**Matter**

**Lesson #7:** **Water – Changing States (Part 1)**

**Time Frame:** 45-60 minutes

**Reminder:** Ice is not provided for this lesson.

**Learning Standards:**

*Science*

Physical Science: States of Matter

1. Compare and contrast solids, liquids, and gases based on the basic properties of each of these states of matter.
2. Describe how water can be changed from one state to another by adding or taking away heat.

Skills of Inquiry

1. Ask questions and make predictions that can be tested.
2. Select and use appropriate tools and technology in order to extend observations.
3. Keep accurate records while conducting simple investigations or experiments.
4. Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.

**Student will be able to:**

1. Observe and explain how water changes between the solid, liquid, and gas state and how heat is involved.
2. Experiment with water in different states.

**Resources and Materials:**

|  |  |
| --- | --- |
| **Item** | **Amount** |
| Science notebooks |  |
| Hot plate (Greylock only) | 1 (in bin) |
| Empty soda can | 3 (in bin) |
| Tongs | 1 (in bin) |
| Thermometers | 15-20 (in bin) |
| Metal pan | 1 (in bin) |
| Plastic bowls | 2 (in bin from lesson #8) |
| Beakers | 30 (in bin) |
| Glass flasks | 3 (in bin) |
| Clay | 2 pack (in bin) |
| Straws | 20 (in bin) |
| Cups | 30 (in bin) |
| Metal can | 1 (in bin) |
| Freezer (not provided) | (in classroom) |
| Ice (not provided) |  |
| Markers (not provided) | (in classroom) |

**Focus Activity:** Ask the students to answer the following question in their science notebooks.  What are the three states of matter?  Does water exist as each state of matter?  Give examples of water in nature changing from one state to another (such as a pond freezing in the winter, etc.)  Discuss this focus activity in depth and use it as a way to access and explore prior knowledge.

**Introduction:** Show the students a demonstration with the imploding soda can. Teacher instructions are provided.

What is all around the can?  What is inside of the can?  What happens when I heat the can?  How do water gas molecules act inside of the can?  What happens when I put the can in the ice water?

Tell students that temperature plays a major role in determining the state of matter.  What state of matter is water when it is cold?  (Solid, ice)  What state of matter is water when it is at room temperature? (Liquid)  What state of matter is water when it is boiled or gets hot?  (Gas, water vapor)  The process of water changing states is what we will investigate in class today.

*Teacher Explanation:  Before heating, the can was filled with water and air. By boiling the water, it changed states from a liquid to a gas. This gas is called water vapor. The water vapor pushed the air that was originally inside the can out into the atmosphere. When the can was turned upside down and placed in the water, the water vapor condensed and turned back into the water. Water molecules in the liquid state are many, many times closer together than molecules in the gas state. All of the water vapor that filled up the inside of the can turned into only a drop or two of liquid, which took up much less space. This small amount of water cannot exert much pressure on the inside walls of the can, so the pressure of the air pushing from the outside of the can is great enough to crush it. The sudden collapsing of an object toward its center is called an* ***implosion****.*

