

PHYSICAL SETTING EARTH SCIENCE

Friday, January 27, 2023 — 9:15 a.m. to 12:15 p.m., only

The possession or use of any communications device is strictly prohibited when taking this examination. If you have or use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

Use your knowledge of Earth science to answer all questions in this examination. Before you begin this examination, you must be provided with the *2011 Edition Reference Tables for Physical Setting/Earth Science*. You will need these reference tables to answer some of the questions.

You are to answer all questions in all parts of this examination. You may use scrap paper to work out the answers to the questions, but be sure to record your answers on your answer sheet and in your answer booklet. A separate answer sheet for Part A and Part B–1 has been provided to you. Follow the instructions from the proctor for completing the student information on your answer sheet. Record your answers to the Part A and Part B–1 multiple-choice questions on this separate answer sheet. Record your answers for the questions in Part B–2 and Part C in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

All answers in your answer booklet should be written in pen, except for graphs and drawings, which should be done in pencil.

When you have completed the examination, you must sign the declaration printed on your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet and answer booklet cannot be accepted if you fail to sign this declaration.

Notice ...

A four-function or scientific calculator and a copy of the *2011 Edition Reference Tables for Physical Setting/Earth Science* must be available for you to use while taking this examination.

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.

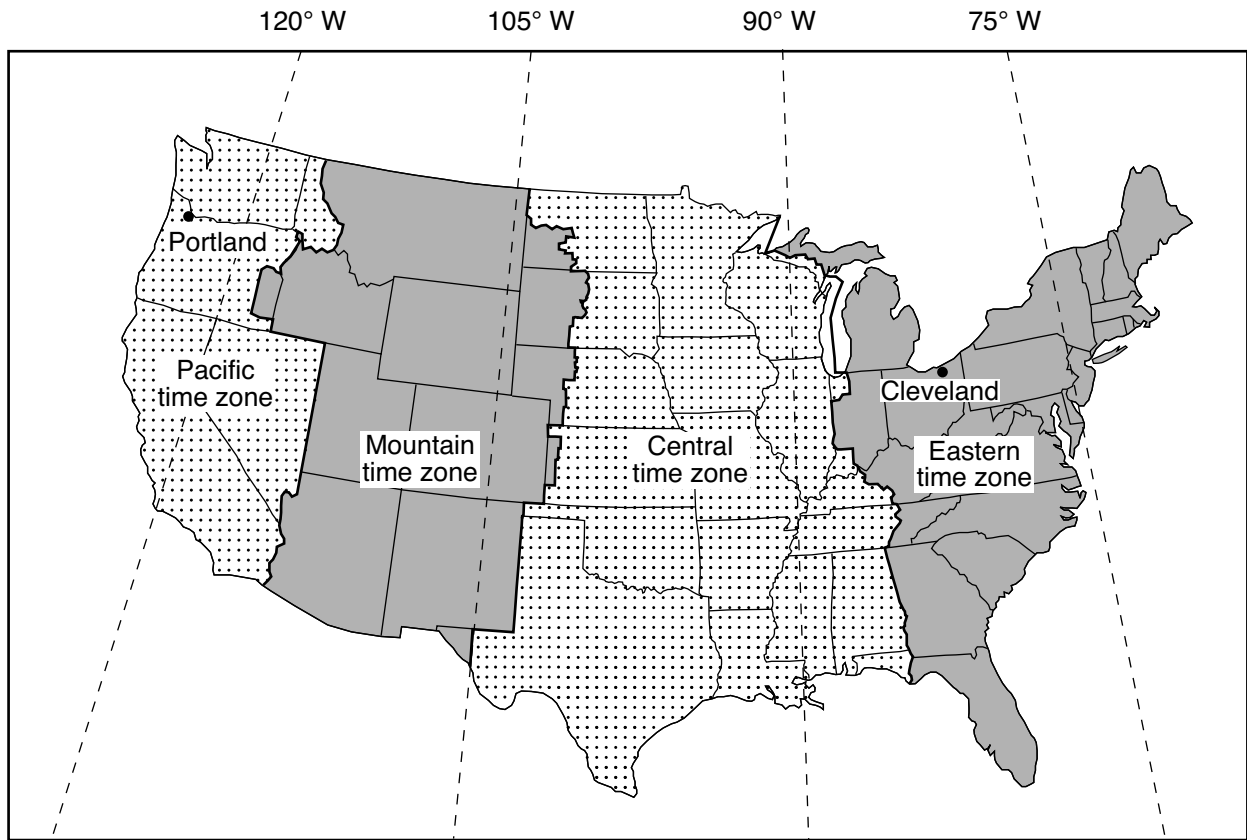
Part A

Answer all questions in this part.

Directions (1–35): For *each* statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Earth Science*. Record your answers on your separate answer sheet.

- 1 The apparent change in direction of swing of a Foucault pendulum, at one specific location, provides evidence that Earth
 - (1) travels around the Sun
 - (2) spins on its axis
 - (3) has a tilted axis
 - (4) has a spherical shape
- 2 The presence of cosmic background radiation is evidence that helps support the
 - (1) Big Bang theory
 - (2) Plate Tectonic theory
 - (3) process of global warming
 - (4) process of radioactive decay
- 3 In New York State, the highest altitude of *Polaris* will be observed at
 - (1) Utica
 - (2) Kingston
 - (3) Massena
 - (4) Old Forge
- 4 Earth's rate of revolution is approximately
 - (1) 1°/day
 - (2) 15°/day
 - (3) 23.5°/day
 - (4) 360°/day
- 5 As water vapor changes phase from gas to liquid, each gram of water vapor
 - (1) releases 2260 joules of heat energy
 - (2) releases 334 joules of heat energy
 - (3) gains 2260 joules of heat energy
 - (4) gains 334 joules of heat energy
- 6 At the time of an equinox, the subtropical jet streams in Earth's troposphere generally are located closest to
 - (1) 0° and 90° S
 - (2) 30° N and 30° S
 - (3) 60° N and 60° S
 - (4) 90° N and 90° S
- 7 When the dry-bulb temperature is 16°C and the dewpoint is 7°C, what are the wet-bulb temperature and the relative humidity?
 - (1) wet-bulb temperature = 9°C and relative humidity = 7%
 - (2) wet-bulb temperature = 9°C and relative humidity = 54%
 - (3) wet-bulb temperature = 11°C and relative humidity = 7%
 - (4) wet-bulb temperature = 11°C and relative humidity = 54%
- 8 Which ocean current warms the climate along a continent's east coast?
 - (1) California Current
 - (2) Brazil Current
 - (3) Falkland Current
 - (4) Guinea Current
- 9 Which process transfers heat energy through molecular collisions?
 - (1) radiation
 - (2) convection
 - (3) infiltration
 - (4) conduction
- 10 Two major greenhouse gases that can be found in Earth's atmosphere are
 - (1) carbon dioxide and methane
 - (2) methane and nitrogen
 - (3) nitrogen and oxygen
 - (4) oxygen and carbon dioxide
- 11 Which event causes a temporary slowing or reversal of the surface ocean currents in the equatorial region of the Pacific Ocean, which may disrupt normal weather patterns in North America?
 - (1) a volcanic eruption
 - (2) a tsunami
 - (3) El Niño
 - (4) Grenville orogeny

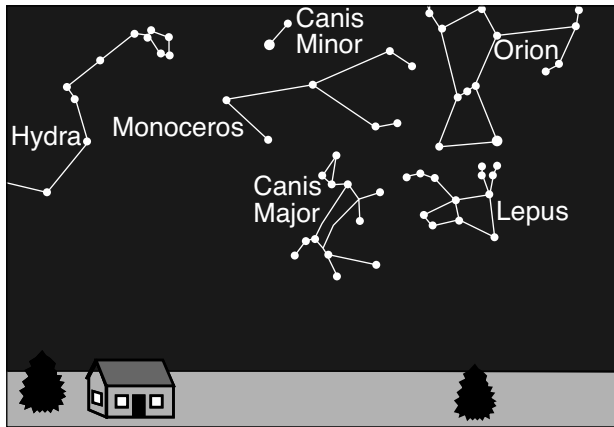
12 The map below shows the time zones of the continental United States. The dashed lines represent meridians of longitude. The locations of Cleveland, Ohio, and Portland, Oregon, are shown.



