THE CHILL ZONE

CHABOT SPACE & SCIENCE CENTER

HOW IT WORKS

Watch the video included in your virtual package to learn about different types of ice and where they can be found in outer space. The video is 58 minutes long without pause, and should take 75 to 90 minutes to complete when incorporating pauses for discussion. You may complete it all in one session, or split it up into multiple days according to the timecodes listed below.

Sample the video ahead of time to get familiar with the flow and decide how your students will engage with the show. After the video, extend the learning with an experiment about ice and melting points. Instructions are written below for your reference.

Discussion questions, additional resources, and related activities to extend the learning are listed on page 8 and 9.

VIDEO TIME CODES

0:00 – 3:01 Introduction
3:02 – 17:28 Water Ice
17:29 – 33:57 Dry Ice
33:58 – 56:27 Liquid Nitrogen
56:28 – 57:40 Conclusion

In this activity, learners will set up and test multiple variables in an ice-melting experiment. They will use their results to explain what happens when ice reaches its melting point, and analyze how its transitions between states can be manipulated with simple, household materials.

ACTIVITY SET UP

1. Gather materials and make substitutions as needed (see list).
2. Make enough ice cubes ahead of time for your group to complete this experiment:
    a. You may group learners to complete the experiment together, or have them work individually to test one selected material against a control ice cube with nothing on it.
3. Set up their testing stations and materials in your designated space.
    a. Note: this experiment is best done inside, to reduce the amount of sun, which can melt the ice cubes at irregular rates compared to inside.

OVERVIEW

- **Video length:** 58 minutes
- **Complete duration** (video, discussion, and activity afterwards): 75 - 90 minutes
- **Grade range:** K – 8th
- **Skills:** Asking questions, Planning and carrying out investigations, Constructing explanations, Obtaining, evaluating, and communicating information
- **Concepts:** Cause and effect, Energy and matter, Stability and change

SUGGESTED MATERIALS*

- Ice cubes
- Salt
- Sugar
- Cold water
- Hot water
- 6 small bowls or cups
- Sticky notes
- Marker
- Timer
- Pencil
- Paper or data sheet (page 5-6)

*SUBSTITUTIONS

Substitute or omit any of the materials listed above as needed based on availability.

Find other activity ideas and experiments on page 9 under "Think Different"!

INTRODUCTION

Congratulate the group on being scientists! In order to use their observation and analysis skills, they are going to conduct an ice-melting experiment!

1. Check that your group has their materials.
2. Explain the experiment:
    a. They will investigate how different materials affect the rate at which ice melts.
    b. In order to do this, they will sprinkle a bit of each material onto separate ice cubes and measure over time how long it takes for them to melt.
    c. They will try to answer these questions:
        i. Which ice cube melts the fastest, and what material did it have on it?
        ii. Which ice cube melts the slowest, and what material did it have on it?
    d. Throughout the experiment, they will record their observations on their own.
    e. Then, they will compare observations and use the data to try to explain their results.
3. Confirm that the group understands the goal of the experiment and take any questions.

SET UP

1. Start by having each person in the group grab 5 ice cubes.
2. Place one ice cube into its own, individual bowl or cup.
3. Pour or sprinkle **one** of the following materials on top of each ice cube:
    a. Salt
    b. Sugar
    c. Cold water
    d. Hot water
    e. Nothing (control)
    f. If they have extra ice cubes, and would like to try a more materials of their own choice, they may!

4. Use a marker and sticky note to label which material was used for each ice cube. This will be important for tracking their data and indicating which treatment melted fastest or slowest.
5. Now, have them discuss and make predictions about their experiment using the questions below. If helpful, have them print and use the data sheet on page 5 and 6 to track these predictions.

Which ice cube do you predict will melt the fastest? Why?
Which ice cube do you predict will melt the slowest? Why?
What do you know about ice already that might help you make a prediction?

EXPERIMENT

1. Now the learners will monitor and record the results of their experiment as the ice begins to melt.
2. Set a 10-minute timer.
3. Every 10 minutes, have them check on their ice cubes, make an observation of their melting status, and record it. Then, re-set the timer for another 10 minutes.
    a. Their observations can be whatever they choose: a written note, a drawing, or a picture.

b. Observations should be made in the same style each time, so they can be used for comparison of results at the end.
c. If needed, print out the data sheet on page 5 and 6 for them to record observations on.

