

PHYSICAL SETTING EARTH SCIENCE

Thursday, January 26, 2017 — 9:15 a.m. to 12:15 p.m., only

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

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

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

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

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

Notice ...

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

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

Part A

Answer all questions in this part.

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

- 1 Which statement best explains why stars viewed from the Northern Hemisphere appear to revolve around *Polaris*?

(1) *Polaris* rotates on its axis.
(2) Earth rotates on its axis.
(3) *Polaris* revolves around Earth.
(4) Earth revolves around *Polaris*.

- 2 The hydrosphere covers approximately what percentage of Earth's lithosphere?

(1) 100% (3) 50%
(2) 70% (4) 25%

- 3 The deflection of prevailing winds and ocean currents in the Northern Hemisphere is called

(1) eccentricity
(2) refraction
(3) the Coriolis effect
(4) the Doppler effect

- 4 Earth's rate of revolution is approximately

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

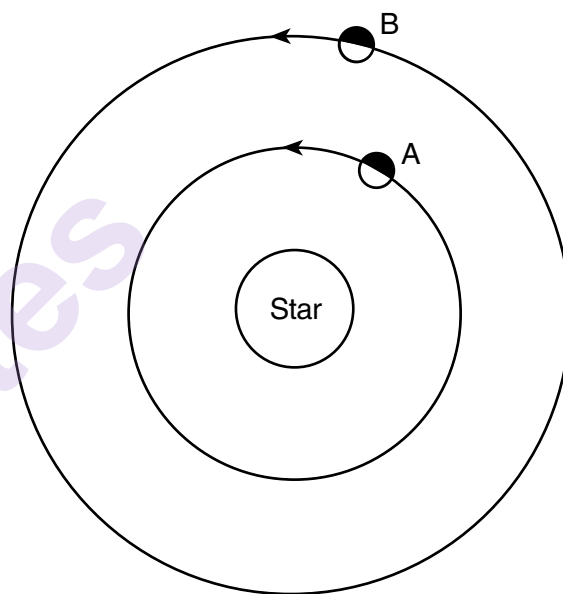
- 5 The asteroid Ceres lies at an average distance of 414 million kilometers from the Sun. The period of revolution of Ceres around the Sun is approximately

(1) 438 days (3) 4.6 years
(2) 687 days (4) 12.6 years

- 6 Which planet has a density that is *less* than the density of liquid water?

(1) Mercury (3) Mars
(2) Earth (4) Saturn

- 7 The diagram below represents two planets of equal mass, *A* and *B*, revolving around a star. The planets are represented at specific positions in their orbits.



(Not drawn to scale)

When both planets are at the positions represented, planet *B*

- (1) can be seen at night from planet *A*, and planet *B* is moving faster in its orbit
(2) can be seen at night from planet *A*, and planet *B* is moving slower in its orbit
(3) cannot be seen at night from planet *A*, and planet *B* is moving faster in its orbit
(4) cannot be seen at night from planet *A*, and planet *B* is moving slower in its orbit

8 Compared to terrestrial planets, Jovian planets have

- (1) smaller equatorial diameters and shorter periods of revolution
- (2) smaller equatorial diameters and longer periods of revolution
- (3) larger equatorial diameters and shorter periods of revolution
- (4) larger equatorial diameters and longer periods of revolution

9 Clouds most likely form as a result of

- (1) moist air rising, compressing, and warming
- (2) moist air rising, expanding, and cooling
- (3) dry air rising, compressing, and warming
- (4) dry air rising, expanding, and cooling

10 The dewpoint is 15°C . What is the wet-bulb temperature on a sling psychrometer if the dry-bulb temperature is 18°C ?

- (1) 16°C
- (2) 2°C
- (3) 3°C
- (4) 20°C

11 Which weather instrument is used to measure air temperatures recorded on a weather map?

- (1) anemometer
- (2) wind vane
- (3) thermometer
- (4) barometer

12 Equal masses of basalt, granite, iron, and copper received the same amount of solar energy during the day. At night, which of these materials cooled down at the fastest rate?

- (1) basalt
- (2) granite
- (3) iron
- (4) copper

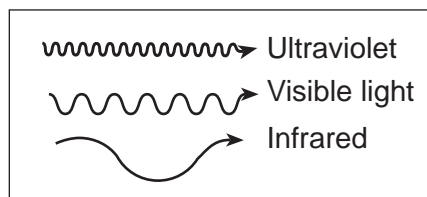
13 Equal areas of which type of surface will reflect the most insolation?

- (1) light gray rooftop
- (2) dark tropical forest
- (3) snow-covered field
- (4) black paved road

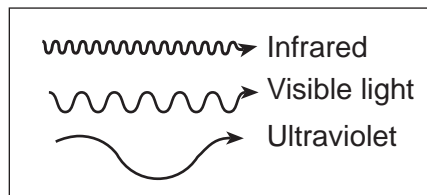
14 Riverhead, New York, has a smaller average daily temperature range than Elmira, New York, because Riverhead is located

- (1) near a large body of water
- (2) at a lower latitude
- (3) at a higher elevation
- (4) near a large city

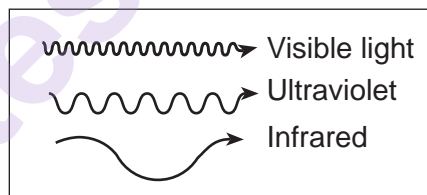
15 Which diagram best represents the relative wavelengths of visible light, ultraviolet energy, and infrared energy?



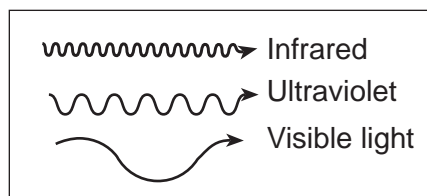
(1)



(2)



(3)



(4)

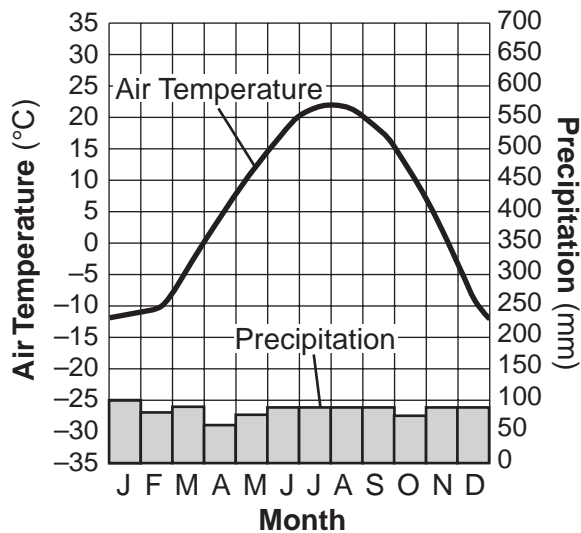
16 Volcanic ash is a good geologic time marker because the ash

- (1) is deposited rapidly over a large area
- (2) spreads evenly in all compass directions
- (3) is easily weathered and eroded
- (4) remains in the atmosphere for millions of years

17 The change in life-forms in the fossil record from less complex organisms to more complex organisms over time is best explained by

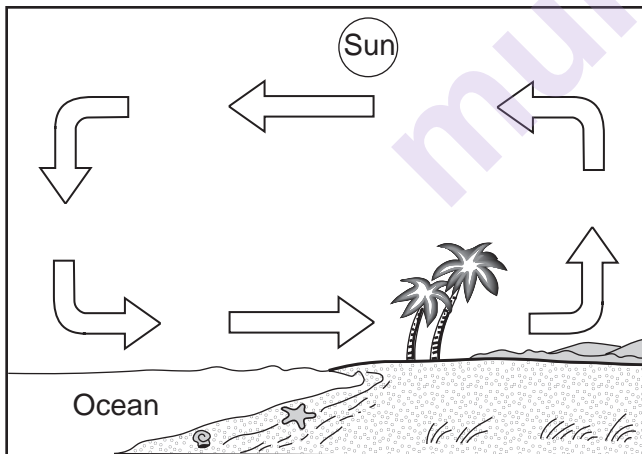
- (1) extinction
- (2) evolution
- (3) dynamic equilibrium
- (4) original horizontality

- 18 The graph below shows the yearly air temperature and precipitation of a location on Earth.



