Government of South Australia

SACE Board of SA

External Examination 2011

2011 GEOLOGY

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RE-MARKED

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

Friday 11 November: 1.30 p.m.

Time: 2 hours

Pages: 23
Questions: 24

Examination material: one 23-page question booklet
one 8-page script book
one multiple-choice answer sheet
one SACE registration number label

Approved dictionaries and calculators may be used.

Instructions to Students

1. You will have 10 minutes to read the paper. You must not write in your question booklets or script book or on your multiple-choice answer sheet, or use a calculator during this reading time but you may make notes on the scribbling paper provided.

2. This paper is in three sections:

   Section A: Multiple-choice Questions (Questions 1 to 15)
   Answer this section on the separate multiple-choice answer sheet, using black or blue pen.
   Answer ***all*** questions in Section A.

   Section B: Short-answer Questions (Questions 16 to 23)
   Answer this section in the spaces provided in this question booklet.
   Answer ***all*** questions in Section B.

   Section C: Extended-response Question (Question 24)
   Answer this question in the separate script book.
   Include maps, diagrams, graphs, and field examples wherever possible.

3. The allocation of marks and the suggested (approximate) allotment of time are as follows:

Section A	30 marks	30 minutes
Section B	70 marks	70 minutes
Section C	20 marks	20 minutes
Total	120 marks	120 minutes

4. The geological time-scale is on page 23. You may remove it from this booklet before the examination begins.

5. Attach your SACE registration number label to the box at the top of this page. Copy the information from your SACE registration number label into the boxes on your multiple-choice answer sheet and on the front cover of your script book.

6. At the end of the examination, place your script book and multiple-choice answer sheet inside the back cover of this question booklet.

STUDENT'S DECLARATION ON THE USE OF CALCULATORS

By signing the examination attendance roll I declare that:

- my calculators have been cleared of all memory
- no external storage media are in use on these calculators.

I understand that if I do not comply with the above conditions for the use of calculators I will:

- be in breach of the rules
- have my results for the examination cancelled or amended
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as the SACE Board of South Australia determines.

SECTION A: MULTIPLE-CHOICE QUESTIONS (Questions 1 to 15)

(30 marks)

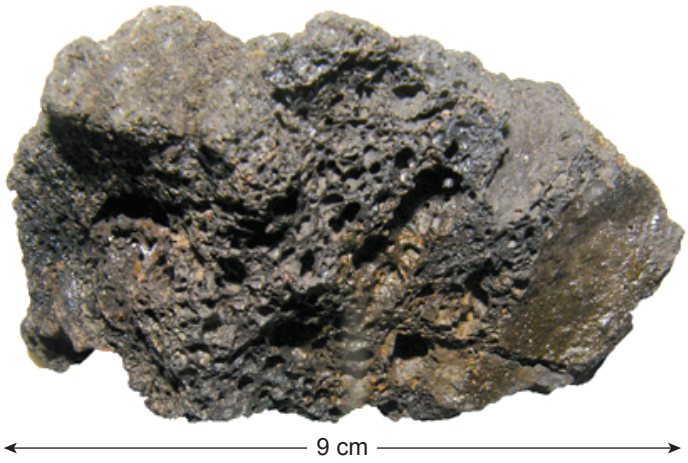
*Answer **all** questions in this section.*

*Each of the multiple-choice questions in Section A involves choosing from four alternative answers. Read each question carefully. Then indicate the **one** alternative that you consider best answers the question by shading the bubble by the appropriate letter alongside the question number on the multiple-choice answer sheet. Use black or blue pen. It is in your interest to give an answer to every question in this section of the paper, as no marks are deducted for incorrect answers. Each question is worth 2 marks. You should spend about 30 minutes on this section.*

