

Activity 5.9

Comparing the amount of acid in different solutions

How can neutralizing acids help you compare the amount of acid in different solutions?

In *Activity 5.8*, students used a base to neutralize an acidic solution and an acid to neutralize a basic solution. In this activity students will use a similar process to compare the *amount* of acid in two different indicator + acid solutions. The teacher demonstrates this process using laundry detergent solution to neutralize two solutions containing 1 and 3 drops of vinegar. Students will then use the same detergent solution to compare two solutions containing vinegar and cream of tartar. By comparing the number of drops used to return each solution back to its blue color, students can discover which solution initially contained more acid.

Materials needed for the demonstration

Red cabbage indicator
Vinegar
Laundry detergent solution
3 Clear plastic cups
2 Droppers
Permanent marker

Materials needed for each group

Red cabbage indicator 2 Droppers
Cream of tartar 1 Toothpick
Vinegar 1 Tablespoon
Laundry detergent solution Permanent marker
3 Clear plastic cups White piece of paper
3 Small cups

Notes about the materials

- Be sure you and the students wear properly fitting goggles.
- Have students make fresh red cabbage indicator solution according to the instructions on p. 286.

Preparing materials for the demonstration

- Label 3 clean clear plastic cups **control**, **1 drop vinegar**, and **3 drops vinegar**.
- Pour 2 tablespoons of red cabbage indicator into each cup.

Preparing materials for each group

- Make detergent solution for the entire class and the demonstration by combining 1 tablespoon powdered laundry detergent and $\frac{3}{4}$ cups of water in a plastic cup. Stir and wait a minute or two to allow some of the detergent to settle.
- Label 3 small cups **vinegar**, **cream of tartar**, and **detergent**.
- Place about 1 teaspoon vinegar and 1 tablespoon detergent solution in their labeled cups.
- Place less than $\frac{1}{8}$ teaspoon of cream of tartar in its labeled cup.

Activity sheet



Copy *Activity sheet 5.9—Comparing the amount of acid in different solutions*, p. 297, and distribute one per student when specified in the activity.

Assessment

An assessment rubric for evaluating student progress during this activity is on pp. 305–307. 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 5.9

Comparing the amount of acid in different solutions

Question to investigate

How can neutralizing acids help you compare the amount of acid in different solutions?

Demonstration

1. Demonstrate how to use drops of a base to compare the amount of acid in two solutions.

You will need 3 clear plastic cups labeled **control**, **1 drop vinegar**, and **3 drops vinegar**. Each cup should contain 2 tablespoons of red cabbage indicator. Explain that you will use a technique similar to one scientists use to compare the amount of acid in different solutions. This technique is also very similar to the process students used to neutralize solutions in *Activity 5.8*.

Procedure

1. In front of students, use a dropper to add 1 drop of vinegar and 3 drops of vinegar to their labeled cups. Swirl each gently to mix. Ask students if they would be able to tell which cup contained more acid if the cups were not labeled.
2. Use a dropper to add 1 drop of detergent solution to the cup with 1 drop of vinegar and gently swirl. Compare the color of the indicator solution to the color of the control.
3. If the color is not yet blue like the control, continue adding a single drop of detergent solution, swirling, and comparing the color to the control. Stop adding drops when the color is similar to the color of the control. Record the number of drops on the board.
4. Repeat Steps 2–3 for the cup with 3 drops of vinegar.



Expected results: More drops of detergent solution are needed to neutralize the solution with three drops of vinegar than the solution with one drop of vinegar.

2. Discuss student observations.

Ask students:

- Which cup had more acid in it?
- What is the relationship between the amount of acid in the solution and the number of drops of base it takes to return the solution back to neutral?

Students should realize that the more acid in a solution, the more drops of a base, like the detergent solution, will be needed to neutralize the solution.

3. Have students compare the amount of acid in an *indicator + vinegar* solution to the amount of acid in an *indicator + cream of tartar* solution.



Distribute *Activity sheet 5.9—Comparing the amount of acid*, along with cups of vinegar, cream of tartar, detergent solution, indicator solution, and 3 clean clear plastic cups. Have students follow the procedure on the activity sheet.

Procedure

1. Label 3 clear plastic cups **indicator + vinegar**, **indicator + cream of tartar** and **control**.
2. Use a dropper to add 1 drop of vinegar to the *indicator + vinegar* cup. Gently swirl to mix.
3. Use the flat end of a toothpick to scoop up a small amount of cream of tartar. Add the cream of tartar to the *indicator + cream of tartar* cup. Gently swirl to mix.
4. Use a dropper to add 1 drop of detergent solution to the cup with the *indicator + vinegar* and gently swirl.
5. Check to see if the color of the indicator solution is similar to the color of the control. If so, stop and record the number of drops in the chart on the activity sheet.
6. If not, continue adding and counting drops of detergent solution, swirling, and comparing the color to the control. Stop adding drops when the color is similar to the color of the control. Record the number of drops in the chart.
7. Repeat Steps 4–6 for the cup with *indicator + cream of tartar*.

Expected results: The number of drops of detergent solution needed to bring the color of the indicator solutions back to the color of the control will vary. In the cup with *indicator + 1 drop vinegar*, expect to use about 6 drops of detergent solution. When we conducted this experiment, it took about 12 drops of detergent solution to neutralize the *indicator + cream of tartar*. Since the amount of cream of tartar your students add to this cup depends on how much they pile on the flat end of a toothpick, expect the number of drops of laundry detergent students use to neutralize this solution to vary accordingly.

4. Have groups discuss their results.

Ask students questions such as the following:

- Which solution contained more acid: the *indicator + vinegar* or the *indicator + cream of tartar*?
- What evidence led you to this conclusion?
- How might you compare the amount of base in two greenish-blue indicator solutions?

Students should realize that more drops of base are required to neutralize the solution that contains more acid. They should also infer that they would need to add drops of vinegar or some other acid to the two greenish-blue indicator solutions to neutralize each solution. The solution that requires more drops of acid to return it to blue must have contained more base than the other.