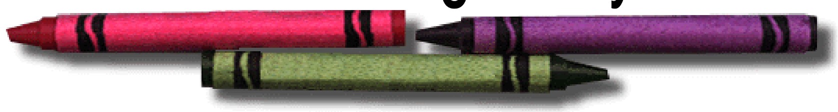
STARS

Activities for Nature of Matter Benchmark SC.A.1.2.2

Name ______________________________ Date__________________

Lab 1: Melting Crayon



Materials

1 tablespoon of crayon shavings per student
20 cm square of aluminum foil per student
1 clothespin per student
1 folded paper towel per student
1 tea light per group

Directions

1. Take extra care with this lab because you will be using fire to perform your experiment.
2. Place the crayon shavings in the center of your foil square.
3. Carefully, fold up the sides of the square aluminum foil to keep all of the crayon shavings in the foil.
4. Choose a corner of the bowl that has no or very little shavings, this is now your clothespin corner.
5. If your pile of shavings is a bit high, try to scatter them within the foil bowl a bit but keep them away from your clothespin corner.
6. Very carefully, grab your foil bowl with your clothespin at the clothespin corner.
7. Have the lab teacher light the group candles.
8. Taking turns with your lab partners, place your foil bowl over the candle. Keep it just above the flame.
9. What do you observe?
10. Once you’ve made your observation, remove your foil bowl from the flame and place it on the paper towel. Don’t forget -- it’s hot!
11. Keep an eye on your experiment, what happens to it next?

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Questions

1. What was the state of matter of the crayon shavings?

2. Describe your first observation. Describe the state of matter.

3. Why did the crayon shavings change state?

4. What did you observe once you removed your experiment from the flame?

5. Why did the state change again? What state did it become?

6. Did they become shavings again? Why or why not?

7. How does heating and cooling affect the states of matter?

8. Describe another example where heating and cooling changed the state of something.

Teacher Notes for Lab 1: Melting Crayon

This experiment can be conducted as a demonstration.

Questions

1. What was the state of matter of the crayon shavings?

Even though they are not whole crayons, they are still in the solid phase.

2. Describe your first observation. Describe the state of matter.

The shavings melted. They are now in the liquid phase.
Note. Not all of the shavings may melt. That is ok. As long as a portion of the shavings melt, they students will observe a phase change.

3. Why did the crayon shavings change state?

They changed state because heat was applied. As more heat is applied substances change from one state to another.

4. What did you observe once you removed your experiment from the flame?

The crayon shavings hardened. They merged to become one strangely shaped crayon.

5. Why did the state change again? What state did it become?

The state changed again because the heat source was removed. In other words, cooling was added. Cooling the substance allows it to return to its original state. It turned back into a solid.

6. Did they become shavings again? Why or why not?

They did not become shavings again. This did not happen because when it turned into a liquid, the shaving melted into each other. Liquids take the shape of their container. The shape of the container becomes the new mold for then the liquid hardens.

7. How does heating and cooling affect the states of matter?

Heating and cooling creates physical changes in the states of matter. That means that the objects in certain states change into other states as heat or cooling is applied.

8. Describe another example where heating and cooling changed the state of something.

Answers will vary, but probably the most common is ice melting into liquid water.

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Lab 2: The State Debate

Although the four states of matter are solid, liquid, gas, and plasma, not all substances seem to fit perfectly into one of these groups.

Take a look at the substance in this experiment and see if you can decide whether it should be called a solid, liquid, gas, plasma, or something in between.

Materials
shaving cream
paper towel
penny
magnifying glass (optional)

Hypothesis

Would you call shaving cream a solid, liquid, or a gas? Why? One characteristic of a solid is that it keeps its shape without being in a container. Does this make the shaving cream a solid? Why or why not?

I believe that shaving cream is a ______________________________ because

____ .

Experiment

1. Place a small mound of shaving cream on a paper towel.

2. Very gently place a penny on top of the shaving cream. What do you observe? Does the shaving cream act most like a solid, liquid, or gas?

   ____

   ____

3. Shaving cream is very light. Look at it very closely or use a magnifying glass if you have one. What do you think makes it so light? Does this make you change your opinion of whether it is a solid, a liquid, or a gas?

   ____

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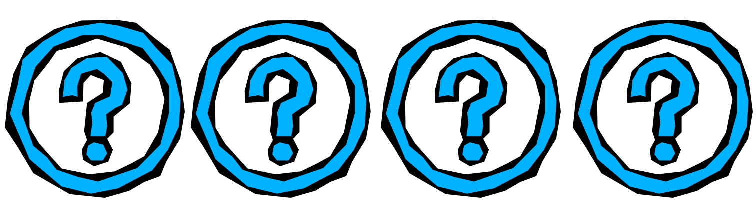

STARS Teacher Workshop
Reference: Chemistry.org Wondernet

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4. Rub a little shaving cream between your thumb and index finger. Does it feel like a solid, liquid, or gas?

