WEATHER OR NOT
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OVERVIEW

Brief Description of the Activities

In *Weather or Not*, students will explore how weather is created by conditions in the air around us. Students will investigate air and other fluids using teacher displays and hands-on activities.

Appropriate Ages

*Weather or Not* is appropriate for students in grades 2 to 7.

Time

*Weather or Not* includes 12 activities. Each activity in *Weather or Not* can be completed in one hour.

Preparation Prior to Presentation

Most activities in *Weather or Not* require some preparation prior to presentation in the classroom. Read each activity to be presented at least one day in advance and collect the required materials.

Test all displays and activities prior to presenting in the classroom.

Read and become familiar with questions and explanations included in the activities presented.

NOTE: Classroom demonstration *OUR PET VORTEX* requires two days for construction.

Student Outcomes

At the end of the activities, students will be able to explain that:

1. Air contains moisture.
2. We live in a fluid, which is air.
3. Warm air rises and cool air sinks, and this process is called convection.
4. Precipitation is the formation of rain, snow, or hail from moisture in the air.
SCIENCE CONTENT

Meteorology

Meteorology is the study of weather processes. In many ways, meteorology is the study of our atmosphere and the air around us. By measuring air conditions, meteorologists can measure and forecast the weather. A drop in air pressure, for example, warns of an impending storm. Meteorologists use a variety of tools from thermometers to weather satellites to measure and forecast weather conditions. Thermometers measure air temperature, barometers measure air pressure, and a psychrometer is used to measure air humidity, or the amount of water vapor in air.

Air Temperature

Temperature is a measurement of the kinetic energy, or motion, of the atoms in a substance. The atoms in cool air are moving more slowly than the atoms in warm air. Because of the high energy of the atoms in warm air, warm air is able to retain moisture as water vapor. When air cools, the moisture in the air condenses, becoming liquid water or solid ice crystals. Air temperature can change due to the temperature of surrounding air or surfaces, such as air warming over warm water and cooling over cool land. Air temperature can also change due to changing air pressure. When under higher pressure, air temperature increases and when under lower pressure, air temperature decreases.

Air Pressure

Air pressure is the force exerted on you by the weight of air molecules. It also can be described as the amount of force felt by a surface due to the surrounding air. The surface that feels the force of the surrounding air can be an instrument, like a barometer, or a package of air itself. Air pressure is due to the density or amount of air in a given volume, of the air and the speed at which the air is moving. Quickly moving air such as air in front of an impending storm has lower air pressure than slowly moving air. Air is a gas, so it is compressible. This means that the density (and therefore the air pressure) can change depending on the pressure of the surrounding air or other forces. Air at sea level is under more pressure, and is therefore denser, than air at higher elevations.

Humidity

Humidity is a measurement of the amount of water vapor in the air. Warm air is able to contain more water vapor than cool air. More than 75% of the composition of air is
nitrogen, with oxygen making up another 20% of our atmosphere. The remaining 5% is composed of gasses such as argon and carbon dioxide are present in the air we breathe, as is water vapor. Image from http://i4weather.net/sling.jpg.

**Evaporation**

Evaporation is a process in which something is changed from a liquid to a vapor. Water vapor is steam. Water doesn't need to boil to evaporate or release steam. You may have had the experience of placing a wet dish on the counter and returning a few hours later to find that the water has evaporated off the dish, leaving it dry. Water molecules evaporated from the surface of the liquid water in the dish and entered the air in the room. In a pan of hot water, water molecules move much faster than if they were at room temperature. These water molecules will evaporate more rapidly and the steam released is clearly visible.

