

# STORM WATCHER

WEATHER LAB

# RAIN? Or SHINE?

# WHAT IS WEATHER?



**Weather is what's** happening in Earth's atmosphere at one place and time. It seems like everyone talks about the weather, but most people don't know much about it. With the help of your Weather Lab and this book, you'll learn a lot about how weather happens and have fun doing it. When you're done, you'll be able to track the wind, chart temperature changes, and measure rainfall.

**The Earth** is inside an envelope of air called the *atmosphere* (AT-muss-fear). Changes in the atmosphere create weather. Even though the Sun is millions of miles away, it's the most important element of weather and it affects our atmosphere. *Solar* energy (energy from the Sun) makes clouds form and winds blow.



Rain or Snow, fog or Sunshine, no matter where you live, the weather affects you every day. That's why the study of weather is so important.

# THE WIND

**Wind** is the way air gets from one place to another. When the Sun heats the air, it expands and rises like a balloon. As the heated air rises, colder air rushes in and takes its place. Then, the warm air cools down and falls back toward the Earth. This cycle of heating and cooling, rising and falling, is called *convection*. Convection creates large masses of moving air, or wind.

## WEATHER LORE

wind before rain, fair weather again.

Whenever there's a strong wind before it rains, it shows that the rain clouds are being moved along by the wind so the storm should pass quickly.

# AIR PRESSURE

Air that's close to the ground has the weight of all the air above it pressing it down. This force is called *air pressure*. The higher up you go in the atmosphere, the less air pressure there is because there's less air above it pushing it down.



Airplanes fly high where the air is thin. To help airplane passengers breathe easily, airplanes have pressurized air.



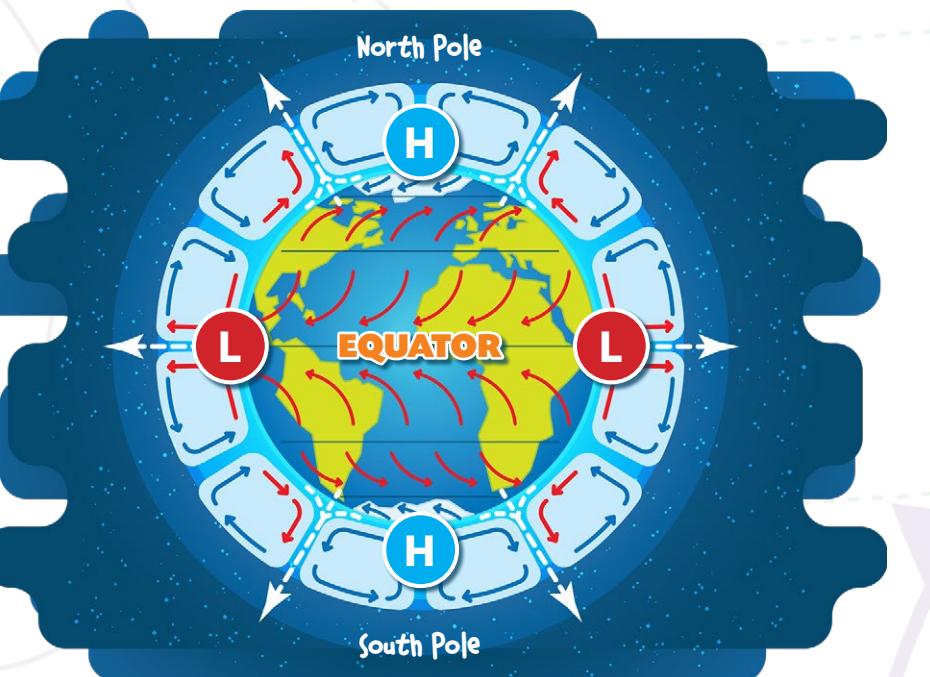
# HIGHS & LOWS

A **large area** or mass of high-pressure air is called a *high*. High-pressure areas are made of air that is cooling and sinking. Highs usually bring clear weather. Low-pressure masses, called *lows*, are made of warming air that is rising. They usually bring stormy weather.



# PRESSURE & WINDFLOW

**Pressure differences** in the atmosphere make the wind move or flow. When atmospheric pressure is high, the air is squashed together. This squashed, high-pressure air flows toward places where the pressure is lower. As air flows from one area to another, the pressure gradually changes. As one area gets warmer, another cools down. There are always changing patterns of high and low air pressure moving around the Earth.



However, within this pattern, there are some things that don't change. At the equator, an imaginary line around the Earth halfway between the North and South Poles, there is a constant band of low pressure. At the poles, there is permanent high pressure.



# TEMPERATURE

## ENERGY FROM THE SUN CREATES TEMPERATURE

Think of the Sun as a gigantic furnace that pumps heat and light in all directions. Less than a billionth of the Sun's heat and light energy actually reaches Earth. A lot of the Sun's energy that does reach the Earth bounces back into space. Most of what doesn't bounce back is absorbed by the atmosphere and heats the air. You can feel the Sun's energy as it warms your skin when you sit in a sunny window.



### WEATHER LORE

when ladybugs swarm, expect a day that's warm.

Ladybugs have hard wings that hold heat close to their body. So, when the weather gets warm, they fly around to cool off.



In 2016, Mitzrah, Kuwait recorded the same temperature.

## WATER A KEY WEATHER INGREDIENT

**Precipitation** (pre-sip-uh-TAY-shin) is water that falls from the sky. Rain, snow, sleet, and hail are different forms of precipitation and different forms of water.

**The fact that** water can take many forms is one of the things that make weather, well, weather. Water can be a solid (ice), a liquid (water), and a gas (water vapor). Water falls to Earth, where it is heated by the Sun and changed into water vapor. The water vapor returns to the atmosphere and forms new clouds.



Parts of the hottest months of the year are called dog days.

## FAHRENHEIT & CELSIUS

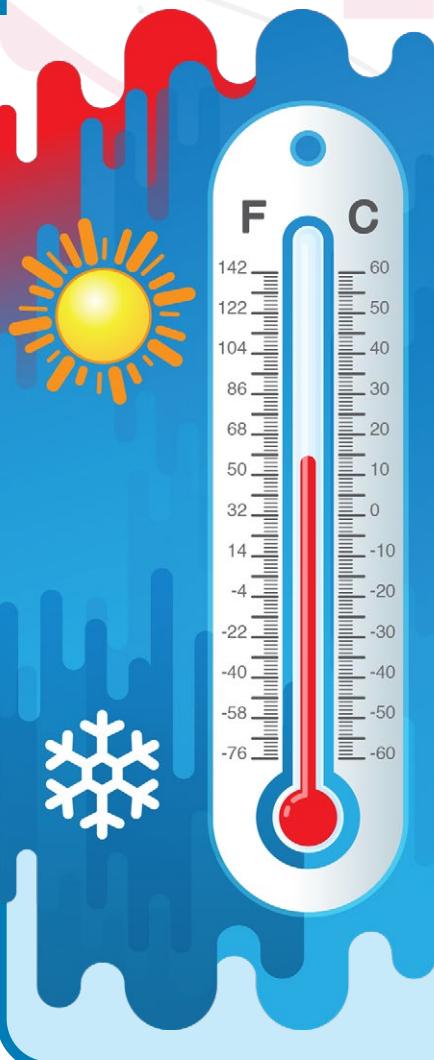
**Thermometers** are instruments used to measure temperature, or the degree of hotness or coldness of an object. About 300 years ago, Gabriel Fahrenheit used mercury to make the first thermometer. He marked a scale and used his thermometer to measure different forms of water. On his Fahrenheit (F) scale, salt water freezes at 0°F and pure water freezes at 32°F and boils at 212°F.

**Anders Celsius created** the Celsius or Centigrade (C) temperature scale a few years later. In his system of measurement, pure water freezes at 0°C and boils at 100°C.

**The United States** is one of the few countries that still use the Fahrenheit scale.



Panting helps dogs cool off. Because dogs don't sweat, they get rid of excess heat in their bodies by panting. The heat turns the water in their mouths into water vapor and it evaporates.



### FAHRENHEIT TO CELSIUS

Here's how to change a Fahrenheit temperature to Celsius.

