

Lesson 3: Wind and Air Pressure (2 Days)

☐ Getting Started

Earth's atmosphere is made of gases that surround our planet. The atmosphere is made of layers of these gases. Watch the following video about the Earth's atmosphere.



Earth's Atmosphere

www.beyondthepage.com/link/13226/

When we talk about air pressure, we are referring to how strongly the atmosphere of the Earth is pressing down on the Earth's surface. This pressure impacts the temperatures and weather that occur on Earth.

The Sun heats the land and water on Earth. It provides the energy that produces winds on Earth. Without the Sun, there would be no wind. Watch the following video.



Solar Radiation

www.beyondthepage.com/link/13227/

NOTE: Look ahead to the instructions for Activity 4 in Day 2 of this lesson. Water with blue food coloring will need to be frozen for the activity. You may want to put the water in the freezer today so it's ready for tomorrow.

Stuff You Need

- "Weather Words" booklet (kit)
- *Weather and Climate* by Kathleen M. Reilly
- 3 empty plastic bottles (juice, milk, soda) with their caps
- apron* (Activity 4 - optional)
- colored pencils
- compass (kit)
- drinking straws (kit)
- food coloring (kit)
- glass pan or clear plastic box
- hair dryer* (Activity 1 - optional)
- hole punch
- ice cube tray* (Activity 4 - optional)
- marker
- measuring cup
- push pin (kit)
- scissors
- small cups (kit)
- stapler
- stopwatch or smartphone

Ideas to Think About

- What factors in the environment affect temperature?
- What cycles on Earth impact the temperature and the seasons of the planet?

Things to Know

- Wind is caused by the way the Earth is unevenly heated by the Sun. Wind occurs when there is a difference in air temperatures.
- Uneven heating creates six large air masses, or cells, of different temperatures across the globe. Between each of these air masses is a powerful river of wind called a jet stream.
- Know the symbols for cold, warm, stationary, and occluded fronts.
- See the "Weather Words" booklet for definitions of the following words: high pressure, low pressure, wind, precipitation, front, occluded.

☐ **Reading and Questions**

Read about wind on pages 22-28 in the book *Weather and Climate*. Then answer these questions. As you read, fill in the definitions for the "Lesson 3" section of your "Weather Words" booklet.

1. Which direction do warm and cool air move in the atmosphere?

2. When air moves from one pressure system to another, what do we feel?

3. Which heats faster, the land or the sea?

4. In a high pressure system, the air is pressing down toward the Earth. When there is a high pressure system, what is the weather like?

5. What happens in a low pressure system?

6. How does altitude affect air pressure?

Activities

☐ Activity 1: Air on the Move

This experiment will help you follow the scientific method to determine what happens when air warms and cools. First review the steps of the scientific method:

- **Ask a question:** What are you going to solve in the experiment? The question explains what you hope to accomplish in the investigation.
- **Make a hypothesis:** How do you think it is going to turn out? Use the facts you already know to come up with a guess that makes sense.
- **Note your materials:** List the supplies you will need to complete the experiment.
- **List the procedure:** Record the steps you need to follow during the experiment.
- **Include your data and work:** Include the tables, observations, and work you do during the experiment. This section is where you keep careful notes on everything you do and discover. Be sure you write down or draw what really happens, even if it's not what you thought would happen. At the end, look over all your data and think about it very hard. Think of the results of your procedure, or how everything turned out.
- **Draw a conclusion:** Note what you found out during the lab. Figure out whether your results agreed with the hypothesis or not. Put everything you observed together and try to make some sense out of it. The conclusion should answer the problem/question.

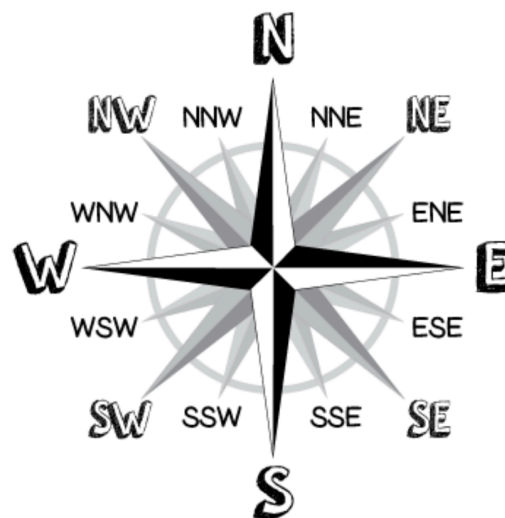
Now conduct the experiment on the "Air on the Move" page. When you finish the experiment if you are not sure you understand "why" you got the results, discuss the

explanation for the results with a parent.

NOTE: You may want to take a picture of the final results to use in your final project.

☐ Activity 2: Make an Anemometer

Wind speed and direction are important weather measurements that help meteorologists predict the weather. In the U.S., wind speed is commonly measured in miles per hour (mph). Wind direction tells you where the wind is coming from. (It does not tell you what direction it is blowing to!) For example, if a forecast for wind says "ESE 7 mph," it means the wind is coming from the east-southeast direction at 7 mph. As you can see on the following compass rose, east-southeast is a direction that is between east and southeast.



Wind direction is often shown using letters, but it can also be shown by using arrows. If your weather resource uses arrows, you can figure out the wind direction by pretending the arrow is on top of a compass rose. North always points up when you are reading wind direction arrows. The base of the arrow shows where the wind is coming from, and the tip of the arrow shows where the wind is blowing to. If the wind direction looks like this on your local forecast:

—> 15 mph

it means that the wind is coming from the west at 15 mph.

