

Large-Type Edition

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING EARTH SCIENCE

Friday, January 25, 2019 — 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 START THIS EXAMINATION UNTIL THE SIGNAL IS GIVEN.

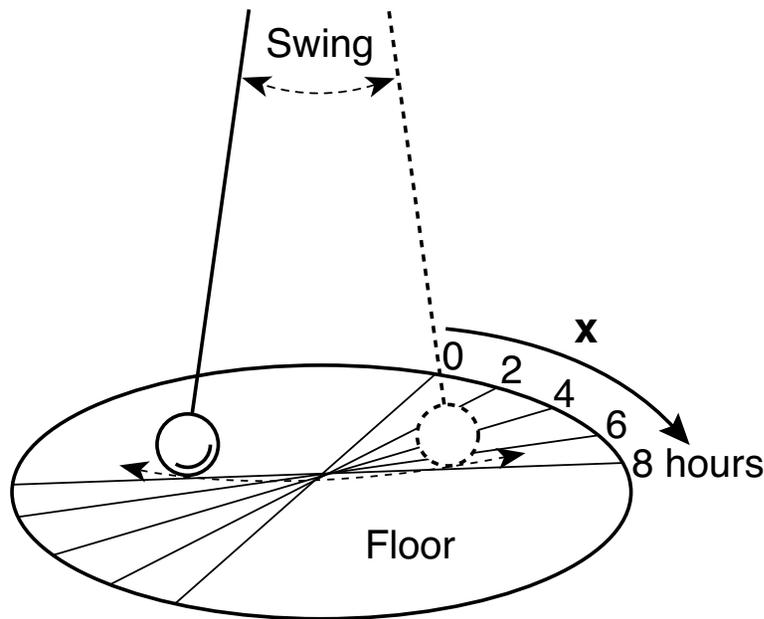
Part A

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 gravitational attraction between two objects in the solar system is greatest when their masses are
 - (1) small, and the objects are close together
 - (2) small, and the objects are far apart
 - (3) large, and the objects are far apart
 - (4) large, and the objects are close together
- 2 Cosmic background radiation detected from all directions in space provides evidence for the
 - (1) greenhouse effect
 - (2) Doppler effect
 - (3) geocentric theory
 - (4) Big Bang theory
- 3 Which characteristic is directly related to a planet's average distance from the Sun?
 - (1) period of revolution
 - (2) period of rotation
 - (3) eccentricity of orbit
 - (4) equatorial diameter
- 4 The frequency of Earth's cycle of ocean tides is primarily controlled by
 - (1) Earth's rotation and the Moon's rotation
 - (2) Earth's rotation and the Moon's revolution
 - (3) Earth's revolution and the Moon's rotation
 - (4) Earth's revolution and the Moon's revolution
- 5 What is the approximate altitude of *Polaris* when viewed from New York City?
 - (1) 90°
 - (2) 74°
 - (3) 49°
 - (4) 41°

- 6 The diagram below represents a large Foucault pendulum that has been in motion over an 8-hour period. The arrow labeled X represents the apparent change in the direction of swing over time.



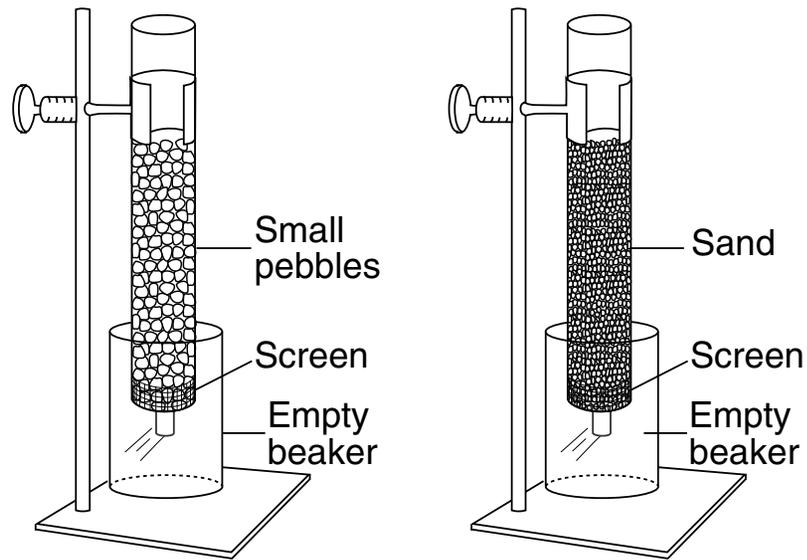
This apparent change in the direction of swing is evidence that Earth

- (1) is tilted on its axis
- (2) rotates on its axis
- (3) revolves in an elliptical orbit
- (4) has magnetic poles that reverse over time

- 7 Which observation provides the best evidence that Earth orbits the Sun?

- (1) The Sun has a cyclic pattern of sunspot events.
- (2) The Sun appears to rise and set in a cyclic pattern.
- (3) The constellations that can be seen at night from Earth change with the seasons.
- (4) The constellations appear to move in a circular pattern around Earth.

8 The diagram below represents two columns, A and B, that were used to determine the infiltration rate and water retention of two different particle sizes by pouring equal amounts of water through each column.



Column A

Column B

(Not drawn to scale)

Compared to column A, column B had a

- (1) lower rate of infiltration and retained less water
- (2) lower rate of infiltration and retained more water
- (3) higher rate of infiltration and retained less water
- (4) higher rate of infiltration and retained more water

9 Which *two* factors will increase the rate of a stream's flow?

- (1) decreased precipitation and decreased slope
- (2) decreased precipitation and increased slope
- (3) increased precipitation and decreased slope
- (4) increased precipitation and increased slope

10 Which condition normally lowers the water table?

- (1) irrigation of fields for several weeks, using well water
- (2) several days of moderate rainfall
- (3) streambanks overflowing during spring runoff
- (4) several days of heavy snowfall, followed by rain

11 What is the dewpoint when the air temperature is 28°C and the relative humidity is 47%?

- | | |
|--------------------------|--------------------------|
| (1) 8°C | (3) 16°C |
| (2) 13°C | (4) 19°C |

12 Clouds are formed when moist, rising air

- (1) contracts and cools, and water vapor condenses
- (2) contracts and warms, and water evaporates
- (3) expands and cools, and water vapor condenses
- (4) expands and warms, and water evaporates

13 Specific heat is used to explain why different substances

- (1) sink or float in water
- (2) change temperature at different rates
- (3) vaporize or condense at different temperatures
- (4) melt and freeze at the same temperature

14 What is the approximate percentage of Earth's history during which humans have existed, compared to the age of Earth?

- (1) 0.04%
- (2) 1.79%
- (3) 4.65%
- (4) 8.32%

15 Which two mantle hot spots are located at mid-ocean ridges?

- (1) Iceland and Yellowstone
- (2) Galapagos and Tasman
- (3) St. Helena and Hawaii
- (4) Easter Island and Bouvet

16 Approximately how many million years ago (mya) were all of Africa and South America inferred to be located south of the equator?

- (1) 59 mya
- (2) 119 mya
- (3) 232 mya
- (4) 359 mya

17 Which fossil has *not* been found in the New York State rock record?

- (1) Silurian eurypterids
- (2) Triassic dinosaur footprints
- (3) Permian trilobites
- (4) Pleistocene mastodont bones

18 What are the inferred pressure and interior temperature at the boundary between Earth's outer core and inner core?

- (1) 3.1 million atmospheres pressure and an interior temperature of 6300°C
- (2) 3.1 million atmospheres pressure and an interior temperature of 6700°C
- (3) 3.6 million atmospheres pressure and an interior temperature of 6300°C
- (4) 3.6 million atmospheres pressure and an interior temperature of 6700°C

19 The photograph below shows parallel scratches on the surface of limestone bedrock near Rochester, New York.



<https://www.flickr.com>

10 cm

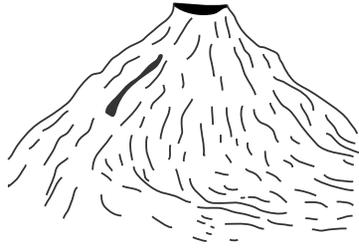
These parallel scratches were most likely caused by

- (1) ocean waves
- (2) running water
- (3) movement of glacial ice
- (4) sandblasting by wind

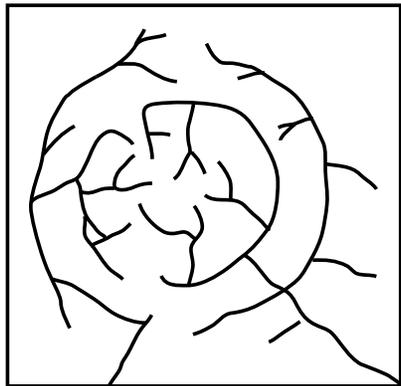
20 Landscapes with a faulted and folded surface bedrock structure, steep slopes, and high elevations are classified as

- (1) mountains
- (2) lowlands
- (3) plains
- (4) plateaus

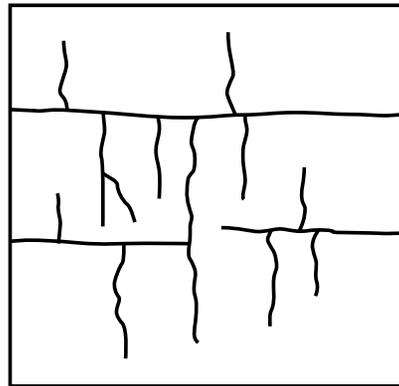
21 The diagram below represents a volcano.



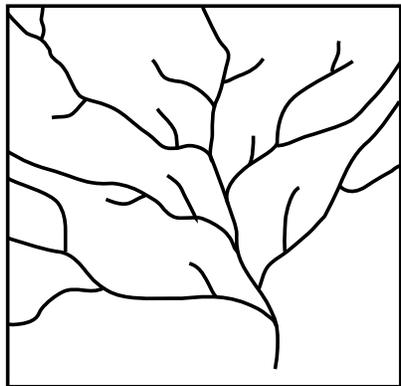
Which stream drainage pattern would most likely form on the entire surface of this volcano?



