

BIG Idea The exchange of thermal energy in the atmosphere sometimes occurs with great violence that varies in form, size, and duration.

Vocabulary

Key Concepts

Section 13.1 Thunderstorms

- air-mass thunderstorm (p. 346)
- frontal thunderstorm (p. 346)
- mountain thunderstorm (p. 346)
- return stroke (p. 348)
- sea-breeze thunderstorm (p. 346)
- stepped leader (p. 348)

MAIN Idea The intensity and duration of thunderstorms depend on the local conditions that create them.

- The cumulus stage, the mature stage, and the dissipation stage comprise the life cycle of a thunderstorm.
- Clouds form as water is condensed and latent heat is released.
- Thunderstorms can be produced either within air masses or along fronts.
- From formation to dissipation, all thunderstorms go through the same stages.
- Lightning is a natural result of thunderstorm development.

Section 13.2 Severe Weather

- downburst (p. 351)
- Fujita tornado intensity scale (p. 353)
- supercell (p. 350)
- tornado (p. 352)

MAIN Idea All thunderstorms produce wind, rain, and lightning, which can have dangerous and damaging effects under certain circumstances.

- Intense rotating updrafts are associated with supercells.
- Downbursts are strong winds that result in damage associated with thunderstorms.
- Hail is precipitation in the form of balls or lumps of ice that accompany severe storms.
- The worst storm damage comes from a vortex of high winds that moves along the ground as a tornado.

Section 13.3 Tropical Storms

- eye (p. 356)
- eyewall (p. 356)
- Saffir-Simpson hurricane scale (p. 358)
- storm surge (p. 359)
- tropical cyclone (p. 355)

MAIN Idea Normally peaceful, tropical oceans are capable of producing one of Earth's most violent weather systems—the tropical cyclone.

- Cyclones rotate counterclockwise in the northern hemisphere.
- Cyclones are also known as hurricanes and typhoons.
- Cyclones go through the same stages of formation and dissipation as other storms.
- Cyclones are moved by various wind systems after they form.
- The most dangerous part of a tropical cyclone is the storm surge.
- Hurricane alerts are given at least 24 hours before the hurricane arrives.

Section 13.4 Recurring Weather

- cold wave (p. 364)
- drought (p. 362)
- heat wave (p. 362)
- windchill index (p. 365)

MAIN Idea Even a relatively mild weather system can become destructive and dangerous if it persists for long periods of time.

- Too much heat and too little precipitation causes droughts.
- Too little heat and a stalled jet stream can cause weeks of cold weather in an area.
- Heat index estimates the effect on the human body when the air is hot and the humidity is high.
- Windchill index tells how wind and temperature affect your body in winter.
- Windchill is a factor used to warn about the effect of cold air and wind on the human body.

Vocabulary Review

Choose the correct *italicized* vocabulary term to complete each sentence.

1. A(n) _____ thunderstorm is characterized by temperature differences within a mass of air.
frontal, severe, air-mass
2. Intense, self-sustaining thunderstorms are known as _____.
downbursts, tornadoes, supercells

Compare and contrast the following pairs of vocabulary terms.

3. cold wave, wind-chill factor
4. eye, eyewall
5. air-mass thunderstorm, frontal thunderstorm
6. stepped leader, return stroke

Replace the underlined term with the correct one from the vocabulary list on the Study Guide.

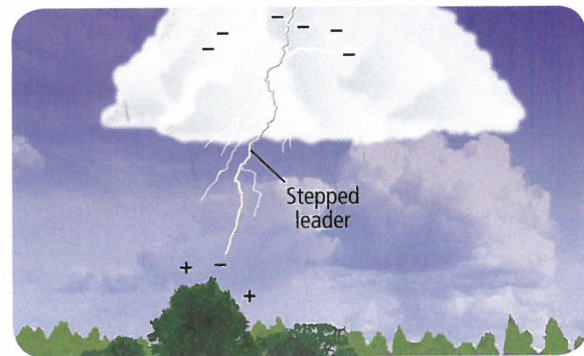
7. More lives are lost during a hurricane's heat wave than from its winds.
8. A microburst is a form of weather that is difficult to predict.
9. Another name for a typhoon is a forecast.
10. A weather map is an extended period of extreme cold in one area.
11. The Fujita tornado intensity scale can tell the possible storm surge heights from a hurricane.