An **anemometer** is an instrument that measures wind speed. (It is pronounced a-nuh-mah-muh-ter.) Use the instructions on the "Build a Cup Anemometer" page to create your own weather tool.

When you are done, take your anemometer and a compass outside. You will use these tools to determine the wind's direction and speed.

First, follow these steps to find the wind direction:

1. Go outside and turn your body until your face is directly in the wind. You are now looking at the direction the wind is coming from.
2. Stay where you are and hold the compass out in front of you in the palm of your hand (flatten your hand so the surface is level).
3. Turn the compass with your other hand until the red arrow is lined up with north. Don't move the hand holding the compass.

4. Now the compass is showing you which direction you are facing. It may be exactly north, east, south, or west. More likely you will be facing a direction in between. If the compass says you are facing northwest, the wind direction is northwest (coming from the northwest). You can use the compass rose on the "Wind Speed and Direction" page as needed to help you determine the direction (line up N on your compass with N on the compass rose, and you'll be able to accurately determine the direction of the arrow on your compass).
5. Record the wind direction in your weather journal.

You will need help to use your anemometer, so ask a parent or sibling to help you. To estimate wind speed, follow these steps:

1. Take your anemometer outside to a spot where the wind is not blocked by any buildings, trees, or fences.
2. Count how many times the marker cup (the cup you colored) passes you in 30 seconds. Ask a partner to use a stopwatch or smartphone and tell you when to start and stop counting. Change the position of the anemometer as needed if it has trouble catching the wind.
3. Use the chart on the "Wind Speed and Direction" activity page to estimate the wind speed.
4. If your anemometer doesn't spin because the wind is very light, or spins too fast to count the rotations, try again on another day. Instead, go outside and estimate the wind speed using the Beaufort wind scale on the "Wind Speed and Direction" activity page.
5. Record the estimated wind speed in your weather journal. You may wish to attach the "Wind Speed and Direction" activity page to your weather journal for easy reference.

Also be sure to record today's temperature, precipitation information, and any notes/forecast details you have in your weather journal.

Day 2

☐ Activity 3: What Does "Wind Chill" Mean?

When you watch or read the weather report for your area, you will probably hear something called the "wind chill," the "heat index," or the "feels like" temperature. The "feels like" temperature refers to the heat index in the summer and the wind chill in the winter. The wind chill and the "feels like" temperatures consider how

much warmer or colder you will feel because of the wind. (The "heat index" refers to the level of moisture in the air, which we will learn more about in the next lesson.)

In the winter, your body gives off heat and makes a small cushion of warmer air around you. If there is no wind, this small cushion of air makes you feel warmer and reduces the chance of frostbite (where parts of your body begin to freeze). If there is a fast wind, however, your body can't keep this small cushion of warmth around you, and you will get chilled more quickly. The colder the wind chill or "feels like" temperature, the greater your risk of frostbite.

The "Wind Chill Chart" page is based on the wind chill chart created by the National Weather Service. You can use this chart to determine both the wind chill and the frostbite risk. Try using the chart to answer these questions:

1. If today's temperature is 10°F and the wind speed is 15 mph, what is the wind chill?
2. According to the weather forecast, the wind chill is -1°F. What is the current temperature and wind speed?
3. The forecast says today's "feels like" temperature is -22°F. How quickly can your skin begin to freeze at this temperature?
4. The temperature outside is currently -5°F. How fast must the wind blow in order for you to be at risk of frostbite within 10 minutes?

Weather journal: In your weather journal, record the temperature data from your thermometer, and use the "Wind Chill Chart" page to find the wind chill and frostbite risk for today. Also record today's temperature, precipitation, and wind speed and direction. (At the end of this lesson, you will also record air pressure readings and forecast information.)

NOTE: If it is warm, you will skip recording the wind chill and frostbite risk in your weather journal today and begin recording the heat index tomorrow.

☐ Activity 4: Fronts

A front happens when warm and cold air meet and push against each other. In a front, the warm air rises or is at least trying to rise, pushing against the cold air. Watch the following video to learn more about the types of fronts.



What Are Weather Fronts?

www.beyondthepage.com/link/13228/

Follow the instructions on the "When Warm and Cold Air Meet" pages. This demonstration helps illustrate what happens when a mass of warm air and a mass of cold air meet. You will be working with red and blue food coloring, so protect the surfaces you work on and wear clothes that can get stained, or protect your clothes with an apron. For best results, use a container with high sides (like a clear glass loaf pan). TIP: If you made ice in the cups, run a little warm water on the sides or bottoms first to help loosen the ice. NOTE: You will need to save a few drops of food coloring for an activity in Lesson 6.

☐ Activity 5: Weather Symbols

For this activity, review the front symbols on page 27 in the book. Then answer the questions on the map page and describe what the weather will be like based on the front symbols.

Wrapping Up

Watch the following video to learn about how a barometer measures barometric pressure.



How Does a Barometer Predict the Weather?

www.beyondthepage.com/link/13229/

Find the air pressure measurement for your area today using one of the resources you explored in Lesson 1. Try to find a measurement that includes an arrow. The following weather website includes an arrow with its pressure information. An arrow pointing up shows an increase in pressure, down shows a decrease, and pointing to the side means no change. This website will also tell you the wind direction and the speed of the wind.



