WARNING: This kit contains citric acid. Avoid contact with eyes. In case of contact with eyes, flush well with water for 15 minutes and seek medical attention. Keep out of reach of young children. When water is added to a mixture of Citric Acid, vinegar, lemonade or lemon juice and Baking Soda, the mixture will quickly and intensely bubble which produces carbon dioxide gas. If the container is sealed, container can build pressure and burst. Always use open (unsealed) containers such as cups/bowls when working with mixtures of Citric Acid, vinegar, lemonade or lemon juice and Baking Soda near water.

Adult Supervision Required

NOTE: When making the volcano, it can get messy. Especially when using food coloring and plaster, protect your skin and work surface from spills. Wear cold clothing and if you get any food coloring on your skin, wash it off with soap and water.
Introduction

Rain, wind, snow, hail, thunder, lightning, heat waves. Weather sure can be weird.

There are all kinds of forces at work in nature that create all kinds of weather conditions—everything from a little bit of drizzle to massive storms like hurricanes.

In this kit, you’ll find everything you need to make your own weather. You’ll unleash tornadoes, explode a volcano and create a blizzard! Along the way, you’ll learn some really cool science about weather and what makes it so weird!

In each activity, you’ll get to act and think like a real scientist. You’ll compare things, you’ll ask questions and you’ll also make observations using your different senses.

Let’s start a storm!

What’s included in the kit:
• Test tube with cap
• Color tablets (blue and red)
• Plastic bottles (2)
• Vortex connector
• 15 Beads
• Balloon
• Instant snow
• Blue measuring spoon
• Volcano mold (Base & Cap)
• Baking soda
• Citric acid

What you’ll need to get or use:
• Water
• Vegetable oil
• Tablespoon
• Bowl
• Ice
• Newspaper or paper towels
• Pie Pan or Plate
• Liquid dish soap
• Measuring cup
• Stopwatch (Optional)
• Wool cloth or clothing
• Metal surface, such as door knob
• Brown paper bag

Fun Fact:
Meteorology is the scientific study of weather.

Fun Fact:
Weather and climate don’t mean the same thing. Weather is the day-to-day condition of the atmosphere. Climate means atmospheric conditions over a long period of time.

WARNING: Never mix citric acid, baking soda in closed container.

Activity #1: Catch the Wave!

We’re going to make water move all by itself!

What you need from your kit:
• Test tube
• Blue color tablet

What you’ll need to get or use:
• Water
• Vegetable oil
• Tablespoon

Let’s get started!
Step 1: Fill the test tube about halfway with water. Add the blue color tablet and let it dissolve. Let’s make some observations! How does the color of the water change? Does the tablet make any bubbles?

Step 2: Pour 2-3 tablespoons of vegetable oil into the test tube (filling about half of the remaining empty space in the test tube). Screw the cap onto the test tube. Let’s make some observations! Do the oil and water mix? Does the color change in the tube?

Step 3: Tip the test tube back and forth. Did you catch a wave?

**Dark and Stormy Science**

What causes waves? Mostly wind. As wind blows across water, pressure and friction transfer energy from the air to the water and waves are formed. The size of the wave depends on how strong the wind is, how wide an area of water it blows over, how deep the water is and how long the wind lasts. The greater each of these factors, the bigger the wave.

Very large ocean waves are called **tsunamis** (soo-na-mes). They’re not caused by wind; they’re caused by underwater earthquakes or volcanic eruptions. Regular waves are usually only 6 feet high; the highest tsunami wave ever was 1700 feet! It was caused by a giant landslide in Alaska. Tsunamis involve huge amounts of water and a lot of energy. They can cause massive damage when they reach land.

So how did you create your wave? Chemistry! The dye in your color tablet doesn’t mix with oil, but it does mix with water—that’s why the water turned blue. When you tipped the tube back and forth, the tiny droplets of colored water joined together to make a wave.

**Fun Fact:**
Surfers ride the crests of waves. The highest wave ever surfed was 80 feet!

**Activity #2: Give It a Whirl**

Tornadoes are one of nature’s most awesome storms, but they’re dangerous too. What’s a safe way to look at a tornado? Make your own in a bottle!

**What you need from your kit:**
- Plastic bottles (2)
- Vortex connector
- Beads

**What you’ll need to get or use:**
- Water

Let’s get started!

**Step 1:** Fill one of the bottles slightly more than \( \frac{3}{4} \) full of tap water. Attach one end of the vortex connector to the filled water bottle and attach the other end to the second, empty bottle.

