Twister!

Examples of Possible Academic Standards to Incorporate:

Kindergarten:

- 7.9.1 Describe an object by its observable properties.
- 7.11.1 Explore different ways that objects move.
- 7.11.1 Use a variety of objects to demonstrate different types of movement. (e.g., straight line/zigzag, backwards/forward, side to side, in circles, fast/slow).
- Inq.2 Communicate interest in simple phenomena and plan for simple investigations.
- Inq.2 Ask questions, make logical predictions, plan investigations, and represent data.
- Inq.3 Communicate understanding of simple data using age-appropriate vocabulary.
- Inq.4 Collect, discuss, and communicate findings from a variety of investigations
- Inq.1 Observe the world of familiar objects using the senses and tools.
- 1.1.2 Employ a variety of strategies to decode words and expand vocabulary.
- **1.1.9** Build vocabulary by reading, listening to, and discussing a variety of literature.
- 1.2.1 Develop critical listening skills essential for comprehension, problem solving, and task completion.
- **1.2.2** Develop critical speaking skills essential for effective communication.
- 1.2.3 Understand and follow simple two-step oral directions.
- Inq.2 Communicate interest in simple phenomena and plan for simple investigations.
- 1.2.9 Retell a story, describing the plot, characters, and setting.
- **1.2.8** Participate in group discussion.
  - Work productively in group discussion for a particular purpose (e.g., respond to literature, solve a problem).
  - Ask and respond to questions from teacher and other group members.

1st Grade:

- 7.8.2 Discuss what makes a weather prediction accurate or inaccurate.
- 7.11.1 Investigate how forces (push, pull) can move an object or change its direction.
- 7.11.1 Use familiar objects to explore how the movement can be changed.
- Inq.1 Use senses and simple tools to make observations.
- Inq.2 Communicate interest in simple phenomena and plan for simple investigations.
- Inq.2 Ask questions, make logical predictions, plan investigations, and represent data.

- Inq.3 Explain the data from an investigation.
- 7.2.1 Identify the basic characteristics of living things.
- 1.1.2 Employ a variety of strategies to decode words and expand vocabulary.
- 1.2.1 Develop critical listening skills essential for comprehension, problem solving, and task completion.
- 1.2.2 Develop critical speaking skills essential for effective communication.
- 1.2.2 Listen attentively to speaker for specific information.
- 1.2.3 Understand and follow simple two- and three-step oral directions.
- 1.2.8 Participate in group discussion.
  • Work productively in group discussion for a particular purpose (e.g., respond to literature, solve a problem).
  • Ask and respond to questions from teacher and other group members.
- 1.2.9 Retell a story, describing the plot, characters, and setting.

2nd Grade:

- 7.9.3 Recognize that air takes up space.
- 7.9.1 Use tools to observe the physical properties of objects.
- 7.12.2 Realize that things fall toward the ground unless something holds them up.
- Inq.1 Use senses and simple tools to make observations.
- Inq.2 Communicate interest in simple phenomena and plan for simple investigations.
- Inq.3 Communicate understanding of simple data using age-appropriate vocabulary.
- Inq.4 Collect, discuss, and communicate findings from a variety of investigations.
- Inq.1 Observe the world of familiar objects using the senses and tools.
- Inq.2 Ask questions, make logical predictions, plan investigations, and represent data.
- Inq.3 Explain the data from an investigation.
- 1.1.2 Employ a variety of strategies to decode words and expand vocabulary.
- **1.1.9** Show evidence of expanding language through vocabulary growth.
- 1.2.1 Develop critical listening skills essential for comprehension, problem solving, and task completion.
- 1.2.2 Develop critical speaking skills essential for effective communication.
- 1.2.2 Listen attentively to speaker for specific information.
- 1.2.3 Understand and follow multi-step oral directions.
- 1.2.8 Participate in group discussion.
  • Work productively in group discussion for a particular purpose (e.g., respond to literature, solve a problem, and plan a project).
  • Ask and respond to questions from teacher and other group members.
- 1.2.9 Retell a story, describing the plot, characters, and setting.
- 1.5.1 Continue to develop the ability to think logically.
- 1.5.2 Apply logic in a variety of ways.
- 1.5.3 Make inferences and draw appropriate conclusions.

3rd Grade:

- 7.8.1 Recognize that that there are a variety of atmospheric conditions that can be measured.
- 7.8.2 Use tools such as the barometer, thermometer, anemometer, and rain gauge to measure atmospheric conditions.
- 7.11.1 Explore how the direction of a moving object is affected by unbalanced forces.
- 7.11.1 Identify how the direction of a moving object is changed by an applied force.
- 7.11.2 Recognize the relationship between the mass of an object and the force needed to move it.
- Inq.1 Explore different scientific phenomena by asking questions, making logical predictions, planning investigations, and recording data.
- Inq.2 Select and use appropriate tools and simple equipment to conduct an investigation.
- Inq.4 Identify and interpret simple patterns of evidence to communicate the findings of multiple investigations.
- Inq.5 Recognize that people may interpret the same results in different ways.
- Inq.6 Compare the results of an investigation with what scientists already accept about this question.
- Inq.2 Identify tools needed to investigate specific questions.
- 1.5.1 Distinguish between fact and opinion.
- 1.1.2 Demonstrate knowledge of strategies and resources to determine the definition, pronunciation, and usage of words and phrases.
- 1.1.20 Use a variety of previously learned strategies to determine the meanings of unfamiliar words.
- 1.2.1 Continue to develop basic listening skills necessary for communication.
- 1.2.2 Continue to develop basic speaking skills necessary for communication.
- 1.2.2 Demonstrate the ability to follow three-step oral directions.
- 1.2.3 Respond to questions from teachers and other group members and pose followup questions for clarity.
- 1.2.4 Listen and respond to a variety of media (e.g., books, audio, videos).
- 1.2.5 Summarize information presented orally by others.
- 1.2.6 Recognize the main idea conveyed in a speech.
- 1.2.10 Participate in group discussions.
- 1.5.1 Develop logic skills to enhance thoughtful reasoning and to facilitate learning.
- 1.5.2 Use learned logic skills to make inferences and draw conclusions in a variety of oral and written contexts.
- 1.5.3 Apply learned logic skills to selections read, as well as to classroom situations.

