

NATIONAL EXAMINATIONS – December 2010

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 a 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 number of 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}

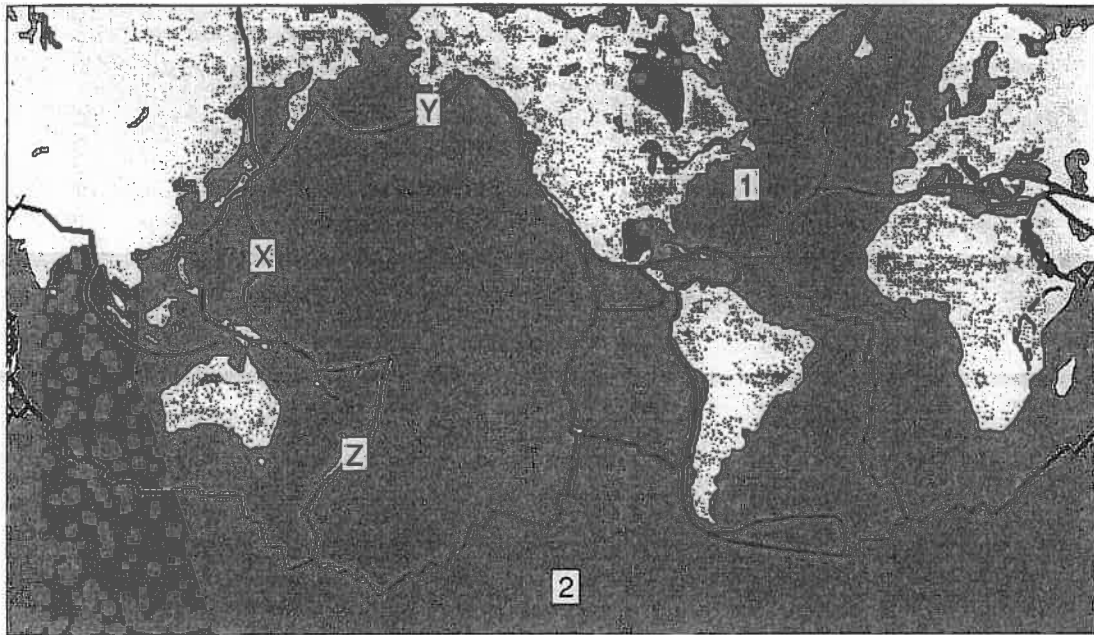
- (i) Name the 2 tectonic plates on the map which are labelled 1 and 2.
(ii) Name each type of tectonic boundary indicated on the map by the capital letters (X, Y, Z).

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

Most of our knowledge about the structure of the Earth's interior comes from a study of _____ (i) _____ which penetrate the Earth. Over 80% of the Earth's volume is contained within the _____ (ii) _____. The tectonic plates comprise the Earth's _____ (iii) _____ which is considered to be a brittle layer about 100 km thick. The only part of the Earth's interior which is considered to be liquid is known as the _____ (iv) _____. An important region in the Earth between about 100-250 km in depth is called the _____ (v) _____ where earthquake waves show a marked decrease in velocity.

- c) Briefly define the following geologic terms. {10 marks}

- | | |
|------------------------------|--------------------|
| (i) magmatic differentiation | (iv) pegmatite |
| (ii) assimilation | (v) Mercalli scale |
| (iii) pyroclastic rock | |



2.

- a) For each mineral listed below, state the best descriptor of the requested physical property. {5 marks}
- | | |
|---|-------------------------|
| (i) olivine - colour | (iv) muscovite - lustre |
| (ii) pyroxene - cleavage | (v) quartz - hardness |
| (iii) galena – specific gravity (approximate) | |
- b) Name a specific natural mineral for each of the following crystal structures: {5 marks}
- | | |
|----------------------------|--|
| (i) single-chain silicate | (iv) single tetrahedral silicate |
| (ii) double-chain silicate | (v) three-dimensional network silicate |
| (iii) sheet silicate | |
- c) State the most appropriate rock name for the following: {4 marks}
- (i) an intrusive igneous rock which is very dark green to black composed primarily of pyroxene and Ca-rich plagioclase
 - (ii) a detrital sedimentary rock consisting of silt and clay-sized particles (iii) a coarse-grained crystalline rock consisting of metamorphosed limestone
 - (iii) a strongly foliated rock consisting primarily of mica resulting from regional metamorphism
- d) Lithification is the process by which unconsolidated sediments are transformed into solid sedimentary rocks. List and briefly define 3 kinds of lithification processes affecting sedimentary rocks. {6 marks}