**Step 1:** Subtract 32 from the Fahrenheit temperature.

**Step 2:** Multiply the difference by 5/9 (which is about .56).

**What is 80°F in Celsius?**

- $80 - 32 = 48$
- $48 \times .56 = 26.88$
- 80°F is about 27°C



# RAIN

**Raindrops form in** clouds, one tiny droplet at a time.

They begin to take shape when the water vapor in the cloud sticks to a speck of dust, smoke, or salt. Inside the cloud, the heaviest droplets fall slowly. Then air inside the cloud pushes the droplets up again. More and more water droplets join together to get bigger and heavier. Eventually, the droplets become heavy enough to fall from the cloud.



## RAINBOWS— LIGHT, WATER, AND AIR

**Sometimes when light** and water meet in the sky you can see a curved band of colored light called a rainbow. Rainbows usually happen during or right after a rain shower when the Sun is shining and there is water in the air. Even though sunlight looks like it is clear or white, it is actually made of the complete spectrum of color. Sunlight includes red, orange, yellow, green, blue, indigo, and violet. When the sunlight bounces off the droplets of water, it separates the light into the color spectrum, and you see a rainbow.



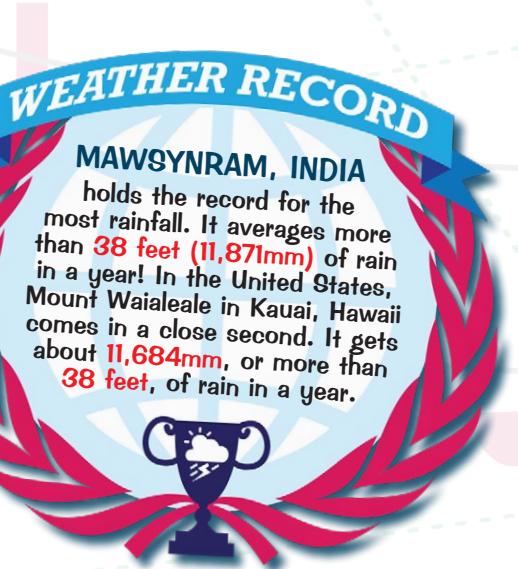
### WEATHER LORE

**Rainbow in the morning, Sailor's warning.**  
**Rainbow at night, Sailor's delight.**

**When sunlight creates a rainbow it bounces off of water droplets. In the morning, rainbows are in the west because the Sun rises in the eastern sky. In the evening, rainbows are in the east because it's the setting Sun in the west that creates the rainbow. Even though rain can come from any direction, most storms move from west to east. So a sailor, or anyone who sees a rainbow in the morning, can expect it to rain. When the setting Sun creates a rainbow to the east, the clouds have already passed so it won't rain.**

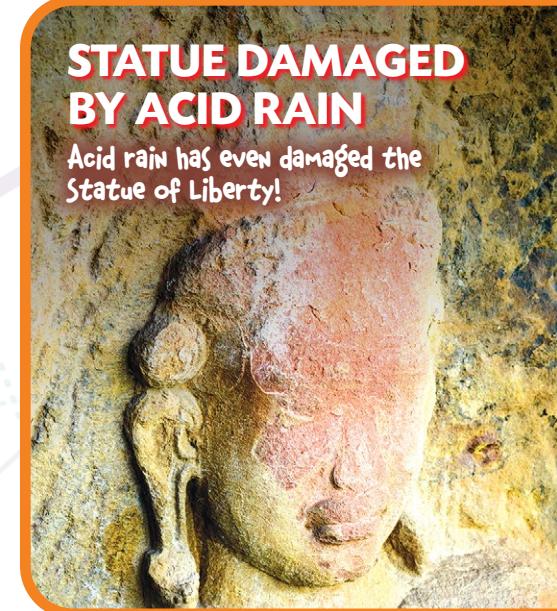
# ACID RAIN

**Factories, homes, cars,** trucks, and buses burn fuels that send some poisonous gases into the air. These poisons combine with water in the atmosphere and become part of rain, snow, or fog. Then, when the poisoned water, called **acid rain**, falls to the ground it damages the environment. Acid rain can destroy the leaves of plants, kill trees, pollute the soil, and change the chemistry of lakes and streams. When that happens, animals, fish, and other wildlife die. Acid rain can also damage buildings and statues.



### STATUE DAMAGED BY ACID RAIN

Acid rain has even damaged the Statue of Liberty!



# SNOW AND ICE

## SNOW— FROZEN WATER CRYSTALS

**Snowflakes are made** of tiny crystals of frozen water vapor that form around bits of dirt or dust, like raindrops do. Almost every raindrop begins as a snowflake because the temperature is very cold up where most clouds form. Snow crystals grow until they're heavy enough to begin their trip to the ground. Snowflakes come in many shapes but every one is different!

**When snowflakes form** in air that is below freezing all the way from the cloud to the ground, they fall slowly and build up, or accumulate, on the ground. But if the air near the ground is warmer, the snowflakes melt on the way down and become softer, wetter snowflakes, sleet, or freezing rain.

### WEATHER LORE

Pale moon rains, red moon blows.  
white moon neither rains or snows.

On a night when the air is dirtier or dustier, the moon looks pale or reddish. When the air is clean, the moon looks white. The dustier the air, the greater the chance that precipitation will form.



### CAN YOU TELL THE DIFFERENCE?

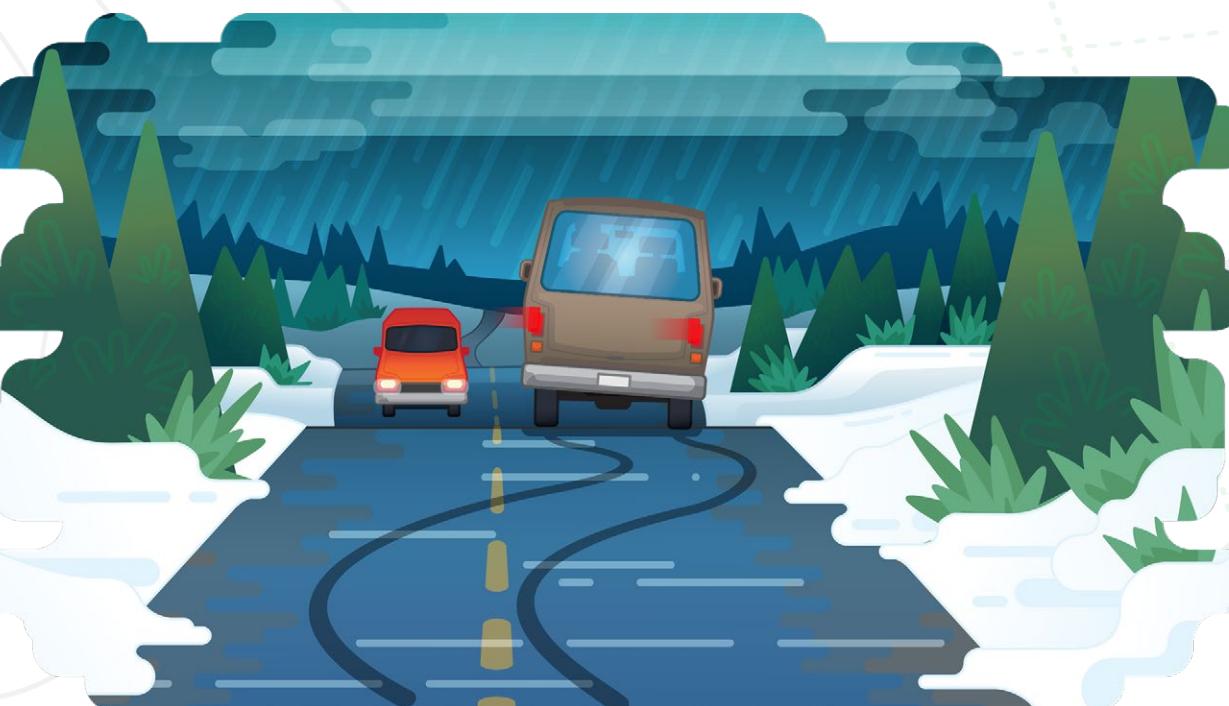
No two snowflakes are identical because every snowflake takes its own path from the clouds to the Earth.



# SLEET & FREEZING RAIN

**If partially melted** snowflakes or raindrops fall through a layer of air near the ground that is colder, they can freeze again and turn to sleet. Sleet is clear pellets of ice.

