



BLOWN AWAY

THE WILD WORLD OF WEATHER

Teacher's Resource Kit

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BLOWN AWAY

Teacher's Resource Kit

Thank you for scheduling a field trip to the New Detroit Science Center and its newest facility, the Dassault Systèmes Planetarium. The Planetarium is a 50-foot wide tilted theater with 115 seats, room for 6 wheelchairs, and assisted listening devices for the hearing-impaired. Using advanced projection equipment, the Planetarium can create virtually any environment. You can be seated in the interior of a spacecraft, witness the birth of a star, stargaze at the night sky over Southeastern Michigan, or travel faster than light through the Milky Way galaxy.

About the Show

Students will be blown away by this look at the fascinating world of weather as they are placed inside a thunderstorm, swept into a tornado and whisked upwards for a view from space of dynamic weather. Students will explore the Water Cycle, how storms develop, and learn safety tips about lightning and tornadoes. The show is narrated by the WDIV-4 Big Picture Weather Team and includes video appearances by Chuck Gaidica and other team members.

This show appropriate for

Grade Level(s): 4 - 12
Program Length: 45 minutes

Michigan Content Standards and Benchmarks

More information can be found at the Michigan Department of Education website at:
<http://cdp.mde.state.mi.us/MCF/ContentStandards/default.html>

*The Detroit Science Center and the Dassault Systèmes Planetarium are dedicated to assisting all educators in building and utilizing curricula based on the above-mention standards and benchmarks. Each of our school shows keep you and your students needs in mind. For **BLOWN AWAY**, the Standards & Benchmarks addressed include:*

Elementary School

Matter & Energy IV. 1-1,1-3-5, 2-1, 3-1,2
Hydrosphere V. 2 1-3
Atmosphere and Weather V 3 1-3
Solar System, Galaxy and Universe V. 4-1,2

Middle School

Matter & Energy IV. 1-1,1-3-5, 2-1, 3-1,2
Hydrosphere V. 2 1-3
Atmosphere and Weather V 3 1-3
Waves & Vibrations IV. 4-4
Solar System, Galaxy & Universe V. 4-2,3

High School

Matter & Energy IV. 1-1,1-3-5, 2-1, 3-1,2
Hydrosphere V. 2 1-3
Atmosphere and Weather V 3 1-3
Waves & Vibrations IV. 4-4
Solar System, Galaxy & Universe V. 4-2,3

We welcome any suggestions, comments, or tips on the activities and resources in this kit, so we can improve these resources for you and your students in the Southeastern Michigan community! Thanks again for choosing the Detroit Science Center and the Dassault Systèmes Planetarium! Contact us @

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<http://www.sciencedetroit.org/theaters/#Digidome>



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Dr. Theodore Fujita – Tornado Researcher.
Courtesy of University of Chicago

Program Objectives:

Upon completion of this program, students will be able to:

1. Identify the steps in the water cycle;
2. Identify the types of clouds.
3. Explain the reason for the seasons, and how it impacts our weather;
4. Understand safety rules to protect themselves from dangerous weather.
5. Understand how weather satellites and ground-based radar help track dangerous weather.

Pre-visit Activities Blown Away -

Focus on Weather Questions

Questions for you and your students to ponder before your visit...



Q: What can I see in the sky?

A: In the daytime, you can see the Sun, the Moon (sometimes), clouds, rainbows, and other atmospheric effects. On a clear night away from city lights, you can see stars, the Milky Way, the Moon (sometimes), planets, meteors (commonly called shooting stars), and comets.



Q: Why is the sky blue?

A: Light is made up of electromagnetic waves. The distance between 2 crests in this wave is called the wavelength. White light contains all the colors of the rainbow. The amount of light scattered for any given color depends on the wavelength of that color. All the colors in white light have different wavelengths. **Red light** has the longest wavelength. The wavelength of **blue light** is about half that of **red light**. This difference in wavelength causes **blue light** to be scattered nearly ten times more than **red light**. Lord Rayleigh studied these phenomena in detail. It is caused the **Tyndall effect or Rayleigh scattering**. He also calculated that even without smoke and dust in the air, the oxygen and nitrogen molecules would still cause the sky to appear **blue** because of scattering. When **blue light** waves try to go straight through an oxygen and nitrogen molecules, its light is scattered in all directions because of this collision. This scattered **blue light** is what makes the sky **blue**



Q. What are clouds?

A. Clouds are large gatherings of very small water droplets, formed around a particle of dust or dirt. Clouds come in many shapes, but there are types of clouds.

