

National Exams December 2014

**04-BS-14, Geology**

3 hours duration

**NOTES:**

1. 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.
2. This is a CLOSED BOOK EXAM. Candidates may use one of two calculators, the Casio or Sharp-approved models.
3. FIVE (5) questions constitute a complete exam paper. YOU MUST ANSWER QUESTIONS 1 TO 4. Candidates must choose one more question from the remaining questions. Where stated in the examination, please hand in any additional pages with your exam booklet.
4. 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.
5. The marks assigned to the subdivisions of each question are shown for information. Each question is worth 20 marks. The total number of marks for the exam is 100

**Question 1.**

- 1) During major earthquakes, instantaneous displacements of \_\_\_\_\_ occur across pre-existing faults.
  - a) a few kilometres
  - b) a few millimetres
  - c) a few metres
  - d) a few thousand kilometres
  
- 2) What are the three types of *differential stress* in the Earth's lithosphere?
  - a) confined, unconfined, and directed
  - b) hydrostatic, lithostatic, and vibratory
  - c) compression, shear, and tension
  - d) upwards, downwards, and sideways
  
- 3) During mountain building episodes, originally flat lying sedimentary and volcanic rocks are often bent into a series of \_\_\_\_\_.
  - a) folded anticlines and synclines
  - b) box pleats
  - c) horsts and grabens
  - d) heaves and sags
  
- 4) Most crustal deformation occurs in active tectonic zones \_\_\_\_\_.
  - a) deep within old plate interiors
  - b) at the base of sedimentary basins
  - c) in thick piles of unconsolidated sedimentary strata
  - d) along plate margins
  
- 5) Explosive volcanic eruptions occur \_\_\_\_\_.
  - a) when violently escaping gases evolve suddenly to drop the magma density and propel molten magma from the chamber
  - b) in response to deflation of the volcano
  - c) when crystallization forces exceed the strength of the volcano
  - d) whenever basaltic magma extrudes on the seafloor
  
- 6) Plutonic rocks are emplaced at depth yet they can be seen at the Earth's surface due mainly to \_\_\_\_\_.
  - a) widespread igneous inversion
  - b) erosion of overlying rocks due to uplift
  - c) catastrophic violent upheavals that bring them to the surface
  - d) continual ongoing intrusion after the magma solidifies

TRUE or FALSE – Answer in the exam booklet

- 7) Evidence for the supercontinent Pangaea includes fit of continents, matching fossils and mountain chains separated by ocean basins, and ancient glaciated rocks in the southern hemisphere.
- 8) During various times in the geologic past, the polarity of Earth's magnetic field has been reversed.
- 9) As continents drift, they plow through the thinner ocean lithosphere like big rocky "ice breakers" and push it out of their way.
- 10) In general, rocks of the continental crust are less dense than rocks of the oceanic crust.
- 11) In general, seafloor sediments gradually thicken away from a mid-ocean ridge.
- 12) The epicentre of an earthquake is on the surface of the Earth directly above the focus.
- 13) Earthquakes result from the sudden release of elastic strain energy previously stored in rocks surrounding a zone of fault movement.
- 14) The energy released by an earthquake is very intense, and felt just as strongly in distant places, in accordance with its magnitude.
- 15) S waves are waves that can travel through solid and liquid media.
- 16) Horizontal vibrations, such as induced by strike-slip faulting, S-waves and some types of surface waves are generally much more dangerous to tall buildings than vertical up and down ground shaking.
- 17) If the P, S, and surface waves arrive almost simultaneously, the seismic recording station is virtually at the epicentre of the earthquake.
- 18) 90% of all earthquakes occur below depths of 700 km.
- 19) The Richter earthquake magnitude scale is based on the total amount of energy released by the earthquake, as measured on a seismograph.

20) Unconsolidated, water-saturated soils or sediments provide good foundation materials for buildings and other structures because they absorb and dampen seismic vibrations.

## Question 2.

- 1) Which of the following best defines a mineral and a rock?
  - a) A rock has an orderly, repetitive, geometric, internal arrangement of minerals; a mineral is a lithified or consolidated aggregate of rocks.
  - b) A rock consists of atoms bonded in a regular, geometrically predictable arrangement; a mineral is a consolidated aggregate of different rock particles.
  - c) In a mineral the constituent atoms are bonded in a regular, repetitive, internal structure; a rock is a lithified or consolidated aggregate of minerals.
  - d) A mineral consists of its constituent atoms arranged in a geometrically repetitive structure; in a rock, the atoms are randomly bonded without any geometric pattern.
  