**Sometimes the colder** layer of air near the ground is shallow. When that happens, there isn't enough time for the melting snowflakes or raindrops to freeze into sleet. Instead, they hit the ground as freezing rain. Freezing rain is very dangerous. When it hits the cold ground, it spreads out and becomes a thin film of slippery ice that can cause automobile accidents.



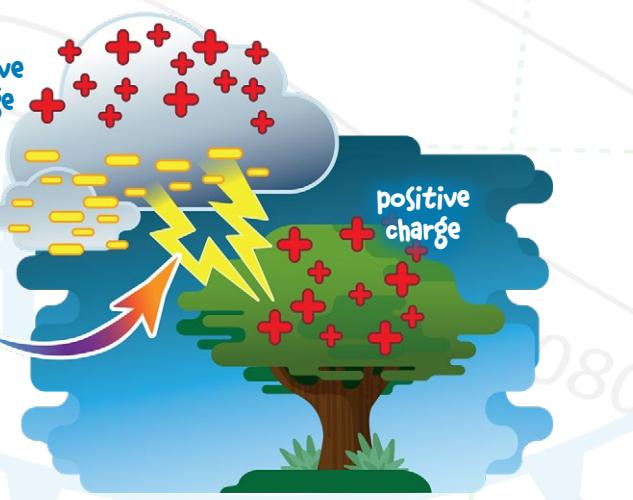
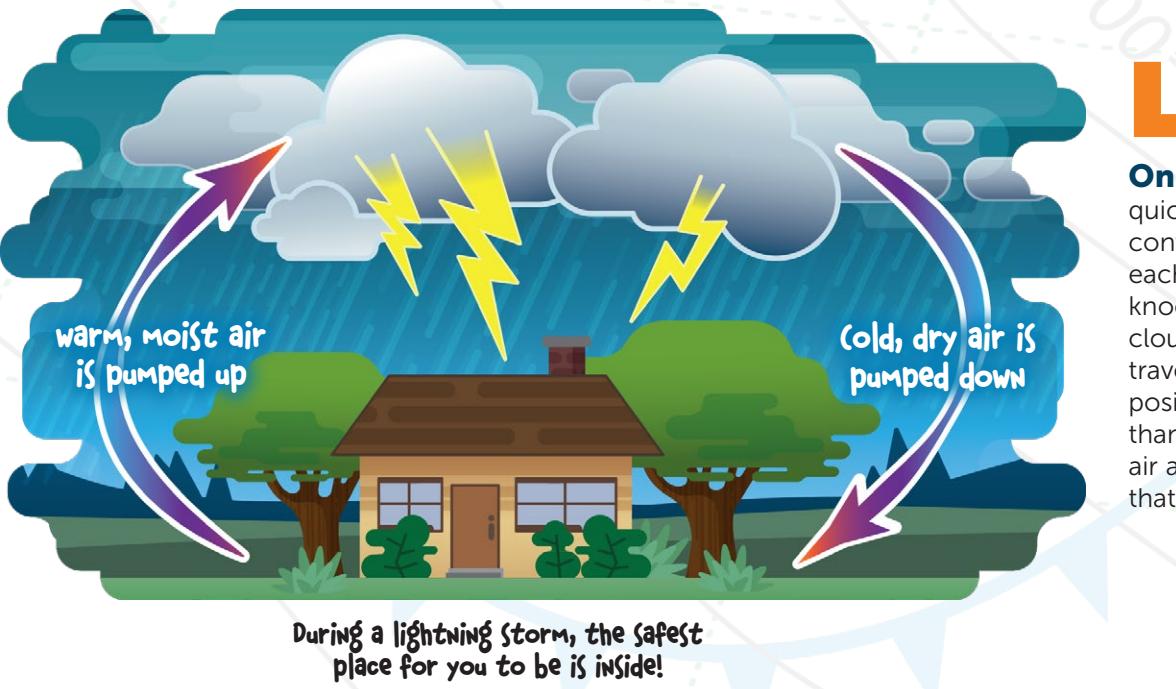
**IT CAN SNOW IN FLORIDA!**  
On January 19, 1977, west Palm Beach, Florida had its first snowfall ever. At Miami's Crandon Park Zoo they used special heat lamps to keep the iguanas warm!



# STORMS

## THUNDERSTORMS

**Thunderstorms** are **powerful** electrical storms designed by nature to create balance in the atmosphere. They pump warm, moist air from the lower atmosphere into the upper atmosphere and they bring cold, dry air from the upper atmosphere down to the lower atmosphere.



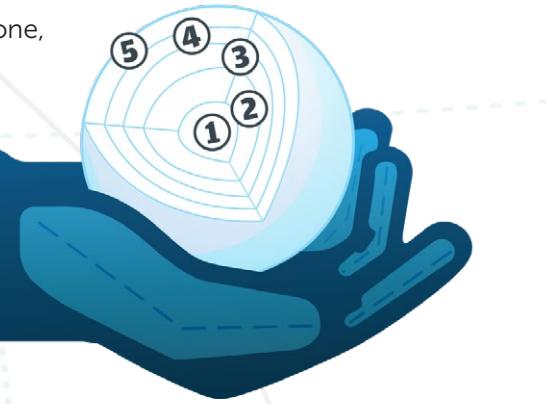
## LIGHTNING

**On hot days**, when the ground heats up quickly, bubbles of hot air float up and create convection currents. As air molecules crash into each other, negatively charged electrons are knocked off and they collect in the bottoms of clouds. Lightning, an intense electrical current, travels from the negatively charged cloud to the positively charged ground. Lightning is hotter than the surface of the Sun, and the superheated air around it expands so fast it explodes. We call that explosion thunder.

## HAIL

**Unlike sleet, which** can only form in cold winter weather, hail occurs in spring, summer, and fall. Hailstones are created by the convection in huge thunderclouds that reach up into the atmosphere where the temperature is below freezing. Each hailstone is actually a raindrop that's been frozen over and over again by bouncing up and down in thunderclouds. As the drops bounce up and down, they are coated again and again by more raindrops that freeze as the wind pushes them back up into the cloud.

**If you sliced** open a hailstone, you'd find rings of ice inside. The number of rings tells you how many up-and-down trips the hailstone made in the thundercloud.



## WEATHER LORE

when clouds appear like rocks and towers,  
The earth will be washed by frequent showers.

On your cloud chart, find the Cumulonimbus (KYOOM-yoo-lo-NIM-bus) cloud. These are the mountainous clouds described by this saying. They often bring big thunderstorms.

## HOW FAR AWAY IS IT?

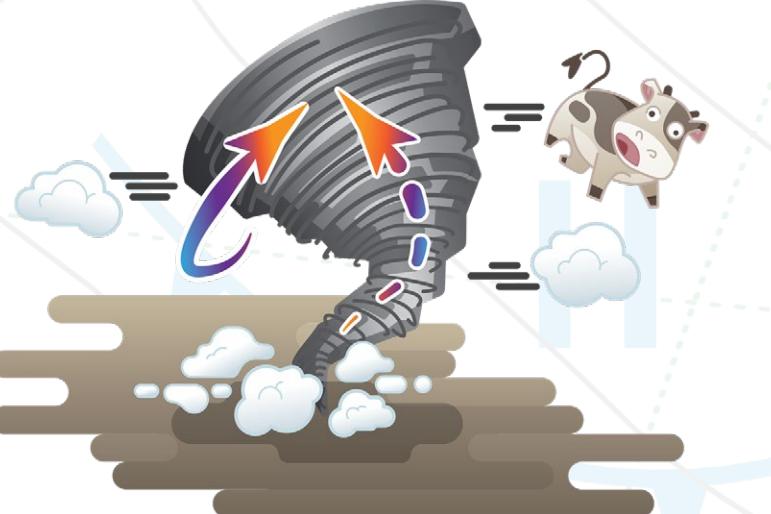
You can estimate how far away lightning strikes are by counting from one to five. As soon as you see a flash of lightning, start counting. Count one number for each second. If you can count to five before you hear thunder, the lightning strike is about a mile away. If you can count to ten, it's about two miles. If you only get to two or three, the lightning struck close by!

# EXTREME AND WILD

Most days, the weather is unexciting. But weather can also pack a real punch. Extreme weather such as tornadoes, hurricanes, or monsoons can do a lot of damage.

