Grade TK - 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.

NEXT GENERATION SCIENCE STANDARDS For States, By States

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:

1. 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. This is a messy lab session.
2. Docent(s) should plan to arrive early to set up <u>before</u> the class arrives.
3. Input the day and time into the Science Lab Master Schedule. Please make sure you add 30 minutes of set up time and 30 minutes of clean up time to the overall class time.
4. Have the students but on lab aprons and safety glasses. Students will need to wear their safety glass during the entire experiment portion of the class.
5. Have students sit on the carpet at the start of class.
6. 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 speaking. See the videos listed below.

7. There are three experiments and one optional demonstration. Students will rotate between stations. Keep track of time and prompt the students to rotate. The Boo Bubble experiment is to be completed as a table demonstration by the docent. Students are allowed to handle the bubbles only but NEVER the dry ice.
8. **Never handle the dry ice with bare hands.**
9. **Never put dry ice in the refrigerator or any closed container.**
10. Allow enough time at the end for students to wash up afterwards. Girls can wash up in the adjacent girl's restroom.
11. 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 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 **<u>phase</u>**. 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.

What makes a state of matter? It's about the **physical state** of the molecules and atoms. Think about solids. They are often hard and brittle. Liquids are fluid and can move around a little, and fill up containers. Gases are always around you, but the molecules of a gas are much farther apart than the molecules in a liquid. If a gas has an odor, you'll be able to smell it before you can see it. The BEC is all about atoms that are even closer and less energetic than atoms in a solid.

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. Of course, in extreme environments such as the Sun, no molecule is safe from destruction.

Phases of Matter:

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

Solids

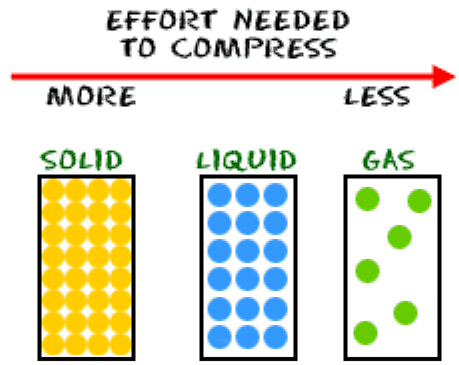
A solid can be described as hard, ridged and brittle. If you were to look at the atoms of a rock under a microscope you would be able to see the molecules are close together. There is very little space in between each molecule. If there is little or no space this means there is no room for the molecules 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). Solids like their shape! If you were to put a rock in a cup it would still look like the same rock. 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. If we take a tall thin glass of water and pour it into a shallow pan does it shape change? Yes. 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. Think about a balloon. No matter what shape you make the balloon, it will be evenly filled with the gas molecules. The molecules are spread equally throughout the entire balloon. Liquids can only fill the bottom of the balloon, while gases can fill it entirely. The shape of liquids is really dependent on the force of **gravity**, while gases are light enough to have a little more freedom to move.

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. But there is another type of change called a CHEMICAL CHANGE.

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 on States of Matter:

1. Everyday Science: What's the Matter (run time 1 min. 39 sec., KET educational video for kids) http://www.ket.org/education/video/kevsc/kevsc_000015.htm
2. States of Matter: Solid, Liquid and Gases (run time 2 min. 37 sec.) http://www.watchknowlearn.org/Video.aspx?VideoID=4280&CategoryID=1563
3. Matter Chatter (A song for kids about solids, liquids and gases) https://www.youtube.com/watch?v=C33WdI64FiY

4. Three States of Matter by Make Me a Genius (run time 2 min. 13 sec.) http://www.watchknowlearn.org/Video.aspx?VideoID=43970&CategoryID=13968

Demonstration: Elephant Toothpaste (shows a chemical reaction)

MATERIAL NEEDED:

- Hydrogen peroxide - 12% (You can find this in the hair care section.)
- Liquid dish soap
- Food coloring
- Package of dry active yeast
- Small cup (make sure it's small enough to fit all the way in your pumpkin)
- Flask with a small neck
- Funnel
- Tray to catch spills

