Activity 2.3
Solubility test

Can you identify the unknown crystal by the amount that dissolves in water?

In *Demonstration 2a*, students saw that more salt is left behind than sugar when both crystals are mixed with the same amount of water. Students can apply this same dissolving test to their known crystals and to the unknown. Since the unknown is chemically the same as one of the known crystals, it should dissolve similarly. By dissolving each of the crystals in the same amount of water and comparing the amount of crystal left behind, students will gain some information about the possible identity of the unknown.

Materials needed for each group

Salt in cup
Epsom salt in cup
MSG (Accent®) in cup
Sugar in cup
Kosher salt in cup (unknown)
Masking tape
Pen
Ruler
Permanent marker
5 Clear plastic cups
6 Small plastic cups, 3½-ounce
Plastic teaspoon
Hot tap water
10 Paper clips

Notes about the materials

- **Be sure you and the students wear properly fitting goggles.**
- **Students should use care when handling hot tap water.**
- Standard metal paper clips weigh about 0.4–0.5 grams each. Students should use 10 identical paper clips to measure 4 to 5 grams of each crystal. About 4 or 5 grams of each crystal is enough to observe differences in solubility.
- The labeled cups and the solutions made during this activity will be used again in *Activity 2.4*.
- *Activity 2.4—Recrystallizing test* should be done immediately after *Activity 2.3—Solubility test*.

Preparing materials

- Use the crystals in the source cups from *Activities 2.1* and *2.2*. If necessary add about 2 teaspoons of each crystal to its labeled cup.

Activity sheet

Copy *Activity sheet 2.3—Solubility test*, pp. 98–100, and distribute one per student when specified in the activity.

Assessment

An assessment rubric for evaluating student progress during this activity is on pp. 108–109. For this formative assessment, check a box beside each aspect of the activity to indicate the level of student progress. Evaluate overall progress for the activity by circling either "Good", "Satisfactory", or "Needs Improvement".

Activity 2.3
Solubility test

Question to investigate

Can you identify the unknown crystal by the amount that dissolves in water?

1. Have students weigh equal amounts of the crystals.

The amounts of crystal and water used in this solubility test are specific and should be used because they give clear results. There are a variety of methods students could use to weigh equal amounts of each crystal. They could construct a balance themselves, like the one described below, or they could use any scale that can weigh 4–5 grams.

Procedure

1. Use your masking tape and pen to label five small cups **salt**, **sugar**, **epsom salt**, **MSG**, and **unknown**. Label five larger clear plastic cups in the same way. You should have two labeled cups for each type of crystal.

2. Tape the pencil down as shown. Roll two small pieces of tape so that the sticky side is out. Stick each piece of tape to the opposite end of the ruler. Place the small empty **salt** cup on one piece of tape so that the edge of the cup bottom is right at the end of the ruler. Place a small unlabeled cup on the other piece of tape in the same way.

3. Lay the ruler on the pencil so that it is as balanced as possible. Use a permanent marker to make a mark on the ruler at the point where it is balanced on the pencil. This is your *balance point*.

Note: Students may find it difficult to get the ruler to balance perfectly. Reassure them that if they get the ruler close to balancing, it will be accurate enough.

4. Carefully place 10 paper clips in the unlabeled cup. Slowly add salt to the **salt** cup until the cup with the paper clips just barely lifts from the table. Remove the **salt** cup from the ruler and set it aside.

5. Weigh the other four crystals in the same way so that you have equal amounts of all five crystals in their small labeled cups.

2. Discuss the variables that need to be controlled in the solubility test.

Ask students how they might mix the crystals into water to compare how they dissolve. You could ask questions such as the following to bring attention to the variables in this test.

- How many cups do we need?
- Should the cups all have the same amount of water?
- What else about the water should be the same? (same temperature)
- What is a good way to mix the crystals into water in each cup?

3. Have students dissolve the crystals in water.

The following procedure is also listed on *Activity sheet 2.3—Solubility test.* The amount of water used in the procedure is specific and should be used because it gives clear results. Swirling the crystals in water is a good way of mixing them to help them dissolve. Lead the class so that all groups pour their crystal samples into the water at the same time. Also tell students when to swirl the water and crystals and when to stop and observe. There will be three 20-second intervals.

Procedure

1. Place 1 teaspoon of hot tap water into each empty clear plastic cup.

2. Match up each pair of cups so that each cup of crystal is near its corresponding cup of water. With the help of your lab partners, listen for your teacher's instructions, and pour the weighed amount of each crystal into its cup of water at the same time.

3. With the help of your lab partners, swirl each cup at the same time and in the same way for about 20 seconds and observe. Swirl again for 20 seconds and observe and then for 20 more seconds and make your final observations.

4. Slowly and carefully pour the solution from each clear plastic cup back into its small empty cup. Try not to let any undissolved crystal go into the small cup. Compare the amount of crystal remaining in each clear plastic cup.

Students should use their observations during the solubility test to help them answer the questions about the possible identity of the unknown on the activity sheet.

4. Have students discuss their observations.

Ask students questions such as the following:

- Do you have enough information to identify the unknown?
- Are there any crystals that you could rule out as probably *not* the unknown?
- What do you think is the identity of the unknown?
- What evidence do you have to support your conclusion?
- If someone in the class had a very different conclusion and had very different observations, what do you think may have led to these differences?

Students should mention possible errors in weighing the crystals, in measuring the amount of water used, the amount and type of stirring, or accidentally pouring the crystals into the wrong cups.

***Expected results*: Results may vary somewhat depending on the temperature of the water. However, Epsom salt and sugar should dissolve the most. MSG should appear to dissolve more than salt and the unknown. The salt and the unknown should appear to dissolve to a similar degree.**

Based on their observations, students are most likely to eliminate Epsom salt and sugar as the possible identity of the unknown. They might conclude that the unknown is salt, but in some cases might think it could also be MSG. Since they may have some doubt, students will do a recrystallization test with the crystal solutions from this solubility test.

Note: *Activity 2.4—Recrystallization test* should be done immediately after the solubility test with the solutions made during this activity.