Geology 12

June 2002 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	S	CO	PLO	Q	K	C	S	CO	PLO
1.	B	U	1	1	A4, 6	29.	D	K	1	3	K3, 6, 7, 2
2.	C	U	1	1	B1	30.	A	U	1	3	K6, 7
3.	C	U	1	1	B2	31.	D	U	1	3	K5, 6, 7
4.	B	U	1	1	B3	32.	B	H	1	3	K2; A7
5.	C	H	1	1	B2, 3	33.	C	U	1	3	L4
6.	A	U	1	1	C3	34.	C	U	1	3	L2
7.	D	U	1	1	C1, 2	35.	B	U	1	3	L5
8.	C	U	1	1	C5	36.	A	U	1	3	L5; K3, 7
9.	D	U	1	1	C6, 7; D4	37.	C	U	1	3	M1
10.	B	U	1	1	D1	38.	C	U	1	3	N1, 3
11.	D	U	1	1	D3	39.	B	H	1	3	N3
12.	B	U	1	1	D4	40.	B	U	1	3	O2
13.	C	U	1	1	E2	41.	B	H	1	3	O7
14.	C	K	1	1	E3	42.	B	U	1	3	O6, 7
15.	B	H	1	1	F1, 4	43.	D	H	1	3	O5, 3
16.	D	H	1	1	F4, 7	44.	A	U	1	3	O4
17.	B	K	1	1	F7	45.	A	K	1	4	Q3
18.	B	K	1	2	G2, 3	46.	D	U	1	4	Q3
19.	C	H	1	2	G2, 5; I2	47.	A	U	1	4	Q1, 2
20.	A	H	1	2	G2, 3, 5; I2	48.	C	H	1	4	Q1, 2, 4
21.	A	H	1	2	G2, 5; H4	49.	C	K	1	4	R1; O2; J2, 3; F1
22.	A	U	1	2	G2, 4	50.	D	U	1	4	Q4; R1
23.	C	U	1	2	H1; I2	51.	D	U	1	4	R1, 2
24.	B	U	1	2	I1; J7	52.	A	U	1	4	P4, 5
25.	B	U	1	2	J2, 3	53.	A	U	1	5	T1
26.	B	U	1	2	J6, 5	54.	C	K	1	5	T3
27.	C	H	1	2	J4, 5	55.	B	H	1	5	T2
28.	B	U	1	2	J7						

Multiple Choice = 55 marks

Part B: Written Response

Q	B	C	T	S	PLO
1.	1	U	1	6	A5; C1, 2, 3, 4, 6, 7, 8; D1; Q1, 2
2.	2	U	1	3	D1, 2, 4; R1; Q2, 4
3.	3	K	1	2	F2, 3, 4, 5, 8
4.	4	U	2	3	J1, 2, 7
5.	5	U	2	2	H1, 3
6.	6	U	2	4	G2, 5
7.	7	U	3	2	K2, 6, 7
8.	8	H	3	2	K7, 3
9.	9	U	3	2	K8, 7; E1, 4
10.	10	H	3	3	N1, 3; L4
11.	11	U	3	5	O6, 7, 9, 10
12.	12	H	4	4	S2, 3, 4
13.	13	U	4	5	P2, 3, 4
14.	14	U	5	2	T3; Q3; K6

Written Response = 45 marks

Multiple Choice = 55 (55 questions)
Written Response = 45 (14 questions)

EXAMINATION TOTAL = 100 marks

LEGEND:

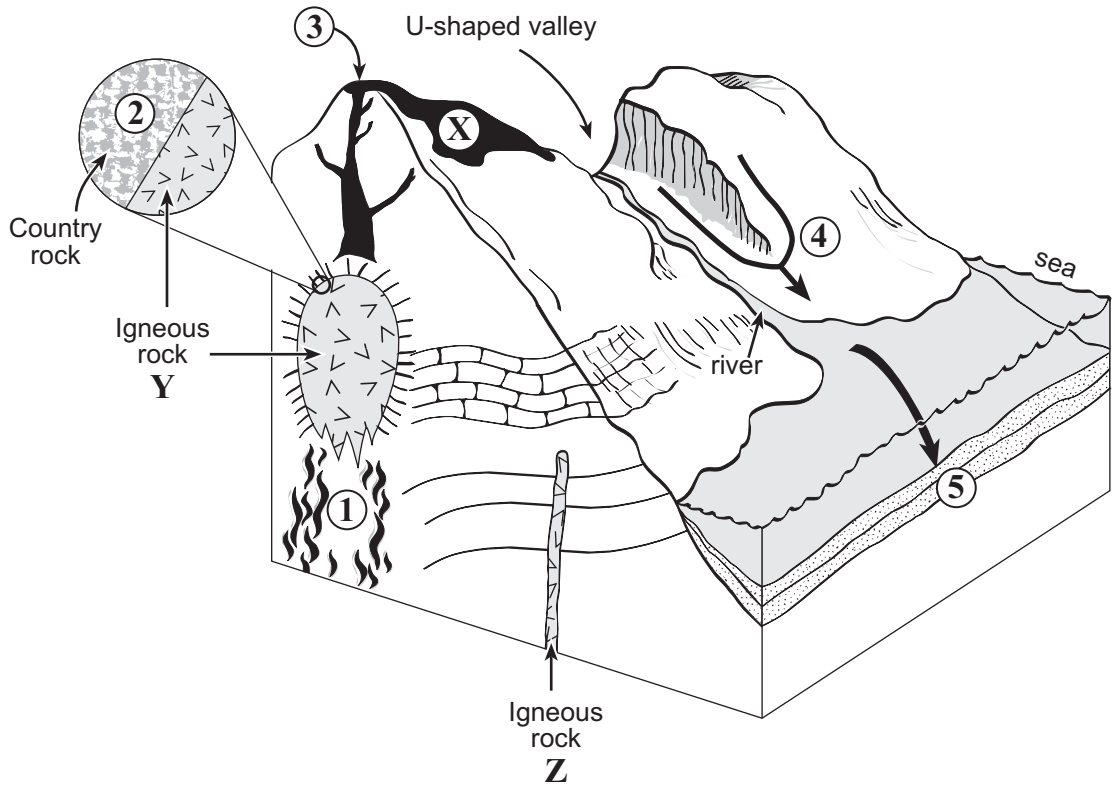
Q = Question Number
B = Score Box Number
PLO = Prescribed Learning Outcome
K = Keyed Response
S = Score
C = Cognitive Level
T = Topic

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.

Use the following diagram to answer all parts of question 1.



1. a) Complete the table below by describing the processes that occur at the numbered locations in the diagram above. An example is given for number 1. **(2 marks)**

½ mark for each correct answer. Total 2 marks

Number	Process
1	*Example: molten material rises*
2	**contact metamorphism**
3	**eruption of molten material**
4	**weathering, erosion and transport of sediments**
5	**deposition of sediments**

REFERENCE DATA BOOKLET

For questions 1b) to 1d), refer to the following in the Data Booklet.

page xiv: Percentage of Minerals in Igneous Rocks

b) Explain why rock **Z** is finer-grained than rock **Y**. **(1 mark)**

Rock Z cooled more rapidly that rock Y. ← **1 mark**

c) Igneous rock **Y** contains 30% dark ferromagnesians and 60% white plagioclase feldspar. What is the name of this rock? **(1 mark)**

diorite ← **1 mark**

d) What is the name of the geologic structure formed by igneous rock **Z**? **(1 mark)**

The geologic structure is a dike/pipe/volcanic neck. ← **1 mark**

REFERENCE DATA BOOKLET

For question 1e), refer to the following in the Data Booklet.

page viii: Photograph 9

e) Photograph 9 shows pyroclastic material found at location **X** in the diagram. Describe how this pyroclastic material formed. **(1 mark)**

Fragmented material produced by explosions during eruption. ← **1 mark**

Use the following diagrams to answer question 2.

