Content Objectives:

- Air pressure is the push of air against its surroundings.
- Air pressure is different from place to place.
- Air pressure is affected by how high you are above sea level and what temperature the air is.

In 1643, an Italian scientist named Torricelli was experimenting with a **vacuum**, which is a space without air and not something you clean carpets with. He filled a tube with mercury and turned it over into a bowl. When only some of the mercury left the tube, Torricelli wondered why. He figured out that air was pushing on the mercury in the bowl, keeping the rest of the mercury in the tube. He also noticed that sometimes the mercury level went up, while at others it went down. He'd created a barometer: a tool that measures air pressure.

As you know, air is matter. It is made of particles, has mass, and takes up space. The air particles are constantly moving all directions, and when they bump into something they push. This push of air against its surroundings is **air pressure**.

Air is affected by **gravity**. The closer you are to sea level, the more particles of air there are. As you move up in the atmosphere, the number of air particles gets smaller. For example, at the top of Mt. Everest, 75% of all air particles in the atmosphere are below you. This means that air pressure is higher when you're at sea level, and lower when you're at high elevations.

We use a **barometer** to measure air pressure. Two kinds of barometers are mercury barometers and aneroid barometers. Most people use or have seen an aneroid barometer. **Aneroid barometers** use a sealed metal can that expands (gets bigger) or contracts (gets smaller) when pressure changes.

Air pressure is also affected by air temperature. When air is cooled, the particles push together (imagine they are trying to stay warm). This means pressure goes up. When air is warmed, the particles in air spread out, so pressure goes down. **Standard Air Pressure** is 29.92 inches of mercury at sea level, when the temperature is 32^{O} F/0^{O} C. This changes when you move away from sea level and/or the air temperature changes. Areas of air where the pressure is higher than the surrounding air are called **high-pressure areas**, and areas of air where the pressure is lower than the surrounding air are called **low-pressure areas**. The difference in air pressure can cause winds.

- **Barometer**: a tool used to measure air pressure
- **Vacuum**: a space without any air
- **Mercury**: a heavy liquid metal
- **Air Pressure**: the push of air against its surroundings
- **Gravity**: the force that pulls all matter toward Earth
- **Aneroid Barometer**: a barometer that uses a sealed metal can that expands (gets bigger) or contracts (gets smaller) to measure air pressure
- **Mercury Barometer**: a barometer that measures air pressure using a column of mercury that rises or falls
- **High-pressure Area**: an area of air where pressure is higher than surrounding air
- **Low-pressure Area**: an area of air where pressure is lower than surrounding air
- **Standard Air Pressure**: 29.92 inches of mercury at 32^{o} F at sea level.

Content Objective

- A windsock and a wind vane are tools used to find wind direction.
- Wind speed can be measured using an anemometer.

Remember that the surface of Earth is heated unevenly. Wind is moving air caused by this uneven heating of Earth. These differences in air temperature also cause differences in air pressure: higher temperatures mean low pressure, and lower temperatures mean higher pressure. When there are two air masses near each other with different pressures, you feel the wind. Wind moves from areas of high pressure to areas of low pressure.

Winds are named for where they come from, ***not*** for where they are going to: a north wind comes <u>from</u> the north, and blows <u>to</u> the south. Two tools that show wind direction are windsocks and wind vanes. A **wind vane** usually has an arrow that points into the wind. If there was a west wind, the wind vane would point west. A **windsock** works in the opposite way from a wind vane. When the wind blows, the windsock points to where the wind is blowing to. So, in a west wind the windsock would point east (where the wind is blowing to), but a wind vane would point west.

To measure wind speed, you can use an anemometer. An **anemometer** is <u>a tool that uses spinning cups to measure wind speed</u>. When the cups spin fast, the wind is strong; if they spin slowly, the wind is weak. The Beaufort Scale is another tool used to measure wind speed. It breaks wind strength into twelve categories, with 12 being the strongest.

Two things determine the strength of the wind. When there is <u>a large difference in air pressure between two air masses</u>, the stronger the winds are. Also, <u>when the two air masses are close together</u>, the stronger the winds are. Winds are weaker when there are smaller differences in air pressure and when the air masses are far apart.

