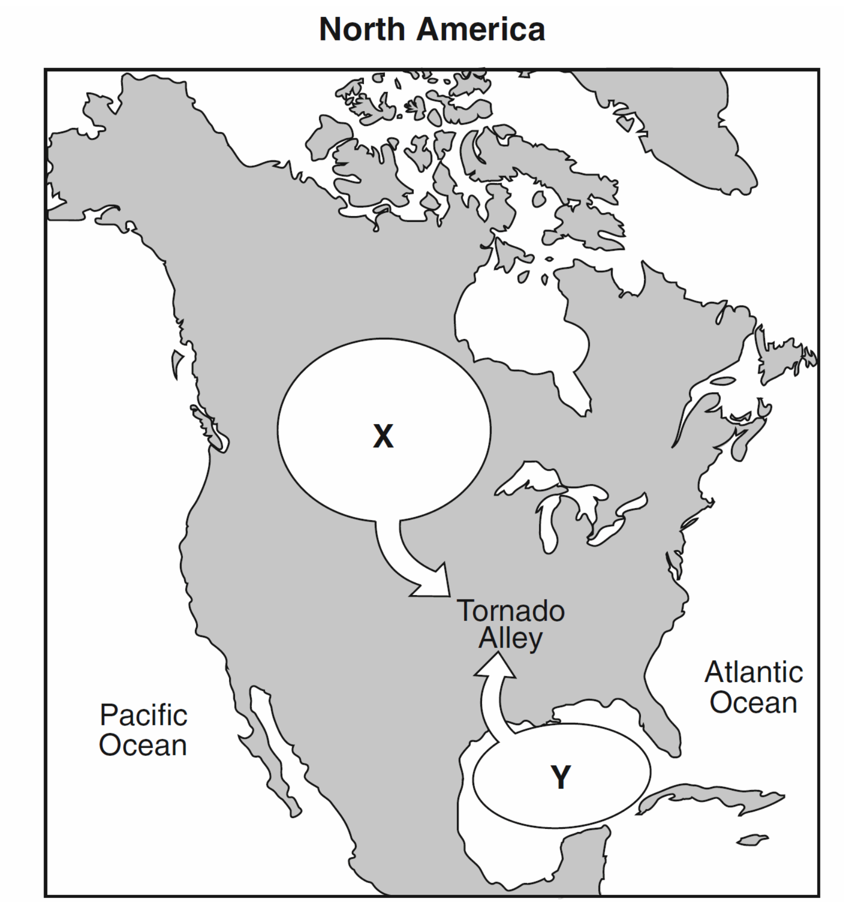
Violent Weather Free Response

Base your answers to questions **1** and **2** on the map below, which represents the geographic source regions of two air masses, *X* and *Y*. The arrows represent the convergence of these air masses, which may result in tornadoes.



1. Use the standard two-letter air-mass symbols to identify air-masses *X* and *Y*.

2. A tornado watch or warning is issued for a location in the area labeled Tornado Alley. State *one* safety precaution that should be taken to avoid possible injury from this tornado.

