

ECOS Inquiry Template

1. CONTRIBUTOR'S NAME:

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2. NAME OF INQUIRY: PHASES OF MATTER: UNDERSTANDING THE CHEMISTRY BEHIND WATER QUALITY

3. GOALS AND OBJECTIVES:

a. Inquiry Questions: How are solutions made? What is dissolved in our water? What does water quality really mean?

b. Ecological Theme(s): Understanding the solubility of compounds in water and how this impacts water quality in the environment

c. General Goal: To teach the students some basic chemistry concepts and vocabulary (i.e. phases of matter, the idea of solutions and solubility, how temperature can change the amount of compound that can go into solution.)

d. Specific Objectives: To teach the students the chemistry concepts behind the idea of water quality. What does pH really mean? Why is it important to test the levels of dissolved compounds in solution? What kind of compounds need to be dissolved in water to allow plant and animal life to survive?

e. Grade Level: 1-5

f. Duration/Time Required: 2-1hour classes for 1/2; 1 hour for 5th graders.

→ Prep time: 1 hour (making supersaturated solutions)

→ Implementing Exercise During Class: 45 min

→ Assessment: 15 min at end of class

4. ECOLOGICAL AND SCIENCE CONTEXT:

a. Background (for Teachers): Water quality is an important ecological topic but what does water quality really mean? We use words like solubility, pH, dissolved compounds in solution but often we don't define these terms in a scientific way. To adequately describe the importance of water quality, students need to understand the chemistry and vocabulary surrounding this issue.

b. Background (to present to Students):

For 1st and 2nd graders: Go over vocabulary for **matter, solid, liquid, gases**. Ice and water, boiling water (water vapor) can be used as visual aids. Talk about the difference in the energy of the different phases of matter (i.e. the molecules in a solid are held very tightly together, to cause a solid to change to a liquid, energy needs to be added to the system. The molecules of a liquid have more energy and are not held as tightly together, etc.) This can be illustrated with the younger students by putting the students into groups. One group is solid, one is liquid, and one is gas. The students that are solids will need to tightly hold onto on another and will not be able to move. Students that are liquids will need to remain in the container that they are placed in (i.e an area of the room) but they can move around freely in the space provided. The students that are in the gas group can move all around the room, anywhere they want. The students in the gas group have plenty of energy and hardly every bump into each other.

Show demo of a liquid changing into a solid rapidly. This is done by making a saturated solution of sodium acetate in water. Ask the students how quickly they think something can change from a liquid to a solid at room temperature. This solution is more of an example of

making crystals, or “crashing out” a solution, but it should hold their attention and make them aware that other solutions/mixtures besides water go through phase changes under normal conditions.

The 1st and 2nd graders can now be introduced to the vocabulary of solutions and solubility. Then the idea of water quality can be presented. This might most easily be explained in the first hour of class by explaining the water cycle. Students can then color and put together a water wheel. This water wheel shows the water cycle and the different phases of water that occur naturally in the environment.

For 5th graders: Start by placing a periodic table of the elements on the board. Ask students what they know about the elements. Based on the responses, fill in blanks, add and expand on ideas, discuss how water is represented. Then go over vocabulary (**matter, solid, liquid, gas, plasma**). Show them a phase diagram for water. Explain that as you change temperature and pressure you can change the phase of the compound/element. At this time, the dry ice topic can be touched on again. The students do not know that dry ice is made of compressed carbon dioxide. With the phase diagram, students will be able to see that under increasing pressure you can cause a gas to be compressed to a solid without going through the liquid phase.

After introducing the periodic table and preliminary vocabulary, introduce the terms **solutions and solubility**. These terms should be familiar to most 5th graders. Then show the demo again asking the students how long they think it takes a solution to change from a liquid to a solid.

Now the concept of water quality can be introduced. Students can be asked what kind of molecules need to be in solution to have healthy water and keep plants and animals alive. Ideas like fertilizer, pesticides can be touched on. Dissolved oxygen, carbon dioxide, nitrogen, pH, phosphorous can all be talked about. Use the periodic table as necessary to show them what the symbol looks like, where it's located on the table, etc.

Students can make estimates as to how much sugar will dissolve in a beaker of water. Hot plates will be provided to heat water if the student chooses to do so. Hopefully they will realize that water has a saturation point at a certain temperature and if you increase the temperature of the water, more sugar can be dissolved into the water. This exercise illustrates what can happen in the summer when it becomes very warm. The amount of oxygen is decreased and the amount of soluble elements is increased. This can lead to unhealthy water for fish. Students can also use the pH, nitrate, and ammonium kits to test the water of the aquarium. The idea of water quality should be more apparent to them at this point.

