

PHYSICAL SETTING EARTH SCIENCE

Friday, August 17, 2018 — 8:30 to 11:30 a.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.

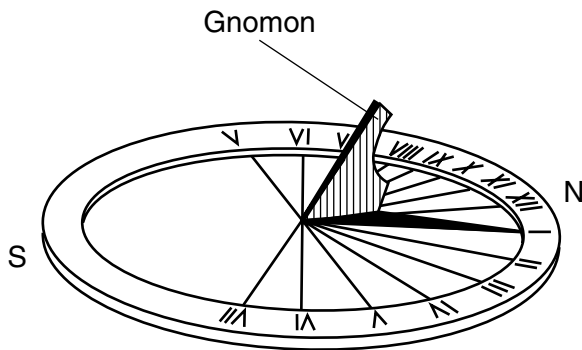
DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.

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.

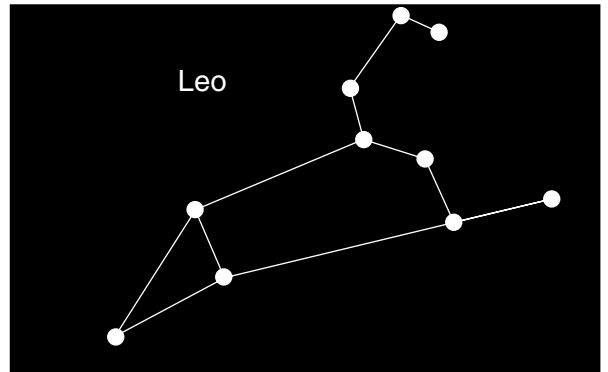
- 1 The diagram below represents a sundial positioned in New York State. During daylight, the shadow cast by the gnomon (pointer) moves across the disc, with the tip of the shadow pointing to the time of day.



This motion of the gnomon's shadow on the sundial is mainly due to

- (1) Earth's rotation
 - (2) Earth's revolution
 - (3) the Sun's rotation
 - (4) the Sun's revolution
- 2 The formation of the planet Uranus is estimated to have occurred approximately
- (1) 100,000 million years ago
 - (2) 2.0 billion years ago
 - (3) 4.6 billion years ago
 - (4) 13.7 billion years ago
- 3 Compared to the Jovian planets in our solar system, the terrestrial planets have
- (1) less mass and are less dense
 - (2) less mass and are more dense
 - (3) more mass and are less dense
 - (4) more mass and are more dense

- 4 The diagram below represents the constellation Leo that can be seen by an observer in New York State at midnight during March.



Leo is *not* visible to this observer at midnight during September because

- (1) Leo has rotated on its axis
 - (2) Leo has revolved in its orbit around the Sun
 - (3) Earth has rotated on its axis
 - (4) Earth has revolved in its orbit around the Sun
- 5 An observer in New York City measured the angle of insolation at solar noon each day. During which month did this observer see the noontime angle of insolation increase each day?
- (1) April
 - (2) July
 - (3) September
 - (4) December
- 6 The Coriolis effect occurs as a result of Earth's
- (1) rotation
 - (2) revolution
 - (3) tilted axis
 - (4) magnetic field

7 During the process of condensation, water vapor

- (1) releases 334 J/g of heat energy
- (2) releases 2260 J/g of heat energy
- (3) gains 334 J/g of heat energy
- (4) gains 2260 J/g of heat energy

8 Infiltration is generally greater than runoff where the land has a

- (1) gentle slope and permeable soil
- (2) gentle slope and impermeable bedrock
- (3) steep slope and permeable soil
- (4) steep slope and impermeable bedrock

9 Nearly 90% of the water vapor that enters Earth's atmosphere comes from the evaporation of Earth's surface waters. Most of the remaining 10% is water vapor that enters the atmosphere through

- (1) precipitation from clouds
- (2) transpiration from plants
- (3) condensation within the troposphere
- (4) melting of polar ice caps

10 What is the relative humidity if the dry-bulb temperature is 26°C and the wet-bulb temperature is 18°C?

- (1) 13 %
- (2) 33 %
- (3) 45 %
- (4) 51 %

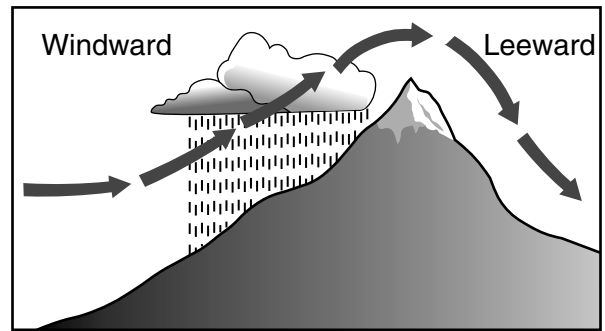
11 Most of the long-wave energy radiated from Earth and lost to space on a cloudless night is

- (1) ultraviolet
- (2) infrared
- (3) visible light
- (4) gamma rays

12 In addition to carbon dioxide, two other major greenhouse gases in Earth's atmosphere are

- (1) oxygen and nitrogen
- (2) oxygen and methane
- (3) water vapor and nitrogen
- (4) water vapor and methane

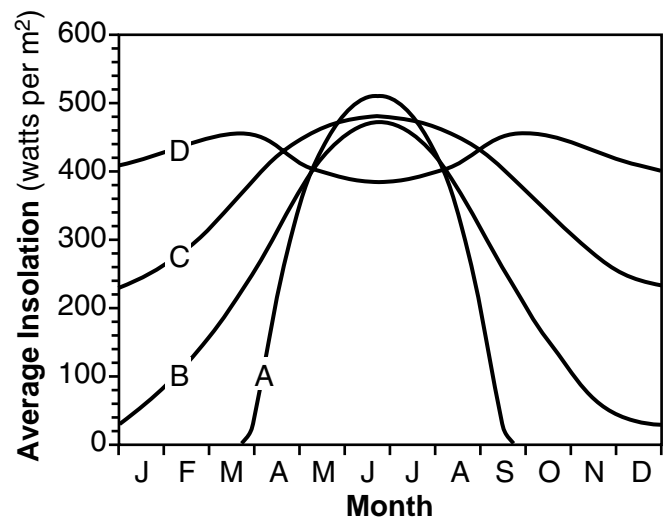
13 The arrows in the diagram below represent the movement of air over a mountain.



Clouds are forming on the windward side of this mountain because the air is

- (1) expanding and cooling to the dewpoint
- (2) expanding and warming to the dewpoint
- (3) compressing and cooling to the dewpoint
- (4) compressing and warming to the dewpoint

14 The graph below shows the average monthly amount of insolation received throughout a year at four locations (A, B, C, and D) on Earth.



Which line on the graph best represents the average monthly insolation received at the equator?

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

15 Earth's polar regions have cold, dry climates because the Sun's rays are at a

- (1) low angle, and upper atmospheric air is sinking
- (2) low angle, and upper atmospheric air is rising
- (3) high angle, and lower atmospheric air is sinking
- (4) high angle, and lower atmospheric air is rising

16 Atmospheric transparency will increase when

- (1) volcanic eruptions occur
- (2) fog is produced
- (3) insolation is reflected by clouds
- (4) precipitation removes dust particles from the air

17 The existence of which group of organisms spans the shortest geologic time?

- (1) birds
- (2) humans
- (3) dinosaurs
- (4) placoderm fish

18 Which New York State geologic event occurred most recently?

- (1) Taconian orogeny
- (2) Grenville orogeny
- (3) formation of the Catskill delta
- (4) dome-like uplift of the Adirondack region

19 The only dinosaur fossils found in New York State are footprints found on 210-million-year-old bedrock. In which New York State landscape region were these dinosaur fossils found?

- (1) Tug Hill Plateau
- (2) Newark Lowlands
- (3) Allegheny Plateau
- (4) Adirondack Mountains

20 The first *P*-wave of an earthquake travels 5600 kilometers from the epicenter and arrives at a seismic station at 10:05 a.m. At what time did this earthquake occur?

- (1) 9:49 a.m.
- (2) 9:56 a.m.
- (3) 10:02 a.m.
- (4) 10:14 a.m.

21 The photograph below shows a New York State index fossil.



What is the best classification of this fossil, and during which geologic time period did the organism that produced this fossil exist?

