

3rd 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)
- A great variety of objects can be built up from a small set of pieces. (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. Let the teacher know this is an edible experiment. If there are any milk allergies students are welcome to bring in an alternative ice cream (it must be nut free ice-cream).
 2. It is recommended that each student bring in mittens on the day of the science lab. Have the teacher notify the students.
 3. 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.
 4. Docent(s) should plan to arrive early to set up before the class arrives. You could even prepackage the ice-cream base the day before.
 5. Input the day and time into the Science Lab Master Schedule. Please make sure you add 15-30 minutes of set up time and 15-30 minutes of clean up time to the overall class time.
 6. Have the students sit on the carpet at the start of class.
 7. 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.
 8. There is one demonstration experiment: Insta Worms.
 9. Allow enough time at the end for students to wash up afterwards if needed. Girls can wash up in the adjacent girl's restroom to keep the flow moving.
 10. The last 5-10 minutes of class review with the students their observations.
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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.

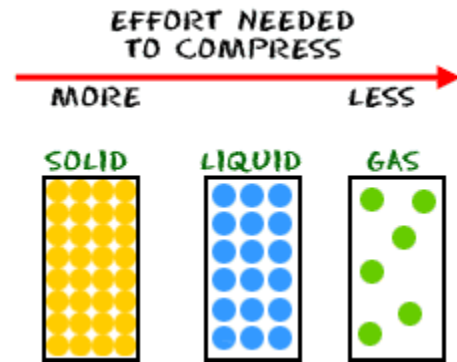
Liquids

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 without 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

States of Matter (3 min. 3 sec., Idaho PTV for kids)

<http://www.pbslearningmedia.org/resource/idptv11.sci.phys.matter.d4kmat/states-of-matter/>

Mystery Mud: Changing States of Matter (7 min. 8 sec, Teacher's Domain of MIT)

<http://www.pbslearningmedia.org/resource/phy03.sci.phys.matter.mud/mystery-mud-exploring-changes-in-states-of-matter/>

Bill Nye the Science Guy Video on States of Matter (18 minutes)

<https://www.youtube.com/watch?v=hYLyggd4Tb8>

Demonstration: Color Changing Insta Worms (from Steve Spangler Science)

Estimated time: 5 minutes

Overview:

This experiment shows how a liquid can be changed into a solid when it comes in contact with another liquid solution/chemical.

Preparation:

1. Before class arrives heat up water in the microwave.
2. Set out (2) large beakers or glass bowls. Fill one with very cold water.
3. Fill the small squeeze bottle with the Worm Activator Solution.

Instructions:

1. To start your worm creation, you need to prepare some Worm Activator Solution. Get a (2) large glass beakers or a clear plastic or glass bowl. It will be easier to see what's going on inside there if it is clear.
2. Measure out 1 cup (8 oz) of warm water into the bowl and stir in 1 blue scoop of Worm Activator Powder. 1 blue scoop is equal to 1 teaspoon or 3 grams of Worm Activator, just in case you happen to lose the blue scoop. Make sure that most of the Worm Activator is dissolved into the water before you move on to the next step.
3. Have the students predict what will happen?
4. Now that you've got Worm Activator Solution, squirt a small stream of Worm Goo into the bowl. The Worm Goo instantly turns into a long stringy worm. Grab the worms and show the class.
5. Take the worms out of the solution. The worm has elastic qualities like rubber, but can break if you tug it too hard. Go ahead and break the worm in half. What happened?
6. What do you notice about the inside of the worm? It's still a gooey liquid. Just dip the broken end of the worm back in the activator solution.
7. Put the worms in the cold water. What happened?
8. Return the worms to the warm water.



How Does It Work? (For Docent Reference)

When you make Insta-Worms®, you're learning about the science of polymers. The real name of this liquid is sodium alginate. Sodium alginate is a long chain of molecules called a polymer. Specifically, sodium alginate is a polysaccharide isolated from seaweed. Polymers are large molecules made by linking many smaller molecules together. Polysaccharides, such as starch and alginate, are made by linking together hundreds of glucose (sugar) molecules. Alginate is commonly used as a thickener for foods such as ice cream and fruit pies.

The sodium alginate (Worm Goo) immediately changes from a liquid to a solid the moment it touches the Worm Activator solution. The Worm Activator solution contains calcium which serves to link the long polymer chains together. Scientists call this “cross-linking.” A polymer strand is formed when the sodium alginate solution is added to a calcium chloride solution. This occurs because the Ca^{++} ions replace the Na^{+} ions and serve as a cross-linking agent to link two alginate chains together. The resulting cross-linked polymer is insoluble in calcium chloride solution and this results in the formation of the polymer strand. See, now you know!

Although Worm Goo starts as a liquid, through polymerization (the formation of polymers) the goo becomes a solid and looks just like a worm. Heat Sensitive Insta-Worms also feature a thermochromic dye that reacts, quite colorfully, to changes in temperature.

