Large-Type Edition

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING

EARTH SCIENCE

Thursday, June 20, 2024 — 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.

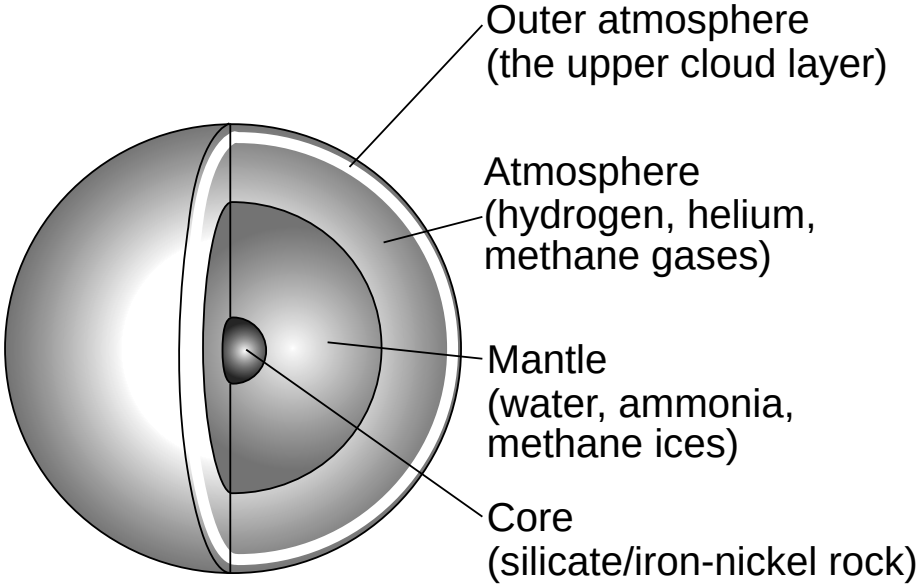
DO NOT START THIS EXAMINATION UNTIL THE SIGNAL IS GIVEN.

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 diagrams below represent the atmosphere and inferred interior structure of the planet Uranus.



Which two factors caused the inferred layered structure of this planet in our solar system?

(1) gravity and eccentricity of the orbit
(2) gravity and density differences of materials
(3) period of rotation at equator and eccentricity of the orbit
(4) period of rotation at equator and density differences of materials

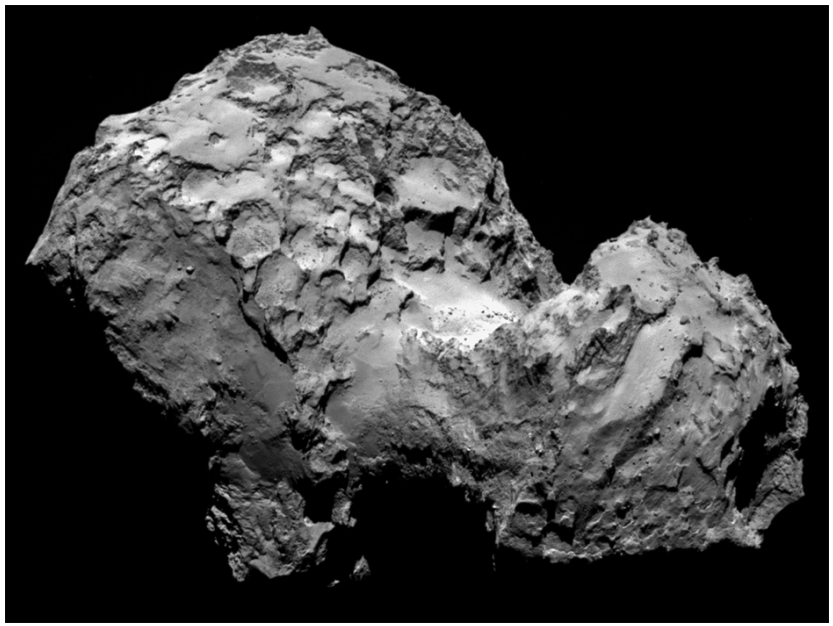
2 Which process occurring in the Sun produces energy by converting lighter hydrogen into heavier helium?

(1) radiation
(2) conduction
(3) radioactive decay
(4) nuclear fusion

3 Compared to the sizes and periods of revolution of the terrestrial planets, the Jovian planets have

(1) smaller sizes and shorter periods of revolution
(2) smaller sizes and longer periods of revolution
(3) larger sizes and shorter periods of revolution
(4) larger sizes and longer periods of revolution

4 The photograph below shows a dust-covered, icy object that has a highly elliptical orbit in our solar system.



This celestial object is most likely a

(1) comet that leaves a trail of particles in space
(2) meteor that leaves a trail of light across the sky
(3) moon that revolves around a planet
(4) planet that revolves around the Sun

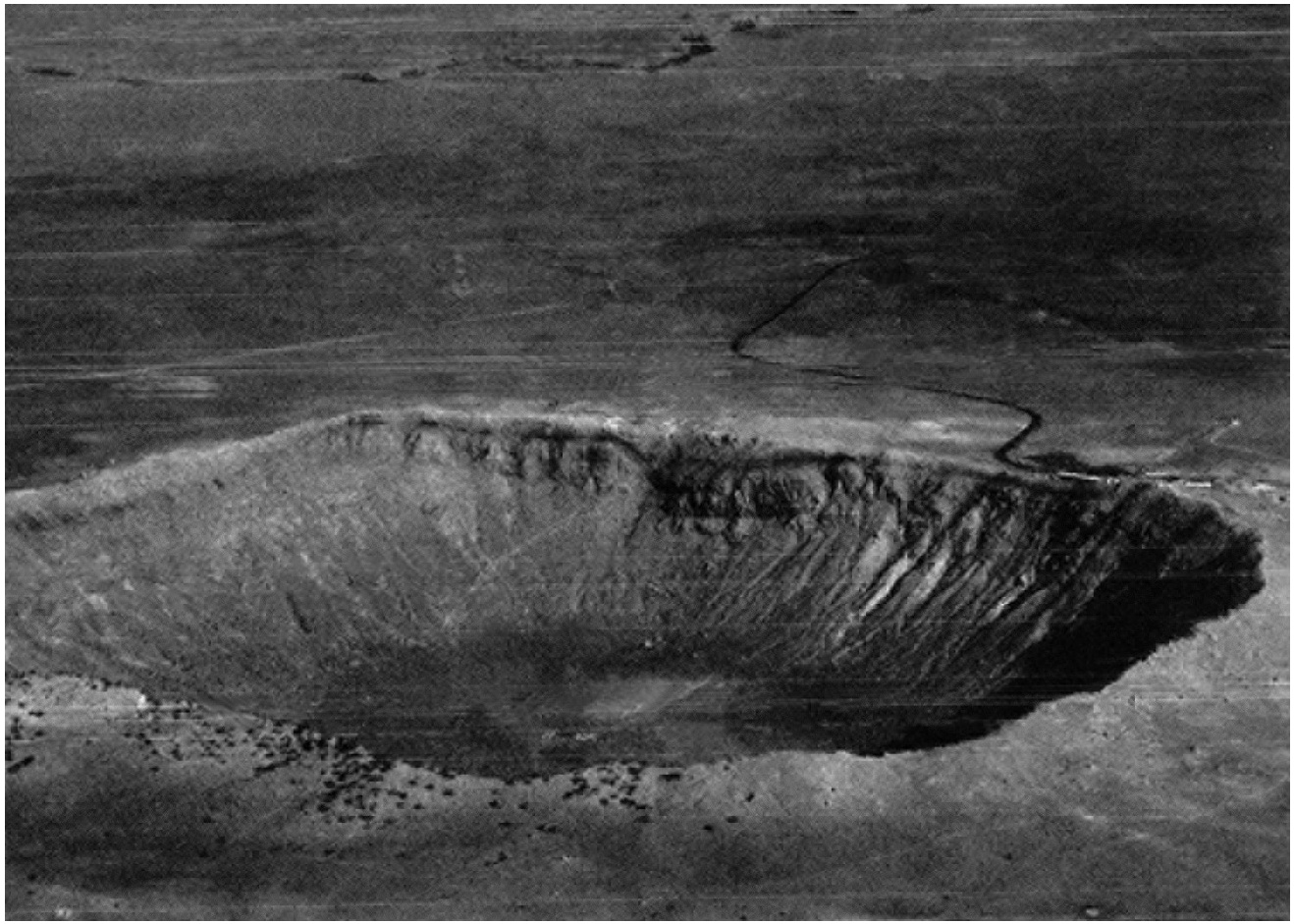
5 At which location will the Sun appear to pass directly overhead for an observer?

(1) northern Asia
(2) northern Australia
(3) southern Greenland
(4) southern Antarctica

6 The hydrosphere covers approximately

(1) 70% of Earth's atmosphere
(2) 70% of Earth's lithosphere
(3) 85% of Earth's atmosphere
(4) 85% of Earth's lithosphere

7 The photograph below shows a one-mile diameter feature on Earth's surface.



What is this feature, and how was it formed?

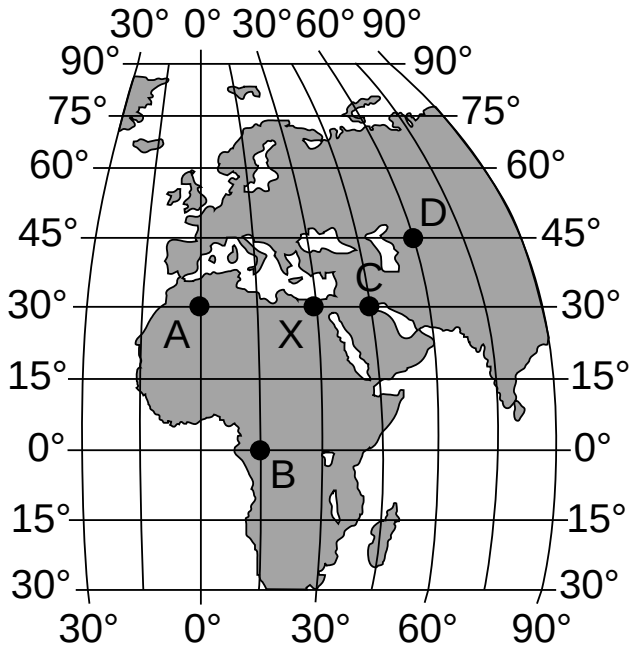
(1) dry kettle lake, formed from an impact event
(2) dry kettle lake, formed from a retreating glacier
(3) crater, formed from an impact event
(4) crater, formed from a retreating glacier

8 The time-lapse photograph below shows stars as they appear to move around the central star Polaris.

Polaris does *not* appear to move in the nighttime sky because Polaris is located

(1) in our solar system
(2) in our galaxy
(3) above Earth's axis of rotation
(4) above Earth's equator

9 The map below shows five locations, labeled *A*, *B*, *C*, *D*, and *X*, on Earth's surface. Solar noon is occurring at location *X*.



At which location is the time 2:00 p.m.?

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

10 Approximately how many degrees per day does Earth move in its orbit around the Sun?

(1) 1°/day
(2) 15°/day
(3) 24°/day
(4) 360°/day

11 Which motion explains why some constellations appear in the night sky only during specific seasons?

(1) The Sun revolves around Earth.
(2) Earth revolves around the Sun.
(3) Constellations revolve around Earth.
(4) Constellations revolve around the Sun.

12 What is the relative humidity when the air temperature is 20°C and the wet-bulb temperature is 11°C?

(1) 9%
(2) 2%
(3) 17%
(4) 30%

13 Earth's early atmosphere consisted of carbon dioxide, water vapor, hydrogen, and nitrogen. During this time in Earth's history, the first crust formed and was made of igneous rock. Based on this information, how did Earth's early atmosphere most likely form?

(1) outgassing from volcanic eruptions
(2) radioactive decay of igneous rock
(3) release of gases from plant life
(4) evaporation of ocean water

14 The subtropical jet streams are located in Earth's

(1) lower troposphere near 30° N and 30° S
(2) upper troposphere near 30° N and 30° S
(3) lower troposphere near 60° N and 60° S
(4) upper troposphere near 60° N and 60° S

15 The transfer of heat energy in the oceans due to density differences is best described as

(1) conduction
(2) convection
(3) radiation
(4) insolation

16 Which list of Earth materials indicates an increasing order in the amount of energy needed to raise the temperatures of equal masses of the materials by 1°C?

