Review and apply
Investigation 4

Let's review
Pages 222-224

1. If someone said to you, "Since a solid dissolves in water, it will dissolve just as well in other liquids."
Would you agree or disagree? Disagree.
Describe a test you could do that would show whether or not you are right. Be sure to explain how you would control the variables so that your test is fair.
Students may describe *Activity 4.2—Dissolving a substance in different liquids*. In this activity, students placed colored sugar in water, alcohol, and oil and then compared what happened in each liquid. Students controlled variables by placing 1 teaspoon of colored sugar and 1 tablespoon of liquid in identical cups. Everything should have been room-temperature. The colored sugar dissolved differently in each of the three liquids. Both the color and sugar dissolved completely in the water. The color dissolved in the alcohol, but the sugar didn't. And neither the color nor the sugar dissolved in the oil.

Students may choose to describe an original test. If so, they should be sure to compare the addition of a solid to at least 2 different liquids. Students should be careful to use the same amount and temperature of each liquid and place the same amount of solid in each.

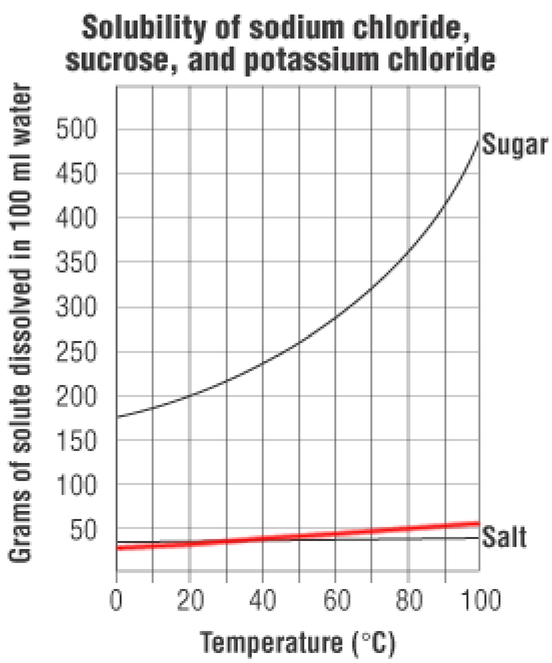
2. If someone said to you, "if one liquid dissolves in water, that means that other liquids will dissolve just as well in water too."
Would you agree or disagree? Disagree.
Describe a test you could do that would show whether or not you are right. Be sure to explain how you would control the variables so that your test is fair.
Students may describe *Activity 4.4—Dissolving different liquids in water*. In this activity, students placed 1 tablespoon of isopropyl alcohol, vegetable oil, and corn syrup in separate cups of water. Students also used the same amount of room temperature water in each cup. All three liquids combined with water differently. The alcohol quickly dissolved in the water and did not need to be stirred. The corn syrup sank to the bottom of the water, but after persistent stirring eventually dissolved. The oil did not dissolve in water: It formed a layer at the surface of the water.

Students may choose to describe an original test. If so, they should be sure to compare the addition of at least 2 different liquids to water. Students should be careful to use the same amount and temperature of each liquid and place each in the same amount of water.

3. The chart below shows approximately how much sodium chloride and potassium chloride can dissolve in 100 milliliters of water at different temperatures. Potassium chloride is used as a salt substitute for people who should not eat regular salt (sodium chloride).

Solubility of sodium chloride and potassium chloride						
Temperature °C	**0**	**20**	**40**	**60**	**80**	**100**
Sodium chloride	**35.5**	**36**	**36.5**	**37.5**	**38**	**39**
Potassium chloride	**28**	**33**	**38**	**44**	**50**	**55**

The graph below shows how much salt (sodium chloride) and sugar (sucrose) can dissolve in 100 milliliters of water at different temperatures. Use the information about the solubility of potassium chloride in the chart above to mark new points on the graph. Then draw a smooth line that comes as close as possible to all the points. This new line will show the solubility of potassium chloride at different temperatures.



4. According to the graph, which substance's solubility is most affected by increasing the temperature of the water? Sugar

Use evidence from the graph to explain your answer.
Much more sugar can dissolve in 100 ml of water at 100°C than at 0°C. At 0°C, about 175 grams of sugar can dissolve, but at 100°C more than 475 grams of sugar can dissolve. That's an increase of over 300 grams of sugar! Barely more salt (3.5 grams) can dissolve at 100°C than at 0°C. And about twice as much potassium chloride (27 grams) can dissolve at 100°C than at 0°C.

5. At what temperature would you say the solubility of sodium chloride and potassium chloride is about the same?
Student's answers should range near 30°C, depending on where they plotted their points. At some point between 20°C and 40°C, the lines for the solubility of sodium chloride and potassium chloride cross.

6. Look at the lines showing the solubility of sodium chloride and potassium chloride. Which is more soluble at low, medium, and high temperatures?
Just above the freezing point of water, sodium chloride is more soluble. At about 30°C, the solubility of sodium chloride and potassium chloride is about the same. At high temperatures near the boiling point of water, potassium chloride is more soluble.

