Lightning

Background

American Red Cross

Visit the American Red Cross Web site at *www.redcross.org/disaster/masters*

Lightning

Lightning is a topic in the series of *Masters of Disaster* materials created by the American Red Cross for schools, clubs, organizations and families across the country. These lesson plans teach young people what causes lightning as well as safe behavior during a thunderstorm.

These activities are specifically tailored for reaching children in lower elementary (K–2), upper elementary (3–5) and middle school (6–8) grades. *Lightning* is divided into two sections, Lightning Science and Lightning Safety.

***Masters of Disaster* Connections**
Refer to the following modules in the *Masters of Disaster* series to learn more about a particular topic and to reinforce the objectives of the lesson. Lightning can be generated in any thunderstorm, and powerful thunderstorms can create tornadoes. *Hurricanes*, the most powerful thunderstorms, generate lightning and tornadoes. You will find important lessons in the modules entitled *Hurricanes* and *Tornadoes* to enhance students' understanding of lightning.

An essential part of preparing for any disaster is to be ready with plans, supplies and practice. Masters of Disaster Be Disaster Safe inspires young people to prepare for all hazards.

The lessons of *In the Aftermath* focus on recovery after any disaster—for the individual, the school and the community.

Why Talk About Lightning?

Education in injury prevention and preparedness enables young people to make timely choices to ensure their own safety. Your role in teaching this curriculum on lightning, and in making sure the messages reach your students' families, is vitally important in the development of safe habits for a lifetime.

Lightning is dangerous, and lightning always accompanies a thunderstorm, making it imperative not to be caught outside in a thunderstorm. The National Oceanic and Atmospheric Administration (NOAA) warns, "Many deaths from lightning occur ahead of storms because people wait too long before seeking shelter, or after storms because people return outside too soon." In the United States alone, there are over 25 million lightning flashes per year. Nearly 100 deaths from lightning occur every year, and 500 people are injured, although not all lightning injuries are reported.

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Sources:
NOAA: Lightning…The Underrated Killer *http://www.lightningsafety.noaa.gov/pdfs/CoachGuide.pdf,* accessed January 4, 2007.
NOAA: Lightning *http://www.noaa.gov/lightning.html*, accessed January 4, 2007

Lightning Science

Thunderstorm Electrification and Ground Electrification
The earth normally has a slight negative charge. However, during the development of a thunderstorm, charges on the ground are affected by charges in the thunderstorm cloud. In a thunderstorm cloud, upwardly moving air causes the formation of different types of precipitation: small ice crystals (individual snow flakes), snow pellets or graupel (snow flakes coated with rime ice). Because ice crystals and snow pellets are different in shape and density, they fall or are carried upward within the clouds at different speeds. The difference in speeds causes collisions between the two, and these collisions cause electrons to move from the ice crystals to the snow pellets. As a result, the ice crystals become positively charged while the snow pellets become negatively charged.

Because the ice crystals are lighter, the updraft of the storm carries the ice crystals—and the positive charge—to the top of the thunderstorm cloud, into what is called the "anvil"—or the flat spreading top—of a cumulonimbus cloud, or thunderhead. The negative charges remain near the middle and lower part of the cloud. Electrons in the ground underneath the cloud respond to the charges in the cloud. Directly under the thunderstorm base, electrons on the ground are repelled by the negative charge in the cloud, leaving the ground under the cloud base positively charged. Away from the cloud base but under the anvil, electrons gather as they are attracted by the positive charge in the anvil aloft. As the storm moves, the charges on the ground follow the thunderstorm cloud like a shadow and are a direct (but opposite in charge) reflection of charges in the cloud.

How Lightning Forms
When the charge difference (electrical potential) between the negative charge in the cloud and the positive charge on the ground becomes too great, the insulating capacity of the air begins to break down. The process begins when electrons (negative charge) surge downward in a channel from the cloud toward the positively charged ground. This negatively charged channel is called the "stepped leader," which usually branches as it surges downward toward the ground.

As the negatively charged stepped leader approaches the ground (but still several hundred feet high), electrons in the air below it are repelled by the negative charge in the leader. These electrons establish a channel and start flowing downward into the ground. Taller objects in the area provide a conduit for the electrons to follow to the ground. However, as the electrons move into the ground, the taller objects, and the channels above the taller objects, become positively charged. These positively charged channels are called "positive streamers" and extend upward toward the stepped leader. (Note: The positive charge does not actually move, but is merely a result of the negative

Lightning

Background

charge [electrons] leaving the channel; positive streamers can occur from any number of the taller objects on the ground.) The process continues until the downwardly propagating, negatively charged stepped leader makes contact with an upwardly propagating, positively charged streamer. At that point, the lightning channel is now established for electrons to flow from the cloud to the ground.