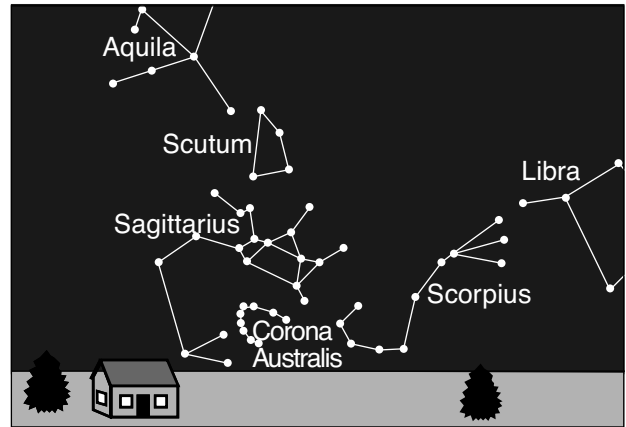
What time is it in Portland, Oregon, when it is 9 p.m. in Cleveland, Ohio?

- (1) 5 p.m.
- (2) 6 p.m.
- (3) 11 p.m.
- (4) 12 midnight

13 The diagrams below represent the constellations that are visible above the southern horizon at midnight from the same New York State location on two different dates of the year.



Southern horizon – January 8



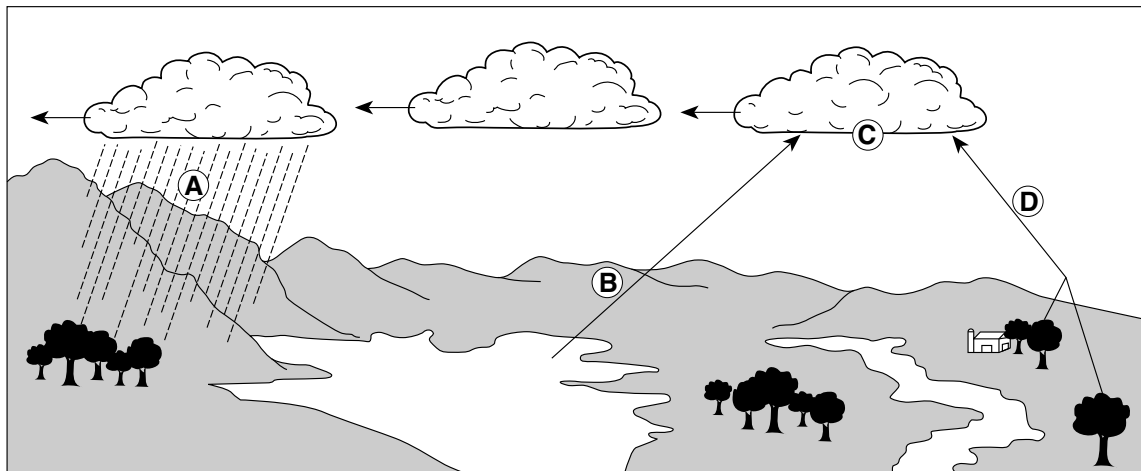
Southern horizon – July 9

(Not drawn to scale)

Why are different constellations seen on these two dates at midnight?

- (1) Constellations rotate on an axis.
- (2) Constellations revolve around the Sun.
- (3) Earth rotates on its axis.
- (4) Earth revolves around the Sun.

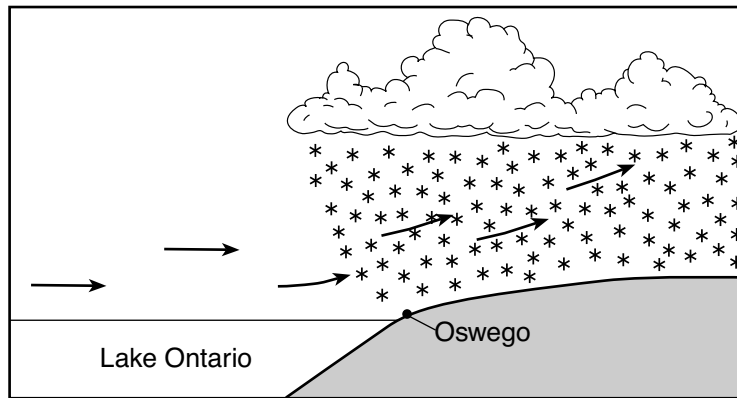
14 Letters A, B, C, and D in the diagram below represent processes in the water cycle.



Which letter represents the process of transpiration?

- (1) A
- (2) B
- (3) C
- (4) D

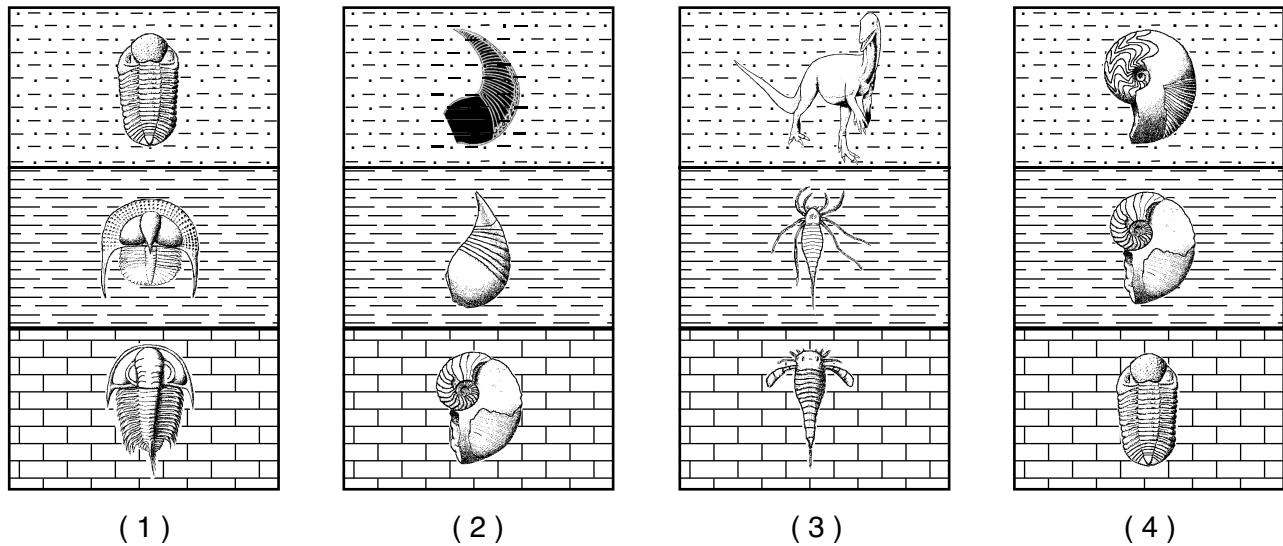
15 The cross section below represents a lake-effect snowstorm that resulted from air moving across Lake Ontario and over Oswego, New York.