(1) copper, iron, basalt
(2) basalt, iron, granite
(3) iron, copper, lead
(4) lead, basalt, granite

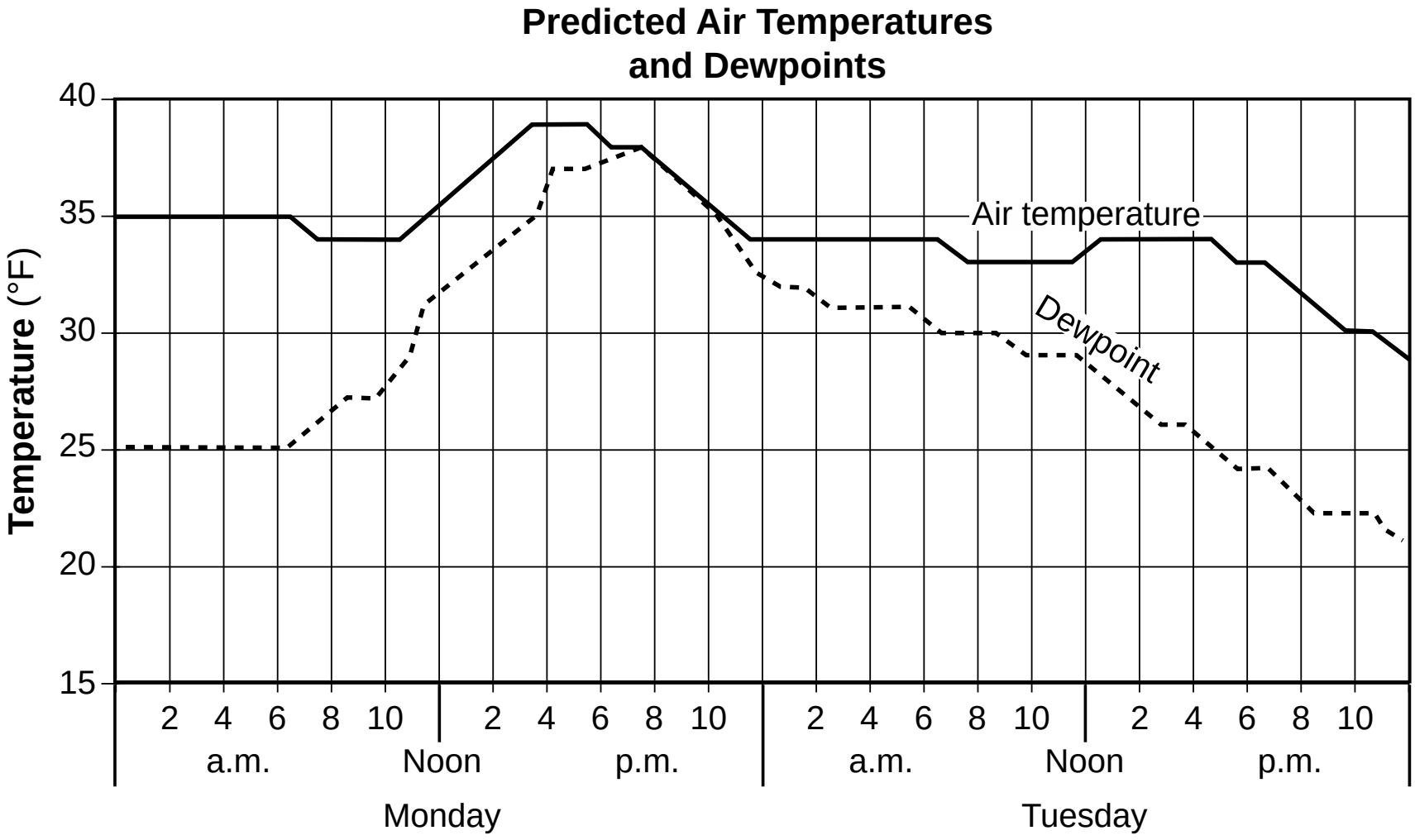
17 Which color and texture of surfaces with equal areas will have the *least* temperature increase when heated by the Sun?

(1) light color and smooth texture
(2) light color and rough texture
(3) dark color and smooth texture
(4) dark color and rough texture

18 Over the last 200 years, global warming is inferred to be primarily caused by

(1) strong El Niño conditions
(2) retreating glaciers
(3) an increase in greenhouse gases
(4) an increase in sea level

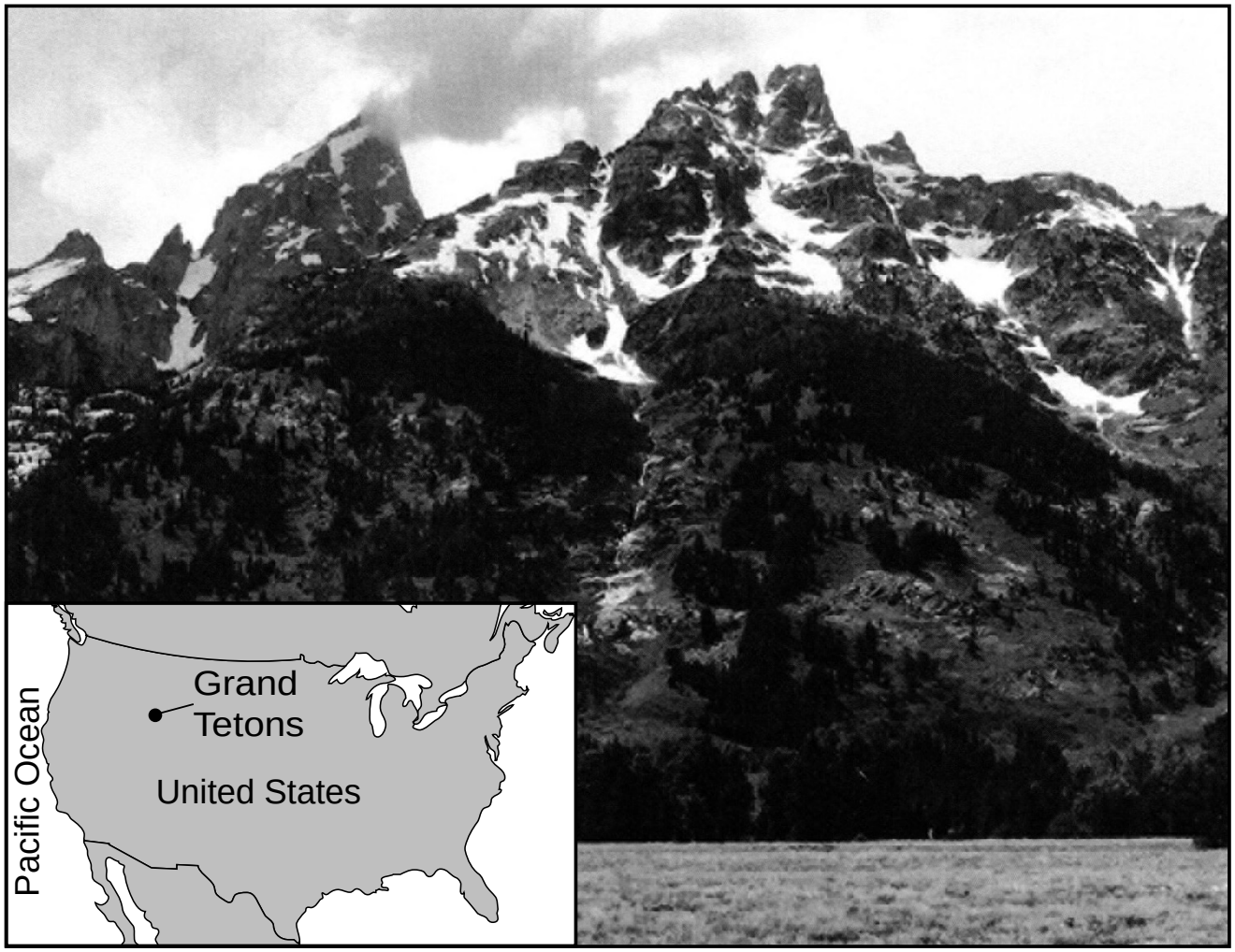
19 The graph below shows predicted air temperatures and dewpoints for a New York State location during a two-day period.



What is the day and time when precipitation will most likely occur at this location?

(1) Monday at 6:00 a.m.
(2) Monday at 8:00 p.m.
(3) Tuesday at 8:00 a.m.
(4) Tuesday at 6:00 p.m.

20 The photograph below shows a portion of the Grand Teton Mountains on a mid-July day. The inset map of the United States shows the location of the Grand Tetons.



Which factor is responsible for the snow seen on these mountains in July?

(1) elevation
(2) longitude
(3) latitude
(4) steep slopes

21 Which percentage of the radioactive potassium-40 in a sample will have decayed in 2.6×10^9 years?

(1) 25%
(2) 50%
(3) 75%
(4) 100%

22 Based on Earth's geologic history, which group of organisms has existed for the *shortest* amount of time?

(1) grasses
(2) dinosaurs
(3) birds
(4) humans

23 Oxygen first became a major part of Earth's atmosphere from the

(1) rifting in the Iapetus ocean
(2) life processes of cyanobacteria in the ocean
(3) extensive coal-forming forests
(4) breakdown of ozone by ultraviolet radiation

24 The letter *X* on the map below shows the location of the present state of Florida on the early continent of North America.

The region that is now Florida is inferred to have been positioned on the equator approximately

(1) 59 million years ago
(2) 119 million years ago
(3) 232 million years ago
(4) 458 million years ago

25 The division of geologic time into eras, periods, and epochs is based upon the

(1) appearance and extinction of life forms
(2) occurrences of widespread volcanic eruptions
(3) reversals in Earth's magnetic field
(4) major mountain-building events

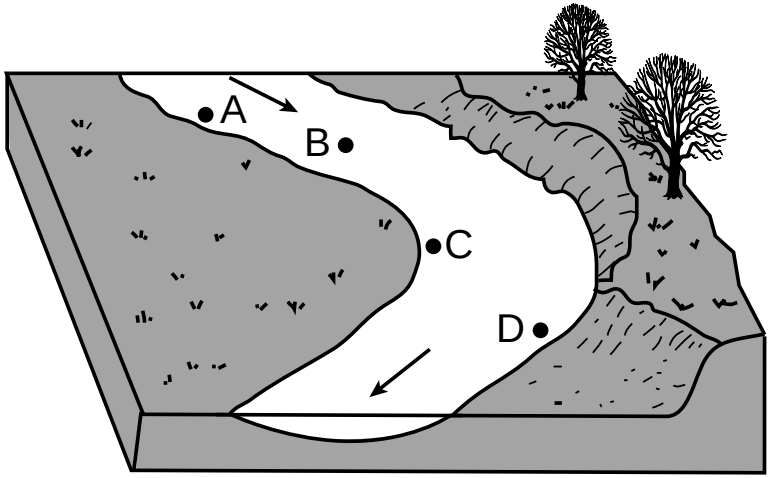
26 The first *P*-wave from an earthquake was recorded at 10:20:00 a.m. at a seismic station located 2200 km from the earthquake epicenter. At what time did the *S*-wave arrive?

(1) 10:12:00 a.m.
(2) 10:16:30 a.m.
(3) 10:23:30 a.m.
(4) 10:27:50 a.m.

27 Which two hot spots are located at plate boundaries?

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

28 The block diagram below shows a portion of a meandering stream. Points *A*, *B*, *C*, and *D* are locations on the streambed. The arrows show the direction of stream flow.



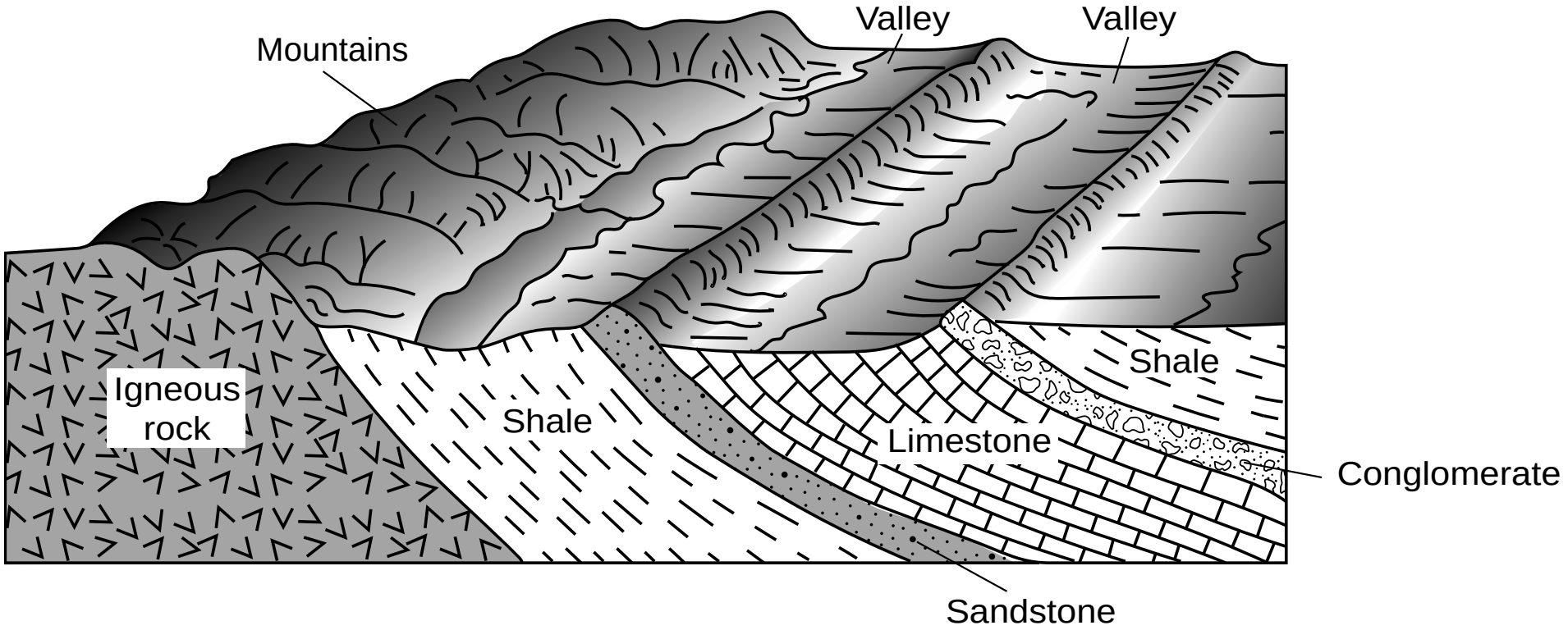
At which location is the greatest amount of deposition most likely occurring?

