

Large-Type Edition

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING EARTH SCIENCE

Friday, January 26, 2024 — 9:15 a.m. to 12:15 p.m., only

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

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

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

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

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

Notice ...

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

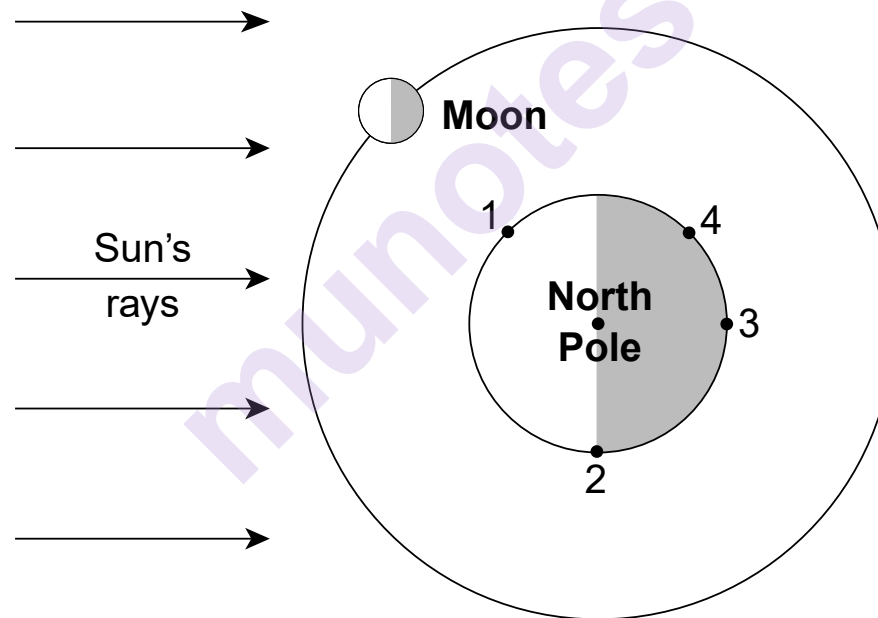
DO NOT START THIS EXAMINATION UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part.

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

- 1 The diagram below represents the Moon at one position in its orbit around Earth. The numbers represent locations on Earth's surface.



(Not drawn to scale)

At which numbered location would high tide be occurring when the Moon is in the location shown in the diagram?

- | | |
|-------|-------|
| (1) 1 | (3) 3 |
| (2) 2 | (4) 4 |

2 Cosmic background radiation provides evidence of the

- (1) Big Bang
- (2) origin of the Sun
- (3) radioactive decay in Earth's core
- (4) formation of the Milky Way Galaxy

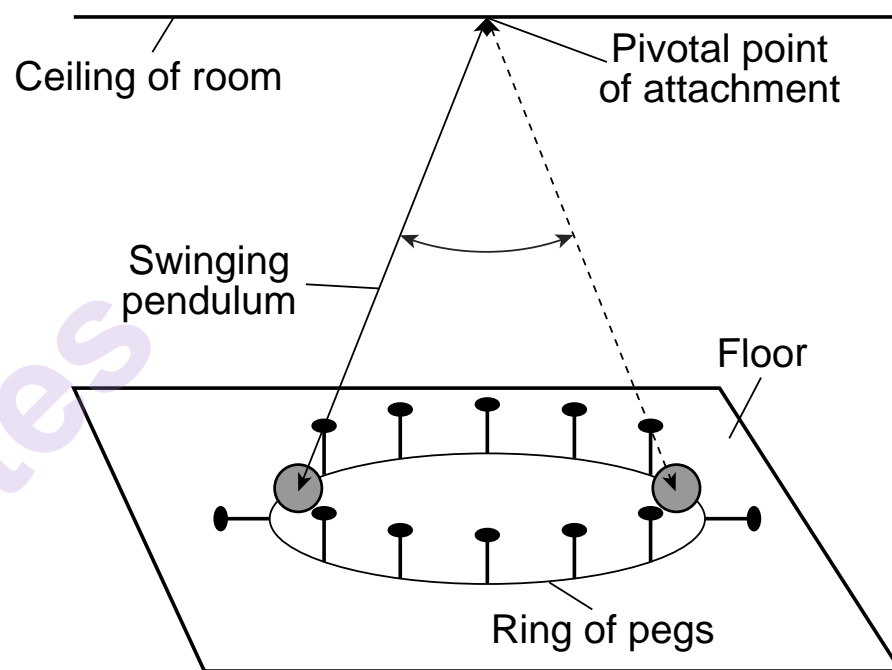
3 Approximately how many degrees does Earth travel in its orbit in six months?

- (1) 30°
- (2) 90°
- (3) 180°
- (4) 360°

4 The constellation Orion is visible in New York State in the night sky during winter, but is not visible in New York State in the night sky during summer because

- (1) Earth rotates on its axis
- (2) Earth revolves around the Sun
- (3) Orion rotates on its axis
- (4) Orion revolves around the Sun

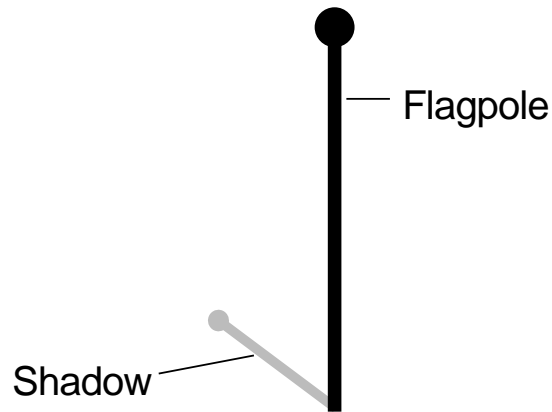
5 The diagram below represents a scientific instrument.



This instrument provides evidence that Earth

- (1) spins on its axis
- (2) is tilted on its axis
- (3) has a spherical shape
- (4) moves along an orbital path

- 6 The diagram below represents a flagpole and its shadow in New York State at solar noon.



The shadow is pointing from the base of the flagpole toward the

- | | |
|-----------|----------|
| (1) south | (3) east |
| (2) north | (4) west |
- 7 Which term best describes the curving of Earth's planetary winds and major surface ocean currents?
- | | |
|--------------------------|---------------------|
| (1) El Niño | (3) Doppler effect |
| (2) orbital eccentricity | (4) Coriolis effect |

- 8 Which landmass has at least one location where the Sun will be directly overhead at solar noon at some time during a year?

- | | |
|----------------|---------------|
| (1) Antarctica | (3) Europe |
| (2) Australia | (4) Greenland |

- 9 What is the primary source of energy that causes all weather phenomena on Earth?

- | |
|--|
| (1) volcanic eruptions |
| (2) residual heat from Earth's formation |
| (3) convection currents in the hydrosphere |
| (4) incoming solar radiation |

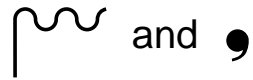
- 10 The dry-bulb temperature is 18°C and the wet-bulb temperature is 8°C on a psychrometer. What is the dewpoint?

- | | |
|--------------------------|--------------------------|
| (1) -5°C | (3) 10°C |
| (2) 2°C | (4) 19°C |

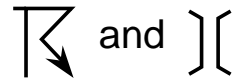
- 11 The polar front jet stream in Earth's atmosphere is located in the upper

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

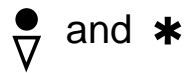
12 Which two weather symbols represent severe weather?



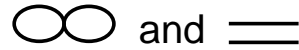
(1)



(3)



(2)



(4)

13 Compared to the average air temperature at the stratopause, the average air temperature at the mesopause is

- (1) 55°C lower
- (2) 55°C higher
- (3) 90°C lower
- (4) 90°C higher

14 Which atmospheric gas is important because it protects living things on Earth from harmful ultraviolet radiation?

- (1) nitrogen
- (2) ozone
- (3) methane
- (4) water vapor

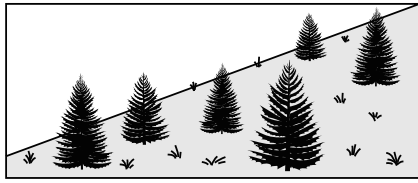
15 Equal areas of which surface absorb the most insolation and heat up most rapidly on a sunny day?

- (1) white sandy beach
- (2) calm lake surface
- (3) snow covered field
- (4) crushed basalt rock

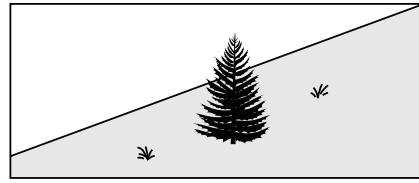
16 Many periods of global warming have occurred during the last 100,000 years. The inferred primary cause of the current rise in global temperatures is the

- (1) change in the eccentricity of Earth's orbit
- (2) change in position of tectonic plates
- (3) increase in atmospheric greenhouse gases
- (4) increase in sunspot activity

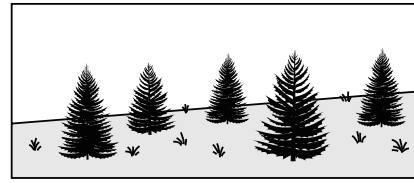
17 The diagram below represents four landscapes in New York State. All the landscapes have the same soil characteristics but different combinations of vegetation and slope.



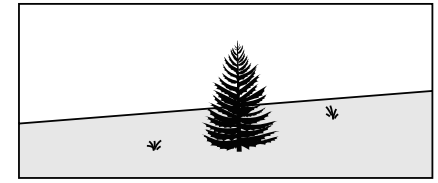
Landscape 1



Landscape 2



Landscape 3



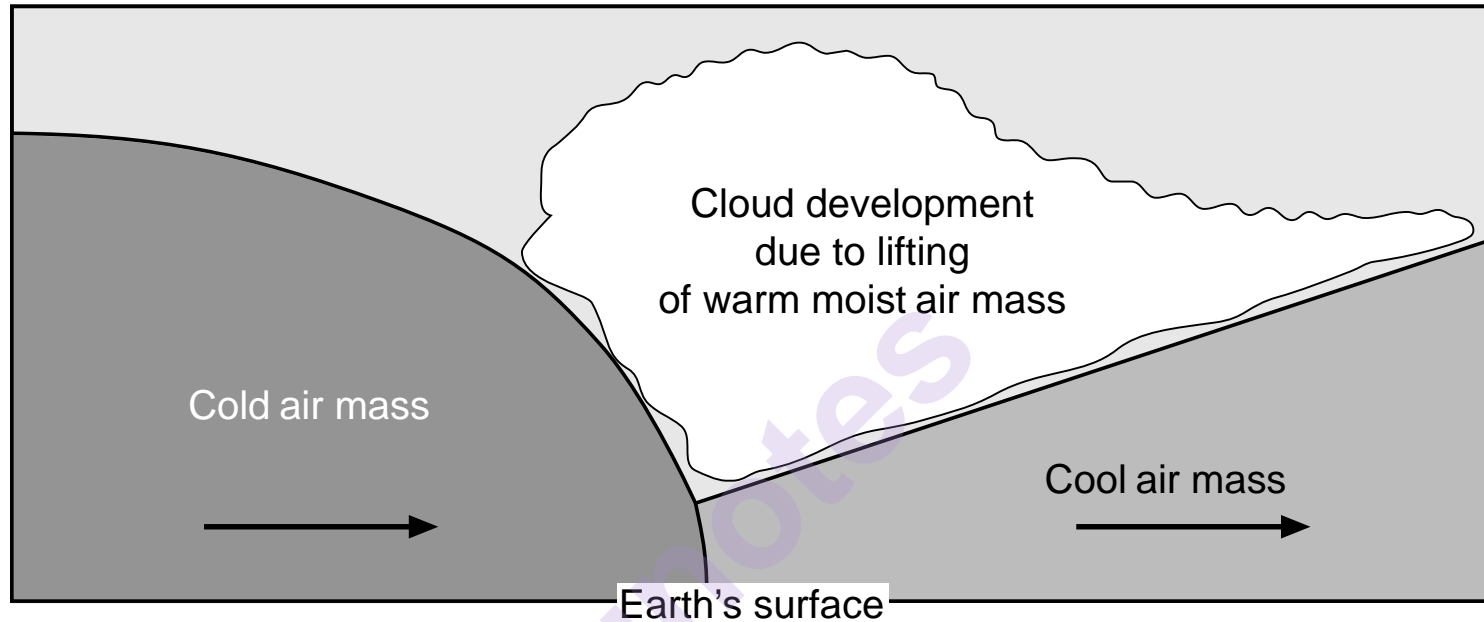
Landscape 4

If these landscape areas receive equal amounts of precipitation, which area will likely produce the greatest amount of runoff?