People have used the wind to help them do work for hundreds of years. In the Middle East windmills were first used to grind grain for flour. Later, the Dutch began using windmills to pump water. In many places today, windmills are still used to do work. Wind can be used to produce electricity by using a **wind turbine**. If you want to create a lot of electricity, you need a lot of wind turbines. This is called a **wind farm.**

- **Wind:** moving air caused by the uneven heating of Earth's surface.
- **Wind vane**: a tool used to find wind direction. Usually it has an arrow that points into the wind. Example: if the arrow points south, it is a south wind.
- **Windsock**: a tool used to find wind direction. It is a cloth bag that is wide at one end, and narrow at the other. Wind gets caught in the windsock and causes it to point the way the wind is blowing.
- **Anemometer**: a tool used to measure wind speed
- **Windmill**: a machine that uses wind to do work work
- **Wind turbine**: a machine that uses wind to produce energy
- **Wind farm**: a system of many wind turbines (50 or more) working together to create electricity

Content Objectives:

- The movement of water into the air and then back to earth, through the processes of evaporation, condensation, and precipitation is called the water cycle.

Water can be found in its three states on Earth: solid (ice), liquid (water), and gas (water vapor). The movement of water into the air as water vapor and then back to Earth's surface as precipitation is called the **Water Cycle.**

The water cycle doesn't have a specific starting point, but it's easy to begin with **evaporation**. If you remember the Greenhouse Effect, sunlight passes through the atmosphere and causes Earth's surface to heat up. Most of Earth is covered in water, and when water warms up, it **evaporates**, or turns into a gas**. Evaporation** is the step in the water cycle where water turns into a gas called water vapor.

When water evaporates it rises up into the atmosphere. The air gets cooler the as you move away from sea level, and when the water vapor cools it turns back into a liquid. The step in the water cycle where water vapor changes into liquid water is called **condensation**. Depending on how warm or cold the air is, the water may freeze and become ice or snow.

Condensation is what causes clouds to form. **Clouds** are made of billions of tiny drops of water condensed together. If you're standing outside on a cold day, you can form a cloud with your breath. When you breathe out, the warm air from your lungs cools down when it meets the cold air outside of your body. This causes the water vapor from your breath to condense into a cloud.

Inside the clouds in the sky, the water droplets get heavier as they grow larger. When they are too heavy to stay in the cloud, they fall as precipitation. **Precipitation** is any form of water that falls from the air. The kind of precipitation a place gets depends on the air temperature. Snow, rain, sleet, hail, and freezing rain are all forms of precipitation. When precipitation falls, it makes its way into the many bodies of water on Earth, where it eventually evaporates, and the water cycle continues.

The amount of water vapor in the air is called **humidity.** Humid days are sometimes described as "muggy": imagine very hot summer days, where you sweat without doing much of anything. Air can only hold so much water vapor, and this changes with temperature. Warm air can hold more water vapor that cold air can. Think of it this way: warm air spreads out, leaving more room for water vapor to fill in; cold air shrinks together leaving less room for water vapor.

Relative humidity is how much water vapor the air is holding compared to how much it could hold at that temperature. If air is holding all the water vapor it can at a certain temperature, the relative humidity is 100%.

- **Water cycle**: the movement of water into the air as water vapor and then back to Earth in some form of precipitation
- **Evaporation:** the process where a liquid turns into a gas. In the water cycle, water turns into water vapor during evaporation.
- **Condensation**: the process where a gas turns into a liquid. In the water cycle, water vapor turns into liquid water during evaporation.
- **Precipitation**: any form of water that falls from the air (rain, sleet, snow, or hail)
- **Cloud**: billions of tiny drops of water condensed from the air
- **Fog**: a cloud that touches Earth's surface
- **Rain gauge**: a tool used to measure precipitation
- **Humidity**: the amount of water vapor in the air
- **Relative humidity**: the amount of water vapor the air is holding compared to the amount it could hold at that same temperature