WILD WEATHER

SCIENCE NORTH SCIENCE NORD

EDUCATION GUIDE

LESSON PLANS FOR GRADES K TO 8

Developed in partnership with ONTARIO SCIENCE CENTRE

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Wild Weather – Education Guide

— Lesson Plans —

Wild Weather was developed and produced by Science North
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Make Your Own Weather Instruments

Activity Description:
This activity will detail how to build three different weather instruments with your class.

Exhibit Description:
This activity relates to the *Wild Weather* exhibition as a whole. Scientists quantitatively measure the weather. An important part of predicting weather is keeping accurate observations and measurements about the weather over the years.

Activity 1: Build a Rain Gauge – measuring precipitation

Materials:
- ❑ Plastic pop bottle
- ❑ Scissors
- ❑ Ruler
- ❑ Marker
- ❑ Observation sheet

Procedure:
1. Cut the top off a clear plastic pop bottle (about ¾ of the way up the bottle).
2. Make a scale in inches (or centimeters) along the side of the bottle.
3. Turn the top (neck) upside down into the bottom part of the bottle to act as a funnel.
4. Leave your rain gauge outside in an open area to collect rain. Check the amount of rainfall at regular intervals, and record your observations.

Conclusion:
Meteorologists measure rainfall in inches (or centimeters), not ounces (or milliliters), of water. Use your observations and compare them to your local weather report.

Make Your Own Weather Instruments

Activity 2: Build a Barometer — measuring air pressure

Materials:

- ❑ Medium-size jar
- ❑ Balloon
- ❑ Duct tape
- ❑ Straw
- ❑ Piece of cardboard
- ❑ Observation sheet

Procedure:

1. Take a medium-size jar and cover the opening by stretching a piece of balloon over it.
2. Make sure the seal is tight by adding duct tape or elastics around the balloon and the mouth of the jar.
3. Cut the end of a straw and make it pointed.
4. Tape the other end of the straw to the middle of the balloon's surface.
5. Place your homemade barometer in front of a piece of cardboard.
6. Use a marker to record the position of the straw, the date, and the time of your recording.
7. Check the level of the straw at regular intervals throughout the day. Record your observations. Has the straw moved up or down?
8. Take a reading the next day and notice any changes.

Conclusion:

When the air pressure outside the jar increases, meaning it is higher than the pressure inside the jar, the air will push against the balloon surface, lifting the end of the straw that's in front of the cardboard and indicating high pressure. When the air pressure outside the jar decreases, meaning it is lower than the pressure inside the jar, the air inside the jar pushes up against the balloon and makes the end of the straw go down, indicating low pressure.

Make Your Own Weather Instruments

Activity 3: Build an Anemometer — measuring wind speed

Materials:

- ❑ Styrofoam ball
- ❑ 4 plastic spoons
- ❑ Wooden skewer
- ❑ Straw

Procedure:

1. Cut the ends off the plastic spoon handles, leaving roughly 1.5 in (4 cm) of stem before the scoop.
2. Push the stems of the spoons into the Styrofoam ball, around the ball's 'equator'. Make sure all four spoons are evenly spaced, and their scoops are facing the same direction.
3. Run the wooden skewer vertically through the center of the ball. Move the skewer around to make the hole bigger.
4. Remove the skewer and insert the straw in its place.
5. The skewer should then be placed inside the straw, as an axle.
6. Hold the anemometer at the bottom of the skewer and let the spoons catch the wind.
7. You can blow on it to test it before going outside.

Conclusion:

What did you notice about the wind strength on different days?

Extensions and Adaptations:

Use one differently colored spoon and count the number of revolutions in a given time period to measure wind speed. Use the anemometer to measure the strength of air from a fan at each fan speed. What happens when you move closer to the fan or farther away from it?

Feeling Pressured!

Activity Description:

Four different hands-on activities will allow your students to explore the properties of air. They will learn that air has mass and it can exert a force, sometimes a great force!

Exhibit Description:

This activity relates to several *Wild Weather* exhibits including the *Solving Storms* stations. In these experiences, visitors use air pressure to help forecast severe weather such as hurricanes and heat waves. Air pressure plays an important part in all weather forecasting analysis, from rainstorms to snowstorms.

Background Information:

Although air may seem to weigh very little, it consists of molecules that have mass.

Air pressure and the weather are tied very closely together. You may hear a weather reporter say: "an area of low air pressure is moving into our area and we will expect rain" or "an area of high air pressure is moving into our area and we expect lots of sunshine. Each of these areas of air is exerting a different pressure.

Why do some air masses exert greater pressure than other air masses? This has a lot to do with air temperature and water vapor. When air is warm, air molecules spread apart and the area of air has less mass and cannot exert as much pressure. When air is cold, the molecules group more closely together and can exert more pressure. Water vapor in the air causes the air to have less mass, so the more water in the air, the less pressure it can exert.

The way that water vapor and temperature interact with each other helps to create our weather.

Activity 1: Air Can Exert a Force

Materials:

(per group of two to three students):

- ❑ Balloon
- ❑ Heavy book

Procedure:

1. Place the balloon at the edge of the desk, so the opening overhangs the desk edge, and then place the book on top of the balloon.
2. Blow into the balloon.
3. Notice the balloon filled with air will be able to lift the book.

Conclusion:

Air can exert a force. Often it is surprising what can be lifted using the power of air. *Think of the power of a tornado, which is essentially air!*

Extensions and Adaptations:

Have the students try to lift different items with air.

Feeling Pressured!

Activity 2: Air Has Mass

Materials:

- ❑ Yardstick or wooden rod
- ❑ Piece of string
- ❑ 2 balloons
- ❑ Tape

Procedure:

1. Mark the center of the yardstick or wooden rod.
2. Tie a string around the rod at this center mark.
3. Test to see if your rod is perfectly balanced by holding it up with the string.
4. Tape a balloon on each end of the rod.
5. Test again to make sure it is perfectly balanced.
6. Remove one of the balloons and inflate it.
7. Reattach the balloon to the rod.
8. Observe what happens when you hold up the rod and balloons using the string.

