ICE

the cool form of water

In the natural world, there is no other element as important as water. Water is the basis for all life. Water is both simple and complex. It has the ability to create landscapes, transform from a liquid to a gas, or even become a solid.

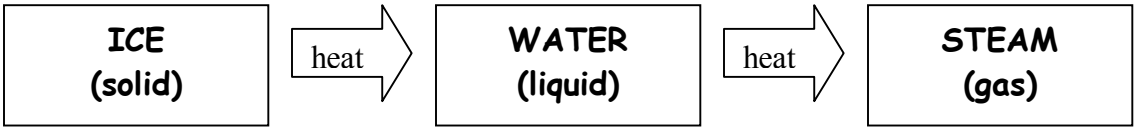
With over 70% of the earth being covered in water, water seems like a resource that is dependable and ever-present. However, for humans there is a limited amount of usable water. Think about how much of the water is salt water. Since it is such an important resource, we need to be able to recognize it in its various forms and how water shapes our lives and our natural environment.

Forms of Water

As you may already know water can take the form of a gas, solid, or liquid. Water is the only natural substance on earth that can be found in all three states (solid, liquid, gas).

So how does water change its form? The answer is temperature change. How is water changed into ice? Remove the heat. How do you create steam? Add heat. You probably already know the answers to these questions, but are you aware of the processes that go on in order for water to change its form?

Basically anytime heat is removed or added to water, it will change the density of the water. The molecular structure of the water determines its density. As water freezes the molecules become more tightly packed together. As water is turned into steam, the water molecules spread out. Yet, unlike most elements, water actually becomes less dense as a solid. Water's composition will still be the same, H2O.



Types of Ice

The type of ice formed is dependent on the type of water that has been frozen. Ice that has been made from sea water behaves and looks differently than rain water that has frozen. At first glance, all ice is basically the same. It is a solid. It has the same chemical composition as water. However there are three basic types of ice, all with unique sets of behaviors and all impact the earth differently.

Freshwater Ice

Lake Ice

We all know that when the temperature dips below 32ºF (0ºC), water freezes. During the winter months in the boreal forest, every body of water freezes. But the process of freezing is more intricate than meets the eye.

During the summer months, when temperatures are highest, the coldest water of the lakes is at the bottom. Just think of when you swim in a lake and dive a few feet below the surface. The temperature quickly gets colder. However, as fall approaches and the air temperature begins to drop regularly, the surface temperature of the lake begins to near 39.2ºF. It is at 39.2ºF that water reaches its maximum density, causing the surface water to sink because it is more dense than the water below. Thus the water that was once the surface water, ends up on the bottom of the lake.

The water that was below the surface during the summer months is now on top of the lake, and becomes even cooler. Once the water reaches 32ºF, it freezes over in a sheet of solid ice.

As lakes freeze, their ice expands. When the ice expands it buckles and bends, creating cracks and pressure ridges. Cold air temperatures, without snow fall, make ice rapidly. During that time, the ice begins to groan and shriek loudly. It's an amazingly haunting noise to hear ice forming.

Often during winter travel, we come to an area of open water or thin ice. Even though the air temperature might be well below freezing, there might not be ice covering sections of rivers or streams.

How could ice get melted if the temperature doesn't get higher than 15ºF all day? The answer is pressure. If it begins to snow heavily, the pressure from the accumulated snow piles up on top of the ice and creates downward pressure. The downward pressure causes the ice to bend down toward the water below the ice.

Since the unfrozen water beneath the ice's surface is warmer, it causes the ice to melt. The snow above the ice's surface acts as an insulator and causes the ice to melt or get softer, just like the bottom of a glacier.

River Ice

Rivers are always changing. Rivers change levels with the season, and those levels are dependant on precipitation and run off. During the winter, rivers shrink in volume because all the precipitation that falls freezes and cannot be transported in the form of run-off.