These include:

<u>Latin Root</u>	<u>Translation</u>	<u>Example</u>
Cumulus	Heap	cumulus
Stratus	layer	altostratus
Cirrus	curl of hair	cirrus
Nimbus	rain	cumulonimbus

Further classification identifies clouds by height of cloud base. For example, cloud names containing the prefix "cirr-", as in cirrus clouds, are located at high levels while cloud names with the prefix "alto-", as in altostratus, are found at middle levels. This module introduces several cloud groups. The first three groups are identified based upon their height above the ground. The fourth group consists of vertically developed clouds, while the final group consists of a collection of miscellaneous cloud types.

High-Level Clouds

High-level clouds form above 20,000 feet (6,000 meters) and since the temperatures are so cold at such high elevations, these clouds are primarily composed of ice crystals. High-level clouds are typically thin and white in appearance, but can appear in a magnificent array of colors when the sun is low on the horizon.

Mid-Level Clouds

The bases of mid-level clouds typically appear between 6,500 to 20,000 feet (2,000 to 6,000 meters). Because of their lower altitudes, they are composed primarily of water droplets, however, they can also be composed of ice crystals when temperatures are cold enough.

Low-level Clouds

Low clouds are mostly composed of water droplets since their bases generally lie below 6,500 feet (2,000 meters). However, when temperatures are cold enough, these clouds may also contain ice particles and snow.

Vertically Developed Clouds

Probably the most familiar of the classified clouds is the cumulus cloud. Generated most commonly through either thermal convection or frontal lifting, these clouds can grow to heights in excess of 39,000 feet (12,000 meters), releasing incredible amounts of energy through the condensation of water vapor within the cloud itself.

Contrails or condensation trails

A contrail, also known as a condensation trail, is a cirrus-like trail of condensed water vapor often resembling the tail of a kite. Contrails are made at high altitudes where extremely cold temperatures freeze water droplets in seconds before they can evaporate. Contrails form by the injection of water vapor into the atmosphere by exhaust fumes from a jet engine. If the surrounding air is cold enough, a state of saturation is attained and ice crystals develop, producing a contrail.

Q. How do clouds turn into thunderstorms?

A: Three basic ingredients are needed to make a thunderstorm. The basic fuel is moisture (water vapor) in the lowest levels of the atmosphere. The air above the lowest level cools rapidly with height, so that 2-3 miles above the ground, it is very cold. Finally, we need something in the atmosphere to push that moist air from near the ground up to where the air around it is cold. This "something" could be a cold front or the boundary between where the cold air from one thunderstorm meets the air outside of the storm (called an outflow boundary) or anything else that forces the air at the ground together. When that happens, the moist air is pushed up. What happens to a blob of moist air as it rises? It cools off and after a while some of the water vapor turns into liquid drops (that we see as clouds). That warms up the rest of the air in the blob so that it doesn't cool off as fast as it would if the air was dry. When that blob of air gets to the part of the atmosphere where it is very cold, it will be warmer and less dense than the air around it. Since it is less dense, it will start to rise faster without being pushed, just like a balloon does when filled with helium. Then more water vapor turns into liquid in the blob, and the blob warms up more and rises even faster until all of the water vapor is gone and the blob eventually reaches a part of the atmosphere where it isn't warmer than the environment (5-10 miles high).

Q. How are thunderstorms detected?

A: Thunderstorms can be seen with a variety of tools. Radars let us see where rain and hail are located in the storm. Doppler radars also let us see how the wind is blowing within and near the storm.

Q. How do thunderstorms make tornadoes?

A. Before thunderstorms develop, a change in wind direction and an increase in wind speed with increasing height create an invisible, horizontal spinning effect in the lower atmosphere. Rising air in the thunderstorm's updraft tilts the rotating air from horizontal to vertical. Most strong and violent tornadoes form within this area of rotation. Moments later, a strong tornado develops within the area of rotation. Softball-size hail and damaging "straight-line" winds also accompanied this storm. (Woodward, Oklahoma - Ron Przybylinski)

Q. How do you tell if tornado activity is possible?

A: A dark, often greenish sky, large hail, and often a loud roar, similar to a freight train, often precede tornadoes. In the southern states, however, tornadoes frequently occur without the presence of large hail. Most strong and violent tornadoes occur with "supercell" thunderstorms. A supercell storm is characterized by intense rotation within the storm. Typically, this area of rotation occurs in the south side of the storm. Visually, a low-hanging cloud base with rotation is often seen. This area may or may not be visible since rain sometimes wraps around the area of circulation. Some tornadoes appear as a visible funnel extending only partially to the ground. Look for signs of debris below the visible funnel.