Conclusion:

Air has mass. Air is not simply made up of empty space. Air contains molecules that have mass.

Extensions and Adaptations:

Inflate the balloons to different sizes to see the changes in mass. Try using warm air from a hair dryer (use caution with heat) to see if this makes a difference.

Feeling Pressured!

Activity 3: Air Pressure – Your Class as Air Molecules

Materials:

- ❑ Tape
- ❑ Measuring tape

Procedure:

1. Map out two identical-size boxes on the floor with tape.
2. Divide the class into four equal groups – Groups A, B, C and D.
3. Have Groups A and B stand in one of the boxes, Box 1 (no one outside the line), and have Groups C and D stand in the other box, Box 2. This represents standard atmospheric pressure.
4. Now have Group B move to Box 2 and fit in with Groups C and D. Ask the students how they feel. Are they squeezed together? Can they move easily or freely? Ask them if they want to move back to the other box.
   - *Box 1 represents low pressure, and Box 2 represents high pressure.*
5. Now have Group A move to Box 2 as well and fit in with Groups B, C and D. Ask the students how they feel now. Are they squeezed together? Can they move easily or freely? Ask them if they want to move back to Box 1.
   - *Box 1 represents very low pressure, and Box 2 represents very high pressure.*
6. Next tell the students that they are individual molecules and they can choose where they want to go. Have them choose either Box 1 or 2 to stand in.
   - *If students are behaving as air molecules would, if given the chance they will choose to evenly distribute themselves between Boxes 1 and 2.*

Conclusion:

Air pressure has to do with the amount of air molecules in a given space. In any given space, the more molecules the higher the pressure.

Feeling Pressured!

Activity 4: Atmospheric Pressure

Materials:

- ❑ Rubber mat with handle in center
- ❑ Stool

Procedure:

1. Place the rubber mat on the center of the stool seat.
2. Have a student try to remove the rubber mat by lifting one of the corners of the mat.
3. Place the rubber mat on the stool once again.
4. Have a student try to remove the rubber mat by lifting it using the handle in the center.
5. Have students try to conclude why it was so easy when lifting from the side, and very difficult when lifting from the center.

Conclusion:

Lifting the corner allows air to get under the mat and when this happens, the pressure on the top and bottom will be the same. When lifting the mat by the middle, air isn't able to get under the mat, which means that there is more air on top than underneath. The air on top is called atmospheric pressure and it forces the mat to stay on the stool.

Coriolis

Activity Description:

Students will learn that the rotation of the earth has an effect on the direction that hurricanes and typhoons move in the Northern Hemisphere and tropical cyclones move in the Southern Hemisphere.

Exhibit Description:

These activities relate to all the exhibits in the *Hurricanes* zone. In this area, visitors learn how to forecast hurricanes and what effect climate change is having on hurricane frequency and intensity. Visitors can also "fly through the eye" of a hurricane to see how forecasters and researchers use aircraft to study and monitor hurricanes. A gallery of photographs shows the power of hurricanes and the damage they can cause.

Background Information:

A hurricane is an intense cyclone that originates over warm, tropical waters. Hurricanes are most often seen in the late summer and early fall when tropical waters are the warmest. The storm must have a maximum sustained wind speed of 74 mph (119 km/h) or higher to be classified as a hurricane.

At the center of the hurricane is an area of almost cloudless skies with little wind called the eye. Around the **eye** is the most intense area of the storm called the **eyewall**. The eyewall is made of large towering, thunderstorm (cumulonimbus) clouds that produce heavy rain and winds.

The dangers that come from hurricanes include heavy rain that may cause flooding, strong destructive winds, tornadoes that can develop within the hurricanes, and storm surge.

A storm surge is a dome of ocean water that sweeps over the coastline as the hurricane makes landfall. Wind-driven waves from 5 to 33 feet (1.5-10 m) top the dome of ocean water. These waves can carry sand and large floating debris that can cause even further damage and flooding.

temperature and water vapor. When air is warm, air molecules spread apart and the area of air has less mass and cannot exert as much pressure. When air is cold, the molecules group more closely together and can exert more pressure. Water vapor in the air causes the air to have less mass, so the more water in the air, the less pressure it can exert.

The way that water vapor and temperature interact with each other helps to create our weather.

Coriolis

Activity 1: Coriolis Effect

Materials:

- ❑ Foam backboard
- ❑ Pushpin
- ❑ Circle of paper
- ❑ Ruler
- ❑ Marker/pencil

Procedure:

1. Attach the circle of paper to the foam backboard with the pushpin.
2. Ensure you are able to spin the piece of paper freely.
3. Run the ruler perpendicular through the diameter of the circle and attach it to the foam backboard. It should not impede the movement of the paper.
4. Starting at the center of the circle, draw a line with the marker along the ruler when the paper circle is not being moved. Show the direction of the line.
5. Next, have a partner rotate the paper circle at a constant speed, counter-clockwise, while drawing a line along the ruler from the center of the circle to the edge. Show the direction of the line.
6. Repeat this while having a partner rotate the paper circle clockwise at a constant speed. Show the direction of the line.

Conclusion:

The students should observe an apparent motion to the right when the paper circle was being rotated counter-clockwise, and an apparent motion to the left when the paper circle is being rotated clockwise. We call this the Coriolis effect. The direction of the line is still the same, but it appears to curve because the paper is moving.

Students may have heard of this term before and may associate it with the direction of swirls in toilet bowls or sinks. This is a great opportunity to explain the Coriolis force only works on very large scales on Earth. It doesn't affect small things such as toilets and sinks. The direction of the swirl is determined by the structure of the drains and local factors, which have a greater effect than the Coriolis force.

