The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
EARTH SCIENCE

Thursday, August 13, 2015 — 12:30 to 3:30 p.m., only

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

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

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

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

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

Notice . . .

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

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

Part A

Answer all questions in this part.

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

1 Which characteristics best describe the star *Betelgeuse*?

(1) reddish orange with low luminosity and high surface temperature
(2) reddish orange with high luminosity and low surface temperature
(3) blue white with low luminosity and low surface temperature
(4) blue white with high luminosity and high surface temperature

2 Which motion occurs at a rate of approximately one degree per day?

(1) the Moon revolving around Earth
(2) the Moon rotating on its axis
(3) Earth revolving around the Sun
(4) Earth rotating on its axis

3 If the tilt of Earth's axis were increased from 23.5° to 30°, summers in New York State would become

(1) cooler, and winters would become cooler
(2) cooler, and winters would become warmer
(3) warmer, and winters would become cooler
(4) warmer, and winters would become warmer

4 Which object in space emits light because it releases energy produced by nuclear fusion?

(1) Earth's Moon
(2) Halley's comet
(3) Venus
(4) *Polaris*

5 Since Denver's longitude is 105° W and Utica's longitude is 75° W, sunrise in Denver occurs

(1) 2 hours earlier
(2) 2 hours later
(3) 3 hours earlier
(4) 3 hours later

6 A major piece of evidence supporting the Big Bang theory is the observation that wavelengths of light from stars in distant galaxies show a

(1) redshift, appearing to be shorter
(2) redshift, appearing to be longer
(3) blueshift, appearing to be shorter
(4) blueshift, appearing to be longer

7 During the month of January, at which location in New York State is the Sun lowest in the sky at solar noon?

(1) Massena
(2) Niagara Falls
(3) Utica
(4) New York City

8 Which process releases 2260 joules of heat energy per gram of water into the environment?

(1) melting
(2) freezing
(3) condensation
(4) evaporation

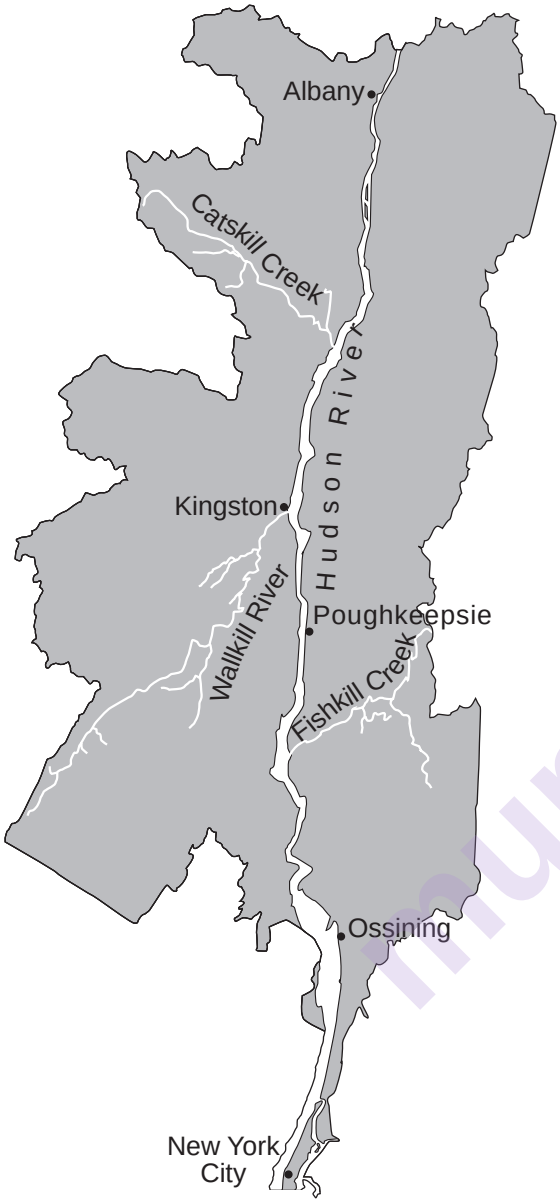
9 When snow cover on the land melts, the water will most likely become surface runoff if the land surface is

(1) frozen
(2) porous
(3) grass covered
(4) unconsolidated gravel

10 Which area is the most common source region for cold, dry air masses that move over New York State?

(1) North Atlantic Ocean
(2) Gulf of Mexico
(3) central Canada
(4) central Mexico

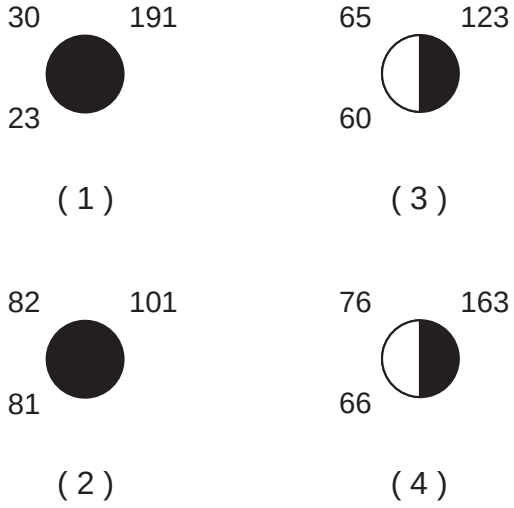
11 The map below shows a portion of the Hudson River and three tributaries: Catskill Creek, Fishkill Creek, and Wallkill River.



The greatest discharge of the Hudson River is generally observed near

(1) Albany
(2) Kingston
(3) Poughkeepsie
(4) Ossining

12 Which station model represents a location that has the greatest chance of precipitation?



13 The Adirondacks are classified as mountains because of the high elevation and bedrock that consists mainly of

(1) deformed and intensely metamorphosed rocks
(2) glacial deposits of unconsolidated gravels, sands, and clays
(3) Cambrian and Ordovician quartzites and marbles
(4) horizontal sedimentary rocks of marine origin

14 In which landscape region are New York State's Finger Lakes primarily located?

(1) Adirondack Mountains
(2) Allegheny Plateau
(3) Atlantic Coastal Plain
(4) Erie-Ontario Lowlands

15 What is the range of pressure in Earth's interior where rock with a density range of 9.9 to 12.2 g/cm^3 is found?

(1) 0.2 to 1.4 million atmospheres
(2) 0.8 to 2.3 million atmospheres
(3) 1.4 to 3.1 million atmospheres
(4) 2.3 to 3.5 million atmospheres

16 Earth's magnetic field has reversed itself several times during the past. This pattern of magnetic reversal is best preserved in

(1) metamorphic bedrock in mountain ranges
(2) bedrock with fossils containing radioactive carbon-14
(3) layers of sedimentary bedrock of the Grand Canyon
(4) igneous bedrock of the oceanic crust

17 Which two features are commonly found at divergent plate boundaries?

(1) mid-ocean ridges and rift valleys
(2) wide valleys and deltas
(3) ocean trenches and subduction zones
(4) hot spots and island arcs

18 New York State bedrock of which age contains salt, gypsum, and hematite?

(1) Cambrian
(2) Devonian
(3) Mississippian
(4) Silurian

19 Scientists infer that oxygen in Earth's atmosphere did *not* exist in large quantities until after

(1) the first multicellular, soft-bodied marine organisms appeared on Earth
(2) the initial opening of the Atlantic Ocean
(3) the first sexually reproducing organisms appeared on Earth
(4) photosynthetic cyanobacteria evolved in Earth's oceans

20 Which organisms were alive when New York State was last covered by a continental ice sheet?

(1) *Eurypterus* and *Cooksonia*
(2) *Aneurophyton* and Naples Tree
(3) mastodont and Beluga whale
(4) *Coelophysis* and *Elliptocephala*

21 One difference between a breccia rock and a conglomerate rock is that the particles in a breccia rock are

(1) more aligned
(2) more angular
(3) harder
(4) land derived

22 The photograph below shows rock layers separated by unconformity *XY*.

Which sequence of events most likely produced this unconformity?

(1) uplift and erosion of bedrock, followed by subsidence and more deposition
(2) intrusion of magma into preexisting rock, causing contact metamorphism
(3) eruption of a volcano, spreading lava over horizontal sedimentary rock layers
(4) separation of one rock layer, by movement along a plate boundary

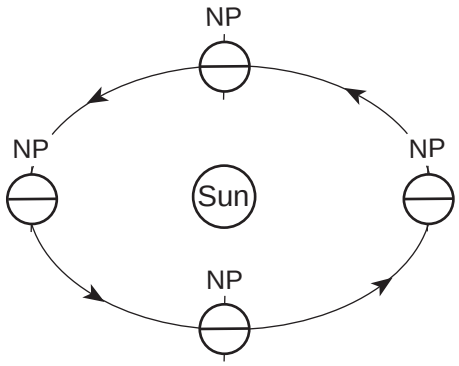
23 The igneous rock gabbro most likely formed from molten material that cooled

(1) rapidly at Earth's surface
(2) slowly at Earth's surface
(3) rapidly, deep underground
(4) slowly, deep underground

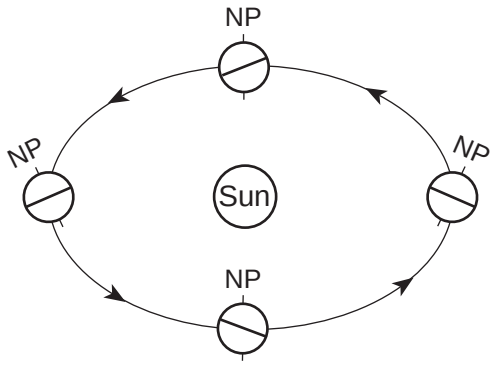
24 Which statement best supports the inference that most of Earth's present-day land surfaces have, at one time, been covered by water?