____

____

5. Leave the shaving cream blob out over night. Look at it very closely the next day. How has it changed? Has its state changed?

____

____

6. Leave it for a few more days and see if you think it has changed state. What do you observe?

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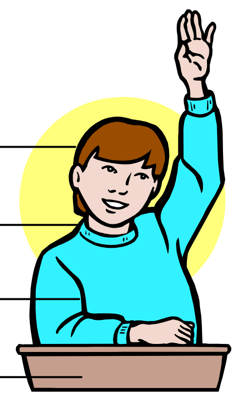
So, what's going on here? Debate your ideas with your classmates and your teacher. After your debate, describe what the shaving cream really is.



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Think about this...

Another example of a substance with a weird state is a mixture of corn starch and water. In a cup, place 2 tablespoons of corn starch and 1 tablespoon of water. Mix with a popsicle stick. If you mix quickly the material will act more like a solid. If you mix slowly, it will act more like a liquid. Poke it with the popsicle stick and then press it gently. What do you notice?

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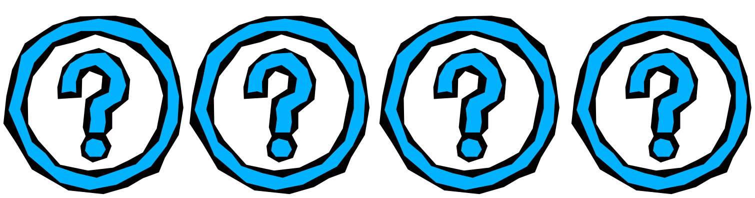

Teacher Notes for Lab 2: The State Debate

Note: This experiment will take a few days to observe.

Shaving cream seems to have an unusual state because it is a **liquid** soap with a lot of **gas** bubbles mixed in it. The gas makes it so thick and frothy that it keeps its shape and supports light objects like a **solid**. When you let the **liquid** from shaving cream evaporate, all that's left is the very light and thin **solid** soap and the spaces where the **gas** bubbles were.

Its not always so easy to say definitely that a substance is a solid, liquid, or gas. Some materials, like cornstarch mixed with water, can act more like a solid when treated a certain way and more like a liquid when treated a different way. Cornstarch with water is actually a liquid with very high viscosity. Viscosity is the term used to describe the thickness of a liquid. If a liquid has low viscosity it flows very well – think of water. If a liquid has high viscosity, it flows rather slowly— think of syrup. The mixture of cornstarch with water has a very high viscosity because it hardly even flows. But place it an incline and it should flow, over time.

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Lab 3: The Plasma Experiment

Materials

- Plasma globe
- Fluorescent light bulb

Procedure

1. Touch the plasma globe with your finger. What happens? Why do you think this happens?

2. What happens when you drag your finger across the glass?

3. Place your whole hand on top of the globe. What happens?

4. How is the plasma stream different when you place your whole hand on the globe compared to just one finger?

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5. Place your hand on the plasma globe. Use one finger from your other hand to touch one of your group member's hands. What happens?

6. Place the fluorescent bulb next to the plasma globe. What happens?

7. Move the fluorescent bulb into different positions near the plasma globe. Draw a picture below to show the best way to get the bulb to light up.

Teacher Notes for Lab 3: The Plasma Experiment

Materials:

(Per group, if possible)

- Plasma globe
- Fluorescent light bulb

Related Links:

NASA Liftoff—The Fourth State Of Matter

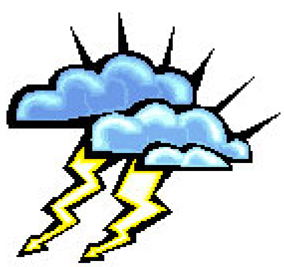
Supporting NASAexplores Article(s):

The Engine That Does More

Pre-Lesson Instructions:

- Equipment differences may vary performance in the activities. You may want to try the experiments ahead of time to see how they will work with your equipment.
- If necessary, the activities in this lesson can be done as teacher demonstrations. If students will be completing the activities, they should work in groups of two or three.

Background Information:



There are three classic states of matter: solid, liquid, and gas; however, plasma is considered by some scientists to be the fourth state of matter. The plasma state is not related to blood plasma, the most common usage of the word; rather, the term has been used in physics since the 1920s to represent an ionized gas. Space plasma physics became an important scientific discipline in the early 1950s with the discovery of the Van Allen radiation belts. Lightning is commonly seen as a form of plasma.