This location would be most likely at a latitude of

- (1) 0° (3) 50° N
(2) 35° S (4) 90° N
- 19 Arrows in the diagram below represent the daytime flow of air over a coastal region.



Which process primarily transfers heat by moving air?

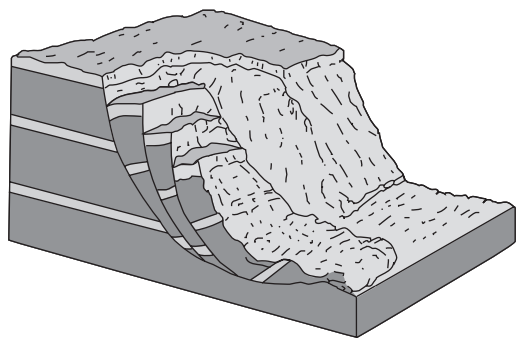
- 20 The graph below shows the radioactive decay of rubidium-87.



What percentage of rubidium-87 atoms will be left after four half-lives?

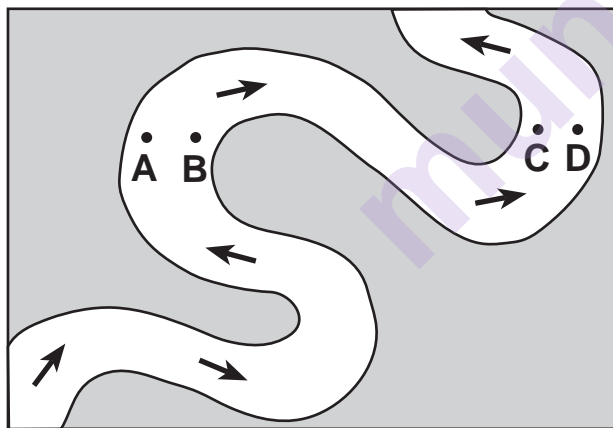
- (1) 25.0% (3) 6.25%
(2) 12.5% (4) 3.125%
- 21 The pressure at the interface between Earth's outer core and inner core is inferred to be
- (1) 0.2 million atmosphere
(2) 1.5 million atmospheres
(3) 3.1 million atmospheres
(4) 3.6 million atmospheres
- 22 Which type of tectonic plate boundary is found between the South American Plate and the Scotia Plate?
- (1) transform (3) divergent
(2) convergent (4) complex or uncertain
- 23 The epicenter of an earthquake was located 1800 kilometers from a seismic recording station. If the S-wave arrived at the seismic station at 10:06:40 a.m., at what time did the P-wave arrive at the same seismic station?
- (1) 10:03:00 a.m. (3) 10:09:40 a.m.
(2) 10:03:40 a.m. (4) 10:10:20 a.m.
- 24 A strong earthquake that occurs on the ocean floor could result in the formation of
- (1) a tsunami (3) an El Niño event
(2) a delta (4) an ocean current

- 25 The block diagram below represents a rapid downslope flow of saturated soil and rock layers.



What are two likely causes of this rapid downslope flow?

- (1) groundwater and abrasion
 - (2) groundwater and gravity
 - (3) prevailing wind and abrasion
 - (4) prevailing wind and gravity
- 26 The map below shows a stream. Letters A, B, C, and D represent locations on the stream surface. Arrows represent the direction of stream flow.

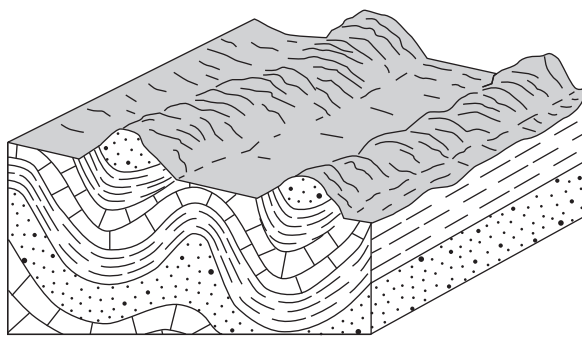


Which two locations have the greatest stream velocities?

- (1) A and B
 - (2) B and C
 - (3) C and D
 - (4) D and A
- 27 Which climate conditions most likely produce a landscape with rounded hills, large river valleys with many tributaries, and tropical vegetation?

- (1) cool and arid
- (2) cool and humid
- (3) warm and arid
- (4) warm and humid

- 28 The block diagram below represents two parallel mountain ranges.



Which two geologic processes most likely created this landscape region?

- (1) volcanism, followed by metamorphism
 - (2) faulting, followed by deposition
 - (3) folding, followed by erosion
 - (4) glaciation, followed by rifting
- 29 Which agent of erosion most likely moves sediments in a sand dune?

- (1) wind
- (2) glaciers
- (3) wave action
- (4) running water

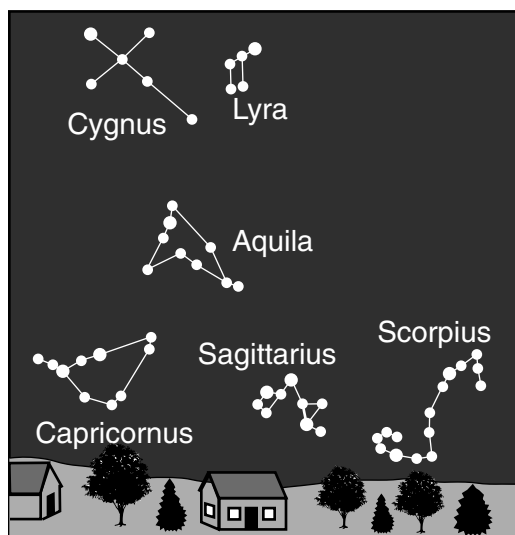
- 30 Which rock is composed of a mineral that can be used for the production of cement?

- (1) basalt
- (2) limestone
- (3) rock salt
- (4) rock gypsum

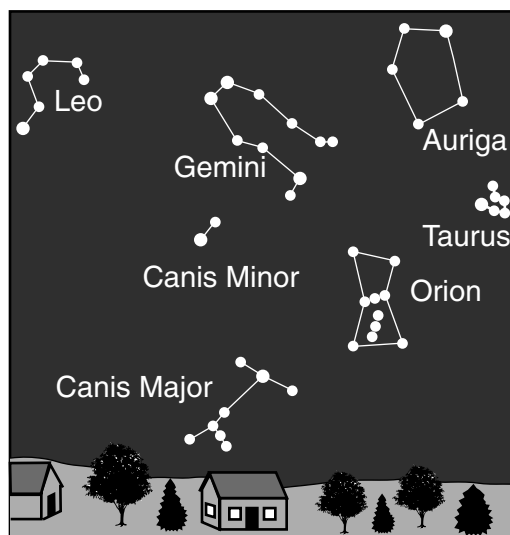
- 31 On April 21, the altitude of *Polaris*, as viewed from a location in New York State, was measured as 41.3° . What will the altitude of *Polaris* be when viewed one month later, on May 21, from the same location?

- (1) 23.5°
- (2) 41.3°
- (3) 66.7°
- (4) 90°

- 32 The diagrams below represent constellations seen by an observer in New York State facing south at midnight on July 7 and January 3.



