1.1 - Conservation of Matter Unit, Packet 1

First & Last Name: _____ Period/Hour:_____

NOTE: Packets are due after completing Part 5. Check each page to be sure all blanks are completed.

Driving Question: What happens to a substance when it dissolves?

Anchoring Phenomenon: When you mix a drink powder into a glass of water, it seems like it disappears. What actually happens to the powder mix? Does it disappear? Does it turn into something else? In this unit, we will investigate how matter changes when it dissolves in a liquid. We will use this as an introduction to investigations in chemistry.

Deeper Questions

1. What is matter?
2. What are the relationships between matter, mass, volume, and density?
3. How can matter be changed?

Schedule

Part 1: Introduction
- Initial Ideas & Data Dive
- Discussion & Developing Explanations

Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

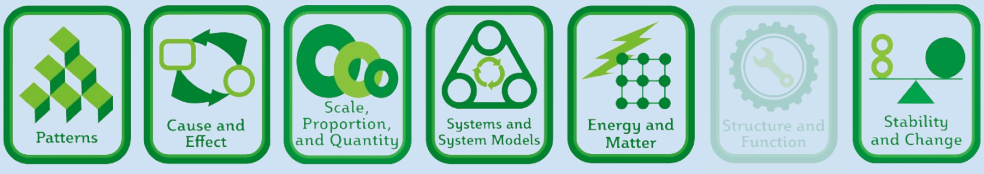
Part 3: Investigation
- 3A: Straw Column
- 3B: Density of Everyday Items

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Mystery Symptoms

NGSS Standards (*PEs & CCCs are summarized below. SEPs are noted throughout the packet*).

HS-PS1-7: Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction.



Semester Schedule

0. Orientation
0.1 Lab Safety & Scientific & Engineering Practices

1. Conservation of Matter
1.1 - What happens when a substance dissolves?
1.2 - Why do some substances change with heat?
1.3 - Assessment

2. Atoms & Its Parts
2.1 - How can we know what is in substances?
2.2 - What are atoms?
2.3 - Assessment

3. Properties of Electrons
3.1 - Electrons & Energy
3.2 - How do electrons play a role in determining atoms behavior?
3.3 - Assessment

4. Periodic Table
4.1 - What does the periodic table tell us?
4.2 - Assessment

Resource Links: Class Website; Core Ideas; Quizlet;

Part 1: Introduction – (1.1.1)

Overview: In this activity, you will begin by discussing your initial ideas about what happens when a substance dissolves in water. Specifically, what happens to the powdered drink mix when you stir it in a glass of water?

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence.

Marisol is on the cross country team, and she uses a sports drink to recover after races. Marisol's parents purchase a powdered sport drink mix which consists of sugar as well as minerals such as sodium and potassium. When Marisol adds the powdered mix to the water, she notices that the volume of water doesn't seem to change. It almost seems like the drink mix disappears.

1. Three students shared their ideas. **Do you agree or disagree with each student's claim?**
    a. Avery: "I know that the sugar and minerals dissolve in the water; I think that some of the atoms are eliminated when they get wet, which is why the volume doesn't change." Agree/ Disagree
    b. Bristol: "I think the atoms in the sugar and minerals attach to the water molecules." Agree/ Disagree
    c. Carlos: "I think there is space in between the atoms in water molecules. Maybe the atoms in sugar and the minerals 'fill up' these empty spaces." Agree/ Disagree
2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas.

Data Dive - *Read the directions below.*
SEP: Analyzing and Interpreting Data.

Here you can see data comparing three different drink mixtures. "Mix mass" refers to the mass of the powder in each packet. "Dissolved mass" is the mass of 1000 ml of water plus the drink mixture powder. The initial and final volume values were obtained using a beaker (which is less precise than a graduated cylinder).

Mixture	Mix Mass (g)	Dissolved Mass (g)	Initial Volume (ml)	Final Volume (ml)
Mix 1	19	1019	1000	1012
Mix 2	39	1039	1000	1025
Mix 3	58	1058	1000	1036

Data Dive Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Asking Questions and Defining Problems.

1. **Begin by individually attempting to make sense of this image**. What trends or patterns do you notice? How does this relate to any prior knowledge or experience?
2. **Next, work in your teams to discuss your ideas**. Where do you agree? Where do you disagree? Can you use this data to reach an agreement? Do others have prior knowledge/experience that could help?
3. **Based on this data, what is one conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?

