Matter and Its Interactions

Essential Questions: What are we made of? What is matter?

Unit Summary: The purpose of this unit is to expose students to the law of conservation of mass. This will be done through a series of multi-day lessons in which students are exposed to physical and chemical characteristics of matter.

- **Lesson 1**: Focuses on defining matter and introduces the notion of volume (introduces basic atomic theory).
- **Lesson 2**: Students explore phases of matter through a measurement and graphing exercise
- **Lesson 3**: Students participate in a series of investigations leading them to the idea that matter is neither created nor destroyed (Law of Conservation of Mass)
- **Lesson 4**: Students make observations and take measurements to identify materials based on their properties. Properties observed include color, smell, reactivity, solubility, and viscosity*.
- **Lesson 5**: In the final lesson, students conduct an investigation to determine whether the mixing of two or more substances result in new substances, creating a chemical reaction.

The activities regarding viscosity, and the readings are not included in this exemplar lesson

In **lessons 3-5**, students will explore the difference between a physical and a chemical change through a variety of hands-on activities, readings, and discussions*

Lesson 4: Using Physical Properties to Identify Substances

Standards

5-PS1: Matter and Its Interactions

Performance Expectations

The lesson outlined in this table is just one step toward reaching the performance expectations listed below

PS1-3. Make observations and measurements to identify materials based on their properties.

PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Dimension	Name and NGSS code/citation	Specific Connections to Classroom Activity
Science and Engineering Practices	**SEP 3: Planning and Carrying Out Investigations** • Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. • Conduct an investigation collaboratively to produce data to serve as the basis for evidence, sing fair tests in which variables are controlled and the number of trails considered.	In Activity 2, students observe and measure five properties of five different powder substances. They use their observations in a later activity as evidence for their claims. In Activity 3, students make observations, which they use as evidence to support their assertion as to the contents of the mystery powder. In Activity 4, students work in groups to plan and conduct an investigation to determine the relative viscosities of various liquids.
Disciplinary Core Ideas	**Structure and Properties of Matter (PS1.A)** • Measurements of a variety of properties can be used to identify materials.	In Activity 2, students observe and record five different properties of five different substances as a way to identify/distinguish between them. (PS1.A) In Activity 2, as students test the reactivity of their powder substances, they observe some chemical reactions. (PS1.B)

	Chemical Reactions (PS1.B) • When two or more difference substances are mixed, a new substance with different properties may be formed.	In Activity 3, students examine the properties of their mystery powder in reference to their observations collected in Activity 2 to determine the mystery powder's contents. Some mystery powders contain substances that react chemically with vinegar. (PS1.A, PS1.B)
Crosscutting Concepts	**CCC 2: Cause and Effect** • Cause and effect relationships are routinely identified, tested, and used to explain change. (5-PS1-4)	In Activity 2, students consider what happens when they add vinegar to several powders. They record the effect in a table. (CCC 2) In Activity 3, students conduct a series of observations and tests in which they add something to their mystery powder (cause) and then observe what happens (effect). (CCC 2)

Connections to Engineering, Technology, and Applications of Science:	N/A

Connecting to the Common Core State Standards

ELA/Literacy - RI.5.9, RI.5.1, RI.5.7, W.5.8, W.5.9*

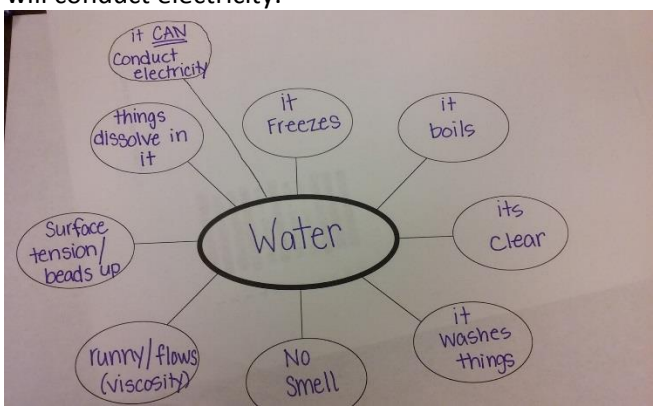
Mathematics – MP.5

**The ELA/Literacy standards are primarily met during Activity 4 (not present here), involving a textbook reading and internet search to further the knowledge students gained in Activities 1-3. The guiding question for this activity should be centered on an engineering issue that requires students to consider how different properties of various substances can be examined to identify a solution (Consider local/regional issues that might be applicable to your students.)*

SUGGESTED PROCEDURE

ACTIVITY 1: Discussion of physical properties of water

1. Begin by posing this question to the class: "What do you know about water?"
2. Create a characteristic/mind map of the properties of water. Remind students their examples have to be about water. (Students may state, "Ducks swim in it. We swim in it. We drink it." These statements are not about water. They are about ducks or us.)
   - Correct examples would be: it freezes, it boils, it's clear, it washes things, no smell, it's runny/flows (viscosity), it beads up/has surface tension, things dissolve in it, can conduct electricity (pure water does not, but minerals in water will conduct electricity.