1. Which one of the following alternatives lists two sources of copper?

   J. Galena, chalcopyrite.
   K. Chalcopyrite, malachite.
   L. Malachite, haematite.
   M. Sphalerite, chalcopyrite.

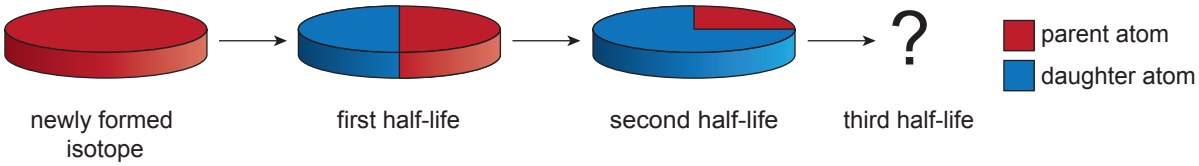
2. *Refer to the following photograph, which shows a rock sample:*



The features visible in the rock sample are:

   J. indicative of honeycomb weathering normally found in coastal areas.
   K. made by humans as these features do not occur naturally.
   L. indicative of volcanic rock that has been extruded and cooled rapidly.
   M. indicative of granite that cooled slowly, resulting in a vesicular texture.

3. *Refer to the following pie charts, which show the decay of a radioactive isotope over time:*



What percentage of the parent atom and the daughter atom would be in a pie chart of the third half-life?

	Parent Atom	Daughter Atom
J.	87.5%	12.5%
K.	90.0%	10.0%
L.	10.0%	90.0%
M.	12.5%	87.5%

4. *Refer to the following photograph, which shows a sedimentary sequence on a coastal cliff:*

The light-coloured, broken piece of rock probably collapsed because:

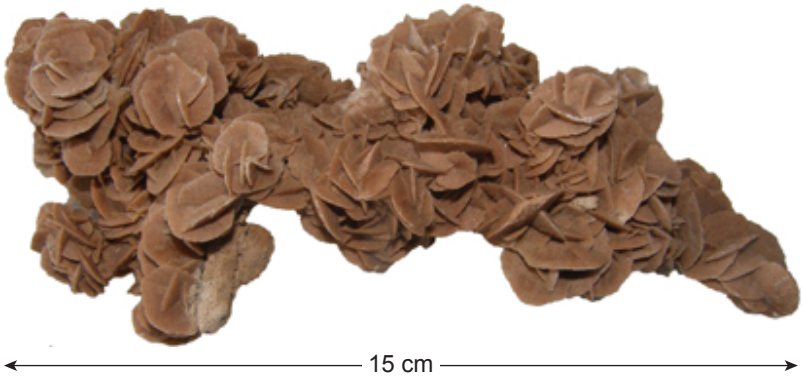
J. the dark rock weathered and eroded away.
K. a horizontal transform fault occurred.
L. there was a sudden change in the local climate.
M. burrows made by animals weakened the dark rock.

5. Scientists have proposed drilling the sea floor to learn about tectonic processes.

The sea floor is most likely to be:

J. a shield area.
K. continental crust with shallow granitic intrusions.
L. extrusive rock of basaltic composition.
M. a Benioff zone.

6. *Refer to the following photograph, which shows an aggregate of crystals of the mineral gypsum:*



Such crystals form:

J. slowly in a solid.
K. slowly in a fluid.
L. rapidly in a solid.
M. rapidly in a fluid.

7. *Refer to the following photographs, which show examples of stone tools:*

Which one of the following rock types would be most suitable for making tools of this kind?

J. Sandstone.
K. Slate.
L. Quartzite.
M. Schist.

8. *Refer to the following photographs, which show two different examples of rock deformation:*

A 

B 

Deformation B is more likely to occur than deformation A when:

J. directed pressure is gradually applied to rocks buried deep beneath the Earth's surface.
K. rocks are in the presence of fluids close to the Earth's surface.
L. low-load pressure is applied to rocks at a low temperature.
M. sudden pressure is applied to rocks at a very high temperature.

9. *Refer to the following photograph, which shows a hand specimen of a medium-grained rock:*

Which one of the following alternatives best describes the cause of the foliation in this rock?

J. The rock crystallised from magma.
K. Heat from a nearby igneous intrusion.
L. Load pressure in the presence of fluids.
M. Heat and directed pressure.

