

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

**PHYSICAL SETTING
EARTH SCIENCE**

Friday, June 19, 2015 — 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.

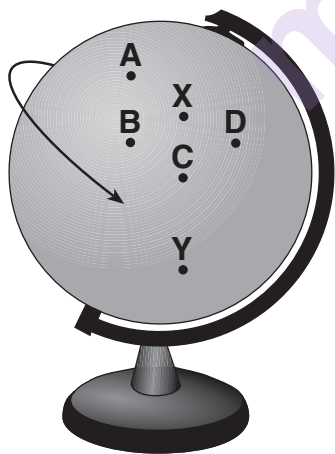
- 1 Compared to the terrestrial planets, the Jovian planets are

(1) larger and less dense
(2) smaller and more dense
(3) closer to the Sun and less rocky
(4) farther from the Sun and more rocky

- 2 Earth, the Sun, and billions of stars are contained within

(1) a single constellation
(2) the Milky Way galaxy
(3) the solar system
(4) a giant cloud of gas

- 3 The diagram below represents a globe that is spinning to represent Earth rotating. The globe is spinning in the direction indicated by the arrow. Points A, B, C, D, X, and Y are locations on the globe.



A student attempted to draw a straight line from point X to point Y on the spinning globe. Due to the Coriolis effect, the student's drawn line most likely passed through point

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

- 4 Flash flooding is most likely to occur when heavy rain falls on

(1) deforested landscapes with clay soils
(2) deforested landscapes with sandy soils
(3) forested landscapes with clay soils
(4) forested landscapes with sandy soils

- 5 Radioactive decay of ^{40}K atoms in an igneous rock has resulted in a ratio of 25 percent ^{40}K atoms to 75 percent ^{40}Ar and ^{40}Ca atoms. How many years old is this rock?

(1) 0.3×10^9 y (3) 2.6×10^9 y
(2) 1.3×10^9 y (4) 3.9×10^9 y

- 6 A student using a sling psychrometer measured a wet-bulb temperature of 10°C and a dry-bulb temperature of 16°C . What was the dewpoint?

(1) -10°C (3) 6°C
(2) 45°C (4) 4°C

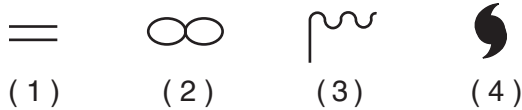
- 7 Most of the hurricanes that affect the east coast of the United States originally form over the

(1) warm waters of the Atlantic Ocean in summer
(2) warm land of the southeastern United States in summer
(3) cool waters of the Atlantic Ocean in spring
(4) cool land of the southeastern United States in spring

- 8 The ozone layer protects life on Earth by absorbing harmful ultraviolet radiation. The ozone layer is located between 17 kilometers and 35 kilometers above Earth's surface in which atmospheric temperature zone?

(1) troposphere (3) mesosphere
(2) stratosphere (4) thermosphere

9 Which weather map symbol is associated with extremely low air pressure?



10 Which two elements make up the greatest percentages by mass in Earth's crust?

- (1) oxygen and potassium
- (2) oxygen and silicon
- (3) aluminum and potassium
- (4) aluminum and silicon

11 What is the approximate *P*-wave travel time from an earthquake if the *P*-wave arrives at the seismic station 8 minutes before the *S*-wave?

- (1) 4 minutes 20 seconds
- (2) 6 minutes 30 seconds
- (3) 10 minutes 0 seconds
- (4) 11 minutes 20 seconds

12 Which two factors have the most influence on the development of landscape features?

- (1) bedrock age and weathering rates
- (2) bedrock structure and climate variations
- (3) rate of deposition and thickness of the bedrock
- (4) rate of erosion and fossils in the bedrock

13 Which two New York State landscape regions have surface bedrock that formed about 1000 million years ago?

- (1) Hudson Highlands and Adirondack Mountains
- (2) Erie-Ontario Lowlands and Atlantic Coastal Plain
- (3) Tug Hill Plateau and Allegheny Plateau
- (4) Newark Lowlands and Manhattan Prong

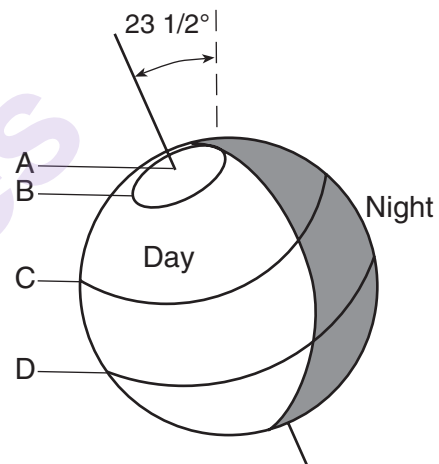
14 What is the minimum water velocity necessary to maintain movement of 0.1-centimeter-diameter particles in a stream?

- (1) 0.02 cm/s (3) 5.0 cm/s
- (2) 0.5 cm/s (4) 20.0 cm/s

15 Compared to a light-colored rock with a smooth surface, a dark-colored rock with a rough surface will

- (1) both absorb and reflect less insolation
- (2) both absorb and reflect more insolation
- (3) absorb less insolation and reflect more insolation
- (4) absorb more insolation and reflect less insolation

16 The diagram below indicates regions of daylight and darkness on Earth on the first day of summer in the Northern Hemisphere. Four latitudes are labeled A, B, C, and D.



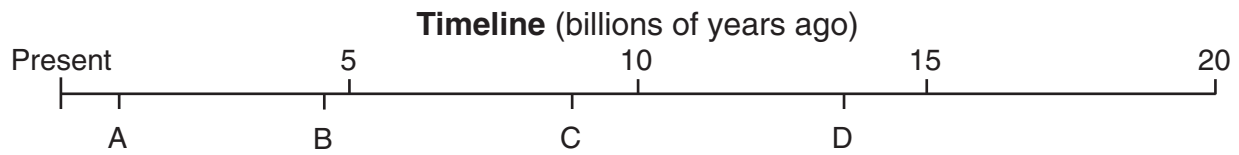
At which latitude is the Sun above the horizon for the *least* number of hours on the day shown?

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

17 Which process is responsible for the greatest loss of energy from Earth's surface into space on a clear night?

- (1) condensation (3) radiation
- (2) conduction (4) convection

18 The timeline below represents time from the present to 20 billion years ago. Letters A, B, C, and D represent specific times.



Which letter on the timeline best represents the time when scientists estimate that the Big Bang occurred?

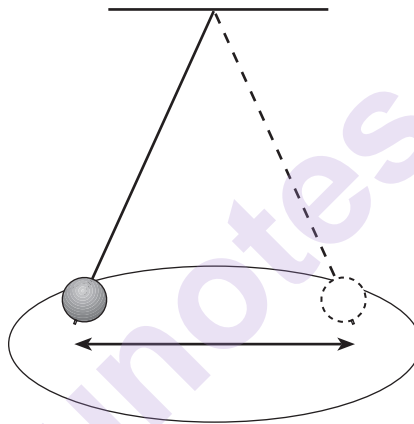
- (1) A

(2) B

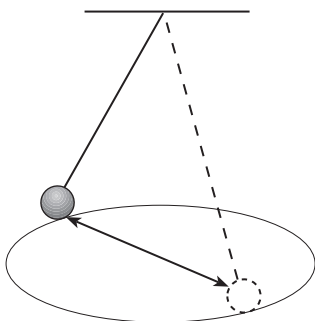
(3) C

(4) D

19 The diagram below represents a Foucault pendulum that is swinging back and forth.

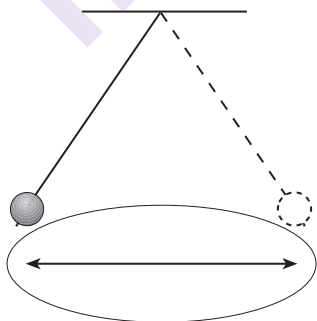


Which diagram best represents the change in the motion of a Foucault pendulum that provides evidence of Earth's rotation?



