HAIL STONE IMPACT

STUDENT EXPECTATIONS

Upon completion of this unit, students will be expected to know or have an understanding of:

1. How and why local convective, possibly severe, storms develop.
2. How hailstones form and the conditions under which they form.
3. The identification of and how to test the variables that may influence the damage caused by hail.
4. How data for various sized hailstones are collected and analyze the impact damage with graphs.
5. What atmospheric factors may affect the size of hailstones?
6. How to compare and analyze insurance damage data for several counties.
7. How to test several materials for their resistance to hail damage and explain their findings.
8. The impact a severe hail storm can have on a community.
9. The impact a severe hail storm can have on crops.
10. The impact a severe hail storm can have on wildlife.

STATE STANDARDS

The following **Colorado** Model Content Standards for Science will be met or exceeded: (Unless otherwise noted, the standards for grades 5 through 8 are used.)

Standards 1, 2.1, 2.2, 3.1, 3.2, 4.1, 4.2, 4.3, 5 and 6

The following **TEXAS** Essential Knowledge and Skills for Science will be met or exceeded: (Unless otherwise noted, the TEKS for Middle School Science are used.)

6.7A,B, 6.2A,C,D,E, 6.3A,B,C,D 6.4A,B, 6.7B, 6.8B, 6.12B,C, 6.14C, 7.1A,B, 7.2A,B,C,D,E, 7.3A,C,D, 7.4A,B, 7.12C, 7.14A,B, 8.1A,B,8.2A,B,C,D,E 8.3A,C,D,E, 8.RA,B, 8.5A,B,C, 8.10B, 8.12B,C

TEACHER NOTES/BACKGROUND

Usually when we think of hail, it is associated with violent thunderstorms. In the Great Plains, the storms can be enormous systems covering many square miles. Closer to the Rocky Mountains, the thunderstorms are often

much smaller in size. Regardless of the way they form, these storms can develop hazardous characteristics to people, property, and animals.

Convective Storms: These storms form when cold air masses meet relatively warm, moist air masses and a strong convective current develops as a result. As the warm moist air rises, it begins condensing droplets and releasing tremendous amounts of energy. The latent heat of vaporization of water is about 540 calories/gram. In other words, 540 calories of heat energy is released for every gram of water that condenses. When some thunderstorms are estimated to have up to 200 million tons of water in them, there is almost an unimaginable amount of energy in them! This energy increases the force of the updraft and accelerates the development of the storm. The droplets continue to cool and move further upward in the atmosphere where they become supercooled. (Liquid water below $0^{o}C$)

So, how is hail formed? In general, hail is formed when the supercooled water droplets crystallize onto a frozen raindrop that has become suspended high up in a cloud. This may happen in several ways. Sometimes the frozen droplets travel up and down in the cloud growing into a layered hailstone. Other stones form while suspended in one place, while still others form around a raindrop that is carried high into the cloud and freezes.

Eventually the mass of the hailstone increases to the point that the force of gravitational pull exceeds the force of the updraft and the stone falls to the surface. Falling rain and hail create a downdraft of cold air as they move downward. Hailstones may vary in size from a pea to an orange, or in some rare instances even larger. On the plains just east of the Rocky Mountains, ½ to ¾ inch diameter hailstones are common.

Early beliefs were that hailstones fell directly downward, but subsequent research indicates that often hailstones not only travel vertically, but horizontally in the cloud sometimes shooting out the side of the cloud and appearing to come from a cloudless sky!

Economic impact of hail: In some regions of the country, hail is the major cause of storm damage. Hailstones break windows, dent vehicles, strip agricultural crops to their stems, and in some cases have even killed

livestock. A hail storm can devastate the economy of a small farming community in just a few minutes. It can also have a devastating affect on the hatching season of many game birds and other wildlife.