- (1) Classification: Coral
Geologic time period: Permian
- (2) Classification: Coral
Geologic time period: Ordovician
- (3) Classification: Trilobite
Geologic time period: Permian
- (4) Classification: Trilobite
Geologic time period: Ordovician

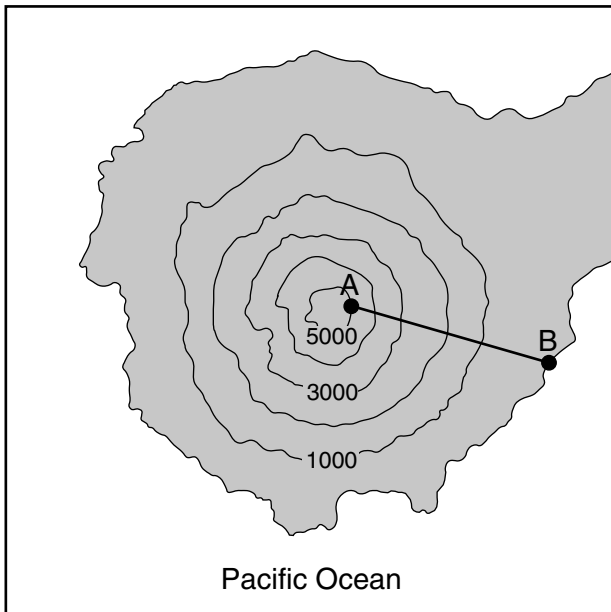
22 As a quartz pebble is transported by a stream, the pebble will become more rounded as a result of

- (1) dissolving as water is running over the rock
- (2) abrasion by colliding with other rocks
- (3) deposition in well-sorted layers
- (4) resistance to weathering and erosion

23 Which three minerals are most likely used in the construction of a house?

- (1) graphite, pyrite, and halite
- (2) garnet, galena, and sulfur
- (3) talc, amphibole, and fluorite
- (4) selenite gypsum, dolomite, and muscovite mica

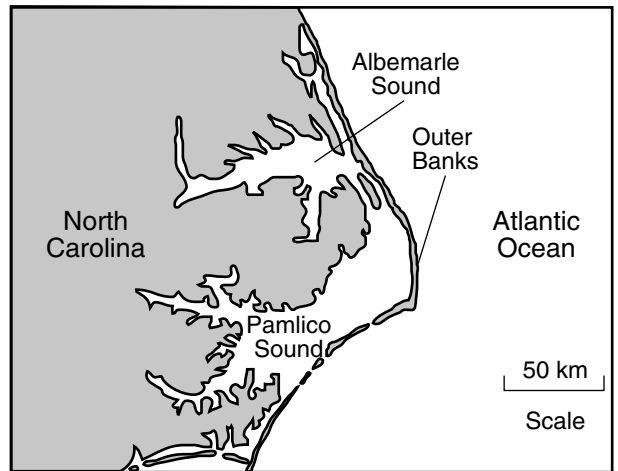
- 24 The topographic map below shows a portion of a volcanic island in the Pacific Ocean. Elevations are shown in feet. Letters A and B represent locations on Earth's surface. Locations A and B are 2.5 miles apart.



What is the approximate gradient from point A to point B on the island?

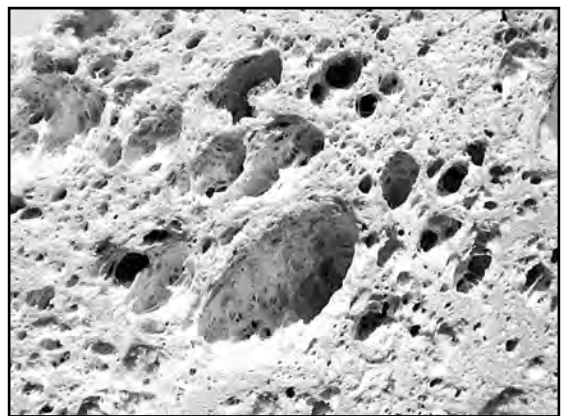
- (1) 1000 ft/mi (3) 2000 ft/mi
 (2) 1250 ft/mi (4) 2500 ft/mi
- 25 Which two rocks usually consist of only one mineral, but may contain additional minerals?
- (1) hornfels and diorite
 (2) quartzite and dunite
 (3) rock salt and basalt
 (4) gabbro and bituminous coal
- 26 Which rock has never melted, but was produced by great heat and pressure, which distorted and rearranged its minerals?
- (1) siltstone (3) pegmatite
 (2) breccia (4) metaconglomerate

- 27 The map below shows a portion of the North Carolina coastline, including some of the Outer Banks. The Outer Banks is a string of narrow barrier islands consisting of well-sorted sand along the Atlantic Ocean coast.



Which agent of erosion is primarily responsible for the formation of these barrier islands?

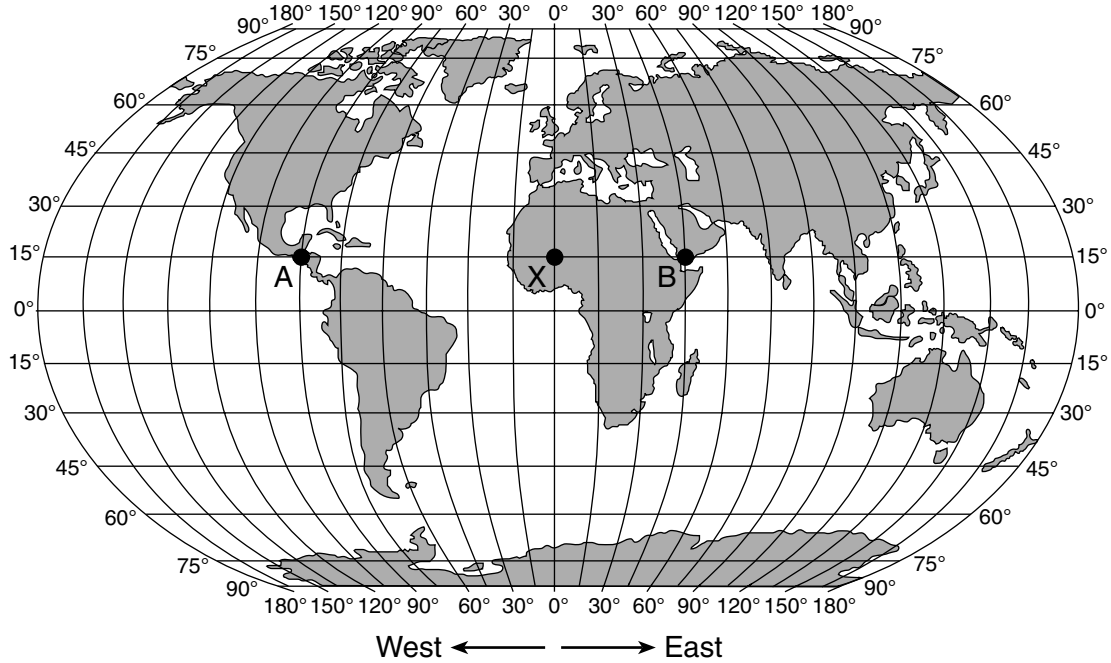
- (1) wave action (3) streams
 (2) landslides (4) glacial ice
- 28 The photograph below shows a magnified view of a portion of a rock that can float if placed in water.



Which terms best describe this rock?

- (1) non-crystalline and vesicular
 (2) coarse and non-vesicular
 (3) clastic and fragmental
 (4) foliated and banded

29 The map below shows three locations, labeled A, X, and B, on Earth's surface.



Which table correctly indicates the solar times at locations A and B when it is 12 noon at location X?

Location	Solar Time
A	6 a.m.
B	9 a.m.

(1)

Location	Solar Time
A	6 p.m.
B	9 a.m.

(3)

Location	Solar Time
A	6 a.m.
B	3 p.m.

(2)

Location	Solar Time
A	6 p.m.
B	3 p.m.