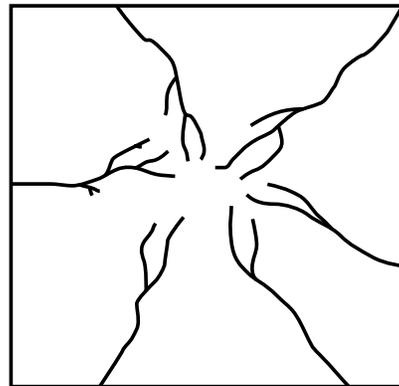
(1)



(3)



(2)

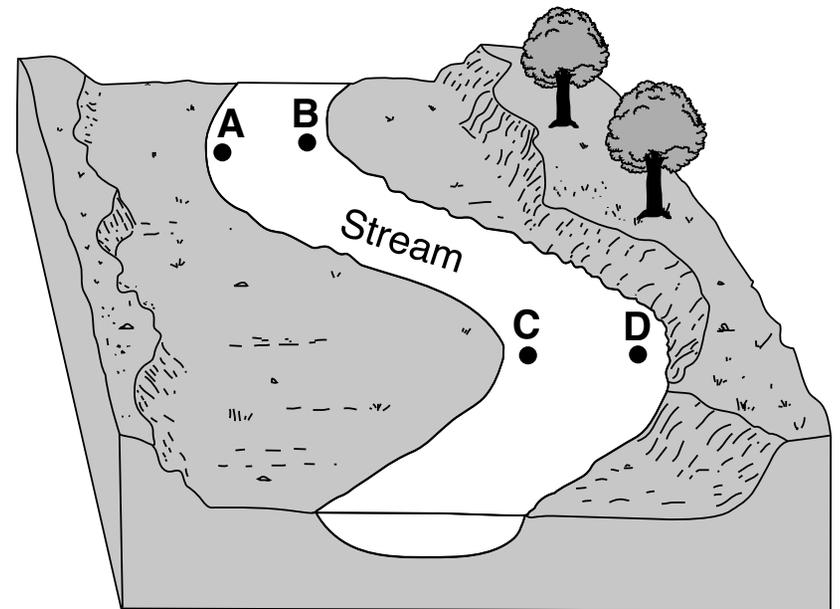


(4)

22 What is the largest particle size that a stream can transport at a velocity of 5 centimeters per second?

- (1) cobble
- (2) pebble
- (3) sand
- (4) silt

23 The diagram below represents a portion of a meandering stream. Letters A, B, C, and D represent locations on the bottom of the stream.



At which two locations would the stream most likely be the deepest?

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

24 The mineral anorthite is typically white to gray in color, has a hardness of 6.0, cleaves in two directions, and is used in making glass and ceramics. Which mineral has properties most similar to anorthite?

- (1) quartz
- (2) calcite
- (3) pyroxene
- (4) plagioclase feldspar

25 What is the texture of inorganic land-derived sedimentary rocks?

- (1) bioclastic
- (2) crystalline
- (3) clastic
- (4) vesicular

26 Which rock will weather at the fastest rate when exposed to acid rain?

- (1) granite
- (2) limestone
- (3) gneiss
- (4) quartzite

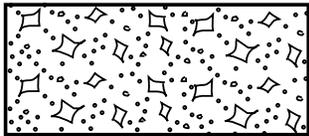
27 The photograph below shows the mineral muscovite mica.



Which physical property can be observed in this photograph?

- (1) cleavage
- (2) hardness
- (3) magnetism
- (4) streak

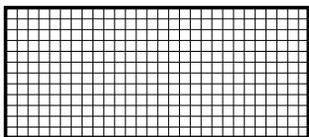
28 Which map symbol is used to represent rock that formed as a result of the evaporation of seawater?



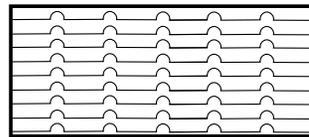
(1)



(3)



(2)



(4)

29 At which New York State location can intensely metamorphosed surface bedrock be found?

(1) Rochester

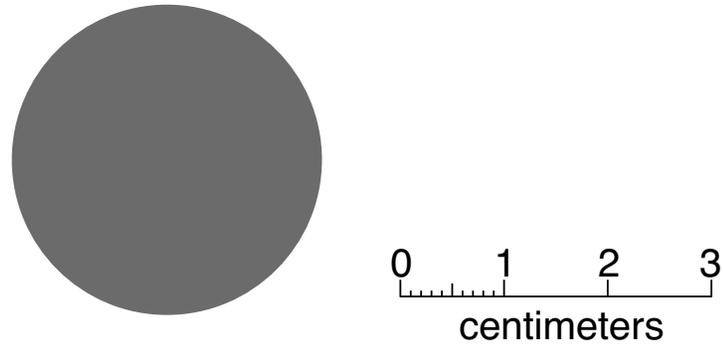
(3) Slide Mountain

(2) Old Forge

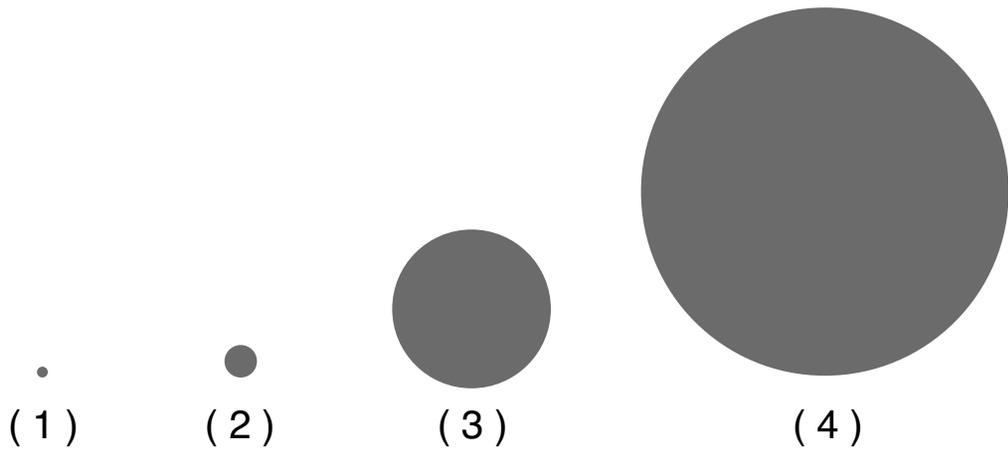
(4) Utica

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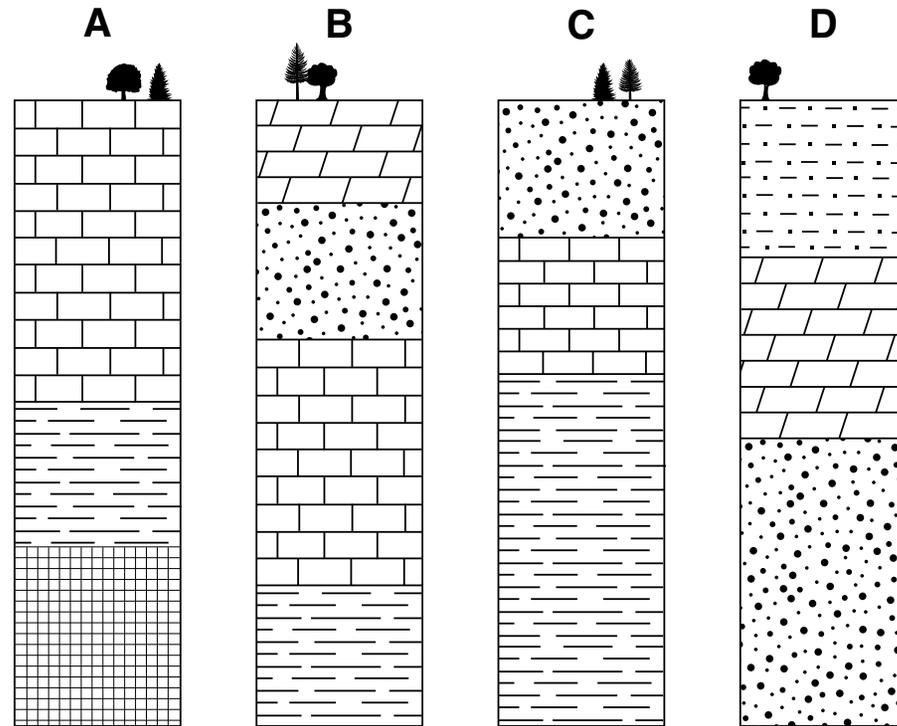
30 The diagram below represents a model of the planet Saturn drawn to a scale of 1 centimeter = 40,000 kilometers.



Which diagram best represents Earth drawn to this same scale?



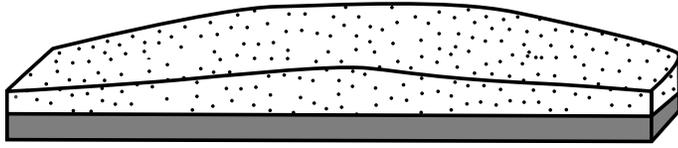
31 Columns *A*, *B*, *C*, and *D* below represent outcrops, of the same sequence of bedrock layers, found within 20 miles of each other. The rock layers have *not* been overturned.



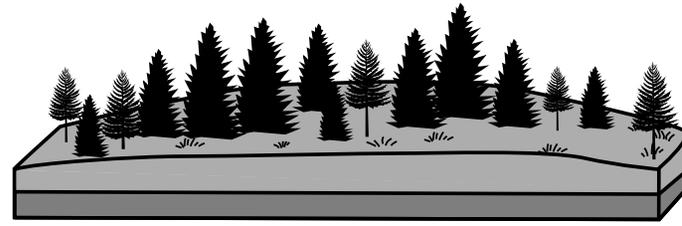
Which surface bedrock is youngest in age?