10. *Refer to the following photograph, which shows an aerial view of Queenstown, in Tasmania. Copper was mined in the area for many years and sulfide ores were smelted for 40 years. The bare hills in the centre of the photograph contrast sharply with the thickly wooded hills in the background:*

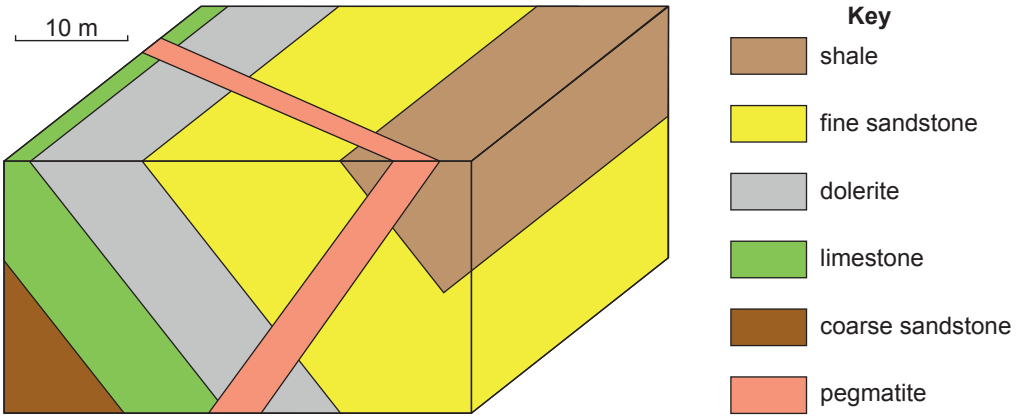
The lack of vegetation in the centre of the photograph is probably due to:

J. the rock type underlying the bare areas.
K. acid rain produced by smelting sulphide ores.
L. clearing the land for agricultural purposes.
M. the arid climate of the area.

11. The hardness scale that is commonly used to identify minerals is based on the:

J. ability of certain objects to scratch the surface of a specimen.
K. width of a scratch made by a quartz crystal on the surface of a specimen.
L. density of a specimen compared with that of another mineral.
M. number of cleavage planes formed when a specimen breaks.

12. *Refer to the following diagram, which shows a tilted sequence of sedimentary rocks into which igneous rocks have intruded. The sedimentary sequence has not been overturned:*



Which one of the following statements about the relative ages of the rocks in the above diagram is correct?

J. The dolerite is younger than the pegmatite.

K. The sedimentary rocks are younger than the igneous rocks.

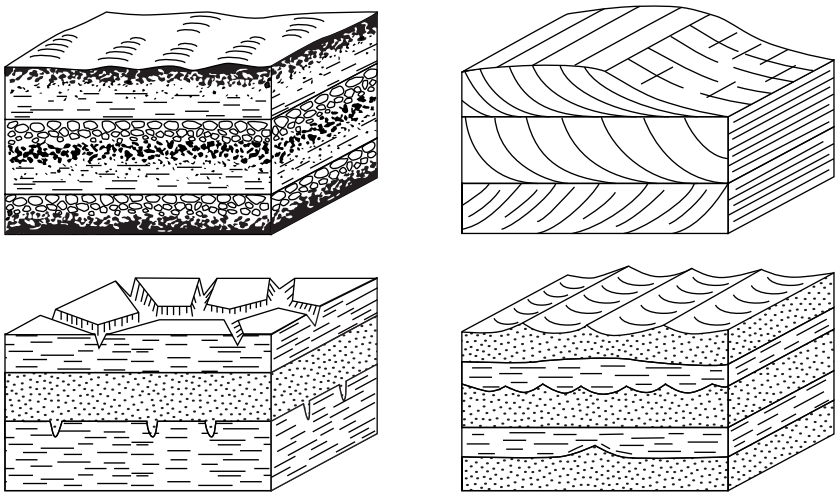
L. The pegmatite is younger than any of the other rocks.

