



Lesson # 2

Lesson Plan
Revised 7/07

Hurricanes

Teachers, this is a basic lesson plan that you may modify at your discretion.

Grade Level: 3 -4

WARNING: This module will get you WET!

Overall Educational Objectives: Students will be able to state and directly experience two laws of Physics (Law of Gravity, Law of Centrifugal Force) that affect weather. They will be able to explain the observations made when using the hurricane bottle set and relate them to other events and phenomenon. They will also be able to explain how the greater density of water compared to the density of air affects the outcome.

Associated Standard and CORE Objective:

- **3040-0601** - Identify the elements of weather. Explain the role of water as it relates to weather. Relate air and air movement to weather.

Materials List:

- 15 - connectors, one per two students
- 1 - world globe
- 1 - bucket with a handle
- 1 - centrifugal force demonstrator (two-liter bottle with colored water)
- 2 - balls (steel and wood)
- 1 – “Hurricanes” book

Teacher Provides:

- 32 - Two-liter pop bottles (2 students per hurricane bottle set – bottle set will be used throughout the day.) Take the plastic ring off the top of the bottle so the connectors will fit tightly.

Lesson Activities:

1. Prepare the 15 hurricane bottle sets before school begins. Each is made by filling one bottle with water just over 3/4 full, then connecting two pop bottles with the connectors provided. You will use these 15 bottle sets all day long.
2. Introduce the concept of density. Density is how close together the molecules of a substance are. Water is 773 times more dense than air. This means that in a certain amount of space there is one air molecule. In that same amount of space, there are 773 water molecules. Compare the density of objects to the density of population. For example, consider an area in Salt Lake City and an area in Moab. In the same amount of space there is 800,000 people in the Salt Lake area and only 6,000 people in the Moab area.
3. Introduce the Law of Gravity--what goes up must come down. Gravity has a greater influence over dense items than over less dense items. Show the globe. Have the students tell where the water is and where the air is in relation to the center of the earth. Since the water is more dense, it is closer to the center of the earth. Referring to your hurricane bottle set, have the students identify the two substances inside (water and air). Have the students identify which substance is more dense. Have the students predict what will happen when you turn the bottles over so the water (more dense) is on the top, and the air (less dense) is on the bottom. Demonstrate what happens when you use your hurricane bottle set without spinning it. (The water and air trade places so the water is again close to the center of the earth.)
4. Introduce the Law of Centrifugal Force. When spun, dense items move to the outside. Demonstrate your hurricane bottle set (spinning it counter-clockwise) and have the students explain the outcome in terms of density. (The dense water moves to the outside and the less dense air stays on the inside.)
5. Which is stronger: gravity or centrifugal force? It depends on the situation. Spin the centrifugal force demonstrator in a windmill fashion to show centrifugal force. Experiment to see at what speed gravity has a stronger pull on the water in the bottle than centrifugal force.
6. Have a student spin a bucket full of water in a circle fast enough to keep all the water inside the bucket. Ask which law is stronger.
7. Demonstrate your hurricane bottle set, and then allow the students to experiment with their own for a few minutes. Have the students brainstorm about what they see as they use their hurricane bottle set (examples: tornado, hurricane, dust devil, water spout, whirlpool, bathtub drain, toilet).
8. Spin the world globe (to the right) and show the students the top of the globe to show how the northern hemisphere spins counterclockwise. Explain that tornadoes, hurricanes etc., spin counterclockwise in the northern hemisphere. Have the children predict which direction these things spin in the southern hemisphere and at the equator. Then show the students the bottom of the globe to show the clockwise spin of the southern hemisphere. Explain that neither clockwise nor counterclockwise rotation occurs at the equator. Therefore, hurricanes and tornadoes don't exist at the equator. Have the students demonstrate

the three different directions (counter-clockwise, clockwise, straight) with their hurricane machines.

9. Have the students predict where on the planet the fastest storms form: the northern hemisphere, southern hemisphere, or at the equator. Time the flow of water from one bottle to another using a watch with a second hand. First, time the water without spinning. Then spin the bottles and time the flow. (Answer: Both the northern and southern hemispheres' generate faster storms than those at the equator. In theory, storms closest to the Tropics of Capricorn and Cancer would be the fastest. Also observe that this is the area where hurricanes form.)
10. Read the students the book about Hurricanes. Ask students to explain how hurricanes and tornadoes develop. Refer to background information.