**Step 2:** Flip the bottles over so that the one with the water is now on top. Give the bottles a strong swirl. What happens? Does the water spin? For how long?

**Step 3:** Wait for the water to calm down and drain into the lower bottle.
Unscrew the bottles from the vortex connector. Now add the beads to the water.

**Step 4:** Repeat Steps 1 and 2, reconnecting the bottles to the vortex connector, flipping so the bottle with the water is on top and giving the bottles another twirl. What happens to the beads? Do they get sucked into the middle of the swirling water?

### Dark and Stormy Science

Tornadoes are very powerful storms. They’re also very mysterious. Scientists have been studying them for years, but still aren’t sure exactly how tornadoes form. Here’s what they do know: Tornadoes, which are violently rotating columns of air, typically develop from thunderstorms called supercells. These supercells contain an area of rotating air high up in the atmosphere. Rain drags descending air, called a downdraft, to the ground, which brings the rotating air with it. In order to be called a tornado, this rotating air has to be in contact with both the ground and the clouds at the same time.

Tornadoes are usually shaped like funnels. Most have wind speeds less than 110 miles per hour and only travel a few miles. But some tornadoes are a lot stronger. The highest wind speed ever recorded by a tornado is 300 miles per hour, which is the highest wind speed on the planet ever! One of the most famous tornadoes struck Missouri, Illinois and Indiana almost 100 years ago. It was on the ground for more than 200 miles!

How do tornadoes pick up debris? The strong horizontal winds at the surface dislodge objects from the ground. Some of this stuff gets caught in the upward air rushing toward the center of the funnel—think of the inside of a tornado like a blender. Tornadoes can lift all kinds of debris into the storm—sometimes even cars and parts of buildings—and carry it a long distance. Lightweight debris, such as pieces of paper, has been found as far as 300 miles away from where the tornado swooped it up.

So how did you create a tornado in a bottle? When you gave the bottle a swirl, you transferred momentum from your hand to the water. The water near the connector had the same amount of momentum as water higher up in the bottle, but less distance to travel because the area around the connector is narrower, so the water spun faster. Voila, you created a vortex, which is what scientists call rotating fluid or air.

**Fun Fact:**
The United States has the most tornadoes of any country.

**Fun Fact:**
A tornado that develops over water is called a waterspout.

**Fun Fact:**
In the northern hemisphere, tornadoes rotate counterclockwise. In the southern hemisphere they rotate clockwise.

**Fun Zone!**
- Try more fun experiments with your tornado and see if you get different results.
- What happens if you fill the bottle with more or less water?
- What happens if you add lighter objects, like glitter?
- Do you think it makes a difference how hard you swirl the bottles to start the activity? Can you get the vortex to spin longer? Try it and see!
- If you used larger two-liter bottles, what would happen?
Activity #3: Hot and Cold

What happens when hot and cold air collide? Let’s find out!

What you need from your kit:
- Plastic bottle
- Balloon

What you’ll need to get or use:
- Hot water (not boiling)
- Bowl
- Ice water

Let’s get started!

Step 1
Fill the bottle with hot water. Swirl the water around to make sure the water heats up the bottle.

Step 2
Pour out the water. Let’s make some observations! Put your hand on the bottle. Does it feel warm?

Step 3
Fill the bottle again, this time only one-fourth full of hot water.

Step 4
Blow up the balloon with a small amount of air and twist at bottom to keep air inside. While still twisted, fit the opening over the mouth of the bottle and let untwist. The balloon should still be filled with air.

Step 5
Fill a large bowl with ice water and put the bottle in the bowl. What happens to the balloon? How does the bottle feel now—hot or cold?

Dark and Stormy Science
When you first put the balloon over the mouth of the bottle, hot air inside the bottle was expanding and helped keep the balloon inflated. At the same time, the ice water was cooling air outside the bottle. This colder outside air began contracting and pushed on the balloon, causing it to collapse.

When it comes to weather, this clash of hot and cold air produces fronts, which are the main cause of weird and wild weather. Fronts are boundaries that separate air masses with different temperatures and humidity—for example, where cold, dry air collides with warm, moist air. Cold fronts are the leading edge of a temperature drop off; they bring thunderstorms and other kinds of severe weather. Warm fronts are the leading edge of a warm air mass; they usually bring fog and rain. Cold air is denser (heavier) than warm air. Because of this, it can replace warm air faster and produce sharper changes in temperature.
Fun Fact:
Cold fronts move east to west. Warm fronts move toward the North & South poles.