- (1) siltstone
- (2) dolostone
- (3) limestone
- (4) sandstone

32 The block diagrams below represent two large regions on Earth's surface.



White Sandy Region

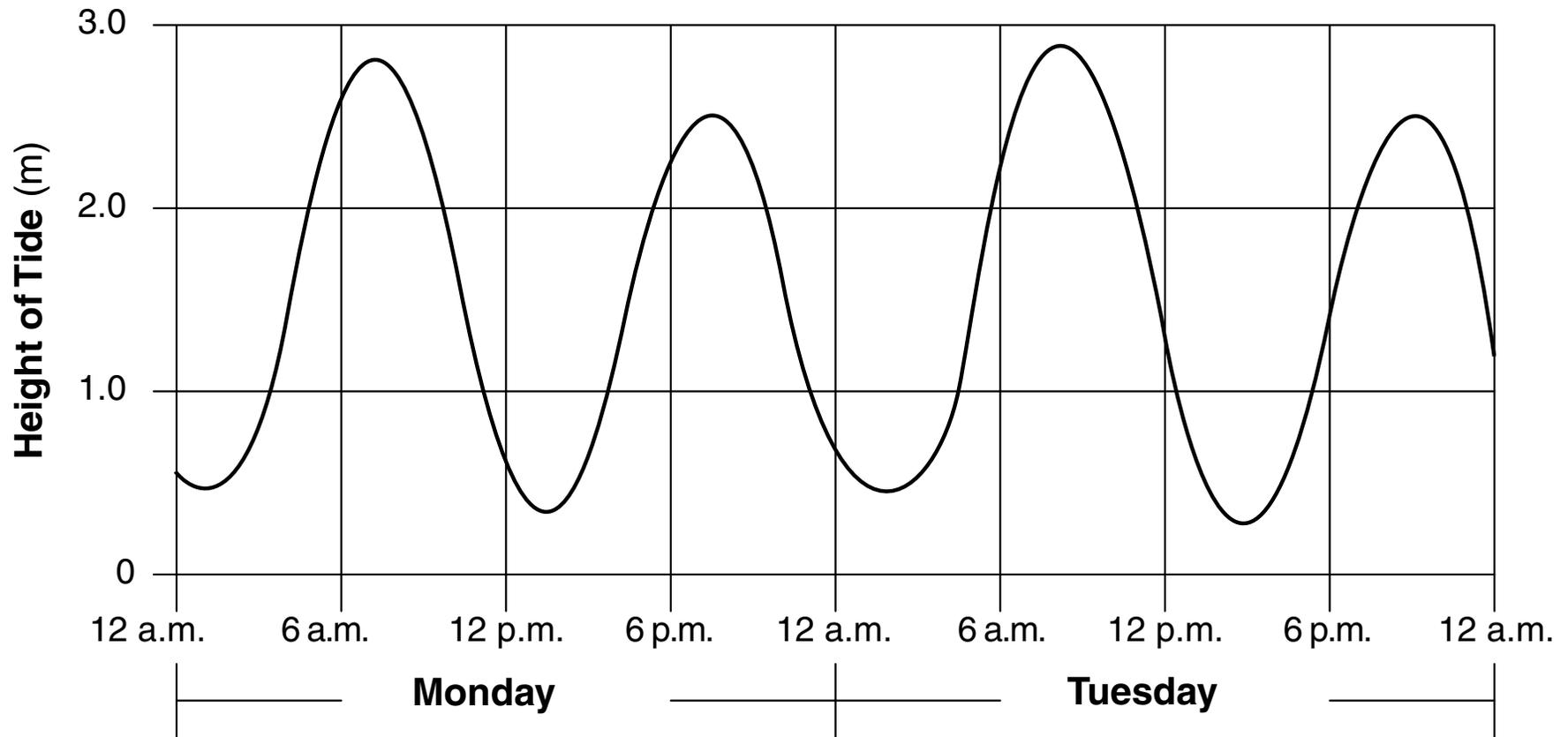


Vegetative Region

Compared to the white sandy region, the vegetative region is

- (1) less humid and absorbs less insolation
- (2) less humid and absorbs more insolation
- (3) more humid and absorbs less insolation
- (4) more humid and absorbs more insolation

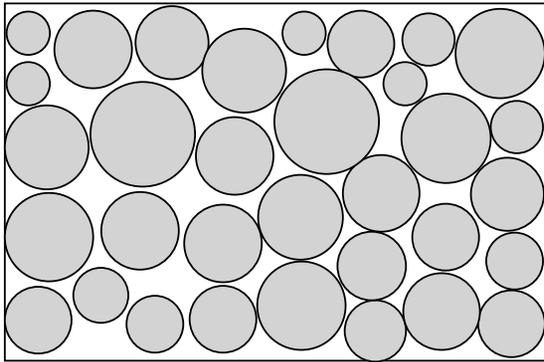
33 The graph below shows the change in the heights of tides for two days.



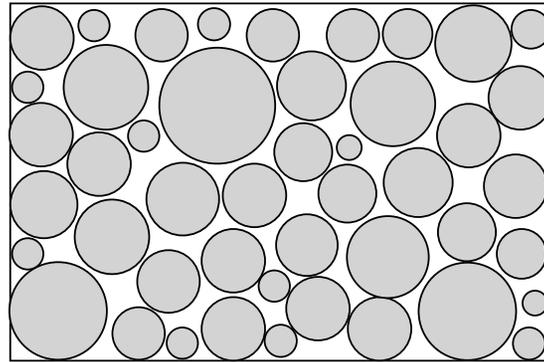
If this pattern continues, during the first six hours on Wednesday, tidal height will

- (1) decrease, only
- (2) decrease, then increase
- (3) increase, only
- (4) increase, then decrease

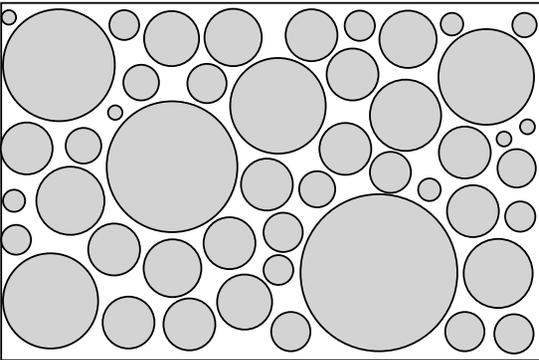
34 Which diagram best represents sediments with the greatest degree of sorting by size?



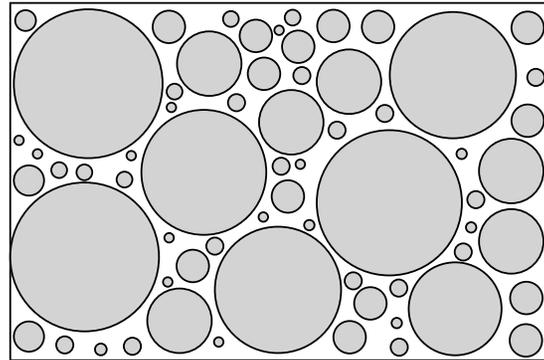
(1)



(3)



(2)



(4)

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35 The photograph below shows a depositional feature located near the shore of Texas. Letter X represents a location on this feature.



QUESTION 35 CONTINUED

On which depositional feature is location *X* found?

- (1) an island arc
 - (2) a barrier island
 - (3) a drumlin
 - (4) a floodplain
-

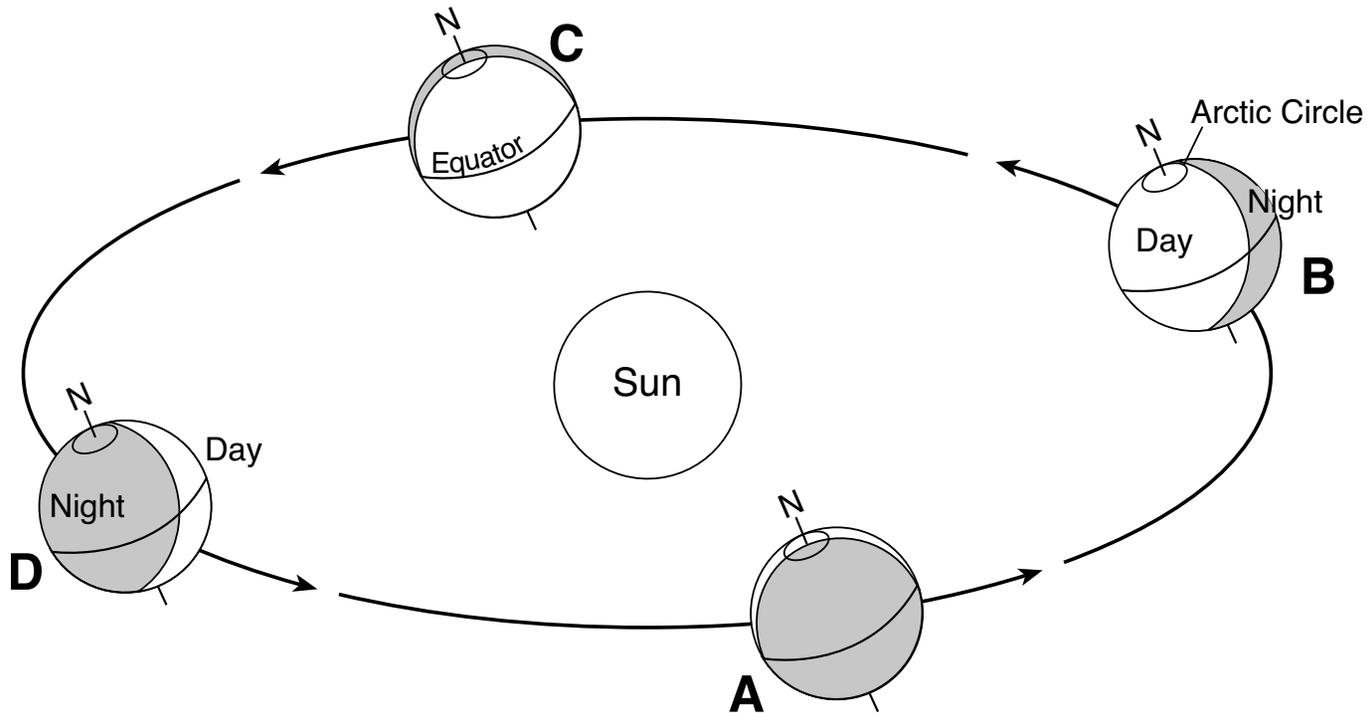
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Part B-1

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 38 on the diagram below and on your knowledge of Earth science. The diagram represents Earth's orbit around the Sun. Positions *A*, *B*, *C*, and *D* represent Earth's location on the first day of each season. Letter *N* indicates the North Pole.



