A key NASA strategy to look for current or past life on Mars involves “following the water” – looking for places where water currently or once existed on the planet. In this activity, we will consider some of the reasons why liquid water is important for life on Earth and may be important for life on Mars. In particular, we will consider the properties of ease of evaporation, solubility, and abundance.

**Ease of Evaporation**

Even though a liquid may not boil at room temperature, it can still evaporate depending upon atmospheric conditions. If a liquid evaporates over the course of a few hours when set on a counter top, it is easy to evaporate. If a liquid can remain on a countertop for several days without evaporating, it is difficult to evaporate.

1) If you place a full cup of water out on a table in your classroom, will it start to boil? Why or why not?

2) If you leave a full cup of water out on the table overnight, would you expect the level of the water to increase, decrease, or stay the same by the next day? Explain your reasoning.

3) Now imagine that you leave three cups out on a table overnight. One is filled with water, the second with rubbing alcohol, and the third with vegetable oil. They are all filled with exactly the same amount of liquid. How would you expect the levels of each liquid to change by the next day? Which will evaporate the most? Explain your reasoning.
Why Follow the Water?
Student Guide

Solubility

The solubility of a liquid describes how easy it is for another substance to dissolve in the liquid. If you dissolve a solid in a liquid, the solid is called the solute and the liquid is called the solvent. Following this pre-lab, you will design and conduct an experiment to test the solubility of three solvents (water, vegetable oil, and rubbing alcohol) using three solutes (salt, sugar, and cornstarch).

1) Two students dissolve a spoonful of salt into a container of water. Which substance is the solvent and which is the solute?

2) Chocolate powder is soluble in milk. What does soluble mean?

3) Two students are preparing to do a solubility experiment. They carefully measure equal amounts of three solvents (water, oil, and rubbing alcohol) into different containers. They are now discussing ideas for testing the solubility of sugar in these liquids.

Student 1: I think we should put ten spoonfuls of sugar into each cup. If the sugar is soluble, the solvent should be able to dissolve all of it. After we stir up the liquid, we’ll see if the sugar has disappeared.

Student 2: What if the solvent can dissolve one spoonful but not ten? If we dump too much sugar in at once, we won’t know if the solvent could have dissolved a smaller amount. I think we should add a spoonful of the sugar at a time.

Do you agree or disagree with either or both of these students? Explain your reasoning.
Lab Objective: The purpose of this lab is to determine the relative solubility of the following solvents: water, rubbing alcohol, vegetable oil. You will have the following solutes to conduct this experiment: sugar, salt, and cornstarch.

Materials: Below is a list of materials for the lab. In the Procedure Section below, describe how you will use these materials to complete the lab objective.

- Solvents: water, rubbing alcohol, vegetable oil
- Solutes: sugar, cornstarch, salt
- Other materials: empty cups for solvents (3), spoons (3), stirrers (3), markers (1)

Procedure: (How will you do your experiment? Be sure to include step-by-step instructions, including the amounts of each substance you are using.)

Observations and Results: (What did you find out? Rank the solvents from best solvent to worst solvent.)
Why Follow the Water?
Student Guide

WHY FOLLOW THE WATER?
Post-Lab Questions

Ease of Evaporation
1) Based on your discussion about ease of evaporation, rank water, oil, and alcohol from the easiest to evaporate to the hardest to evaporate.

2) Based upon the results regarding evaporation ALONE, which liquid would you expect to be the most useful for life? Explain your reasoning.

Solubility Experiment
3) With the three solutes tested in the solubility lab, which liquid was the worst solvent (water, rubbing alcohol, or vegetable oil)? Explain your reasoning.

4) Sugars, salts, and other solutes need to be able to move into, out of, and inside cells in order to carry out the basic functions of life. If a cell composed of mostly the liquid you listed in Question 3, would the cell still be able to transport solutes easily around the cell? Explain your reasoning.

5) Based upon the results of the solubility experiment, rank the three liquids from highest solubility to lowest solubility.

6) Based upon the results of the solubility experiment ALONE, which liquid would you expect to be the most useful for life? Explain your reasoning.
Why Follow the Water?

Student Guide

Abundance at the Surface of the Earth and Other Properties

A final characteristic we will consider is the abundance or amount of liquid present at or near the surface of the Earth. The table below lists the abundances of rubbing alcohol, crude oil, and water at or near the surface of the Earth in units of cubic kilometers. Crude oil and vegetable oil have similar solubility and evaporation properties, but there is much more crude oil present at or near the surface of the Earth than vegetable oil.

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Abundance (in cubic kilometers)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubbing Alcohol</td>
<td>Trace amounts</td>
</tr>
<tr>
<td>Crude Oil</td>
<td>175</td>
</tr>
<tr>
<td>Water</td>
<td>1,375,500,000 (over 1 billion)</td>
</tr>
</tbody>
</table>

7) What do you notice about the abundance of water near the surface of the Earth compared to other two liquids?

8) Based upon abundance ALONE, which liquid would you expect to be the most useful for life? Justify your answer.

9) In this activity, we have tested only three liquids (water, vegetable oil, and rubbing alcohol) for three properties (solubility, evaporation, and abundance). List some other liquids we could test if we had more time and resources. What are some additional properties that could be investigated?
Conclusions
10) Now consider all three liquid characteristics we have investigated. Complete the following table based upon the results of our three investigations. In each column, rank the solvents from high (1) to low (3) in terms of their solubility, ease of evaporation, and abundance at or near the surface of the Earth.

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Solubility</th>
<th>Ease of Evaporation</th>
<th>Abundance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubbing Alcohol</td>
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</tbody>
</table>

11) Based upon all three properties considered TOGETHER, decide which liquid (water, oil, rubbing alcohol) is probably most important for life on Earth. Explain your reasoning.

12) NASA scientists looking for evidence of life on Mars think it is important to “follow the water.” Why do you think scientists link the presence of water on other planets to possible life there?