NATIONAL EXAMINATIONS – DECEMBER 2008

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, and are generally of equal value. 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 (Fig. 1, 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.

Label the following features listed below directly on the map, using the appropriate letter corresponding to each feature. {*5 marks*}

[A] Philippine Plate
[B] East Pacific Rise
[C] a rift valley
[D] a triple-point junction where 3 convergent boundaries meet
[E] an island arc associated with subduction

b) Sketch a geologic cross-section of the plate boundary between the Pacific Plate and South American Plate to a depth of 150 km, labelling all major geologic features and geologic boundaries at appropriate depths within the Earth. {*10 marks*}

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

Earthquakes commonly occur every year. Most earthquakes are associated with movement along faults where the rock exhibits _____(i)_____ behaviour. A _____(ii)_____ wave is a kind of body wave in which particle motion is parallel to the direction of wave propagation, whereas a _____(iii)_____ wave is a kind of surface wave which causes the ground to move in an elliptical path. _____(iv)_____ - focus earthquakes are the most common, and the most objective way of measuring the energy released by a large earthquake is by using its _____(v)_____.

***** 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 1 for instructions.

NAME: _____

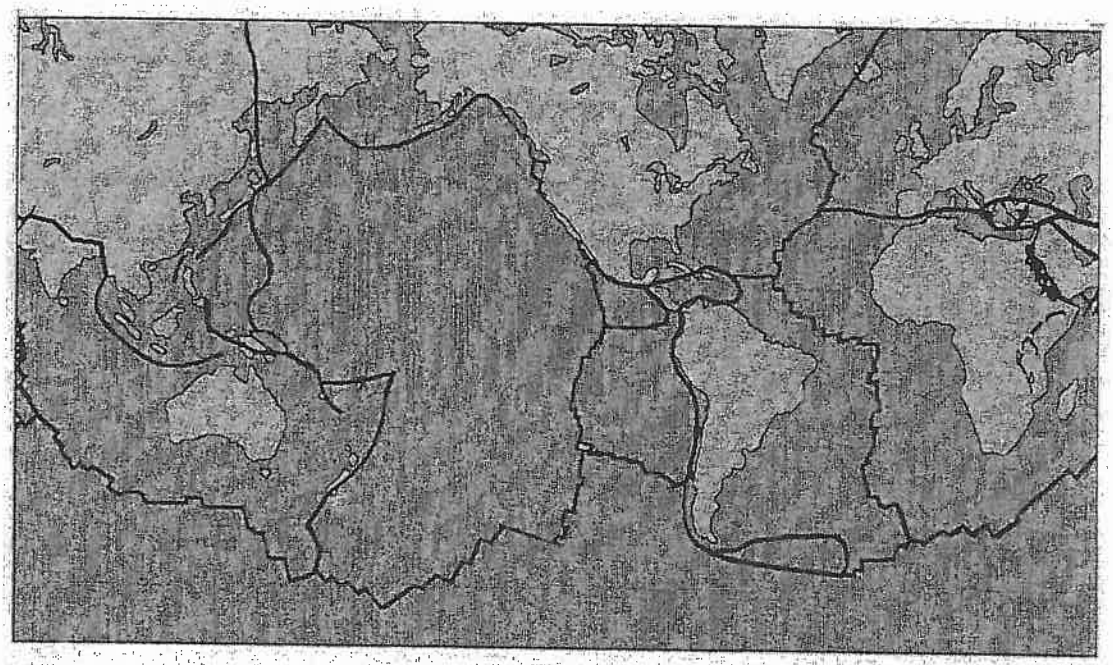


Fig. 1

2.

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

(i) hornblende - colour
(ii) hematite - streak
(iii) fluorite - hardness
(iv) pyrite - lustre
(v) feldspar - cleavage

b) Name one specific mineral that has the requested silicate structure or chemical group. {*5 marks*}

(i) framework silicate
(ii) sheet silicate
(iii) oxide
(iv) single-chain silicate
(v) double-chain silicate

c) State what kind of rock is best described by the following: {*5 marks*}

(i) Igneous rock comprised primarily of olivine and pyroxene, thought to be from the mantle
(ii) Chemical sedimentary rock formed from limestone when the Ca is replaced by Mg
(iii) Hard, fine-grained sedimentary rock formed from the oceanic deposition of silica
(iv) Medium-to-coarse-grained metamorphic equivalent of a granite
(v) Extrusive intermediate volcanic rock; grey color; fine grain. Rapid-cooled mineral equivalent of a diorite

d) Define the following: {*5 marks*}

(i) foliation
(ii) plateau basalt
(iii) graded bed
(iv) index mineral
(v) greywacke