Coriolis

Activity 2: Pressure and Direction

Materials:

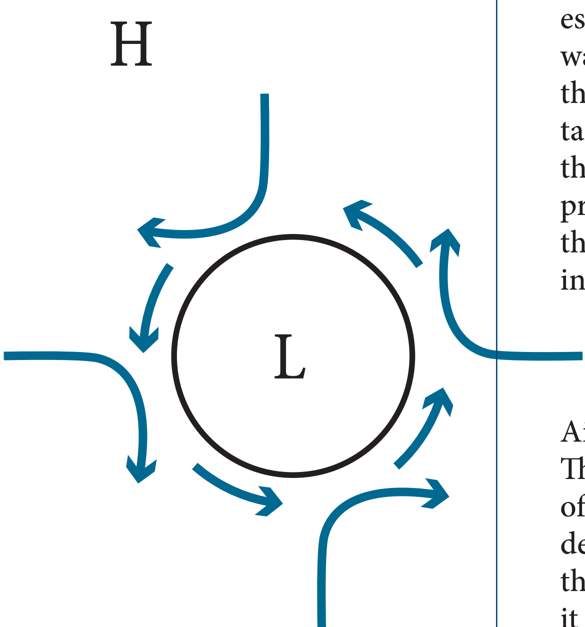
- ❑ Wide-mouth glass bottle (such as a big juice jar)
- ❑ Balloon
- ❑ Tongs
- ❑ Matches
- ❑ Small strip of paper
- ❑ Straw

Procedure:

1. Fill the balloon with water and tie a knot. It should be just slightly bigger than the mouth of the jar.
2. Holding the strip of paper with the tongs, light it with a match.
3. Drop the burning paper into the glass bottle and quickly put the water balloon on the mouth of the jar.
4. Observe what happens.

Conclusion:

The burning paper heats up the air molecules. They have more energy and are moving faster. They have more volume and escape past the balloon. You may have noticed the balloon was jumping and jiggling around. When the flame goes out, the air molecules start to cool down. The air is contracting, taking up less space, and there are fewer molecules inside the bottle than before because they escaped earlier. The air pressure inside the bottle is lower than air pressure outside the bottle. The higher pressure outside will push the balloon into the bottle.



Air flows from high-pressure areas to low-pressure areas. The eye of a hurricane, typhoon or tropical cyclone is an area of low pressure. Even though Coriolis force will apparently deflect objects to the right in the Northern Hemisphere, as the air moves toward the low-pressure center of the hurricane, it will spin in a counter-clockwise direction.

Citizen Science

Activity Description:

Scientists need to collect data from around the world and you can help! Scientists from Colorado State University want to measure hail from around the world, and this is where your students come in. Students will contribute to scientific research by making hail pads and sending them to the researchers at the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS).

Exhibit Description:

This activity is directly related to the *Hailstorms* exhibit. Visitors examine hail pads from real thunderstorms and compare the pads to models of various sizes of hail. Visitors learn more about citizen science and how to become involved in studying the weather at home.

Background Information:

Hail is frozen precipitation that is often round or spherical and more than 0.2 in (5 mm) in diameter. Hail develops high in the atmosphere and it almost always forms within large cumulonimbus clouds with strong updrafts. Hailstones grow by and colliding with supercooled water droplets.

Hail develops when a frozen water droplet is swept up higher in the cloud by the storm's updrafts. Supercooled moisture freezes to the surface of the droplet, creating a new layer of ice. This new hailstone grows heavier and falls downwards. Updrafts of air push the hailstone back higher in the cloud. If the updrafts are strong enough to keep the heavy hailstone in the cloud, it will grow bigger and bigger. When the hailstone becomes too heavy, it falls to the ground.

Hail can be destructive and is responsible for over a billion dollars in damage each year in North America.

Making Hail Pads

Materials:

- ❑ 12 in x 12 in (30 cm x 30 cm) pieces of 1 in (2.5 cm) thick Styrofoam
- ❑ 18 in x 18 in (45 cm x 45 cm) pieces of heavy duty aluminum foil
- ❑ Packing tape
- ❑ Box for mailing

Procedure:

1. Cut out an 18 in x 18 in (45 cm x 45 cm) piece of heavy duty aluminum foil.
2. Wrap the Styrofoam piece in aluminum foil. Use a clean dry surface to ensure the aluminum foil doesn't get marks on it that could later be confused for hail marks.
3. Securely tape the edges of the aluminum foil to the back of the Styrofoam pad.
4. Once you have created the hail pad, place it in a secure location outside. You may want to tightly pack bricks or rocks on all four sides to help keep the hail pad in place.

Continued.

Making Hail Pads (cont.)

Mail to:

CoCoRaHS Hail Pad Analysis Center
Colorado State University
1371 Campus Delivery
Fort Collins, CO 80523

Procedure:

5. Use a compass to determine which way is north.
6. Mark the hail pad using permanent marker with an "N" to show which way north was in relation to the hail pad.
7. Wait for it to hail!
8. Caution: Hail is associated with large storm systems that can also include heavy rain, lightning, winds and even tornadoes. Only collect your hail pad after the storm has passed and when it is safe to do so.
9. Use the CoCoRaHS Hail Report form to record your information about the hail and the storm. (Search on the internet for CoCoRaHS)
10. Mail the hail pad and the report card to the CoCoRaHS Hail Pad Analysis Center.

Extensions and Adaptations:

If it doesn't hail in your area, you can try dropping hail-size objects on your hail pads to see how the hail pad reacts. Try things such as frozen peas, marbles, golf balls and tennis balls. Try dropping the objects from different heights to see if your results change. Be sure not to send these "experimental hail pads" to CoCoRaHS!

You can also check out Zooniverse on the internet for other weather-related citizen science.

Thunder and Lightning - Light and Sound

Activity Description:

This is a two-part activity. The first part is designed to get students to understand that light and sound are both waves, and the second part is to get students thinking of the speed of light and sound quantitatively.

Exhibit Description:

This exhibit relates to the *Thundergames* exhibit in the *Severe Thunderstorms* zone. In this exhibit, two players practice estimating the distance of a thunderstorm by listening for the delay between the lightning strike and the sound of the thunder reaching their ears.

Background Information:

Where there is lightning, there is thunder. Sometimes you can see lightning in the distance, but cannot hear the thunder, or sometimes you hear the thunder many seconds after seeing lightning.

Lightning is incredibly hot and heats the air around it to temperatures around 45,000°F (25,000°C). When air is heated, it expands, but because lightning heats the air so quickly, it generates a shock wave. The shockwave moves outward, producing sound waves that you hear as thunder.

