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BASIS Lesson Plan

Lesson Name: CheMystery Liquids

Grade Level Connection(s)

NGSS Standards: 2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

FOSS CA Edition:

**Note to teachers: Detailed standards connections can be found at the end of this lesson plan.*

Teaser/Overview

This interactive lesson will teach students about the scientific process by allowing them to become science detectives who will solve the problem of the mystery liquids! Students will rotate through three stations, at which they will carry out experiments to determine the identity of four mystery liquids. Then, using one of the (now identified) mystery liquids, we will make an exploding foam tower!

Lesson Objectives

- Students will discover that reactions can occur when you mix two substances together.
- Students will experiment with mixing two substances to see which combinations react.
- Students will experiment with mixing two liquids together in order to identify the densest liquid.
- Students will participate in the scientific process by observing their experiments.
- Students will solve a mystery by drawing conclusions based on their observations.

Vocabulary Words

- Matter- something that exists and takes up space. Matter can be a solid (hard), liquid (wet), or a gas (invisible).
- Chemistry- the study of matter. Chemists study what things are made of, how things work, and how to make new things.

- Observe- to watch and listen as something happens and then tell someone what you saw and heard.
- Experiment- testing a question. *What happens when I mix A with B?* Mix A with B to find out!
- Reaction- combining two or more ingredients to make something new and different. For example, two liquids can react and make a solid, or a solid can react with a liquid to make a gas.
- Density- how heavy a liquid is.
- Indicator- a special chemical that changes color when you add something it reacts with.

Materials

Scientist Volunteers will bring:

- Mystery liquids (3 bottles of each liquid in 0.5 L plastic bottles):
  - Vinegar (labeled "A")
  - dilute sodium hydroxide (approx. 0.01 M NaOH in H_2O) (labeled "B")
  - mineral oil (labeled "C")
  - 3% hydrogen peroxide solution (labeled "D")
  - Eight cards with magnets attached to the back: acetic acid, hydrogen peroxide, sodium hydroxide, mineral oil, A, B, C, and D
- Reaction Station
  - Card with station name
  - Baking soda
  - Measuring spoon
  - Centrifuge tubes and holder
  - 2 Funnels
  - Masking tape and sharpie
  - Towel
- Density Station
  - Card with station name
  - 10 beakers (100 mL, glass or plastic)
  - 2 Funnels
  - Towel
  - Food coloring
  - Popsicle sticks
  - Pieces of paper and sharpie
- Indicator Station
  - Card with station name
  - Phenolphthalein solution (0.5 wt. % in 1:1 H_2O/ethanol)
  - Reusable plastic pipettes
  - Centrifuge tubes and holder

  - 2 Funnels
  - Masking tape and sharpie
- Clean up:
  - Large bottles/mason jars at each station for collecting waste
- Final demonstration:
  - 30% hydrogen peroxide solution
  - Dish soap
  - Potassium iodide
  - Tall graduated cylinder
  - Food coloring
  - Large bin for containment

Materials teachers should provide:

- Science notebooks for recording observations, if available

Classroom Set-Up

We will start the lesson with students in a large group; we will need access to a white board and markers. After the introduction, students will rotate through three stations. Please have the students divided into three, equally sized groups before our arrival. Name tags for calling on students are always appreciated.

Classroom Visit

1. Introduction (15 minutes)

Role Model Introduction:
We are students at UC Berkeley and we all study science! You are all in second grade right now. Would anyone like to guess what grade we are in? We are in 19th grade! We study science because we are excited about the world around us and we want to find out how things work. Let's go around and introduce ourselves and tell you a bit about what we do at Berkeley. My name is ____ and I study ____. I decided to become a scientist when/because _____.

Topic Introduction:
Has anyone heard of the word "matter" before? Matter is a fancy word that means "something that exists and takes up space. Can you point to some examples of matter in this classroom? Matter can be a solid, liquid, or gas. Solids are hard and don't change shape, like this desk. Liquids are wet and take the shape of their container, like water. Gases are invisible, but still exist and take up space – in fact, we're breathing gas right now! At Berkeley, we all study a type of science called chemistry. Has anyone heard the word "chemistry" before? Chemistry is the study of matter, and matter is everything around us. So, we study everything!

