

Changing States!



Lesson Overview

Students conduct simple experiments to learn more about solids, liquids, and gases.

Suggested Grade Levels: K~8

Standards for Lesson

Content Standard A: Science as Inquiry

Content Standard B: Physical Science

VA SOL:

K.1 a, b, c, g, j; K.2 a, b; K.5 a; 1.1 a, d, f, g, h; 1.3 b, c; 2.1 a, b, d, e; 2.3 a, b

3.1 a, c, h, j; 3.3 b, c; 4.1 a, b, c, d; 5.1 g, h; 5.2 a, b; 5.4 a, b, c

6.1 a, b, e, f, g, h, i, k; 6.5 a, b; LS.1 a, b, e, f, g; PS.1 g, h, k; PS.2 a, b, c, d, e; PS.5 a; PS.7 b; PS.8

Time Needed

This lesson takes several class periods. Sample schedule:

Day One: Complete the **Engage, Explore, and Explain** portion of the lesson

Day Two: Complete the **Elaborate** and **Evaluate** portion of the lesson

Materials for Lesson

- Dry ice
- Graduated cylinder
- Water
- Gloves
- Tongs
- Thermometer
- Timer

- Hammer
- Dish soap

Content Information:

Information for teacher:

Matter is everything around us that has mass and takes up space (volume). Matter can be described by its physical properties: color, size, shape, smell, feel, and sound. There are four states of matter: solid, liquid, gas, and plasma. In elementary school, the students are held responsible for solid, liquid, and gas.

- **Solid:** the state of matter in which the molecules are close together; it has a definite volume and shape.
- **Liquid:** the state of matter in which the molecules are further apart; it has a definite volume but takes on the shape of its container.
- **Gas:** the state of matter in which the molecules are very far apart; it takes on the volume and shape to fill its container.

Water is a substance with which students are familiar that comes in three states, solid, liquid, and gas. Water readily changes from one state to another. In weather, we see water as a solid in hail or snow. When temperatures warm, water becomes a liquid in rain. If we heat water to a boil, we see water as a gas in steam.

One of the most remarkable properties of water is its ability to dissolve a large number of substances. For this reason, water is often called the universal solvent. In general, solids dissolve more rapidly in water when the water is hot because the water molecules are moving more quickly and acting upon the solid to break it apart. *Care must be taken that the water is not too hot when used around children.*

Safety: Dry ice is frozen carbon dioxide. Instead of melting, dry ice turns directly into carbon dioxide gas (sublimation), but does not melt like real ice. *Dry ice must be handled with care as it is -110oF (-78oC). It must be handled using gloves or tongs, as it will cause severe burns if it comes in contact with your skin. Never put dry ice into your mouth.* When you drop a piece of dry ice in a bucket of water, the gas that you see is a combination of carbon dioxide and water vapor. The gas that you see is actually a cloud of tiny water droplets.

Grocery stores use dry ice to keep food cold during shipping. Some grocery stores and ice cream shops will sell dry ice to the public. When purchasing, bring a beverage cooler with you to transport the ice and a pair of gloves to protect your hands. If you are planning to perform a number of dry ice demonstrations, plan to purchase 5 to 10 pounds.

Engage

Conduct a quick experiment to help children understand the difference between ice and dry ice. Show students a piece of dry ice. Ask, "Why do you think they call this dry ice?" Allow students to discuss with their shoulder partners.

Using gloves or tongs, place a regular ice cube on one plate and a similar size piece of dry ice on a second plate. Keep both plates out of the reach of the children. "Let's try to guess what is going to happen to the ice cube and the piece of dry ice if we leave it on the plate for one hour." **THINK-PAIR-SHARE** Students will most likely predict that both pieces of ice will melt, turning into a puddle of water. (Continue with the lesson and return to the plate later).

While conducting the explore phase of the lesson, allow the children to view the plates occasionally for about one hour and to discover the difference between real ice and dry ice. There should be a puddle of water on the plate where the real ice was, but the dry ice plate will be "dry." Where did the dry ice go? Dry ice is not made from water; it's made from some of the air that we breathe... it's frozen carbon dioxide. The dry ice turned into invisible carbon dioxide gas that disappears into the air.

