describe evidence which shows that the limestone and the shale are weathering at different rates. **(1 mark)**

The limestone is protruding much higher from the ground. It must therefore be much more resistant than the shale. } ← **1 mark**

b) Describe **one** type of chemical weathering that could be affecting the layers. **(1 mark)**

Any description of chemical weathering for **1 mark**, e.g.:

- **Minerals being dissolved by carbonic acid (rainwater) or acid rain.**
- **Oxidation of the minerals.**
- **Minerals such as feldspar being converted to clay by the action of carbonic acid.**
- **Hydrolysis.**

c) Describe **one** type of biological weathering that is likely affecting the layers. **(1 mark)**

Any description of biological weather for **1 mark**, e.g.:

- **Tree roots prying open cracks or joints in either rock.**
- **Organic acids associated with roots in moss dissolving the rocks.**
- **Human activities.**
- **Burrowing animals.**

REFERENCE DATA BOOKLET

Refer to page x of the Data Booklet.

Use the Basic Data on the Solar System chart to answer question 14.

14. a) Density can be used to divide the planets into two groups: the inner and outer planets. What difference in **composition** would account for the difference in density of the two groups? **(1 mark)**

The inner planets are rocky and metallic, while the outer planets are largely composed of hydrogen, helium and other gases. } ← **1 mark**

b) Describe how the Nebular Theory of the origin of the solar system explains the difference in density between the inner and outer planets. **(1 mark)**

Any 1 for **one mark**:

- **Only high temperature materials (rock and metal) could condense near the sun and low temperature materials (hydrogen, helium, etc.) would condense in cooler regions away from the sun.**
- **Gravitational pull pulls dense material to centre.**
- **Solar winds stripping lighter volatiles from inner planets.**

END OF KEY