

**PHYSICAL SETTING/EARTH SCIENCE
REGENTS EXAMINATION**

TEST SAMPLER DRAFT

Summer 2000

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Office of Curriculum, Instruction, and Assessment
Albany, New York 12234

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Regents of The University

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August 2000

Dear Colleagues:

Following several years of planning and development, the Physical Setting/Earth Science Test Sampler Draft is complete. School districts, science teachers, supervisors, and administrators have assisted the State Education Department in the development process in a variety of ways. Teachers have pretested test items with their students and developed and reviewed test items and scoring materials. Administrators have arranged for their students to participate in the pretest and field test process. Teachers and supervisors will continue to write, develop, pretest, and field test questions for future Physical Setting/Earth Science examinations.

This Test Sampler Draft is being distributed to all secondary schools in the State. Schools are requested to make additional copies available to their Earth science teachers.

The Test Sampler Draft provides examples of the types and formats of questions and scoring materials that are being developed for the Physical Setting/Earth Science Regents examination that will be administered for the first time in June 2001. We expect that further refinements of the formats of questions and scoring materials will occur as a result of information gathered from the development process.

We are interested in receiving your feedback on these preliminary materials. A comment sheet is included on the inside back cover of the Test Sampler Draft so that you may forward your responses to us. The comment sheet may be faxed to (518) 473-0858 or mailed to the address listed below:

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Sincerely,

Roseanne DeFabio

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Diana Harding, Associate in Science Education
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Anthony Costa, Artist/Designer

Special thanks go to Jan Christman for her technical expertise.

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Introduction

The Physical Setting/Earth Science Regents examination has been developed to assess student achievement at commencement level of Standards 1, 2, 4, 6, and 7 of the *Learning Standards for Mathematics, Science, and Technology*. Items for the examination were developed through the cooperative efforts of teachers, school districts, other science educators, and New York State Education Department staff. The written portion of this examination will be administered in a 3-hour period and will first be offered in June 2001.

The written portion of the examination will include three parts: A, B, and C. Students should be prepared to answer questions in multiple-choice, constructed-response, and extended constructed-response formats. Questions will be content- and skills-based and may require students to graph data, complete a data table, label or draw diagrams, design experiments, make calculations, or write short or extended responses. In addition, questions may require students to hypothesize, interpret, analyze, evaluate data, or apply their scientific knowledge and skills to real-world situations. Some of the questions will require use of the 2001 edition of the Earth Science Reference Tables.

Part D of the examination will be an assessment of laboratory skills. Until a new Part D is developed, the 1994 edition of the Earth Science Performance Test with minor revisions will be administered as Part D of the Physical Setting/Earth Science examination. Students will be required to complete the performance test at the school's convenience during the last two weeks of the course, but no later than the day prior to the administration of the written portion of the examination. A general description of this performance test is given on page 42 of the Test Sampler Draft.

Students will be required to answer ALL of the questions on the Physical Setting/Earth Science Regents examination.

Physical Setting/Earth Science Regents Examination Format

PART	ITEM TYPE(S)	DESCRIPTION OF THE ITEMS	APPROXIMATE PERCENT OF TOTAL TEST RAW SCORE
A	Multiple-choice questions	Content-based questions assessing the student's knowledge and understanding of core material (primarily from Standard 4)	30–40
B	Multiple-choice and constructed-response questions	Content- and skills-based questions assessing the student's ability to apply, analyze, and evaluate material (primarily from Standards 1, 2, 4, and 6)	25–35
C	Constructed-response and/or extended constructed-response questions	Content-based and application questions assessing the student's ability to apply knowledge of science concepts and skills (primarily from Standards 1, 2, 4, 6, and 7)	15–25
D	Performance tasks*	Laboratory performance test	10

Each examination will be scaled, and all examination forms equated, based on a standard-setting process. A chart for converting the student's total examination raw score to a scaled score will be provided in the rating guide for each administration.

Appendix I, Examination Blueprint (page 59), indicates the approximate percentage of examination questions for each content standard in the Physical Setting/Earth Science Core Curriculum. Appendices II and III, Mapping the Sampler to the Core Curriculum (page 60) and Mapping the Core Curriculum to the Sampler (page 61), link each question in the Test Sampler Draft to the Physical Setting/Earth Science Core Curriculum and the 2001 edition of the Earth Science Reference Tables. Individual questions may be linked to multiple standards in addition to the Earth Science Reference Tables.

* When a new Part D is developed, the type of assessment may change.

Test modifications must be consistently provided to students with disabilities when it is determined that such accommodations are necessary. Such modifications must be documented either in an Individualized Education Plan (IEP) or in a Section 504 Accommodation Plan. Modifications are being redrawn to reflect the requirements of the new assessments. The revised State assessments are being developed by both special and general educators to ensure that they are appropriate for students with disabilities.

The Physical Setting/Earth Science Regents Examination Test Sampler Draft may be used in the classroom to help teachers plan for instruction. Teachers are encouraged to reproduce and use the sample examination in the Test Sampler Draft to introduce students to the test format and use the scoring materials for practice in scoring student papers.

Laboratory Requirements: Critical to understanding science concepts is the use of scientific inquiry to develop explanations of natural phenomena. Therefore, as a prerequisite for admission to the performance test and the written portion of the Regents examination in Physical Setting/Earth Science, students must have successfully completed a minimum of 1200 minutes of hands-on laboratory experience with satisfactory reports on file. Because of the strong emphasis on student development of laboratory skills, a minimum of 280 minutes per week of class and laboratory time is recommended.

Sample Test Questions for the Physical Setting/Earth Science Regents Examination Part A

Answer all questions in this part. [35]

Directions (1–35): For each statement or question, select the word or expression that, of those given, best completes the statement or answers the question. Record your answer on the separate answer sheet in accordance with the directions on the front page of this booklet. Some questions may require the use of the *Earth Science Reference Tables*.

1 Which mineral is an ore of iron and has a characteristic reddish brown streak?

- | | |
|-------------|------------|
| 1 magnetite | 3 hematite |
| 2 pyrite | 4 olivine |

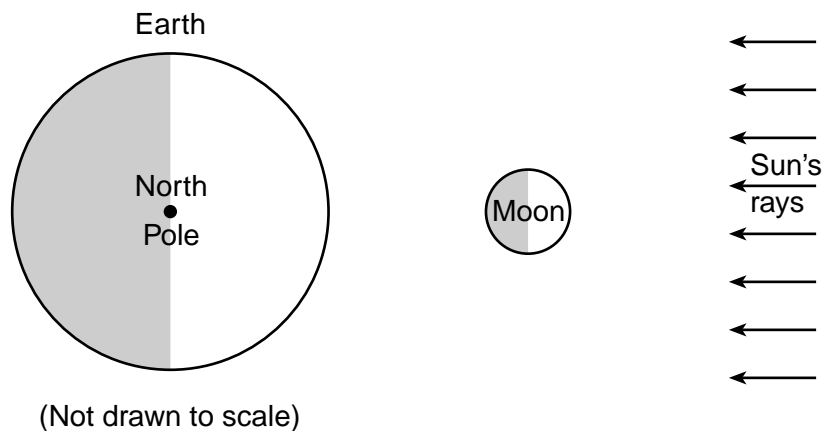
2 A student recorded the times of three successive high tides at one location as:

9:12 a.m.
9:38 p.m.
10:04 a.m.

What is the approximate time of the next high tide?

- | | |
|----------------|----------------|
| (1) 10:12 p.m. | (3) 10:38 p.m. |
| (2) 10:30 p.m. | (4) 11:04 p.m. |

3 The diagram below shows Earth, the Moon, and the Sun's rays as viewed from space.



For observers on Earth, which phase of the Moon is represented by the diagram?

- | | | | |
|-------|---------------|-------|--------------|
| New | First quarter | Full | Last quarter |
| | | | |
| (1) | (2) | (3) | (4) |

4 In which list are celestial features correctly shown in order of increasing size?

- 1 galaxy → solar system → universe → planet
- 2 solar system → galaxy → planet → universe
- 3 planet → solar system → galaxy → universe
- 4 universe → galaxy → solar system → planet

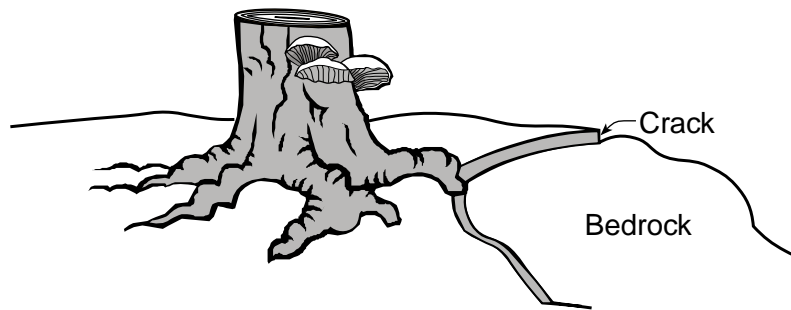
5 Because Venus has greater atmospheric carbon dioxide (CO₂) content than Earth has, the surface temperature of Venus is

- 1 warmer, due to absorption of long-wave (infrared) radiation by a greenhouse gas
- 2 warmer, due to absorption of short-wave (ultraviolet) radiation by a greenhouse gas
- 3 cooler, due to absorption of long-wave (infrared) radiation by a greenhouse gas
- 4 cooler, due to absorption of short-wave (ultraviolet) radiation by a greenhouse gas