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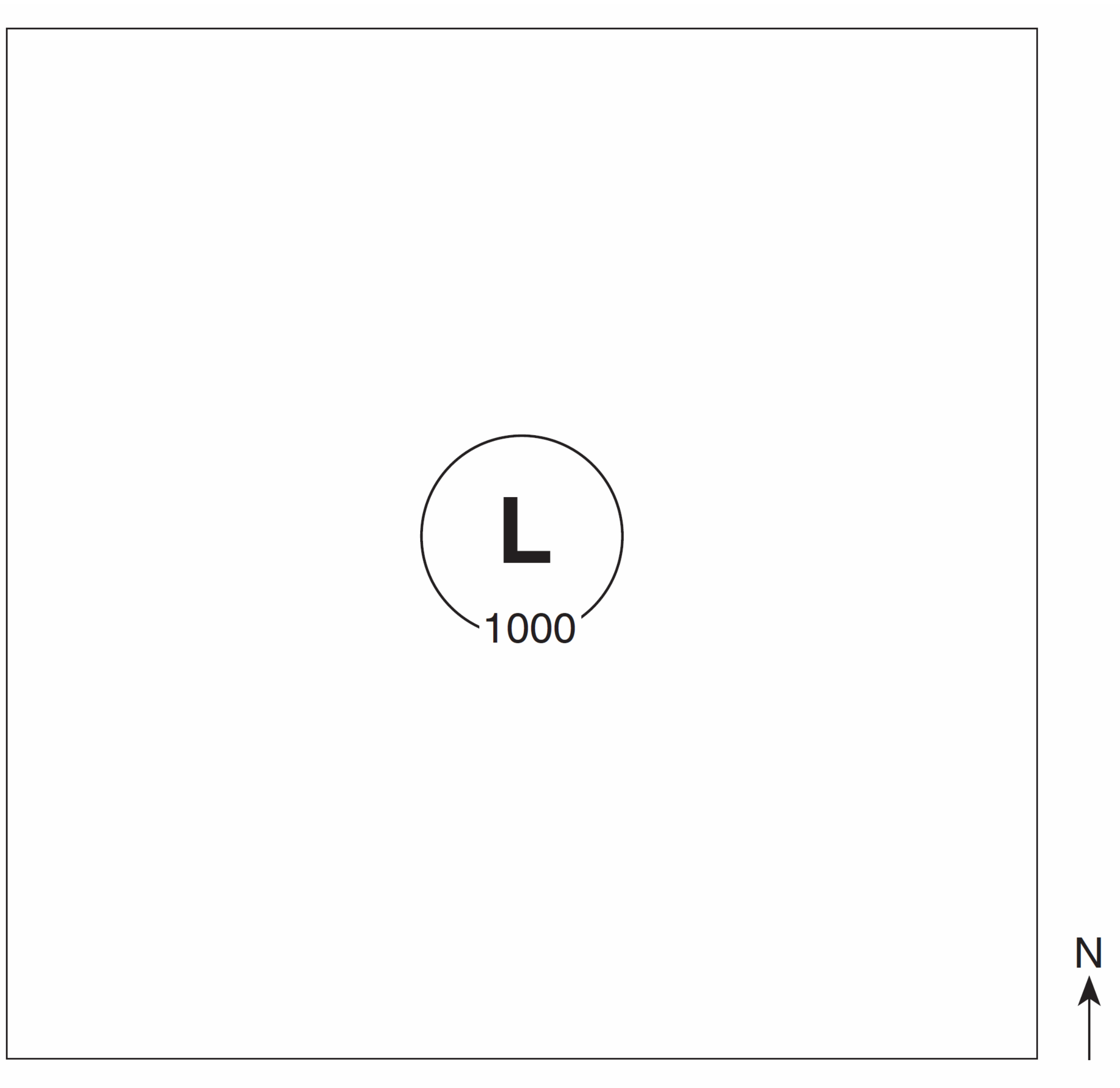
Base your answers to questions **3** and **4** on the map below, which represents the center of a low-pressure system indicated by L. The 1000-millibar (mb) isobar is drawn around the center of this low-pressure system.



3. Identify *one* factor that usually causes many low-pressure centers to generally move from west to east across the United States.

4. On the map above, draw *two* additional isobars around the outside of the 1000-mb isobar in a way that indicates that the strongest winds are west of the low-pressure center.