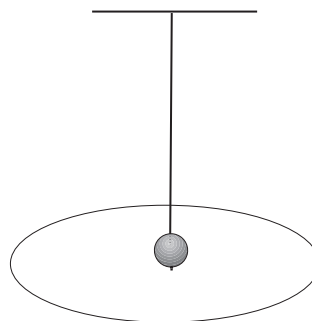
Different direction
of swing

(1)



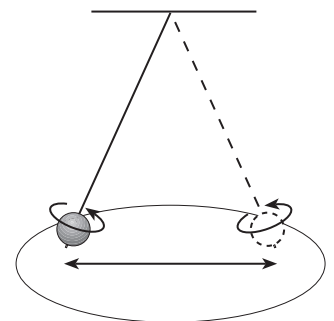
Longer length
of swing

(2)



Swinging stops

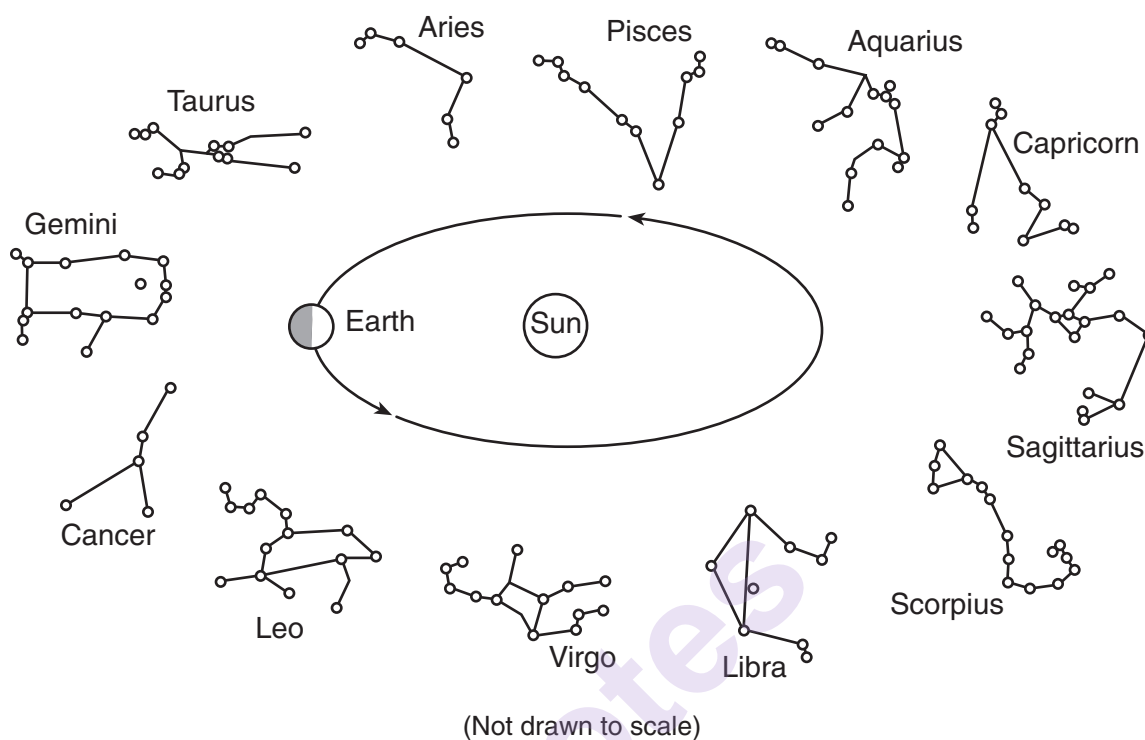
(3)



Begins to spin

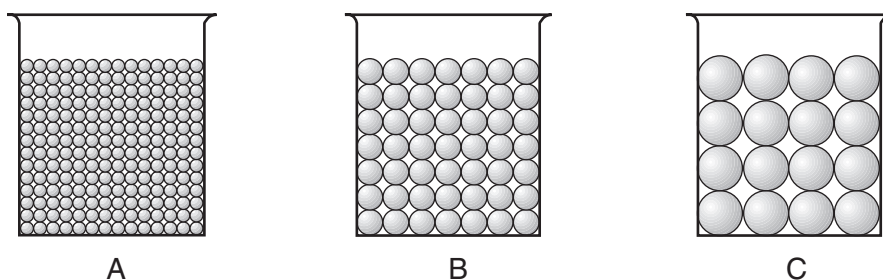
(4)

- 20 The diagram below represents some constellations and one position of Earth in its orbit around the Sun. These constellations are visible to an observer on Earth at different times of the year.



When Earth is located in the orbital position shown, two constellations that are both visible to an observer on Earth at midnight are

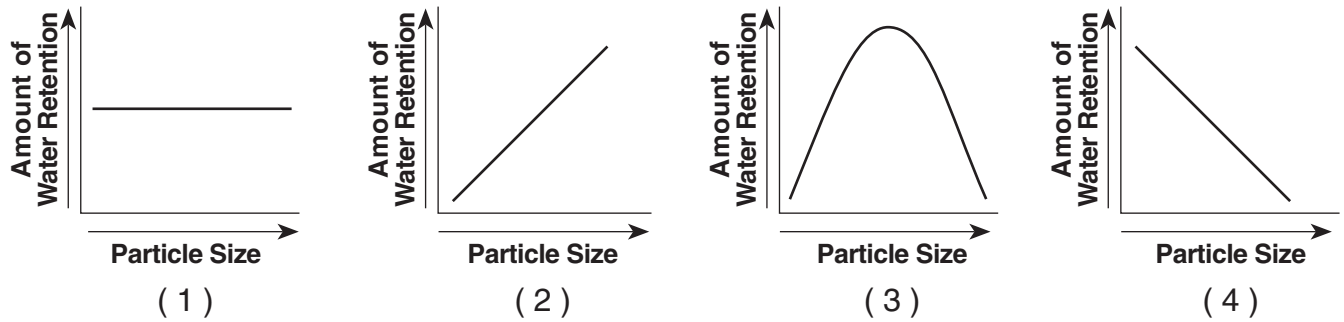
- (1) Libra and Virgo
 - (2) Gemini and Taurus
 - (3) Aquarius and Capricorn
 - (4) Cancer and Sagittarius
- 21 The cross sections below represent three beakers that were used to test porosity. Beakers A, B, and C each contain a different size of bead. Each beaker holds an equal volume of beads. The amount of water needed to fill the total pore space between the beads in each beaker was measured.



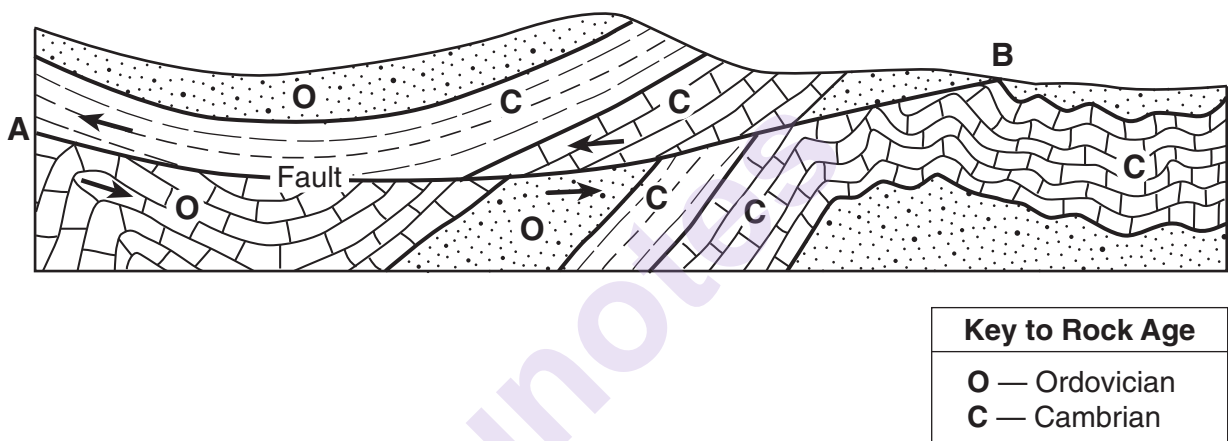
Which statement best describes the porosity that was found for these three samples?

- (1) A had a greater porosity than B and C.
- (2) B had a greater porosity than A and C.
- (3) C had a greater porosity than A and B.
- (4) All three samples had the same porosity.

22 Which graph best indicates the general relationship between soil particle size and the amount of water retention by a permeable soil?



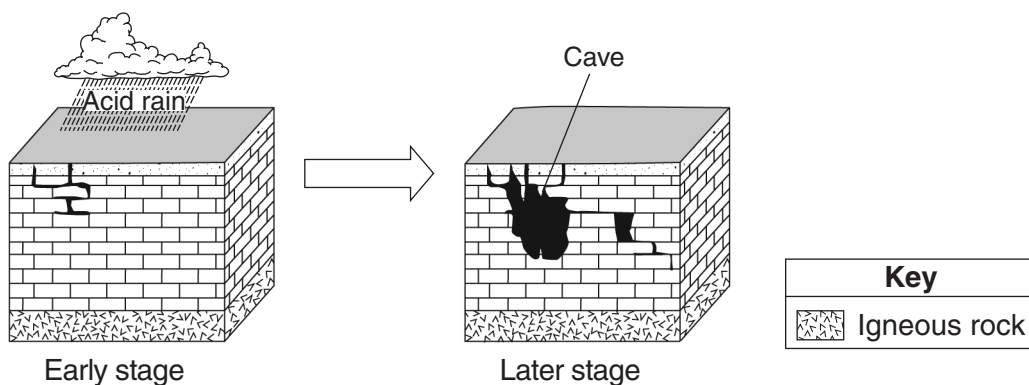
23 The cross section below represents surface bedrock where faulting has occurred along line AB.



When could this faulting have occurred?