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

29 Instruments that record seismic waves on Mars allow scientists to infer the

(1) gravitational forces between Mars and its two moons
(2) percentage of minerals in the crust of Mars
(3) availability of surface water on Mars
(4) internal structure of Mars

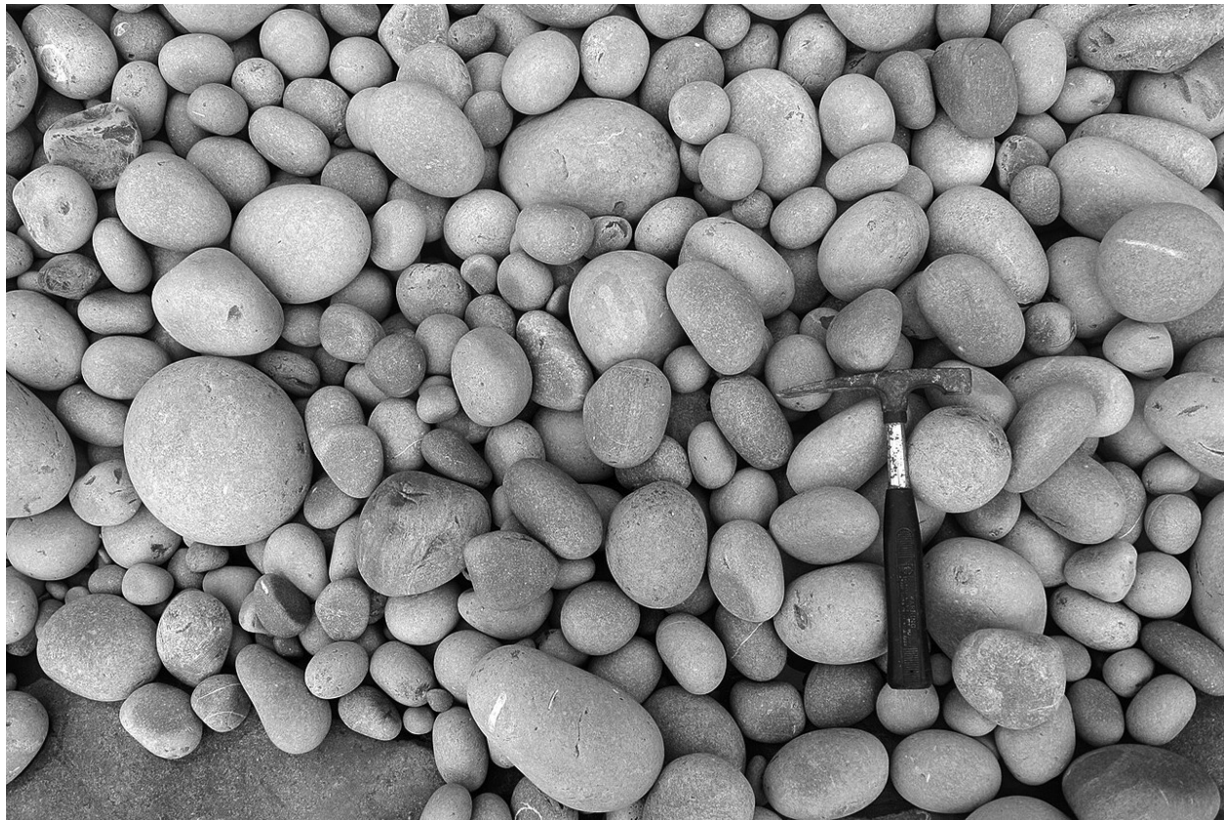
30 The block diagram below represents a landscape with two valleys.



The two valleys most likely formed because the shale and limestone bedrock

(1) are less resistant to weathering than the igneous, sandstone, and conglomerate bedrock
(2) are more resistant to weathering than the igneous, sandstone, and conglomerate bedrock
(3) have undergone shorter periods of weathering than the igneous, sandstone, and conglomerate bedrock
(4) have undergone longer periods of weathering than the igneous, sandstone, and conglomerate bedrock

31 The photograph below shows rocks found in England.

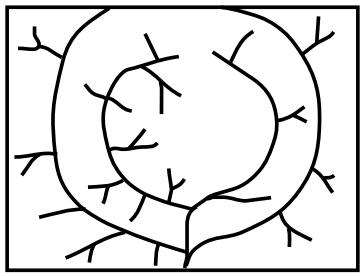


Which process most likely caused these rocks to become smooth and round over time?

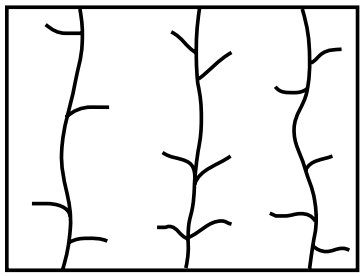
(1) abrasion in moving water
(2) dragging by a glacier
(3) sandblasting by wind
(4) downward movement by gravity

32 The photograph below shows a volcanic mountain.

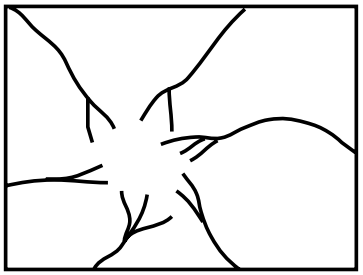
Which map best shows the most likely complete stream drainage pattern near the summit (top) of this mountain at the time of this photograph?



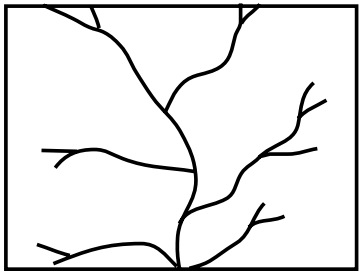
(1)



(2)

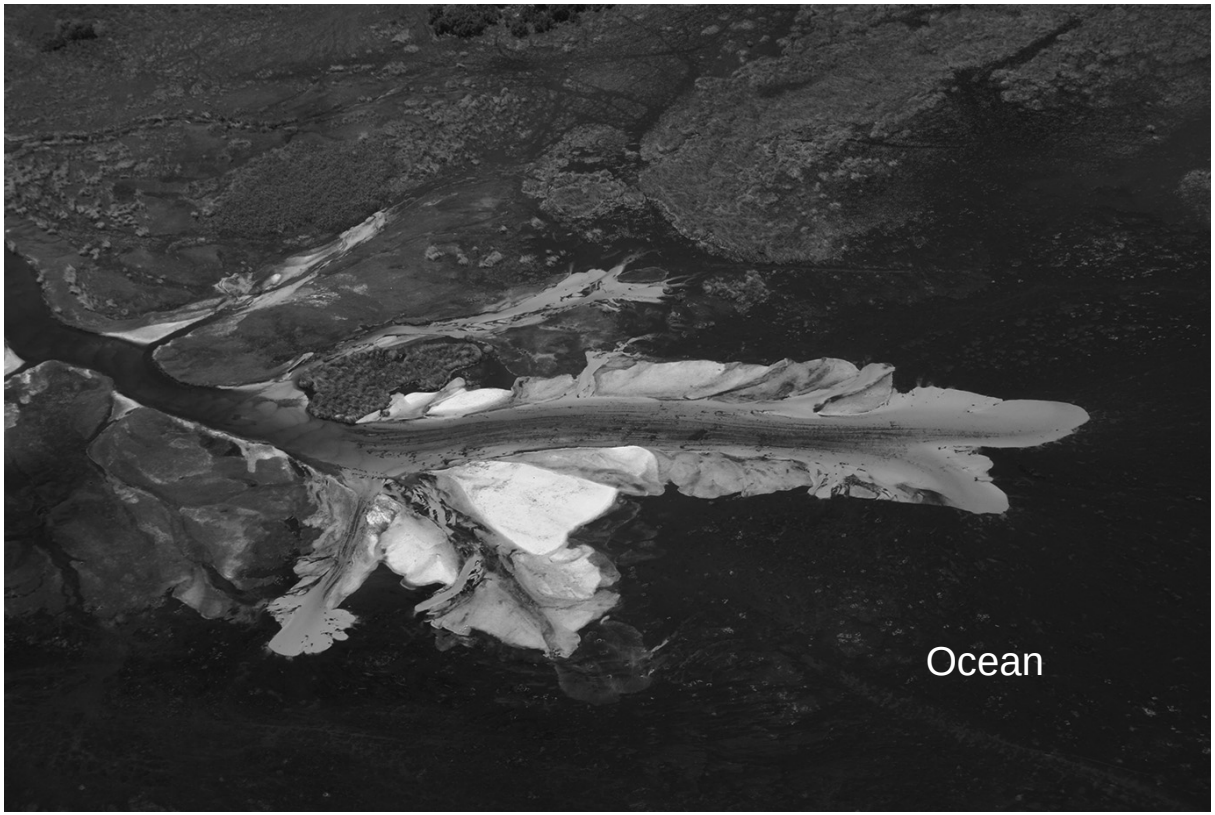


(3)



(4)

33 The aerial photograph below shows a landscape feature.



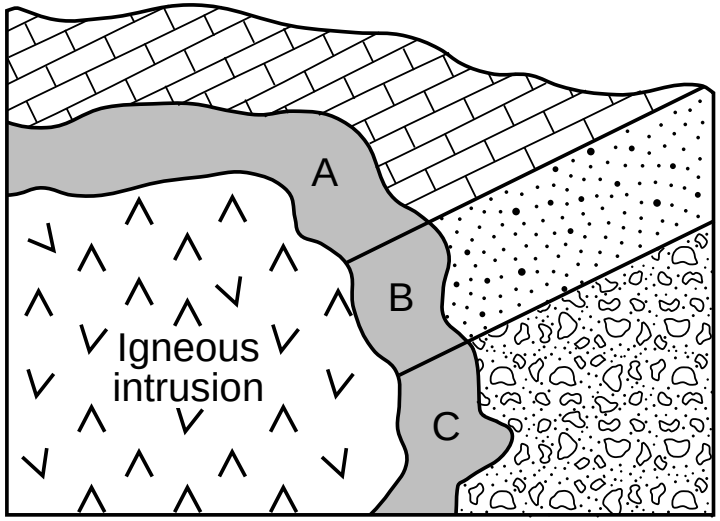
This landscape feature is a

(1) landslide formed by mass movement
(2) landslide formed by stream deposition
(3) delta formed by mass movement
(4) delta formed by stream deposition

34 What is the name and texture of a sedimentary rock composed of carbon?

(1) shale with a clastic texture
(2) shale with a bioclastic texture
(3) bituminous coal with a clastic texture
(4) bituminous coal with a bioclastic texture

35 The cross section below represents an igneous intrusion into sedimentary bedrock layers. Letters *A*, *B*, and *C* identify different rocks within the shaded zone of contact metamorphism.



Which metamorphic rocks are most likely formed in zones *A*, *B*, and *C*?