Southern horizon – July 7



Southern horizon – January 3

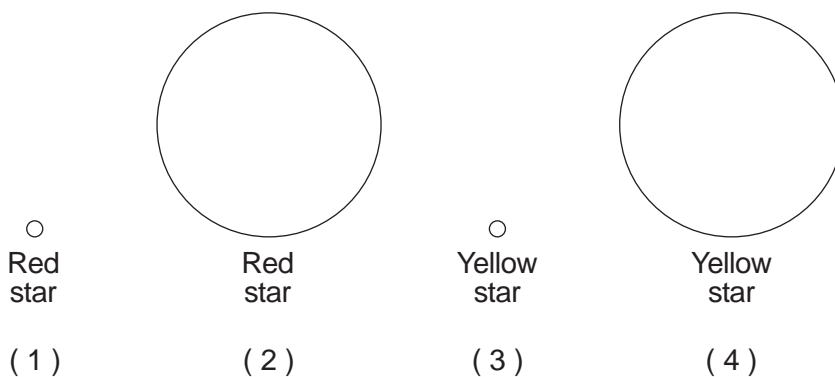
Which motion causes the observer to see different constellations at midnight on July 7 compared to midnight on January 3?

- (1) revolution of the constellations in their orbits
- (2) revolution of Earth in its orbit
- (3) rotation of the stars in the constellations
- (4) rotation of Earth on its axis

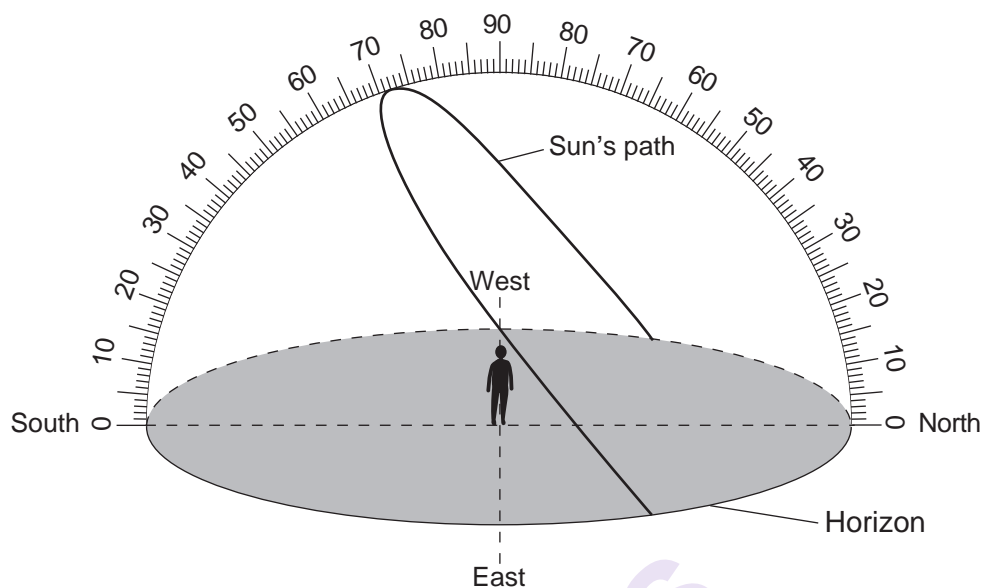
- 33 The diagram below represents a model of the size of the Sun and indicates the color of the Sun.



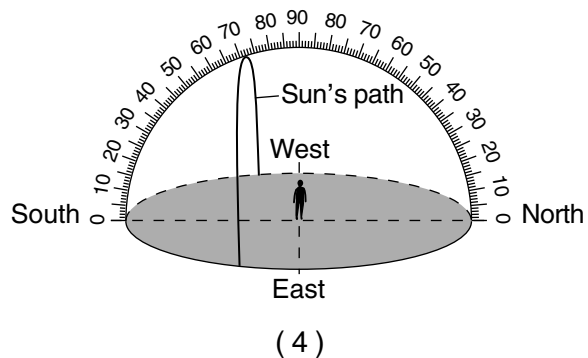
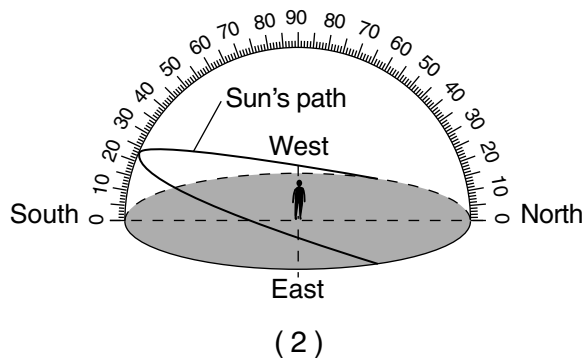
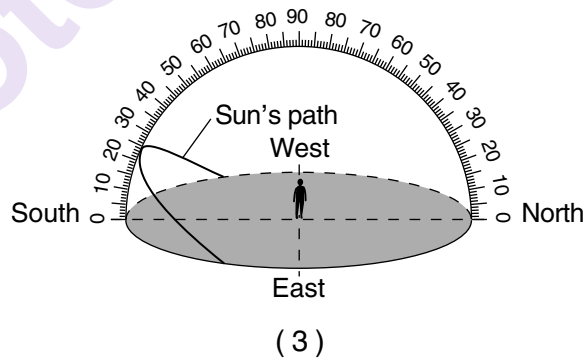
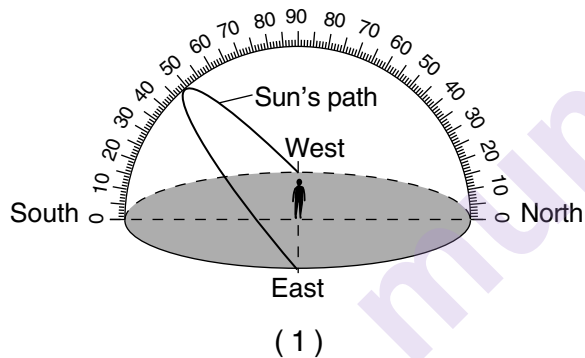
Which diagram best represents the relative size and indicates the color of *Polaris* compared to the Sun?



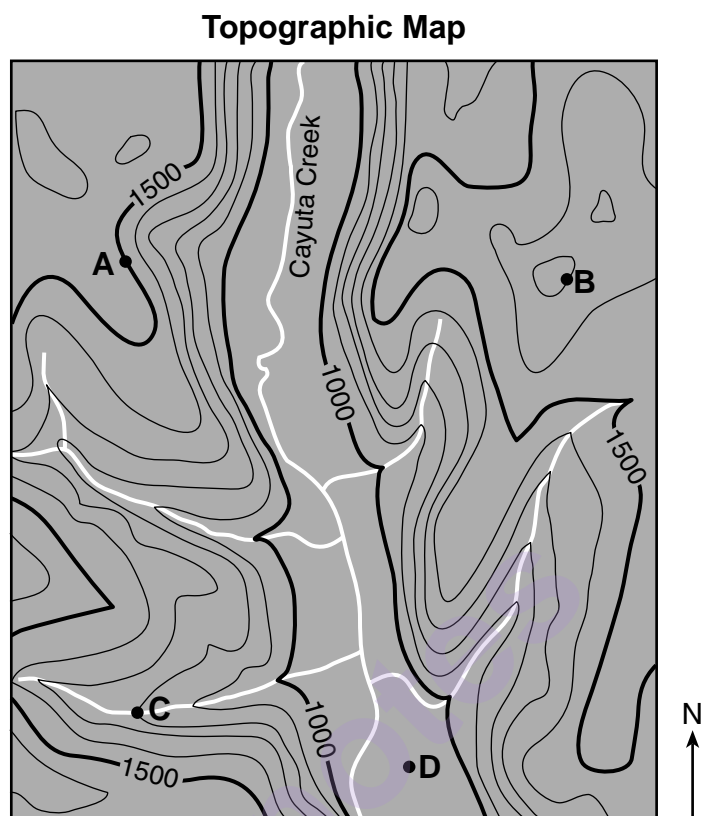
- 34 The diagram below represents the apparent path of the Sun as seen by an observer on June 21 at a location in New York State.



