



Question: What are the properties of water?

1 The shape of a water droplet

Table 1: The shape of a water droplet

	Describe shape of water droplet	Why does it look this way?
Wax paper		
Copy paper		
Glass slide		

- a. Of the three surfaces—wax paper, copy paper, and glass—which is polar and which is nonpolar?
- _____
- _____
- b. Fill the pipette with some water. Release water drops from the pipette so that they fall to the floor. Describe the shape of the water droplets. Come up with an explanation of the shape of these falling droplets. When you have answered this question, be sure to dry the floor with a paper towel.
- _____
- _____
- _____
- c. The falling water droplets are most like which of the droplets that you placed on the three surfaces? Why do you think the shape of this water droplet resembled a falling water droplet?
- _____
- _____
- _____
- _____

Table 2: Building molecules

Name of molecule	Chemical formula	Number of lone pairs	Shape of molecule
Methane			
Ammonia			
Water			

- a. In each of the molecules you built, there is a center atom surrounded by four sets of electron pairs. The electron pairs are either alone, or part of a bond. How does the presence of lone electron pairs influence the shape of a molecule of water?

- b. Water and ammonia are polar molecules (having positive and negative ends) while methane is nonpolar. Do you think the presence of lone electron pairs affects the polarity of a molecule? Explain your reasoning.


3**Polarity versus nonpolarity**

- a. Describe what happened when you first tried to mix the oil and water. What evidence did you observe that proves that oil and water do not mix?

- b. What happened when you added a little detergent to the oil layer? In particular, describe how the oil layer “reacted” to the detergent.

- c. At the end of step 5, there are three kinds of molecules in the beaker—water, oil, and detergent. Make a diagram that shows how these molecules interact with each other in the beaker.

- d. Now that some time has passed, do you notice any changes? Try to stir the oil into the water. What happens? Explain your observations.

- e.  Having done this demonstration, do you think detergent would be useful in cleaning up an oil spill in the ocean? What would be the advantages or disadvantages of using detergent to clean up an environmental problem like an oil spill? You may do research on the Internet or in your local library to answer this question.

4**Using electrolysis to demonstrate the composition of water**

- a. The setup you have created will result in water molecules splitting into hydrogen and oxygen atoms. Hydrogen and oxygen are both gases. Therefore, you will see small bubbles collecting near each pencil tip. Describe the number and size of the bubbles collecting near each pencil tip.

- b. Which gas is collecting near the pencil tip that is connected to the “+” lead? Justify your answer.

- c. Which gas is collecting near the pencil tip that is connected to the “-” lead? Justify your answer.

- d. How could you prove that your answers to 4b and 4c are correct? Come up with a research plan to prove your answers. Hint: It will be helpful to know the properties of both gases to prove their identity.

23.2

Solutions



Question: Can you identify mixtures as solutions, suspensions, or colloids?

1**Preparing the Tyndall effect viewer**

Safety Tips: Wear safety goggles and a lab apron throughout the experiment. Use a utility knife with care.

There are no questions to answer for Part 1.

2**Testing the Tyndall effect viewer**

3. View the beaker through the square cut in the short side. The path of the light beam should be visible in your mixture. Describe what you see.

4. Fill a 250-milliliter beaker with 200 milliliters of water. Place it in the viewer. Can you see the path of the light beam now? If no beam is visible, the viewer is working correctly. Use this beaker in parts 3 through 5 of the Investigation.

3**Preparing the mixtures**

There are no questions to answer for Part 3.

4**Designing your procedure**

- a. Revisit the table of properties of solutions, colloids, and suspensions in section 23.1 What is a Solution? of the student text. Design a procedure that will enable you to classify your six mixtures correctly. Your procedure should include at least two tests for each mixture.

- b. Observe each mixture. Write a hypothesis that explains what type of mixture you believe it is. Give a reason for each prediction.

5

Collecting your data

Follow your written procedure. Record your results in the table below.

Table 1:

Substance added to 200 mL water	results of test #1	results of test #2	solution, colloid, or suspension?
(1) corn oil			
(2) food coloring			
(3) corn starch			
(4) granulated sugar			
(5) modeling clay			
(6) gelatin			
(7) plain water			control solution

6

Cleaning up

There are no questions to answer for Part 6.

