5th Grade

States of Matter – Chemical change

Objective:

Through a hands on experiment students will combine liquids and solids to create a mixture and a solution. When the mixture and solution are combined they cause a chemical reaction.

PS1.B: Chemical Reactions

1. When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4)
2. No matter what reaction or change in properties occurs, the total weight of the substances does not change. (Boundary: Mass and weight are not distinguished at this grade level.) (5-PS1-2)

5-PS1-4: Conduct an investigation to determine if the mixing of two or more substances results in a new substance.

General Scheduling Guidelines:

1. Schedule a date and time with your teacher to have the students come into the lab.
2. Docent(s) should plan to arrive early to set up before the class arrives. It takes about 40 minutes to set up. And about 30 minutes to clean up.
3. Input the day and time into the Science Lab Master Schedule.
4. This will be a messy lab. **Students must wear eye protection** and lab coats or aprons.
5. Have the students sit on the carpet at the start of class. Briefly explain the topic and the experiment. Instead of a docent lead discussion on the states of matter briefly go over the materials/tools.
6. The goal is to have the students do as much of the experiment on their own. Encourage them to read the instruction before they start and students to collaborate with each other if they have questions.
7. Debrief the last 5-10 minutes of class. Invite students to come up to the front of the class to share their bouncy ball results and observations.
8. If there is enough time at the end of class show them one of the videos listed below. These are fun experiments showing a chemical reaction that are attention getters but can't be done in our lab.

Helpful Tips noted from Previous Classes:

The following tips are based on doing this experiment with the 5th graders for the first time in March 2016. The 3 - fifth grade classes were scheduled back to back, as requested by the teachers. There was only about 10 minutes between classes to reset the tables for the next group.

1. Cover the tables with brown paper. For the three classes we were able to use the same paper but wiped it down with a paper towel before each new class arrived.
2. When setting up for the lab consider the short turnaround time and set out enough materials to make the turnaround time smoother. You really have to move fast.
3. It took 2 docents about 40 minutes to set up.
4. It took 4 docents about 20 minutes to clean up at the end of the three classes.
5. One of the docents took all the measuring spoons and containers home to wash in the dishwasher. This helped reduce in-class clean-up time.
6. Set out only the measuring spoons needed. If you put the entire set of measuring spoons out the students get confused.
7. This lab session runs best with at least 3 docents per class. Two docent can manage but 3 or more is better.
8. Before class arrives make a sample bouncy ball to show the students.
9. Have students work in pairs with one set of directions to share. They can each make their own bouncy ball.
10. The main issues we noticed with the students:
    a. They didn't read the direction carefully.
    b. Confused teaspoon with tablespoon. Review measurements with the class is important. For example what is a teaspoon? What is a tablespoon?
    c. Didn't know how to put the warm water on the spoons. They kept scooping the water which never measured a full tablespoon. Pour the water into the measuring spoon.
    d. Students mixed up their two cups with each solution. Thereby putting the wrong ingredient in each cup.
    e. Forgot to keep on their safety glasses.
    f. A few of the students had texture issues and didn't want to touch/roll their solution. For these students we have rubber gloves available. But do not offer them unless there is a student with a texture issue. Otherwise everyone will want gloves and they soon realize they are hard to use and end up throwing them away.
    g. It is best to limit the food coloring choices on the table.
    h. Make sure to leave enough time for washing sticky hands. Wash up time is long for this experiment.
11. It is recommended that one docent write down and review the list of "Tips for a Successful Experiment" (see below) with the class before they start the experiment.
12. Some classes finished in about 15 minutes and had time to make 2 bouncy balls or show the video while other classes struggled.
13. If you have time at the end to debrief there is a list of questions (see below) that you can ask the class.
14. The water at the tables gets contaminated. You may need to empty the containers and fill them back up with warm water for each new class.

Student Tips for a Successful Experiment (Docents can write these on the board or review with the class)

1. Wear safely glasses at all times. Suggest assigning a student safety officer for each table who can remind other students to follow safety rules.
2. Read all the directions first **before** starting. Pay close attention to the instructions.
3. Measure all ingredients accurately. A tablespoon heaping with cornstarch is not really 1 tablespoon.
4. Clean the measuring spoons after each use. Do not dip wet spoons into the dry ingredients otherwise your measurement will not be accurate.
5. Stir slowly and completely. Stirring to fast will cause the ingredients to splash.
6. TBSP = Tablespoon
7. TSP = teaspoon

8. ½ TSP + ½ TSP = 1 teaspoon
9. If you changed the quantities of ingredients added make a note and observe how it effects the end result.
10. The borax and cornstarch are both white substances. Look carefully before selecting one.

States of Matter Basics: For Docent's Reference Only

What is matter and why is it important?

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.

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.

Vocabulary: (The students should be familiar with these terms. They are straight out of their science text book)

Atom - The smallest particle of an element that has the properties of that element.

Element - A pure substance that cannot be broken down into any simpler substances.

Molecule - A particle that contains two or more atoms joined together. (Example: oxygen molecule)

Mixture - A physical combination of two or more substances that does not form a new substance. (Example: muddy water, trail mix).

Suspension -A mixture whose visible particles settle and separate over time.

Solution -A mixture that is blended so completely that it looks the same everywhere. (Example: sugar dissolved into water)

Solvent -The substance in a solution into which other substances dissolve. (In salt water, water is the solvent)

Solute -The substance in a solution that dissolves. (In salt water, salt is the solute)

Solubility - The greatest amount of a solute that can be dissolved by a given amount of a solvent.

