# Lesson 1

# Describing Weather

## Reading Guide

### Key Concepts

ESSENTIAL QUESTIONS

- What is weather?
- What variables are used to describe weather?
- How is weather related to the water cycle?

### Vocabulary

**weather** p. 451
**air pressure** p. 452
**humidity** p. 452
**relative humidity** p. 453
**dew point** p. 453
**precipitation** p. 455
**water cycle** p. 455

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## Inquiry Why are clouds different?

If you look closely at the photo, you'll see that there are different types of clouds in the sky. How do clouds form? If all clouds consist of water droplets and ice crystals, why do they look different? Are clouds weather?

## Launch Lab

15 minutes

### Can you make clouds in a bag?

When water vapor in the atmosphere cools, it condenses. The resulting water droplets make up clouds.

1. Read and complete a lab safety form.
2. Half-fill a **500-mL beaker** with **ice** and **cold water.**
3. Pour 125 mL of **warm water** into a **resealable plastic bag** and seal the bag.
4. Carefully lower the bag into the ice water. Record your observations in your Science Journal.

**Think About This**

1. What did you observe when the warm water in the bag was put into the beaker?
2. What explanation can you give for what happened?
3. **Key Concept** What could you see in the natural world that results from the same process?

## What is weather?

Everybody talks about the weather. "Nice day, isn't it?" "How was the weather during your vacation?" Talking about weather is so common that we even use weather terms to describe unrelated topics. "That homework assignment was a breeze." Or "I'll take a rain check."

**Weather** *is the atmospheric conditions, along with short-term changes, of a certain place at a certain time.* If you have ever been caught in a rainstorm on what began as a sunny day, you know the weather can change quickly. Sometimes it changes in just a few hours. But other times your area might have the same sunny weather for several days in a row.

## Weather Variables

Perhaps some of the first things that come to mind when you think about weather are temperature and rainfall. As you dress in the morning, you need to know what the temperature will be throughout the day to help you decide what to wear. If it is raining, you might cancel your picnic.

Temperature and rainfall are just two of the **variables** used to describe weather. Meteorologists, scientists who study and predict weather, use several specific variables that describe a variety of atmospheric conditions. These variables include air temperature, air pressure, wind speed and direction, humidity, cloud coverage, and precipitation.

**Key Concept Check** What is weather?

**REVIEW VOCABULARY**

variable
a quantity that can change

**REVIEW VOCABULARY**

kinetic energy
energy an object has due to its motion

## Air Temperature

The measure of the average kinetic energy of molecules in the air is air temperature. When the temperature is high, molecules have a high kinetic energy. Therefore, molecules in warm air move faster than molecules in cold air. Air temperatures vary with time of day, season, location, and altitude.

## Air Pressure

*The force that a column of air applies on the air or a surface below it is called* **air pressure.** Study **Figure 1.** Is air pressure at Earth's surface more or less than air pressure at the top of the atmosphere? Air pressure decreases as altitude increases. Therefore, air pressure is greater at low altitudes than at high altitudes.

You might have heard the term *barometric pressure* during a weather forecast. Barometric pressure refers to air pressure. Air pressure is measured with an instrument called a barometer, shown in **Figure 2.** Air pressure is typically measured in millibars (mb). Knowing the barometric pressure of different areas helps meteorologists predict the weather.

**Reading Check** What instrument measures air pressure?

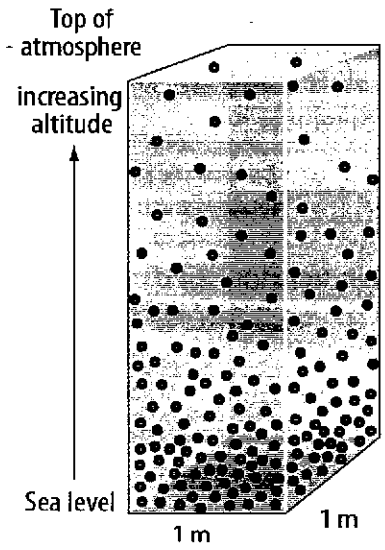



**Figure 1** Increasing air pressure comes from having more molecules overhead.

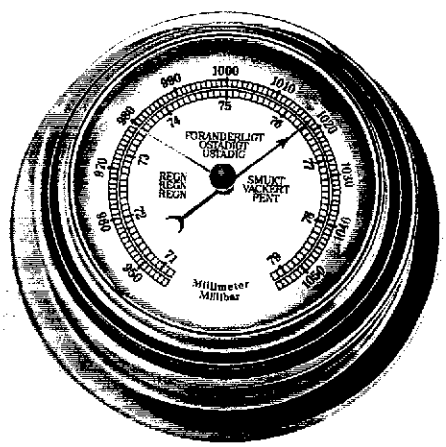
**Visual Check** What happens to air pressure as altitude decreases?