- 2) Minerals consist of an ordered array of atoms or ions that are \_\_\_\_\_.
  - a) all the same size and charge
  - b) always packed together in cubes or octahedra
  - c) physically attached to each other by shared protons
  - d) chemically bonded in a regular crystalline structure
  
- 3) Silicate igneous rocks make up the \_\_\_\_\_.
  - a) majority of shallow rocks covering the continents but everything deeper is sedimentary and metamorphic
  - b) bulk of the Earth's crust and mantle
  - c) densest rocks and are mainly found in the core
  - d) bulk of volcanic mountains but not much else on Earth

TRUE OR FALSE – Answer in the exam booklet

- 4) All atoms of the same element have the same atomic number.
  
- 5) Graphite and diamond have the same chemical composition and different crystalline structures.
  
- 6) Diamond and quartz are both minerals composed of a single element.

- 7) Mineral lustre is broadly classified as either metallic or opaque.
- 8) Colour is one of the most diagnostic properties of minerals.
- 9) Oxygen ions are larger in size than silicon ions.
- 10) As silicate tetrahedra link together in larger units, more oxygens are shared and the size of the negative charge per silicon decreases.
- 11) Calcite and dolomite are both carbonate minerals.

**SHORT ANSWER – 1 Mark each**

- 12) Carefully observe each of the photographs below of sedimentary rocks. To the right of each sample, name the rock and describe its origin (how it formed).

(6 marks)

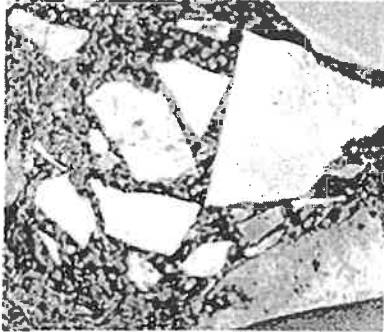
a)



b)

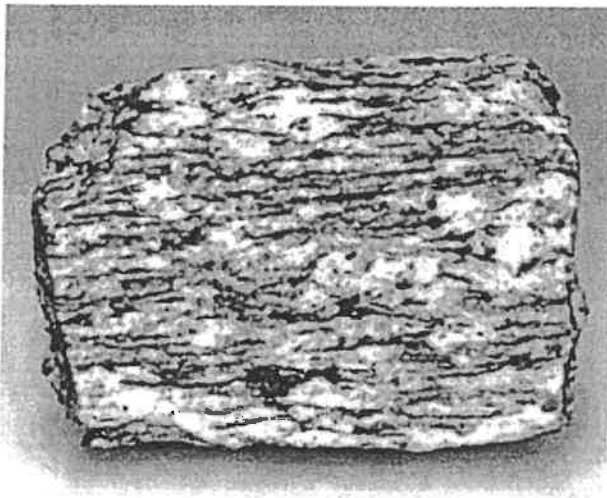


c)



13) Carefully examine the photograph below of a metamorphic rock sample. The sample is shown as its actual size. (3 marks)

- a) Is this rock foliated or nonfoliated?
- b) What is the name of this metamorphic rock?
- c) Consider how this rock got its texture. Was it compressed from top to bottom or from side to side?



### Question 3.

- 1) Make a sketch of a cross-section through the ground to show and label the following features: (6 marks)
  - a) capillary fringe
  - b) zone of aeration
  - c) water table
  - d) belt of soil moisture
  - e) zone of saturation
  - f) groundwater

- 2) Describe the formation and consequences of Karst topography (6 marks)
- 3) (8 marks)
- If Point 1 is at an elevation of 255 m and Point 2 is at an elevation of 270 m. Calculate the hydraulic gradient if the points are 1.5 km apart on a map.
  - A hydraulic conductivity test is completed on a sample of soil (porosity,  $n=0.45$ ). The hydraulic conductivity of the soil is  $5 \times 10^{-5} \text{ m/s}$ . The dimensions of the sample are diameter=10cm and the length=14cm. A hydraulic gradient across the sample is 0.05. What volume of water flows out of the sample in 5 minutes.