7**What are your conclusions?**

- a. Did your two procedures help you tell the difference between solutions, colloids and suspensions? Provide evidence to support your response.

- b. Were your hypotheses about each mixture correct? If not, explain why.

- c. Why was plain water tested in the Investigation? What does the word *control* mean?

- d. Is water a true solution? Explain your answer.

- e. If you had a mixture that was not translucent, how could you determine if it should be classified as a solution, colloid, or suspension?

8 Dissolving rates

- a. *Practice:* Suppose it takes 45 seconds for 3.0 grams of rock salt to enter a solution. What is the average dissolving rate?

- b. Which variables do you think affect the dissolving rate of rock salt?

9 Brainstorming ideas and formulating your hypothesis

- a. As a group, decide on three different methods to influence the rate of dissolving. Remember that in order to draw valid conclusions in an experiment, you can change only one variable at a time! Write a step-by-step procedure for each method. When you have finished, submit your set of procedures to your teacher for approval.

- b. Write a statement describing which of your three procedures will produce the fastest dissolving rate. Be sure to explain your reasoning.



Be sure to include safety instructions in your procedures.

Collecting your data

Follow your written procedure for each of your three methods, recording your data and observations in the table each time.



When you have finished this part of the Investigation, clean all of the materials used by your group.

Table 2:

Summary of procedure	mass of rock salt (grams)	time to dissolve rock salt (seconds)	average dissolving rate (grams / second)	notes

What did you learn?

- a. Using what you have learned in your reading, describe what was happening on a molecular level as you tried to dissolve the rock salt. You may want to use diagrams in your explanation.

b. Which method produced the fastest average dissolving rate? Did you prove or disprove your hypothesis?

c. What other, even faster, methods could you use to get 5 grams of rock salt to dissolve in 250 milliliters of water? Describe these.

Extra space for notes and diagrams:



Question: What factors affect solubility?

1 Experiment I: temperature and solubility

There are no questions to answer for Part I.

2 Procedure



Safety Tip: Carefully follow your teacher's directions for working with the hot water. Take care not to spill it on yourself or others.

Record your observations here:

Table 1: Starting and ending temperatures for the experiment

Temperature range	Starting temperature (°C)	Ending temperature (°C)
Ice water (blue)		
Room temperature water (green)		
Hot water (red)		

Table 2: Starting and ending times for the experiment

Start time for experiment minute:second	End time for experiment minute:second

Table 3: Sugar cube data

Number of cubes	Time recorded when cube dissolves in ice water	Time recorded when cube dissolves in room temperature water	Time recorded when cube dissolves in hot water
1			
2			
3			

3

Analyzing your results

- a. In which beaker of water did three sugar cubes dissolve the fastest? In which beaker of water did the sugar cubes dissolve the slowest?

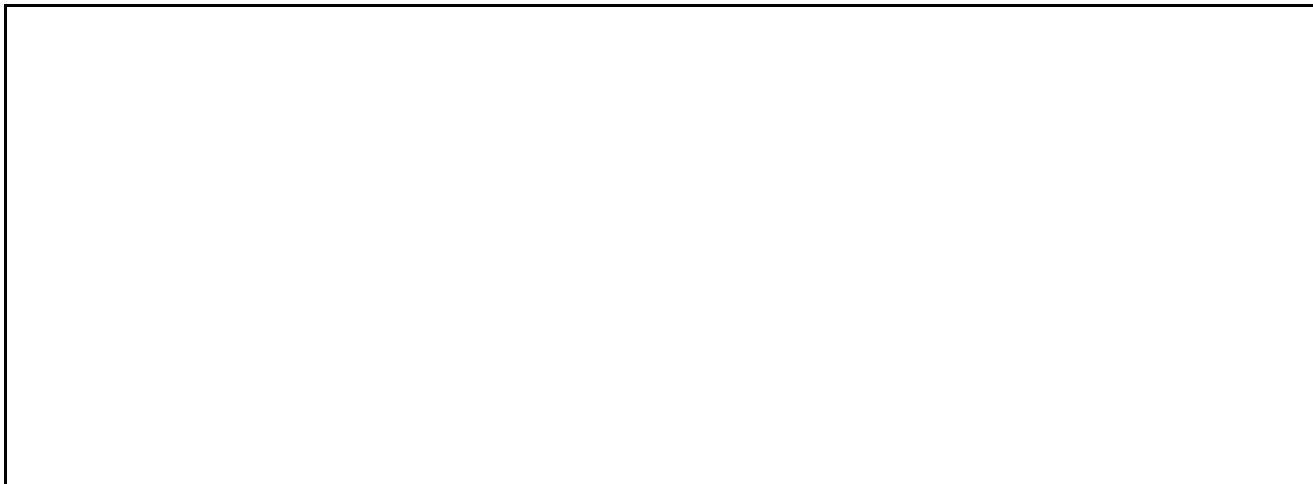
- b. Did the ice water stay colder than the room temperature water for the whole experiment? Did the hot water stay warmer than the room temperature water for the whole experiment? Why was it important to check the water temperature in each beaker at the start and at the end of the experiment?