4. **Based on this data, what is a second conclusion that would be supported by this data?** How is this conclusion supported by this data? What specifically suggests that your claim is accurate?

5. **Does this data support or refute any of the initial claims?** If so, explain.

Discussion - *Record your ideas in the spaces below.*

As a class, discuss your ideas about this data. What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas in the spaces below.

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.*
SEP: Constructing Explanations and Designing Solutions; Asking Questions and Defining Problems.

What happens to a substance when it dissolves in water? Write down an initial explanation in the space below. Don't worry if you aren't completely sure about this. You will come back and revise this explanation as you gain more information during this unit.

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

Part 2: Core Ideas (1.1.2)

Overview: In this activity, you will begin with a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing and Using Models.

1. What is matter?
2. How are the following similar and different? *Atoms, molecules, elements*.
3. How many atoms and how many elements are found in a molecule of water?
4. How are the following related but different? *atoms*, *mass*, *weight*
5. In space, both an astronaut and a satellite have zero weight; however, the satellite has more mass than the astronaut. How is this possible?
6. When sugar dissolves in water, it seems like sugar disappears. What is actually happening to the atoms in the sugar molecules as they dissolve in water? How do you know?
7. What is the relationship between a solute, a solvent, and a solution?
8. Create a diagram that shows how atoms in a molecule can change when a substance dissolves in water. Make sure that your diagram shows how molecules of that substance interact with water molecules.
9. What is the relationship between atoms, volume, and density?
10. If we claim that substance A is denser than substance B, what does this mean? In your response, include and explain volume and mass.
11. A ship is made from steel, but a steel rod will sink in water. How is it possible for steel ships to float?
12. What is energy? How is it different from matter?

Revising Explanations - *Record your ideas in the spaces below.*
SEP: Constructing Explanations and Developing Solutions.

What happens to a substance when it dissolves in water? Based on this new information, how would you now respond to this question?

_____

_____

_____

Throughout this packet, you will be updating this explanation as you gain more information and more experience. When you complete this packet, compare your initial explanation to your final version. You should see clear improvement with each revision.

HINT - Remember the "rules" for energy and matter:

- All solids, liquids, and gases are made of tiny particles called atoms. Multiple atoms can bond together to form molecules (e.g., water molecules consist of 1 oxygen atom & 2 hydrogen atoms).
- In biology, atoms last forever. Atoms cannot be created or destroyed (e.g., a carbon atom is always a carbon atom). Atoms found on molecules can be rearranged to form new molecules.
- In biology, energy lasts forever. Energy cannot be created or destroyed. Energy can exist as light, heat, motion, or as chemical energy stored in the bonds of molecules. Energy in one form can be transferred into a different form (e.g., light energy can be transformed into heat energy).

Part 3A: Straw Column (1.1.3)

Score: _____/25

First & Last Name: _____ Period/Hour:_____

Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are <u>all</u> ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*

SEP: Developing and Using Models.

1. What is matter?
2. How are the following similar and different? Atoms, molecules, elements.
3. What is the relationship between a solute, solvent and solution?
4. What is volume? Mass? Density?
5. How can you determine whether or not something will float?

This activity was completed _____ (*instructor signature*)

Overview: Do you want to float on water? Take a trip to the Dead Sea or the Great Salt Lake. Because both bodies of water contain huge amounts of salt, swimmers can easily float! In this lab activity you will use trial and error to determine the approximate densities of 6 salt water solutions.

SEP: Planning and Carrying Out Investigations.

Materials needed (per group): 6 solutions with varying densities and a clear straw.

Pre-Investigation Discussion & Demonstration - *record your answers in the spaces below.*

1. Your teacher will demonstrate what occurs when you mix water and sugar together. Record your observations: (*1 pt*)

   _____

   _____

2. In the space below, draw what is taking place when water and sugar mix **at a molecular level**. (*2 pts*)

3. Your teacher will demonstrate what occurs when you mix water and rubbing alcohol. Record your observations: (*1 pt*)

   _____

   _____

4. In the space below, draw what is taking place when water and rubbing alcohol mix **at a molecular level**. (*2 pts*)

5. How was what you observed in the two demonstrations similar? How were they different? Discuss what you think might account for these differences. *Be prepared to talk about this as a class.* (*3 pts*)