#### Question 4.

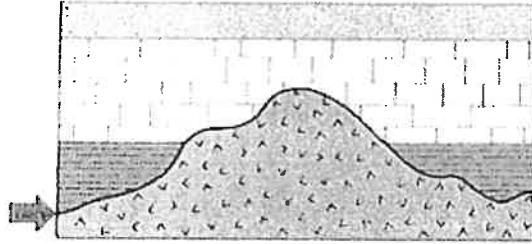
- Which one of the following stress situations results in folding of flat-lying, sedimentary strata?
  - horizontally directed, extensional stresses
  - vertically oriented digital stresses
  - vertically directed, extensional or stretching stresses
  - horizontally directed, compressive stresses
- How does elastic deformation of rocks differ from brittle or plastic deformation?
  - It only happens to rocks that can bounce .
  - It can only occur once and never happens in cycles.
  - It only occurs at very fast or high strain rates.
  - It is reversible or recoverable and when the stress is removed, the rocks snap back to their original shape or position.
- Brittle deformation would be favoured over plastic deformation in which of the following conditions?
  - warmer temperatures and high confining pressures
  - cooler temperatures and low confining pressures
  - shallow depths
  - high confining pressures
- When does permanent rock deformation occur?
  - once its elastic limit is surpassed
  - when it goes on a real bender
  - once it is completely lithified and becomes inflexible
  - only after it comes to be located on a plate margin

- 5) When do rocks succumb to ductile deformation?
- a) at great depth under active mountain belts with high confining pressure and low strain rates or prolonged strain
  - b) in fault zones with intermittent high strain rates
  - c) at shallow depth, at low confining pressure, and low temperature
  - d) on the rims of meteorite impact craters
- 6) A syncline is \_\_\_\_\_.
- a) a fold with only one limb
  - b) a fold in which older flanking strata dip toward the axis
  - c) a paralytic drunken fold characterized by recumbent limbs
  - d) a fold in which the older central strata dip away from the axis

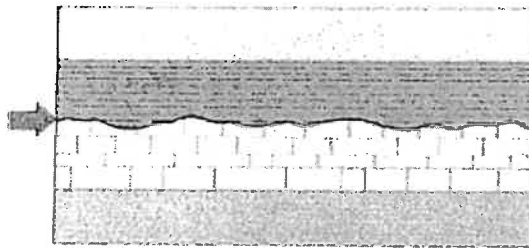


7) What is the name of the specific type of unconformity that is labeled with an arrow. The v-pattern indicates igneous rocks. All other patterns are different types of sedimentary rocks. (3 marks)

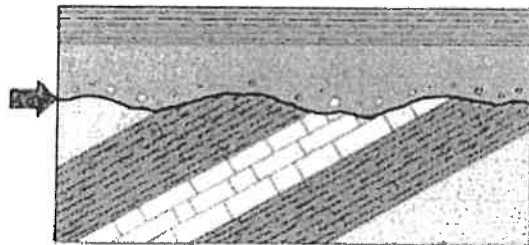
a)



b)



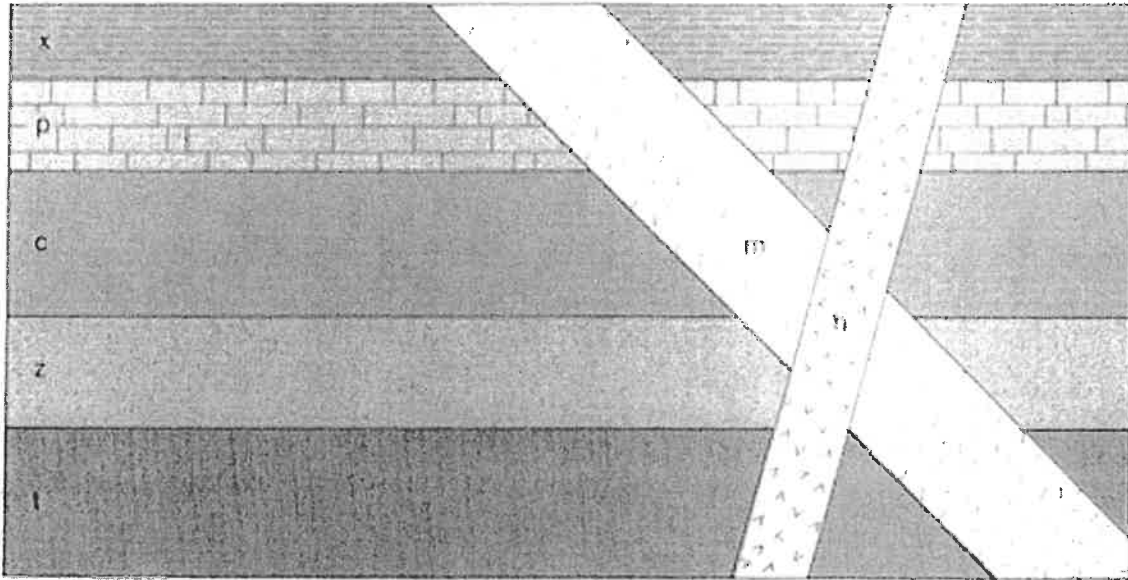
c)



8) Examine the geologic cross section below.