4

How does temperature influence solubility?

- a. List three observations you made during the experiment. Use what you know about solubility to explain each of these observations. In other words, describe why something you observed occurred or looked a certain way.

- b. Based on your observations of the experiment and your own ideas, draw a diagram that shows how temperature influences how a substance dissolves on the molecular level.



5

Experiment 2: pressure and solubility

- a. How do you know that the liquid in the bottle is under pressure?

- b. How do you know that the liquid contains a dissolved gas?

- c. What do you think will happen to the gas dissolved in the liquid after you take the cap off?

d. Has the size of the bubbles in the liquid changed since you opened the bottle? If so, come up with a reason to explain why this might have happened.

e. Why was the balloon important in this Investigation?

f. How did the pressure change before and after opening the bottle?


g. How did you know the pressure changed?

h. Based on the results and your observations from the experiment, how was the solubility of carbon dioxide gas in water affected by the pressure in the bottle? Use evidence from the Investigation in your response.

i. Make a prediction for how the seltzer will taste a week from now if the bottle is left open. Explain your prediction using the terms pressure and solubility.

- a. Soft drinks contain dissolved carbon dioxide that has been added to make a carbonated solution. The carbon dioxide is kept in solution using pressure. If you were going to start a company that makes carbonated soda, what kind of processes would you use to make and package the soda in aluminum cans? Write out and diagram your ideas. Once you have recorded your ideas, do some research at the local library or on the Internet to see how your ideas compare to real world practices for making and packaging carbonated soda. Record your findings.

- b. In this part of the Investigation, we only looked at the solubility of a gas in a liquid. How do you think pressure affects the solubility of a liquid in a liquid or a solid in a liquid? How do you think temperature would affect the solubility of a gas in a liquid? Provide evidence to support your ideas.

- c.  Read “Science in the Real World: Scuba diving” in the student text. Based on this reading and what you observed in the Investigation, explain why you need to understand the influence of pressure on the solubility of a gas in order to scuba dive safely.

23.4

Acids, Bases, and pH



Question: What is pH?

1 Setting up

  **Safety Tip: Wear goggles and a lab apron during the Investigation to protect your eyes and clothing from the household chemicals that you will be using.**

There are no questions to answer in Part I.

2 Make a pH scale using indicators

Name of solution	Color when mixed with red cabbage juice	Red litmus paper: If paper turns blue, write "base," or make an "x"	Blue litmus paper: If paper turns red, write "acid," or make an "x"	pH
1. lemon				2
2. vinegar				3
3. seltzer				4
4. red cabbage juice				6.5
5. baking soda solution				8.5
6. bar soap solution				10
7. ammonia				11
8. green tea				
9. antibacterial cleaner				
10. apple juice				
11. mystery solution A				
12. mystery solution B				

3**Evaluating the role of the pH test plate**

- a. What is the role of a pH indicator? What is the range of pH measured by each of the indicators you used (red cabbage juice, red litmus paper, blue litmus paper)?

- b. Which of your solutions has the highest concentration of H_3O^+ ions? Which has the highest concentration of OH^- ions? Explain your reasoning.

- c. The red cabbage juice used in the Investigations has two roles. It is the pH indicator and, in the series on the pH test plate, it is a *control*. Why is a control needed on the pH test plate?