Which diagram best represents the apparent path of the Sun at this same location on December 21?



- 35 The topographic map below shows a portion of the Cayuta Creek that is located in New York State. Points A, B, C, and D represent locations on Earth's surface.



Which point on the map most likely represents a location within the flood plain associated with Cayuta Creek?

- (1) A
(2) B

- (3) C
(4) D

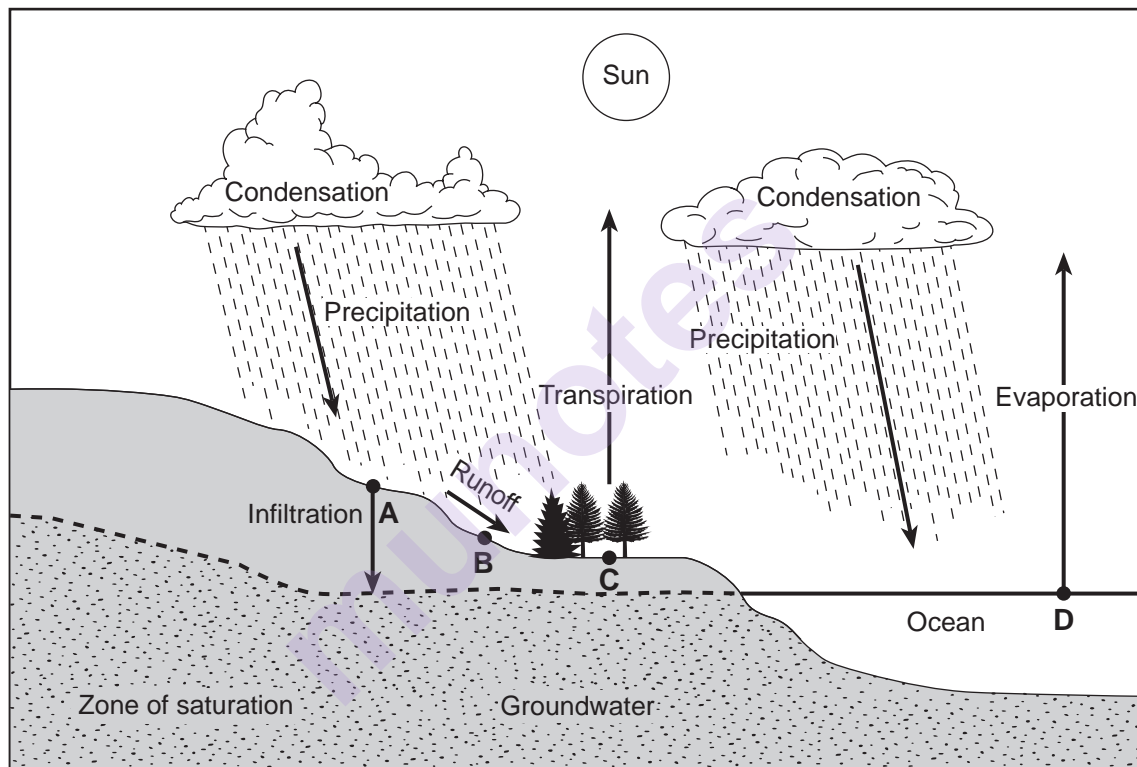
Part B-1

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.

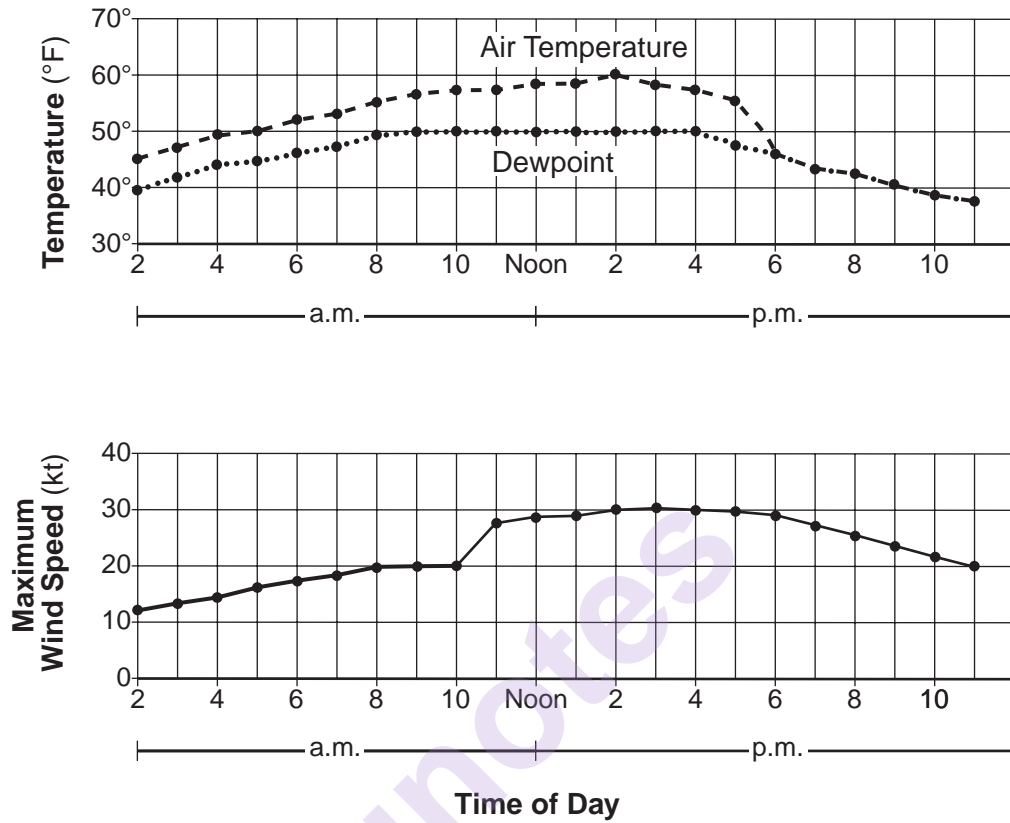
Base your answers to questions 36 through 38 on the cross section below and on your knowledge of Earth science. The cross section represents processes in the water cycle. Arrows represent the movement of water. Letters A, B, C, and D represent locations on Earth's surface.

The Water Cycle

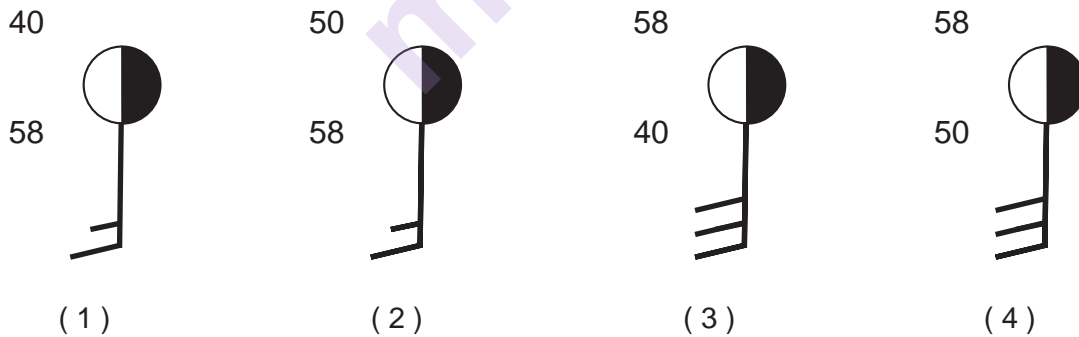


- 36 The downward movement of water from location A will usually be greatest when the soil is
- (1) nonporous and the particles are uniformly small in size
 - (2) nonporous and the particles are uniformly large in size
 - (3) porous and the particles are uniformly small in size
 - (4) porous and the particles are uniformly large in size
- 37 What would most likely reduce the amount of runoff at location B?
- | | |
|--|---|
| (1) infiltration occurring faster than precipitation | (3) saturated soil below the land surface |
| (2) greater condensation than evaporation | (4) a frozen land surface |
- 38 The greatest amount of transpiration and evaporation will occur most likely when the air temperature is
- | | |
|----------------------------------|-----------------------------------|
| (1) low and the humidity is low | (3) high and the humidity is low |
| (2) low and the humidity is high | (4) high and the humidity is high |

Base your answers to questions 39 and 40 on the graphs below and on your knowledge of Earth science. The graphs show air temperatures and dewpoints in °F, and wind speeds in knots (kt) from 2:00 a.m. to 11:00 p.m. at a certain New York State location.