(Not drawn to scale)

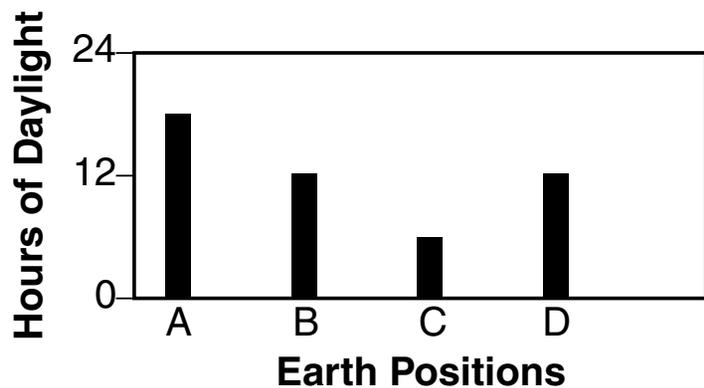
36 At each position in Earth's orbit, the North Pole is pointing toward

- (1) *Pollux*
- (2) the Sun
- (3) *Polaris*
- (4) the Moon

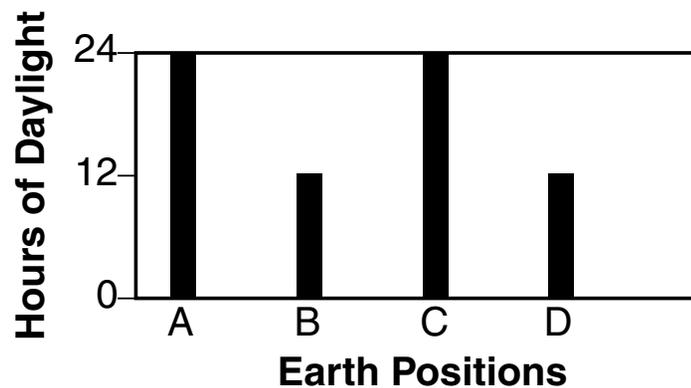
37 Earth revolves around the Sun at the rate of approximately

- (1) 1° per day
- (2) 360° per day
- (3) 15° per hour
- (4) 23.5° per hour

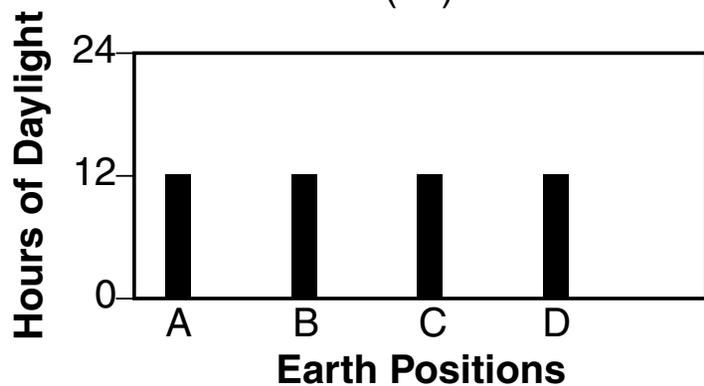
38 Which graph best shows the hours of daylight that occur at the equator on all four Earth positions shown?



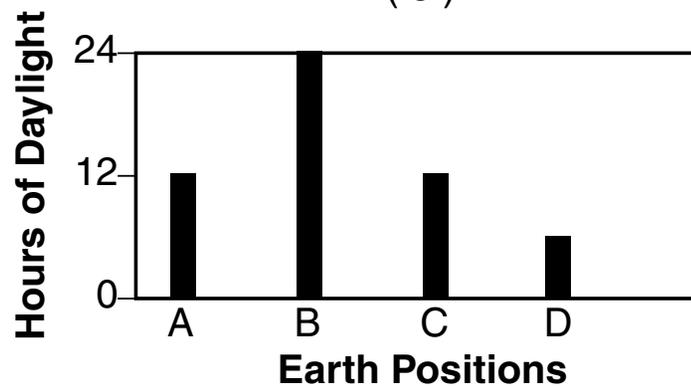
(1)



(3)



(2)



(4)

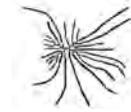
Base your answers to questions 39 through 41 on the passage and data table below, on the diagrams on the next page, and on your knowledge of Earth science. The age ranges shaded on the data table show the geologic periods and epochs when six different graptolite fossils existed on Earth. Diagrams of the six graptolites are shown.

Graptolite Fossils

Although graptolite fossils are found in bedrock from the Cambrian Period into the Pennsylvanian Period, their remains are most abundant in Ordovician and Silurian rock layers. During their existence on Earth, graptolites evolved quickly and spread widely due to ocean circulation. These tiny and fragile fossils are usually found in dark shales that formed in marine environments. They are rare in sandstones or other rocks that formed near shore.

Data Table of Graptolite Age Ranges

Fossil Graptolite	Ordovician			Silurian	
	Early	Middle	Late	Early	Late
<i>Climacograptus</i>					
<i>Clonograptus</i>					
<i>Cyclograptus</i>					
<i>Didymograptus</i>					
<i>Dimorphograptus</i>					
<i>Goniograptus</i>					



Climacograptus

Clonograptus

Cyclograptus

Didymograptus

Dimorphograptus

Goniograptus

39 Which graptolite from the data table would best serve as an Early Ordovician index fossil?

(1) *Climacograptus*

(3) *Didymograptus*

(2) *Clonograptus*

(4) *Goniograptus*

40 A *Clonograptus* fossil was found in the surface bedrock at 43° N 73°30' W. In which New York State landscape region was this fossil found?

(1) Adirondack Mountains

(3) Allegheny Plateau

(2) Taconic Mountains

(4) Champlain Lowlands

41 Which graptolite lived at the same time that large amounts of salt and gypsum were deposited in evaporite basins in New York State?

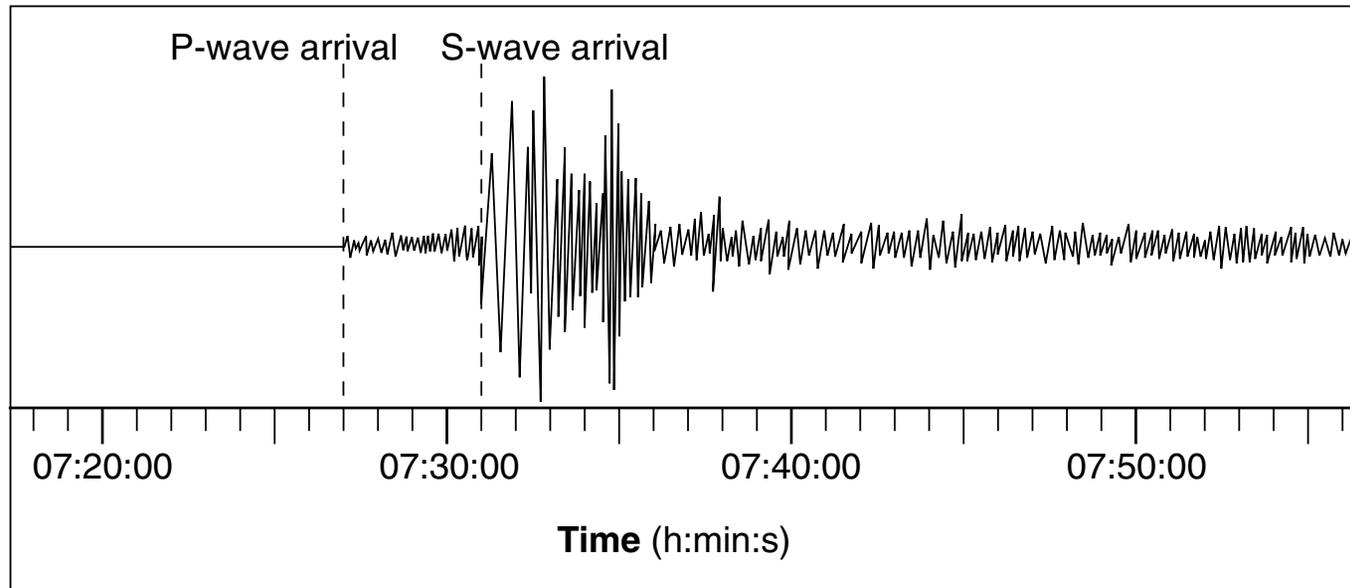
(1) *Clonograptus*

(3) *Didymograptus*

(2) *Cyclograptus*

(4) *Goniograptus*

Base your answers to questions 42 and 43 on the seismogram below and on your knowledge of Earth science.



- 42 Which statement best describes the arrival of *P*-waves and *S*-waves recorded at a station located closer to the epicenter of this same earthquake?
- (1) The time difference between the arrival of the first *P*-wave and *S*-wave would be less than 4 minutes.
 - (2) The time difference between the arrival of the first *P*-wave and *S*-wave would be greater than 4 minutes.
 - (3) *P*-waves would be recorded, but no *S*-waves would arrive.
 - (4) *S*-waves would be recorded, but no *P*-waves would arrive.

43 The rock movement that caused the earthquake occurred 10 kilometers below Earth's surface. In which Earth layer did this earthquake originate?

