1st 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 hands-on experiments.

PS1.A: Structure and Properties of Matter

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)

Different properties are suited to different purposes. (2-PS1-2),(2-PS1-3)

PS1.B: Chemical Reactions

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)

Docent Lab Guidelines:

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. It would be better to have 75-90 mins. as this session is a messy.

Docent(s) should plan to arrive early to set up before the class arrives.

Input the day and time into the Science Lab Master Schedule. Please make sure you add 45 minutes of set up and at least 30 minutes of clean up time to the class time.

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.

Give a brief 5-10 minute discussion on the states of matter. As well, briefly discuss chemical and phase changes. 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 a formal discussion. See the videos listed below.

There is one demonstration experiment: The Soap Soufflé. This is optional. This should be done at the beginning of the class.

There are three hands-on experiments: (1) Vanishing Water (2) Fizzing Foam Dough and (3) Rock Candy Expanders.

Have students put on aprons as they enter the class. Provide eye protection at each table.

Divide the students into 3 table groups with a docent at each table. If there are not enough docent's available scale back and only do as many experiments as are manageable. You can also discuss with your teacher the possibility of having a few of your classroom's Big Buddies there to help.

Keep track of time and alert the students when it is time to rotate. About 10-15 minutes per station.

Allow enough time at the end for students to wash up afterwards. Girls can wash up in the adjacent girl's restroom.

The last 5 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 a 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** to another and not change their basic structure. Oxygen (O_2) 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 (H_2O) 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**, **liquid**, or **solid**. 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 the molecules are close together. There is very little space in between each molecule. If there is little or no space this means there is no room for the molecules to move around and its shape stays constant or the same. Molecules in a solid are slow and inactive. The mass of a solid is dense and its shape will not change without for example a physical force like pressure (hammer hitting a table). Sand is also a solid but is just 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 ridge 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….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 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 which out changing the molecules 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 Bye Longer Version (18:20 minutes)
https://www.youtube.com/watch?v=hYLyggd4Tb8
Matter Chatter (A song for kids about solids, liquids and gases)
https://www.youtube.com/watch?v=C33WdI64FiY

Demonstration: Soap Soufflé (Optional) *(From Steve Spangler Science)*

Estimated time: 5-10 minutes

Materials:

1 bar of Ivory Soap
1 bar of any other brand of soap
Large clear bowl
2 microwavable plates
Water
Microwave
Knife

Preparation:

Prior to the class arriving fill the large bowel with water at place on table at the front of the classroom. Also leave two plate on the table ready to use.
Unwrap both bars of soap.
Put the knife in a safe place away from student's hands.

Instructions:

Ask the class to describe the soap and the water? What properties do they have?
Have the class predict what will happen when you place the bars of soap in the bowl of water. You can drop them both in at the same time or one at a time. You can even pick a volunteer to drop in the soap.
The Ivory Soap floats while the other one sinks. Why?
Remove the Ivory Soap and the non-Ivory soap from the water.
Place the Ivory soap on a plate and cut into four pieces. Put the whole thing in the microwave and heat on high for about 2 minutes. **Keep an eye on the soap not to overheat it as it will smell if it burns.**
Keep the students seated on the floor while the soap is heating. While you are waiting ask the class to predict what will happen to this bar of soap? Will it become a liquid? Will it remain a solid? Will it keeps it shape?
The Ivory soap will expand into a puffy looking cloud shape. Why did this happen?
Take the soap out of the microwave and **let it cool for a couple of minutes before handling it**. It remains a solid but is no longer ridged.
Repeat the heating process with the non-Ivory bar of soap. What do you think will happen with his different brand of soap? **The non-Ivory brand of soap will probably take 1-1/2 minutes to heat up. Keep an eye on it. It should just melt into a gooey puddle.**

Optional: After both bars of soap have cooled down leave them on the table in the front of the classroom and invite the students to touch them if they have time between their rotations.

Instruction Video of the Experiment:
https://www.youtube.com/watch?v=z1hzatoE1tg

What Happened?
Ivory soap is one of the few brands of soap which floats in water. It floats because it has air pumped into it during the manufacturing process. There is a legend that many years ago an employee from Protector and Gamble forgot to turn off the mixing machine during his lunch break. This caused air to be whipped into the bars of soap. The small pockets of air caused the soap to float. Protoctor and Gamble's customer's liked this mistake. The air is still whipped into the soap today and is trademarked as "The Soap that floats".