5. **MOTIVATION AND INCENTIVE FOR LEARNING:** This inquiry is designed to build off previous inquiries on ecosystems. The students have already been exposed to designing a healthy aquarium and the idea of water quality to keep the frogs alive. This inquiry specifically discusses water quality and there are some hands on activities for the students to participate in. Students will be able to determine how much sugar will dissolve in cold and warm water.

6. VOCABULARY:

Matter: The scientific name for everything that has mass (weight) and takes up space.

Solid: Matter in which the molecules are very close together and cannot move around. Examples include rocks, wood, ice (frozen water).

Liquid: Matter in which the molecules are close together and move around slowly. Liquids can take the shape of the container they are in but they cannot move outside of the container. Examples include water, lava (molten rock).

Gas: Matter in which the molecules are widely separated, move around freely, and move at high speeds. Examples include the air we breathe (nitrogen, oxygen, and others), steam (water vapor).

Plasma (for 5th grade only): A plasma is a gas composed of free-floating ions (atoms with positive or negative charges-use periodic table to illustrate). A plasma conducts electrical currents and there are many different types of plasma. There is plasma in stars, and the solar wind is made of plasma. Plasma was discovered in 1879 by William Crookes.

Solutions: This is when one group can dissolve another group, or when a solvent (water) can dissolve a solute (sugar). Solutions specifically happen when the solute (sugar) is evenly distributed throughout the solvent (water). There is usually more solvent than solute and the solvent is the one that does the dissolving. Mixtures occur when the solute is not evenly distributed throughout. Think sand in water in this case. Some of the sand dissolves but most sinks to the bottom of the container. Since this is not an even distribution, it is called a mixture.

Solubility: Solubility is the ability of the solvent (water) to dissolve the solute (sugar). Temperature can change solubility. When you heat up a solvent, it can dissolve more solid materials (sugar) and less gas (carbon dioxide). Also, when you increase the surrounding pressure, you can usually dissolve more gases in the liquid (think soda cans).

7. SAFETY INFORMATION: STUDENTS WILL BE USING HOT PLATES TO BOIL WATER AND TO HEAT WATER TO DISSOLVE SUGAR/HOT CHOCOLATE. HOT PLATES ARE MUCH SAFER THAN BUNSEN BURNERS BUT MONITOR STUDENTS TO ENSURE THAT THEY DO NOT TURN THE HEAT UP ALL THE WAY AS THE TOP OF THE HOT PLATE CAN BE HOT.

8. MATERIALS LIST (including any handouts or transparency masters): GLASS BEAKERS, HOT PLATES, SUGAR OR HOT CHOCOLATE, WATER (SOME TO BE HEATED)

9. METHODS/PROCEDURE FOR STUDENTS:

a. Pre-investigation work:

b. Investigation work:

- 1) What evidence (data, samples) do students collect?
- 2) How do students present the evidence (data)?
- 3) What conclusions are drawn from the evidence students collect?
- 4) Include examples of data sheets.

10. ASSESSMENT: (worksheet for 5th grade)

Name: _____

1.) Estimate the amount of sugar that will dissolve in 50 milliliters of water.

Using the table below, record the amount of sugar added initially to the water. Also, if more sugar is added, record that value as well.

Time to dissolve sugar	Initial amount of sugar	Additional sugar added

Total sugar added:

2.) Based on your observation in part 1 and what you have learned today, estimate how much sugar will dissolve in 50 milliliters of water with an increase in temperature.

This time heat the water slowly. Using the table below, record the initial amount of sugar added to the water. Record the additional amount of sugar added. Record your observations and any differences that occur when heating the water.

Time to dissolve sugar	Initial amount of sugar	Additional sugar added

Total sugar added:

3.) Based on your observations in questions 1 and 2, what conclusions can you make about the solubility of sugar in water?

11. EXTENSION IDEAS:

12. SCALABILITY: THIS OUTLINE COULD BE SCALED UP TO HIGHER GRADE LEVELS AND IT COULD ALSO BE EXPANDED TO TAKE UP MORE THAN ONE CLASS PERIOD.

13. REFERENCES:

PHASES OF MATTER, ENCHANTED LEARNING.COM, INTERNET (2005),
[HTTP://MEMBERS.ENCHANTEDLEARNING.COM/PHYSICS/PHASESOFMATTER.SHTML?P.](http://members.enchantedlearning.com/physics/phasesofmatter.shtml)

RADER'S CHEM4KIDS.COM, INTERNET (2005),

14. LIST OF EXPERTS AND CONSULTANTS

DR. GARON SMITH, UNIVERSITY OF MONTANA CHEM. DEPT.

15. EVALUATION/REFLECTION BY FELLOWS AND TEACHERS OF HOW IT WENT:

Overall, this lesson went really well with both grade levels. The 5th graders did not have enough time for the sugar water activity, so less time should be spent on the introduction if there is only a 1 hour time slot. Otherwise, the 5th graders really loved having a hands-on activity to work on.