(1) *A* = marble, *B* = gneiss, *C* = schist
(2) *A* = marble, *B* = quartzite, *C* = metaconglomerate
(3) *A* = metaconglomerate, *B* = quartzite, *C* = marble
(4) *A* = metaconglomerate, *B* = schist, *C* = gneiss

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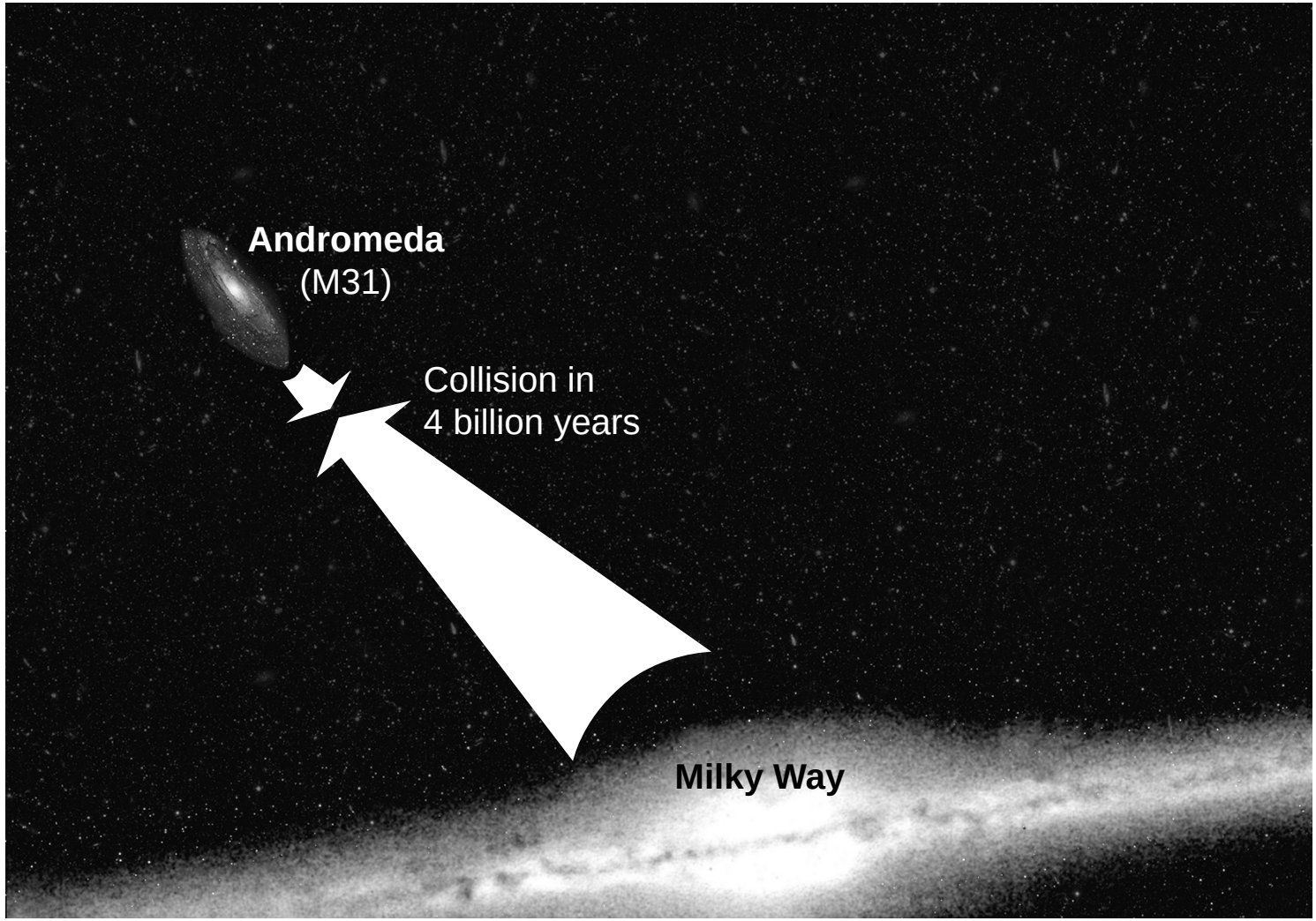
Part B–1

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 and 37 on the diagram on the next page and on your knowledge of Earth science. The diagram represents the predicted collision between the Milky Way and its sister galaxy, Andromeda. The collision is predicted to begin in about four billion years. It will take an additional two billion years to completely merge these two galaxies into one galaxy.

Collision Scenario for the Milky Way and Andromeda Galaxies



36 The gravitational force pulling the galaxies together is influenced by the

(1) mass of the stars and amount of cosmic background radiation
(2) mass of all the stars and the distance between the two galaxies
(3) ages of the stars and amount of cosmic background radiation
(4) ages of the stars and the distance between the two galaxies

37 The Andromeda Galaxy has a shape that is similar to the Milky Way Galaxy. The shape of the Andromeda Galaxy is best described as

(1) elliptical and is the only other galaxy in the universe
(2) elliptical and is one of the billions of other galaxies in the universe
(3) spiral and is the only other galaxy in the universe
(4) spiral and is one of billions of other galaxies in the universe

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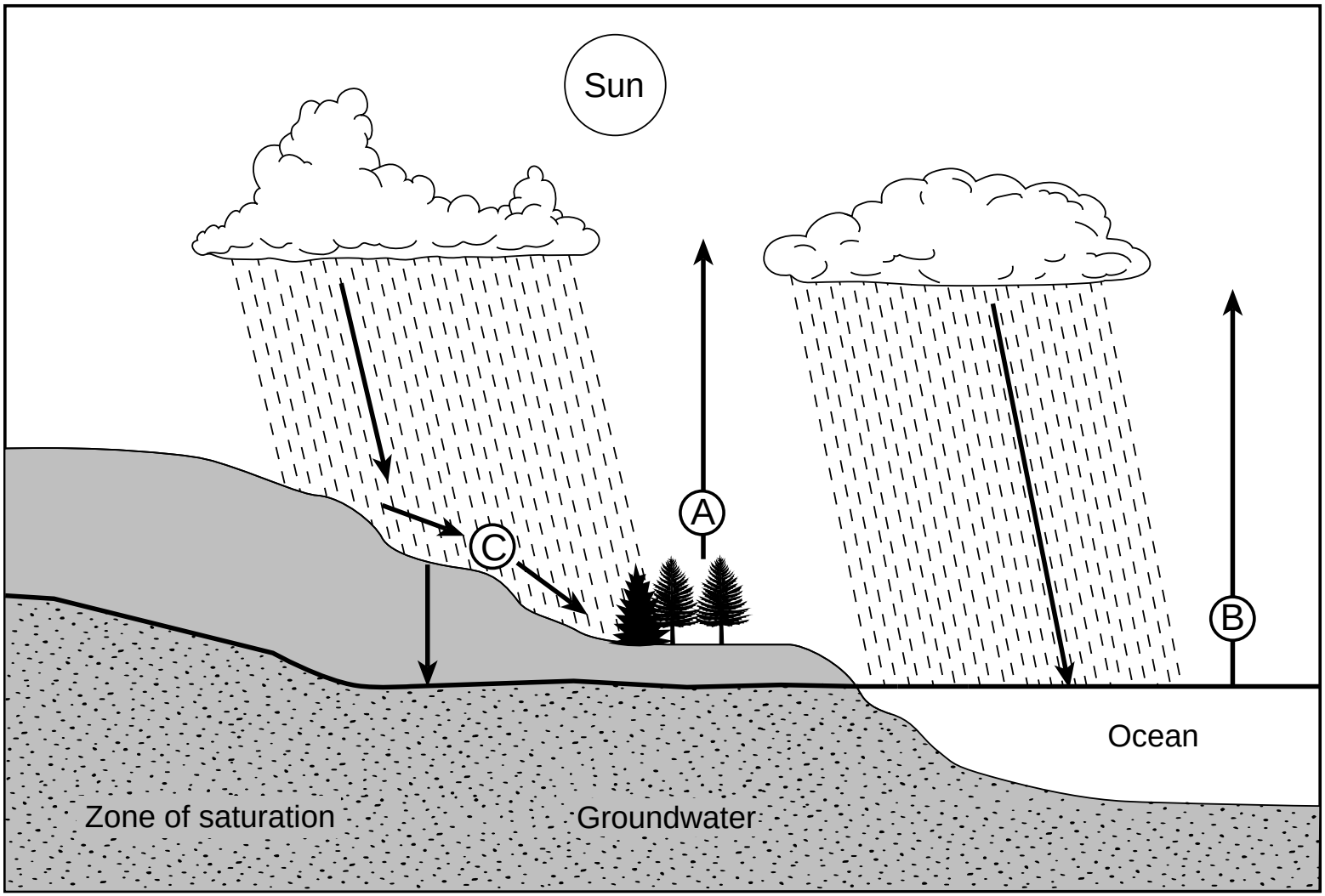
Base your answers to questions 38 through 40 on the diagram below and on your knowledge of Earth science. The diagram represents the water cycle. Letters *A* through *C* identify some processes. Arrows represent the movement of water.

The Water Cycle



38 Which process is represented by letter *A*?

(1) transpiration
(2) capillarity
(3) infiltration
(4) precipitation

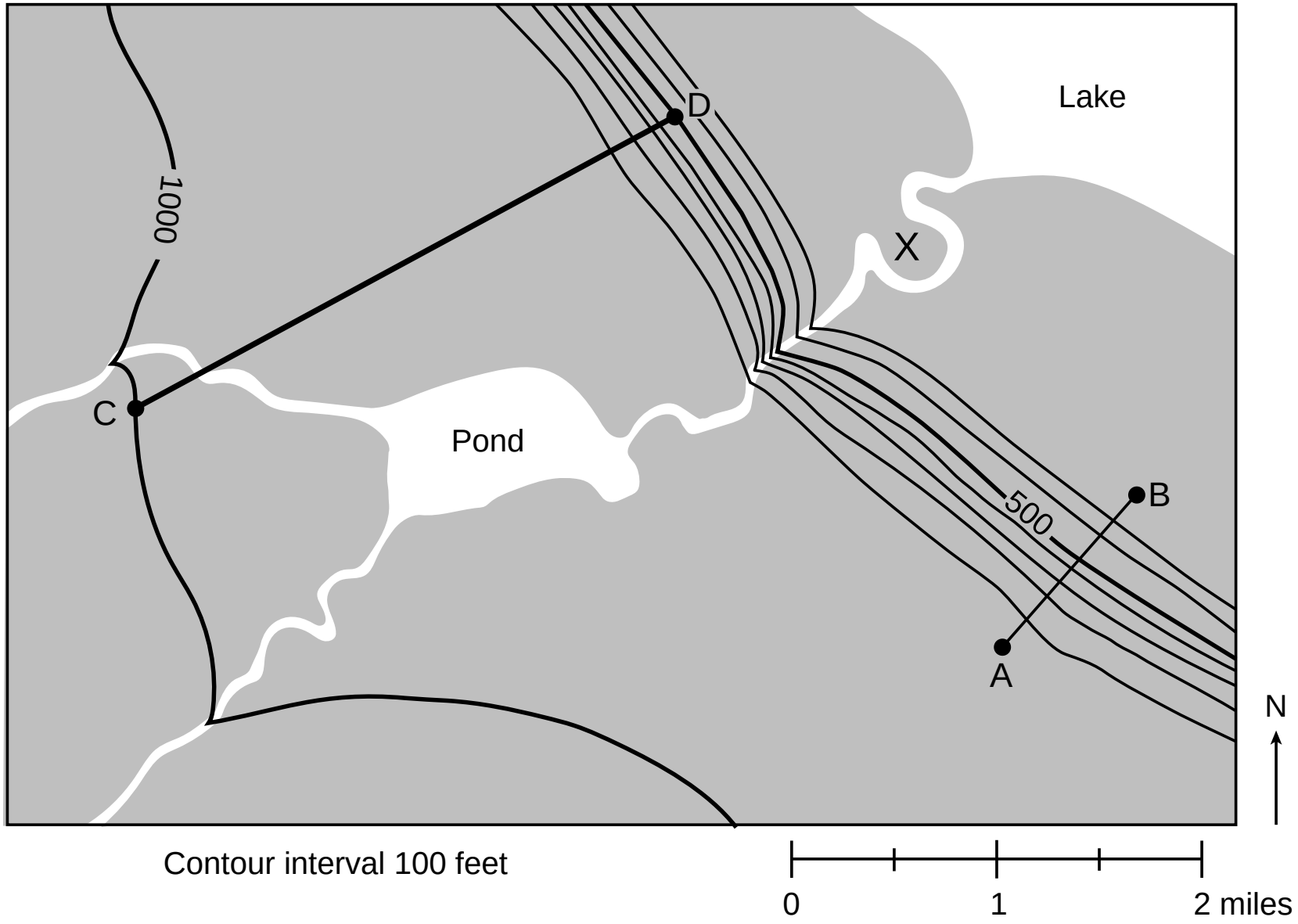
39 Which process and heat-energy exchange are represented by letter *B*?

(1) condensation; gain of 334 J/g
(2) condensation; release of 2260 J/g
(3) evaporation; gain of 2260 J/g
(4) evaporation; release of 334 J/g

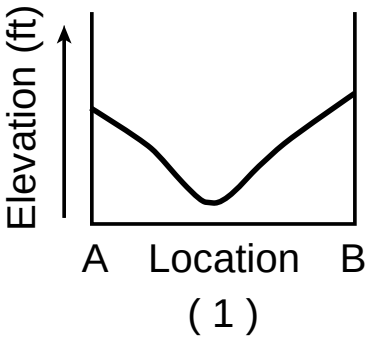
40 Which conditions would cause runoff at location *C* to *decrease*?

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

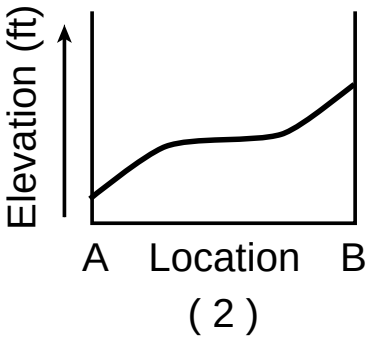
Base your answers to questions 41 through 44 on the topographic map below and on your knowledge of Earth science. Lines *AB* and *CD* are reference lines on the map. Elevations are shown in feet. Letter *X* represents a location on Earth's surface.



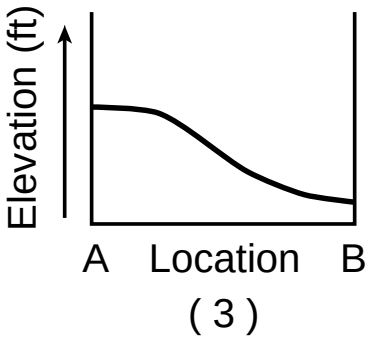
41 Which profile represents the most likely shape of the land between locations *A* and *B*?