## TORNADOES

**Tornadoes can happen** when the energy inside a cloud creates an updraft—a sucking-in-and-up of air. All the air pulled up into the cloud spins and twists. All that twisting air is a tornado. Winds inside a tornado can spin at more than 300 mph. Most tornadoes strike in an area of the United States called Tornado Alley. It includes parts of South Dakota, Minnesota, Wyoming, Nebraska, Iowa, Colorado, Oklahoma, New Mexico, and Texas.



### ENHANCED FUJITA TORNADO SCALE

T. Theodore Fujita developed a scale for classifying the strength of tornadoes.

SCALE	WIND SPEED	DAMAGE
EF0—Light:	65–85 mph (105–137 km/h)	Some damage to gutters, siding, and roofs
EF1—Moderate:	86–110 mph (138–179 km/h)	Roofs stripped, mobile homes overturned, doors blown off houses and windows broken
EF2—Considerable:	111–135 mph (180–217 km/h)	Roofs torn off, houses moved off foundations, mobile homes destroyed
EF3—Severe:	136–165 mph (218–266 km/h)	Severe damage to large buildings, heavy cars lifted off the ground
EF4—Devastating:	166–200 mph (267–324 km/h)	Well-constructed homes completely destroyed, cars thrown
EF5—Incredible:	200+ mph (324+ km/h)	Well-constructed homes swept away, bark stripped from trees, extensive damage to high-rise buildings and schools

# WEATHER

## MONSOONS CHANGE DIRECTION

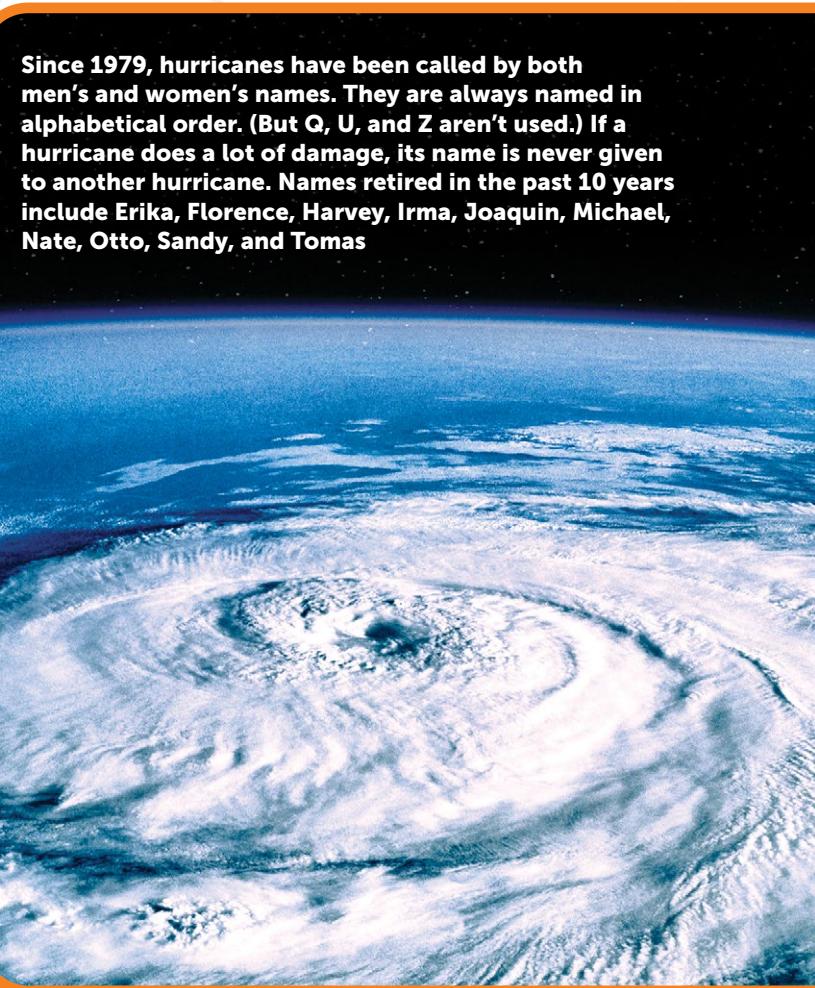
**A monsoon is** a type of wind that reverses direction seasonally. The best example of a monsoon occurs in the Indian Ocean and southern Asia. In warm summer months, a moist southwest wind blows from the ocean toward the land and brings heavy rain. Sometimes it rains so much that it causes floods that affect billions of people. In the winter, the dry monsoon wind blows from the land toward the ocean.

## HURRICANES

**Hurricanes start over** warm ocean water when a group of big thunderstorms comes together and the wind picks up speed. Once the winds reach 74 mph (119 km/h), what was called a tropical storm becomes an official hurricane. In the last ten years, improvements in technology have helped meteorologists predict the path a hurricane will take. But because hurricane winds can get very strong, they sometimes go off in another direction.

**A hurricane watch** means there could be a hurricane in the next 36 hours. During a hurricane warning, a hurricane is expected within 24 hours and people in its path may be told to leave the area.

Since 1979, hurricanes have been called by both men's and women's names. They are always named in alphabetical order. (But Q, U, and Z aren't used). If a hurricane does a lot of damage, its name is never given to another hurricane. Names retired in the past 10 years include Erika, Florence, Harvey, Irma, Joaquin, Michael, Nate, Otto, Sandy, and Tomas



# WEATHER AROUND THE WORLD

**Different parts of** the world have different climates. That means they have different weather.

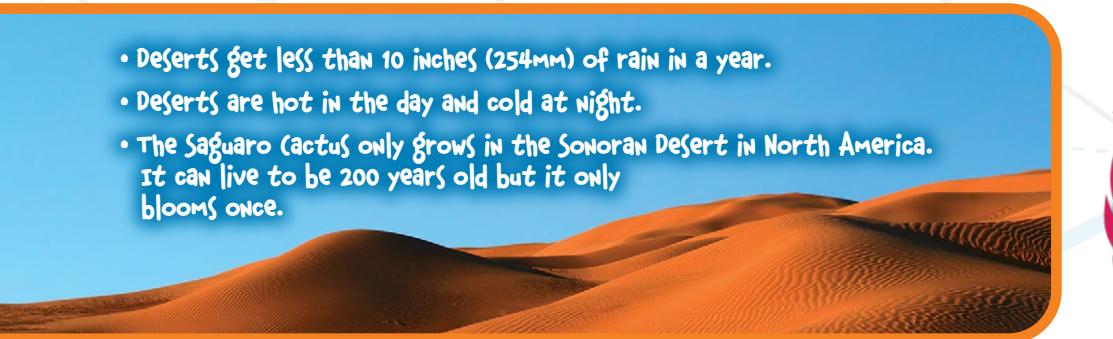
## CLIMATE

**Some parts of** the world have deserts. Others have rainforests. Did you ever wonder why? The reason is **climate** (KLY-mitt). Climate is the weather a place has over a long period of time. It includes the general pattern of weather in the area, its seasons, and extremes like droughts or rainy periods. An area's climate has a lot to do with the atmosphere near Earth's surface.

## HOT or COLD

**The amount of** sunlight that reaches a place helps determine its climate. The equator has a temperature that is almost always the same because the Sun's rays hit it directly. In places where the Sun's rays hit the Earth at an angle, the warmth of the Sun isn't as strong. The closer you move to the North or South Pole (that is, the farther you go from the equator), the colder it is.

- Deserts get less than 10 inches (254mm) of rain in a year.
- Deserts are hot in the day and cold at night.
- The Saguaro Cactus only grows in the Sonoran Desert in North America. It can live to be 200 years old but it only blooms once.



## WET OR DRY

**An area's climate** also depends on how much precipitation it gets. In addition to heat from the Sun, Earth's climate system is created by atmospheric circulation—wind—that moves hot and cold air masses around the globe. Wet areas, like rainforests and jungles, are located in places where these traveling masses of air meet and create rain clouds.

## CLIMATE ZONES

**Climates are grouped** into zones that share similar features.

**There is always** ice in the **polar zone** and only a short time in the summer when the temperature rises above freezing. Parts of northern Canada and Siberia are in the polar zone.

**People who like** warm weather visit the **tropical zone** where the temperature doesn't change much from season to season. The southwestern United States, islands in the Caribbean Sea, southern Africa, and northern Australia are in the tropical zone.

**Places in the** **temperate zone** have four very different seasons with hot summers and cold, snowy winters. Much of Western Europe and the United States is in the temperate zone.