(1) Volcanic eruptions contain large amounts of water vapor.
(2) Coral reefs formed, in the past, along the edges of many continents.
(3) Seafloor spreading has pulled landmasses apart and pushed them together.
(4) Sedimentary bedrock of marine origin covers large areas of Earth's continents.

25 Which diagram best represents the correct orientation of the North Pole [NP] as Earth revolves around the Sun? [Diagrams are not drawn to scale.]



(1)



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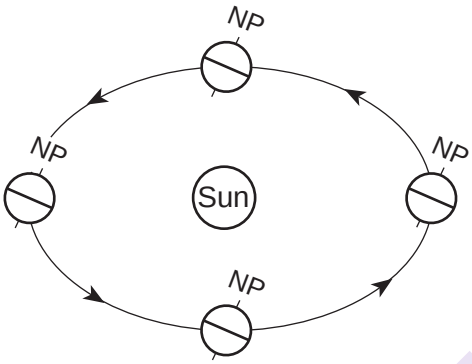

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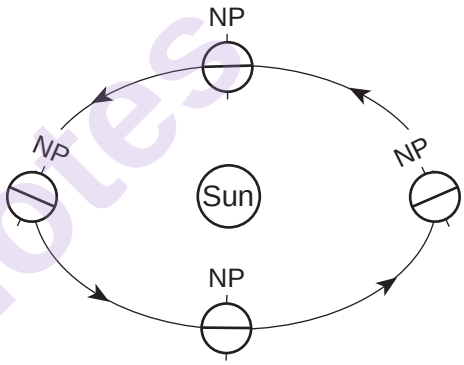
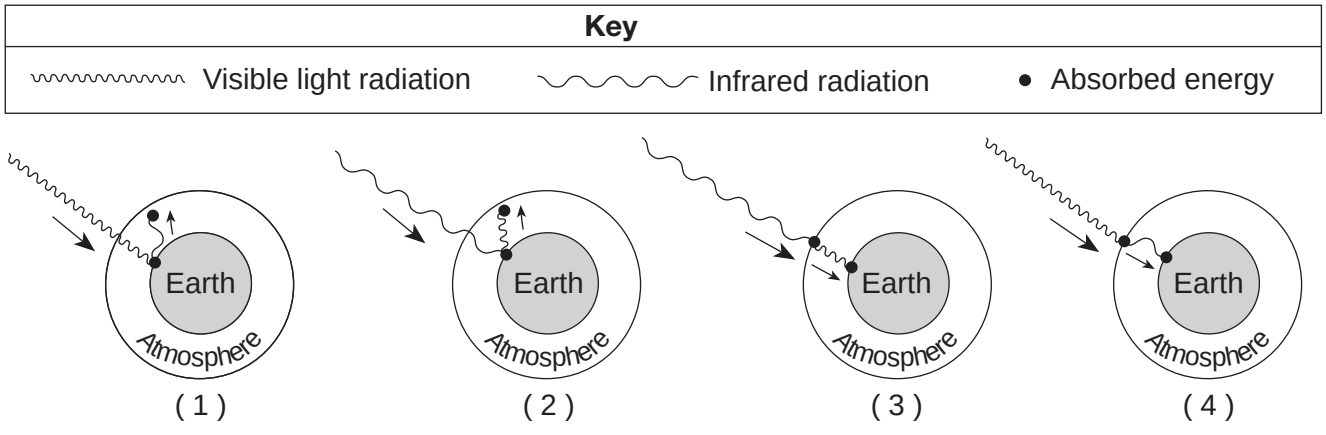


(4)

26 Which diagram best represents how greenhouse gases in our atmosphere trap heat energy?

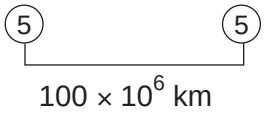


27 The symbols below represent two planets.

5 represents a planet with a mass 5 times Earth's mass.

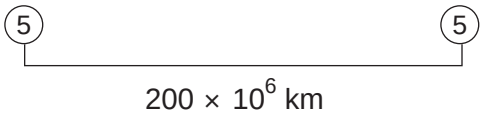
9 represents a planet with a mass 9 times Earth's mass.

Which combination of planet masses and distances produces the greatest gravitational force between the planets?



(1)

(3)



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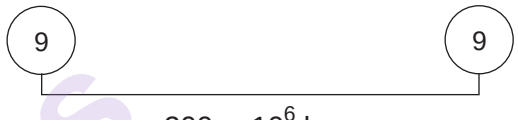
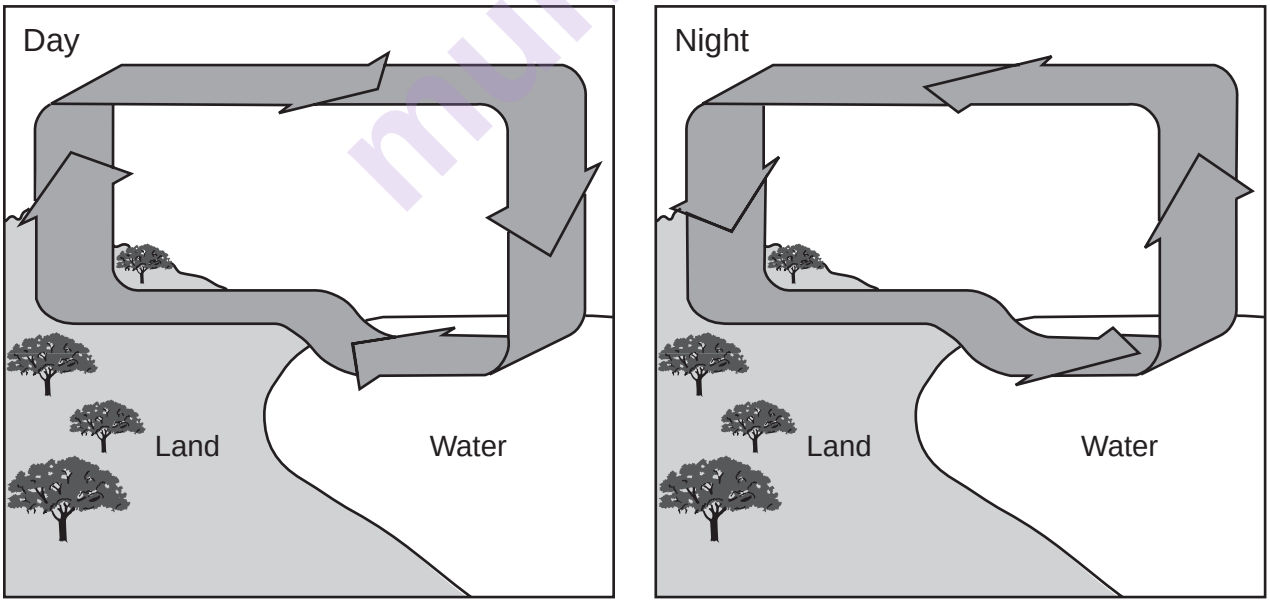


(4)

28 The diagram below represents the circulation of air above Earth's surface at a coastal location during the day and at night.

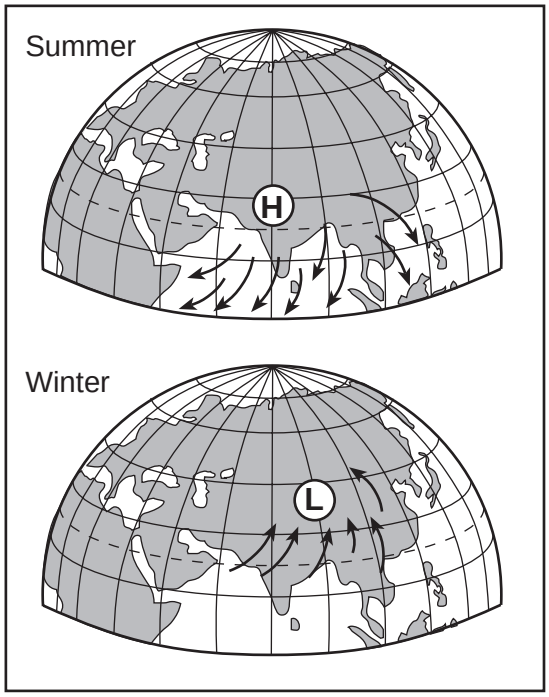


This local air movement is best described as an example of

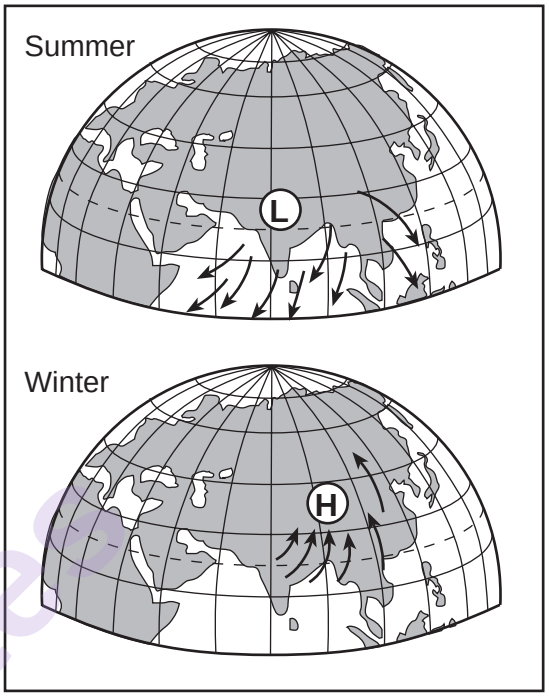
(1) conduction between Earth's surface and the atmosphere above it
(2) condensation of water vapor during the day, and evaporation of water during the night
(3) convection resulting from temperature and pressure differences above land and water
(4) greater radiation from the warmer ocean during the day and from the warmer land at night

29 A change in the type and location of large high-pressure systems (**H**) and large low-pressure systems (**L**) over Asia creates shifts in prevailing winds that cause a rainy summer season and a dry winter season in southern Asia. Which set of maps below best represents the type and location of pressure systems and the wind pattern around these pressure systems that cause these seasonal changes?