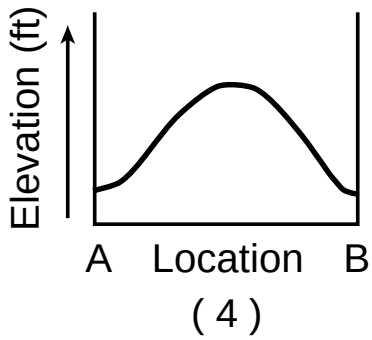
(1)



(2)



(3)



(4)

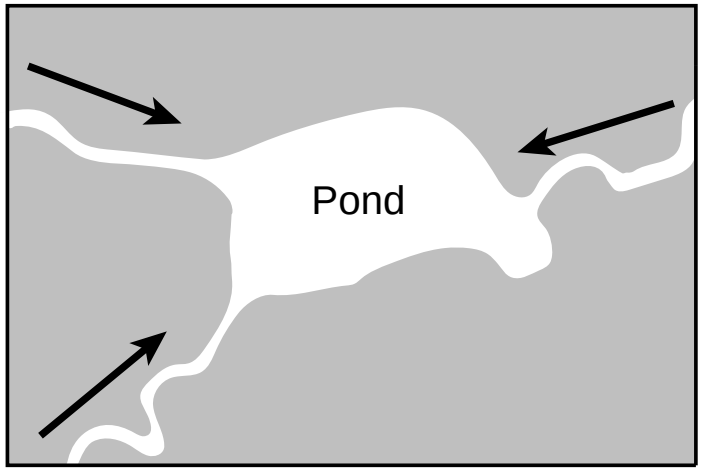
42 What is the approximate gradient, in feet per mile (ft/mi), from point *C* to point *D* on the map?

(1) 133 ft/mi
(2) 167 ft/mi
(3) 250 ft/mi
(4) 500 ft/mi

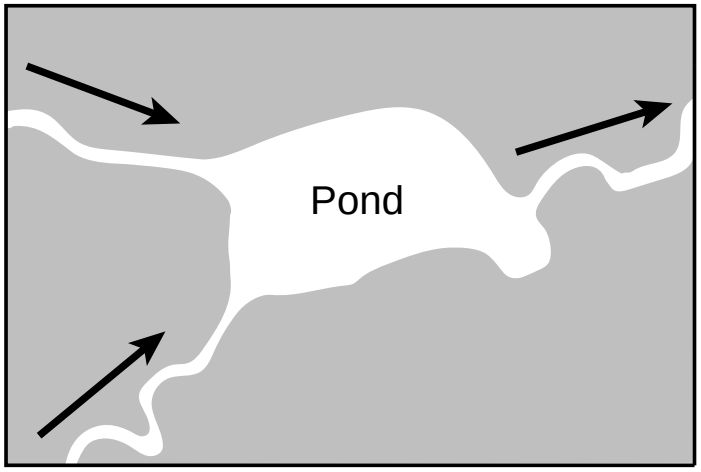
43 Letter *X* is located on which landscape feature?

(1) sandbar
(2) sand dune
(3) escarpment
(4) flood plain

44 The arrows on which map best represent the direction of stream flow relative to the pond?



(1)



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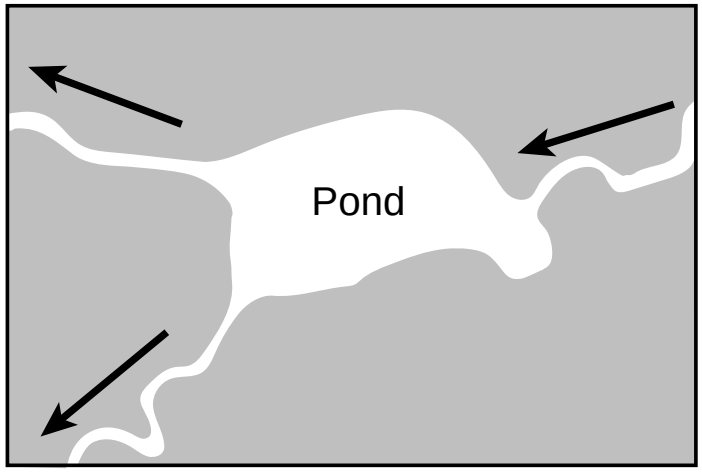

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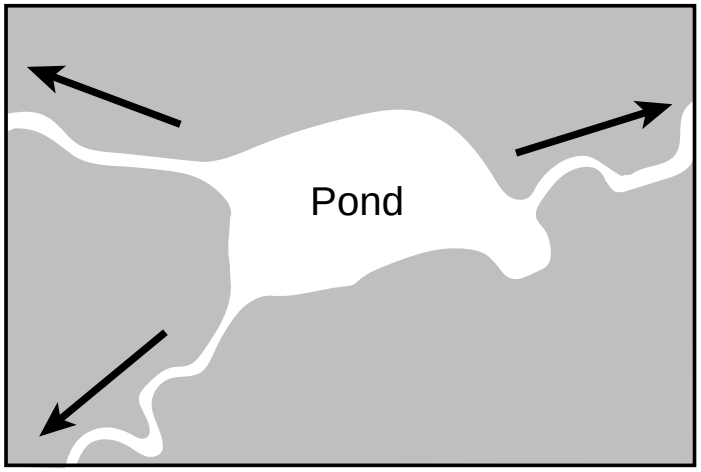

(4)

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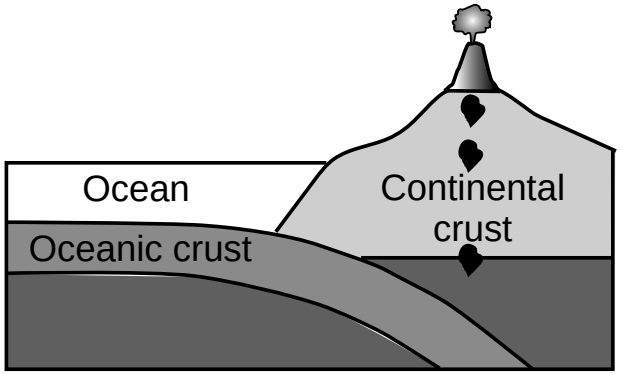
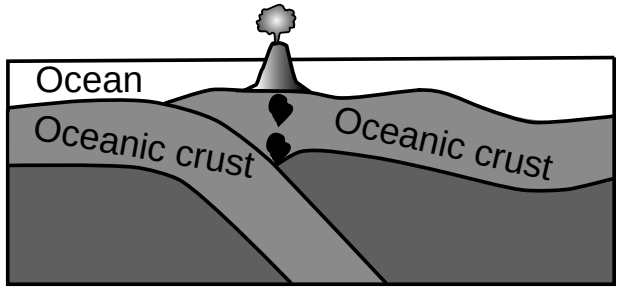
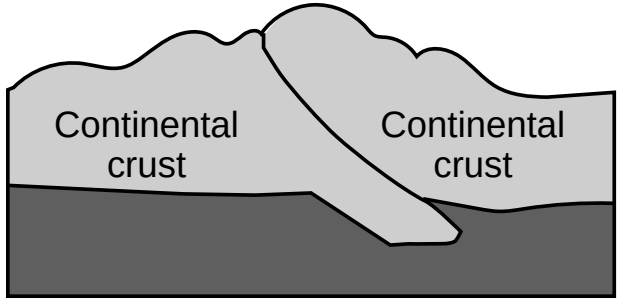
Base your answers to questions 45 through 47 on the cross sections below and on your knowledge of Earth science. The cross sections represent three plate boundaries labeled *A*, *B*, and *C*.



(A)



(B)

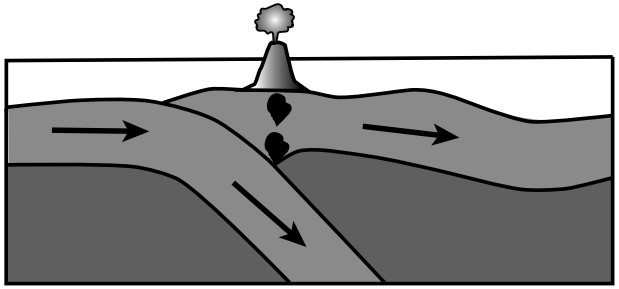


(C)

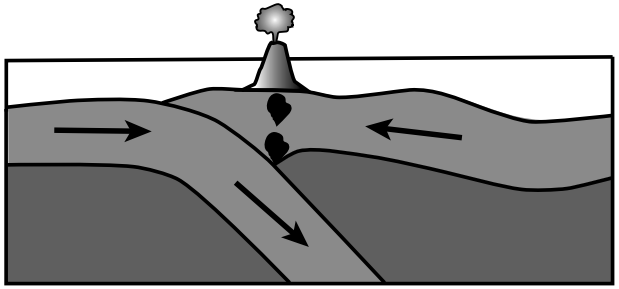
45 Compared to the density and thickness of the continental crust in diagram *A*, the oceanic crust is

(1) less dense and thinner
(2) less dense and thicker
(3) more dense and thinner
(4) more dense and thicker

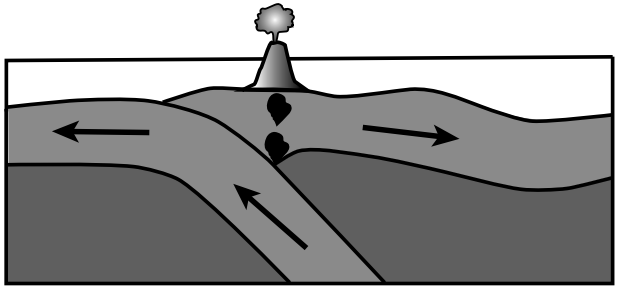
46 Which diagram best represents the relative motion of the oceanic crust at plate boundary *B*?



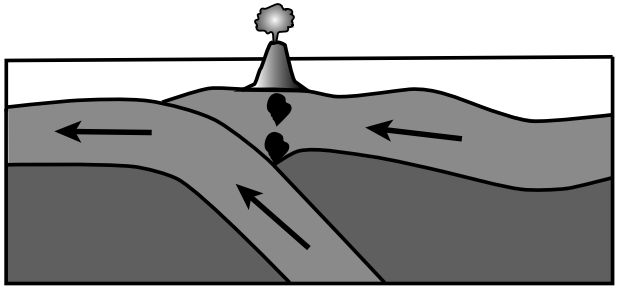
(1)



(3)



(2)



(4)

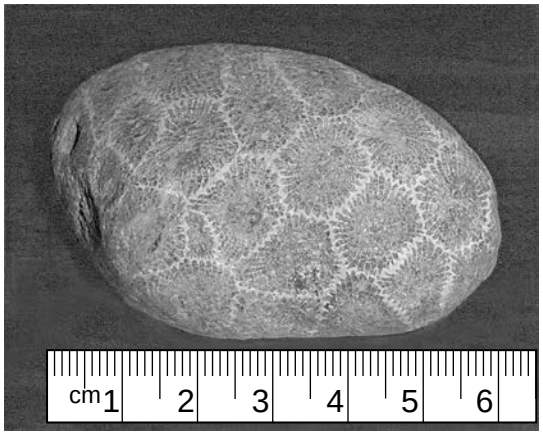
47 Which geologic surface feature is created at plate boundary *C*?

(1) ocean trench
(2) rift valley
(3) volcanic mountain
(4) folded mountain

Base your answers to questions 48 through 50 on the passage and photograph on the next page and on your knowledge of Earth science. The photograph shows a typical Petoskey stone.

Petoskey Stones

Petoskey stones are famous rock specimens found on beaches all around Lake Michigan, but especially on beaches near the city of Petoskey, Michigan. The stones are actually well-eroded pieces of coral reefs that were alive between 375 and 400 million years ago. At the time the coral animals were living and forming the reefs, the area was underwater and the coral, along with many other reef animals, thrived. Eventually, the ocean disappeared and the fossil reefs were uncovered. Advancing and retreating glaciers broke pieces off the fossil reefs, smoothed their edges, and distributed them throughout the area. Lake Michigan, along with the other Great Lakes, formed at the end of the Ice Age. Today, lake waves continue to distribute a seemingly endless supply of Petoskey stones, with their unique coral fossils, to the beaches around Lake Michigan.



(Actual size)

48 The coral that eventually became Petoskey stones were alive during which geologic time period?

(1) Permian
(2) Devonian
(3) Silurian
(4) Ordovician

49 Which New York State index fossil is in the same group of organisms as the Petoskey stone coral?

(1) *Lichenaria*
(2) *Platyceras*
(3) *Bothriolepis*
(4) *Cooksonia*

50 The Petoskey stone shown in the photograph is classified as a

(1) sand
(2) pebble
(3) cobble
(4) boulder

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 weather map in your answer booklet and on your knowledge of Earth science. The weather map shows air pressures in millibars (mb) at locations on and around the Florida Peninsula during Hurricane Wilma. Five isobars are shown.

51 On the map *in your answer booklet*, draw the 1000 mb and 1004 mb isobars. Extend the isobars to the edges of the map. [1]

52 Convert the air pressure of the lowest value isobar shown on the map from millibars to inches of mercury. [1]

53 Identify the weather instrument used to measure air pressure. [1]

54 Write the two-letter weather map symbol for the type of air mass in which this hurricane formed. [1]

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Base your answers to questions 55 through 57 on the passage and data table below and on your knowledge of Earth science. The data table shows garnet coefficients and rock formation temperatures.