- (1) landscape 1
- (2) landscape 2

- (3) landscape 3
- (4) landscape 4

18 The cross section below represents a frontal boundary between two air masses. Arrows represent the direction of moving air masses.



The type of front represented at the boundary between the cold air mass and the cool air mass is

- (1) an occluded front caused by a cold front overtaking a warm front
- (2) an occluded front caused by a warm front overtaking a cold front
- (3) a stationary front caused by a cold front overtaking a warm front
- (4) a stationary front caused by a warm front overtaking a cold front

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

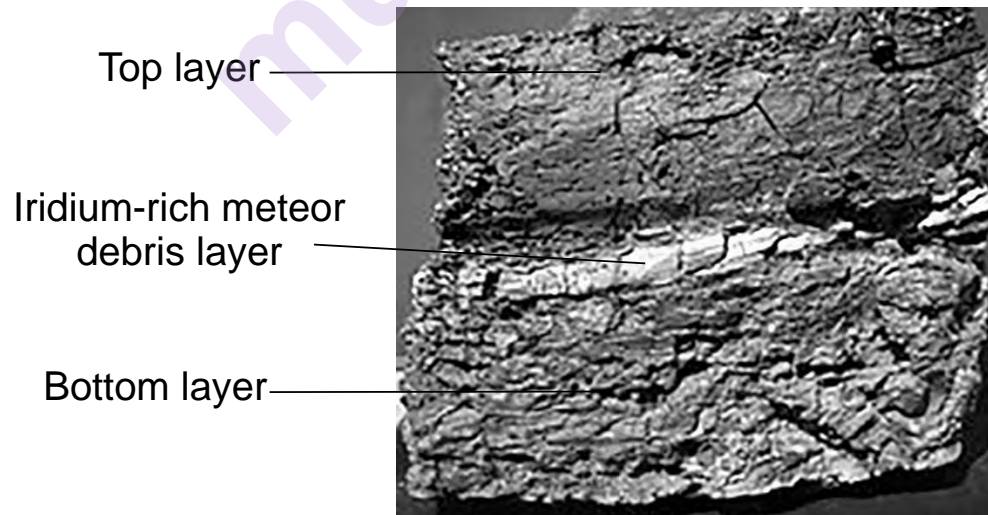


This index fossil would be classified as a

- (1) gastropod
- (2) nautiloid

- (3) coral
- (4) brachiopod

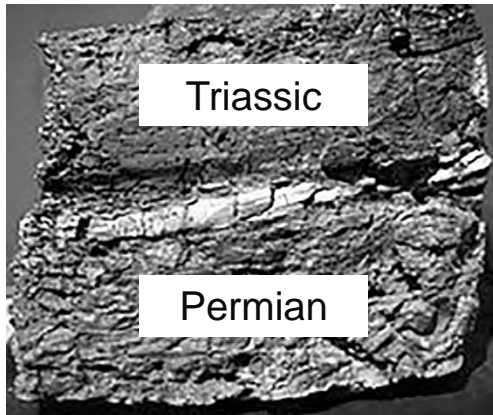
20 The photograph below shows a cross sectional view of an iridium-rich meteor debris layer between two rock layers. This debris was deposited at the same time as the extinction of ammonoids. The layers have *not* been overturned.



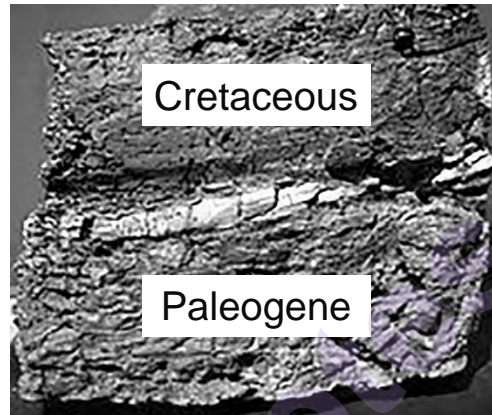
Question 20 is continued on the next page.

Question 20 continued

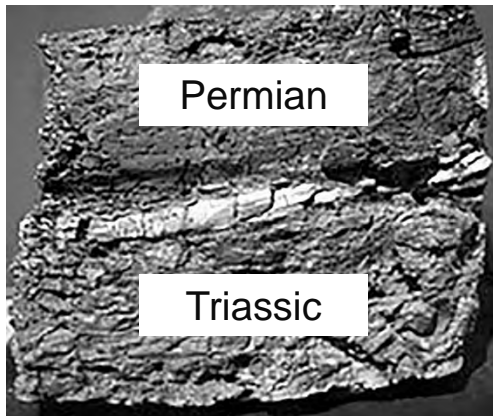
Which photograph shows the most likely geologic time periods when the rock layers above and below this debris layer formed?



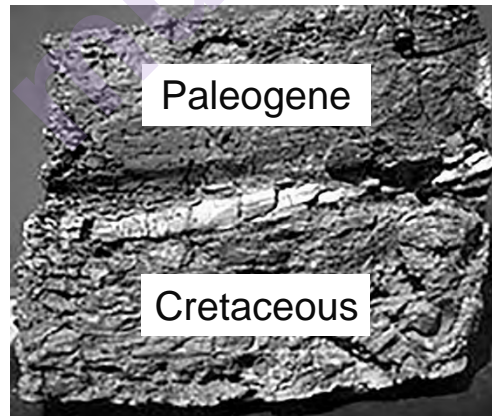
(1)



(3)



(2)

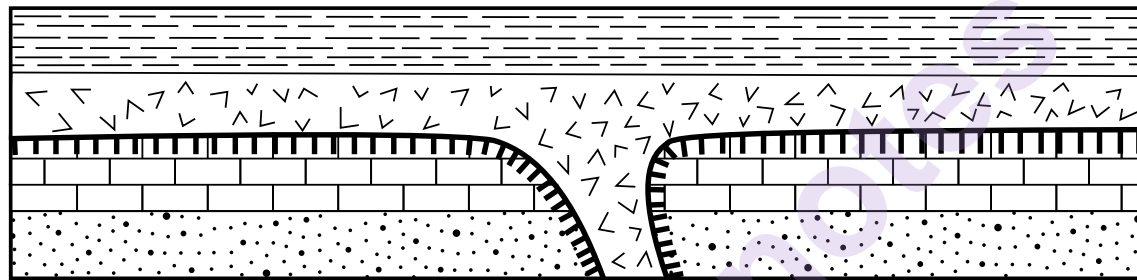




(4)

21 Why is volcanic ash a good geologic time marker?

- (1) Ash deposits usually contain identifiable fossils.
- (2) Ash is rapidly deposited over a large geographic area.
- (3) Volcanoes are distributed worldwide.
- (4) Volcanoes often continuously erupt over long periods of time.

22 The cross section below represents a portion of Earth's crust.



Key	
	Contact metamorphism
	Igneous rock

Compared to the sedimentary rock layers, the igneous rock is

- (1) older than all the sedimentary rock layers
- (2) younger than all the sedimentary rock layers
- (3) older than the shale, but younger than the sandstone and limestone
- (4) younger than the shale, but older than the sandstone and limestone

- 23 The table below was prepared to compare the surface bedrock of four New York State locations. The table contains some errors.

New York State Location	Geologic Age of Surface Bedrock	Dominant Bedrock Type
Finger Lakes	Devonian Period	gneisses, marbles
Mount Marcy	Middle Proterozoic Era	sandstones, shales
Syracuse	Cambrian Period	sandstones, dolostones
Watertown	Ordovician Period	limestones, shales

For which New York State location in the table are both the geologic age of the surface bedrock and the dominant type of surface bedrock correct?

- (1) Finger Lakes
- (2) Mount Marcy
- (3) Syracuse
- (4) Watertown

24 Which table below correctly shows the characteristics of seismic waves when they reach liquid material?

(1)

Seismic Wave Type	Ability to Travel Through Liquid Material
P-wave	can pass through
S-wave	cannot pass through

(3)

Seismic Wave Type	Ability to Travel Through Liquid Material
P-wave	can pass through
S-wave	can pass through

(2)

Seismic Wave Type	Ability to Travel Through Liquid Material
P-wave	cannot pass through
S-wave	can pass through

(4)

Seismic Wave Type	Ability to Travel Through Liquid Material
P-wave	cannot pass through
S-wave	cannot pass through

25 The first S-wave of an earthquake took 10 minutes 40 seconds to travel to a seismic station from the epicenter of an earthquake. What is the distance from this seismic station to the epicenter of this earthquake, and how much time did it take for the first *P*-wave to travel that distance?

- (1) 3200 kilometers; 4 minutes 40 seconds
- (2) 3200 kilometers; 6 minutes
- (3) 7200 kilometers; 4 minutes 40 seconds
- (4) 7200 kilometers; 6 minutes

26 Which two hot spots are located on the same tectonic plate?

- (1) Tasman and Easter Island Hot Spots
- (2) Hawaii and Yellowstone Hot Spots
- (3) Iceland and Bouvet Hot Spots
- (4) Canary Islands and St. Helena Hot Spots

27 Long Island is part of which New York State landscape region?

- (1) Newark Lowlands
- (2) Manhattan Prong
- (3) Tug Hill Plateau
- (4) Atlantic Coastal Plain

28 The data table below classifies three types of sand based on their particle diameters in centimeters.

Data Table

Sand Particle	Diameter (cm)
coarse sand	0.1
medium sand	0.04
fine sand	0.01

Which stream velocity would cause medium and coarse sand to settle to the bottom of the stream, while fine sand continues to move downstream?

- (1) 1.0 cm/s
- (2) 0.2 cm/s
- (3) 5.0 cm/s
- (4) 10.0 cm/s

29 What is the primary reason that water-filled cracks in rock widen in winter?

- (1) Ice is less dense than water.
- (2) Ice is more dense than water.
- (3) Water expands when it freezes.
- (4) Water contracts when it freezes.

30 The photograph below shows “Mitten Butte,” a sand-blasted landscape feature in Monument Valley, Utah.



Source: https://www.tripadvisor.com/LocationPhotoDirectLink-g57072-d3645830-i302356888-Wildcat_Trail-Monument_Valley_Utah.html

Which type of climate and agent of erosion are continuing to shape this landscape feature?

- | | |
|---|--|
| (1) humid climate and running-water erosion | (3) arid climate and running-water erosion |
| (2) humid climate and wind erosion | (4) arid climate and wind erosion |

31 Kettle lakes are formed when blocks of glacial ice are partially buried by sediments and melt on

- | | |
|--------------------|---------------------|
| (1) flood plains | (3) sand dunes |
| (2) outwash plains | (4) barrier islands |

32 Which mineral resource is used in making both furnace bricks and jewelry?

- | | |
|--------------|-------------|
| (1) dolomite | (3) garnet |
| (2) pyroxene | (4) olivine |

munotes

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33 The photograph below shows the bedrock structure of an outcrop.

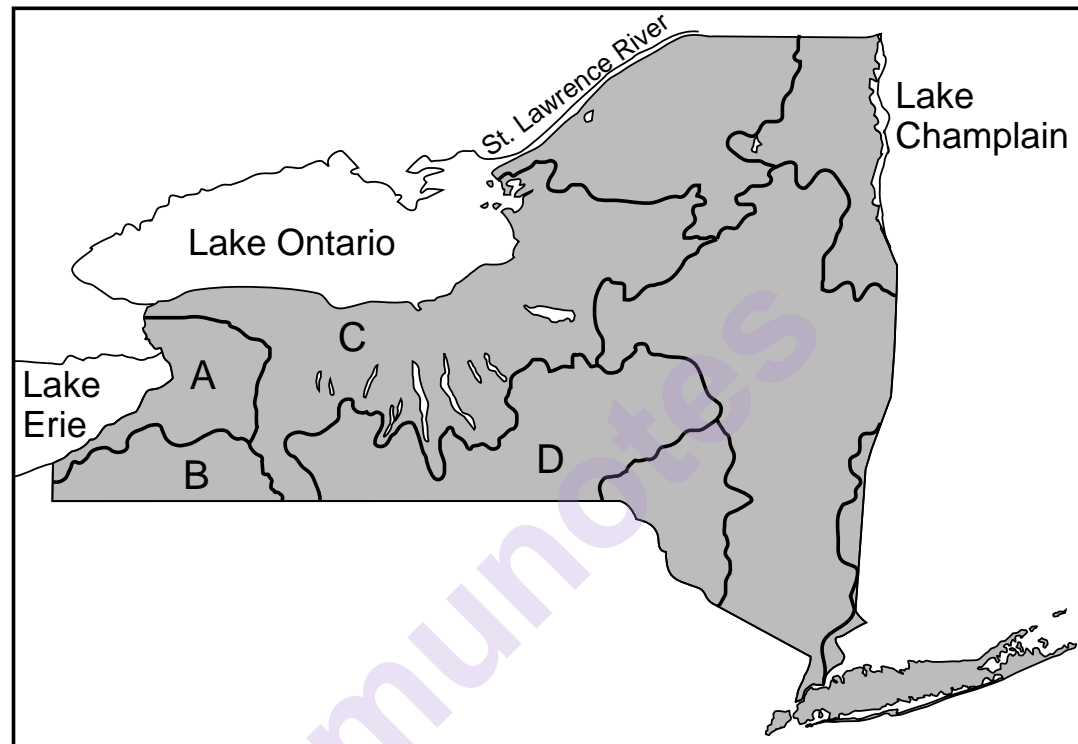


Source: <https://2.bp.blogspot.com/>

Which process is responsible for the folding of this bedrock?