Matter changes state as it is exposed to different physical conditions. Ice is a solid with hydrogen (H_2) and oxygen (O) molecules arranged in regular patterns, but if the ice melts, the H_2O enters a new state: liquid water. As the water molecules are warmed, they separate further to form steam, which is a gas. In these classic states, the positive charge of each atomic nucleus equals the total charge of all the electrons orbiting around it so that the net charge is zero. Each entire atom is electrically neutral.

When more heat is applied, the steam may be ionized: an electron will gain enough energy to escape its atom. This atom is left one electron short and now has a net positive charge; now it is called an ion. In a sufficiently heated gas, ionization happens many times, creating clouds of free electrons and ions; however, not all the atoms are necessarily ionized, and some may remain completely intact with no net charge. This ionized gas mixture, consisting of ions, electrons, and neutral atoms, is called plasma. A plasma must have sufficient numbers of charged particles so that the gas, as a whole, exhibits a collective response to electric and magnetic fields. Plasma density, therefore, refers to the density of the charged particles.

Although plasma includes electrons and ions and conducts electricity, it is macroscopically neutral: in measurable quantities, the number of electrons and ions are equal. The charged particles are affected by electric and magnetic fields applied to the plasma, and the motions of the particles in the plasma generate fields and electric currents from within. This complex set of interactions makes plasma a unique, fascinating, and complex state of matter.

Plasma is found in both ordinary and exotic places. When an electric current is passed through neon gas, it produces both plasma and light. Lightning is a massive electrical discharge in the atmosphere that creates a jagged column of plasma. Part of a comet's streaming tail is plasma from gas ionized by sunlight and other unknown processes. The Sun is a 1.5-million-kilometer ball of plasma, heated by nuclear fusion.

Scientists study plasma for practical purposes. In an effort to harness fusion energy on Earth, physicists are studying devices that create and confine very hot plasmas in magnetic fields. In space, plasma processes are largely responsible for shielding Earth from cosmic radiation, and much of the Sun's influence on Earth occurs by energy transfer through the ionized layers of the upper atmosphere.

Guidelines:

1. Read the NASAexplores 5-8 article, “The Engine That Does More.” Answer any questions the students may have about the content.
2. Discuss the concept of plasma with the class. See the Background Information for more information.
3. Hand out the Student Sheet. Go over the directions with the class. If doing this activity as a teacher demonstration, explain that the students can still answer the questions, even if they only get to observe.

4. Allow time for the students to complete the activities.

Discussion / Wrap-up:

- Go over the answers to the Student Sheets.
- Have students share what they learned about plasma.

Extensions:

- Research plasma on the Internet to discover all of the places it can be found and what it can be used for.
- Create your own experiments to conduct with the plasma globe.

Answers to Student Sheet Questions

1. The plasma stream moves to the place where your finger touches the globe. The plasma stream moves to your finger because it is a ground source. The current doesn't flow through your body, but rather along the surface of your skin.
2. The plasma stream follows your finger.
3. The plasma stream intensifies at the place where your hand touches the globe.
4. The plasma stream is much wider when you place your whole hand on the globe than when you place just a finger on the globe.
5. A spark jumps from your finger to your partner's hand. They get a small shock.
6. The fluorescent bulb lights up.
7. Answers will vary.

A note on plasma tv's

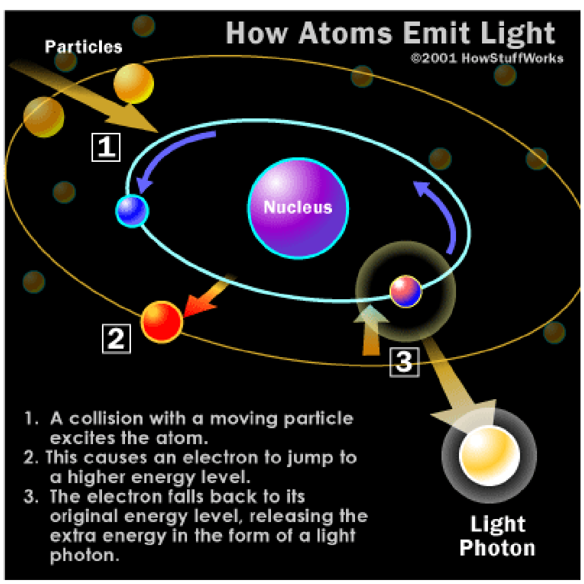
A basic tv is based on the information in a video signal, the television lights up thousands of tiny dots (called pixels) with a high-energy beam of electrons. In most systems, there are three pixel colors -- red, green and blue -- which are evenly distributed on the screen. By combining these colors in different proportions, the television can produce the entire color spectrum.