Using Garnet as a Geothermometer

A geothermometer mineral is a mineral with slight differences in composition that can be used to estimate the temperature at which some types of metamorphic rock form. Garnet is a geothermometer mineral because there are several kinds of garnet that contain different amounts of iron and magnesium. The "garnet coefficient" indicates the ratio of iron to magnesium found in the garnet. When the garnet coefficient is high, there is a greater percentage of iron compared to magnesium. The garnet coefficient is an indicator of the temperature at which a metamorphic rock formed.

Garnet Coefficient and Rock Formation Temperature

Garnet Coefficient	Temperature at Which Metamorphic Rock Formed (°C)
1.22	720
1.34	680
1.38	670
1.40	660
1.47	640
1.63	590
1.70	570

55 Determine the rock formation temperature for a rock sample with a garnet coefficient of 1.55. [1]

56 Describe the rock formation temperatures that are indicated when higher garnet coefficients are found. [1]

57 Identify *one* foliated metamorphic rock for which the garnet coefficient might be used to determine the temperature at which the rock formed. [1]

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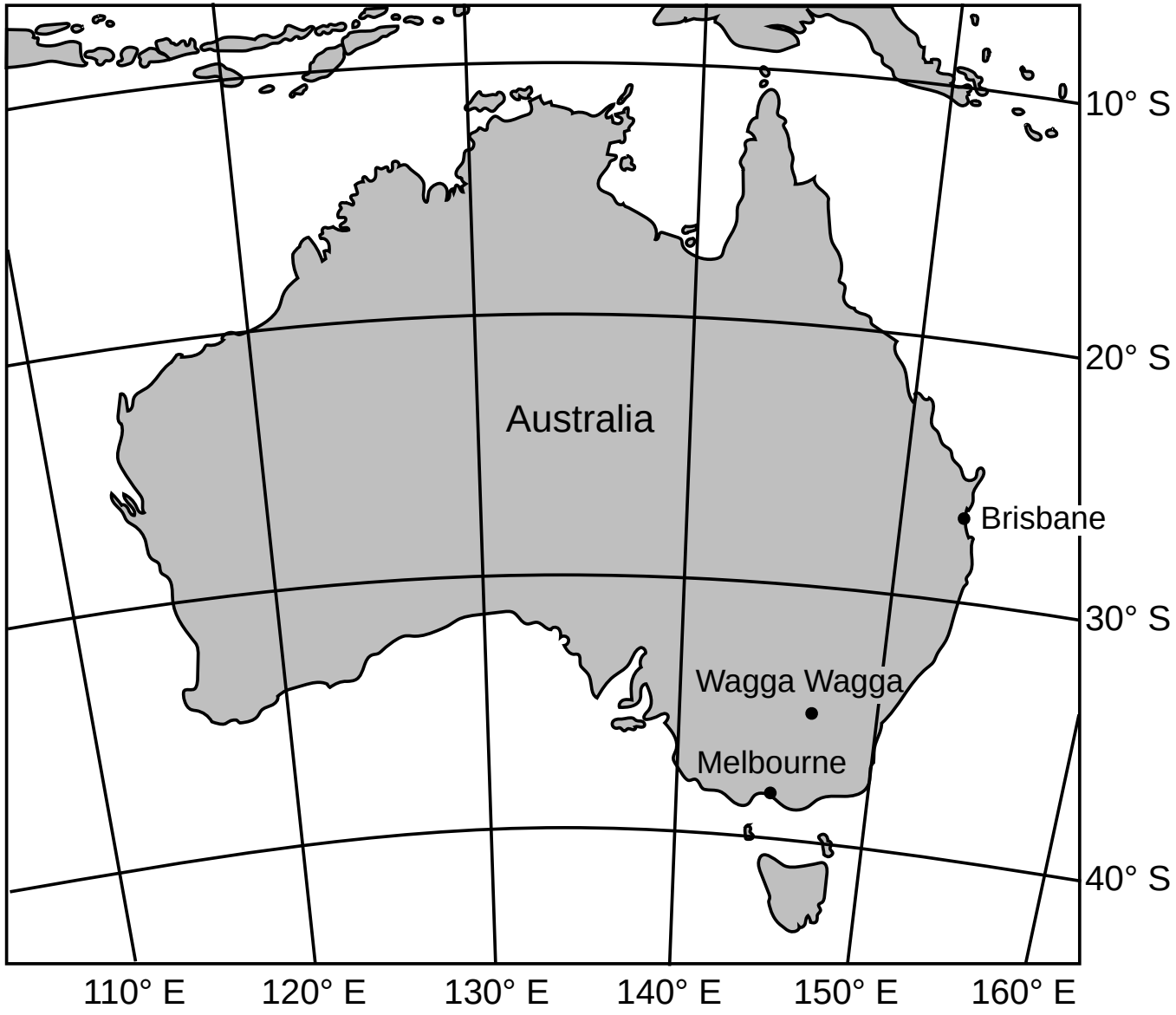
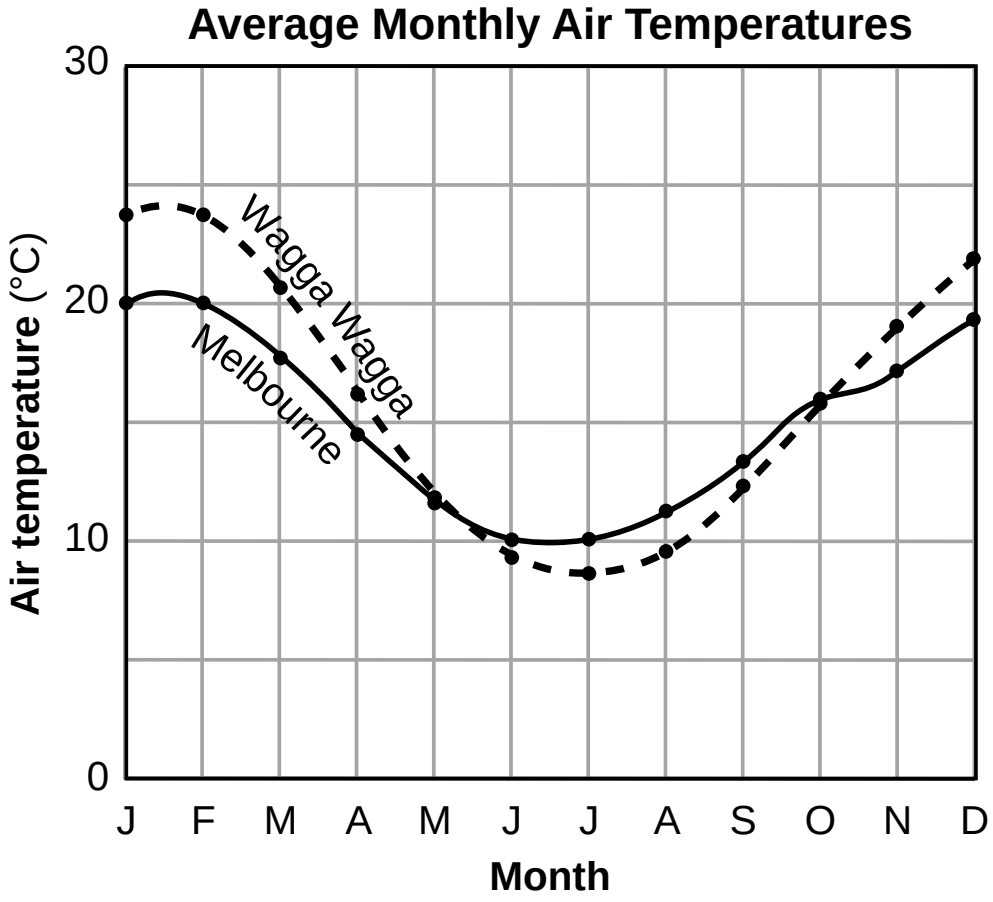
Base your answers to questions 58 and 59 on the map below, the graph on the next page, and on your knowledge of Earth science. The map of Australia shows the locations of three cities: Brisbane, Melbourne, and Wagga Wagga. The graph shows the average monthly air temperatures in Wagga Wagga and Melbourne, in degrees Celsius (°C).

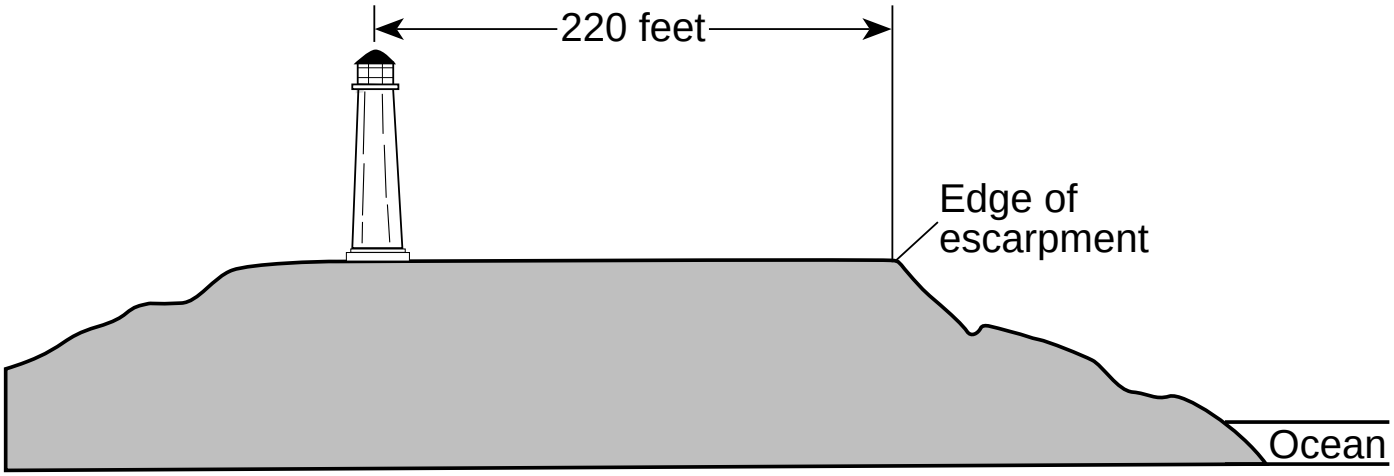




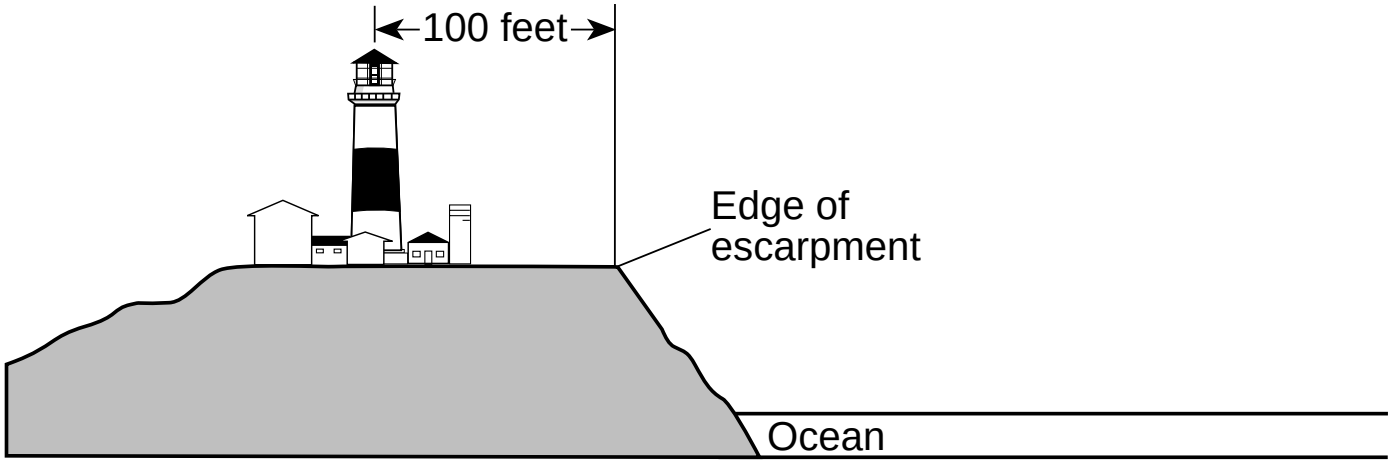
58 Compared to the average monthly air temperature curve for Melbourne, describe how the average monthly air temperature curve is different for a city in New York State. [1]

59 *In your answer booklet*, circle warm or cool to indicate the relative temperature of the ocean current that flows off the coast of Brisbane. State the name of this current. [1]

Base your answers to questions 60 through 62 on the cross sections below and on your knowledge of Earth science. The cross sections represent changes in the land at the Montauk Lighthouse between 1838 and 1988. The Montauk Lighthouse, built on unconsolidated sediments, is located on the easternmost tip of Long Island. The distance from the center of the lighthouse to the edge of the escarpment is indicated in each cross section.