M. The shale is the youngest rock depicted in the diagram.

13. Which one of the following rows correctly pairs an organism with a period in which it existed?

	Organism	Period
J.	trilobite	Cretaceous
K.	Ediacaran fauna	Devonian
L.	Archaeocyatha	Silurian
M.	graptolite	Ordovician

14. *Refer to the following diagrams, which show examples of structures that can provide evidence of whether a sequence has been overturned:*



Source: Adapted from I.F. Clark & B.J. Cook (eds), *Geological Science: Perspectives of the Earth*, Australian Academy of Science, Canberra, 1983, p. 295

The sequence that has been overturned in these diagrams is the one containing:

J. graded bedding.
K. cross-bedding.
L. mud cracks.
M. ripple marks.

15. A well-sorted and well-rounded sediment with polished quartz grains would most likely be found in a:

J. sandy beach.
K. tidal flat.
L. desert dune.
M. river delta.

SECTION B: SHORT-ANSWER QUESTIONS (Questions 16 to 23)

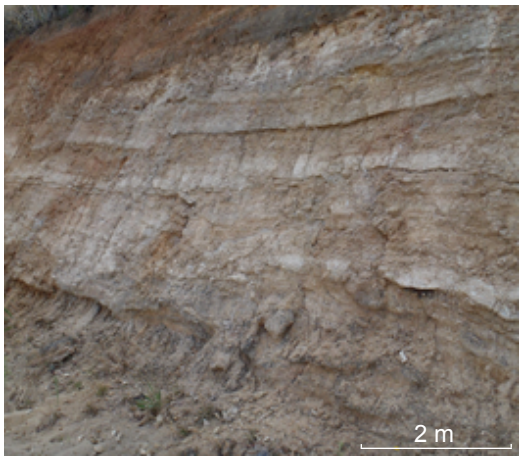
(70 marks)

*Answer **all** questions in this section. Write your answers in the spaces provided under each question. The allocation of marks is shown in brackets at the end of each part of each question. You should spend about 70 minutes on this section.*

16. *Refer to the following photographs, which show rock outcrops in two road cuttings in the Adelaide Hills, 100 metres apart:*

Photograph A

Photograph B



(a) (i) On photograph A, use an arrow to indicate the oldest rock layer, assuming that the sequence has not been overturned. (1 mark)

(ii) Name the geological principle used to determine your answer to part (a)(i).

_____ (1 mark)

(b) Describe how the visible layers in these rock outcrops were most likely formed.

_____

_____

_____

_____ (2 marks)

(c) In photograph A, the rock forms a solid wall along the roadside, whereas loose material can be seen in photograph B. Suggest two possible geological reasons for this difference.

(i) _____

_____

_____ (2 marks)

(ii) _____

_____

_____ (2 marks)

(d) Describe one way you could correlate rock strata from these two road cuttings.

_____

_____

_____

_____ (2 marks)

17. *Refer to the following photograph:*

(a) Name the organism shown in the photograph.

_____ (1 mark)

(b) (i) State the type of environment in which this organism would have lived.

_____

_____ (1 mark)

(ii) Describe the structure of this organism that enabled the organism to survive in the environment named in part (b)(i).

_____

_____

_____ (2 marks)

(c) State the type of distribution of this organism.

_____

_____ (1 mark)

(d) State the likely time range of this organism.

_____

_____ (2 marks)

18. A significant proportion of petroleum is found offshore.

(a) Describe two environmental impacts of a large petroleum spill in a marine environment.

(i) _____

_____

_____ (2 marks)

(ii) _____

_____

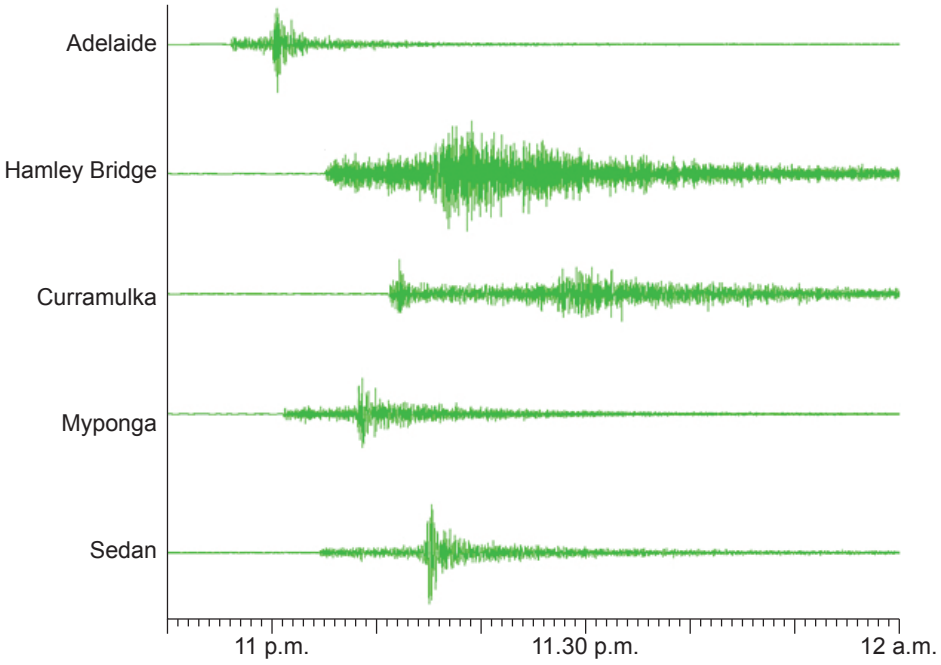
_____ (2 marks)