(4)

30 Which equation is used to determine the approximate rate of Earth's revolution?

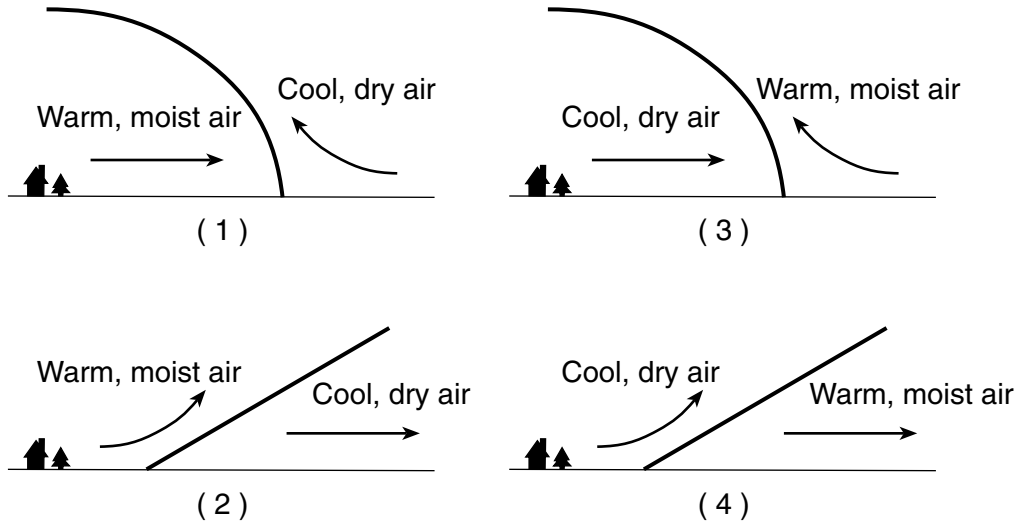
(1) Approximate rate of Earth's revolution = $\frac{365^\circ}{360 \text{ days}}$

(2) Approximate rate of Earth's revolution = $\frac{360^\circ}{24 \text{ hours}}$

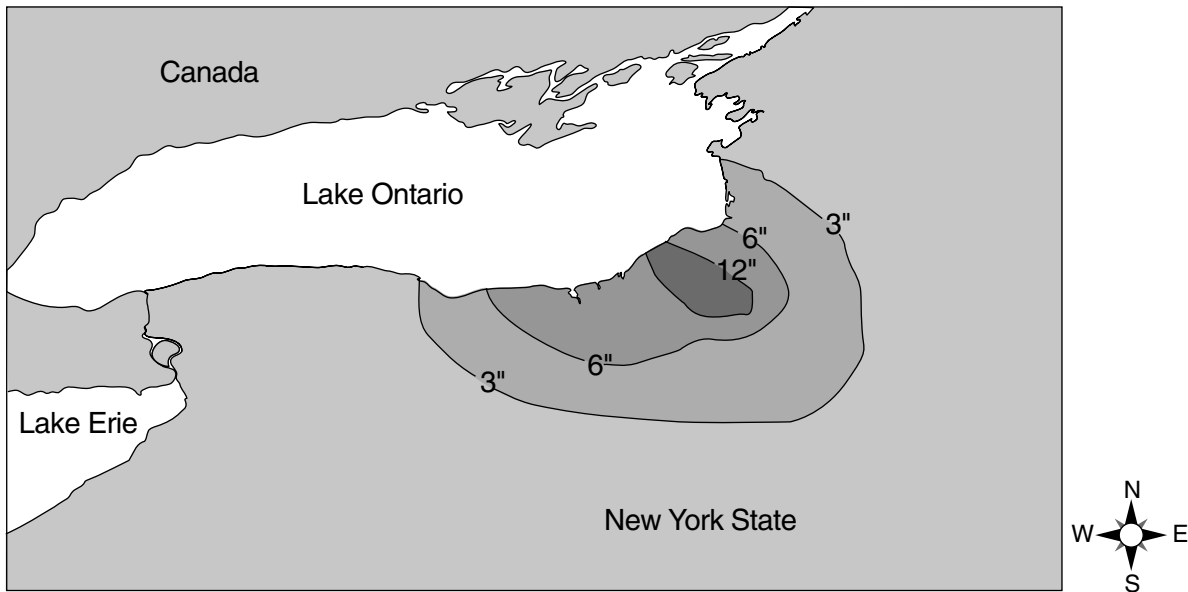
(3) Approximate rate of Earth's revolution = $\frac{360^\circ}{365 \text{ days}}$

(4) Approximate rate of Earth's revolution = $\frac{24^\circ}{360 \text{ hours}}$

31 Which cross section best represents a cold front?



32 The isolines on the map below show snowfall totals from a lake-effect storm that affected a portion of New York State.



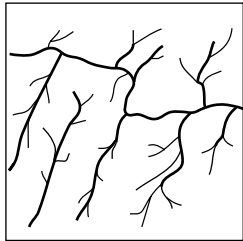
The surface winds that produced this storm came from which direction?

- (1) northwest
- (2) northeast
- (3) southeast
- (4) southwest

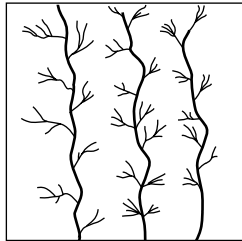
33 The photograph below shows Mount Rainier, a volcano in the state of Washington.



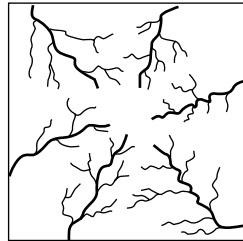
Which map best shows the complete stream drainage pattern for this mountain?



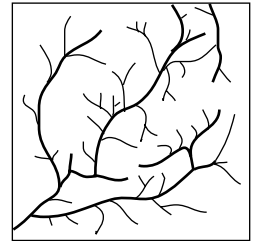
(1)



(2)



(3)



(4)

34 Which table best represents the characteristics of the continental crust and the oceanic crust?

Type of Crust	Density (g/cm ³)	Composition	Relative Thickness
Continental	3.0	basaltic	thicker
Oceanic	2.7	granitic	thinner

(1)

Type of Crust	Density (g/cm ³)	Composition	Relative Thickness
Continental	2.7	granitic	thinner
Oceanic	3.0	basaltic	thicker

(3)

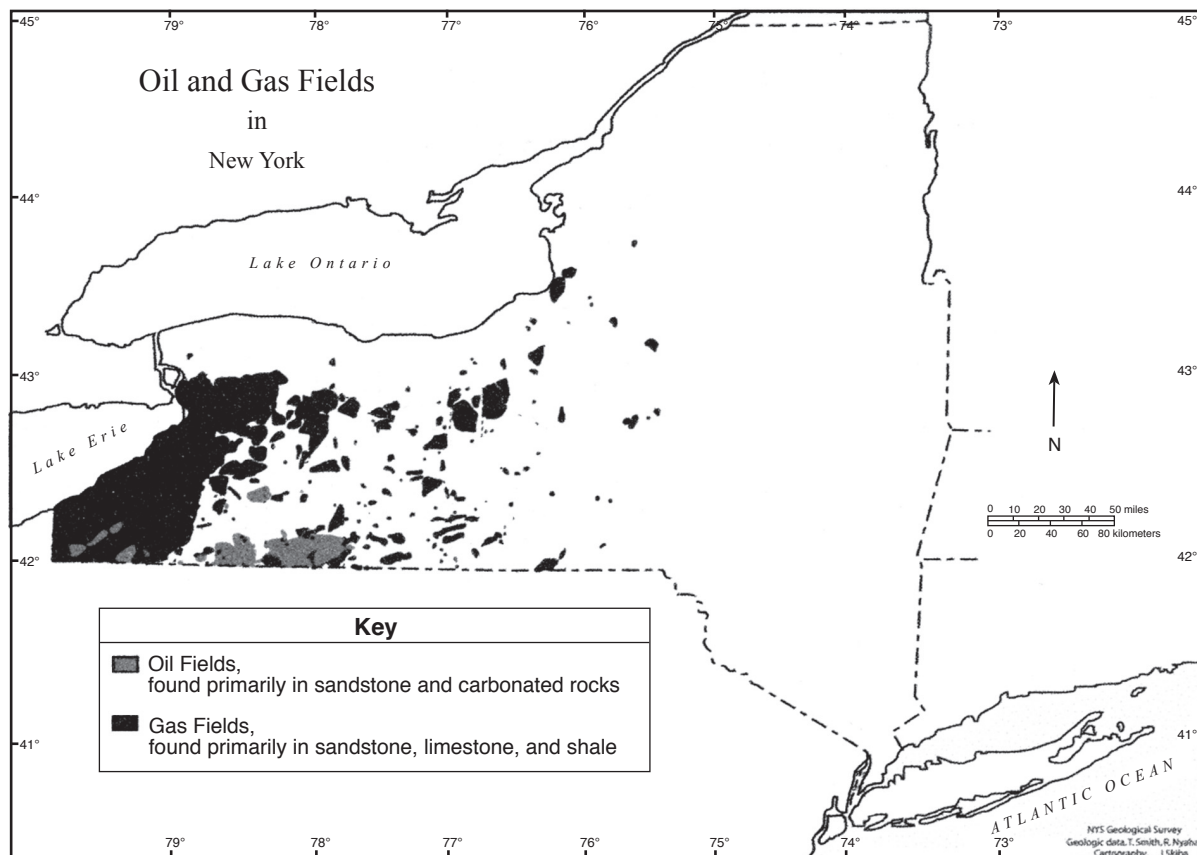
Type of Crust	Density (g/cm ³)	Composition	Relative Thickness
Continental	3.0	granitic	thicker
Oceanic	2.7	basaltic	thinner

(2)

Type of Crust	Density (g/cm ³)	Composition	Relative Thickness
Continental	2.7	granitic	thicker
Oceanic	3.0	basaltic	thinner

(4)

35 The map below shows the locations of some oil and gas fields in New York State.



Source: New York State Museum, State Geological Survey

Which type of bedrock contains these oil and gas deposits?