_____

_____

_____

_____

Pre-Lab - *Discuss your ideas and record your answers in the spaces below.*

1. Your teacher will perform a demonstration of what happens when you do this experiment with liquids that all have the same density.
2. Observe what occurs: _____ (*1 pt*)
3. This experiment functions as our _____, where no variables were changed. (*1 pt*)

Directions - *Carefully read the directions below <u>before</u> beginning. Record info where prompted.*

1. ☐ Obtain 6 solutions of varying density. You should have one of each of the following colors: red, orange, yellow, green, blue and purple.
2. ☐ Use the following procedure <u>each time</u> you test out a different order of colors:
    a. Cap the straw with your thumb.
    b. Holding the straw vertically, dip the straw into the first color about ½ inch.
    c. Release your thumb to suck up water, recap with thumb.
    d. Lift the straw out and go to the next color.
    e. If your colors mix, dispose of them in the designated beaker and start over.
3. ☐ Record your observations to help you figure out the approximate densities of each solution - your goal is to order them from most dense to least dense (or vice versa).
4. ☐ Continue the process until all 6 colors of water remain in layers and **do not** mix.

Results - *Record your data below.*

Record your observations here. Make note of what works and what does not work for each trial. (*2 pts*)

Post-Investigation Questions - *Record your ideas in the spaces below.*
SEP: Analyzing and Interpreting Data; Constructing Explanations and Developing Solutions. Engaging in Argument from Evidence.

1. Draw a **colored** diagram of your final results. Label the top and bottom of the straw. (*2 pts*)

2. Which color of water is the most dense? _____ (*1 pt*) Justify your answer. (*3 pts*)

_____

_____

_____

3. Explain the following scenario: you have two colors of water in the straw and the color on top appears to "fall through" the one on the bottom. (*3 pts*)

_____

_____

_____

4. Your teacher does another demonstration and mixes water with table salt (NaCl). You notice a slight increase in the volume of the solution; however, it is not as much of an increase as when you mixed water with sugar ($C_{12}H_{22}O_{11}$). Explain. (*3 pts*)

_____

_____

_____

_____

Be prepared to discuss and defend your ideas in small groups and as a class.

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Part 3B: Density of Everyday Objects (1.1.3) Score: _____/31

First & Last Name: _____ Period/Hour:_____

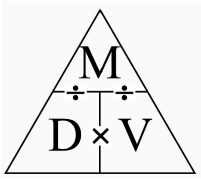
Pre-Investigation Questions - *Work as a group to prepare verbal responses for these questions. When you think you are <u>all</u> ready to provide responses, raise your hand. Your instructor will listen to your explanations, provide feedback, and determine if you are ready to move on to the investigation.*

SEP: Developing and Using Models.

1. How are mass, volume, and density related?
2. What are the units for mass? Volume? Density?
3. What happens to a substance when it dissolves in water?
4. How do you accurately measure volume and mass for a substance?

This activity was completed _____ (*instructor signature*)

Overview: Density is a property of matter. Density measures how close together the pieces of matter in an object are packed. Density is the relationship between an object's mass and volume. An object's density can also be used to see if it will float in another substance. If the object's density is *less than* the substance's density it will float. If it is *greater than* the substance's density, it will sink.



SEP: Planning and Carrying Out Investigations.

Materials needed (per group): Graduated cylinder, marble, carrot, wood, oil, paperclip, balance, calculator.

Hypothesis - *Discuss your ideas and record your predictions in the spaces below.*

1. Record whether you think each object will float or sink in water. (*1 pt*)
   a. Marble _____
   b. Carrot _____
   c. Wood _____
   d. Oil _____
   e. Paperclip _____
   f. Penny _____

Directions - *Carefully read the directions below <u>before</u> beginning. Record info where prompted.*

1. ☐ Measure the mass and volume of each object. *Make sure to include units.*
2. ☐ Calculate each object's density using the above formula.
3. ☐ Observe and record each object's behavior in water.
4. ☐ Observe and record each object's behavior in salt water.

Results - *Record your data below. (15 pts, ½ pt each box)*

Object	Mass	Volume	Density	Behavior in H_2O	Behavior in Salt Water
Marble					
Carrot					
Wood					
Oil					
Paperclip					
Penny					

Post-Investigation Questions - *Record your ideas in the spaces below.*
SEP: Analyzing and Interpreting Data; Constructing Explanations and Developing Solutions. Engaging in Argument from Evidence.