AccuWeather

www.beyondthepage.com/link/13230/

You can predict the weather based on the change in the barometric pressure and the direction of the wind. So tomorrow you can compare the barometric pressure to the previous day to determine the forecast. Each day on your journal, you will write in the barometric pressure with an arrow going up or down to show how it changed from the previous day.

The chart at the following web link tells you how you can use air pressure measurements, also called barometric measurements, to predict the weather. You can also use the wind direction to predict the weather as seen on the chart. Fill out your weather journal and predict what weather might be on its way on Page 4 of your weather journal based on the wind direction and the barometric pressure.

**Air Pressure: Barometric Readings**

www.beyondthepage.com/link/13231/

Air on the Move

Materials:

marker 3 empty bottles (juice, milk, soda) with caps hair dryer (optional)

Question: What will happen to the plastic bottles when the air inside is cooled or warmed?

Hypotheses:

The warmed bottle will _____

The cooled bottle will _____

The room-temperature bottle will _____

Procedure:

1. Label the bottles "Room Temperature," "Cooled," and "Warmed."
2. Screw the lids tightly onto the bottles.
3. Place the "Room Temperature" bottle away from direct sunlight or AC/heating vents.
4. Place the "Cooled" bottle in the freezer.
5. Place the "Warmed" jug in a sunny window, outside in the sunlight, or in a car in the Sun. The hotter you get the jug, the better. Note: Be careful around a closed, hot car. If it is cold outside, you can heat the bottle with a hair dryer. Have a parent help you with this step as needed.
6. Wait an hour, and then retrieve the bottles. Compare their shapes. If there is no change, replace the bottles and then wait another hour.

Results:

What happened to the "Room Temperature" bottle? Why? _____

What happened to the "Cooled" bottle? Why? _____

What happened to the "Warmed" bottle? Why? _____

Conclusion:

Were your hypotheses correct? _____

Does warmed air or cooled air take up more room? _____



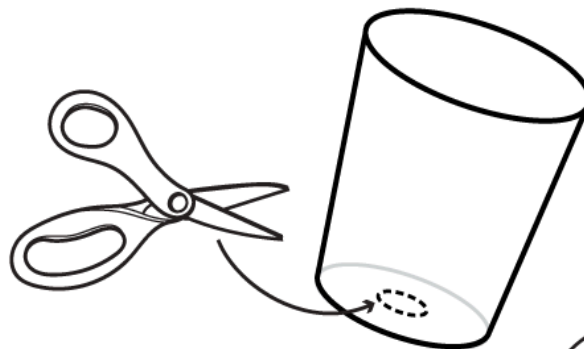
Build a Cup Anemometer

Materials:

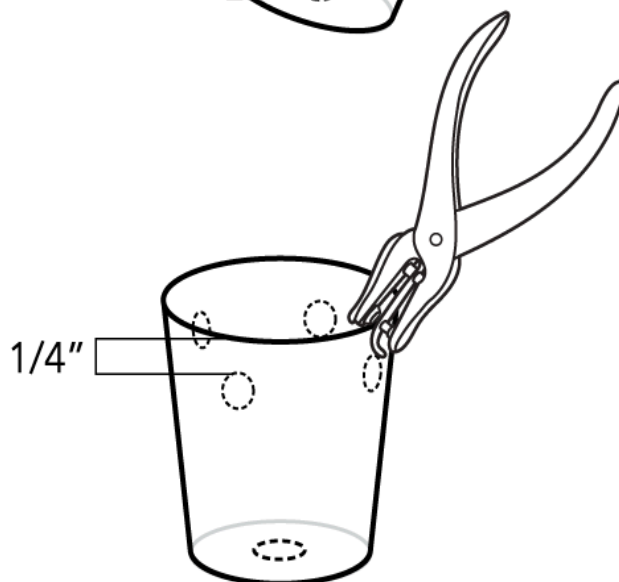
- scissors
- marker
- 3 drinking straws (kit)
- stapler
- hole punch
- 5 three-ounce paper cups (kit)
- push pin (kit)

Directions:

1. Use scissors to make a small hole in the bottom of one of the cups.

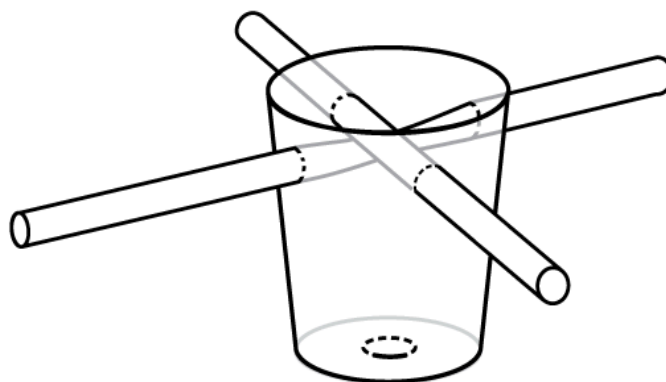


2. Use a hole punch to make 4 evenly spaced holes about 1/4 inch from the top of the cup.

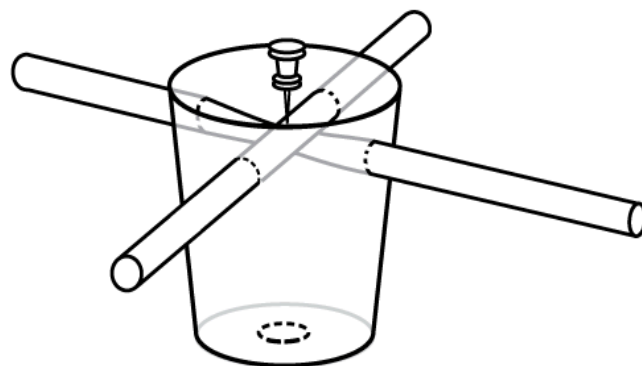


3. Push a straw through a hole so that it comes out the opposite hole.

4. Repeat Step 3 with the other straw. One straw will lie on top of the other straw.

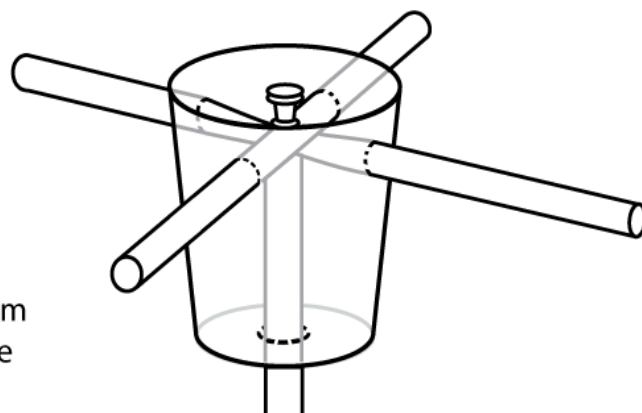


5. Ensure that the straws are evenly spaced (that about the same amount of the straw comes out of each hole). Then press the push pin through the two straws.



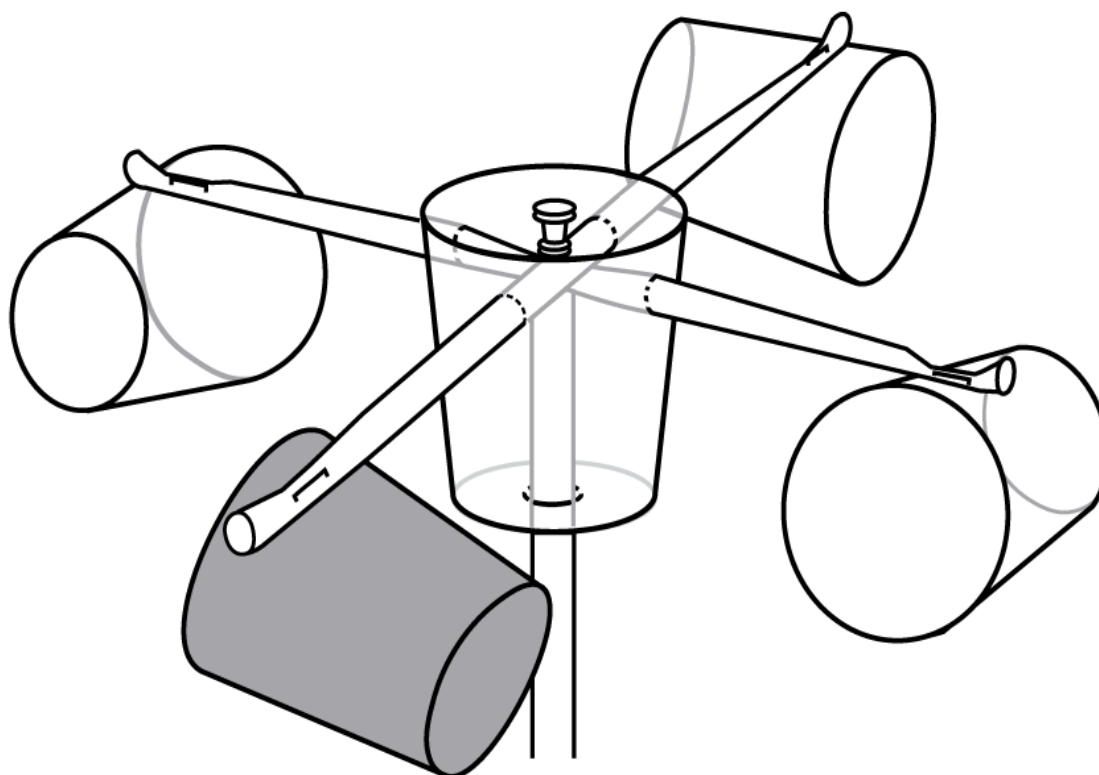
6. Use a marker to color or draw designs on one of the remaining 4 cups.

7. Position one of the straws about 1/2 inch from the top of the cup, and then securely staple the straw to the cup. Repeat with the other 3 cups. Refer to the illustration below to help you understand how to arrange the four cups.