4. Have them repeat this process until most of the ice has melted, or until the results have become clear enough to answer the two questions of the experiment:
    a. Which ice cube melts the fastest, and what material did it have on it?
    b. Which ice cube melts the slowest, and what material did it have on it?
5. This can take several rounds depending on the conditions of your testing environment. Plan about one hour, or six observation points, into your schedule to allow enough time to see distinct melting results.
    a. Check in and make observations with them throughout. As a backup, have another activity such as a game or video to keep them busy in between the 10 minute periods.

RESULTS

1. Once everyone in the group has completed the experiment, share out the results! Use some of the questions below to guide the conversation:

> Which ice cube melted the fastest in your experiment? What material was on it?
> Which ice cube melted the slowest in your experiment? What material was on it?
> How did your predictions compare with your results?
> Was there anything that surprised you about these results?

2. This experiment can produce mixed results, depending on environmental factors. Typically, materials like salt and hot water melt ice the fastest. No materials (the control) and cold water melt ice the slowest.
3. Ask your group to think harder about their results, and try to come up with their best explanation of them.

> Why do you think salt and/or hot water melted ice faster?
> Why do you think no materials/cold water melted ice slower?
> What do you know about ice that might help you explain the results?
> What do you know about the materials (salt, water, etc.) that might help you explain the results?
> Is there anything you've seen or experienced before in life that relates to this experiment?

ANALYSIS AND EXPLANATION

1. Share out and compare explanations among the group.
2. Reveal some of the science behind their results using the information below. Share as little or as much as you feel is appropriate for your group. You can also encourage them to research some of this information and explanation on their own:
    a. **Salt**: Salt melts ice the fastest.
        i. As salt dissolves into ice, its molecules break up the bonds between water molecules, which are responsible for keeping it frozen in place, as a solid. As a result, the solid cube begins to melt into liquid faster than if no salt were added.

b. **Sugar**: The same interaction described between salt and ice applies to sugar and ice.

c. **Hot water:** Hot water melts ice at a similar rate to salt, but for slightly different reasons.

   i. Hot water molecules contain *more* energy than ice water molecules, which are so low in energy that they are frozen still.

   ii. As hot water is poured onto an ice cube, the excess energy is transferred to the molecules in the ice cube. This causes their movement to increase and their bonds between surrounding molecules to loosen up. Eventually, the bonds will get loose enough to allow fluid movement, melting the ice into liquid.

d. **Cold water:** Cold water produces a much slower melting rate than the other materials.

   i. Cold water molecules contain *more* energy than ice water molecules, which are so low in energy that they are frozen still. But they do not contain *as much* excess energy as hot water.

   ii. As cold water is poured onto an ice cube, there is less energy available to transfer to the molecules in the ice cube. Less energy creates less movement, which means the water molecules in ice will maintain their bonds and remain solid for a longer period of time.

e. **Nothing**: The control ice cube, which has nothing added to it, produces a much slower melting rate than the other materials. It may be the slowest, depending on your procedure.

   i. Ice that is placed in room temperature will inevitably melt because water has a freezing point of 32°F (0°C). This means it will take on a solid state under 32°F, and a liquid state above 32°F. Since most rooms have temperatures above 32°F, ice cubes absorb heat from the surrounding air, which turns them from solid to liquid.

   ii. This transfer of energy is much slower and lower than any of the materials listed above because it is the *only* transfer of energy occurring. All others have the interaction between ice, air, *and* a third party material which increases the rate it melts. Therefore, ice with nothing typically melts the slowest.

CONCLUSION

1. Summarize the experiment and what you learned.
2. Encourage them to think about how this experiment might apply to their everyday lives:

> Do you use ice in your day-to-day life? What for?
> Why do you think it's important to know how ice melts?
> Do you think it's helpful to know which materials melt ice the fastest/slowest? Why or why not?
> Are there any other materials you would like to test now?

3. Ice can be used in many different areas of life. From cooling down a drink to preserving life-saving medicines as they are shipped over long distances. Studying ice and knowing how to create, preserve, and use it for human benefit is just one way that science affects all of our lives in ways that we may not consider.

4. Once you are finished with the activity, check out some of the resources and extension activities, listed on page 9 to learn more about ice!

ICE MELTING EXPERIMENT DATA SHEET

NAME: _____

PREDICTIONS

Which ice cube do you predict to melt the fastest? Why?
Which ice cube do you predict to melt the slowest? Why?