- (1) before the Ordovician rocks were deposited
- (2) during the Ordovician period
- (3) before the Cambrian rocks were deposited
- (4) during the Cambrian period

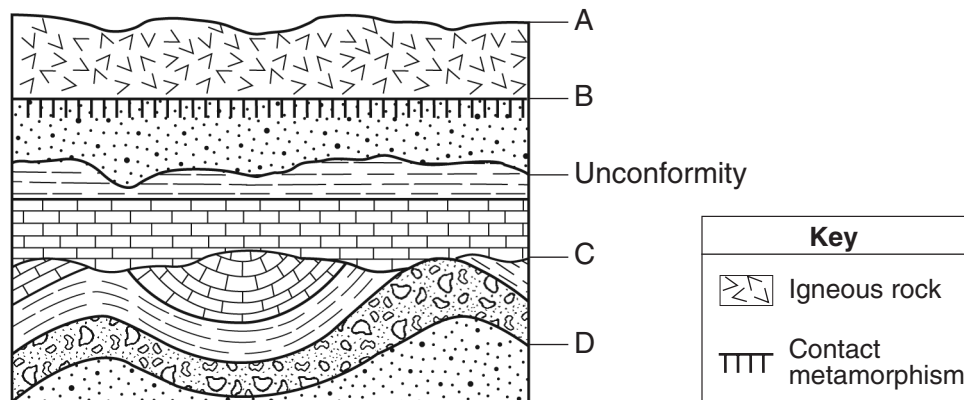
24 The two block diagrams below represent the formation of caves.



Which types of weathering and erosion are primarily responsible for the formation of caves?

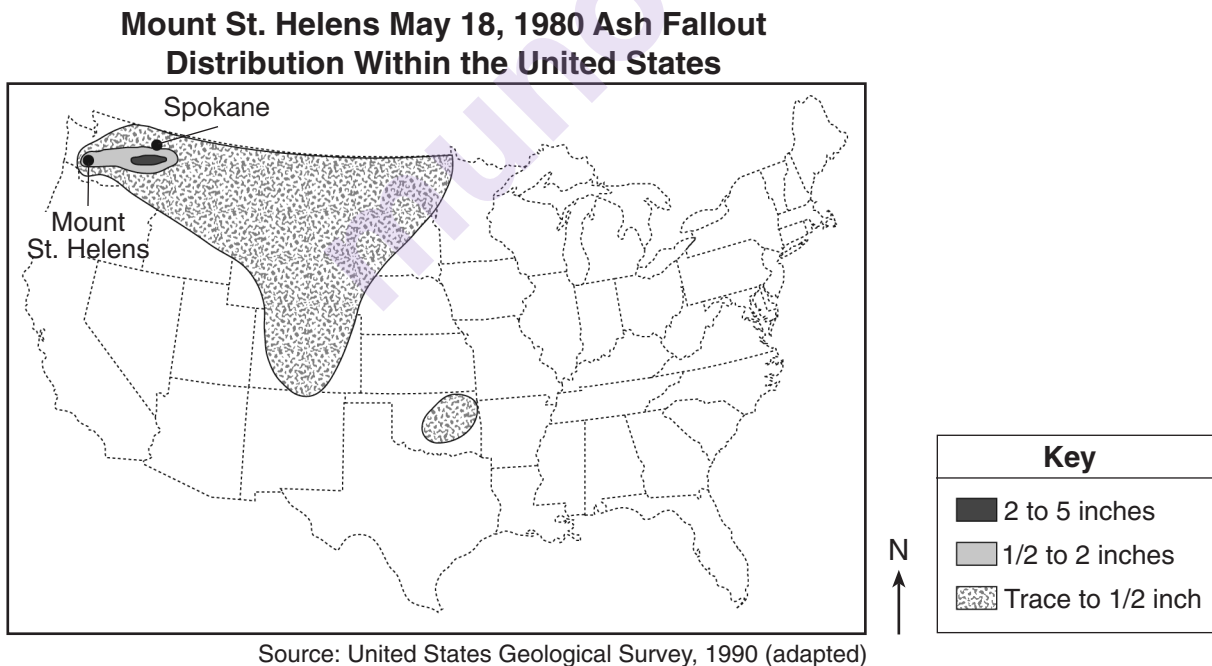
- (1) chemical weathering and groundwater flow
- (2) chemical weathering and runoff
- (3) physical weathering and groundwater flow
- (4) physical weathering and runoff

- 25 The cross section below represents several rock units within Earth's crust. Letter A represents Earth's surface. Letters B, C, and D indicate boundaries between rock units. One of the unconformities is labeled.



Which lettered boundary is most likely another unconformity?

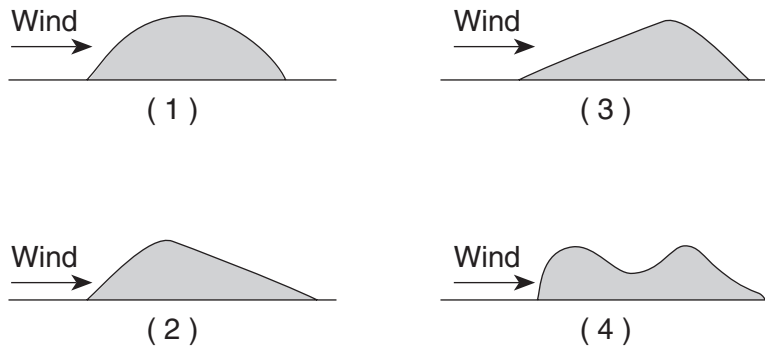
- (1) A (3) C
(2) B (4) D
- 26 The map below shows the distribution of ash across the United States as a result of the May 18, 1980 volcanic eruption of Mount St. Helens.



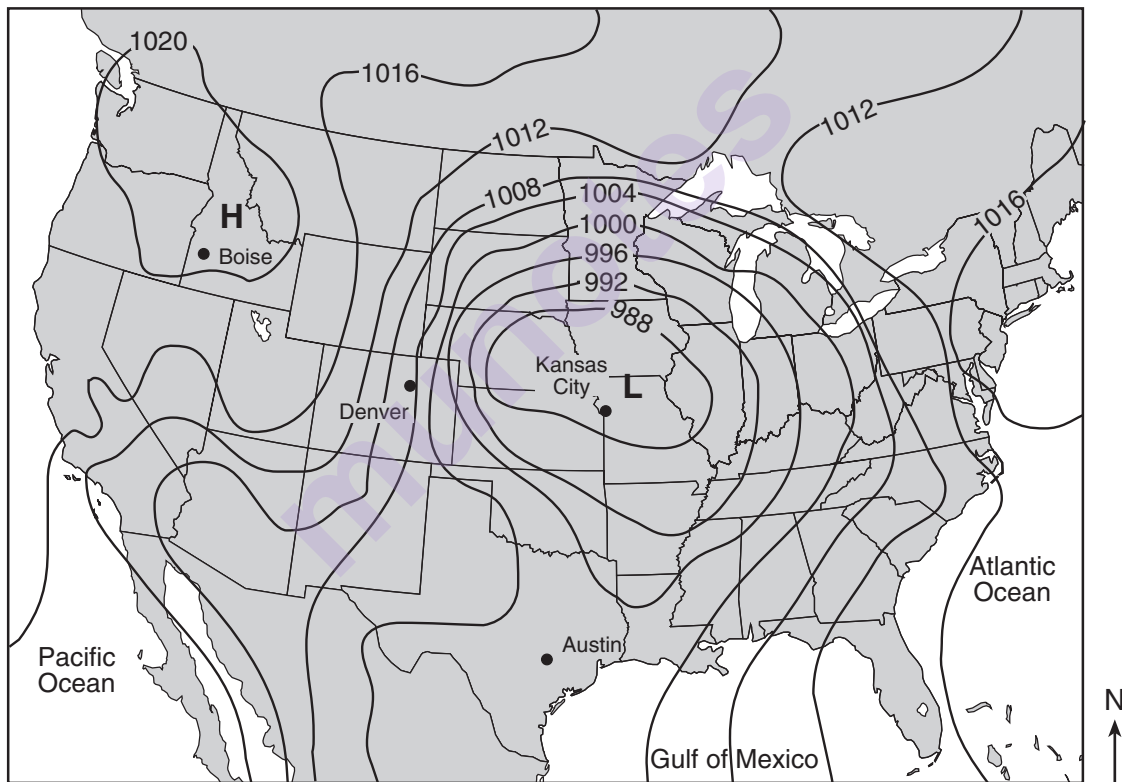
Volcanic ash deposits such as these are usually excellent geologic time markers because they

- (1) occur at regular time intervals
(2) spread over a large area in a short amount of time
(3) represent a time gap in the rock record
(4) contain index fossils from different time periods

27 Which diagram represents a side view of a sand dune most commonly formed as a result of the prevailing wind direction shown?



28 The map below indicates an air-pressure field over North America. Isobar values are recorded in millibars.



At which city was the greatest wind speed occurring?

