

Lesson Topic: Water as a Solvent**Objective:**

Students will be able to:

1. Determine what substances dissolve in water and why they do or do not dissolve.
2. Describe why water is the universal solvent.
3. Identify the solute and solvent in a solution.
4. Identify if a substance is soluble or insoluble.

Time Required: 75 minutes**Materials Needed:**

- 5 glasses/mason jars
- 5 cups of water (1 per glass/5 cups per group)
- 5 spoons per group (stirrers)
- 1 Tbs of the following substances:
 - Sugar
 - Salt
 - Baking soda
 - Vegetable oil
 - Sand
- Instant lemonade mix or Koolaid
- Pitcher of water for the lemonade
- M&Ms (at least 1 per group, 1 per student).
- Wooden spoon (or something to use as a stirrer)
- Small disposable cups (1 per student)
- Teacher computer with internet access
- Projector/Smartboard
- 1 computer/laptop/iPad per student with internet access
- Water as a Solvent handout (attached)

Teacher Preparation:

- Divvy up materials for each group.
- Assign a Legends of Learning Content Review [Quick Play](#) playlist for the day(s) you will be teaching the lesson.
 - Content Review - Middle School - Water as a Solvent
- Make copies of Water as a Solvent Worksheet (1 per student)

Engage (10 minutes):

1. Tell students you are going to make a pitcher of lemonade and show students all materials you will use to make instant lemonade.
 - a. Pitcher, water, instant lemonade mix, stirrer.
2. Ask students "Have any of you ever made lemonade like this before?" (answers will vary, but more than likely some students will have made some before).
3. Pour water into the pitcher.
 - a. As you measure out the lemonade mix, tell students "This is pre-mixed to make

lemonade quickly. It is essentially sugar.”

4. Ask students “After adding the sugar to the pitcher of water, am I finished? (no) What do I need to do next?” (stir the sugar until it is completely dissolved).
 - a. “Yes, I need to stir the water and sugar together until the sugar is completely dissolved.’
5. Stir the sugar until dissolved.
6. Tell students “Keep this in mind as you continue through the lesson today.”
7. Place in a refrigerator, or you can pour small cups of lemonade for students to drink while they conduct the Explore activity (teacher discretion).

Explore (10 minutes):

1. Have students get into small groups.
2. Pass out the Water as a Solvent handout.
3. Tell students “Today we are going to explore what happens to substances when they are added to water. Right now we are going to be working with M&Ms.”
4. Explain each step of the activity that is on their handout:
 - a. Add water to the cup. Just enough to cover an M&M.
 - b. Place the M&M in the middle of the cup without stirring the water up too much.
 - c. Observe for two minutes.
 - d. Record your results on the handout.
5. Pass out the following materials to each group (M&M, room temperature water, and a white plastic cup).
6. Give students time to complete the activity.

Explain (15 minutes):

1. Tell students “Before we talk about this activity, let’s discuss some key terms.”
 - a. Write the following on the board and have students write it on their handouts.
 - i. Solute - substance that is dissolved in a solvent.
 1. Ask students “In this activity what was the solute?” (M&M coating/sugar).
 - ii. Solvent - substance that dissolves the solute.
 1. Ask students “In this activity and the lemonade activity, what was the solvent?” (water)
 - iii. Soluble - a substance that can be dissolved.
 - iv. Insoluble - a substance that is incapable of being dissolved.
2. Tell students “Who can tell me what happened to the M&M in the activity?”
 - a. Choose a volunteer to summarize what they observed during the activity.
3. Ask students ‘Would you say that the M&M coating is soluble or insoluble? (soluble, because the coating completely dissolved in the solvent.”
4. Tell students “Yes, the coating is mostly sugar, so just like the lemonade demonstration at the beginning of class, it dissolved in water. In fact, water is considered the ‘universal solvent.’ Why do you think that is?” (Because so many substances are dissolved by water).
5. Go through the questions on their handout together as a class.
 - a. Write the answers on the board for students to write down on their handout (Key is attached).
6. Ask students “So, why do some substances dissolve in water?”