- | | |
|-------------------------|----------------------|
| (1) volcanic activity | (3) crustal movement |
| (2) earthquake activity | (4) mass movement |

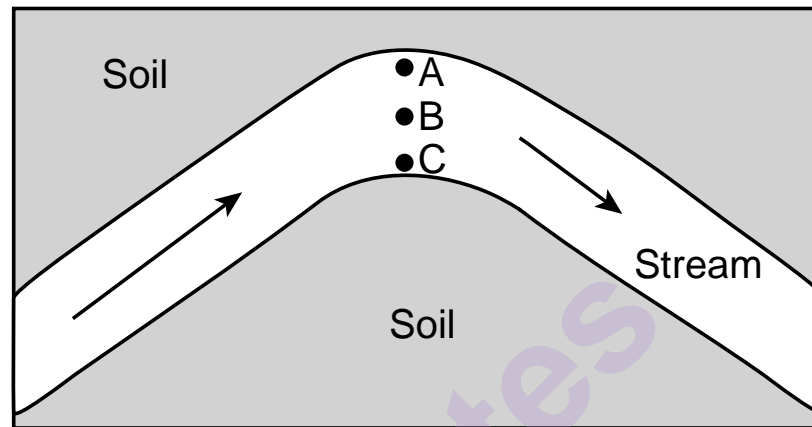
- 34 The map below shows the major watershed regions of New York State. Letters *A*, *B*, *C*, and *D* identify four of these watersheds.



The Genesee River is located in which watershed?

- | | |
|--------------|--------------|
| (1) <i>A</i> | (3) <i>C</i> |
| (2) <i>B</i> | (4) <i>D</i> |

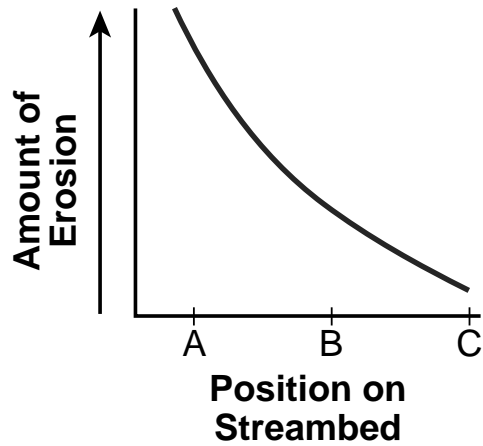
- 35 The map below shows a meandering stream flowing around a curve. The arrows indicate the direction of streamflow. Points A, B, and C are locations on the streambed.



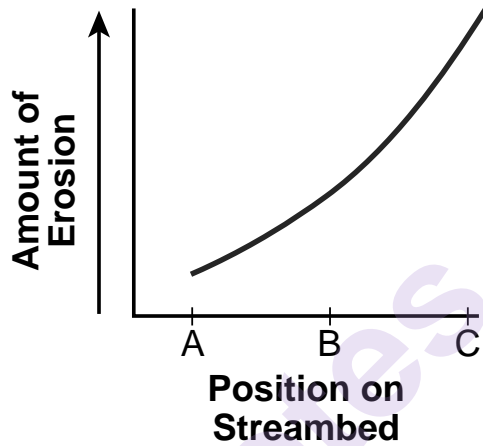
Question 35 is continued on the next page.

Question 35 continued

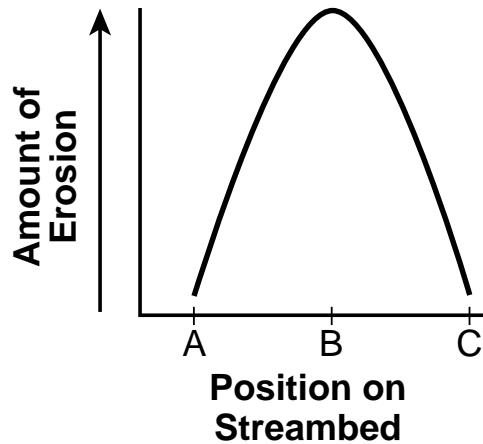
Which graph best represents the relative amounts of erosion within this stream at locations A, B, and C?



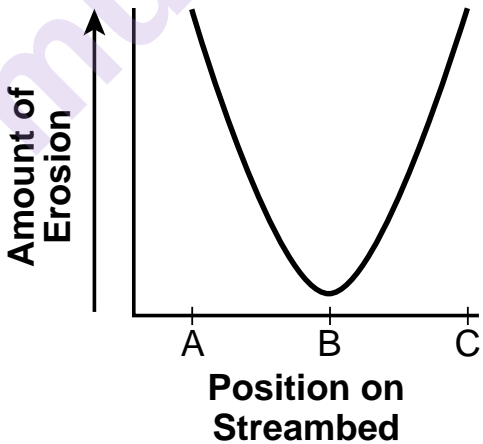
(1)



(3)



(2)



(4)

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.

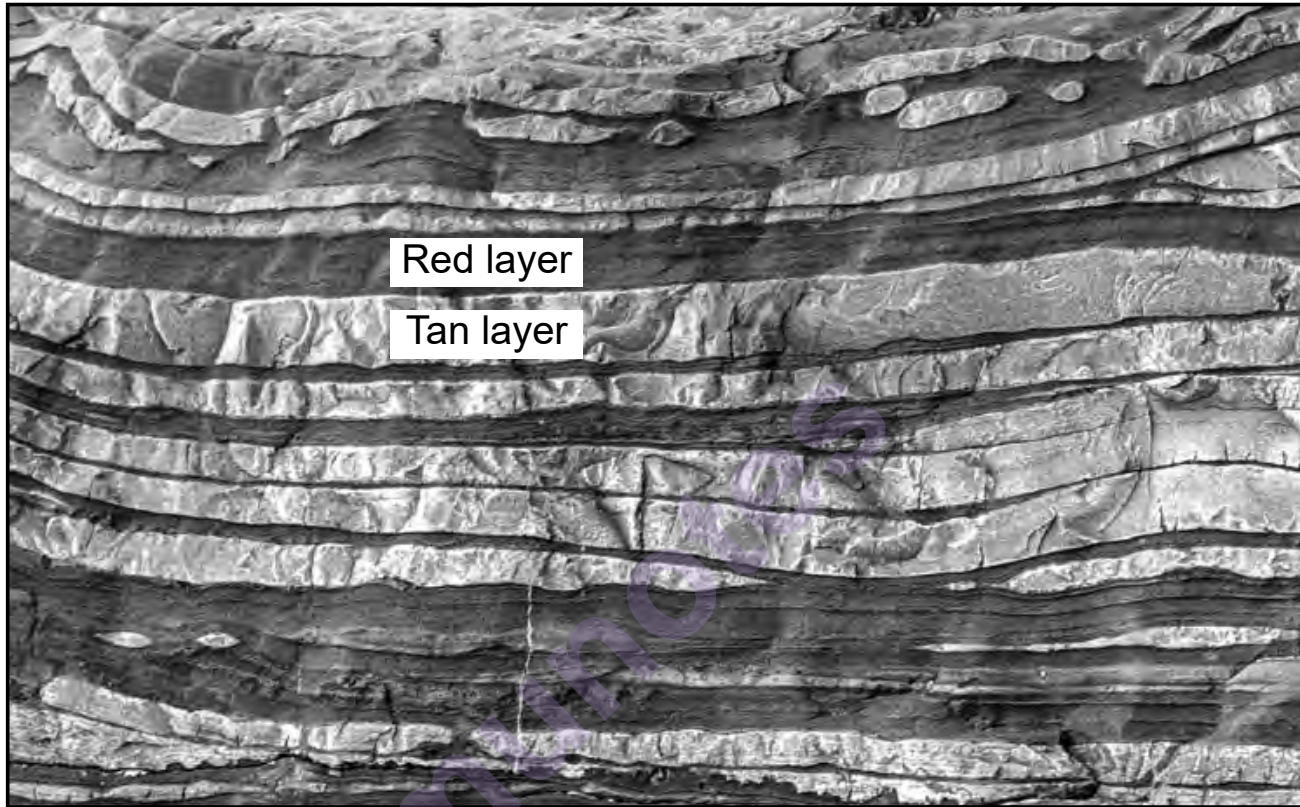
Base your answers to questions 36 through 38 on the passage below and the photograph on the next page, and on your knowledge of Earth science. The photograph shows a banded iron rock formation located in northwestern Australia where iron ores are mined. The colors of two layers are labeled.

Banded Iron Formations

Iron (Fe) is responsible for the red color in many rocks. However, iron is not usually found in pure form within rocks; instead, it is combined with oxygen in ore minerals such as hematite and magnetite. Most deposits of iron ore in the world are found in rocks known as banded iron formations.

In Earth's early history, there was little to no oxygen in the atmosphere or dissolved in oceans. However, oceans contained a lot of dissolved silica (SiO_2), which came from the weathering of land rocks. Deposition of this silica often produced the sedimentary rock chert, which is almost entirely composed of SiO_2 . About 3000 million years ago, the oceans became inhabited by organisms that developed the ability to undergo photosynthesis, which produced oxygen as a waste product. This oxygen reacted with iron dissolved in the oceans to produce iron oxides that settled to the ocean floor in layers, alternating with the fine-grained silica layers. Over millions of years, these processes of precipitating iron oxide minerals and silica were repeated over and over again, producing banded iron formations. Once the iron levels in the oceans began to decrease, the extra oxygen produced by these photosynthetic organisms began entering Earth's atmosphere.

Banded Iron Formation



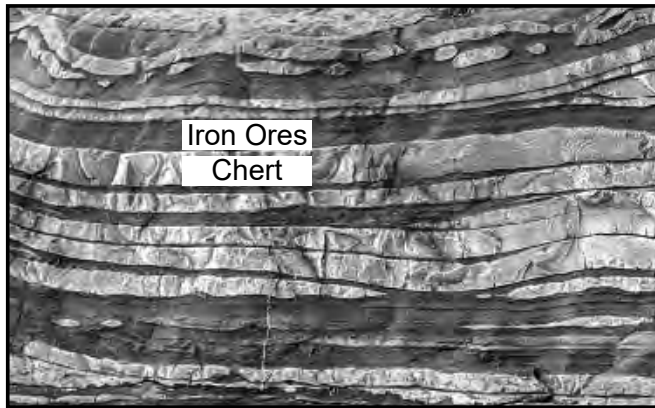
36 Which mineral has a chemical composition most similar to chert?

- (1) pyrite
- (2) quartz
- (3) garnet
- (4) calcite

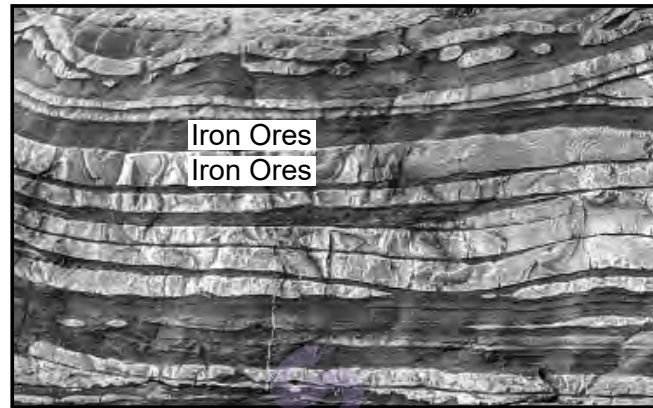
37 The first organisms that developed the ability to undergo photosynthesis and produce atmospheric oxygen were

- (1) great coal-forming forests
- (2) the earliest plants
- (3) coral reefs
- (4) cyanobacteria

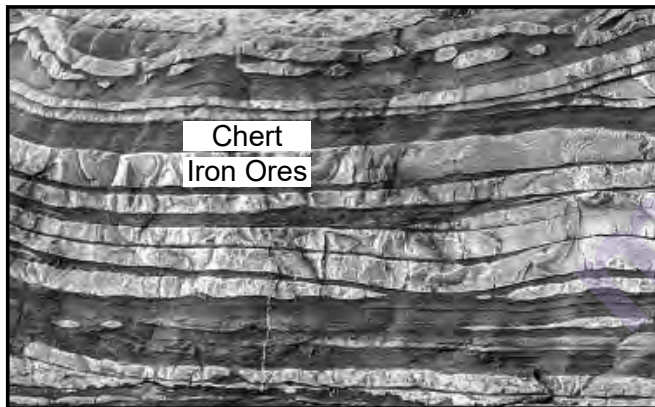
38 Which photograph correctly identifies the composition of the red and tan layers?



