



Chemical or Physical Reaction?

Teacher Background Information:

This lab replaces traditional reactions involving chemicals such as cupric chloride, 6M hydrochloric acid, potassium hydroxide, and copper sulfate. Students will understand the difference in chemical reactions vs. physical reactions using all green materials.

This lab is designed to be done very early in the year. Students will have minimal lab experience. The goal is to use observations of different types of reactions to discover common threads, ultimately leading to conclusions regarding evidence of chemical reactions. Students will ultimately learn the difference between chemical and physical changes. The goal of the lab is to dispel common misconceptions; i.e. boiling water is not a chemical reaction

Safety information:

Acetic acid, although very dilute in this lab, is a skin irritant and if it comes into contact with the skin should be washed with soap and water. Sodium bicarbonate solution, also very dilute, is a skin irritant, and if it comes into contact with the skin should be washed with soap and water. The sparkler is going to become hot and spray sparks, do NOT light it near anything flammable, hold at arm's-length from body.

Educational Goal: Students will understand ...

- How to make observations
- That inferences then lead to conclusions
- The difference between an observation and the interpretation of the observation
- What makes a chemical reaction a chemical reaction
- What makes a physical reaction a physical reaction

Student Objectives: Students will ...

- Use basic lab procedures
- Makes observations
- Make inferences from the observations

- Understand and be able to identify the difference between a chemical and physical change
- Practice lab safety

Materials (per group ~2 students):

- 3% Hydrogen peroxide
- 0.1 M Na₂CO₃ (1mL)
- 0.1 M CaCl₂ (1mL)
- 1.0 M NaHCO₃ (1mL)
- CaCl₂ (s) (0.5g)
- Urea (s) (0.5g)
- Yeast (0.1g)
- Citric acid (or pixie sticks)
- Vinegar
- Lemon juice (1mL)
- Cabbage Juice Indicator
- Steel wool
- Vanilla Extract
- Kool-Aid (or sugar)
- Ice
- Sparkler
- 5 Test tubes
- 2 Well plates
- 2 50-mL beakers
- 1 100-mL Beaker
- 6 thermometers
- 4 spatulas
- 4 Stirring rods
- Plastic Pipettes
- 2 Hot plates
- 4 balances
- Bunsen Burner
- Striker

Time required: 2 class periods (90 minutes)

National Standards Met: S2

Green Chemistry Principles Addressed:

Pollution Prevention ☐ Atom Economy ☐ Less Hazardous Chemical Syntheses ☐ Designing Safer Chemicals ☐ Safer Solvents and Auxiliaries ☐ Use of Renewable Feedstock ☐ Design for Degradation ☐ Inherently Safer Chemistry for Accident Prevention

Prerequisites:

Students should have studied of the difference between a chemical and physical reaction, however this is meant to be a lab done very early in the study of chemistry. Students should also understand laboratory safety procedures.

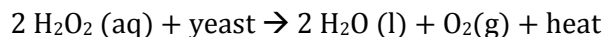
Teacher Prep: Teacher should prepare ...

- 0.1 M solution of calcium chloride (CaCl_2 FW=110.98g/mol anhydrous)
Hint: To prepare 50 mL of 0.1 M solution of calcium chloride, dissolve 0.56 g CaCl_2 in 50 mL of water.
- 0.1M solution of sodium carbonate (Na_2CO_3 FW=105.99g/mol anhydrous)
Hint: To prepare 50 mL of 0.1 M solution of sodium carbonate, dissolve 0.53 g Na_2CO_3 in 50 mL of water.
- 1.0 M solution of sodium bicarbonate (NaHCO_3 FW= 84.01g/mol)
Hint: To prepare 50 mL of 1.0 M solution of sodium bicarbonate, dissolve 4.2 g NaHCO_3 in 50 mL of water.
- Cabbage Juice Indicator
 - Chop the cabbage into small pieces until you have about 2 cups of chopped cabbage. Boil for at least ten minutes to allow time for the color to leach out of the cabbage.
(Alternatively, you can place about 2 cups of cabbage in a blender, cover it with boiling water, and blend it.)
 - Filter out the plant material to obtain a red-purple-bluish colored liquid. This liquid is at about pH 7. (The exact color you get depends on the pH of the water.)
 - Dilute about 100x until the juice is a light purple, it makes the changes in color easier to distinguish.

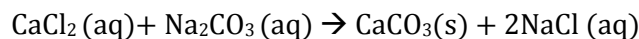
Procedure:

11- Reactions (Stations)

1. Students will mix Hydrogen peroxide and yeast – reaction will produce a gas and the temperature should increase



2. Calcium Chloride and Sodium carbonate- Students will mix the two prepared solutions to see the formation of white precipitate

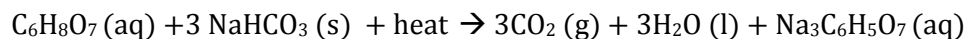


3. Lemon Juice and Sodium Bicarbonate and an acid base indicator/ cabbage juice- color change - Students will add lemon juice to cabbage juice and observe the color change and then will add sodium bicarbonate solution to observe a second color change

Lemon juice (aq) + cabbage juice indicator → purple to red color change

Acidic solution with cabbage juice indicator + 1.0 M NaHCO₃ (aq) → red to purple to blue color change