These lake-effect snowstorms commonly occur in the region around Oswego during winter because Lake Ontario

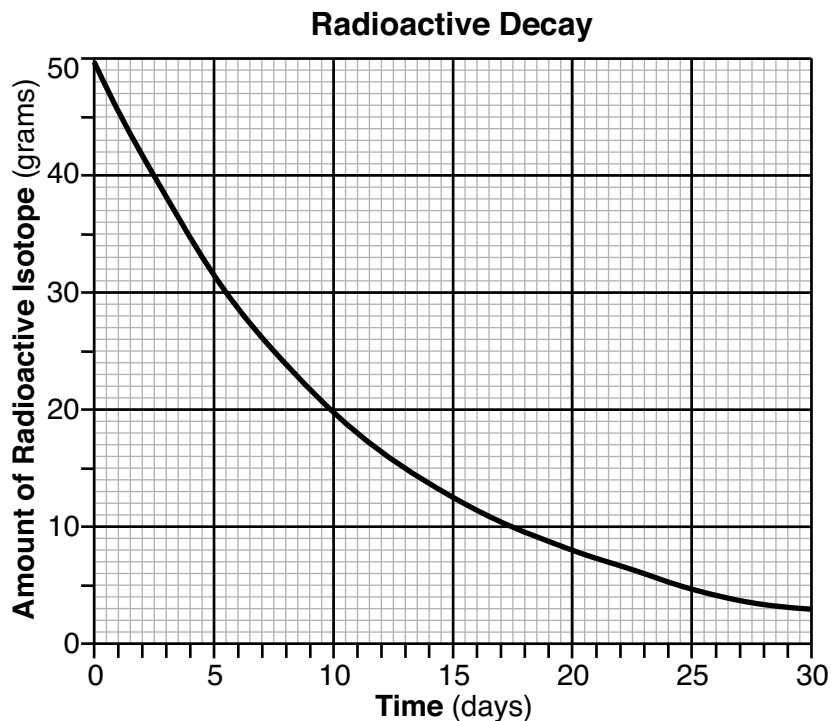
- (1) cools the air so that it is no longer saturated, which then produces frozen drops of water
- (2) warms the air so that it is no longer saturated, which then produces frozen drops of water
- (3) cools the air, which rises, contracts, and warms to the dewpoint, forming clouds and snow
- (4) warms the air, which rises, expands, and cools to the dewpoint, forming clouds and snow

16 Assuming that no overturning of rock layers has occurred, which geologic outcrop containing New York State index fossils represents the correct sequence of time within the same group of organisms?



- 17 Equal areas of which type of surface absorb the most insolation?
 (1) dark-colored and smooth
 (2) dark-colored and rough
 (3) light-colored and smooth
 (4) light-colored and rough
- 18 Which material requires the *least* amount of heat energy to raise its temperature one Celsius degree?
 (1) liquid water (3) basalt
 (2) ice (4) granite
- 19 One characteristic of a good index fossil is that the organisms that produced these fossils
 (1) left remains that can be found in igneous, sedimentary, and metamorphic rocks
 (2) lived over a wide geographic area
 (3) existed on Earth for a long period of geologic time
 (4) lived both on land and in the water during part of their lives
- 20 During which geologic epoch was nearly all of Earth's landmass inferred to have been located in the Southern Hemisphere?
 (1) Early Cretaceous (3) Middle Triassic
 (2) Early Mississippian (4) Middle Ordovician
- 21 The Alleghenian orogeny occurred as a result of the
 (1) intrusion of the Palisades sill
 (2) breakup of Pangaea, which formed the Atlantic Ocean
 (3) collision of the North American Plate with the African Plate
 (4) metamorphism of the bedrock in the Adirondack Mountains
- 22 Which concept states that most sediments are deposited in layers that are flat and parallel to Earth's surface?
 (1) principle of superposition
 (2) cross-cutting relationship
 (3) dynamic equilibrium
 (4) original horizontality
- 23 Which layer of Earth's interior is inferred to be composed mostly of iron and nickel, and has an interior temperature that is greater than its melting point?
 (1) plastic mantle (3) outer core
 (2) stiffer mantle (4) inner core
- 24 A seismic station that is 4000 kilometers from the epicenter of an earthquake records the arrival time of the first *P*-wave at 10:00:00 (hours: minutes: seconds). At what time did the first *S*-wave arrive at this station?
 (1) 9:54:20 (3) 10:07:05
 (2) 10:05:40 (4) 10:12:40
- 25 What is the approximate latitude and longitude of the Bouvet Hot Spot?
 (1) 54° N 3° W (3) 3° N 54° E
 (2) 54° S 3° E (4) 3° S 54° W
- 26 As the distance from the Mid-Atlantic Ridge increases, the age of the ocean floor surface bedrock
 (1) decreases, only
 (2) increases, only
 (3) decreases, then increases
 (4) increases, then decreases

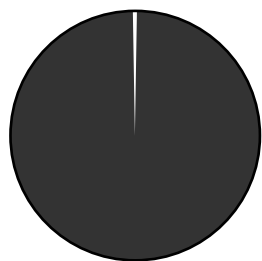
27 The graph below shows the decay of a 50-gram sample of a radioactive isotope over 30 days.



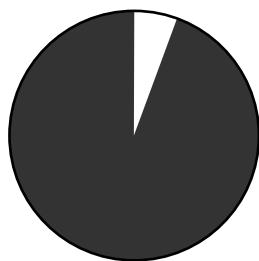
The half-life of this radioactive isotope is approximately

- (1) 7.5 days
- (2) 12.5 days
- (3) 15.0 days
- (4) 25.0 days

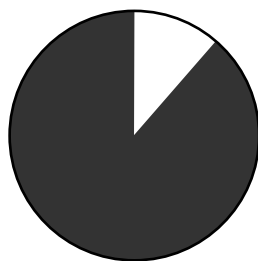
28 Based on fossil evidence, which pie graph best shows the percentage of time that humans have existed on Earth since the time of Earth's origin?



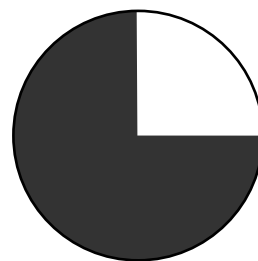
(1)



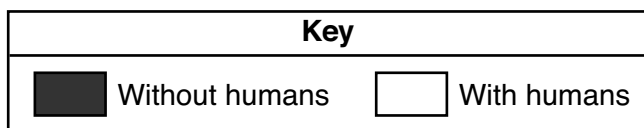
(2)



(3)



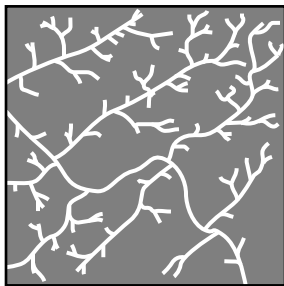
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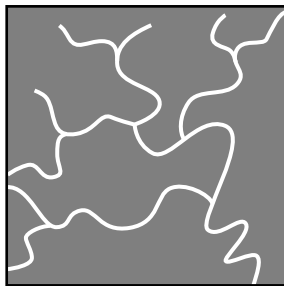
29 The photograph below shows a cone-shaped volcano.



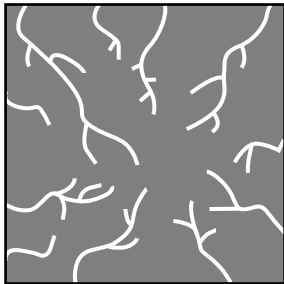
Which stream drainage pattern most likely will be found on this volcano?