1. Order the five objects from least dense to most dense. (*1 pt*)

   _____

2. Explain your theory of why one substance is more dense than another. What causes a substance to have more mass in a certain volume? (*3 pts*)

   _____

   _____

   _____

3. Draw, on a particulate level, two objects: one with high density and one with low density. (*2 pts*)

4. Were there any objects that sank in water but floated in salt water? _____

   Explain why this occurs. (*3 pts*)

   _____

   _____

   _____

   _____

   _____

5. From 1962 until 1981, the US cent coin was made of copper (95%) and zinc (5%). These pennies have a density of 8.85 g/cm^3. After 1982, the US mint changed the composition of the cent coin to zinc (97.5%) and copper (2.5%). These pennies have a density of 7.185 g/cm^3. Based on the results of your measurements, could you state with confidence whether ***the single penny*** you measured was pre- or post- 1982? What else could you do to improve your results? (*3 pts*)

   _____

   _____

   _____

6. A ship is made from steel, but a steel rod will sink in water. How is it possible for steel ships to float? (*3 pts*)

   _____

   _____

   _____

   _____

Be prepared to discuss and defend your ideas in small groups and as a class.

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Part 4: Review & Assessment (1.2.4)

Step 1: Rank each Driving Question in Part 2 based on your comprehension (you can rank them as *1,2,3* or *green/yellow/red*, or any other method). Then work in teams to review anything that is still unclear.
Step 2: Identify any remaining areas of confusion or concern. Then review these topics with your instructor.
Step 3: Complete the Formative Assessment (*last page of the packet*). Your instructor will determine if you will work individually, in pairs, or in small groups. Then compare and evaluate your responses as a class.
Step 4: Individually complete a Mastery Check (link on pg. 1). If your performance indicates that additional support is needed, your instructor will determine how to help you move forward.

Part 5: Life Connections (1.1.5)

Background - *Complete the reading before answering the questions below.*
SEP: Asking Questions and Defining Problems.

Directions: For this activity, you will consider a real-world scenario related to our topics this week. You will use your understanding of this week's content to develop an explanation based on the evidence provided.

Background: A teenage patient is brought to the emergency room with severe abdominal pain, nausea, and a fever. The ER physicians determine that the symptoms and conditions are consistent with acute pancreatitis, or an inflammation of the pancreas. The pancreas is the organ that produces digestive enzymes and hormones. Nurses asked the parents of the patient whether they were on any medications. The parents stated that they were. They also noted that because the pills were large, they had sometimes broken the medication into smaller pieces to make them easier to swallow. All other factors, including diet and activity, were unchanged.

Initial Questions: work in your assigned groups to answer the questions below. Record your group's ideas using scratch paper, a dry erase board, a digital document, or another option.

1. Based on the information provided, what do you think caused the pancreatitis?
2. What evidence and reasoning support your claims?
3. What additional information would you need to confirm your ideas?
4. How might your ideas be inaccurate? What assumptions are making that might be inaccurate?

Going Deeper: Next, read the excerpt below. As you read the texts, underline any words that are challenging or unfamiliar. Complete an initial read-through, and check with your group to identify the key points of the excerpt. Then use an internet search engine to look up unfamiliar terms and/or find additional information to help you make sense of these readings. Then use this information to make hypotheses about the case above.

The dissolution test is a globally required test for most of all pharmaceutical products that are not true solutions. Dissolution, or in vitro release, of the drug substance from the product into a typically aqueous-based medium, is linked to the release of the drug into the body, making it available for absorption, and then efficacy or clinical outcome. Dissolution testing is primarily used in industry as a quality control tool to monitor the formulation and manufacturing processes of the dosage form. The regulatory agencies use the dissolution test to provide a quality connection from a pivotal biobatch to the commercialized product. For this reason, the dissolution test development and validation are critical factors in ensuring that the test is robust and clinically relevant. Development and validation of a dissolution method requires a good understanding of the theory of dissolution and the roles of the key parameters of a dissolution test.

(Source: Vivian A. Gray, Thomas W. Rosanske, in Specification of Drug Substances and Products (Second Edition), 2020).