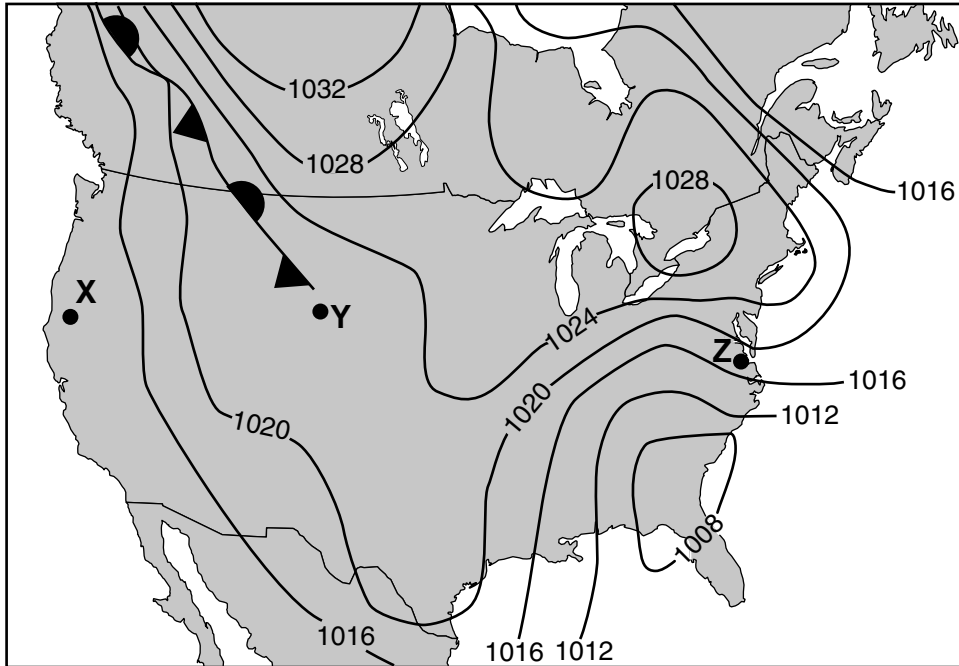
- (1) extrusive igneous rock
- (2) intrusive igneous rock
- (3) metamorphic rock
- (4) sedimentary rock

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 map below and on your knowledge of Earth science. The map shows typical weather systems over North America. Letters X, Y, and Z represent locations on the map. The isobars on the map are measured in millibars (mb).



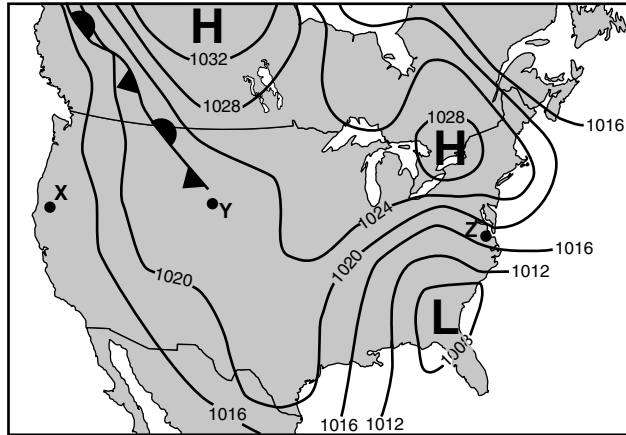
36 Which map information indicates that the wind velocity is greater at location Z than at location X?

- (1) Location Z is closer to the ocean.
- (2) The isobars are closer together at Z.
- (3) The latitude of location X is greater.
- (4) Location X is closer to the front.

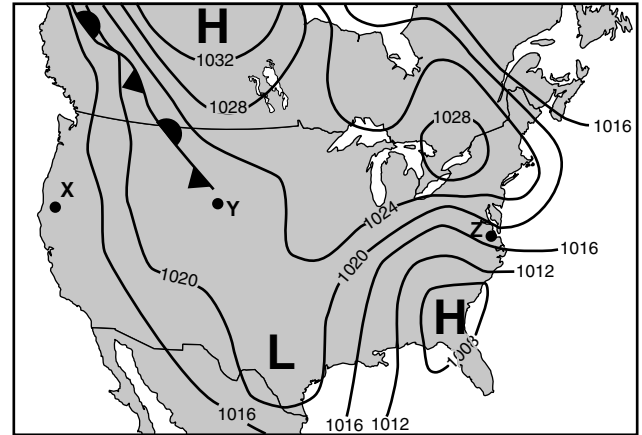
37 Which type of front extends northwest from location Y?

- (1) warm front
- (2) cold front
- (3) occluded front
- (4) stationary front

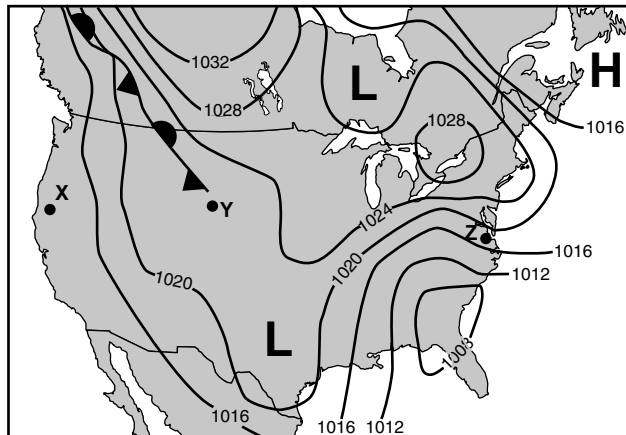
38 Which map best shows the locations for the centers of high pressure (H) and low pressure (L)?



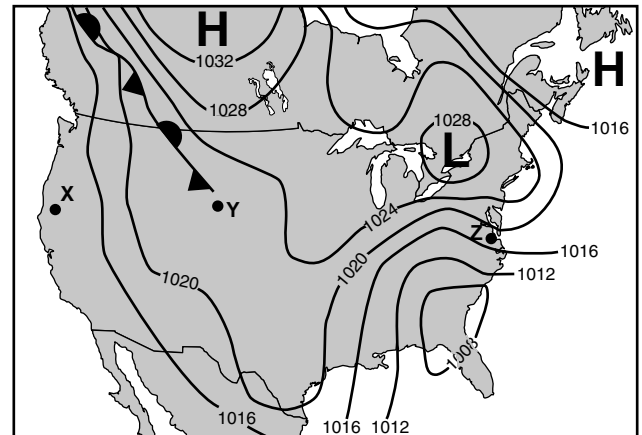
(1)



(3)



(2)



(4)

Base your answers to questions 39 through 41 on the passage below and on your knowledge of Earth Science.