If you are really close to the lightning, the sound is very loud and occurs almost at the same time as the lightning flash. If you are far away, you can see the lightning flash and wait several seconds until you hear the thunder. Lightning that is more than 12 miles (20 km) away is too far away for the thunder to be heard – although you still might see it.

When you see lightning or hear thunder, you should go indoors right away. Even though the storm may look far away, lightning can still be dangerous.

Activity 1: Waves

Materials:

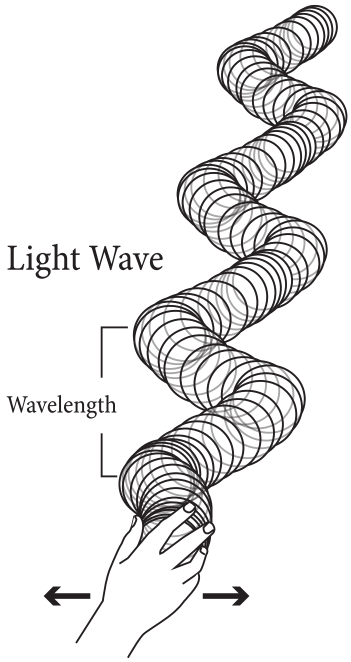
- ❑ Slinky

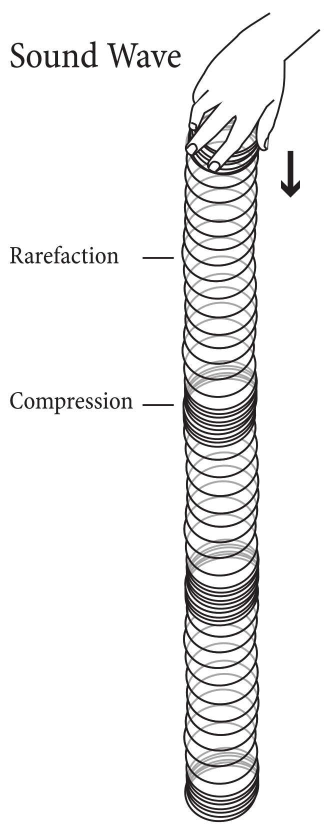
Procedure (For educator):

1. Get volunteers to hold a slinky and generate standing waves by shaking it back and forth on a table. (Be sure to shake the slinky side to side, not up and down). This is representative of a light wave. The wave of light is made of electricity and magnetism, hence electromagnetic radiation (light).
2. Discuss the properties of the wave (wavelength, amplitude). Discuss how you can change the properties, and then try it. Move the slinky faster side to side, and with bigger movement.

Continued.

Thunder and Lightning - Light and Sound





Activity 1: Waves (cont.)

Procedure (cont.):

3. Next, ask volunteers to hold a slinky and generate a longitudinal wave by shaking it forward and backward, rather than side-to-side. It is easiest if you just pinch a small portion the slinky together on one end and release it. This will demonstrate what a longitudinal wave looks like. This is representative of a sound wave.
4. Discuss the properties of the wave (compression and rarefaction). Sound is transmitted through the air, moving the air particles.

Conclusion:

In order to move into the second activity ask the students a few questions:

a. Do sound waves or light waves travel faster?
   (Answer: Light waves)

b. Would we be able to tell the difference between the speeds, given that they are both very fast?
   (Answer: If you are far enough away you should be able to tell the difference. The next activity demonstrates this.)

Thunder and Lightning - Light and Sound

Activity 2: Speed of Light and Sound

Materials:

- ❑ 4 timers
- ❑ Tape measure
- ❑ 2 observation sheets
- ❑ 4 large metal pot lids

CAUTION:
Remember to always stay in a safe location for 30 minutes after the last rumble of thunder is heard.

Procedure (For educator):

1. In order to do this activity you will need a large space outdoors, such as your school playground or city park.
2. Split the group into two and give each group two timers, a sheet of paper to record their observations, and two large objects that when hit together make noise (such as two large metal lids).
3. The groups will need to be at opposite ends of the playground, but with a clear line of sight to one another.
4. Have the students choose the spots, then measure the distance between the two spots with the tape measure. Record the distance.
5. When ready, have one group be the "makers," and the other group to be the "receivers." The "makers" will be the group to hit their objects together, and the "receivers" will be the group that records the time at which they see, and hear the hitting of the objects.
6. Designate one person to stop the timer when they SEE the objects hit one another and another person to stop the time when they HEAR the objects hit one another. Record both times. Repeat this step until each person in the group has had a chance to stop the timer.
7. Then switch roles for the groups so that each group gets a chance to be the "receiver" and the "maker. The group making the noise should do so at regular intervals so that the "receiver" group has time to record the times properly.
8. Have the students graph their observations, and draw some conclusions. They should figure out that light travels faster than sound. They should see the objects hit before they hear the sound.

Continued.

Thunder and Lightning - Light and Sound

Activity 2: Speed of Light and Sound (cont.)

Conclusion:

Light and sound travel at different speeds. Light travels much faster than sound.

Extensions and Adaptations:

You can reinforce this concept by having students record the time at which they see lighting and what time they hear the thunder during a real thunderstorm. With a simple calculation you can roughly estimate how far away you are from the lighting strike. Divide the number of seconds between the flash of lightning and the sound of the thunder by five to arrive at the distance in miles (divide by 3 for kilometers). For example: 15 seconds/5 = 3 miles away.

Geodesic Domes

Activity Description:

Students will design a structure and see how well it stands up to strong winds. They will then build a geodesic dome, using different materials, and compare its stability to other structures.

Exhibit Description:

This activity relates to the *Town vs. Tornado* exhibit. Visitors choose the *Enhanced Fujita* (EF) rating of a tornado and examine the damage that a tornado of that scale causes to the different structures in the town.

Background Information:

Tornadoes are the most violent of all weather systems. Damage from a tornado can be significant and an ordinary house, school, or car will not provide enough protection for you during a tornado.

When a tornado warning or emergency is issued for your area, you need to seek shelter immediately. The best place to seek shelter is in a tornado cellar, shelter or safe room below ground level. If no tornado shelter is available, seek shelter in interior hallways, lying flat on the floor with your head covered.