6 Rainfall is most likely to infiltrate into soil that is

- 1 permeable and saturated
- 2 permeable and unsaturated
- 3 impermeable and saturated
- 4 impermeable and unsaturated

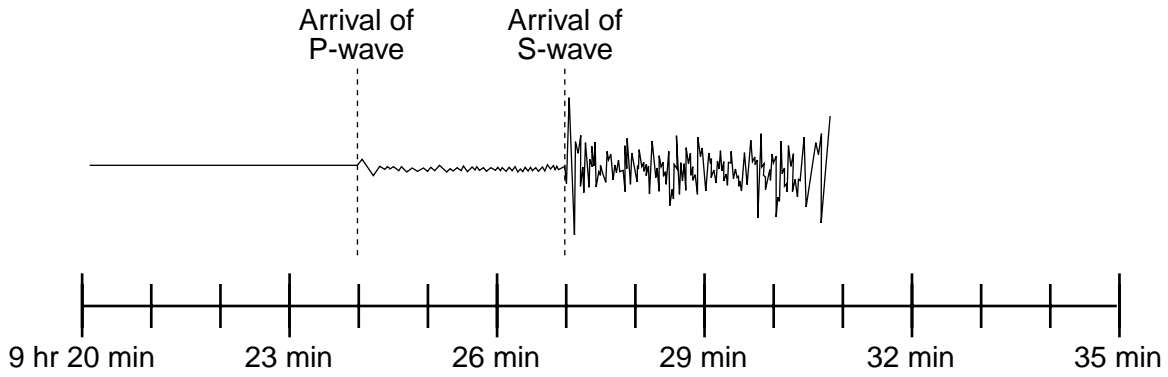
7 The diagram below shows the stump of a tree whose root grew into a small crack in bedrock and split the rock apart.



The action of the root splitting the bedrock is an example of

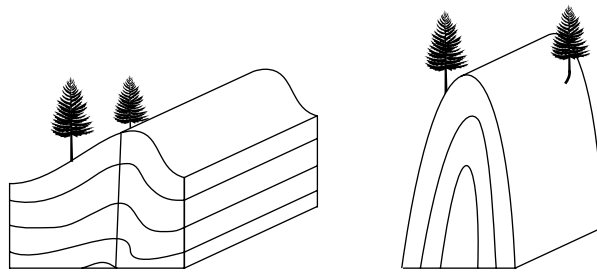
- 1 chemical weathering
- 2 deposition
- 3 erosion
- 4 physical weathering

- 8 The seismogram below shows the arrival times of an earthquake's *P*-wave and *S*-wave recorded at a seismic station in Portland, Oregon.



What was the distance from Portland to the earthquake's epicenter?

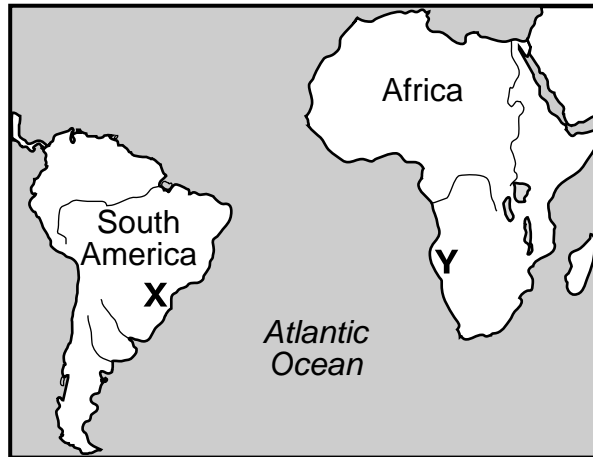
- (1) 1800 km (3) 3200 km
 (2) 2500 km (4) 4100 km
- 9 The cross sections of crust below represent two regions of sedimentary rock layers that have been altered.



The sedimentary bedrock in both regions originally formed as

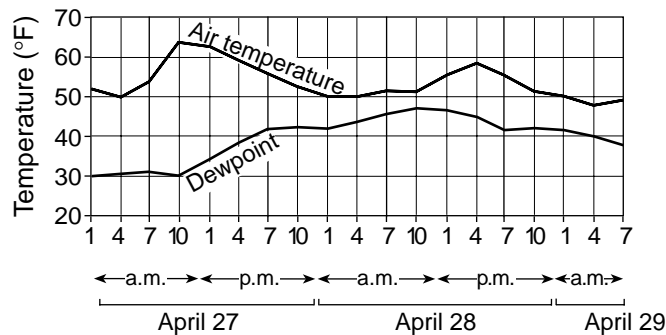
- 1 horizontal layers 3 faulted layers
 2 recrystallized layers 4 folded layers

- 10 The map below shows the present-day locations of South America and Africa. Remains of *Mesosaurus*, an extinct freshwater reptile, have been found in similarly aged bedrock formed from lake sediments at locations *X* and *Y*.



Which statement represents the most logical conclusion to draw from this evidence?

- 1 *Mesosaurus* migrated across the ocean from location *X* to location *Y*.
 - 2 *Mesosaurus* came into existence on several widely separated continents at different times.
 - 3 The continents of South America and Africa were joined when *Mesosaurus* lived.
 - 4 The present climates at locations *X* and *Y* are similar.
- 11 Surface bedrock of the Allegheny Plateau is most likely to contain fossils of the earliest
- 1 grasses
 - 2 flowering plants
 - 3 dinosaurs
 - 4 amphibians
- 12 The air outside a classroom has a dry-bulb temperature of 10°C and a wet-bulb temperature of 4°C. What is the relative humidity of this air?
- (1) 1%
 - (2) 14%
 - (3) 33%
 - (4) 54%
- 13 The graph below is a computer-generated forecast of air temperature and dewpoint for a city during a period of 2 1/4 days.



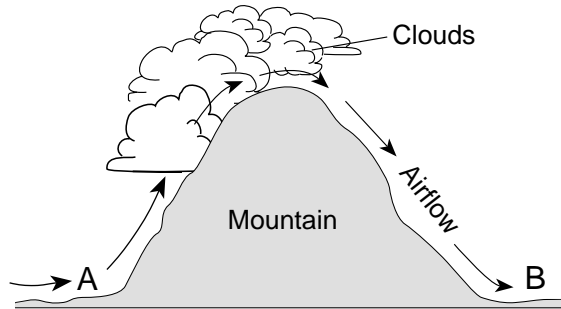
At which time during this period is the rate of evaporation expected to be highest?

- 1 April 27 at 10 a.m.
- 2 April 28 at 10 a.m.
- 3 April 28 at 4 p.m.
- 4 April 29 at 4 a.m.

14 What is the general pattern of air movement on March 21 at Earth's Equator (0°)?

- 1 upward, due to low temperature and high pressure
- 2 upward, due to high temperature and low pressure
- 3 downward, due to low temperature and high pressure
- 4 downward, due to high temperature and low pressure

Base your answers to questions 15 and 16 on the diagram of a mountain shown below. The arrows represent the direction of airflow over the mountain.



15 As the air moves up the windward side of the mountain, the air

- | | |
|------------------------|---------------------|
| 1 compresses and warms | 3 expands and warms |
| 2 compresses and cools | 4 expands and cools |

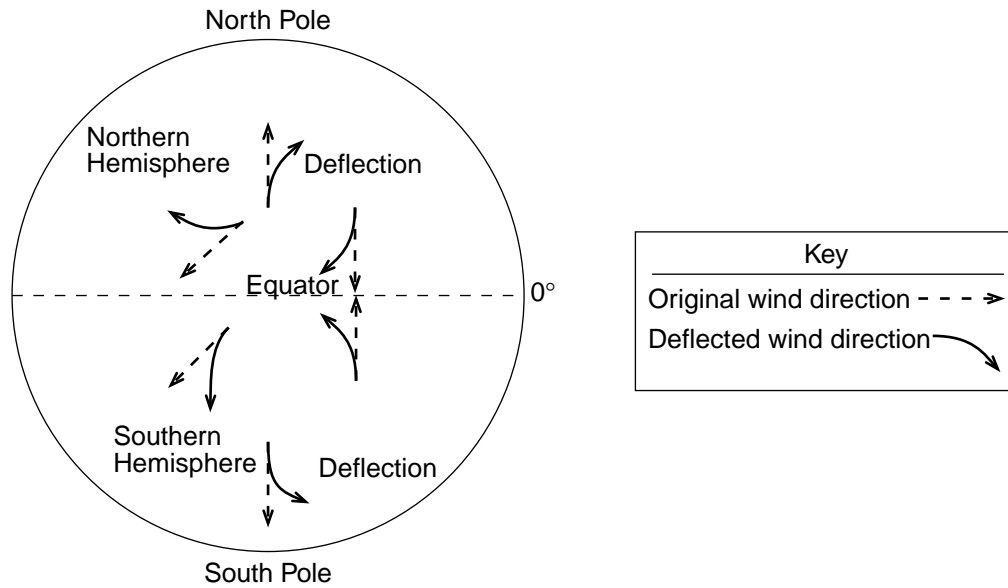
16 Compared to the temperature and humidity conditions at location *A*, the conditions at location *B* are

- | | |
|-------------------------|-------------------------|
| 1 warmer and less humid | 3 cooler and less humid |
| 2 warmer and more humid | 4 cooler and more humid |

17 An air mass classified as mT usually forms over which type of Earth surface?

- | | |
|--------------|--------------|
| 1 cool land | 3 warm land |
| 2 cool water | 4 warm water |

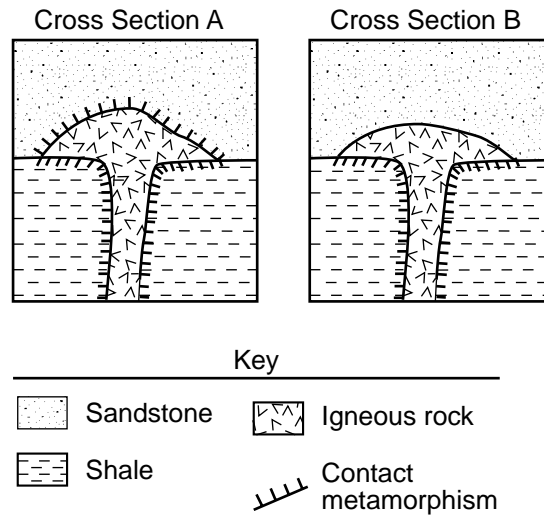
- 18 The diagram below shows some examples of how surface winds are deflected in the Northern and Southern Hemispheres because of Earth's rotation.



