

The University of the State of New York  
REGENTS HIGH SCHOOL EXAMINATION

**PHYSICAL SETTING**  
**EARTH SCIENCE**

**Thursday, June 19, 2014 — 1:15 to 4:15 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

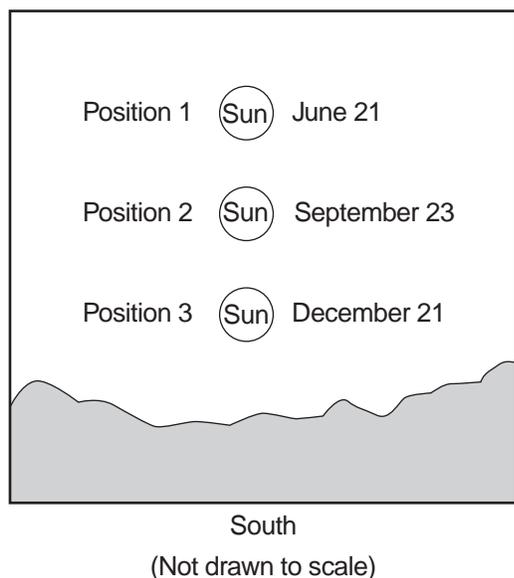
### Answer all questions in this part.

*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 Which New York State city is located at  $42^{\circ}39' \text{ N}$   $73^{\circ}45' \text{ W}$ ?

- (1) Buffalo (3) Ithaca  
 (2) Albany (4) Plattsburgh

2 Positions 1, 2, and 3 in the diagram below represent the noon Sun above the horizon on three different days during the year, as viewed from Binghamton, New York.



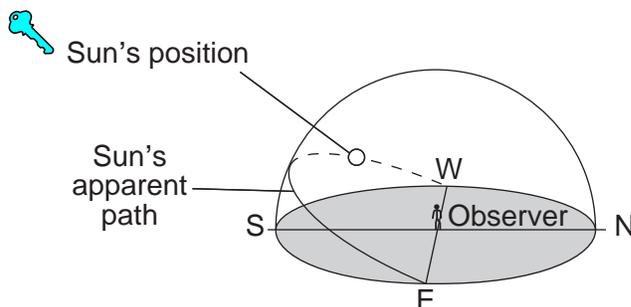
At which position was the noon Sun on January 21, as viewed from Binghamton?

- (1) above position 1  
 (2) below position 3  
 (3) between position 1 and position 2  
 (4) between position 2 and position 3

3 Which evidence best supports the theory that the universe began with a massive explosion?

- (1) cosmic background radiation in space  
 (2) parallelism of planetary axes  
 (3) radioactive dating of Earth's bedrock  
 (4) life cycle of stars

4 The diagram below represents the apparent path of the Sun as seen by an observer at  $65^{\circ} \text{ N}$  on March 21.



The Sun's position shown in the diagram was observed closest to which time of day?

- (1) 9 a.m. (3) 3 p.m.  
 (2) 11 a.m. (4) 6 p.m.

5 Which statement best describes Earth's approximate rates of rotation and revolution?

- (1) Earth's rotation rate is  $15^{\circ}/\text{hour}$  and its revolution rate is  $1^{\circ}/\text{day}$ .  
 (2) Earth's rotation rate is  $1^{\circ}/\text{hour}$  and its revolution rate is  $15^{\circ}/\text{day}$ .  
 (3) Earth's rotation rate is  $24^{\circ}/\text{hour}$  and its revolution rate is  $360^{\circ}/\text{day}$ .  
 (4) Earth's rotation rate is  $360^{\circ}/\text{hour}$  and its revolution rate is  $24^{\circ}/\text{day}$ .

6 The accumulation of water vapor, carbon dioxide, and nitrogen in Earth's early atmosphere approximately 4 billion years ago resulted mainly from

- (1) outgassing from Earth's interior  
 (2) radioactive decay  
 (3) photosynthesis by the earliest land plants  
 (4) convection currents in Earth's outer core

7 Fossils of which type of animal would most likely be found in the surface bedrock of the Catskills?

-  (1) reptiles (3) mammals  
(2) brachiopods (4) birds

8 Which geologic event occurred in New York State at approximately the same time as the extinction of dinosaurs and ammonoids?

-  (1) formation of the Queenston Delta  
(2) deposition of the sands and clays underlying Long Island  
(3) initial opening of the Atlantic Ocean  
(4) advance and retreat of the last continental ice sheet

9 The impacts of large asteroids on Earth are inferred to be associated with

-  (1) free oxygen entering Earth's atmosphere  
(2) seafloor spreading  
(3) the creation of subduction zones  
(4) global climatic changes

10 Volcanic ash deposits found in the geologic record are most useful in correlating the age of rock layers if the volcanic ash was distributed over a

-  (1) large area during a short period of time  
(2) large area during a long period of time  
(3) small area during a short period of time  
(4) small area during a long period of time

11 A fossil formed 11,400 years ago. Which percentage of the original amount of carbon-14 remains in the fossil?

-  (1) 100% (3) 25%  
(2) 50% (4) 12.5%

12 A psychrometer is used to determine which weather variables?

-  (1) wind speed and wind direction  
(2) percentage of cloud cover and cloud height  
(3) air pressure and air temperature  
(4) relative humidity and dewpoint

13 In the Northern Hemisphere, surface winds around the center of a hurricane move

-  (1) clockwise and inward  
(2) clockwise and outward  
(3) counterclockwise and inward  
(4) counterclockwise and outward

14 Equal areas of which surface will absorb the most insolation?

-  (1) partially melted snowfield  
(2) blacktop parking lot  
(3) white sand beach  
(4) lake surface

15 A city located on the coast of North America has warmer winters and cooler summers than a city at the same elevation and latitude located near the center of North America. Which statement best explains the difference between the cities' climates?

-  (1) Ocean surfaces change temperature more slowly than land surfaces.  
(2) Warm, moist air rises when it meets cool, dry air.  
(3) Wind speeds are usually greater over land surfaces than over ocean surfaces.  
(4) Ocean surfaces have a lower specific heat than land surfaces.

16 Dry areas caused by sinking air and diverging surface winds are located at which two latitudes?

-  (1) 0° and 30° N (3) 30° N and 30° S  
(2) 0° and 60° S (4) 60° N and 60° S

17 Which event is inferred by most scientists to be responsible for a climate change that has recently led to a *decrease* in the size of most glaciers?

- (1) a decrease in the rate of divergence of lithospheric plates along a mid-ocean ridge
- (2) a decrease in the amount of insolation reaching Earth's surface
- (3) an increase in the amount of greenhouse gases in Earth's atmosphere
- (4) an increase in the amount of vegetative cover in the tropics

18 The map below shows California and a section of the San Andreas Fault.



What is the primary geologic process occurring along the San Andreas Fault?

- (1) transform movement
- (2) spreading movement
- (3) subduction
- (4) convergence

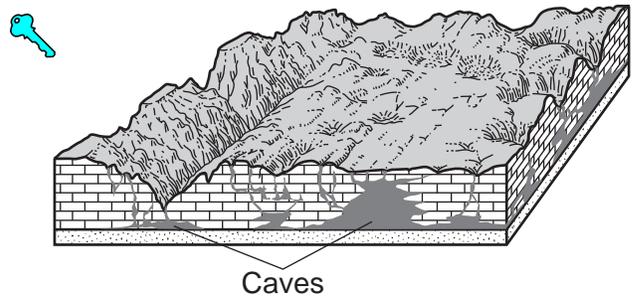
19 Compared to the oceanic crust, the continental crust is usually

- (1) thicker, with a less dense granitic composition
- (2) thicker, with a more dense basaltic composition
- (3) thinner, with a less dense granitic composition
- (4) thinner, with a more dense basaltic composition

20 Which mantle hot spot is located directly below a mid-ocean ridge plate boundary?

- (1) Yellowstone
- (2) Iceland
- (3) Canary Islands
- (4) Hawaii

21 The block diagram below represents caves that developed in a region over time.



Which type of weathering was primarily responsible for the development of these caves?

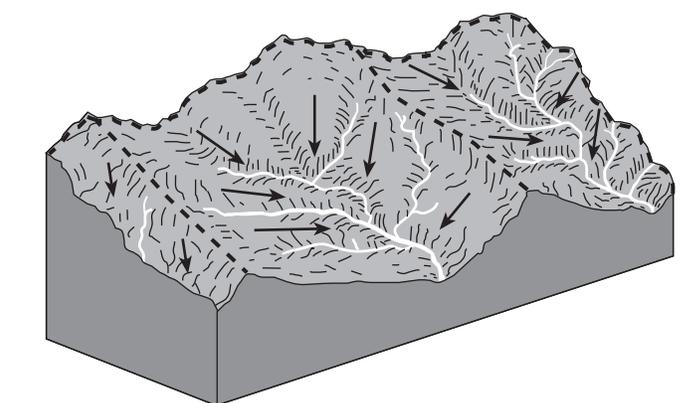
- (1) physical weathering of sandstone
- (2) physical weathering of limestone
- (3) chemical weathering of sandstone
- (4) chemical weathering of limestone

22 Which agent of erosion is most likely responsible for the deposition of sandbars along ocean shorelines?

- (1) glaciers
- (2) mass movement
- (3) wave action
- (4) wind action

23 The block diagram below represents the drainage basins of some river systems separated by highland divides, shown with dashed lines. The arrows show the directions of surface-water flow.

The arrows show the directions of surface-water flow.



The three areas separated by highland divides are called

- (1) meanders
- (2) floodplains
- (3) watersheds
- (4) tributaries

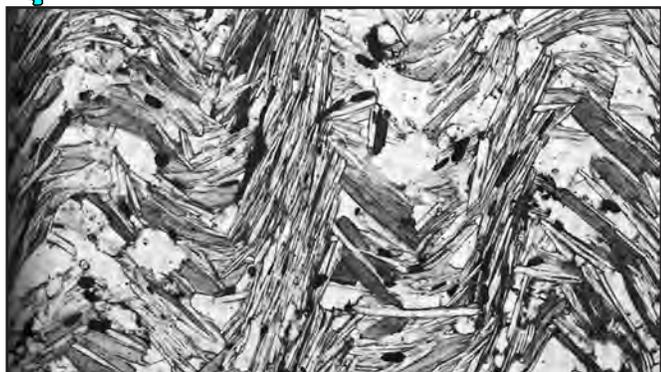
24 Which New York State landscape region is mostly composed of horizontal sedimentary bedrock at high elevations?

