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Chapter: Weather

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1

Weather Factors

- **Weather** refers to the state of the atmosphere at a specific time and place. 
- Weather describes conditions such as air pressure, wind, temperature, and the amount of moisture in the air.
- The Sun provides almost all of Earth's energy.
- Energy from the Sun evaporates water into the atmosphere where it forms clouds.
- Eventually, the water falls back to Earth as rain or snow.



1

Weather Factors

- The Sun is also a source of heat energy.
- Heat from the Sun is absorbed by Earth's surface, which then heats the air above it.
- Differences in Earth's surface lead to uneven heating of Earth's atmosphere.
- Heat is eventually redistributed by air and water currents.



1

Air Temperatures

- Air is made up of molecules that are always moving randomly, even when there's no wind.
- Temperature is a measure of the average amount of motion of molecules.
- When the temperature is high, molecules in air move rapidly and it feels warm.
- When the temperature is low, molecules in air move less rapidly, and it feels cold.



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Wind

- Air moving in a specific direction is called wind.
- As the Sun warms the air, the air expands and becomes less dense.
- Warm, expanding air has low atmospheric pressure.

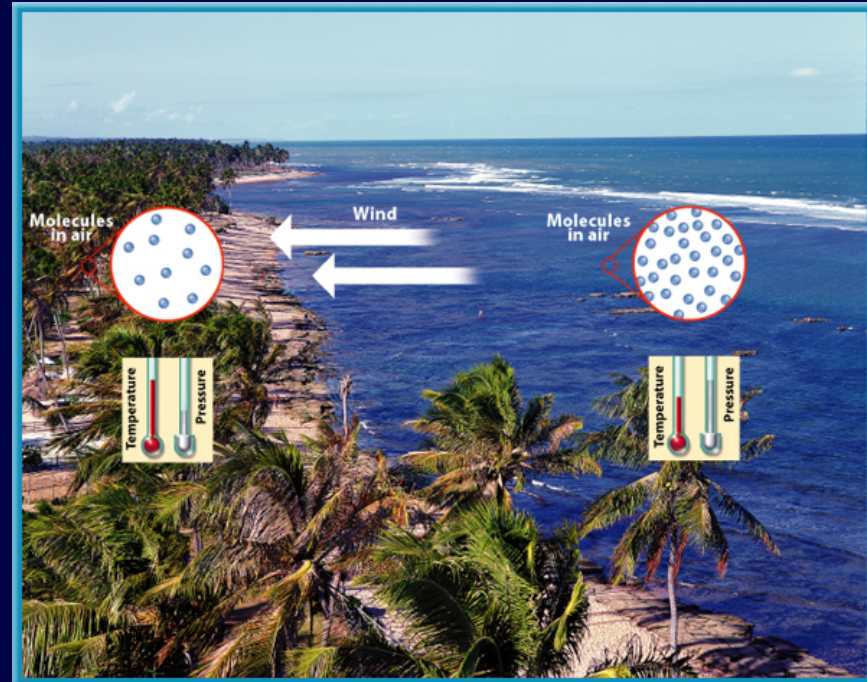


What is weather?

1

Wind

- Cooler air is denser and tends to sink, bringing about high atmospheric pressure.
- Wind results because air moves from regions of high pressure to regions of low pressure.



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1

Wind

- Wind direction can be measured using a wind vane which has an arrow that points in the direction from which the wind is blowing.
- Wind speed can be measured using an anemometer (a nuh MAH muh tur).
Anemometers have rotating cups that spin faster when the wind is strong.



Humidity

- Heat evaporates water into the atmosphere.
- Water vapor molecules fit into spaces among the molecules that make up air.
- The amount of water vapor present in the air is called **humidity**. 

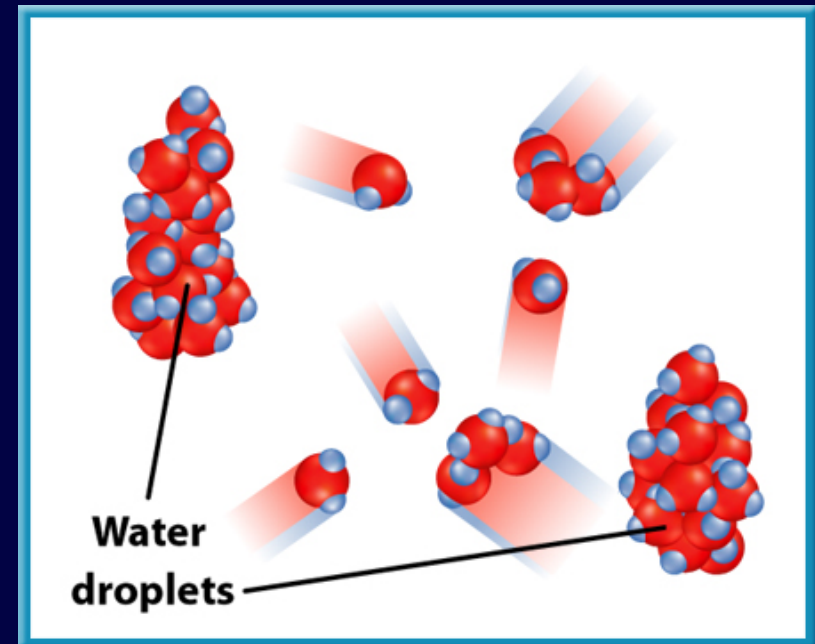


What is weather?

1

Humidity

- Air doesn't always contain the same amount of water vapor.
- More water vapor can be present when the air is warm than when it is cool.
- At warmer temperatures, the molecules of water vapor in air move quickly and don't easily come together.



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END


1

Humidity

- At cooler temperatures, molecules in air move more slowly.
- The slower movement allows water vapor molecules to stick together and form droplets of liquid water.
- The formation of liquid water from water vapor is called condensation.
- When enough water vapor is present in air for condensation to take place, the air is saturated.



Relative Humidity

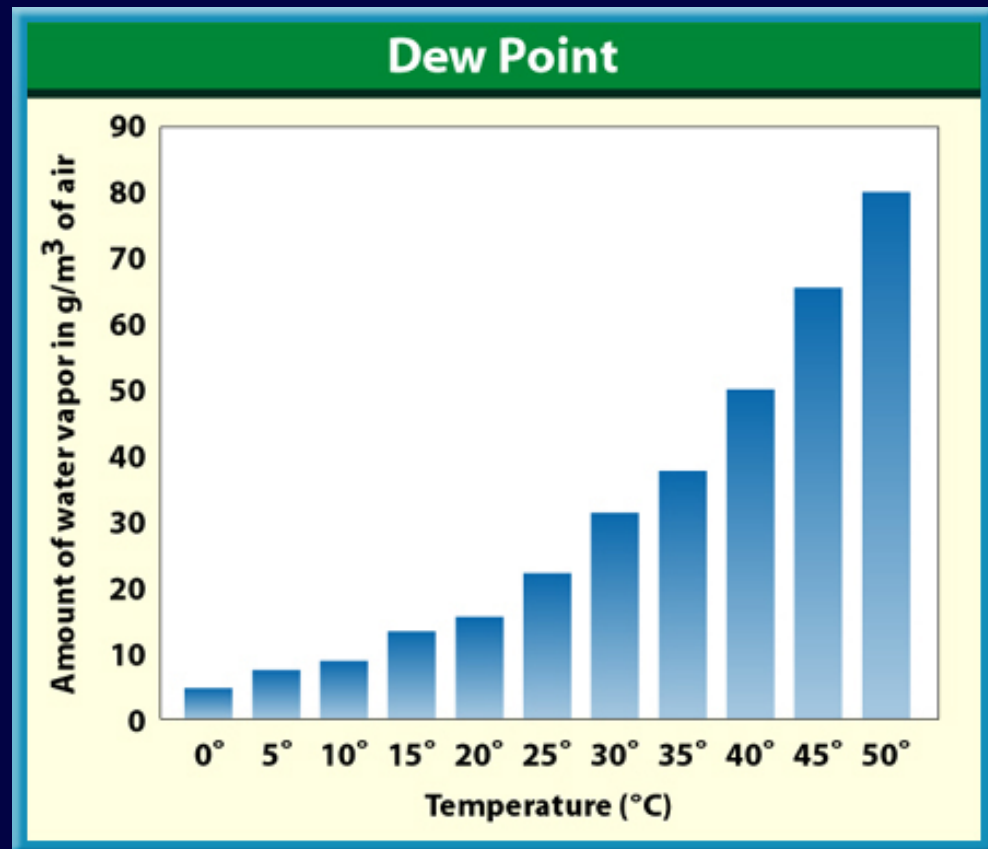
- **Relative humidity** is a measure of the amount of water vapor present in the air compared to the amount needed for saturation at a specific temperature. 
- If you hear a weather forecaster say that the relative humidity is 50 percent, it means that the air contains 50 percent of the water needed for the air to be saturated.