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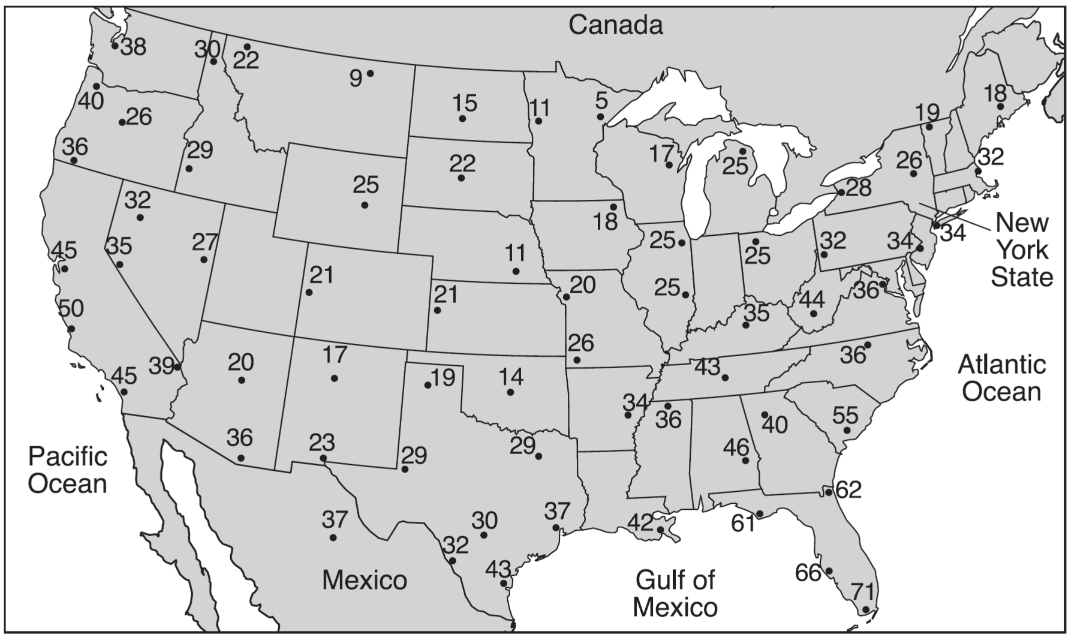
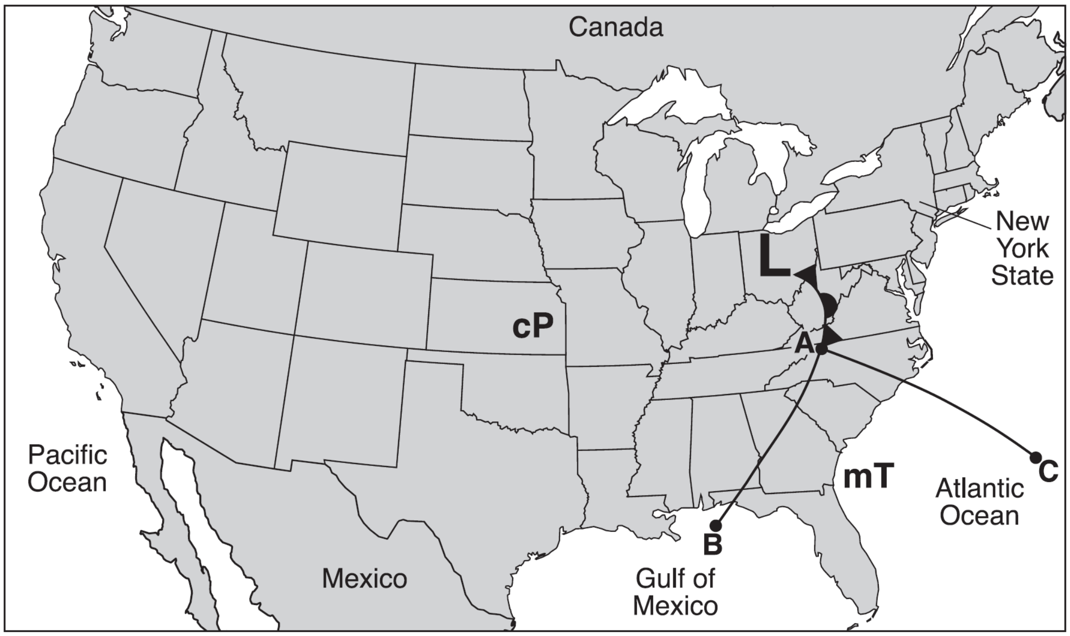
Base your answers to questions **5** through **9** on the two maps below. Map 1 shows air temperatures in the United States and Mexico, recorded in °F, at the points shown on the map. Map 2 shows the location of a low-pressure system at the time these air temperatures were measured. An occluded front extends from the center of the low-pressure system (**L**) to point *A*. Lines *AB* and *AC* are two other frontal boundaries. Two air masses are shown. The storm system later moved toward New York State and produced an ice storm.

Map 1–Temperatures (°F)



Map 2–Weather Fronts



5. On map 1, draw the 32°F isotherm.

6. On map 2, draw weather front symbols on the correct sides of both line *AB* and line *AC* to show the most probable type and direction of movement of each front.

7. Describe the general surface wind pattern associated with the low-pressure system shown on map 2.

8. Explain what caused the center of this low-pressure system to move toward New York State.

9. State *one* action New York State residents should have taken to prepare for the approaching ice storm.

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Base your answers to questions **10** through **13** on on the passage and map below. The map shows the average yearly precipitation in New York State measured in inches.

Landscapes and Precipitation

Moisture from the Gulf of Mexico and the Atlantic Ocean is carried to New York State by storm systems and air currents. Rain and snowfall amounts vary by region. Heavy snow belts are located near Lake Erie and Lake Ontario as well as in the plateau regions of eastern and northern New York State. Long Island and New York City usually experience lighter snowfalls. Snowfall amounts are converted to inches of water to determine yearly precipitation.

Average Yearly Precipitation in Inches

10. Identify *two* bodies of water that are major sources of moisture for the precipitation that occurs in New York State.

11. Identify the New York State landscape region that has the greatest average yearly amount of precipitation.

12. Identify *one* process that occurs in rising air that produces clouds from water vapor.

13. On the map *in your answer booklet,* draw *one* arrow to show the path that air travels to produce heavy lake-effect snowfall in Oswego, New York.