***If the students have trouble making the map, you can ask questions on the properties like: "What color is water?" "How does clean water smell?"*

***To get students to think about reactivity, talk about what happens when you put baking soda into vinegar (it reacts). Then ask students what would happen if you put baking soda into water (no reaction). "What does that say about water?" (water is neutral).*

Some Physical Properties:

Color	Smell	Freezing point	Boiling point	Solubility
Viscosity	Conductivity	Reactivity		

Example video of water in space to show how water sticks to itself: https://youtu.be/KFPvdNbftOY

ACTVITY 2 (targets SEP 3, DCI PS1.A, PS1.B): Physical Properties Investigation

Purpose:

Content: Understand that physical properties can be used to identify various substances.
Language: physical properties, reactivity, solubility
Social: Work in groups

1. "Last time we brainstormed the physical properties of water. Do all substances have the same properties? Can someone give an example?" How might substances differ? Have students brainstorm. Share out and lead them to the 5 things you want to test (appearance, smell, solubility, reactivity, iodine). **For smell, be sure to remind students that smelling is not always safe to do, but you know that they can with the substances they'll work with today** (At this point, students may not know the distinction between chemical and physical changes. You could insert an activity prior to this to help students understand this concept prior to this lesson, but at this point, understanding what happens in the reactivity portion is enough. Students will get further experiences with this in Lesson 5.)
2. Students will be given 5 substances (baking soda, cornstarch, salt, sugar, and plaster of Paris) in small plastic cups. Cups should be labeled so students know what substances they have. They will identify the following physical properties of each substance: appearance, smell, solubility, and reactivity. Throughout this investigation, students will create a key (handout) to record the physical properties of each substance.

Substance	Appearance	Smell	Solubility	Reactivity	Iodine
Salt					
Baking Soda					
Cornstarch					
Sugar					
Plaster of Paris					

3. When testing reactivity, give the students additional cups (1 for each substance = 5 per group) and a Popsicle stick to mix each substance with vinegar. Have students note any reactions that are present. Have them note the differences in the reactions (e.g. produces bubbles/gas, does not produce bubbles/gas) and write this in the reactivity column.
4. To test the solubility, repeat the same process with water instead of vinegar. This time students should note if a substance dissolves, partially dissolves, or doesn't dissolve. Be sure students don't put too much of the substance in with the water or it will become oversaturated.

5. As students record the "appearance" of each substance, be sure to include the different crystal formations of the salt and sugar. Use or borrow microscopes to view the crystals. (If microscopes are unavailable, Google crystal formations of salt and sugar to show students the difference.)
6. Extension – if students already have an understanding of physical and chemical changes you can have students add a column to the table that addresses whether or not the test causes substance to be mixed and create a chemical reaction. Remind them that when this occurs, it results in a new substance with new properties. "What is evidence that a new substance has occurred?" (*It creates a gas, other properties* change). Have students identify the other times, that mixing two substances does not change the properties – for example, when it is clear the two substances have not combined to create something new, but can be separated back into their original forms.
7. Have students or teacher keep the finished Physical Investigation Key to be used during the next class period.

ACTVITY 3 (targets SEP 3, DCI PS1.A, PS1.B, CCC 2): Mystery Powder Investigation

1. Before class, make up several mystery powder mixtures using a combination of two of the same ingredients used during the last lesson: salt, sugar, baking soda, corn starch, and Plaster of Paris. There is no need to keep track of the substances in each group's mixture. Students will have to use evidence collected and the key created during the previous lesson to determine which two substances were in their mixture.
2. Allow students to test mixtures using any of the tests from the previous lesson (appearance, smell, solubility, reactivity, and iodine).
   - Alternative idea: Have each partner group make up a mixture on their own, and exchange it with another group to try to solve the mystery.
3. Ask students how they might test to see if their conclusions are correct. One way students can test their results is by attempting to create a matching sample and conducting the same test on each until they find a match. Have students record their results on the Mystery Powders Mixtures sheet.
4. Conduct a whole group discussion regarding the groups' results. Questions to pose to students could include: "How did you use your knowledge about your original tests to figure out the mystery substances?" "How can we use the big idea *Cause and Effect* to help make evidence-based claims about your results?" This second question helps students to understand how a Crosscutting Concept can be used to frame their new knowledge.
5. To wrap-up the unit, have each group of detectives write their final conclusions in their science journals about each mystery powder (what they think it is and what they know about it).