- a. Answer: Water is a polar substance. Water, H₂O, has two hydrogen atoms that are positively charged and a negatively charged oxygen atom. The opposition of these charges make water extremely attracted to other polar molecules, like sugar. Water can become so heavily attracted to a different molecule that it can disrupt the attractive forces that hold it together, making it dissolve.
- b. Polar molecules dissolve in polar solvents; Non-polar molecules dissolve in nonpolar solvents.

Elaborate (30 minutes):

1. Next, the students will do an experiment using different substances to see if they are soluble or not (This can be done as a demonstration or again in groups).
2. Give each group 5 cups or mason jars. In it, they will put in 1 tablespoon of each of the different substances (salt, sugar, baking soda, sand, and vegetable oil).
 - a. Sugar has already been demonstrated, however the data has not been taken, so it is still a valuable substance to experiment with.
3. Then, they will add one cup of water.
4. Give each group 1 spoon for each glass (5 spoons) to use as stirrers.
5. For each substance, students need to keep track of how many stirs it takes for the substance to completely dissolve.
 - a. Then, write the number in the correct place in the data table.
 - b. Tell students “If you find that the substance is not dissolving, write N/A in the data table for that substance.
6. Tell students “Before we begin, write your hypothesis, or prediction, on the handout.”
 - a. Give students time to write in their hypothesis and then let them share out what they think will happen.
7. Tell students “After you work through each substance and record your data, graph your data in the space provided and answer the questions.
8. Ask if there are any questions, then, let the groups begin the experiment.
9. When all students are finished, go through the data with students and see how things turned out (Answer Key attached. Answers will vary for much of the experiment data, but likely answers are provided as well).
 - a. Ask “Was your hypothesis correct?”

Evaluate (10 minutes):

1. Have your students [sign in to Legends of Learning](#). Instruct students to complete the Content Review playlist.
2. [Analyze student results](#) to determine what concepts need to be a focus for reteaching.

Additional Lesson Strategies:

- To use Legends for additional instruction, create a [custom playlist](#) with an [instructional game](#) and pre and post [assessment](#).
- To use Legends for a quick formative assessment, create a 5-question [assessment](#) in a [playlist](#).
- To use Legends for a student-directed experience, create a [targeted freeplay](#) playlist.



- Encourage students to play on their own at home in [Legends of Learning: Awakening](#) for a student-driven experience including avatars, battling, and quests all centered around topics they are covering in class.

Name: _____

Water as a Solvent

Solute -

Solvent -

Soluble -

Insoluble -

Part 1: M&Ms in Water

Follow the directions below to complete this activity.

1. Add water to the cup. Just enough to cover an M&M.
2. Place the M&M in the middle of the cup without stirring the water up too much.
3. Observe for two minutes.
4. Record your results in the table below:

Action	Observations
Placed an M&M in water and observed for 2 minutes.	

Answer the following questions based on the M&M activity.

1. What was the solute?
2. What was the solvent?



3. Why did the M&M react the way that it did in the water?
4. Draw a picture to represent the water and sugar molecules during the activity.

Part 2: What is Soluble?

Hypothesis: If we have 5 glasses of water and add 1 Tbsp of one of five substances (salt, sugar, baking soda, sand, and oil) respectively into each glass, then