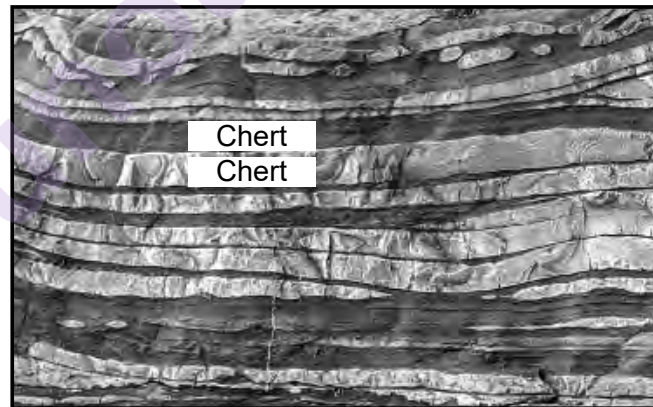
(1)



(3)

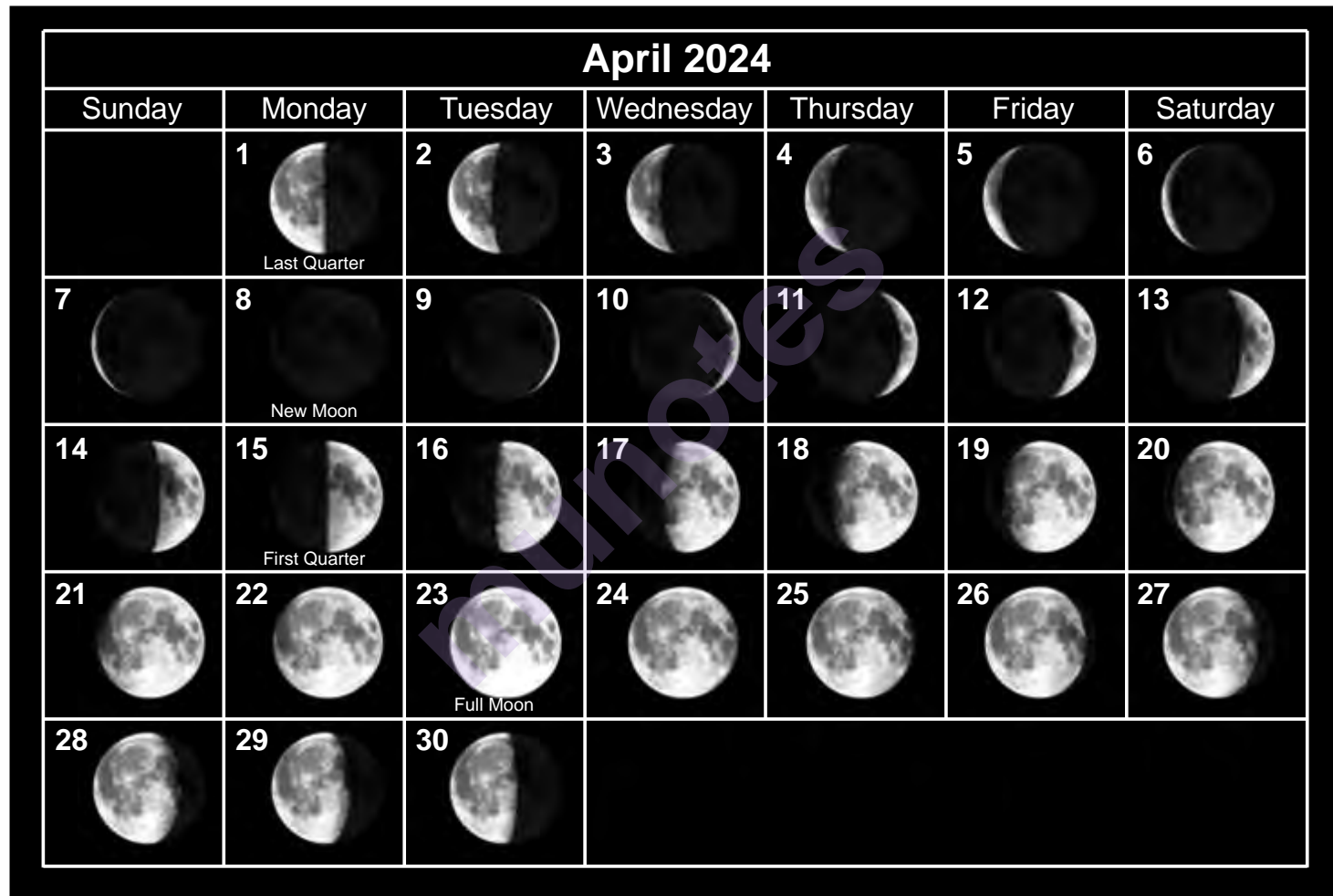


(2)



(4)

Base your answers to questions 39 through 42 on the diagram below and on your knowledge of Earth science. The diagram represents how Moon phases will appear to an observer in New York State during the month of April 2024.



39 During the month of April 2024, there will be a total solar eclipse visible for large portions of New York State. On which day in April will this solar eclipse occur?

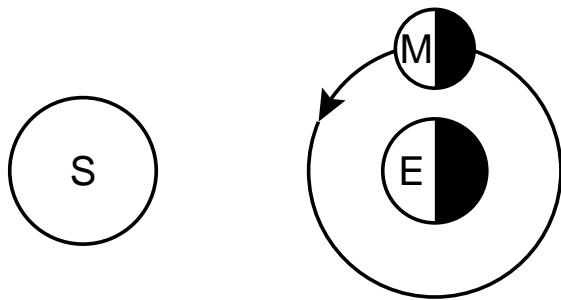
(1) April 1

(3) April 15

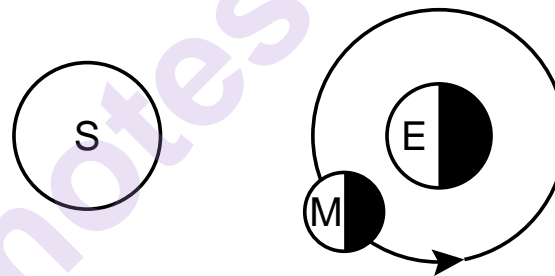
(2) April 8

(4) April 23

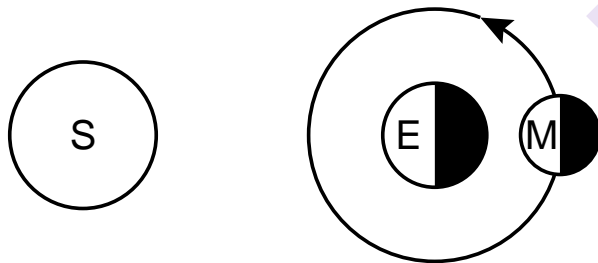
40 Which diagram below best represents the positions of the Sun (S) and Earth (E), and the orbital position of the Moon (M) on April 12? [Diagrams are not drawn to scale.]



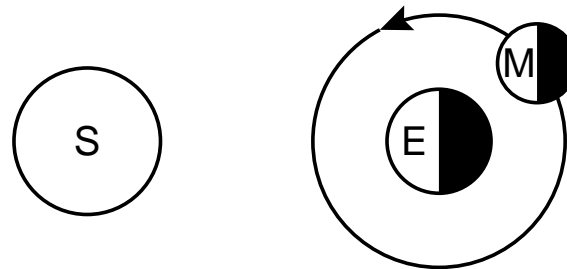
(1)



(3)



(2)

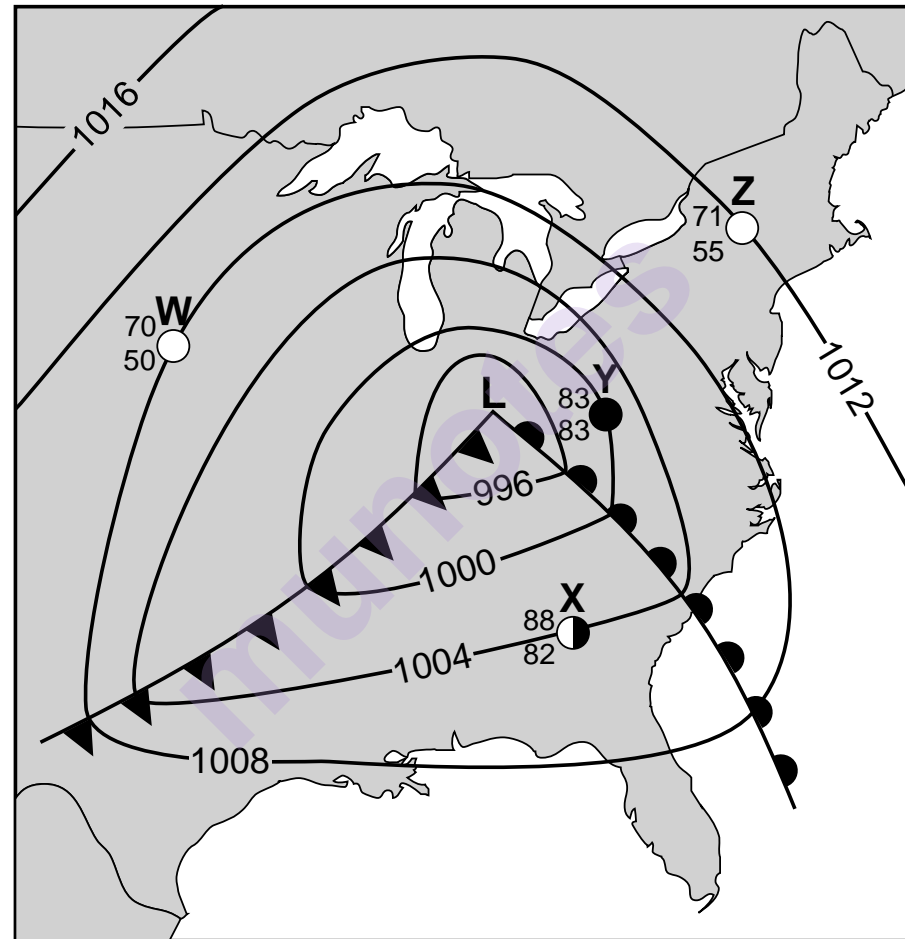


(4)

- 41 The same side of the Moon is always visible to an observer on Earth because the Moon has a period of
- (1) rotation greater than its period of revolution
 - (2) rotation equal to Earth's period of rotation
 - (3) revolution greater than Earth's period of revolution
 - (4) revolution equal to its period of rotation
- 42 Compared to the density of the terrestrial and Jovian planets, the density of the Moon is
- (1) less than the densities of both the terrestrial and Jovian planets
 - (2) greater than the densities of both the terrestrial and Jovian planets
 - (3) less than the densities of terrestrial planets, but greater than the densities of Jovian planets
 - (4) greater than the densities of terrestrial planets, but less than the densities of Jovian planets
-

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Base your answers to questions 43 through 45 on the weather map below and on your knowledge of Earth science. The map shows a low-pressure system located over the eastern United States. Partial weather station models are indicated at locations W, X, Y, and Z. Isobars are recorded in millibars.