Understand Key Concepts

12. Which would work against the development of a thunderstorm?
 - A. rising air
 - B. stable air
 - C. moisture
 - D. unstable air

13. Which does not describe a type of damaging thunderstorm wind?
 - A. downburst
 - B. microburst
 - C. land breeze
 - D. macroburst

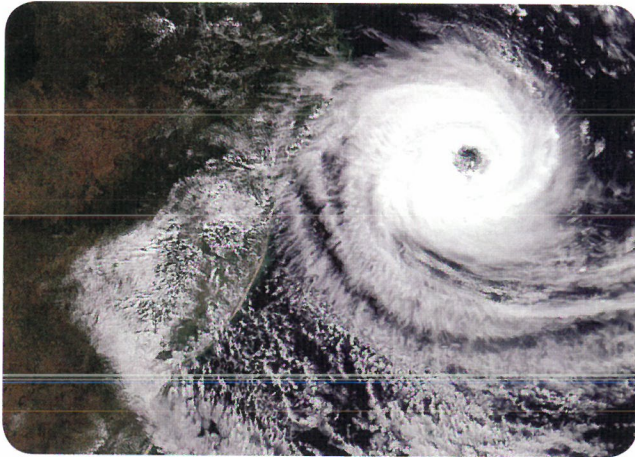
Use the diagram below to answer Question 14.



14. What phrase describes a stepped leader?
 - A. return stroke
 - B. partially charged air
 - C. positive charge
 - D. downdraft
15. Which does not play a key role in the development of hail?
 - A. supercooled water
 - B. freezing temperatures
 - C. warm ocean water
 - D. strong updrafts
16. Heat waves involve high-pressure systems that cause air to sink and warm by which process?
 - A. compression
 - B. conduction
 - C. evaporation
 - D. condensation
17. Which weather hazard involves a lack of moisture?
 - A. hail
 - B. drought
 - C. storm surge
 - D. flood

18. Flooding is most likely to take place because of rains associated with which type of storm?
- Category 5 hurricane moving at 25 m/s
 - F2 tornado moving at 10 m/s
 - A stationary tropical storm
 - thunderstorm moving at 2 m/s

Use this photo to answer Question 19.



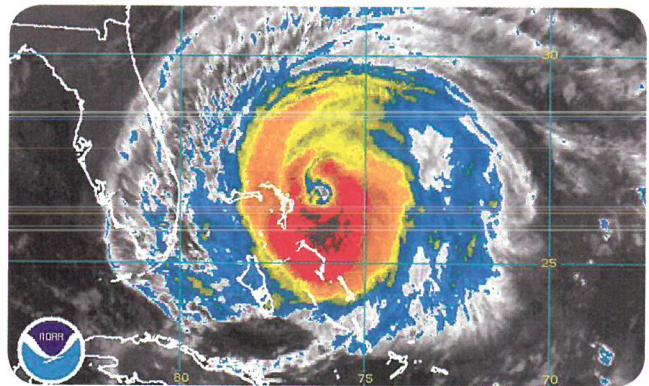
19. Which part of the hurricane is not visible in the photo above?
- eye
 - eyewall
 - storm surge
 - cirrus overcast
20. What percentage of tornadoes are classified as F4 or F5 on the Fujita tornado intensity scale?
- 1 percent
 - 10 percent
 - 50 percent
 - 75 percent
21. Which factor, if increased, would increase the chance that a severe thunderstorm would occur?
- upper-level temperature
 - surface moisture
 - strength of the jet stream
 - conduction
22. In which ocean would you not expect to experience a hurricane?
- West Pacific
 - Indian
 - North Atlantic
 - South Atlantic

23. What weather events are cold waves most often associated with?
- floods
 - polar high-pressure systems
 - tropical high-pressure systems
 - droughts

Constructed Response

24. **Determine** the effect humidity has on the heat index.
25. **Compare and contrast** storm surges of Category 1 and Category 4 hurricanes using **Table 13.2**.

Use the photo below to answer Question 26.



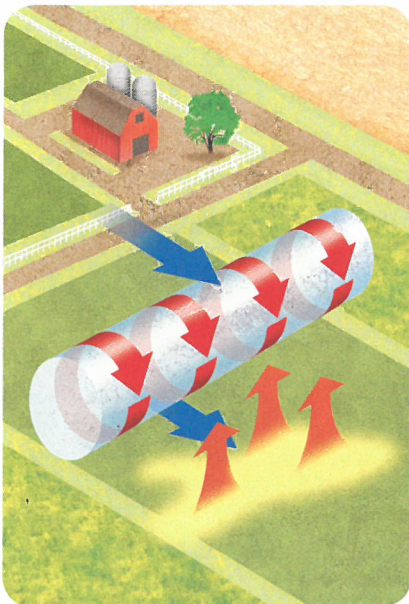
26. **Predict** the area of landfall, the areas affected by storm surge, and evacuation routes for this hurricane.
27. **Compare and contrast** tornadoes and hurricanes.
28. **Point out** the differences between a microburst and a macroburst.
29. **Develop** a plan of safety for a family that might encounter flooding, lightning, and a tornado in the area where they live.