(1) lithosphere

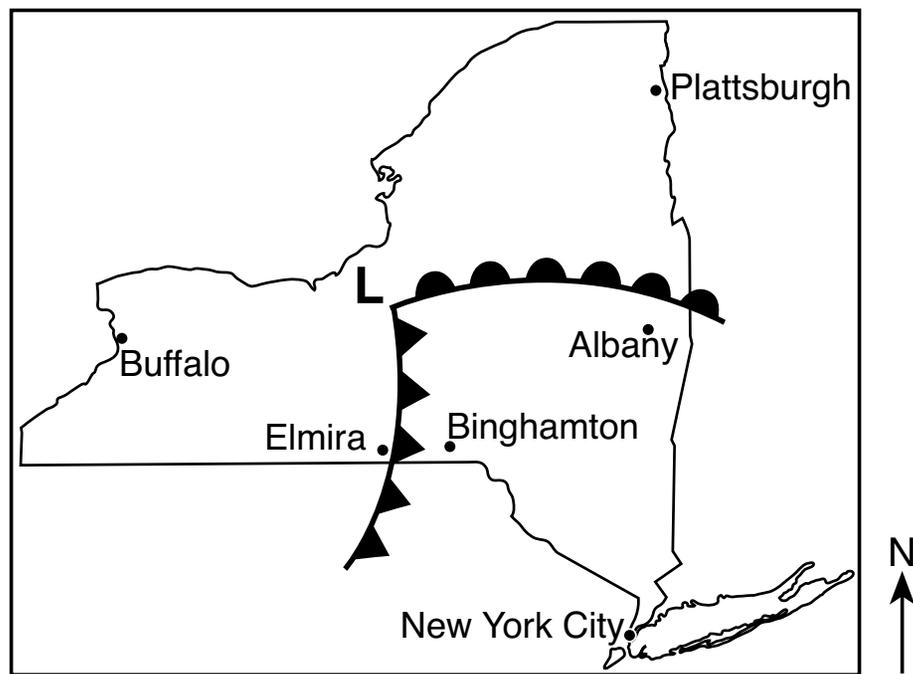
(3) stiffer mantle

(2) asthenosphere

(4) outer core

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Base your answers to questions 44 through 46 on the weather map below and on your knowledge of Earth science. The weather map shows a low-pressure system over New York State on a July day. The **L** represents the center of the low, and two fronts extend from this center. Locations of some cities are indicated.



44 If the center of the low-pressure system follows a normal storm track, toward which city would the center of this low most likely move?

- (1) Buffalo
- (2) Elmira

- (3) New York City
- (4) Plattsburgh

45 Severe weather was occurring in Elmira, New York. Which present weather symbol was most likely recorded on the station model for Elmira?



(1)



(2)

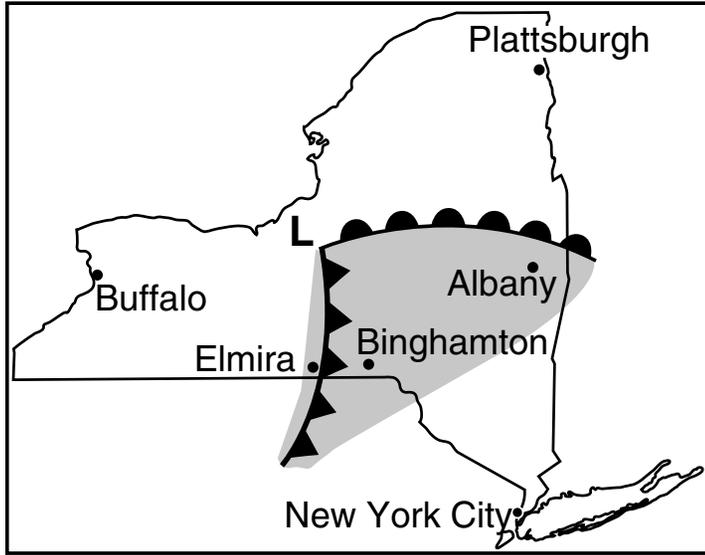


(3)

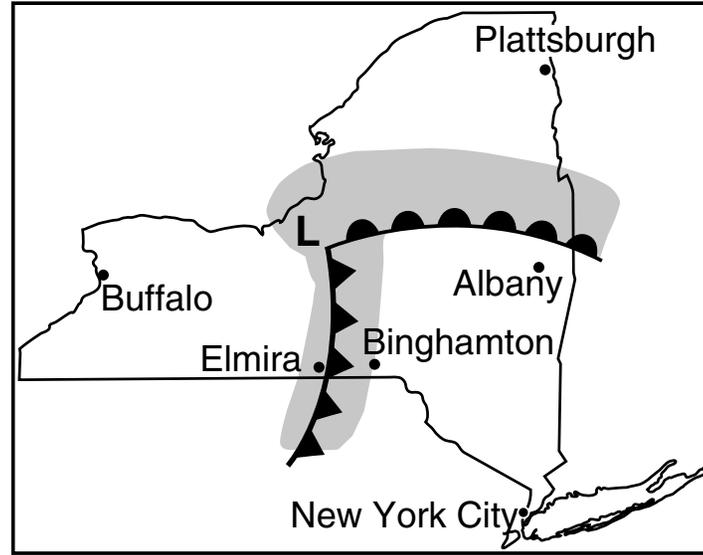


(4)

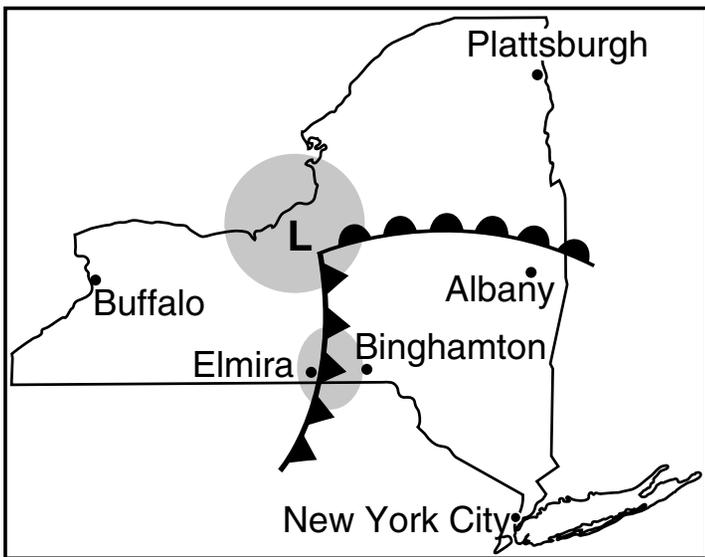
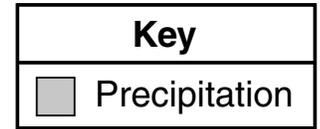
46 Which map shows the most probable areas of precipitation that would appear on a radar image taken at the time of these frontal positions?



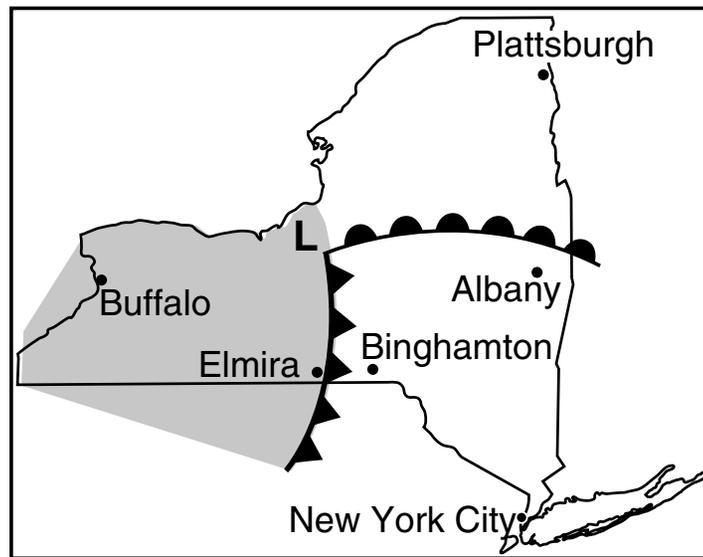
(1)



(3)



(2)



(4)

Base your answers to questions 47 through 50 on the map below and on your knowledge of Earth science. The map shows the continental United States and parts of Mexico and Canada. Letters A through F represent surface locations.



47 The climate of location *A* is more humid than location *B* because *A* is

- (1) at a lower elevation
- (2) at a higher latitude
- (3) on the side of a mountain range facing the prevailing wind
- (4) receiving a greater amount of energy from the Sun

48 Compared to the annual range in temperatures at location *C*, the annual range in temperatures at location *D* will be

- (1) less, because *D* is located near a large body of water
- (2) less, because *D* is located at a greater longitude
- (3) greater, because *D* is located near a large body of water
- (4) greater, because *D* is located at a greater longitude

49 The table below compares the average annual temperature for locations *C* and *F*.

Location	Average Annual Temperature
C	55°F
F	68°F

The best explanation for this temperature difference is that location *C*

- (1) is in the polar NE wind belt
- (2) is farther from the equator
- (3) has less cloud cover
- (4) has more frequent tornadoes