1

Relative Humidity

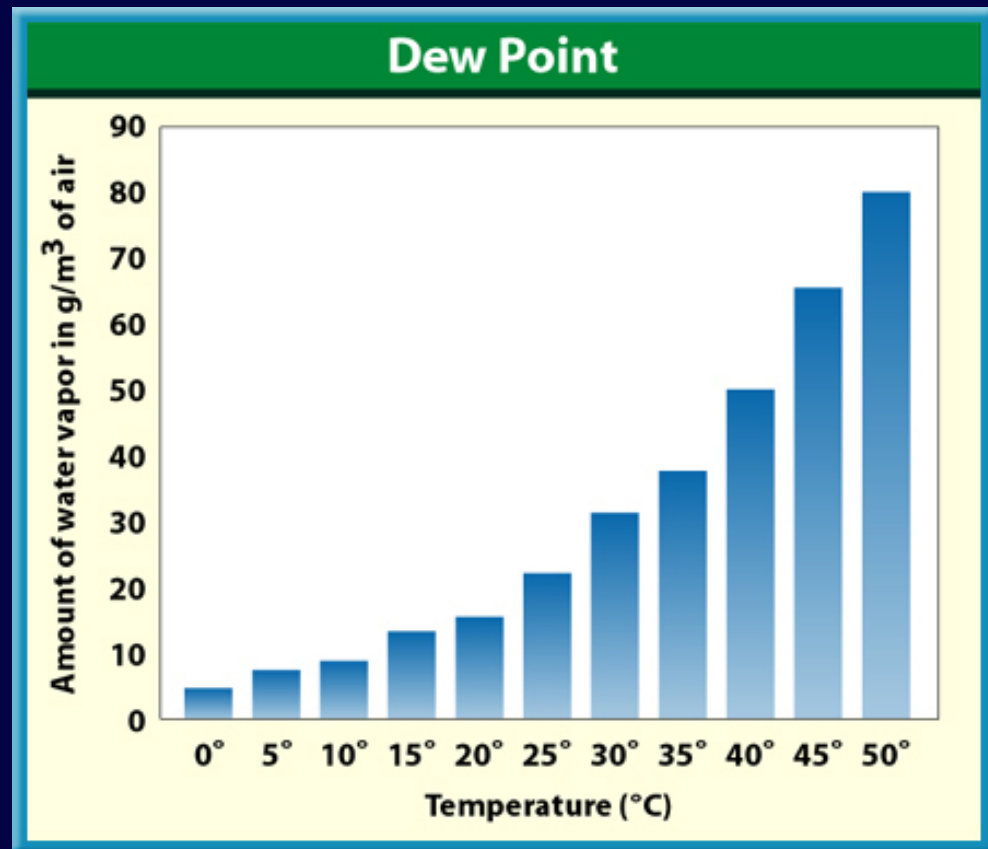
- Air at 25°C is saturated when it contains 22 g of water vapor per cubic meter of air.
- The relative humidity is 100 percent.




1

Relative Humidity

- If air at 25°C contains 11 g of water vapor per cubic meter, the relative humidity is 50 percent.



Dew Point

- When the temperature drops, less water vapor can be present in air.
- The water vapor in air will condense to a liquid or form ice crystals.
- The temperature at which air is saturated and condensation forms is the dew point.
- The **dew point** changes with the amount of water vapor in the air. 



1

Dew Point

- When air near the ground cools to its dew point, water vapor condenses and forms dew.
- Frost may form when temperatures are near 0°C.

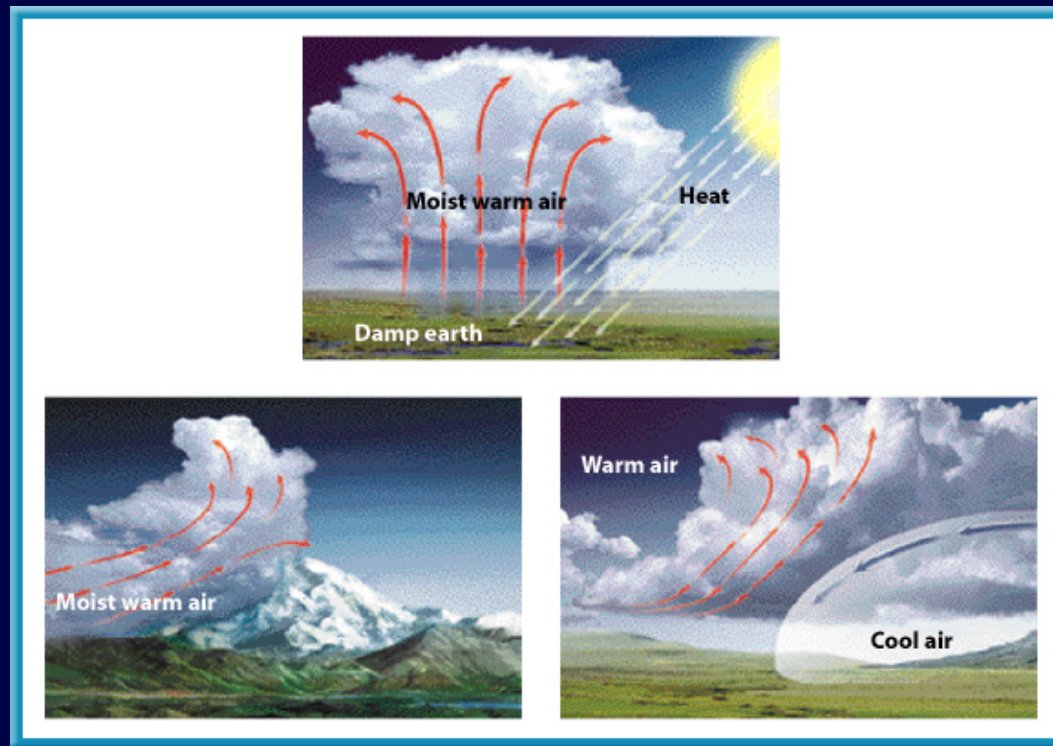


What is weather?

1

Forming Clouds

- Clouds form as warm air is forced upward, expands, and cools.



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END

1

Forming Clouds

- As the air cools, the amount of water vapor needed for saturation decreases and the relative humidity increases.
- When the relative humidity reaches 100 percent, the air is saturated.
- Water vapor soon begins to condense in tiny droplets around small particles such as dust and salt.
- Billions of these droplets form a cloud.



1

Classifying Clouds

- Clouds are classified mainly by shape and height.
- Some clouds extend high into the sky, and others are low and flat.
- Some dense clouds bring rain or snow, while thin, wispy clouds appear on mostly sunny days.
- The shape and height of clouds vary with temperature, pressure, and the amount of water vapor in the atmosphere.



1

Shape

- The three main cloud types are stratus, cumulus, and cirrus.
- Stratus clouds form layers, or smooth, even sheets in the sky.



1

Shape

- When air is cooled to its dew point near the ground, it forms a stratus cloud called **fog**. 
- Stratus clouds usually form at low altitudes and may be associated with fair weather or rain or snow.



1

Shape

- Cumulus (KYEW myuh lus) clouds are masses of puffy, white clouds, often with flat bases.
- They sometimes tower to great heights and can be associated with fair weather or thunderstorms.



1

Shape

- Cirrus (SIHR us) clouds appear fibrous or curly.
- They are high, thin, white, feathery clouds made of ice crystals.
- Cirrus clouds are associated with fair weather, but they can indicate approaching storms.