# GLOBAL WARMING

## THE GREENHOUSE EFFECT

**A shifting balance** of energy between the planet and our atmosphere creates the climate. The Sun heats the Earth's surface and the Earth radiates that heat back into space. Like the glass in the greenhouse, gases in the atmosphere trap some heat.

**Over centuries, there** have been cycles of extreme heat and cold. When they occur, life on Earth changes dramatically. Just 18,000 years ago, parts of Europe and the North American continent were covered with ice. So much water was stored in these *glaciers* (GLAY-shurs), that the sea level was about 400 feet lower!

## WHAT'S A GREENHOUSE?

Plants that wouldn't be able to survive outside can grow in a greenhouse—a building with a roof and sides made from glass. Greenhouses work by trapping heat from the Sun, like a car that's parked in sunlight. The glass allows the heat energy and light from the Sun to enter the greenhouse but prevents it from escaping, so the plants stay warm enough to live through the winter.

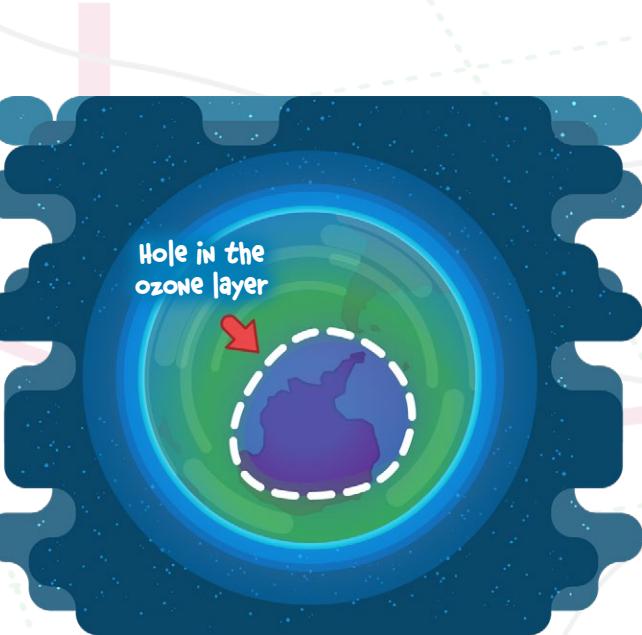


## GREENHOUSE GASES

**Recently, the amount** of carbon dioxide, methane, and nitrous oxide—the “greenhouse” gases that trap heat in the atmosphere—has increased. Having more greenhouse gases in the atmosphere has made the Earth hotter. That's because there are more gases to trap heat in the atmosphere.

**Greenhouse gases** from human activity are causing Earth's average temperature to rise. We burn coal, oil, and gas to heat buildings, run cars and airplanes, and power factories. Burning these fuels releases greenhouse gases into Earth's atmosphere.

**Because Earth's** average temperature is getting hotter, glaciers worldwide have begun to melt. Water from the glaciers could cause the ocean to rise. The melting glaciers could eventually flood every coastal city on the planet.



## THINGS YOU CAN DO TO SLOW GLOBAL WARMING

Most of us can do something to reduce the amount of greenhouse gas we put into the atmosphere.

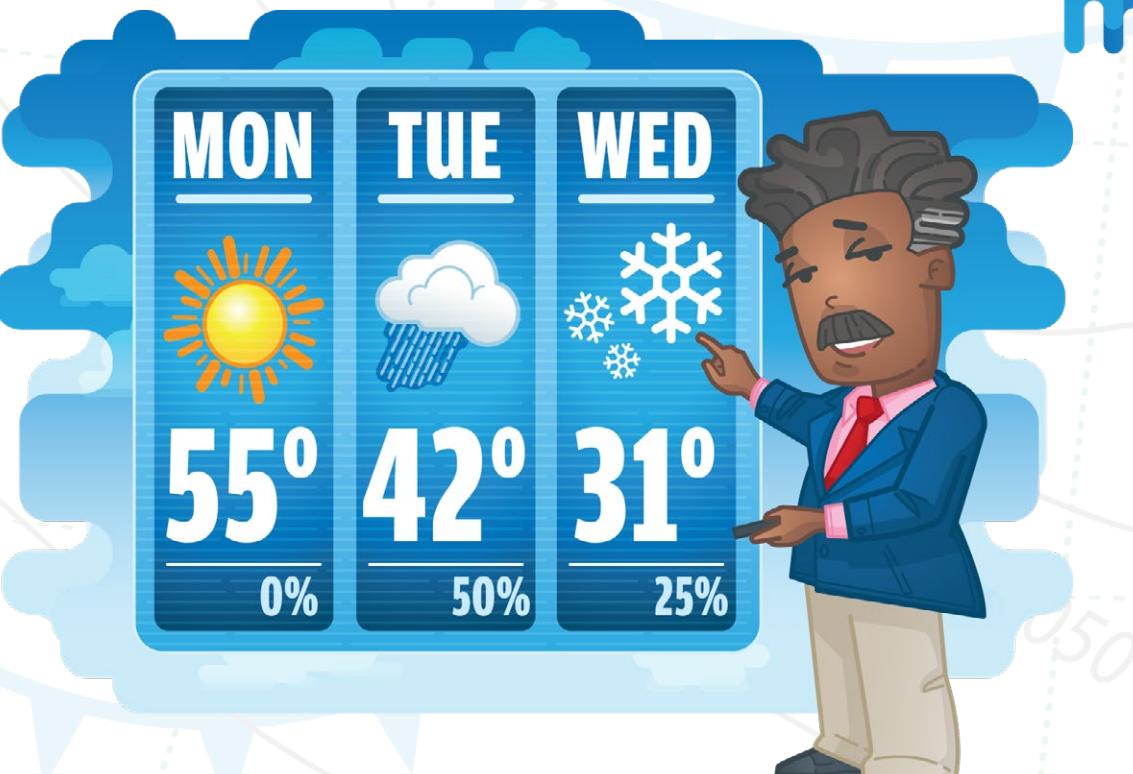
- When you can, walk, use your bicycle, ride in a carpool, or take the bus.
- Turn off lights, the television, and the computer when you finish using them.
- Plant more trees—they absorb carbon dioxide from the air.
- Recycle cans, plastic bottles and bags, newspapers, cardboard, glass, and metal.
- Learn more about renewable energy resources like wind, solar, and wave power.
- Encourage the people you know to buy products that are specially made to save energy.

# METEOROLOGY

**Day and night**, for thousands of years, people have watched the sky and tracked the weather.

## METEOROLOGY

The study of weather is called **meteorology** (MEET-ee-or-OL-uh-jee). Scientists who examine the weather and predict how it will change are called **meteorologists**. They use special instruments to collect information from different parts of the atmosphere. Meteorologists also learn about the weather history of a place. Knowing what happened in the past helps them identify patterns and predict what might happen in the future.

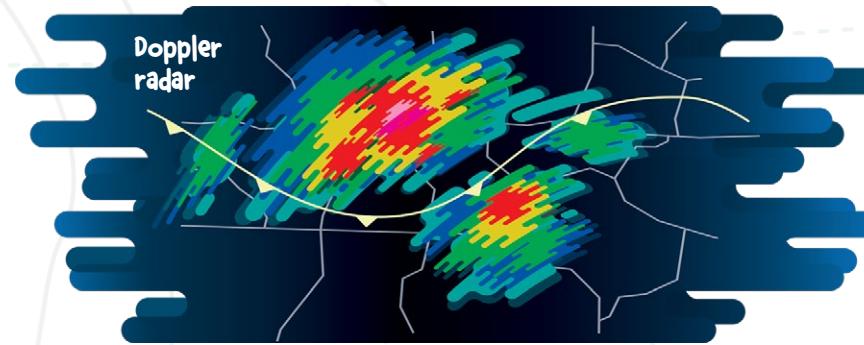


weather stations launch weather balloons every day. These special balloons tell meteorologists about temperature, humidity, and wind speed.



## DOPPLER RADAR SATELLITES AND COMPUTERS

**Meteorologists use Doppler** radar, weather satellites, and computers to tell them what's happening on and around Earth. Satellites orbit the Earth and take pictures of the atmosphere. Doppler radar bounces signals off of rain, snow, bugs, and anything else in the air to create another kind of picture of the location and strength of growing storms. All of this information is put into computers that draw models meteorologists use to predict the weather.