(1)



(3)



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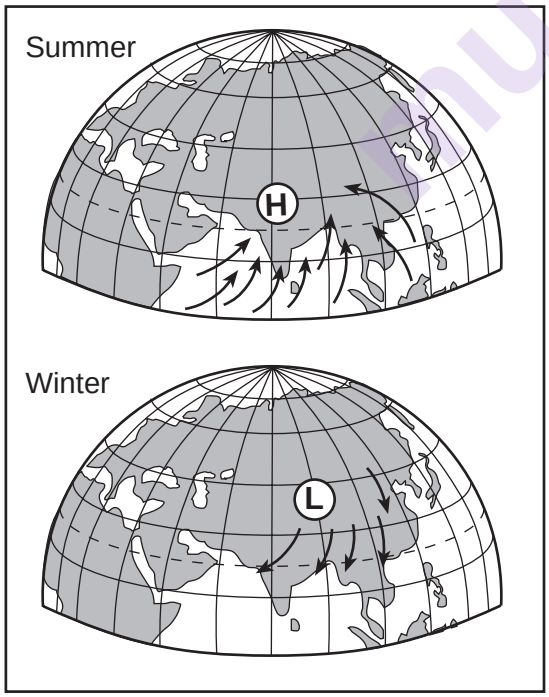

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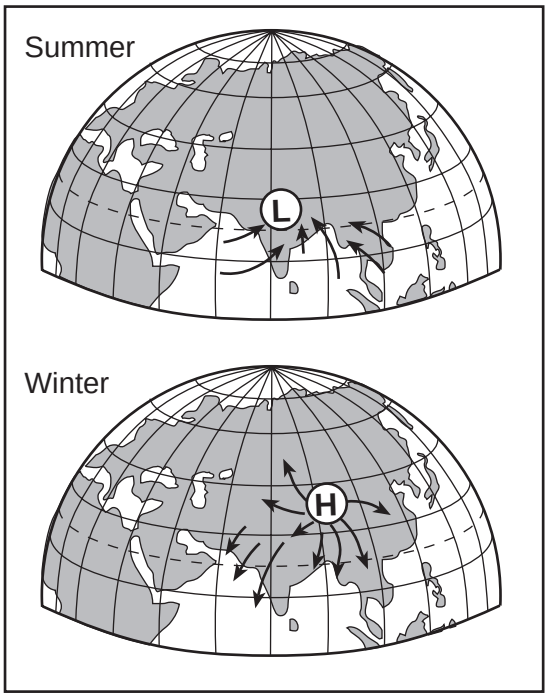
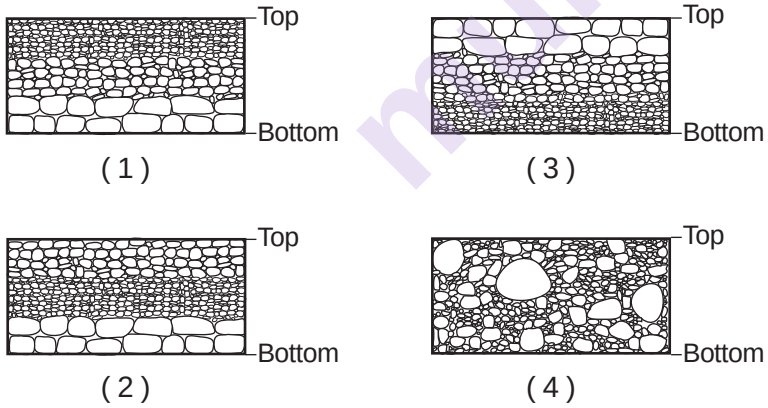


30 The photograph below shows both erosional and depositional features formed by an agent of erosion.

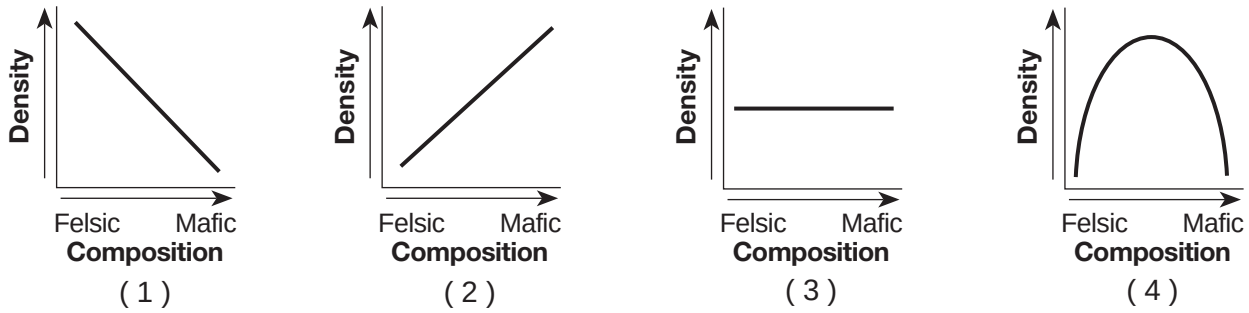
Which agent of erosion produced the features shown in the photograph?

(1) running water
(2) glacial ice
(3) ocean waves
(4) prevailing wind

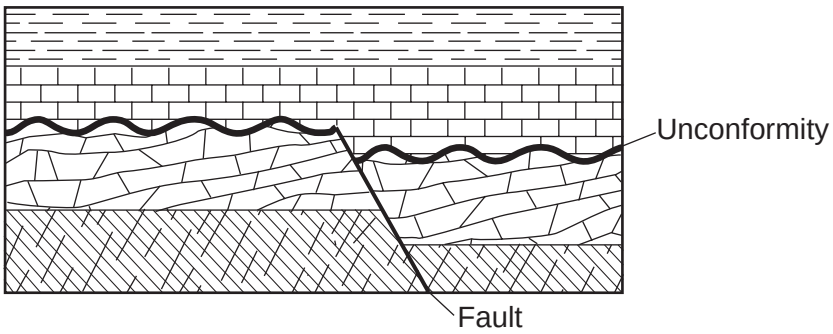
31 Which cross section best represents the pattern of sediments deposited on the bottom of a lake as the velocity of the stream entering the lake steadily decreased?



32 Which graph best shows the relationship between the compositions of different igneous rocks and their densities?



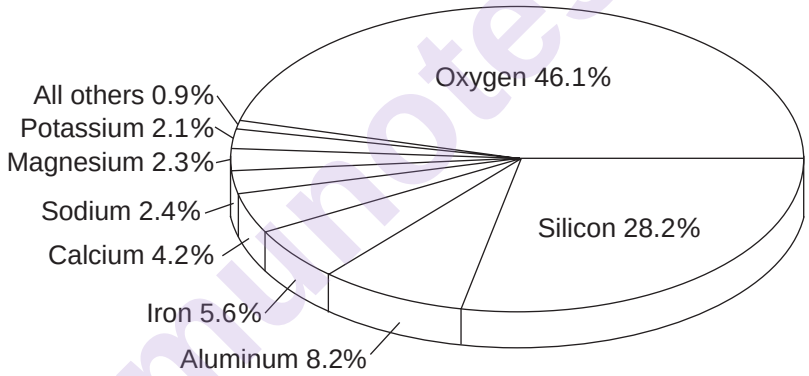
33 The geologic cross section below shows rock layers that have not been overturned.



The fault is older than the

(1) slate
(2) marble
(3) unconformity
(4) shale

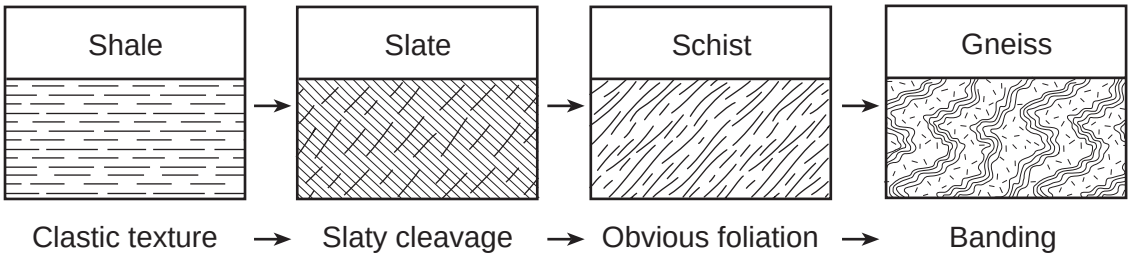
34 The pie graph below represents the composition, in percent by mass, of the chemical elements found in an Earth layer.



The composition of which Earth layer is represented by the pie graph?

(1) crust
(2) outer core
(3) troposphere
(4) hydrosphere

35 The diagram below indicates physical changes that accompany the conversion of shale to gneiss.



Which geologic process is occurring to cause this conversion?