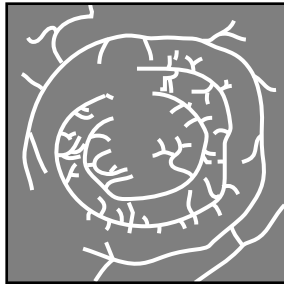
(1)



(3)

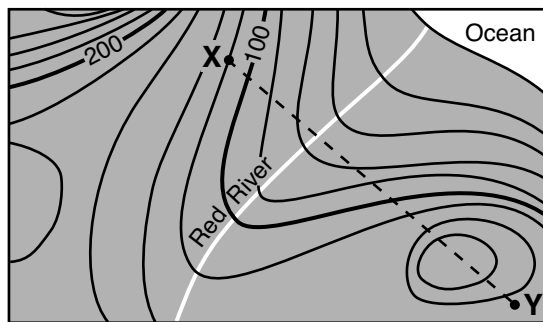


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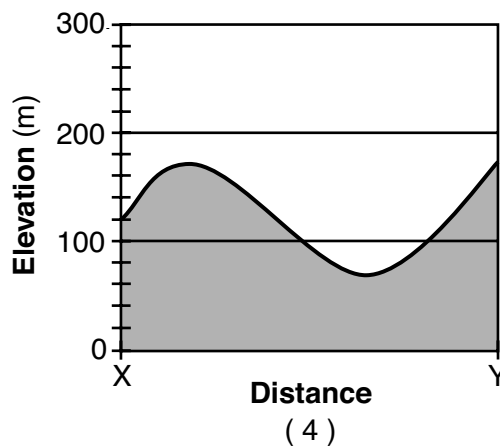
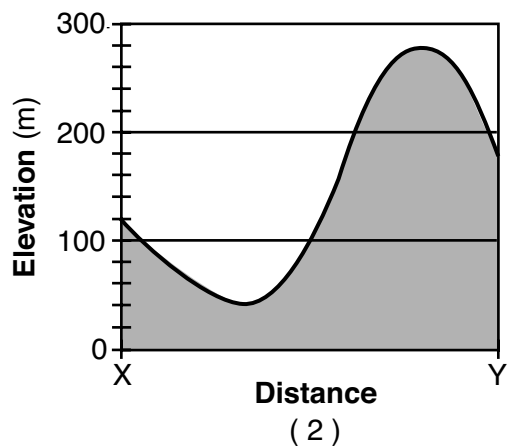
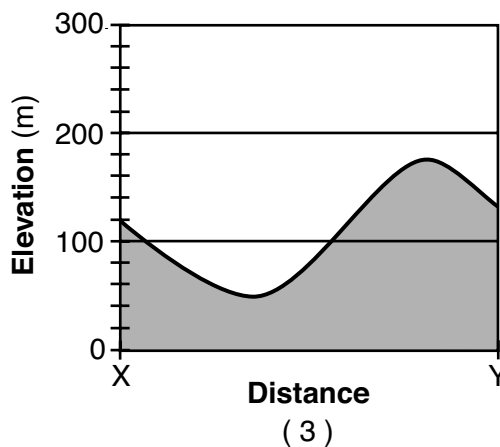
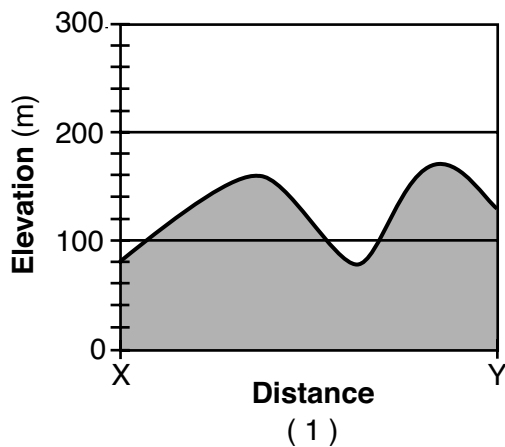


(4)

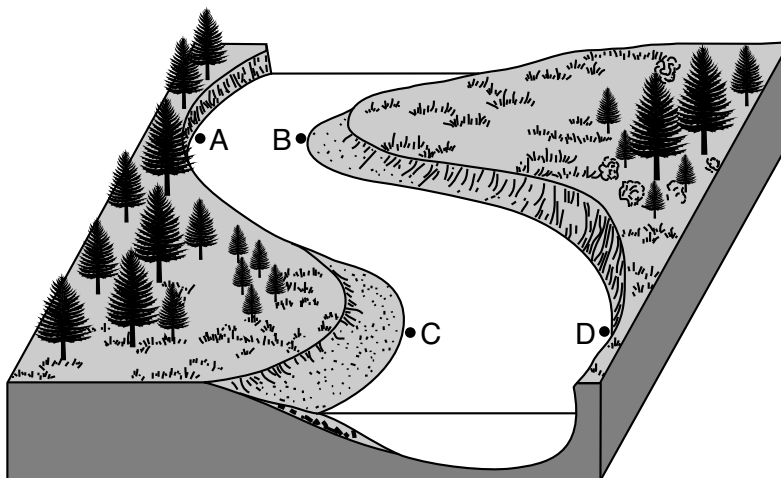
30 The topographic map below shows the surface features of a coastal location. Line XY is a reference line on the map.



Which profile best shows the landscape elevations along line XY?



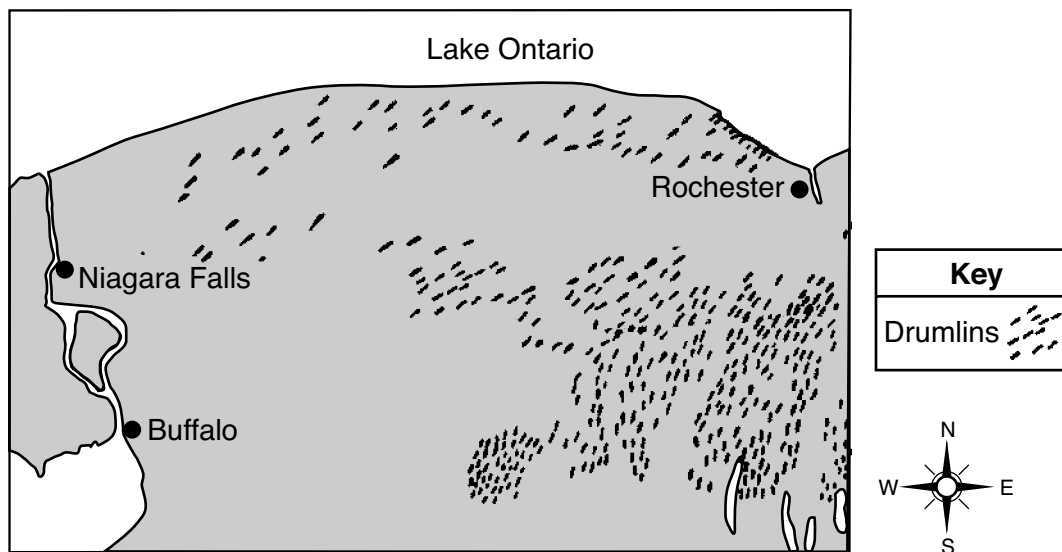
31 The block diagram below represents a meandering river. Points A, B, C, and D represent locations near the edge of the river.



The greatest amount of erosion is most likely occurring at locations

- (1) A and B
- (2) B and C
- (3) C and D
- (4) D and A

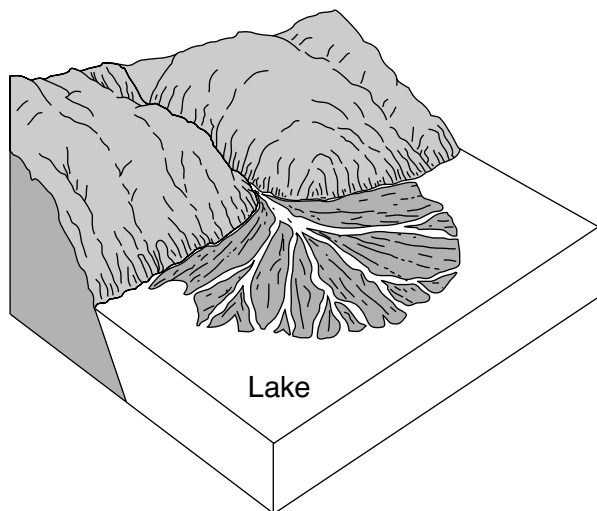
32 The map below shows the locations of numerous drumlins south of Lake Ontario.