- (1) Boise
- (2) Denver
- (3) Kansas City
- (4) Austin

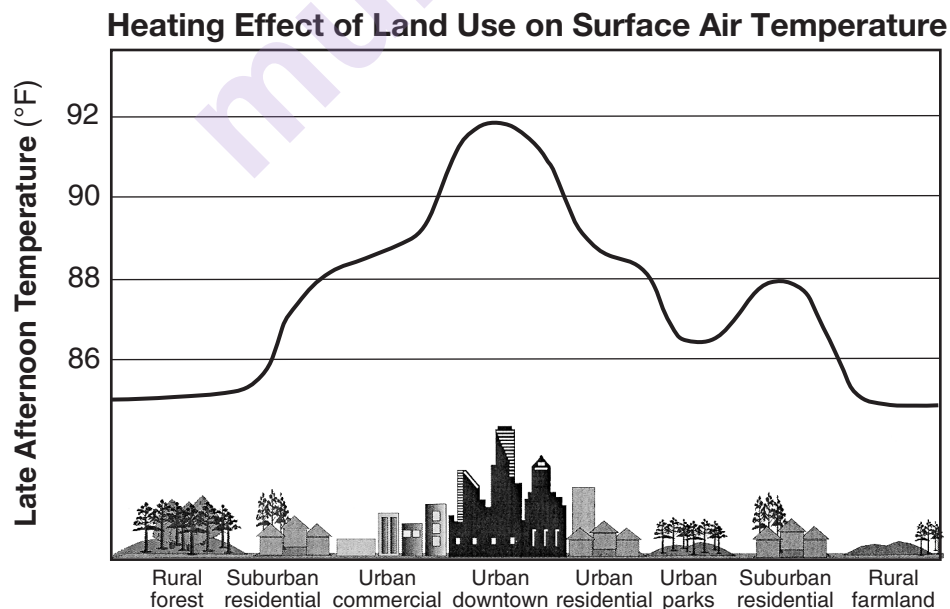
- 29 The striped areas on the map below show regions along the Great Lakes that often receive large amounts of snowfall due to lake-effect storms.



These storms generally develop when

- (1) cold air moves to the east over warmer lake water
- (2) cold air moves to the west over warmer land regions
- (3) warm air moves to the east over colder lake water
- (4) warm air moves to the west over colder land regions

- 30 The graph below shows the heating effect that different land uses have on surface air temperatures on a summer afternoon.

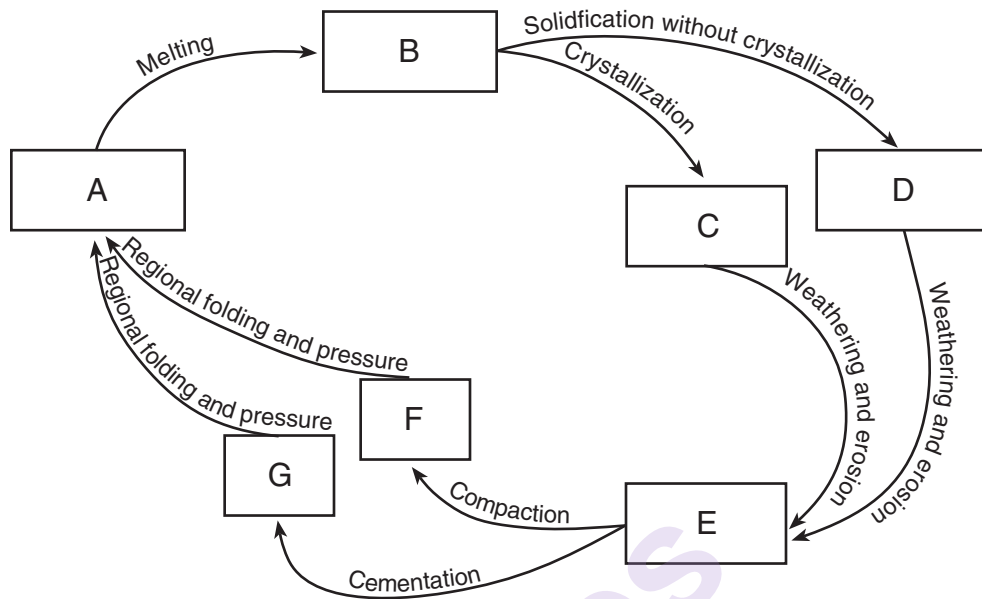


Source: US Global Change Research Program (adapted)

Which land use results in the *least* heating effect in urban areas?

- (1) commercial
- (2) downtown
- (3) residential
- (4) parks

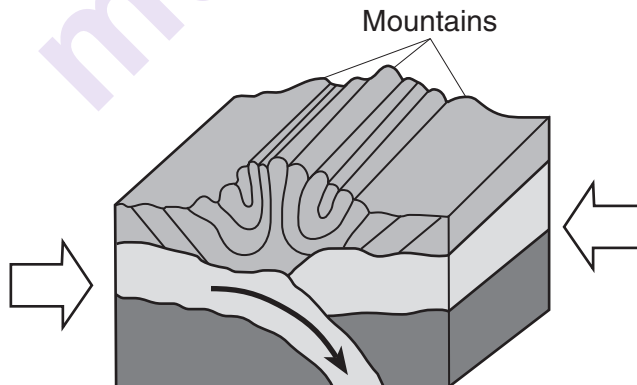
Base your answers to questions 31 and 32 on the flowchart below and on your knowledge of Earth science. The boxes labeled A through G represent rocks and rock materials. Arrows represent the processes of the rock cycle.



31 Which lettered box could represent the rock conglomerate?

- | | |
|-------|-------|
| (1) E | (3) C |
| (2) G | (4) D |

32 The arrows in the block diagram below represent forces forming mountains in a region of Earth's lithosphere.



Metamorphic rocks that formed from these forces are represented by which lettered box in the flowchart?

- | | |
|-------|-------|
| (1) A | (3) E |
| (2) B | (4) F |

33 Which rock is composed of the mineral halite that formed when seawater evaporated?

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

34 Which mineral is mined for its iron content?

- (1) hematite
- (2) fluorite
- (3) galena
- (4) talc

35 The data table below gives characteristics of the gemstone peridot.

Characteristics of Peridot

Luster	nonmetallic
Hardness	6.5
Color	green
Composition	(Fe,Mg) ₂ SiO ₄

Peridot is a form of the mineral

- (1) pyrite
 - (2) pyroxene
 - (3) olivine
 - (4) garnet
-

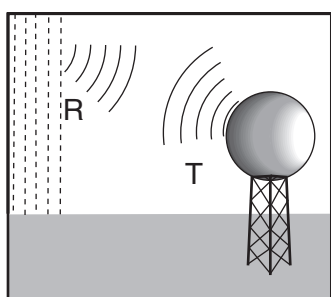
Part B-1

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.

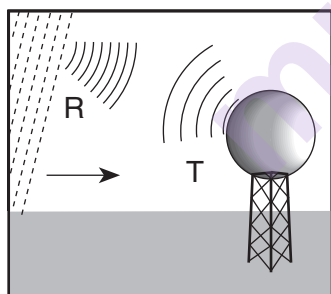
Base your answers to questions 36 through 38 on the diagrams below and on your knowledge of Earth science. The diagrams represent electromagnetic waves being transmitted (T) by a Doppler radar weather instrument and waves being reflected (R) by rain showers. This instrument produces computer images that show the movement of rainstorms.

**A Stationary
Rain Shower**



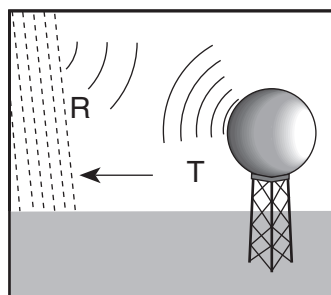
The reflected wavelengths (R) from a stationary rain shower are equal to the transmitted wavelengths (T).

**A Rain Shower Moving
Toward the Instrument**



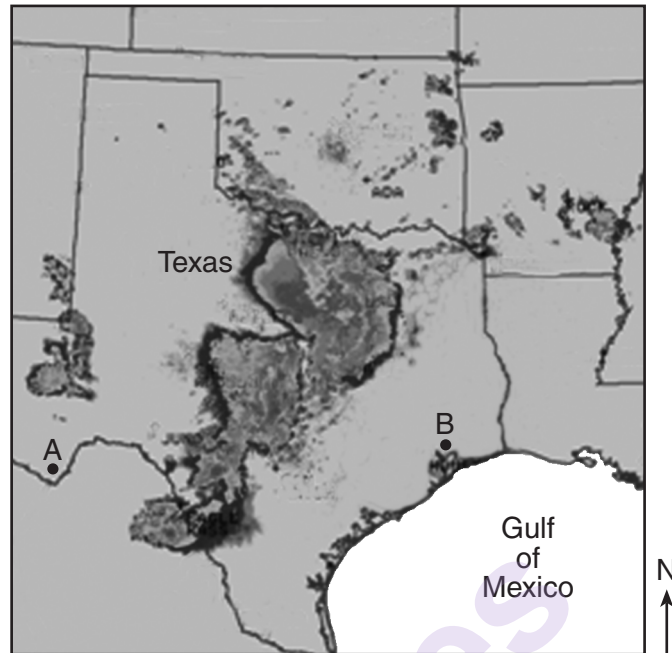
The reflected wavelengths (R) from a rain shower moving toward the instrument are shorter than the transmitted wavelengths (T).

**A Rain Shower
Moving Away from
the Instrument**



The reflected wavelengths (R) from a rain shower moving away from the instrument are longer than the transmitted wavelengths (T).