## Wind

As air moves from areas of high pressure to areas of low pressure, it creates wind. Wind direction is the direction from which the wind is blowing. For example, winds that blow from west to east are called westerlies. Meteorologists measure wind speed using an instrument called an anemometer (a nuh MAH muh tur). An anemometer is also shown in **Figure 2.**

## Humidity

*The amount of water vapor in the air is called* **humidity** (hyew MIH duh tee). Humidity can be measured in grams of water per cubic meter of air ($g/m^3$). When the humidity is high, there is more water vapor in the air. On a day with high humidity, your skin might feel sticky, and sweat might not evaporate from your skin as quickly.



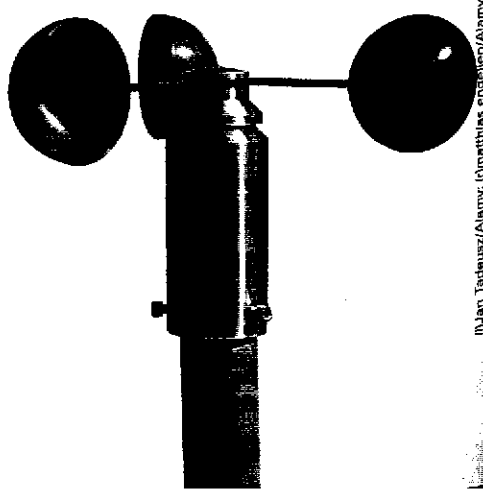


**Figure 2** Barometers, left, and anemometers, right, are used to measure weather variables.

(l)Jan Tadeusz/Alamy, (r)matthias engelen/Alamy

## Relative Humidity

Think about how a sponge can absorb water. At some point, it becomes full and cannot absorb any more water. In the same way, air can only contain a certain amount of water vapor. When air is saturated, it contains as much water vapor as possible. Temperature determines the maximum amount of water vapor air can contain. Warm air can contain more water vapor than cold air. *The amount of water vapor present in the air compared to the maximum amount of water vapor the air could contain at that temperature is called* **relative humidity.**

Relative humidity is measured using an instrument called a psychrometer and is given as a percent. For example, air with a relative humidity of 100 percent cannot contain any more moisture and dew or rain will form. Air that contains only half the water vapor it could hold has a relative humidity of 50 percent.

**Reading Check** Compare and contrast humidity and relative humidity.

## Dew Point

When a sponge becomes saturated with water, the water starts to drip from the sponge. Similarly, when air becomes saturated with water vapor, the water vapor will condense and form water droplets. When air near the ground becomes saturated, the water vapor in air will condense to a liquid. If the temperature is above 0°C, dew forms. If the temperature is below 0°C, ice crystals, or frost, form. Higher in the atmosphere clouds form. The graph in **Figure 3** shows the total amount of water vapor that air can contain at different temperatures.

When the temperature decreases, the air can hold less moisture. As you just read, the air becomes saturated, condensation occurs, and dew forms. *The temperature at which air is saturated and condensation can occur is called the* **dew point.**

### MiniLab 20 minutes

### When will dew form?

The relative humidity on a summer day is 80 percent. The temperature is 35°C. Will the dew point be reached if the temperature drops to 25°C later in the evening? Use **Figure 3** below to find the amount of water vapor needed for saturation at each temperature.

1. Calculate the amount of water vapor in air that is 35°C and has 80 percent relative humidity. (Hint: multiply the amount of water vapor air can contain at 35°C by the percent of relative humidity.)
2. At 25°C, air can hold 2.2 g/cm$^3$ of water vapor. If your answer from step 1 is less than 2.2 g/cm$^3$, the dew point is not reached and dew will not form. If the number is greater, dew will form.