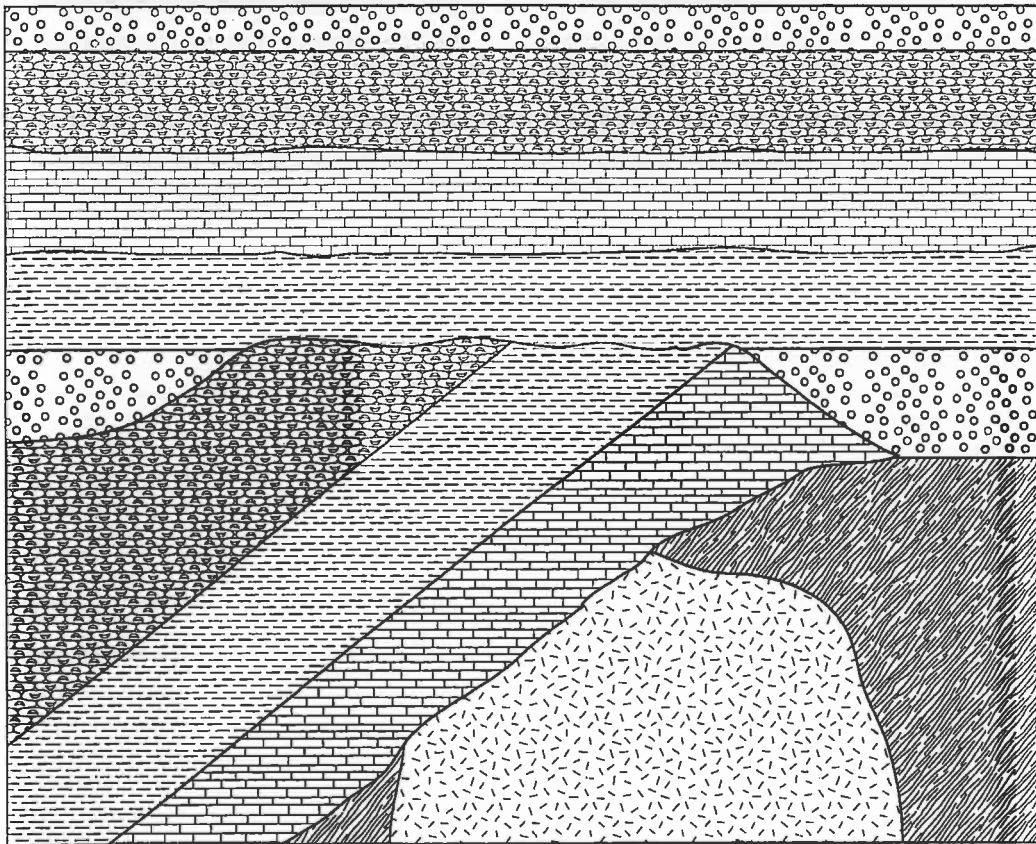
3.

- a) Define the following terms: {5 marks}
- (i) porosity
 - (ii) permeability
 - (iii) effluent stream
 - (iv) perched water table
 - (v) artesian
- b) Indicate in your examination booklet whether each statement below is either true (T) or false (F): {5 marks}
- (i) If a sandstone has a specific yield of 22% and a porosity of 25%, then it has poor permeability.
 - (ii) Because its porosity is high, clay also has a high specific retention.
 - (iii) In the hydrosphere, groundwater is the most important source of fresh water.
 - (iv) An aquiclude consists of permeable rock strata that can transmit groundwater.
 - (v) A karst landscape is typically underlain by sandstone which has been shaped by groundwater.
- c) Calculate the following: {6 marks}
- (i) In a particular coastal area, the water table is 2.5 metres above sea level. Approximately how far below sea level does the fresh water reach?
 - (ii) If Point A is at an elevation of 3 m below sea level and Point B is at an elevation of 29 m above sea level, what is the hydraulic gradient between A and B if both points are on the water table and are separated by a horizontal distance of 25 m?
 - (iii) The estimated groundwater velocity of an aquifer from Point X to Y is about 2.0×10^{-6} m/s. If the distance between X and Y is 43 m, the hydraulic conductivity K is 0.5×10^{-3} cm/s, and the elevation of Point Y is 126 m above sea level, what is the elevation of Point X?
- d) Briefly describe some engineering problems that may result from land subsidence caused by the excessive pumping of groundwater. {4 marks}