1

Height

- Some prefixes of cloud names describe the height of the cloud base.
- The prefix *cirro-* describes high clouds, *alto-* describes middle-elevation clouds, and *strato-* refers to clouds at low elevations.
- Some clouds' names combine the altitude prefix with the term *stratus* or *cumulus*.



1

Height

- Cirrostratus clouds are high clouds.
- Usually, cirrostratus clouds indicate fair weather, but they also can signal an approaching storm.
- Altostratus clouds form at middle levels.
- If the clouds are not too thick, sunlight can filter through them.



1

Rain- or Snow-Producing Clouds

- Clouds associated with rain or snow often have the word nimbus attached to them.
- The term *nimbus* is Latin for “dark rain cloud.”
- The water content of these clouds is so high that little sunlight can pass through them.




Rain- or Snow-Producing Clouds

- When a cumulus cloud grows into a thunderstorm, it is called a cumulonimbus (kyew myuh loh NIHM bus) cloud.
- These clouds can tower to nearly 18 km.
- Nimbostratus clouds are layered clouds that can bring long, steady rain or snowfall.



1

Precipitation

- Water falling from clouds is called **precipitation**. 
- Precipitation occurs when cloud droplets combine and grow large enough to fall to Earth.
- The cloud droplets form around small particles, such as salt and dust.
- These particles are so small that a puff of smoke can contain millions of them.



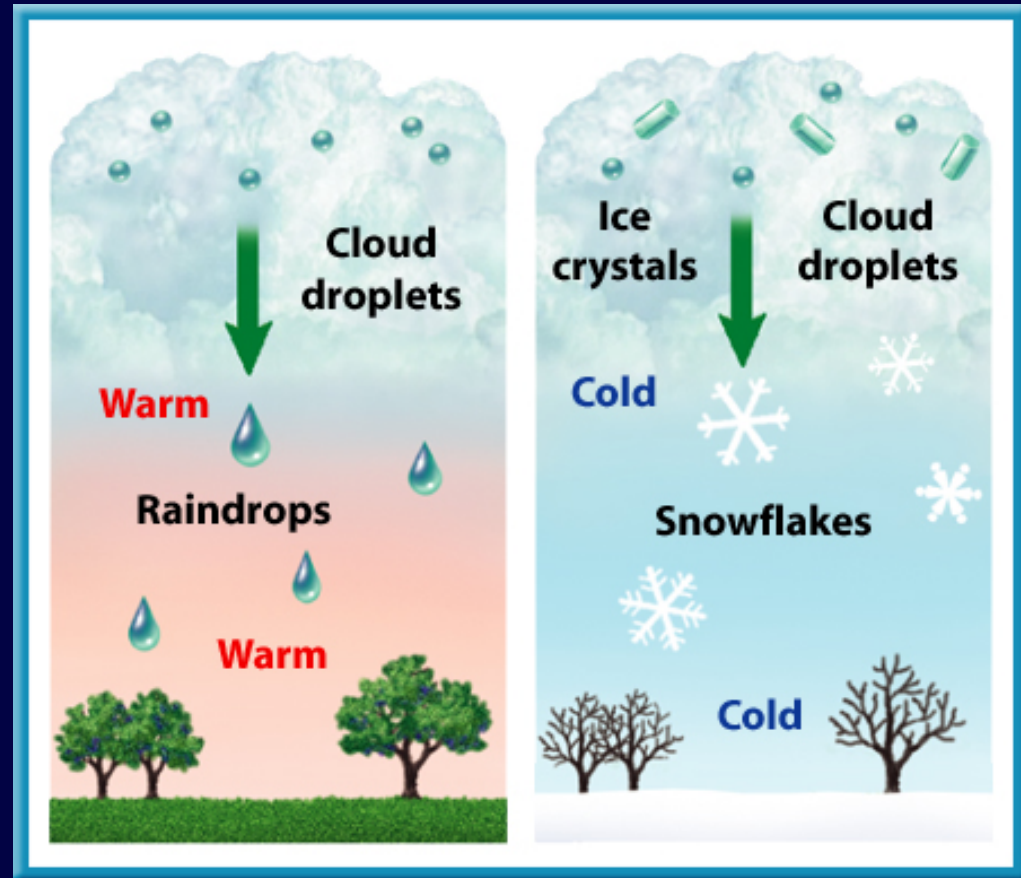
Precipitation

- The size of raindrops depends on several factors. One factor is the strength of updrafts in a cloud, which can keep drops suspended in the air where they can grow larger.
- The rate of evaporation as a drop falls to Earth also can affect its size.



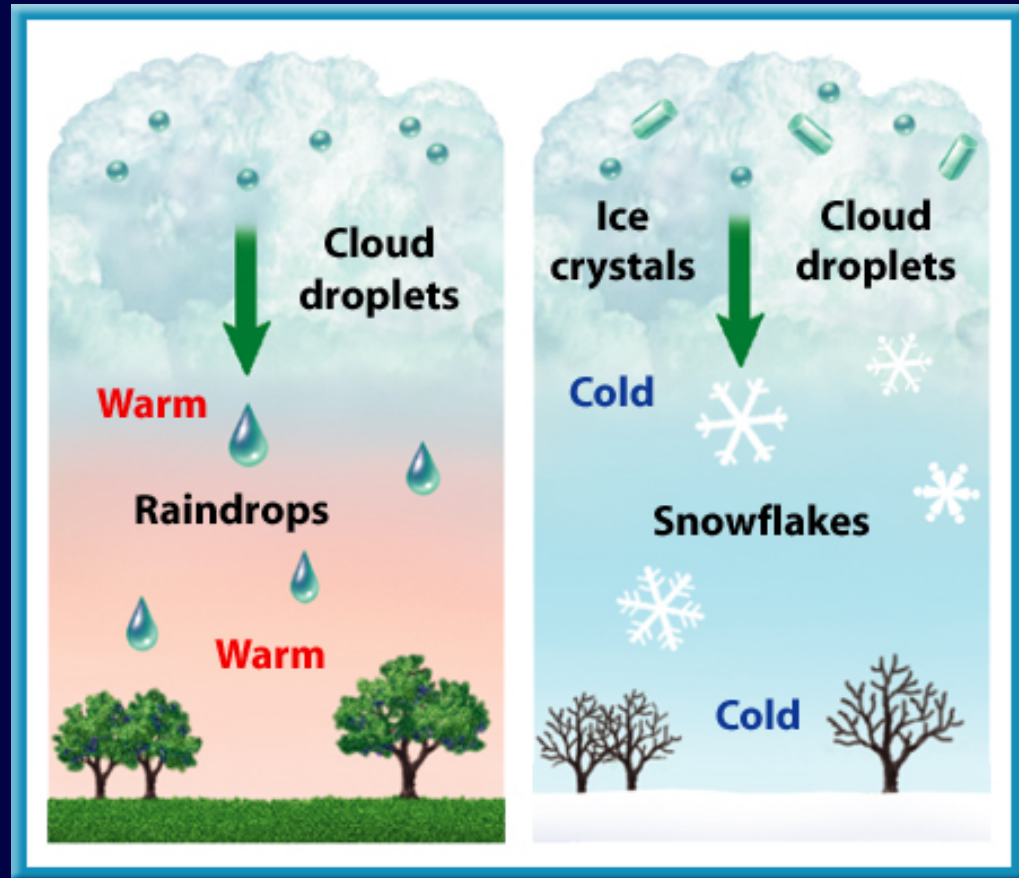
Precipitation

- Air temperature determines whether water forms rain, snow, sleet, or hail—the four main types of precipitation.