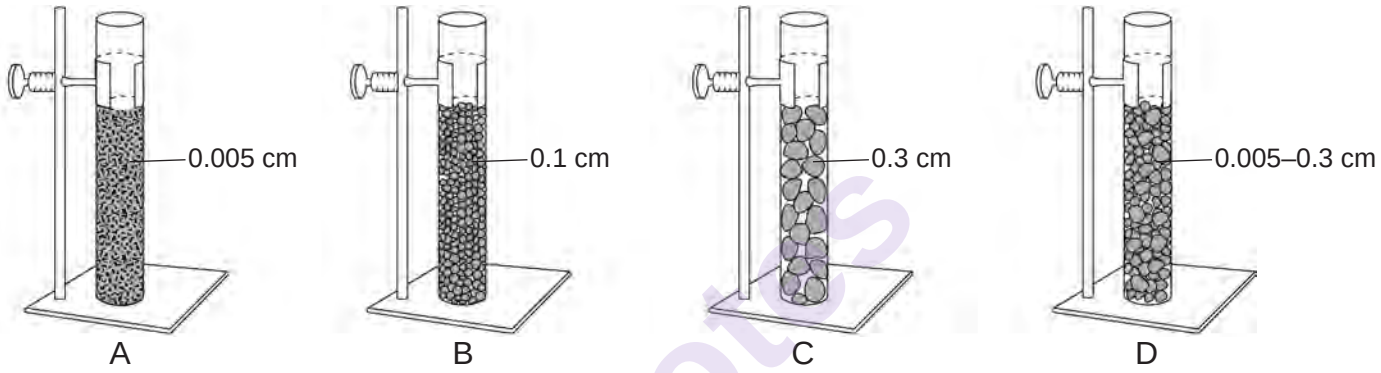
(1) sedimentary layering
(2) intrusion of magma
(3) metamorphism
(4) weathering

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 and 37 on the diagram below and on your knowledge of Earth science. The diagram represents four tubes, labeled *A*, *B*, *C*, and *D*, each containing 150 mL of sediments. Tubes *A*, *B*, and *C* contain well-sorted, closely packed sediments of uniform shape and size. Tube *D* contains uniformly shaped, closely packed sediments of mixed sizes. The particle size of the sediment in each tube is labeled.



(Not drawn to scale)

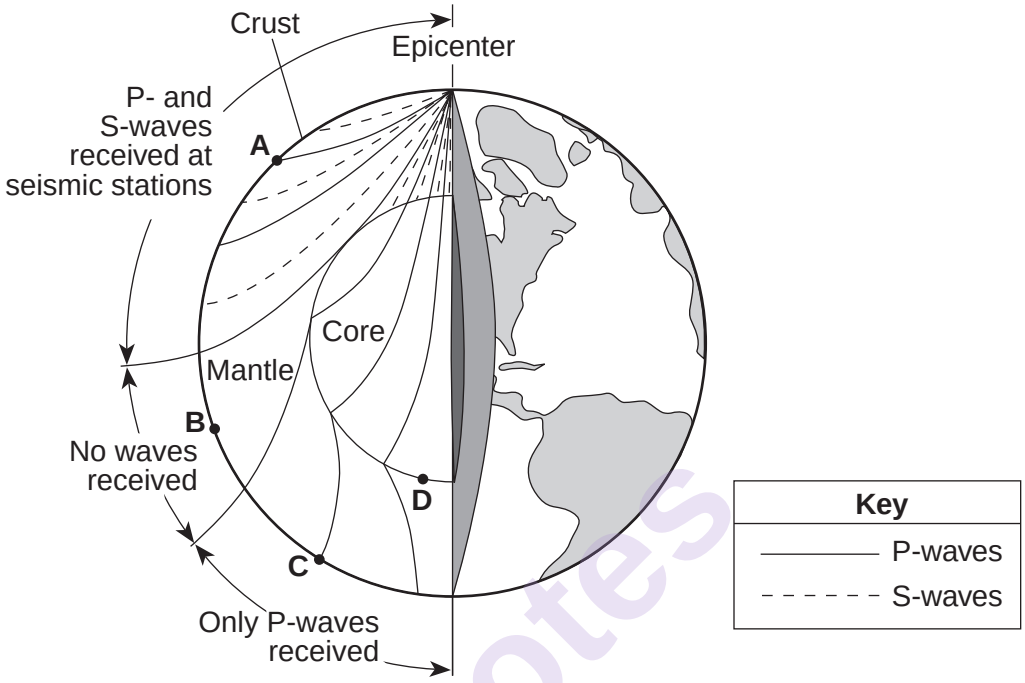
36 Water was added to each tube to just cover the sediments and the volumes of water added were recorded. These data can best be used to determine the

(1) particle size of the sediments
(2) particle shape of the sediments
(3) water retention of the sediments
(4) porosity of the sediments

37 If tubes *A*, *B*, and *C* were set up to test for capillarity, the data would show that capillarity is

(1) greatest in tube *A*
(2) greatest in tube *B*
(3) greatest in tube *C*
(4) the same for tubes *A*, *B*, and *C*

Base your answers to questions 38 through 40 on the diagram below and on your knowledge of Earth science. The diagram represents a cut-away view of Earth's interior and the paths of some of the seismic waves produced by an earthquake that originated below Earth's surface. Points *A*, *B*, and *C* represent seismic stations on Earth's surface. Point *D* represents a location at the boundary between the core and the mantle.



38 Seismic station *A* is 5000 kilometers from the epicenter. What is the difference between the arrival time of the first *P*-wave and the arrival time of the first *S*-wave recorded at this station?

(1) 2 minutes 20 seconds
(2) 6 minutes 40 seconds
(3) 8 minutes 20 seconds
(4) 15 minutes 00 second

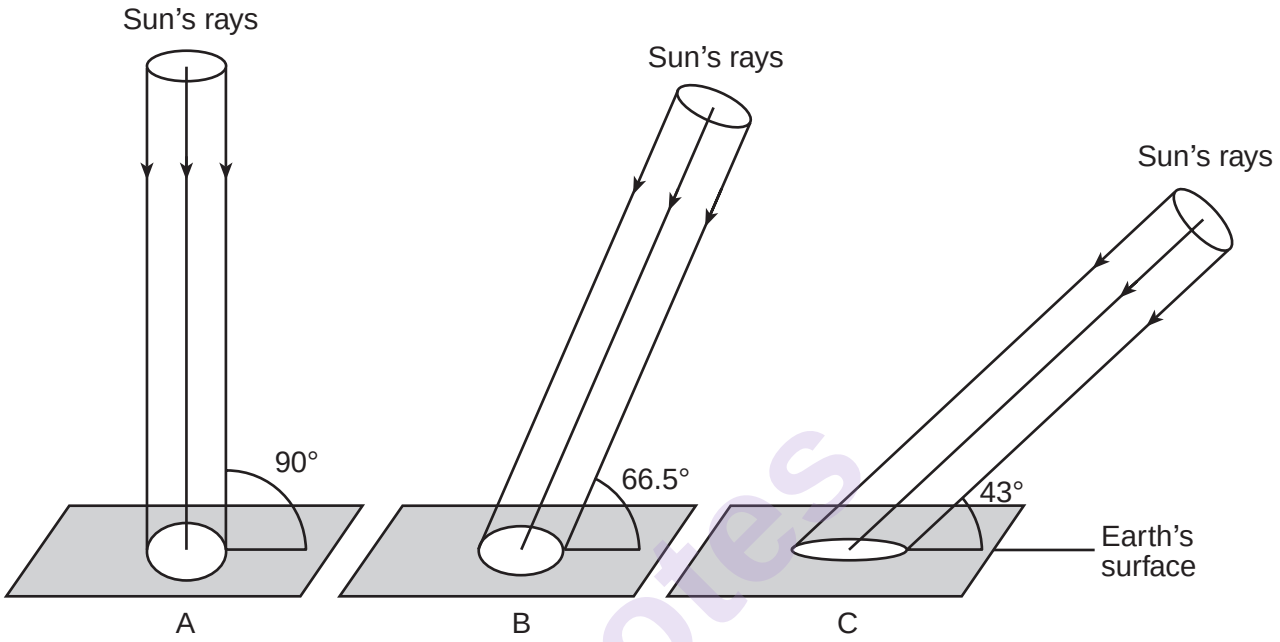
39 Which process prevented *P*-waves from arriving at seismic station *B*?

(1) refraction
(2) reflection
(3) convection
(4) conduction

40 Only *P*-waves were recorded at seismic station *C* because *P*-waves travel

(1) only through Earth's interior, and *S*-waves travel only on Earth's surface
(2) fast enough to penetrate the core, and *S*-waves travel too slowly
(3) through iron and nickel, while *S*-waves cannot
(4) through liquids, while *S*-waves cannot

Base your answers to questions 41 through 43 on the diagrams below and on your knowledge of Earth science. The diagrams, labeled *A*, *B*, and *C*, represent equal-sized portions of the Sun's rays striking Earth's surface at 23.5° N latitude at noon at three different times of the year. The angle at which the Sun's rays hit Earth's surface and the relative areas of Earth's surface receiving the rays at the three different angles of insolation are shown.



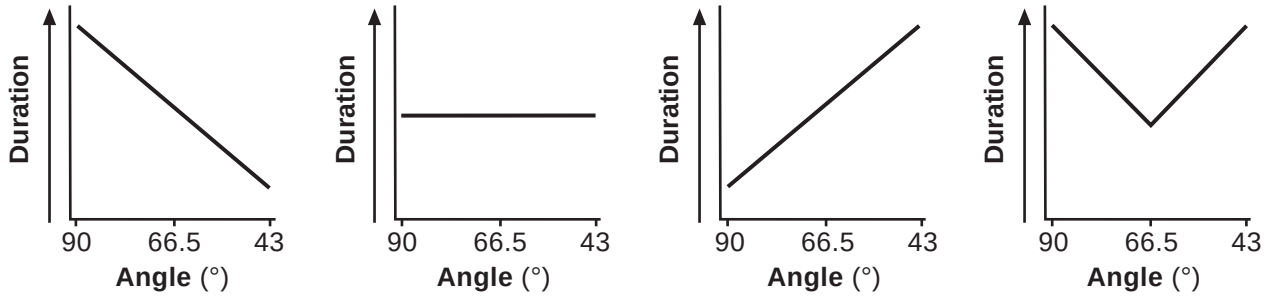
41 As viewed in sequence from *A* to *B* to *C*, these diagrams represent which months and which change in the intensity of insolation?