Earth's rotation causes winds to be deflected to the

- 1 right in both the Northern and Southern Hemispheres
 - 2 right in the Northern Hemisphere and left in the Southern Hemisphere
 - 3 left in the Northern Hemisphere and right in the Southern Hemisphere
 - 4 left in both the Northern and Southern Hemispheres
- 19 What is the average velocity of an earthquake's S-wave in its first 4 minutes of travel?
- (1) 1 km/min
 - (2) 250 km/min
 - (3) 500 km/min
 - (4) 4 km/min
- 20 At the Aleutian Trench and the Peru-Chile Trench, tectonic plates are generally
- 1 moving along a transform boundary
 - 2 moving over a mantle hot spot
 - 3 diverging
 - 4 converging

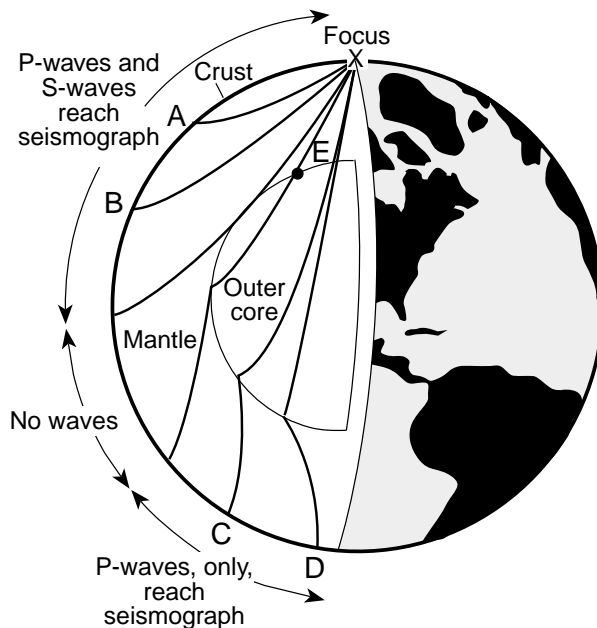
- 21 The diagrams below represent two different geologic cross sections in which an igneous formation is found in sedimentary bedrock layers. The layers have not been overturned.



Which statement best describes the relative age of each igneous formation compared to the overlying sandstone bedrock?

- 1 In *A*, the igneous rock is younger than the sandstone and in *B*, the igneous rock is older than the sandstone.
- 2 In *A*, the igneous rock is older than the sandstone and in *B*, the igneous rock is younger than the sandstone.
- 3 In both *A* and *B*, the igneous rock is younger than the sandstone.
- 4 In both *A* and *B*, the igneous rock is older than the sandstone.

Base your answers to questions 22 and 23 on the diagram below, which shows a cutaway view of Earth in which the interior layers are visible. The paths of earthquake waves generated at point *X* are shown. *A*, *B*, *C*, and *D* are locations of seismic stations on Earth's surface, and point *E* is located in Earth's interior.



22 Both *P*-waves and *S*-waves were received at seismic stations *A* and *B*, but only *P*-waves were received at seismic stations *C* and *D*. Which statement best explains why this occurred?

- (1) *S*-waves are much weaker than *P*-waves.
- (2) *S*-waves travel faster than *P*-waves.
- (3) The liquid outer core prevents *S*-waves from traveling to seismic stations *C* and *D*.
- (4) The solid outer core prevents *S*-waves from traveling to seismic stations *C* and *D*.

23 The actual rock temperature at point *E* is inferred to be approximately

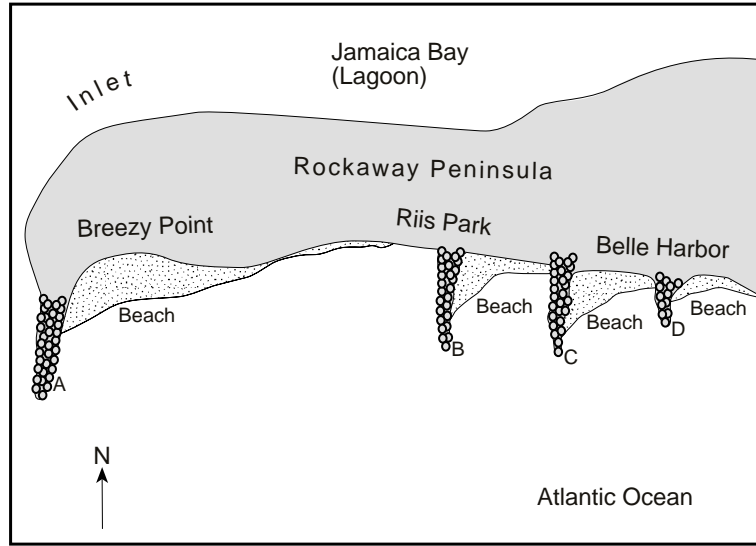
- (1) 1,500°C
- (2) 2,900°C
- (3) 5,000°C
- (4) 6,200°C

Base your answers to questions 24 through 26 on the map below, which shows a portion of a drumlin field near Palmyra, New York. Elevations are in feet.

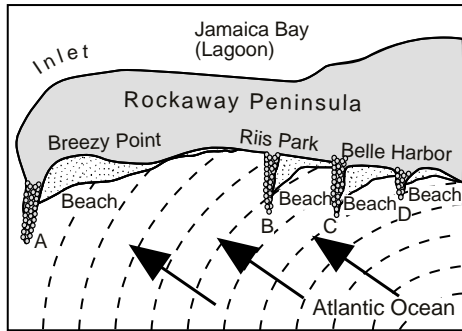


- 24 What is the contour interval of this map?
- (1) 5 ft (3) 20 ft
(2) 10 ft (4) 25 ft
- 25 At this location, the glacial ice generally advanced from the
- 1 north 3 east
2 south 4 west
- 26 These drumlins are composed of sediments transported and deposited directly by glacial ice. These sediments are likely to be
- 1 well-rounded, sand-sized particles
2 well sorted in horizontal layers
3 unsorted and not in layers
4 found underwater, mixed with organic materials
-
- 27 In which New York State landscape region is surface bedrock generally composed of metamorphic rock?
- 1 Tug Hill Plateau 3 Newark Lowlands
2 Adirondack Mountains 4 the Catskills

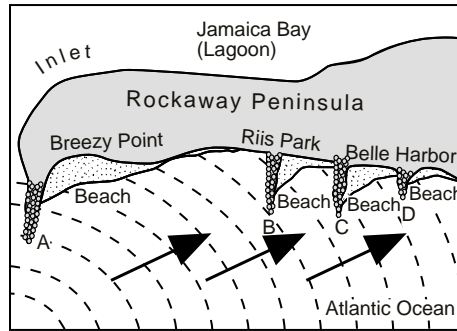
The map below shows Rockaway Peninsula, part of Long Island's south shore, and the location of several stone barriers, A, B, C, and D, that were built to trap sand being transported along the coast by wave action.



On which map do the arrows best show the direction of wave movement that created the beaches in this area?

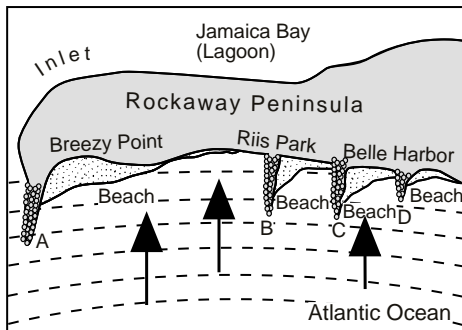


(1)

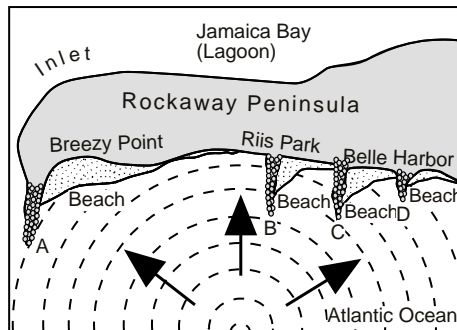


(3)

Key
 - - - - wave crests



(2)



(4)

29 The table below provides information about the mineral composition of a sample of beach sand from Hawaii.

Mineral	Composition (%)
Pyroxene	50
Plagioclase feldspar	40
Olivine	3
Amphibole	5
Unidentified minerals	2