- (1) Hudson Highlands
- (2) Allegheny Plateau
- (3) Taconic Mountains
- (4) Atlantic Coastal Plain

25 Which characteristic do samples of the mineral pyroxene normally exhibit?

- (1) yellow to amber color
- (2) bubbling in hydrochloric acid
- (3) cleaves at  $56^\circ$  and  $124^\circ$
- (4) hardness of 5 to 6

26 The photograph below shows the texture of a rock composed of various minerals as seen through a microscope.



(Magnified 20 times)

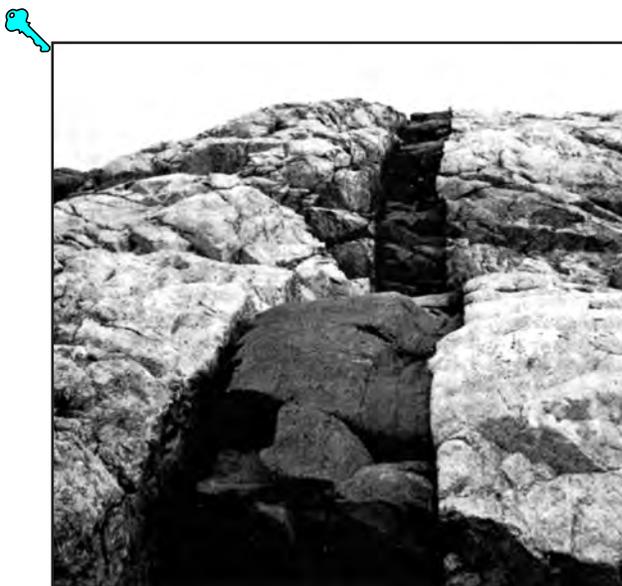
Which rock is most likely shown above?

- (1) sandstone
- (2) anthracite coal
- (3) dunite
- (4) schist

27 Which minerals contain the two most abundant elements by mass in Earth's crust?

- (1) fluorite and calcite
- (2) magnetite and pyrite
- (3) amphibole and quartz
- (4) galena and sulfur

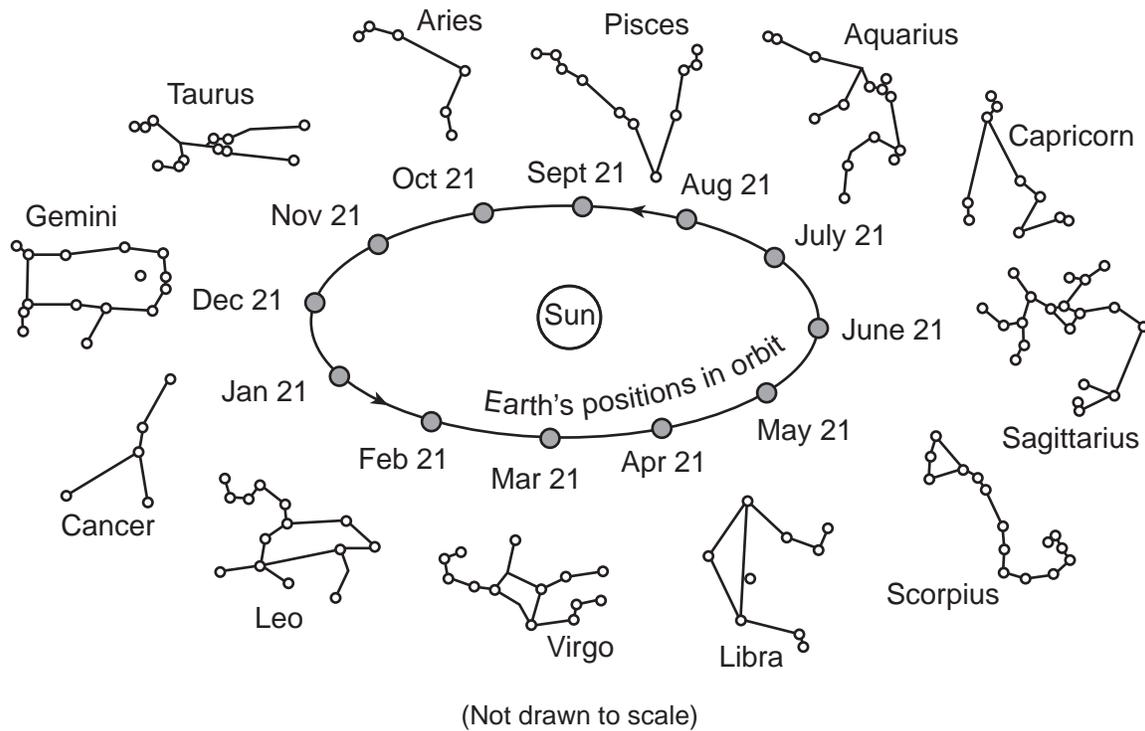
28 The photograph below shows an outcrop where a light-colored, igneous rock is cross cut by a dark-colored, igneous rock.



This fine-grained, dark-colored, igneous rock is most likely

- (1) rhyolite
- (2) diorite
- (3) basalt
- (4) gabbro

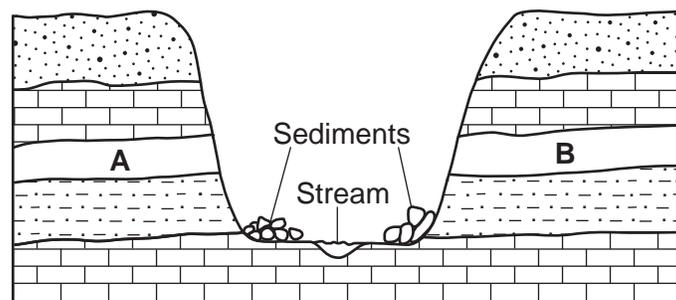
29 The diagram below represents positions of Earth in its orbit around the Sun and twelve constellations that can be seen in the midnight sky by an observer in New York State at different times of the year. The approximate locations of the constellations in relation to Earth's orbit are shown.



Which date is correctly paired with two constellations that can be seen in the sky at midnight?

- (1) May 21: Scorpius and Taurus
- (2) August 21: Libra and Virgo
- (3) November 21: Gemini and Capricorn
- (4) February 21: Leo and Cancer

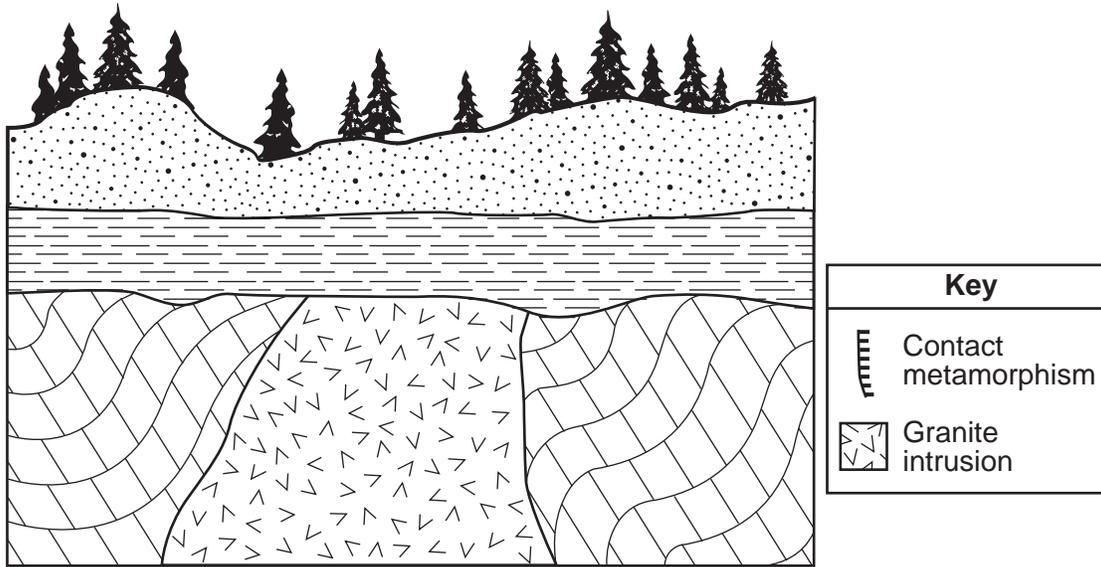
30 The cross section of the bedrock layers of a canyon is represented below. Letters A and B represent rock layers on the sides of the canyon.



Layer A can best be correlated to layer B by comparing the

- (1) sediments on each side of the stream
- (2) sequence of rock layers on each side of the canyon
- (3) organisms currently living in rock layers A and B
- (4) rate of erosion of rock layers A and B by the stream

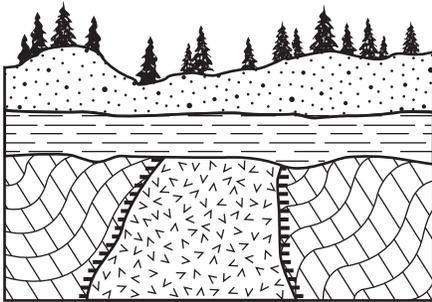
31 The cross section below represents four different rock units. The symbol for contact metamorphism has been omitted from the cross section.



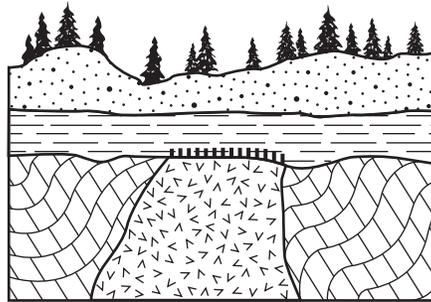
The sequence below represents the relative ages of the rock units from oldest to youngest.

limestone → granite → shale → sandstone

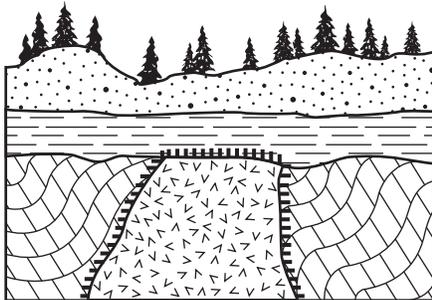
Which cross section below represents where the symbol for contact metamorphism would be located, based on the relative age sequence?



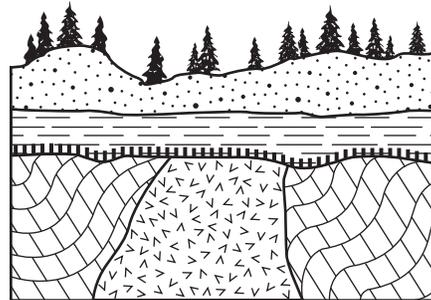
(1)



(3)

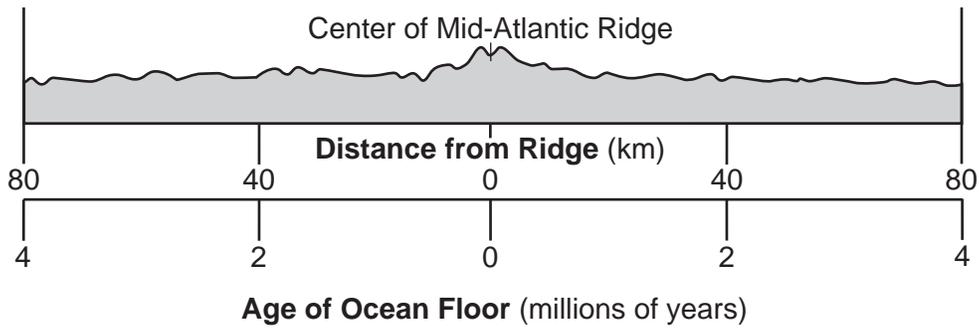


(2)



(4)

Base your answers to questions 32 and 33 on the cross section below and on your knowledge of Earth science. The cross section represents the distance and age of ocean-floor bedrock found on both sides of the Mid-Atlantic Ridge.