Figure 2.1

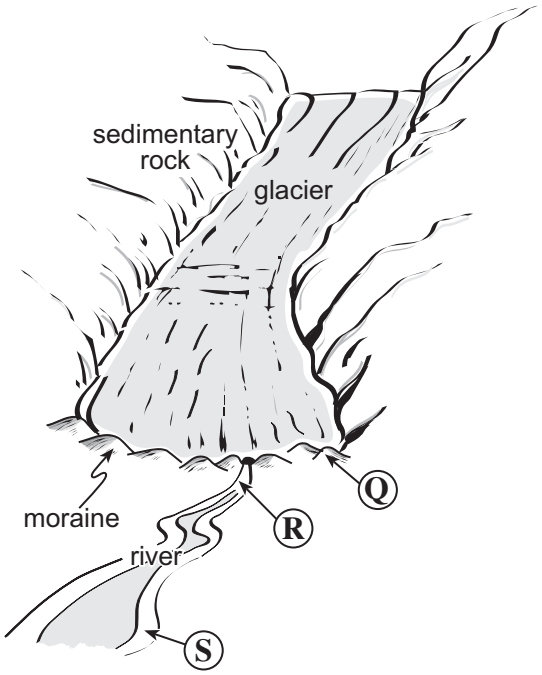
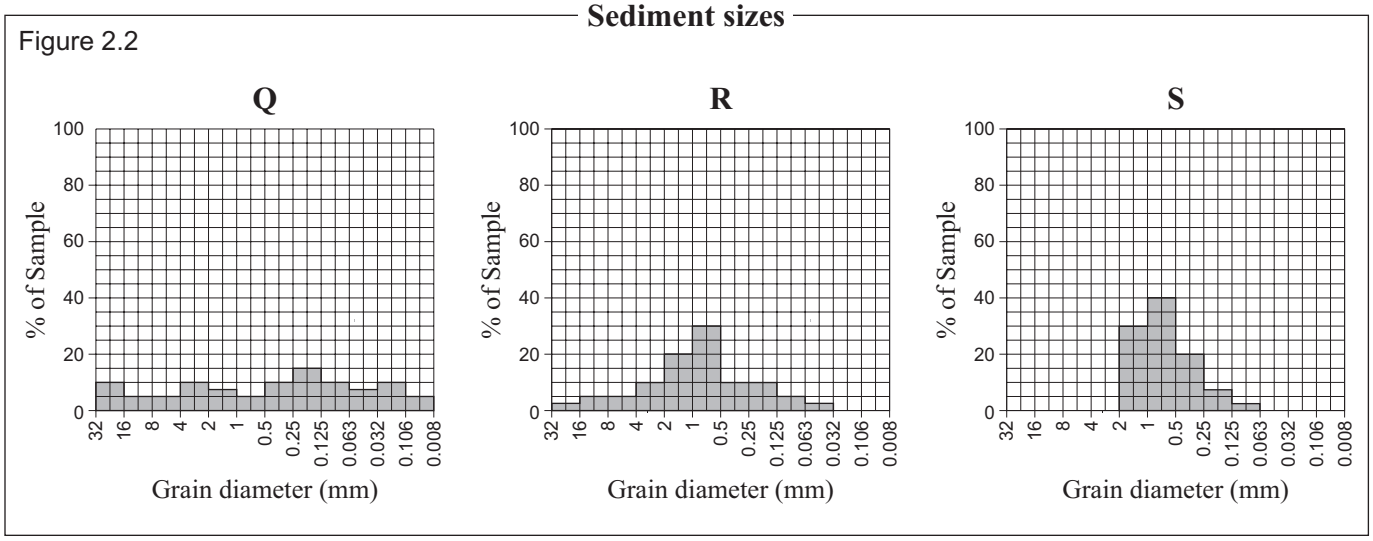