(b) Draw well-labelled diagrams in the space below to show two geological structures that can trap petroleum. Clearly indicate on each diagram where the petroleum would accumulate.

(6 marks)

19. *On Friday 16 April 2010 an earthquake occurred 3 km south of Mount Barker in the Mount Lofty Ranges in South Australia. The area's population density is low. The earthquake had a magnitude of 3.8 and a focus 25 km beneath the surface. It had an intensity of III at the epicentre.*

Refer to the following diagram, which shows a record of the arrivals of seismic waves at five seismic recording stations:



Source: Adapted from http://www.pir.sa.gov.au/minerals/earthquakes/recent_earthquakes_in_sa/mount_barker_earthquake/seismogram

(a) (i) Label the above diagram to show the arrival of P and S waves at the Sedan seismic recording station. (2 marks)

(ii) Determine the difference (to the nearest minute) between the arrival times of these two waves at the Sedan seismic recording station.

_____

_____ (1 mark)

(b) (i) Name the seismic recording station that was closest to the focus of this earthquake.

_____ (1 mark)

(ii) Explain your answer to part (b)(i).

_____

_____

_____

_____ (2 marks)

(c) Suggest a reason why the seismic waves had a greater intensity and a longer duration at Hamley Bridge than at any other seismic recording station.

_____

_____

_____

_____ (2 marks)

(d) State the type of damage you would expect this earthquake to have caused.

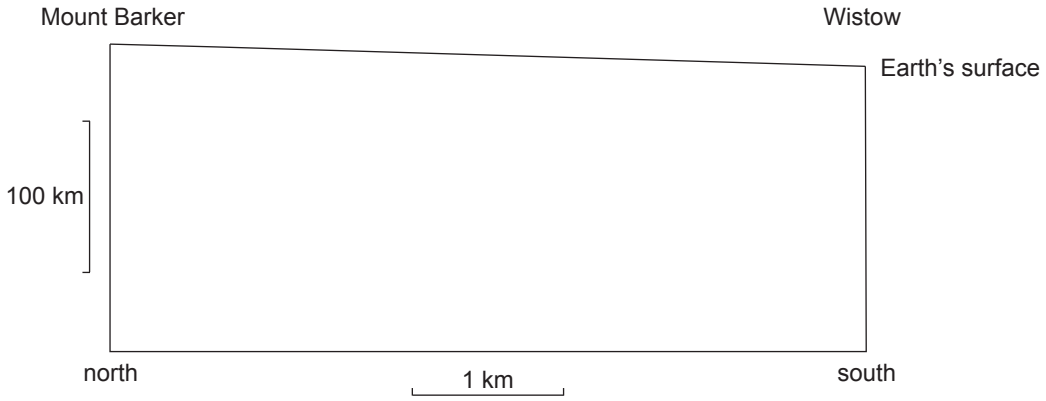
_____

_____ (1 mark)

(e) On the cross-section below, identify the:

(i) focus of the earthquake with the symbol ✻. (1 mark)

(ii) epicentre of the earthquake with the symbol ▲. (1 mark)



(f) Complete the following table of information about the Richter and Mercalli scales.

	Richter scale	**Mercalli scale**
What is measured?		
How is it measured?		

