

STUDENT ACTIVITY: Solids to liquids to gases

Activity idea

In this activity, students examine the role of heat as water changes from a solid to a liquid to a gas and back again.

By the end of this activity, students should be able to:

- identify a logical sequence of solids to liquids to gases and the reverse
- discuss in very simple terms the role of heat in water's changes of state.

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Introduction/background

Water, like all other types of matter, requires heat (a form of energy) to change states. When heat energy is transferred to ice, the ice melts to become a liquid. When more heat is transferred, liquid water becomes water vapour. When water vapour transfers some of its heat to another substance (like a cold surface or cold air), it condenses back into liquid water. As water continues to give up or transfer its heat, it freezes into a solid.

It is ideal to do the student activity [Water molecules in drama](#) prior to this activity.

Note: Words often have both scientific and common meanings. Scientists talk about 'heat energy' instead of the more common use of the word 'heat'. Steam is the gaseous state of water, formed when water boils. For scientists, steam refers to water vapour, which is invisible and cannot be seen. The common usage of 'steam' is the visible mist of water droplets formed as water vapour condenses in the cooler air.

What you need

- Small portable gas stove, electric hotplate or similar
- 2 metal saucepans
- Ice bricks/ice packs (the reusable plastic blocks used to cool chilly bins)
- Ice cubes
- Plastic plate or tray

What to do

1. Discuss the terms 'melting', 'freezing', 'condensation', 'water vapour' and 'liquid'.
2. Gather students' ideas on how these changes to the states of water take place. Expand on any student comments involving heat energy – the Sun melting ice or evaporating water from a puddle, a freezer for making ice, water becoming water vapour as it rises from an electric jug or boiling pot. Demonstrate heat energy and changing states of water by doing the following.
3. Place the ice bricks in the first metal saucepan to cool it down. (Use the plastic, reusable ice bricks instead of ice cubes to avoid confusion – the condensation that forms on the outside of the saucepan cannot be from ice/water 'leaking' from the pan.)
4. Hold up or distribute a few ice cubes. (If this activity follows on from the [Water molecules in drama](#) activity, discuss the properties of a solid – including its physical structure – vibrating and in an array.) Place several ice cubes into the second saucepan.

5. Light the gas cooker or turn on the hotplate and place the pan of ice cubes onto the heat. Discuss the concept of heat energy, using any of the language or examples from the initial student discussion. Watch as the ice cubes melt, discussing the transfer of heat energy and how the physical structure changes. (Water molecules are no longer rigid so they slide past each other.) Continue heating the pan until the water boils, forms mist/steam and becomes water vapour. Again, talk about how gas molecules behave. (Moving quickly and widely throughout the room.)
6. Show students the saucepan holding the plastic ice bricks. Have a student or two feel and verify the coldness of the pan. Place the cold pan above the pan of boiling water. Watch as the water vapour comes in contact with the cold metal surface. The water vapour transfers some of its heat energy to the cold pan. The water vapour condenses to liquid water droplets on the pan. When enough water droplets form, they join together and drip from the pan.
7. Catch some of the water drops on the plate or tray. Roll the water around on the plate so students see it moves freely. Ask students what would happen if the water were put in the freezer. (Freezers work by drawing the heat energy from the freezer compartment. Water turns to ice as its heat is taken away.)
8. Discuss the cyclical nature of water and how it can change states over and over provided there is a heat energy source.

Extension ideas

Place a small fragment of ice in each student's hand. As it melts, ask them where the heat energy needed to change the solid to a liquid is coming from (their own bodies). Let them continue to observe the changes as the liquid water evaporates from their palms.

Give students the starter words 'ice', 'solid', 'melting', 'liquid', 'water', 'cooling', 'condensing', 'heat', 'water vapour', 'gas' and 'energy' and ask them to draw a sequence or cycle for states of matter. Ask students to add where heat energy transfers take place.

It actually takes more than a lack of heat to make ice. Encourage older students to read the Science Ideas and Concepts article [Water and ice](#) to see what else is needed.

Compare this activity to the [water cycle](#) in nature. Where would students find water in its different states? What is the energy source behind all of these changes of state? (The Sun.)

Changes of state happen in different substances too. Place a chocolate biscuit on a piece of aluminium foil and set it in the Sun. Discuss the energy source and changes to the chocolate. What happens if the biscuit is placed in a cool environment? Can you think of other substances that change from solid to liquid? (Butter, ice cream and candle wax are some examples.)