50 What is the relative temperature and name of the surface ocean current that affects the climate of location *E*?

(1) warm Alaska Current

(3) cool Peru Current

(2) warm Gulf Stream Current

(4) cool California Current

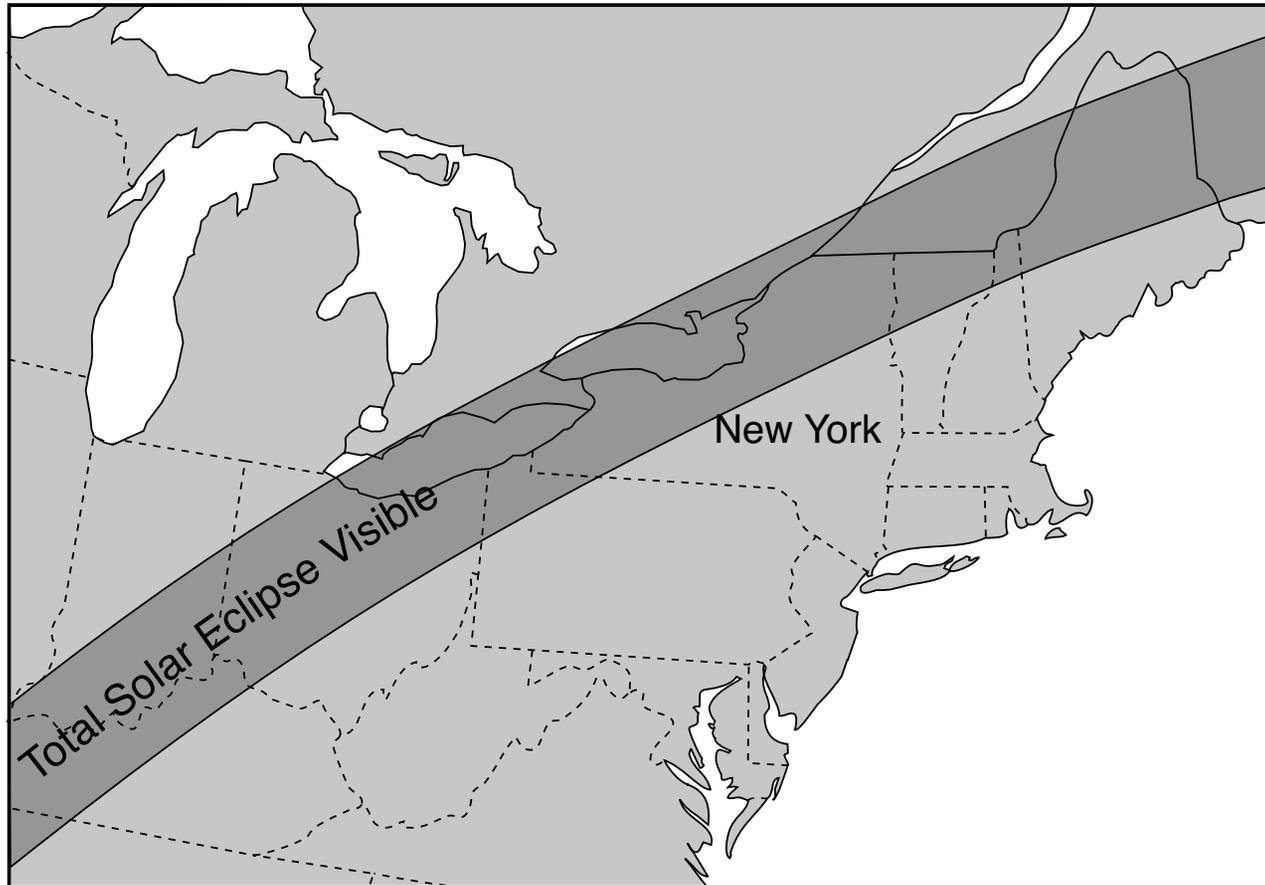
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Part B–2

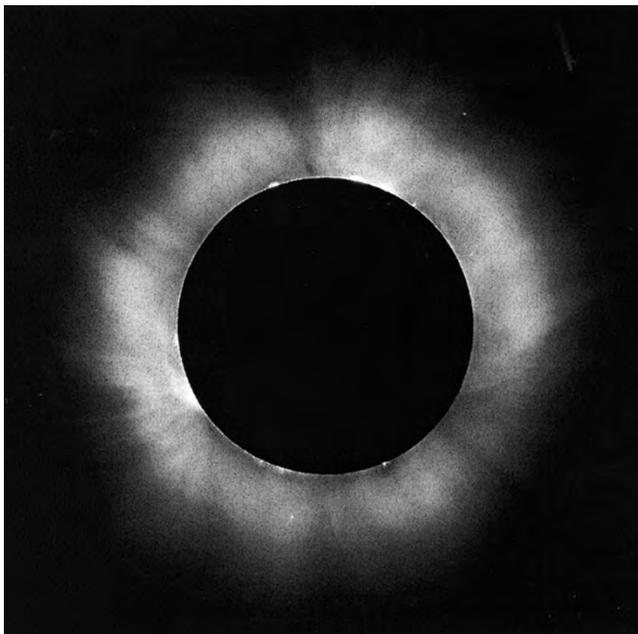
Answer all questions in this part.

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 and 52 on the map below, on the photograph on the next page, and on your knowledge of Earth science. The map shows a path across northeastern North America, where a total solar eclipse will be visible on April 8, 2024. The photograph shows an example of a total solar eclipse.



Total Solar Eclipse

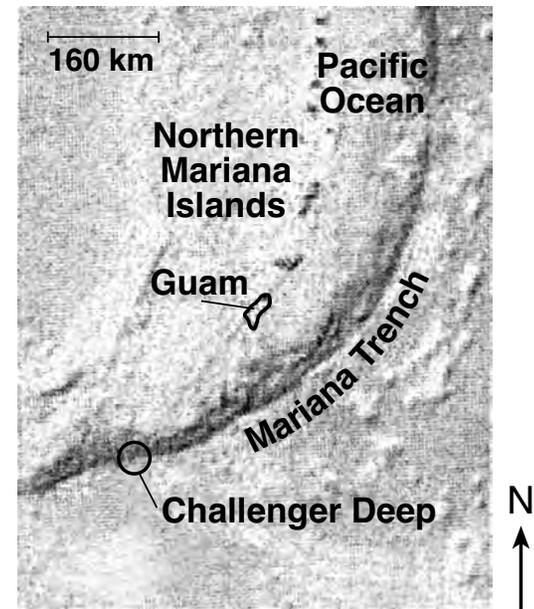
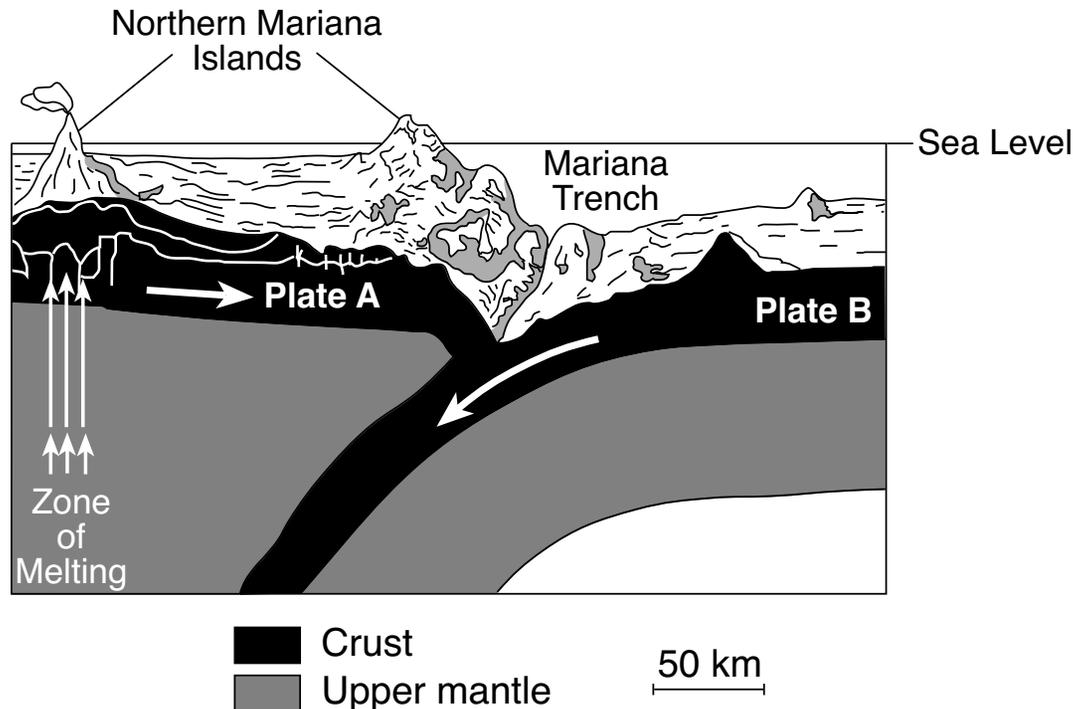


- 51 On the chart *in your answer booklet*, place a check mark (✓) in the box next to each New York State location where a total solar eclipse will be visible with clear skies on April 8, 2024. [1]
- 52 On the diagram *in your answer booklet*, place an **X** on the Moon's orbit to indicate the Moon's position during the solar eclipse on April 8, 2024. [1]
-

Base your answers to questions 53 through 56 on the passage, cross section, and map below and on your knowledge of Earth science. The cross section represents the relative movement of two tectonic plates, labeled *A* and *B*, at the Mariana Trench. Arrows in the plates indicate the direction of this movement.

Challenger Deep

Challenger Deep is the deepest known point in Earth's oceans. This relatively narrow depression, only 7 miles long and 1 mile wide, is located in the bottom of the southern end of the Mariana Trench near the Mariana Islands, which includes the island of Guam. Challenger Deep is 6.83 miles deep, compared to Mount Everest, which is 5.49 miles above sea level.