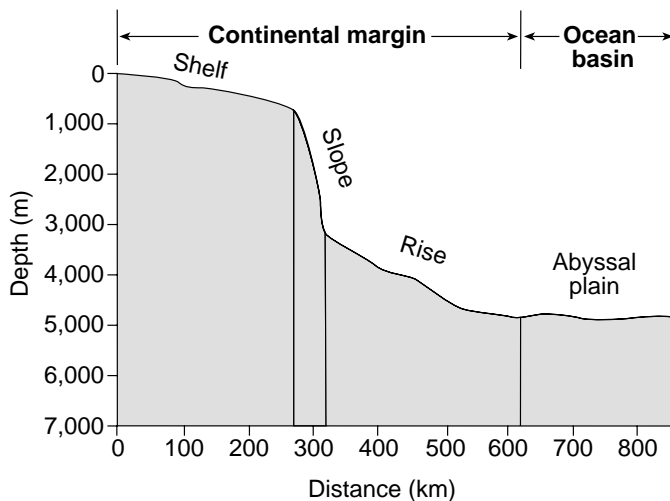
If the sand deposited on this beach recently weathered from only one type of igneous rock, the rock was most likely

- 1 granite
- 2 peridotite
- 3 diorite
- 4 basalt

30 Warm water from tropical oceans is carried to northern Europe by the Gulf Stream and the

- 1 Alaska Current
- 2 Canaries Current
- 3 North Atlantic Current
- 4 Brazil Current

31 The profile below shows four regions of the ocean bottom.



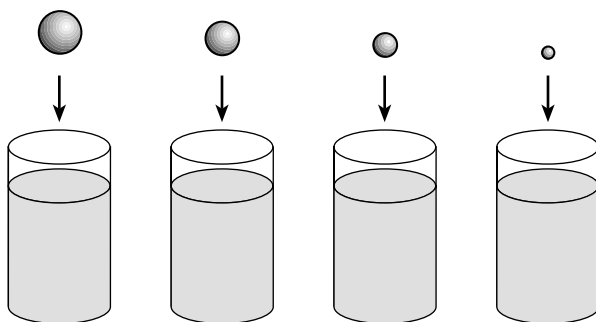
In which list are these regions arranged in order of gradient from least steep to most steep?

- 1 rise → abyssal plain → shelf → slope
- 2 slope → rise → shelf → abyssal plain
- 3 abyssal plain → shelf → rise → slope
- 4 shelf → abyssal plain → rise → slope

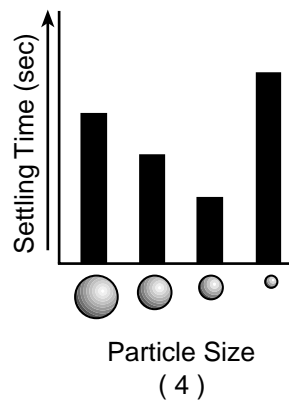
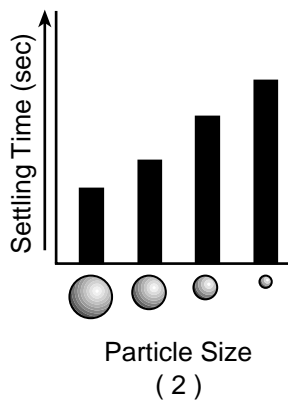
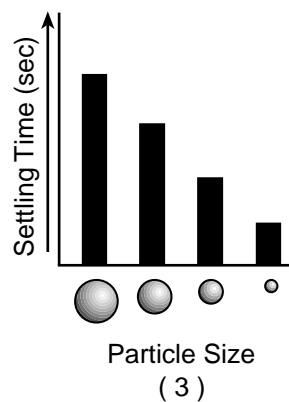
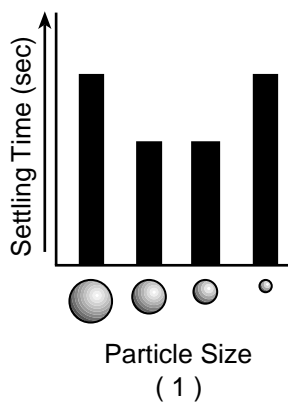
32 Which statement best explains why climates at continental shorelines generally have a smaller yearly temperature range than inland climates at the same latitude?

- 1 Land is a poor absorber and a poor conductor of heat energy.
- 2 Land changes temperature rapidly, due to the high specific heat and lack of transparency of land.
- 3 Ocean water is a good absorber and a good conductor of heat energy.
- 4 Ocean water changes temperature slowly, due to the high specific heat and transparency of water.

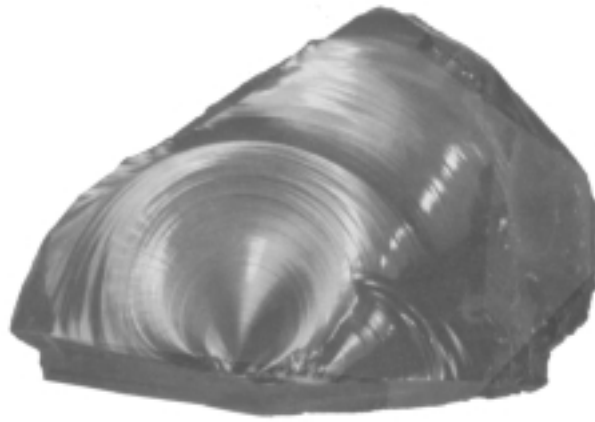
The diagram below shows four identical columns containing the same amount of water. Four different-sized spherical particles, made of the same uniform material, are dropped into the columns and settle to the bottom.



Which graph best shows the relative settling times of the four particles?



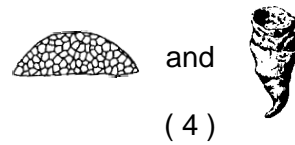
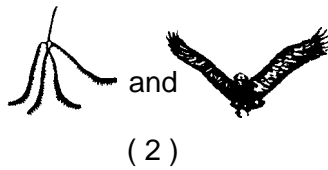
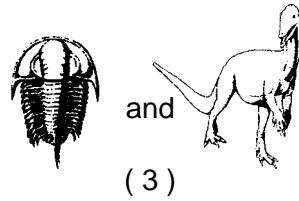
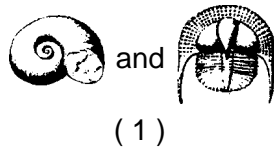
34 The picture below shows the igneous rock obsidian.



The obsidian's glassy texture indicates that it formed from a magma that cooled

- 1 slowly, deep below Earth's surface
- 2 slowly, on Earth's surface
- 3 quickly, deep below Earth's surface
- 4 quickly, on Earth's surface

35 Which pair of index fossils can be found in Ordovician bedrock?



Part B

Answer all questions in this part. [30]

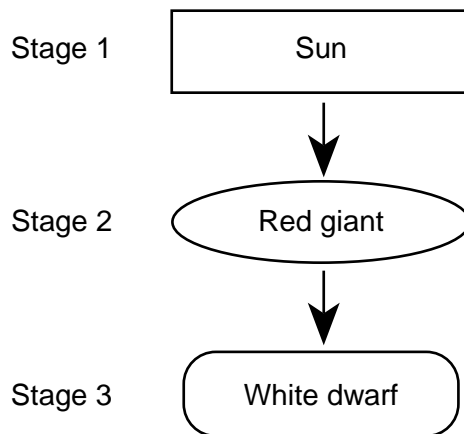
Directions (36–46): For each statement or question, select the word or expression that, of those given, best completes the statement or answers the question. Record your answer on the separate answer sheet in accordance with the directions on the front page of this booklet. Some questions may require the use of the *Earth Science Reference Tables*.

Base your answers to questions 36 and 37 on the "Luminosity and Temperature of Stars" graph in the *Earth Science Reference Tables*. The graph shows the temperature and relative brightness of many stars observed from Earth.

36 According to the graph, the Sun is classified as a

- 1 main sequence star with a temperature of approximately 4,000°C and a luminosity of 100
- 2 main sequence star with a temperature of approximately 6,000°C and a luminosity of 1
- 3 white dwarf star with a temperature of approximately 10,000°C and a luminosity of 0.01
- 4 blue supergiant star with a temperature of approximately 20,000°C and a luminosity of 700,000

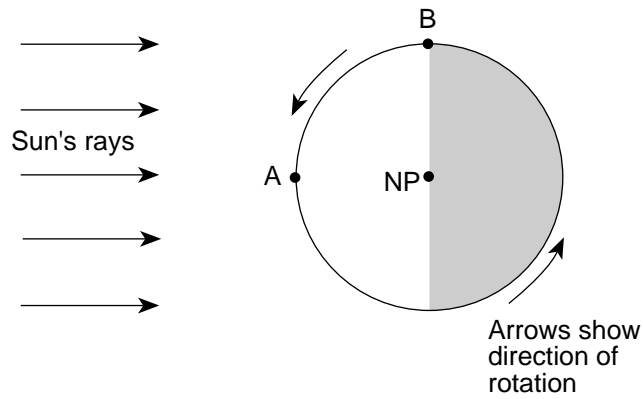
37 Stars are believed to undergo evolutionary changes over millions of years. The flowchart below shows stages of predicted changes in the Sun.



According to this flowchart, the Sun will become

- 1 hotter and brighter in stage 2, then cooler and dimmer in stage 3
 - 2 cooler and dimmer in stage 2, then hotter and brighter in stage 3
 - 3 hotter and dimmer in stage 2, then cooler and brighter in stage 3
 - 4 cooler and brighter in stage 2, then hotter and dimmer in stage 3
-

38 The diagram below shows Earth as viewed from above the North Pole (NP). Points *A* and *B* are locations on Earth's surface.