Extension materials are to be provided by the teacher.

Extension: Make a density column in a large graduated cylinder. First, pour a layer of corn syrup, followed by colored water, vegetable oil, and finally a layer of colored rubbing alcohol. List the layers on the board, study the cylinder, have students predict what will happen, then shake it.

Safety Factors: Hold the bucket tightly while spinning it. Prepare to clean up water, if necessary.

References:

- Sea Frontiers v38 Nov/Dec '92, p. 28-31 "An Inside Look at the Planet's Powerhouse" This article contains a thorough description of hurricanes: conditions that favor their formation, a developed hurricane's motion, and causes of a hurricane's demise.

Background Information and Terminology:

1. **Centrifugal Force:** The force that appears to move outward on a body moving in a circle.
2. **Density:** The mass per unit volume of a substance
3. **Front:** The first part of an advancing mass of cold or warm air.
4. **Gravity:** The force of attraction between any two masses (Objects are pulled toward the Earth because of its enormous mass).
5. **High Pressure:** Made by falling air, is slow moving, and brings settled weather, brings hot and dry weather in the summer and cold clear weather in the winter.
6. **Low Pressure:** Made by rising moist air; causes cloud formation, rain, and snow.

Hurricanes: Hurricanes form when the sun's heat evaporates large quantities of water from heated tropical oceans (water in excess of 80 degrees Fahrenheit), creating the eye, which is a large low-pressure system, that can be 185 miles wide. The eye is relatively calm. Winds around the eye are gale force, 43 mph. As the eye of the low-pressure

becomes smaller the wind speed increases. Once the eye reaches a diameter of 30 miles, the wind speed becomes hurricane speed, 74 mph.

As the hurricane travels over warm tropical waters, moist hot air rises around the eye in a spiral fashion, due to the rotation of the earth. As this moist air rises it becomes cooler, therefore, it condenses and returns to the Earth as rain. Once a hurricane reaches land the source of warm moist air is extinguished and the hurricane dies.

Scientists attempt to decrease the intensity of hurricanes by creating a second eye. This is accomplished by adding ice, salt, or iodine crystals. If the second eye combines with the original eye the diameter of the eye increases and the winds produced by the hurricane decrease.

Tornadoes and Waterspouts: Tornadoes form when warm air (less dense) rises quickly, often into a thundercloud. In the United States cold dry air (more dense) from the Rocky Mountains flows over warm moist air (less dense) traveling North from the Gulf of Mexico. If strong winds spin the uprising moist air, a tornado or waterspout can form.

In Utah tornadoes can and do occur on very hot, humid days. Cold air traveling over the mountains sinks as the hot air in the valleys rises. This creates a wind shear between the rising hot air and the sinking cool air. This creates strong winds, which spin according to the directional spin of each hemisphere. However, when the tornado and thundercloud hit the mountains they lose the capability to produce large wind gusts and the tornado dies.

Please make your students aware that this lesson relates to the following:

Career Fields:

Science, Social-Humanitarian

Occupations:

- **Meteorologist:** Study the atmosphere' s physical characteristics, motions, processes, and the way it affects the rest of our environment. This includes forecasting the weather. They also apply weather information and meteorological research in air-pollution control, agriculture, air and sea transportation, defense, and the study of trends in the earth' s climate such as global warming and ozone depletion.

Education: Bachelor's Degree

- **Ship Captain:** Operate and maintain deep sea merchant ships, tug boats, tow boats, ferries, dredges, research vessels, and other water borne craft on the oceans, in the Great Lakes, in harbors, on rivers and canals, and on other waterways. Captains supervise the work of the other officers and crew. They set course and speed, maneuver the vessel to avoid hazards and other ships, and periodically

determine position using navigation aids, celestial observations, and charts. They insure that proper procedures and safety practices are followed, check that machinery and equipment are in good working order, and oversee the loading and unloading of cargo or passengers. They also maintain logs and other records of the ship' s movements and cargo carried.

Education: Bachelor's Degree

Review Questions:

1. What direction does the Earth rotate?
2. How does the Earth' s rotation affect the northern and southern hemispheres? The equator? (Referring to tornadoes, hurricanes and toilets.)
3. What does "density" mean?
4. What do density and temperature of air have to do with formation of tornadoes and waterspouts?