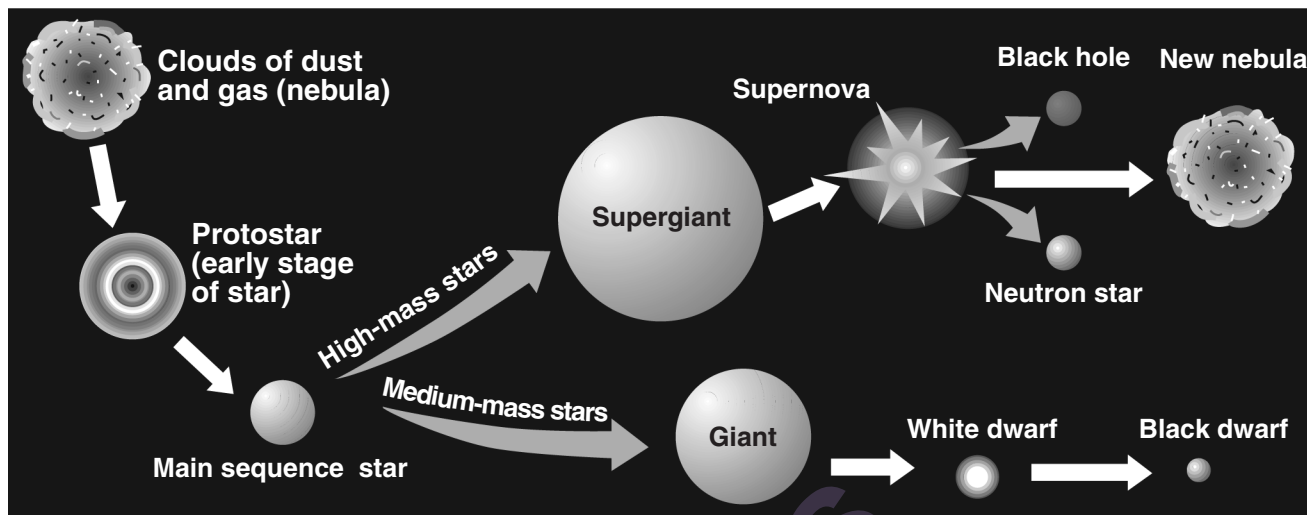
- 36 The computer image below shows a rainstorm over Texas. Letters *A* and *B* represent locations on Earth's surface.



- If Doppler radar is used at locations *A* and *B*, as this rainstorm moves eastward, reflected wavelengths from this storm will be
- (1) shorter at both locations *A* and *B*
 - (2) longer at both locations *A* and *B*
 - (3) shorter at location *A* and longer at location *B*
 - (4) longer at location *A* and shorter at location *B*
- 37 This Doppler radar instrument transmits electromagnetic energy in the form of microwaves. Some microwave wavelengths are between the wavelengths of
- (1) gamma rays and x rays
 - (2) infrared and radio waves
 - (3) ultraviolet and infrared
 - (4) x rays and ultraviolet
- 38 Which weather instrument was used to measure the amount of rainfall from this storm?
- (1) barometer
 - (2) anemometer
 - (3) precipitation gauge
 - (4) wind vane
-

Base your answers to questions 39 through 42 on the diagram below and on your knowledge of Earth science. The diagram represents two possible sequences in the evolution of stars.

Stages of Star Evolution



(Not drawn to scale)

39 What causes clouds of dust and gas to form a protostar?

- (1) magnetism
- (2) gravitational attraction
- (3) expansion of matter
- (4) cosmic background radiation

40 Which property primarily determines whether a giant star or a supergiant star will form?

- (1) mass
- (2) color
- (3) shape
- (4) composition

41 Which table includes data that are characteristic of the surface temperature and luminosity of some white dwarf stars?

Surface Temperature	5000 K
Luminosity	100

(1)

Surface Temperature	10,000 K
Luminosity	100

(3)

Surface Temperature	5000 K
Luminosity	0.001

(2)

Surface Temperature	10,000 K
Luminosity	0.001

(4)

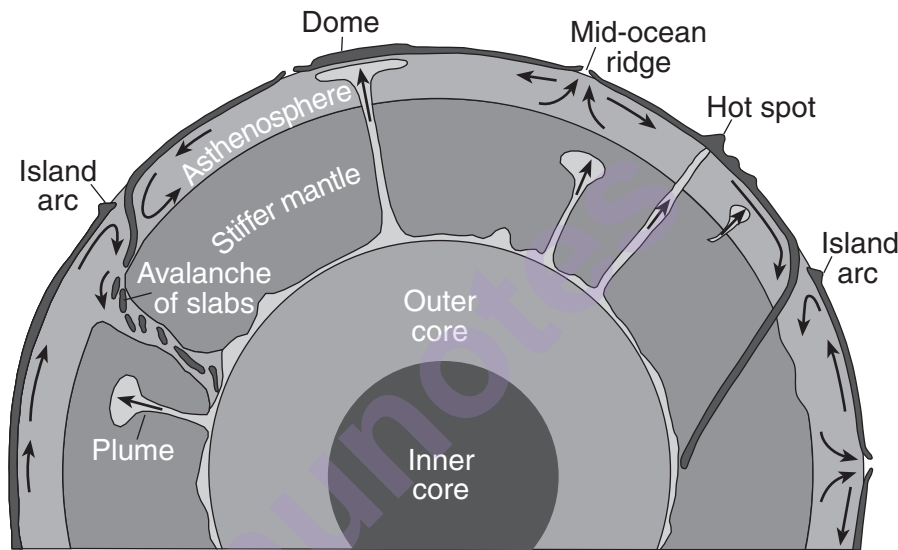
42 Which process generates the energy that is released by stars?

- (1) nuclear fusion
- (2) thermal conduction
- (3) convection currents
- (4) radioactive decay

Base your answers to questions 43 through 45 on the passage and cross section below and on your knowledge of Earth science. The cross section represents one theory of the movement of rock materials in Earth's dynamic interior. Some mantle plumes that are slowly rising from the boundary between Earth's outer core and stiffer mantle are indicated.

Hot Spots and Mantle Plumes

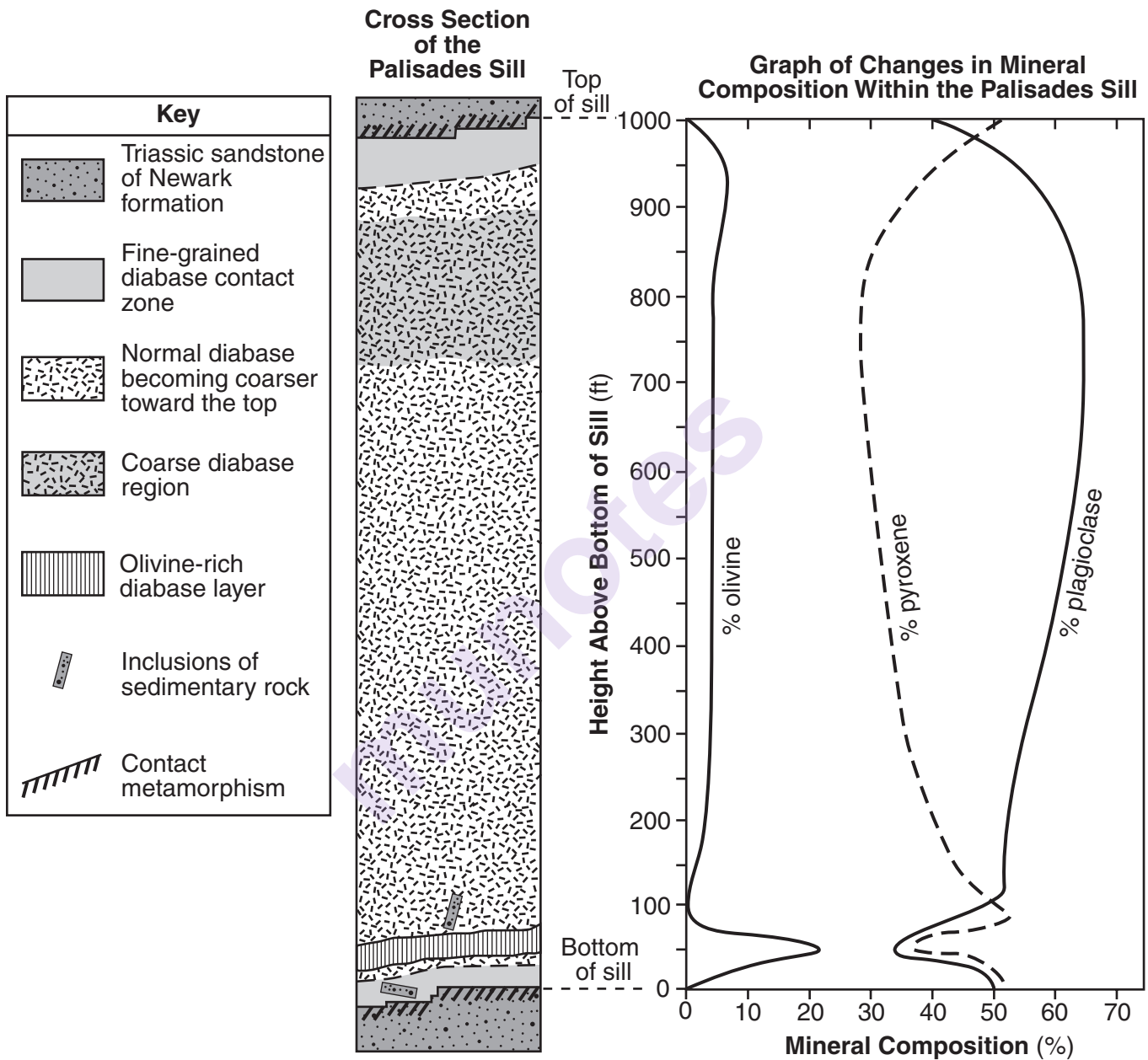
Research of mantle hot spots indicates that mantle plumes form in a variety of sizes and shapes. These mantle plumes range in diameter from several hundred kilometers to 1000 kilometers. Some plumes rise as blobs rather than in a continuous streak; however, most plumes are long, slender columns of hot rock slowly rising in Earth's stiffer mantle. One theory is that most plumes form at the boundary between the outer core and the stiffer mantle. They may reach Earth's surface in the center of plates or at plate boundaries, producing volcanoes or large domes.