#### Analyze and Conclude

**Key Concept** After the Sun rises in the morning the air's temperature increases. How does the relative humidity change after sunrise? What does the line represent?

**Figure 3** As air temperature increases, the air can contain more water vapor.

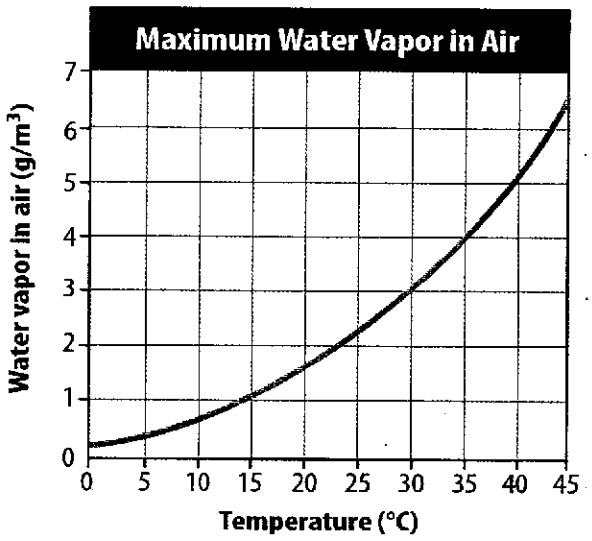
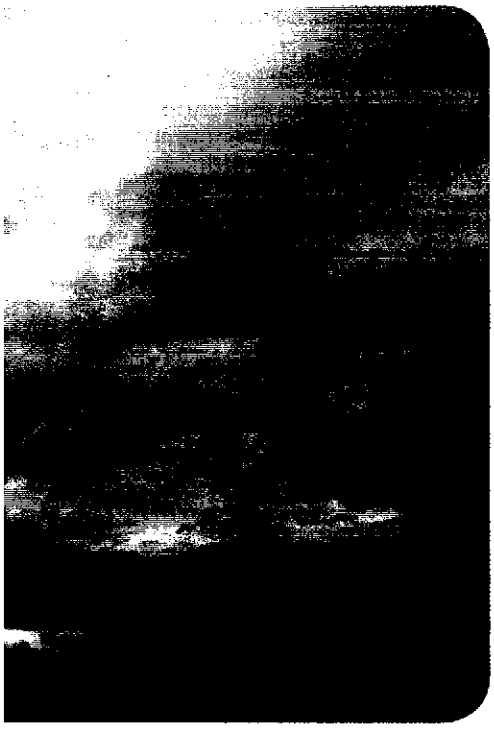
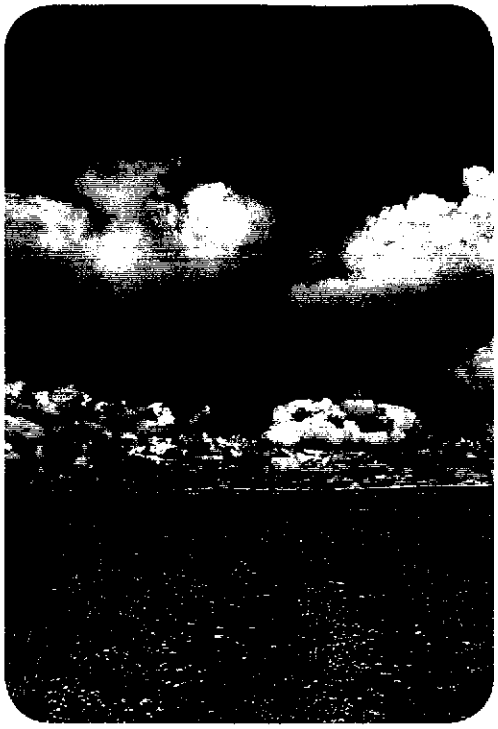


**Figure 4** Clouds have different shapes and can be found at different altitudes.



**Stratus clouds**
- flat, white, and layered
- altitude up to 2,000 m



**Cumulus clouds**
- fluffy, heaped, or piled up
- 2,000 to 6,000 m altitude

**Cirrus clouds**
- wispy
- above 6,000 m

## Clouds and Fog

When you exhale outside on a cold winter day, you can see the water vapor in your breath condense into a foggy cloud in front of your face. This also happens when warm air containing water vapor cools as it rises in the atmosphere. When the cooling air reaches its dew point, water vapor condenses on small particles in the air and forms droplets. Surrounded by thousands of other droplets, these small droplets block and reflect light. This makes them visible as clouds.