4th Grade:

- 7.8.2 Differentiate between weather and climate.
- 7.11.1 Recognize that the position of an object can be described relative to other objects or a background.
- 7.11.2 Identify factors that influence the motion of an object.
- 7.11.2 Design an investigation to identify factors that affect the speed and distance traveled by an object in motion.

- 7.11.1 Describe the position of an object relative to fixed reference points.
- 7.7.1 Investigate how the Earth's geological features change as a result of erosion (weathering and transportation) and deposition.
- 7.7.1 Prepare a demonstration to illustrate how wind and water affect the earth's surface features.
- Inq.1 Explore different scientific phenomena by asking questions, making logical predictions, planning investigations, and recording data.
- Inq.2 Select and use appropriate tools and simple equipment to conduct an investigation.
- Inq.4 Identify and interpret simple patterns of evidence to communicate the findings of multiple investigations.
- Inq.5 Recognize that people may interpret the same results in different ways.
- Inq.6 Compare the results of an investigation with what scientists already accept about this question.
- Inq.1 Identify specific investigations that could be used to answer a particular question and identify reasons for this choice.
- Inq.2 Identify tools needed to investigate specific questions.
- Inq.4 Analyze and communicate findings from multiple investigations of similar phenomena to reach a conclusion.
- 1.1.2 Demonstrate knowledge of strategies and resources to determine the definition, pronunciation, and usage of words and phrases.
- 1.2.1 Continue to develop oral language skills necessary for communication.
- 1.2.2 Continue to develop listening skills necessary for communication.
- 1.2.3 Understand and follow multi-step directions (e.g., follow directions for a game).
- 1.2.4 Formulate and respond to questions from teachers and group members.
- 1.2.7 Participate in creative and expressive responses to text (e.g., choral reading, discussion, dramatization, oral presentations, and personal experiences)
- 1.2.8 Express reactions, personal experiences, and opinions orally.
- 1.2.13 Continue to develop group discussion skills and to work in teams.
- 1.5.1 Continue to develop logic skills to facilitate learning and to enhance thoughtful reasoning.
- 1.5.2 Use logic to make inferences and draw conclusions in a variety of oral and written contexts.
- 1.5.3 Apply logic skills to classroom situations and to selections read.

5th Grade:

- 7.11.1 Design an investigation, collect data and draw conclusions about the relationship among mass, force, and distance traveled.
- 7.11.3 Design and conduct experiments using a simple experimental design to demonstrate the relationship among mass, force, and distance traveled.
- 7.12.3 Provide examples of how forces can act at a distance.
- 7.12.2 Identify the force that causes objects to fall to the earth.
- Inq.1 Explore different scientific phenomena by asking questions, making logical predictions, planning investigations, and recording data.
- Inq.2 Select and use appropriate tools and simple equipment to conduct an investigation.
- Inq.4 Identify and interpret simple patterns of evidence to communicate the findings of multiple investigations.

- Inq.5 Recognize that people may interpret the same results in different ways.
- Inq.6 Compare the results of an investigation with what scientists already accept about this question.
- Inq.1 Identify specific investigations that could be used to answer a particular question and identify reasons for this choice.
- Inq.2 Identify tools needed to investigate specific questions.
- Inq.4 Analyze and communicate findings from multiple investigations of similar phenomena to reach a conclusion.
- 1.1.2 Demonstrate knowledge of strategies and resources to determine the definition, pronunciation, and usage of words and phrases.
- 1.2.1 Continue to develop critical listening skills necessary for comprehension and task completion.
- 1.2.2 Continue to develop strategies for expressing thoughts and ideas clearly and effectively.
- 1.2.4 Participate in teams for work and discussion.
- 1.2.1 Listen attentively by facing the speaker, asking questions, and summarizing what is said.
- 1.2.3 Give multi-step directions.
- 1.2.4 Formulate and respond to questions from teachers and group members.
- 1.2.7 Participate in creative and expressive responses to text (e.g., choral reading, discussion, dramatization, oral presentations, and personal experiences).
- 1.5.1 Refine logic skills to facilitate learning and to enhance thoughtful reasoning.
- 1.5.2 Use logic to make inferences and to draw conclusions in a variety of oral and written contexts.

6th Grade:

- 7.8.4 Interpret meteorological data to make predictions about the weather.
- 7.8.6 Use data collected from instruments such as a barometer, thermometer, psychrometer, and anemometer to describe local weather conditions.
- Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.
- Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.
- Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.
- 1.1.2 Employ a variety of strategies and resources to determine the definition, pronunciation, and usage of words and phrases.
- 1.2.1 Demonstrate critical listening skills essential for comprehension, evaluation, problem solving, and task completion.
- 1.2.8 Participate in work teams and group discussions.
- 1.2.1 Follow multi-step oral instructions to perform single tasks, to answer questions, and to solve problems.
- 1.2.17 Participate productively in self-directed work teams for a particular purpose (e.g., to interpret literature, to solve a problem, to make a decision):
- 1.5.1 Use logic to make inferences and draw conclusions in a variety of oral and written contexts.