Figure 2.2



2. Figure 2.1 shows a glacial environment. Figure 2.2 shows the particle size distribution of the sediments found at locations **Q**, **R** and **S** in Figure 2.1.

a) With reference to Figure 2.2, describe a characteristic of the sediment found at **Q**. **(1 mark)**

Sediments at Q are poorly sorted. ← **1 mark**

b) Why is the particle size distribution at **S** different from that at **Q**? **(1 mark)**

The particles at S have been transported by fluvial processes. Small particles have been washed away and larger particles have been left behind. } ← **1 mark**

c) Sand-sized particles have been extracted from Q and S. How would the shape of particles from **Q** compare with the shape of particles from **S**? **(1 mark)**

Sediments at S would have slightly rounded grains due to transport, while sediments at Q would most likely be more angular. } ← **1 mark**

3. Complete the table below to show how the earth's resources of coal and gravel are formed and used. **(2 marks)**

½ mark for each correct answer. Total 2 marks

Earth resource	How it formed	One use
Example: **Rock salt (halite)**	*evaporation of sea water*	*road salt*
Coal	• **burial of woody material from swamps/forest**	• **generates electricity** • **petrochemicals** • **steel production**
Gravel	• **erosion, transport and deposition of sediments** • **glacial deposition**	• **construction** • **concrete**

REFERENCE DATA BOOKLET

For questions 4 and 5, refer to the following in the Data Booklet.

page i: Geologic Cross Section
page ii: Geological Time Scale
page iii: Fossil Samples

4. After an extensive search of Precambrian unit **U**, the only fossils that geologists could find were a number of worm burrows and an impression of a jellyfish.

a) What kind of fossil is formed from worm burrows? **(1 mark)**

trace fossil ← 1 mark

b) Give **one** reason why no evidence of other organisms was found in unit U. **(1 mark)**

Either one for 1 mark:

- **No organisms with hard parts existed in the Precambrian—hard parts hadn't evolved.**
- **No organisms with hard parts lived in the area represented by these rocks.**

c) Despite a thorough, worldwide search in Precambrian rock, no vertebrate fossils have ever been found. Explain why. **(1 mark)**

Vertebrates had not evolved at this time. ← 1 mark

5. Unit **S** at the base of the canyon section is an intensely folded and metamorphosed basalt. The metamorphosed basalt has been dated using two different techniques, resulting in two widely different ages. Both ages are considered to be accurate.

State what events the two different radiometric dating methods are measuring. **(2 marks)**

$^{238}U/^{206}Pb$ dating method:

The older age of the metabasalt is probably the actual age when the basalt crystallized. } ← **1 mark**

$^{40}K/^{40}Ar$ dating method:

The younger age, determined by $^{40}K/^{40}Ar$ is the time when the lava was metamorphosed and all the argon was released—i.e., the original age was reset. } ← **1 mark**

REFERENCE DATA BOOKLET	*For question 6, refer to the following in the Data Booklet.* **page viii: Photograph 10 and the cross-sectional sketch**

6. Examine the rock sequence shown in the lower half of Photograph 10 and the cross-sectional sketch.

   a) List four processes in order, from oldest to youngest, that have occurred between the deposition of unit **X** sediments and the deposition of unit **Z** sediments. **(3 marks)**

