

NATIONAL EXAMINATIONS –

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.

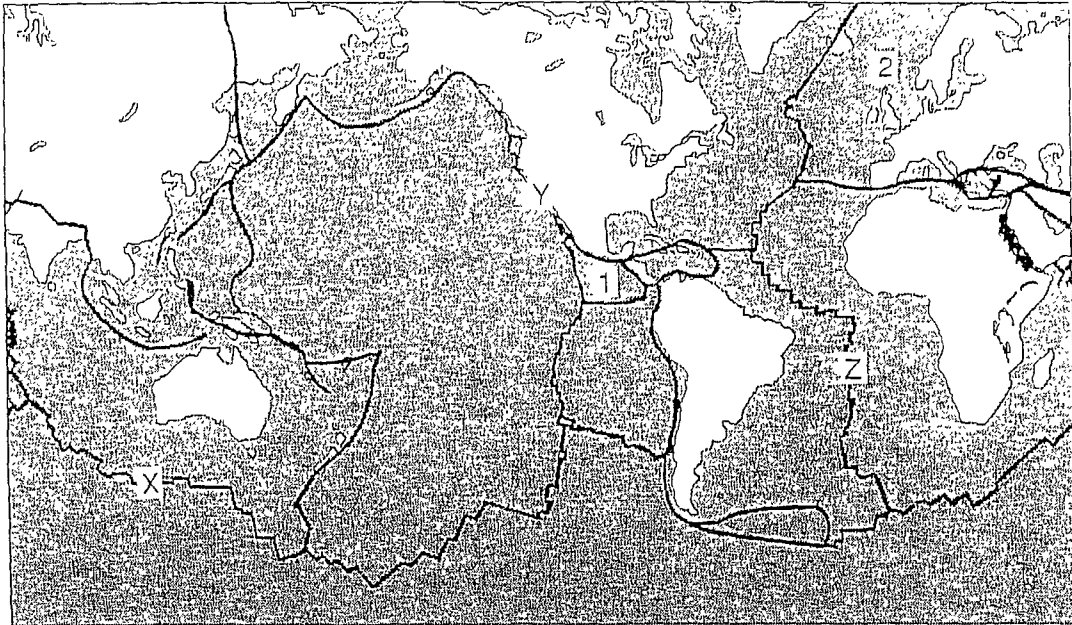
Do not mark anything on the map and do not hand it in with your exam booklet. Clearly write the answers in your exam booklet. {5 marks}

- (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) Sketch and label a cross-section of the earth's mantle, showing approximate depths from the Earth's surface and all important geochemical and/or geophysical boundaries. {5 marks}
- c) Fill in the blanks in the following passage. {5 marks}

The mechanism or theory by which earthquakes are generated is known to scientists as _____. (i) _____. One type of earthquake-generated wave in which particle motion is perpendicular to the direction of wave travel is known as a _____ (ii) _____ wave. The region where seismic activity associated with a plate subduction is found is known as a _____ (iii) _____ zone. Earthquake _____ (iv) _____ is a measure of the strength of an earthquake. In areas where unconsolidated materials are saturated with water, earthquakes can generate a phenomenon known as _____ (v) _____.

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

The process by which more than one rock type can be developed from a common magma is known as _____ (i) _____. The largest intrusive igneous bodies are known as _____ (ii) _____. _____ (iii) _____ is the physical property which best describes how rapidly (or slowly) volcanic lava or molten magma can move. Pulverized rock, lava, and glass fragments explosively blown from a volcanic vent are collectively known as _____ (iv) _____. The extrusion of a fluid lava on the Earth's surface can create a broad domal structure known as a _____ (v) _____ volcano.



2.

- a) For each mineral listed below, state the best descriptor of the requested physical property. {5 marks}

- | | |
|---------------------------------|---------------------------|
| (i) apatite - hardness | (iv) garnet - lustre |
| (ii) quartz - cleavage/fracture | (v) pyrite - crystal form |
| (iii) hematite - streak | |

- b) Name one natural mineral for each of the following categories: {5 marks}

- | | |
|----------------|---------------|
| (i) silicate | (iv) halide |
| (ii) oxide | (v) carbonate |
| (iii) sulphide | |

- c) State the most appropriate rock name for the following: {5 marks}

- (i) fine-grained, medium-coloured extrusive rock with amphibole and intermediate plagioclase
- (ii) a phaneritic rock primarily composed of olivine
- (iii) a detrital sedimentary rock consisting of poorly-sorted quartz, feldspar, and rock fragments
- (iv) a detrital sedimentary rock consisting of rounded pebbles and gravels
- (v) a microcrystalline silica rock created from the skeletons of diatoms and radiolarians

- d) State the most likely original (protolith) rock associated with the following metamorphic rock types: {5 marks}

- | | |
|----------------|------------------|
| (i) marble | (iv) amphibolite |
| (ii) gneiss | (v) migmatite |
| (iii) phyllite | |

3.