(4 marks)

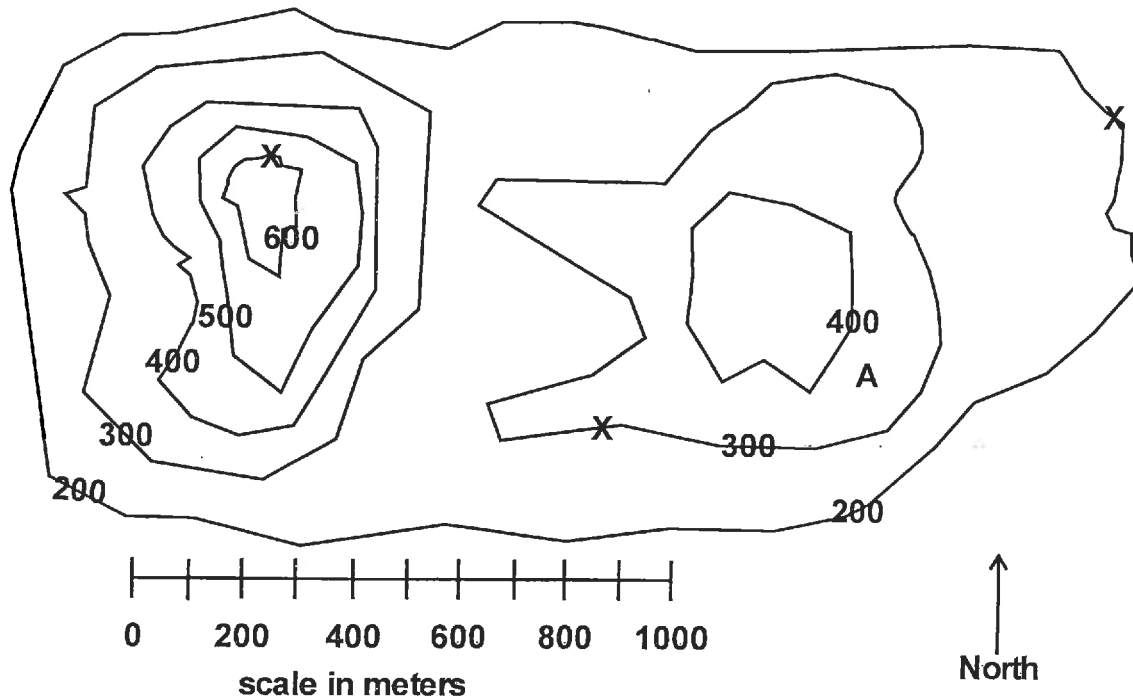
- a) Which feature is the youngest?
- b) Which feature is the oldest?



9) On the contour map below three (3) X's mark an outcrop of a coal layer

(7 marks)

- a) Determine the strike and dip of the coal layer.
- b) Trace the outcrop pattern.
- c) What is the depth of the coal layer at point A?
- d) What is the apparent dip in the direction  $N90^{\circ}E$ ?



### Question 5.

- 1) The main direct geologic effect(s) of glaciers is (are) to \_\_\_\_\_.
  - a) raise global sea level by depressing the crust
  - b) warm the global climate by absorbing more solar radiation
  - c) erode the continental landscape and to transport and deposit sediments
  - d) reduce high latitude marine sedimentation by reducing biologic productivity
  
- 2) Compared to earlier or subsequent streams in the same valleys, alpine glaciers move \_\_\_\_\_ but carry \_\_\_\_\_ sediment.
  - a) faster; less
  - b) mainly in the winter; mostly very coarse
  - c) a little slower; only finer
  - d) very much slower; vastly more
  
- 3) Abrasion and plucking generally involve what part of a glacier?
  - a) the snout zone
  - b) the surface, brittle zone
  - c) the internal, flowage zone
  - d) the basal, sliding zone