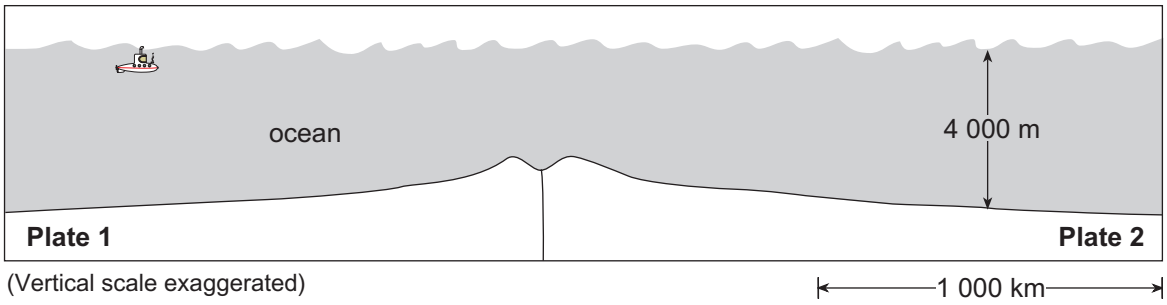
$\frac{1}{2}$ mark for each correct process. 1 mark for correct order. Total 3 marks.

youngest	*deposition of unit Z sediments*
4	**deposition of sediment Y**
3	**weathering and erosion of unit X**
2	**folding and deformation of unit X**
1	**lithification of unit X**
oldest	*deposition of unit X sediments*

   b) An angular unconformity exists between unit **X** and unit **Y**. Describe evidence, visible in the photograph, for this feature. **(1 mark)**

There are tilted layers underneath horizontal layers. ← 1 mark

The following cross-section sketch shows the seafloor at a typical mid-ocean ridge.



7. Describe any **two observable** and **measurable** pieces of evidence which would show that the seafloor is spreading in this area. **(2 marks)**

Any two for 1 mark each:

- **symmetrical magnetic striping**
- **active basaltic volcanism at the rift** $\left(\frac{1}{2}\right.$ **mark**$\left.\right)$
- **there is younger rock at the ridge, and older rock further from the ridge**
- **there are less sediments at the ridge, and a greater depth of sediments further from the ridge**
- **there are younger fossils in sediments near the ridge, and older fossils further from the ridge**
- **there is a rift valley**
- **GPS detecting crustal movement over time**
- **mirror image topography**

8. Complete the table below, describing the differences between earthquakes at subduction zones and at transform faults. An example is provided. **(2 marks)**

1 mark for each correct answer. Total 2 marks

	Earthquakes at subduction zones	**Earthquakes at transform faults**
Example: **Magnitude**	*low to very high*	*low to high*
Depth of foci	• **shallow at trench, deeper away from trench** • **under over-riding plate**	• **shallow along the trace**

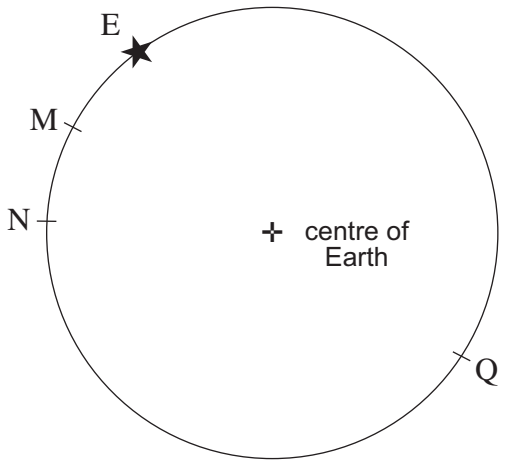
9. Metamorphic rock can be formed at some types of plate boundaries. Name a type of boundary where large volumes of metamorphic rock could be found and describe how they would have formed. **(2 marks)**

Plate boundary type: **convergent, subduction, collision**

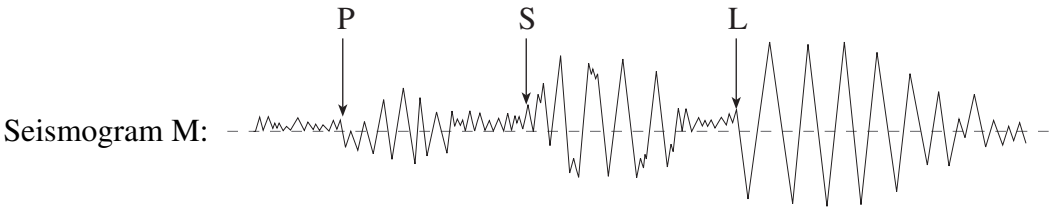
Description of formation: **from pressure of the plate and heat from being pushed down into the mantle.**
heat and pressure on country rock as the magma formed at subduction intrudes.