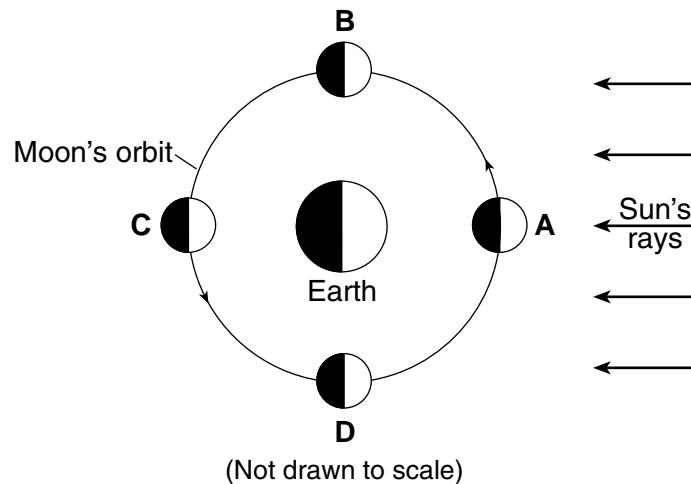
Supermoon Eclipse

On September 27, 2015, a rare total lunar eclipse of a supermoon occurred. A supermoon occurs when the entire lighted half of the Moon faces Earth (full Moon phase) and the Moon is at its closest point to Earth in its orbit. At this time, the Moon will appear 14% larger and 30% brighter than normal. Supermoon events are rare, but a total lunar eclipse during a supermoon is even more rare. There have been only six total supermoon lunar eclipses since 1900. The next one will not happen until 2033.

39 Supermoon total lunar eclipses are celestial events that

- (1) are random occurrences
- (2) are predictable
- (3) will never happen again after 2033
- (4) will happen every full Moon

40 The diagram below represents the Moon in four positions, A through D, in its orbit around Earth.



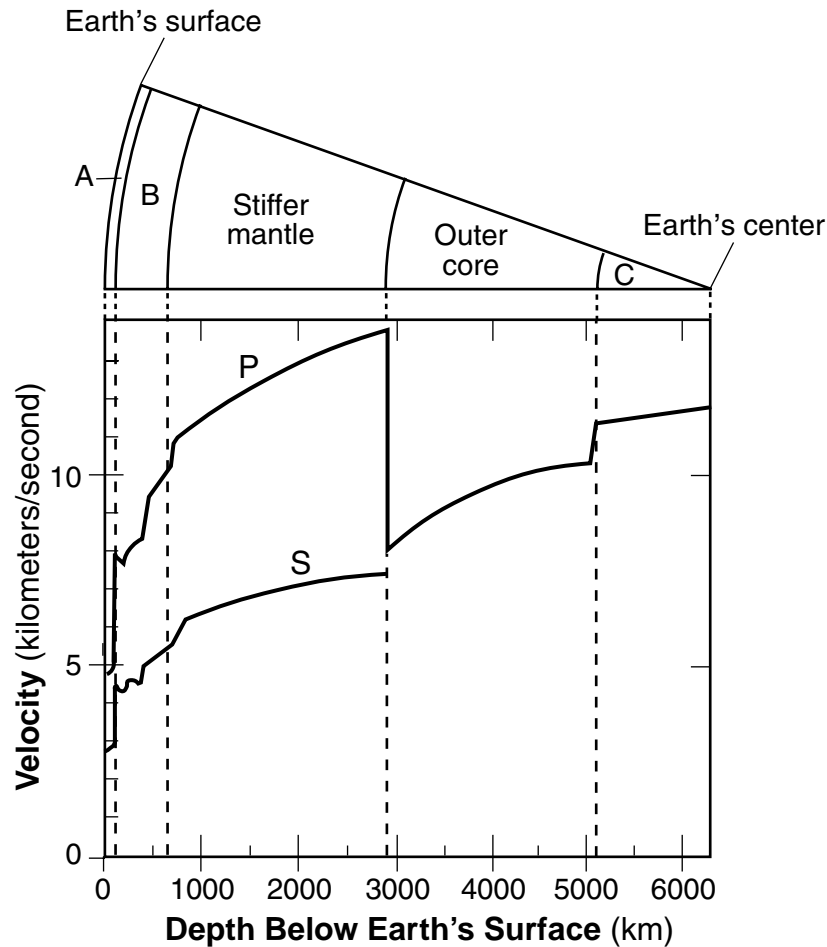
At which position in its orbit was the Moon located during the 2015 supermoon total lunar eclipse?

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

41 The time it took for the Moon to go from this supermoon to the next full moon phase was

- (1) 15 days
 - (2) 27.3 days
 - (3) 29.5 days
 - (4) 365 days
-

Base your answers to questions 42 through 44 on the diagram and graph below and on your knowledge of Earth science. The diagram represents a portion of Earth's interior. Letters A, B, and C represent interior layers. The graph shows the velocity of P-waves and S-waves at various depths in Earth's interior.



42 Which layers of Earth's interior are represented by letters A and B?

- (1) A is the crust and B is the rigid mantle.
- (2) A is the lithosphere and B is the asthenosphere.
- (3) A is the asthenosphere and B is the crust.
- (4) A is the rigid mantle and B is the lithosphere.

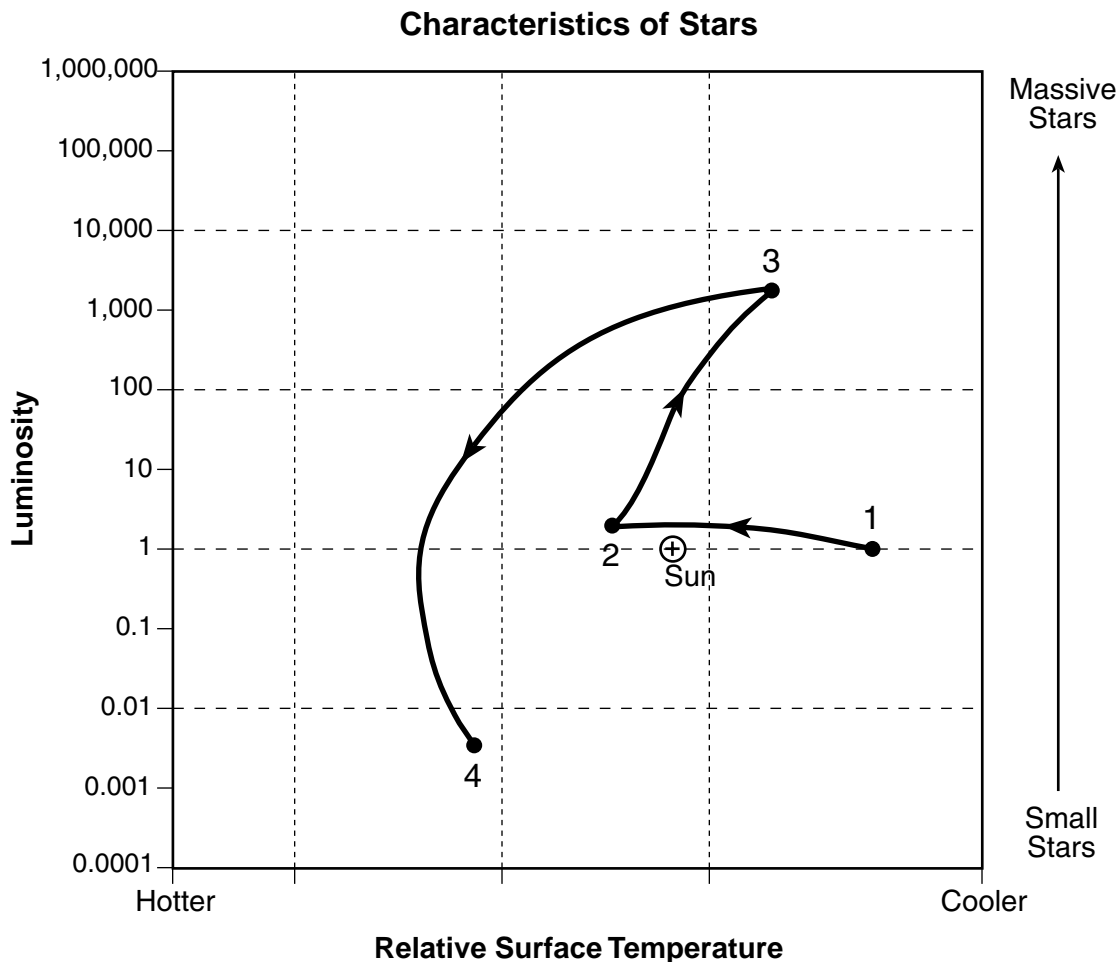
43 What is the approximate velocity in kilometers/second of the P-waves at a depth of 1000 kilometers?

- (1) 6.2 km/s
- (2) 7.2 km/s
- (3) 11.3 km/s
- (4) 13.8 km/s

44 Some locations within layer C have an inferred density of

- (1) 3.4 g/cm³
- (2) 5.6 g/cm³
- (3) 11.5 g/cm³
- (4) 12.9 g/cm³

Base your answers to questions 45 through 47 on the graph below and on your knowledge of Earth science. The graph shows the changes in a single star's luminosity and relative temperature from its formation (point 1) to its late stage (point 4) relative to the Sun.