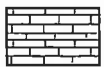


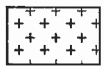
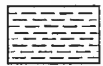






***** IMPORTANT: REMOVE THIS PAGE FROM THE EXAM PAPER!! *****
 Clearly PRINT your name on this page and hand it in with your answer booklet.
 See Question 4 for instructions.

NAME: _____

4. Consider the geological cross-section shown below.



LEGEND (in alphabetical order)

| | | | | | |
|---|---------------------|---|-----------|--|---------------------------|
|  | Basalt |  | Limestone |  | Schist |
|  | Fossiliferous Chert |  | Pegmatite |  | Shale |
|  | Gneiss |  | Quartzite |  | Slate |
|  | Granite |  | Sandstone |  | Volcanic Breccia and Tuff |

- a) For the given cross-section, select the best answer. **Please record your answers in the answer booklet. Do NOT circle your answers on this exam paper.** {5 marks}
- (i) A list of rocks, In order of youngest to oldest, would be:
 - [A] chert, limestone, sandstone
 - [B] limestone, schist, granite
 - [C] limestone, granite, slate
 - [D] sandstone, chert, limestone
 - [E] none of the above
 - (ii) A list of geologic events, In order of oldest to youngest, would be:
 - [A] metamorphism, tilting of sediments, igneous intrusion
 - [B] deposition of sediments, tilting of sediments, metamorphism
 - [C] deposition of sediments, igneous intrusion, metamorphism
 - [D] tilting of sediments, erosion, igneous intrusion
 - [E] none of the above
 - (iii) A list of geologic events, In order of oldest to youngest, would be:
 - [A] igneous intrusion, erosion, faulting
 - [B] metamorphism, igneous intrusion, erosion
 - [C] erosion, deposition of sediments, igneous intrusion
 - [D] tilting of sediments, deposition of sediments, erosion
 - [E] none of the above
 - (iv) A list of geologic environments in which these rocks would have formed, in order of earliest to latest, are:
 - [A] warm and shallow sea, surface exposure, deep ocean
 - [B] sandy beach, warm and shallow sea, burial in the mid-crust
 - [C] deep ocean, warm and shallow sea, burial in the mid-crust
 - [D] burial in the mantle, surface exposure, sandy beach
 - [E] none of the above
 - (v) There has been:
 - [A] magmatic differentiation
 - [B] erosion of sediments prior to igneous injection
 - [C] deformation without metamorphism
 - [D] faulting after sedimentary deposition
 - [E] none of the above
- b) On the geologic cross-section, label all of the following features. {6 marks}
- (i) angular unconformity
 - (ii) nonconformity
 - (iii) disconformity

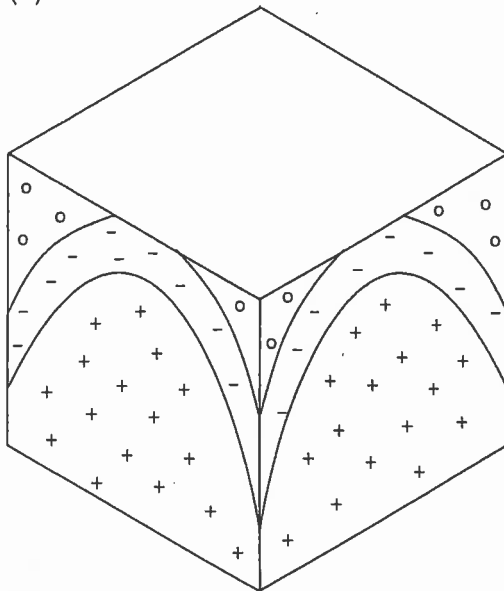
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 Clearly PRINT your name on this page and hand it in with your answer booklet.

