

NATIONAL EXAMINATIONS – May 2009

04-BS-14 Geology

3 hours duration

NOTES:

- A. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.
- B. This is an CLOSED BOOK EXAM. Candidates may use one of two calculators, the Casio or Sharp approved models.
- C. FIVE (5) questions constitute a complete exam paper. YOU MUST ANSWER QUESTIONS 1 TO 4. Candidates must choose one more question from any of the remaining questions. Where stated in the examination, please hand in any additional pages with your exam booklet.
- D. The first of any of Questions 5 to 7 as it appears in the answer book will be marked, unless the candidate clearly indicates that another question should be substituted for a specified question that was answered previously.
- E. Each question is of equal value. The marks assigned to the subdivisions of each question are shown for information. The total marks for the exam is 100.

***** IMPORTANT: YOU MUST ANSWER QUESTIONS 1, 2, 3, and 4 *****

1.

- a) In the accompanying map of the Earth (next page), the continents are shown in white and the oceans are shown in grey. In addition, the boundaries between tectonic plates are shown as solid black lines.

Do not mark anything on the map and do not hand it in with your exam booklet. Clearly write the answers in your exam booklet. {5 marks}

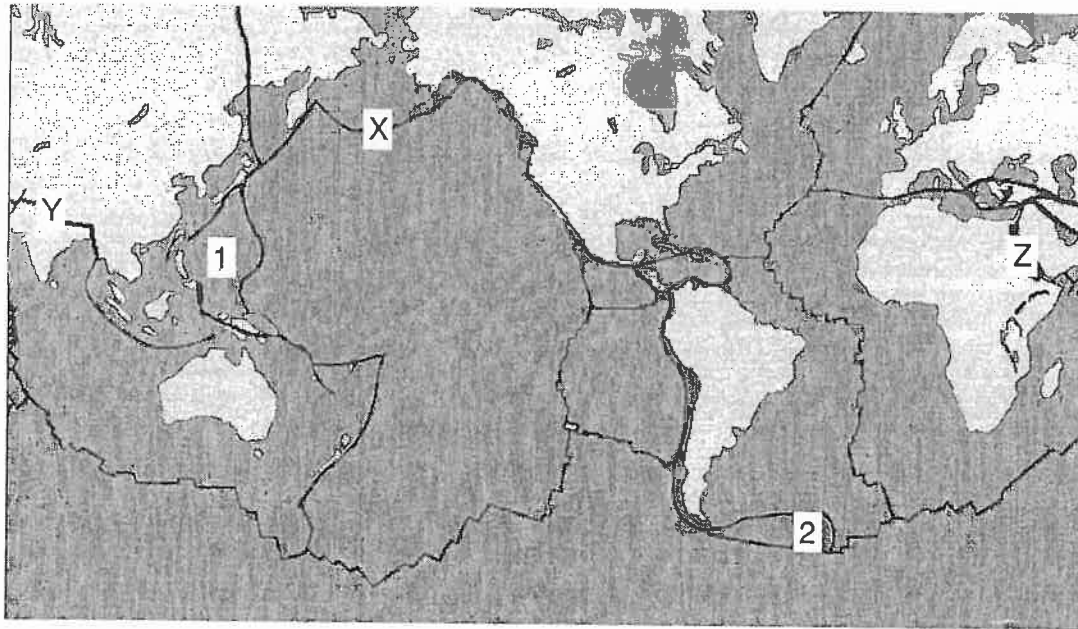
- (i) Name the 2 tectonic plates on the map which are labelled 1 and 2.
- (ii) Name each type of tectonic boundary indicated on the map by the capital letters (X, Y, Z).

- b) State the major characteristics of the following features and give the approximate thickness (in km) of each. {10 marks}

- (i) oceanic crust
- (ii) mantle
- (iii) lithosphere
- (iv) inner core
- (v) D" zone

- c) Fill in the blanks in the following passage. {5 marks}

Earthquakes commonly occur every year. The point where the seismic waves originate is known as the _____ (i) _____. _____ (ii) _____ waves are a family of seismic waves that travel through the Earth's interior and can be recorded by a piece of equipment known as a _____ (iii) _____. _____ (iv) _____ are small earthquakes that often follow the main earthquake. A _____ (v) _____ can be generated by a submarine earthquake that displaces the sea floor.