- 1.5.3 Identify stated or implied cause/effect relationships.
- 1.5.7 Make inferences and draw conclusions based on evidence.
- 1.8.2 Sequence and identify the plot's main events, their causes, and the influence of each event on future actions in texts.

7th Grade:

- 7.11.3 Distinguish between speed and velocity.
- 7.11.4 Investigate how Newton's laws of motion explain an object's movement.
- Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.
- Inq.2 Identify tools and techniques needed to gather, organize, analyze, and interpret data collected from a moderately complex scientific investigation.
- Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.
- Inq.4 Review an experimental design and draw a conclusion to determine possible sources of bias or error, state alternative explanations, and identify questions for further investigation.
- 1.1.2 Employ a variety of strategies and resources to determine the definition, pronunciation, and usage of words and phrases.
- 1.1.17 Continue to use previously learned strategies to distinguish among multimeaning words and to determine the meaning of unfamiliar words.
- 1.2.1 Demonstrate critical listening skills essential for comprehension, evaluation, problem solving, and task completion.
- 1.2.7 Participate in work teams and group discussions.
- 1.2.1 Follow multi-step oral instructions to perform single tasks, to answer questions, and to solve problems.
- 1.2.16 Participate productively in self-directed work teams for a particular purpose (e.g., to interpret literature, to solve a problem, to make a decision) by adhering to the list below.
- 1.4.10 Collect evidence in various ways (e.g., gathering relevant reasons, examples, and facts; defining key terms and ideas; identifying relationships such as cause/effect).
- 1.5.1 Use logic to make inferences and draw conclusions in a variety of oral and written contexts.
- 1.5.6 Determine the relevance and quality of evidence given to support or oppose an argument.

8th Grade:

- Inq.1 Design and conduct an open-ended scientific investigation to answer a question that includes a control and appropriate variables.
- Inq.3 Synthesize information to determine cause and effect relationships between evidence and explanations.
- Inq.2 Use appropriate tools and techniques to gather, organize, analyze, and interpret data.

- Inq.5 Communicate scientific understanding using descriptions, explanations, and models.
- Inq.3 Use evidence from a dataset to determine cause and effect relationships that explain a phenomenon.
- Inq.4 Draw a conclusion that establishes a cause and effect relationship supported by evidence.
- 7.5.3 Compare and contrast the ability of an organism to survive under different environmental conditions.
- 1.1.2 Employ a variety of strategies and resources to determine the definition, pronunciation, and usage of words and phrases.
- 1.2.1 Demonstrate critical listening skills essential for comprehension, evaluation, problem solving, and task completion.
- 1.2.7 Participate in work teams and group discussions.
- 1.2.1 Follow multi-step oral instructions to perform single tasks, to answer questions, and to solve problems.
- 1.2.18 Participate productively in self-directed work teams for a particular purpose (e.g., to interpret literature, solve a problem, make a decision)
- 1.5.1 Use logic to make inferences and draw conclusions in a variety of oral and written contexts.

High School: Physical Science

- Inq.10 Explore how bias can affect conclusions and identify conclusions that are affected by bias.
- T/E.2 Apply the engineering design process to construct a prototype that meets developmentally appropriate specifications.
- T/E.4 Describe the dynamic interplay among science, technology, and engineering within living, earth-space, and physical systems.

High School: Scientific Research

- T/E.1 Distinguish among tools and procedures best suited to conduct a specified scientific inquiry.
- T/E.3 Explain the relationship between the properties of a material and the use of the material in the application of a technology.
- 5.1.3 Recognize that in science one solution often leads to new questions.
- 5.1.5 Follow safety procedures in the classroom, laboratory, and home environments.
- 5.2.3 Recognize the limitations of scientific investigations.
- 5.2.1 Compare the results of an experiment with what is already known about the topic under investigation.
- 5.3.1 Develop a testable question for a scientific investigation.
- 5.3.8 Demonstrate appropriate measurement techniques.
- 5.3.4 Perform an experiment to test a prediction.
- 5.3.2 Differentiate between variables and controls in an experiment and select appropriate variables for an experiment.

Examples of Possible Academic Vocabulary to Incorporate:

Kindergarten

- animal
- change
- cloud
- collect
- day/night
- growth
- natural
- observe
- parts
- seasons
- senses
- shape
- size
- temperature
- thermometer
- tools
- water
- weather

1st Grade

- adult
- balance
- classify
- environment
- invent
- investigate
- light
- living/non-living
- location
- planet
- plant
- precipitation
- prediction
- property
- push/pull
- shelter
- weather data

2nd Grade

- compare/contrast
- depend
- dissolve
- distance
- infer
- investigate
- observation
- parent
- reasoning
- scientific inquiry
- scientist
- similarities/differences
- sound
- temperature pattern
- transform
- type

3rd Grade

- anemometer
- atmosphere
- barometer
- cirrus
- cross section
- cumulonimbus
- cumulus
- force
- mixture
- physical change
- rain gauge
- revolution
- rotation
- stratus
- threatened
- wind vane

4th Grade

- climate
- Population
- Physical Change
- Compare
- Making inferences (inferring)
- mass
- opaque
- physical change
- weathering