Montauk Lighthouse - 1838



Montauk Lighthouse - 1988

60 Identify *one* agent of erosion that removed the sediment and changed the position of the escarpment between 1838 and 1988. [1]

61 Calculate the rate of erosion, in feet per year, between the lighthouse and the edge of the escarpment that occurred between 1838 and 1988. Express your answer to the *nearest tenth*. [1]

62 Describe *one* action that could be taken to slow down or prevent the future erosion of the land between the escarpment and the ocean. [1]

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Base your answers to questions 63 through 65 on the data table below and on your knowledge of Earth science. The data table shows the Sun's altitude and the shadow length measured from the base of a five-meter-high pole on June 22 in Rochester, New York. During daylight savings time, clocks are set one hour ahead, so solar noon occurs at approximately 1:00 p.m.

Data Table

Time of Day (EDT)	**Altitude of Sun in Degrees** (º)	**Shadow Length in Meters** (m)
9:00 a.m.	35	7.1
10:00 a.m.	46	4.8
11:00 a.m.	56	3.3
12:00 p.m.	65	2.3
1:00 p.m.	70	1.8
2:00 p.m.	68	2.0
3:00 p.m.	60	2.9
4:00 p.m.	50	4.1
5:00 p.m.	40	6.0
6:00 p.m.	29	9.1

63 On the graph *in your answer booklet*, construct a line graph by plotting the altitude of the Sun for each time of day shown on the data table. Connect all ten plots with a line. The shadow-length data have already been plotted using the scale on the right. [1]

64 Based on the data table, describe the relationship between the altitude of the Sun and the length of the shadow. [1]

65 Based on the graph, determine the shadow length of the pole, in meters, at 4:30 p.m. [1]

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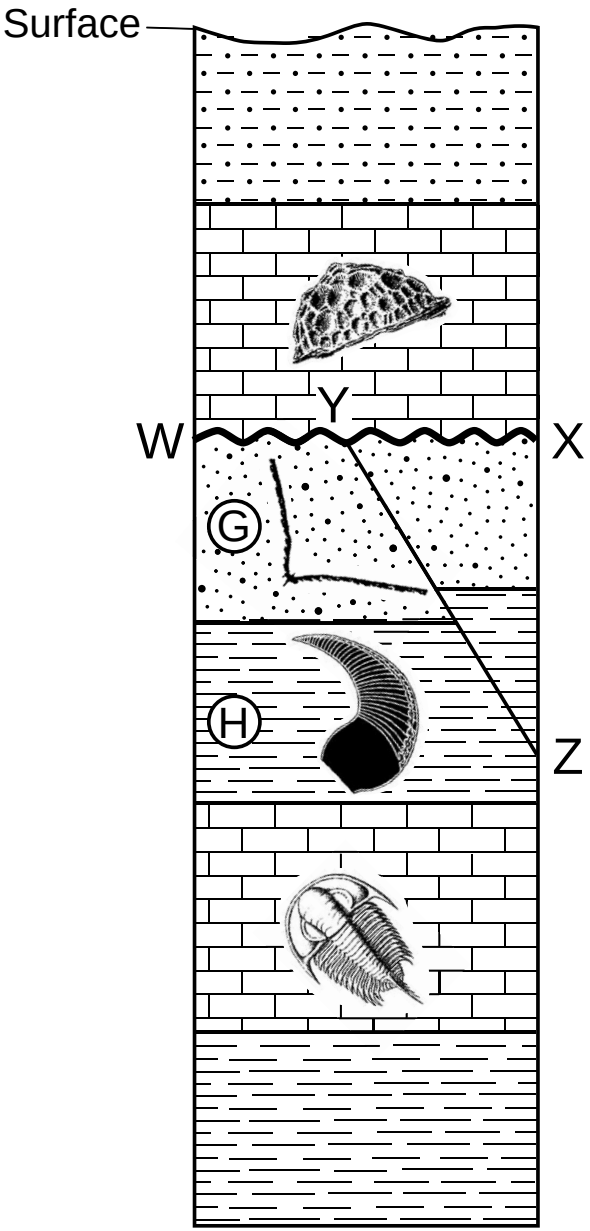
Part C

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 cross section on the next page and on your knowledge of Earth science. Letters *G* and *H* identify some rock layers. The wavy line *WX* indicates an unconformity, and line *YZ* indicates a fault. Index fossils are represented in some rock layers. Rock layers have *not* been



66 Identify the most likely geologic time period during which unconformity *WX* was forming. [1]

67 *In your answer booklet*, circle the term that best describes the relative age of fault *YZ* compared to layers *G* and *H*. Describe the evidence that infers this relative age. [1]

Base your answers to questions 68 through 71 on the data table and passage below, and on your knowledge of Earth science. The data table shows the location and characteristics of seven stars, numbered 1 through 7, found in the constellation Cygnus.

Location and Characteristics of Seven Stars in Cygnus

Star Number	**Star Name**	**Celestial Longitude** (hours)	**Celestial Latitude** (degrees)	**Temperature** (K)	**Luminosity**
1	Deneb	20.7	45	8500	197,000
2	Sadr	20.3	40	5800	60,000
3	Delta Cygni	19.8	45	9800	180
4	Epsilon Cygni	20.8	34	4800	60
5	Eta Cygni	20	35	4840	54
6	Alberio	19.5	28	4400	950
7	Tabby's Star	20.1	44	6200	1.5

The Mystery of Tabby's Star

Located in the constellation of Cygnus, there is a mysterious star named Tabby's Star that has a constant luminosity, but has a brightness that appears to change in a cyclic manner. A team of astronomers has developed a plausible explanation for this change. A dust cloud with a variable thickness has an approximate 700-day period of revolution around Tabby's Star. Why dust? Astronomers observed that a portion of the electromagnetic spectrum having wavelengths just shorter than visible light is blocked out, causing a decrease in apparent brightness. While astronomers don't know the origin of the dust cloud around Tabby's Star, dust unevenly spaced in its orbit around the star would explain this cyclic dimming of Tabby's Star.

68 On the grid *in your answer booklet*, plot the positions of stars 1 through 6. Record the star number of *each* star beside the plot. In order to create the correct shape of Cygnus, connect the plots with *two* lines: the first line connects the plots numbered 1-2-5-6; the second line connects the plots numbered 4-2-3. This position of Tabby's Star, number 7, has been indicated with a ⊕. [1]

69 Identify the planet in our solar system that has a period of revolution most similar to the dust cloud orbiting Tabby's Star. [1]

70 State the name of the shortwave electromagnetic energy that is mostly blocked out by the dust cloud orbiting Tabby's Star. [1]

71 Complete the table *in your answer booklet* by identifying the color and classification for *two* of the stars in the constellation of Cygnus based on temperature and luminosity shown in the table. Color and classification for Deneb have been completed as an example. [1]

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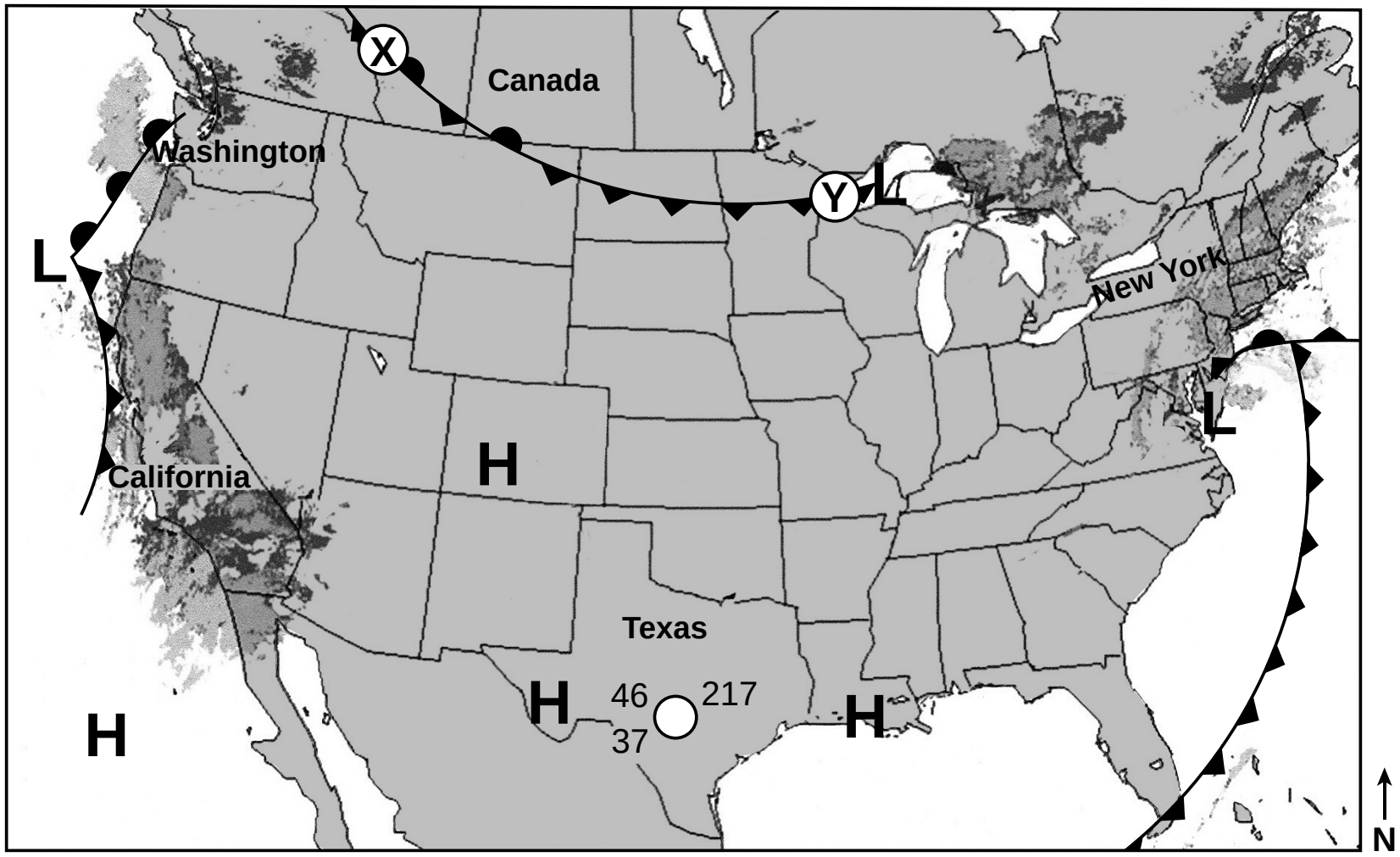
Base your answers to questions 72 through 74 on the weather map below and on your knowledge of Earth science. The weather map shows the high (**H**) and low (**L**) pressure centers and fronts across the United States on a January morning. The darker gray shaded areas show radar images of precipitation. A partial station model represents weather conditions in southern Texas. Two different types of fronts are represented along the line from *X* to *Y*.



72 Identify the *two* fronts represented along line *XY*. [1]

73 Identify the compass direction toward which the low-pressure system located just south of New York State will move if it follows a normal storm track. [1]

74 Complete the table *in your answer booklet* by filling in the values for the *four* weather variables that are represented by the station model. [1]