Use the following sketch of a cross section of the earth which shows an earthquake at E and seismograph stations at M, N and Q, to answer question 10.

Assume the seismograph stations at M, N and Q have equivalent sensitivity.



10. a) Using the line below as a centre line for seismogram **N**, sketch the seismogram showing the P, S and L waves that would be recorded at N to show at least two differences between seismogram N and the one recorded at M. **(2 marks)**



Seismogram N:

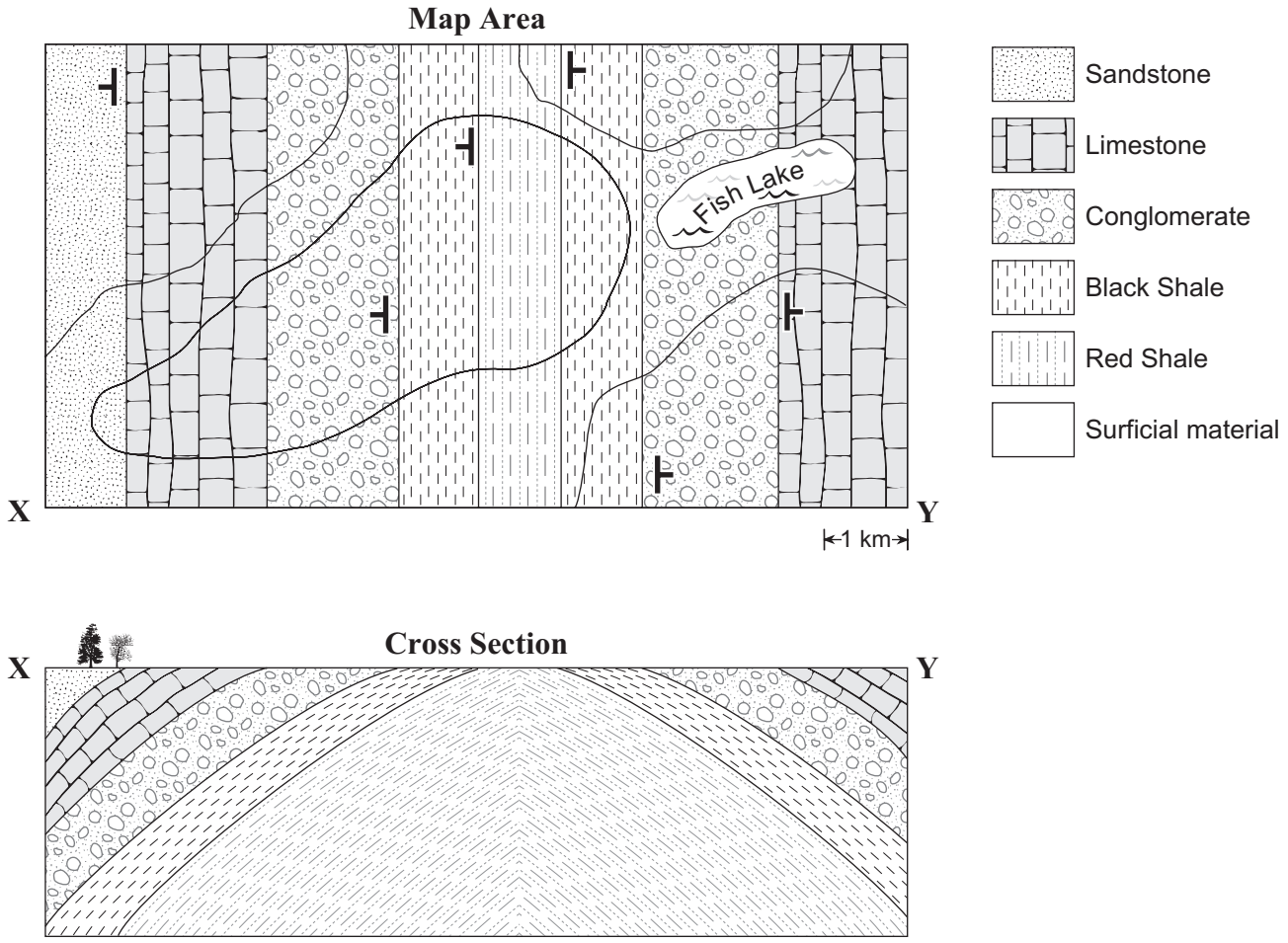
Seismogram N could show:

- **later arrival times for P, S and L waves than seismogram M**
- **greater P–S difference than seismogram M**
- **less amplitude than seismogram M**

b) A seismograph recording at station **Q** did not show L-waves (surface waves). Explain why. **(1 mark)**

The earthquake may not have been large enough to produce waves that could be detected. } ← **1 mark**

Use the following geological map and cross section to answer question 11.



11. a) Complete the map area above. **(1 mark)**

See diagram above. ← **1 mark** **(Contacts alone are adequate)**

b) Complete the cross section X–Y. **(2 marks)**

See diagram above. ← **2 marks** **(Contacts alone are adequate)**

c) Name the fold structure shown. **(1 mark)**

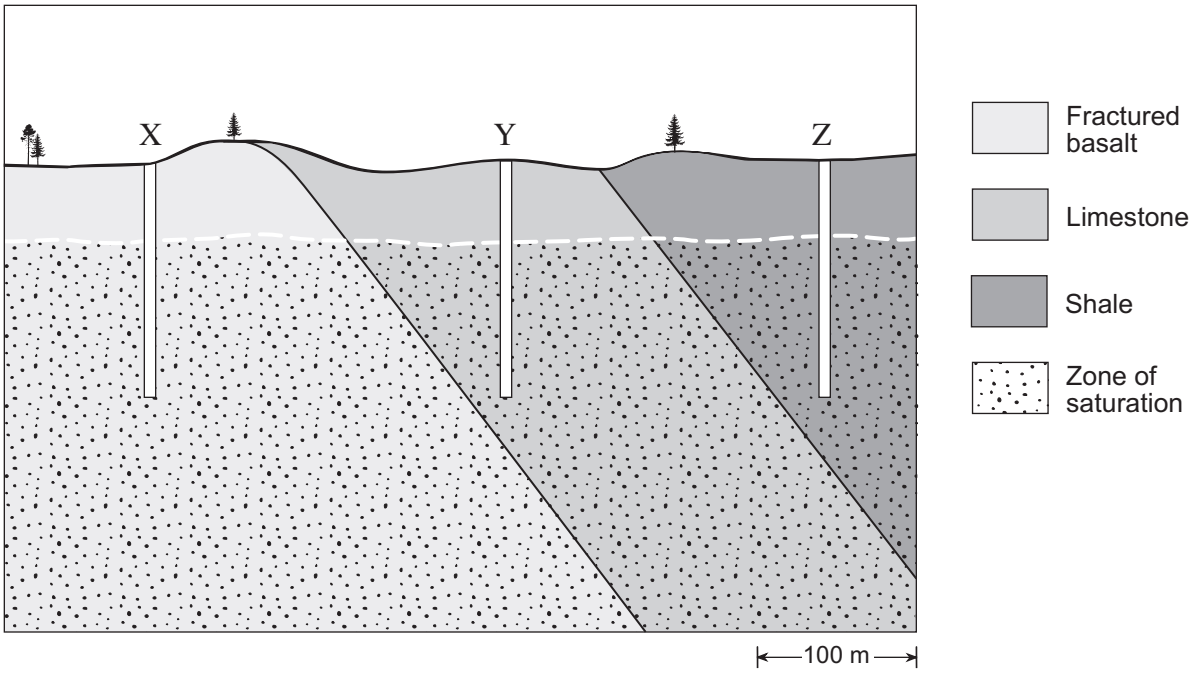
The fold structure is a non-plunging anticline. ← **1 mark**

d) State the relative age of the limestone compared to the black shale. **(1 mark)**

The limestone is younger than the black shale. ← **1 mark**

Use the following cross section and drill test data to answer question 12.