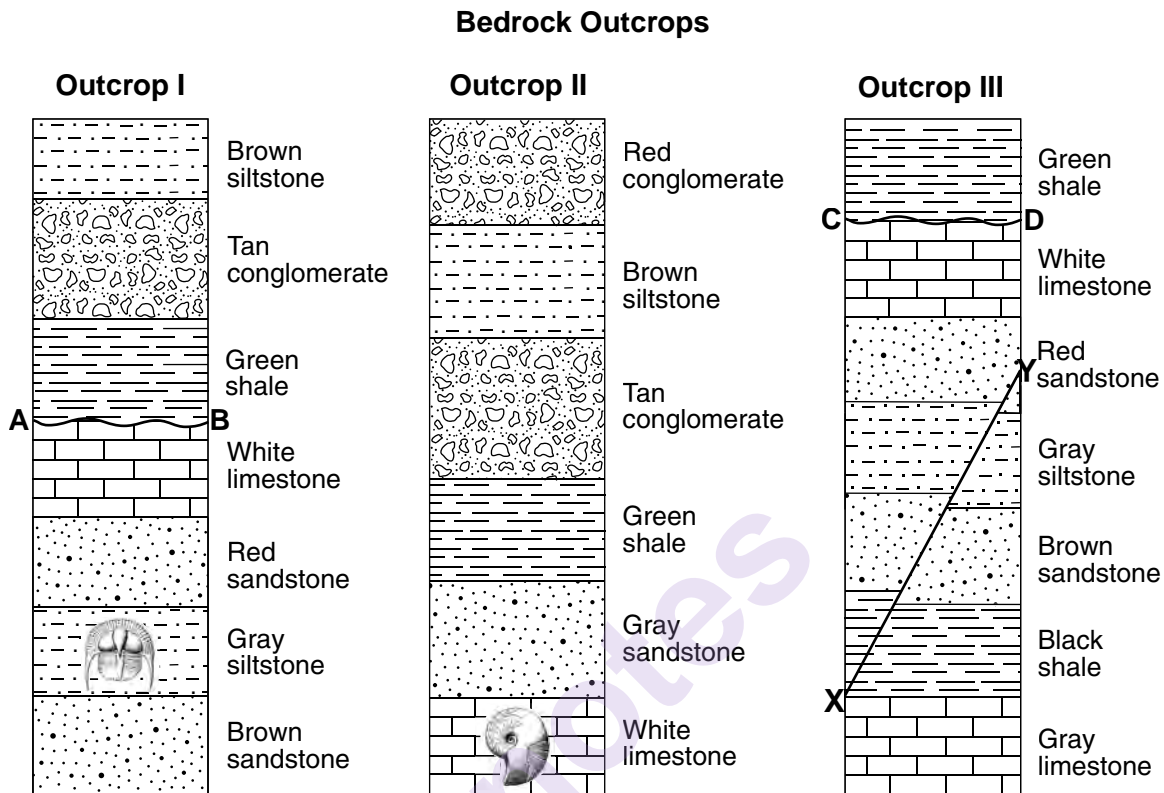
39 Which station model represents the weather data for this location at 4:00 p.m.?



40 What was the relative humidity at 8:00 p.m.?

- (1) 30%
- (2) 45%
- (3) 75%
- (4) 100%

Base your answers to questions 41 through 44 on the three bedrock outcrops below and on your knowledge of Earth science. The outcrops, labeled I, II, and III, are located within 15 kilometers of each other. Lines *AB* and *CD* represent unconformities. Line *XY* represents a fault. No overturning of the layers has occurred.



- 41 Which layer is the youngest?
- (1) gray limestone
 - (2) red conglomerate
 - (3) brown siltstone
 - (4) brown sandstone
- 42 The unconformities at *AB* and *CD* resulted from
- (1) uplift and erosion, followed by subsidence and deposition
 - (2) movement along a crack between two rock layers
 - (3) contact metamorphism between two sedimentary layers
 - (4) regional metamorphism of deeply buried sedimentary rocks
- 43 Based on evidence shown in the diagram, which rock layer is older than fault *XY*?
- (1) tan conglomerate
 - (2) black shale
 - (3) brown siltstone
 - (4) white limestone
- 44 Which processes produced the brown siltstone layer in outcrops I and II?
- (1) cooling and solidification of mafic lava at Earth's surface
 - (2) cooling and solidification of felsic magma deep within Earth
 - (3) compaction and cementation of rock fragments ranging in size from 0.006 to 0.2 centimeter in diameter
 - (4) compaction and cementation of rock fragments ranging in size from 0.0004 to 0.006 centimeter in diameter

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

Island Arcs

Island arcs are long, curved chains of oceanic islands associated with seismic activity and mountain-building processes at certain plate boundaries. They occur where oceanic tectonic plates collide. Along one side of these island arcs, there is usually a long, narrow deep-sea trench.

At island arcs, the denser plate is subducted and is forced into the partially molten mantle under the less dense plate. The islands are composed of the extrusive igneous rocks basalt and andesite. The basalt originates most likely from the plastic mantle. The andesite originates most likely from the melting of parts of the descending plate and sediments that had accumulated on its surface.

45 An island arc is found along the

- | | |
|------------------------|-----------------------|
| (1) East Pacific Ridge | (3) Aleutian Trench |
| (2) Iceland Hot Spot | (4) Peru-Chile Trench |

46 Most of the basalt that forms island arcs comes from the

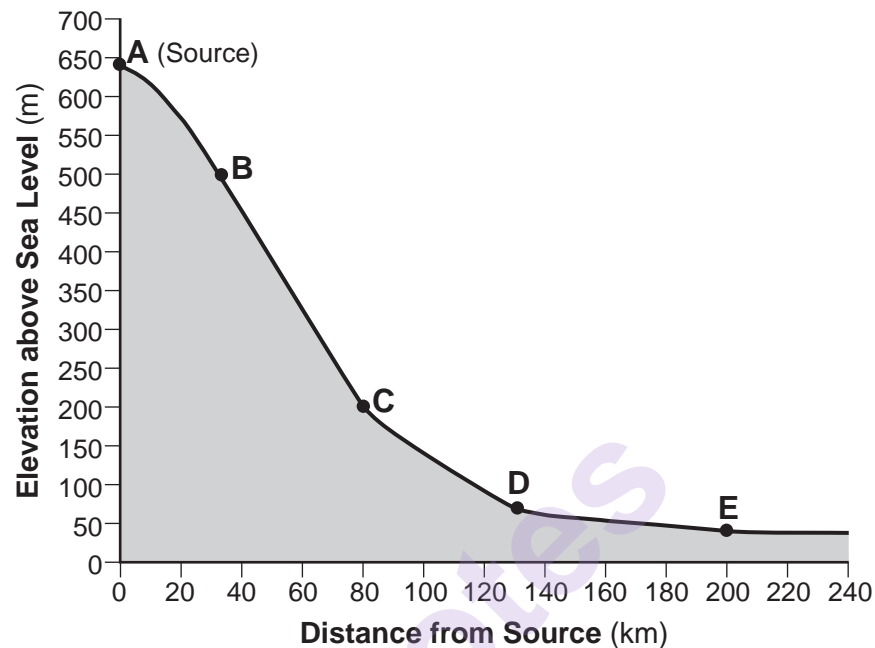
- | | |
|------------------|--------------------|
| (1) crust | (3) asthenosphere |
| (2) rigid mantle | (4) stiffer mantle |

47 Which list identifies minerals present in andesite from the greatest percentage by volume to the least percentage by volume?