**The Water Cycle**

The water cycle is the constant circulation of water between atmosphere, land, and sea by evaporation and precipitation. Water evaporates from rivers, oceans, and other sources on Earth into our atmosphere, just like the steam rising from a pan of boiling water. Once this water enters the air, it rises and cools, eventually condensing back into liquid water droplets and forming clouds. You may have noticed condensation on the outside of a cool glass or pitcher. The water vapor in the air condenses onto the cool surface, creating droplets. In clouds, these droplets are created by condensing around small particulates or ions. When they become large and heavy, the water droplets fall, or precipitate, to the ground as rain, snow, or hail. The cycle continues as the water on the ground evaporates again up into the air. Image from http://www.educ.uvic.ca/faculty/mroth/438/WEATHER/watercycle.html

**Convection**

The process of convection is when hot air rises and cold air falls. This statement describes convection, or the transfer of heat in a fluid due to the motion of currents. We can imagine following a small packet of air as it moves along in a convection current. Near the ground, the air is warmed by sunlight reflecting off the earth’s surface. As the air warms up, it occupies a larger space and becomes less dense. Density describes how much matter there is in a certain volume. The
same amount of air is in the warm packet of air as there was in the cool packet of air; it simply takes up more space now that it is warmer. The warmer air floats upward away from the ground and gradually cools. As it cools, the packet of air shrinks and becomes denser. The air falls back down towards the ground.

Image from http://earth.geol.ksu.edu/sgao/g100/plots/

**Adiabatic Expansion**

When air (or any fluid) quickly expands into a larger volume, it cools, and when it quickly contracts into a smaller volume, it warms. Another way to state this is that air temperature decreases as pressure decreases, and air temperature increases as pressure increases. This characteristic of fluids is called adiabatic expansion and contraction. When one blows onto a hot cup of coffee or bowl of soup, the process is adiabatic expansion. When one quickly blows air through pursed lips, it expands out over the bowl of soup. As the air expands, it cools. The heat from the soup is transferred into the cool air, and the soup becomes palatable. The air cools because it’s quickly moving from a small space (pursed lips) to a bigger space (soup-bowl-sized).

An example of adiabatic expansion in weather is the process of some cloud formations, very large packets of air rise up from the ground. These air packets are so large (some larger than a football field!) that they don’t interact strongly with the air surrounding them. We can imagine the air packet encased in a large, thin bag or balloon. As this balloon of air rises, its pressure decreases, allowing it to expand and cool. Air pressure is much greater close to the ground than at higher elevations in the atmosphere.

One way to think of the cooling due to expansion is to consider the molecules inside the balloon of air. When they were closer together, they moved quickly and bounced off of one another often. As the air balloon rises and expands, the molecules have more room to move around, so they don’t hit one another as often and they slow down. Temperature is a measurement of molecular motion. As the air molecules were moving more quickly, they had a higher temperature, and when they slowed down, they cooled.


**Clouds**

A cloud is a visible mass of water in the atmosphere from which rain and other forms of precipitation fall. As air rises, it expands and cools. The slow-moving air molecules in the cool air stick to each other and condense onto particulates in the air, forming the water droplets that make up clouds. Cloud formation can be helped along by “seeding” clouds by adding dust or ions for the water droplets to condense onto. Fog is similar to
clouds, forming when warm air cools. Fog often forms in coastal areas as air comes in over the warmer ocean onto cooler land in the early morning.

The names used for the clouds are based on three factors: their shape, the altitude at which they occur, and whether they are producing precipitation. Clouds occur in three altitude ranges (specifically, the altitude of the cloud base). These include High Clouds (base above 6,000 m), Mid-level Clouds (base between 2,000-6,000 m), and Low Clouds (base below 2,000 m). Clouds also come in three basic shapes, Cumulus (heaped and puffy), Stratus (layered), and Cirrus (wispy). High clouds, designated by "cirrus" or "cirro-", include Cirrus, Cirrocumulus, and Cirrostratus. Mid-level clouds, designated by "alto-", include Altocumulus and Altostratus. Low clouds include Stratus, Nimbostratus, Cumulus, Stratocumulus, Cumulonimbus, and fog. Clouds whose names incorporate the word "nimbus" or the prefix "nimbo-" are clouds from which precipitation is falling.