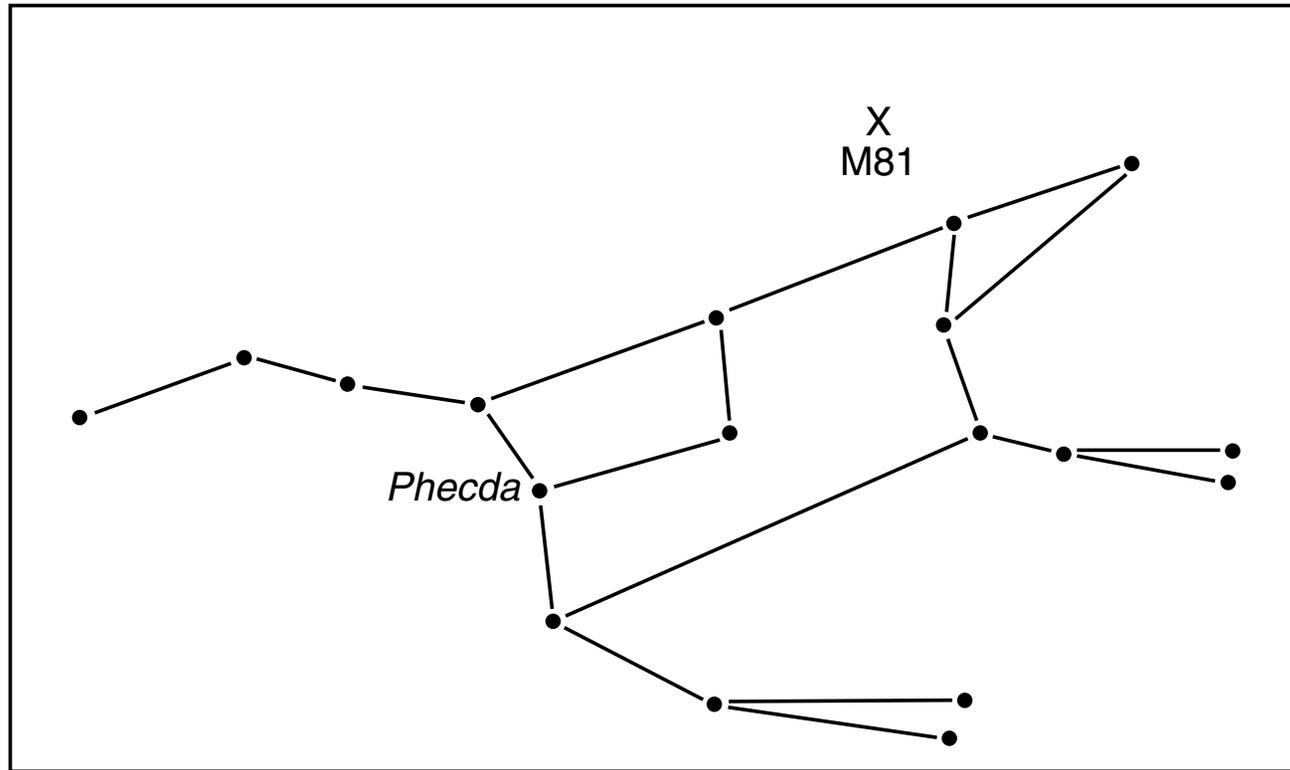


- 53 Identify the names of tectonic plate *A* and tectonic plate *B*. [1]
- 54 Identify the type of tectonic plate boundary shown in the cross section. [1]
- 55 Identify *one* other geologic surface feature, other than a trench, found at the region represented in the cross section. [1]
- 56 The diagram *in your answer booklet* represents the depth of Challenger Deep. For comparison, on the Height of Mount Everest scale to the right, draw a horizontal line across the scale to indicate the height above sea level of Mount Everest. [1]
-

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Base your answers to questions 57 through 59 on the diagram below, on the photograph on the next page, and on your knowledge of Earth science. The diagram represents the constellation Ursa Major. One star, *Phecda*, has been labeled. Letter X represents the location of the Messier 81 galaxy (M81), which can be observed near Ursa Major. The photograph shows the Messier 81 galaxy as viewed through a telescope.

Ursa Major



Messier 81 Galaxy



- 57 *Phecda* has a surface temperature of approximately 9500 K and a luminosity of 63. Identify the name of the star found on the Characteristics of Stars chart in the *2011 Edition Reference Tables for Physical Setting/Earth Science* that has a surface temperature and luminosity closest to *Phecda*. [1]
- 58 State the name of the nuclear process occurring in *Phecda* that produces this star's energy by combining lighter elements into heavier elements. [1]
- 59 The study of spectral lines from the Messier 81 galaxy suggests that it is moving toward Earth. Identify the color toward which these spectral lines shift when visible light from the Messier 81 galaxy is observed on Earth. [1]

Base your answers to questions 60 through 62 on the diagram in your answer booklet and on your knowledge of Earth science. The diagram represents a model of the radioactive decay of carbon-14. The white boxes represent radioactive carbon-14 remaining, and the black boxes represent the disintegration product after the first half-life.

- 60 On the diagram *in your answer booklet*, shade in the correct number of carbon-14 boxes to represent the additional disintegration product after the second half-life. [1]
- 61 State the name of the disintegration product of carbon-14. [1]
- 62 Explain why carbon-14 would *not* be used to find the age of a *Coelophysis* fossil. [1]
-

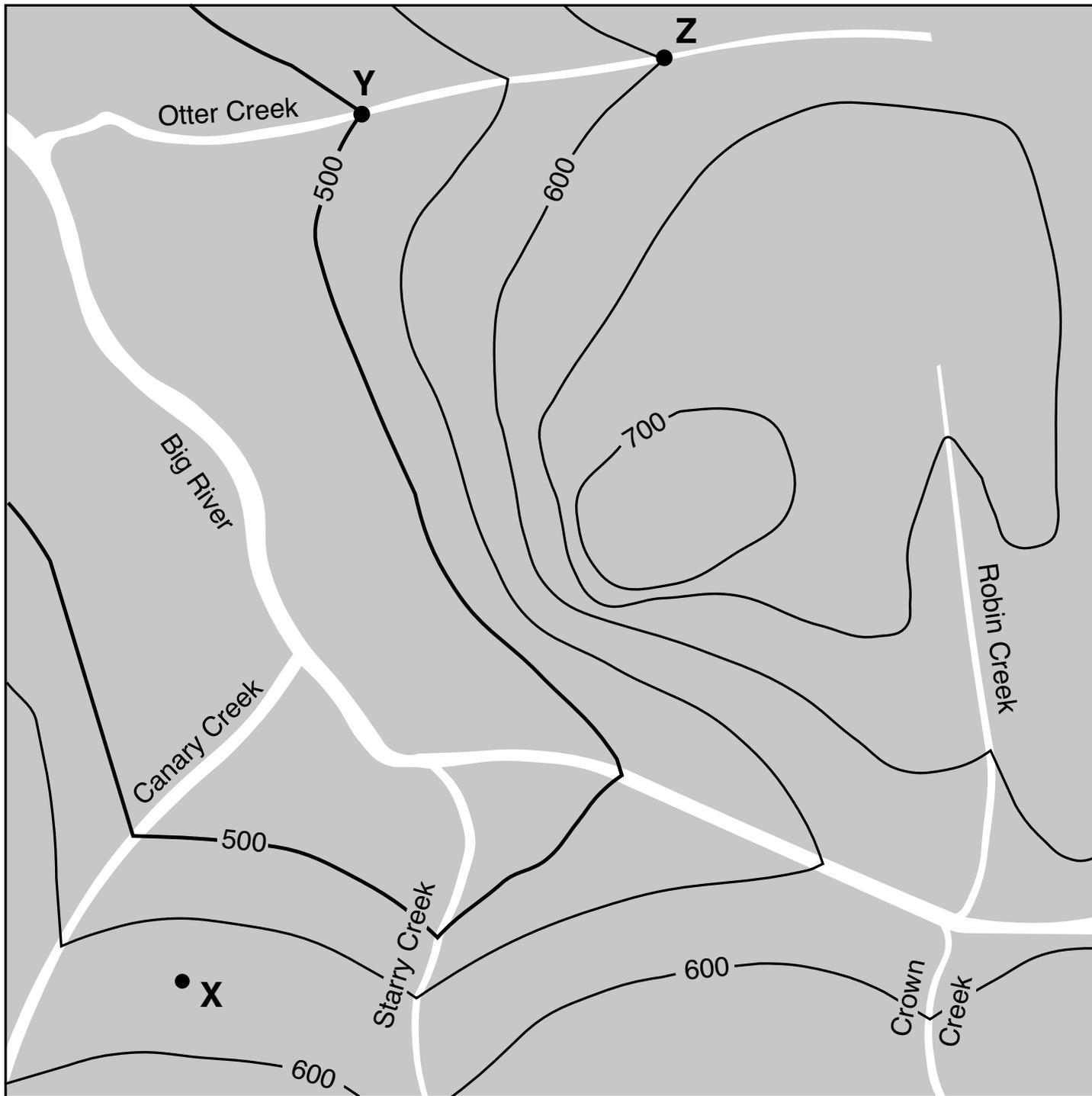
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Base your answers to questions 63 through 65 on the topographic map on the next page and on your knowledge of Earth science. Points X, Y, and Z indicate surface locations. Elevations are shown in meters.

63 State *one* possible elevation of point X. [1]

64 Calculate the gradient of Otter Creek, in meters per kilometer, between points Y and Z. [1]

65 Identify the compass direction toward which Canary Creek is flowing. [1]



Contour interval = 50 meters



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 70 on the air pressure field map in your answer booklet and on your knowledge of Earth science. The map shows air pressures recorded in millibars (mb) at locations in eastern North America. Four isobars are shown. Points *W*, *X*, *Y*, and *Z* represent locations on Earth's surface. Letter **L** represents the center of a low-pressure system.

- 66 On the map *in your answer booklet*, draw the 1000 mb and 996 mb isobars. [1]
- 67 Which location on the map, *W*, *X*, *Y*, or *Z*, most likely has the greatest wind speed? Describe *one* piece of evidence on the map indicating that this location has the greatest wind speed. [1]
- 68 Identify the weather instrument used to measure air pressure. [1]
- 69 Describe the *two* characteristics of the general surface wind circulation pattern associated with this low-pressure system. [1]
- 70 One air mass associated with this pressure system originally formed over the Gulf of Mexico. Write the two-letter weather map symbol for this type of air mass. [1]
-

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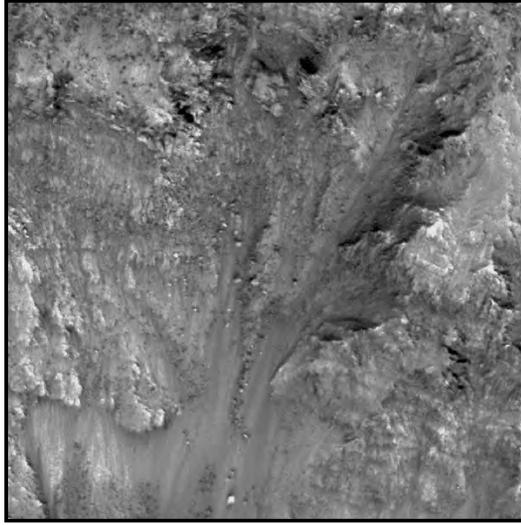
Base your answers to questions 71 through 74 on the passage below and photographs on the next page and on your knowledge of Earth science. The photographs show “dark streaks” of water that form and become longer over the summer months on Mars.