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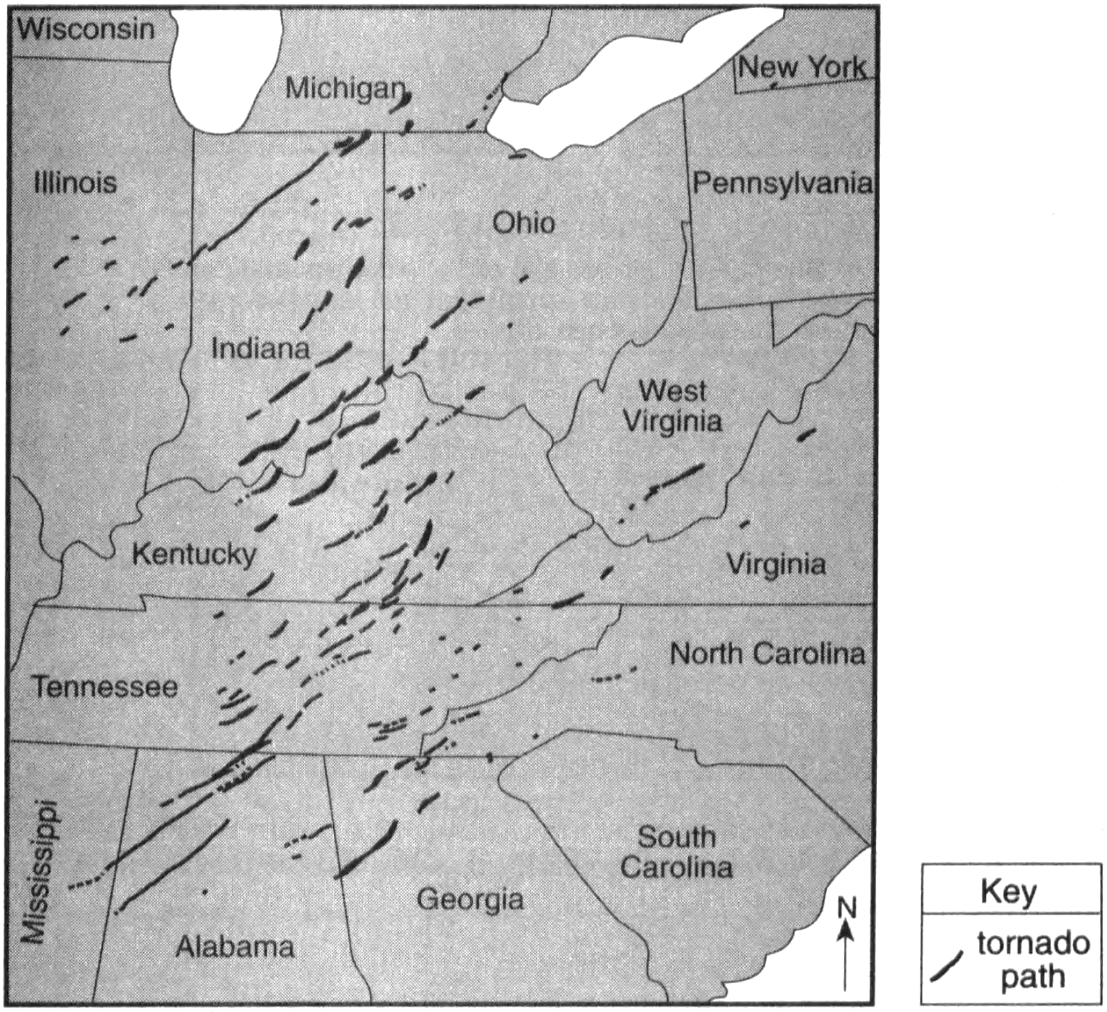
Base your answers to questions **14** through **17** on the map below, which shows a portion of the United States where 148 tornadoes occurred during a 24-hour period in April 1974. The paths of the tornadoes are shown.



14. Explain why all the tornadoes moved toward the northeast.

15. Describe the air movement most likely found within these tornadoes.

16. A school receives a tornado warning. Describe one emergency action that a teacher and the students in a classroom should immediately take to protect themselves from injury.

