***2nd Grade States of Matter***

**Objective:**

Students will learn about the three phases of matter. They will learn to identify a solid, liquid and a gas and a chemical reaction through a hands-on experiment.

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| [http://www.nextgenscience.org/sites/all/themes/science/logo.png](http://www.nextgenscience.org/)  [**PS1.A: Structure and Properties of Matter**](http://www.nap.edu/openbook.php?record_id=13165&page=106)  [Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. (2-PS1-1)](http://www.nap.edu/openbook.php?record_id=13165&page=106)  [Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3)](http://www.nap.edu/openbook.php?record_id=13165&page=106)  [**PS1.B: Chemical Reactions**](http://www.nap.edu/openbook.php?record_id=13165&page=109)  [Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible and sometimes they are not. (2-PS1-4)](http://www.nap.edu/openbook.php?record_id=13165&page=109) |  |

**Docent Lab Guidelines:**

1. Let the teacher know this is an edible experiment. If there are any food allergies those students are welcome to bring in an alternative ice-cream (it must be nut free).
2. Schedule a date and time with your teacher to have the students come into the lab. Schedule a minimum of 1 hour of classroom time.
3. Docent(s) should plan to arrive early to set up before the class arrives.
4. Input the day and time into the Science Lab Master Schedule. Please make sure you add 15-30 minutes of set up time and at least 30 minutes of clean up time to the overall class time.
5. Have the students sit on the carpet at the start of class. Since this is the first session review the lab rules and the Scientific Method.
6. Give a brief 5-10 minute discussion on the states of matter. Briefly discuss chemical and phase changes, as well. During the group discussion you are welcome to use props to show solids, liquids and gases. There is a box with props available. You can also opt to play a short video on the states of matter instead of speaking. See the videos listed below.
7. If there are not enough docent’s, discuss with your teacher the possibility of having a few of your classroom’s Big Buddies come to help.
8. Allow enough time at the end for students to wash up afterwards if needed. Girls can wash up in the adjacent girl’s restroom.
9. The last 5-10 minutes of class review with the students their observations.

**States of Matter Basics: For Docent’s Reference Only**

**What is matter and why is it important?**

Look around you….matter is everywhere. From the air we breathe to the tiniest speck of dust to the largest star in the sky. Matter is anything that has mass and takes up space, even if it is a small space. Matter is anything made up of atoms and molecules. In simple terms, it is the amount of stuff in an object. The study of matter is important because it is the foundation or building block to understanding of our universe.

Even though matter can be found all over the Universe, you will only find it in a few forms on Earth. These are solid, liquid and gas, which we study in class. Each of those states is sometimes called a **phase**. There are also two other forms of matter, plasma and Bose-Einstein Condensate (BEC), discovered in 1995. Naturally occurring Plasma is rarely found on earth. But stars are made of plasma. On earth we have a few man made plasmas: neon signs and fluorescent light bulbs. Other forms could exist in extreme environments and scientist may one day discover other forms.

**Changing States of Matter**

Molecules can move from one [**physical state**](http://www.chem4kids.com/files/matter_chemphys.html) to another and not change their basic structure. Oxygen (O2) as a gas has the same chemical properties as liquid oxygen. The liquid state is colder and denser, but the molecules (the basic parts) are still the same. Water (H2O) is another example. A water molecule is made up of two hydrogen (H) atoms and one oxygen (O) atom. It has the same molecular structure whether it is a [**gas**](http://www.chem4kids.com/files/matter_gas.html), [**liquid**](http://www.chem4kids.com/files/matter_liquid.html), or [**solid**](http://www.chem4kids.com/files/matter_solid.html). Although its physical state may change, its chemical state remains the same.Chemical changes occur when the bonds between atoms in a molecule are created or destroyed. Changes in the physical state are related to changes in the environment such as temperature, pressure, and other physical forces. Generally, the basic chemical structure does not change when there is a physical change.

**Phases of Matter:**

Each phase has its own physical characteristics or properties of its molecules and atoms that make it unique.

