Chemical Reactions

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Adapted from: http://www.ehow.com/list_6578681_fun-science-tricks.html
chem.csusb.edu/documents/304_Lab_manual_04_Winter.pdf

Overview
This module is focused on introducing students to the chemical and physical changes that occur when a chemical reaction has taken place. Students will observe several reactions before being asked to determine which of two experiments leads to a chemical reaction.

Science Standards
PS – Physical Science
S:PS1:8:1.2. Composition: Students will recognize that elements can combine in a variety of ways to form compounds
S:PS2:8:1.1 Explain how substances react chemically with other substances to form new substances, known as compounds, and that in such recombinations, the properties of the new substances may be very different from those of the old.
S:PS2:8:3.5 Recognize that most chemical and nuclear reactions involve a transfer of energy.

Focus Question
What indicators act as a signal that a chemical reaction has taken place?

Objectives
Through this lesson, students will:
• Be able to collect and write down observations while conducting an experiment
• Be able to monitor the changes in pH and temperature that occur when a chemical reaction takes place
• Be able to use their observations to determine if a chemical reaction has occurred

Background
This activity assumes that students have covered mixtures, compounds, and molecules. They should also have an understanding of physical changes and chemical changes. Students are asked to balance equations, but that can be removed if necessary; conversely, the students can be asked to come up with their own equations. If you are including the methylene blue demonstration as an extension, then the students should also understand redox reactions.
Vocabulary
- Compounds
- Mixture
- Solvent
- Chemical changes
- Chemical reactions

Materials (for 25 students or groups)
- 25 candles
- 50 plastic cups
- 125 g baking soda (must be baking soda, don't use washing soda)
- 375 mL vinegar
- 125 g Calcium chloride
- 25 plastic baggies
- 1 L of water
- Thermometers
- pH strips
- 1 L 4% borax solution (Borax can be found at Hardware stores)
- 1 L mixture of half Elmer's glue, half water
- 1 box of cornstarch, at least 1.5 kg

Preparation
Depending on your students, you can modify the procedure so that they measure out their materials, however, as a default things go much more smoothly and fit into a one hour time period if everything is pre- aliquoted for the students. At each station, set up the exact amount of each material that is needed for each experiment, grouped by experiment. About 1 hour before your first class/section, you can set-up the methylene blue demonstration if you choose to do it (http://www.nuffieldfoundation.org/practical-chemistry/blue-bottle-experiment). The demonstration shows a color change when oxygen is introduced to the bottle. During the initial scramble of grabbing materials and reading the protocol, light all the candles at the stations for the students.

Procedure –
1. Introduction: If this is not your normal class, introduce yourself. Read the introduction from the sheet.
2. Hook: Proceed with the methylene blue demonstration with the following dialog:
   What for example, happens if I add oxygen to this flask? (Open the flask and swish it around.) What do you see? Here we see a color change occur that let's us know that a chemical reaction occurred, but what else can serve as signs of a chemical reaction?
3. Background: This lab should be done after the class has at least touched on molecules, compounds, and mixtures. A discussion on physical versus chemical changes prior to the lab would also be good.
4. Experiment: See attached handout.
5. Extend the Experiment: See extensions below.
8. Lesson/wrap: Ask the students which activity in experiment 3 lead to a chemical reaction. Have them defend their choice. Let them take home their glurch and ooblek as reminders.

Assessment
- The ability of the students to correctly identify which of the final experiments is a chemical reaction is a built-in assessment of the module

Extensions
Students could be encouraged to:
- Write a proper, balanced equation for each experiment they conduct
- For experiment 2, cabbage juice or bromothymol blue can be used instead of water to introduce the concept of indicators
- To research polymers for experiment 3
- With more advanced students, you can have them figure out the redox change that occurs during the methylene blue demonstration (http://www.csun.edu/scied/2-chem/redox_methylene_blue)
- Play around with the materials. For example, they can use different types of water in experiment 2, add more vinegar/baking soda to experiment 1, or play with different amounts of borax in experiment 3.
**Chemical Reactions**

Chemicals can combine with each other in several ways. Mixtures are made when compounds are blended, like in the making of brass or of mayonnaise. Solutions are made when chemicals can dissolve in a solvent, such as when you add sugar to water. However, other times, new compounds can be made. How can we know that a chemical reaction has occurred? What things can we look for that give us a clue that a new substance was created?