OBSERVATIONS

TIME	OBSERVATIONS					
	SALT	SUGAR	COLD WATER	HOT WATER	NOTHING	YOUR CHOICE

OBSERVATIONS (CONTINUED)

TIME	OBSERVATIONS					
	SALT	SUGAR	COLD WATER	HOT WATER	NOTHING	YOUR CHOICE

RESULTS

Which ice cube melted the fastest? What was on it?	Why do you think that is?
Which ice cube melted the slowest? What was on it?	Why do you think that is?

NEXT GENERATION SCIENCE STANDARDS (NGSS)

Completing these activities and experiments will satisfy the following NGSS standards:

- **2-PS1-4:** Argument is constructed from evidence that some changes caused by heating or cooling can be reversed and some cannot.
- **4-PS3-2:** Observations are made to provide evidence that energy can be transferred from place to place by heat.
- **5-PS1-4:** An investigation is conducted to determine whether the mixing of two or more substances results in new substances.
- **MS-PS1-4:** An experiment is developed that predicts and describes changes in particle motion, temperature, and state of a substance when thermal energy is added or removed.

NGSS: CROSS CUTTING CONCEPTS

Completing these experiments and activities will help children understand the following about cross cutting concepts:

- **Cause and Effect:** cause and effect relationships are routinely identified and used to explain change and that events have causes that generate observable patterns.
- **Energy and Matter:** energy is tracked into, out of, and within a system to help understand the systems' possibilities and limitations.
- **Stability and Change:** change is measures in terms of difference over time and rate.

NGSS: PRACTICES FOR K-12 CLASSROOMS

Throughout these activities, learners of all ages will practice skills such as:

- Asking questions
- Planning and carrying out Investigations
- Constructing explanations
- Obtaining, evaluating, and communicating information

DISCUSSION QUESTIONS

Use the discussion questions listed below to guide conversation with your students before, during, and after completing The Chill Zone Science Show. Discuss them as a group or assign them as a journal prompt or writing exercise.

PRE-SHOW

What do you know about ice?

Do you think other materials, besides water, can be used to make ice?

What other ices do you know of?

What is needed to make ice? / How is ice made?

MID-SHOW

Have you ever seen or used dry ice before?

What do you think dry ice is used for in real life?

Have you ever seen or used liquid nitrogen before?

What do you think liquid nitrogen is used for in real life?

Are there any other types of ice that you know of that weren't shown in the video?

POST-SHOW

What questions do you have about water ice, dry ice, or liquid nitrogen?

If you could experiment with one of the ices in the video, what would you do?

Why do you think there is so much ice found in space?

What can ice tell us about other planets (or moons)?

Do you think it's important to study ice? Why or why not?

FROM CHABOT

Check out this video on the States of Matter, made by one of Chabot's teen volunteers in the Galaxy Explorers program. Watch to learn about the different states of matter and the physical conditions necessary to switch between them.

Weather is a great example of a system that naturally cycles water through all three states of matter (solid-snow, liquid-rain, and gaseous-clouds). Track the weather and pay close attention to where ice is, or is not, present in our lives with Chabot's Become a Meteorologist activity.

FROM NASA

Discover more about the locations in our solar system that contain water, dry ice, and liquid nitrogen with NASA's Solar System Exploration website. Travel to Earth, Mars, and Triton to understand their physical conditions, average temperatures, and ability to support the presence of water and ice.

Curious to learn more about the water-ice recently discovered on the Moon's poles? Watch this video from NASA Goddard, Water on the Moon, to see how scientists detected and confirmed its presence using the Lunar Reconnaissance Orbiter (LRO).

Check out NASA's Climate Kids webpage on Water. Find activities, videos, and lessons about water, its importance, and how NASA scientists are studying it on Earth.

EXTENSION ACTIVITIES

KEEP IT GOING

Experiment with another batch of ice cubes, adding your own set of materials to sprinkle or pour on top! Predict, observe, and analyze how they affect the melting-rate of an ice cube and compare the results to the original tests.

THINK DIFFERENT

Encourage your students to think differently about this experiment. If you do **not** have the materials needed, how else can you demonstrate a transition in states of matter? Come up with your own experiments that involve a transition from one state to another. Some ideas listed below:

- Try melting different foods found in the kitchen by heating them up. Determine which types of foods can melt and which cannot. Determine which experience a true change in states and which do not.
- Instead of melting ice, try keeping ice cold as long as possible by experimenting with insulation. Test different materials and compare their results.

WRITE A STORY

Imagine you are a tiny water molecule, trapped inside a cube of ice. Write about your experience as you transition from solid ice, to liquid water, to water vapor. How does your movement change as you gain energy? What is your journey from each state to the next like? How does it feel to be a water molecule? Use your imagination and get creative with it!