

**BIG Idea** The composition, structure, and properties of Earth's atmosphere form the basis of Earth's weather and climate.

## Vocabulary

## Key Concepts

### Section 11.1 Atmospheric Basics

- conduction (p. 288)
- convection (p. 288)
- exosphere (p. 286)
- mesosphere (p. 284)
- radiation (p. 287)
- stratosphere (p. 284)
- thermosphere (p. 284)
- troposphere (p. 284)

**MAIN Idea** Energy is transferred throughout Earth's atmosphere.

- Earth's atmosphere is composed of several gases, primarily nitrogen and oxygen, and also contains small particles.
- Earth's atmosphere consists of five layers that differ in their compositions and temperatures.
- Solar energy reaches Earth's surface in the form of visible light and infrared waves.
- Solar energy absorbed by Earth's surface is transferred as thermal energy throughout the atmosphere.

### Section 11.2 Properties of the Atmosphere

- dew point (p. 295)
- humidity (p. 294)
- latent heat (p. 295)
- relative humidity (p. 294)
- saturation (p. 294)
- temperature inversion (p. 292)

**MAIN Idea** Atmospheric properties, such as temperature, air pressure, and humidity describe weather conditions.

- At the same pressure, warmer air is less dense than cooler air.
- Air moves from regions of high pressure to regions of low pressure.
- The dew point of air depends on the amount of water vapor the air contains.
- Latent heat is released when water vapor condenses and when water freezes.

### Section 11.3 Clouds and Precipitation

- cirrus (p. 301)
- coalescence (p. 302)
- condensation nucleus (p. 297)
- cumulus (p. 301)
- orographic lifting (p. 299)
- precipitation (p. 302)
- stratus (p. 301)

**MAIN Idea** Clouds vary in shape, size, height of formation, and type of precipitation.

- Clouds are formed as warm, moist air is forced upward, expands, and cools.
- An air mass is stable if it tends to return to its original height after it starts rising.
- Cloud droplets form when water vapor is cooled to the dew point and condenses on condensation nuclei.
- Clouds are classified by their shapes and the altitudes at which they form.
- Cloud droplets collide and coalesce into larger droplets that can fall to Earth as rain, snow, sleet, or hail.



## Vocabulary Review

Match each description below with the correct vocabulary term from the Study Guide.

1. outermost layer of Earth's atmosphere
2. transfer of energy from a higher to a lower temperature by collisions between particles
3. temperature at which condensation of water vapor can occur
4. occurs when the amount of water vapor in a volume of air has reached the maximum amount
5. the amount of water vapor present in air

Complete the sentences below using vocabulary terms from the Study Guide.

6. \_\_\_\_\_ are small particles in the atmosphere around which water droplets form.
7. The atmospheric layer that is closest to Earth's surface is the \_\_\_\_\_.
8. Types of \_\_\_\_\_ include hail, sleet, and snow.

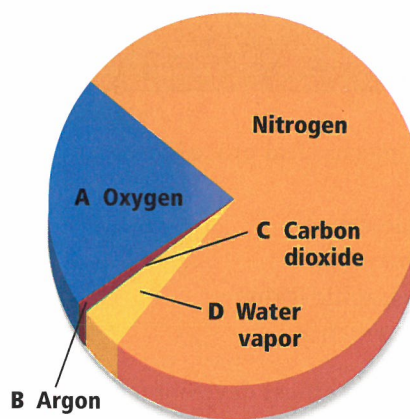
Each of the following sentences is false. Make each sentence true by replacing the italicized words with terms from the Study Guide.

9. *Convection* occurs when small cloud droplets collide to form a larger droplet.
10. *Mesosphere* is the layer of Earth's atmosphere that contains the ozone layer.
11. The transfer of energy in matter or space by electromagnetic waves is called *latent heat*.
12. When the bottom of a pan of water is heated and the water expands, becoming less dense than the surrounding water, it is forced upward. As it rises, the water cools and sinks back to the bottom of the pan. This process is called *precipitation*.
13. When *saturation* occurs, an air mass is forced to rise over a topographic barrier.

