Pre-Visit Activity #2

Solubility

Overview — Solubility is the ability of a substance to dissolve. Some substances have higher solubility than others. In this activity students explore solubility by trying to dissolve different substances in oil and water. Students will use their knowledge of solutions to grow their own speleothems.

Objectives — Students will demonstrate dissolution of solids and liquids and investigate deposition (the process that allows growth of speleothems) through simple experiments. Based on their observations, students will conclude that both solids and liquids can dissolve, but not necessarily in all liquids. Students will be able to infer how a deposit of oil from a mammal's skin can kill a cave formation.

Subjects — Science

TEKS — **(5.5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:**

D. identify changes that can occur in the physical properties of the ingredients of solutions such as dissolving salt in water or adding lemon juice to water.

Part A: Dissolution

Materials needed for each group

Water	Sugar	5 clear cups or baggies
Vegetable oil	Spoon	Food coloring

Background

The characteristics of oxygen and hydrogen atoms and how they bond together to form water molecules result in a negative charge near the oxygen and a positive charge near the hydrogens. The molecules in liquid water associate very closely with each other. The positive part of one water molecule is attracted to the negative part of another. In order for something to dissolve, the solvent (water in this case) must have a strong enough charge to overcome the attraction that exists amongst the molecules of the solute (sugar in this case). A solute that dissolves in water, like sugar, will not dissolve in vegetable oil because the orientation of the atoms that make up an oil molecule is different from that of water. The mutual attraction between an oil molecule and a sugar molecule is not strong enough to overcome the attraction of sugar molecules to themselves. The same goes for oil and water. This is why we do not touch any of the formations in a cave. Once we put oil from our skin on a formation, the calcium bicarbonate solution that makes our formations grow (calcite and carbon dioxide

dissolved in water) will not bond with the oil on the formation's surface. The calcite will not precipitate, and the formation will stop growing.

Getting Ready

You can either use four separate containers for the experiment, or have your students rinse and dry two containers between the procedures for dissolving in water and dissolving in oil. It may help to explain to your students that they can see dissolution in everyday things: sugar in tea, Kool-Aid, Jell-O, etc.

Doing the Activity

A. Dissolving in water - Sugar

1. Place about 1 tablespoon of room-temperature water in each of 2 clear containers.
2. Add 1 teaspoon of sugar to one container and swirl/shake for 10 seconds. Observe.
3. Swirl for another 10 seconds and observe.
4. Then swirl for a final 10 seconds and observe.

B. Dissolving in water – Food coloring

1. Gently place 1 drop of food coloring in the other container of water. Observe.
2. Swirl for a few seconds and observe.
3. Swirl for a few more seconds and observe.

Expected results

After swirling, very little to no sugar is visible in the water. The food coloring combines quickly and colors the water evenly. Make sure your students understand that the sugar is present even though they can't see it, and that the sugar and food coloring are distributed evenly throughout the water. The experiment so far has shown that both solids and liquids can dissolve.

C. Dissolving in oil

Substitute vegetable oil for water and follow the same procedure as stated above for both sugar and food coloring.

Expected results

After swirling, most or all of the sugar and small drops of food coloring are visible in the oil. Certain substances dissolve in some liquids but not necessarily in others.

D. Oil & water

Conduct the experiment one more time with oil and water. Explain to your students that, as mammals, we have oils on our skin. This is important in helping them to understand why we do not touch cave formations.

Assessment

As a class, write a list of their observations from the experiments. Some observations that you might include are:

Sugar and food coloring were evenly mixed in the water-no pieces or drops were visible

Sugar "disappeared"

Solids and liquids can both dissolve

Sugar dissolved in water, but not oil. Even though a solid or liquid may dissolve in one liquid, it may not necessarily dissolve in another

Part B: Speleothem Formation

Materials	Epsom salts	Spoon	A piece of cotton yarn or string
	Warm water	2 washers	2 jars or cups of the same size
	A saucer (anything for the formation to drip onto)		

Background

Water containing the Epsom salt moves through the string. As the water evaporates, crystals of Epsom salts are deposited. The Epsom salt formations are just models of how crystal deposits form in caves. Calcium found in limestone dissolves in carbonic acid (rain water plus carbon dioxide), which seeps through the roofs of caves. When the water falls from the ceiling, small particles of calcium carbonate, or calcite, are left behind. These deposits eventually form stalactites. The water that reaches the floor evaporates, again leaving behind the calcite. These grow to form stalagmites. This process takes place over hundreds or thousands of years.

Doing the Activity

1. Tell the students that they will be conducting an experiment that will demonstrate how water can deposit minerals to create speleothems (secondary mineral deposits formed in caves).

2. Ask the students if they have ever seen stalactites or stalagmites. Do they know which is which? How do they form? Discuss how water can carry calcite in solution then deposit the calcite in crystalline form in a cave.

3. Explain that this process takes thousands of years in a cave. Your students will speed up the process in the classroom by using a concentrated solution and sunlight to aid in evaporation.

4. Note: Your students may create the set-up, help with it, or watch as you complete the steps.

Procedure:

Dissolve as much Epsom salt as you can in two jars half full of very warm water.

Attach a washer to each end of the yarn and soak the entire yarn in the solution. Lay the yarn on the jars so that both ends are well inside the solution in each jar and it hangs over the saucer with a slight dip in the middle.

Allow the jars to sit undisturbed for several days.

5. Have the students check the experiment each day. Are there crystals in other places than at the dip in the string? Where and why? As the stalactite grows, it may either become heavy and fall off the string or grow into the stalagmite beneath it and form a column.

Troubleshooting

If the water that drips into the saucer evaporates but no formation grows, there is probably not enough salt in your solution. If the saucer fills with water, you need to increase the rate of evaporation or decrease the drip rate. Try differing amounts of sunlight or changing the length of string between the cups.

Supplemental

A. Watch the water level in the jars and discuss speleothems, water levels, groundwater and recharge. Notice the water levels go down and do not get refilled. Would this happen in a cave situation? (The water does drip and goes further into the ground and, depending on the area, may not be recharged until a heavy rain.) If there is no recharge, what will eventually happen? What does this mean to the cave system? (The formations would stop growing.)

B. Refill your cups with water, but not salt. When the unsaturated solution comes into contact with the formations that have formed, it will dissolve the salt and destroy the formations. This happens in the cave environment as well. Usually the entire formation will not be destroyed; rather a depression or cavity will form in the formation. This is the same process that formed the cave! It is dissolution, not erosion, that is the working mechanism of cave and speleothem formation.

Assessment

As a class, have your students summarize what they have learned about solutions and explain in detail what happens when a person touches the formations in a cave.