(Not drawn to scale)

- 43 Compared to the surrounding material, mantle plumes rise toward Earth's surface from the core-mantle boundary because they are
- | | |
|---------------------------|---------------------------|
| (1) cooler and less dense | (3) hotter and less dense |
| (2) cooler and more dense | (4) hotter and more dense |
- 44 At which depth below Earth's surface is the boundary between Earth's outer core and stiffer mantle located?
- | | |
|-------------|-------------|
| (1) 700 km | (3) 2900 km |
| (2) 2000 km | (4) 5100 km |
- 45 The basaltic rock that forms volcanic mountains where mantle plumes reach Earth's surface is usually composed of
- | | |
|--|---|
| (1) fine-grained, dark-colored felsic minerals | (3) coarse-grained, light-colored felsic minerals |
| (2) fine-grained, dark-colored mafic minerals | (4) coarse-grained, light-colored mafic minerals |

Base your answers to questions 46 through 50 on the geologic cross section and graph below, and on your knowledge of Earth science. The cross section represents the intrusive igneous rock of the Palisades sill and surrounding bedrock located on the west side of the Hudson River across from New York City. The graph indicates changes in the percentages of the major minerals found in the sill.



- 46 The inclusions shown near the bottom of the Palisades sill are pieces of the Triassic sandstone that
- (1) formed from deposits of minerals within the sill
 - (2) crystallized within the sill and were cemented together
 - (3) were part of the olivine-rich layer that broke apart
 - (4) broke off from the surrounding bedrock during the intrusion

- 47 Approximately how far above the bottom of the Palisades sill is the coarse diabase region found?
- (1) 50 ft
 - (2) 400 ft
 - (3) 800 ft
 - (4) 950 ft
- 48 The graph shows that, within the olivine-rich diabase layer near the bottom of the sill, as the percentage of olivine increases, the
- (1) percentages of both plagioclase and pyroxene decrease
 - (2) percentages of both plagioclase and pyroxene increase
 - (3) percentage of plagioclase decreases and the percentage of pyroxene increases
 - (4) percentage of plagioclase increases and the percentage of pyroxene decreases
- 49 The Palisades sill intruded as North America began the process of separating from Africa and Europe as Pangaea was breaking apart. Approximately when did these events occur?
- (1) 65 million years ago
 - (2) 200 million years ago
 - (3) 299 million years ago
 - (4) 400 million years ago
- 50 Which two minerals, *not* shown on the Graph of Changes in Mineral Composition Within the Palisades Sill, are also likely to be found in some other samples of diabase?
- (1) amphibole and potassium feldspar
 - (2) potassium feldspar and quartz
 - (3) quartz and biotite
 - (4) biotite and amphibole
-

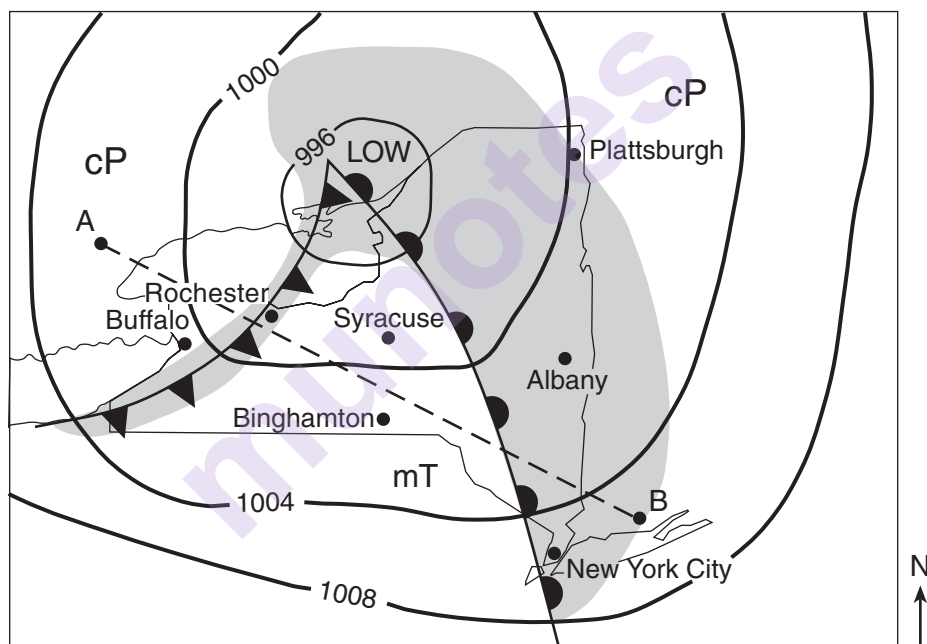
Part B–2

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*.

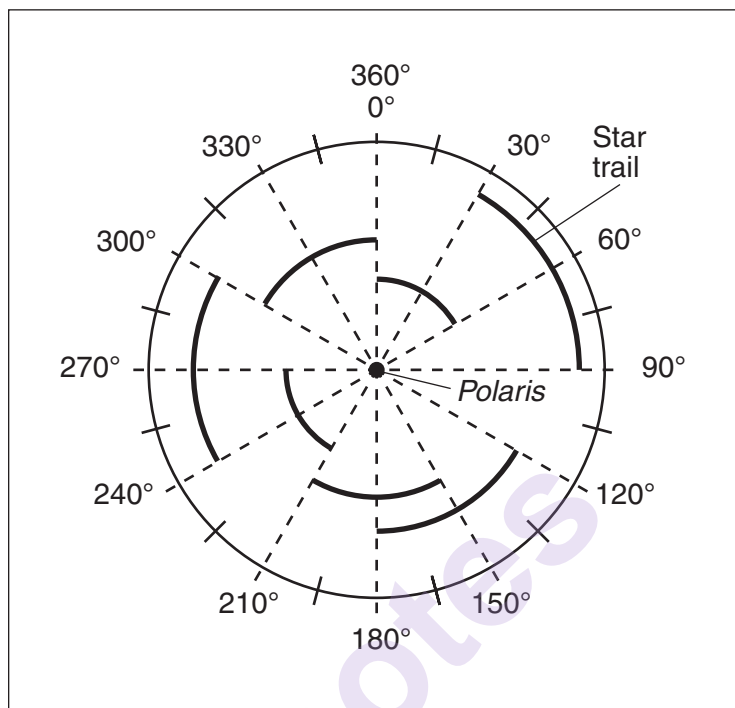
- 51 Describe the effect that global warming most likely will have on *both* present-day glaciers and sea level. [1]
-

Base your answers to questions 52 and 53 on the weather map below and on your knowledge of Earth science. The map indicates the location of a low-pressure system over New York State during late summer. Isobar values are recorded in millibars. Shading indicates regions receiving precipitation. The air masses are labeled mT and cP. The locations of some New York State cities are shown. Points A and B represent other locations on Earth's surface.



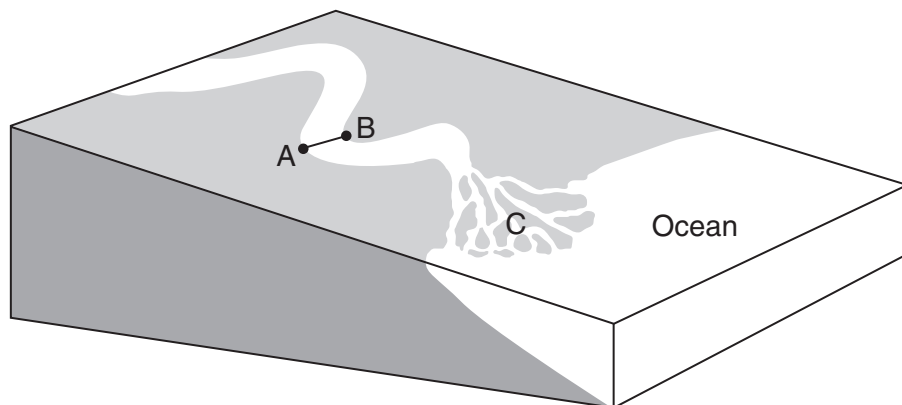
- 52 An air mass acquires the characteristics of the surface over which it forms. *In your answer booklet*, circle the type of Earth surface (land or ocean) and describe the relative temperature of the surface over which the mT air mass most likely formed. [1]
- 53 The cross section *in your answer booklet* represents the atmosphere along the dashed line from A to B on the map. The warm frontal boundary is already shown on the cross section. Draw a curved line to represent the shape and location of the cold frontal boundary. [1]
-

Base your answers to questions 54 through 57 on the diagram below and on your knowledge of Earth science. The diagram represents a time-exposure photograph taken by aiming a camera at *Polaris* in the night sky and leaving the shutter open for a period of time to record star trails. The angular arcs (star trails) show the apparent motions of some stars.