4**Using pH indicators to measure unknown pH**

There are no questions to answer in Part 4.

Preparing for your field trip

1. Describe the place that your class will perform water quality testing. Where is it located? What kind of surface water will be tested?

2. Make a prediction about the quality of the surface water to be tested. Will the water in this location be clean or polluted? Justify your answer.

With the class:


1. Create data sheets for collecting quantitative and qualitative data. What information needs to go on the data sheets?

2. Look at a map of the surface water that will be tested. Discuss and decide where samples will be taken. Assign locations to each group.



Question: What is the quality of your tap water?

1 Obtaining your water samples

1. Before coming to class, collect two 500-milliliter (about 2 cups) samples of water from a faucet at your house. One sample should be of very hot water and the other sample very cold water.
2. Collect your samples in large sealable plastic bags. Be sure to label which bag has the cold sample and which the hot sample. Let the water run for 5 minutes before collecting each of your samples. Once you have your samples, place them inside a **second** larger, sealable bag. Make sure all the bags are tightly sealed! You will have to be very careful while you transport your samples. Drop them off with your teacher when you arrive at school.
3.  **Try to use the water that runs from the faucet before you collect your sample. For example, you can collect it for watering your houseplants.**
4. While you are at home collecting your samples, look for any signs that you may have high levels of copper (blue stains), iron (orange stains), or minerals in your water (scale on glasses). Write down your observations in the space below.

5. Find out where your water comes from. You may need to use the Internet to trace this information. A helpful Web site is <http://www.epa.gov/surf>.

Testing your water quality

The pH test: The pH of your tap water can have an effect on the pipes in your house. The pH scale ranges from acids (0 to 6) to bases (8 to 14). Pure water is neither an acid or a base. It is neutral (pH of 7). Acids can corrode pipes and cause iron, copper, or lead to get into your drinking water. Bases can mean that calcium or magnesium deposits will clog your pipes.

- Add a pH wide-range tablet to each of your samples.
- Compare your results with the color series that your teacher has set up. What color is each sample?

- What is the pH of each of your samples?

The hardness test: Hard water has high levels of dissolved calcium and magnesium. These minerals form white deposits on drinking glasses and inside pipes. The deposits, called “scale,” can clog pipes.

- Add a hardness-test tablet to each of your samples.
- Compare your results with the color series that you teacher has set up. What color is each sample?

- Is the water in each of your samples hard or soft?

The chlorine test: Chlorine in safe amounts is added by water treatment facilities to kill harmful bacteria and algae. Chlorine does not occur naturally in water supplies.

- Add a chlorine-test tablet to each of your samples.
- Compare your results with the color series that your teacher has set up. What color is each sample?

- Do your samples contain low or high amounts of chlorine?

The iron test: Iron is a natural component of tap water. However, when water is too acidic, iron may be leached from pipes into the water supply.

- a. Add an iron-test tablet to each of your samples.
- b. Compare your results with the color series that your teacher has set up. What color is each sample?

- c. Do your samples contain low or high amounts of iron?
NOTE: Iron is unstable in water. For this reason, you may not detect iron even when it is present in your water supply.

The copper test: Copper, like iron, can be leached from pipes into the water supply when the water is too acidic. In small quantities, copper is an essential element for human health. Too much copper can make water taste bitter and cause blue stains in sinks and bathtubs.

- a. Add a copper-test tablet to each of your samples.
- b. Compare your results with the color series that your teacher set up. What color is each sample?

- c. Do your samples contain low or high amounts of copper or none at all?

3 Analyzing results and drawing conclusions

- a. Organize your results into a table on a separate sheet of paper.
- b. Write a five to eight sentence paragraph that explains the results of your testing. Use a separate sheet of paper if you need more space to write your paragraph.

c. Is there a difference between the hot and cold tap water samples? Why or why not?

d. How could the method of testing water quality that was used in this Investigation be improved?

e. At a local store or in your classroom, look at the packaging for a water-filtration device. What substances -- and how much of their total presence in the water -- does the device claim to remove? Based on your testing results, would you purchase this device to improve the quality of your own drinking water? Explain your answer.



Question: What is acid rain?