A chemist can do many different things, but the most exciting thing we do is called a "reaction." A reaction happens when you mix two or more things together, and they combine to form something totally different and new (draw a picture on the board: two circles, one red and one black, come together to form a blue square). For example, you can mix together two liquids (point to circles), and a solid might form (point to square). Baking a cake is an example of a reaction: you mix together many ingredients, like flour and eggs, and when you bake them, they turn into something new and delicious, called a cake! It's fun to make new things!

Today, we want you to help us do some reactions. Instead of baking ingredients like flour and eggs, we're going to use chemicals. These chemicals won't hurt you, but they will make you sick if you eat them. Let's be careful not to spill them or get them on our hands, so that we don't accidently eat any chemicals. The first reaction that we are going to do today is called the "exploding foam tower," and we will use a chemical called hydrogen peroxide. Erik, will you pull out the chemicals so we can show the students? Oh no! We forgot to label our chemicals! We need science detectives to help us figure out which chemical is which. We know what the four mystery liquids are, but not which bottle is which. We can give you some clues about each liquid. We need you to use science tools to help us: we need you to carry out experiments and make observations. An experiment is testing a question. What happens when I mix A with B? Mix A with B to find out! An observation means to watch and listen as something happens and then tell someone what you saw and heard. Can you help us? **Take-away message: scientists use experiments and observations to solve problems.**

On the board:
Put up cards with the names of the mystery liquids: **acetic acid**, **mineral oil**, **sodium hydroxide**, and **hydrogen peroxide**.
Put up cards labeled A, B, C, and D, off to the side of the mystery liquid cards.
Write a list of science tools: experiment, observe, take notes, and ask questions.
Write the clues next to the mystery liquid cards:

1. We know that baking powder and acetic acid react and make bubbles. The baking soda won't react with any of the other liquids.
2. We know that mineral oil is very "dense." Dense means that it is a heavy liquid. It will sink below the other mystery liquids and it will not mix with them.
3. We know that sodium hydroxide will turn pink when you add a drop of our special indicator. The "indicator" reacts with sodium hydroxide and changes color.

Let's split into three teams, and each team will try to identify our mystery liquids using the clues on the board. We will rotate through three stations and use our science tools and clues at each. At the Reaction Station, with Harry, you will add baking soda to each liquid and see which one reacts (acetic acid). At the Density Station, with Amanda, you will mix liquids together and see which one sinks (mineral oil). At the Indicator Station, with Erik, you will add the special indicator to each liquid and see which one changes color (sodium hydroxide). Don't worry – everyone will get the chance to go to

all the stations. Once we figure out what the mystery liquids are, we can do the exploding foam tower reaction!

2. Learning Experience (35 minutes: 8 minutes per station, 10 minutes for final demo)

Reaction Station. Mixing solids and liquids: dissolve, react, or no change.

- The scientist will explain to the students that acetic acid (vinegar) and baking soda react to form a gas (liquid + solid → gas). The other three liquids will not react.
- The scientist will help the students use masking tape and a sharpie to label four centrifuge tubes "A," "B," "C," and "D."
- The students will use funnels to pour each of the four mystery liquids (in bottles labeled A-D) into the corresponding test tube.
- The scientist will remind the students to watch, listen, and talk about what they observe.
- The students will take turns adding one teaspoon of baking soda to each centrifuge tube.
- Based on their observations, the students will vote on which liquid they think is acetic acid. The scientist will write down their vote.
- If there is extra time, the students may re-test any of the mystery liquids in a clean centrifuge tube.

Station 2. Mixing two liquids: density and mixing.

- The scientist will explain to the students that mineral oil is very dense (heavier than most other liquids). It also does not mix well with other liquids.
- The students will come up with combinations of mystery liquids to test. The most conclusive tests will involve only two of the four liquids, but the students may want to mix all four. When the students have decided which combinations they want to test, the scientist will help them set out beakers on a piece of paper and label the paper with the combination (such as "A+B").
- The scientist will remind the students to watch, listen, and talk about what they observe.
- Using a funnel, a student will pour one of the two liquids into a beaker, and add a few drops of food coloring. Then, another student will use a funnel to add the second liquid. The food coloring should help the students see if the (normally colorless) liquids are mixing together. The students can also use popsicle sticks to try to stir the combinations.
- Students will test the various combinations of mystery liquids until they have tried them all, or until their time at the station is almost up.
- Based on their observations, the students will vote on which liquid they think is mineral oil. The scientist will write down their vote.

