Shocking Weather! Secrets Revealed…

Subject: Science

Grade Level: 6th – 8th Grades

Rationale or Purpose: This activity introduces the concept of static electricity as the cause of lightning. Inside a cloud, electrical charges can build up from the friction of ice, dust, and water droplets. The bottom of a cloud then becomes negatively charged, or unstable, and will discharge a lightening strike in order to regain stability. Most hurricanes do not produce lightening, but three of the most powerful hurricanes of 2005 produced lots of lightening. After a hands-on lab with static electricity, students will be asked to hypothesize why recent hurricanes produced lightening.

Source of Lesson: *Hot Science – Cool Talks* CD-ROM # 44: "Is Climate Change Increasing Hurricane Activity?"

Materials for 4 Stations:
Station 1: ground pepper, plastic comb or knife (buy a pack of 30+ combs, so each student can use their own comb), wool or nylon cloth
Station 2: plastic combs, piece of wool or fur, metal doorknob
Station 3: two rubber balloons (buy a pack of 30+ for re-use during these experiments as needed), a dark room, 1 fluorescent light bulb
Station 4: plastic combs, bowl of puffed rice

Lesson Duration: 50 – 55 minutes

TEKS Objectives:
6th Grade Science 111.22
(1A) demonstrate safe practices during field and laboratory investigations
(2A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology
(2B) collect data by observing and measuring
(2C) analyze and interpret information to construct reasonable explanations from direct and indirect evidence
(3C) represent the natural world using models and identify their limitations
(5A) identify and describe a system that results from the combination of two or more systems
(5B) describe how the properties of a system are different from the properties of its parts
(9A) identify energy transformations occurring during the production of energy for human use such as electrical energy to heat energy or heat energy to electrical energy
(9B) compare methods used for transforming energy in devices such as water heaters, cooling systems, or hydroelectric and wind power plants
(9C) research and describe energy types from their source to their use and determine if the type is renewable, non-renewable, or inexhaustible
7th Grade Science 112.23
(1A) demonstrate safe practices during field and laboratory investigations
(2A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology

(2B) collect data by observing and measuring
(2C) organize, analyze, make inferences, and predict trends from direct and indirect evidence
(2D) communicate valid conclusions
(5A) describe how systems may reach an equilibrium
(8A) illustrate examples of potential and kinetic energy in everyday life
(14A) describe and predict the impact of different catastrophic events on the Earth

8th Grade Science 112.24.
(1A) demonstrate safe practices during field and laboratory investigations
(2A) plan and implement investigative procedures including asking questions, formulating testable hypotheses, and selecting and using equipment and technology
(2B) collect data by observing and measuring
(2C) organize, analyze, evaluate, make inferences, and predict trends from direct and indirect evidence
(2D) communicate valid conclusions
(3A) analyze, review, and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information
(3C) represent the natural world using models and identify their limitations
(10B) describe interactions among solar, weather, and ocean systems
(12B) relate the role of oceans to climatic changes

Background Information[1]:

Electric Hurricanes!
The biggest storms of all, hurricanes, are notoriously lacking in lightning. Hurricanes blow, they rain, they flood, but seldom do they crackle with that negative static discharge known as lightning. However, during the record-setting hurricane season of 2005, three of the most powerful storms, Hurricanes Rita, Katrina, and Emily, did have lightning and lots of it! This was a big surprise to scientists.

Flying high above the storm, a team of scientists, who explored Hurricane Emily using NASA's ER-2 aircraft, noted frequent lightning in the cylindrical wall of clouds surrounding the hurricane's eye. Both cloud-to-cloud and cloud-to-ground lightning were present.

Hurricane research scientist, Richard Blakeslee of the Global Hydrology and Climate Center, said, "Generally there's not a lot of lightning in the eye-wall region, so when people see lightning there, they perk up. They say, okay, something's happening."

What does it all mean? The answer could teach scientists something new about the inner workings of hurricanes. What do we know about those three powerful hurricanes of 2005? All three storms were powerful: Emily was a Category 4 storm; Rita and Katrina were Category 5; all three were over water when their lightning was detected; and, in each case, the lightning was located around the eye-wall.