The basic idea of a plasma display is to illuminate tiny colored fluorescent lights to form an image. Each pixel is made up of three fluorescent lights -- a red light, a green light and a blue light. Just like a CRT television, the plasma display varies the intensities of the different lights to produce a full range of colors.

The central element in a fluorescent light is a **plasma**, a gas made up of free-flowing **ions** (electrically charged atoms) and **electrons** (negatively charged particles). Under normal conditions, a gas is mainly made up of uncharged particles. That is, the individual gas atoms include equal numbers of protons (positively charged particles in the atom's nucleus) and electrons. The negatively charged electrons perfectly balance the positively charged protons, so the atom has a net charge of zero.

If you introduce many free electrons into the gas by establishing an electrical voltage across it, the situation changes very quickly. The free electrons collide with the atoms, knocking loose other electrons. With a missing electron, an atom loses its balance. It has a net positive charge, making it an ion.

In a plasma with an electrical current running through it, negatively charged particles are rushing toward the positively charged area of the plasma, and positively charged particles are rushing toward the negatively charged area.



In this mad rush, particles are constantly bumping into each other. These collisions excite the gas atoms in the plasma, causing them to release **photons** of energy. (For details on this process, see How Fluorescent Lamps Work.)

Xenon and neon atoms, the atoms used in plasma screens, release **light photons** when they are excited. Mostly, these atoms release **ultraviolet** light photons, which are invisible to the human eye. But ultraviolet photons can be used to excite visible light photons.

Source: http://electronics.howstuffworks.com/plasma-display.htm/printable

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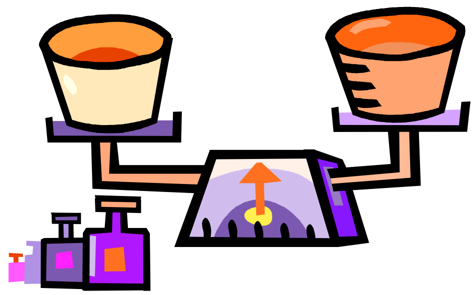
Lab 4: Will it conserve?

Does matter disappear or appear when it's going through the physical changes? That's what we're about to find out!

Materials (per group)
- Mass Balance
- Small Styrofoam bowl
- Small ice cube
- Tongs



	Mass (g) Base Reading
Plate	
Plate with ice cube	
Solid	

Directions
1. Determine the mass of the plate. Record the mass in your chart.
2. Using the tongs, place the ice cube on the plate. Determine the mass of the plate and the ice cube. Record it in your chart.
3. Calculate the mass of the ice cube. Record.
4. In your group determine what your time interval should be. Answer this question: How often do we want to measure the mass? Every ___________ minutes.
5. After the decided number of minutes has passes, take your first measurement. Record.
6. Calculate the mass of the solid.
7. Repeat until you have completed 3 measurements.

	Mass (g)		
	Reading # 1	Reading # 2	Reading # 3
Plate with ice cube			
Solid/Liquid			

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Questions

1. As time passed, what did you observe? What happened to the ice cube?

2. Why were tongs used to place the ice cube on the plate? Why didn't you use your hands?

3. What can you conclude about the results of the three readings?

4. If more readings were done, would you notice a difference? Why or why not?

5. Was the mass conserved?

6. Think back to the crayon experiment. Do you think if you had measured the crayon shavings before and after the experiment, would the masses be the same? Try it again to find out!

Another addition to the experiment could be to cover the bowl and ice cube with a tight seal. Doing this, the experiment could be extended for days. The solid ice would turn to liquid and the liquid could then evaporate. The mass of the sealed bowl and gas could be compared to the mass of the sealed bowl and ice cube.

1. As time passed, what did you observe? What happened to the ice cube?
   The ice melting.
2. Why were tongs used to place the ice cube on the plate? Why didn't you use your hands?
   Tongs were used because heat from the hands would have melted the ice a bit and would have tainted the mass. The hands would have been wet, hence some "ice" was rubbed off the ice cube.
3. What can you conclude about the results of the three readings?
   The masses remained the same. So, matter does not disappear as it goes from one state to another.
4. If more readings were done, would you notice a difference? Why or why not?
   No, if we let it melt completely. The water would weigh the same as the ice cube. Yes, if we let the water evaporate. Since we had no way to contain the ice/water, if it would have evaporated then it would have gone into the atmosphere.
5. Was the mass conserved?
   Yes, because the mass did not change.
6. Think back to the crayon experiment. Do you think if you had measured the crayon shavings before and after the experiment, would the masses be the same? Try it again to find out!
   Yes, the masses should have been the same.