Many homeowners and communities are now building protective tornado and storm shelters. Since many places cannot build below the ground, many of these shelters are being built above ground. They come in many shapes and sizes and are made from a variety of strong materials such as concrete and steel. Some people are trying a different shape of shelter – a dome. The dome shape is very strong and if made from the right materials, could be a safe structure to help save lives when a tornado strikes.

Activity 1: Build a Wind Resistant Structure

Materials:

- ❑ Straws
- ❑ Paperclips or pipe cleaners
- ❑ Tape
- ❑ Paper
- ❑ Electric fan

Procedure:

1. Use straws, paperclips, tape and paper to design a structure you think will be resistant to strong winds.
2. Try any type or shape of structure. The paper can serve as the walls of the structure.
3. Attach your completed structure to a platform (tabletop) and test it with an electric fan. Start with the slowest speed, and increase the speed of the "wind."
4. Which form of structure was the most stable, and why?

Conclusion:

Students should see that structures that expose a lot of surface area perpendicular to the wind are more likely to fall over or fall apart. Structures that are lower to the ground or curved will allow the winds to pass over them. Made out of the right materials, they may be more likely to resist the winds and stay intact during a violent storm.

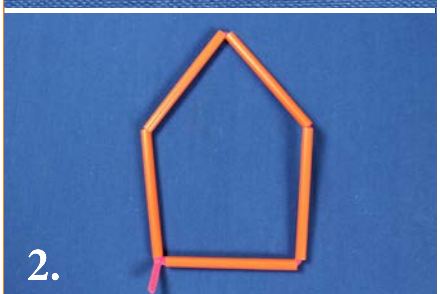
Geodesic Domes

Activity 2: Build a Geodesic Dome with Straws

Materials:

- ❑ 33 straws: 18 of one color, 15 of another color
- ❑ Pipe cleaners
- ❑ Scissors
- ❑ Ruler


1.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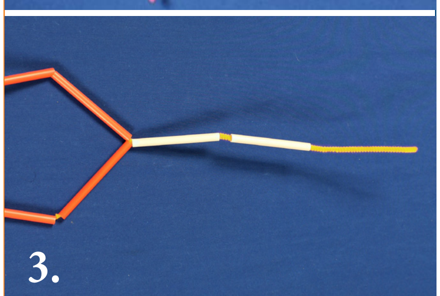
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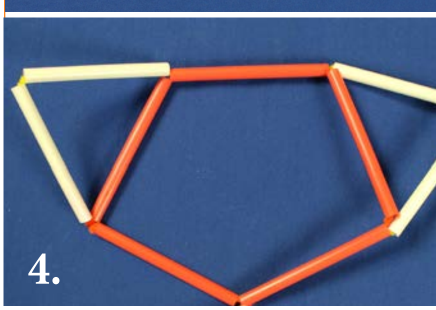

4.

Procedure (For educator):

i. Designate one color to be Strut A and the other color to be Strut B.

ii. Strut A will be longer. Cut the straws in half to create 35 Strut A pieces.

iii. Strut B is shorter than Strut A by a factor of 0.885. Measure the length of half a straw and multiply it by 0.885. This is how long Strut B will be. Use your first Strut B to be the guide for all the others. You need 30 Strut B pieces.

iv. Now you will build six pentagons by attaching the cut straws together with pipe cleaners. Twist the ends of the pipe cleaners together to make them longer as needed.

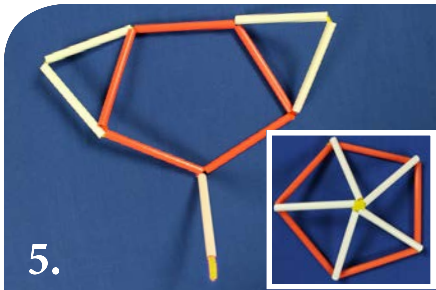
v. Strut A cut straws will form the outside of the pentagon. Strut B cut straws will be on the inside of the pentagon. Each pentagon will have five triangles inside.

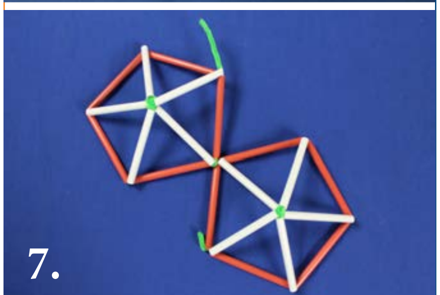
Procedure (For students):

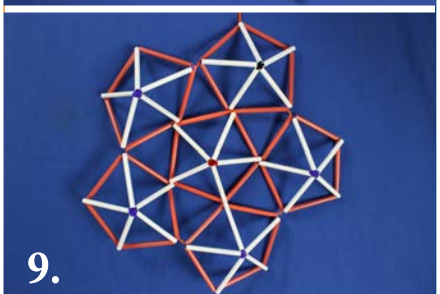
1. Take 1 Strut A and feed a pipe cleaner through it. Bend back the end of the pipe cleaner to secure it in place.
2. Thread 4 more Strut A straws for a total of 5. Bring the first and the last together to create a five sided shape.
3. Then thread 2 Strut B straws onto the long end of the pipe cleaner and thread the pipe cleaner through an adjacent Strut A.
4. Thread 2 more Strut B's onto the pipe cleaner and again pass through an adjacent Strut A.

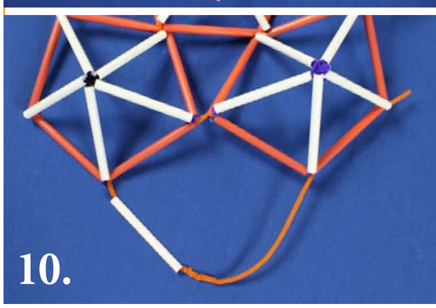
Continued.