Precipitation

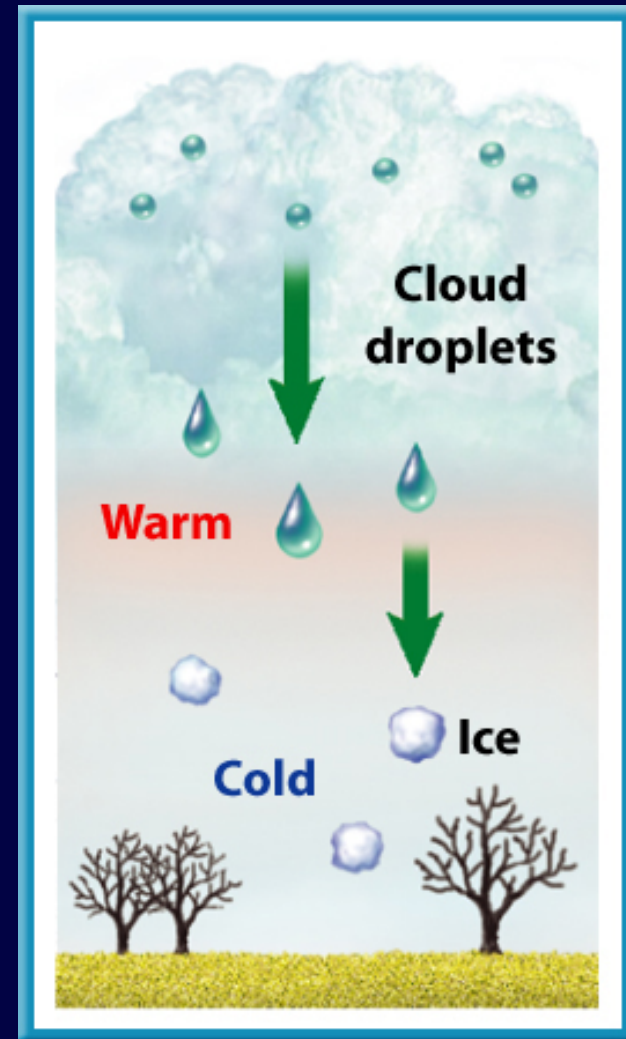
- Drops of water falling in temperatures above freezing fall as rain.
- Snow forms when the air temperature is freezing.



1

Precipitation

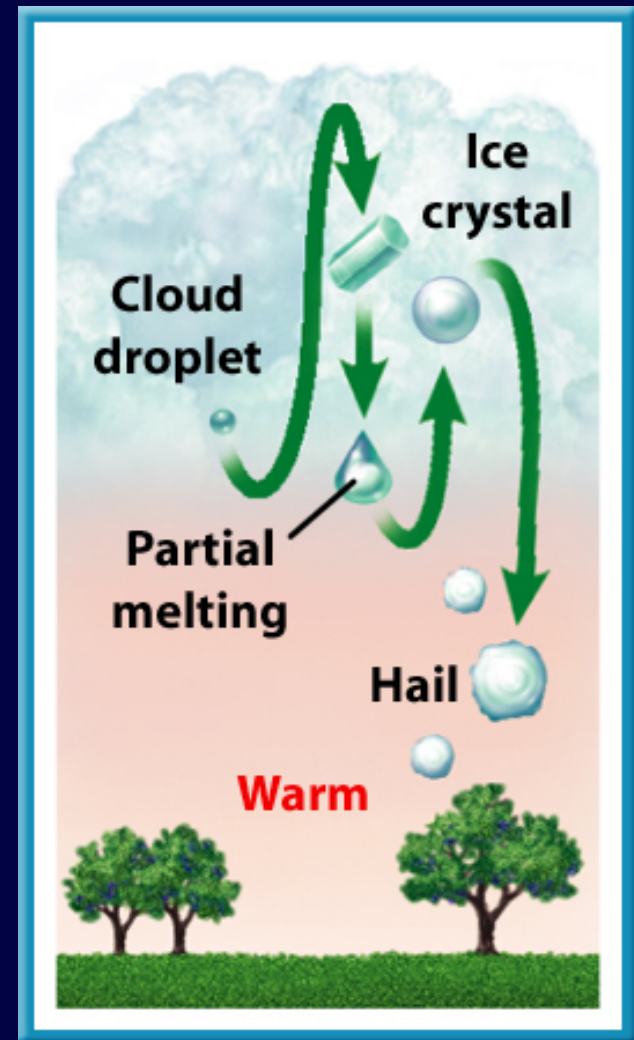
- Sleet forms when raindrops pass through a layer of freezing air near Earth's surface, forming ice pellets.



1

Hail

- Hail is precipitation in the form of lumps of ice.
- Hail forms in cumulonimbus clouds of a thunderstorm when water freezes in layers around a small nucleus of ice.



1

Question 1

The state of the atmosphere at a specific time and place is _____.

- A. climate
- B. meteorology
- C. season
- D. weather



Section Check

1

Answer

The answer is D. Climate is the weather pattern over many years.



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1

Question 2

The amount of water vapor present in the air is _____.

- A. dew
- B. condensation
- C. fog
- D. humidity



Section Check

1

Answer

The answer is D. Relative humidity compares the amount of water vapor in the air to the amount needed for saturation at a specific temperature.



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Section Check

1

Question 3

What is the dew point?



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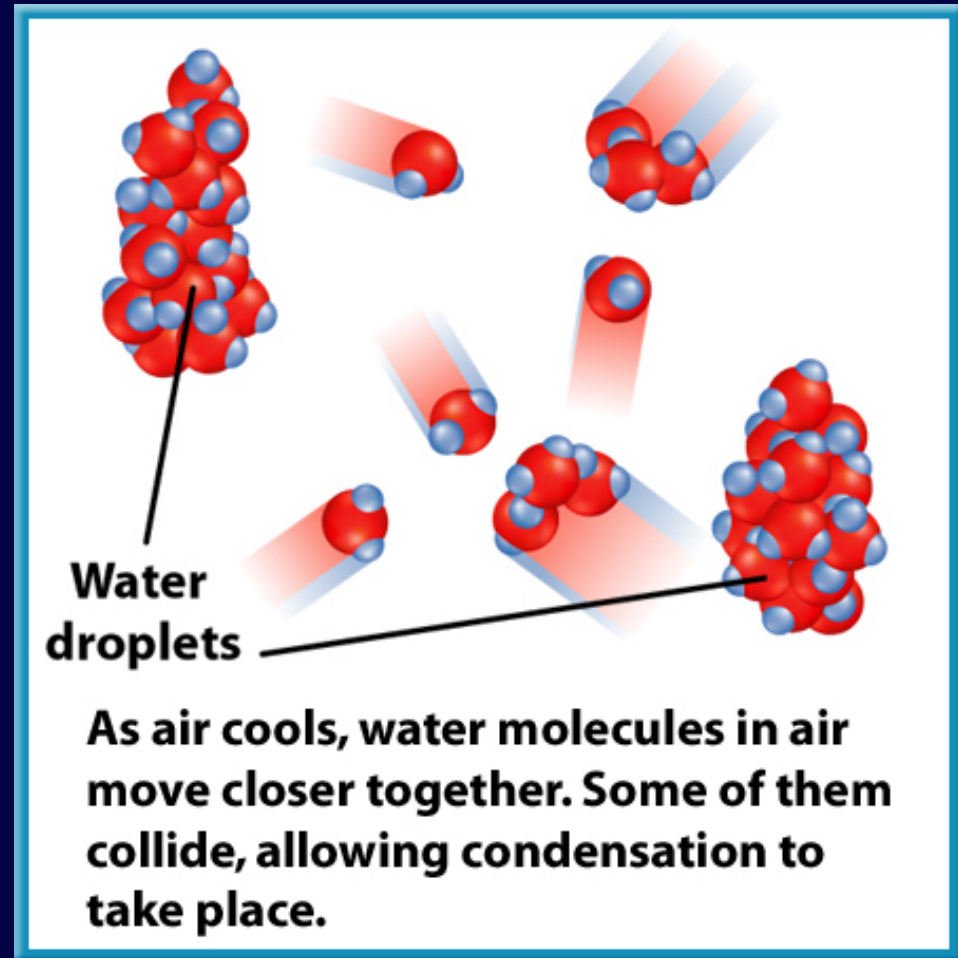


Section Check

1

Answer

The dew point is the temperature at which the air is saturated and condensation forms.