Which agent of erosion formed these drumlins?

- (1) wind
- (2) streams
- (3) moving ice
- (4) wave action

33 The landscape diagram below represents a fan-shaped feature that is composed of sediments that were transported and deposited by a stream entering a lake.



This fan-shaped feature is best identified as a

- (1) watershed
- (2) moraine
- (3) delta
- (4) tributary

34 The tendency of a mineral to split along flat surfaces indicates the mineral property called

- (1) cleavage
- (2) fracture
- (3) composition
- (4) hardness

35 The data table below shows a student's observations of a mineral sample.

Property	Observation
luster	metallic
color	brassy yellow
streak	green-black
density	5.0 g/cm ³

Based on the student's observations, the mineral can best be identified as

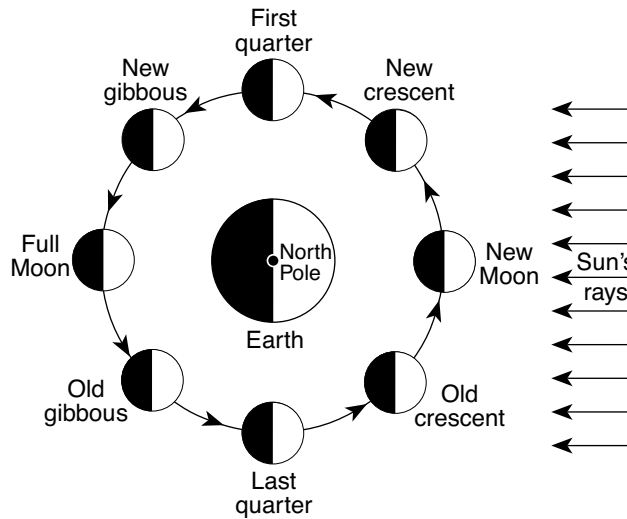
- (1) magnetite
- (2) hematite
- (3) sulfur
- (4) pyrite

Part B-1

Answer all questions in this part.

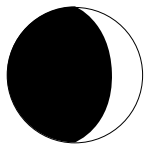
Directions (36–50): For *each* statement or question, choose the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Earth Science*. Record your answers on your separate answer sheet.

Base your answers to questions 36 through 40 on the diagram below and on your knowledge of Earth science. The diagram represents the Moon at different positions in its orbit around Earth. The phases of the Moon as seen by an observer in New York State have been labeled.

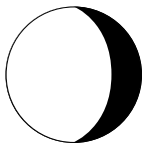


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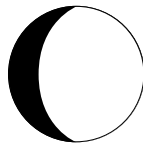
36 Which diagram best represents the new gibbous phase of the Moon as seen by an observer in New York State?



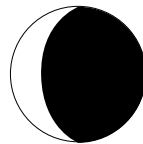
(1)



(2)



(3)



(4)

37 How many days (d) are required for the Moon to complete a cycle of phases from one full Moon phase to the next full Moon phase?

- (1) 15.0 d
- (2) 27.3 d

- (3) 29.5 d
- (4) 365.3 d

- 38 At which two Moon phases will the difference in height between high tide and low tide most likely be the greatest?
- (1) new Moon and full Moon
 - (2) new gibbous and old crescent
 - (3) new crescent and old gibbous
 - (4) first quarter and last quarter
- 39 Eclipses do *not* occur each time that the Moon revolves around Earth because the Moon's
- (1) orbit is less eccentric than Earth's orbit
 - (2) orbit is inclined to Earth's orbit
 - (3) diameter is greater than Earth's diameter
 - (4) diameter is less than Earth's diameter
- 40 The same side of the Moon always faces Earth because the period of revolution of the Moon is
- (1) shorter than the period of rotation of Earth
 - (2) shorter than the period of rotation of the Moon
 - (3) equal to the period of rotation of Earth
 - (4) equal to the period of rotation of the Moon
-

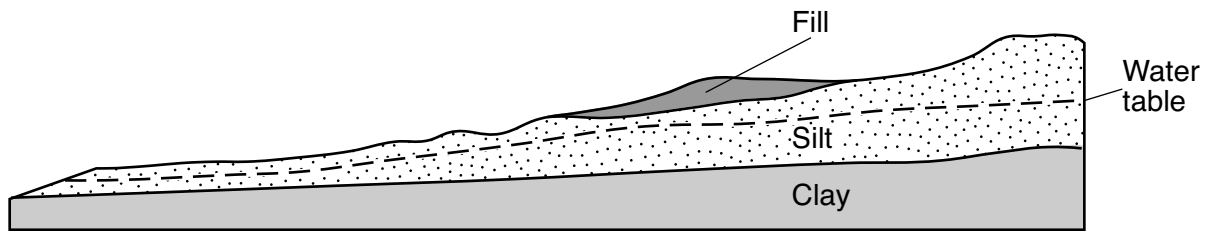
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Base your answers to questions 41 through 44 on the passage and cross section below and on your knowledge of Earth science. The cross section represents the area of Scoby Hill where fill was added to construct a roadway.

Scoby Hill Landslides

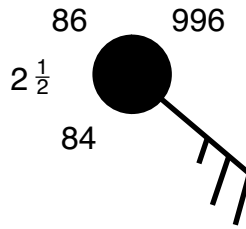
Scoby Hill is approximately 40 miles south of Buffalo, New York. The silt layer of Scoby Hill may have been unstable ever since it formed from glacial outwash approximately 12,000 years ago. Construction of a road required the addition of fill, which consisted of clay, silt, sand, and pebbles. The resulting landslides that occurred were a surprise because the gradient of Scoby Hill was thought to be too low for landslides. Geologists discovered that landslides easily started because of the weight of the fill. In order to decrease pressure on the silt layer, engineers decided to remove the fill and some of the silt layer to create a level surface for the road. In addition, drain pipes were installed to lower the water table and reduce the chance of future landslides.

Cross Section of Scoby Hill



- 41 The outwash sediment that formed Scoby Hill is best described as
- (1) sorted and layered
 - (2) sorted and nonlayered
 - (3) unsorted and layered
 - (4) unsorted and nonlayered
- 42 The maximum diameter of the particles in the fill was
- (1) 0.006 cm
 - (2) 0.2 cm
 - (3) 6.4 cm
 - (4) 25.6 cm
- 43 The drain pipes that were installed lowered the water table by
- (1) decreasing the porosity of the clay
 - (2) decreasing the permeability of the silt
 - (3) removing infiltrated water from the ground
 - (4) removing clay and silt from the groundwater
- 44 In which New York State landscape region is Scoby Hill located?
- (1) Allegheny Plateau
 - (2) Tug Hill Plateau
 - (3) Adirondack Mountains
 - (4) Atlantic Coastal Plain

Base your answers to questions 45 through 47 on the station model below and on your knowledge of Earth science.