3.

a) Using a diagram, draw a cross-section through the ground to illustrate the meaning of "water table". Label all relevant zones. {*5 marks*}

b) Rate the permeability of the following materials as either poor, moderate, or excellent. {*5 marks*}

(i) gravel
(ii) clay
(iii) sandstone, well-sorted
(iv) shale
(v) granite

c) In the context of ground water, define the following terms: {*10 marks*}

(i) capillary fringe
(ii) hydraulic head
(iii) cone of depression
(iv) recharge
(v) artesian well

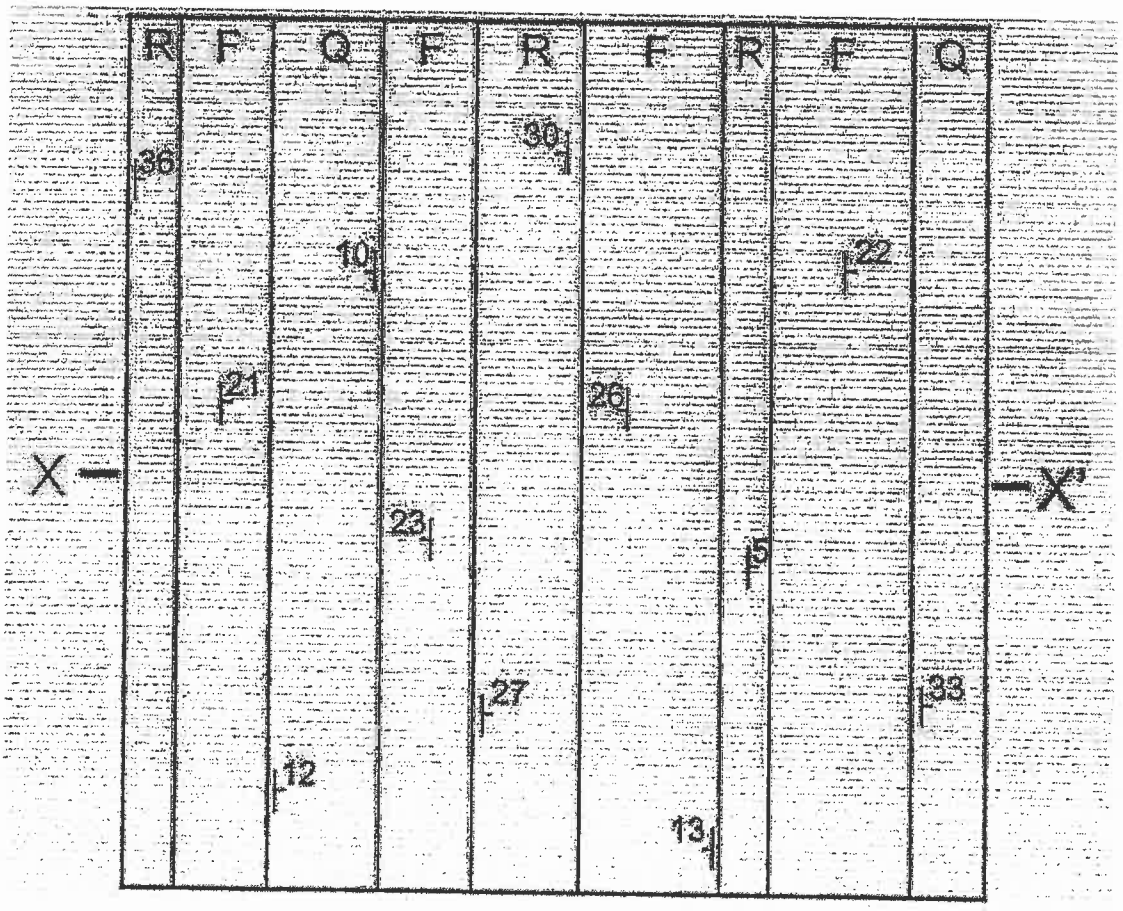
***** IMPORTANT: REMOVE THIS PAGE FROM THE EXAM PAPER!! *****

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 map of a flat, horizontal terrain shown below, complete with strike and dip measurements. North is towards the top of the page. Rock units are designated by the letters R, F, and Q and dips are given in degrees.