5th Grade

- core
- dissipate
- gravity
- hurricane
- tornado
- tsunami
- volcano

6th Grade

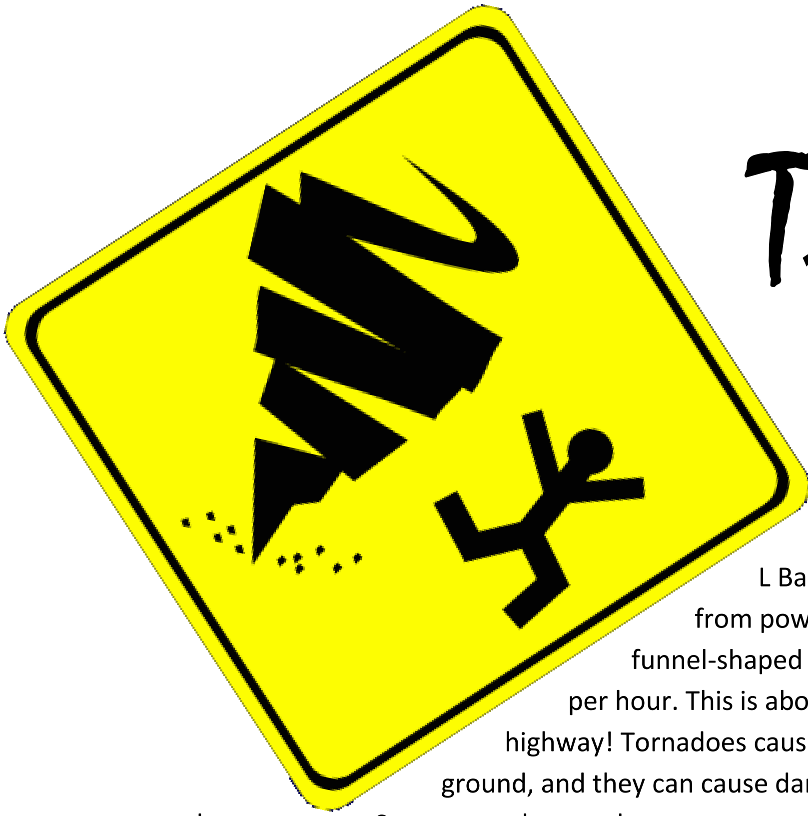
- atmospheric convection
- bias
- cause and effect
- chemical potential energy
- climate change
- control
- criteria
- design constraint
- meterological data
- protocol
- prototype
- variable

7th Grade

- acceleration
- amplitude
- momentum
- phenomenon
- speed
- synthesize
- velocity

8th Grade

- base
- class
- diffusion
- family
- order
- product
- variation

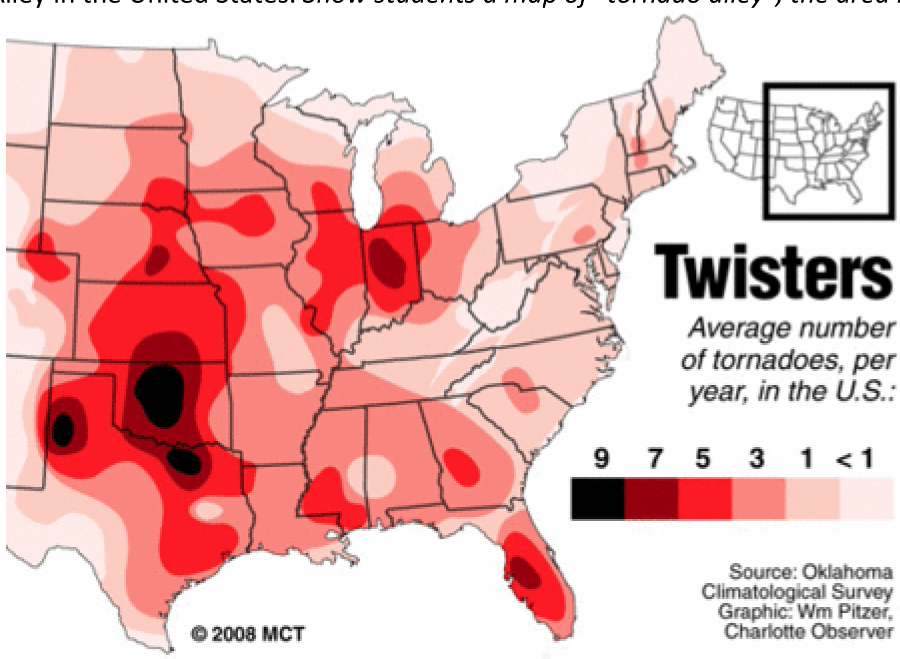


Twister!

What is a tornado?

A tornado isn't likely to take you to Munchkinland, as it did to Dorothy in Frank L Baum's, *The Wizard of Oz*. Tornadoes come from powerful thunderstorms and appear as rotating, funnel-shaped clouds with winds reaching up to 300 miles per hour. This is about 5 times as fast as a car driving on a highway! Tornadoes cause damage when they touch down on the ground, and they can cause damage in areas one mile wide and 50 miles long. Severe weather can be very scary, and tornadoes are one of nature's most violent storms. In an average year, 1000 tornadoes are reported nationwide in the United States, more than in any other country in the world. No other weather phenomenon can match the fury and destructive power of tornadoes. They can destroy large buildings, lift 20-ton railroad cars from their tracks, and drive straw and blades of grass into trees and telephone poles.