- 45 The number $2\frac{1}{2}$ on the station model indicates that
- (1) 2.5 inches of precipitation has fallen in the past 6 hours
 - (2) the farthest object that can be seen is located 2.5 miles away
 - (3) an advancing cold front is 2.5 miles away
 - (4) the air pressure has risen 2.5 millibars in the past 3 hours

46 Which present-weather symbol represents the form of precipitation that is most likely occurring at this location?



(1)



(3)



(2)

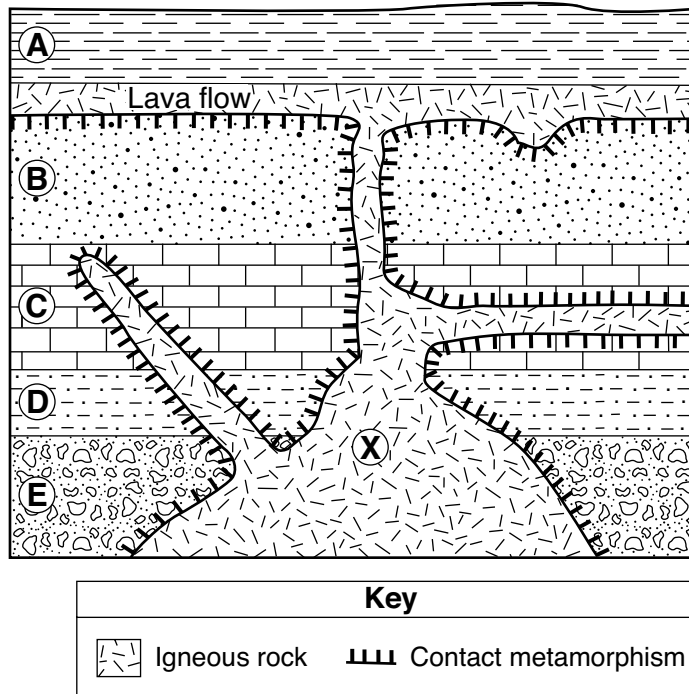


(4)

47 What are the wind direction and the wind speed at this location?

- (1) wind from the southeast at 15 knots
 - (2) wind from the northwest at 15 knots
 - (3) wind from the southeast at 25 knots
 - (4) wind from the northwest at 25 knots
-

Base your answers to questions 48 through 50 on the cross section below and on your knowledge of Earth science. The cross section represents rock units labeled A through E that have *not* been overturned. A lava flow is represented between rock units A and B. Letter X represents a location in the igneous rock.



- 48 Rock unit A was formed most likely by
- | | |
|---------------------------|---------------------------------|
| (1) chemical weathering | (3) the eruption of a volcano |
| (2) regional metamorphism | (4) the compaction of sediments |
- 49 Which two minerals would most likely be found in the igneous rock if the rock is highly mafic?
- | | |
|-----------------------------------|------------------------------------|
| (1) quartz and potassium feldspar | (3) olivine and potassium feldspar |
| (2) quartz and pyroxene | (4) olivine and pyroxene |
- 50 Which metamorphic rock most likely formed at the interface between rock unit B and the igneous rock?
- | | |
|----------------------|--------------|
| (1) quartzite | (3) phyllite |
| (2) metaconglomerate | (4) marble |

Part B–2

Answer all questions in this part.

Directions (51–65): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Earth Science*.

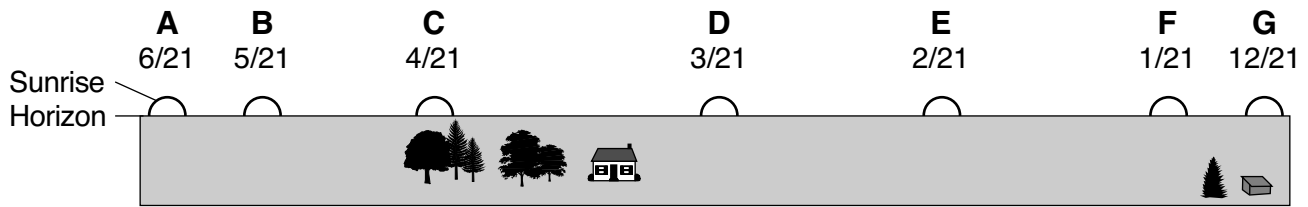
Base your answers to questions 51 through 54 on the passage below and on your knowledge of Earth science.

Salt — A Valuable Commodity

In New York State, salt is a valuable natural resource. Approximately 8500 square miles of New York State has bedrock that contains rock salt. The layers of rock salt formed after parts of New York State were covered by a shallow inland sea, which eventually evaporated. Groundwater dissolved some of the deeper rock salt layers and carried salty water up to the surface in central New York. Commercial salt production began in the Syracuse area in the late 1700s. Early production of salt involved heating the salty water by burning wood from the surrounding area. The heat vaporized the water, leaving salt behind. When lumber supplies dwindled, solar methods were used to evaporate the water. Although the salt industry had an overall positive effect on Syracuse, the industry in Syracuse closed down in the 1920s, leaving negative environmental effects. There are currently salt mines operating south of Syracuse and in the Finger Lakes region of New York State.

- 51 Identify *one* process that formed rock salt from the shallow inland sea that covered parts of New York State. [1]
- 52 Identify the geologic time period during which the rock salt in the surface bedrock at Syracuse was formed. [1]
- 53 Identify the name of the mineral that makes up rock salt and describe *one* use of this mineral. [1]
- 54 Describe *one negative* environmental effect that resulted from the mining of salt in Syracuse. [1]
-

Base your answers to questions 55 and 56 on the diagram below and on your knowledge of Earth science. The letters A through G on the diagram represent positions of sunrise on several dates during the year as seen by an observer at 40° N latitude.



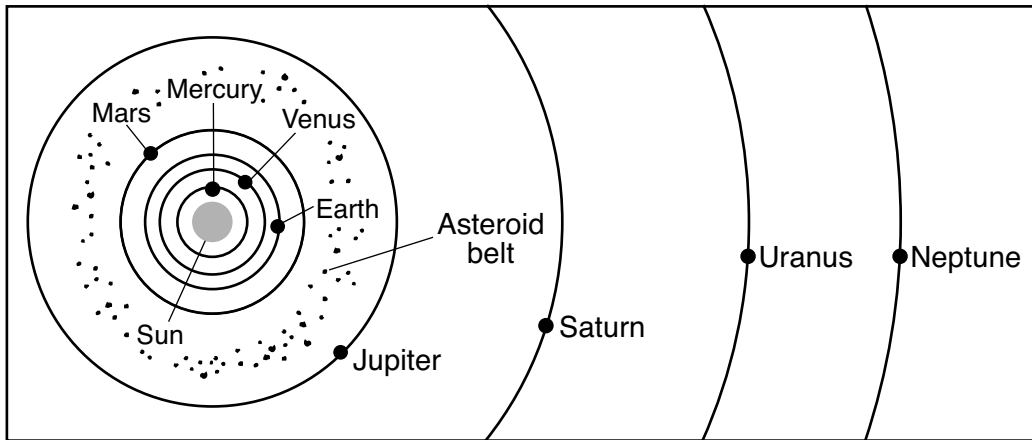
Sunrise Positions

(Not drawn to scale)

55 Identify the date of the sunrise position when the insolation from the noontime Sun will be most intense. [1]

56 A stick is placed vertically into the ground at the observer's location, and its shadow is observed from sunrise to sunset on January 21 (1/21). Identify the time of day when the *shortest* shadow is cast by the stick. [1]