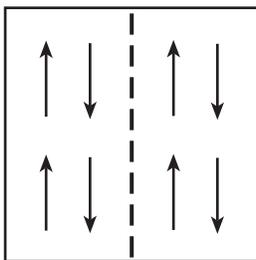
- 32 According to the cross section, every 1 million years, the ocean floor bedrock moves approximately
- (1) 20 km toward the Mid-Atlantic Ridge
  - (2) 20 km away from the Mid-Atlantic Ridge
  - (3) 40 km toward the Mid-Atlantic Ridge
  - (4) 40 km away from the Mid-Atlantic Ridge



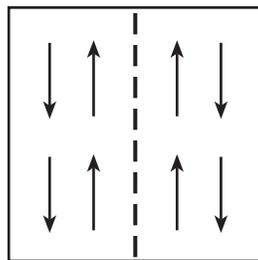
- 33 Which map best represents the pattern of magnetic polarity in the minerals of ocean-floor bedrock on each side of the Mid-Atlantic Ridge?



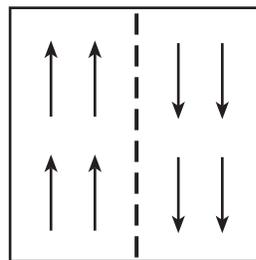
Key	
↑	Normal magnetic polarity
↓	Reversed magnetic polarity
- -	Mid-Atlantic Ridge



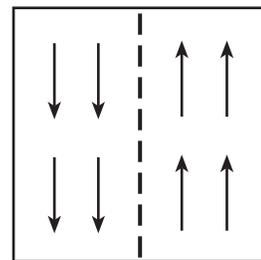
(1)



(2)

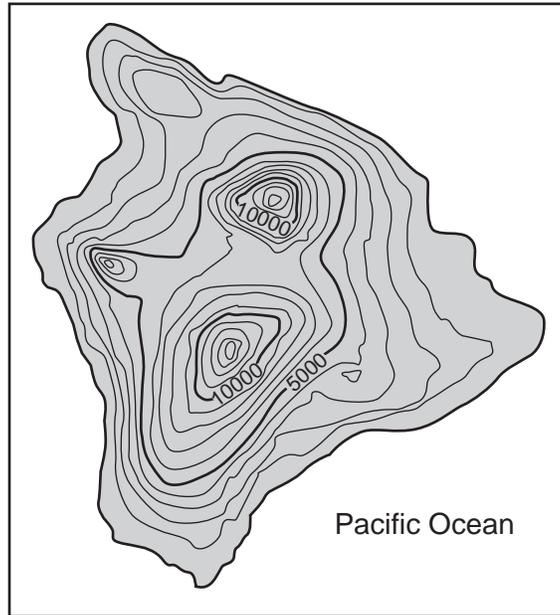


(3)

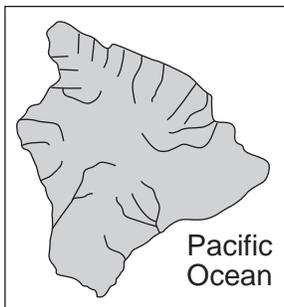


(4)

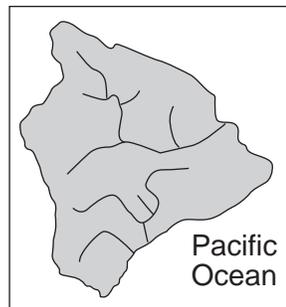
34 The topographic map below shows the largest island of the Hawaiian Islands.



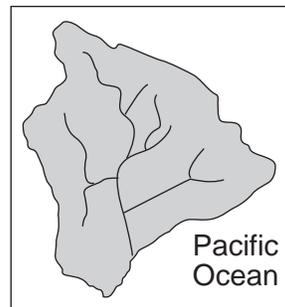
Which map below best shows the most likely stream drainage pattern of this island?



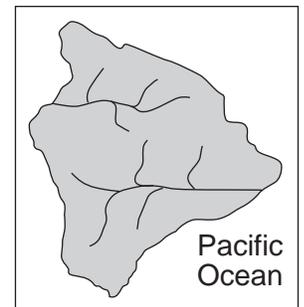
(1)



(2)



(3)

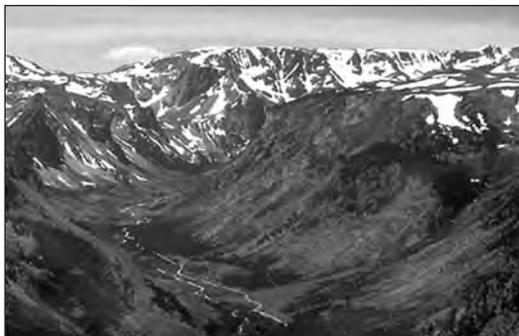


(4)

35 Photographs A and B below show two different valleys.

**Photograph A**

**Photograph B**



Which list best identifies the agent of erosion that primarily determined the shape of each valley?

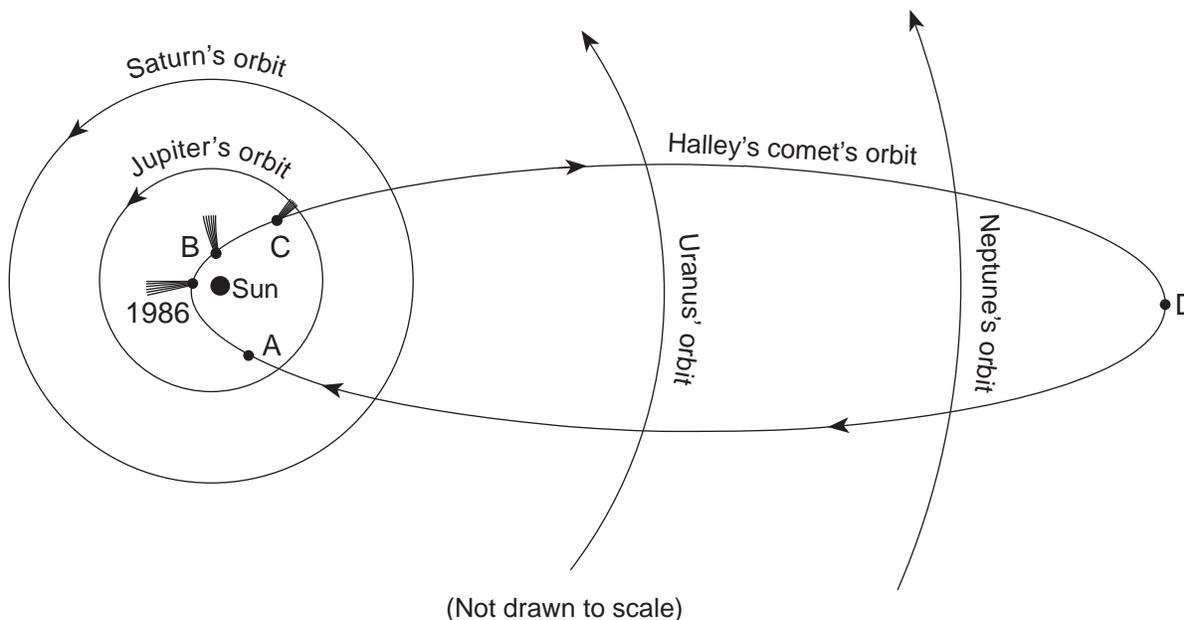
- (1) photograph A—glacier; photograph B—river
- (2) photograph A—river; photograph B—glacier
- (3) both photographs—river
- (4) both photographs—glacier

**Part B-1**

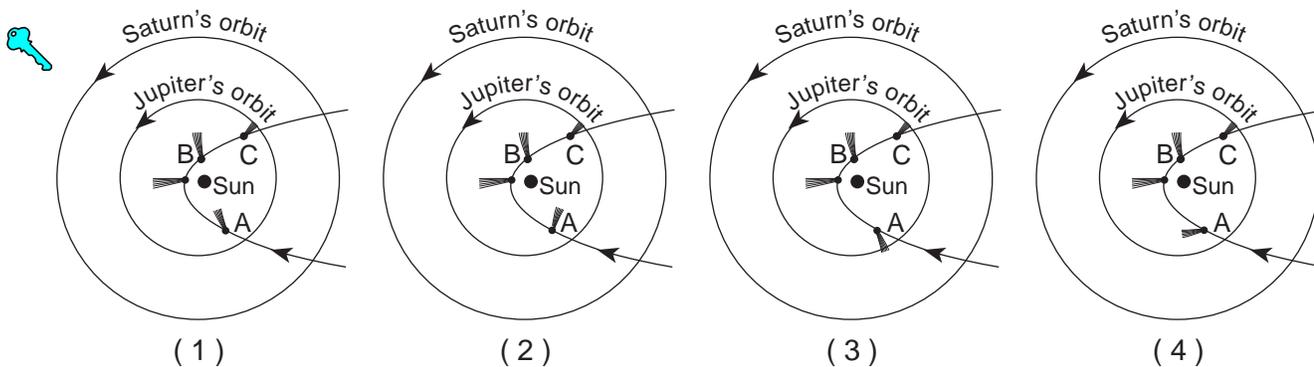
**Answer all questions in this part.**

*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 orbital paths of the four Jovian planets and Halley's comet around the Sun. Halley's comet has a revolution period of 76 years. In 1986, Halley's comet was at perihelion, its closest point to the Sun. Letters A, B, C, and D represent locations of Halley's comet in its orbit. Location D represents Halley's comet at aphelion, its farthest point from the Sun. The comet's tail is shown at perihelion and at locations B and C.



36 Based on the pattern shown above, which diagram best represents the correct position of the comet's tail at location A relative to the Sun?



