

Universal Solvent

Strand	Matter
Topic	Investigating properties of water
Primary SOL	6.5 The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment. Key concepts include a) water as the universal solvent.
Related SOL	6.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which f) one variable is manipulated over time, using many repeated trials.

Background Information

One of the most remarkable properties of water is its ability to dissolve a large number of substances. For this reason, water is called the *universal solvent*. Since water molecules are *polar* molecules, meaning they have a positive side and a negative side, the charges of one molecule attract the opposite charges of other molecules, which is called *cohesion* (the attraction of one molecule to another). *Adhesion* is the attraction of the molecules to molecules of other substances. This attraction, caused by the charges of water molecules, causes many substances to easily dissolve in water.

The substance (water) doing the dissolving or breaking apart of another substance is called the *solvent*. It is not changed chemically when it does this, and it can be recovered for reuse after all dissolved substances are removed. The substance that is dissolved is called the *solute*. The homogeneous mixture of the solute and the solvent is called a *solution*. Most water on the Earth is actually a solution.

Materials

- Beakers
- Water
- Measuring spoons
- Sugar
- Salt
- Sand
- Vegetable oil
- Rubbing alcohol
- Copies of the attached handout
- Test tubes
- Test tube rack
- Graduated cylinder
- Margarine
- Goggles

Vocabulary

adhesion, solute, solution, solvent, universal solvent

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

Introduction

1. Pass out copies of the attached Inquiry Graphic Organizer handout.
2. Put 50 ml of water in each of three beakers. Place 1 tsp. salt in one of the beakers, 1 tsp. sugar in another, and 1 tsp. sand in the third. Stir all three vigorously.
 - Tell students to make observations and list them on the graphic organizer.
 - Ask students which mixtures formed solutions. Have them explain their answers.
 - Ask them which substance in each beaker is the solvent (*water*) and which is the solute (*sugar, salt*).
3. Put 50 ml of water in each of two clean beakers. Add 50 ml of oil to one of the beakers and 50 ml of rubbing alcohol to the other.
 - Ask students to make observations and list these also on the graphic organizer.
 - Ask students which mixture formed a solution, based on their observations. Have them explain their answers and write them on the graphic organizer.
 - Ask them which substance is the solvent and which is the solute.
4. Have students develop class definitions for *solution, solvent, and solute*.

Procedure

1. Organize students into lab teams of four or five students each.
2. List materials on the board, and ask, “How could you use all or some of these materials to design an investigation to demonstrate the ability of water to dissolve materials?”
3. Give teams time to brainstorm, and allow them time to fill out the graphic organizer and come up with an experimental design. (A sample lab investigation is attached: Universal Solvent—Sample Lab Design.)
4. Instruct the teams to write up their lab design and get your approval before proceeding with the investigation.
5. Allow the teams to conduct their experiment and complete their lab reports.

Observations and Conclusions

1. Which solvent dissolved the most solute? Why?

Assessment

- **Questions**
 - What gives water the ability to dissolve so many solutes?
 - How does the ability of water to dissolve materials aid in life processes?
- **Journal/Writing Prompts**
 - Describe in your own words and with illustrations what happens when sugar dissolves in water.
- **Other**
 - Use completed lab reports.

Extensions and Connections (for all students)

- Have students try different amounts of the solutes in water and vary the temperature, predicting, and then recording, the outcomes.

Strategies for Differentiation

- Have students brainstorm examples of common solutions (e.g., powdered drink mix). Have them identify the solute(s) and solvent(s) for each example.
- Have students create a three-way foldable to define and describe, through illustration and definition, the terms *solute*, *solvent*, and *solution*.
- Have students use a digital camera to record and observe experiment results over time.
- Have students draw or cut and paste a visual representation of their observations and conclusions.
- Have students use graphic organizers to record observations and results of the experiment.
- Have students work in pairs or assigned groups to complete the graphic organizer and answer the Reflection Questions.
- Have students work with partners or in small groups to complete the procedure.

Inquiry Graphic Organizer

Name: _____ Date: _____ Class: _____

OBSERVATIONS:



RELEVANT FACTS OR RULES:
Water is the universal solvent.



POSSIBLE EXPLANATION:



HYPOTHESIS:



ACTIVITY OR EXPERIMENT (list steps):



RESULTS:

Inquiry Graphic Organizer Answer Key

OBSERVATIONS: Sugar and salt dissolved in water, but sand did not. Rubbing alcohol mixed completely in water, but oil did not.

POSSIBLE EXPLANATION: A solution forms when one substance mixes into another liquid substance. More substances will dissolve in water than in any other liquid.

HYPOTHESIS: If sugar, salt, and margarine are mixed in water, rubbing alcohol, and oil, then sugar and salt will dissolve in water and alcohol, but not in oil.

ACTIVITY OR EXPERIMENT: (list steps)

(Possible steps: see attached Universal Solvent—Sample Lab Design)

Universal Solvent—Sample Lab Design

Purpose

Hypothesis

Materials

Graduated cylinder, nine test tubes, test tube rack, water, rubbing alcohol, vegetable oil, salt, sugar, margarine, goggles

Procedure

Independent Variable:

Dependent Variable:

Constants:

Steps

1. Number the test tubes 1–9.
2. Put on goggles.
3. Pour 10 ml of water into test tubes 1–3. Pour 10 ml of alcohol into test tubes 4–6. Pour 10 ml of vegetable oil into test tubes 7–9.
4. Place 1/2 teaspoon sugar into test tubes 1, 4, and 7. Place 1/2 teaspoon salt into test tubes 2, 5, and 8. Place a small piece of margarine into test tubes 3, 6, and 9.
5. Cover each test tube with your thumb, and shake vigorously.
6. Observe each test tube, and record observations.

Data Table

Fill in the table, using numbers to indicate the degree of dissolving, as follows: 3 = 100% dissolved; 2 or 1 = partially dissolved; 0 = undissolved.

SOLVENT	SOLUTE		
	Sugar	Salt	Margarine
Water			
Alcohol			
Vegetable oil			

Reflection Questions

1. Which solvent dissolved the most solute?
2. What gives water the ability to dissolve so many solutes?

3. How might the fact that water can dissolve so many other substances be essential for life?
4. What would this help living organisms do?

Conclusions

1. What was your hypothesis?
2. Do the results support your hypothesis?
3. Was your hypothesis correct or incorrect?
4. What happened in the investigation?

5. Use the average data and your answers to the Reflection Questions to summarize the results. Explain why the results happened as they did, and include all discoveries you made. Make an inference based on what you know.