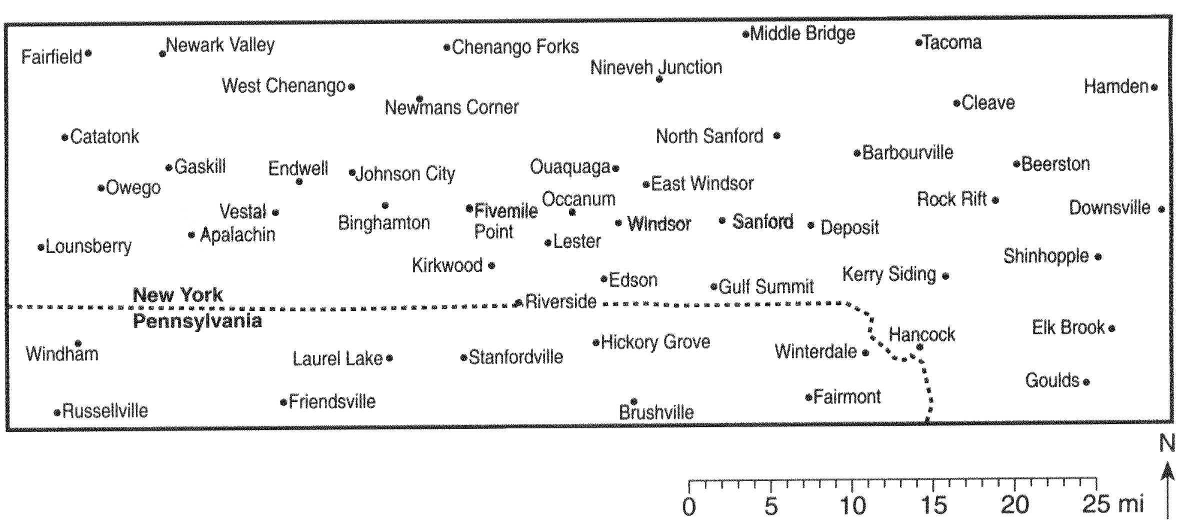
17. Most of these tornadoes occurred with thunderstorms along cold fronts. Identify the water cycle process that forms clouds along cold fronts.

Base your answers to questions **18** through **22** on the passage below. The passage describes a tornado produced from a thunderstorm that moved through a portion of New York State on May 31, 1998.

New York Tornado

A small tornado formed and moved through the town of Apalachin, New York, at 5:30 p.m., producing winds between 40 and 72 miles per hour. The tops of trees were snapped off, and many large limbs fell to the ground. The path of the destruction measured up to 200 feet wide. At 5:45 p.m., the tornado next moved through the town of Vestal where winds ranged between 73 and 112 miles per hour. Many people experienced personal property damage as many homes were hit with flying material. At 6:10 p.m., the tornado moved close to Binghamton, producing winds between 113 and 157 miles per hour. A 1000-foot television tower was pushed over, and many heavy objects were tossed about by the strong winds. Then the tornado lifted off the ground for short periods of time and bounced along toward the town of Windsor. At 6:15 p.m., light damage was done to trees as limbs fell and small shallow-rooted trees were pushed over in Windsor. The tornado increased in strength again at 6:20 p.m. as it moved into Sanford. Some homes were damaged as their roof shingles and siding were ripped off. One mobile home was turned over on its side. The tornado moved through the town of Deposit at 6:30 p.m., creating a path of destruction 200 yards wide. The tornado skipped along hilltops, touching down occasionally on the valley floors. However, much damage was done to homes as the tornado's winds reached their maximum speeds of 158 to 206 miles per hour. The tornado weakened and sporadically touched down after leaving Deposit. By 7:00 p.m., the tornado had finally ended its $1\frac{1}{2}$-hour rampage.

18. On the map, draw the path of the tornado and the direction the tornado moved, by following the directions below.
    - Place an **X** through the point for each of the six towns mentioned in the passage.
    - Connect the **X**s with a line in the order that each town was mentioned in the passage.
    - Place an arrow at one end of your line to show the direction of the tornado's movement.



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19. The tornado mentioned in this passage was produced by cold, dry air from Canada quickly advancing into warm, moist air already in place over the northeastern United States. List the two-letter air-mass symbols that would identify each of the two air masses responsible for producing this tornado.

20. Which type of front was located at the boundary between the advancing cold, dry air mass and the warm, moist air mass?

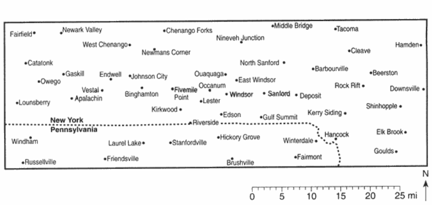
21. Using the Fujita Scale shown below and the information in the passage, complete the table by assigning an F-Scale number for the tornado as it passed through each town given in the table.