Tornadoes

A tornado is a violently rotating column of air descending from a cumulonimbus cloud to the ground. Tornadoes are formed in connection with severe thunderstorms called super cells. Tornadoes are formed when winds at two different altitudes and differing wind speeds create a spinning horizontal column of air. This can be due to a change in wind direction combined with an increase in wind speed and height. A method to visualize this is to consider holding a thin roll of clay. If one would hold the clay in both hands and move one hand across the clay more quickly than the other, the clay would twist along its length. As one would continue moving their hands along it, it would twist tighter.

With the tornado, the horizontal column of air created by the differing wind speeds may be pushed upwards as warm air rises into the thunderstorm. The column becomes tighter and spins even more quickly, just as an ice skater who pulls in his arms spins more quickly.

Activities in this module will have students create rotating columns of water vapor that resemble tornadoes. The spinning, as in the tornado, is caused by forces along the column in different speeds or directions. Image from http://eo.ucar.edu/webweather/tornado2.html
Hurricanes

A hurricane is a severe tropical storm with torrential rain and winds above 119 km 74 mi per hour. Hurricanes and tornadoes are very different storms. Hurricanes form over warm ocean water and are fueled by the energy released when the warm water vapor in the air cools and condenses. A hurricane starts as a low pressure wind moving over the warm ocean. The moist air in the ocean rises into the low pressure area, expands, and cools. This cooling releases energy with causes the wind speed to increase, which in turn causes more warm moist air to rise, expand and cool. This vicious circle stops only when the storm passes over land and no longer has the warm ocean water to feed the storm.

Lightning

Lightning is the electrical discharge between positive and negative regions. During a thunderstorm, an electrical potential builds both within a cloud and between the cloud and the ground as negative and positive particles in the cloud separate. The separation of the particles is due to movement within the cloud, updrafts, and gravity. Eventually, the resistance in the air breaks down and an electrical flash is produced. The negative charges are attracted to the positive charges in the ground. The flash we see is occurs when the connection is made, discharging the positive and negative regions. A bolt of lightning heats the air along its path causing it to expand rapidly. Thunder is the sound caused by the shockwave of the rapidly expanding air.

Rainbows

Rainbows are caused by refraction; light bending in a medium. When sunlight passes through a water drop the constituent colors bend at different angles, splitting up the white light into a rainbow of colors. This also occurs when light passes through other mediums such as prisms or telescope lenses. We see rainbows when the Sun is behind us. When the light hits the back of the water drop, most of the light is reflected off the back surface and passes through the front of the water drop.
Northrop Grumman Space Technology is the prime contractor for NPOESS, a constellation of polar-orbiting satellites that will observe Earth from space. The Integrated Program Office (IPO), a joint effort of the Department of Defense, Department of Commerce and NASA, oversees the program. NPOESS will monitor our planet and provide data for long-range weather and climate forecast models. NPOESS will provide atmospheric, oceanographic, terrestrial and solar-geophysical data to help improve short-term weather forecasts. NPOESS will also continue the mission of collecting data for a vital portion of the Earth’s climate record that will enhance capabilities to predict the Earth’s environment and increase our understanding of the natural and human-made forces at work. Image from http://www.ipo.noaa.gov/logo_popUp.html
IT’S GETTING HOT IN HERE
Measuring Temperature

During this hands-on activity, students will discover how temperature is measured.

**Materials**

Materials described below are appropriate for an individual student or groups of two students.

1 – 11 ounce clear water bottle (empty and dry)
1 – ¼ cup room temperature water
1 – ¼ cup rubbing alcohol
2 – drops food coloring
1 – clear straw
1 – 1 inch block of modeling clay

**Procedures**

1. Pour the water and rubbing alcohol into the water bottle.
2. Place food coloring into bottle.
3. Stir the water to completely mix the food coloring in the water.
4. Place the straw into the water bottle. Do not touch the bottom of the water bottle with the straw.
5. Cover the opening of the bottle with the modeling clay. The modeling clay will hold the straw in place.
6. Rub hands together to make them warm.
7. Place hands on the water bottle.
Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened in the experiment?