(1) December → March → June; and decreasing intensity
(2) December → March → June; and increasing intensity
(3) June → September → December; and decreasing intensity
(4) June → September → December; and increasing intensity

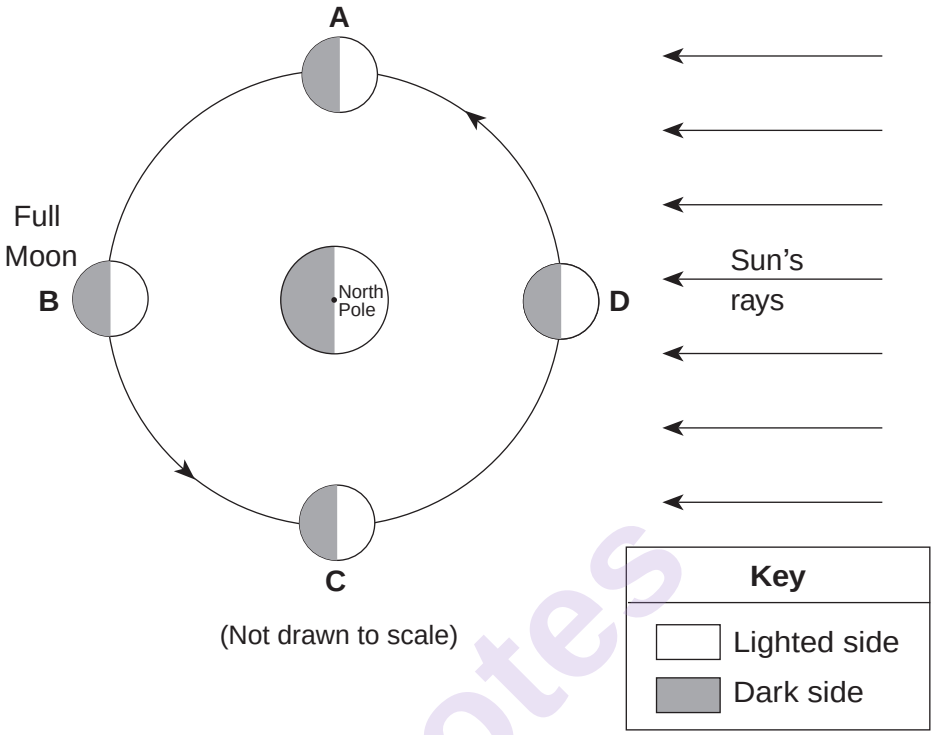
42 As the angle of the Sun's rays striking Earth's surface at noon changes from 90° to 43°, the length of a shadow cast by an object will

(1) decrease
(2) increase
(3) decrease, then increase
(4) increase, then decrease

43 Which graph best shows the duration of insolation at this location as the angle of insolation changes?



Base your answers to questions 44 through 47 on the diagram below and on your knowledge of Earth science. The diagram represents the Moon at four positions, labeled *A*, *B*, *C*, and *D*, in its orbit around Earth. The position of the full-Moon phase is labeled.



44 Approximately how many days (d) does it take for the Moon to move from the phase shown at position *A* to the full-Moon phase?

(1) 7.4 d
(2) 14.7 d
(3) 27.3 d
(4) 29.5 d

45 Which phase of the Moon could be observed from New York State when the Moon is at position *C*?

46 The same side of the Moon always faces Earth because the Moon's period of revolution

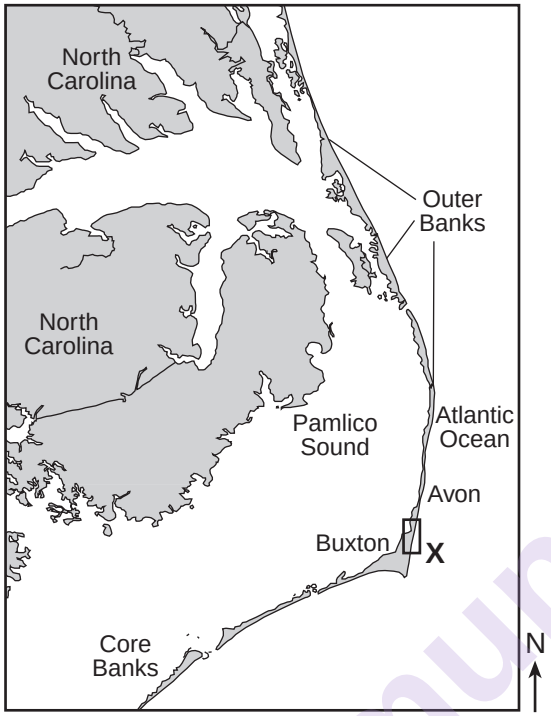
(1) is longer than the Moon's period of rotation
(2) equals the Moon's period of rotation
(3) is longer than Earth's period of rotation
(4) equals Earth's period of rotation

47 Solar and lunar eclipses rarely happen during a cycle of phases because the

(1) Moon's orbit is circular and Earth's orbit is elliptical
(2) Moon's orbit is elliptical and Earth's orbit is elliptical
(3) plane of the Moon's orbit is different from the plane of Earth's orbit
(4) plane of the Moon's orbit is the same as the plane of Earth's orbit

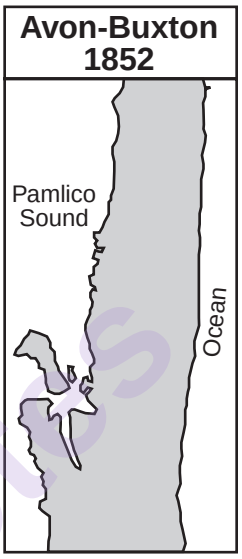
Base your answers to questions 48 through 50 on the maps and data table below and on your knowledge of Earth science. Map I shows the Outer Banks and part of North Carolina along the southeastern coast of the United States. Maps II and III show enlargements of the Avon-Buxton section of the Outer Banks indicated by box **X** on map I. Map II shows the land and shoreline in 1852. Map III shows the land and shoreline in 1998. The dotted line on map III shows the location of the 1852 shoreline. The data table shows the average width, in meters, at various years, of the Avon-Buxton section.

Map I

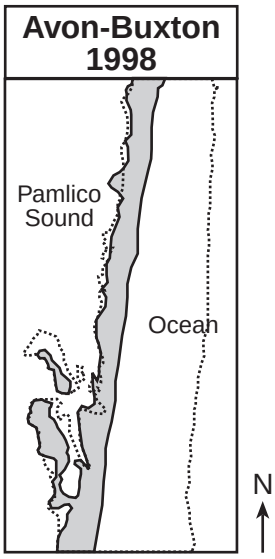


Avon-Buxton Section of Outer Banks

Map II



Map III



Key
..... 1852 shoreline

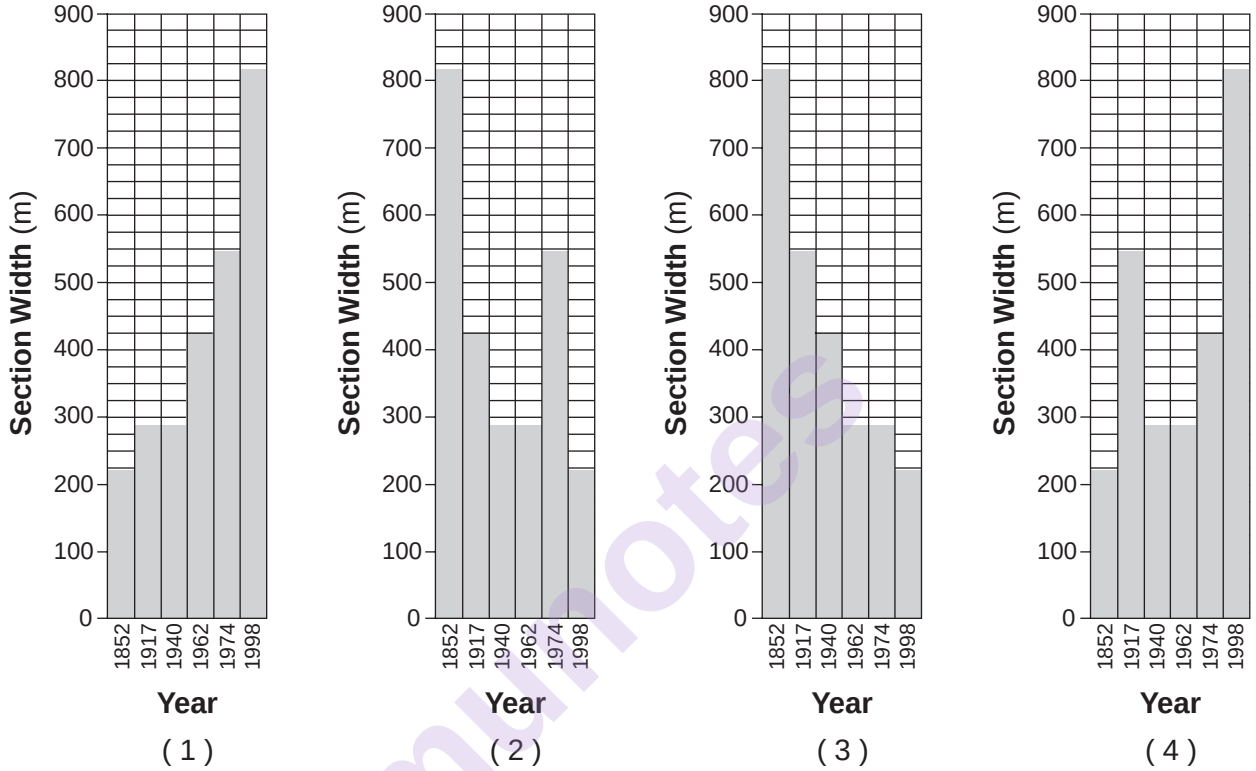
Avon-Buxton Section Width from 1852 to 1998

Year	Average Width (m)
1852	813
1917	547
1940	426
1962	284
1974	284
1998	219

48 The Outer Banks were formed primarily from sediments eroded and deposited by ocean waves. Which type of landform are the Outer Banks?