Think Critically

30. **Explain** how temperature and condensation are limiting factors to the growth of a thunderstorm.
31. **Distinguish** how an investigator would differentiate between a microburst and a tornado.
32. **Point out** the features of the South Atlantic that might deter the formation of hurricanes.

33. **Explain** why supercells that produce tornadoes also often produce large hailstones.
34. **Predict** why extreme cold waves are more common in the northern hemisphere than in the southern hemisphere.
35. **Describe** how cold fronts are more likely to produce severe thunderstorms than warm fronts.

Use the diagram below to answer Questions 36 and 37.



36. **Explain** how the wind shears that produce a tornado go from horizontal to vertical.
37. **Identify** what causes the lift for the vertical motion.
38. **CAREERS IN EARTH SCIENCE** Imagine you work for the National Weather Service and it is your job to write public service announcements. Write a safety plan for people who live in places where hurricanes are frequent.

Concept Mapping

39. Make a concept map to differentiate among thunderstorms, tornadoes, and tropical cyclones.

Challenge Question

40. **Appraise** the use of the wind-chill factor to determine school delays and work closings versus temperature, daylight, or icy conditions alone.

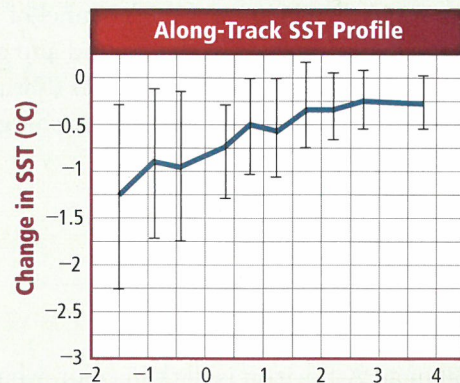
Additional Assessment

41. **WRITING in Earth Science** Imagine that you are a weather research scientist researching a way to stop hurricanes. Tell about your research that includes ways to cool the ocean's surface.

DBQ Document-Based Questions

Data obtained from: National Oceanic and Atmospheric Administration, 2004. *Hurricane Research Division.*

When a hurricane passes over the surface of the ocean, the sea surface temperature (SST) can become several degrees cooler. This is the result of cooler water being churned up to the surface from lower levels. The radial distance is the distance from the eye (TC center) measured in degrees of latitude.



Radial distance from TC center (degrees latitude)

42. What is the estimated range of temperature change for each radial distance indicated?
43. A difference of 0.5°C can be the difference between a storm that intensifies and one that stops developing. At what distance from the TC center would that range be most critical?
44. What factors in a hurricane might cause the increased temperature changes to happen closer to the eye than at the edges?

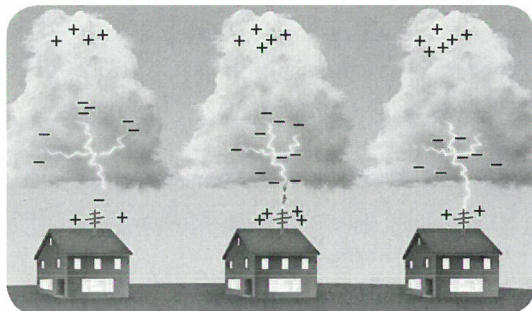
Cumulative Review

45. What are the two most abundant elements in Earth's crust? (Chapter 4)
46. Describe why radiosonde data is important. (Chapter 12)

Standardized Test Practice

Multiple Choice

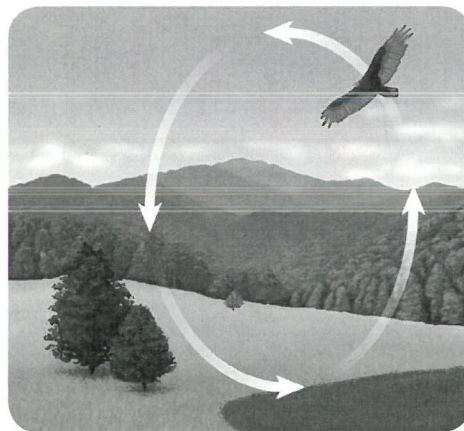
Use the illustration to answer Questions 1 and 2.