Tornadoes can happen anytime, anyplace under the right conditions, but the United States is more prone to tornadoes than anywhere else in the world and the most famous and active breeding ground for tornadoes is Tornado Alley in the United States. *Show students a map of "tornado alley", the area in the middle of the country where tornadoes are most likely to occur.* This geographical area extends from Texas up through Oklahoma, Kansas and Nebraska to the Dakotas. Warm, moist air from the Gulf of Mexico clashes with cold air from the north and fuels storms that form there. Tornadoes can form any time of



year, but many occur in the stormy spring, when these warm and cold air masses collide. Storms often are triggered where two different kinds of air masses meet, such as dry and moist air masses, or cold and warm air masses.

We don't know all the reasons a tornado forms, but scientists have a basic idea of what weather ingredients need to come together in order to make a tornado.

In order to form a tornado, a storm recipe has to be followed. For the recipe to work, you need four very different types of air to come together in a particular way (Tip: You can also build tornado sundaes in cups with the students to help solidify the thunderstorm storm layers in their memories. Ideas for ingredients are included below.):

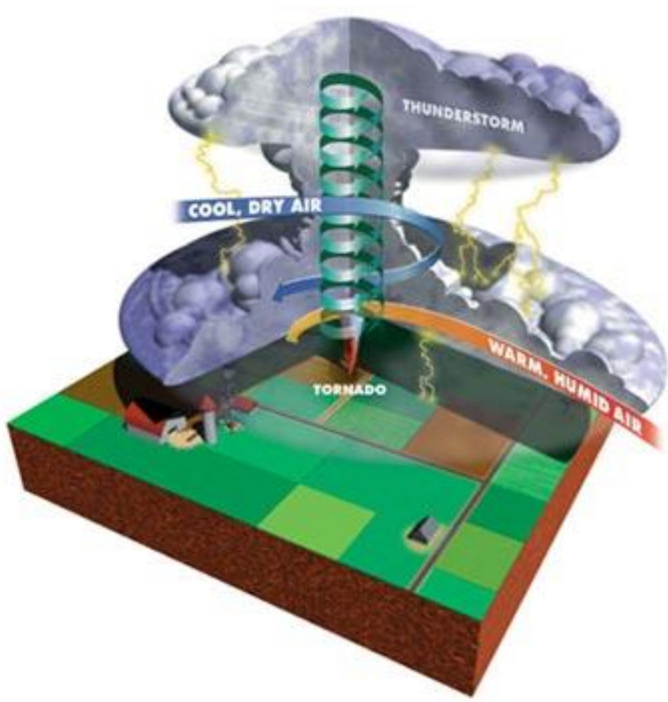
1. Near the ground, there's a layer of warm, humid (wet) air and strong south winds (whipped topping).

2. In the upper atmosphere, you'll find colder drier air and strong west or southwest winds (ice cream).

3. The air near the surface is much less dense (thinner) than the cold, dry air up higher. This condition is called *instability,* which means it can be changed*.* If the warm, moist air can be given an initial push to move upwards, by a changing air current, or wind, the air will keep on rising, (warm always prefers to rise and cold tends to want to sink) sending moisture and energy to form a tornado's parent, a thunderstorm.

4. The next ingredient is a change in wind speed and direction with height, called wind shear (fast changes in air pressure and wind direction.) These fast changes in wind direction are linked to the eventual development of rotation (spin) from which a tornado may form. *(spoon)*

5. The last thing you need is a layer of hot, dry air between the upper and lower layers. This middle layer acts as a cap and keeps the heat from the lower layer from escaping, this allows the warm air underneath to get even warmer and make the atmosphere even less stable. (plain cake)



When a storm system high in the atmosphere moves east and begins to lift the layers, it begins to build severe thunderstorms that spawn tornadoes.

Tornadoes start deep within vast thunderclouds, where a column of strongly rising warm air is set spinning by high, fast winds streaming through the clouds (fat straw or tube cookie). As air is sucked into this swirling column, or mesocyclone, it spins very fast, stretching thousands of feet up and down through the cloud, with a corkscrewing funnel descending from the cloud's base - the tornado.

To visually show students how cold air and warm air behave do the following demonstration from stevespanglerscience.com:

Colorful Convection Currents

Convection is one of those words that we often hear used, but we may not completely understand its meaning. Weather forecasters show how convection currents are formed on maps when warm and cold air masses meet in the atmosphere and create storms, but how can we see for ourselves?

Materials

•Four empty identical bottles (mouth of the bottle should be at least 1 1/2 inches in diameter) or use a small Split Demo Tank
•Access to warm and cold water
•Food coloring (yellow and blue) or True Colors Coloring Tablets
•3 x 5 inch index card or an old playing card
1.Fill two bottles with warm water from the tap and the other two bottles with cold water. Use food coloring or True Colors Coloring Tablets to color the warm water yellow and the cold water blue. Each bottle must be filled to the brim with water.
2.Hot over cold: Place the index card or old playing card over the mouth of one of the warm water bottles. Hold the card in place as you turn the bottle upside down and rest it on top of one of the cold water bottles. The bottles should be positioned so that they are mouth to mouth with the card separating the two liquids. You will want to do this over a sink, bucket, aluminum pan, garbage can, or outside.
3.Carefully slip the card out from in between the two bottles. Make sure that you are holding onto the top bottle when you remove the card. Observe what happens to the colored liquids in the two bottles.
4.Cold over hot: Repeat steps 2 and 3, but this time place the bottle of cold water on top of the warm water. Have students observe what happens.

A tornado is only a tornado if it's in contact with the ground. Otherwise, it's a funnel. Some tornadoes don't have a visible funnel, but if debris is visible at the ground, it is considered a tornado. Because big storms can suck up dust or kick up dust even when there's no tornado, sometimes they can be confusing to observers. If there is rotation in the clouds above the dust, then it may very well be a tornado.