Fun Fact:
On weather maps, cold fronts are marked with lines of blue triangles. Warm fronts are marked with lines of red semicircles.

Activity #4: Let It Snow

Snow is one kind of weather that a lot of people really love. You can build a snowman or snow fort, go skiing or have a snowball fight. Let’s make it snow indoors!

What you need from your kit:
- Instant snow
- Blue measuring spoon

What you’ll need to get or use:
- Water
- Pie pan or Plate
- Tablespoon

Let’s get started!

Step 1
Let’s make some observations! Pour some of the instant snow in your hand. What does it look like? How does it feel?

Step 2
Scoop 10-12 blue measuring spoons of the instant snow into a mound in the middle of the pie pan or plate.

Step 3
Add water a tablespoon at a time to the mound of instant snow. What happens? Use your spoon to mound up the snow again and add some more water.

Step 4
Now check out your snow. What does it look like? How does it feel? How did it change from Step 1?

Your snow should last for days. If it dries out, add more water. If you want to make it more like real snow, put it in the refrigerator or freezer. What happens?

Dark and Stormy Science
Your instant snow is made from something called a super absorbent polymer. This chemical can hold more than 300 times its own mass in water. When you added water to the instant snow, the polymer soaked up the liquid and swelled up into much bigger flakes.

Of course, that’s not how real snow is made. Snow starts as water vapor up in the clouds. When the temperature is very cold, this vapor turns into ice crystals. These crystals bump into each other and combine to form snowflakes. Although every snowflake is different, they all have six sides. Some are made up of as many as 200 ice crystals. As the snow crystals grow, they become heavy and fall to the ground—that’s snow!
Fun Fact:
Heavy snowfall is called a snow storm. Heavy snowfall with wind is called a blizzard.

Fun Fact:
The whiteness of snow reflects sunlight. That’s why when there’s snow on the ground, temperatures are even colder.

Activity #5: Lava Blast!
Volcanoes can shoot rocks and gases miles into the air and their lava flows can outrace a speeding car. Let’s try that at home!

What you need from your kit:
- Volcano mold
- Baking soda
- Blue measuring spoon
- Citric acid
- Red color tablet

What you’ll need to get or use:
- Newspaper or paper towels
- Pie pan or plate
- Water
- Measuring cup
- Liquid dish soap

Let’s get started!

Step 1
Start by covering your work area with newspaper or paper towels and set your pie pan or plate on top of it. Now place the volcano base (without cap) in the middle of the pan. Be sure to work on a hard, flat surface in the kitchen, basement, garage or some other area away from furniture and carpeting. This could get messy!

Step 2
Open the container of baking soda. Let’s make some observations! What does it look like? What color is it? How does it smell? How does it feel?

Step 3
Using the blue measuring spoon, pour 6 scoops of baking soda into the volcano base. Screw the Volcano Cap onto the Volcano Base.

Step 4
Fill a measuring cup with 1/4 cup of water. Open the container of citric acid. Let’s make some observations! What does it look like? What color is it? How does it smell? How does it feel? How is it similar to or different from baking soda?

Step 5
Measure 8 blue measuring spoons of citric acid and add it to the water. Also add a red color tablet and 5 blue measuring spoons of liquid dish soap. Use the blue measuring spoon to mix everything together in the
measuring cup.

**Step 6**
Slowly pour this liquid mixture into the Volcano Base through the hole in the Volcano Cap. Step back as it gets ready to erupt!

**Step 7**
What happened? Did your volcano explode? How high did the “lava” shoot? Did it flow down the sides? Did the volcano make any noise? Did it shake when it erupted?

**Step 8**
Once your volcano has finished erupting, rinse it out and wash your measuring cup and spoon. Repeat the activity as many times as you'd like—feel free to do some experimenting of your own. Change the amounts of water, citric acid, baking soda and dish soap. Add more or less—you’re the scientist! How is each eruption different? Can you make the explosion bigger or smaller? Give it a try! See what works and what doesn’t and try to figure out why.

**Dark and Stormy Science**
A volcano is an opening in the Earth’s surface, or crust. This opening allows hot molten rock, called magma, and gases to explode from below. You didn’t have any actual magma in your volcano, but you did create an explosive gas. When you combined citric acid and baking soda, a chemical reaction occurred. One of the products of this reaction was the gas carbon dioxide (or CO$_2$), which you also find in real volcanoes. The CO$_2$ built up inside your volcano until it erupted. The dish soap was added to create more spectacular foaming bubbles.