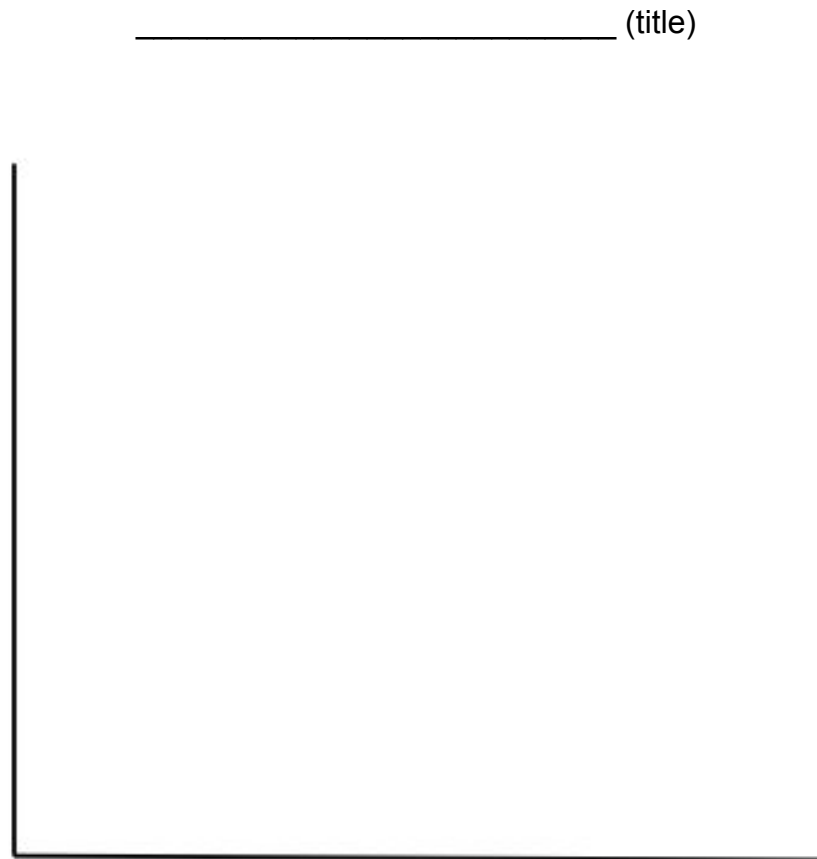
_____ will dissolve and _____ will not dissolve.

For each substance below, keep track of how many stirs it takes to dissolve completely. Record your data below.

	Salt	Sugar	Baking Soda	Sand	Vegetable Oil
Stir Number					
Is it Soluble?					

Create a bar graph using the data you collected. Be sure your graph includes:

- A title
- Hash marks and numbers along the y-axis
- Label units on each axis
- Label the substance for each bar in the graph



Answer the following questions.

1. Which substance dissolved the fastest?
2. Which soluble substance took the longest to dissolve?
3. What is the difference in stirs between the fastest substance and the slowest substance to dissolve?



4. Which substances are insoluble?
5. What is the molecular reason that a substance is insoluble?

Name: KEY

Water as a Solvent

Solute -**substance that is dissolved in a solvent.**

Solvent -**substance that dissolves the solute.**

Soluble - **a substance that can be dissolved**

Insoluble - **a substance that is incapable of being dissolved.**

Part 1: M&Ms in Water

Follow the directions below to complete this activity.

5. Add water to the plate. Just enough to cover an M&M.
6. Place the M&M in the middle of the plate without stirring the water up too much.
7. Observe for two minutes.
8. Record your results in the table below:

Action	Observations
Placed an M&M in water and observed for 2 minutes.	The color coating dissolved from the M&M. The color formed an area of color around it.

Answer the following questions based on the M&M activity.

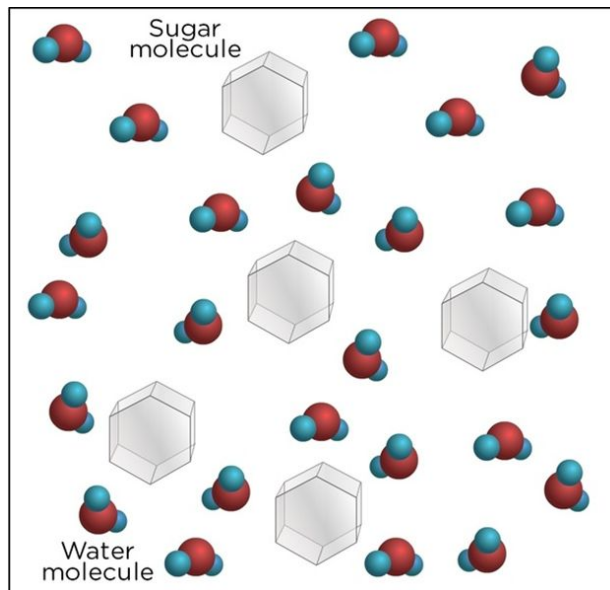
5. What was the solute? **The coating/sugar of the M&M**
6. What was the solvent? **Water**