2. What is happening to the liquid as your hands warm the bottle?

3. What is happening to the air molecules as you warm them with your hands?

4. What happened to the straw and why?

Explanation

As you hold the bottle, your hands warm up the air above the water/alcohol mix in the bottle. Warm fluids have higher pressure because the atoms in them are moving more quickly than atoms of the cooler fluids. As the air’s pressure increases, it expands and pushes down on the water/alcohol mix, forcing it up into the straw.
SINGING IN THE RAIN
Making Rain in a Jar

During this hands-on activity, students will discover how rain drops are formed.

**Materials**

Materials described below are appropriate for an individual student or groups of two students.

1 – 20 ounce mason jar with lid ✽
1 – ¼ cup hot water ✽
1 – ⅛ cup cold water ✽
1 – ½ cup ice cubes ✽
1 – tablespoon salt ✽
1 – hammer ✽
1 – nail ✽

**Procedures**

1. Using a hammer and nail, make 10 indentations in the lid of the jar. Do not punch through the lid. The placement of the indents should be evenly spaced.

2. Pour the hot water into the jar.

3. Place the lid upside-down over the opening of the jar.

4. In the lid, place the ice cubes, cold water, and salt and mix the ingredients completely.

**Questions Posed to Students**

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened in the activity?
2. What is needed in the air to cause rain?

3. What causes rain drops?

4. How does gravity contribute to rain?

**Explanation**

The hot water adds moisture to the air in the jar. As the air comes in contact with the cool lid, the air cools and is no longer able to contain the moisture in the air. The moisture condenses onto the surface of the lid as water drops. When the drops become heavy enough, their weight overcomes the adhesive forces holding them to the lid forming rain drops, and these rain drops fall into the water below.
WHAT’S IN A NAME?
Categorizing Clouds

During this hands-on activity, students will discover different types of clouds.

**Materials**

Materials described below are appropriate for an individual student or groups of two students.

4 – 9 inch x 12 inch blue sheets of construction paper

30 – cotton balls

1 – black marker

1 – bottle of glue

**Procedures**

1. Distribute the 9 inch x 12 inch blue sheets of construction paper, cotton balls, and markers to each student or group of students.

2. Ask students to identify any four cloud types by using their cotton balls to form each type.

3. Tell the students that the blue paper will represent the sky. Students should draw a ground level on their paper.

4. Their cloud “creations” should be glued to the construction paper and labeled correctly.

5. Make sure they glue High, Mid-level and Low Clouds to the correct area of their paper. For example, Mid-level Clouds should be glued to the middle section of their paper.

**Follow Up Activity**

Students should keep a week-long cloud journal in which they would observe cloud formations at school. Students should know that clouds are a combination and variations of the three general types and should be able to identify which variations they see each day.
Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened in the experiment?
2. How are clouds formed?
3. Identify a type of cloud which will not produce rain?
4. What words may be used to describe the elevation of clouds?

Explanation

The names used for the clouds are based on three factors: their shape, the altitude at which they occur, and whether they are producing precipitation. Clouds occur in three altitude ranges (specifically, the altitude of the cloud base). These include High Clouds (base above 6,000 m), Mid-level Clouds (base between 2,000-6,000 m), and Low Clouds (base below 2,000 m).

Clouds also come in three basic shapes, Cumulus, Stratus, and Cirrus. High clouds include Cirrus, Cirrocumulus, and Cirrostratus. Mid-level clouds include Altocumulus and Altostratus. Low clouds include Stratus, Nimbostratus, Cumulus, Stratocumulus, Cumulonimbus, and fog.

Cirrus “curl” clouds are high and wispy and do not produce rain. Cumulus “heap” clouds are big and puffy, the type of clouds that it’s easy to see animals and other shapes in. Stratus “stretched out” clouds are low layers of clouds that often extend far into the horizon.
CLOUD 9
Making a Cloud in a Bottle

During this hands-on activity, students will discover how pressure allows air to cool and moisture in air to condense, forming clouds.

Materials

Materials described below are appropriate for an individual student or groups of two students.