- 4) A \_\_\_\_\_ is an erosional feature specifically produced by alpine glaciation.
- V-shaped valley
  - U-shaped valley
  - kame
  - lateral moraine
- 5) A fjord is \_\_\_\_\_.
- a glacier-cut valley which sinks below sea level due to glacial rebound after the ice melts
  - a large, kettle-pocked moraine left as an island when sea level rises following melting of the ice
  - a stream valley deepened by glacial erosion, that floods as sea level rises
  - a glacier-cut valley that is dammed by an end moraine and a large lake is formed
- 6) Which of the following best describes the term glacial drift?
- slow, plastic flow in the brittle zone of a glacier
  - the sedimentary materials outwash and till
  - the slow, southward advance of the continental ice sheets over Canada and North America during the Pleistocene
  - floating of icebergs southward from the north polar seas
- 7) Which one of the following statements concerning glacial deposits is false?
- Till is deposited directly from the ice; outwash is deposited by meltwater streams.
  - Outwash is mainly stratified sand and gravel.
  - Tills are poorly sorted and their fragments are mostly angular.
  - Glacial erratics are blocks of rock that are too large for the glacier to move.
- 8) Drumlin fields contain \_\_\_\_\_.
- mounds of outwash deposited by meltwater streams at the snout of a glacier
  - smooth, striated, bedrock ridges shaped and polished by a glacier's erosive action
  - bowl-shaped depressions eroded largely by frost action and glacial plucking
  - smooth, tapering, asymmetric ridges of till usually formed and shaped beneath a continental ice sheet
- 9) All of the following descriptions apply to stratified drift (not till) except for \_\_\_\_\_
- commonly layered, well sorted sand and gravel beds

- b) deposited in advance of the ice front on outwash plains, in glacial lakes, or fjords
  - c) deposited or redeposited by glacial meltwater
  - d) rock flour deposited directly from advancing ice
- 10) A(n) \_\_\_\_\_ represents a former meltwater channel or tunnel on, in, or beneath glacial ice, that became filled with sand and gravel.
- a) drumlin
  - b) esker
  - c) valley train
  - d) kettle
- 11) Which one of the following prominent features were significantly larger than at present day during the Pleistocene glacial episodes?
- a) horns, arêtes, and cirques produced by alpine glaciation
  - b) the Great Lakes and Lake Agassiz
  - c) terminal moraines of continental ice sheets that moved south from Canada
  - d) subaerial fan deltas covering more extensive coastal plains
- 12) \_\_\_\_\_ is one of the three ways a glacier can move over its bed.
- a) Frost heaving
  - b) Basal slip
  - c) Morainal sliding
  - d) Crevassal slip
- 13) A(n) \_\_\_\_\_ is a depositional feature composed primarily of till and usually associated with continental glaciation, not with alpine glaciers.
- a) moraine
  - b) drumlin
  - c) cirque
  - d) outwash deposit
- 14) The \_\_\_\_\_ was the most recent Pleistocene glacial episode in North America.
- a) Wisconsinan
  - b) Kansan
  - c) Indianan
  - d) Dakotan
- 15) The \_\_\_\_\_ of the geologic time scale occurs within the time of Earth's most recent "Ice Age."

- a) Proterozoic Eon
- b) Pleistocene Epoch
- c) Permian Period
- d) Pliocene Epoch

16) (5 marks)

- a) Sketch and label the layers of a vertical cross section of a location that has permafrost.
- b) Name and describe the differences between the two zones of permafrost in Canada.

### Question 6.

- 1) The physical removal of dissolved or disaggregated rock from the site of weathering by wind, water, or ice is termed \_\_\_\_\_.
  - a) ablation
  - b) recidivism
  - c) solifluction
  - d) erosion
  
- 2) \_\_\_\_\_ is the dissolution or decomposition of minerals and rocks.
  - a) Mechanical weathering
  - b) Chemical weathering
  - c) Hydrolysis
  - d) Rendering
  
- 3) In nature, where does the acidity come from to speed up chemical weathering?
  - a) plutonism
  - b) nuee ardentes from explosive volcanic eruptions
  - c) Bowen's reaction series
  - d) organic acids from decayed plants, acid rain, and sulphuric acid from oxidation of pyrite
  
- 4) The principal causes of mechanical fragmentation of rocks *in place* are \_\_\_\_\_.
  - a) erosion and transport by moving wind, water, or ice
  - b) the relentless actions of Sisyphus
  - c) always inscrutable because they happened at some time in the past
  - d) biologic activity, expansion from unloading, frost wedging
  
- 5) The three major processes involved in chemical weathering are \_\_\_\_\_.

- a) dissolution, hydrolysis, and oxidation
  - b) precipitation, ion exchange reactions, and degasification
  - c) carbonation, dissimulation, and salinization
  - d) recrystallization, pitting, and rinsing
- 6) Briefly define the following terms (8 marks)
- a) Oxbow lake
  - b) Meander
  - c) Levee
  - d) Tide dominated delta
- 7) Describe and sketch three types of drainage basins (7 marks)

**Question 7.**

- 1) List and describe the factors that influence mass wasting. (8 marks)
- 2) Briefly define the following terms (8 marks)
- a) loess
  - b) crescent dune
  - c) wave-cut platform
  - d) deflation
- 3) Briefly describe two methods of shoreline protection (4 marks)