Why does the soap expand in the microwave?
This is actually very similar to what happens when popcorn pops or when you try to microwave a marshmallow. Those air bubbles in the soap (or the popcorn kernels or the marshmallow) contain water. Water is also caught up in the matrix of the soap itself. The expanding effect is caused when the water is heated by the microwave. The water vaporizes, forming bubbles, and the heat causes trapped air to expand. Likewise, the heat causes the soap itself to soften and become pliable.
This effect is actually a demonstration of *Charles' Law*. Charles' Law states that as the temperature of a gas increases, so does its volume. When the soap is heated, the molecules of air in the soap move quickly, causing them to move far away from each other. This causes the soap to puff up and expand to an enormous size. Other brands of soap without whipped air tend to heat up and melt in the microwave

Experiment #1: Vanishing Water *(From Steve Spangler Science)*

Estimated hands-on time: 10 minutes

Materials:

Super Absorbent polymer crystals (non-toxic)
Food coloring - optional
Clear Plastic cups or containers
Small Dixie-size cups
Plastic Spoon or stirring stick
Water
Paper plates to contain mess

Large white bins to discard completed experiments
Large bowl filled with soapy water
Paper towels

Preparation:

Prior to the class's arrival prefill clear plastic cups with ½ teaspoon of polymer crystals. One for each student.
At each seat place (1) paper plate (1) clear plastic cup or container, (1) one spoon (1) small Dixie cup for water.
Set out small pitchers of water. Small enough for students to handle. If you would rather not have the students pour their own water than have the docents pour water into small Dixie cups as needed.
Set out food coloring. (optional)
Fill up a large bowel with soapy water and leave it near the science table along with a roll of paper towels and a trash can. This will be used to rinse off polymer crystals from students hands. Try not to let them rinse the crystals down the sink.
Set out a large white bin in the middle of the table. This is to be used to discard the used crystals and cups.
Have clean plastic cups and paper plates set aside and ready to use for each rotation.
This experiment can get a little messy. Have a trash can nearby to discard paper plates and cups

Instructions:

Pour water into the Dixie cups.

Add food coloring (optional) and stir.

What do you think will happen when water is added to the polymer crystals? Are the crystals a solid, liquid or a gas? What about the water?

Pour the Dixie cup of water into the cup containing the polymer crystals.

Mix it with a spoon until the mixture thickens. Stirring is actually not required as the gel thickens quickly on its own.

Observe the creation that the polymer crystals and water created. What happened?

Turn the cup upside-down. Will the water pour out? No the mixture has solidified into a gel.

Invite the students to touch the crystals. Try adding more water. What happens?

Additional Study – Optional: Take a few (1-3) polymer crystals and place them in a petri dish. Have the kid's exam the crystals with a magnifying glass. How do they look? What size are the crystals? Next add a ½ dropper of water to the petri dish. Watch the crystals with a magnify glass. What much did one crystal grow?
When the students are done have them discard the crystals in the large white bin or in the trash as well as used paper plates. **DO NOT PUT CRYSTALS DOWN THE DRAIN**. If students have a lot of crystals on their hands have them rinse their hands in the large bowel of soapy water instead of the sink. At the end of the session throw this soapy water outside.

How does it work (For Docent Reference Only)

The polymer crystal chains act like giant sponges. Some can soak up as much as 800 times their weight in water! It's easy to see that even a little bit of powder will hold a huge quantity of water, but it does have its limits. What happens if you add to much water? Think of a baby with a diaper on playing in a swimming pool. The diaper ends up soggy and eventually the polymer crystals spill out.

Superabsorbent polymers were first developed for use in the oil industry. They are still used today to soak up oil spills in our oceans. Today, there are many uses for superabsorbent polymers; including use in disposable diapers. Florists also use polymer crystals as a dirt-free way to store water and to keep cut flowers fresh for a long time. Other uses include water and sewerage treatment plants use it to trap and suspend solid particles to make the solids easier to remove and soil conditioning.

History:
Dr Walter Lincoln (Linc) Hawkins is considered one of the founding fathers of polymers. He was the first African American to join the Technical Staff of the Bell Labs in 1942. He worked developing plastics to replace lead and rubber sheathing used for insulation of wiring. He was recognized internationally for his contributions to technology, engineering and polymer chemistry.