“Actually,” says Blakeslee, “the reason most hurricanes don't have lightning is understood. They're missing a key ingredient: vertical winds."

NASA's *Science@NASA Headlines* says:

> Within thunderclouds, vertical winds cause ice crystals and water droplets (called "hydrometeors") to bump together. This "rubbing" causes the hydrometeors to become charged. Think of rubbing your socked feet across wool carpet--zap! It's the same principle. For reasons not fully understood, positive electric charge accumulates on smaller particles while negative charge clings to the larger ones. Winds and gravity separate the charged hydrometeors, producing an enormous electric field within the storm. This is the source of lightning.

A hurricane's winds are mostly horizontal, not vertical. So the vertical churning that leads to lightning doesn't normally happen. What exactly caused the lightning to occur in Hurricanes Rita, Katrina, and Emily? Scientists are still exploring the mysterious missing factor that caused these rare electric hurricanes.

Students will learn about the causes of static electricity then be asked to hypothesize why lightening occurred in these recent hurricanes.

Procedures[2]:

Students will work in teams of four and rotate through four stations. Teachers can set up the stations as needed for class size, i.e. set up multiple stations of the same set-up, etc. First, darken the classroom as much as possible; this will help in spark visualization.

Station 1: Students will spread grains of ground pepper on a small area of a desktop. Vigorously rub a plastic utensil (comb or knife) with a wool or nylon cloth to produce a negative charge. Hold the utensil about 1 inch over the mixture and observe what happens. (The utensil will pick up the pepper.)
Station 2: Rub a plastic comb with a piece of wool or fur. Hold the comb near a metal doorknob. Observe what happens. (Students will see tiny sparks.)
Station 3: Blow up two balloons and rub them on your sleeve. Rub the two balloons together. Observe what happens. (Students will see tiny sparks.) Now, if possible, go into a very dark room in small groups (the teacher may want to be in charge of this demonstration) and charge up the balloons again. Gently touch an end of a fluorescent light bulb tube with a charged balloon. Did you see a faint spark in the tube? Even balloons can carry enough charged electrons to provide energy to light a fluorescent bulb!
Station 4: Run a comb through their hair (only one student should use each comb). Put the comb into a bowl of dry puffed rice. Observe what happens. (Grains of rice will stick to the comb; after they lose their charge, they will fall off.)

After each group has performed its demonstration, explain that in each case, friction created a buildup of electrons, causing an electrical charge. This is known as **static electricity**. Tell students that in a storm cloud, friction from dust, ice, and water droplets produces an accumulation of charges, as did the friction in each of the demonstrations. **It is this static electricity that causes lightning**.

Hurricanes and Lightening

Now that students have gained hands-on experience in the creation static electricity, ask them to hypothesize why recent hurricanes had lightening. Students should come up with a research plan to test their hypothesis (including what topics they would need to research, what tools they would need to collect data, etc.).

Further Inquiry *(from Discovery Education, Discovery School)*

1. Examine the development of a lightning bolt from small charge to discharge. Explain the phases in the life of a lightning bolt.
2. Develop an idea for capturing and using lightning as a power source. What areas of the world would most benefit from such a device?
3. Explain what type of structure you would choose as shelter during a lightning storm. Include reasons for your choice.
4. Keeping in mind that Ben Franklin didn't invent or discover lightning, write a letter from Mr. Franklin to George Washington detailing your experiment and the things you learned. Explain to Mr. Washington how your lightning bells work and of what use they have to households in the new country of America.
5. Mary Shelley speculated that a person could be made from parts of dead people. In her book *Frankenstein,* a mad doctor assembled people parts into a person-like shape, and then brought it to life with lightning. Knowing what you now know about lightning, debate whether or not this would really work.

Ideas for Data Collection and Analysis:

- You may want your students to keep a journal, recording their predictions, lab procedures, diagram of the "lightning" stations, etc.
- Concept mapping of the how lightning is formed in general, and how lightning is formed in hurricanes
- Encourage questions and connections
- Relate lightning formation to the hydrologic cycle of condensation

Resources:

[1] *Adapted from Science@NASA Headlines: http://science.nasa.gov/headlines*
[2] These experiments are based on information found from the *Discovery Education* site: http://school.discovery.com/lessonplans