37 Compared to the orbit of the Jovian planets, the orbit of Halley's comet is

- (1) less elliptical, with a shorter distance between its foci
- (2) less elliptical, with a greater distance between its foci
- (3) more elliptical, with a shorter distance between its foci
- (4) more elliptical, with a greater distance between its foci



38 Compared to the velocity of Jupiter in its orbit, the velocity of Halley's comet is

- (1) always less
- (2) always greater
- (3) always the same
- (4) sometimes less and sometimes greater



39 This diagram of our solar system represents a

- (1) geocentric model with the Sun near the center
- (2) geocentric model with Earth near the center
- (3) heliocentric model with the Sun near the center
- (4) heliocentric model with Earth near the center



40 Which sequence lists the Jovian planets in order of increasing mass?

- (1) Jupiter, Saturn, Neptune, Uranus
- (2) Uranus, Neptune, Saturn, Jupiter
- (3) Jupiter, Saturn, Uranus, Neptune
- (4) Neptune, Uranus, Saturn, Jupiter



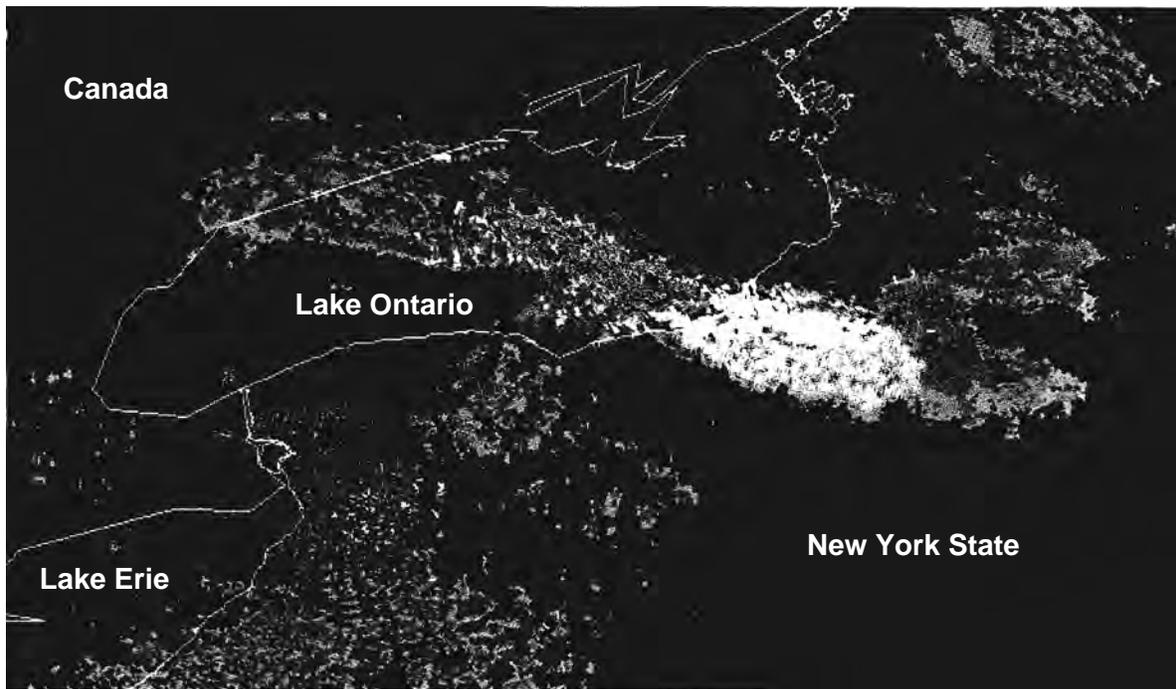
Base your answers to questions 41 through 44 on the reading passage about lake-effect snow and the radar image map below, and on your knowledge of Earth science. The radar map shows areas where snowfall was occurring. The whitest area indicates where snowfall was heaviest.

### Lake-Effect Snow

In late fall, cold air originating in Canada and then moving over the Great Lakes often produces lake-effect snow in New York State.

When the cold air mass moves across large areas of warmer lake water, water vapor enters the cold air. When this moist air moves over the cooler land, the moisture comes out of the atmosphere as snow. The effect is enhanced when the air that flows off the lake is forced over higher land elevations. The areas affected by lake-effect snow can receive many inches of snow per hour. As the lakes gradually freeze, the ability to produce lake-effect snow decreases.

### Radar Image Map



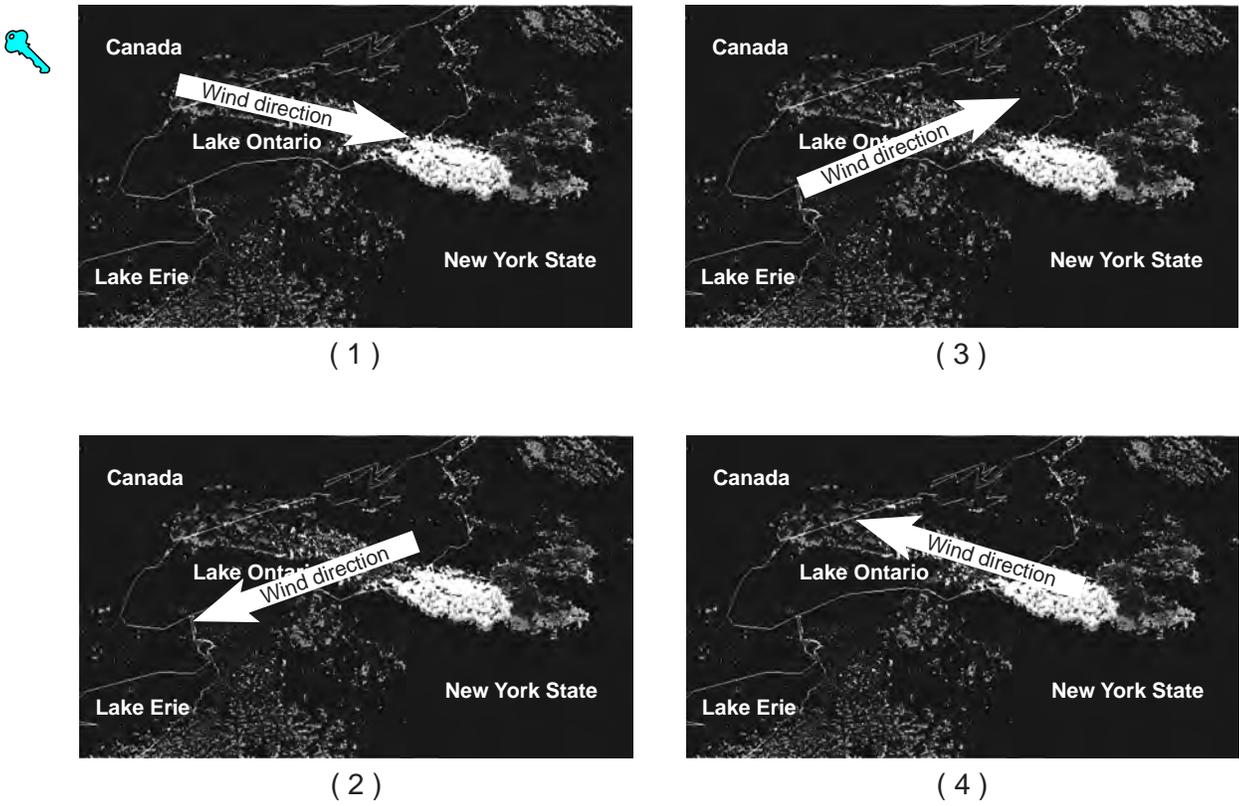
Adapted from: [www.erh.noaa.gov](http://www.erh.noaa.gov)

41 What is the most likely two-letter air mass symbol for an air mass from Canada that produces lake-effect snow in New York State?

- (1) mT
- (2) mP
- (3) cT
- (4) cP



42 Which map shows the most likely direction that winds were moving across Lake Ontario to produce this lake-effect snow?



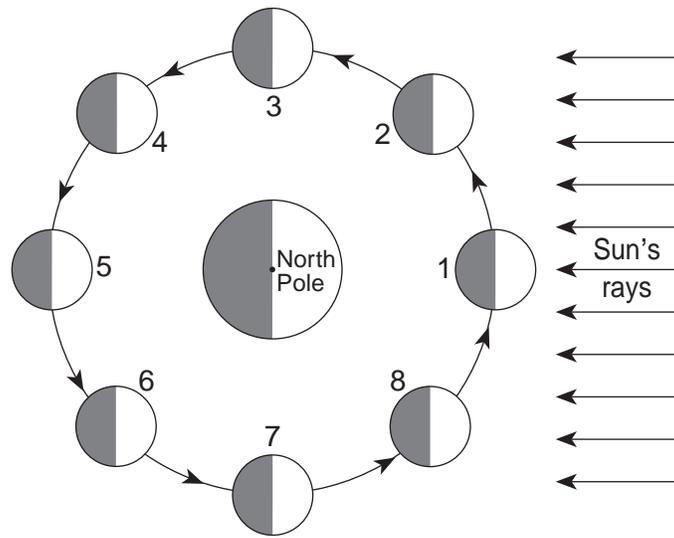
43 Which list indicates the correct sequence in the formation of a lake-effect snow cloud?

- (1) air contracts as it sinks → air warms to the dewpoint → water evaporates
- (2) air expands as it rises → air warms to the dewpoint → water vapor condenses
- (3) air contracts as it sinks → air cools to the dewpoint → water evaporates
- (4) air expands as it rises → air cools to the dewpoint → water vapor condenses

44 Which statement best explains why lake-effect snow *decreases* when lakes freeze gradually?

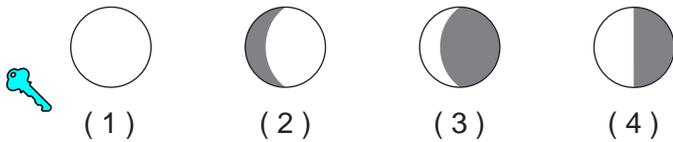
- (1) The ice prevents liquid water from evaporating into the atmosphere.
- (2) The lower temperature of ice makes liquid water condense at a slower rate.
- (3) More water is available to evaporate.
- (4) Ice speeds up the air moving above it, so less water can evaporate.

Base your answers to questions 45 through 47 on the diagram below and on your knowledge of Earth science. The diagram represents eight numbered positions of the Moon in its orbit around Earth.



(Not drawn to scale)

45 Which phase of the Moon will be observed in New York State when the Moon is at position 8?



46 Which two motions cause the Moon to show a complete cycle of phases each month when viewed from New York State?

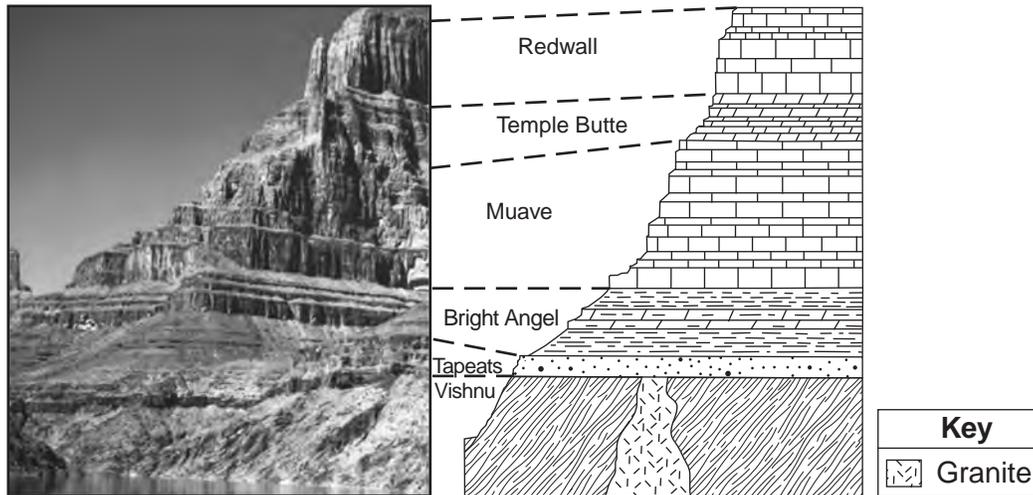
- (1) the Moon's rotation and Earth's rotation
- (2) the Moon's revolution and Earth's rotation
- (3) the Moon's rotation and the Sun's rotation
- (4) the Moon's revolution and the Sun's rotation

47 A solar eclipse might be observed from Earth when the Moon is at which position?

- (1) 1
- (2) 5
- (3) 3
- (4) 7

\_\_\_\_\_

Base your answers to questions 48 through 50 on the photograph and cross section below and on your knowledge of Earth science. The sequence of rock types found in the walls of the Grand Canyon are shown. The names of rock formations are shown and the upper and lower boundaries of each formation are indicated by dashed lines. The rock layers have *not* been overturned.