## Understand Key Concepts

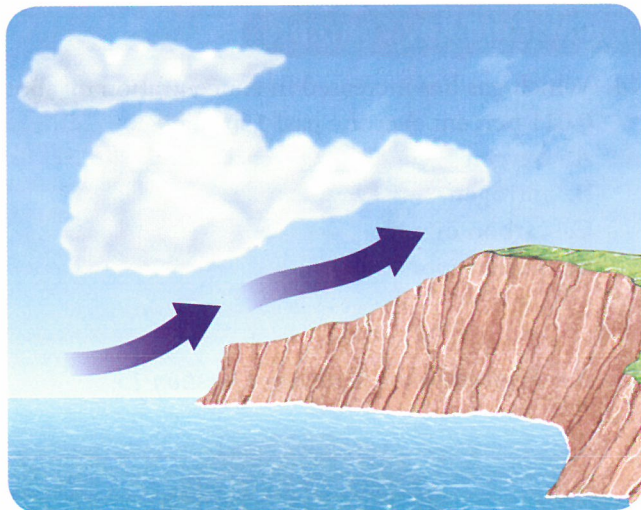
14. Which gas has increased in concentration by about 0.011 percent over the past 150 years?
  - A. oxygen
  - B. nitrogen
  - C. carbon dioxide
  - D. water vapor

Use the diagram below to answer Question 15.



15. Which gas is least abundant in Earth's atmosphere?
  - A. A
  - B. B
  - C. C
  - D. D
16. Which is the primary cause of wind?
  - A. air saturation
  - B. pressure imbalances
  - C. pollution
  - D. movement of water
17. Which process takes up latent heat?
  - A. condensation of water vapor
  - B. evaporation of water vapor
  - C. adiabatic heating
  - D. pressure increase
18. Wind speed on Earth is reduced by which?
  - A. temperature
  - B. friction
  - C. weather
  - D. convergence

Use the diagram below to answer Question 19.



19. Which mechanical process is causing the air to rise?
  - A. coalescence
  - B. convection
  - C. orographic lifting
  - D. convergence
20. Which is a vertical development cloud?
  - A. cumulonimbus
  - B. cirrus
  - C. stratus
  - D. altocumulus
21. Almost all weather, clouds, and storms occur in which layer of the atmosphere?
  - A. thermosphere
  - B. mesosphere
  - C. stratosphere
  - D. troposphere
22. What color would be best for a home designed to absorb energy?
  - A. red
  - B. white
  - C. gray
  - D. black
23. Which temperature is coldest?
  - A. 32°F
  - B. 10°C
  - C. 280 K
  - D. 5°C

## Constructed Response

24. **Explain** why precipitation from a cumulonimbus cloud is generally heavier than that from a nimbostratus cloud.
25. **Identify** the role that evaporation and condensation play in Earth's water cycle.
26. **Compare** what happens to latent heat in the atmosphere during evaporation to what occurs during condensation.

Use the figure below to answer Question 27.



27. **Describe** the process that causes the cloud type shown to reach heights of over 6000 m.
28. **Determine** whether the average relative humidity on a small island in the ocean would likely be higher or lower than 100 km inland on a continent.
29. **Explain** If clouds absorb only a small amount of solar radiation, how is Earth's atmosphere heated?
30. **Distinguish** between convection and conduction as methods of transferring energy in the atmosphere.
31. **Compare** the temperature and composition of the troposphere and the stratosphere.
32. **Determine** what causes precipitation to fall as rain or snow.
33. **Relate** dew point and saturation.
34. **Describe** the importance of water vapor in the atmosphere.