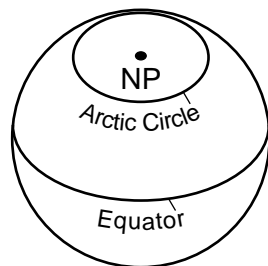


At location *A*, the time is 12 noon. What is the time at location *B*?

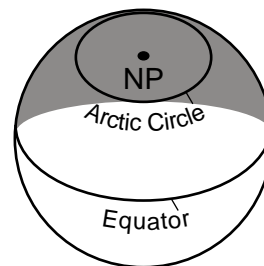
- (1) 6 a.m.
- (2) 6 p.m.
- (3) 3 p.m.
- (4) 12 midnight

39 Which diagram most correctly shows the portion of Earth that is illuminated by sunlight and the portion that is in shadow on the first day of summer in the Northern Hemisphere?

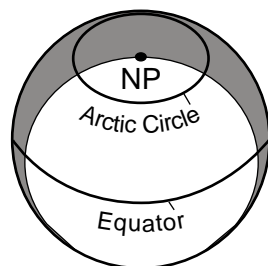
[Key: = illuminated, = shadow, NP = North Pole]



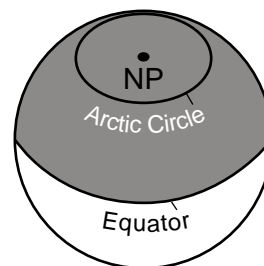
(1)



(3)

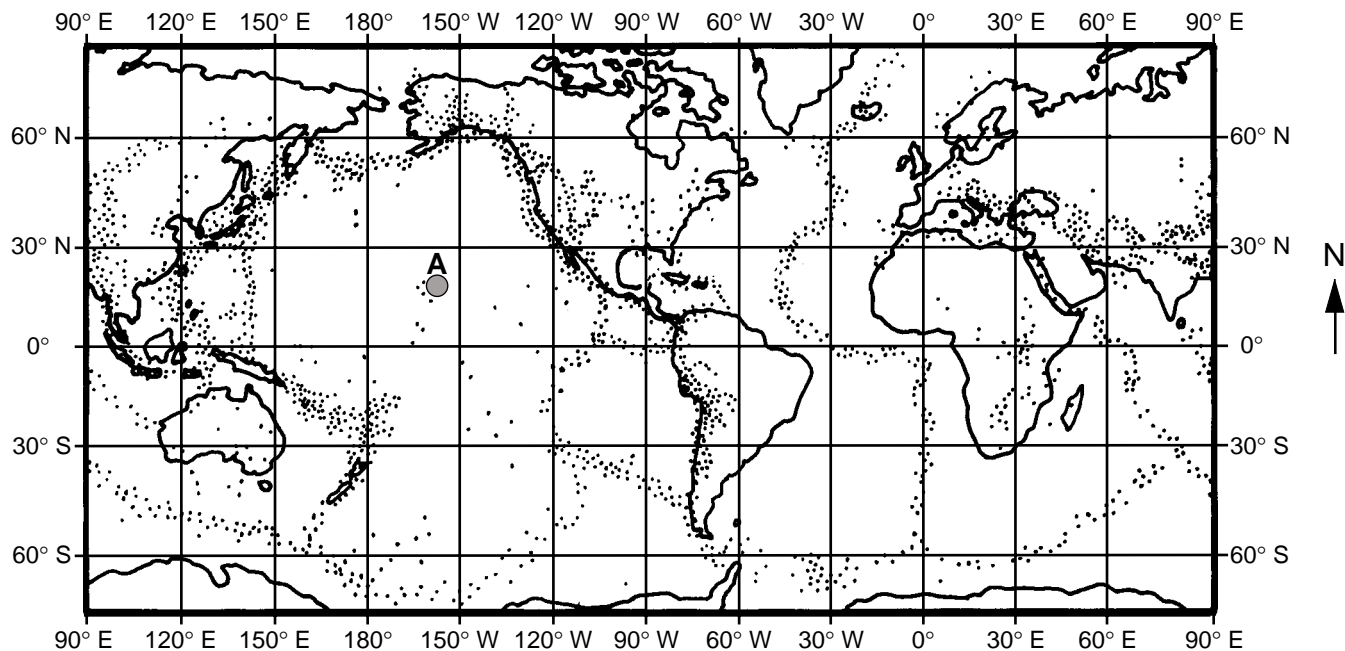


(2)



(4)

Base your answers to questions 40 and 41 on the map below. Dots on the map show the distribution of major earthquake epicenters. The shaded circle labeled *A* represents a location on Earth's surface.



40 Which conclusion can best be inferred from the data shown on this map?

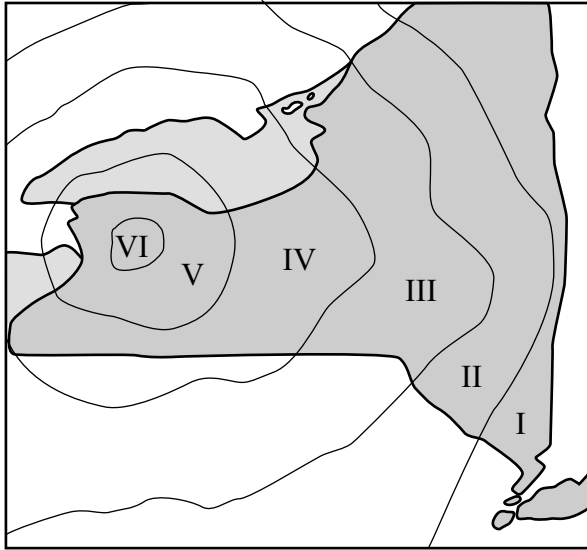
- 1 Earthquakes generally are evenly distributed over the surface of Earth.
- 2 Most earthquakes occur west of the Prime Meridian and north of the Equator.
- 3 Most earthquakes are concentrated in zones along plate boundaries.
- 4 Most earthquakes occur on continents.

41 Location *A* is best described as an area that is

- 1 within a rift valley at a mid-ocean ridge
- 2 at the boundary between two diverging plates
- 3 within a deep-sea trench between two converging plates
- 4 above a mantle hot spot near the center of a crustal plate

- 42 The map below shows the intensity values (Earth-shaking effects observed by people) during an earthquake that occurred in New York State. The numbered areas on the map were determined from the Modified Mercalli Scale shown at the right. The scale is used to group locations according to the observed effects of an earthquake.

New York State



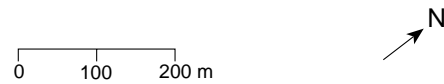
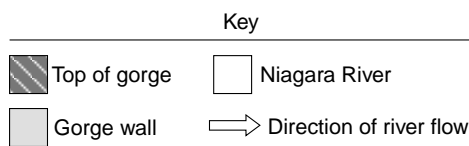
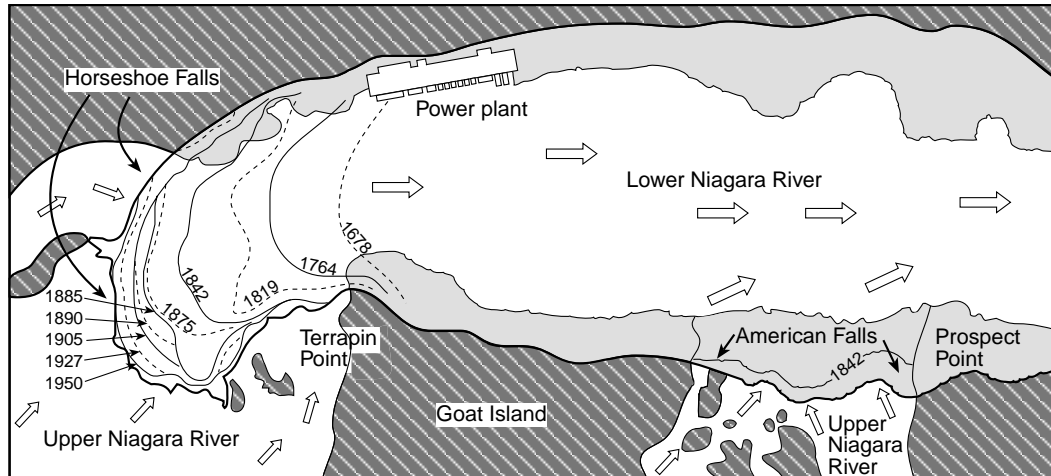
Modified Mercalli Scale

Intensity Value	Observed Effects
I	Usually detected only by instruments
II	Felt by a few persons at rest, especially on upper floors
III	Hanging objects swing; vibration like a passing truck; noticeable indoors
IV	Felt indoors by many, outdoors by few; a sensation like a heavy truck striking a building; parked automobiles rock
V	Felt by nearly all; sleepers awakened; liquids disturbed; unstable objects overturned; some dishes and windows broken
VI	Felt by all; many frightened and run outdoors; some heavy furniture moved; glassware broken; books fall off shelves; damage slight
VII	Difficult to stand; noticed in moving automobiles; damage to some masonry; weak chimneys broken at roofline
VIII	Partial collapse of masonry; chimneys, factory stacks, columns fall; heavy furniture overturned; frame houses moved on foundations

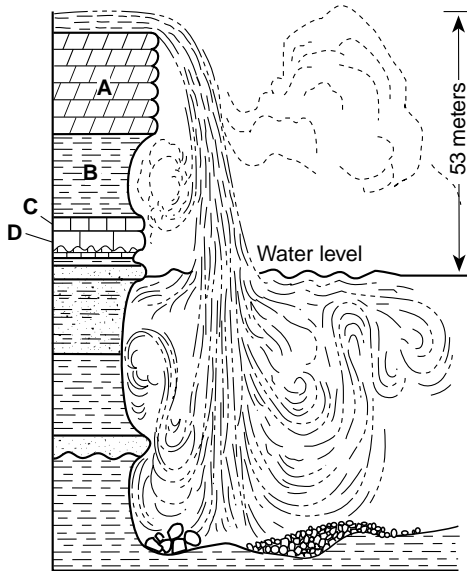
At which location in New York State could everyone feel the vibrations caused by this earthquake?