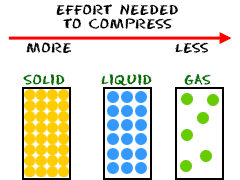
**Solids**

A solid can be described as hard, ridged, and brittle. If you were to look at the atoms of a rock under a microscope, you would be able to see that the molecules are close together. There is very little space in between each molecule. If there is little or no space, this means that there is no room for the molecules to move around and its shape stays the same. Molecules in a solid are slow and inactive. The mass of a solid is dense and its shape will not change without a physical force change (for example the pressure of a hammer hitting a table.) Sand is also a solid but it has smaller pieces of the original rock it came from. The same is true for baby powder. Although baby powder is smooth, soft and powdery looking, it is still a solid.

We described a solid as hard and ridged but not all solids are hard. Your clothes are a solid even though they are soft.

**Liquids**

A liquid has a definite volume, meaning it can occupy a space, but it does not have a specific shape. Liquids are shape changers. It takes on the shape of whatever container you put it in. This is because the molecules in a liquid have more space to move around. This movement creates the fluidity of liquids. The top part of a liquid will usually have a flat surface. That flat surface is the result of **gravity** pulling on the molecules. There are many types of liquids but not all liquids flow at the same rate. For instance if you had a drop of water, oil and honey on one end of a tray and sloped the tray so that the water, oil and honey are at the top of the tray moved….which liquid would flow the fastest? This property of liquids is called viscosity.

**Gases**

A gas does not have a defined volume or a defined shape. Most of the time gas cannot be seen and many do not have an odor. Gas will fill a room but you cannot see it. A gas is usually clear but not always. The molecules in a gas are so far apart you cannot see them. These molecules are very active in comparison to a solid’s molecules.

Gases can fill a container of any size or shape. It doesn't even matter how big the container is. The molecules still **spread out** to fill the whole space equally. That is one of their **physical** characteristics.

**Changes in physical state – PHYSICAL CHANGE**

When a substance like ice goes from being a solid to a liquid, this change is called a PHYSICAL CHANGE or a PHASE CHANGE. The thing that causes the change is called an ENERGY FORCE. Heat is an energy force. Pressure is an energy force, cold is an energy force, sounds and electricity are energy forces that can all change the physical characteristics of matter. A substance like water can change back into a solid (ice) and right back to water over and over again without changing the molecule’s structure. It still remains as water no matter if it is a solid, liquid or a gas.

**Changes in physical state – CHEMICAL CHANGE**

A chemical change occurs when a new substance is created. This means the molecules in the original mixture changed (they bonded together) and became a new arrangement. This change is also caused by an energy force.

**Videos:**

What’s the Matter (1:39 minutes, KET educational video for kids)

<http://www.ket.org/education/video/kevsc/kevsc_000015.htm>

Short Bill Nye the Science Guy Video on States of Matter (37 seconds)

<https://www.youtube.com/watch?v=tBQcpF_j5Xg>

Bill Nye Longer Version (21 minutes)

https://www.youtube.com/watch?v=QM412ltmFKM

Matter Chatter (A song for kids about solids, liquids and gases) <https://www.youtube.com/watch?v=C33WdI64FiY>

**Experiment #1: Root Beer Float Science**

***Estimated hands-on time: 15 minutes***

**Materials:**

* Cans of root beer (this enables students flexibility in making the float)
* Plastic cups
* Vanilla Ice Cream
* Large spoons to scoop (Ice Cream Scoops)
* Spoons
* Straws
* Paper towels
* Worksheets – One per student
* Pencils
* Whipping Cream – Optional
* Marciano Cherries - Optional

**Preparation:**

1. Prior to the class arriving set out spoons, straws, pencils, plastic cups and paper towels at the tables.
2. Put cans of soda on the table and large serving spoons for the ice cream.
3. Make sure there are enough worksheets for your class.