EXPERIMENT

1. Docent to wear gloves and eye protection.
2. Place flask in a tray before class arrives. Have all your materials and warm water ready to go before class starts.
3. Fill a flask with 30 mL of hydrogen peroxide (12%). Use funnel if needed.
4. Add a squirt of dish soap to your hydrogen peroxide.
5. Mix in some food coloring to give your reaction a bit of effect. Swirl to mix.
6. In a separate small beaker or cup mix an entire package of dry yeast with 4 tablespoons of very warm water. If the mixture is too thick, like a paste, add a little more warm water to thin it out.
7. Pour the yeast solution into the flask with a funnel and quickly remove funnel.
8. The students are not to touch the foam. They can look at it but not touch.

HOW DOES IT WORK?

In this reaction, you've got a catalyst in the form of your yeast solution. This catalysts works to release the oxygen molecules that are contained in the hydrogen peroxide. Those molecules are being released as the hydrogen peroxide breaks down into two components, water (H_2O) and oxygen (O_2), from the addition of the yeast catalyst. The foam is the molecules of oxygen being made into tiny bubbles as they pass through the soap that was added. In addition, as the bonds break between the H_2O and O_2, they release energy in the form of heat.

Experiment #1: Boo Bubbles (from Steve Spangler Science)

Estimated time: 10 minutes

Bubbles, smoke, and fog provide a demonstration of solids and gases. This experiments gets so many giggles and smiles.

MATERIALS

- Dry ice
- Hammer
- Dish soap
- Large Graduated cylinder (or similar container)
- Brown craft paper
- Heavy gloves
- Warm water in a pitcher or thermos
- Safety glasses
- Paper towels
- Tongs
- Food coloring

Preparation:

1. It is recommended to set this experiment up at one of the tables near the counter top. This will allow the docents to keep the dry ice on the counter away from little hands. Plus it allows easy access to the sink because docents will need to rinse the large cylinder between rotations.
2. Before the class arrives line the table with brown craft paper. It will get fairly soapy by the end of class.
3. Warm the water in the microwave and store in a thermos or pitcher until the experiment is ready to start.
4. Break up the dry ice into smaller chucks using a hammer. Make sure to wear safety glasses when doing this.
5. Set a roll of paper towels on the table.
6. Place the bottle of dish soap, food coloring, mittens and tongs on the table.

INSTRUCTIONS:

1. Fill the large graduated cylinder half-full with warm water. Ask students what state of matter is the water.
   NOTE: Before handling any dry ice, put on a pair of heavy gloves. Dry ice is so cold (-110ºF/-78ºC) that it will burn your skin!

2. Using tongs show a piece of the dry ice to the students. Ask them if they can guess what state of matter dry ice is? (Dry ice is actually compressed gas. It is a gas called carbon dioxide.)
3. Ask students to predict what will happened when you place the dry ice in the cylinder.
4. Once you've created the small pieces, drop a few into the graduated cylinder. Once in the water, the dry ice will begin bubbling and producing a smoke within the cylinder. Eventually the smoke flows right over the top. Ask students what happened?
5. Next add food coloring.
6. Now add a large squirt of dish washing soap. Columns of bubbles begins to form at the mouth of your cylinder.
7. With the docent holding onto the base of the cylinder at all times slide the cylinder around the table and invite the students to grab thee bubbles and give them a squeeze! These bubbles burst with an amazing explosion of fog. Students are not allowed to put their hands inside the cylinder.
8. If the bubbles slow up or stop add more warm water and soap.
9. Between rotations the docent will need to rinse out the cylinder of any soap. Do not leave any dry ice in the sink while the students are using the sink.

HOW DOES IT WORK?

When you add dry ice to warm water, you immediately see the dry ice begin to bubble and create fog within its container. This effect is directly caused by the rapid warming of the dry ice. Dry ice is frozen, compressed carbon dioxide gas and when you add it to warm water, it combines with the water to create the fog (carbon dioxide and water vapor) that you see bubbling out of your cylinder.