43 Locations W and X are within which types of air masses?

- | | |
|--|--|
| (1) W is within mP and X is within cT. | (3) W is within mT and X is within cP. |
| (2) W is within cP and X is within mT. | (4) W is within cT and X is within mP. |

44 Which weather station has an approximate air pressure of 29.65 inches of mercury?

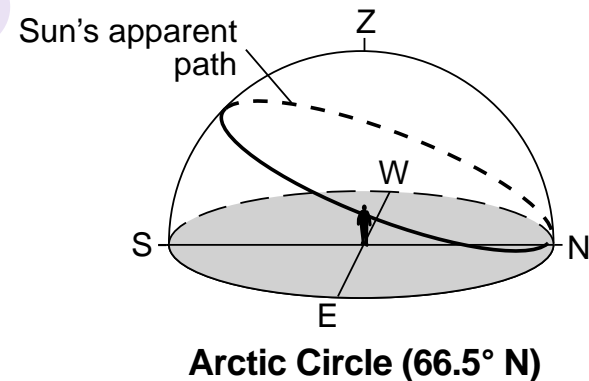
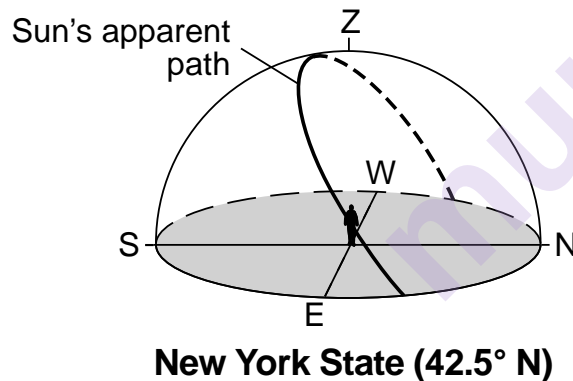
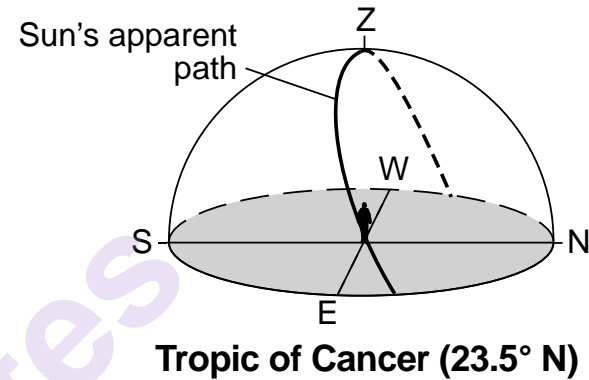
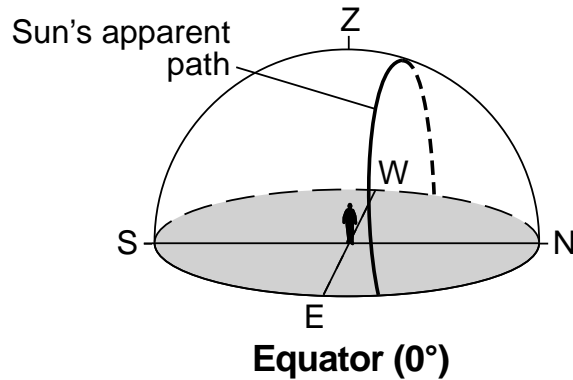
- | | |
|-------|-------|
| (1) W | (3) Y |
| (2) X | (4) Z |

45 The prevailing winds will cause this low-pressure system to most likely move toward the

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

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Base your answers to questions 46 and 47 on the diagrams below, which show the apparent paths of the Sun across the sky on June 21 for observers at four different Earth locations. The zenith (Z) is the point in the sky directly above the observer.



46 At which location will the longest noontime shadow be observed on the date indicated in the diagrams?

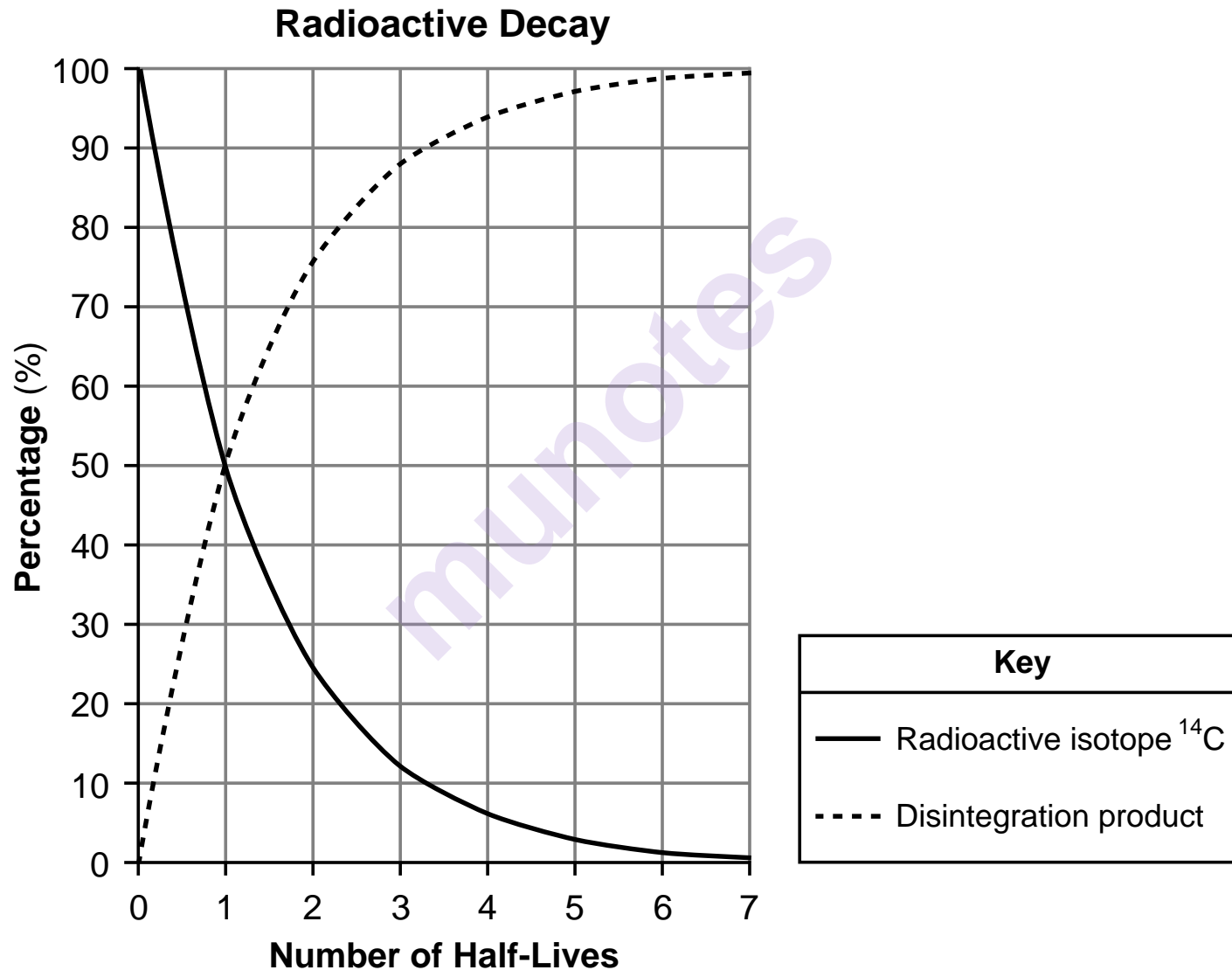
- | | |
|----------------------|--------------------|
| (1) Equator | (3) New York State |
| (2) Tropic of Cancer | (4) Arctic Circle |

47 Three months after the date indicated in the diagrams, sunrise in New York State will occur

- | | |
|-------------------|-------------------|
| (1) due east | (3) north of west |
| (2) south of east | (4) due west |
-

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Base your answers to questions 48 through 50 on the graph below and on your knowledge of Earth science. The graph shows the decreasing percentage of a radioactive isotope, carbon-14 (^{14}C), as it decays and the increasing percentage of the disintegration product that forms.



48 Which percentage of this radioactive isotope remains at the end of 3 half-lives?

- | | |
|-----------|-----------|
| (1) 6.25% | (3) 25.0% |
| (2) 12.5% | (4) 87.5% |

49 What is the disintegration product of this radioactive isotope?

- | | |
|-----------------------|----------------------|
| (1) ^{40}Ar | (3) ^{14}N |
| (2) ^{206}Pb | (4) ^{87}Sr |

50 Carbon-14 can be used to determine the ages of both a

- | | |
|--|--|
| (1) quartz crystal and a calcite crystal | (3) mastodon bone and a human bone |
| (2) lava flow and a granite intrusion | (4) trilobite fossil and a dinosaur fossil |
-

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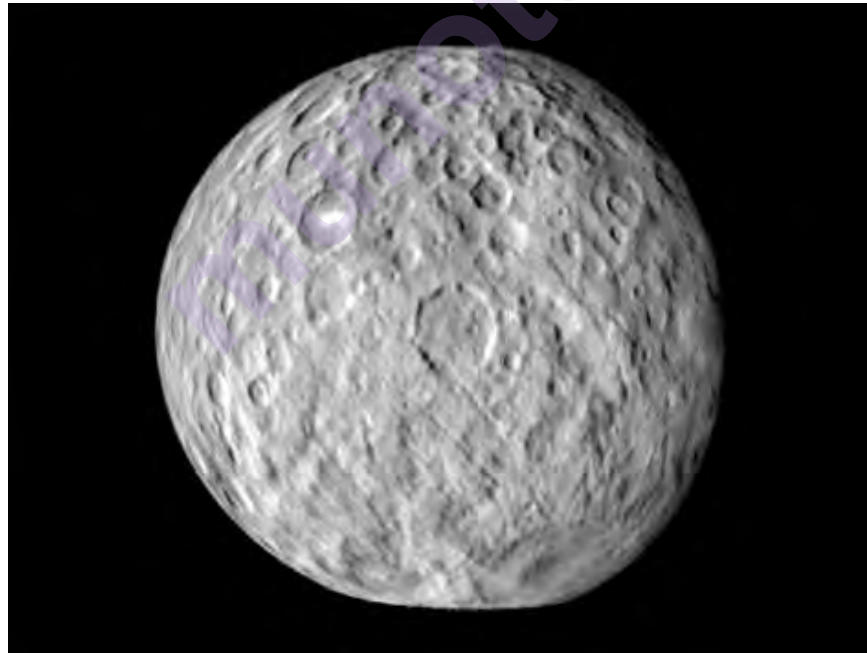
Part B–2

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 photograph below and the passage and table on the next page, and on your knowledge of Earth science. The photograph shows the surface of Ceres, a dwarf planet. The passage describes what is currently known about Ceres. The table includes data about Ceres.

Ceres



Ceres

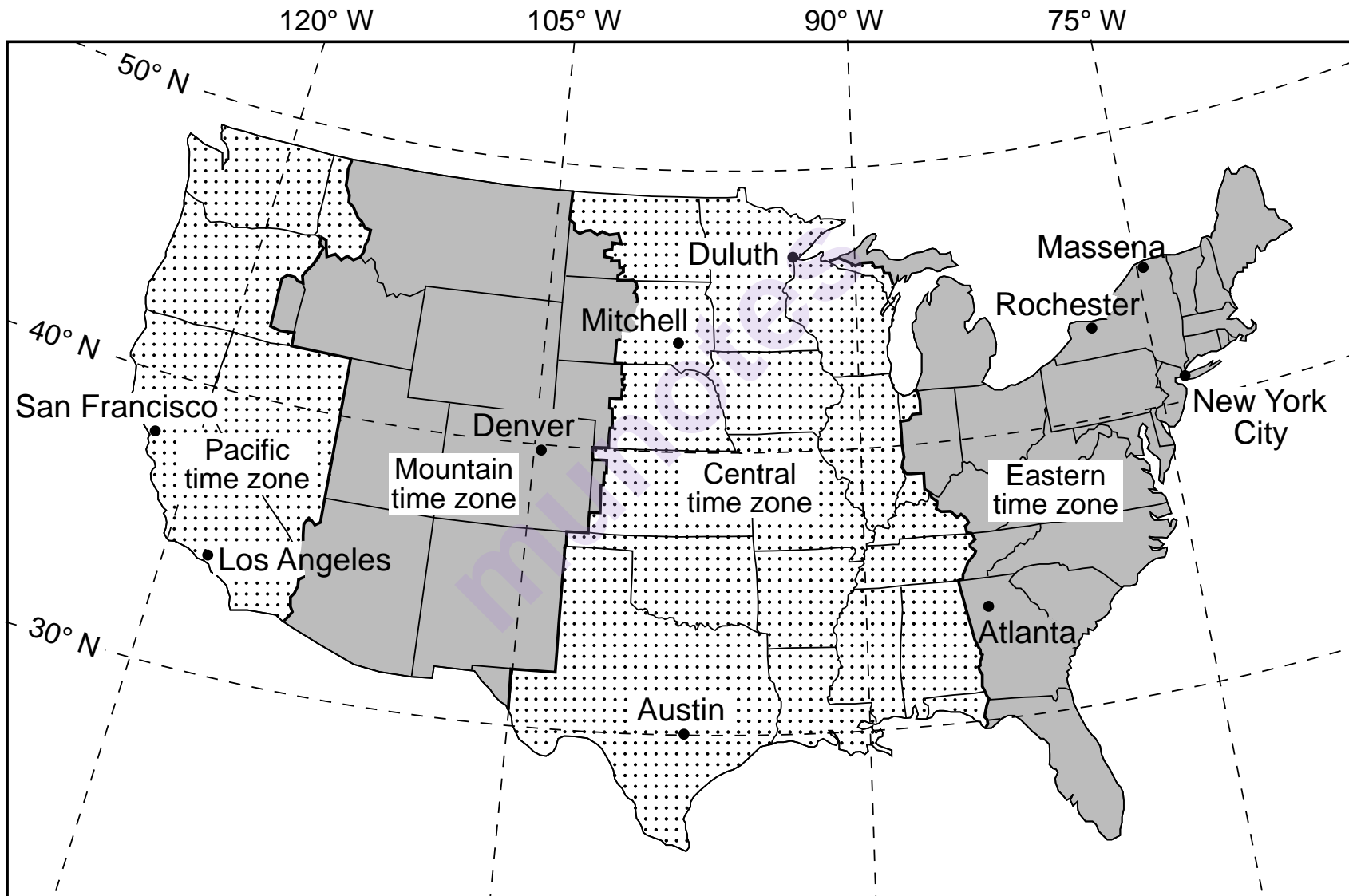
Ceres is the largest object in the asteroid belt, which is located between Mars and Jupiter. NASA's Dawn spacecraft has been studying Ceres because it is considered to be "a time capsule from the very beginning of the solar system," according to a principal scientist of the mission. Ceres is smaller than Pluto, and like Pluto, is classified as a dwarf planet because of its round shape and very small size. Ceres has a very thin atmospheric layer containing water vapor.