1. With what type of cloud is lightning associated?
A. altocumulus C. cirrus
B. stratocumulus D. cumulonimbus
2. Lightning occurs when an invisible channel of negatively charged air descends to the ground and a channel of positively charged ions rushes upward to meet it. What is the channel of positively charged ions called?
A. return stroke
B. stepped leader
C. ground stroke
D. electronic leader
3. If the soil in an A-horizon is dark in color, what does this imply?
A. The layer of soil is rich in humus.
B. The layer of soil is extremely fertile.
C. The layer of soil is from a poorly drained area.
D. The layer of soil is rich with iron materials.
4. Where is the majority of freshwater found?
A. in the atmosphere
B. underground
C. in rivers, streams, and lakes
D. in polar ice caps and glaciers
5. Why is the Geographic Information System (GIS) beneficial to science?
A. It is very similar to traditional mapping.
B. It can be used by scientists in many different disciplines.
C. It limits maps to just one layer of information.
D. It does not change with new information.

6. What does Doppler radar monitor?
A. the motion of moving raindrops
B. atmospheric pressure
C. temperature, air pressure, and humidity
D. the height of cloud layers
7. The data gathered by Doppler radar can be used to make a type of forecast that relies on numerical data. What is this type of forecast called?
A. an analog forecast C. an isopleth
B. a digital forecast D. ASOS

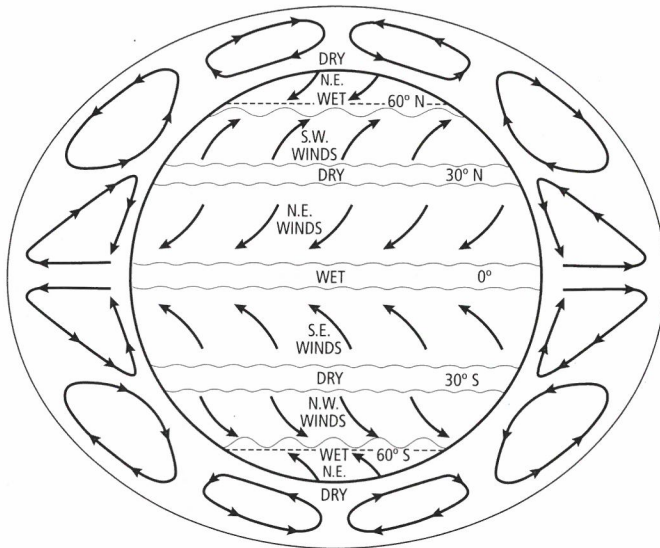
Use the illustration below to answer Questions 8 and 9.



8. What process is being demonstrated by the circulating arrows?
A. radiation
B. a convection current
C. a wind current
D. a conduction current
9. Describe the process of radiation to warm Earth's surface.
A. It is one of the methods that transfer energy from the Sun through different forms of electromagnetic waves to warm Earth.
B. It transfers energy through the collision of molecules to warm Earth.
C. It transfers energy through the flow of a heated substance to warm Earth.
D. It allows the atmosphere to absorb the Sun's rays or reflect them back into space.

Short Answer

Use the diagram below to answer Questions 11–13.



- How does the rotation of Earth affect wind systems?
- Analyze the wind pattern occurring between the equator and 30° north and south latitudes.
- Why would it benefit sailors to know what type of wind system they are traveling in?
- Why do tornadoes form in the spring during the late afternoon and evening?
- Describe a step farmers can take to improve soil fertility.
- Explain the properties of a geyser.
- How does the amount of water on Earth change as a result of the water cycle?

Reading for Comprehension

Hurricane Preparedness

The Saffir-Simpson scale, used by the National Weather Service since the 1970s to classify hurricane strength, ranks storm strength from Level 1 to 5, and is used to give an estimate of the possible property damage and flooding expected when the hurricane makes landfall. A Category 5 storm maintains winds in excess of 155 mph and is capable of causing widespread damages such as destroying or causing extensive structural damage to homes. It can also trigger a storm surge more than 18 ft above normal.

Two of the most fundamental steps people can take are assembling a disaster supplies kit and making an emergency plan. They are simple measures, but can make all the difference when disasters strike.

Article obtained from: Booth, M. Hurricane Isabel strengthens to Category 5. *In the News*. September 12, 2006. (Online resource accessed October 2006.)

- For what purpose is the Saffir-Simpson scale used?
 - estimating property damage and flooding when a hurricane makes landfall
 - estimating the height of a storm surge above normal
 - determining who should be told to evacuate before a hurricane hits
 - measuring the strength of an approaching hurricane
- What can be inferred from this passage?
 - Only Category 5 hurricanes will cause major damage.
 - Only people living along the shoreline are in danger during hurricanes.
 - Category 5 hurricanes have the potential to cause major damage.
 - People should have a disaster supply kit or an evacuation plan in place before a hurricane hits.

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 . . .	13.1	13.2	7.3	10.1	2.3	12.3	12.3	11.1	11.1	12.2	12.2	12.2	13.2	7.3	10.1	11.3