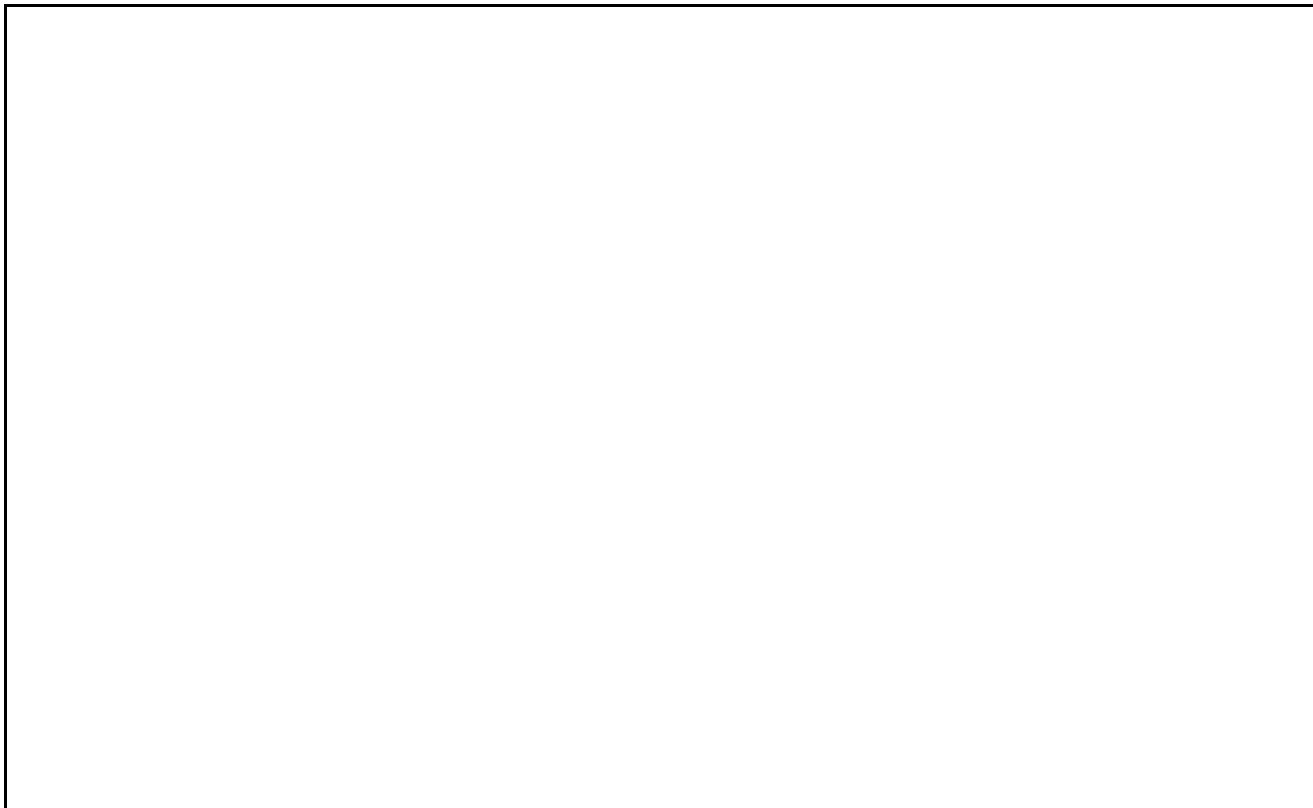


Safety Tips: Wear goggles, gloves, and a lab apron during the Investigation.

1

Observing Daphnia


- a. To understand how Daphnia might react to an acidic environment, it is best to figure out how it acts under normal conditions. Look carefully at this organism. Draw a detailed diagram of a single individual. It may help to use a magnifying glass to see the different parts of this small animal.



- b. Once you have drawn your diagram, watch the Daphnia individuals for 5 minutes. Record the movements and behaviors of Daphnia. Be very detailed in your recording.

- c. Based on your observations, label the parts of Daphnia that you included in your diagram. Next to each label, write what you think the role of each part is.

2**Making predictions**

 You will be exposing Daphnia to different concentrations of acid dissolved in water. Record what you think will happen as you expose Daphnia to acid. Include a list of behaviors that you think will indicate that Daphnia is being harmed by the acid. Determine the lowest concentration of acid that you think will cause harm to Daphnia. Record this hypothesis.