- 54 Identify the motion of Earth that causes these stars to appear to move in a circular path. [1]
- 55 Determine the number of hours it took to record the star trails labeled on the diagram. [1]
- 56 The diagram in your answer booklet represents Earth as viewed from space. The dashed line indicates Earth's axis. Some latitudes are labeled. On the diagram *in your answer booklet*, draw an arrow that points from the North Pole toward *Polaris*. [1]
- 57 Record, to the *nearest whole degree*, the altitude of *Polaris* when it is viewed from the top of New York State's Mt. Marcy. [1]
-

Base your answers to questions 58 through 61 on the block diagram below and on your knowledge of Earth science. The diagram represents a meandering stream flowing into the ocean. Points *A* and *B* represent locations along the streambanks. Letter *C* indicates a triangular-shaped depositional feature where the stream enters the ocean.



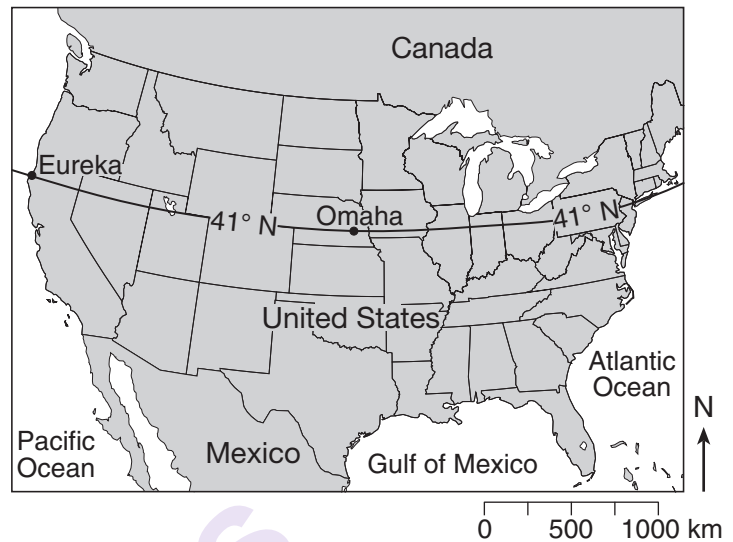
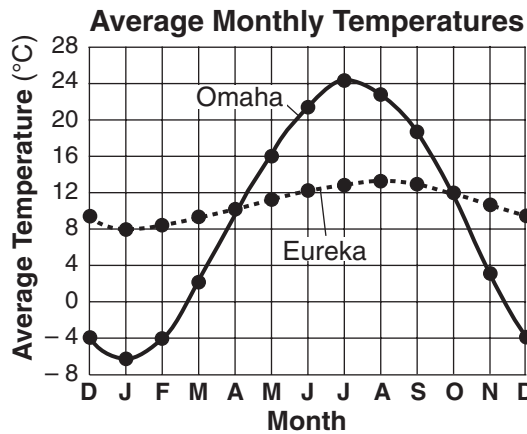
58 The top of the box *in your answer booklet* represents the stream surface between points *A* and *B*. In the box, draw a line from point *A* to point *B* to represent a cross-sectional view of the shape of the bottom of the stream channel. [1]

59 Explain how sediments eroded by the water in this stream become smoother and rounder in shape. [1]

60 Identify the triangular-shaped depositional feature indicated by letter *C*. [1]

61 Identify *two* factors that determine the rate of stream erosion. [1]

Base your answers to questions 62 through 65 on the graph and map below and on your knowledge of Earth science. The average monthly temperatures for Eureka, California, and Omaha, Nebraska, are plotted on the graph. The map indicates the locations of these two cities.



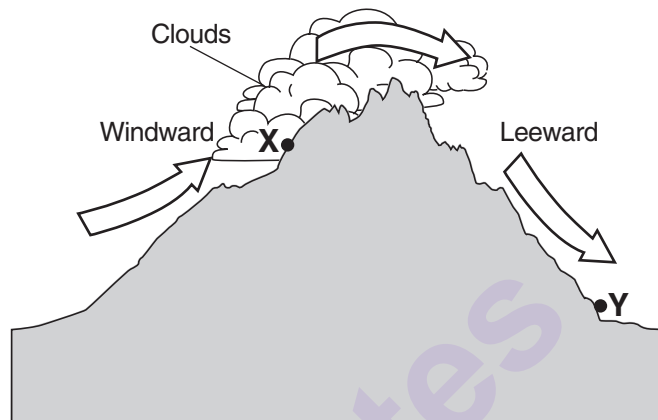
- 62 Calculate the rate of change in the average monthly temperature for Omaha during the two-month period between October and December, as shown on the graph. [1]
- 63 Explain why Omaha, which is farther inland, has a greater variation in temperatures throughout the year than Eureka, which is closer to the ocean. [1]
- 64 Identify the month with the greatest difference in the average temperature between these two cities. [1]
- 65 Identify the surface ocean current that affects the climate of Eureka. [1]
-

Part C

Answer all questions in this part.

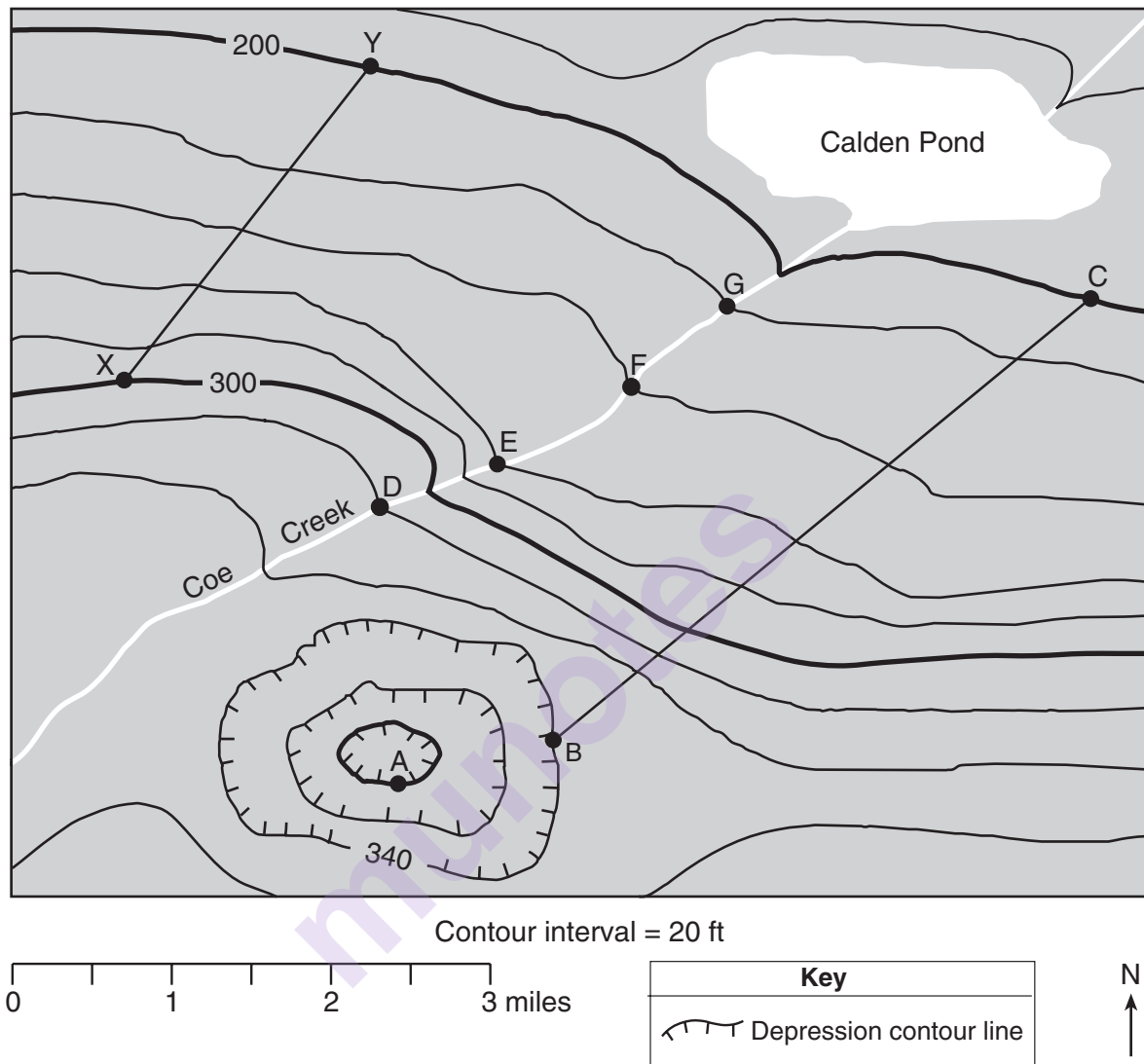
Directions (66–85): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Earth Science*.