## Think Critically

35. **CAREERS IN EARTH SCIENCE** Research information about the workday of a weather observer.
36. **Predict** how the concentration of ozone molecules would change if the concentration of oxygen molecules decreased.
37. **Infer** Using the idea that almost all weather occurs in the troposphere, infer why many airliners usually fly at altitudes of 11 km or higher.
38. **Predict** whether afternoon summertime temperatures near the beach would be warmer or cooler than temperatures farther inland. Explain.
39. **Predict** why spring is often the windiest time of the year based on your knowledge of temperature and wind.
40. **Predict** how the energy absorbed by the Arctic Ocean would change if the amount of the sea ice covering the ocean is reduced. Keep in mind that sea ice reflects more incoming solar energy than water does.
41. **Assess** which cloud type would be of most interest to a hydrologist who is concerned with possible heavy rain and flooding over large regions. Why?
42. **Analyze** why relative humidity usually decreases after the Sun rises and increases after the Sun sets.

## Concept Mapping

43. Use the following terms and phrases to construct a concept map that describes the process of the water cycle: *water cycle; evaporation; condensation; precipitation; water changes from liquid to gas; water changes from gas to liquid; water falls as rain, snow, sleet, or hail*. For more help, refer to the *Skillbuilder Handbook*.

## Challenge Question

44. Based on what you know about radiation and conduction, what conclusion might you make about summer temperatures in a large city compared with those in the surrounding countryside?

## Additional Assessment

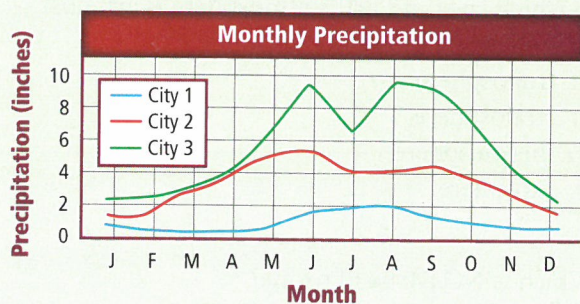
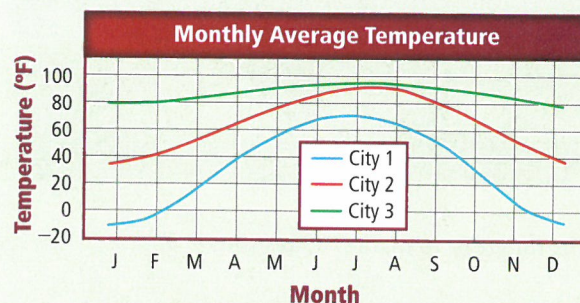
45. **WRITING in Earth Science** Write and illustrate a short story for elementary students that describes cumulonimbus cloud formation and the kinds of weather patterns they produce.



## Document-Based Questions

Data obtained from: Climatological normals 1971–2000. *National Oceanographic and Atmospheric Administration, National Climatic Data Center.*

The graphs show the monthly variations in temperature and precipitation at three locations in the United States. Use the data to answer the questions below.



46. Estimate from the data which location probably receives the least annual solar radiation.
47. In which location would you expect heavy precipitation?
48. Deduce from the graphs which station probably receives the most annual snowfall.

## Cumulative Review

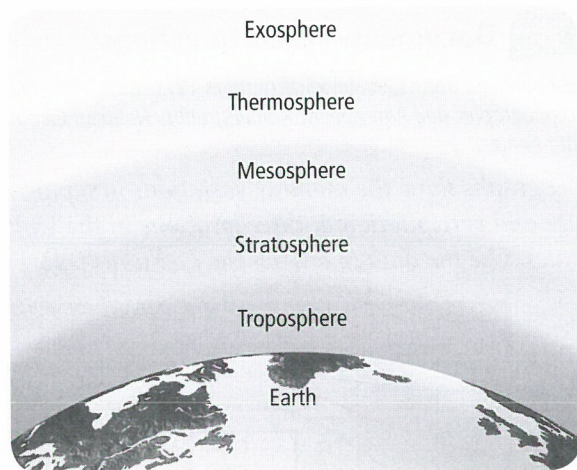
49. Describe the properties of a contour line. (Chapter 2)
50. What process is explained by Bowen's reaction series? (Chapter 5)



# Standardized Test Practice

## Multiple Choice

1. What is the composition of dripstone formations?
- A. gravel
  - B. limestone
  - C. clay
  - D. sand



Use the diagram to answer Questions 2 and 3.