**Activity:**

1. Break the students up into small groups and give each group a beaker of water at room temperature and a beaker filled with ice cubes.  Boil water in a flask at the front of the room.  Ask the students to make observations about each state of water and write them down (with drawings) in their science notebooks.  Provide the students with thermometers to make their observations.  Remind the students to remember the different properties of the 3 states of matter and relate this to their study of water. Demonstrate that water is really coming out of the flask by holding a metal pan above the water vapor and watching the water droplets form.
2. Discuss the student observations, measurements, and diagrams with the class.  Then, ask the students to write down a few questions in their science notebooks about water and how it changes states.
3. Using a model of a water molecule, remind students what a water molecule looks like.  Tell students that when water changes its state of matter, its chemical structure remains the same.  Individual water molecules do not change, but their speed and closeness to one another changes.
4. Use the following terms to help the students describe the changes that happen with water.  Define these terms with the class: evaporation, condensation, freezing, boiling, and melting.  Write the terms on the board and work with the students to come up with working definitions.  Most of these terms will probably be familiar.
   1. **Evaporation:** water changes from a liquid to a gas (vapor), this occurs a little bit at temperatures above freezing and more at higher temperatures
   2. **Condensation:** water changes from a gas to a liquid, occurs when warm water vapor gets cold or touches something cold (like when the water in the air becomes clouds)
   3. **Melting:** water changes from a solid to a liquid, ice melts above 32º F, 0º C
   4. **Freezing**: water changes from a liquid to a solid, water freezes at 32º F, 0º C
   5. **Boiling:** heated water molecules become gas (vapor) and this happens at 212º F or 100º C (relate this to the slower process of evaporation)
5. Fill up a metal can with lots of ice cubes.  Stand it in a warm place and leave it for a few minutes.  Observe the outside of the can and discuss condensation and how the warmer water vapor turns into liquid water when it contacts the cold ice cubes.
6. Tell students that they will now be exploring the changing states of water through a series of week-long mysteries.  Have students write in their science notebooks their predictions about what will happen to the water in each mystery.  Ask them to try to use the new vocabulary in their descriptions when appropriate.  Choose from the following demonstrations.  Set up as many demonstrations as many as time permits.
   1. Mystery 1:  Show that water expands when frozen.  Press a piece of clay against the inside bottom of a jar.  Fill the jar with water. Add a few drops of food coloring and stir.  Slowly lower the straw into the clay and stand it up in the jar.  Slowly pour out all of the water in the jar, leaving the water in the straw.  Use a pen to mark the height of the water in the straw and observe after the water freezes.  Discuss that water is a very special molecule because it actually expands when it becomes solid (freezes) and takes up less space as a liquid.  This is because the molecules of water bond together to make structures with more space when the temperature is lower and water freezes.
   2. Mystery 2:  Set up the same experiment (above) but leave the straw with water at room temperate for several days.  Observe what happens to the water level and discuss the process of evaporation (liquid water turns into water vapor slowly, even when water is not boiling).
   3. Mystery 3:  Get two cups and add about 1 tablespoon of salt to one of the cups.  Label the cup with the salt and add water to each cup. Stir the salt water so that the salt dissolves.  Put both cups in the freezer and observe regularly over the course of one day or after 24 hours.  Salt interferes with the bonding between the water molecules that occurs when liquid water freezes to solid water. Consequently, the water temperature with the salt must be lower before it freezes.  Relate this to salting icy roads and walkways during the winter.

**Closure:** Do the can demonstration again and ask students to consider the different states of matter in this demonstration and apply the new terms they learned to this experiment (condensation, boiling, melting, evaporating, etc.).

More questions for discussion:  What are the properties of water vapor?  What are the properties of ice?  What are the properties of liquid water?  Does the water change or stay the same?  Explain.  Is it still water in each state?

**Assessment:** Science notebook responses, observations and drawings of water (in each state), participation in class discussions of water definitions, contributions to class questions

**Can Crushing Demonstration**

**Materials:**

2-3 empty soda cans

Hot plate

Tongs

A bowl of ice water

**Experiment:**

1. Fill the bowl with cold water (the colder the better) and add plenty of ice.
2. Add one generous tablespoon of water to the empty soda can (just enough to cover the bottom of the can).
3. Place the can on the burner of the stove and turn on the burner to heat the water. Soon you'll hear the bubbling sound of the water boiling and you'll see the water vapor rising from the can. Continue heating the can for one more minute.
4. Using one swift motion, lift the can off the burner, turn it upside down, and plunge it into the cold water. Get a good grip on the can near its bottom with the tongs held so that your hand is in the palm up position.
5. Repeat as desired.

**How Does It Work?**

Before heating, the can was filled with water and air. By boiling the water, it changed states from a liquid to a gas. This gas is called water vapor. The water vapor pushed the air that was originally inside the can out into the atmosphere. When the can was turned upside down and placed in the water, the water vapor condensed and turned back into the water. Water molecules in the liquid state are many, many times closer together than molecules in the gas state. All of the water vapor that filled up the inside of the can turned into only a drop or two of liquid, which took up much less space. This small amount of water cannot exert much pressure on the inside walls of the can, so the pressure of the air pushing from the outside of the can is great enough to crush it. The sudden collapsing of an object toward its center is called an implosion.