- | | |
|--|--|
| (1) biotite, plagioclase feldspar, amphibole | (3) plagioclase feldspar, biotite, amphibole |
| (2) biotite, amphibole, plagioclase feldspar | (4) plagioclase feldspar, amphibole, biotite |
-

Base your answers to questions 48 through 50 on the cross section and data table below and on your knowledge of Earth science. The cross section shows the profile of a stream that is flowing down a valley from its source. Points *A* through *E* represent locations in the stream. The data table shows the average stream velocity at each location. The volume of water in the stream remains the same at all locations.

Stream Profile



Location in Stream	Average Stream Velocity (cm/s)
A	10
B	110
C	130
D	20
E	15

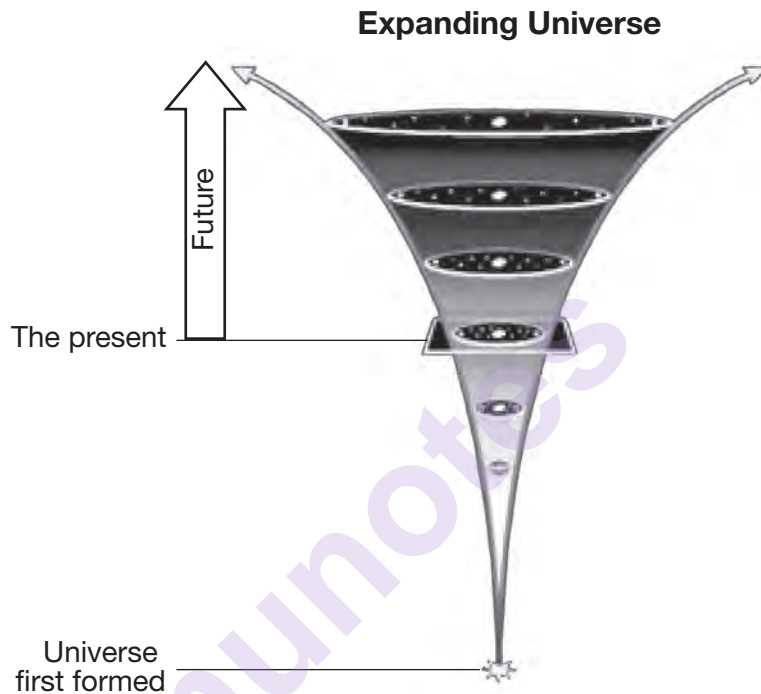
- 48 The average stream velocity at each location is controlled primarily by the
- (1) elevation above sea level
 - (2) slope of the land
 - (3) sediment carried by the stream
 - (4) distance from the stream's source
- 49 What is the largest type of sediment that could be transported at location *B*?
- (1) silt
 - (2) sand
 - (3) pebbles
 - (4) cobbles
- 50 Which features could be formed by the stream between locations *D* and *E*?
- (1) meanders
 - (2) kettle lakes
 - (3) barrier islands
 - (4) drumlins

Part B–2

Answer all questions in this part.

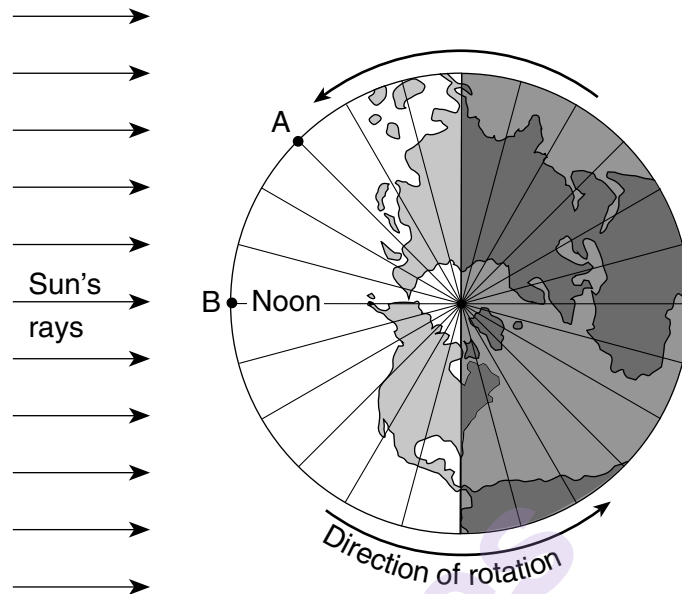
Directions (51–65): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Earth Science*.

Base your answers to questions 51 through 54 on the diagram below and on your knowledge of Earth science. The diagram represents a model of the expanding universe.



- 51 Identify the name of the event that is inferred by scientists to have occurred when the universe first formed. [1]
- 52 Identify *one* piece of evidence that led astronomers to infer that the universe is expanding. [1]
- 53 Identify the force that caused stars and planets in the universe to become layered according to density differences in their composition. [1]
- 54 Identify the nuclear process that combines lighter elements into heavier elements to produce the energy radiated by stars. [1]
-

Base your answers to questions 55 and 56 on the diagram below and on your knowledge of Earth science. The diagram represents a view of Earth from above the North Pole, showing longitude lines at 15 degree intervals. Letters *A* and *B* represent surface locations on the equator.



55 Identify *one* date represented by this diagram. [1]

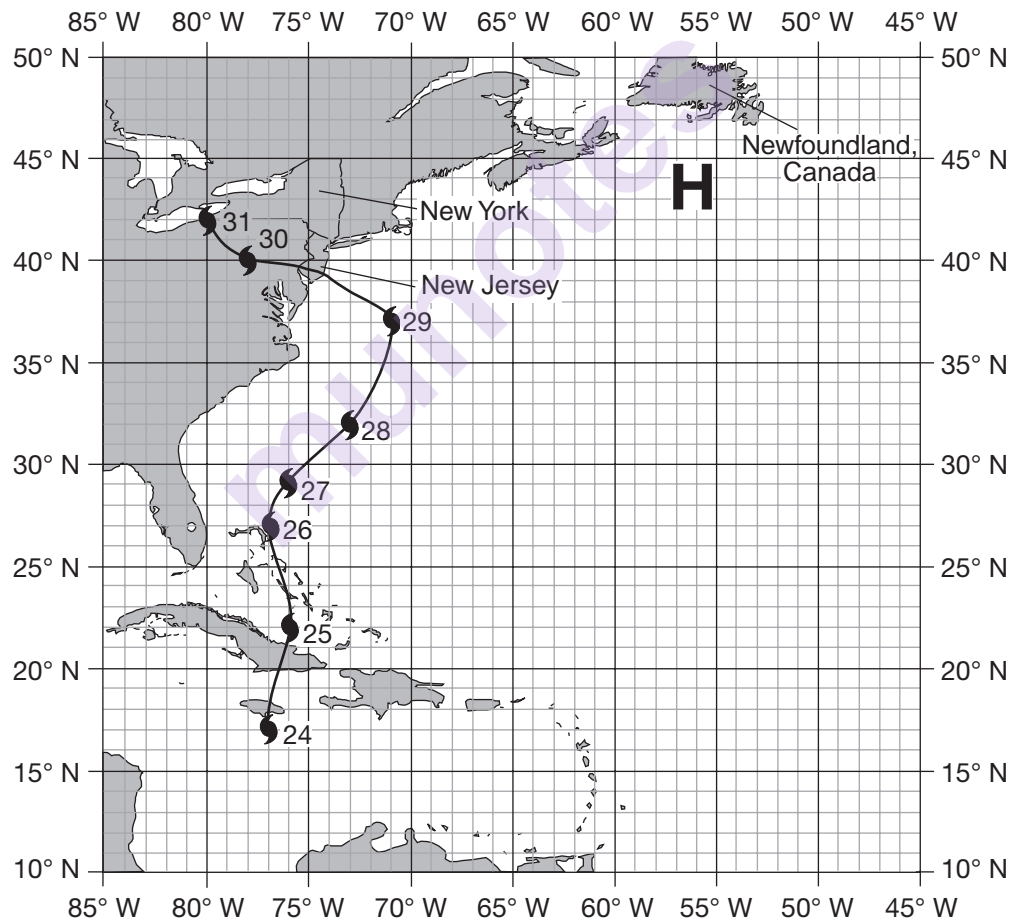
56 State the time at location *A* when it is noon at location *B*. Indicate a.m. or p.m. in your answer. [1]