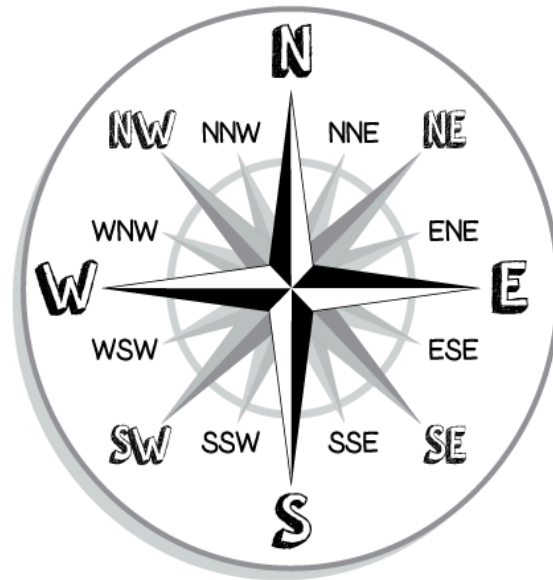
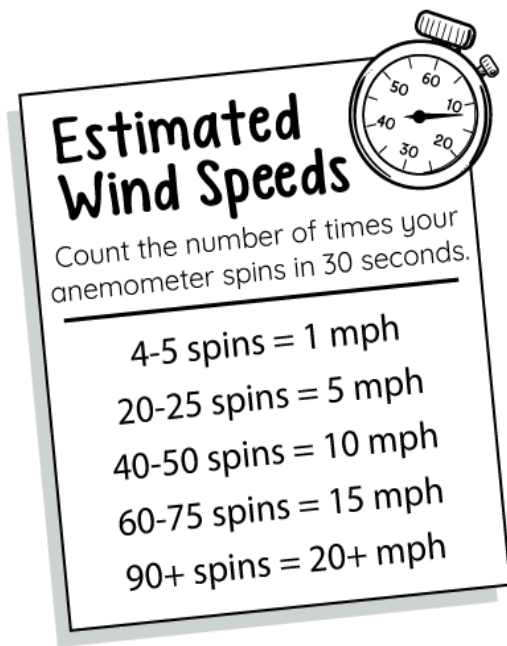


8. Insert the third straw through the hole in the bottom of the cup. The tip of the push pin should rest inside the straw.

9. Blow firmly into one of the cups to make sure your anemometer spins freely. If it doesn't, widen the hole at the bottom of the cup using a pencil.