(4 marks)

20. *Refer to the following article and photograph, which describe a recently discovered fossil:*

Dream to track fossil footprints

SCIENCE REPORTER

CLARE PEDDIE

TRACKING the beasts that walked the Earth more than 40,000 years ago sounds an impossible task. But "the biggest marsupial that ever lived" did leave some pretty big footprints.

South Australian palaeontologist Dr Aaron Camens is searching for signs in ancient sand and sediment turned to stone.

Fossil trackways tell us things that animals bones can't, Dr Camens says.

"Like how far apart [the animals'] feet were when they walked, what their feet might have looked like when they were alive, how fast they were able to move and even things like whether they moved in herds or as solitary animals," he said.

A team of palaeontologists was searching for bones when they stumbled across some footprints in the river bed.

The team was "blown away" by "not one or two prints but six separate trackways, composed of over 100 individual prints, of a very large animal".

The track was preserved in sediments of the Tirari Formation, which had previously been dated to around 4.8 million years.

A clue to the track-maker was retrieved five years earlier. The leg of a beast known as *Euowenia grata* was found in 2001.

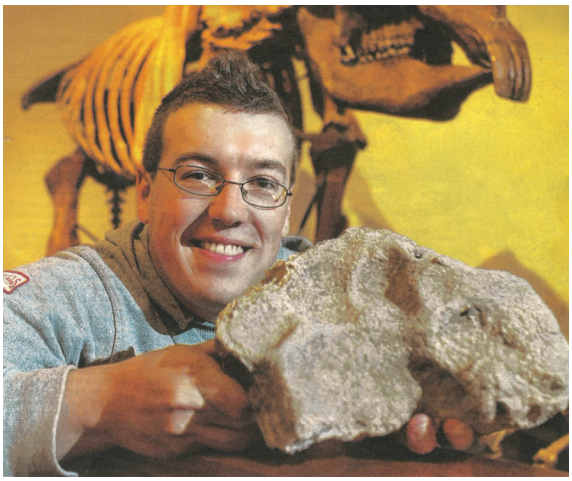
Euowenia grata belongs to an extinct family of marsupials related to wombats, call diprotodontids.

"Diprotodon weighed about two tonnes, stood two metres tall at the shoulder and was 3½ metres long," Dr Camens said.

These giant wombats died out about the same time that humans arrived on the scene. It's been suggested they were wiped out by hunting. Other scientists blame a drying climate. The truth may lie somewhere in between.

"When Aborigines arrived in Australia, they might have significantly altered the vegetation patterns by burning," Dr Camens said.

"And then, large animals like diprotodon need good seasons in order to reproduce, so they're going to be more vulnerable to small climatic fluctuations. Add on top of that, the hunting, and that could be the nail in the coffin."



ON TRACK: Dr Aaron Camens with a diprotodon skeleton and a fossil footprint at the SA Museum.

Source: Adapted from the *Advertiser*, Adelaide, 7 September 2010, p. 44

(a) (i) Determine a possible time range of diprotodons.

_____

_____

_____

_____ (2 marks)

(ii) Compare the time range of diprotodons with the probable time range of dinosaurs.

_____

_____

_____

_____ (2 marks)

(b) (i) Identify the two factors listed in the article that may have contributed to the extinction of diprotodons.

_____

_____

_____

_____ (2 marks)

(ii) Explain why one of these factors could *not* have contributed to the extinction of dinosaurs.

_____

_____

_____

_____ (2 marks)

21. *Refer to the following article:*

HOW BIG?

In volume terms, the rocks of mineable grade defined so far [at Olympic Dam] could fill the Melbourne Cricket Ground almost 2,000 times. In value terms, the minerals in the ground at Olympic Dam now have an estimated value of $US863,000,000,000 or $US863 billion …

The amount of uranium in Olympic Dam is perhaps the most staggering number. It approaches 10 times the size of the next largest uranium resource and contains more uranium than the combined total of the rest of the top 10. If the world gave up coal-fired power for nuclear electricity, Australia could command global energy supply in the same way Saudi Arabia dominates oil.