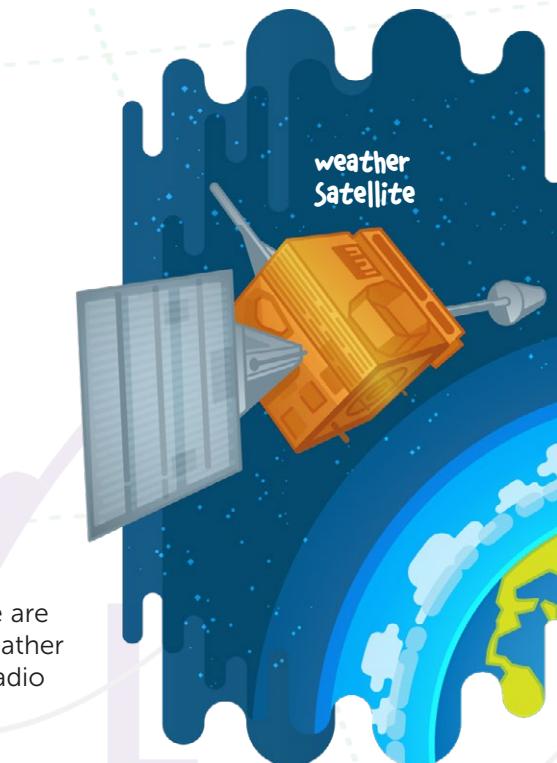


## ALL WEATHER ALL THE TIME

**Now you know** that weather never stops. Maybe that's one reason people are always interested in it. Today there are places you can go to find out what weather events are happening anywhere in the world. There are television channels, radio stations, and web sites that give you weather information 24 hours a day.

## CAN ANYONE MAKE IT RAIN?

There was once a man called the rainmaker. Charles Mallory Hatfield earned his title in 1904 when he promised the people of Los Angeles that he could end their drought within four months. Hatfield built a tower and sent his secret mixture of chemicals into the sky. It started to rain almost immediately! Other people hired him and he traveled all over. Hatfield said he was responsible for more than 500 successful rainmaking events. Today, meteorologists don't believe that Hatfield had a secret formula to make it rain. They think he was just a very lucky man.



# WEATHER WORDS

## HUMIDITY

**Have you ever** heard anyone say, "It's not the heat, it's the humidity that's making me feel so hot"? **Humidity** (hyoo-MID-uh-tee) is the word meteorologists use to describe the amount of water vapor in the air. When the humidity is low, there is less water vapor in the air so the sweat on your body is able to evaporate quickly. When the humidity is high, it takes longer for your sweat to evaporate, so you feel hotter (and sticky).



## FRONTS

**Weather events** like rain and snow, usually happen when a mass of warm air (a low) meets a mass of cold air (a high). The place these two air masses meet is called a **front**. When they meet, the two different air masses struggle for control at the front.

**Cold fronts** are created when the cold air mass cools down the warm air it meets. The cold air pushes the warm air upwards. When that happens, the warm air cools down quickly and forms clouds that give off short bursts of heavy precipitation.



# WEATHER SYMBOLS

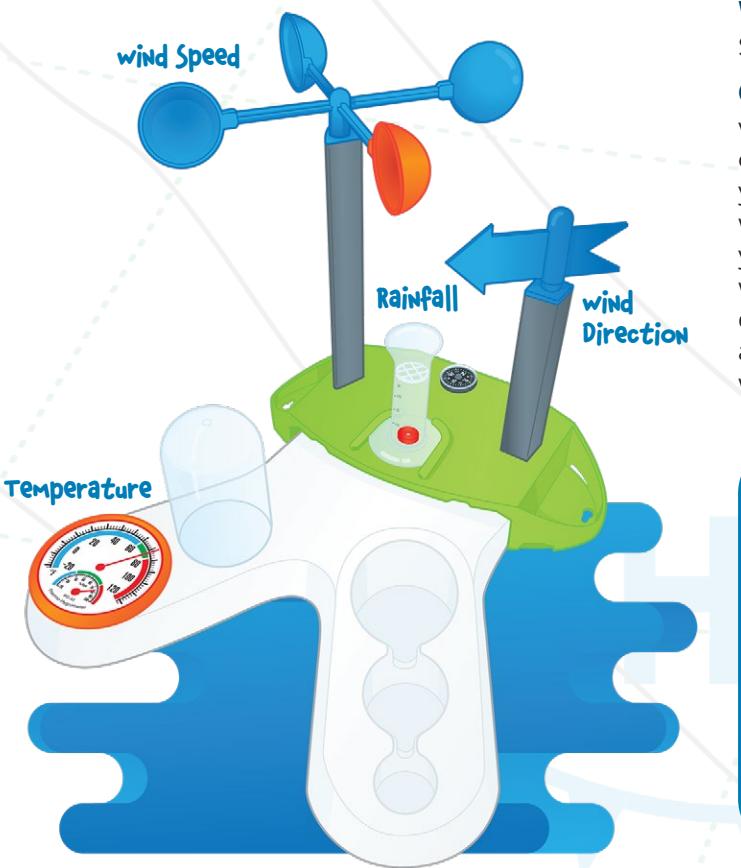
**Have you noticed** that weather maps have funny-looking lines or symbols on them? Each one of them represents a weather condition like snow or rain. These symbols tell you what the weather in different places is like.

## BELLOW ARE THE MOST COMMON SYMBOLS METEOROLOGISTS USE.



# WEATHER PROJECTS

**With your Weather** Station, you can check the temperature, track the wind, find out how much rain fell on your home, and identify weather patterns. Here are some ideas to get you started.



## PROJECT 1 WIND DIRECTION

**When the wind** blows, it pushes against the weather vane on your Weather Station. This makes the arrow swivel and point in the direction the wind is blowing.

**Compare the weather** vane arrow to the directions on the compass. This tells you what direction the wind is blowing. (Unlike your Weather Station, when weather reports give wind directions, they're talking about the direction the wind is blowing from.)



### HOW FAST IS THE WIND BLOWING?

**IF:**

You can follow the one orange cup with your eyes as the anemometer spins ...

You can't follow the one orange cup with your eyes, but the cups aren't spinning fast enough to blur together ...

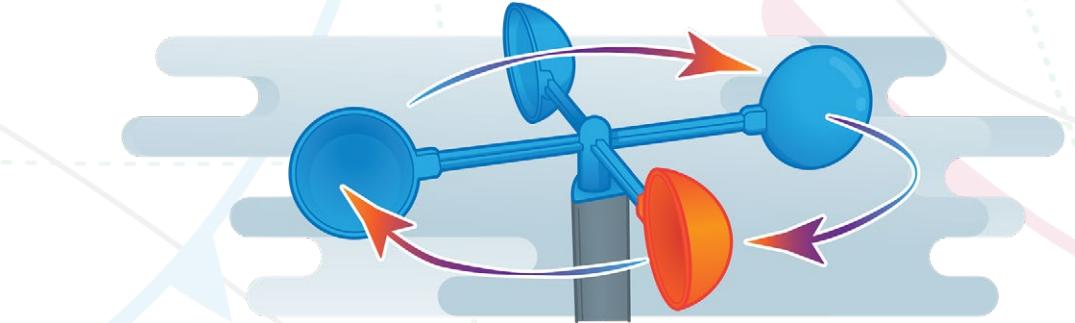
The cups blur together into one donut-shaped disk as the anemometer spins ...

#### THEN THE WIND IS BLOWING THIS FAST:

0-5 mph  
(0-8 km/h)

5-10 mph  
(8-16 km/h)

Over 10 mph  
(16 km/h)



## PROJECT 3 TEMPERATURE

**To find the** temperature using your Weather Station, look at the thermometer mounted on the Weather Lab. Find the number the needle is pointing to. That number is the temperature and it is marked in Fahrenheit.



## PROJECT 4 RAIN

**Your Weather Station's** rain gauge can show you quickly and clearly how much rain has fallen. The little floating disk inside shows you the amount of rainfall. The gauge is marked. Find the mark next to the floating disk. That's how much rain has fallen. Empty your rain gauge often. It holds half an inch (12.7mm) of rain when it's full.