- (1) 43;30' N
75;30' W
- (2) 43;00' N
78;30' W
- (3) 41;00' N
74;00' W
- (4) 42;45' N
74;00' W

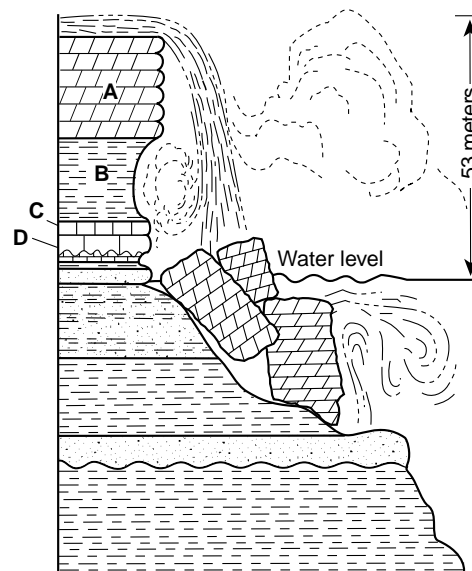
Base your answers to questions 43 and 44 on the map and cross sections below. The map shows measured changes in the position of Niagara Falls since 1678. The cross sections show the two parts of Niagara Falls: Horseshoe Falls and American Falls. Letters *A* through *D* represent the same rock layers at both locations.



Horseshoe Falls



American Falls



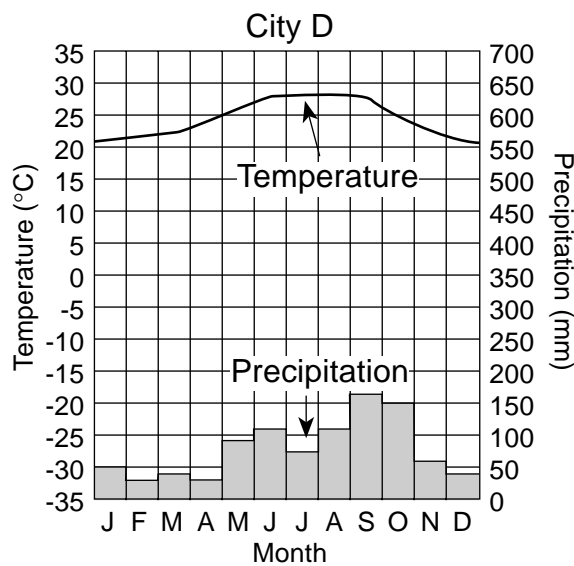
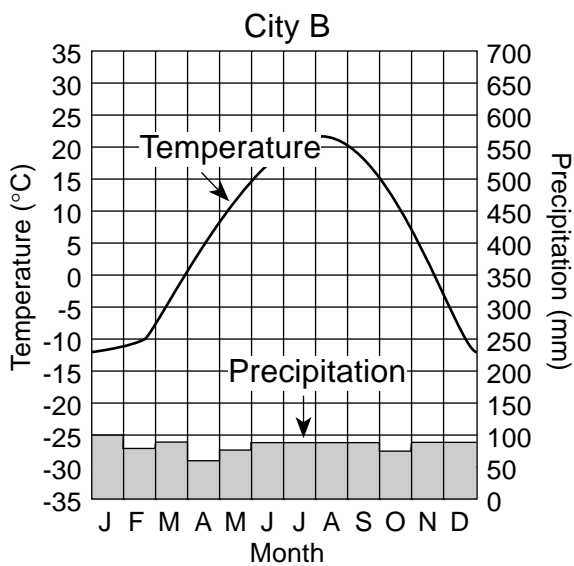
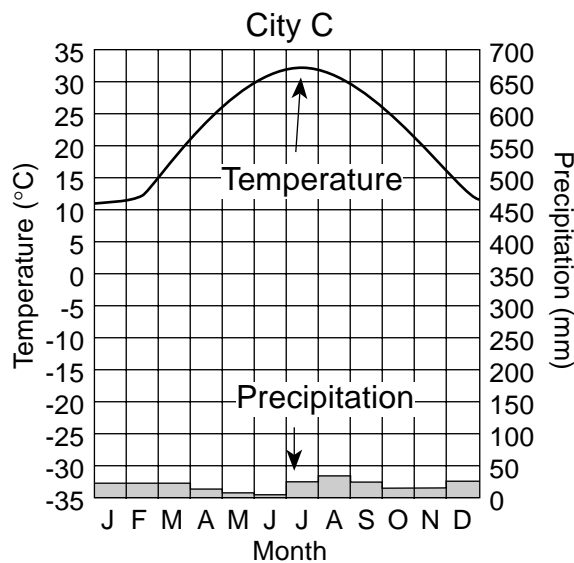
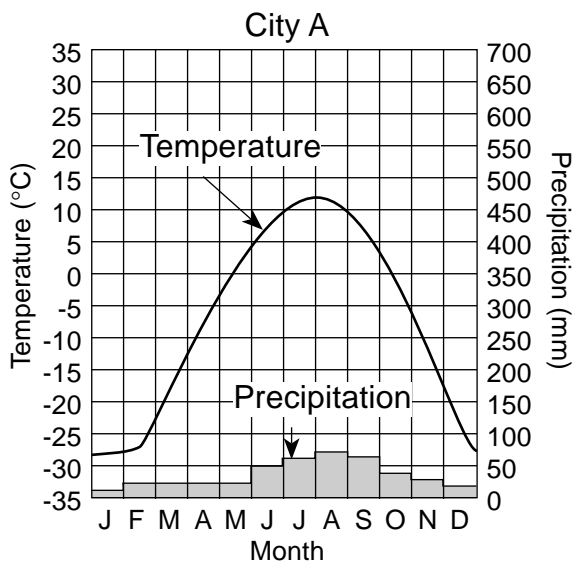
43 Which statement best explains why Horseshoe Falls has eroded back more than American Falls since 1842?

- 1 Dolostone is the top rock layer at Horseshoe Falls.
- 2 Dolostone is the top rock layer at American Falls.
- 3 More water flows over Horseshoe Falls.
- 4 More water flows over American Falls.

44 Which rock layer shows the most resistance to weathering and erosion at Horseshoe Falls?

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

Base your answers to questions 45 and 46 on the climate graphs below. Each graph represents data for a different city in North America. The line graphs connect the average monthly temperatures in degrees Celsius. The bar graphs indicate the average monthly precipitation in millimeters.



45 For which cities is the winter precipitation most likely to be snow?

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

46 In which sequence are the cities listed in order of decreasing average yearly precipitation?

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

Directions (47–58): Record your answers in the spaces provided on the separate answer paper. Some questions may require the use of the *Earth Science Reference Tables*.

Base your answers to questions 47 through 50 on the weather map below, which shows partial weather data for several weather stations. Point *A* is the center of a low-pressure system. Lines *AB* and *AC* represent the frontal boundaries between different air masses.



Write your answers to questions 47 and 48 on the weather map shown on your answer paper.

- 47 Draw the correct weather map symbols for the *two* different fronts located on lines *AB* and *AC*. The symbols must show the direction the fronts are moving. [2]
- 48 In each of the *three* map sections (Section 1, Section 2, and Section 3), draw curved arrows to represent the general direction that surface winds will move in association with the center of the low-pressure system at location *A*. [2]
- 49 Atlanta, Georgia, has the following additional weather variable measurements.

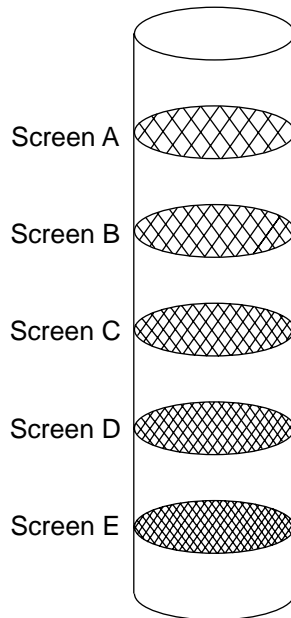
Visibility	6 miles
Amount of cloud cover	1/2 or 50%
Air pressure	1001.1 millibars

On the station model provided on your answer paper, place these *three* weather measurements in their correct location using the proper format. [2]

- 50 Name the weather instrument used to measure the air pressure at the center of the low. [1]

Base your answers to questions 51 through 53 on the information, diagram, and data table below.

To sort a quartz sediment sample by particle size, a student shook the sample through a column containing screens *A* through *E*. The mesh of the screens (the open spaces between the wires) had different-sized openings, as represented by the diagram. The results of the sorting are given in the student's data table.