- 66 The cross section below represents the windward and leeward sides of a mountain range. Arrows show the movement of air over a mountain. Points X and Y represent locations on Earth's surface.



Describe how the air's temperature and water vapor content at point X is different from the air's temperature and water vapor content at point Y. [1]

Base your answers to questions 67 through 71 on the topographic map below and on your knowledge of Earth science. Point A represents a location on Earth's surface. Lines BC and XY are reference lines on the map. Points D, E, F, and G represent locations along Coe Creek. Elevations are shown in feet.



- 67 What is the elevation of location A? [1]
- 68 On the grid in *your answer booklet*, construct a topographic profile of the land surface along the line from point B to point C. Plot the elevation of *each* contour line that crosses line BC. Connect *all nine* plots with a line to complete the profile. [1]
- 69 Describe the evidence shown on the map that indicates Coe Creek flows toward the northeast. [1]
- 70 Describe how the contour lines indicate that Coe Creek flows faster between locations D and E than between locations F and G. [1]
- 71 Calculate the gradient along line XY. Label your answer with the correct units. [1]

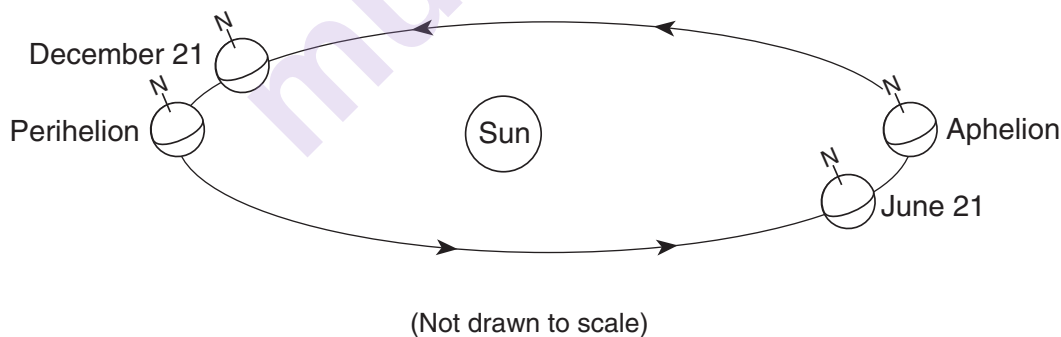
Base your answers to questions 72 through 76 on the modified Mercalli scale of earthquake intensity below, on the map of Japan in your answer booklet, and on your knowledge of Earth science. The modified Mercalli scale classifies earthquake intensity based on observations made during an earthquake. The map indicates the modified Mercalli scale intensity values recorded at several locations in Japan during the March 11, 2011 earthquake, which triggered destructive tsunamis in the Pacific Ocean.

Modified Mercalli Scale of Earthquake Intensity

Intensity Value	Description of Effects
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Parked cars may rock slightly. Vibrations similar to the passing of a truck.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Parked cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage minimal in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage with partial collapse in ordinary substantial buildings. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures tilted. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Most masonry and frame structures and foundations are destroyed. Train rails bent.
XI	Few, if any, structures remain standing. Bridges destroyed. Train rails bent greatly.
XII	Damage total. Objects thrown into the air.

- 72 On the map *in your answer booklet*, a line has been drawn to separate regions with Mercalli values of V from regions with Mercalli values of VI. Draw *another* line to separate regions with Mercalli values of VI from regions with Mercalli values of VII. [1]
- 73 Your answer booklet lists some observations that might be made during an earthquake according to the modified Mercalli scale. *In your answer booklet*, place a check mark (✓) in the box if that observation most likely was recorded at Yamagata during the March 11, 2011 earthquake. More than one box may be checked. [1]
- 74 The epicenter of this earthquake was located at 38° N 142° E. Identify the type of tectonic plate boundary that is located nearest to the epicenter of this earthquake. [1]
- 75 Describe *one* way the *P*-waves and *S*-waves recorded on seismograms at Ishinomaki and Nagano were used to indicate that Ishinomaki was closer to the earthquake epicenter than was Nagano. [1]
- 76 A 25-foot high tsunami hit the Japanese city of Ishinomaki. Describe a precaution the city could take now to protect citizens from tsunamis in future years. [1]
-

Base your answers to questions 77 and 78 on the diagram below, which represents an exaggerated model of the shape of Earth's orbit, and on your knowledge of Earth science. The positions of Earth in its orbit on December 21 and June 21 are indicated. The positions of perihelion (when Earth is closest to the Sun) and aphelion (when Earth is farthest from the Sun) are also indicated. Both perihelion and aphelion occur approximately two weeks after the dates shown.



- 77 How many months after Earth's perihelion position does Earth's aphelion position occur? [1]
- 78 Explain why warm summer temperatures occur in New York State when Earth is at aphelion. [1]
-

Base your answers to questions 79 through 82 on the passage and chart below, and on your knowledge of Earth science. The chart identifies some human species and the times when they are believed to have existed.

Human Species

Modern humans, *Homo sapiens*, appear to have evolved through several species of earlier members of the genus *Homo*. Each of these human species possessed specific features that made that species distinct. Many lived in (or at least have been discovered in) specific geographic areas, and existed for specific time ranges shown in the chart. In many cases, fossil remains are partial, often consisting of only teeth and skulls. Interpretation of human evolution continues to change with new discoveries.

Human Species Distributed Through Time

Human Species	Time of Existence from Fossil Evidence (million years ago)
<i>Homo sapiens</i>	0.25 to the present
<i>Homo neanderthalensis</i>	0.35 to 0.03
<i>Homo rhodesiensis</i>	0.6 to 0.1
<i>Homo heidelbergensis</i>	0.6 to 0.3
<i>Homo mauritanicus</i>	1.2 to 0.6
<i>Homo erectus</i>	1.5 to 0.2
<i>Homo ergaster</i>	1.8 to 1.25
<i>Homo habilis</i>	2.25 to 1.4

79 Complete the graph in your answer booklet by drawing a bar to represent the time span that *each* human species existed. The bars for the first four species listed have already been drawn. [1]

80 Which human species shown in the chart was the first to exist? [1]

81 One species of the genus *Homo* could have evolved directly from another species of the genus *Homo* only if the other species:

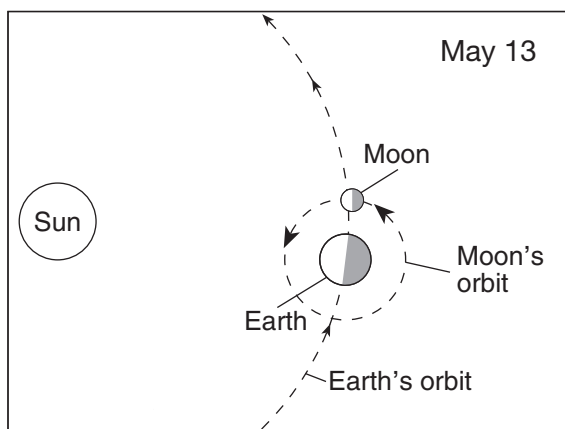
- existed before the new species appeared
- did not become extinct before the new species appeared

Identify *two* species of the genus *Homo* from which *Homo neanderthalensis* may have directly evolved. [1]

82 During which geologic epoch did the *Homo mauritanicus* species exist? [1]

Base your answers to questions 83 through 85 on the diagrams and tables below and on your knowledge of Earth science. Each diagram represents the Moon's orbital position and each table lists times of high and low tides and tide heights, in meters, at New York City for the date shown.

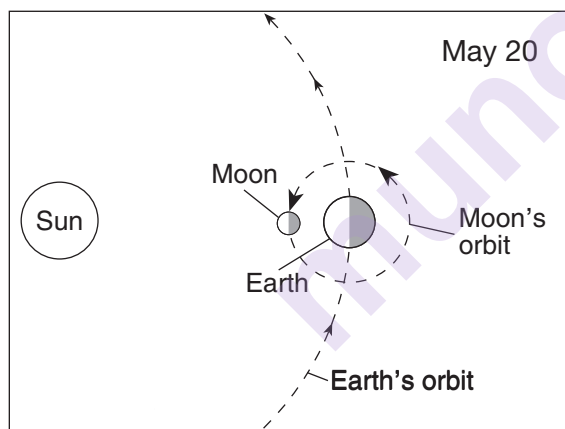
Moon's Orbital Position and Tide Data on May 13



(Not drawn to scale)

Tide	Time	Height (m)
high	12:59 a.m.	1.92
low	7:15 a.m.	0.37
high	1:32 p.m.	2.07
low	7:59 p.m.	0.27

Moon's Orbital Position and Tide Data on May 20



(Not drawn to scale)

Tide	Time	Height (m)
low	1:22 a.m.	0.06
high	7:50 a.m.	2.47
low	2:10 p.m.	0.09
high	8:10 p.m.	2.21

83 Determine the length of time between the two high tides shown for May 13. [1]

84 On the diagram *in your answer booklet*, shade the portion of the Moon that is in darkness to observers in New York City on May 13. [1]

85 On the diagram *in your answer booklet*, place an **X** on the Moon's orbit to represent the location of the Moon on May 28. [1]

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