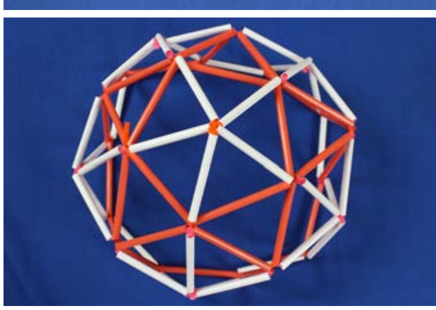
Activity 2: Build a Geodesic Dome with Straws (cont.)











Procedure (cont.):

5. Thread 1 final Strut B onto the pipe cleaner then fold all the Strut B's into the center and secure them together forming a pentagon with five triangles inside.
6. Repeat steps 1 to 5 until you have a total of 6 pentagons.

Now you will attach the six pentagons together with pipe cleaners to create a dome. As you build your dome keep in mind that you will want the centers of your pentagons pointing out.

7. Take one pentagon and thread a pipe cleaner through one Strut A, bend back the pipe cleaner on one end to secure it as you did in step 4. Then thread the long end of the pipe cleaner through a Strut A of a second pentagon.
8. Thread the pipe cleaner through a Strut A of a third pentagon before going back to the first pentagon and threading through an adjacent Strut A.
9. Continue in this manner until you have attached all pentagons to each vertex around the first pentagon. Remember, keep all peaks pointing out.
10. To complete the dome shape, use your last 5 Strut B pieces to fill in the spaces along the bottom. Thread around the outer edges of the dome, alternating between Strut B and pentagon. Use extra pipe cleaners when necessary.
11. You can cover the "windows" of the dome with paper to test for wind resistance.

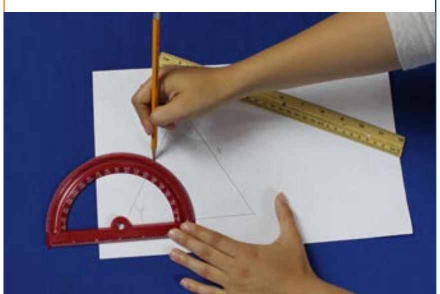
Conclusion:

Geodesic domes come in a variety of shapes (classes). The dome you created here is a 2V class dome. It has two different sizes of triangles. A higher class of dome has higher stability. Therefore, larger dome frames are higher classes. They are more complex and use multiple sizes of triangles.

Geodesic Domes

Activity 3: Build Your Own Geodesic Dome with Paper

Materials:
- ❑ Paper
- ❑ Ruler
- ❑ Protractor
- ❑ Compass
- ❑ Pencil
- ❑ Scissors



1. You will need 10 equilateral triangles with side lengths of 4.9 in (12.4 cm). Use the protractor to measure three 60° interior angles. Call these A-A-A triangles.
2. You will need 30 isosceles triangles with two side lengths of 4.3 in (10.9 cm) and one side length of 4.9 in (12.4 cm). Using the protractor again, measure two interior angles of 55.6° and one interior angle of 68.8°. Call these B-A-B triangles.
3. NOTE: You also need 0.4 in (1 cm) glue tabs on each side of the triangles. See diagram on page 6.5 for a template.
4. Fold up the 0.4 inch glue tabs.
5. You will create pentagons using the B-A-B triangles. Glue the B sides together, ensuring that the A sides form the outside of the pentagons. The pentagons will be raised at the center.
6. Draw a circular base of 16 in (40 cm). Cut out an 8 in (20 cm) circle from the center to create a doughnut shape.
7. Join together two pentagons by gluing an A-A-A triangle between them.
8. Continue to join pentagons and triangles to create a ring-like structure.
9. Glue this to the base.
10. Glue A-A-A triangles between the tops of the pentagons.
11. Glue the final pentagon on top.
12. Test your geodesic dome for wind resistance.

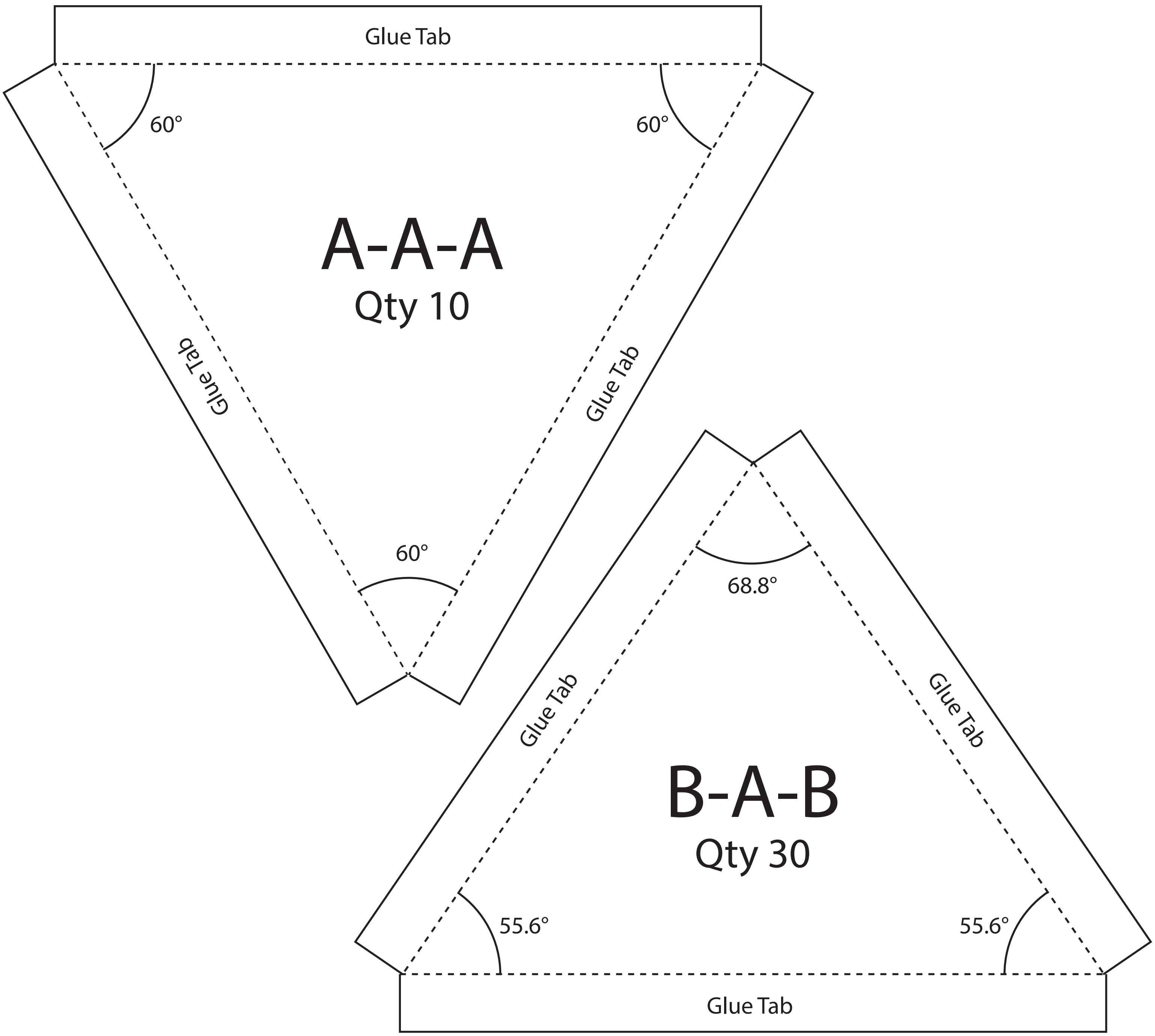
Conclusion:

Geodesic domes are strong due to the fact that triangles are very stable shapes. It is difficult to distort a triangle, because compression at one joint is balanced by tension along the opposite side. Loads are distributed over all of the different triangles within a dome.

Geodesic Domes

Activity 3: Build Your Own Geodesic Dome with Paper (cont.)

A-A-A and B-A-B Triangles



Feeling Chilly!

Activity Description:

This inquiry-based activity will allow students to discover wind chill by recording observations and drawing their own conclusions.

Exhibit Description:

This activity relates to the *Feel the Wind Chill* exhibit inside the *Severe Winter Storms* zone's winter cabin. Visitors watch the surface temperature of their hands change with wind exposure. This and other exhibits in the winter cabin help visitors understand how to prepare for a weather emergency.

Exhibit Description:

One of the biggest dangers in the winter is wind chill. Wind chill describes how cold your skin will feel when exposed to cool temperatures and wind. Your skin warms a thin layer of air around it, keeping you warm. Wind blows this layer away and evaporates moisture, leaving you feeling even colder.

The National Weather Service Wind Chill Temperature (WCT) index is used to provide an understandable formula for calculating the dangers from winter winds and cold temperatures. It is not a real measurement, but is communicated in a temperature format to help us understand how cold the wind may make us feel.

Wind Chill Activity

Materials:

- ❑ Paper
- ❑ Ruler
- ❑ Protractor
- ❑ Compass
- ❑ Pencil
- ❑ Scissors

Procedure:

1. Place your thermometer on the table.
2. Record the temperature from the thermometer. This is the ambient room temperature.
3. Turn the fan on low and direct it toward the thermometer. Wait 20 seconds, then record the temperature. Repeat this at least three times to show a pattern.
4. Place your hand in front of the fan and record if your hand feels colder or warmer.
5. Record the temperature from the thermometer again.
6. Dip your hand in the bowl of cold water and place it in front of the fan. Record if you hand feels colder or warmer.
7. Record temperature of the room again.

Continued.

Feeling Chilly!

Wind Chill Activity (cont.)

Procedure (cont.):

8. Dip your hand in the bowl of warm water and place it in front of the fan. Record if your hand feels colder or warmer.
9. Record room temperature again.

Conclusion:

Students should notice that the temperature on the thermometer doesn't change. The wind from the fan does not affect the temperature in the room, as it is simply moving the air around. They should feel a little colder when placing their dry hand in front of the fan, and much colder when placing a wet hand, regardless of the water temperature, in front of the fan.

Extensions and Adaptations:

Have the students vary the speed of the fan and record the temperatures at various intervals.

Human Health and Heat

Activity Description:

These four activities will allow your students to explore heat and its effects on human health. Students will learn that our bodies, which are mostly made up of water, maintain a constant temperature regardless of exertion or the external temperature. The heat capacity of water is responsible for our body's ability to maintain a regular temperature. Through inquiry based activities students will learn ways that are effective to help guard against the harmful rays of the sun.

Exhibit Description:

This activity relates to the *Body Heat Alert* exhibit where visitors explore how physical exercise, hydration, and sun exposure can affect the body's ability to dissipate heat. Visitors adjust these factors affecting our athlete, named Sunny, and see what physiological responses can happen with heat exposure.

Background Information:

When you're working or playing, your muscles and other metabolic functions produce heat. Your body has natural ways to help get rid of extra heat so your internal body temperature doesn't get too high. Your body increases blood flow to the skin to get rid of heat and you start to sweat.

Hot weather can be dangerous if you are not careful. Hot, humid weather prevents your body from being able to cool itself by its normal mechanisms and if exposed to heat for too long, your internal body temperature could begin to rise.

Extreme heat is one of the deadliest of all severe weather events. A heat wave forms when an area of high pressure hovers over one region for several days to several weeks. Warm air rises, but this area of high pressure acts as a cap, trapping heat and pushing it back toward the ground. Heat then builds up close to ground, resulting in a heat wave.

This area of high pressure prevents clouds from forming, resulting in little rain. Heat waves can lead to other devastating weather conditions, including drought and wildfires.

Activity 1: Internal Body Temperature

Procedure:

1. If using the modeling clay, roll it into a little ball the size of a large pea and flatten the bottom. Insert a toothpick into the top of the clay. If using marshmallows, insert the toothpick into the marshmallow.
2. While sitting down, one student in each group lays one arm on a desktop, palm facing up.
3. Place the clay or marshmallow on the student's wrist. Move it around until the toothpick starts moving back and forth.

Continued.

Human Health and Heat

Activity 1: Internal Body Temperature (cont.)