Q. Where do you get warnings for dangerous weather?

A: There are several methods to get severe weather information. [NOAA weather Radio](#), operating commercial-free by the National Weather Service (NWS), provides continuous weather information 24 hours a day. When severe weather threatens, regular programming is stopped to provide information of threatening weather in your area. The local NWS office can automatically turn on some weather radios before severe weather information is broadcast.

In addition, your local radio and television stations, and a cable television service, called the Weather Channel, are excellent sources of severe weather information



WEATHER ACTIVITY ONE: Cloud Formation

Concept: Cloud formation results when warm, humid air rises and cools, causing the water vapor in the air to condense and form clouds.

Teacher Materials:

Large jar, a plastic bag of ice that will fit over the jar opening, Pitcher of warm water, 1 sheet of black paper, Flashlight, and matches

Student Materials:

Pen and paper to record observations

Optional Extension Student Materials:

More jars, bags of ice, black paper, flashlights, and warm water, dust, flour, sand, cedar shavings, any other particulate materials, white construction paper, Newspaper, and crayons

Teacher Background Information:

Sunlight causes water to evaporate into the atmosphere. This air containing the water vapor is heated at the surface of the earth and rises. As it rises, it cools and the water vapor condenses on some form of particulate matter such as dust, ash, or smoke to form clouds.

Management Strategies:

This activity would be most appropriately done with small groups so that all students can view the cloud formation in the jar. Other class members could be working on researching the different types of clouds, drawing and labeling these clouds, researching and drawing the water cycle, working on a forecast for the rest of the day based on the clouds in the sky, etc. The activity itself should not take more than 10 to 15 minutes. For safety reasons, students should not be allowed to handle the matches. Also, students need to be careful around the glass jars. Much of the following procedure will vary, depending on students' reactions, comments, and levels of understanding.

Procedure:

1. Ask students what some of the different types of clouds are, what they are made of, and ask the focus question, how do you think clouds form? The responses to this question could be written on the board to return to later.
2. Tell the students that we are going to perform a simulation of the forming of a cloud. Take out the jar and have one of the students tape the

black piece of paper onto one side of the jar. Ask another student to pour the warm water into the jar until it is one third full.

3. Light a match and hold it in the jar for a few seconds and then drop it in. At this point, have a student quickly cover the jar with the bag of ice.
4. Have another student (or teacher) shine the flashlight on the jar while they record their observations.

5. Now the students will explore what happened. The following questions can be used to help the class learn about what was happening:

What did you see in the jar? (**A cloud**) **Where** did the cloud come from? (**The water in the bottom of the jar**) **How** did the warm water effect the cloud formation? (**Caused the water to evaporate and warmed the air, causing it to rise**) **What** did the ice cubes do to help the clouds form? (**Cooled the air [made the water vapor condense]**). **What** role did the match and its smoke play in the cloud formation? (**Gave the water something to condense or grab on to**) **Now** what would you tell me a cloud is made of? (**Small water droplets**) --Ask someone to describe the process of cloud formation from what they just learned.

Assessment/Evaluation:

As a learning activity in itself, assessment is not really needed, but an option for assessment would be to have students draw a picture of how the cloud formed in the jar. In addition, the products of the following extension activities could be assessed.

Extension/Integration:

As an application of what they learned, each student could draw a picture of how a real cloud would form, and what effects the warm earth and the cool air in the mountains would have. Students could repeat the process without using the match or with dust, flour, sand, cedar shavings, or other particulate materials to see if the cloud would still form. As an art activity, students could construct different types of clouds by cutting two sheets of construction paper simultaneously and stapling them part of the way together. Then they can be filled with newspaper and decorated.

For a math activity, students could record the clouds they see for a couple of weeks and graph how many days they saw each type of cloud. A language arts activity that could be used is to have students write weather reports and then present them to the class. Students could also write poems about clouds or stories from a cloud's point of view, discussing what type of cloud it is and what kind of weather it would bring.