(Screen mesh not drawn to scale)

Student Data Table

Screen	Screen Mesh Opening Size (cm)	Percentage of Particles Trapped by the Screen (%)
<i>A</i>	0.1	0
<i>B</i>	0.05	30
<i>C</i>	0.025	45
<i>D</i>	0.0125	15
<i>E</i>	0.00625	10

- 51 Explain why screens *B* through *E* must be arranged in the order shown in the diagram to separate the sediments as shown in the student data table. [1]
- 52 State *two* processes that must occur in nature to change a deposit of these sediments into a clastic sedimentary rock. [1]
- 53 Which clastic sedimentary rock may be formed from particles of the same size as this quartz sediment sample? [1]
-

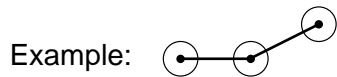
Base your answers to questions 54 and 55 on the table below, which shows the results of a student’s demonstration modeling radioactive decay. To begin, the student put 50 pennies heads up in a container. Each penny represented one radioactive atom. The student placed a top on the box and shook the box. Each penny that had flipped over to the tails up side was replaced with a bean that represented the stable decay product. The student continued the process until all of the pennies had been replaced by beans.

Shake Number	Number of Radioactive Atoms (pennies)	Number of Stable Decay Atoms (beans)
0	50	0
1	25	25
2	14	36
3	7	43
4	5	45
5	2	48
6	1	49
7	0	50

54 On the grid provided on your answer paper, graph the data shown on the table by following the steps below.

a Mark with a dot each number of radioactive atoms (pennies) after each shake. Surround each dot with a small circle (⊙). The zero shake has been plotted for you. [1]

b Connect all the dots with a solid line. [1]

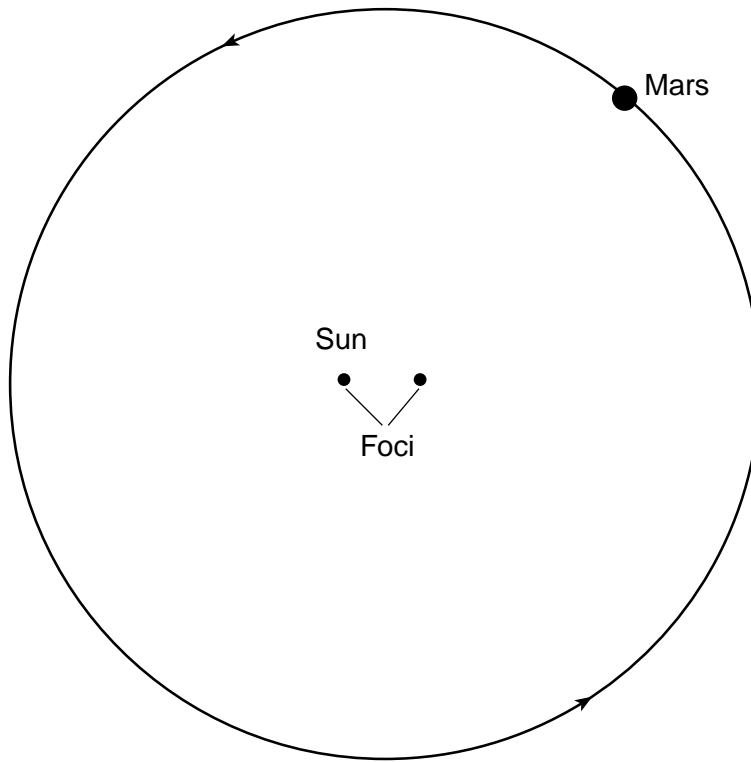


c Mark with an X the number of stable decay atoms (beans) after each shake. The zero shake has been plotted for you. [1]

d Connect all the X s with a dashed line. [1]

55 Assume that each shake number represents an additional 100 years. State the half-life of the radioactive material in this model. [1]

Base your answers to questions 56 through 58 on the diagram below, which represents Mars orbit around the Sun.



(Not drawn to scale)

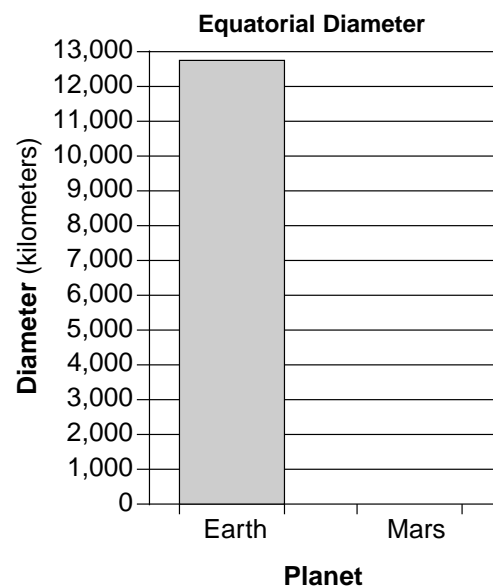
56 On the diagram provided *on your answer paper*:

a Draw and label the major axis of Mars orbit. [1]

b Place an **X** on the orbit to show the location of Mars greatest orbital velocity. [1]

57 State the difference between the shape (not the size) of Earth's orbit and the shape of Mars orbit. [1]

58 The bar graph to the right shows the equatorial diameter of Earth.



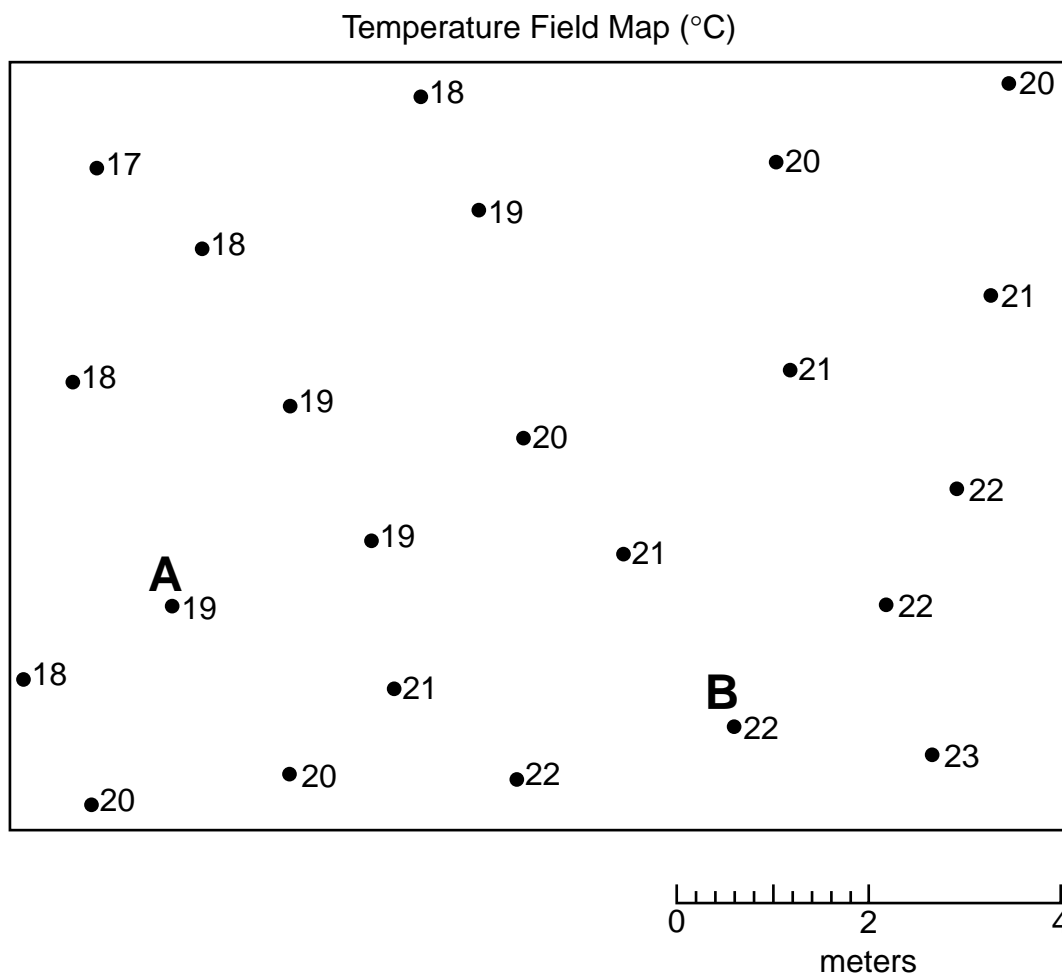
On the grid provided *on your answer paper*, construct the bar that represents the equatorial diameter of Mars. [1]

Part C

Answer all questions in this part. [20]

Directions (59–71): Record your answers in the spaces provided on the separate answer paper. Some questions may require the use of the *Earth Science Reference Tables*.

Base your answers to questions 59 through 61 on the temperature field map below. The map shows temperature readings ($^{\circ}\text{C}$) recorded by students in a science classroom. The readings were taken at the same time at floor level. Temperature readings for points *A* and *B* are labeled on the map.



- 59 On the temperature field map provided *on your answer paper*, use solid lines to draw the 18°C , 20°C , and 22°C isotherms. Isotherms must extend to the boundary of the map. Label each isotherm to indicate its temperature. [3]
- 60 Determine the temperature gradient from point *A* to point *B* by following the directions below.
- Write the equation used to determine the gradient. [1]
 - Substitute values from the field map into the equation. [1]
 - Solve the equation and label the answer with the proper units. [2]
- 61 State the temperature of point *A* in degrees Fahrenheit ($^{\circ}\text{F}$). [1]

Base your answers to questions 62 through 65 on the reading passage and maps below. The reading passage discusses acid rain. Map I shows the locations of some major United States producers of nitrogen oxide and sulfur dioxide that are released into Earth's atmosphere. Map II shows the pH concentration of acid rain in the United States.