1 – 2-liter clear plastic soda bottle with cap and label removed

1 – book of matches

1 – tablespoon of water

Procedures

1. Distribute the water bottles, water, and matches to the students.

2. Instruct students to pour 1 tablespoon water into their soda bottle.

3. Light the match and hold it in the opening of the bottle. Drop the match into the bottle and quickly place the cap on the bottle, allowing the smoke of the match to enter the bottle. Have students repeat this while explaining to them that the match trapped dust inside the bottle. Dust, smoke, and other particles in the air are needed to make a cloud.

4. Squeeze the bottle hard without releasing. Explain to students that you are increasing the pressure inside the bottle. Ask the students to increase the pressure in their bottles and make sure they don’t let go.

5. Count to three and instruct everyone to release their grip on the bottle (reducing the pressure) a cloud will appear. Explain that because you have reduced the pressure, the air inside the bottle cooled and the moisture in the air condenses onto the smoke particles, forming a cloud.

6. Squeeze the bottle again and your cloud should disappear. When your grip is released, your cloud will reappear.
Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened in the experiment?

2. How can we cool the atmosphere in the bottle?

3. What must the air pressure be like in order for a cloud to form?

4. What are the three things needed to form a cloud?

Explanation

Squeezing the bottle increases the temperature of the atmosphere in the bottle. As the air and water molecules move closer together, the molecules hit each other more often and increase their kinetic energy, causing the air in the bottle to heat. Releasing the squeeze cools the atmosphere as the molecules move farther away and hit each other less. Another way to think of this is that the pressure is increased when the bottle is squeezed and decreased when the squeeze is released. Clouds form when air pressure decreases, cooling the air and allowing the water to condense onto the smoke particles created by the match. Dust, smoke, or other particles in the air are needed for water to condense onto and create a cloud.
A FOGGY DAY
A Classroom Display to Explain Fog

This classroom display is used to show students how fog is formed.

Materials

1 – clear vase or glass container 5 inch diameter x 13 inch height
2 – pounds dry ice
1 – ½ cup warm water
1 – tablespoon baby powder or dirt
1 – protective gloves
1 – hot plate (optional)
1 – handheld fan (optional)

Procedures

1. Place the glass container on a hot plate using low heat. (Optional: the dry ice cools the water placed in the jar which slows down the sublimation process of the dry ice resulting in less fog.)

2. Using the protective gloves place the dry ice into the glass container.

3. Pour the warm water into the glass jar filling the jar.

4. Sprinkle the baby powder into the container. This may be substituted with dirt or other light weight particles that can represent dust, smoke, or dirt particles.

5. Using the fan (optional) over the top of the container will cause the cloud to intensify. Blowing into the glass container will have a similar effect but will not be as dramatic.

6. Explain to students that your breath represents the warm, humid air. When the warm, humid air hits the cool area around the dry ice the warm, humid air cools down as well. When our breath cools the warm, humid air, the air can no longer hold onto the water so it condenses into a layer of fog.
Questions Posed to Students

To insure that the students will understand the science content related to this display the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. How does fog form?

2. Why does fog typically form in coastal areas?

3. How is fog related to clouds?

Explanation

Fog forms when humid warm air cools. The slow-moving air molecules in the cool air stick to each other and condense onto particulates in the air, forming the water droplets. These water droplets form fog. Fog often forms in coastal areas because the cool air comes in over the warmer ocean onto cooler land.
SOMEBODY OVER THE RAINBOW
A Classroom Display

This classroom display is used to show students how rainbows are formed.

Materials

1 – 5 inch diameter x 10 inch height glass jar
1 – flash light
1 – 2 inch square mirror
5 – cups water

Procedures

1. Place the large glass jar on a table 1 foot from a clean wall, preferably a white wall.
2. Place the small mirror in jar at an angle, facing away from the wall.
3. Pour the water in the glass jar, so that the water line is above the top of the mirror.
4. Dim the lights in the classroom.
5. Focus the beam of the flashlight on the mirror.

Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What is a rainbow?
2. Why is light needed to form a rainbow?
3. Why can’t rainbows be formed without rain?
**Explanation**

A rainbow is an arc of light separated into bands of color that appears when the sun’s rays are refracted and reflected by drops of mist or rain. The water in the jar bends or refracts light. This refraction separates light into the colors of the visual light spectrum (as seen in the colors of the rainbow). When light passes through water the constituent colors of white light bend at different angles, splitting up the light into a light spectrum or rainbow. The mirror in the jar acts like the back of the raindrop, reflecting the light back towards the observer.
YOU BLOW ME AWAY  
An Activity Making Windsocks

During this hands-on activity, students will be able to demonstrate variations and characteristics of wind.

**Materials**

Materials described below are appropriate for an individual student.

1 – 9 inch x 12 inch sheet of construction paper

5 – 12 inch piece of streamer

1 – 12 inch piece of yarn

1 – Box of crayons or markers

1 – Roll of tape

**Procedures**

1. Instruct the students to decorate one side of their sheet of paper with any picture they desire.

2. Ask students, once they are done decorating their papers, to glue the streamers to sheet side of the paper (on one end)

3. Instruct the students to then roll the paper into a cylinder and tape the sides.

4. Ask students to knot a 10-inch piece of yarn at each end and staple them to the other side of the windsock (like a handle).

5. Hang the windsocks from a place where they will be protected from strong winds.

6. Have students make observations and predictions about the direction and speed of wind at school/home.
Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened when we put the windsocks outside?

2. What would happen to a windsock on a very windy day?

3. What can a windsock tell us about the speed of wind today?

Explanation

The windsocks move in response to the motion of the air around them. The windsocks will also indicate the direction and speed of the air. Little to no movement of the windsock suggests that wind speeds are low. Jerky or rapid movements may indicate higher wind speeds.
UP, UP, AND AWAY
An Activity to Make a Windmill

During this hands-on activity, students will be able to demonstrate how a tornado works or how wind can cause unequal forces.

**Materials**

Materials described below are appropriate for an individual student.

1 – 8 inch square sheet of paper
1 – Straight pin
1 – Pencil with eraser
1 – Scissors

**Procedures**

1. Fold the paper diagonally and evenly, fold it again.

![Folded paper](image)

2. Open the paper and lay it out flat, it will have an "x" creased through it.

![Creased paper](image)

3. Cut along each fold to within one inch of the center.

4. Pick up one corner and hold it in the center.
5. Pick up each of the other corners and hold them in the center.

6. Keep all the corners in the center by sticking a straight pin through them.

7. Stick the pin through the eraser.

8. Move the windmill through the air and watch it spin!

Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. How does a windmill work?

2. Where are the unequal forces of wind?

3. What natural disaster can we compare our windmills to?

Explanation

The windmill is spinning in reaction to unequal forces about its center of rotation. This is the same thing the column of air in a tornado does. In a tornado, the unequal forces are the winds above and below the column of air. In the windmill, the unequal forces are the winds (your breath or the surrounding air hitting the folded section of the windmill) above and below the windmill.
OUR PET VORTEX
A Classroom Display

This classroom display is used to show students how tornados are formed.

Materials

2 – 24 inch square pieces of ply wood
4 – 12 inch x 24 inch x .093 inch clear pieces of polycarbonate (Home Depot or Lowes)
1 – electric burner
2 – pounds dry ice
1 – 8 ½ inch tin cake pan
1 – 12VDC micro fan (Radio Shack)
1 – ½ cup water
1 – can black spray paint
16 – 1 ½ inch corner braces (any hardware store)
24 – #6 x ½ inch long flat head wood screws (any hardware store)
1 – protective gloves
1 – screwdriver
1 – protective eye wear

Preparation by the Teacher Before Teaching the Activity

1. One day prior to building Our Pet Vortex take one 1 piece of the 24 inch square X ½ inch thick plywood. Using a pencil and ruler sketch a cross hair center mark and cut a TBD inch opening using a Jigsaw. Remove TBD material from the panel (NEED TO FIGURE THIS OUT)

2. After the center on one of the boards is cut out, spray paint the two – 24 inch square pieces of wood black.
3. Once the spray paint on the wood is dry, take one 1 piece of the 24 square inch X ½ inch thick plywood without the center cut out and place it on a large stable working surface. Using a pencil and a 24 inch long ruler (or a device with a straight edge), sketch a 12 inch square centered on the plywood.