Science in action!
Pages 225-226

1. **Describe a test you could conduct to find out which dissolves faster: a sugar cube or the same amount of sugar granules. Be sure to explain how you will control variables such as the amount of sugar, amount and temperature of the water, etc.**
   Answers will vary. Teachers should check to make sure students have designed an experiment with only one variable—the form of sugar being used. Students should take care to use the same mass of sugar granules as is in the sugar cube, use the same amount and temperature of water, and stir each (or not) in the same way.

   What did you observe during your dissolving test?
   Student drawings should show that more of the sugar granules dissolved in water than sugar from the cube.

2. **What is your conclusion: Does the size of the material being dissolved affect the rate at which it dissolves?**
   Yes, the smaller sugar granules dissolve faster than the larger sugar cube.

3. **Based on what you know about dissolving, try to explain why the sugar granules dissolved faster than the sugar cube.**
   When sugar is in individual granules, many water molecules are able to surround each granule and begin dissolving the sucrose molecules in that granule. But when sugar is in a cube, water molecules do not have easy access to the granules on the inside of the cube so the cube takes longer to dissolve.

Think about it

Pages 229-230

1. **According to the reading, inventors most likely designed another way to make carbonated water because:**
    a. It was dangerous to drip sulfuric acid over marble.
    b. It tasted better when marble was no longer used.
    c. A faster and more convenient way to make carbonated water was needed.
    d. Fermenting grain produces a bad smell.

2. **The idea of modern soda pop came from people in history drinking carbonated water. In the reading, what is the best description of the word *carbonated*?**
    a. water that has flavoring added
    b. the syrup used to make soda pop
    c. any liquid that is sold by the glass
    d. water that contains dissolved carbon dioxide gas

3. **Which is the best summary of the section entitled "Soda pop today"?**
    a. The disagreement over which type of soda is best continues today.
    b. Soda pop is made from four ingredients: water, sweetener, flavoring, and carbon dioxide gas.
    c. Joseph Priestly discovered the method in which soda pop is made today.
    d. Soda pop is actually made from a solid, liquid, and gas.

4. **The purpose for the entire reading is to:**
    a. tell how Joseph Priestly was an amazing inventor.
    b. explain that soda pop contains carbon dioxide and water.
    c. give some examples of how soda pop used to be made with machines in drug stores.
    d. inform the reader about the history of soda pop and how it compares to soda pop today.

5. **The sweetener used in modern soda pop is made from:**
    a. Sugar cane
    b. Starches from corn
    c. Glucose
    d. Fruit juice concentrate

6. **Look back at the picture showing the steps for making modern soda pop. The last step in the process is to:**
    a. add sugar and stir.
    b. add the carbon dioxide and soda solution and seal the container.
    c. heat the soda solution to release carbon dioxide gas.
    d. add the sweetener and flavoring and shake.

7. **What was one of the most challenging problems in making the first artificially carbonated water?**
   One of the most challenging problems was adding carbon dioxide to water. The previous methods depended on using natural springs or adding carbonation in a way that was not convenient for stores and pharmacies where soda was sold.

8. **Why did scientists and pharmacists want to find a way to artificially add carbon dioxide gas to water?**
   Scientists and pharmacists wanted to find a way to artificially add carbon dioxide gas to water so people wouldn't have to depend on the natural springs as the only supply for carbonated water.

9. **Joseph Priestly tried two methods for dissolving carbon dioxide into water. What were they?**
   Priestly first hung a container of water over a beer-making tub that contained fermented grain releasing carbon dioxide gas. He then tried dripping sulfuric acid into marble to produce carbon dioxide gas.

10. **Describe one way old-style and modern soda pop are similar and one way they are different.**
    Answers will vary. However, students should list one example from each category.

    Old-style and modern soda pop are *similar* because:
    - They both use water, sweetener, flavoring and carbon dioxide gas as ingredients.
    - They both use local water.

    Old-style and modern soda pop are *different* because:
    - They produce carbonated water differently. Carbonated water was produced, flavored, and sold in drug stores. In modern factories, carbonated dioxide gas is injected under pressure as soda solution is being added to the bottles of cans.
    - Modern soda is now able to be produced in large quantities by machinery, whereas old-style was produced by hand in small amounts.

What's going on here?

Pages 234-235

1. **Imagine that the six circles represent molecules of a solid. The black dots represent water molecules. Draw pictures and write captions to explain how a solid dissolves in water.**
   Answers will vary but students should make the second drawing with the black dots near and touching the circles of the solid. They might show some of the circles separating a bit from each other. In the third drawing, the black dots should surround each circle of solid which should be separated from the other circles.

2. **Why does sugar dissolve better in hot water than in cold water?**
   Heating makes molecules vibrate and move faster. The movement helps break the attraction sugar molecules have for each other. The higher the temperature, the more grams of sugar can be dissolved.

3. **Most solids dissolve better in hot water than in cold, but the opposite is true for gases. Why does carbon dioxide leave water faster when carbonated water is warmed?**
   Cooling carbonated water slows the motion of the molecules. The slower movement allows the carbon dioxide gas molecules and the water molecules to stay together better. If water containing carbon dioxide is heated, the heat makes the molecules of water and carbon dioxide move faster. This faster motion helps break the attractions between the carbon dioxide and water allowing the carbon dioxide to leave the water.