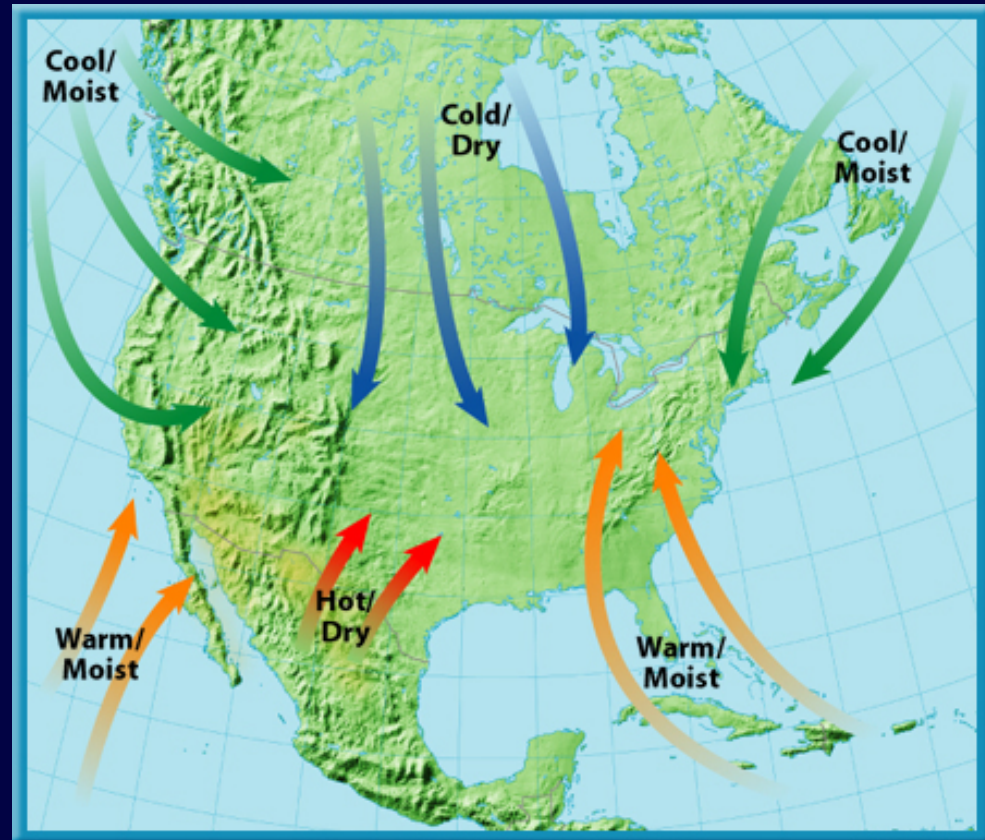
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2

Weather Changes—Air Masses

- An **air mass** is a large body of air that has properties similar to the part of Earth's surface over which it develops. 
- Six major air masses affect weather in the United States.



Weather Changes—Air Masses

- An air mass that develops over land is dry compared with one that develops over water.
- An air mass that develops in the tropics is warmer than one that develops over northern regions.
- An air mass can cover thousands of square kilometers.



2

Highs and Lows

- Weather has high- and low-pressure systems.
- Winds blow from areas of high pressure to areas of low pressure.
- As winds blow into a low-pressure area in the northern hemisphere, Earth's rotation causes these winds to swirl in a counter-clockwise direction.
- Large, swirling areas of low pressure are called cyclones and are associated with stormy weather.



2

Highs and Lows

- Winds blow away from a center of high pressure.
- Earth's rotation causes these winds to spiral clockwise in the northern hemisphere.
- High-pressure areas are associated with fair weather and are called anticyclones.
- Air pressure is measured using a barometer.



2


Highs and Lows

- Low pressure systems at Earth's surface are regions of rising air.
- Clouds form when air is lifted and cools.
- Areas of low pressure usually have cloudy weather.
- Sinking motion in high-pressure air masses makes it difficult for air to rise and clouds to form.
- That's why high pressure usually means good weather.



2

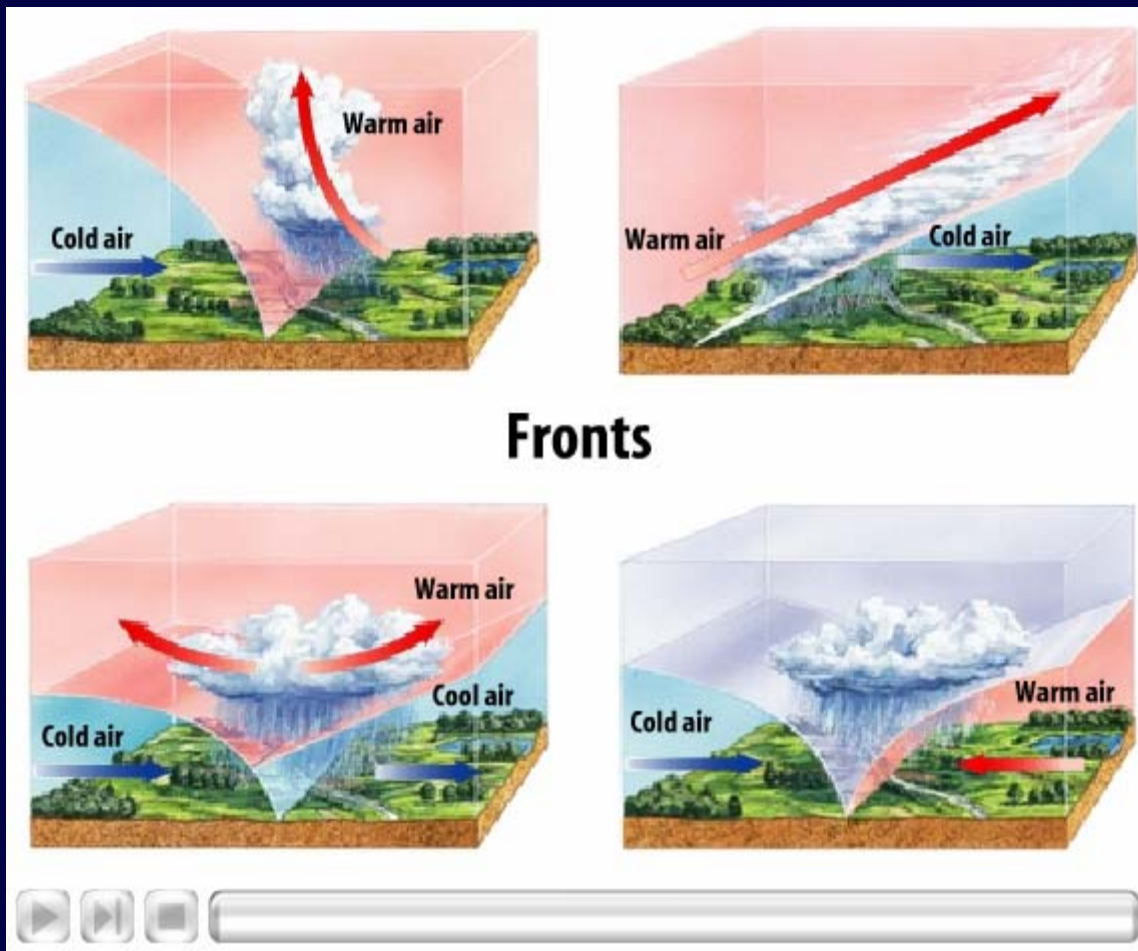
Fronts

- A boundary between two air masses of different density, moisture, or temperature is called a **front**. 
- Cloudiness, precipitation, and storms sometimes occur at frontal boundaries.
- Four types of fronts include cold, warm, occluded, and stationary.



Fronts

 MAC OS X
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2

Severe Weather—Thunderstorms

- Thunderstorms occur in warm, moist air masses and along fronts.
- Warm, moist air can be forced upward where it cools and condensation occurs, forming cumulonimbus clouds that can reach heights of 18 km.



Severe Weather—Thunderstorms

- When rising air cools, water vapor condenses into water droplets or ice crystals.
- Smaller droplets collide to form larger ones, and the droplets fall through the cloud toward Earth's surface. Raindrops cool the air around them.
- This cool, dense air then sinks and spreads over Earth's surface.



Severe Weather—Thunderstorms

- Sinking, rain-cooled air and strong updrafts of warmer air cause the strong winds associated with thunderstorms.
- Hail also may form as ice crystals alternately fall to warmer layers and are lifted into colder layers by the strong updrafts inside cumulonimbus clouds.