Water on Mars

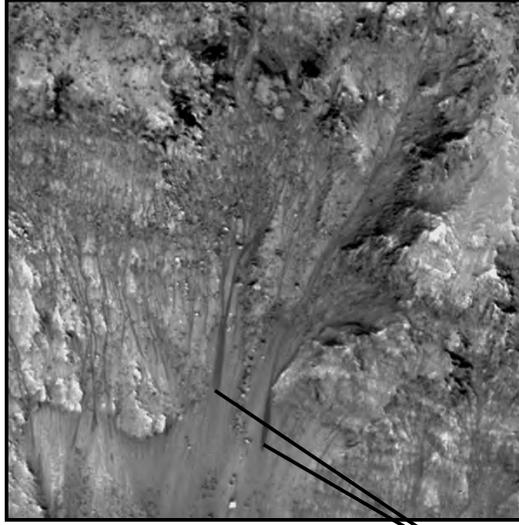
NASA scientists have found evidence of flowing water on Mars. Mysterious “dark streaks” have been viewed forming on the slopes of Martian craters and mountain valleys during the summer months on Mars. These streaks were first thought to be landslides. Additional study caused scientists to infer that these streaks are salt compounds with water chemically attached to them. This salty-water compound is inferred to rise up from underground storage areas after thawing in the summer, or is formed when salts on the surface of Mars absorb water from the atmosphere until there is enough liquid water to run downhill. These salty-water flows are promising sites to find life on Mars. Future human missions to Mars may obtain and process water from this natural source.

Flowing Water On Mars

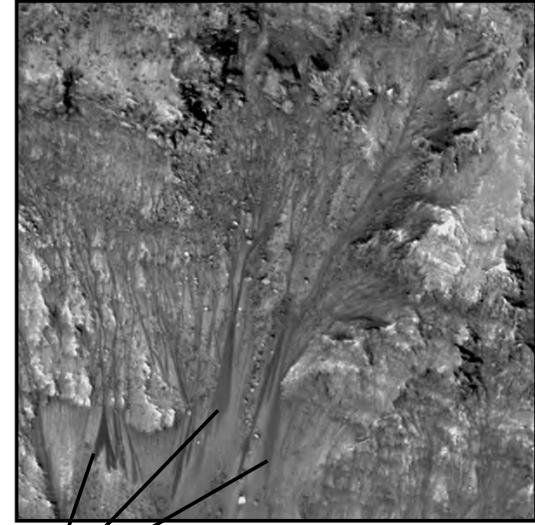
Before Martian Summer:
No “dark streaks”
are visible.



Early Martian Summer:
“Dark streaks”
first become visible.



Late Martian Summer:
“Dark streaks” become longer
and more numerous.



Dark Streaks

- 71 Identify the force that causes the type of mass movement first inferred to have formed the “dark streaks.” [1]
- 72 Identify *one* event that could have formed the Martian craters. [1]
- 73 Determine the number of days from the first day of summer on Mars to the next first day of summer on Mars. [1]
- 74 Indicate whether Mars is classified as a terrestrial planet or Jovian planet by circling the correct term *in your answer booklet*. Explain why Mars is classified as this type of planet. [1]

Base your answers to questions 75 through 79 on the data table below and on your knowledge of Earth science. The data table shows how the destruction of the ozone layer in Earth's atmosphere has affected the amount of ultraviolet radiation reaching Earth's surface beneath the areas of ozone destruction.

Ozone Loss and Ultraviolet Radiation

Ozone Destruction (%)	Average Increase in Ultraviolet Radiation Reaching Earth's Surface (%)
0	0
5	5
10	12
15	20
20	28
25	36
30	47
35	60
40	76

75 On the grid *in your answer booklet*, construct a line graph by plotting the data for the average increase in ultraviolet radiation reaching Earth's surface for each percentage of ozone destruction shown on the data table. Connect *all nine* plots with a line. [1]

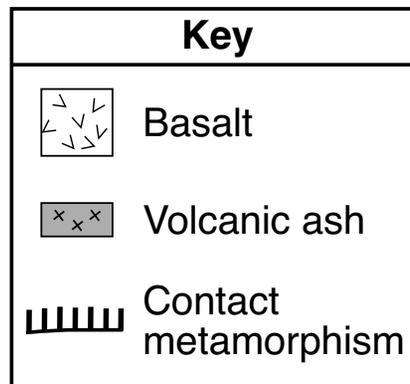
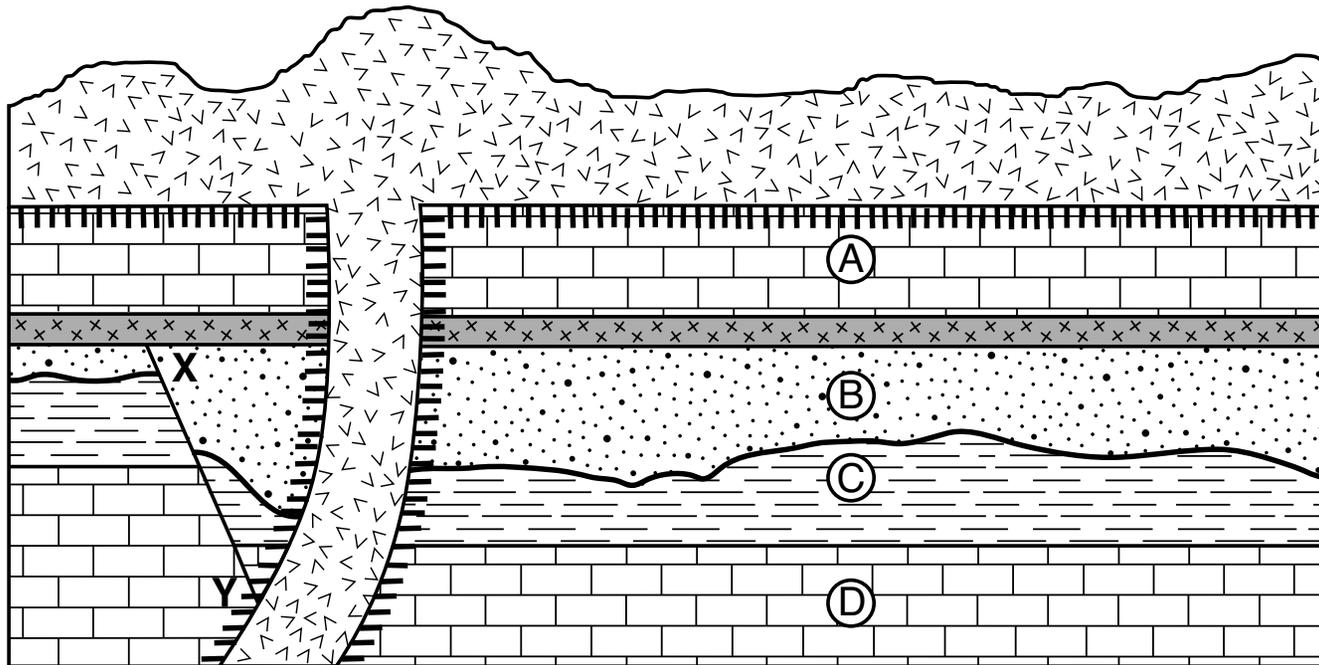
76 Ozone destruction was estimated to be 22% in the atmosphere above a Lake Ontario beach. Based on the pattern shown in the data table, predict the average increase in ultraviolet radiation reaching that beach. [1]

- 77 The ozone layer is mostly concentrated between 20 and 25 kilometers above Earth's surface. State the name of the atmospheric temperature zone layer where this ozone concentration can be found. [1]
- 78 On the table *in your answer booklet*, place one check mark in each row to compare the relative wavelengths of other types of electromagnetic radiation to ultraviolet (UV) radiation. [1]
- 79 Ozone closer to Earth's surface has been identified as a greenhouse gas. Identify *two* other gases in Earth's atmosphere that are considered major greenhouse gases. [1]
-

Base your answers to questions 80 through 82 on the diagram in your answer booklet and on your knowledge of Earth science. The diagram represents the apparent paths of the Sun observed in solar time (time based on the Sun's position in the sky) at Albany, New York, on June 21 and December 21. A portion of the Sun's path on June 21 is shaded. A protractor has been included in the diagram.

- 80 On the diagram *in your answer booklet*, draw an **X** to indicate the position of sunrise on March 21. [1]
- 81 Determine the altitude of the Sun at solar noon on December 21 and June 21. [1]
- 82 The shaded portion on the June 21 path represents 45 degrees of the Sun's apparent motion. Determine the number of hours that this shaded portion represents. [1]
-

Base your answers to questions 83 through 85 on the geologic cross section below and on your knowledge of Earth science. The cross section represents sedimentary rock units labeled *A* through *D*, a layer of volcanic ash deposits, and a basalt extrusion. An unconformity is present between rock units *B* and *C*. Line *XY* represents a fault. The rock layers have *not* been overturned.



- 83 State the name of *one* metamorphic rock that most likely formed in the zone of contact metamorphism between rock unit *A* and the basalt. [1]
- 84 Fossils of the first multicellular, soft-bodied marine organisms were found in rock unit *D*. Identify the eon that indicates the geologic age of this rock unit. [1]
- 85 Determine the relative age sequence of the following geologic features, in order from oldest to youngest: [1]
- Basalt
 - Fault *XY*
 - Volcanic ash
-