3**Simulating the effect of acid rain on Daphnia**

Con- centration of acid	Treatments	pH	Start time	Observations	End time
none	spring water (control)				
lowest	1				
	2				
	3				
	4				
highest	5				

4



Analyzing results and drawing conclusions

a. Write a paragraph that summarizes the results of this experiment. Do not include any conclusions in this paragraph. Simply write down what you observed.

b. Write a paragraph that explains whether or not your predictions from part 2 were correct. Include a conclusion statement that addresses what you learned by performing this experiment.

c. Was this experiment a good way to understand some of the effects of acid rain on organisms that live in a pond or lake? How could this experiment be improved to better demonstrate the effects of acid rain?

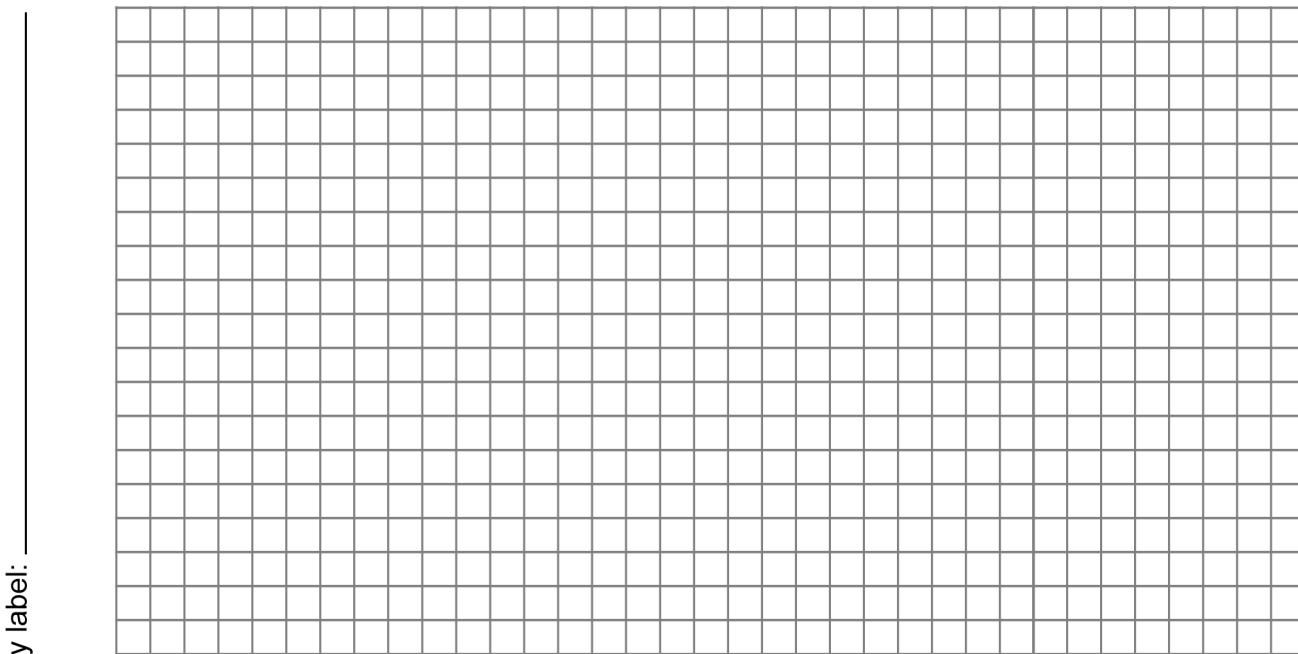
d. What is an *ecosystem*? Why is it difficult to simulate the effects of an event like acid rain on an ecosystem?

3

Analyzing your results

Make a graph of the data in Table 2. Plot the number of drops of acid on the x -axis and pH on the y -axis. You should plot data for beaker **A** using one colored pencil and for beaker **B** with a contrasting color on the same grid.

Title: _____



x label: _____

a. What differences do you observe between the pH changes in beakers **A** and **B**?

b. Do your results provide evidence that buffers help stabilize the pH of solutions? Explain your answer in detail.