2.

- a) For each mineral listed below, state the best descriptor of the requested physical property. {5 marks}
- | | |
|-------------------------|---------------------------|
| (i) calcite - hardness | (iv) quartz - lustre |
| (ii) biotite - cleavage | (v) halite - crystal form |
| (iii) ice - density | |
- b) For each mineral listed below, state the type of silicate structure that it has (i.e. isolated, single-chain, double-chain, sheet, or framework). {5 marks}
- | | |
|----------------|--------------|
| (i) orthoclase | (iv) augite |
| (ii) muscovite | (v) asbestos |
| (iii) olivine | |
- c) State what kind of rock or feature is best described by the following: {5 marks}
- (i) Very coarse-grained igneous rock of granitic composition
 - (ii) A tabular, discordant intrusive structure
 - (iii) A Variety of limestone formed from the cementation of shells and shell fragments
 - (iv) Small spheres of calcite inorganically precipitated in a warm, shallow sea
 - (v) The metamorphic equivalent of a well-sorted, quartz sandstone
- d) Define the following: {5 marks}
- | | |
|-----------------|----------------------------|
| (i) andesite | (iv) prograde metamorphism |
| (ii) peridotite | (v) migmatite |
| (iii) evaporite | |

3.

- a) Fill in the blanks in the following passage. {5 marks}

Ground water is an important resource for communities. _____ (i) _____ refers to the capacity of a rock to transmit fluid. In a cross-section of near subsurface ground, the _____ (ii) _____ is the zone where ground water would fill a well drilled into it, whereas the _____ (iii) _____ is a transition zone just above the water table. _____ (iv) _____ are lines of constant hydraulic head. If seepage from a waste landfill reaches the water table, it can be dispersed in the direction of groundwater flow in the form of a contaminant _____ (v) _____.

- b) Rate the porosity of the following materials as either poor (<20%), moderate (20-35%), or excellent (>35%). {5 marks}

- (i) gravel
- (ii) sand
- (iii) glacial till
- (iv) granite
- (v) sandstone, well-sorted

- c) For the following environments, name a typical contaminant associated with the land use that could pollute the groundwater. {5 marks}

- (i) farmland
- (ii) industrial
- (iii) slaughterhouse
- (iv) gold mine
- (v) drilled well near the ocean

- d) A factory is located at an elevation of 550 m above sea level (a.s.l.). Groundwater flows downslope along an aquifer from the factory a horizontal distance of 100 m to a small village at an elevation of 525 m. If the groundwater velocity is 0.2 m/s and the porosity of the aquifer is 10%, what is the hydraulic conductivity K of the aquifer? State the units of K and show all calculations. {5 marks}

4.

a) Define, with the aid of a sketch, each of the following geological terms below. {6 marks}

(i) strain

(ii) dip angle

(iii) right-lateral fault

b) Consider the following regional geologic history.

In this region, precipitation within a warm shallow tropical sea results in the deposition of calcite and the formation of limestone. As the sea deepens, thick layers of silt are deposited and subsequent compaction and lithification turns this into shale. Tectonic forces tilt and fold the rocks, and also result in the intrusion of a granite pluton. The entire package of rocks are uplifted to the surface, where they undergo erosion for several million years. Further subsidence and erosion result in the deposition of flat-lying sandstones, which are subsequently cut by a diabase dyke that also crosscuts the granitic pluton. A hiatus in deposition occurs for several million years during which some of the sandstone layers are eroded and the dyke is exposed on the surface, but renewed deposition buries the rocks, on which form flat-lying greywackes.

