

Paint by Number

Grade: K-12	Unit: Chemistry	Topic: Acids and Bases
Time frame: 2 45-minute periods.	Equipment: pH probe	Science skills: Comparison Measurement Categorize Calibration

Purpose:

Students will determine the pH of household products including both acids and bases. Students will compare the pH numbers with a pH color indicator. Using both the color and number scales, students will develop a chart comparing color with pH.

The Plan:

Set the Stage

- *Begin with a predictable event.* Hold up two clear containers. One contains water colored with yellow food coloring, the other contains water colored with blue food coloring. Ask students to predict what will happen if the two liquids are combined.
- *Present a discrepant event.* Hold up two containers. One holds a purple liquid (purple cabbage juice) and the other holds a clear liquid (tonic water). Ask students to predict what will happen when the two liquids are mixed.
- Allow students time to try to explain the puzzle. Do not offer the correct answer.

Develop the Concept

- Present students with containers of a variety of liquids found around the house. Some suggestions are vinegar, baking soda in water, dishwashing detergent, lemon juice, salt and water, tonic water, ammonia and liquid cleanser.

- Give each group litmus paper. Allow students to test, categorize, and make conclusions about each liquid.
- When students have discovered that some things are acids and others are bases, they will be ready to begin developing their own experiment.

Generate the Experimental Question

Students may have many different questions they want to investigate. Let the students “do their own thing” by designing their own experiment. Guide students to ask questions they can answer. Suggestions are listed below.

1. Which is more acidic, Coke or Pepsi?
2. How much distilled water is needed to raise the pH of lemon juice to 5?
3. Do all types of vinegar have the same pH?
4. How much baking soda is needed to neutralize (pH 7) vinegar?
5. Does adding sugar to a grapefruit reduce its acidity?

Internet Investigations

There are many excellent web sites that contain information on acids and bases and pH indicators. Ask students to research a question such as:

1. What is a pH indicator?
2. What is the pH of stomach acid?
3. What is the difference in the amount of acidity between a pH of 7 and a pH of 5?

Calibrate the Instrument

The pH probe, as do the other science probes, measure voltage. The reading will not likely be calibrated to the pH scale of 1-14. Using buffer solutions of known pH (check instructions with the CBL's or MBL's) the pH probe can be calibrated. Using pH paper to determine the values of three different solutions would provide another, less precise calibration method. Using ratios, students can develop an entire pH chart. Provide younger students with a chart that was prepared before class. Calibration will probably take around 30 minutes to complete.

Procedure/Activity Suggestions

Activity I

- A. Students can use a variety of techniques, dependent upon their inquiry question, to produce a set of solutions with a wide range of pH.
- B. Label each solution with its measured pH. This become the “paint set”.
- C. Draw an outline picture. Put numbers, which correspond to the pH of the solutions in the drawing to produce a paint-by-number picture.
- D. Give the picture and solution set to someone in class to paint. Let dry.
- E. Spray a natural pH indicator such as purple cabbage juice over the dried picture. Voila color!

Activity II

- A. Soak a coffee filter in a natural pH indicator. Purple cabbage juice or red onions are two examples.
- B. When the coffee filter has dried, cut it into strips.
- C. Dip the pH indicator strips into various acids and bases. Compare the color produced with the pH indicated by the pH probe.
- D. Create a color chart using the pH indicator strips. Use this to test other unknowns.

Assessment:

Students should be able to explain a method for determining whether something is an acid or a base.

Students should be able to explain a comparison between two acids or two bases.

Students should be able to explain how to change a solution to raise or lower its level of acidity.

Students should be able to measure the pH of a solution.