48 The granite formation was primarily formed by

- (1) metamorphism of layered sandstone
- (2) solidification of felsic magma
- (3) compaction of precipitated gypsum
- (4) cementation of clastic sediments

49 The sequence of rock layers in the cross section provides evidence that the Muave formation is

- (1) younger than the Temple Butte, but older than the Bright Angel
- (2) younger than both the Temple Butte and the Bright Angel
- (3) older than the Temple Butte, but younger than the Bright Angel
- (4) older than both the Temple Butte and the Bright Angel

50 If the Vishnu schist had been exposed to greater heat and pressure during metamorphism, it could have formed

- (1) gneiss
- (2) marble
- (3) quartzite
- (4) phyllite

## 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 53 on the passage below and on your knowledge of Earth science.

### Coral Reefs and Ocean Currents

The location of shallow-water coral reefs is controlled largely by warm-water temperatures, which originate in tropical regions and are then widely spread by ocean currents. Major surface ocean currents flow in circular patterns called gyres. Ocean current gyres flow in a clockwise direction in the Northern Hemisphere, and flow in a counterclockwise direction in the Southern Hemisphere. This pattern of circulation generally moves warm water from equatorial regions into the shallow waters along eastern continental coasts. This extends the range of coral reef growth approximately  $5^\circ$  of latitude beyond both the tropic of Cancer and the tropic of Capricorn.

51 Identify the surface ocean current that prevents the formation of coral reefs in the shallow waters along the western coast of South America. [1]

52 Which Earth motion causes the Coriolis effect that results in the curving of the planetary winds and surface ocean currents? [1]

53 Identify the *two* prevailing planetary wind belts that provide the greatest force in pushing the surface ocean currents of the North Pacific Ocean gyre. [1]

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Base your answers to questions 54 through 56 on the topographic map in your answer booklet and on your knowledge of Earth science. Some contour lines have been drawn. Line *AB* is a reference line on the map.

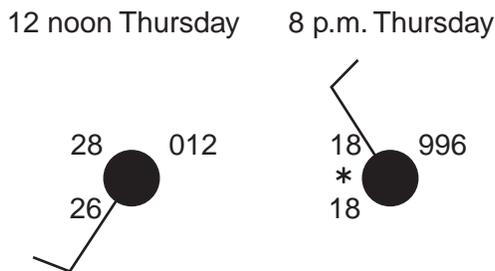
54 On the map *in your answer booklet*, draw the 60-meter and 70-meter contour lines. The contour lines should extend to the edges of the map. [1]

55 State a likely surface elevation of Pebble Lake. [1]

56 Calculate the gradient along the reference line from *A* to *B*, in meters per kilometer. [1]

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Base your responses to questions 57 through 60 on the station models below and on your knowledge of Earth science. The changing weather conditions at a location in New York State during a winter storm are recorded on the station models.



57 Complete the table *in your answer booklet* by recording the weather data shown on the station model for 12 noon Thursday. [1]

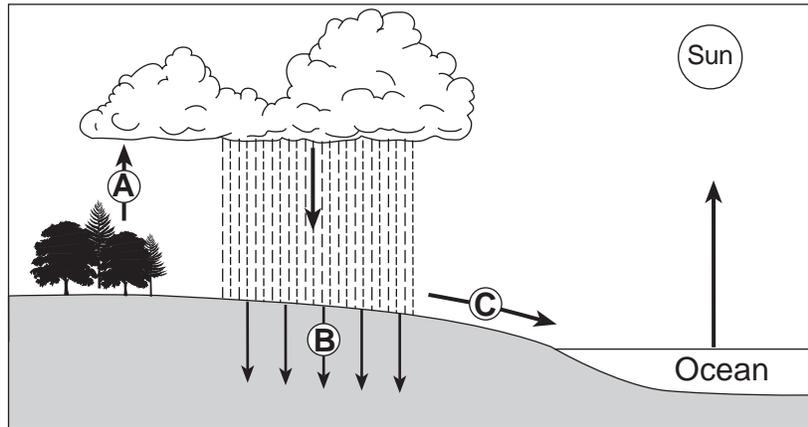
58 State the relative humidity at this location at 8 p.m. Thursday. [1]

59 From 12 noon Thursday until 8 p.m. Thursday, the total amount of snowfall was 12 inches. Calculate the snowfall rate, in inches per hour. [1]

60 As this storm approached, the National Weather Service issued a winter storm warning. Identify *two* items that should be included in emergency preparedness supplies for a winter storm. [1]

---

Base your responses to questions 61 through 64 on the diagram below and on your knowledge of Earth science. The diagram represents portions of the water cycle. Letters A, B, and C represent processes in the water cycle. Arrows show the movement of water.



61 Identify *one* process represented by A. [1]



62 Identify the process represented by B. [1]



63 Describe the general relationship between the amount of rainfall and the amount of runoff represented by C. [1]



64 What is the main source of energy for the water cycle? [1]



\_\_\_\_\_

65 Identify a process occurring in the plastic mantle that is inferred to cause tectonic plate motion. [1]



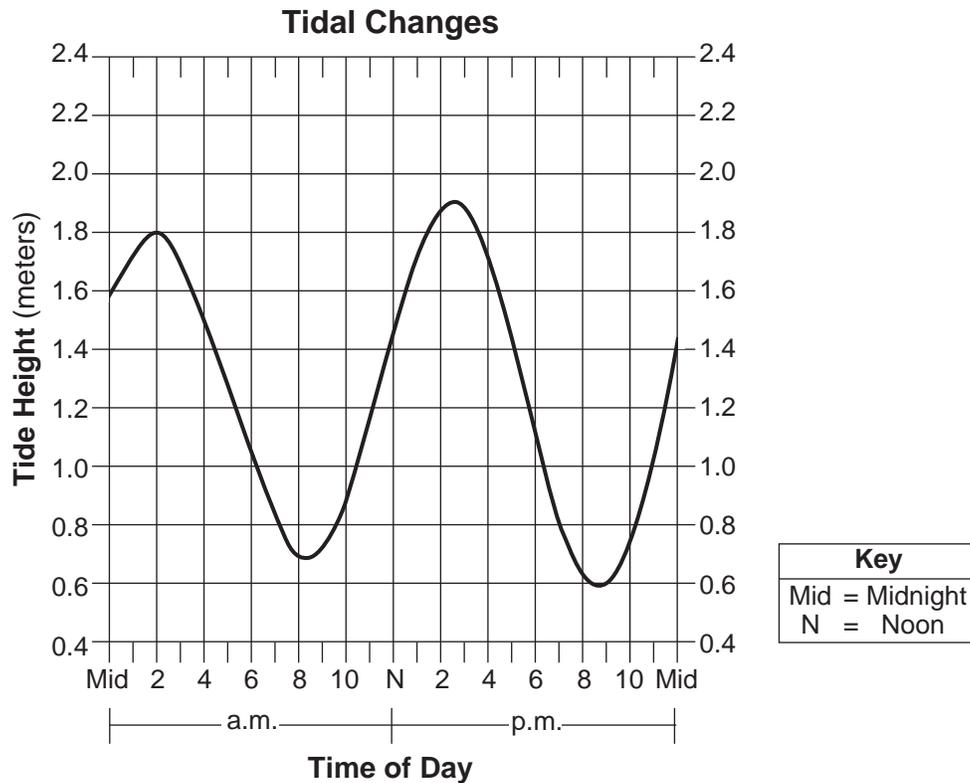
\_\_\_\_\_

### 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*.

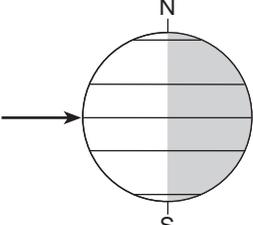
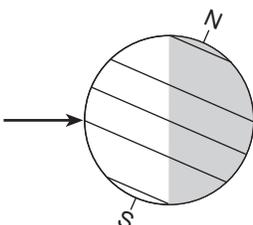
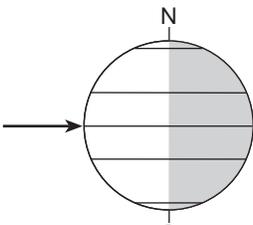
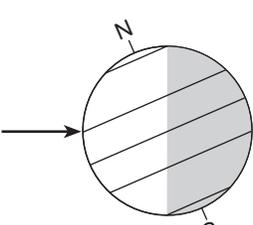
Base your answers to questions 66 and 67 on the graph below and on your knowledge of Earth science. The graph shows the changes in ocean tide height at a New York State location during 1 day.



66 Determine the tide height and time of day for the *lowest* tide shown on the graph. Include a.m. or p.m. in your answer for the time of day. [1]

67 Explain why the Moon has a greater influence on Earth tides than the Sun. [1]

Base your answers to questions 68 through 71 on the table below and on your knowledge of Earth science. The table provides information about sunlight received on four dates of a certain year. Letter A represents a date. The arrows indicate the Sun's direct rays.

