NATIONAL EXAMINATIONS – December 2011

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 3 and 5.
(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. **Please record your answers in the answer booklet. Do NOT answer on this exam paper.** *{5 marks}*

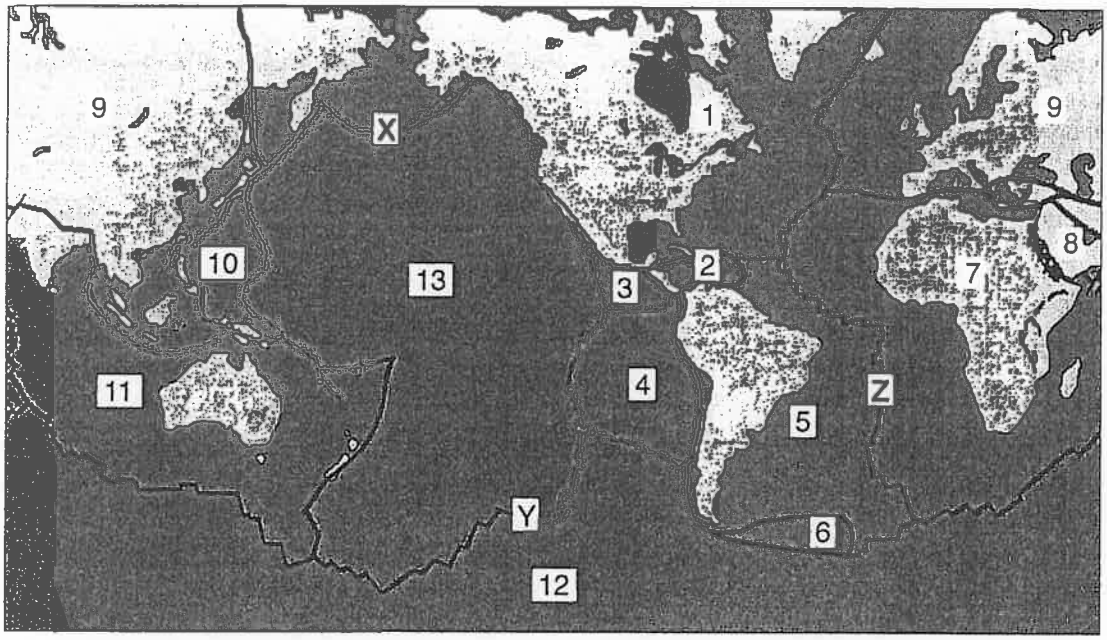
Plate tectonics is one of the most important and fundamental theories in earth science. We know today that plate boundaries are defined primarily by _____(i)_____. In the model, such features as deep-ocean _____(ii)_____ are produced when cold, dense slabs of oceanic lithosphere are subducted into the mantle. The resultant zone of seismic activity in the subducted plate is known as a _____(iii)_____ zone. Some earthquake and volcanic activity can be found within tectonic plates. Such phenomena may be attributed to rising plumes of mantle material known as _____(iv)_____. One of the simplest and earliest mechanisms to explain the movement of the plates is _____(v)_____ in the mantle.

c) Briefly define the following geologic terms. *{5 marks}*

(i) seismogram
(ii) L wave
(iii) deep earthquake
(iv) tsunami
(v) fault creep

d) Indicate in your examination booklet whether each statement below is either true (T) or false (F): *{5 marks}*

(i) Bowen's reaction series illustrates the relative size of minerals that can crystallize from a magma.
(ii) The predominant minerals in a peridotite are olivine and biotite.
(iii) Basalt is the most common intrusive igneous rock
(iv) A dike forms when magma intrudes concordantly along bedding planes in a sedimentary rock.
(v) Xenoliths are domes of magma that can move upwards through the crust due to their lower density than the surrounding rocks.


9
X
1
9
10
13
3
2
8
7
11
4
Z
5
Y
6
12

2.