Because the river is always changing, river ice is a little more complex than lake ice. The river's current may keep the river's water un-frozen. If the current is strong enough, the river will stay open all winter long. Also if the water is flowing just beneath the ice's surface, the friction caused by the running water will melt the ice or keep it thinner than other sections.

River's current's change from region to region. In areas that the river's current in faster, ice is more reluctant to form.

Also when rivers are deposited into lakes, the water temperature ranges from 39ºF to 33ºF, thus making it more difficult for ice to form.

Travel on Ice

Lakes and rivers with more than one inch of uniform ice will hold a person. Ice conditions are rarely similar from day to day, though, because of temperature change and snow fall. This makes winter travel a bit more interesting.

Imagine you're pulling your toboggan on a nice clear, cold day and you come to an area of open water. Of course you wouldn't want to get wet, so you need to find out how to make your way around the open water.

The open water in a particular section of river is referred to as a lead. Leads can pose problems for winter travelers because each lead brings with it a new set of circumstances.

Usually when we encounter a lead we have to figure out a way around it. Usually we can skirt the edge of the river or stay close to the lead because the surrounding ice is safe for travel.

However, if there is a sizable stretch of open water, we may need to look to the shoreline to provide safe passage. Blazing a trail through the boreal forest's dense flora and fauna can be quite difficult. The snow gets deep, toboggans get stuck, winter walkers get frustrated, and travel becomes slow and laborious.

Yet, it's all worth it. The bounty of the boreal forest in the winter provides for amazing sights and natural phenomena.

Activities for the Classroom

Discover how water transforms

Objective: Students will gain a greater understanding of the water cycle and its ability to transform its state. Students will learn about key concepts such as evaporation, sublimation, and condensation. Students will learn and apply concepts that describe properties of matter. Students will learn and describe properties of solids and liquids

Skills Used: Scientific method and reasoning, guided internet research, vocabulary strengthening exercises, and apply theories of matter transformation.

Procedure: Have students visit http://ga.water.usgs.gov/edu/sc3.html and take the on-line Water Challenge Quiz.

Discuss the physical properties of water and how it can change from a solid, to a liquid, and then to a gas. Ask students if they know how the processes of freezing and thawing occur. Introduce concepts of sublimation, evaporation, and condensation. Illustrate these concepts with a group guided experiment of bringing a cup of ice to a boil. Make sure to note the water's transformation. Ask students to define how the water's density has changed with the introduction of a heat source.

Answer the first 7 questions on the How Does Water Change Its Form? Worksheet.

Fill two containers with ice or snow. Label containers #1 and #2. Leave container #1 alone in room temperature. Define this container as the control group.

Add a small amount of water to container #2 of ice or snow.

Have students develop a hypothesis as to why they believe one container of ice or snow will melt more rapidly.

Record the amount of time it takes for all of the ice or snow to melt in both containers.

Have students evaluate their hypothesis.

Why Does Water Change It's Form?

1. In order for water to change its form, what needs to be added or removed? _____

2. The process known as evaporation changes water to _____.

3. The process known as sublimation changes water to _____.

4. The gas form of water is called _____.

5. The solid form of water is called _____.

6. Ice has a greater or lesser density than water? _____.

7. Why does ice float?_____
   _____

Create a hypothesis by filling in the rest of the sentence.

I think that Container _____ will melt faster than Container _____, because_____
_____
_____

Record your findings in the table below

	TIME NEEDED TO MELT
CONTAINER 1	
CONTAINER 2	

Was your hypothesis correct? Why or why not?

_____
_____
_____

Questions for the Chat Room or Classroom Discussion

Topic: The Land of Ice and Snow. What makes ice so cool?

Suggested Questions

Why is traveling on ice so different than traveling on water?

Besides cold weather what causes ice to form? What causes ice to melt?

How thick does ice need to be in order to walk on?

How do you measure the thickness of the ice?

How does water in all of its forms affect winter travel?

What role does water vapor play in everyday life?

What do you do if you encounter an open stretch of water, or lead?

How does snow affect the formation of ice?

How do you get water on the trail?