NAME: _____

- c) Consider the three-dimensional block diagrams below. For each diagram, (i) complete the missing geological information from any faces to clearly demonstrate all the geologic features in 3 dimensions, (ii) on each face label the oldest rocks with an "O" and the youngest rocks with a "Y", and (iii) name the geological structure (e.g. type of fold/fault, if present). {9 marks}

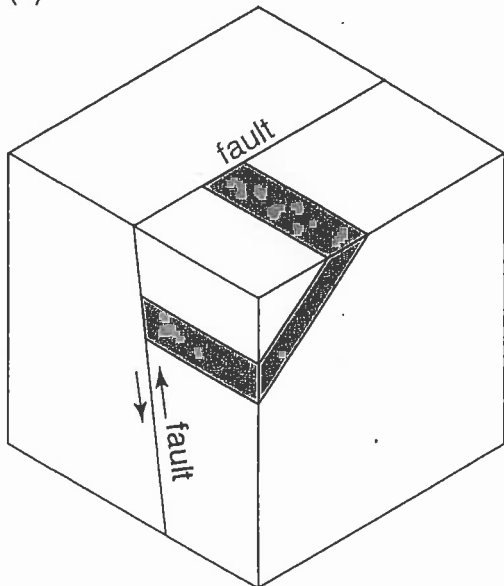
(1)

Name of Geologic Structure:



(2)

Name of Geologic Structure:



***** 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) Piedmont glacier

(iii) arête

(ii) drumlin

(iv) outwash plain

- b) Fill in the blanks in the following passage. {4 marks}

Glaciers generally erode land in two ways – _____ (i) _____ and _____ (ii) _____. The pulverized rock produced at the base of a glacier is known as _____ (iii) _____. _____ (iv) _____ are long, linear grooves and scratches cut into the bedrock when rock fragments at the bottom of a glacier are carried along by the movement of the ice.

- c) Permafrost affects a large part of Canada and also poses some engineering challenges. 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) In regions underlain by permafrost, the most common form of mass wasting is the earthflow.

(ii) The zone of soil above the permafrost is known as the thawed layer.

(iii) Oil pipelines in the Arctic are generally placed above ground to ensure that the warmer air will facilitate the flow of oil

(iv) Permafrost does not typically reach thicknesses beyond 50 m.

- d) Use a schematic drawing of a map view of a glacier to show the various zones of a typical glacier (including the snowline) and use this diagram to explain why a glacier advances or retreats {4 marks}

6.

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

- | | |
|-----------------------------|-------------------|
| (i) point bar | (iii) saltation |
| (ii) competence of a stream | (iv) distributary |

b) Understanding streamflow is important in many geological and civil engineering projects. {6 marks}

- (i) Using a sketch, show how the stream velocity varies around the bend of a meandering stream. Indicate where you would expect to find deposition and erosion of sediments.
- (ii) An engineer measuring streamflow notices that, on average, flow within the stream takes approximately 2.5 hours to travel 3 km. If the stream has a trapezoidal cross-section with a width along its surface of 5 m and a width along its stream bed of 3 m and an average depth of 2 m, what is the estimated discharge of the stream (in m^3/s)?

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

As a youthful stream is downcutting through the bedrock, it typically creates narrow _____ (i) _____ valleys. As streams reach maturity, they often _____ (ii) _____ across the floodplain. The abandoned bend of such a stream is called an _____ (iii) _____ lake. A typical landform associated with streams entering old age are _____ (iv) _____ – raised banks built by successive floods over many years. Uplift of a mature stream could cause it to begin downcutting again, when it would be called a _____ (v) _____ stream. In this case, remnants of the old floodplain would be called _____ (vi) _____.

7.

a) Briefly discuss two ways in which the transport of sediment by wind differs from the transport of sediment by water. {4 marks}

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

(i) barchan dune

(iii) ephemeral stream

(ii) bornhardt

(iv) fetch

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

Waves can result in significant erosion along coastlines. Waves oblique to the shoreline can produce currents flowing parallel to the coast called _____ (i) _____. The process in which waves bend as they approach the shore is known as _____ (ii) _____. In some areas, a _____ (iii) _____ may be constructed to create a quiet water zone near shore in order to protect boats from the force of large breaking waves. _____ (iv) _____ are massive barriers used to prevent waves from reaching the land behind them. In order to stabilize shoreline sands, large quantities of sand can be added to beaches in a process known as _____ (v) _____.

d) Coastal storms can reshape shorelines and have an important impact on society. Briefly list three categories of damage associated with hurricanes (or cyclones). {3 marks}