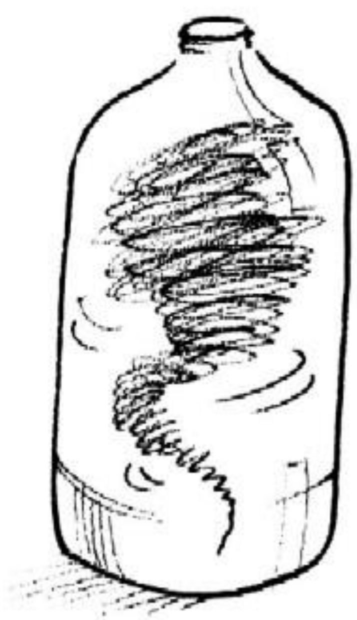
Most tornadoes last only 5 or 10 minutes, but some have been known to last more than an hour. Close to 1,000 tornadoes are reported every year in the United States. Most, but not all, tornadoes in the northern hemisphere spin counter-clockwise, or cyclonically. In the southern hemisphere - for instance, Australia - the opposite is true.

Another type of tornado is a waterspout - a tornado over water. Waterspouts form out of quickly growing cumulus (puffy) clouds or storms. They are sometimes weaker than their land cousins, but they can still cause damage or flip boats.

Vortices occur in nature in many forms: Tornadoes, whirlpools, weather systems, galaxies, etc. Have you ever seen the leaves on the side of your house blow around in a circle for a few seconds? That so-called dust devil is a vortex. A dust devil, however, is not a tornado. If it's a warm day, and light winds at the surface cooperate, you may see one of these whirling columns of dust in a farm field, a parking lot or the desert.

Extensions:

- *Use a hair dryer (on the cool setting!) to create a small-scale wind. Have students make some small "trees" by sticking a toothpick into a marshmallow or gumdrop for the trunk and roots, and taping paper onto the toothpick to represent the leaves. Set up a whole bunch of trees, and investigate how far from the hair dryer the trees have to be before they aren't blown over by the wind. Discuss why the wind strength seems to diminish the farther away you are from the source. How might diminishing wind strength, weaker winds, affect a tornado the farther it gets away from its source?*
- *Have students use tops and small blocks or their gumdrop trees to demonstrate the direction of spin and the unpredictability of tornados and diminishing wind-strength as the top loses its energy.*



Tornado in a Bottle

Do tornadoes make you dizzy? Do their spinning, twirling winds make you wonder how they work? Well, shake up a mini-tornado of your own with this wild indoor tornado activity and study its spiraling vortex of currents without fear.

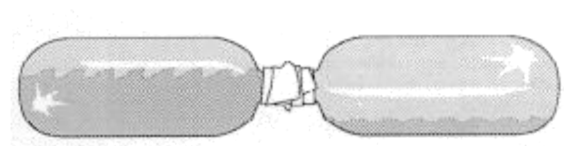
With this experiment students will be able to see what a tornado looks like on a very small scale. This experiment shows water moving through a small hole in a manner that simulates the spiraling behavior of the tail of the tornado. The condensation funnel, or tail, causes great destruction for anything in its path, as it touches the earth and sweeps objects and debris up into its vortex (the spinning center).

Materials

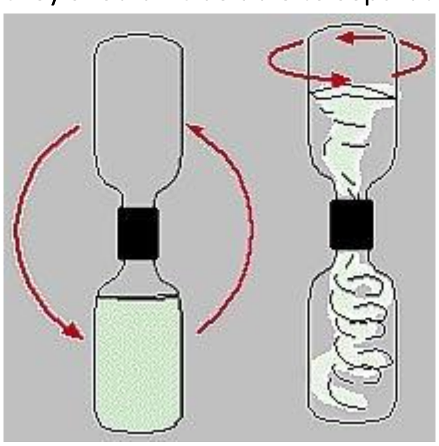
- 2 empty 2-liter soda bottles, rinsed out and with labels removed
- Black Marker
- Rubber washers that are the same size as the bottle opening (washer with a 3/8" hole in it)
- Electrical tape or duct tape
  Water
- Optional: Lamp Oil
- Optional: bits of paper, glitter, or Styrofoam for “debris”

Procedure

Have students work in pairs or groups to:



1) Label each bottle with your black marker. Label one bottle "A" and the other "B".
   Tape the washer to the mouth of bottle A. Do not cover the washer hole with tape.
2) Fill bottle A 3/4 full of water. Place bottle B upside down on top of bottle A.
3) Have another person hold the bottles steadily in place as you wrap the bottle necks and washers tightly with duct tape and tape the mouths of both bottles together.
4) You will need to fasten it tightly enough that the bottles stand straight up together--they shouldn't be able to separate or tilt in any way. The duct tape should also be secure enough that when you turn the tornado experiment over (the top bottle now on the bottom) there is no water leakage.



5) Place the two bottles on a table with the filled bottle on top. Watch the water slowly drip down into the lower bottle as air simultaneously bubbles up into the top bottle. The flow of water may come to a complete stop.
6) With the filled bottle on top, rapidly rotate the bottles in a circle a few times. just like you would spin a hula hoop. Swirl them several times. Then place the bottles on a table. The water will start swirling down from bottle A to bottle B just like a tornado, observe the formation of a funnel-shaped *vortex* as the bottle drains. *(Image credit to http://www.ehow.com/how_2192645_tornado-science-experiment.html)*

7) Notice the shape of the vortex. Also, notice the flow of the water as it empties into the lower bottle.