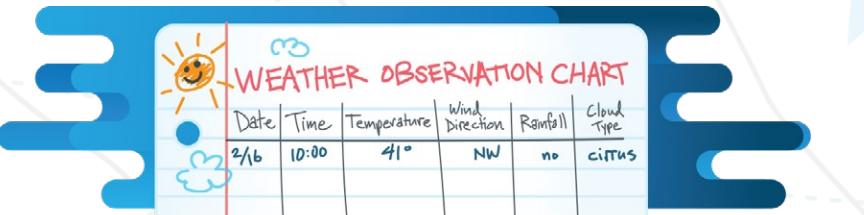


## PROJECT 2 WIND SPEED

**The anemometer** (an-uh-MOM-uh-ter) on your Weather Station measures how fast the wind is blowing. Wind blows into the cups and spins the arms around. The harder the wind blows, the faster the anemometer spins.

## PROJECT 5 CHART THE WEATHER!

**Keep track of** the readings you take with your Weather Station by making your own weather observation chart and using it to find patterns in your local weather. Begin by making a grid that looks like this:



**Make your chart** big enough to last one month. Set your Weather Station up in the same place each time you use it. Take your reading of wind speed and wind direction, temperature, and rainfall at the same time each day. After the month is over, you'll have a set of weather data that you can work with. Can you find any patterns in the data? Did it rain more when it was warmer or cooler? Is there a connection between the temperature and wind speed?

## PROJECT 7 MAKE A WEATHER MAP

**Watch the weather** report on television or look it up in the newspaper. Then use the symbols you learned and draw your own weather map.

## PROJECT 6 WIND DIRECTION AND THE WEATHER

**Using the data** you recorded in your Weather Chart, see if you can answer this question:

**Can you see any connection between the wind's direction and the weather?**

**Make a new** page in your weather observation chart that gives you two or three places to record wind direction each day. See if you can observe and record wind direction three times every day for the next week. For example, you could check the wind direction after breakfast, when you come home from school, and before you have dinner. Once you have data for a week, compare the wind direction with the weather you've recorded. What happened to the weather when the wind changed direction?



## PROJECT 8 BEAT THE METEOROLOGIST

**Find out if** the meteorologists on the local news or in the paper are right. Keep track of their predictions and see how they match up with the readings you take with your Weather Station. Can you use your data to predict tomorrow's weather? See if you agree with the meteorologists. Who's right more often?



## PROJECT 10 SOFT SHELLS

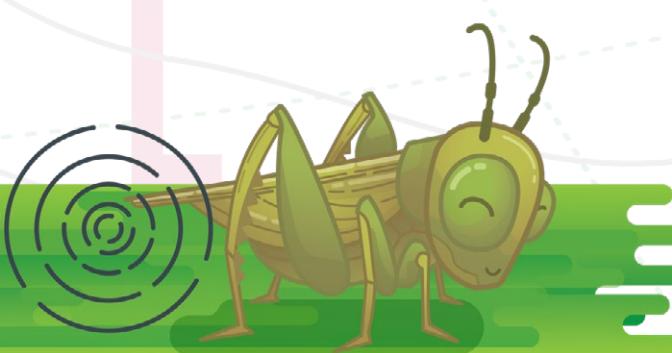
1. Place small pieces of clean eggshell into the large beaker.
2. Fill the beaker with vinegar and set it in its well on the Weather Lab.

**Do you see bubbles?** Those are carbon dioxide bubbles. The acid in the vinegar is creating a chemical reaction with the calcium carbonate in the shell. In time, the acid will completely dissolve the shell. As the ocean becomes more acidic, the shells of some sea creatures are dissolving, just like the eggshell.

## PROJECT 9 SIX-LEGGED THERMOMETERS

**Did you know** that crickets can be accurate thermometers? But you have to know the code to figure out the temperature. First, you count how many times a cricket chirps in 15 seconds. Then, add 37. Whatever number you get for a total is the temperature in degrees Fahrenheit. And it's completely accurate! Or, maybe not completely accurate. Some people say to add 37; others say to add 40. Still others say to add 48. To check it, observe crickets in your area and see if you can figure out the correct formula.

Never take readings or measurements from your weather station during stormy weather. Stay inside when the weather's bad.



## PROJECT 11 WATER FILTRATION

1. Fill the top well of the Filtration Station with small rocks or gravel.
2. Line the middle well with a layer of fabric, paper towel, or a paper napkin.
3. Cover the liner with sand.
4. In a paper cup, make a thick mixture of dirt and water.
5. Slowly pour the muddy water over the rocks in the top well.
6. After the water has run into the bottom well, compare it to the muddy water in the paper cup.

**Rain falling** on the ground can make a muddy mess. The muddy water slowly drips through the soil. It drips through small spaces in rocks, roots, and sand. In time, the water has been filtered so much that it's clean enough to drink! This is called groundwater. (But don't drink your experiment!)

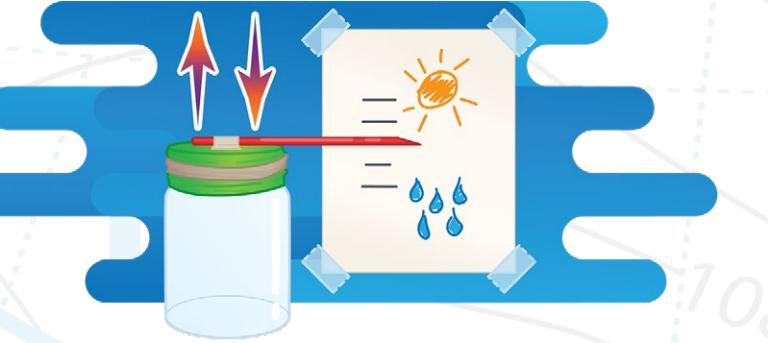


## PROJECT 12 MAKE YOUR OWN BAROMETER

You'll need a glass jar, a balloon, Scissors, a rubber band, a plastic drinking straw (or a wooden skewer), tape, paper, a pen.

1. Cut off the opening of a balloon and discard it.
2. Stretch the remaining balloon piece around the opening of the glass jar. Make sure it is tight across the top—like a drumhead.
3. Secure the balloon to the jar with the rubber band.
4. Tape one end of the straw flat onto the middle of the balloon.
5. Place the jar against a wall that doesn't receive direct sunlight. Tape a piece of paper to the wall (ask first!) and make a mark where the straw touches the paper.
6. Check on your barometer at different times during the day, has the straw moved up or down? If so, mark the location on the paper.
7. Check your barometer every day to see how the straw moves.

**The straw** will point upward with rising atmospheric pressure, because the air outside the jar pushes down on the balloon. With falling atmospheric pressure, the straw will point downward because the pressure inside the jar pushes up on the balloon. Marking the location of the straw every day can tell you what kind of weather to expect.



## PROJECT 13 TEST FOR ACID RAIN

You'll need fresh rainwater from your rain gauge for this experiment.

**Tear up** a couple leaves of red or purple cabbage and place them in a bowl. Pour hot water into the bowl. Mash the leaves with a spoon until you have dark purple water. Pour the cabbage water into the large beaker.

**Pour rainwater** from your rain gauge into the cabbage water. If the cabbage water turns pink, it means the rainwater was mildly acidic.

**The natural dye in the cabbage turns pink when mixed with acids and blue-green when mixed with a base.**



## PROJECT 14 A LITTLE LIGHTNING

You'll need a compact fluorescent light bulb and an inflated balloon.

1. Take a compact fluorescent light bulb and an inflated balloon into a completely dark room or closet.
2. Keep your eyes open and count to 200 (or higher) s-l-o-w-l-y.
3. Once your eyes are adjusted to the dark, rub the balloon on your hair vigorously. Continue rubbing as you feel your hair being pulled toward the balloon.
4. When you've generated lots of static electricity, touch the balloon to the glass part of the bulb.

**The bulb** will begin to glow. That's because the extra electrons in the balloon jumped to the positively charged bulb, making an electric current—like lightning!