Source: Excerpts from D. Upton, *The Olympic Dam Story*, Upton Financial PR, Armadale, Victoria, 2010, pp. 11, 13

(a) Give two reasons why the world might 'give up coal-fired power for nuclear electricity'.

(i) _____

_____ (1 mark)

(ii) _____

_____ (1 mark)

(b) Explain the expression 'mineable grade'.

_____

_____

_____

_____ (2 marks)

(c) State whether uranium ore is a renewable or non-renewable energy resource.

_____ (1 mark)

(d) Give two possible reasons why some people are opposed to using uranium to generate electricity.

(i) _____

_____ (1 mark)

(ii) _____

_____ (1 mark)

22. *Refer to the following photograph, which shows part of a road cutting in a hilly location:*

(a) (i) State the geological term for the cracks in the rocks.

_____ (1 mark)

(ii) Name one form of physical weathering that could have caused these cracks to widen.

_____

_____ (1 mark)

(b) (i) Identify a possible geological hazard shown in the photograph.

_____

_____ (1 mark)

(ii) Describe one preventive measure that an engineering geologist might recommend to reduce the hazard identified in part (b)(i).

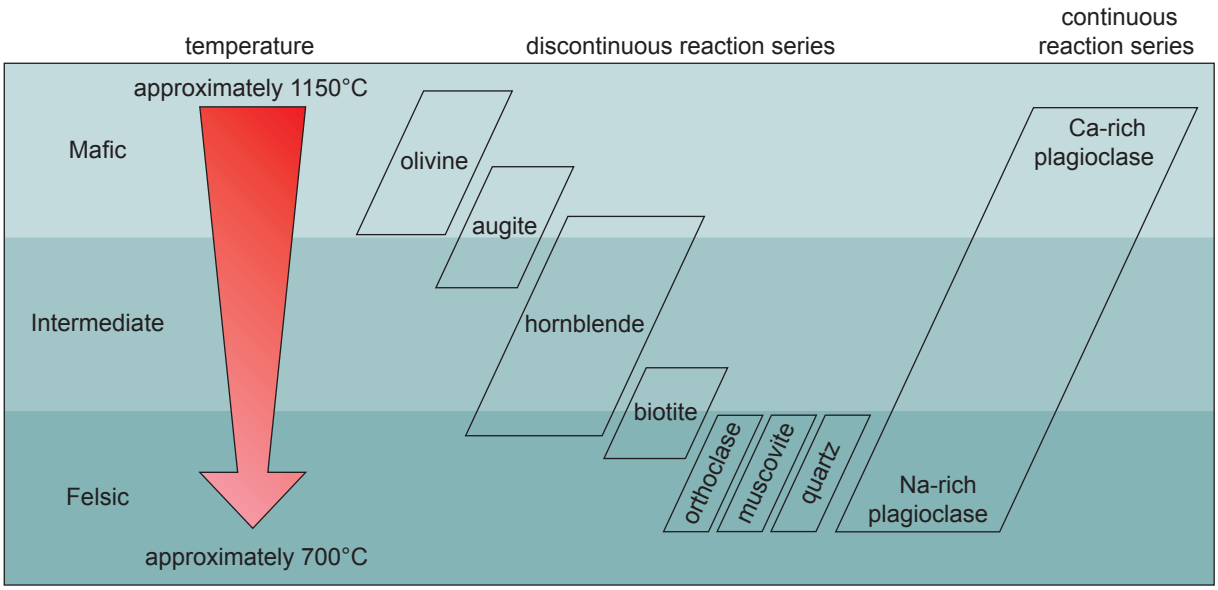
_____

_____

_____

_____ (2 marks)

23. (a) *Refer to the following diagram of Bowen's reaction series, which compares the temperatures at which different constituent minerals crystallise as they cool from magma to form igneous rocks:*



(i) From the diagram, name the first two minerals to crystallise from magma.