7. Why did the M&M react the way that it did in the water?

Water is a polar substance. Water, H₂O, has two hydrogen atoms that are positively charged and a negatively charged oxygen atom. The opposition of these charges make water extremely attracted to other polar molecules, like sugar. Water can become so heavily attracted to a different molecule that it can disrupt the attractive forces that hold it together, making it dissolve.

8. Draw a picture to represent the water and sugar molecules during the activity.

Drawings will vary.



Part 2: What is Soluble?

Hypothesis: If we have 5 glasses of water and add 1 Tbsp of one of five substances (salt, sugar, baking soda, sand, and oil) respectively into each glass, then **(Answers will vary: Example)** then the salt will dissolve the fastest and the vegetable oil will not dissolve at all.

For each substance below, keep track of how many stirs it takes to dissolve completely. Record your data below.

****The actual stir-number data for each group will differ slightly.****

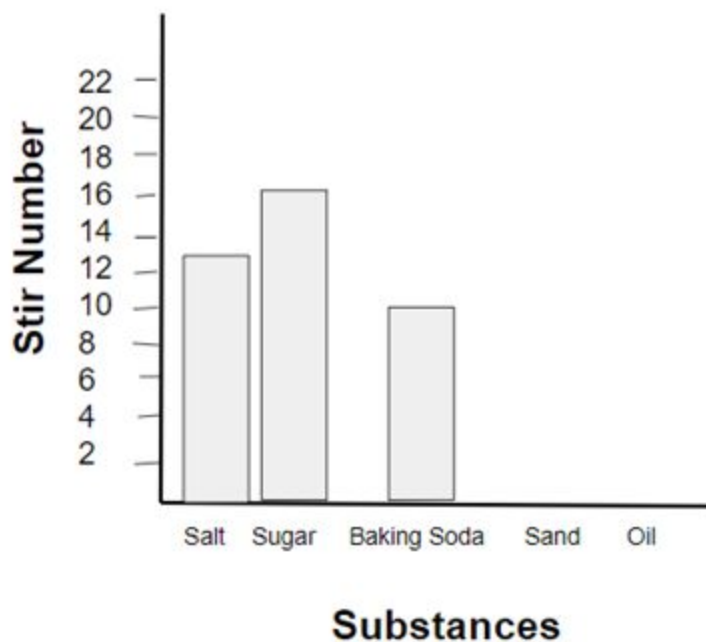
	Salt	Sugar	Baking Soda	Sand	Oil

Stir Number	13	16	10	N/A sank to the bottom	N/A floated on top
Soluble (Yes or No)	yes	yes	yes	no	no

Create a bar graph using the data you collected. Be sure your graph includes:

- A title
- Hash marks and numbers along the y-axis
- Label units on each axis
- Label the substance for each bar in the graph

Water as a Solvent Experiment



Answer the following questions. **Answers will vary. The answers below are based on the example data provided.**

6. Which substance dissolved the fastest?

Baking Soda

7. Which soluble substance took the longest to dissolve?

Sugar

8. What is the difference in stirs between the fastest substance and the slowest substance to dissolve?

6 stirs $16-10 = 6$

9. Which substances are insoluble?

Sand and Vegetable Oil

10. What is the molecular reason that a substance is insoluble?

Insoluble substances have non-polar molecules that do not interact well with water molecules. This means that vegetable oil and sand have non polar molecules. As a rule, nonpolar molecules can dissolve other nonpolar molecules.