Instructional How-to Video:

<https://www.youtube.com/watch?v=l1e4xBPEsvc>

Experiment: Ice-Cream in a Bag

Estimated hands-on time: 15-20 minutes

Overview

This do-it-yourself treat also serves as a simple chemistry lesson. Investigate changing states of matter, chemical reactions, and the properties of ice and salt while working for your dessert.

Materials: This recipe yields 1 serving

- ½ cup half & half
- ½ teaspoon vanilla
- 1 tablespoon white sugar

- crushed ice
- rock salt
- quart size Zip-lock bags (2 per student) – use Zip Lock Brand
- gallon size Zip-Lock freezer bags (1 per student) – use Zip Lock Brand
- winter gloves (ask students to bring from home)

Preparation:

1. Before the class arrives the docent(s) to prepare the ice cream base and put it into individual quart size Ziploc bags. (1 for each student).
2. Pour the first three ingredients into a quart size Zip Lock Bag. Then place this bag inside another quart size bag. This can even be prepared the day before. Squeeze out the air and seal the bag tightly. Store the bags in the refrigerator.
3. Before class purchase 2 large bags of crushed ice.
4. Set out the gallon size Zip-lock bags, ice-cream salt and spoons.

Instructions:

1. When ready to start the experiment set out the bags of ice in the sink with large measuring cups to use as scoops.
2. Set out the double bagged ice cream base next to the gallon sized Zip Lock bags.
3. Have the students' line up. They will move through three stations. There should be 1 docent at each station but it is not necessary.
4. **Station 1:** Pick up a double bagged Zip-lock with the ice-cream base. Place the quart size bag inside a gallon size bag.
5. **Station 2:** Put 2-3 scoops of ice inside the gallon bag.
6. **Station 3:** Ice-Cream Salt. Pour in about 3-4 tablespoons of rock salt. Seal bag.
The salt will begin to melt the ice because it lowers the freezing point of water.
7. Now comes the fun part: Put on mitten and gently shake the bag, making sure the ice is evenly spread out. Continue to gently shake and knead the bag in your hands.
 - a. *The energy from shaking and kneading—and the heat transferred from your hands—causes the ice to melt further. Melting ice doesn't look as cold as frozen ice, right? But remember, it's mixed with salt. As the melting ice combines with the salt, the salt-water solution has a lower freezing point than plain water. So the melted ice is actually colder than the original ice!*
8. Can you guess how long it will take for the liquid to freeze into a solid? (It should take between 5—10 minutes.)
9. When the ice-cream is ready have the students remove the inner bag out of the large bag. Students are to hand the large bag with ice to the docents. Students will finish at various times. But for reference have the class stop shaking their bags about 10 minutes after the last student receives their ice-cream base.
10. Shaking the bags is a loud and fun process for the kids. They are free to walk around while shaking their bags. 10 minutes of shaking is a long time for them.
11. Docents will discard the slushy ice in the sink and toss all the Zip-Lock bags in the trash.
12. Student to grab a spoon and start eating.

How does it work?

During the ice-cream making process, the ice (a solid) turns into a liquid (melted ice). When ice absorbs energy, it changes the phase of water from a solid to a liquid. The ice absorbs energy

from the ice-cream ingredients and also from your hands as you hold the bag. The molecules start moving around again as the ice melts.

Discussion points:

- Ask: Did your liquid become ice-cream? If not why? Was there not enough ice? Salt? Force (shaking)?
- Salt makes ice melt. That's why people sprinkle it on icy roads and driveways in cold climates. How does salt do this? It actually lowers the freezing point of the ice. Water normally freezes at 32 degrees Fahrenheit, or 0 degrees Celsius.
- Salt water is harder to freeze than plain water. You have to make it colder than 32 degrees Fahrenheit in order to freeze it. That's one of the reasons why a fresh water pond will freeze before one that's mixed with salt water from a nearby ocean. If you put two ice cube trays in the freezer, one with plain water and the other with a salt water solution, the plain water will freeze first.
- Not all types of salt work the same. The larger the salt crystals, the more time it takes to dissolve. This keeps it colder, longer. You could experiment with table salt, kosher salt and rock salt to test this.
- As salt melts, the compound (NaCl) breaks into two parts—Na and Cl. These particles then disrupt the arrangement of the ice crystals.
- This process changes the state of matter. For example, the liquid (milk mixture) turns into a solid (ice-cream). As the liquid gets colder it expands. (Have you ever put a soda bottle in the freezer and forgotten about it? The liquid expands and then explodes!) The molecules in the liquid slow down and eventually freeze in place.

Thought Starters

- What is the freezing point of water?
o A: 32 degrees Fahrenheit or 0 degrees Celsius
- What is the freezing point of salt water?
o A: It depends on how salty it is.
- Is the freezing point of salt water warmer or colder than plain water?
o A: Colder
- What happens when you put salt on ice, like on an icy road in winter?
o A: The salt melts the ice.
- So why do we mix salt with ice to freeze ice-cream?
o A: Let's make it and find out!