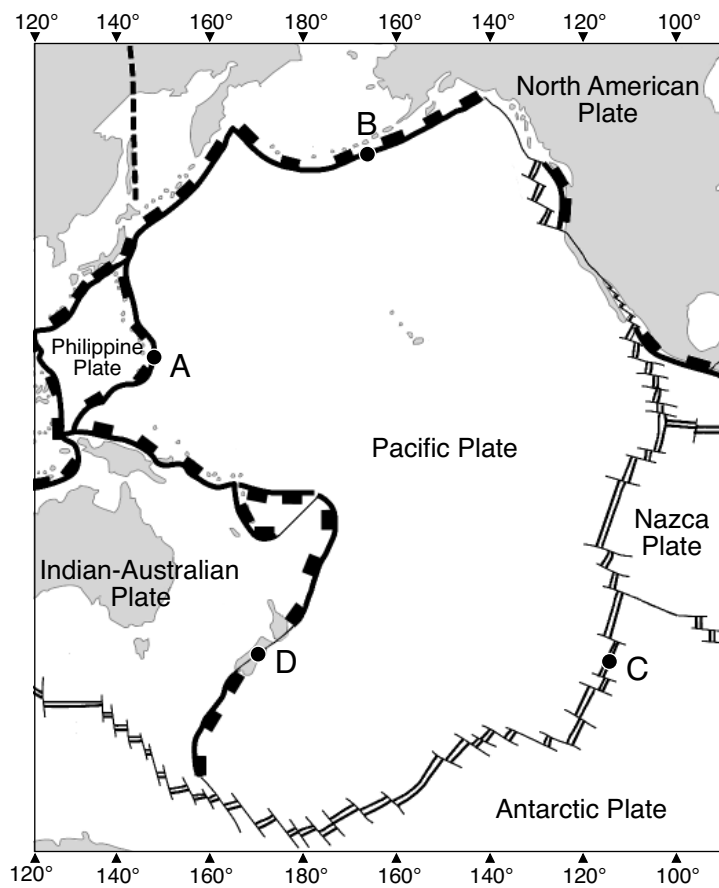
Base your answers to questions 57 through 61 on the diagram below and on your knowledge of Earth science. The diagram represents relative orbital positions for the planets and the asteroid belt in our solar system.



(Not drawn to scale)

- 57 State the general relationship between a planet's distance from the Sun and the planet's period of revolution. [1]
- 58 Identify *one* terrestrial planet and *one* Jovian planet represented in the diagram. [1]
- 59 Explain why this diagram represents a heliocentric model of the solar system. [1]
- 60 State *one* possible distance from the Sun, in million kilometers, at which an asteroid in the asteroid belt can be found. [1]
- 61 Calculate how many times greater Mercury's average density is than Neptune's average density. [1]
-

Base your answers to questions 62 through 65 on the map below and on your knowledge of Earth science. The map shows some of Earth's tectonic plates and the boundaries between them. Letters A through D represent locations on Earth's surface.



62 Identify *one* geologic feature found along the subducting plate boundary at location A. [1]

63 Identify the names of the subducting plate and overriding plate at location B. [1]

64 State the name of the mid-ocean ridge found at location C. [1]

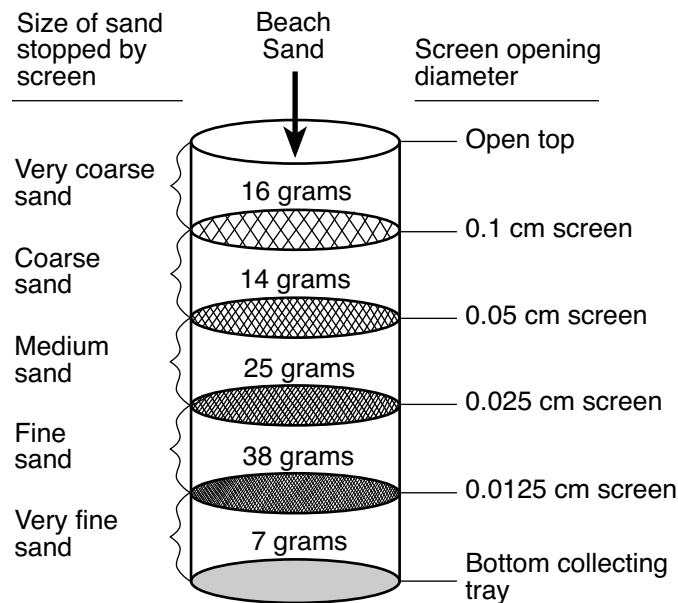
65 Identify the type of tectonic plate boundary represented at location D. [1]

Part C

Answer all questions in this part.

Directions (66–85): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Earth Science*.

Base your answers to questions 66 through 68 on the diagram below and on your knowledge of Earth science. The diagram represents a laboratory setup that is used to analyze the different sizes of sand in a 100-gram sample of beach sand. The laboratory setup consists of a column containing a series of screens. The size of each screen opening and the size of sand stopped by each screen are labeled. The beach sand was poured into the top of the column, which was then shaken from side to side to sort the sand. The total mass, in grams, of each size of sand stopped by the screen at that level is indicated above each screen.



(Not drawn to scale)

- 66 On the graph *in your answer booklet*, construct a bar graph that shows the mass of each size of sand listed inside the column. [1]
- 67 The various sand samples separated by the screens were tested to determine capillarity. On the graph *in your answer booklet*, draw a line to show the general relationship between the size of sand and capillarity. [1]
- 68 Identify the minimum stream velocity, in centimeters per second, needed to maintain movement of a sand particle with a diameter of 0.1 centimeter. [1]
-

Base your answers to questions 69 through 72 on the passage below, the cross section in your answer booklet, and on your knowledge of Earth science. The cross section represents a portion of the Grand Canyon, indicating the location of the Great Unconformity. Letter *A* identifies an igneous rock unit. Line *BC* represents another unconformity.

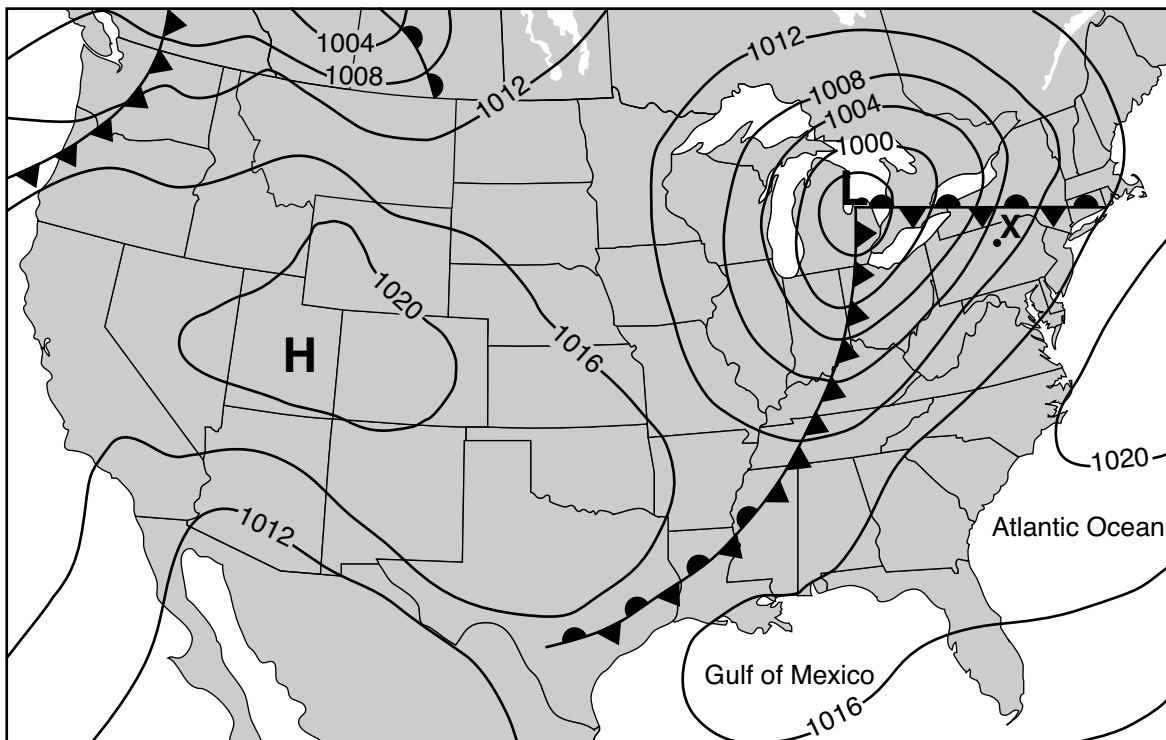
The Great Unconformity

One of the world's most famous unconformities is located in North America. This dramatic gap in the geologic record (The Great Unconformity) stretches from Arizona in the United States to Alberta in Canada. Perhaps the best place to see this unconformity is in Grand Canyon National Park, where, over the last 5 to 6 million years, the Colorado River has cut down through the overlying sedimentary rock layers to reveal the 2-billion-year-old Vishnu schist. In the Grand Canyon, the Great Unconformity exists at the bottom of the Tapeats sandstone. At certain locations, where the Vishnu schist is in contact with the Tapeats sandstone, it is possible to touch two rock units that are over 1.5 billion years apart in age with the span of your hand.