Cross Section



Drill Test Data

Well	Rock type	% porosity	Pump test flow rate (litres/minute)
X	fractured basalt	15	250
Y	limestone	20	670
Z	shale	10	2

12. A hydro-geologist has drilled three exploratory test wells (X, Y, Z) in search of a suitable location for a new garbage landfill site. In order to investigate the rocks in the test wells, the hydro-geologist measured the porosity by noting how much water was contained in each of the rocks when saturated. The hydro-geologist also attached a pump to the top of each well and determined the rate at which water could be drawn to the surface. The results of these tests are given above.

a) Choose the well which is at the best location for a garbage landfill site, and explain why you have chosen this site. **(2 marks)**

Well Z would be at the best location for a garbage landfill site because the shale found there has the lowest permeability and any toxic leachates from the landfill would flow very slowly, and in very small quantities, to the groundwater. ← **2 marks**

b) In preparing the landfill site, what other precaution could be taken to ensure that drainage liquids (leachates) do not contaminate the groundwater? **(1 mark)**

A clay and/or plastic liner could be put around the bottom of the landfill. Efforts could be made to prevent water getting into the landfill by using a cover of some sort, diverting streams away from the landfill. ← **1 mark**

or

A barrier could be erected to prevent surface water flowing from the landfill into the area of the limestone.

c) During the pump tests, the level of the water table in well **Y** was lowered by 10 metres. How would this affect the water table in each of the other two wells? **(1 mark)**

The water tables in the other wells, X and Z, would be lowered. (It would be lowered much faster in well X containing the fractured basalt, than in well Z, containing the shale.) ← **1 mark**

REFERENCE DATA BOOKLET

For question 13, refer to the following in the Data Booklet.

page ix: Photograph 11

13. Photograph 11 shows nearly vertical slate layers. The tops of the layers have been bent downslope by mass wasting.

a) Name and describe the type of mass wasting that is responsible for bending the slate layers. **(2 marks)**

Name: **soil creep** ← **1 mark**

Description: **slow, downslope movement of soil under the influence of gravity.** ← **1 mark**

b) Rocks such as the slate shown in the photograph 11 are very susceptible to weathering. With reference to the slate layers, describe how the following types of weathering might affect the rock. **(3 marks)**

Chemical weathering: **carbonic acid in rainwater and oxygen in the air are attacking and dissolving the slate layers.** } ← **1 mark**

Physical weathering: **processes such as frost wedging are mechanically prying the layers apart.** } ← **1 mark**

Biological weathering: **grass, moss and tree roots are prying the layers apart. Organic acids from the plants are dissolving the rocks and minerals.** } ← **1 mark**

14. A planet has been discovered by a space probe which took high resolution photographs of its surface from a low orbit around the planet. The probe found no evidence that the planet had an atmosphere or hydrosphere at the time of discovery. Describe a feature that might have been seen in the photographs which would indicate that the following geological processes had been active on the planet's surface. **(2 marks)**

Any one for 1 mark:

Water erosion in the planet's past:
- **channel islands**
- **V-shaped valleys**
- **deltas**
- **stream channels**
- **braiding**
- **meanders**
- **alluvial fans**
- **boulder fields**
- **gullying**

Any one for 1 mark:

Plate tectonics in the planet's past:
- **chains of volcanoes**
- **arcs of composite cone volcanoes**
- **rift valleys**
- **trenches**
- **fold mountains**

Other answers are possible.

END OF KEY