(1) First: _____ (1 mark)

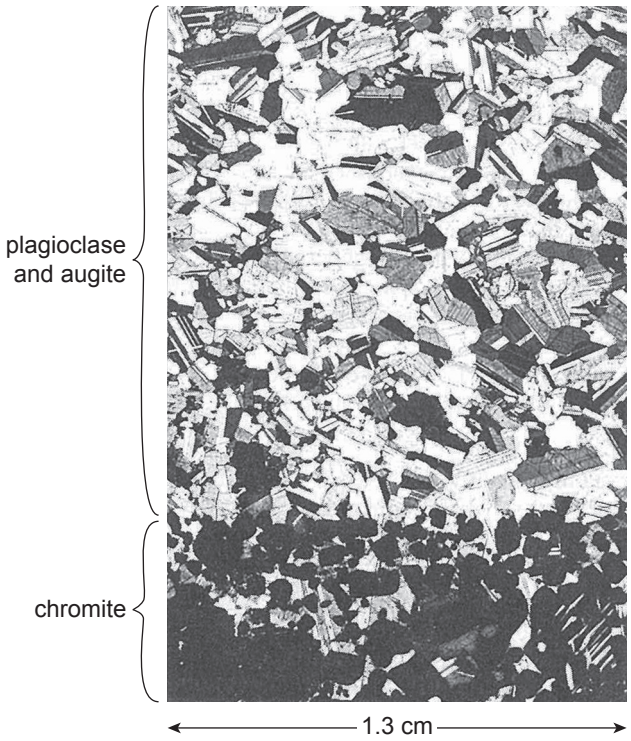
(2) Second: _____ (1 mark)

(ii) From the diagram, name *two* minerals that are likely to occur in andesite.

(1) _____ (1 mark)

(2) _____ (1 mark)

(b) *Refer to the following photograph, which shows layering of minerals in a section of an igneous intrusion:*



Source: Adapted from I.F. Clark & B.J. Cook, *Geological Science: Perspectives of the Earth,* Australian Academy of Science, Canberra, 1983, p. 168

(i) Compare the temperature at which chromite crystallised with the temperatures at which the other minerals in this magma crystallised.

_____

_____ (1 mark)

(ii) Give two reasons why a layer of chromite has formed at the bottom of the intrusion shown above.

(1) _____

_____ (1 mark)

(2) _____

_____ (1 mark)

(iii) Name an economic benefit of the process that produces the chromite layer.

_____

_____ (1 mark)

SECTION C: EXTENDED-RESPONSE QUESTION (Question 24)

(20 marks)

Answer this section in the separate script book. You should spend about 20 minutes on this section.

You should present a clear, logical, and well-illustrated response to this question. Include maps, diagrams, graphs, and field examples wherever possible.

24. *Refer to the following photograph, which shows the Wivenhoe Dam, which is situated across the Brisbane River, 60 km north-west of Brisbane:*

Source: http://couriermail.com.au/ipad/seqwater-comes-clean-on-flood-release/story-fn6ck51p-1226017323715

Heavy rains during January 2011 caused major flooding across Queensland. The flooding replenished many aquifers that had been depleted by a long period of drought. The Wivenhoe Dam filled to over 85% of its capacity, which significantly reduced the impact of the 2011 floods.

Discuss the role of water in geological processes and the importance of water as a sustainable resource. Your answer should include a description of:

- the role of water in transporting sediments
- the geological features of an aquifer, with the aid of a well-labelled diagram
- the use of aquifers to conserve stormwater in metropolitan areas
- two features of the Wivenhoe Dam that make it suitable for reducing the impact of floods.

You may remove this page from the question booklet by tearing along the perforations so that you will have the information in front of you for easy reference.

THE GEOLOGICAL TIME-SCALE

Eon	Era	Period	Epoch	Date at Boundary (million years)
Phanerozoic	Cainozoic	Neogene (previously Quaternary)	Holocene	0.01
			Pleistocene	1.5
		Old Tertiary–Quaternary boundary	Pliocene	5
			Miocene	24
		Palaeogene (previously Tertiary)	Oligocene	35
			Eocene	55
			Palaeocene	65
	Mesozoic	Cretaceous		145
		Jurassic		210
		Triassic		250
	Palaeozoic	Permian		300
		Carboniferous		350
		Devonian		400
		Silurian		440
		Ordovician		500
		Cambrian		540
Proterozoic		Ediacaran		600
				2500
Archaean				4500

GEOLOGY 2011

ACKNOWLEDGMENT

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