Date	Position of Earth Relative to the Sun's Rays	Seasonal Event
Sept 23		Fall equinox: Equal day and night Sun on the horizon at poles Direct ray at equator
Dec 21		Winter solstice: Area north of Arctic Circle in constant darkness
A		Spring equinox: Equal day and night Sun on the horizon at poles Direct ray at equator
June 21		Summer solstice: Area south of Antarctic Circle in constant darkness Direct ray at 23.5° N

68 Identify *one* possible date represented by letter A. [1]



69 State the numerical latitude at which the Sun is directly overhead at noon on December 21. Include the units and compass direction in your answer. [1]



70 State the number of daylight hours occurring north of the Arctic Circle on June 21. [1]



71 Explain why the Sun's direct rays are at different latitudes as Earth revolves around the Sun. [1]

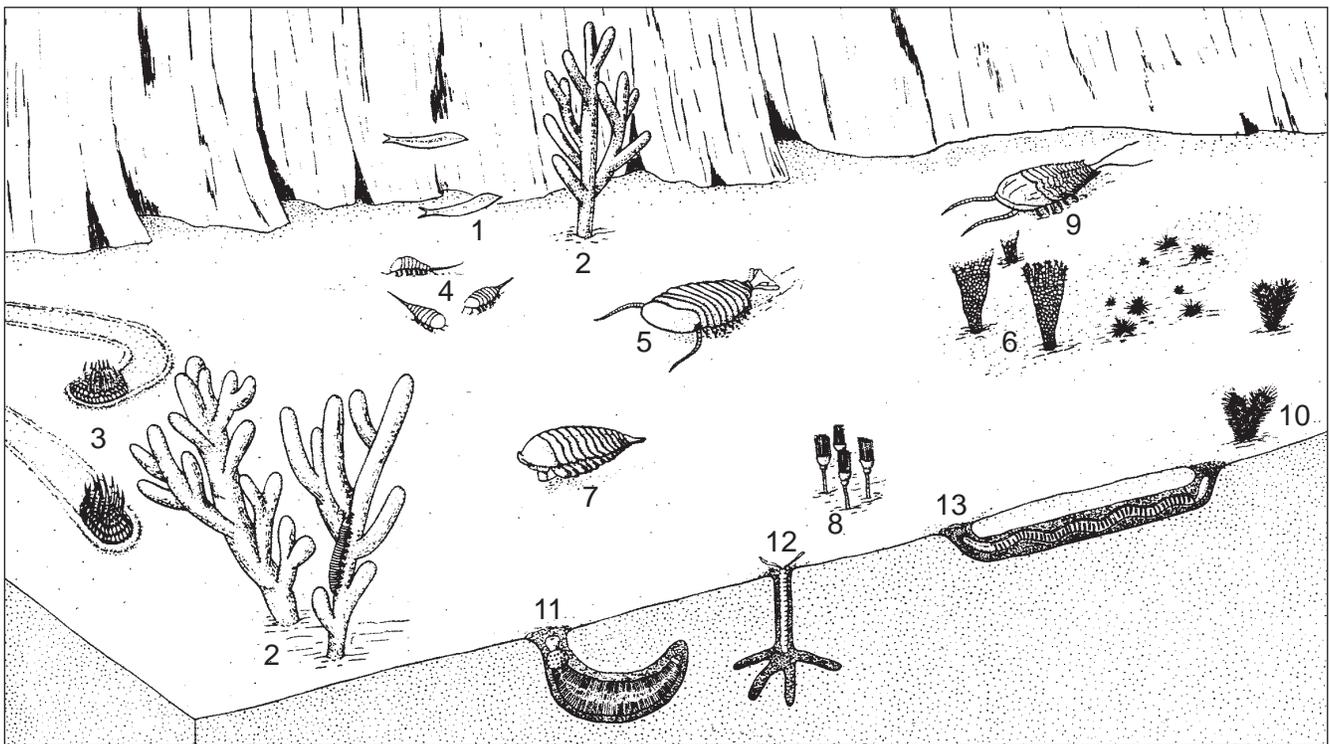



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Base your answers to questions 72 through 74 on the passage and diagram below and on your knowledge of Earth science. The diagram represents some of the Burgess shale community of organisms that existed together during part of the Cambrian Period. Thirteen different types of organisms are numbered in the diagram.

### Burgess Shale Fossils

The Burgess shale fossil discovery revealed unique Cambrian life-forms, most of which were not present in the previously known fossil record. Normally, soft body parts of dead organisms are destroyed by scavengers and bacteria on the ocean floor. However, in the deep-water depositional environment of the Burgess shale, oxygen was lacking and organisms were buried rapidly, preserving the unique community seen in the diagram. The soft-bodied organisms had previously been unknown. The Burgess shale fossils were originally found in a layer of bedrock in southwestern Canada.



Adapted from: Briggs, et al., *The Fossils of the Burgess Shale*, Smithsonian Institution Press, 1994

72 During which epoch of the Cambrian Period were the Burgess shale organisms and sediments deposited? [1]



73 Explain why so many soft body parts of organisms were preserved in the Burgess shale. [1]



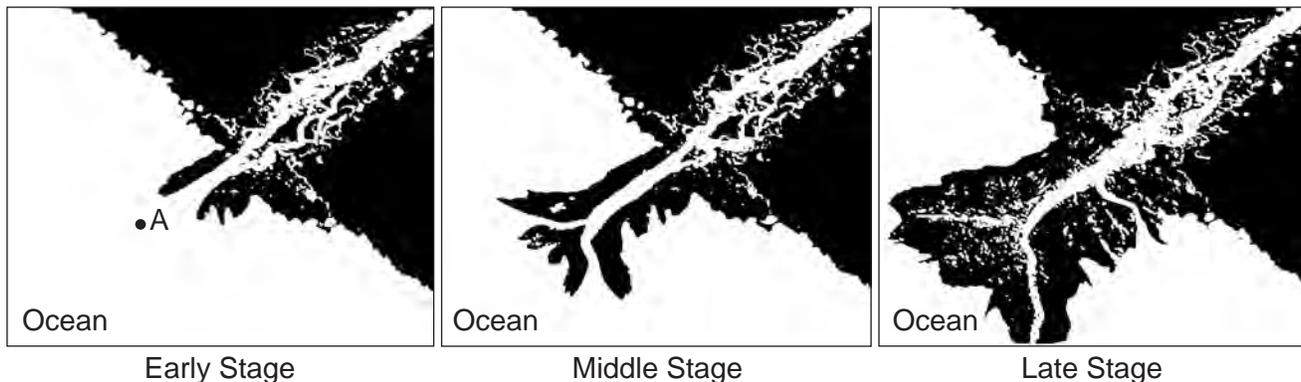
74 Identify the number of *one* organism in the diagram that is most likely a trilobite. [1]



\_\_\_\_\_

Base your answers to questions 75 through 78 on the three diagrams below and on your knowledge of Earth science. The diagrams represent stages in the formation of a large depositional feature formed as a river deposited sediment over time in the ocean. Letter A represents a location in the ocean.

### Formation of a River Depositional Feature



75 State the name of this large depositional feature forming in the ocean. [1]



76 Describe the arrangement of the sediments deposited where the river enters the ocean. [1]



77 Identify the largest particle diameter of sediment that can be carried by the water current at location A, if the water has a velocity of 0.05 cm/s. [1]



78 Large amounts of dissolved calcite were carried by the river into the ocean and precipitated onto the ocean floor. Identify the sedimentary rock composed only of calcite that most likely formed. [1]




---

Base your answers to questions 79 and 80 on the diagram in your answer booklet and on your knowledge of Earth science. The diagram represents the star patterns of the Big Dipper and the Little Dipper relative to Earth's horizon. Dashed vertical reference lines are shown for four of the stars. *Polaris* is labeled.

79 On the diagram *in your answer booklet*, place an **X** at a point on the horizon line to indicate due north. [1]



80 Record, to the *nearest whole degree*, the altitude of *Polaris* if these constellations were observed from Slide Mountain in New York State. [1]




---

Base your answers to questions 81 through 83 on the data table below, on the graph in your answer booklet, and on your knowledge of Earth science. The data table shows the velocity of seismic S-waves at various depths below Earth's surface. The graph shows the velocity of seismic P-waves at various depths below Earth's surface. Letter A is a point on the graph.

**Data Table**

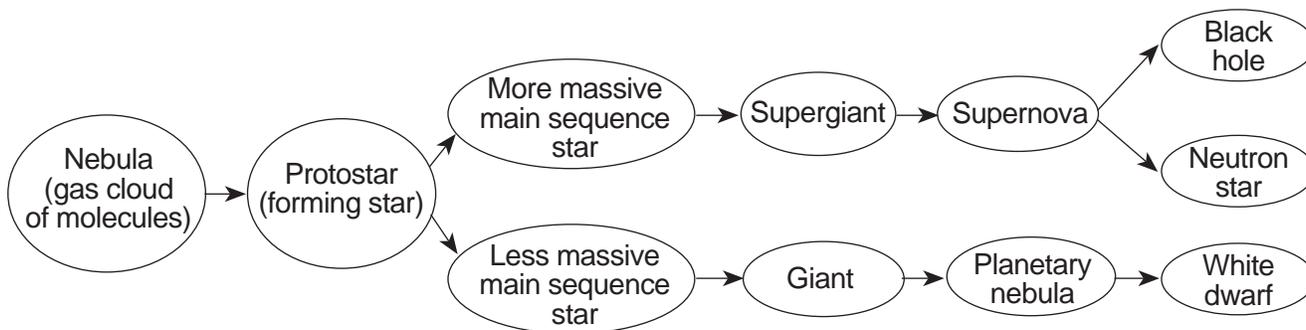
<b>Depth Below Surface (km)</b>	0	100	200	700	800	1800	2900
<b>S-Wave Velocity (km/s)</b>	2.8	4.5	4.2	5.3	6.2	7.0	7.4

81 On the graph in your answer booklet, plot the S-wave velocity at each depth given on the data table.  Connect the plots with a line. [1]

82 What property of Earth's interior causes the S-waves to stop at 2900 km, but allows the P-waves to continue?  [1]

83 State the pressure and temperature of Earth's interior at the depth indicated by point A on the graph.  \_\_\_\_\_ [1]

Base your answers to questions 84 and 85 on the flowchart below and on your knowledge of Earth science. The flowchart shows the evolution of stars.



84 Identify the force responsible for the contraction of a nebula (a gas cloud of molecules) to form a protostar.  [1]

85 Describe how the diameter and luminosity of a main sequence star change as the star becomes either a giant or a supergiant.  \_\_\_\_\_ [1]

**Part B–2**

**Allow a maximum of 15 credits for this part.**

**51** [1] Allow 1 credit for Peru Current.

**52** [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- rotation
- turning on its axis
- spinning

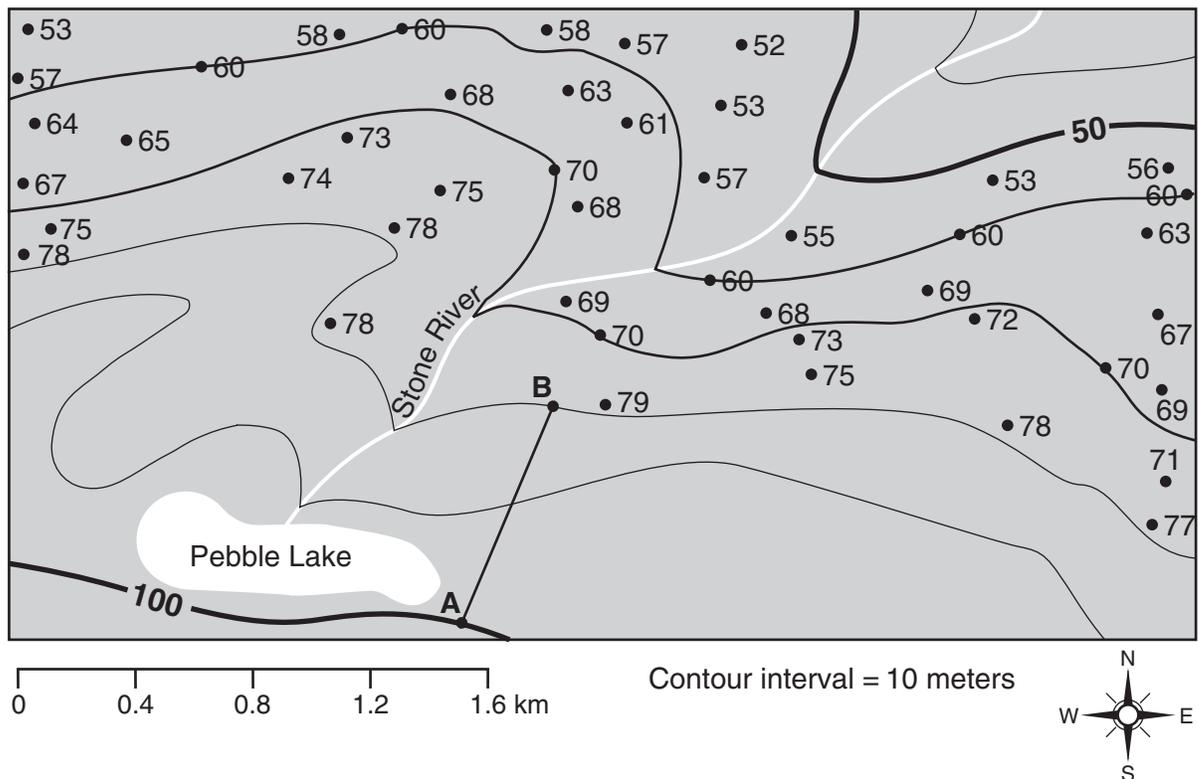
**53** [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- southwest winds and northeast winds
- NE winds and SW winds
- prevailing southwesterly winds and northeast trade winds

**54** [1] Allow 1 credit for correctly drawing *both* the 60-m and 70-m contour lines extended to the edges of the map.

**Note:** If additional contour lines are drawn, all must be drawn correctly to receive credit.

**Example of a 1-credit response:**



55 [1] Allow 1 credit for any value greater than 90 m, but less than 100 m.