Ceres Data

Period of revolution	1680 d
Period of rotation at equator	9 h
Eccentricity of orbit	0.079
Equatorial diameter	952 km
Density	2.1 g/cm ³

- 51 Identify the planet in our solar system that has an equatorial diameter approximately five times the equatorial diameter of Ceres. [1]
- 52 State *one* possible distance of Ceres from the Sun, in million kilometers (km). [1]
- 53 Identify the planet in our solar system with an orbital eccentricity closest to the eccentricity of Ceres. [1]
- 54 Identify the many circular surface features, shown in the photograph, that cover much of Ceres, and describe how these features most likely formed. [1]

Base your answers to questions 55 and 56 on the map below and on your knowledge of Earth science. The map shows the four time zones of the continental United States. Some cities are labeled on the map.



55 Determine the time of day at Atlanta and time of day at Los Angeles when it is 1:00 p.m. at Rochester, New York. Indicate a.m. or p.m. in *both* answers. [1]

56 Identify the city shown on the map where an observer would view Polaris closest to the horizon. [1]

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Base your answers to questions 57 through 61 on the passage below, the data table on the next page, and the maps on the following page, and on your knowledge of Earth science. The data table shows the approximate surface area and volume of the Aral Sea in 1960 and 2000, and the present-day data for the five North American Great Lakes. The 1960 map shows the Aral Sea and the city of Aralsk, which was located on the shoreline. The 2000 map shows the change in size of the Aral Sea.

The Aral Sea

The Aral Sea is actually an inland saltwater lake located in southwest Russia. It is estimated to have formed approximately 5.5 million years ago due to the uplift of mountainous regions to the south. The region's two major rivers, fed by snowmelt and precipitation, flowed down from these mountains and pooled together to form the Aral Sea. The Aral Sea was one of the largest lakes in the world. In the 1960s, government officials began diverting most of the river water for farming. Since 1960 the size of the lake has dramatically decreased. As the lake dried up, fisheries and the communities that depended on them collapsed. The increasingly salty water became polluted with fertilizer and pesticides. The blowing dust from the exposed lakebed, contaminated with agricultural chemicals, became a public health hazard. The salt left behind made the ground unusable for farming.

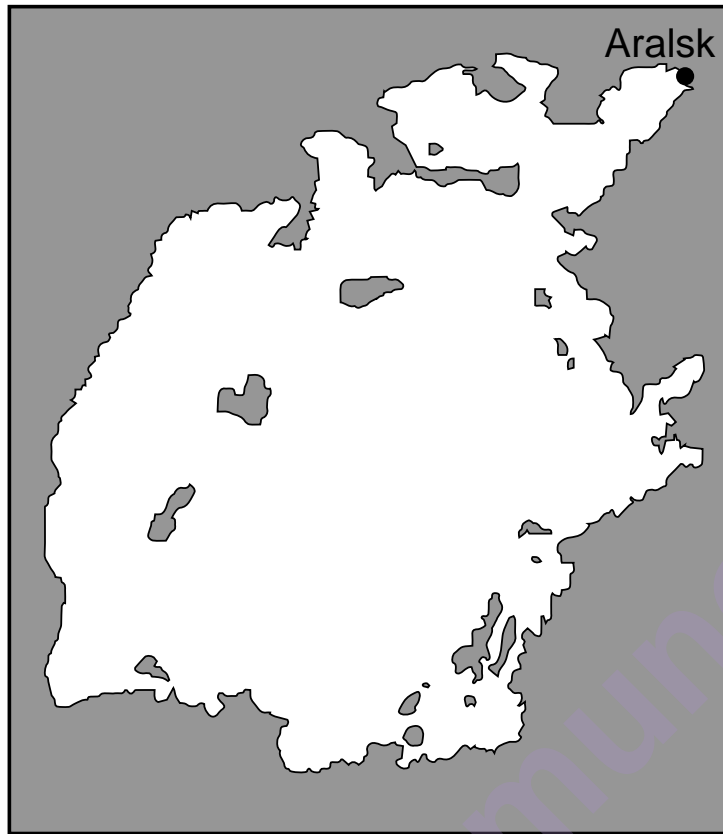
Data Table

	Surface Area (km ²)	Volume (km ³)
Aral Sea 1960	66,458	1064
Aral Sea 2000	23,400	400
Lake Superior	82,100	12,100
Lake Michigan	57,800	4920
Lake Huron	59,600	3540
Lake Erie	25,700	484
Lake Ontario	18,960	1640

Source: Great Lakes information, <http://www.epa.gov/glnpo/atlas/gl-fact1.html>

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Aral Sea Shoreline



1960



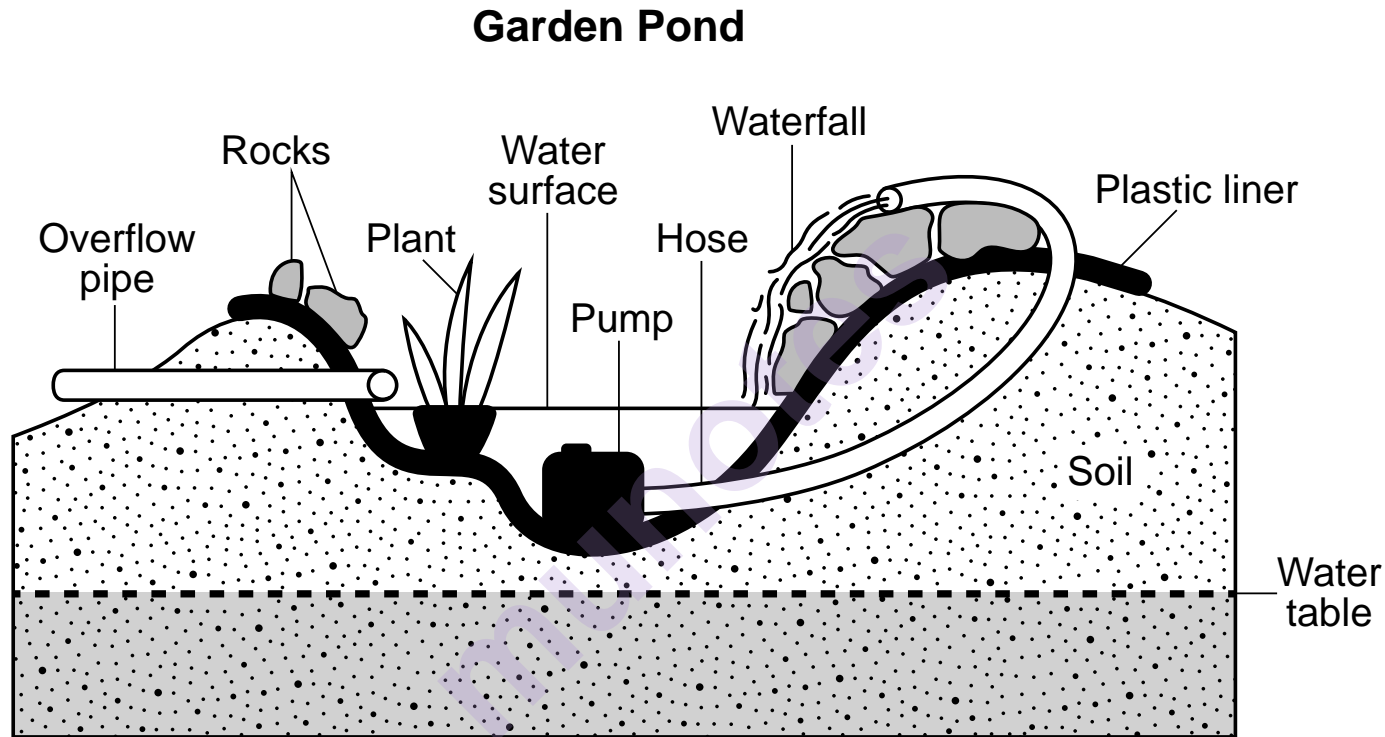
2000

Key	
	Aral Sea
	Exposed lakebed

- 57 Identify the name of the geologic epoch when the Aral Sea formed. [1]
- 58 Calculate, to the nearest tenth, the rate of change in the volume of the Aral Sea in cubic kilometers per year (km^3/y) in the 40 years from 1960 to 2000. [1]
- 59 State *one* human activity that led to the decrease in size of the Aral Sea and describe one effect of this decrease on the environment. [1]
- 60 State *one* effect that the reduced size of the Aral Sea had on the summertime air temperature and the amount of precipitation in Aralsk. [1]
- 61 Identify the Great Lake that has a surface area and volume of water most similar to the surface area and volume of water of the Aral Sea in 2000. [1]
-

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Base your answers to questions 62 and 63 on the cross section below and on your knowledge of Earth science. The cross section represents a small garden pond in New York State. An impermeable plastic liner covers the bottom and sides of the pond. A pump delivers water to an artificial waterfall.



- 62 The garden pond owner has to add water to the pond on a regular basis. Explain why the water surface level would naturally decrease if the owner did not perform this task. [1]
- 63 Explain what would happen to the water in the pond if the liner were removed. [1]
-

Base your answers to questions 64 and 65 on the data table below and on your knowledge of Earth science. The data table shows the surface temperatures (K), luminosities, and inferred ages in million years (my) of three stars located in the pattern of stars referred to as the Little Dipper.

Data Table

Star Name	Surface Temperature (K)	Luminosity (relative to the Sun)	Inferred Age (my)
Kochab	4000	500	2950
Pherkad	8900	1200	100
Polaris	5800	2600	70

64 *In your answer booklet*, circle the relative surface temperature and luminosity of Pherkad compared to the surface temperature and luminosity of the Sun. [1]