Base your answers to questions 57 through 60 on the passage and map below and on your knowledge of Earth science. The map shows the positions of the eye (center) of Hurricane Sandy in its path from October 24 to October 31, 2012. A high-pressure center (H) is shown on the map.

Hurricane Sandy

In October 2012, Hurricane Sandy produced extreme damage to New York City and the coast of New Jersey due to high winds and a high storm surge. A storm surge is the rise in the level of ocean water along a coast that is caused by strong winds blowing toward land from a severe storm. High ocean tides, occurring at the same time, added to the height of the storm surge. A high-pressure center, located just south of Newfoundland, Canada, affected Hurricane Sandy by altering the path of the jet stream. This change in the jet stream, combined with surface wind circulation around the high-pressure center, caused Hurricane Sandy to curve westward, making landfall along the coast of New Jersey.

Path of Hurricane Sandy from October 24, 2012 to October 31, 2012



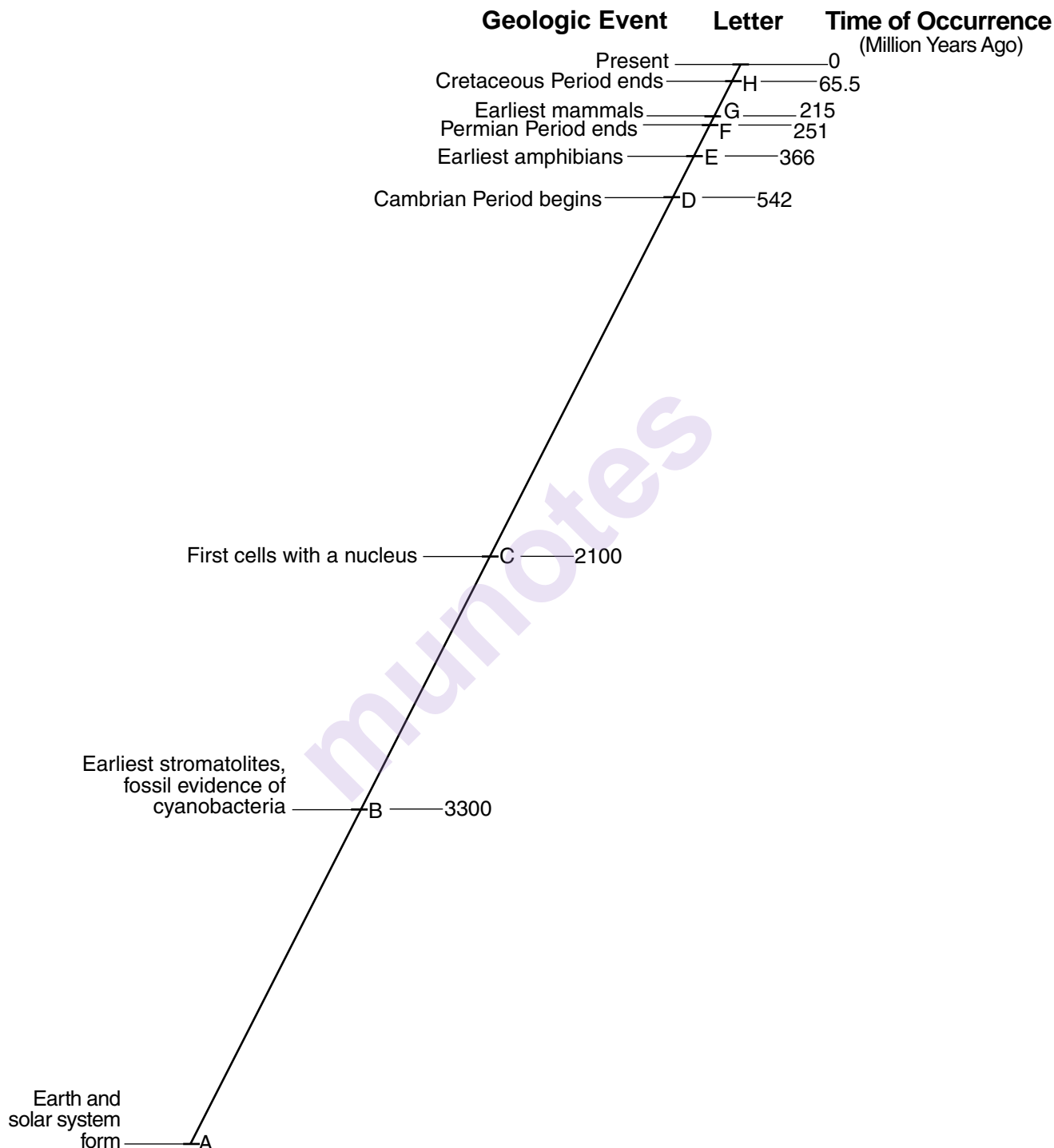
- 57 Using information from the map, complete the data table *in your answer booklet* by identifying the latitude and longitude positions of the eye of Hurricane Sandy from October 27, 2012 to October 29, 2012. Express your latitude and longitude positions to the nearest whole degree. [1]
- 58 Describe the surface wind circulation around the high-pressure center (**H**) that is located south of Newfoundland. [1]
- 59 The data table below shows the air pressure, measured in millibars (mb), and surface wind speed, measured in miles per hour (mi/h), recorded near the center of Hurricane Sandy on three separate days.

Date	Air Pressure (mb)	Surface Wind Speed (mi/h)
October 24, 2012	973	70
October 27, 2012	958	75
October 29, 2012	943	90

On the set of axes *in your answer booklet*, draw a line to represent the general relationship between air pressure and surface wind speed associated with Hurricane Sandy for these three days. [1]

- 60 Explain why Hurricane Sandy weakened on October 30 and October 31. [1]
-

Base your answers to questions 61 through 65 on the geologic timeline below and on your knowledge of Earth science. The geologic timeline, drawn to scale, represents Earth's geologic history. The letters *A* through *H* on the timeline represent the times of occurrence for specific, labeled geologic events. The time of occurrence for letter *A* has been omitted.



- 61 Identify the *two* consecutive letters on the timeline that represent the time span within which the earliest insects appeared on Earth. [1]
- 62 State the time of occurrence for the geologic event labeled A on the geologic timeline. [1]
- 63 Describe the major change in Earth's atmosphere that was occurring at the time when the first cells with a nucleus appeared on Earth. [1]
- 64 The table below lists the five major mass extinctions that occurred on Earth during the Paleozoic and Mesozoic Eras.

Time of Mass Extinction	Description of Mass Extinction Events
Letter <i>H</i> on timeline	Dinosaurs, along with 80% of all organisms
End of Triassic	Most ammonoids, many brachiopods and gastropods, 80% of four-legged animals
Letter <i>F</i> on timeline	Largest mass extinction in history, 90% of all species
Late Devonian	70-80% of marine species
Late Ordovician	85% of marine species

Identify the group of marine organisms found in the *2011 Edition Reference Tables for Physical Setting/Earth Science* that became extinct during the largest mass extinction in history. [1]

- 65 Identify the geologic eon during which event letter *B* occurred. [1]
-

Part C

Answer all questions in this part.