2

Thunderstorm Damage

- Sometimes thunderstorms can stall over a region, causing rain to fall heavily for a period of time.
- When streams cannot contain all the water running into them, flash flooding can occur.
- Flash floods can be dangerous because they occur with little warning.



2

Thunderstorm Damage

- Strong winds generated by thunderstorms also can cause damage.
- If a thunderstorm is accompanied by winds traveling faster than 89 km/h, it is classified as a severe thunderstorm.
- Hail from a thunderstorm can dent cars and the aluminum siding of houses.
- Although rain from thunderstorms helps crops grow, hail has been known to flatten and destroy entire crops in a matter of minutes.



2

Lightning and Thunder

- Inside a storm cloud, warm air is lifted rapidly as cooler air sinks. This movement of air can cause different parts of a cloud to become oppositely charged.



CHAPTER RESOURCES



2

Lightning and Thunder

- When current flows between regions of opposite electrical charge, lightning flashes.
- Lightning can occur within a cloud, between clouds, or between a cloud and the ground.



2


Lightning and Thunder

- Thunder results from the rapid heating of air around a bolt of lightning, which can reach temperatures of about $30,000^{\circ}\text{C}$.
- This extreme heat causes air around the lightning to expand rapidly. Then it cools quickly and contracts.
- The rapid movement of the molecules forms sound waves heard as thunder.



2

Tornadoes

- A **tornado** is a violently rotating column of air in contact with the ground. 
- In severe thunderstorms, wind at different heights blows in different directions and at different speeds.
- This difference in wind speed and direction, called wind shear, creates a rotating column parallel to the ground.



2

Tornadoes

- A thunderstorm's updraft can tilt the rotating column upward into the thunderstorm creating a funnel cloud.
- If the funnel comes into contact with Earth's surface, it is called a tornado.



2

Tornadoes

- A tornado's destructive winds can rip apart buildings and uproot trees.



2

Tornadoes

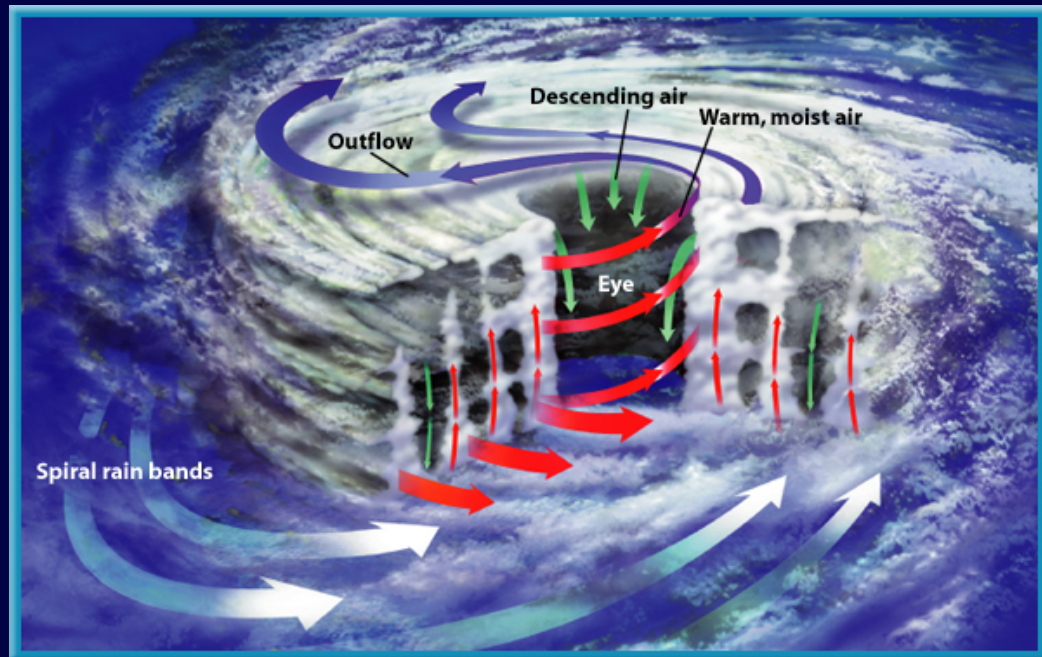
- The updraft in the center of a powerful tornado can lift animals, cars, and even houses into the air.
- Although tornadoes rarely exceed 200 m in diameter and usually last only a few minutes, they often are extremely destructive.



2

Hurricanes

- The most powerful storm is the hurricane.
- A **hurricane** is a large, swirling, low-pressure system that forms over the warm Atlantic Ocean. 📢



2

Hurricanes

- It is like a machine that turns heat energy from the ocean into wind.
- A storm must have winds of at least 119 km/h to be called a hurricane.
- Similar storms are called typhoons in the Pacific Ocean and cyclones in the Indian Ocean.



2

Hurricanes

- Hurricanes are similar to low-pressure systems on land, but they are much stronger.
- In the Atlantic and Pacific Oceans, low pressure sometimes develops near the equator.
- In the northern hemisphere, winds around this low pressure begin rotating counterclockwise.
- The strongest hurricanes affecting North America usually begin as a low-pressure system west of Africa.



2

Hurricanes

- Steered by surface winds, these storms can travel west, gaining strength from the heat and moisture of warm ocean water.
- When a hurricane strikes land, high winds, tornadoes, heavy rains, and high waves can cause a lot of damage.



2

Hurricanes

- Floods from the heavy rains can cause additional damage.



2


Hurricanes

- Hurricane weather can destroy crops, demolish buildings, and kill people and other animals.
- As long as a hurricane is over water, the warm, moist air rises and provides energy for the storm.
- When a hurricane reaches land, however, its supply of energy disappears and the storm loses power.



2

Blizzards

- The National Weather Service classifies a winter storm as a **blizzard** if: 
 - The winds are 56 km/h.
 - The temperature is low.
 - The visibility is less than 400 m in falling or blowing snow.
 - These conditions persist for three hours or more.



2

Severe Weather Safety

- When severe weather threatens, the National Weather Service issues a watch or warning.
- Watches are issued when conditions are favorable for severe thunderstorms, tornadoes, floods, blizzards, and hurricanes.
- When a warning is issued, severe weather conditions already exist.
- You should take immediate action.



2

Question 1

Water falling from clouds is _____.

- A. cloud cover
- B. dew
- C. fog
- D. precipitation



2

Answer

The answer is D. Precipitation can be rain, snow, sleet or hail.



CHAPTER RESOURCES



2

Question 2

A large body of air that has properties similar to the part of Earth's surface over which it develops is a(n) _____.