Fujita Scale

F-Scale Number	Wind Speed (mph)	Type of Damage Done
F–0	40–72	some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages sign boards
F–1	73–112	peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed
F–2	113–157	considerable damage; roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated
F–3	158–206	roof and some walls torn off well-constructed homes; trains overturned; most trees in forest uprooted
F–4	207–260	well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated
F–5	261–318	strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile-sized missiles fly through the air in excess of 100 meters; trees debarked; steel-reinforced concrete structures badly damaged

Town	F-Scale Number
Vestal	
Windsor	
Sanford	
Deposit	

22. Calculate the tornado's average rate of travel, in miles per minute, between Vestal and Windsor, by using the map and equation below. Express your answer to the nearest tenth.



$$\text{tornado's rate of travel} = \frac{\text{distance between Vestal and Windsor (miles)}}{\text{time (minutes)}}$$

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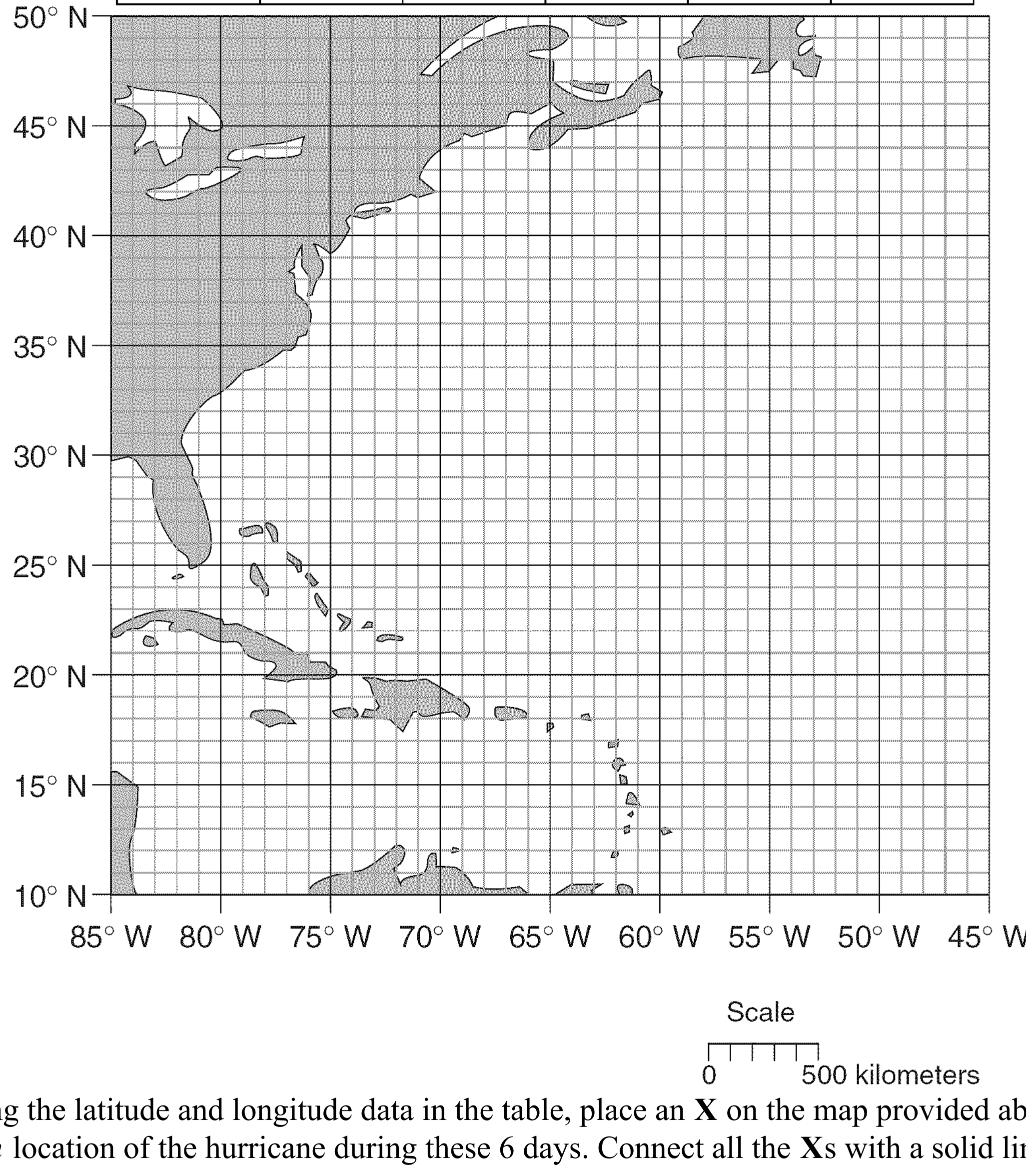
Base your answers to questions **23** through **26** on the data table, which shows recorded information for a major Atlantic hurricane and the map below.