(1) outwash plains
(2) moraine deposits
(3) river deltas
(4) barrier islands

49 Which bar graph best shows the average width of the Avon-Buxton section of the Outer Banks from 1852 to 1998?



50 Which ocean current has the greatest warming influence on the climate of the Outer Banks of North Carolina?

(1) Gulf Stream Current
(2) North Atlantic Current
(3) Labrador Current
(4) Canary Current

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 passage and the graph below and on your knowledge of Earth science.

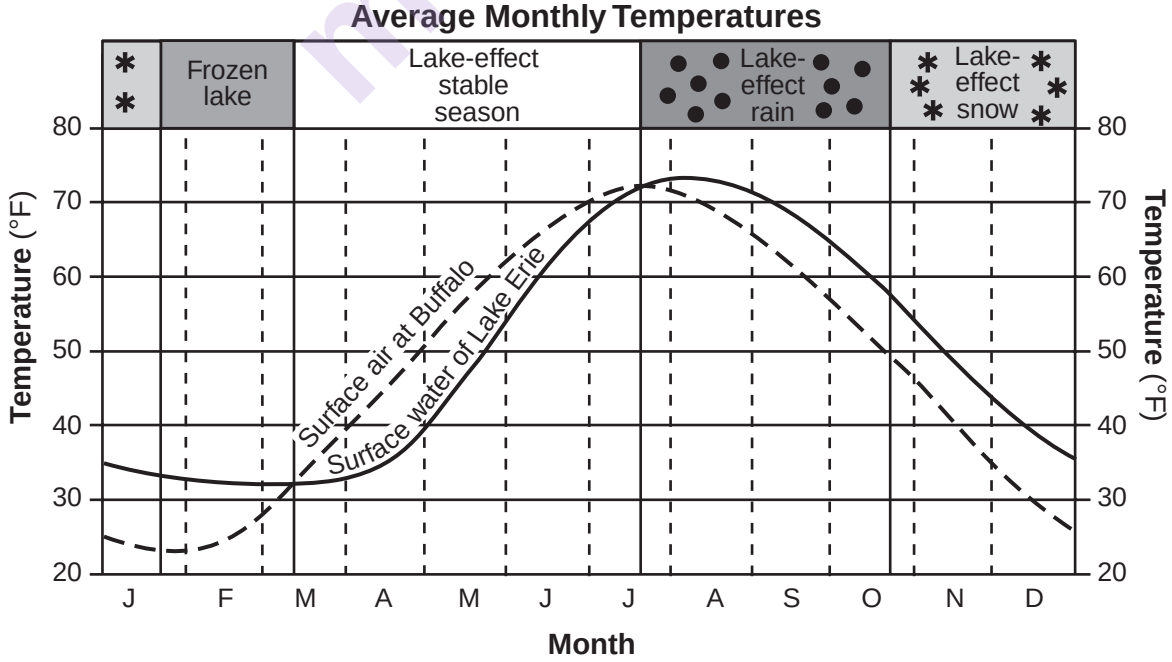
Great Lake Effects

The Great Lakes influence the weather and climate of nearby land regions at all times of the year. Much of this lake effect is determined by the relative temperatures of surface lake water compared to the surface air temperatures over those land areas. The graph below shows the average monthly temperature of the surface water of Lake Erie and the surface air temperature at Buffalo, New York.

In an average year, four lake-effect seasons are experienced. When surface lake temperatures are colder than surface air temperatures, a stable season occurs. The cooler lake waters suppress cloud development and reduce the strength of rainstorms. As a result, late spring and early summer in the Buffalo region tends to be very sunny.

A season of lake-effect rains follows. August is usually a time of heavy nighttime rains, and much of the rainy season is marked by heavy, localized rainstorms downwind from the lake. Gradually, during late October, lake-effect rains are replaced by snows. Generally, the longer the time the wind travels over the lake, the heavier the lake effect becomes in Buffalo.

Finally, conditions stabilize again, as the relatively shallow Lake Erie freezes over, usually near the end of January. Very few lake-effect storms occur during this time period.



Source: www.erh.noaa.gov (adapted)

51 The passage states, "The cooler lake waters suppress cloud development…" because the water cools the air above its surface. Explain why this cool air above the lake surface reduces the amount of cloud development. [1]

52 Identify *one* weather variable that determines whether Buffalo receives rain or snow from a lake-effect storm in October. [1]

53 On the map *in your answer booklet*, draw *one* straight arrow in Lake Erie to show the winter wind direction most likely to bring the heaviest lake-effect snows to Buffalo. [1]

54 Explain why the Buffalo surface air temperatures increase faster and earlier in the year than do the surface water temperatures of Lake Erie. [1]

Base your answers to questions 55 through 58 on the graph in your answer booklet and on your knowledge of Earth science. The graph shows planet equatorial diameters and planet mean distances from the Sun. Neptune is *not* shown.

55 *In your answer booklet*, place an **X** on the graph to indicate where Neptune would be plotted, based on its mean distance from the Sun and its equatorial diameter. [1]

56 The diagram in your answer booklet represents Earth drawn to a scale of 1 cm = 2000 km. Centimeter markings along the equatorial diameter of Earth are also shown on the diagram. On the diagram *in your answer booklet*, shade in the space between the centimeter markings to represent the equatorial diameter of Earth's Moon at this same scale. [1]

57 Compared to the periods of revolution and periods of rotation of the terrestrial planets, how are the periods of revolution and periods of rotation for the Jovian planets different? [1]

58 The center of the asteroid belt is approximately 404 million kilometers from the Sun. State the name of the planet that is closest to the center of the asteroid belt. [1]

Base your answers to questions 59 through 61 on the map of Haiti's location and portion of the Modified Mercalli Intensity Scale below, on the Haiti Earthquake Intensity Map in your answer booklet, and on your knowledge of Earth science. The map shows the location of Haiti in the Atlantic Ocean. The Modified Mercalli Intensity Scale describes the amount and type of damage caused by an earthquake on a scale from I to XII. A portion of this scale is shown below. Modified Mercalli intensity values for the January 12, 2010, earthquake in Haiti are represented on the Haiti Earthquake Intensity Map in your answer booklet.

Map of Haiti's Location

A Portion of the Modified Mercalli Intensity Scale

Intensity	Description of Effects
IV	Generally felt by people in motion, loose objects disturbed
V	Felt by nearly everyone; some dishes, windows broken
VI	Felt by all; slight damage to ordinary structures
VII	Damage rare in buildings of good design and construction; slight to moderate in ordinary structures; considerable damage in poorly built structures; some chimneys broken
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse; damage great in poorly built structures; falling chimneys, columns, monuments, walls
IX	Damage considerable in specially designed structures; damage great in substantial buildings, with partial collapse; buildings shifted off foundations
X	Some well-built wooden structures destroyed; most concrete and frame structures destroyed along with foundations

59 On the earthquake intensity map in your answer booklet, boundary lines have been drawn between the Modified Mercalli intensity values of IV and V. On the map *in your answer booklet*, draw boundary lines between the Modified Mercalli intensity values of V and VI. [1]

60 State the latitude and longitude of Savane Baptiste. Include the units and compass directions in your answer. [1]

61 Haiti is located at a transform boundary between which two tectonic plates? [1]

Base your answers to questions 62 through 65 on the passage below and on your knowledge of Earth science.

Dinosaur Fossils

Bones of juvenile long-necked sauropod dinosaurs, *Abydosaurus mcintoshi,* have recently been found in 105-million-year-old sandstone at the Dinosaur National Monument in Utah. The remains of four individual dinosaurs were found, including two intact skulls. This find is unusual because the softer tissue holding the thin sauropod dinosaur skull bones together usually disintegrates, allowing the skull bones to separate. Only 8 of 120 types of sauropods discovered have complete skull specimens. These dinosaurs were herbivores, with large numbers of sharp teeth that were probably replaced five to six times each year. These teeth allowed only for the harvesting of plant material, but not for chewing it afterward. The plant-harvesting teeth and long neck identify *Abydosaurus mcintoshi* as a descendant of the brachiosaurs.

62 On the timeline *in your answer booklet*, place an **X** on line *AB* to indicate the time when *Abydosaurus mcintoshi* lived. [1]

63 Indicate the range of grain sizes in the type of bedrock in which *Abydosaurus mcintoshi* bones were found. [1]

64 Identify *one* group of organisms that was a likely food source for *Abydosaurus mcintoshi*. [1]

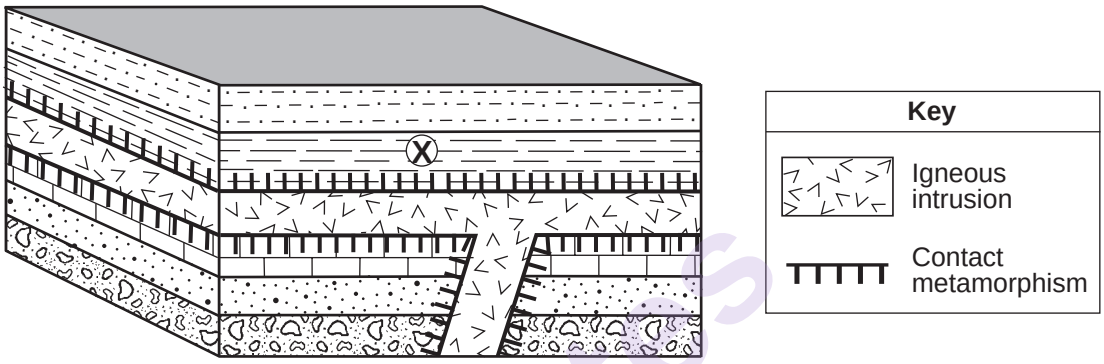
65 State a natural event that is inferred by most scientists to be the cause of extinction of the last of the dinosaurs. [1]

Part C

Answer all questions in this part.