- A. air mass
- B. cloud
- C. fog
- D. front

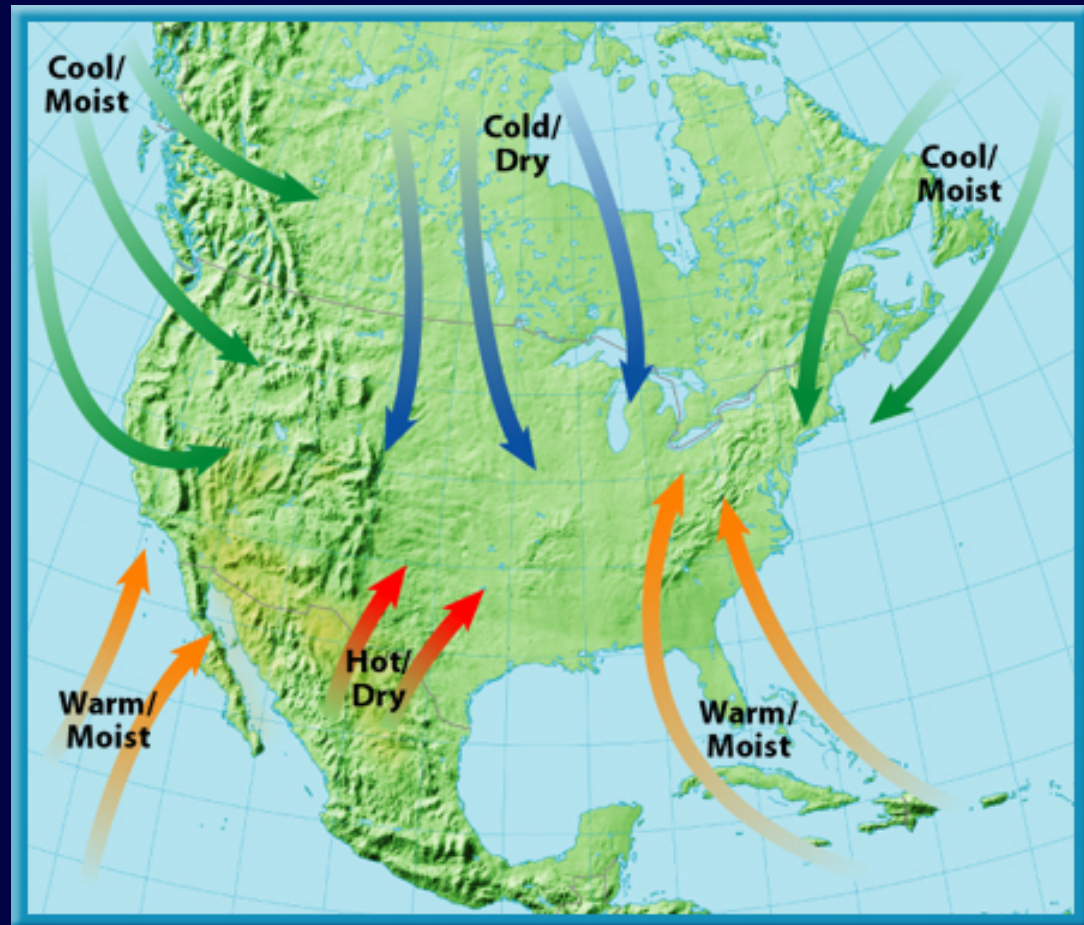


Section Check

2

Answer

The answer is A.
An air mass can cover thousands of square kilometers.



CHAPTER RESOURCES



2

Question 3


What is the boundary between two air masses of different density, moisture, or temperature called?

Answer

This boundary is called a front, and can be classified as a cold, warm, occluded or stationary.



Weather Observations

- A **meteorologist** (mee tee uh RAH luh jist) is a person who studies the weather. 
- Meteorologists take measurements of temperature, air pressure, winds, humidity, and precipitation.
- Computers, weather satellites, Doppler radar, and instruments attached to balloons are used to gather data.



3

Weather Observations

- Meteorologists use the information provided by weather instruments to make weather maps.
- These maps are used to make weather forecasts.



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3

Forecasting Weather

- Meteorologists gather information about current weather and use computers to make predictions about future weather patterns.
- Because storms can be dangerous, you do not want to be unprepared for threatening weather.
- However, meteorologists cannot always predict the weather exactly because conditions can change rapidly.




3

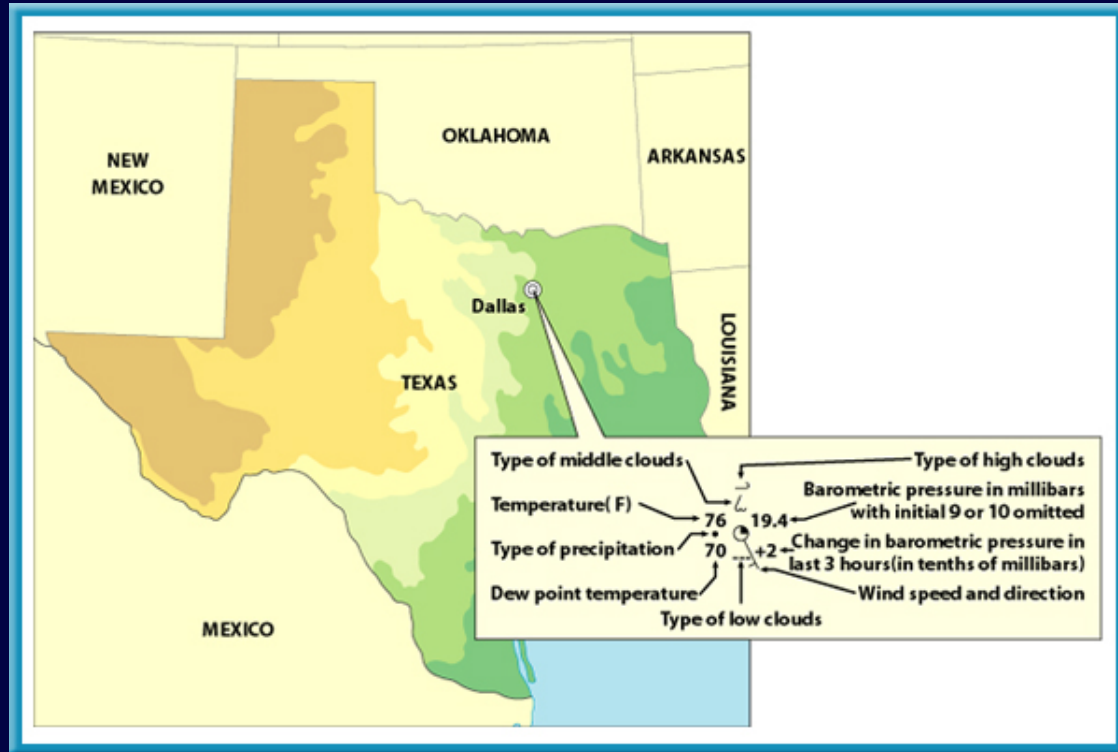
Forecasting Weather

- The National Weather Service depends on two sources for its information—data collected from the upper atmosphere and data collected on Earth's surface.
- Meteorologists of the National Weather Service collect information recorded by satellites, instruments attached to weather balloons, and from radar.
- This information is used to describe weather conditions in the atmosphere above Earth's surface.



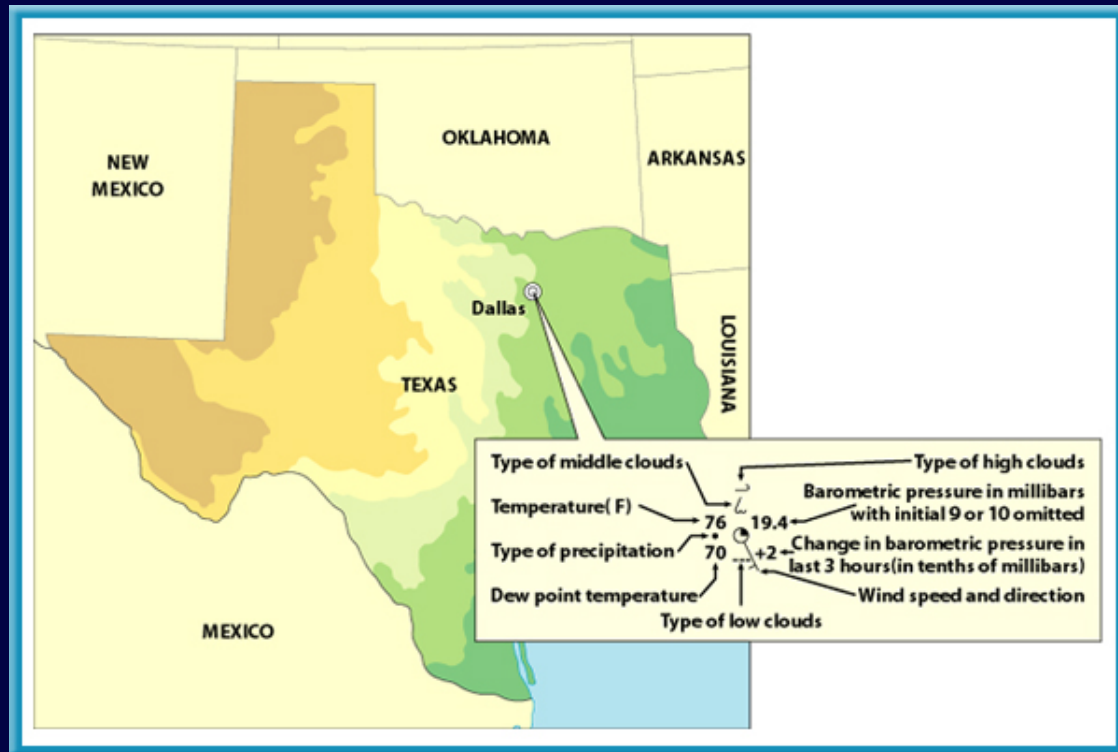
Station Models

- When meteorologists gather data from Earth's surface, it is recorded on a map using a combination of symbols, forming a **station model**. 