Materials:

(per group of two to three students):

- ❑ Classroom set of thermometers that can be used orally and cleaned easily
- ❑ Mini marshmallows or small bits of modeling clay
- ❑ Toothpicks
- ❑ Stopwatches
- ❑ Observation sheet

Procedure (cont.):

3. Place the clay or marshmallow on the student's wrist. Move it around until the toothpick starts moving back and forth.
4. Count the number of vibrations in one minute. Record this information in a chart labeled as "resting heart rate."
5. Measure this student's internal body temperature, orally, with a clean thermometer. Place the tip of the thermometer under the tongue. If it is a glass thermometer, wait three minutes. If it is a digital thermometer, wait until it beeps. Record this information in a chart labeled as "resting body temperature."
6. Repeat steps 2 to 5 for all the students in the group.
7. One student at a time in each group will exercise for one minute (for example, jumping jacks or running on spot). Make a note of the student's external signs of exertion (for example, sweating or heavier breathing).
8. Measure and record each student's heart rate and internal body temperature immediately following the exercise.
9. This can be repeated with a longer session of exercise.

Conclusion:

Students should see external signs of exertion such as a red face and sweating. Students should note that their heart rates increased after exercise when compared to their resting heart rates. However, their internal body temperature should not change after exercise. Ask students what they think would happen to their internal body temperature if they were outside during cold weather.

The temperature of your body does not drastically change while you are outside. Due to water's high heat capacity, it is used by warm-blooded animals to more evenly disperse heat in their bodies. In our bodies, water acts in a similar manner to a car's cooling system by transporting heat from warm places to cool places. This helps the body to maintain a more even temperature.

Human Health and Heat

Activity 2: "Burning" a Paper Cup

Materials:

- ❑ Paper cups
- ❑ Candle or Bunsen burner
- ❑ Thermometer
- ❑ Tongs
- ❑ Water

CAUTION:
Be careful around the open flame. Always hold the paper cups with tongs while exposing them to a flame. Have a fire extinguisher nearby for any accidents. Do not use flammable liquids (if testing other liquids).

Procedure:

1. Make sure you are in a well-ventilated room and put on safety goggles.
2. Fill the paper cup ¾ full with water.
3. Measure the temperature of the water.
4. Light the candle or Bunsen burner.
5. Pick up the paper cup with the tongs and hold it over the flame for one minute. Carefully observe what is happening to the cup and the water. If the cup starts to burn, remove it from the flame.
6. After one minute, remove the cup from the flame and immediately record the temperature of the water.
7. If the water has not boiled, put the cup back over the flame until the water boils.
8. Remove the cup from the flame and measure the temperature of the water immediately.

Conclusion:

The water will draw the heat away from the heat source by convection. The temperature of the liquid water will remain at 212°F (100°C) while boiling and will not go above this. The hotter water becomes steam. Most paper burns at 433°F (223°C). The water in the cup conducts the heat away from the paper, preventing the paper from reaching its flash point. Heat is also escaping with the steam. As long as there is liquid water in the paper cup, it will not burn.

These principles can be applied to understand how the human body works to remove excess heat. When moisture on the skin evaporates, it carries away a lot of heat with it. For humans, the moisture appears when our sweat glands generate perspiration (mostly water). Although many animals lack sweat glands, they achieve the same effect by panting, licking or splashing themselves with water. Because of water's high evaporation temperature, even a small amount of water can carry away large amounts of heat

Human Health and Heat

Activity 3: Albedo of Colors

Materials:

- ❑ 1 sheet of black paper
- ❑ 1 sheet of white paper
- ❑ Scissors
- ❑ Stapler
- ❑ Stopwatch
- ❑ 4 thermometers
- ❑ Heat lamp or sunlight

Procedure:

1. Cut both papers into rectangles measuring 3 in x 1.5 in (8 cm x 4 cm). Fold each rectangle in half to make a square and staple along the sides to make a pocket.
2. Place the thermometers into the pockets, and record the initial temperatures.
3. Position the heat lamp 20 in (50 cm) above the thermometers, or place the pockets in the same sunny location.
4. Measure the temperature every two minutes for a total of ten minutes. Record your results in a table.
5. Graph the results of temperature over time for the two colors.

Conclusion:

Albedo is the ability of a surface to reflect light. Objects appear white to us because they reflect almost all of the visible light. Objects appear black because they absorb visible light. If an object absorbs more light radiation, it will heat up more. In the summertime, would you get warmer faster if you wore light-colored clothing or dark-colored clothing?

To beat the heat in the summertime, wear light colored clothes. Cover your head with a hat. The hat will absorb the direct radiation from the sun and heat up before the top of your head heats up. Wear sunglasses to protect your eyes from UV radiation. Be sure to keep yourself hydrated. Once you lose the ability to sweat, you will start to overheat. Can you think of ways to cool yourself down?

Human Health and Heat

Activity 4: Sun Protection

Materials:

- ❑ UV beads
- ❑ String
- ❑ Clear plastic bag
- ❑ Different types of sunscreen

Activity Description:

One of the most effective ways to protect yourself from the harmful rays of the sun is to wear sunscreen. Students often don't think that the sun can do any damage, especially in winter months, or when it's a little cloudy, or even when it's cool outside. With this experiment, they can discover when sunscreen is needed.

Procedure:

1. Ask each student to create a bracelet using UV beads.
2. Next, have the students go outside and see the beads change colors.
3. Have the students test their UV bead bracelet on different days: cloudy, cold, sunny, and so on, and record their observations.
4. Once the initial testing is complete and students can conclude that the rays from the sun can penetrate even on cold, cloudy days, have them move on to testing different sunscreens.
5. The easiest way to test sunscreen is to place the beads inside a clear plastic bag, take it outside to ensure they still change color, and then apply the sunscreen directly to the outside of the bag to see if the beads still change color.

Extensions and Adaptations:

Sunglasses (polarizing and non-polarizing lenses)

Repeat steps 4 and 5, but instead of using sunscreen, use sunglasses.

If you'd like to show your students exactly what polarizing sheets do, you can usually get two polarized sheets from your local eyeglasses manufacturer. Take the two sheets and place them one on top of the other. Slowly rotate one of the sheets while keeping it directly in front of the other until all the light is completely blocked.

This is what polarizing lenses do: they eliminate UV rays.

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