Extension: Twist of Color

- Try adding 2 ounces of colored lamp oil to the water. Lamp oil is available at most department stores where oil lamps are sold. The oil will float on the surface of the water since oil is less dense than water. When the oil and water swirl together, the less dense oil travels down the vortex first and creates a "colored tornado" effect.

How does it work?

If you've ever seen a dust devil on a windy day or watched the water drain from the bathtub, you've seen a *vortex*. A vortex is a type of motion that causes liquids and gases to travel in spirals around a center line. A vortex is created when a rotating liquid falls through an opening. Gravity is the force that pulls the liquid into the hole and a continuous vortex develops.

Swirling the water in the bottle while pouring it out causes the formation of a vortex. The vortex looks like a tornado in the bottle. The formation of the vortex makes it easier for air to come into the bottle and allows the water to pour out faster. The hole in the vortex allows air from the lower bottle to flow easily into the upper bottle. This enables the upper bottle to drain smoothly and completely.

If you look carefully, you will be able to see the hole in the middle of the vortex that allows the air to come up inside the bottle. If you do not swirl the water and just allow it to flow out on its own, then the air and water have to essentially take turns passing through the mouth of the bottle, thus the glug-glug sound.

To make water move in a circle, forces called centripetal forces must act on the water. These "center pulling" forces are provided by a combination of air pressure, water pressure, and gravity, similar to the way that real tornados are formed..

You can tell where the centripetal forces are greater by looking at the slope of the water. Where the water is steeper, such as at the bottom of the vortex, the centripetal force on the water is greater. Water moving with higher speeds and in smaller radius curves requires larger stronger forces to keep them in place. The water at the bottom of the vortex is doing just this, and so the wall of the vortex is steepest at the bottom. (Think about race cars: race tracks have steeper banks on high-speed, sharp corners to hold the cars in their circular paths around the track.)

I'll Huff and I'll Puff!

Option: Read a version of the three little pigs with students to introduce the lesson. Ex. *The Three Little Tamales, The Three Little Wolves and the Big Bad Pig*, the original story, etc.

The F-Scale

How do we know how bad a tornado is?

A tornado's intensity doesn't depend on its actual size, since a skinny funnel can be either weak or strong; the same is true for a very large tornado. The Fujita scale is what scientists use to rank the strength of tornadoes.

What is the Fujita scale?

This scale was developed in 1971 by Dr. T. Theodore Fujita of the University of Chicago and Allen Pearson, then Director of the National Severe Storms Forecast Center (NSSL).
The scale they came up with was based on six categories and converts the degree and type of damage caused by a tornado into an estimation/an educated guess of the wind speeds **inside** the funnel.
The scale ranges from F0 to F5 and the rankings are based according to destructive capacity rather than tornado size. However, by examining the damage a storm has caused, scientists can determine the accurate wind speed which is a key component in the Fujita scale.

The classification of a tornado must, therefore, be done after the event, and is based on the degree of damage, not the appearance or size of the funnel. Storm spotters, storm chasers and other weather observers often try to estimate the intensity of a tornado when they are in the field, basing their judgement on the rotational speed and amount of debris being generated as well as the width.
However, the official estimate is made after the tornado has passed. Personnel from the National Weather Service office that issued the warning survey the site to determine the F-Scale rating.
As of February 1, 2007, the original Fujita Scale has been replaced by the Enhanced Fujita Scale (EF Scale), now used to estimate tornado intensity and wind speed. But still, EF scale wind speeds remain as educated guesses

Assigning and Enhanced Fujita Scale rating involves a much more detailed inspection of damage than with the original F-Scale, with wind speeds now estimated based upon guidelines for 28 different types of structures and objects. An EF rating is then applied to the tornado based upon the damage including the highest wind speed.

EF0 65-85 mph

EF1 88-110 mph

EF2 111-135 mph

EF3 136-165 mph

EF4 166-200 mph

EF5 over 200 mph

Note: The Fujita scale goes higher—from F6 ("inconceivable" damage) all the way up to F12—but an F5 is the most intense type of tornado that has ever been observed. An F12 would be estimated at 738 mph.

The Fujita Scale is very subjective, and varies according to how experienced the surveyor is. Many people try to do their own "surveys" of tornado damage when storms occur. However, the less experienced the surveyor is, the more likely he/she is to be awed by the damage, and the more likely they are to give it a high rating, which it may not deserve.

As if doing a site survey of a tornado's trail is not difficult enough, tornadic storms may also be accompanied by complex combinations of strong downbursts and other straight line winds. Separating tornado damage from other wind damage makes for a daunting, difficult task for even the most experienced surveyor.

Can Students Build a Wind-proof/Tornado-proof House?

Tornadoes are hard to predict, but when you build a house you have to be prepared. Most of the time you will only have a few minutes warning and you can't make a house wind-proof in only a few minutes. So what do house-builders do?

Realistically speaking, it is not practical, much less reasonable, to build a tornado-**proof** house. Research has shown that what is practical and reasonable is to do a better job of building your home with good wind resistance connections.

The Challenge: Divide the kids into three or more groups, have them draw lots on what kind of materials they get to build with. They have to go and be the three little piggies. Students must build wind-resistant/tornado resistant homes using only the provided materials.

Have each group brainstorm the type of home they would build and form their hypothesis on how they can make it the strongest possible, as well as deciding on details such as how many rooms, windows, and doors it will have and the strength of their materials.