- 45 Which is a possible surface temperature of this star at point 2?
- | | |
|------------|--------------|
| (1) 3000 K | (3) 7000 K |
| (2) 5000 K | (4) 10,000 K |
- 46 Between points 1 and 3, this star is visible to observers on Earth because it emits light energy. This energy is released by the process of nuclear fusion when
- (1) dust collides with the star
 - (2) dust is broken apart by radiation
 - (3) lighter elements combine to form heavier elements
 - (4) heavier elements are broken down to form lighter elements

47 Which table correctly classifies this star at points 3 and 4?

Point	Classification
3	Giant
4	White Dwarf

(1)

Point	Classification
3	Supergiant
4	Main Sequence

(3)

Point	Classification
3	White Dwarf
4	Supergiant

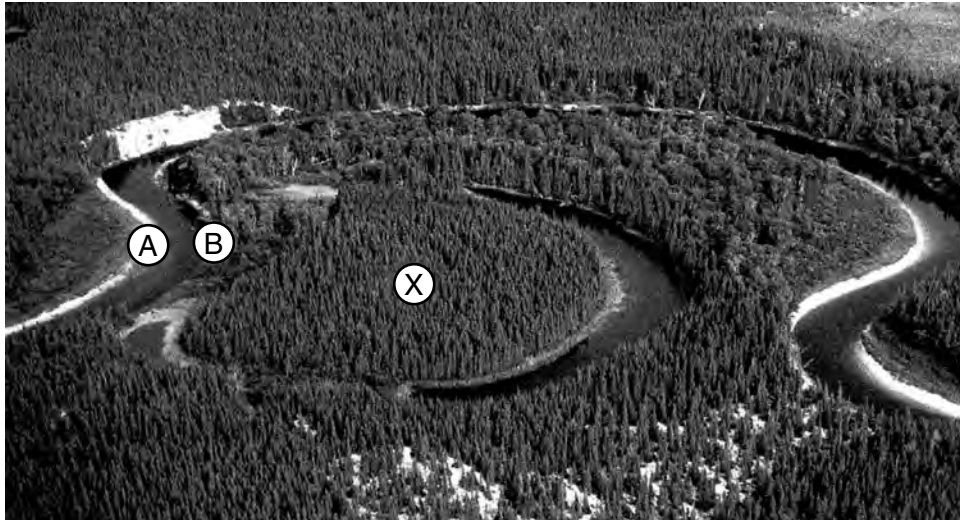
(2)

Point	Classification
3	Giant
4	Main Sequence

(4)

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Base your answers to questions 48 through 50 on the photograph below and on your knowledge of Earth science. The photograph shows a meandering stream in a wooded area. Points *A* and *B* represent locations on the streambanks. Letter *X* represents a flat area near the stream.



48 The streambank at location *B* is steeper than the streambank at location *A* because the water near location *B* is moving

- (1) slower than the water near location *A*, causing more erosion
- (2) slower than the water near location *A*, causing more deposition
- (3) faster than the water near location *A*, causing more erosion
- (4) faster than the water near location *A*, causing more deposition

49 The area labeled letter *X* represents a portion of a

- (1) delta
- (2) sand dune
- (3) finger lake
- (4) floodplain

50 Most of the particles deposited where the stream velocity *decreases* from 50 centimeters per second to 5 centimeters per second are

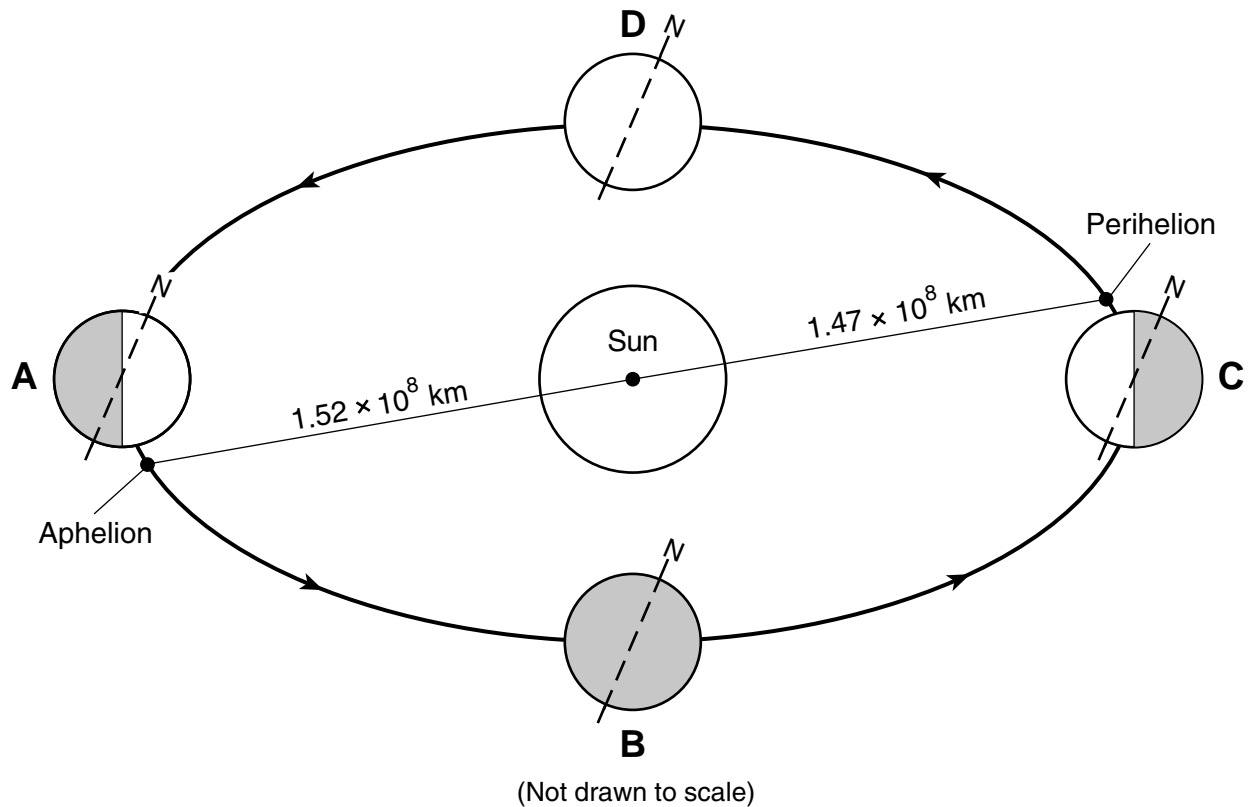
- (1) small cobbles and large pebbles
 - (2) small pebbles and large sand
 - (3) small sand and large silt
 - (4) small silt and large clay
-

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. In the diagram, letters *A*, *B*, *C*, and *D* represent Earth's location on the first day of the four seasons as it orbits the Sun. Aphelion (Earth's farthest distance from the Sun) and perihelion (Earth's closest distance to the Sun) are labeled to show the approximate positions where they occur in Earth's orbit. The dashed lines represent Earth's axis, and the North Pole is labeled *N*.



- 51 State the number of degrees that Earth's axis is tilted from a line perpendicular to the plane of its orbit at each lettered location. [1]
- 52 Identify the season in New York State during which Earth is at perihelion. [1]
- 53 State the number of hours of daylight that an observer in New York State will experience when Earth is at position *D*. [1]
- 54 Identify the name of the star that is aligned with Earth's axis above the North Pole. [1]
-

Base your answers to questions 55 through 58 on the passage, chart of definitions and photograph below, and on your knowledge of Earth science. The passage is an excerpt from the 1994 novel *Inca Gold*, by Clive Cussler, which describes the formation of a sinkhole in the Andes Mountains of South America. The chart of definitions helps the reader understand some concepts in the passage. The photograph shows a sinkhole that formed in a South American village.

Excerpt from *Inca Gold*

...The sinkhole's early history began in the Cambrian era when the region was part of an ancient sea. Through the following geological eras, thousands of generations of shellfish and coral lived and died, their skeletal carcasses forming an enormous mass of lime and sand that compressed into a limestone and dolomite layer two kilometers thick. Then, beginning sixty-five million years ago, an intense earth uplifting occurred that raised the Andes Mountains to their present height. As the rain ran down from the mountains it formed a great underground water table that slowly began dissolving the limestone. Where it collected and pooled, the water ate upward until the land surface collapsed and created the sinkhole....