56 [1] Allow 1 credit for any value from 22 m/km to 29 m/km.

57 [1] Allow 1 credit if *all three* weather variables for 12 noon Thursday are correctly recorded.

Time and Day	Actual Barometric Pressure (mb)	Cloud Cover (%)	Wind Direction From the
12 noon Thursday	1001.2	100	SW or SSW

58 [1] Allow 1 credit for 100%.

59 [1] Allow 1 credit for 1.5 in/h or  $1\frac{1}{2}$  in/h.

**Note:** Do *not* allow credit for  $\frac{12}{8}$  or  $\frac{3}{2}$  in/h because these do not show a complete calculation.

60 [1] Allow 1 credit for *two* acceptable items. Acceptable responses include, but are not limited to:

- first aid kit
- blankets
- batteries
- radio
- flashlight
- bottled water
- food
- generator
- necessary medications

**61** [1] Allow 1 credit for transpiration *or* evaporation/vaporization *or* evapotranspiration.

**62** [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- infiltration
- water seeping into the ground
- absorption/recharge of the storage
- seeping/seepage/percolation
- water entering/soaking/sinking into the soil

**Note:** Do *not* allow credit for:

“precipitation” (The arrows are underground.)

“saturation” (It is not a process.)

“drainage” (Drainage can also be surface runoff.)

**63** [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- As precipitation/rainfall increases, runoff increases.
- More rain leads to more runoff.
- direct relationship
- Runoff is usually less than rainfall.

**64** [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- the Sun
- insolation
- solar radiation/solar energy
- sunlight

**65** [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- convection
- convective circulation
- slab pull
- subduction
- convection currents
- magma rising

## Part C

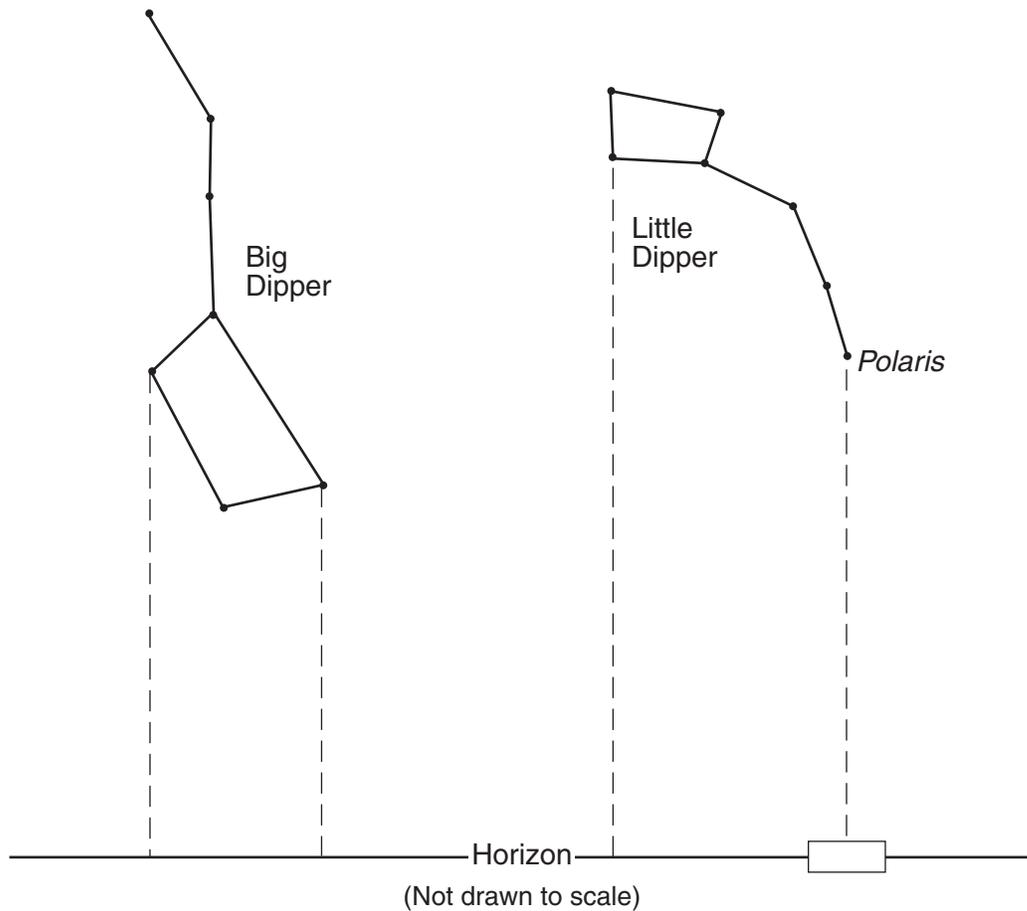
- 66** [1] Allow 1 credit if *both* the tide height and time of day, including p.m., are correct.  
Tide height: any value from 0.58 m to 0.6 m.  
Time: any value from 8:30 p.m. to 9:00 p.m.
- 67** [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- The Moon is closer to Earth.
  - The Moon’s gravitational pull is stronger because the Moon is closer to Earth than the Sun is.
- Note:** Do *not* allow credit for “The Moon’s gravity is stronger” alone because the Moon’s distance from Earth is not described.
- 68** [1] Allow 1 credit for the correct month and day of March 19 *or* March 20 *or* March 21 *or* March 22.
- 69** [1] Allow 1 credit for any value from 23.4° S to 23.5° S. The acceptable unit and compass direction must be included.
- Note:** Allow credit if the student indicates a fraction, such as  $23\frac{1}{2}^{\circ}$  or minute form, such as 23° 30’ S, for the decimal value.
- 70** [1] Allow 1 credit for 24 h.
- 71** [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- Earth’s axis is tilted 23.5 degrees from a line perpendicular to the plane of Earth’s orbit.
  - axis is tilted
  - Earth’s axis is always parallel to itself at any other place in Earth’s orbit.
  - parallelism of Earth’s axis
  - Earth’s axis is always aligned with the North Star (*Polaris*) as Earth orbits the Sun.

- 72** [1] Allow 1 credit for Middle Cambrian Epoch.
- 73** [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- They were rapidly buried by sediment deposition.
  - Oxygen was lacking.
  - It was a deep-water environment.
- 74** [1] Allow 1 credit for 4, 5, 7, *or* 9.
- 75** [1] Allow 1 credit for delta *or* any specific type of delta.
- 76** [1] Allow 1 credit. Acceptable responses include, but are not limited to:
- Larger particles are deposited in shallow water and smaller particles are carried farther from the shore.
  - horizontal sorting/biggest to smallest
  - boulders, pebbles, sand, silt, clay/decreasing order of sizes
  - The sediment is sorted.
  - The sediment is arranged in beds or layers/vertically sorted.
  - Higher-density particles are deposited first.
- 77** [1] Allow 1 credit for any value from 0.0008 cm to 0.001 cm.
- 78** [1] Allow 1 credit for limestone.

79 [1] Allow 1 credit if the center of the student's **X** is located within or touches the clear rectangle.

**Note:** Allow credit if a symbol other than an **X** is used.

It is recommended that an overlay of the same scale as the student answer booklet be used to ensure reliability in rating.

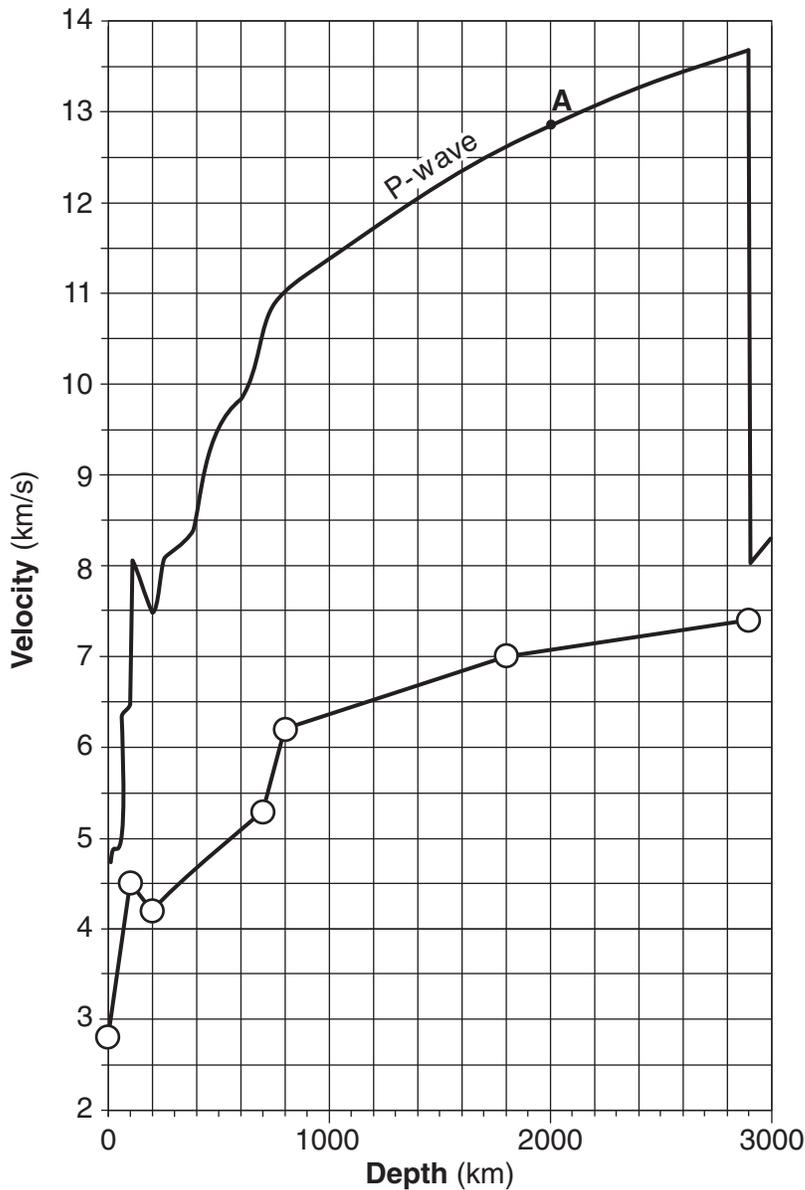


80 [1] Allow 1 credit for 42°.