Clouds are water droplets or ice crystals suspended in the atmosphere. Clouds can have different shapes and be present at different altitudes within the atmosphere. Different types of clouds are shown in **Figure 4**. Because we observe that clouds move, we recognize that water and thermal energy are transported from one location to another. Recall that clouds are also important in reflecting some of the Sun's incoming radiation.

A cloud that forms near Earth's surface is called fog. Fog is a suspension of water droplets or ice crystals close to or at Earth's surface. Fog reduces visibility, the distance a person can see into the atmosphere.

**Reading Check** What is fog?

**WORD ORIGIN**

precipitation
from Latin *praecipitationem*, means "act or fact of falling headlong"

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Make a horizontal two-tab book and label the tabs as illustrated. Use it to collect information on clouds and fog. Find similarities and differences.

## Precipitation

Recall that droplets in clouds form around small solid particles in the atmosphere. These particles might be dust, salt, or smoke. Precipitation occurs when cloud droplets combine and become large enough to fall back to Earth's surface. **Precipitation** *is water, in liquid or solid form, that falls from the atmosphere.* Examples of precipitation–rain, snow, sleet, and hail–are shown in **Figure 5.**

Rain is precipitation that reaches Earth's surface as droplets of water. Snow is precipitation that reaches Earth's surface as solid, frozen crystals of water. Sleet may originate as snow. The snow melts as it falls through a layer of warm air and refreezes when it passes through a layer of below-freezing air. Other times it is just freezing rain. Hail reaches Earth's surface as large pellets of ice. Hail starts as a small piece of ice that is repeatedly lifted and dropped by an updraft within a cloud. A layer of ice is added with each lifting. When it finally becomes too heavy for the updraft to lift, it falls to Earth.

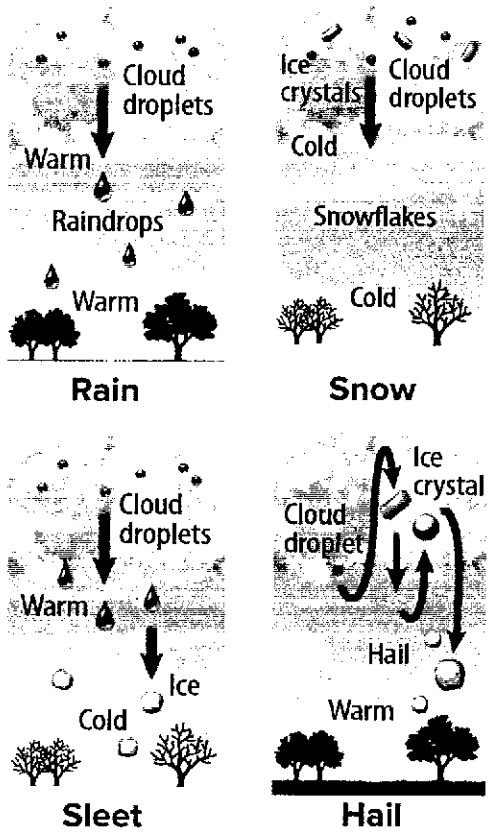
**Key Concept Check** What variables are used to describe weather?

## The Water Cycle

Precipitation is an important process in the water cycle. Evaporation and condensation are phase changes that are also important to the water cycle. *The* **water cycle** *is the series of natural processes by which water continually moves among oceans, land, and the atmosphere.* As illustrated in **Figure 6**, most water vapor enters the atmosphere when water at the ocean's surface is heated and evaporates. Water vapor cools as it rises in the atmosphere and condenses back into a liquid. Eventually, droplets of liquid and solid water form clouds. Clouds produce precipitation, which falls to Earth's surface and later evaporates, continuing the cycle.

**Key Concept Check** How is weather related to the water cycle?

### Types of Precipitation




▲ **Figure 5** Rain, snow, sleet, and hail are forms of precipitation.

**Visual Check** What is the difference between snow and sleet?

### The Water Cycle

Personal Tutor

**Figure 6** The Sun's energy powers the water cycle, which is the continual movement of water between the ocean, the land, and the atmosphere.