Hurricane Data

Date	Time	Latitude	Longitude	Maximum Winds (knots)	Air Pressure (mb)
Sept. 10	11:00 a.m.	19° N	59° W	70	989
Sept. 11	11:00 a.m.	22° N	62° W	95	962
Sept. 12	11:00 a.m.	23° N	67° W	105	955
Sept. 13	11:00 a.m.	24° N	72° W	135	921
Sept. 14	11:00 a.m.	26° N	77° W	125	932
Sept. 15	11:00 a.m.	30° N	79° W	110	943



23. Using the latitude and longitude data in the table, place an **X** on the map provided above for *each* location of the hurricane during these 6 days. Connect all the **X**s with a solid line.

24. Label the September 15 (9/15) position of the hurricane on the map. Starting from this plotted position on September 15, draw a dashed line on the map provided above to indicate the storm's most likely path for the next 5 days.

25. Identify the weather instrument used to measure the air pressure associated with this hurricane.

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26. Describe the relationship between air pressure and wind speed associated with this hurricane.

Base your answers to questions **27** through **29** on data tables I and II and on the Hurricane Tracking Map below. Table I represents the storm track data for an Atlantic hurricane. Location, wind velocity, air pressure, and storm strength are shown for the storm's center at 3 p.m. Greenwich time each day. Table II shows a scale of relative storm strength. The map shows the hurricane's path.

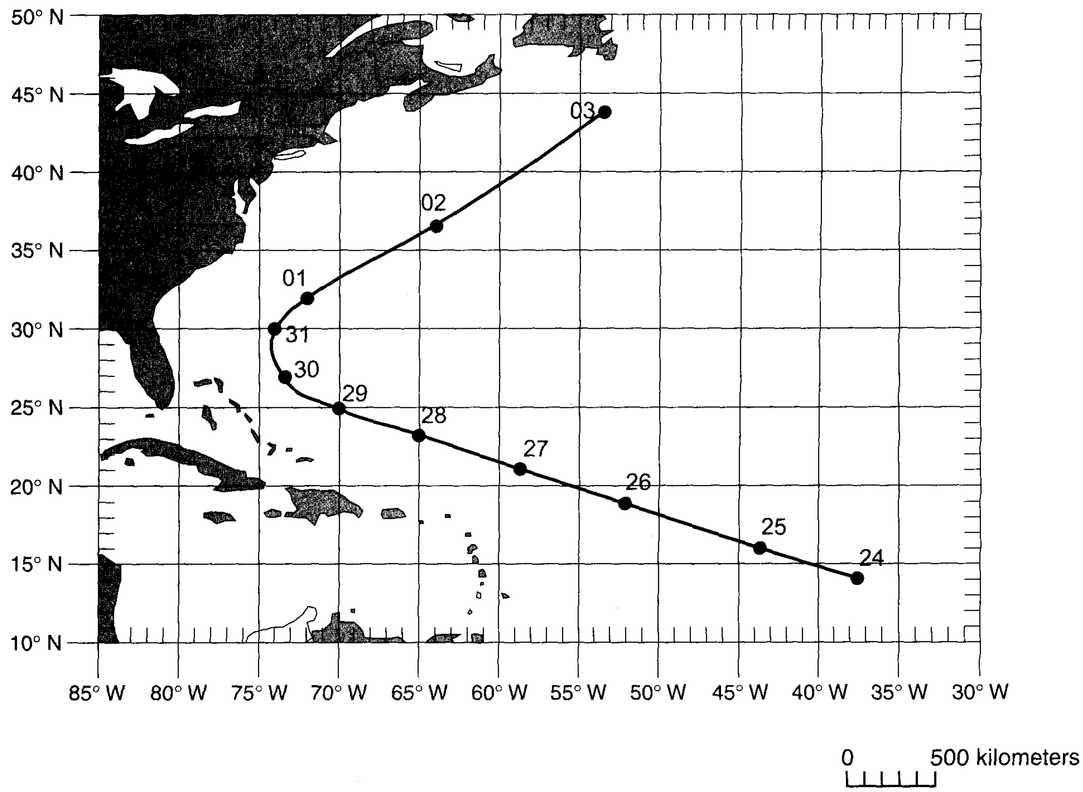
Data Table I

Latitude (°N)	Longitude (°W)	Date	Wind Velocity (knots)	Air Pressure (millibars)	Storm Strength
14	37	Aug. 24	30	1006	Tropical depression
16	44	Aug. 25	70	987	Category-1 hurricane
19	52	Aug. 26	90	970	Category-2 hurricane
21	59	Aug. 27	80	997	Category-1 hurricane
23	65	Aug. 28	80	988	Category-1 hurricane
25	70	Aug. 29	80	988	Category-1 hurricane
27	73	Aug. 30	65	988	Category-1 hurricane
30	74	Aug. 31	85	976	Category-2 hurricane
32	72	Sept. 01	85	968	Category-2 hurricane
37	64	Sept. 02	70	975	Category-1 hurricane
44	53	Sept. 03	65	955	Category-1 hurricane