81 [1] Allow 1 credit if the centers of *all seven* student plots are within or touch the circles shown below and are correctly connected with a line that passes within or touches the circles.

**Note:** Allow credit even if the student extends the line beyond 2900 km.

It is recommended that an overlay of the same scale as the student answer booklet be used to ensure reliability in rating.



82 [1] Allow 1 credit. Acceptable responses include, but are not limited to:

- The outer core is a liquid.
- The interior temperature of Earth is above the melting point.
- The outer core absorbs S-waves.
- S-waves cannot travel through a liquid.
- They can not travel through a fluid.

**83** [1] Allow 1 credit if *both* responses are correct.

Pressure: any value from 0.7 million atmospheres to 0.9 million atmospheres.

Interior temperature: any value from 4100°C to 4300°C.

**84** [1] Allow 1 credit. Acceptable responses include, but are not limited to:

— gravity

— gravitational attraction

**85** [1] Allow 1 credit if *both* responses are correct. Acceptable responses include, but are not limited to:

Diameter:

— increases

— becomes larger

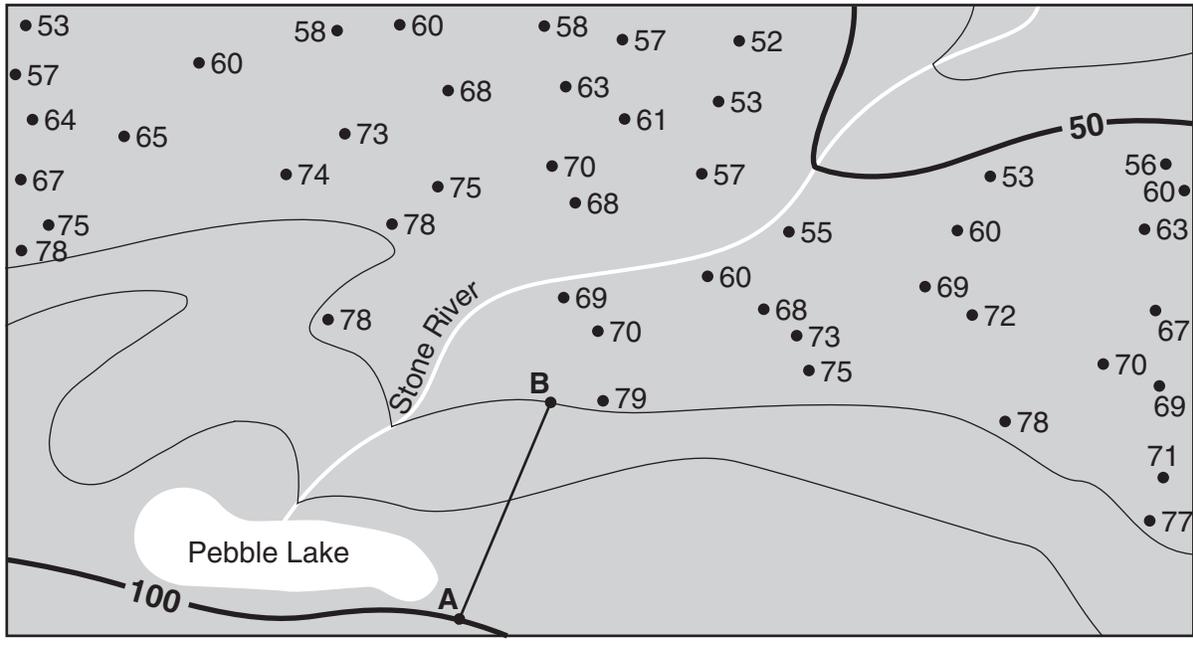
Luminosity:

— increases

— higher rate of energy emission

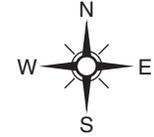
— The star appears brighter.

54



0 0.4 0.8 1.2 1.6 km

Contour interval = 10 meters



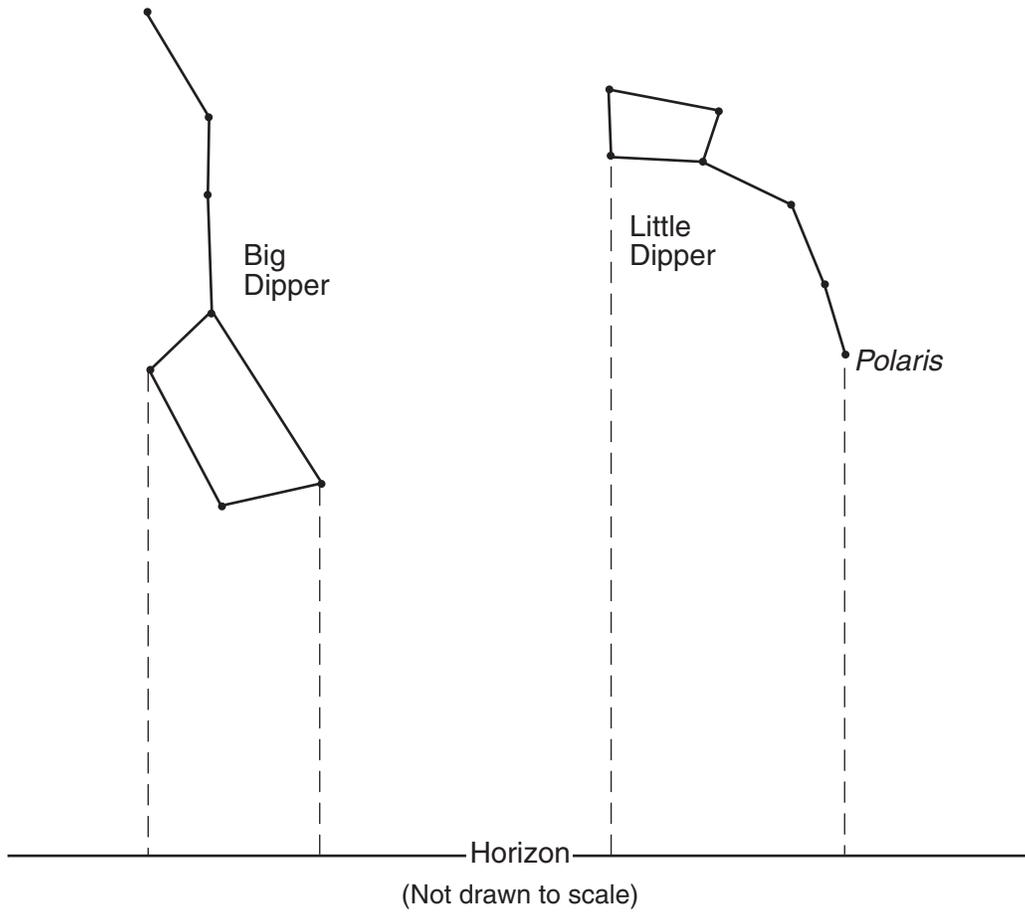
55 \_\_\_\_\_ m

56 Gradient = \_\_\_\_\_ m/km

57

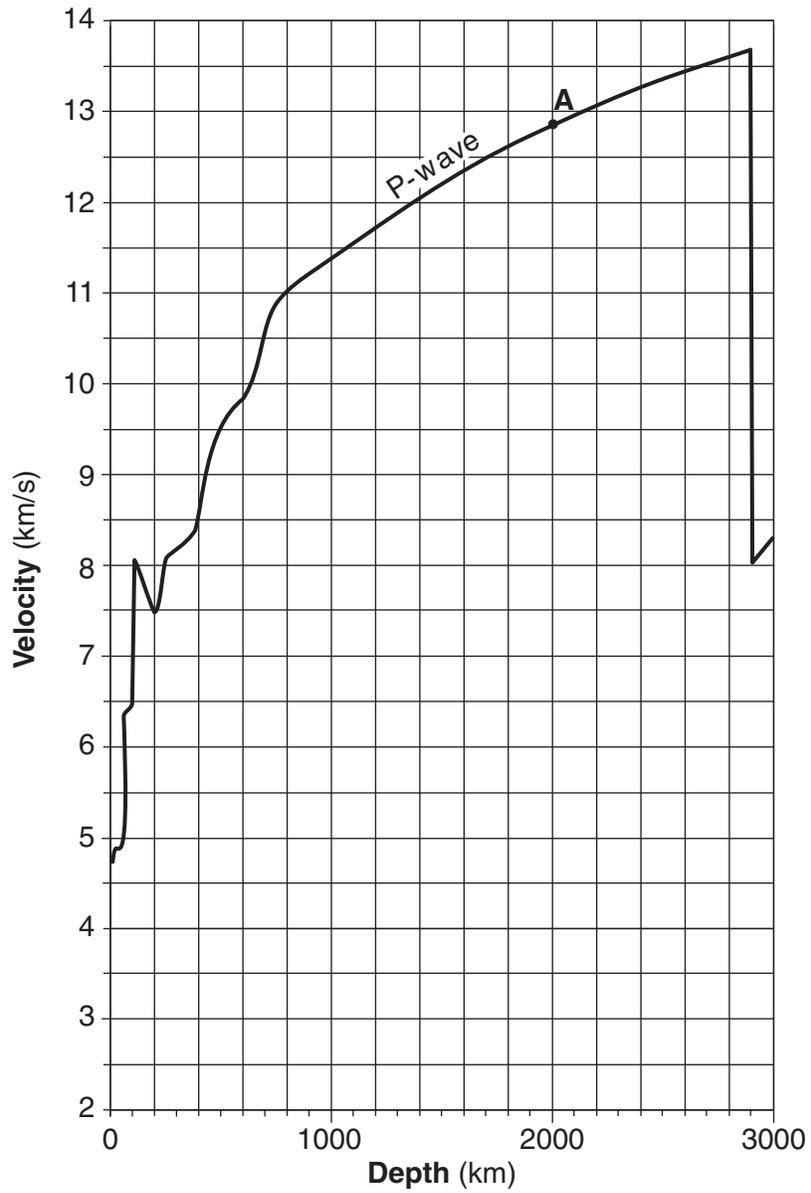
Time and Day	Actual Barometric Pressure (mb)	Cloud Cover (%)	Wind Direction From the
12 noon Thursday			

79



80 \_\_\_\_\_ °

81



82 \_\_\_\_\_

83 Pressure: \_\_\_\_\_ million atmospheres

Interior temperature: \_\_\_\_\_ °C