4. Take 12-1½ inch corner Braces, 24 - #6 X 1/2 inch long flat head wood screws and install them using the screwdriver.

5. Install the Velcro tape on the 12 inch x 24 inch clear panels of polycarbonate. (The Velcro tape is used to stabilize the top ends of the panels.)

6. Install 3 of the 12 inch x 24 inch clear panels of polycarbonate on to the base of the assembly using the brackets as shown in Figure 4. Make the Velcro tape is at the top and facing the outside of the panels and to align the indicated edges of the polycarbonate panel as shown to provide enough airflow into the chamber. Secure the corners of the panels using the mating half of the Velcro tape.

7. Locate the electric burner in the center of the corner brace grid and place the 8 ½ inch tin cake pan on the electric burner as shown in Figure 5. Pour the about a ½ cup of water into the pan. Set the electric burner to TBD heat level. Using protective gloves, place about TBD lbs of dry ice into the cake pan. (TBD lbs of dry ice which is about a X inch square will last about TBD minutes).

8. Install the remaining polycarbonate panel using the same procedure as the previous panels. Run the electric stove power cord through one of the openings. See Figure 6

9. Place the top panel on the assembly and locate the 12VDC micro fan over the opening as shown in Figure 7.

10. Turn on the electric stove by plugging in the power cord. Turn on the fan using TBD. You have now created a pet vortex in a controlled chamber!

**Procedures**

1. Show students each component of *Our Pet Vortex* (water electric burner dry ice, fan). To understand the importance of each part. Explain the following.

   1a. The pan of water adds moister to the air.

   1b. The electric burner heats the water and causes the air in *Our Pet Vortex* to become humid.

   1c. The dry ice cools the humid air above the pan to form a cloud.
1d. The fan along with the openings in *Our Pet Vortex* allows wind velocity.

2. Have the students predict what will appear in *Our Pet Vortex* once it is assembled.  
   [Expected response: A cloud will form.]

3. Place the base of *Our Pet Vortex* on the pre assigned location in the classroom.

4. Slide three polycarbonate panes into place around the base of Our Pet Vortex.

5. Place the electric burner in the center of *Our Pet Vortex*. Remind students the purpose of the electric burner is to make the air in *Our Pet Vortex* humid.

6. Place the cake pan with ½ a cup of water on the electric burner. Remind students the water is adding moister to the air in *Our Pet Vortex*.

7. Turn the electric burner on low.

8. Add a 1 pound chunk of dry ice to the pan with water. Remind the students that the dry ice is cooling the air above the tin cake pan and will create a cloud.

9. Slide the fourth piece of polycarbonate pane into place.

10. Place the top of *Our Pet Vortex* in place.

11. Place the fan on top of the piece of wood. Make sure the fan is over the opening of the wood.

12. Turn on the fan.

13. Wait for the “Wows”.

**Questions Posed to Students**

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What is a tornado?

2. How is a tornado formed?

3. What is the primary composition of a tornado?

4. What are the basic elements needed to for a tornado?
**Explanation**

As the dry ice cools the humid air above it, the air expands and the water in the air condenses to form a cloud. The cloud makes the tornado visible, as air and wind is invisible. Tornadoes are formed when winds at two different altitudes and differing wind speeds create a spinning horizontal column of air. In our tornado display, the winds are coming in from opposite sides of the cloud and creating a torque around the cloud’s center. The cloud spins and a vortex is formed. This vortex is also called a tornado.
LET’S BUILD A TORNADO
Creating a Vortex

During this hands-on activity, students will be able to demonstrate how a vortex is created.