Lightning Characteristics
Lightning occurs either as cloud-to-ground or within clouds and releases so much energy that the air it passes through "explodes" with thunder—the noise heard when atmospheric gases are superheated in less than a second to 15,000–60,000° F (8,000–33,000° C) by a discharge of lightning. The nearby air expands and vibrates. You always hear thunder after the flash of lightning because of the difference between the speeds at which light and sound travel.

Thunder comes in a tremendous bang, a loud crack, or a sharp snap. Then you may hear a rumbling or growling sound as the noise travels from different distances along the channel of air through which the lightning traveled. On average, thunder can be heard 10 miles (16 kilometers) away, or 50 seconds from the flash (the lightning you see) to the bang (the thunder you hear).

If you see sparks fly as you pull socks from the dryer or as you pet a cat's soft fur when the humidity is low, you are seeing a tiny version of lightning. Lightning is essentially a 100-million-volt spark of electricity that is 5 to 10 miles (8 to 16 kilometers) long and as hot as 60,000° F (33,000° C). Benjamin Franklin's kite experiment provided the essential discovery that lightning is electricity—a tremendous spark in the sky.

Lightning Safety

Lightning is a major threat during a thunderstorm. Lightning is very unpredictable, which increases the risk to individuals and property. Sometimes, lightning strikes outside an area of heavy rain, and it may occur as far as 10 miles away from any rainfall. "Heat lightning" is actually lightning from a thunderstorm too far away for thunder to be heard. When you see heat lightning, a storm may be moving in your direction, so be alert.

Because light travels so much faster than sound, lightning flashes can sometimes be seen long before the resulting thunder is heard. When lightning and thunder occur very close to one another, the lightning is striking nearby. **If you hear thunder, you are in danger from lightning.** Get to a safe place as soon as you hear thunder (even a distant rumble). You can hear thunder about 10 miles away and lightning can strike 10 miles from the storm. Therefore, the sound of thunder should be an immediate warning to get to a safe place: "When thunder roars, go indoors!"

The checklists on the following pages provide valuable information about these topics and practical steps to take to improve the safety of children's environments and prevent injury. Feel free to photocopy the checklists for distribution to your students and their families.

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Lightning

Background

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For more detailed information about lightning safety, contact your local chapter of the American Red Cross or visit *www.redcross.org/disaster/masters* to obtain copies of the *Masters of Disaster Lightning* curriculum.

Lightning Safety Checklist

Be Aware and Avoid the Risk
Plan ahead and don't take chances. Know where you'll go if an unexpected thunderstorm develops; monitor weather conditions; and be prepared to take immediate action to get to a safe place before the thunderstorm arrives.

If you are indoors during a thunderstorm—

- Stay off the telephone. Telephone lines can conduct electricity.
- Unplug televisions, computers and other appliances. Lightning can cause power surges and travel through electric lines.
- Stay away from running water in faucets, sinks and bathtubs. Electricity from lightning has been known to come inside through plumbing.
- Close the blinds and shades of your windows, then keep away from them.
- Listen to weather advisories on a battery-powered radio. Obey advisories promptly.

If you are outdoors during a thunderstorm—

- If you are boating or swimming, get to land, get off the beach and find a safe place immediately. Stay away from rivers, lakes and other bodies of water. Water is an excellent conductor of electricity. When lightning strikes nearby, the electrical charge can travel through the water as well as the ground.
- Go to safety in a substantial, permanent, enclosed structure, such as a reinforced building. A sturdy building is the safest place to be. Avoid unprotected gazebos, rain or picnic shelters, golf carts, baseball dugouts and bleachers.
- If there are no reinforced structures in sight, get into a car or bus. Keep car windows closed and avoid convertibles. Rubber-soled shoes and rubber tires provide no protection from lightning. The steel frame of a hard-topped vehicle provides increased protection if you are not touching metal. Practice the Hands on Lap rule.
- If you are in the woods, find an area protected by a low clump of trees. Never stand under a single, large tree in the open.
- As a last resort—

  — if no structure is available, go to a low-lying, open place. Stay away from tall things—trees, towers, fences, telephone poles, power lines. Be aware of the potential for flooding in low-lying areas.

  — if you feel your hair stand on end, lightning is about to strike. Squat low to the ground on the balls of your feet. Place your hands over your ears and bend your head down. Make yourself the smallest target possible. Do not lie flat on the ground—you will be a larger target and put more of your body into contact with an excellent conductor of electricity: wet ground.

Lightning

Background

If lightning strikes a person—

- Call for help. Get someone to dial 9-1-1 or your local number for Emergency Medical Services (EMS). A person who has been struck by lightning needs medical attention as quickly as possible.
- Give first aid. If the person has stopped breathing, begin rescue breathing. If the person's heart has stopped beating, someone trained in CPR should administer it. If the person has a pulse and is breathing, look and care for other possible injuries.
- Check for burns. The injured person has received an electric shock and may be burned. Being struck by lightning can also cause damage to the nervous system, broken bones and loss of hearing or eyesight.
- Move the victim to a safer place. **Remember**, people struck by lightning carry no electric charge, and they can be handled safely

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