2. In which layer of Earth's atmosphere is air most likely warmed by conduction?
- A. troposphere
  - B. stratosphere
  - C. thermosphere
  - D. exosphere
3. Which is NOT true of ozone?
- A. It absorbs ultraviolet radiation.
  - B. Its concentration is decreasing.
  - C. It is concentrated in the atmospheric layer called the mesosphere.
  - D. It is a gas formed by the addition of one oxygen atom to an oxygen molecule.
4. Which describes the temperature of groundwater flowing through a natural spring?
- A. hotter than the region's average temperature
  - B. cooler than the region's average temperature
  - C. the same temperature no matter where the spring is located
  - D. the same temperature as the region's average temperature

5. Why do deserts experience wind erosion?
- A. There is limited rain to allow plants to grow and hold down sediment.
  - B. Saltation does not occur readily in desert areas.
  - C. The increased amount of heat increases wind patterns.
  - D. Wind can carry larger particles than water.
6. Which is NOT a significant agent of chemical weathering?
- A. oxygen
  - B. nitrogen
  - C. carbon dioxide
  - D. water

Use the table below to answer Questions 7 and 8.

Population of Unknown Organisms				
	Spring	Summer	Autumn	Winter
1995	564	14,598	25,762	127
1996	750	16,422	42,511	102
1997	365	14,106	36,562	136

7. What inference can be made based upon the data?
- A. Scientists have a hard time consistently tracking the organism.
  - B. The organism migrates yearly.
  - C. The organism is most abundant during summer and fall.
  - D. The organism should be placed on the endangered species list.
8. What would be the best graphical representation of this data?
- A. bar graph
  - B. line graph
  - C. circle graph
  - D. model
9. Which is most likely to cause orographic lifting?
- A. a sandy beach
  - B. a flowing river
  - C. a rocky mountain
  - D. a sand dune
10. Why are the lakes in Central Florida considered to have karst topography?
- A. They are depressions in the ground near caves.
  - B. They are part of a sinking stream.
  - C. They are layered with limestone.
  - D. They are sinkholes.

## Short Answer

Use the illustration below to answer Questions 11–13.



11. What type of rock is shown above? What features indicate this?
12. Hypothesize how this sample of rock formed.
13. According to the rock cycle, what changes could occur in this rock? What new type of rock would be produced?
14. Describe temperature and heat.
15. Define ion and explain how an ion is formed.
16. Describe how a flood might cause residual soil to become transported soil.

## Reading for Comprehension

### Ozone Layer Recovery

Damage to the ozone layer, caused by chlorofluorocarbon (CFC) chemicals and other pollutants, may be starting to reverse itself, according to data collected by NASA satellites. Ozone degradation continues despite global bans on ozone-depleting pollutants. The rate has slowed enough in the upper stratosphere that scientists think ozone could start to be replenished there within several years.

Evidence suggests that international efforts to reduce chlorofluorocarbon (CFC) pollution are working. Some predictions suggest that the ozone layer will have recovered to preindustrial levels by the late twenty-first century, though total recovery could happen within 50 years.

17. According to the passage, what is the major cause of the replenishing of the ozone layer?
  - A. the ban of chlorofluorocarbons
  - B. preindustrial pollution
  - C. the upper stratosphere
  - D. NASA satellites
18. What can be inferred from this passage?
  - A. The ozone layer is recovering, but will never be fully restored.
  - B. CFC pollution is no longer occurring.
  - C. The upper stratosphere is the only layer with ozone depletion.
  - D. Ozone depletion in the upper stratosphere has slowed down.
19. According to the text, how long could it take for a full recovery of the ozone layer?
  - A. a decade
  - B. until the late twenty-first century
  - C. 50 years
  - D. several years
20. Why is it important that the ozone layer in the upper stratosphere is replenished?

### NEED EXTRA HELP?

If You Missed Question . . .	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Review Section . . .	10.2	11.1	11.1	10.1	8.2	7.1	1.2	1.3	11.3	10.2	6.3	6.3	6.3	11.2	3.1	7.3