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

Base your answers to questions 66 through 69 on the data table below and on your knowledge of Earth science. The data table shows the average level of atmospheric carbon dioxide (CO₂), measured in parts per million (ppm), for the month of February at the Mauna Loa observatory in Hawaii from 2008 to 2014.

Year	Average February Atmospheric CO ₂ Levels (ppm)
2008	386
2009	387
2010	390
2011	392
2012	394
2013	396
2014	398

- 66 On the grid in your answer booklet, construct a line graph by plotting the data for the average February atmospheric carbon dioxide (CO₂) levels for the years 2008 to 2014. Connect the plots with a line. [1]
- 67 These measurements of atmospheric carbon dioxide were collected at an altitude of 3.4 kilometers. Identify the temperature zone of the atmosphere where these data were collected. [1]
- 68 Identify *one* major greenhouse gas, other than carbon dioxide. [1]
- 69 Describe *two* human activities that would *decrease* the amount of carbon dioxide that humans add to Earth's atmosphere. [1]
-

Base your answers to questions 70 through 73 on the weather map in your answer booklet and on your knowledge of Earth science. The weather map shows the center of a high-pressure system (**H**) and the center of a low-pressure system (**L**) affecting North America. Isobars are drawn for the eastern portion of the map, and one isobar is drawn around the high-pressure center. Air pressures are shown at various points in the western portion of the map. All air pressures were recorded in millibars (mb). Points *A* through *F* represent surface locations.

70 On the map *in your answer booklet*, draw the 1012 mb, 1016 mb, and 1020 mb isobars. Extend the isobars to the edges of the map. [1]

71 Convert the air pressure at location *A* from millibars (mb) to inches of mercury (in of Hg). [1]

72 Calculate the air pressure gradient between locations *A* and *B* in millibars per kilometer. [1]

73 Identify *one* possible air pressure at the center of the low-pressure system. [1]

Base your answers to questions 74 through 77 on the diagram in your answer booklet and on your knowledge of Earth science. The diagram represents the Moon's orbit around Earth as viewed from space above Earth's North Pole (NP). Letter *A* represents one position of the Moon in its orbit.

74 On the diagram *in your answer booklet*, place an **X** on the Moon's orbit to indicate the position of the Moon when a solar eclipse would be observed from Earth. [1]

75 State the number of days that it takes the Moon to orbit Earth once. [1]

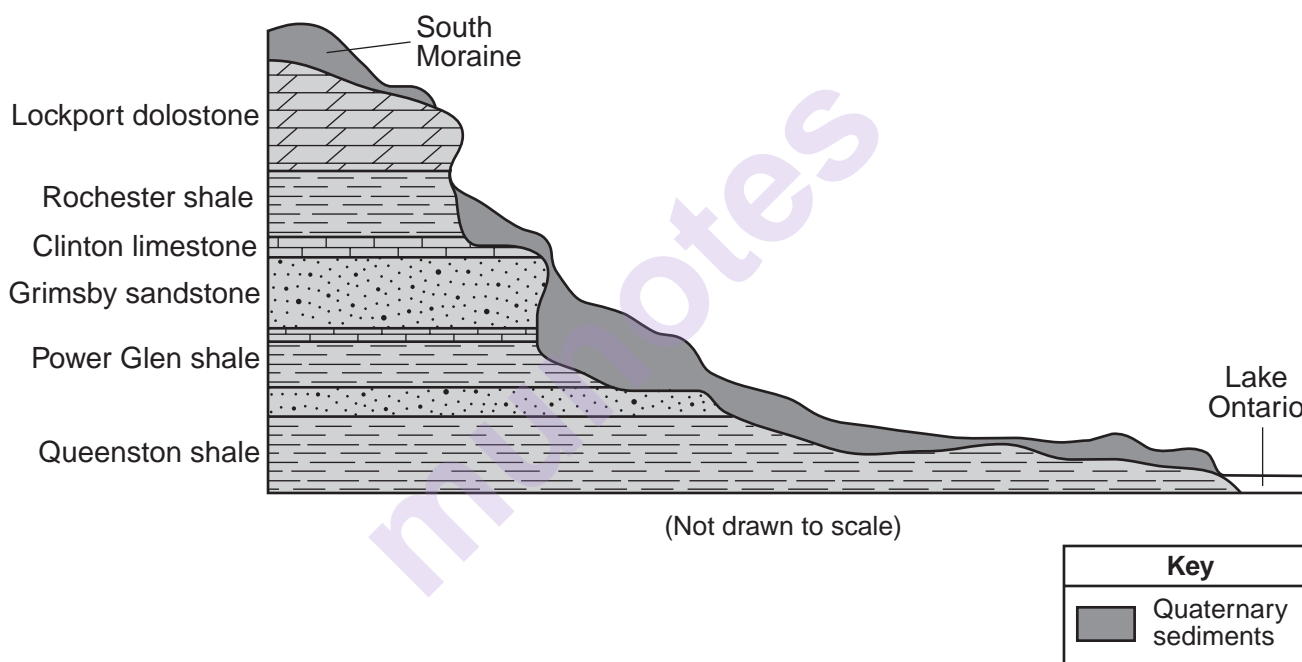
76 On the diagram *in your answer booklet*, shade the portion of the Moon that is in darkness as viewed from New York State when the Moon is at position *A*. [1]

77 Describe the actual shape of the Moon's orbit. [1]

Base your answers to questions 78 through 81 on the passage and geologic cross section below and on your knowledge of Earth science. The geologic cross section represents rock layers of a portion of the Niagara Escarpment, and landscape features that are found in the Niagara region. The rock layers have *not* been overturned.

The Niagara Escarpment

A prominent feature found along the shore of Lake Ontario in western New York State is the Niagara Escarpment. This escarpment is the remains of an ancient seabed that was formed when the area was covered by a warm, shallow sea from approximately 450 to 430 million years ago. Erosion of the Taconic Mountains to the east provided the sediments deposited in this basin area. From these sediments, rock layers such as shale, sandstone, and limestone formed. Later, magnesium replaced some of the calcium in the top layer of limestone, turning it into a dolostone layer. When the high ocean levels of the Ordovician Period dropped, the draining of this inland sea caused unequal erosion of the exposed layers. The South Moraine was deposited on the top of the Niagara Escarpment in this region.



- 78 Identify the New York State landscape region in which the Niagara Escarpment is located. [1]
- 79 Identify the mineral composition of the Lockport dolostone. [1]
- 80 Describe the inferred position of North America when this area was covered by the warm, shallow sea. [1]
- 81 Describe the tectonic event that caused the Taconian orogeny. [1]
-

Base your answers to questions 82 through 85 on the photographs below and on your knowledge of Earth science. The photographs show eight common rock-forming minerals.

Biotite mica



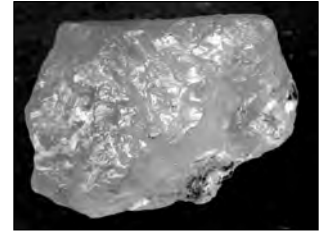
Potassium feldspar



Olivine



Quartz



Muscovite mica



Plagioclase feldspar



Amphibole



Pyroxene



82 Identify the mineral shown that can scratch all of the other minerals shown. [1]

83 In the table *in your answer booklet*, place an **X** in the appropriate box to indicate whether each mineral is found mainly in felsic or mafic igneous rock. [1]

84 Identify the *two* most abundant elements, by mass, in Earth's crust that are part of the composition of all eight of these minerals. [1]

85 Identify the *two* minerals shown that exhibit fracture as a dominant form of breakage. [1]

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