**Experiment 1**

Materials:
- Candle
- Baking soda (NaHCO₃)
- Vinegar (HC₂H₃O₂)
- Plastic cup

If the vinegar and baking soda combine in a chemical reaction, what would the reactants be? Write down the reactant side of an equation down below.

**Protocol:**

1. Add 3 g of baking soda to the cup.
2. Carefully tip the cup and "pour" the AIR above the baking soda (NOT THE BAKING SODA) over the lit candle. Record your observation below.
3. Add 5 mL of vinegar to the cup. Cover the cup with your hand and let the foam build up for about 10 seconds.
4. Carefully tip the cup and "pour" the AIR above the vinegar (NOT THE LIQUID) over the lit candle.

What happened to the candle in step #2?

What happened to the candle in step #4?

What observations can you make about this combination of vinegar and baking soda? Is there less liquid in the cup now? Is there anything on the sides of the cup?

What do you think happened in step #3 that led to different things happening during the two "pourings?"
Do you think a chemical reaction occurred? Why or why not?

Experiment 2
Materials:
Calcium Chloride (CaCl₂)
One small Ziploc bag
Baking soda (NaHCO₃)
Water
pH strips
Thermometer

Protocol
1. Measure the pH of the water. Record the pH below.
2. Take the temperature of the water. Record it below.
3. Place 5 g calcium chloride in the Ziploc sandwich bag. Place 5 g baking soda in the bag also.
4. After placing the dry ingredients in the bag, shake the ingredients into the corner of the bag and twist the corner of the bag with the powders to prevent the liquid from mixing with them when poured into the bag. Then, pour 20 mL of water into the other side of the bag. Carefully seal the bag, removing as much air as possible as you do so. Allow the bag to untwist and mix the ingredients. Keep the bag sealed unless making measurements.
5. Keep your hand on the bottom of the bag. Record any any observations you make below.
6. Measure the pH and temperature of the liquid in the bag every 30 seconds for 2.5 minutes. Record below.

pH of water in step #1 ____________

Temperature of the water in step #2 ____________

What are the reactants of this experiment? Write them down below.

<table>
<thead>
<tr>
<th>Observations for step 6.</th>
<th>Minute 0.5</th>
<th>Minute 1</th>
<th>Minute 1.5</th>
<th>Minute 2</th>
<th>Minute 2.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
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<td></td>
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</tr>
</tbody>
</table>

What do you think caused the pH to change?
Do you think a chemical reaction occurred? Why or why not?

Balance the equation below.

\[ \text{NaHCO}_3 + \text{CaCl}_2 \longrightarrow \text{CaCO}_3 + \text{NaCl} + \text{HCl} + \text{H}_2\text{O} + \text{CO}_2 \]

**Experiment 3**

**Materials A**
- Half glue—half water mixture
- 4% borax solution
- Cup

What are the properties of the materials before they are mixed? Describe below.

**Protocol A**
1. Measure 250 ml half glue—half water mixture. Pour into the cup.
2. Slowly add 50 mL of the 4% borax solution to the mixture.

What are the properties of the mixture after adding the borax? Describe below.

**Materials B**
- Water
- Cornstarch

What are the properties of the materials before mixing? Describe below.

**Protocol B**
1. Add the water to the cornstarch slowly. Mixed until it is smooth (wetter than a paste).

What are the properties of the mixture after mixing? Describe below.

Only one of the protocols, A or B, is a chemical reaction. Which protocol resulted in a chemical reaction? What is your evidence?