65 List Kochab, Polaris, and the universe in order by their inferred age from oldest to youngest. [1]

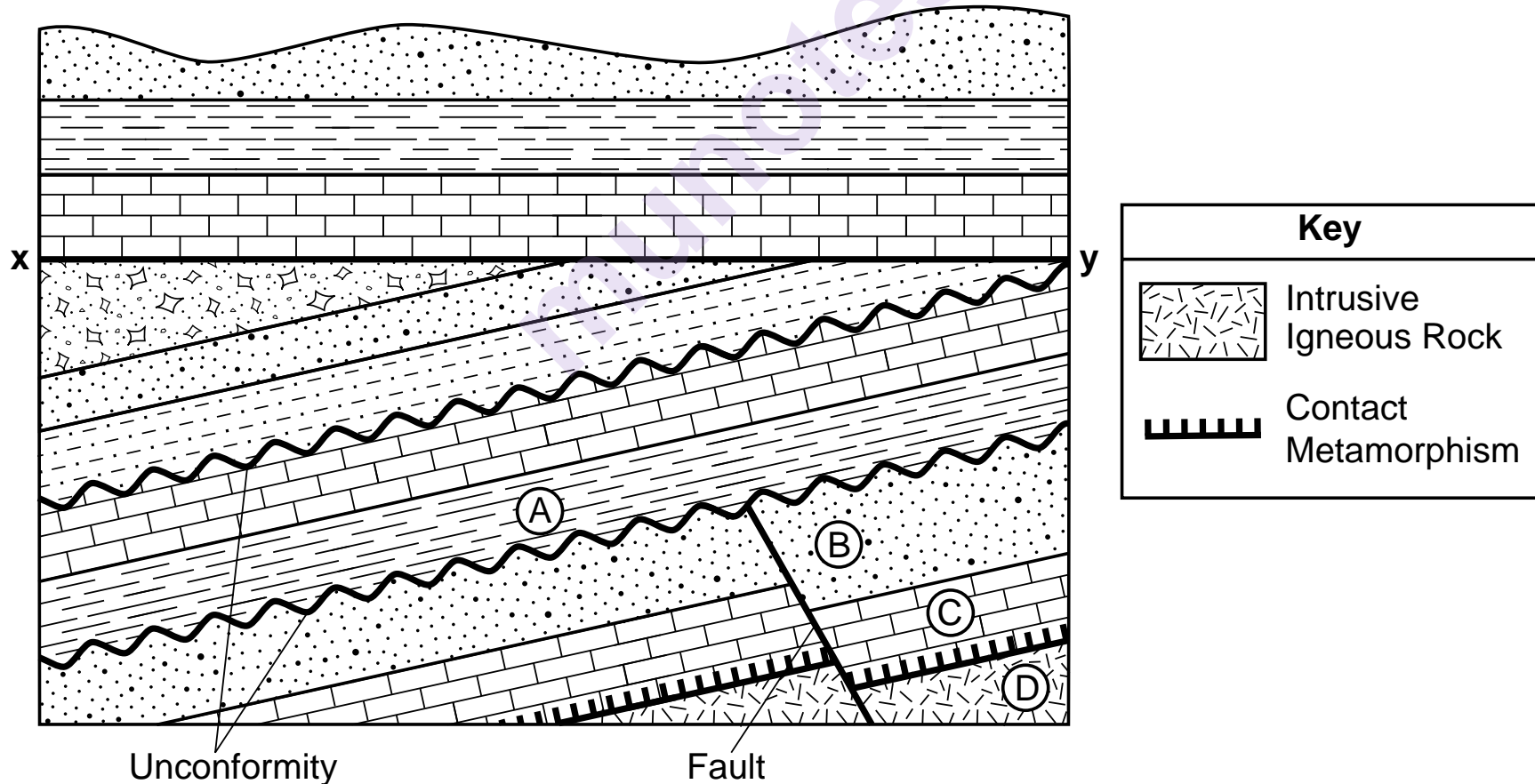
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Part C

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 cross section below and on your knowledge of Earth science. The geologic cross section represents a portion of Earth's crust. Letters A, B, C, and D identify rock units. Two unconformities and a fault are labeled. Line XY represents a third unconformity.



- 66 State the name of the sedimentary rock layer that was the last to form before unconformity *XY*. [1]
- 67 Describe the rate of cooling of the magma that formed rock unit *D*. [1]
- 68 State the diameter, in centimeters, of the largest particle size that is possibly found in the sedimentary rock represented by rock layer *B*. [1]
-

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Base your answers to questions 69 through 71 on the passage and data tables below and on the next page, the map in your answer booklet, and on your knowledge of Earth science. Table 1 shows latitude and longitude locations of the center of Hurricane Michael, recorded at 1:00 p.m. each day from October 7, 2018 to October 11, 2018. The data table also shows the wind speed in miles per hour (mph) and the barometric pressure in millibars (mb). Table 2 shows the Saffir-Simpson Scale, which organizes hurricanes into categories based on maximum sustained wind speeds.

Hurricane Michael

On October 10, 2018 at approximately 1:00 p.m., Hurricane Michael made landfall near Mexico Beach, Florida, with wind speeds of 160 mph. This was the third-strongest Atlantic hurricane to make landfall in the United States, as well as the strongest hurricane to make landfall along the Florida panhandle, the part of northwest Florida along the Gulf of Mexico coast. Thousands of homes were ripped apart by the winds, and an estimated 650,000 people in two states were left without electrical power.

Table 1: Hurricane Michael Data Taken at 1:00 p.m.

Date	Latitude (°N)	Longitude (°W)	Maximum Sustained Wind Speed (mph)	Air Pressure at the Center (mb)
October 7, 2018	19.0	86.0	40	1004
October 8, 2018	21.5	85.0	75	978
October 9, 2018	25.5	86.5	110	965
October 10, 2018	30.0	85.5	160	919
October 11, 2018	35.5	80.0	50	991

Table 2: Saffir-Simpson Scale

Category	Maximum Sustained Wind Speed (mph)
1	74-95
2	96-110
3	111-129
4	130-156
5	>157

- 69 On the map *in your answer booklet*, plot the *five* locations of the center of Hurricane Michael indicated by the latitudes and longitudes shown in table 1. Connect *all five* plots with a line. [1]
- 70 Based on the maximum sustained wind speeds, identify the Saffir-Simpson Scale category that Hurricane Michael was when it made landfall. [1]
- 71 Describe the relationship between air pressure and the maximum sustained wind speed at the center of this hurricane. [1]
-

Base your answers to questions 72 and 73 on the topographic map in your answer booklet and on your knowledge of Earth science. The map shows elevations, recorded in meters (m). Some contour lines are shown. Point A is a location on the land surface.

72 On the map *in your answer booklet*, draw the 30-meter and 40-meter contour lines. Extend both contour lines to the edge of the map. [1]

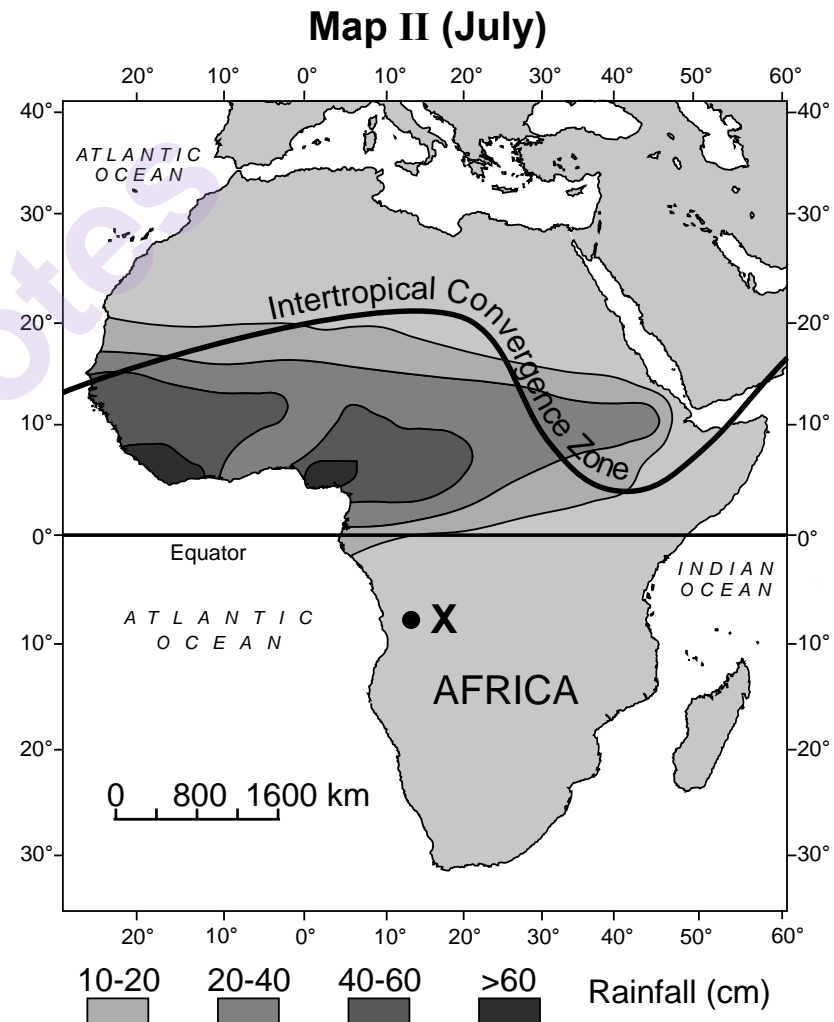
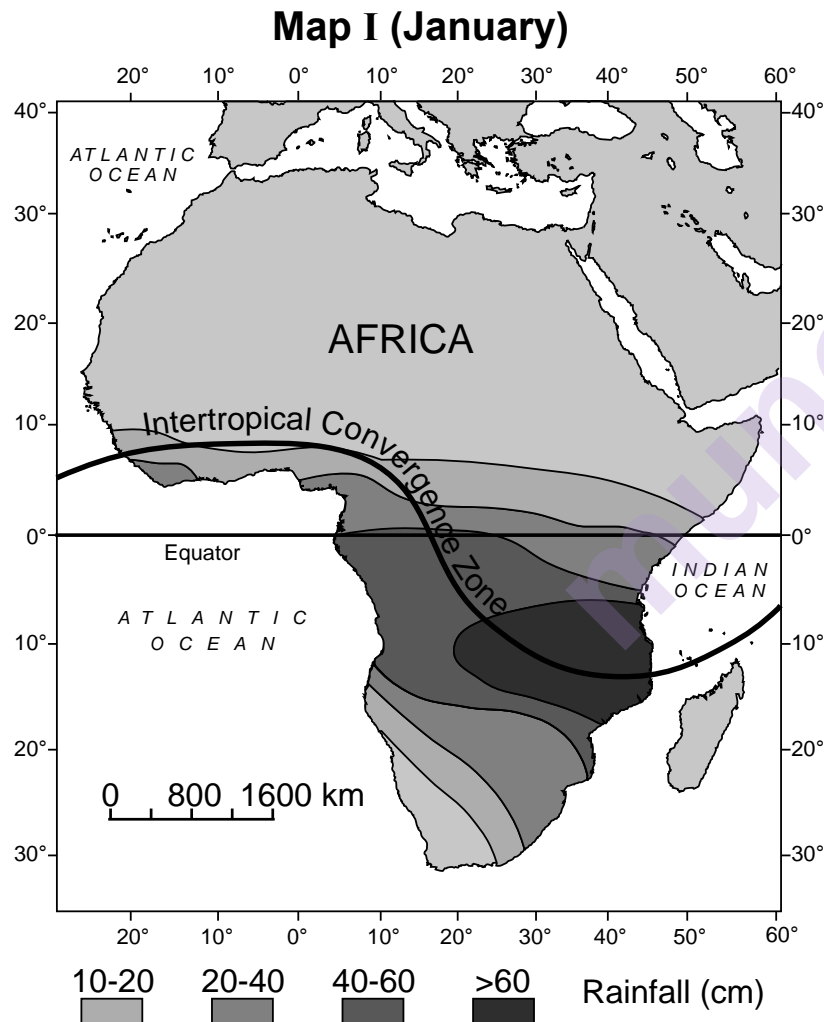
73 State a possible elevation, in meters, of point A. [1]

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Base your answers to questions 74 and 75 on the maps of Africa below and on your knowledge of Earth science. The Intertropical Convergence Zone (ITCZ) is a belt of low pressure that circles Earth where the planetary winds on either side of the ITCZ converge. The maps show the locations of the ITCZ in January (map I) and July (map II), and the nearby average amounts and patterns of precipitation during those months. Point X indicates a surface location.