Source:

Bugenig, D. 1996 *How does a cloud form?* :
<ftp://ftp.unr.edu/pub/archive/mailling-lists/galileo/clouds>

WEATHER ACTIVITY TWO: **DOPPLER RADAR – How it Works?**

Concept: Most everyone is familiar with the drop in pitch of a train whistle as a train passes your position and switches from moving toward you to moving away from you. This phenomenon is called the **Doppler Effect**, and is associated with the wave nature of sound: the relative motion of the source causes the wavelength of the sound waves to be decreased ahead of the source and stretched out behind the source (musically, the pitch of a note is correlated with the wavelength of the corresponding sound wave; thus, the longer the wavelength, the lower the pitch). Here is a [Java Virtual Experiment](#) that illustrates the Doppler effect.



Light also can be described as a wave, and relative motion of the source of light waves leads to a corresponding Doppler effect for light. In this case it is not the pitch but the color (that is, the wavelength) that is shifted by the motion of the

source. The wavelength is shifted to larger values if the motion of the source is away from the observer and to smaller values if the motion is toward the observer.

Astronomers call the shift to larger wavelengths by motion away from the observer a **red shift** and a shift to shorter wavelengths caused by motion toward the observer is called a **blue shift**. The terminology is borrowed from the visible part of the spectrum where **blue** is toward the short wavelength end and **red** is toward the long wavelength end, but the Doppler effect occurs for all wavelengths of light, not just the visible spectrum.

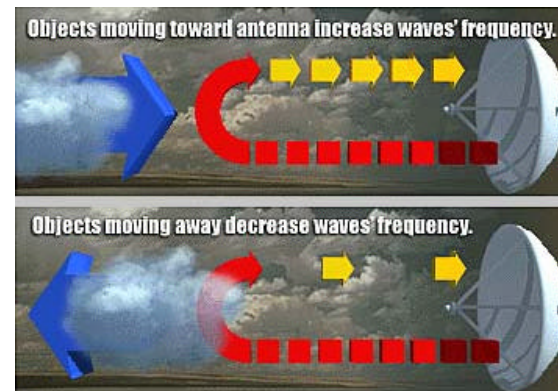
Objective: Everyone hears the weatherman talk about the Doppler radar, but just what is this? In this experiment, we will discover the principles associated with the Doppler radar, and examples of the Doppler effect that we may hear everyday.

Materials: string, electric buzzer or noisemaker, and a small bag or sock

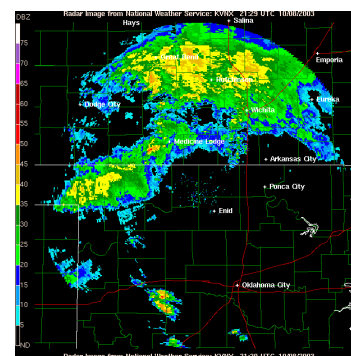
Procedure: Place the noisemaker in the sock and tightly close the end of the sock with the string. Make sure to leave several feet of string free.

Next, swing the buzzer around by the end of the cord. If you are standing away from the noisemaker, notice that the pitch changes. A longer string will make the change in sound more noticeable. If the change is difficult to hear, listen for a 'wawa' sound.

Meteorologists use Doppler radar to measure moisture's movement inside storm clouds. They can also measure the amount of precipitation (rain, snow, or hail) inside storm systems. If meteorologists see a rotating pattern of moisture inside a particular cloud system, it may indicate the spiraling winds that would start a wall cloud, and from that cloud you could have the birth of a tornado.



Source: The USA TODAY Weather Book by Jack Williams



Doppler Radar image of Thunderstorm. Courtesy of National Weather Service/NOAA



Source: Jerry Straka, University of Oklahoma



WEATHER ACTIVITY THREE: MAKE A TORNADO

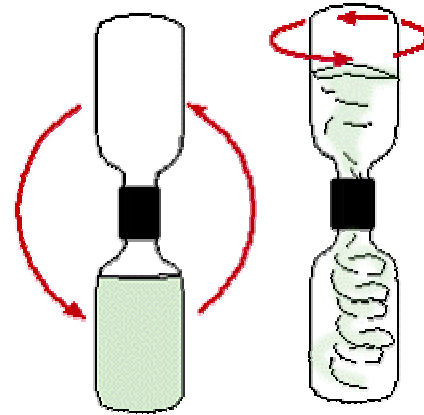
MATERIALS:

1. Two 2-liter clear pop bottle
2. Water
3. 1-inch metal washer
4. Duct tape
5. OR get a 'tornado tube' that connects the bottles @

http://edushop.edu4kids.com/catalog/product_info.php?products_id=295 or
<http://shop.store.yahoo.com/insectlore/tornadotube.html>

PROCESS:

1. Fill one of the bottles two-thirds full of water
2. Place the metal washer or twist the 'tornado tube' over the opening of the bottle
3. Turn the second bottle upside down and place it on the washer **or** twist it on the 'tornado tube'
4. Skip this step if you used the Tornado Tube. Use the duct tape to fasten the two containers and the metal washer together. Make sure to tape tightly to make sure that no water will leak out when you turn the bottle over. If you use the 'tornado tube', just twist together tightly.
5. Turn the tornado maker, so that the bottle with the water is on top.