- 69 On the cross section *in your answer booklet*, place an **X** on the Great Unconformity at the point where the greatest difference in age between the bedrock above and below the unconformity exists. [1]
- 70 Identify *two* geologic processes necessary for the formation of any unconformity. [1]
- 71 Describe *one* piece of evidence shown in the cross section that supports the inference that rock unit *A* is younger than unconformity *BC*. [1]
- 72 Identify *one* process that produced the Vishnu schist from a previously existing rock. [1]
-

Base your answers to questions 73 through 77 on the weather map below and on your knowledge of Earth science. The weather map shows a low-pressure center (**L**) with associated fronts. A high-pressure center (**H**) is also shown. The isobars represent air pressure in millibars (mb). Point X represents a surface location.

Weather Map



- 73 Identify the weather instrument that is used to measure air pressure. [1]
- 74 Identify the type of front that extends eastward through New York State from the center of the low. [1]
- 75 The air mass over location X originated in the Gulf of Mexico. Write the two-letter air mass symbol that represents this air mass. [1]
- 76 This low-pressure center is following a normal storm track. Identify the compass direction toward which this low-pressure center will move in the next 24 hours. [1]
- 77 Describe the pattern of surface wind circulation around the high-pressure system. [1]
-

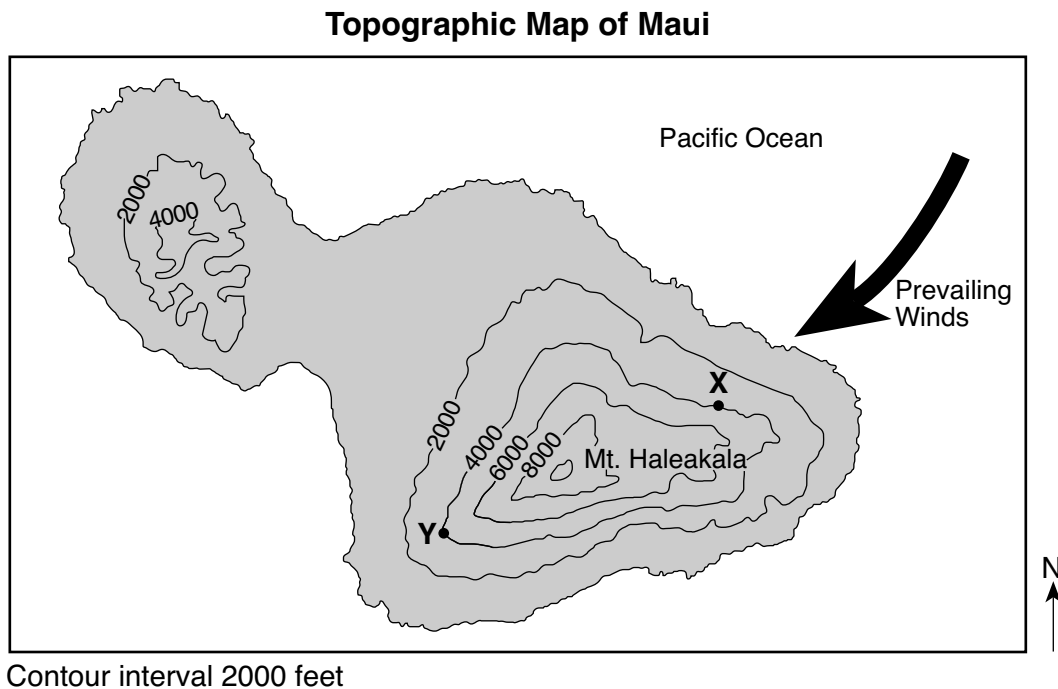
Base your answers to questions 78 through 81 on the map in your answer booklet and on your knowledge of Earth science. The map shows the average yearly rainfall received, in centimeters, at various locations on the Hawaiian island of Maui. Rainfall isolines have been drawn on the northwestern part of the island. Points A, B, and C represent surface locations.

78 On the eastern section of the Average Yearly Rainfall Map for Maui *in your answer booklet*, draw the 100-centimeter rainfall isoline. Extend the isoline to the edge of the island. [1]

79 State a possible average yearly rainfall amount, in centimeters, for location A. [1]

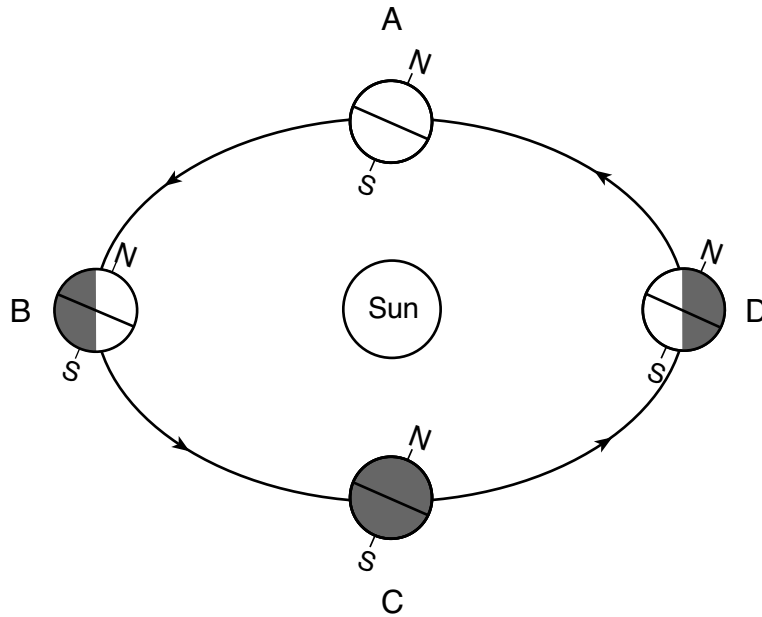
80 Calculate the average yearly rainfall gradient between locations B and C, in centimeters per kilometer. [1]

81 The topographic map below shows contour lines on the island of Maui. Points X and Y represent two locations on the island. Mt. Haleakala is a volcano on this island. The arrow represents the direction of the prevailing winds.



State *one* reason why location X receives more yearly rainfall than location Y. [1]

Base your answers to questions 82 through 85 on the diagram below and on your knowledge of Earth science. The diagram represents Earth in its orbit. Letters *A* through *D* represent Earth's location on the first day of each of the four seasons.



(Not drawn to scale)

- 82 Calculate the number of days (d) that it takes Earth to travel in its orbit from position *A* to position *D*. [1]
- 83 Identify the latitude where the Sun is directly overhead when Earth is at position *B*. Include units and compass direction in your answer. [1]
- 84 Identify the primary force that causes Earth's orbital velocity to change from position *B* to position *D*. [1]
- 85 Over 42,000 years, Earth's axis tilt has varied between 22.1° and 24.5° . Describe the effect on New York State's relative summer and winter temperatures when the tilt of Earth's axis increased from 22.1° to 24.5° . [1]