Based on the above information, construct a geologic cross-section which reflects all of these events. Be sure to clearly label all of the rock units and any unconformities in your cross-section. {10 marks}

c) Explain what a joint set is, and how a joint set can be either geologically advantageous and disadvantageous for society in an engineering context. {4 marks}

***** IMPORTANT: COMPLETE ONLY ONE MORE QUESTION ***
FROM QUESTIONS 5, 6, OR 7**

- 5.
- a) Indicate whether the following features are characteristic of alpine or continental glaciation and then briefly define each. {8 marks}
- | | |
|--------------------|------------------------|
| (i) truncated spur | (iii) kame |
| (ii) cirque | (iv) paternoster lakes |
- b) With the aid of a sketch, show the following features on an alpine glacier. {4 marks}
- | | |
|---------------------------|-----------------------------|
| (i) zone of ablation | (iii) firn line |
| (ii) zone of accumulation | (iv) layer of snow and firn |
- c) Glaciation affected a large part of Canada and is responsible for many surficial features that are the basis of many geological-engineering investigations. Answer TRUE or FALSE to the following statements. **Please record your answers in the answer booklet. Do NOT answer on this exam paper.** {4 marks}
- (i) The last episode of extensive glaciation, covering large parts of North America and Europe, was at its peak about 10,000 years ago.
 - (ii) The climate changes necessary for a glacial age to occur require global average temperatures to be at least 10 degrees C cooler than at present.
 - (iii) A large inland sea known as Lake Agassiz resulting from glacial meltoff once covered most of Alberta.
 - (iv) Eskers are not commonly utilized as raw sources of material for construction works.
- d) It is often important for engineers to understand the nature of permafrost. Answer TRUE or FALSE to the following statements. **Please record your answers in the answer booklet. Do NOT answer on this exam paper.** {4 marks}
- (i) Most solifluction takes place in Arctic regions.
 - (ii) Permafrost is impermeable.
 - (iii) Solifluction is a form of earthflow.
 - (iv) Overland travel on roads built on permafrost is difficult due to potential landslides.

***** IMPORTANT: COMPLETE ONLY ONE MORE QUESTION ***
FROM QUESTIONS 5, 6, OR 7**

6.

a) Briefly define the following geologic terms. {8 marks}

(i) sheetwash

(iii) stream discharge

(ii) divide

(iv) saltation

b) Briefly discuss the different ways streams can erode rock and sediment. {6 marks}

c) Fill in the blanks in the following passage. {6 marks}

_____ (i) _____ deposits of gold and diamonds are found in streams where running water has mechanically concentrated heavy sediments. A cutoff meander of a river is known as an _____ (ii) _____ lake. If a river floods repeatedly over many years, low ridges of flood-deposited sediment known as _____ (iii) _____ may build up on either side of the stream channel. _____ (iv) _____ beds form the main body of a delta. Floods are often described by a _____ (v) _____, the average time between floods of a given size. To control floods, _____ (vi) _____ can be used along rivers to reduce the discharge in the main channel by diverting water through gates into designated basins in the floodplain.

***** IMPORTANT: COMPLETE ONLY ONE MORE QUESTION ***
FROM QUESTIONS 5, 6, OR 7**

7.

a) Briefly define the following geologic terms. {8 marks}

(i) blowout

(iii) slip face

(ii) desert varnish

(iv) longitudinal dune

c) Fill in the blanks in the following passage. {6 marks}

_____ (i) _____ is the vertical distance between the wave crest and trough.
_____ (ii) _____ currents are narrow currents that flow straight out to sea in the surf zone of a shoreline. When sediment moves parallel to shore when the waves strike the shoreline at an angle, this is known as _____ (iii) _____. In order to protect the shoreline from wave action and absorb the force of large, breaking waves, artificial structures known as _____ (iv) _____ can be constructed. Wave erosion of headlands produces _____ (v) _____. When sea level rises, _____ (vi) _____ coasts are created.

c) Explain 3 different ways in which engineering structures can be used to prevent the mass wasting of soil associated with a road cut into a hill. {6 marks}