6. Swirl the bottle in a circular motion. A tornado will form in the top bottle as the water rushes into the bottom bottle.
7. *If you want to get creative, you can also use food coloring to make the tornado have a color and glitter to represent debris.

EXPLANATION:

The swirling motion you give the bottle forms a vortex. This is an easy way to create your own tornado.

This is not completely understood by scientists, but one way the rotation appears to happen is when winds at two different altitudes blow at two different speeds creating wind shear.

For example, a wind at 1000 feet above the surface might blow at 5mph and a wind at 5000 feet might blow at 25mph. This causes a horizontal rotating column.

If this rotating column of air gets caught in a supercell thunderstorm, the updraft tightens the spin and it speeds up (much like a skater spins faster the arms are pulled close to the body). A funnel cloud is created.

The rain and hail in the thunderstorm cause the funnel to touch down creating a tornado.

Earth and Space Weather Web Sites

<http://www.clickondetroit.com/weather/>



WDIV – Channel 4's Big Picture Weather

Stay informed on the ever-changing skies over Metro Detroit. Featuring Doppler 4000 Radar, satellite weather images, and live web cam video from the Motor City!

<http://www.nws.noaa.gov/>

National Weather Service - Come right to the primary source for weather forecasting and prediction. This is the home page for the National Weather Service with links to all the Weather forecast offices around the country.

<http://www.noaa.gov/stormwatch>

NOAA's Storm Watch - This is a roundup of NOAA weather Web sites. You'll find links to the latest weather forecasts around the USA and even around the world. Track storms through NOAA weather satellites, get the latest weather maps and learn how to protect yourself and your city from severe weather.

<http://www.weather.com/>



[weather.com](http://www.weather.com/)

The Weather Channel - Since 1982, The Weather Channel has brought timely weather information to the world. As a 24-hour TV channel devoted to weather, it has expanded across several mediums to bring breaking weather to its viewers and users.

<http://tgs5.nws.noaa.gov/nwr/nwrback.htm>

NOAA Weather Radio - The voice of the National Weather Service. NOAA Weather Radio broadcasts National Weather Service watches, warnings and forecasts and other hazard information 24 hours a day.

<http://www.nws.noaa.gov/om/start.htm>

Weather Education - This site includes Web Units that have been developed to assist students with the AMS DataStreme project lessons. These units include: a virtual tour of the NWS Weather Forecast Office at Sterling, VA; a description of the calibration, ascent and data obtained during a radiosonde Ascent; and a discussion of How Come Lows Don't Fill and Highs Smooth as the Winds Blow.

<http://www.nws.noaa.gov/om/edures.htm>

Weather Educational Resources - A variety of weather educational resource links for students, teachers, and administrators.

<http://www.nhc.noaa.gov/>

The National Hurricane Center - The Center maintains a continuous watch on tropical cyclones from 15 May in the eastern Pacific and 1 June in the Atlantic through November 30. The Center prepares and issues forecasts, watches and warnings within text advisories and graphical products.

<http://www.wunderground.com/US/MI/Detroit.html>

Weather Underground - Committed to delivering the most reliable, accurate weather information possible. Our state-of-the-art technology monitors conditions and forecasts for over 60,000 U.S. and international cities, so you'll always find the online weather information that you need.

[http://ww2010.atmos.uiuc.edu/\(Gh\)/guides/mtr/cl/home.xml](http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/cl/home.xml)

Clouds - The University of Illinois web module that introduces cloud classifications, different types of precipitation, and the mechanisms responsible for producing them.

http://www.weatherworks.com/monthly/activities/activity_index.html

How the Weather Works – Welcome to our *Activities, Experiments and Investigations* index page. These are a sampling of some of our favorite “things” to do in studying about the weather. The listing is far from complete, but it should give you a good idea about how we use weather as a bridge to multi-disciplinary education.

<http://www.weatherwizkids.com/WxGames.htm>

Weather Wiz -

Go to the Weather Wiz for Kids web site and play six games to help you learn more about weather!