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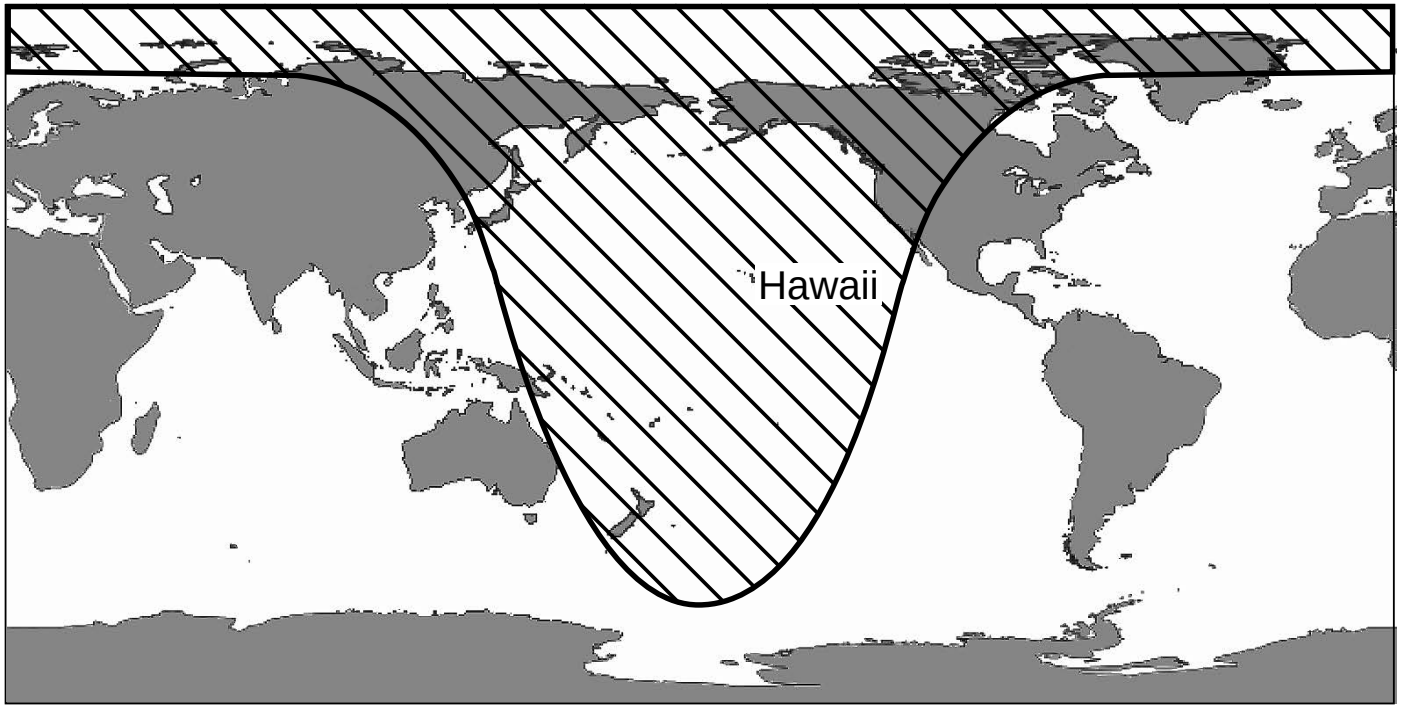
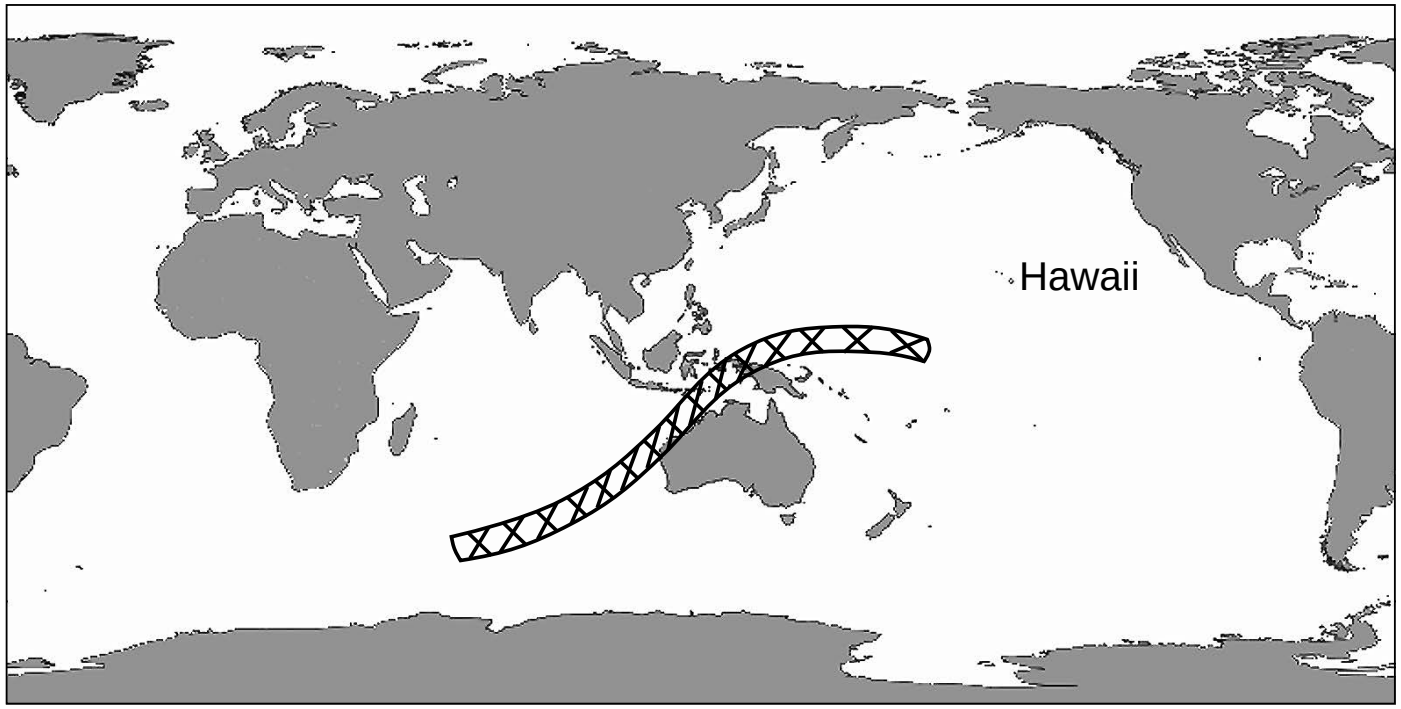
Base your answers to questions 75 and 76 on the maps below and on page 51, the data table on page 52, and on your knowledge of Earth science. Map 1 shows the area where a total lunar eclipse was visible on November 8, 2022. Map 2 shows the area where a total solar eclipse was visible on April 20, 2023. The data table shows the date, type, and duration of totality for each total eclipse that has occurred or will occur at a specific location during the years 2022 through 2025.

Map 1 - November 8, 2022



Key
Area where the total lunar eclipse was visible

Map 2 - April 20, 2023



Key	
⊠	Area where the total solar eclipse was visible

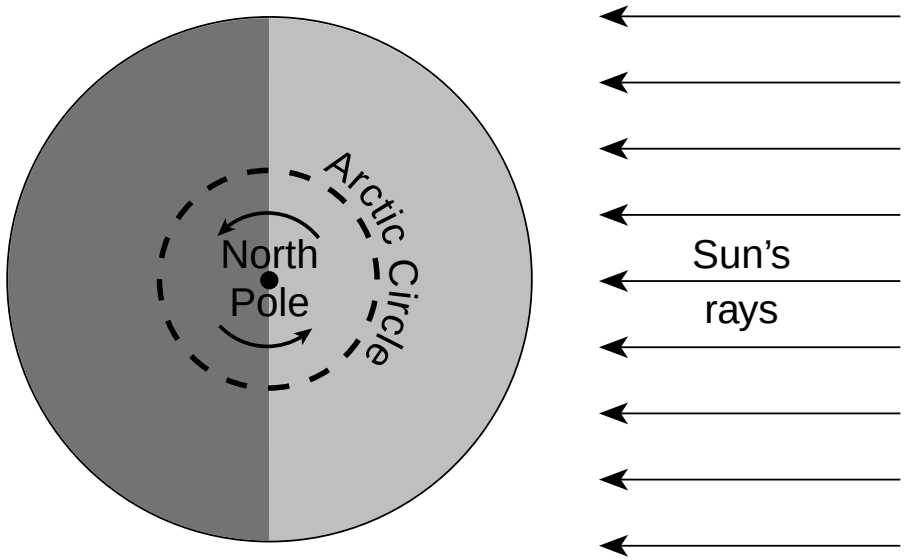
Total Eclipses 2022–2025

Date	Type of Eclipse	Duration of Totality
May 16, 2022	lunar	1 hour 25 minutes
November 8, 2022	lunar	1 hour 25 minutes
April 20, 2023	solar	1 minute 16 seconds
April 8, 2024	solar	4 minutes 28 seconds
March 14, 2025	lunar	1 hour 5 minutes
September 7, 2025	lunar	1 hour 22 minutes

75 Determine whether each of the eclipses shown on the maps were visible or not visible to an observer in Hawaii. *In your answer booklet*, circle "visible" or "not visible" on the line next to the date of each eclipse. [1]

76 On the diagram *in your answer booklet*, place an **X** on the Moon's orbit to indicate the position of the Moon on September 7, 2025. [1]

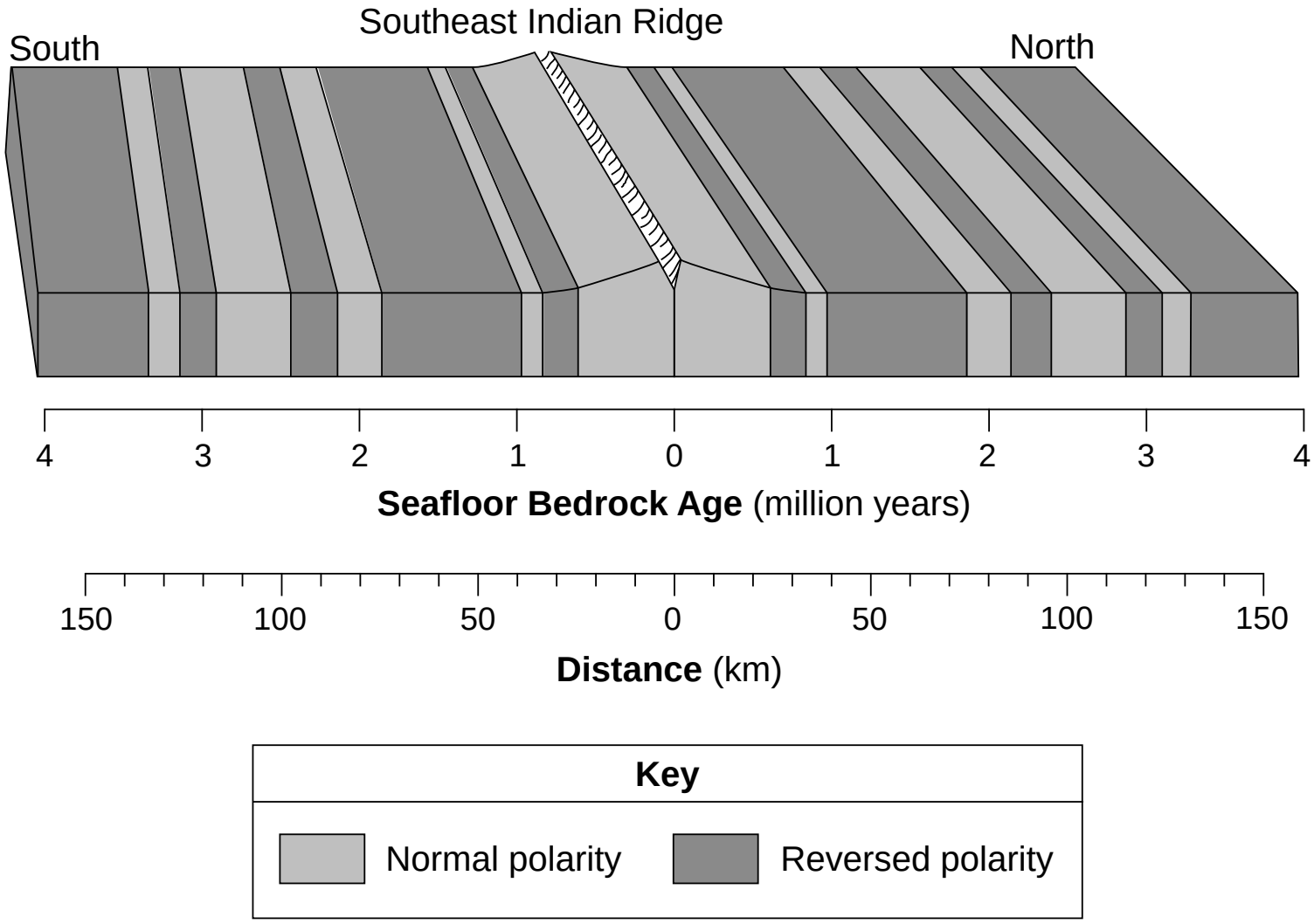
Base your answers to questions 77 and 78 on the diagram below and on your knowledge of Earth science. The diagram represents a North polar view of Earth as viewed from space on September 23. The curved arrows indicate the direction of Earth's rotation.



77 State the number of degrees Earth's axis is tilted to a line perpendicular to the plane of its orbit. [1]

78 Explain why a Foucault pendulum located on the Arctic Circle appears to change direction as it swings. [1]

Base your answers to questions 79 through 81 on the block diagram below and on your knowledge of Earth science. The diagram represents the magnetic orientation of the seafloor bedrock on both sides of the Southeast Indian Ridge. The age of the igneous bedrock and its distance, in kilometers, from the ridge center are shown.



79 Determine the age and the magnetic orientation of the seafloor bedrock located 80 kilometers south of the ridge center. [1]

80 Identify the *two* tectonic plates that are diverging at the Southeast Indian Ridge. [1]

81 Explain, in terms of cooling rate, why surface oceanic crust forming at this ocean ridge is most likely basalt instead of gabbro. [1]

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Base your answers to questions 82 through 85 on the passage and photograph below and on your knowledge of Earth science. The photograph shows a Herkimer diamond located in a cavity in dolostone.

Herkimer Diamonds

Herkimer "diamonds" are actually quartz crystals that are double terminated (pointed at both ends) and found within exposed outcrops of dolostone around the Mohawk River Valley. The dolostone was formed about 500 million years ago in a shallow sea that was filled with sediment from the eroded ancient Adirondack Mountains to the north. While buried, cavities were formed in the dolostone by the slightly acidic ocean water. As sediment buried the rock, crystals grew in the cavities, slowly creating quartz crystals of exceptional clarity. The quartz crystals in the cavities are believed to have formed during the Carboniferous Period.

Source: "Herkimer Diamonds" Geology.com

Herkimer Diamond in Dolostone Cavity

82 Identify the chemical composition of the quartz that makes up a Herkimer diamond. [1]

83 Identify *one* physical characteristic of a Herkimer diamond, other than its color, that allows it to be used in jewelry. [1]

84 Identify the orogeny that was responsible for the metamorphism of bedrock now exposed in the Adirondack Mountains. [1]

85 *In your answer booklet*, circle the term that describes the relative age of the Herkimer diamonds compared to the relative age of the dolostone. Explain how the evidence cited in the reading passage supports your answer. Use the terms Herkimer diamonds and dolostone in your explanation. [1]