Station 3. Indicator solution: color change.

- The scientist will explain to the students that we made a special indicator solution that will react with sodium hydroxide. Adding one drop of the special indicator solution to sodium hydroxide will cause a color change to pink; the other mystery liquids will not change color.
- The scientist will help the students use masking tape and a sharpie to label four centrifuge tubes "A," "B," "C," and "D."
- The students will use funnels to pour each of the four mystery liquids (in bottles labeled A-D) into the corresponding test tube.
- The scientist will remind the students to watch, listen, and talk about what they observe.
- The scientist will show the students how to use a pipette. The students will take turns adding one drop of indicator solution to each test tube.
- Based on their observations, the students will vote on which liquid they think is sodium hydroxide. The scientist will write down their vote.
- If there is extra time, the students can see if adding more drops of indicator solution to the sodium hydroxide causes the pink color to become more intense.

Final demonstration:

- The students will remain at their final station. A scientist will go up to the board and announce that it is time to talk about the observations that the science detectives made.
- The scientist will point to the Reaction Station, remind the students what they did there, and ask for their decisions about which mystery liquid is acetic acid (the scientist at that station will have a list of the student's votes). The scientist will write the decision on the board. Similarly, the scientist will gather data from the Density and Indicator Stations. If there is disagreement among the groups of students, the experiment from that station can be repeated in front of the entire class.
- The scientist at the board will explain that, by process of elimination, the only liquid left to be identified must be the hydrogen peroxide.
- Now that we know which liquid is hydrogen peroxide, we can finally do our exploding foam tower reaction!
- The scientist will place a tall graduated cylinder in the containment bucket. The scientist will ask one volunteer from each station to bring up their bottle of hydrogen peroxide and pour it into the cylinder. The scientist will also add a splash from their own bottle of hydrogen peroxide (but this will be 30% hydrogen peroxide).
- The scientist will ask the students what color they want the foam to be and will add a few drops of food coloring. The scientist will also add a squirt of dish soap and swirl to mix.
- The scientist will explain that dropping in the solid, called potassium iodide, will cause a reaction to happen! The reaction will make gas, which we will trap in the dish soap (as bubbles). If the students identified the mystery liquids correctly, the reaction will work!
- The scientist will ask if the students are ready, and then drop in the potassium iodide. A foam tower will explode out of the cylinder!

3. Wrap Up: Review and Discuss the Learning Experience (5 minutes)

The students will return to their seats. The scientist will remind the students of the **take-away message: scientists use experiments and observations to solve problems.** The scientist will then ask the students the following questions.

- At the Reaction Station, with Harry, what experiment did you do? What did you observe?
- At the Density Station, with Amanda, what experiment did you do? What did you observe?
- At the Indicator Station, with Erik, what experiment did you do? What did you observe?

Wrap-up: So, using these experiments and observations, we solved the problem of the mystery liquids and got to see the exploding foam tower. Thank you for your help!

4. Connections & Close (5 minutes)

Connections to the real world around students:
Now that you know how to do experiments and make observations, you are all scientists! You can use these science tools to solve any problem you want. Maybe you're curious about reactions. You can test different things to see if they react by mixing them together! Here is a fun experiment you can do at home: try mixing lemon juice and baking soda and see what happens.
Close:
We have a few minutes left for questions. You can ask us questions about what we did today, about science, about being a scientist, and about becoming a scientist. Close by mentioning that we have to get back to lab, and thank the students for helping us solve the problem of the mystery liquids!

Follow Up: After the Presentation

Teachers who wish to extend the impact of this lesson may find the following CRS web pages useful:

- http://www.crscience.org/educators/helpfulreports
- http://www.crscience.org/educators/treasuretrove

Standards Connections

NGSS Standards: 2-PS1-1: Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.