## PROJECT 15 TREES ARE COOL

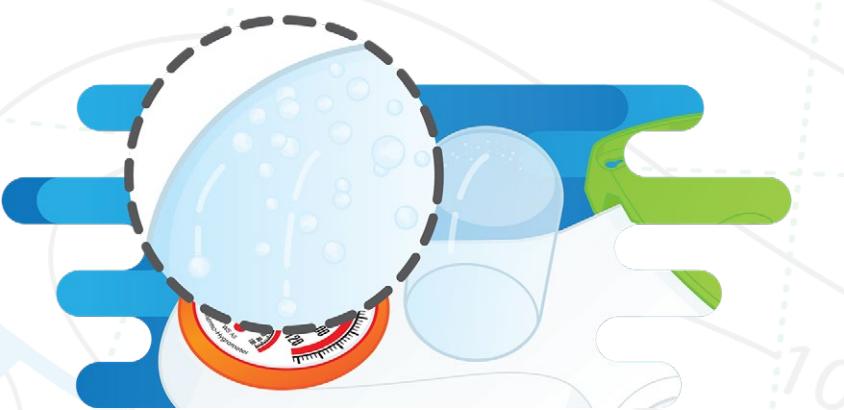
1. On a warm, sunny day, find some soil that is in direct sunlight. Set your thermometer in the Sun for 5 minutes. Record the temperature.
2. Find some nearby soil that's been shaded by trees for several hours. Set your thermometer in the shady area for 5 minutes.

**You will probably** notice a difference in the temperature. In addition to absorbing carbon dioxide and releasing oxygen, trees help prevent global warming by providing shade from the Sun's rays.



## PROJECT 16 CONDENSATION STATION

**Pour some** warm (not hot) water in the base of the Condensation Station. Place the large test tube upside down over the water. Press down on the tube to get a good seal. As the warm water vapor (a gas) inside the tube rises, it's trapped inside the tube. The water molecules condense (become liquid) on the walls of the tube. When the water droplets combine, they can become heavy enough to drip down the side—just like rain!



## PROJECT 17 UNDER PRESSURE

**Do this one outside or over a sink.**

1. Fill the large test tube part way with water.
2. Cover the mouth of the tube completely with a playing card or other stiff card.
3. Hold the card tightly in place with your hand and turn the tube over.
4. Let go of the card.

**If you did it right,** the card stayed in place and the water stayed inside! That's because atmospheric pressure—the same pressure that makes weather—is pushing on you, and on all sides of the container, including the card on the bottom.

## PROJECT 18 SOLAR OVEN

**Do this outdoors on a warm, sunny day.**

1. Line the large test tube with aluminum foil—shiny side facing inside the tube. Make sure you cover all the sides and the bottom.
2. Place a chocolate chip inside the tube.
3. Set the tube so that Sun is directed inside the tube. See how long it takes the chip to get soft.



**Solar radiation**—the heat from the Sun—keeps our planet warm and livable. The aluminum foil reflects the Sun's rays and concentrates the heat inside the tube. In some countries, solar ovens are helping people cook without cutting down trees for fuel.

# CLOUD CHART

## CIRRUS

(SEER-iss)

**Above 18,000 feet (5.48 km).**

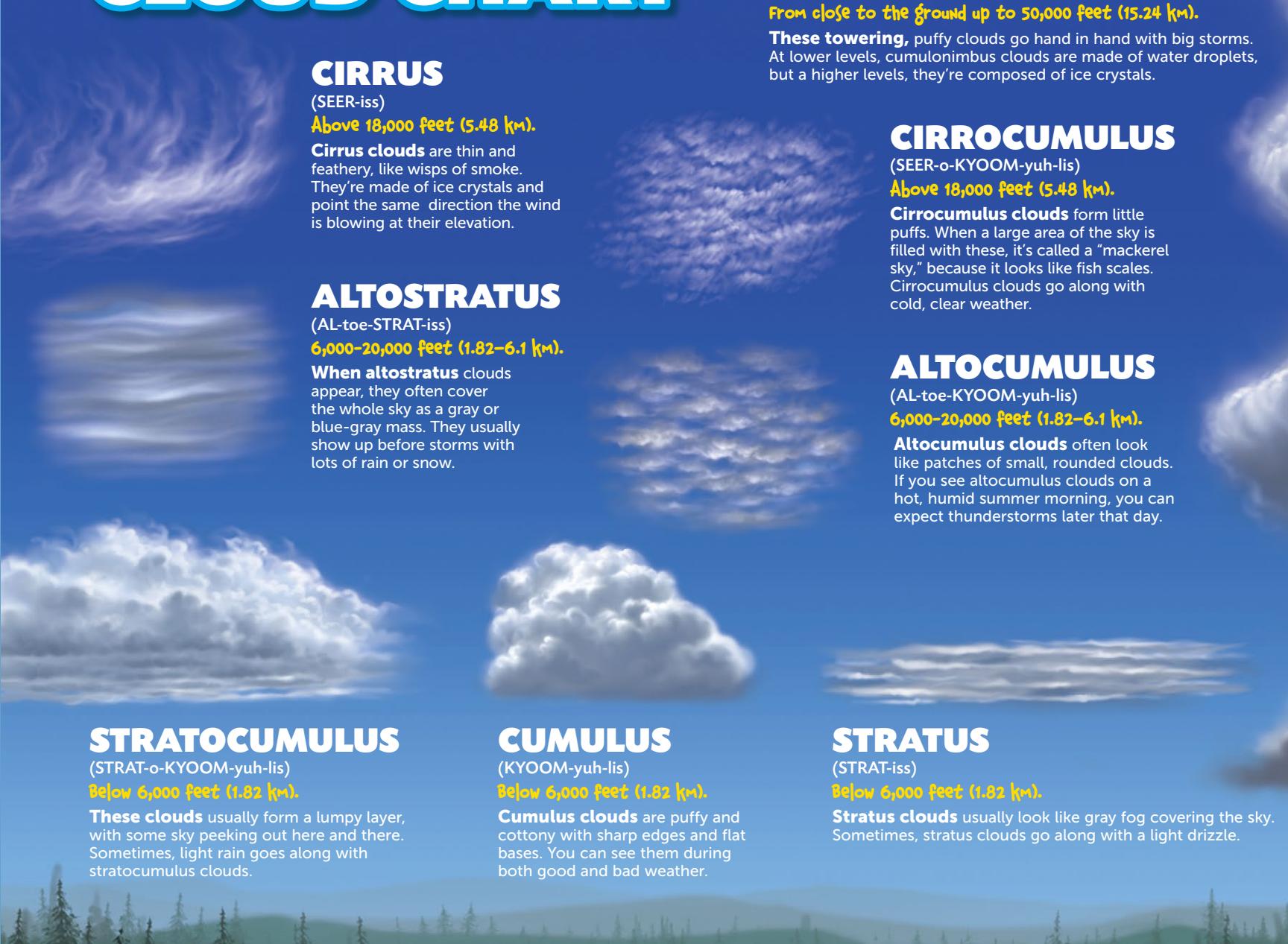
**Cirrus clouds** are thin and feathery, like wisps of smoke. They're made of ice crystals and point the same direction the wind is blowing at their elevation.

## ALTOSTRATUS

(AL-toe-STRAT-iss)

**6,000-20,000 feet (1.82-6.1 km).**

**When altostratus clouds** appear, they often cover the whole sky as a gray or blue-gray mass. They usually show up before storms with lots of rain or snow.



## CUMULONIMBUS

(KYOOM-yoo-lo-NIM-biss)

**From close to the ground up to 50,000 feet (15.24 km).**

**These towering, puffy clouds** go hand in hand with big storms. At lower levels, cumulonimbus clouds are made of water droplets, but a higher levels, they're composed of ice crystals.

## CIRROCUMULUS

(SEER-o-KYOOOM-yuh-lis)

**Above 18,000 feet (5.48 km).**

**Cirrocumulus clouds** form little puffs. When a large area of the sky is filled with these, it's called a "mackerel sky," because it looks like fish scales. Cirrocumulus clouds go along with cold, clear weather.

## ALTOCUMULUS

(AL-toe-KYOOOM-yuh-lis)

**6,000-20,000 feet (1.82-6.1 km).**

**Altocumulus clouds** often look like patches of small, rounded clouds. If you see altocumulus clouds on a hot, humid summer morning, you can expect thunderstorms later that day.

## CUMULUS

(KYOOM-yuh-lis)

**Below 6,000 feet (1.82 km).**

**Cumulus clouds** are puffy and cottony with sharp edges and flat bases. You can see them during both good and bad weather.

## STRATUS

(STRAT-iss)

**Below 6,000 feet (1.82 km).**

**Stratus clouds** usually look like gray fog covering the sky. Sometimes, stratus clouds go along with a light drizzle.



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