a) Define strike and dip and explain their purpose. *{3 marks}*

b) One of the measurements on the above map is likely to be incorrect. State the dip of this measurement and briefly explain why this measurement is problematic. *{2 marks}*

c) Sketch a geologic cross-section along X-X' (see map) using the information provided. On your sketch, label all geological structures *{6 marks}*

d) What is the oldest rock unit? What is the youngest? *{2 marks}*

e) On the geologic map, mark any additional structural symbols which are missing. Make sure that you remove the page from the exam paper, print your name in the space provided, and hand this page in with your answer booklet. *{2 marks}*

f) With the aid of a sketch, illustrate a reverse fault and label the hanging wall and footwall. Briefly explain how a fault could play an important role in the oil exploration industry. *{5 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. {*12 marks*}

(i) ice sheet
(ii) tarn
(iii) terminal moraine
(iv) hanging valley

b) 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 primary control on Pleistocene glacial and interglacial episodes seems to be variations in the Earth's orbit and inclination towards the Sun.
(ii) The last ice sheet melted away from Canada about 18,000 years ago.
(iii) The resulting sea-level rise associated with global warming and subsequent melting of ice sheets is relatively insignificant compared with the thermal expansion of oceans.
(iv) Glaciers can be considered to be an important water resource.

c) 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) Solifluction is the flow of water-saturated soil over permeable material.
(ii) Permafrost occurs at depths ranging from a few cm to a few m below the surface.
(iii) The cementing agent in permafrost is clay.
(iv) The engineering design of buildings on permafrost does not require any special considerations.

6.

a) What is the hydrologic cycle? Explain the cycle in more detail with the aid of a sketch. {*10 marks*}

b) Briefly define three different kinds of drainage patterns that streams and rivers can display and the nature and/or structure of the rocks that may typically lie underneath it. {*6 marks*}

c) The discharge of streams is an important engineering consideration because of the potential for flooding. {*4 marks*}

(i) Define the discharge of a stream.

(ii) A stream varying from 50-100 m in width and from 1-2 m in depth flows with an average velocity of 10 km/h. The water temperature also varies from 10 °C at the stream bed to 16 °C at the surface. State your best estimate of the discharge of the stream in cubic metres per second, showing your calculations and stating any reasoning.

7.

a) Select the best answer for each of the following multiple-choice questions. **Please record your answers in the answer booklet. Do NOT answer on this exam paper.** {*6 marks*}

i) The following best describes the sequence of various mass-wasting processes from slower to faster time scales:
[A] debris flow, creep, rockslide
[B] rockfall, mudflow, earthflow
[C] solifluction, avalanche, slump
[D] mudflow, landslide, creep
[E] rotational slide, earthflow, solifluction
[F] none of the above

ii) What term implies that a descending mass moves downslope as a viscous fluid?
[A] creep
[B] flow
[C] debris
[D] fall
[E] avalanche
[F] slide
[G] slump
[H] none of the above

iii) Factors that could influence the rate of movement for mass-wasting phenomena are:
[A] water
[B] gravity
[C] tidal forces
[D] earthquakes
[E] [A] and [B]
[F] [A], [B], and [C]
[G] [B], [C], and [D]
[H] [A], [B], and [D]

iv) A mixture of soil and water flowing down a channel is best called:
[A] creep
[B] an earthflow
[C] a lahar
[D] a mudflow
[E] a rockslide
[F] a slump
[G] solifluction
[H] none of the above

v) What is talus?
[A] a glacial moraine
[B] a snow avalanche with an abundance of rock in it
[C] another term for rockslide
[D] an apron of fallen rock fragments at the base of a cliff
[E] the slowest type of mass wasting
[F] none of the above

vi) Consider a road cut in rock which has a strong foliation. The situation in which there is the greatest risk of a rockslide or rockfall onto the road is when:
[A] the planes of foliation are horizontal
[B] the planes of foliation are incllined away from the road
[C] the planes of foliation are incllined towards the road
[D] the planes of foliation are vertical
[E] the rock is intruded by dykes
[F] all of the above
[G] none of the above

b) Define the following terms. {*8 marks*}

(i) deflation
(ii) ventifact
(iii) loess
(iv) transverse dune

c) With the aid of sketches, explain how 3 different engineering structures can be used to interrupt the flow of sand along a beach and the main purpose for which they are used. {*6 marks*}