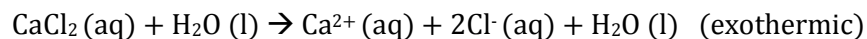
4. Citric acid solution and baking soda- Students will observe the formation of a gas and the temperature will decrease



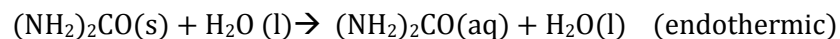
5. Boiling water- Students will boil water to observe the formation of a “gas” and an increase in temperature



6. Calcium Chloride and water- Students will observe an increase in temperature



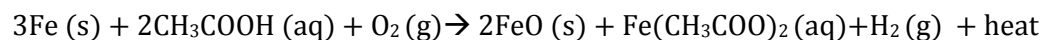
7. Urea and water- Students will mix urea and water to observe a decrease in temperature



8. Heating an extract- Students will heat a vanilla extract in a test tube in a water bath heated to 80 degrees °C.

9. Kool-aid crystals- Students will make a saturated solution of kool-aid at room temperature by adding the solute until it does not dissolve. The solution will then be cooled using an ice bath at 0-5°C and observe what happens. It should crystallize, but doesn't always.

10. Steel wool and vinegar- Students will place a piece of steel wool in a beaker and saturate it with vinegar. Students will observe a change in color on the steel wool as well as a temperature increases. A gas will also most likely be produced.



11. Reaction that produces light- Students will light a standard sparkler and observe what happens.



Student Lab Procedure, Data Collections and Questions

Procedure and Data:

Hydrogen Peroxide and Yeast

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. In a test tube add 40 drops of hydrogen peroxide. 2. Record the temperature. 3. Mass 0.1 grams of yeast and add to the test tube with the hydrogen peroxide. 4. Observe the reaction. Record the temperature. 5. Pour solution down the drain when finished and rinse test tube for the next group 		

Sodium Carbonate and Calcium Chloride

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. In a well plate or test tube add 10 drops of sodium carbonate solution 2. Add 10 drops of calcium chloride solution 3. Swirl the solutions 4. Observe results 5. Rinse materials for the next group 		

Lemon Juice and Sodium Bicarbonate -Indicator

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. Add 1-2 drops of cabbage juice into a well plate 2. Add 3-5 drops of lemon juice into the well plate with the cabbage juice 3. Observe 4. Add 3-5 drops of 1M sodium bicarbonate to the same well 		

5. Observe 6. Clear well plate for the next group		
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Citric Acid and Baking Soda

Steps	Observations	Questions/Conclusions Chemical or Physical?
1. Mass 0.3 grams of citric acid (or 0.5g of pixie stick) and place in a test tube 2. Add 20 drops of 1M NaHCO ₃ 3. Observe the reaction. Record the temperature. 4. Pour solution down the drain when finished and rinse test tube for the next group		

Boiling Water

Steps	Observations	Questions/Conclusions Chemical or Physical?
1. Add 20 ml of water to the empty beaker at the station. Record the temperature. 2. Place beaker on the hot plate CAUTION- Hot plate will be warm from previous group. 3. Increase the heat of the hot plate until the water in the beaker is boiling 4. Record the temperature 5. Observe 6. Empty the beaker for the next group and remove it from the hot plate		

Calcium Chloride and Water

Steps	Observations	Questions/Conclusions Chemical or Physical?
1. In a test tube add 0.5 grams of calcium chloride 2. Add 3 ml of water to the test tube 3. Record the temperature 4. Observe 5. Rinse the test tube for the next		

group		
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Urea and Water

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. In a test tube add 0.5 grams of urea 2. Add 3 ml of water to the test tube 3. Record the temperature 4. Observe 5. Rinse the test tube for the next group 		

Heating an Extract

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. Add 20-30 drop of the extract to a test tube 2. Place the test tube in the hot water bath at the station 3. Observe for at least 1 minute. 4. Rinse test tube for the next group 5. Leave water bath for the next group 		

Kool-Aid

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. Add 20 ml of water to the test tube 2. Add enough kool-aid to the water so that some of the kool-aid does not dissolve 3. Placed the test tube in the ice bath for at least 3mins 4. Observe 5. Rinse the test tube for the next 		

group 6. Leave the ice bath for the next group		
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Steel Wool and Vinegar

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. Place a quarter size mound of steel wool into the beaker. 2. Submerge the steel wool in vinegar 3. Place a thermometer in the beaker and seal the beaker with parafilm 4. Record the temperature multiple times 5. Observe 6. Place steel wool in the garbage and rinse the beaker for the next group 		

Producing light

Steps	Observations	Questions/Conclusions Chemical or Physical?
<ol style="list-style-type: none"> 1. Obtain a sparkler 2. Light the sparkler 3. Observe 4. Rinse sparkler under water 5. Dispose of the sparkler in the garbage 		

Questions for thought:

1. Using three examples from your data; discuss how properties of substances compare before, during, and after the reaction?

2. Were there any results common to the reactions? Use specific examples in your answer. What might this suggest?

3. The experiments you conducted produced either a chemical or physical change- place the experiments in the proper column

Physical Change

Chemical Change

4. Using three examples from your data, discuss why you placed the reaction as either a chemical change or a physical change.

5. What would we need to do to further our interpretations of the collected results? How can we be sure we placed the reactions in the correct column?

6. Name three ways this experiment demonstrates green chemistry?