**Instructions:**

1. Fill out the first part of the worksheet before setting out to make the root beer floats. What do you predict will happen? Draw your prediction. Name the type of matter for each items listed on the worksheet.
2. While the students are working on this sheet out the ice cream.
3. Have the student make their root beer float but tell them afterwards they must write down how they make it (the sequence). Some may add the root beer first, others the ice cream or others may add a small amount of root beer, ice cream then more root beer. Whatever combination they do write it down and compare it with others at their table. Did the outcome change depending on how it was made?
4. Allow only 2 small scoops of ice cream per student.
5. What happened? Was your prediction correct?
6. Optional – add whipping cream and a cherry.
7. Enjoy eating!

**How does it work (For Docent Reference Only)**

Root beer is carbonated by dissolving carbon dioxide gas in the water. While it is still in the capped bottle/can, the CO**2** is kept in solution by pressure. Once we open the bottle a number of factors control whether the gas fizzes out or stays dissolved:

• Temperature—cold water holds more gas in solution than warm water.

• Surface area and roughness—bubbles tend to form on surfaces;

Particularly on rough surfaces.

• Agitation—shaking will encourage bubble formation.

Ice cream contains a lot of air bubbles. On a very fine scale, the bubbles increase the surface area and roughness of the ice cream. It also has chemical agents to thicken it. Some of these chemicals will enter the root beer and affect the bubbles.

Think about the differences between pouring root beer over ice cream and placing a scoop of ice cream into a glass of root beer. Which one will excite more bubbles? Which one will dissolve more thickeners from the ice cream? How do you like your foam; thick and heavy, or light and effervescent?

**POSSIBLE QUESTIONS to ask students:**

1. The solid (ice cream) and the liquid (Root Beer) form a gas. Is this a physical or chemical change? {chemical}
2. Draw and label the solid, liquid and gas produced when making the root beer float. What happened and why?

**Experiment #2: What Makes Popcorn Pop?**

**Materials:**

* Flask
* Burner (can of Sterno)
* Popcorn kernels
* Pot and oil or air-popper
* Balloon and ice.
* *Popcorn! by Elaine Landau ISBN13: 978-1-57091-443-0*
* Thermometer
* Identify objects and materials as solid, liquid, or gas. Recognize that solids have a definite shape and that liquids and gases take the shape of their container.

**Discussion:**

Ask students what the similarities are between ice, water and steam. They are all the same compound (made of the same molecules) but they are in different states. The reason they change states is due to change in temperature.

*Recommended reading:*

1. *“Popcorn!” by Elaine Landau ISBN13: 978-1-57091-443-0 don’t read straight through.*
2. Demonstrate three states of matter. Put some ice in a flask and hold the ice over a lit can of Serno. Allow the students to see that as the ice heats up it turns into water. When H2O is below 32 degrees F it is ice and when it is above 32 it is water. However when water gets too hot, it turns to steam.
3. Keep the water in the flask and put a balloon over the top of the flask. Now put the flask over the fire again. As the water heats up it turns to steam which takes up more room than the water. The kids can then see the balloon expand. Explain that if there is enough water the balloon will eventually get so big that it will pop. Inform the students that water must be 212 degrees F to turn into steam. Ask the students if they know of any foods that pop.
4. See if the students can come up with some answers as to why popcorn pops. Explain that around 14% of a popcorn kernel is made of water. This water is surrounded by a hard covering, which doesn’t let any moisture out (just like the balloon). When the popcorn kernel is heated what do you think happens to the water? When the water turns to vapor it also expands and it is too big to fit inside of the kernel. There is enough water inside the kernel so that the kernel pops when the water turns to steam. Show this short clip of popcorn popping in slow motion: www.youtube.com/watch?v=CXDstfD9eJ0&feature=related
5. Use either an air-popper or a pot with oil, and pop popcorn in front of students. As the popcorn pops make sure the students understand why it is happening.

**Closure:** Hand out popcorn and allow students to eat.

If time: The following video is a 1:30 clip about interesting properties of water.

http://www.youtube.com/watch?v=QH1yphfgfFI

Emphasize that popcorn pops because water changes states from liquid to vapor and vapor takes up more space than liquid.

Or you could read to the class as they eat the popcorn.