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

Ground water is an important resource for communities. Water that soaks into the soil but does not penetrate very far is held in a _____ (i) _____, which serves as a source of water for plants. Water that penetrates further downward passes through a zone of _____ (ii) _____ until it reaches the zone of _____ (iii) _____ where all of the open spaces in the sediment and rock are filled with water. The upper limit of this zone is called the _____ (iv) _____. The movement of ground water into a channel at all times of the year produces an _____ (v) _____ stream.

b) Define the following terms: {5 marks}

- (i) permeability
- (ii) hydraulic gradient
- (iii) aquiclude
- (iv) travertine
- (v) cone of depression

c) Calculate the following: {6 marks}

- (i) If sand has a porosity of 20% by volume and a specific retention of 3%, what is its specific yield?
- (ii) If Point A is at an elevation of 136 m above sea level (a.s.l.) and Point B is at an elevation of 128 m a.s.l., 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 15 m?
- (iii) If clay has a porosity of 50 volume % and a hydraulic conductivity of 10^{-5} m/s, what would be the estimated groundwater velocity from A to B as described in (ii) above?

d) Briefly describe some engineering remediation measures that could be used to mitigate the following groundwater problems: {4 marks}

- (i) saltwater contamination
- (ii) polluted groundwater

- 4.
- a) Sketch a geologic map showing at least 3 different sedimentary layers (labelled A, B, and C) folded into an anticline and a syncline both plunging to the northeast. On the map, label the anticline and syncline, the oldest and youngest layers, the fold axes, the direction of plunge, and the strike and dip direction of the strata using the correct geological symbols. {10 marks}
 - b) With the aid of a sketch, illustrate each of the following geological unconformities. {6 marks}
 - (i) angular unconformity
 - (ii) disconformity
 - (iii) nonconformity
 - c) Crustal deformation can create structures within the earth's crust that can serve as structural traps for oil and natural gas. With the aid of sketches, show how two different kinds of geologic structures can do this. {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) fiord | (iii) lateral moraine |
| (ii) roche moutonnée | (iv) esker |

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

The time when ice sheets and alpine glaciers were far more extensive than today is known as the Ice Age. Studies of seafloor sediments have shown that glacial/interglacial cycles have occurred about every _____ (i) _____ years. The most recent glacial age occurred during the _____ (ii) _____ epoch. Glaciers are important sources of data about climate change because they record past temperatures as measured by _____ (iii) _____ isotopes. Earlier glaciations in geologic history are indicated by lithified glacial deposits known as _____ (iv) _____.

- c) Glaciation affected a large part of Canada and is responsible for various 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) Today, we know that the Ice Age began between 500,000 to 1 million years ago.
- (ii) Glaciers can cause vertical movement of the earth's crust.
- (iii) It is estimated that the growth of ice sheets in the past has caused a drop in sea level of up to 400 m lower than the present sea level.
- (iv) Glaciers themselves can trigger important climatic changes.

- d) It is often important for engineers to understand the nature of permafrost. Explain how erecting a house directly on permafrost could be problematic and the measures which could be taken to solve this problem. {4 marks}

6.

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

- | | |
|---------------------------|--------------------|
| (i) infiltration capacity | (iii) laminar flow |
| (ii) rill | (iv) base level |

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

- (i) Is the rate of water movement within a straight channel uniform? Explain.
- (ii) An engineer measuring streamflow notices that, on average, flow within the stream takes approximately 1 hour to travel 1 km. If the stream has a semi-circular cross-section with a radius of 3 metres, what is the estimated discharge of the stream?

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

The movement and circulation of the earth's total water inventory can be described by the _____ (i) _____ cycle. Water moves from the oceans into the atmosphere mainly through the process of _____ (ii) _____. Wind transports the moisture-laden air where cloud formation eventually returns the water to the Earth's surface through _____ (iii) _____. Some water that has fallen on land soaks into the ground in a process known as _____ (iv) _____, but additional water can flow over the surface into lakes and streams in another process called _____ (v) _____. Water that is absorbed by land plants can be released into the atmosphere in a process known as _____ (vi) _____.

7.

a) Briefly discuss the two mechanisms by which wind can erode. {4 marks}

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

(i) bajada

(iii) ventifact

(ii) loess

(iv) inselberg

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

Waves can reshape shorelines and have an important impact on society. Several features which may develop related to movements of sediments along the shore. _____ (i) _____ are elongated ridges of sand that project from the land into the mouth of an adjacent bay. A _____ (ii) _____ is a ridge of sand that connects an island to the mainland. Low ridges of sand which are parallel to the coast are commonly known as _____ (iii) _____ islands. Along submergent coasts, drowned river mouths known as _____ (iv) _____ characterize many of these coastlines.

c) Engineering structures such as jetties and groins can be used to mitigate the effects of wave erosion. Explain the difference between a jetty and a groin. {4 marks}