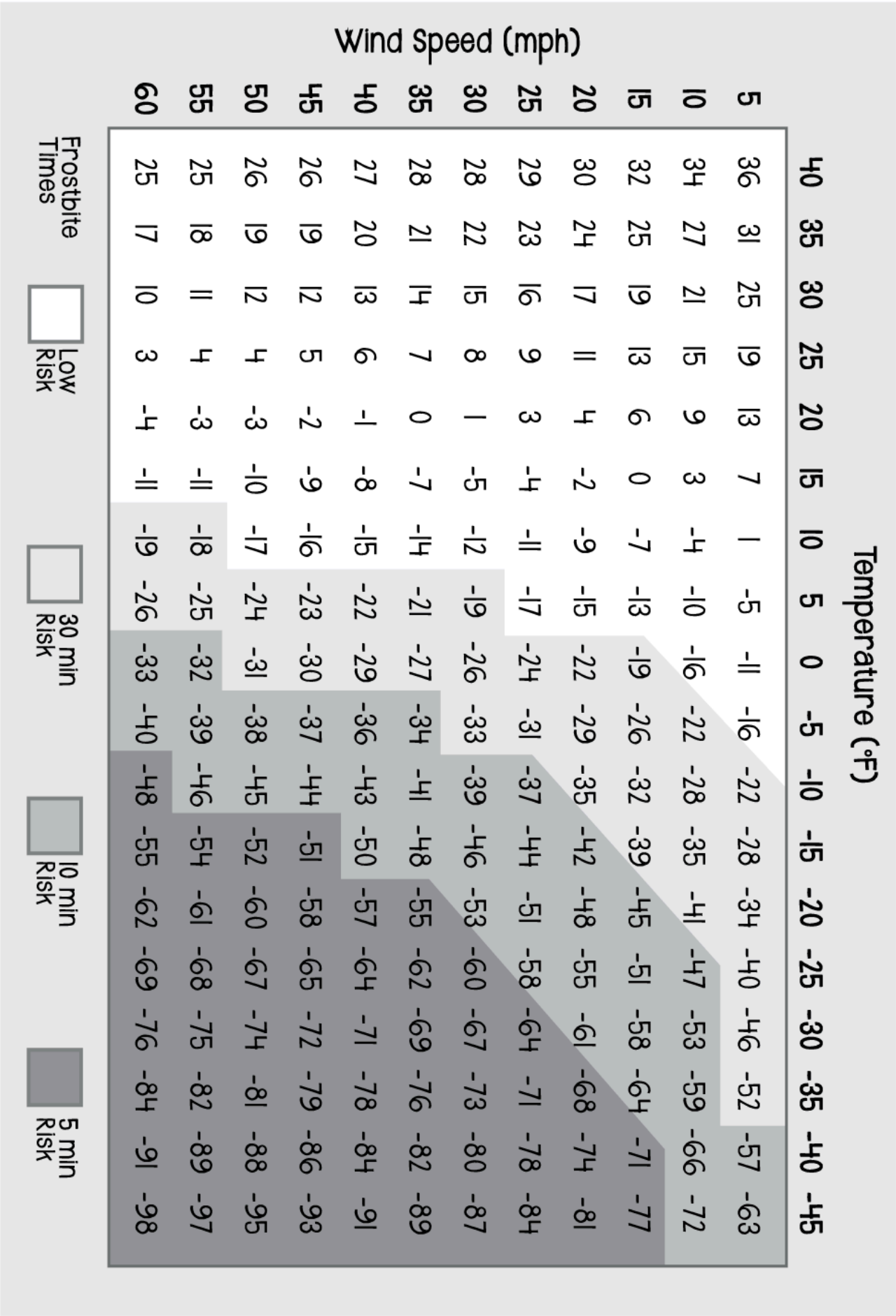
Wind Speed and Direction



The Beaufort Wind Scale

mph		effects on land
Light	0-1	smoke rises vertically
	2-3	direction of the wind shown by smoke, but not by wind vanes
	4-7	wind felt on face; leaves rustle; vanes begin to move
	8-12	leaves and small twigs constantly moving; light flags extended
Moderate	13-18	dust, leaves, and loose paper lifted; small tree branches move
	19-24	small branches in trees begin to sway
	25-31	larger tree branches moving; whistling in wires
	32-38	whole trees moving; resistance felt walking against wind
High	39-46	twigs break off trees; difficulty felt walking against wind
	47-54	slight structural damage occurs; shingles blown off roofs
	55-63	trees broken or uprooted; structural damage occurs
	64-72	not often experienced; accompanied by widespread damage
	73+	rarely experienced; extensive damage occurs

Wind Chill Chart



When Warm and Cold Air Meet



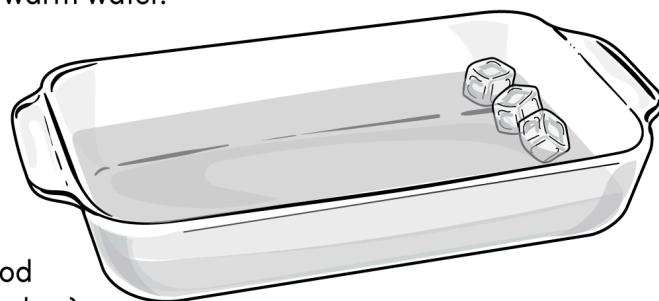
Materials:

- red and blue food coloring (kit)
- 2 small cups (kit) or ice cube tray
- measuring cup
- medium-sized deep glass pan or clear plastic container
- colored pencils

Part 1:

Directions:

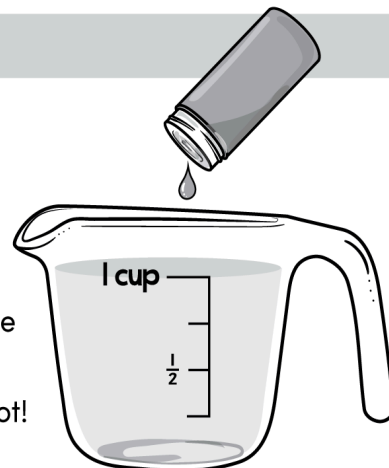
1. Mix a few drops of blue food coloring in about a cup of water.
2. Pour the blue water into an ice cube tray (make 6 cubes) or evenly into 2 small cups and place in the freezer until the water is frozen.
3. Fill a glass pan or clear plastic container 2/3 full with warm water.
4. Remove the blue ice from one of the cups or 3 ice cubes from the tray and gently place the ice on one side of the pan.
5. Wait a few seconds and then add 3-4 drops of red food coloring to the other end of pan (not close to the ice cubes).
6. Watch the side of the container for the next few minutes. Then use the following box and colored pencils to draw what happens.

A large, empty rectangular box with a black border, intended for students to draw their observations of the experiment.

Part 2:

Directions:

1. Rinse out your glass pan/plastic container.
2. Fill the pan 1/2 to 2/3 full of cold water. Add the blue ice from the other cup or 3 more blue ice cubes to the water.
3. Once the ice cubes have melted some and the water is very cold, remove any remaining ice.
4. Microwave 1 cup of water for 1 minute. Be careful, as the water will be hot! Add 2-3 drops of red food coloring to the hot water and stir it.
5. Slowly pour the hot water into one end of the pan, watching through the side of the container for a minute or two.
6. Use the following box and colored pencils to draw how the warm water moves in the first 30-60 seconds.



Questions:

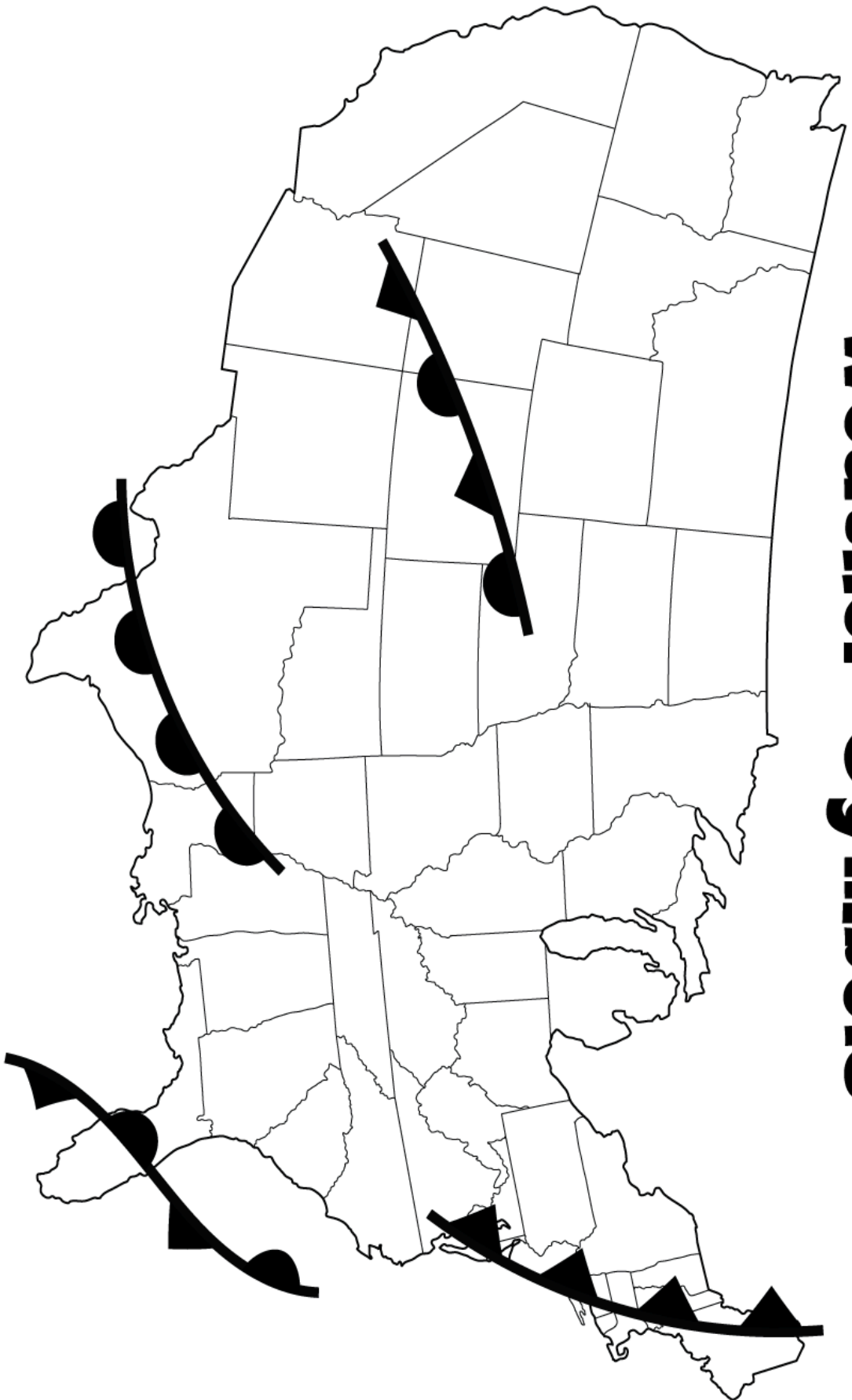
Does Part 1 demonstrate a warm front or a cold front? _____

What happens when a cold air mass hits a warm air mass? Why? _____

Does Part 2 demonstrate a warm front or a cold front? _____

What happens when a warm air mass hits a cold air mass? Why? _____

Weather Symbols



What might happen across south Texas? _____

What is happening in Colorado? _____

What is happening in the New England States? _____

What is happening in Florida? _____

Lesson 3: Wind and Air Pressure (2 Days)

Getting Started

✿ Ideas to Think About

- What factors in the environment affect temperature?
- What cycles on Earth impact the temperature and the seasons of the planet?

📖 Things to Know

- Wind is caused by the way the Earth is unevenly heated by the Sun. Wind occurs when there is a difference in air temperatures.
- Uneven heating creates six large air masses, or cells, of different temperatures across the globe. Between each of these air masses is a powerful river of wind called a jet stream.
- Know the symbols for cold, warm, stationary, and occluded fronts.
- See the "Weather Words" booklet for definitions of the following words: high pressure, low pressure, wind, precipitation, front, occluded.

🕒 Skills

- Explain the influence of convection, global winds and the jet stream on weather and climatic conditions. (S)
- Recognize that the Sun provides the energy that drives convection within the atmosphere and oceans, producing winds. (S)
- Identify how global patterns of atmospheric movement influence local weather using weather maps that show high and low pressures and fronts. (S)
- Compare the composition, properties and structure of Earth's atmosphere to include: mixtures of gases and differences in temperature and pressure within layers. (S)
- Explain the relationship between the movement of air masses, high and low pressure systems, and frontal boundaries to storms (including thunderstorms, hurricanes, and tornadoes) and other weather conditions that may result. (S)
- Recognize how interactions in solar, weather, and ocean systems create changes in weather patterns and climate. (S)
- Describe how energy from the Sun, hydrosphere, and atmosphere interact and influence weather and climate. (S)

Introducing the Lesson

Today, your child will explore the forces that drive wind and air pressure, learning how these factors influence weather patterns. He will discover how the Sun's energy creates wind, how differences in air pressure lead to movement in the atmosphere, and how meteorologists measure and predict wind speed and direction. He will see firsthand how warm and cool air interact, build a simple anemometer, and analyze weather maps to interpret wind patterns and air pressure changes. By the end of this lesson, he will have a deeper understanding of how wind shapes our weather and impacts the environment.

As your child does today's reading, he will fill in the definitions for the "Lesson 3" section in his "Weather Words" booklet. His definitions should be similar to the following:

- high pressure: air that pushes down on the Earth with more force than the air around it because it is more dense
- low pressure: air that pushes down on the Earth with less force than the air around it because it is less dense
- wind: air that is moving
- precipitation: water that falls from the sky to the ground, such as rain, sleet, hail, or snow
- front: the place where two air masses meet and interact
- occluded: when a front catches up and runs into a slower moving front

NOTE: Look ahead to the instructions for Activity 4 in Day 2 of this lesson. Water with blue food coloring will need to be frozen for the activity. You may want to put the water in the freezer today so it's ready for tomorrow.

Reading and Questions

1. Which direction do warm and cool air move in the atmosphere?

Warm air rises and cool air falls.