Adding soap to burping, bubbling, smoking water creates a whole new effect. Instead of the dry ice just bubbling in the water to make a cloud, the soap in the water traps the carbon dioxide and water vapor in a soapy bubble. Bursting the bubbles in your hands (or as they flow out of the cylinder) releases the gases in a brilliant cascade of fog.

HOW-TO VIDEO:

https://www.youtube.com/watch?v=kLO5SJ2uxEE

Additional discussion items:

- Discuss the difference in temperature between regular ice and dry ice? (Use a thermometer as a prop).
- Discuss the difference in phase change of dry ice and regular ice.

Experiment #2: Lemon Suds

Estimated hands-on time: 5-10 minutes

A simple experiment showing a chemical reaction.

Materials:

- Lemons (cut into quarters or juice)
- Baking soda
- Liquid dish washing soap
- glass beakers or plastic containers
- droppers
- measuring spoons
- paper towel
- stirring utensil or stick
- plastic trays with low sides to contain spills

Preparation:

1. Before the class arrives set out the following on the table: plastic containers, stirring utensils, bowls of baking soda, measuring spoons and bowls of lemon wedges.
2. Put out several small containers of dish soap with a droppers in them.
3. Place a plastic tray at each seat. This will be used to contain spills.
4. Set out a roll of paper towels and set a trash can nearby.
5. Place the large white plastic bin in the middle of the table. This will be used to discard the completed experiment.
6. Set out clean plastic containers off to the side so they are ready for the next rotation.

Instructions:

1. Measure 1 teaspoon of baking soda into the empty container.
2. Add about a 1-2 droppers of liquid soap to the cup. Stir the mixture.
3. Before the students add the lemon juice, ask them to predict what will happen.
4. Squeeze the lemon into the cup (squeeze hard to get as much lemon juice as possible) and stir the mixture with your spoon. In just a few seconds, a chemical reaction occurs and the cup fills with lemon suds!
5. When the students are finished, poured the mixture into the white rectangular bin and set the containers aside to be washed later. The mixture is safe to pour down the drain.
6. If it is too difficult for the students to squeeze the lemon wedges then juice the lemons before class.

How Does It Work?

This is a simple but elegant example of a classic chemical reaction between baking soda and citric acid (lemon juice). When the citric acid combines with the baking soda, a chemical reaction takes place producing carbon dioxide gas (those are the bubbles) and water. You also produce a small amount of sodium citrate.

Experiment #3: Ice Cube Tunnels

Estimated hands-on time: 5-10 minutes

A simple, colorful but messy experiment showing a phase changes in water.

Materials:

- Large Ice cubes or boxes (can even get creative and freeze flowers and leaves in the ice)
- Salt
- Food coloring
- Large plastic trays with high sides
- Cups of water
- Droppers or pipettes
- Stirring utensils
- Roll of paper towels
- towels
- Brown craft paper

Preparation:

1. Several days before or the night before freeze blocks of ice in various size plastic containers. Bring to class. At least one block of ice per student or two students can share one block.
2. Cover the table with brown craft paper.
3. Place a plastic tray with sides each seat. This will be used to contain the melting water and food coloring
4. Set out bowels of salt with several plastic spoons in each bowl.
5. In clear plastic cups mix water and food coloring together. Make a variety of colors. Put several droppers or pipettes in each cup.
6. Set out a roll of paper towels and set a trash can nearby.
7. Place the large white plastic bin in the middle of the table. This will be used to discard the completed experiment.
8. Set out clean plastic containers off to the side so they are ready for the next rotation.

Instructions:

1. Provide each student with a block of ice.
2. Ask them to tell you what state of matter the ice is? Ask them to carefully examine their block of ice. What characteristics does it have? Is it completely solid or are there any lines or tunnels in the ice? Ask them to predict what would happen when colored water is placed on the ice.
3. Using the droppers add color. Does the color show anything in the ice? (Cracks and tunnels should be visible in the ice now).
4. What happens to the ice when salt is added? Does the ice remain a solid?
5. Add salt and investigate.
6. Students can experiment with their ice block for 5 minutes. When asked to clean up students are to place their block of ice in the large white bin in the center of the table.
7. Place new trays out for the next rotation.