Funny Informational Video on the Experiment:
https://www.youtube.com/watch?v=YWoQ3D6RMXs

POSSIBLE QUESTIONS TO ASK STUDENTS:

What happens if too much water is added to the polymer?
How does the polymer look after the water is added?
How long did it take for the water to disappear?
What does the polymer feel like?

What do you think polymer is made from?
What other uses could superabsorbent polymer be used for besides diapers?
What do you think will happen to the polymer once the water evaporates?

Experiment #2: Fizzing Foam Dough

Estimated hands-on time: 10 minutes

Materials:

Flour
Baking Soda
Vegetable Oil
Food coloring
Vinegar
water
Droppers
Plastic Trays or heavy duty paper plates
Large white bin to discard used dough
Paper towels

Preparation:

The day before or prior to the class arriving make 4-6 batches of fizzing foam dough depending on the class size. Mix 2 cup of flour, 2 cup of baking soda and 1/2 cup of vegetable oil, drops of food coloring. Mix until it forms into a dough. Mix up a variety of colors and enough for each student. Put dough in Ziploc bags until ready to use.
Set out (1) tray and (1) dropper at each seat.
Place 3-4 containers of vinegar and water on the table. Label the containers. Feel free to add food coloring. One color for the water and another for the vinegar so they will not be mixed up.
Place a roll of paper towels at the table.
Have new clean trays or paper plates out and ready for the next rotation.

Instructions:

Have students take a handful of dough.
Explain how the dough was made. What properties does it have?
Place the dough on the paper plate and play with it. Can it be squished into shapes?
What does it feel like? Is it ridged, soft, wet?

Next add a dropper of vinegar. Is vinegar a solid, liquid or gas? What do you think will happen when vinegar is added to the dough? Do you think this is a chemical reaction? If so then why?
Now repeat with a dropper of water? Does the same reaction occur? If not then why.
Continue experimenting with the vinegar and water.
Discard used experiment into the white bin.
Prepare for next rotation by putting out a clean paper plate or tray.

Tips:

Before class docents can place pre-measured dough in Dixie cups. Have a cup prepared for each students. Then when the students rotate all you have to do is grab a new cup.
Paper plates rather than the reusable plastic trays make clean up easier at the end of class.

Experiment #3: Rock Candy Expanders *(From Steve Spangler Science)*

Estimated hands-on time: 10 minutes
This experiment to be done in groups of 2-3

Materials:

Rock Candy
Balloons
Funnels
Small Soda bottles (1 per 2 students)
Scissors
Large plastic rectangular containers (to contain spills)

Preparation:

This experiment will be done in groups of 2-3. Or if you are shorthanded you can do this experiment as a group demonstration.
Set funnels, balloons, scissors and rock candy out on the table.
Set out large white plastic rectangular containers. One for each group. This will be used to contain spills.
Hand out bottles of soda at each rotation. One bottle per group.

Instructions:

Put soda bottle in the rectangular bin.

Using the scissors cut open the top of the rock candy packet.

Open the soda bottle. Be careful not to shake it.

Predict what will happen with the Rock Candy is added to the soda.

Next using the funnel carefully pour the rock candy into the balloon.

Carefully put the balloon over the mouth of the bottle. Tilt it straight up so all the rock candy spills into the soda. Docents may need to help with this part.

Observe what is happening inside the soda as the liquid reacts with the candies. What type of reaction is this? Did the reaction create a gas? How can you prove this?

The balloon should be inflating, even if the change is only very slight.

Once completed pour the soda down the sink.

Put the balloon in the trash.

Recycle the soda bottle for another experiment.

Instructional How-to Video:

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

How Does It Work (for docent reference only)?

Pop Rocks candy has pressurized carbon dioxide gas. Each of the tiny little candy pebbles contains a small amount of the gas. These tiny carbon dioxide bubbles make the popping sound you hear when they burst free from their candy shells.

So what causes the balloon to inflate? The carbon dioxide contained in the candy isn't enough to cause even the small amount of inflation you observe in the experiment. That's where the soda comes into play. The soda also contains pressurized carbon dioxide gas (it's why we call soda a carbonated beverage). When the Pop Rocks are dropped into the soda, some carbon dioxide is able to escape from the high fructose corn syrup of the soda and, because the carbon dioxide gas has nowhere to go in the bottle, it rises into the balloon.