Materials

Materials described below are appropriate for an individual student or groups of two students.

1 – 20 ounce mason jar with lid
1 – ½ teaspoon pepper
2 – drops liquid dish soap
2 – cups water

Procedures

1. Ask students to put all the ingredients into the jar and close the lid.

2. Ask students to twist the jar to see a vortex form. (Grab the jar around its lid and make small circular motions.)

Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened?

2. How is a vortex formed?

3. How is a tornado formed?
**Explanation**

Air is a fluid, just like water. Just as fish are surrounded by water, we are surrounded by air. In this activity, students will see that spinning a fluid creates a vortex. When tornadoes form, different air speeds create a spinning column of fluid, a vortex. In our activity, by spinning the jar we create a vortex in the water.
YOU SAY TORNADO I SAY “TORNAHDO”
Build a Tornado in a Bottle

During this hands-on activity, students will be able to demonstrate how a vortex is created.

Materials

Materials described below are appropriate for an individual student or groups of two students.

2 – 2 liter plastic bottles
1 – metal washer
2 – drops food coloring
1 – roll duct tape
4 – cups water

Procedures

1. Clean and dry each water bottle.

2. Remove the labels from the bottles.

3. Place four cups of water in one of the bottles.

4. Add three drops of food coloring into the same bottle.

5. On the bottle containing water, Place the washer on the opening of the bottle with water.

6. Place the empty bottle on top of the bottle containing water so that the openings of the two bottles meet.

7. Secure the two bottles together with the tape.

8. Hold the two bottles with your hands and slowly turn the bottle with water upside down.

9. Twist the top bottle counterclockwise to form the vortex.
Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened in the experiment?

2. How is a vortex formed?

3. How is a tornado formed?

Explanation

Air is a fluid, just like water. Just as fish are surrounded by water, we are surrounded by air. In this activity, water from the top bottle wants to fall into the lower bottle, but it can’t because the lower bottle is filled with another fluid … air! By twisting the bottles we create a vortex in the water, and the air is able to move into the upper bottle through the center of the vortex.
HOW SHOCKING!
Making Lightning

During this hands-on activity, students will be able to demonstrate how lightning is produced by static electricity. This activity should be used on a hot, dry day for the best results.

Materials

Materials described below are appropriate for an individual student or groups of two students.

1 – Styrofoam plate
1 – Thumbtack
1 – Pencil with new eraser
1 – Aluminum pie tin
1 – Small piece of wool fabric

Procedures

1. Push the thumbtack through the center of the aluminum pie so that the head of the thumbtack is on the bottom of the pie tin.

2. Push the eraser and of the pencil into the thumbtack. The pencil becomes a handle to lift the pan.

3. Place the Styrofoam plate upside-down on a table so that the pencil is pointing upward.
4. Using the piece of wool, rub the wool rapidly on the underside (the side if the pie tin where the head of the thumbtack is positioned). Rub the underside of the plate with the wool for one minute. (Rub hard and fast)

5. Using the pencil as a handle, pick up the pie tin and place it on top of the upside down plate.

6. Turn the lights off in the classroom before the next step and ask the students gather around the table.

7. Touch the pie tin with your finger and a shock (lighting) should be felt. Rub the plate again if a shock is not felt.

Questions Posed to Students

To insure that the students will understand the science content related to this activity, the following questions can be posed to the class. The answers to each question can be found in the science content section or in the explanation section below.

1. What happened in this activity?

2. How can this model be used to represent how lightning occurs in nature?

3. What is static electricity?

4. What causes lightening?

Explanation

It's all about static electricity! Lightning happens when the negative charges (electrons) in the bottom of the cloud (and your finger) are attracted to the positive charges (protons) in the ground (and the pie tin). The resulting spark is like a mini-bolt of lightning. The connection is made and the electrons rush to the ground to meet the
protons. It is at that point that we see lightning. What we are actually seeing are electrons jumping from the clouds (or your finger) to the ground (or the pie tin). A bolt of lightning heats the air along its path causing it to expand rapidly.