After a half hour, or the given time limit, the teacher will be the big bad tornado and come with a blow drier and try to blow each house down, using different wind speeds (ex: F1=Low, F3=Medium, F5=Turbo setting). At the end, discuss the results, expected and unexpected, and talk about the different materials used to build houses in general, those that have survived storms, and the planning that needs to go into them. What were your houses all missing? A foundation?

Building Materials Ideas:

- Straw
- Plastic Straws
- Legos or other building blocks (for bricks)
- Masking Tape
- Popsicle Sticks
- Small pigs or other figures

Tips for YOU!

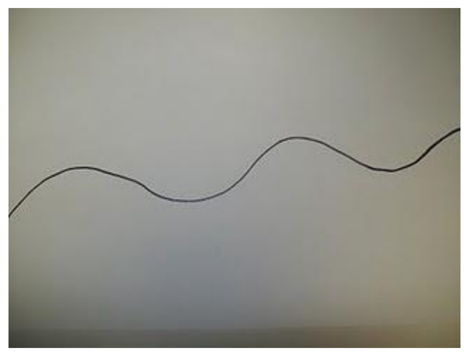
The most important thing to do is TAKE COVER when a tornado is nearby. It is also important to know the difference between a tornado watch and a tornado warning. A tornado watch is when tornadoes are **possible** in your area. No tornado has been spotted, but it could happen. A tornado warning is when a tornado has been seen, and you should take shelter immediately in a place without windows, such as your bathroom or your basement.

Twister Art

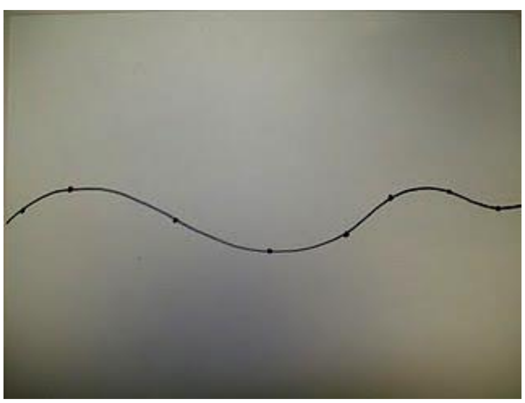
http://artwithmre.blogspot.com/2010/05/line-design-w-shading-steps.html

Line Design w/ Shading- The Steps

Another MNPS art teacher showed me this project several years ago, and I really liked it. I tweeked it a bit here and there, but it is basically as he showed me. The students LOVE IT! All you need is paper, Sharpie, and colored pencils!

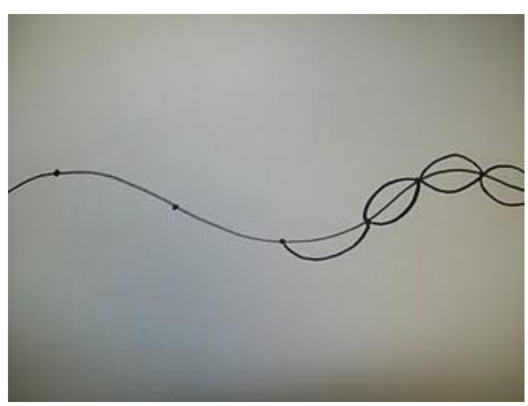


Have them start by drawing a curve line across the paper. Tell students to think rolling hill...not roller coaster!



Add 8 dots across the line. They could be (should be) at different lengths apart. You need a dot at relatively close to the edges of your paper.

They will then start connecting the dots. The dots close to the edge will go off the edge of the paper to an imaginary dot. You can not cross over any lines. However, you can share a line as you begin going up and out. The lines should be taken off the edge of the paper as you extend outwards. Some sections may be pinched off as other sections grow larger...and that is totally ok.



Have your students go connect the dots across both sides top and bottom...then have them "camp out" at different points...this will cause some areas to balloon outward.

At the top of the page is a students work that's a great example of what it should look like. The students should pick a group of colors they feel work well together. The will press harder in the corners of the shapes...and as they near the center get lighter and lighter. This is a great way to get them practice with pressure control!

Tornado! Vocabulary Review Game

It's great for reviewing vocabulary using picture cards or word cards. You will need 35-40 small picture cards or word cards of the vocabulary you covered during the above lesson or other vocabulary you wish to review. 45 small magnets (or use stickyback magnet strips), a chalkboard and you will need to use the 9 small "special" cards, made from the images on the next sheet. You will set up the cards (including the special cards) in the following grid-like format:

...1 2 3 4 5 6 7 8

A X X X X X X X X X

B X X X X X X X X X

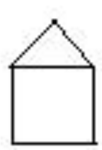
C X X X X X X X X X

D X X X X X X X X X

E X X X X X X X X X

With larger classes you may wish to use a 5x9 grid instead.

There are 3 types of special cards: a tornado, a house, and a switch score card.
House card - this is 6 free points
Tornado card- wipes out the houses (points) of the team that picked it
Switch Scores card - Team 1's score is now Team 2's score and vice versa
You will need 3 tornado cards, 3 house cards, and 3 switch scores cards. These cards will be randomly mixed in with the small cards and placed in the grid-like format. The front of the cards should be facing the board so that the students don't know what they are picking. This game is played best with two teams. Each correct answer is worth 2 points which is 2 lines. 6 lines makes one house so each house is worth 6 points. Here's what the house or 6 points looks like:



If the student doesn't know what the picture card is then they get zero points and the card is flipped back over so that someone else can pick it later on. If they get it correct then the card can't be used again.