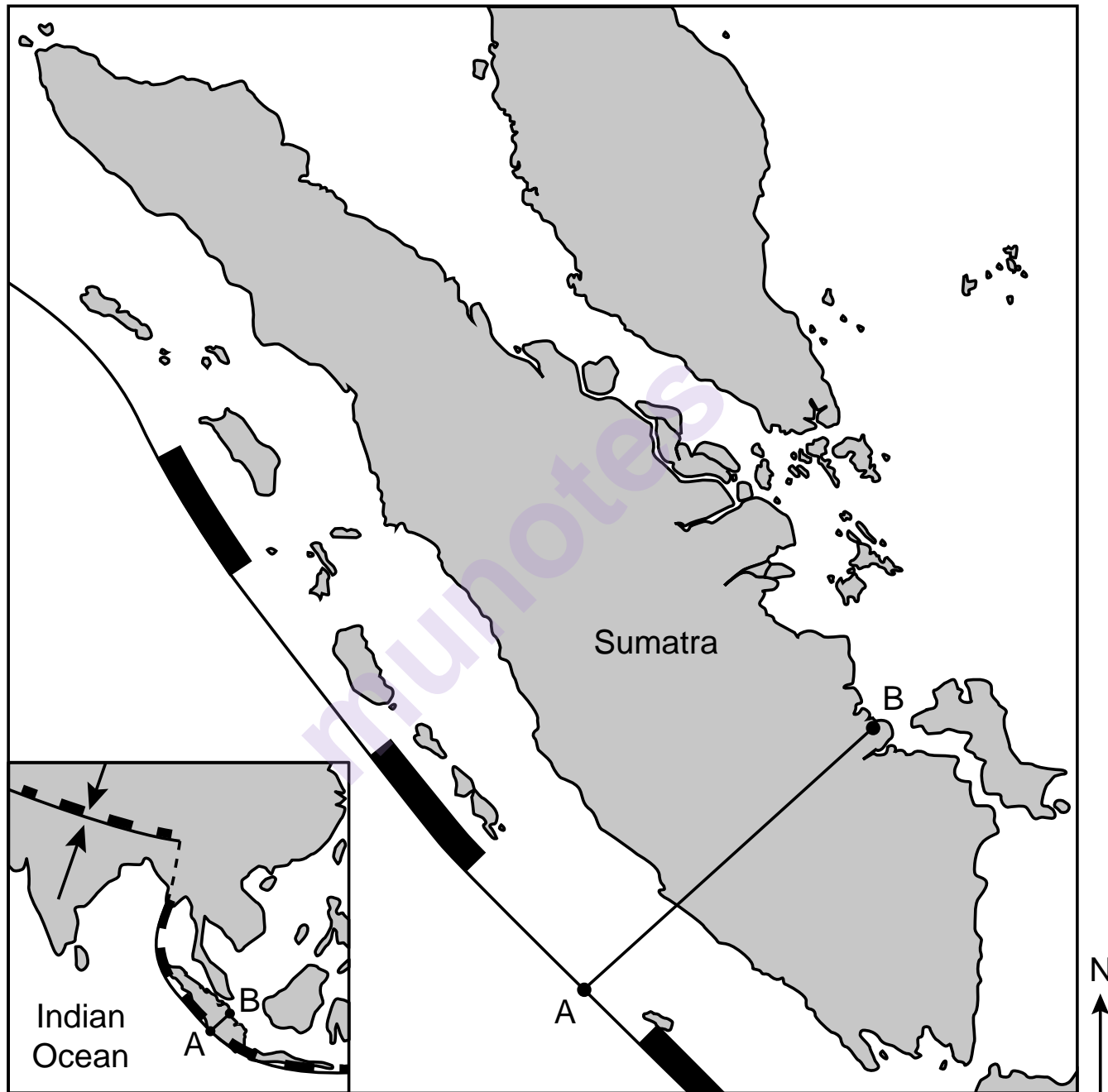
- 74 Compare the amount of precipitation that occurs at location X in July to the amount of precipitation that occurs at the same location in January. Use both January and July in your answer. [1]
- 75 Determine, in kilometers, an approximate distance north of the equator where the greatest amount of precipitation occurs in Africa during July. [1]
-

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Base your answers to questions 76 through 79 on the map on the next page, the data table on the following page, and on your knowledge of Earth science. The map shows the island of Sumatra in the eastern Indian Ocean. Line *AB* represents a reference line on the map. The inset map shows the location of plate boundaries in this region. The data table shows the depths of five earthquakes and their distances from the plate boundary, at location A, along line *AB*.

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Data Table

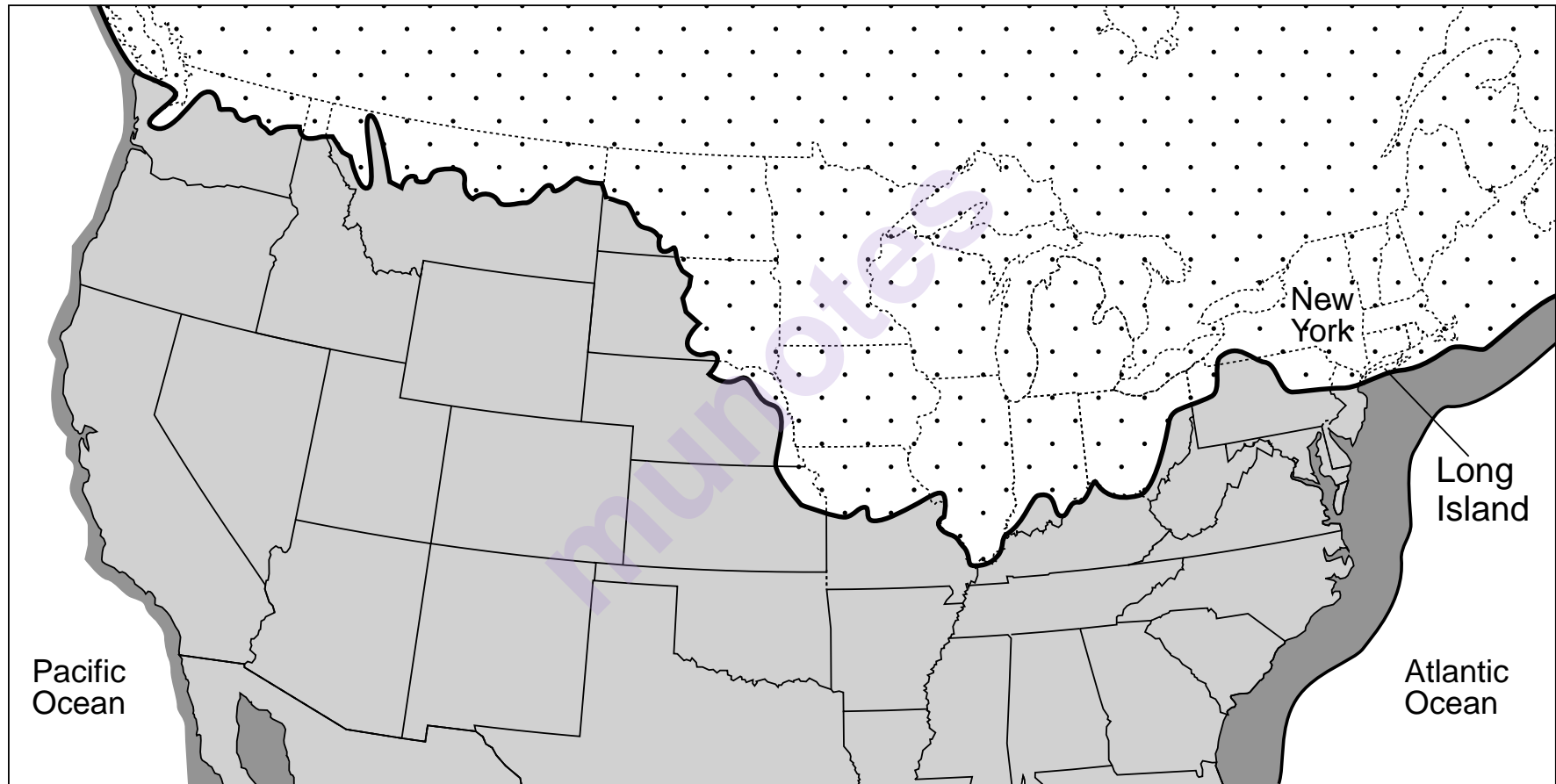
Distance From Location A (km)	Depth of Earthquake (km)
0	10
100	35
225	80
310	170
335	235

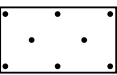

- 76 On the grid *in your answer booklet*, construct a line graph by plotting the data for the earthquake depths shown in the data table, and connect *all five* plots with a line. Do *not* extend your line beyond the given data. [1]
- 77 State the names of the tectonic plates on each side of the boundary at location A. [1]
- 78 Identify the layer of the mantle in which the deepest earthquake shown in the data table occurred. [1]
- 79 On September 28, 2018, a tsunami warning was issued to the people of Sumatra only a few minutes before a seven-meter-high wave came on to the shore. Explain *one* action that individuals should have taken as soon as the warning was issued. [1]
-

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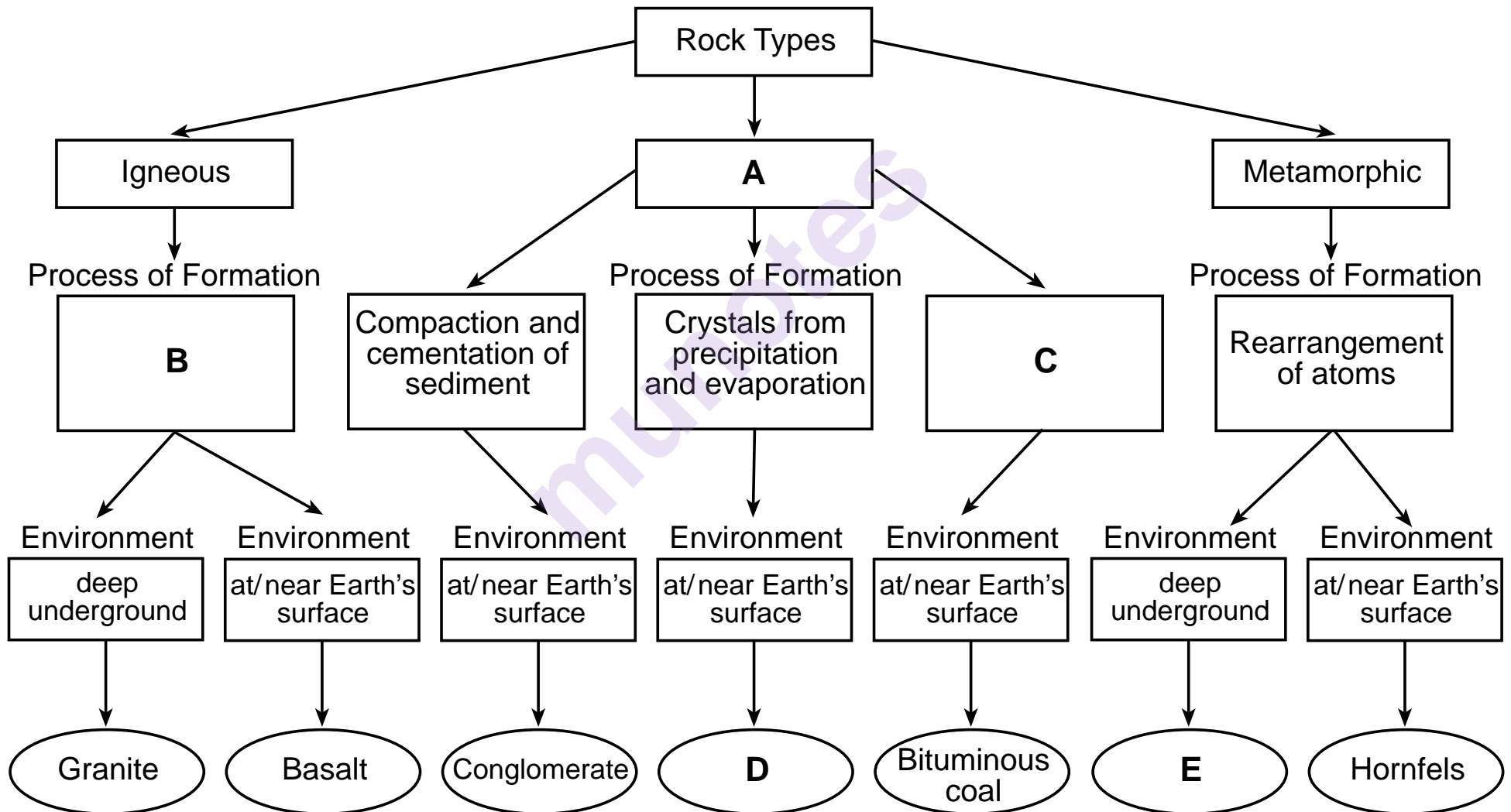
Base your answers to questions 80 through 82 on the map below and on your knowledge of Earth science. The map shows a portion of North America. The dark line shows the southernmost advance of the last continental ice sheet to cover North America. The coastal land areas exposed by a lower sea level at that time are shown with darker shading. The location of New York State, including Long Island, is labeled.



Key	
 Ice-covered areas	 Coastal land area exposed by lower sea level

- 80 The glacial moraines that form much of Long Island, New York, mark the farthest advance of this ice sheet. Describe the arrangement of rock particles making up these moraines. [1]
- 81 Old river valleys in central New York State were eroded by glacial ice, forming the Finger Lakes. Describe the cross-sectional shape of the original stream-cut valleys. Describe the cross-sectional shape of the valleys after they were carved by glacial ice. [1]
- 82 In some places, grooves and parallel scratches on surface bedrock provide evidence that the ice sheet moved over this bedrock. Explain how the grooves and scratches were produced by glacial movement. [1]
-

Base your answers to questions 83 through 85 on the flow chart below and on your knowledge of Earth science. The flow chart represents the three different rock types, the processes by which these rock types form, the environment in which these rock types form, and the names of some specific examples of these rocks. Letters A, B, C, D and E represent missing information on the chart.



- 83 Compared to the texture of basalt, describe how the texture of granite is different. [1]
- 84 Identify *one* possible Earth material that was most likely buried or compacted during the process of rock formation represented by letter *C* that resulted in the formation of bituminous coal. [1]
- 85 State the name of *one* rock that could be represented by letter *D*. [1]
-

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