Chart of Definitions

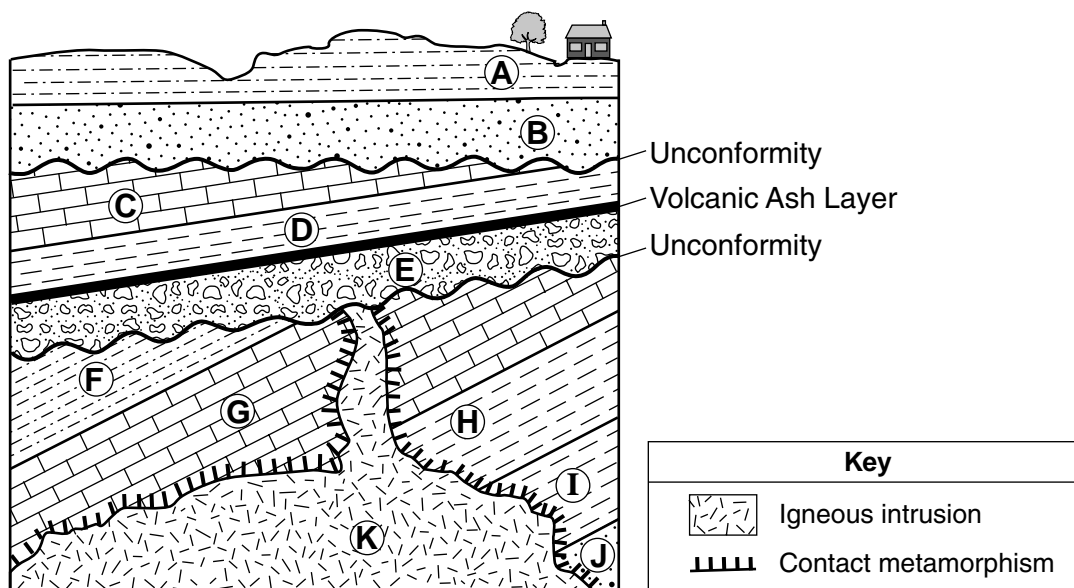
Sinkhole	A natural depression or hole in the ground surface caused by some form of collapse of the bedrock beneath. Most are caused when slightly acidic groundwater chemically breaks down the carbonate rocks or the carbonate cement holding the rock particles together. The removal of the carbonates by groundwater gradually forms a hollow space or cavern under the surface layer. As the roof of the cavern weakens, it sometimes collapses, forming a sinkhole.
Lime	A general term for material containing the element calcium that combined with oxygen.

Photograph of a Sinkhole



- 55 In the first line of the passage, referring to Cambrian as an “era” is scientifically incorrect. State the unit of geologic time that should be substituted for the word “era.” [1]
- 56 Identify *one* group of animals that became extinct at the time the passage states that intense uplifting of the Andes Mountains began. [1]
- 57 Using chemical symbols, state the chemical composition of the mineral found in limestone. [1]
- 58 Describe the chemical weathering that contributes to the formation of sinkholes. [1]

Base your answers to questions 59 through 61 on the geologic cross section below and on your knowledge of Earth science. The cross section represents rock units, labeled A through K, that have *not* been overturned. Two unconformities and a volcanic ash layer are indicated.



- 59 List the letters *E*, *H*, and *K* to indicate the correct order of rock unit formation, from oldest to youngest, that formed this portion of Earth’s crust. [1]
- 60 Identify *two* processes that most likely caused the formation of both unconformities. [1]
- 61 Identify *one* metamorphic rock that most likely formed within rock unit *G* at the boundary of rock unit *K*. [1]

Base your answers to questions 62 through 65 on the field map in your answer booklet and on your knowledge of Earth science. The map shows the depth of Cuba Lake, located in New York State at latitude $42^{\circ}14'$ N, longitude $78^{\circ}18'$ W. Isoline values indicate water depth, in feet. Points *A* and *B* represent locations on the shoreline of Cuba Lake. Points *W*, *X*, *Y*, and *Z* represent locations on the bottom of the lake. The 30-foot isoline has been partially drawn.

- 62 On the map *in your answer booklet*, complete the 30-foot water depth isoline from point *W* to point *X*. [1]
- 63 On the grid *in your answer booklet*, construct a profile of the bottom of Cuba Lake from point *A* to point *B*. Plot each point where an isoline showing depth is crossed by line *AB*. Connect the plots with a line, starting at *A* and ending at *B*, to complete the profile. [1]
- 64 State the compass direction and distance in feet (ft) from point *Y* to point *Z*. [1]
- 65 Identify the New York State landscape region where Cuba Lake is located. [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 through 68 on the table below and on your knowledge of Earth science. The data table lists some information about the dwarf planet Pluto, which revolves around our Sun, and the five known moons that orbit Pluto.

Data for Dwarf Planet Pluto and Its Five Moons

Object Name	Classification	Period of Revolution in Earth Days (d)	Eccentricity of Orbit	Diameter (km)
Pluto	Dwarf Planet	90,511.4 (247.8 years)	0.2488	2370
Charon	Moon	6.4	0.0022	1208
Styx	Moon	20.2	0.0058	10 to 15 *
Nix	Moon	24.9	0.0020	40
Kerberos	Moon	32.2	0.0033	13 to 34 *
Hydra	Moon	38.2	0.0059	33 to 43 *

* There is a range in diameters for these moons due to their irregular shapes.

66 Identify the name of Pluto's moon that most likely has an orbit farthest from Pluto. Explain how the data indicate that this moon's orbit has the greatest distance from Pluto. [1]

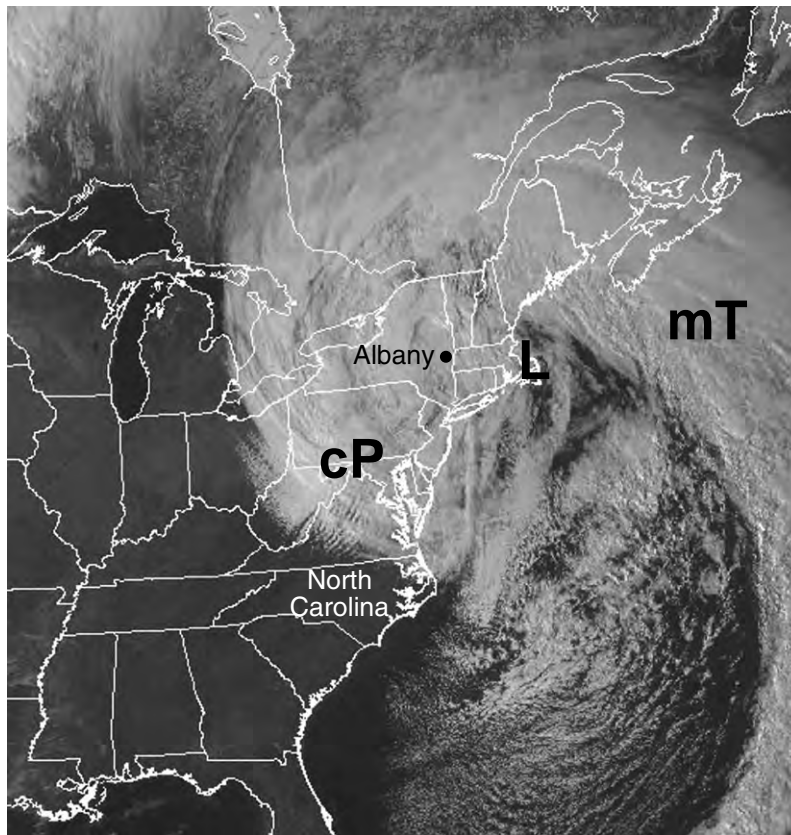
67 Describe the shape of the orbit of Pluto and the orbits of its five moons. [1]

68 Explain why Pluto and its five moons are considered to be part of our solar system. [1]

Base your answers to questions 69 through 73 on the passage and map below and on your knowledge of Earth science. The map shows a satellite image of a nor'easter that influenced the weather of the northeastern United States. The white areas represent clouds associated with this storm system. The locations of North Carolina and Albany, New York, are labeled on the map. The storm's low-pressure center is represented by letter **L**. Letters **cP** and **mT** represent two air masses.