2. When air moves from one pressure system to another, what do we feel?

wind

3. Which heats faster, the land or the sea?

the land

4. In a high pressure system, the air is pressing down toward the Earth. When there is a high pressure system, what is the weather like?

It is clear day.

5. What happens in a low pressure system?

The warm air rises, and as it cools, it creates precipitation.

6. How does altitude affect air pressure?

At higher altitudes there is less air pressure. The lower you are, the more the air is pressing down on you, so the air pressure is higher.

Activities

Activity 1: Air on the Move

Your child will conduct an experiment to see how cooled and warmed air behave. Note that your child will need to warm the air in one of the bottles by placing it in sunlight or inside a closed car in the sunlight. If the weather is cold, your child can instead use a hair dryer to warm the bottle. With the hair dryer method, the results should be noted right away.

After your child conducts the experiment, he may want to take a picture of the results to use in his final project. Review his findings. The jug that was cooled should have collapsed in on itself. Explain that when air cools, air molecules remain closer together because they move around less. This makes cool air more dense. Because it is more dense, it sinks, taking up less space in the bottle and causing the sides of the bottle to be sucked in.

The jug that was heated in the sunlight should have bulged out at the sides. As air warms, the molecules move around faster and take up more space, pushing against the sides of the bottle and causing the sides to push out. Warm air, because it is more spread out, is less dense.

The jug that was left at room temperature should not have changed. Explain that the room temperature jug serves as a control. The control shows what happens if the temperature of the air is not changed.

Activity 2: Make an Anemometer

Your child will use common household materials to make an anemometer to measure wind speed. The illustrations should help if your child has difficulty. A pencil can also be used as the base of the anemometer if needed (the anemometer will not spin quite as freely as with a straw but will still work). Simply insert the pencil eraser through the hole in the bottom of the cup and gently press the push pin into the eraser. If the cups don't spin well, pull the pin out slightly from the eraser.

Your child will use a compass to determine the wind direction outside. Then he will use his anemometer to investigate the wind speed.

Your child will need you or a partner to assist him with his anemometer. The partner will use a stopwatch or smartphone to tell him when to stop and start counting, and your child will count the number of times the anemometer spins. If the anemometer does not catch the wind well, he should try moving it around to different locations and angles. He should also be sure the cups are level (not angled too far up or down). He will then estimate the wind speed using the chart on the "Wind Speed and Direction" activity page.

Please note that the calculations in the estimated wind speed chart are calibrated to an anemometer made with the items listed, so if you use a different cup or straw size, the estimated wind speed chart will not be applicable. Instead, your child can use his anemometer to estimate whether the wind speed is light, moderate, or high based on how fast it is spinning. He can then check his estimate using the Beaufort wind scale on the activity page.

He should also record today's temperature, precipitation information, and any notes/forecast details he has in his weather journal.

Day 2

Activity 3: What Does "Wind Chill" Mean?

In this activity, he learns how wind affects how cold it feels outside and why "wind chill" matters. He explores how moving air removes the body's warmth, increasing the risk of frostbite, and practices using a wind chill chart to interpret temperature, wind speed, and safety conditions. He also records real weather data in his journal to connect the concept to everyday observations.

Activity 4: Fronts

In this simulation, your child will combine warm water and ice cubes together in a shallow tray and watch how the two substances mix. It involves water and food coloring, so make sure that the work area and your child's clothes are protected. This demonstration works best in a container or glass dish that has high sides so that the water is deeper.

When your child has finished, ask to see his illustrations. The illustration for Part 1 should show that the cold water from the ice sinks and pushes the warm water out of the way. In Part 2 he should see that the

warm water pushes some of the cold water away but eventually flows up to the surface at a diagonal.

Answer Key:

- Does Part 1 demonstrate a warm front or a cold front? (a cold front)
- What happens when a cold air mass hits a warm air mass? Why? (Because cold air is denser, it lifts the warm air and pushes it out of the way.)
- Does Part 2 demonstrate a warm front or a cold front? (a warm front)
- What happens when a warm air mass hits a cold air mass? Why? (Warm air is less dense than cold air and has a harder time pushing the cold air out of the way. Eventually it slides up the mass of cold air.)

NOTE: If your science kit is a Semester 1 kit, be sure he puts the leftover blue food coloring back in the science kit. He will use it again in Unit 3.

Activity 5: Weather Symbols

Your child will use the symbols on the map to describe the weather.

Answer Key:

- What might happen across south Texas (A warm front is coming in and it may rain.)
- What is happening in Colorado? (There is an occluded front and the temperatures will most likely drop. Could bring lots of rain.)
- What is happening in the New England States? (A cool front is coming in. The temperatures will drop and there is a chance of rain.)
- What is happening in Florida? (There is a stationary front. It will most likely be cloudy for days, and it may rain.)

Wrapping Up

Questions to Discuss

- How is wind created? (It is created by air moving from cooler, high-pressure areas to areas of low pressure.)
- In what kinds of situations do people need to know wind direction and speed today? (Answers will vary but may include sailing, flying planes, sports, and flying kites.)
- In the winter, do you think it is more important to know the "wind chill" temperature or the actual temperature? Why? (Answers may vary; however, the wind chill temperature gives you a better idea of what it feels like outside.)

Things to Review

Review that high pressure systems, usually coincide with fair weather and low pressure systems unusually correspond with cooler weather and rain.

Review the chart on p. 27 with your child and discuss what the different weather symbols mean.