*Please note: When the dry ice comes into contact with the metal tongs, the molecules in the tongs might "sing." Discuss what is sound (vibrations) and how/why sound is produced.

Explore

COOPERATIVE PLAY: Place supplies at each table (large beaker, glove, tongs, water, soap, etc). Explain to students safety precautions when handling dry ice. Allow each team of 4 students to play with materials, but don't tell them how to play. Just say, "What can you learn about these things?"

OR

ALTERNATE GUIDED METHOD: Demonstration

Pour room temperature water into large graduated cylinder. (If desired, use thermometer and record temperature of water.) Ask students to predict what they think will happen when you place dry ice into the water. **SINGLE ROUND ROBIN**

Use the tongs or gloves to place a piece of dry ice into water. (If desired, record water temperature and time of reaction.)

Have students draw what they saw and/or write words to describe what they saw.

Explain

Immediately, the dry ice will begin to turn into carbon dioxide gas and water vapor, forming a neat cloud! This cloud is perfectly safe for the children to touch and feel as long as they do not put their fingers far enough down into the water to accidentally touch the dry ice.

Return to introduction experiment with regular ice and dry ice on plates. Discuss student observations. Where did the dry ice go? Dry ice is not made from water; it's made from some of the air that we breathe... it's frozen carbon dioxide. The dry ice turned into invisible carbon dioxide gas that disappears into the air. We saw regular ice go through two phase changes: solid to liquid (melting) and if we wait long enough, liquid to gas (evaporation). We saw dry ice go through only one phase change: solid directly to gas (sublimation).

Elaborate

Ask students to think about the primary materials used in this experiment (dry ice and water). “How could you change these materials to affect how the dry ice reacts?” Students record their answers on material chart. (temperature or amount of water, size of dry ice chunk, type of liquid water, add soap to water, etc)

PAIRED HEADS TOGETHER: Students **RALLY ROBIN** with their shoulder partners. If their partner says an idea on their list, they check it off. If it is not on their list, they add the idea. After one minute, students share with their face partners.

POPCORN SHARE: One at a time, students pop up from chair to share an answer. As a class, choose one idea to change in the experiment. (Consider the standards for your grade level.)

Ask students, “What will we observe or measure to see if changing _____ affects how the dry ice acts?” (type of reaction, time of reaction, etc.)

In teams (or as whole class), students complete their experimental design (question, hypothesis, independent and dependent variables, and constants). **ROUND TABLE CONSENSUS:** Each team has one copy of lab report and one pencil. Student with paper says an answer. All members of team must agree before student records answer. Paper and pencil are passed to next student.

Assign lab roles: Principal Investigator who directs others to follow procedures; Materials Manager who does experiment; Reporter who records data; Timekeeper / Clean Up Captain who keeps time and helps clean up. Allow students to conduct experiment (or do experiment as a demonstration.) *Safety: Remind students of the danger of touching dry ice and safety precautions. Teacher may choose to place ice in each group's water container.*

Students collect data and record observations. If time, allow students to do multiple trials.

Ask students, “Based on what you know about dry ice, can you explain the results of your experiment?”

Evaluate

Students write conclusion including three key parts:

- Make a CLAIM: Statement saying if the results support or do not support the hypothesis.
- Provide EVIDENCE for the CLAIM: Summary of the results and data
- Provide REASONING that links the EVIDENCE to the CLAIM: Explanation of results

Extension:

To create the best effect, be sure to use warm water. Over time, the dry ice will make the water cold and the "smoking" will slow down. Replace the cold water the warm water and you're back in business!

Place Dawn dish detergent in the graduated cylinder with dry ice. Allow students to touch bubble filled with CO₂ gas.

4-Question Experimental Design Sheet

What did the dry ice do?

What materials did we use in order to conduct the activity?

What could you change about each material to affect how the dry ice acts?

If you change _____, what could you describe or measure to determine if _____ affects how dry ice acts?