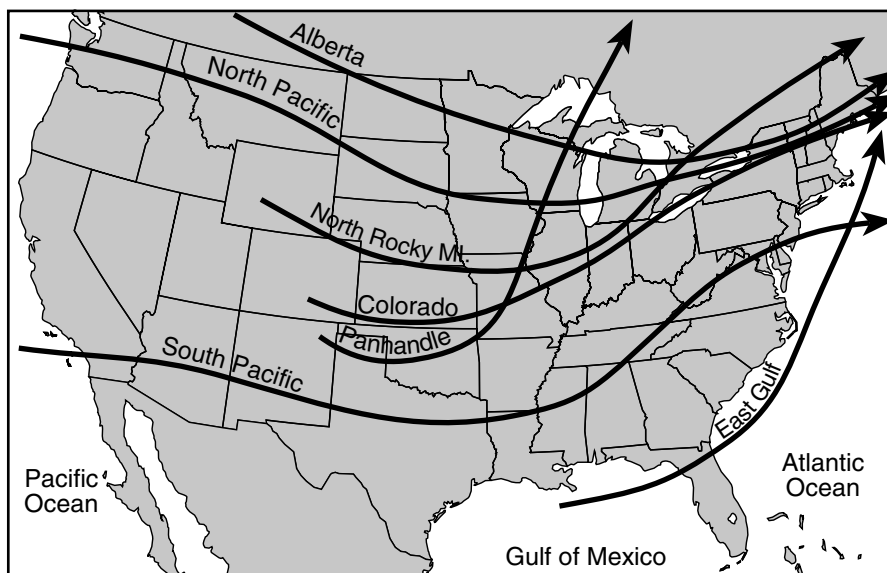
Nor'easters

A nor'easter is a large, low-pressure storm system that moves along the east coast of the United States. The wind over the land blows generally from the northeast as the center of the low passes by a location, hence the name nor'easter. Due to the circulation of winds around the center of the low-pressure system, large amounts of precipitation occur as moist air is carried from the ocean to the land. These storms usually intensify off of the North Carolina coast as they track toward the northeast.



- 69 Describe *two* characteristics of the circulation pattern of the surface winds around the center of the low-pressure area represented on the map. [1]
- 70 Circle the terms that best describe the relative moisture and relative temperature characteristics of the mT air mass compared to the cP air mass shown on the map. [1]

71 The map below shows some of the principal storm tracks across the United States and the names of these storm tracks.



Identify the name of the storm track that this nor'easter most closely followed. [1]

72 The table below shows weather conditions recorded in Albany, New York, at the time that the satellite image was taken.

Dewpoint	22°F
Barometric Pressure	988.0 mb
Cloud Cover	100%
Present Weather	Snow

On the station model *in your answer booklet*, use the correct symbols and proper format to indicate the four conditions in the table. [1]

73 Identify *one* weather instrument that was most likely used to determine the dewpoint at Albany, New York. [1]

Base your answers to questions 74 through 76 on the data table below and on your knowledge of Earth science. The data table shows the mass of a sample of radioactive carbon-14 remaining after each half-life.

Data Table

Number of Half-lives	Mass of Carbon-14 (g)
0	64
1	32
2	16
3	8
4	4
5	2
6	1

74 On the grid *in your answer booklet*, construct a line graph by plotting the data for the mass of carbon-14 in the sample for *each* half-life shown on the data table. Connect the plots with a line. [1]

75 Identify the stable disintegration product of the radioactive isotope carbon-14. [1]

76 Determine the number of grams of carbon-14 remaining in this sample at 17,100 years. [1]

Base your answers to questions 77 through 79 on the data tables below and on your knowledge of Earth science. Data table 1 shows the average maximum and average minimum water temperatures at different depths in Lake Michigan. Data table 2 shows the average maximum and average minimum land temperatures at different depths in soil at St. Paul Minnesota (MN).

Table 1

Water in Lake Michigan, 45° N		
Water Depth Range (m)	Average Temperature (°C)	
	Maximum (Occurs in Summer)	Minimum (Occurs in Winter)
0 – 10	24.0	4.0
10 – 20	19.5	4.0
20 – 30	12.5	4.0
30 – 40	7.5	4.0
40 – 60	5.5	4.0
60 – 110	4.5	4.0
110 – 150	4.0	4.0

Table 2

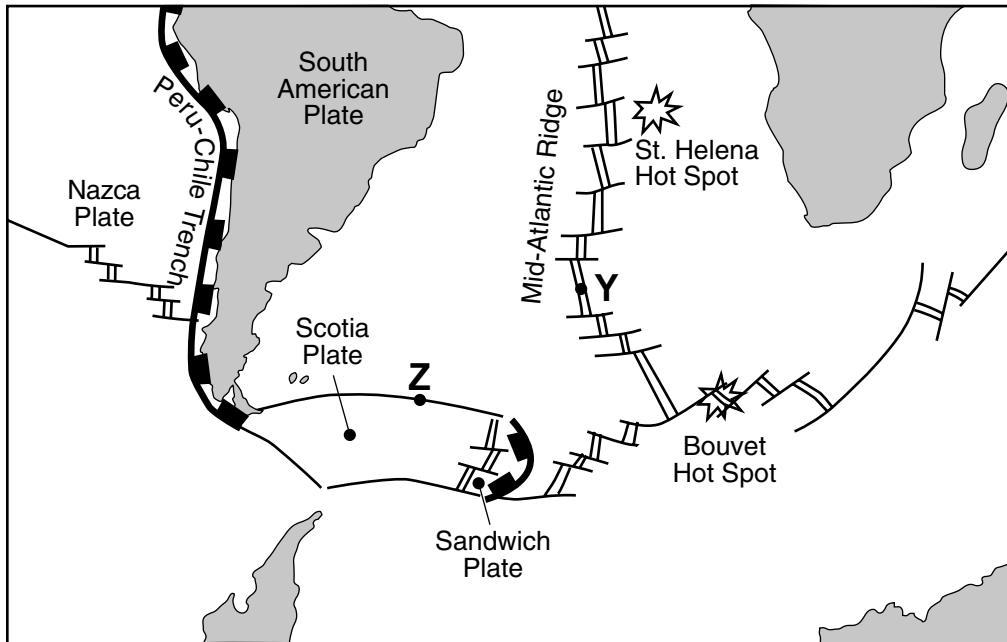
Land in St. Paul, MN, 45° N		
Soil Depth Range (m)	Average Temperature (°C)	
	Maximum (Occurs in Summer)	Minimum (Occurs in Winter)
0 – 0.1	25.5	–6.0
0.1 – 1	23.0	–1.5
1 – 2	19.5	2.0
2 – 3	16.0	4.5
3 – 4	13.5	7.0
4 – 5	12.5	8.5
5 – 6	11.0	10.0

77 Identify the water depth range and the soil depth range, in meters, that have the same average maximum temperature of 12.5°C. [1]

78 Describe the general relationship between depth and average temperature for both water and soil in the summer. [1]

79 Explain why the winter water surface is warmer than the winter land surface. [1]

Base your answers to questions 80 through 82 on the map below and on your knowledge of Earth science. The map shows an enlargement of a portion of the *Tectonic Plates* map from the *Physical Setting/Earth Science Reference Tables*. Arrows showing plate motion have been omitted. Points Y and Z represent locations on plate boundaries.



80 Identify the type of tectonic plate boundary found at location Z. [1]

81 State the names of the tectonic plates on *each* side of the Bouvet Hot Spot. [1]

82 The cross section *in your answer booklet* represents a portion of Earth's interior beneath point Y. On this cross section, draw an arrowhead on *each* of the *four* bold lines, to represent the direction of the convection currents in the asthenosphere. [1]

Base your answers to questions 83 through 85 on the passage below and on your knowledge of Earth science.

Glacier Movement

Glaciers are thick sheets of ice in motion. Mountain glaciers tend to move down the slopes of mountains from higher elevations to lower elevations, while continental ice sheets move over large areas of continents. The bottom of a glacier is under great pressure due to the weight of the thick sheet of ice. This pressure causes the bottom of the glacier to partially melt, allowing the glacier to move. As the glacier thickens, more pressure is created and the glacier moves faster. Different parts of a glacier can move at different rates, depending on the amount of pressure and friction between the glacier and the underlying bedrock.

- 83 Describe the relationship between the thickness of a glacier and its rate of movement downhill. [1]
- 84 Describe the most likely shape of the cross section of a valley formed as a result of erosion by a mountain glacier. [1]
- 85 Compared to sediments deposited by meltwater from a glacier, describe the difference in the arrangement of the sediment deposited directly by a glacier. [1]
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