Station Models

- A station model shows the weather conditions at a specific location on Earth's surface.




Temperature and Pressure

- Weather maps have lines called **isotherms** (I suh thurmz) that connect locations of equal temperature or pressure. 
- *Iso* means “same” and *therm* means “temperature.”



3

Temperature and Pressure

- An **isobar** is a line drawn to connect points of equal atmospheric pressure. 
- You can tell how fast wind is blowing in an area by noting how closely isobars are spaced.
- Isobars that are close together indicate a large pressure difference over a small area, which causes strong winds.
- Isobars that are spread apart indicate a smaller difference in pressure.



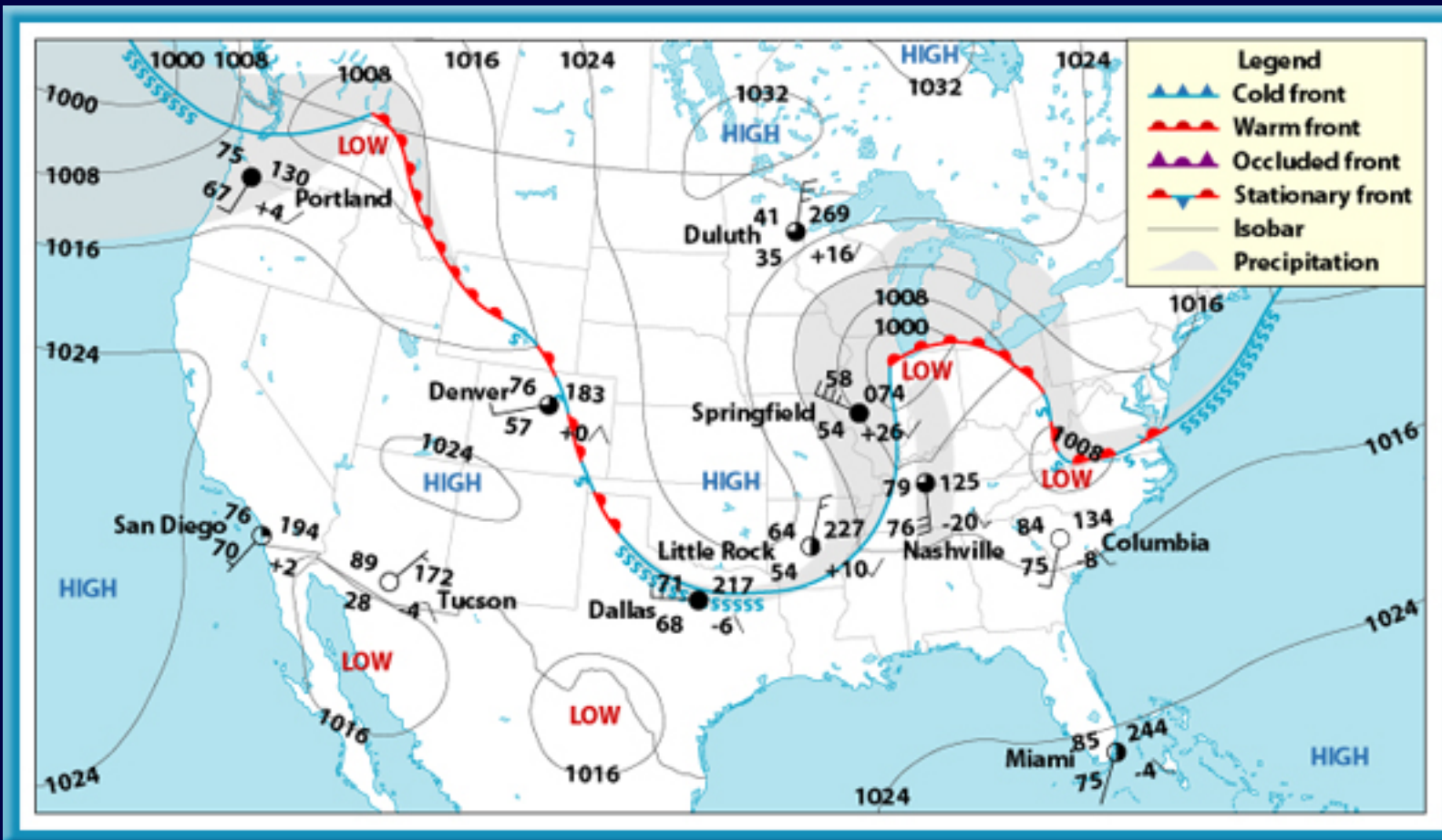
3

Weather Maps

- On a weather map, pressure areas are drawn as circles with the word High or Low in the middle of the circle.
- Fronts are drawn as lines and symbols.
- In general, weather fronts move from west to east.



Weather Maps



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3

Question 1

A(n) _____ shows the weather conditions at a specific location on Earth's surface.

- A. isobar
- B. isotherm
- C. station model
- D. weather map

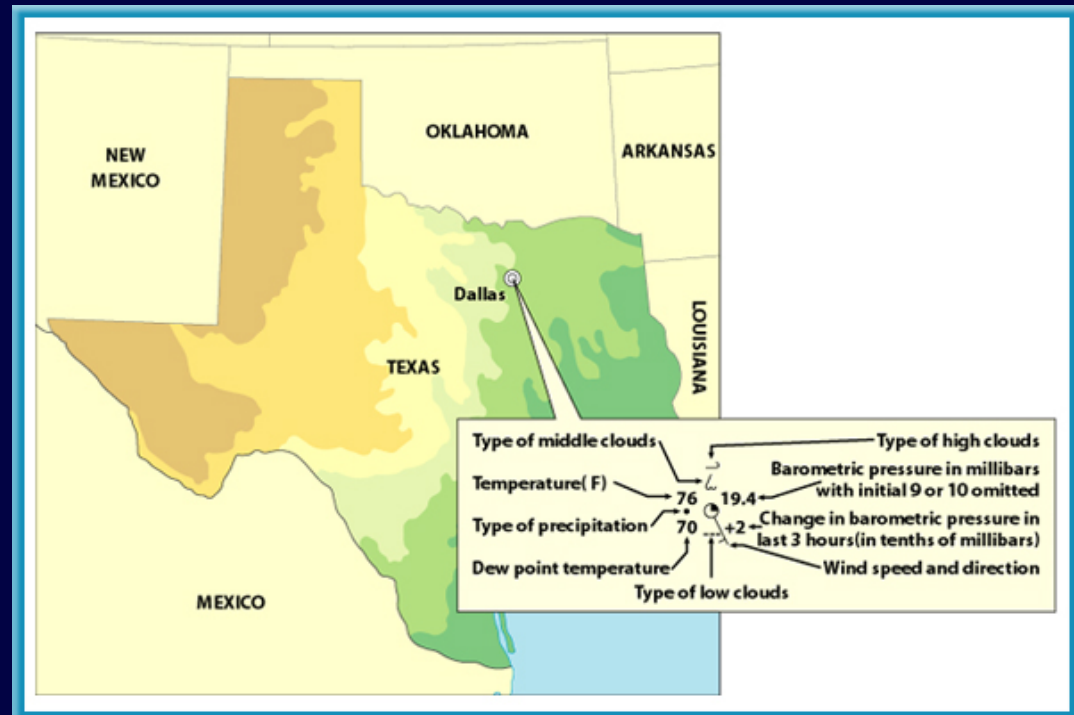


Section Check

3

Answer

The answer is C.
Meteorologist use
a combination of
symbols to form a
station model.



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3

Question 2

On a weather map, a line that connects points of equal temperature is called a(n) _____.

- A. berm
- B. front
- C. isobar
- D. isotherm



3

Answer

The answer is D. *Iso* means “same” and *therm* means “temperature”.



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3

Question 3

What is an isobar?

Answer

An isobar is a line drawn to connect points of equal atmospheric pressure on a weather map.



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