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

(i) asbestos - luster
(ii) topaz - hardness
(iii) amethyst – streak
(iv) diopside - cleavage
(v) graphite - specific gravity

b) For each mineral listed below, state to which mineral group it belongs (i.e. silicate, sulfate, sulfide, oxide, carbonate, halide, hydroxide, phosphate, or a native element) . *{5 marks}*

(i) dolomite
(ii) pyrite
(iii) chromite
(iv) garnet
(v) sylvite

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

(i) a phaneritic igneous rock composed of about 25% quartz and over 50% feldspar
(ii) a sedimentary rock consisting of silt and clay-sized particles
(iii) a very-fine grained foliated rock consisting of minute mica flakes and exhibiting excellent cleavage
(iv) a rock which has undergone extreme deformation and ductile flow such that the mineral grains are elongated and give the rock a foliated appearance
(v) a sedimentary rock that typically consists of sand-sized particles of quartz, feldspar, and rock fragments

c) State a typical rock type that would typically be produced by metamorphosing the following source rocks. *{5 marks}*

(i) limestone
(ii) granite
(iii) quartz sandstone
(iv) shale
(v) gneiss

3.

a) Briefly contrast the following pairs of geologic terms: *{8 marks}*

(i) porosity vs. permeability
(ii) influent stream vs. effluent stream
(iii) stalactite vs. stalagmite
(iv) aquiclude vs. aquifer

b) The movement of groundwater can be described by Darcy's Law. State Darcy's Law as a mathematical formula using the most fundamental parameters and define all of the parameters that are used. *{6 marks}*

c) Wells are commonly used to remove groundwater. With the aid of sketches, explain how the following situations may occur. *{6 marks}*

(i) The withdrawal of water from one well may cause nearby wells to become dry.

(ii) In coastal regions, a pumped well near the ocean may become contaminated with salt water.

4.

a) Briefly define the different kinds of geologic unconformities. {*6 marks*}

b) Select the best answer for each of the following multiple-choice questions. **Please record your answers in the answer booklet. Do NOT circle your answers on this exam paper.** {*10 marks*}

(i) Which types of geologic structures have younger rocks at their core?

[A] anticlines and synclines
[B] anticlines and domes
[C] domes and basins
[D] synclines and basins
[E] anticlines and basins
[F] synclines and domes
[G] all of the above
[H] none of the above

(ii) Which geologic feature is characteristically associated with metamorphic rocks?

[A] syncline
[B] bedding
[C] compositional layering
[D] reverse fault
[E] horst
[F] foliation
[G] sill
[H] none of the above

(iii) Which type of fault involves the fault blocks moving exclusively in a horizontal direction?

[A] strike-slip fault
[B] oblique-slip fault
[C] normal fault
[D] thrust fault
[E] reverse fault
[F] none of the above

(iv) Which type of fault involves the relative downward movement of the hanging-wall block?

[A] left-lateral strike-slip fault
[B] right-lateral strike-slip fault
[C] normal fault
[D] thrust fault
[E] reverse fault
[F] none of the above

(v) Which type of fault is most likely found at a transform plate boundary?

[A] strike-slip fault
[B] oblique-slip fault
[C] normal fault
[D] thrust fault
[E] reverse fault
[F] none of the above

(vi) The following structures always form during brittle deformation:

[A] folds and faults
[B] folds only
[C] faults only
[D] folds and joints
[E] faults and joints
[F] none of the above

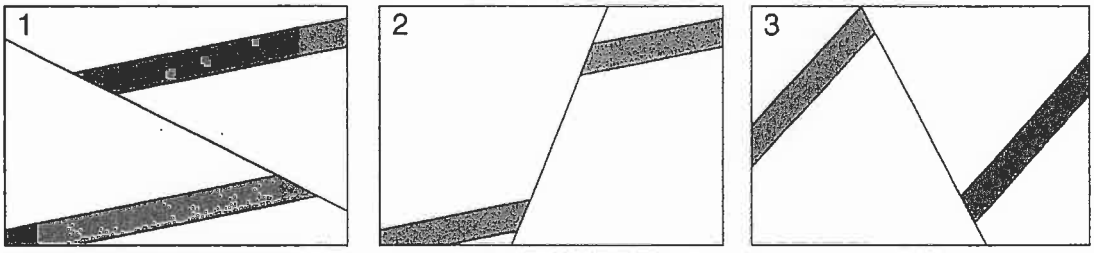
(vii) Brittle deformation generally occurs:

[A] during high-grade metamorphism
[B] at low temperatures
[C] during contact metamorphism
[D] during folding
[E] at deposition
[F] none of the above

(viii) The best type of structure for trapping hydrocarbons is:
[A] syncline
[B] a volcano
[C] a dune
[D] horst
[E] joint sets
[F] none of the above

(ix) In describing the orientation of a geologic structure, which of the following pairs of strike-azimuth and dip-direction azimuth (assuming the azimuth for due north is 000°) is <u>not</u> possible?
[A] 050° / 140°
[B] 280° / 010°
[C] 050° / 310°
[D] 120° / 210°
[E] 200° / 110°
[F] none of the above

(x) Diagrammatic cross-sections through several faults are shown below. A reverse fault is shown in:



[A] 1
[B] 2
[C] 3
[D] 1 and 2
[E] 2 and 3
[F] 1 and 3
[G] all of the diagrams
[H] none of the diagrams

c) Faults and faulted rocks can have potentially significant impacts for engineering projects and society. Briefly discuss. {*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. *{10 marks}*

(i) cirque
(ii) drumlin
(iii) col
(iv) stratified drift
(v) horn

b) Fill in the blanks in the following passage. **Please record your answers in the answer booklet. Do NOT answer on this exam paper.** *{6 marks}*

The time in the past when ice sheets and glaciers were far more extensive than today is known as the _____(i)_____ Age. At this time, ice was thought to have covered about _____(ii)_____ per cent of the Earth's land area. We know now that glaciers have advanced and retreated over the land surface several times throughout history; these glacial/interglacial cycles appear to occur about every _____(iii)_____ years. The last glacial event to affect the Earth occurred about _____(iv)_____ years ago, in what is known as the _____(v)_____ epoch. One major effect resulting from the retreat of the glaciers is vertical crustal movement known as _____(vi)_____.

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) The most common form of mass wasting in areas underlain by permafrost is liquefaction.
(ii) The active layer is a zone of soil within the permafrost which thaws in the summer and freezes in the winter.
(iii) The impact of human activities in permafrost regions can remain for decades.
(iv) One engineering solution to mitigate problems building in permafrost regions is to insulate structures from the ground.

6.

a) Briefly define the following geologic terms with respect to streams. {*8 marks*}

(i) stream competence
(ii) point bar
(iii) water gap
(iv) base level

b) Describe the longitudinal profile of a typical stream from its head to its mouth. {*6 marks*}

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

A stream is only a small component of a much larger regional system or network of streams called a _____(i)_____ . These regional networks are separated from each other by an imaginary line called a _____(ii)_____ . Networks of streams can form particular patterns, often in response to the kinds of rocks on which the streams develop or the structural geology of the rocks underneath. A common pattern is known as a _____(iii)_____ pattern, in which tributaries form a system of irregular branches. A _____(iv)_____ pattern often develops on volcanic cones or domes. If the bedrock contains many joints and faults, a _____(v)_____ pattern often develops. If the bedrock consists of alternating layers of resistant and less-resistant strata of rock, a _____(vi)_____ pattern can form.

7.

a) Briefly discuss the two main types of weathering. For each type, describe three specific processes as illustrations. {*8 marks*}

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

Wind can transport fine particles and debris in two ways – via _____(i)_____ and _____(ii)_____ . The wind can also erode in two ways. _____(iii)_____ occurs when loose material is lifted and removed; on desert surfaces, the stony veneer resulting from this process is called _____(iv)_____ . _____(v)_____ occurs when a rock is ground and scraped through the impact of particles; this can create interestingly shaped stones known as _____(vi)_____ .

c) Briefly define the following terms. {*6 marks*}

(i) submergent coast
(ii) neap tide
(iii) breakwater