Videos That Can be shown at the end of class:

Steve Spangler Liquid Nitrogen Experiment (4.05 minutes)

https://www.youtube.com/watch?v=48WYRzgm_zM

Steve Spangler Elephant Toothpaste Experiment (3:23 minutes)

https://www.youtube.com/watch?v=ZDd3pGIyS7I or

https://www.youtube.com/watch?v=QLSC-iGOOyc

Experiment: Polymer Bouncy Ball

Estimated hands-on time: 30-35 minutes

Materials:

- Borax
- Pitchers of warm water (1 per small table and 2 per large table)
- corn starch
- school glue
- 2 small plastic cups per student
- a stirring stick or plastic spoon (one per student)
- food coloring
- Measuring spoons (1 TBSP, 1 TSP & ½ TSP)
- Rulers
- Snack or Sandwich size Zip-lock bags
- Butcher paper (to cover and protect the tables) & tape
- Paper towels & wipes
- Permanent Markers for labeling
- Containers for Borax and cornstarch, clearly marked. (You will need 1 container of each per small table and 2 containers of each per large table)

Preparation:

1. Cover tables with butcher paper.
2. Set out materials on tables and enough measuring cups and spoons for each table group.
3. Label the containers of borax and cornstarch.
4. Set out instruction at each table. One set of instructions for every 2 students.
5. Heat water in the microwave before the class arrives.
6. At each seat there should be the following:
    - Pair of safety glasses
    - 1 paper towel
    - 1 stirring stick or spoon
    - 2 cups

Safety Concerns:

Students need to wear lab coats to protect clothes. Wear safety glasses at all times to prevent any liquids from splashing up in student's eyes while stirring. Do not ingest any chemicals and never put the bouncy ball in your mouth.

Procedure:

Start by taking two cups. With a marker label one cup **Borax Solution** and the other cup **Ball Mixture**.

In the cup labeled "Borax Solution"

1. Pour 2 tablespoons (30ml) of warm water into the cup labeled. Then add 1/2 teaspoon of the borax powder into the cup. For a bouncer ball add 1 tsp of borax. Stir the mixture to dissolve the borax.

In the cup labeled "Ball Mixture"

1. Pour 1 tablespoon of glue into the cup. Add 4-5 drops of food coloring and stir.
2. Add 1/2 teaspoon of the borax solution from the cup labeled **Borax Solution** (the one you just made) and put it into the cup labeled **Ball Mixture**.
3. Add 1 tablespoon of cornstarch to the glue mixture. **Do not stir.** Allow the ingredients to interact on their own for 15 seconds and then stir them together to fully mix.
4. Stir. Once the mixture becomes impossible to stir, take it out of the cup and start molding the ball with your hands. The ball will start out sticky and messy, but will solidify as you knead it. Once the ball is less sticky, continue rolling between your hands until it is smooth and round!
5. Set it aside and allow it to rest on the table for 5 minutes before bouncing it.
6. While waiting for your ball to dry clean up your materials and table area.
7. Try bouncing your ball. Use a ruler to measure the height of its bounce and compare it your other students.
8. Each student can take their bouncy ball home. Write your name on a zip lock bag and place ball inside.

How-to video for Docent Reference:

https://www.youtube.com/watch?v=NcnHwC5_ytI

How does it work?

This activity demonstrates a chemical reaction, primarily between the borax and the glue. The borax acts as a "cross-linker" to the polymer molecules in the glue – basically it creates chains of molecules that stay together when you pick them up. The cornstarch helps to bind the molecules together so that they hold their shape better.

These are "temporary" bouncing balls and will lose their elasticity within a few days as they dry. Keeping the bouncy ball in a sealed bag will increase its bouncy lifespan.

The original "Super Balls" got their amazing bounce ability from compressed rubber under thousands of pounds of pressure.

Debrief with the class:

If time allows at the end of class review the class results. Encourage them to discuss if a physical or a chemical change occurred and provide evidence why they believe so. Discuss how the molecules in the solution reacted with one another and created a new a new chain of molecules. The two main reactants are the borax and the glue. The borax acts as a "cross-linker" to the polymer molecules in the glue. It creates a chain of molecules that stay together when picked up. The cornstarch binds the molecules together to give the ball its shape. If anyone in the class forgot to add the cornstarch they may have noticed a "bouncy ball" can be formed. It will bounce BUT as soon as you leave it on the table it flattens out and loses its shape. It is essential putty.

Possible questions to review with the class:

1. ***How do you know a chemical change occurred when you created the bouncy ball?***
   Answer: A sign of a chemical reaction is when two solutions are mixed together and they form a solid. (This is straight from the student's text book)

2. ***What happens to the molecules when a chemical reaction occurs?***
   Answer: Molecules are in constant motion. When certain molecules collide with one another (like the molecules in Borax solution with the molecules in the glue solution) then their bonds (electrons) break and connect in a new arrangement. Think back to the marshmallow molecules experiment. The marshmallows represented elements and the toothpicks represented bonds (electrons) that connect the elements together. When the elements are connected together in a certain pattern a molecule is created. During a chemical reaction more than one type of molecules collide with one another. The force from their collision causes the bond (electron) to break and the molecules connect together in a new arrangement.

3. ***What different kind of results did students get in the class? Ask if anyone would like to stand up and share their results.***
   Some Discoveries Noted from students:
   a. More cornstarch = a ball that stretches and bends
   b. Less Borax = a goopier ball
   c. More glue = slimmer ball
   d. More Borax = bouncier ball

4. ***What observation did you make? For example: texture of the ball, diameter of the ball, how long did it take to solidify, how high does it bounce?***