Near a volcano, eruptions can cause rain, lightning and thunder. All of the ash particles that get thrown into the air from an exploding volcano attract and collect water droplets, which is why it rains.

Volcanic eruptions can even change the weather on the entire planet. The biggest explosions produce huge amounts of gas and ash that circle the earth. These tiny particles of debris form clouds that can block incoming energy from the sun and cause temperatures to cool across the globe. Most recently this happened in 1991, following the eruption of Mount Pinatubo in the Philippines. If the debris particles are larger, they let sunlight in, but don’t allow heat from the earth to escape. In this case, temperatures across the planet would be warmer. These changes in temperature, whether hotter or colder, will affect things like wind patterns and where storms occur.

**Fun Fact:**
Volcanoes are found on other planets and moons. Jupiter’s moon Lo is the most volcanically active body in our solar system. It also has the hottest lava—almost 3,000°F!

**Activity #6: Can You Hear the Lightning?**
If you know how to count, you know how to tell how far away you are from a lightning strike.

**What you’ll need to get or use:**
- Stopwatch (optional) or other device with timer

Let’s get started!
Step 1
The next time there’s a thunderstorm, find a safe place in your house to watch for lightning.

Step 2
When you see a flash of lightning, use a stopwatch to count the seconds between when you see the lightning and when you hear thunder. If you don’t have a stopwatch, here’s how you can count seconds: Say “one Mississippi, two Mississippi, three Mississippi…. ” Each “Mississippi” is one second.

Step 3
The time between lightning and thunder tells you how far away you are from where the lightning hit. For every five seconds that you counted, that means the storm is 1 mile away. So if you counted 10 seconds between lightning flash and thunder, the storm is 2 miles away. If you counted 15 seconds, the storm is 3 miles away. Divide the number of seconds you counted by 5 to see how far away the storm is.

Step 4
If you see lightning and hear thunder at the same time… yikes! That means the lightning is super close!

Dark and Stormy Science
Lightning is very hot. How hot is it? Lightning can reach temperatures of 54,000 degrees Fahrenheit. That’s six times hotter than the sun! It heats the air along its path, causing the air to rapidly expand. This expanding and collapsing air creates a sound wave that we hear as thunder. Lightning and thunder actually take place at the same time, but because light travels faster than sound, you see the bolt of lightning before you hear the rumble of thunder.

Fun Fact:
Lightning more than 15 miles away is too far to hear its thunder. People call this heat lightning.

Fun Zone!
You can make your own thunder, and you won’t need lightning. Find a brown paper lunch bag. Blow into the bag until it’s full of air. Twist the open end and close it with your hand. With your empty hand, smash the air-filled end of the bang. POW! The air that rushed out of the bag pushed away the air already surrounding the bag, the same way that lightning causes air to expand and push. The air moves forward in a wave and this wave reaches your ear as sound.

Activity #7: In a Flash

You never want to get close to real lightning, but you can make a safe version at home.
What you need from your kit:
  - Balloon

What you’ll need to get or use:
  - Wool clothing, such as a sweater
  - Metal surface, such as a door knob

Let’s get started!

Step 1
Blow up the balloon and tie it off at the end.
Step 2
Take the balloon and your piece of wool into a room like a bathroom or basement, where there isn’t a lot of light. Make the room as dark as you can.

Step 3
Rub the balloon against the wool 10 times or more, really fast.

Step 4
Move the balloon close to something metal. Zap!

Dark and Stormy Science
Lightning is a bright flash of electricity. It forms in a thunder cloud when small bits of ice bump into each other. These collisions create an electric charge and pretty soon the cloud is full of electric charges. Positive charges form at the top of the cloud and negative charges form at the bottom. A positive charge builds up on the ground beneath the cloud and attracts the negative charge. When these two charges, the positive and negative, meet and connect, you get lightning.

So how did you make lightning with a balloon? When you rubbed the balloon and wool, you created an electric charge on the balloon, just like the charge created in thunder clouds. As you moved the balloon close to the metal, the charge on the balloon connected with the charge from the metal and caused a little spark.

Fun Fact:
How fast is lightning? It can travel at 140,000 miles per hour!

Fun Fact:
There are 16 million lightning storms in the world every year!

Fun Fact:
Trees attract lightning because they are filled with moisture and water is an excellent conductor of electricity. Oak trees, because they’re very tall, tend to get hit by lightning more than other trees.