

## Activity A3 Inquiry Lab

### Evidence of Chemical Change

**Grouping:** pairs

**Time:** 45 min

**Safety:** goggles, glassware, apron, gloves; caution about handling acids and bases carefully

### Purpose

To examine energy changes, physical changes, and the formation of new substances with new properties during chemical reactions.

### Activity Notes

- The data table should look similar to the example below when finished.

Reaction	Observations	
	Before	During and After
a)	shiny solid zinc colourless aqueous acid	bubbles released zinc dissolved
b)	colourless aqueous solutions	pink solution
c)	shiny solid magnesium colourless aqueous acid	bubbles released magnesium dissolved
d)	colourless aqueous acid aqueous blue solution	blue solution turns green then yellow
e)	colourless aqueous solutions	cloudy white
f)	yellow aqueous solution and colourless solution	brown (rust colour)
g)	shiny solid magnesium colourless aqueous acid	bubbles released magnesium dissolved
h)	colourless air	burning, flame, smoke, heat and light released

- Safety Notes:
  - Caution students about handling acids and bases carefully. If a spill occurs, make sure they wash immediately with cold water.
  - The concentration of the acids should be 1 mol/L (see instructions below). At this concentration, acid will not damage skin if it is washed off within about 30 seconds. Note that sulfuric acid in particular will damage clothing.
  - It would be very serious if any acid were to get into an eye. Safe eye protection cannot be stressed enough.
  - Remind students to exercise caution when working around flames. Ensure that students follow correct procedures for lighting and using candles.
  - The volumes used are quite small, but even so, students should empty the waste solutions into a large beaker before washing the test tubes in the sink.

- Metal solutions and their precipitates can be collected. You can treat the solutions by adding sodium carbonate, which causes metal ions to precipitate. The resulting carbonates can be filtered out for later disposal. This cuts down the volume of metal waste.
- Dispose of all chemicals as directed by your school district's policy.
- There has been some concern about recent reports that phenolphthalein has carcinogenic properties. However, in these reports the phenolphthalein was ingested in macroscopic near-**gram** quantities per dose over a period of **years** in medications, not the microscopic amounts used in indicators. Phenolphthalein indicator is completely safe for use in the student laboratory when used according to MSDS guidelines. It is non-volatile, meaning that breathing near the solution cannot result in an exposure, and it does not go through the skin, so touching the solution does not cause exposure either. It is not poisonous. Phenolphthalein is just one of several reagents that are suitable as acid-base indicators. Phenol red and cresol red also work well. Both of these dyes are red in basic solution and change to yellow on the addition of acid. The phenolphthalein changes in the pH range 8.2–10, colourless to pink; the phenol red in the pH range 6.6–8.0, yellow to red; and the cresol red in the pH range 7.0–8.8, yellow to red.
- Provide students with small test tubes. Precise measures of volumes are not necessary, but about 1 mL will work fine. This can be estimated as about the width of a small fingernail.
- The following amounts per class are needed for each reagent. Put the liquid reagents in dropper bottles.
  - 30 pieces of mossy zinc
  - 150 mL of 1 mol/L hydrochloric acid (84 mL of 12 mol/L HCl per litre of solution)
  - 150 mL of 0.1 mol/L NaOH (4.0 g/L)
  - 50 mL phenolphthalein indicator in dropper bottles (10 g phenolphthalein per litre in 50% denatured ethanol/50% water)
  - 60 1-cm pieces of magnesium metal strip
  - 150 mL of 1 mol/L sulfuric acid (56 mL of 18 mol/L H<sub>2</sub>SO<sub>4</sub> per litre of solution)
  - 50 mL bromothymol blue indicator in dropper bottles (0.4 g in 60 mL of 0.01 mol/L NaOH made up to 1 L)
  - 150 mL of 0.1 mol/L NaCl (5.9 g/L)
  - 150 mL of 0.1 mol/L AgNO<sub>3</sub> (17.0 g/L)
  - 150 mL of 0.1 mol/L Fe(NO<sub>3</sub>)<sub>3</sub> (40.3 g/L Fe(NO<sub>3</sub>)<sub>3</sub>·9H<sub>2</sub>O )
  - 150 mL of white vinegar or 1 mol ethanoic (acetic) acid (58 mL glacial (17 mol) acetic acid per litre of solution)

### Analyzing and Interpreting

1. Metals placed in acids produced bubbles, and the metal itself dissolved.
2. The reactions that resulted in a solid (or cloudiness) both involved two solutions of ionic compounds mixing together.
3. Evidence that burning involves a chemical reaction is that the burning candle released energy in the form of heat and light and the wax appeared to be consumed.

### **Forming Conclusions**

4. Types of observations that indicated a reaction had taken place involved formation of bubbles, formation of solid (cloudiness), colour changes, and/or dissolving of a metal. Temperature changes may also have been observed.

### **Extending**

5. Students could perform further tests on the products. For example, they could collect the bubbles and test them with a flame test to determine if any of the gases produced were hydrogen. (In fact, all were hydrogen.) They could filter or centrifuge cloudy solutions to demonstrate that solids were actually produced. They could use thermometers to detect small temperature changes. As a demonstration, pass a cold glass plate through the candle flame to show that water is being produced (condensation appears on the glass).

### **Assessment**

Collect students' tables and answers to the questions to assess their level of understanding of the concept that chemical reactions are accompanied by energy changes, physical changes, and the formation of new substances with new properties. You may wish to use the Inquiry Lab Rubric (2) to help you record students' progress.