Acid Rain

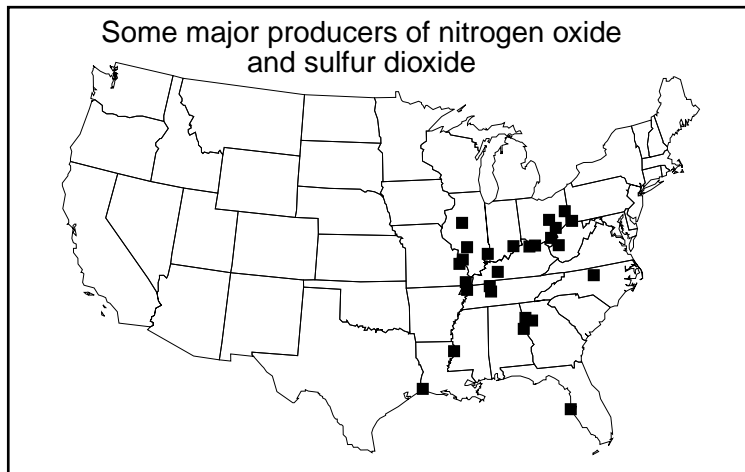
Acid deposition consists of acidic substances that fall to Earth. The most common type of acid deposition is rain containing nitric acid and sulfuric acid. Acid rain forms when nitrogen oxide and sulfur dioxide gases combine with water and oxygen in the atmosphere.

Human-generated sulfur dioxide results primarily from coal-burning electric utility plants and industrial plants. Human-generated nitrogen oxide results primarily from burning fossil fuels in motor vehicles and electric utility plants.

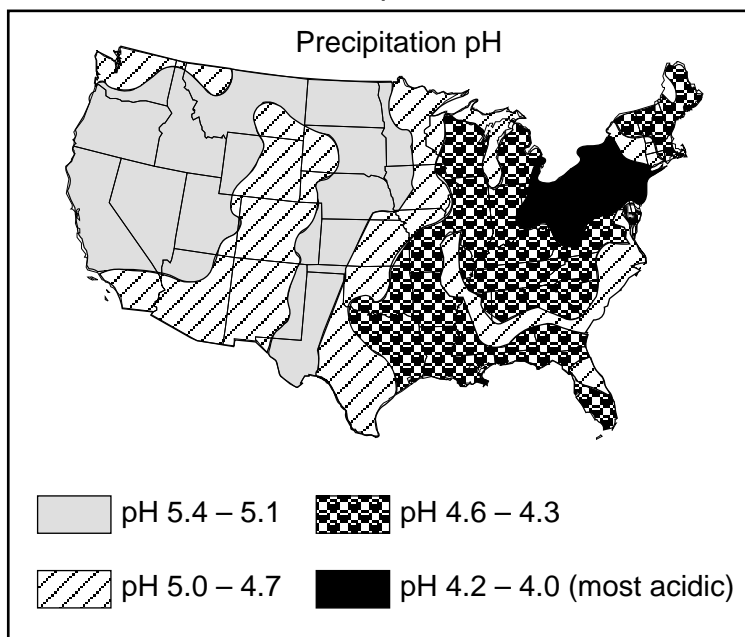
Natural events, such as volcanic eruptions, forest fires, hot springs, and geysers, also produce nitrogen oxide and sulfur dioxide.

Acid rain affects trees, human-made structures, and surface water. Acid damages tree leaves and decreases the tree's ability to carry on photosynthesis. Acid also damages tree bark and exposes trees to insects and disease. Many statues and buildings are composed of rocks containing the mineral calcite, which reacts with acid and chemically weathers more rapidly than other common minerals. Acid deposition lowers the pH of surface water. Much of the surface water of the Adirondack region has pH values too acidic for plants and animals to survive.

Map I



Map II



- 62 State *one* reason that the northeastern part of the United States has more acid deposition than other regions of the country. [1]
- 63 State *one* sedimentary *or one* metamorphic rock that is most chemically weathered by acid rain. [1]
- 64 Describe *one* law that could be passed by the government to prevent some of the problems of acid deposition. [1]
- 65 Explain why completely eliminating human-generated nitrogen oxide and sulfur dioxide will *not* completely eliminate acid deposition. [1]

Base your answers to questions 66 and 67 on the newspaper article below.

New Fossils Indicate Arctic Climate Used To Be Floridian

The frigid Arctic regions were as warm as present-day Florida some 90 million years ago, according to researchers who found fossils of a crocodile-like animal in northern Canada.

Six hundred miles from the North Pole, researchers from the University of Rochester found the fossilized remains of the champosaur, a toothy, 8-foot-long extinct crocodile.

"We found a whole collection of fossils, from both young and adults," said scientist John H. Tarduno.

"The champosaur is a cold-blooded animal that could not have survived in the current climate of the Canadian Arctic where the fossils were found," Tarduno said.

Temperatures at the fossil site now routinely drop to minus 60 degrees Fahrenheit in the winter. When the champosaur lived there 86 million to 92 million years ago, winter temperatures rarely dropped to freezing and summer readings of 80 degrees were common.

The cold-blooded champosaur depended on the environment for warmth and probably became immobile if the temperature was too cold. Most likely, the champosaur was too small to have migrated seasonally.

A field team from the University of Rochester found the fossils in a layer of sandstone located above a layer of basaltic lava.

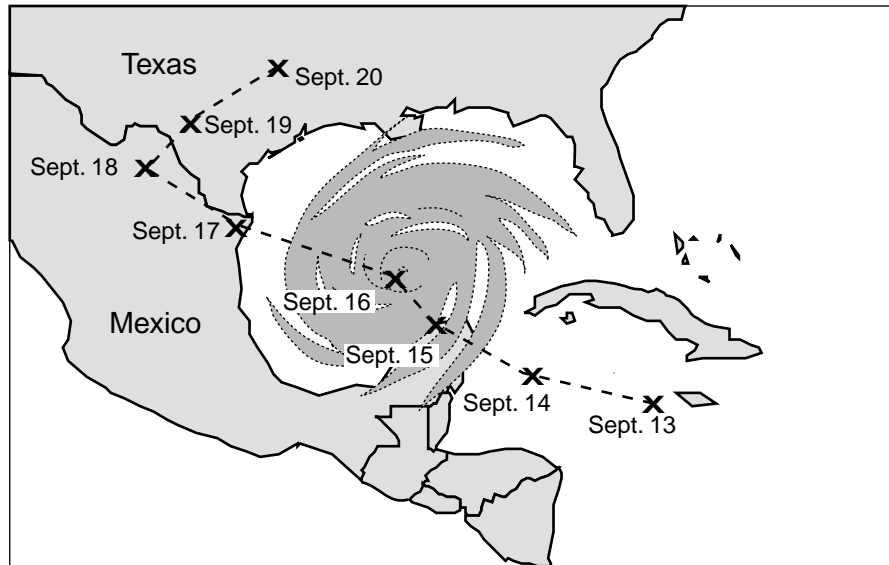
66 State the geologic time period in which the champosaur lived. [1]

67 Explain why no champosaur fossils were found within the layer of basaltic lava. [1]

68 A student read an article in the local newspaper stating that a major earthquake can be expected to affect the region where the student lives within the next year. The student's family plans to stay in this region. As a result, the student decides to help prepare her home and family for this expected earthquake.

State *three* specific actions the student could take to increase safety or reduce injury or damage from an earthquake. [3]

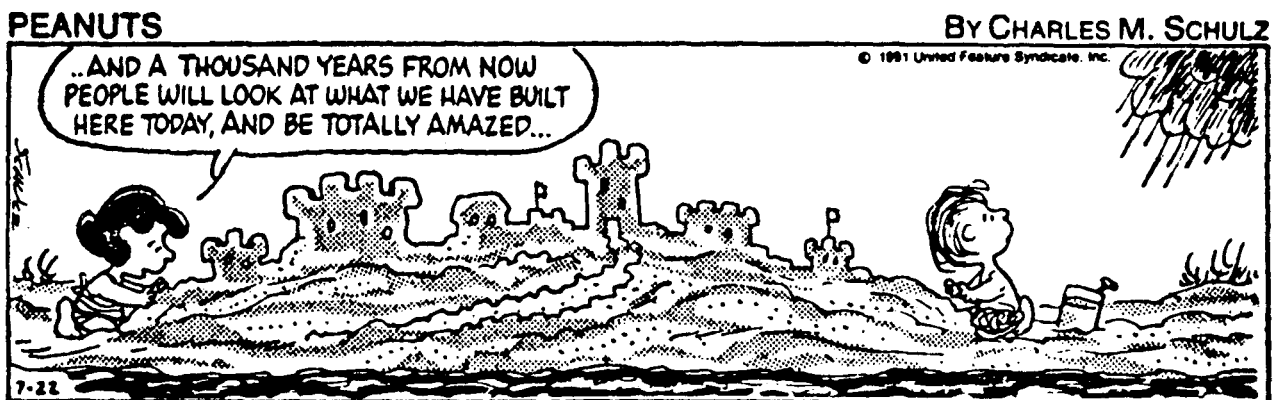
Base your answers to questions 69 and 70 on the map below, which represents a satellite image of Hurricane Gilbert in the Gulf of Mexico. Each X represents the position of the center of the storm on the date indicated.



69 Describe *one* threat to human life and property that could have been caused by the arrival of Hurricane Gilbert along the coastline at the Texas-Mexico border. [1]

70 State *one* reason Hurricane Gilbert weakened between September 16 and September 18. [1]

71 The cartoon below shows characters building a sand castle on an ocean beach.



State *one* reason other than human activity that the sand castle will *not* exist a thousand years from now. [1]