Data Table II

Storm Strength Scale	Relative Strength
Tropical depression Tropical storm Category 1 Category 2 Category 3 Category 4 Category 5	Weakest ↓ Strongest

Hurricane Tracking Map



27. Describe *two* characteristics of the circulation pattern of the surface winds around the center (eye) of a Northern Hemisphere low-pressure hurricane.

28. The hurricane did not continue moving toward the same compass direction during the entire period shown by the data table. Explain why the hurricane changed direction.

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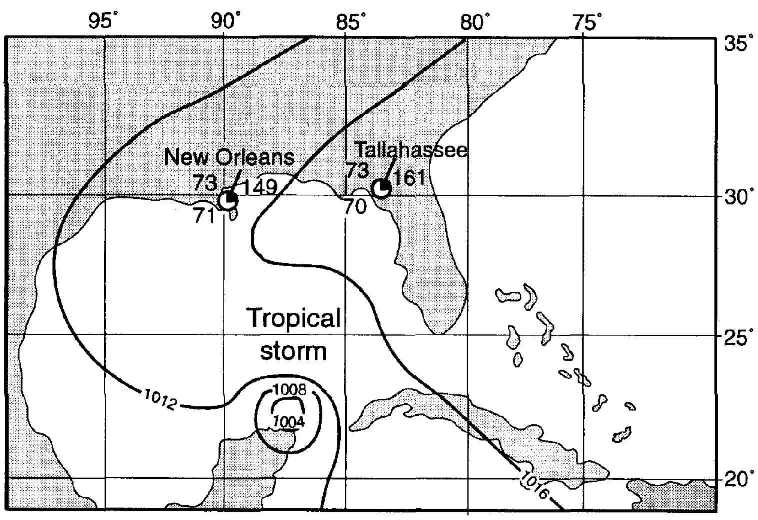
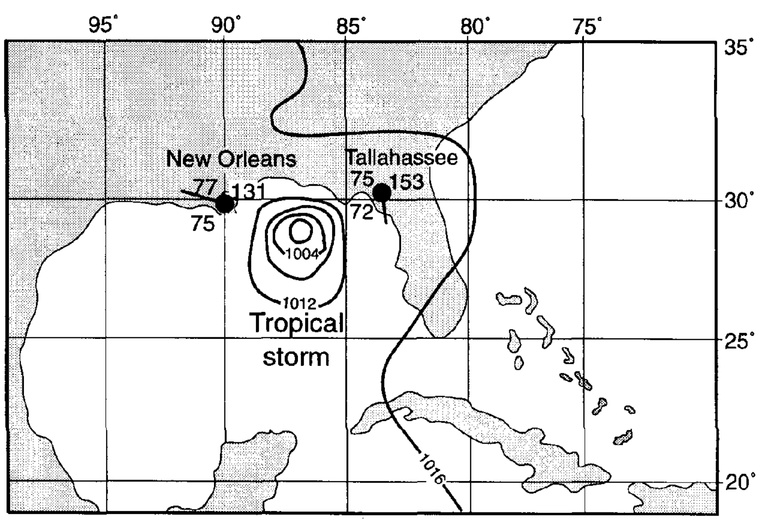
29. Calculate the average daily rate of movement of the hurricane during the period from 3 p.m. August 24 to 3 p.m. August 28. The hurricane traveled 2,600 kilometers during this 4-day period. Follow the directions given below.
    a Write the equation used to determine the rate of change.
    b Substitute data into the equation.
    c Calculate the rate and label it with the proper units.

Base your answers to questions **30** through **32** on the weather maps below. The weather maps show the positions of a tropical storm at 10 a.m. on July 2 and on July 3.

July 2



July 3



30. State the dewpoint temperature in Tallahassee on July 2.

31. Windspeed has been omitted from the station models. In one or more sentences, state how an increase in the storm's windspeed from July 2 to July 3 could be inferred from the maps.

32. The storm formed over warm tropical water. State what will most likely happen to the windspeed when the storm moves over land.