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

Base your answers to questions 66 through 69 on the block diagram below and on your knowledge of Earth science. The diagram represents an igneous intrusion that solidified between some layers of sedimentary rock. Letter *X* represents an index fossil in a sedimentary rock layer. The rock layers have *not* been overturned.



(Not drawn to scale)

66 Describe the evidence represented in the diagram that indicates that the shale layer and the limestone layer are older than the igneous intrusion. [1]

67 The limestone layer is composed mostly of what mineral? [1]

68 Describe *one* characteristic of fossil *X* that makes it a good index fossil. [1]

69 The igneous intrusion contains the radioactive isotope potassium-40, which is used in radioactive dating to determine the age of rocks. State *one* property of potassium-40 that allows it to be useful in the radioactive dating of rocks. [1]

Base your answers to questions 70 through 73 on the data table below and on your knowledge of Earth science. The data show the rate of change in the apparent direction of the swing of a Foucault pendulum at various latitudes on Earth, in degrees per hour.

A Foucault Pendulum's Swing

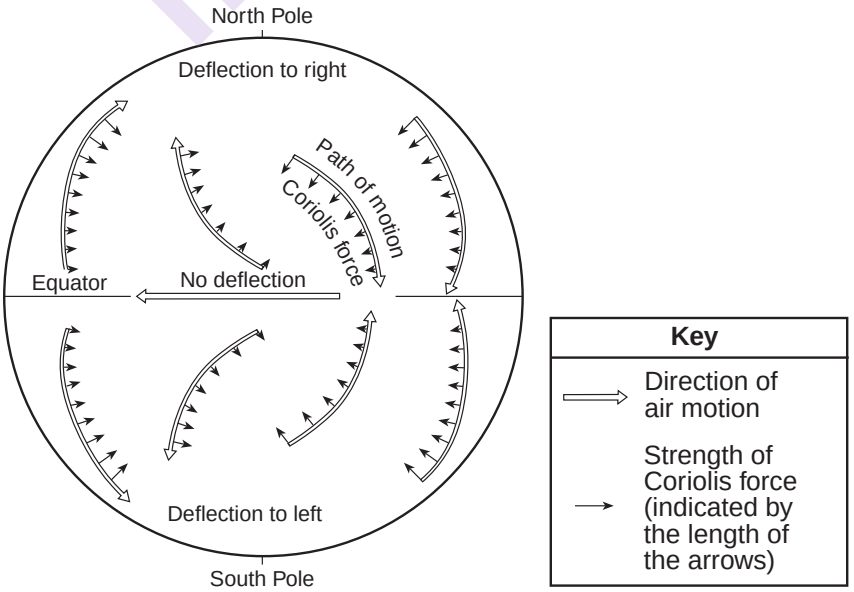
Latitude (°)	**Rate of Change in Apparent Direction of Swing** (°/h)
0	0.0
10	2.6
20	5.1
30	7.5
40	9.6
50	11.5
60	13.0
70	14.1
80	14.8
90	15.0

70 On the grid *in your answer booklet*, plot the hourly change in a Foucault pendulum's apparent direction of swing at the latitudes shown on the data table. Connect the plots with a line. [1]

71 Calculate how many hours are needed for a Foucault pendulum located at the North Pole to complete a 360° change in its apparent direction of swing. [1]

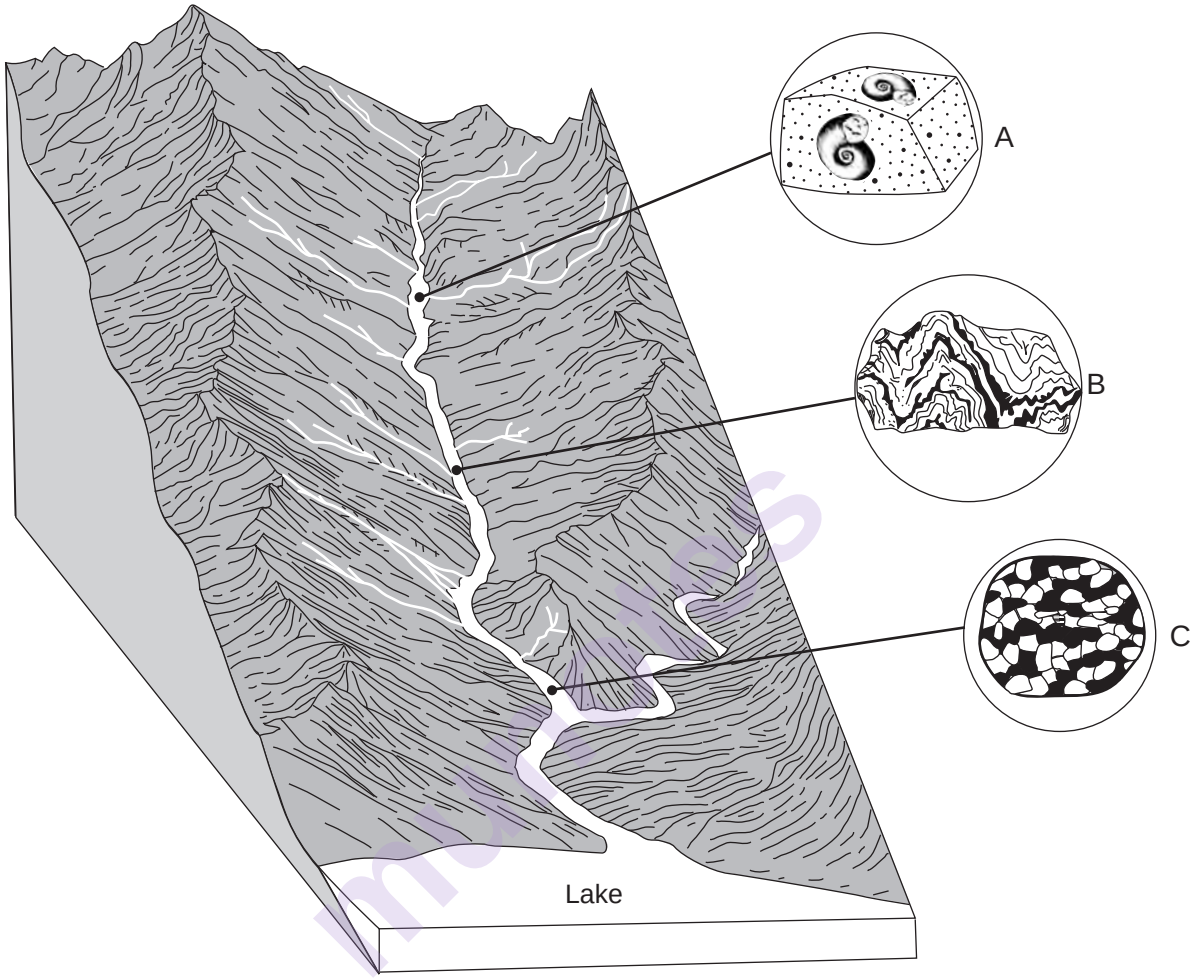
72 If a Foucault pendulum were set up on Mars, it would most likely show similar changes in the pendulum's apparent direction of swing. Identify the motion of the planet Mars that would cause this change. [1]

73 The Coriolis force results from the same motion that causes the Foucault pendulum to change its apparent direction of swing. The diagram below represents the relative strength of the Coriolis force acting on air moving over Earth's surface.



Describe how the strength of the Coriolis force changes with latitude. [1]

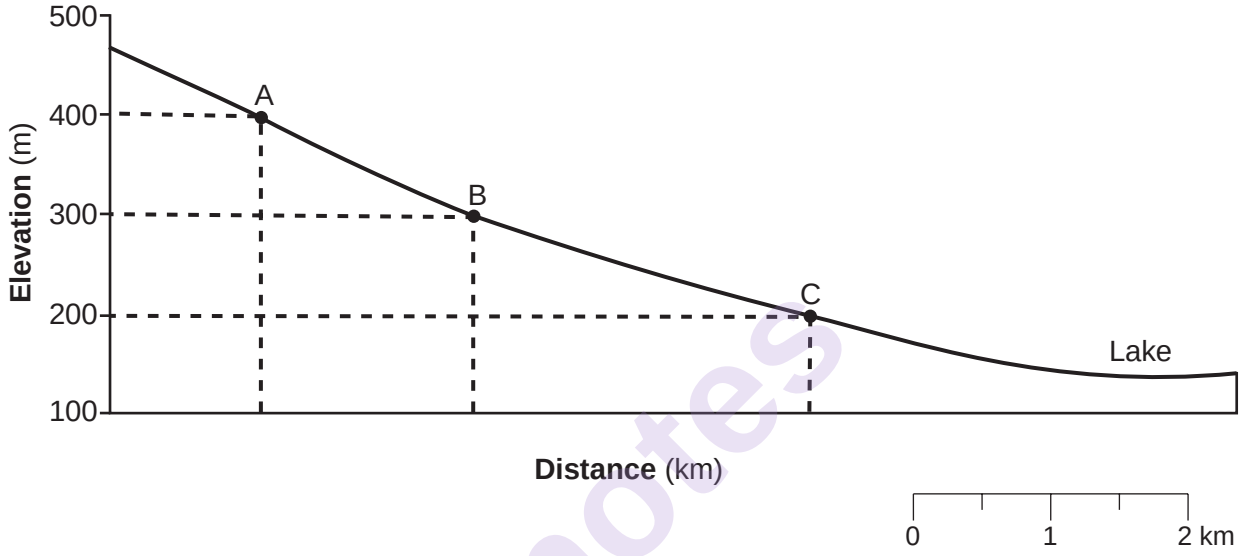
Base your answers to questions 74 through 76 on the block diagram below, which represents a landscape drained by a stream system, and on your knowledge of Earth science. The actual sizes and shapes of three rock samples, labeled *A*, *B*, and *C*, and the locations where they were found in the stream are indicated in the diagram. A New York State index fossil is shown in rock sample *A*.



