

Subject: Physics

Topic: - Expanding Ice

Sub – Topic: Different states of Substances

Class: Grade 6

Duration: 15 Mins

Aim: - Amazing Expanding Ice

Overview

Children experiment with freezing water to observe another special property of ice: that it is less dense as a solid (ice) than it is as a liquid (water). *Amazing, Expanding Ice!* is an "overnight" activity requiring 20 minutes of preparation, overnight freezing of the experiment, and 10 minutes of follow-up discussion.

What's the Point?

- Substances exist in different states; i.e. solid, liquid, gas
- Ice is a unique substance because it's solid state — ice — is less dense than its liquid state.
- *Physical properties* are characteristics of a substance. They do not change. Physical properties include color, smell, freezing/melting point, and density.
- Density is a measure of the mass (amount of stuff) per unit volume (amount of space) of a substance.

Materials

For the group:

- Several pitchers of water
- Access to a freezer
- Trays to carry cups of water
- Paper towels in case of spills
- Access to a kitchen scale or postal scale (optional)

Foil to cover the cups

- Marker to write on cups
- Ruler

Preparation

- Fill the pitchers with water to a level that the children will be able to pour into the cups. Each child will need enough water to fill both cups.

- If we are going to undertake *The Tip of the Iceberg* activity on another day, plan to return the cups with ice to the freezer to keep them frozen.

Activity

1. Invite the children to think about what they have learned about ice and water.
 - What state of water is ice? *A solid.*
 - What has to happen to turn water into ice? *It has to freeze.*
 - At what temperature does water turn into ice? *32°F or 0°C.*
 - Can they think of any examples in their lives when they make ice from water? *Some children may share that they have made ice cubes or popsicles in their freezers.*
 - What else do they know from their experiences about ice and water? *Some children may observe that the ice "grows" or expands in the ice cube tray.*
2. Provide the children with the materials and their *Ice Investigator Journals*. Have each child label their two cups with their names on the side.
3. Have each child fill their two cups with water to identical levels between half and three-quarters full. They should carefully mark the levels of the water in the cups.
4. Have them carefully cover each cup with foil and secure it (like a lid).
5. Have the children weigh their cups of water on the kitchen scale and mark the weight on the cup.
6. Share with the children that you will now freeze one of each group's cups of water overnight or until you see them the next time.
 - What do they think will happen?
 - Why did they cover the cups with the foil? *This prevents another state change — the change of liquid water into water vapor through the process of evaporation!*

Have the children record their ideas and information from their experiments in their *Ice Investigator Journals*.

7. Have the children place one of their cups of water on the "goes to the freezer" tray and one on the "stays in the room" tray. Place the "freezer" cups in the freezer overnight. Remove them from the freezer just before we see the children during the next session.
8. After the water in the cups has frozen, return the two cups to each group. Invite the children to compare their cups.

- What do they observe happened? *The water turned to ice.*
- What is this change from one form of a substance to another called? *A state change!*
- What do they observe about the level of water and ice compared to the lines they drew to mark the water levels originally? *The ice is above the line they drew, but the water is still at the same line.*
- How can this be? Are ice and water the same "thing" (composition)? Yes. What happened when the ice froze? *It "grew" or expanded. Some children may say that more water was added and that's why there is more ice.*

9. Have the children weigh their cups.

- Is there a difference in the weights? *No (other than a little variability of the scale, the weights should be the same).*
- What can the children conclude about the amount of water that the ice contains? *It is the same as the amount of water with which they started.*

10. Share with the children that there is a difference in density between ice and water. In their experiment, the children had the same amount of material in both cups — the same amount of water - but when they froze the water, the volume changed. The amount of water was "stretched" to make a larger volume of ice.

- What would the children have had to do to get the ice to fill the cup only to the line when the water froze? *Add less water!*

Ice is less dense than water. If you had the same volume of ice, or ice that only went to the line on the cup, it would contain less material (water) than water of the same volume.

Facilitator's Note: Density is mass per unit volume, or the ratio of the amount of matter in an object compared to its volume, or simply put:

Mass = the amount of "stuff"

Weight = how heavy the "stuff" is (Weight is determined by the amount of gravitational pull on an object, which is a property of the mass of the planet the "stuff" is on. The greater the gravitational pull, the more the "stuff" weighs.)

Density = how tightly packed the "stuff" is

Volume = the area of space the "stuff" takes up

If we apply this information to the cups, the cup of water and the cup of ice have the same mass, i.e. amount of "stuff." Because they had the same amount of "stuff," they have the same weight.

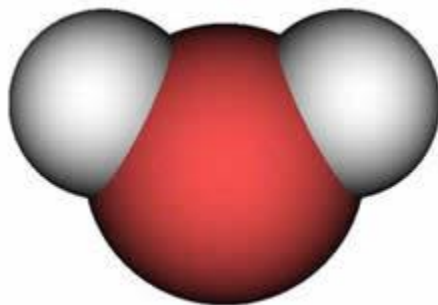
The "stuff" (molecules) in water is more tightly packed than in ice, so water has greater density than ice. Don't let the fact that ice is a solid fool you!

As water freezes it expands. So, ice has more volume (it takes up more space, but has less density) than water.

Share with the children that this is a very special property of water. As most substances get colder, their material (molecules) scrunch closer and closer together, like penguins snuggled together to keep warm. Water molecules, however, don't like to scrunch. They spread out like acrobats in formation to form ice crystals like we see in snowflakes and frost.

Facilitator's Note: Water molecules in the liquid state like hanging out together as droplets, but in the solid (frozen) state, they need their space.

A water molecule is similar in outline to Mickey Mouse, with two hydrogen atoms placed on one end of an oxygen atom. The oxygen atoms are positively charged and hydrogen atoms negatively charged, so water molecules stick to each other like tiny magnets. The hydrogen "ears" make loose bonds, called hydrogen bonds, with the oxygen "faces" of other water molecules.



*Each molecule of water is made of two hydrogen atoms (white) and one oxygen atom (red). The hydrogen atoms are not placed on opposite sides of the oxygen atom; they occur at one end. Image modified from:
[http://commons.wikimedia.org/wiki/File:H2O_\(water_molecule\).jpg](http://commons.wikimedia.org/wiki/File:H2O_(water_molecule).jpg).*

In ice crystals, their hydrogen bonds link them together like acrobats, stacked one on top of the other, with their arms and legs outstretched. This provides more space between the molecules in the crystal structure of ice than the molecules of liquid water. As a result, ice is less dense than the liquid form. Water is the only known non-metallic substance that expands when it freezes; its density decreases and it expands approximately 9% by volume.

11. Have the children record their results and interpretations in their *Ice Investigator Journals*.

12. Ask the children to predict what will happen if ice, which is *less dense* than water, is placed into water? Find out in the next activity!

Conclusion

If the children have started to construct a snow mobile, invite them to record any answers they discovered on the appropriate pieces. Some of the questions that they can answer might include:

- When water turns to ice, it expands/contracts. (circle one)
- Water is more dense/less dense than ice. (circle one)

Have them annotate any new questions they have or interesting things they learned on the appropriate shapes of either raindrop, cloud, or snowflake.