ACTIVITY DESCRIPTION:

In this activity, students will work in teams of 2 to study the formation of convective storms and formation and structure of hail stones. Each team will test mock hailstones of varying sizes to investigate the impact and damage caused by hailstones. The teams will also be required to graph and analyze the collected data.

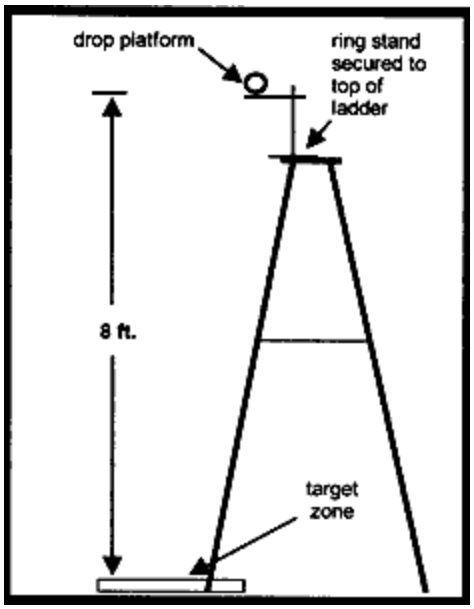
MATERIALS

- 5 to 10 mock hailstones of various masses, and diameters. (Metallic balls or lead shot work well, but glass or clay marbles of various sizes can be used, but for safety should be covered with tape or something to prevent breakage.)
- A soft grade of Styrofoam material measuring approximately 6 x 24 inches.
- Aluminum foil
- A 6 to 8 foot ladder with gravity apparatus (see drawing)
- Metric ruler and calipers if available
- A waterproof marker for labeling impact craters
- Large sheet of white butcher paper

APPARATUS:

A gravity drop apparatus can be a simple grooved piece of wood or metal set at a slight incline so the “hailstone” will gently roll off when released. A more elaborate spring-loaded platform can be constructed if desired.

Set up the ladder and attach the ring stand with gravity drop apparatus to it. The distance to the top of the target does not have to be exactly eight feet, as long as it is constant for all tests.



When setting up the apparatus, make certain all components are securely fastened together. The ladder should be sturdy and in good repair. Be certain to review proper ladder usage safety rules with your students and supervise them appropriately.

PROCEDURE

- In this activity, you will drop a spherical "mock hailstone" from a height of 6 to 8 ft., and determine its impact by measuring the depth and diameter of the impact crater created in the foam. If possible, use a gravity drop apparatus similar to the diagram.
- Cover your foam board with aluminum foil and place under platform.
- Select a "hailstone" as directed by your teacher.
- Find its mass in grams using a balance.
- If available, use a caliper to find its diameter, if no caliper is available, use a metric ruler and measure the diameter as accurately as possible.
- Drop your hailstone from the known height.
- Measure the diameter and depth of the impact crater formed in the foam board.
- Record all measurements in your data table.
- Move the foam board so a non-dented area is in the target area.
- Repeat the procedures with different size and mass hailstones.

- When all data is collected, form a graph and spreadsheet (if a computer is available) for analysis.
- If time allows drop each hailstone 5 times and record the data each time.
- With another Styrofoam board, repeat the procedures, but tilt the board at an angle assigned by your teacher.

ANALYSIS

Construct a line graph of the mass and crater depth of the hailstones. Is there a relationship illustrated by this graph?
Construct another graph with actual diameter and crater diameter.
Is there a relationship illustrated by this graph?
Explain some similarities and differences from real hail and the "mock hail".

CONCLUSIONS

Discuss or have students write up what it would be like to have many of the "hail dents" in a single square foot. As an extension, you might have them call an insurance agent for annual damage figures from your city/county/state due to hail. Discuss or have students find out what part of the year do most hail storms happen and why. Have them decide if a steep pitched roof would be less likely to sustain damage from hail or more damage. Ask them what happens to livestock and wildlife during a hail storm. You might want them to discuss or research what type of building materials for roofs would be damaged most or least.