74 Explain how the appearance of rock sample *A* indicates that the sample has spent very little time being transported by the stream. [1]

75 Rock sample *C* has a diameter of 2 centimeters. Determine the minimum stream velocity needed to transport rock sample *C* to its present location. [1]

76 The stream profile below shows the locations of rock samples *A*, *B*, and *C* in the streambed.



Calculate the stream gradient between the locations of rock sample *A* and rock sample *C*. [1]

Base your answers to questions 77 through 80 on the map in your answer booklet and on your knowledge of Earth science. The map shows the path of a tornado that moved through a portion of Nebraska on May 22, 2004 between 7:30 p.m. and 9:10 p.m. The path of the tornado along the ground is indicated by the shaded region. The width of the shading indicates the width of destruction on the ground. Numbers on the tornado's path indicate the Fujita intensity at those locations. The Fujita Intensity Scale (F-Scale), in the left corner of the map, provides information about wind speed and damage at various F-Scale intensities.

77 On the map *in your answer booklet*, place an **X** at a location where the tornado damage was greatest. [1]

78 State a possible wind speed of the tornado, in kilometers per hour (km/h), when it was moving through the town of Bennet. [1]

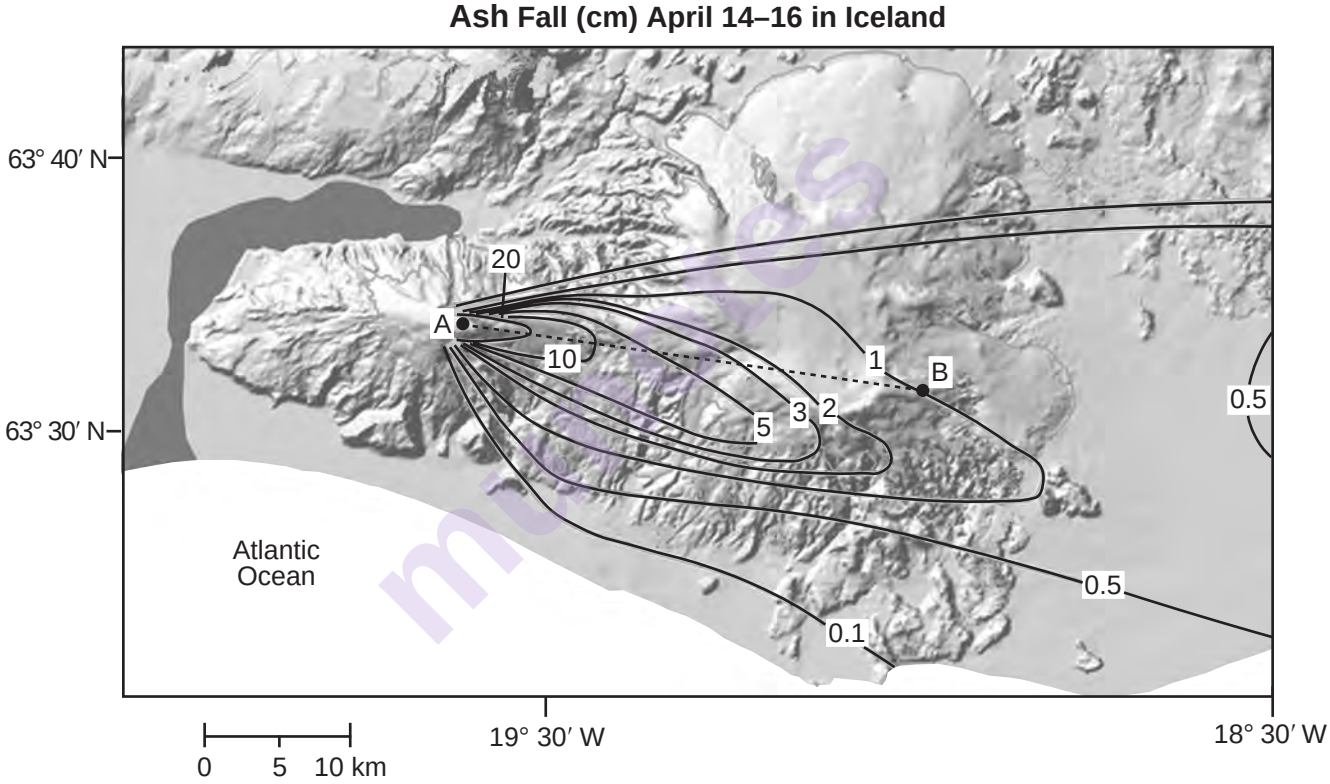
79 Identify the weather instrument usually used to measure wind speed. [1]

80 Describe *one* safety precaution that should be taken if a tornado has been sighted approaching your home. [1]

Base your answers to questions 81 through 85 on the reading passage and map below and on your knowledge of Earth science. The passage provides information regarding the eruption of a volcano in Iceland. The map shows the thickness of ash deposits, in centimeters (cm), during the first three days of the eruption. Point *A*, representing the volcano's location, and point *B*, representing a location on Earth's surface, are connected with a reference line.

Iceland Volcano Eruption Spreads Ash Cloud over Europe

On April 14, 2010, Eyjafjallajökull volcano, located in southern Iceland, explosively erupted, sending large volumes of volcanic ash high into the atmosphere. Much of the ash fell quickly to Earth, as seen in the map, but large quantities remained airborne and spread over Europe. Most of the ash was transported within the atmosphere below 10 kilometers. Air traffic across the Atlantic and throughout Europe was severely disrupted, as airlines were forced to keep jet aircraft on the ground.



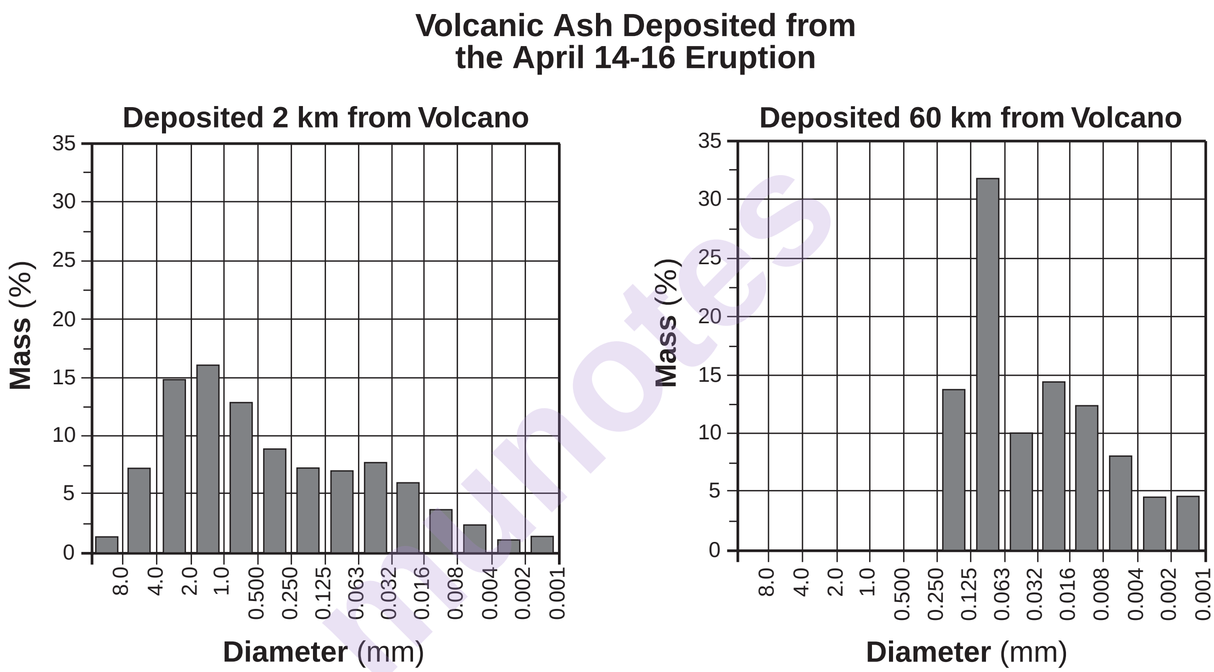
Source: Ash generation and distribution from the April-May 2010 eruption of Eyjafjallajökull, Iceland, Gudmundsson et al., *Scientific Reports*, August 14, 2012 (adapted)

81 On the grid *in your answer booklet*, construct a profile of the thickness of the volcanic ash deposits by plotting the ash fall along line *AB*. Plot *each* point where an isoline showing thickness is crossed by line *AB*. Ash thickness at location *A* has been plotted. Complete the profile by connecting *all seven* plots with a line. [1]

82 Identify the atmospheric layer within which most of the volcanic ash was transported. [1]

83 Describe *one* way the volcanic ash cloud may have contributed to cooler weather conditions in Europe. [1]

84 The graphs below indicate the percent by mass of different diameters of ash particles deposited at 2 kilometers and 60 kilometers from the volcanic eruption.



Describe how the size of the deposited ash particles changed with increased distance from the volcano. [1]

85 Explain why the lithosphere in the vicinity of Eyjafjallajökull is more volcanically active than most other regions of Earth's surface. [1]

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