**VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE**

**http://studentorgs.vanderbilt.edu/vsvs**

**Evidence of Chemical Reactions**

**Elementary school,**

**Spring 2013**

**Goal:** To show students evidence of chemical changes.

Fits TN standards for 4th Grade

**Lesson Outline**

**I. Introduction**

Explain physical and chemical changes. Tell the students that chemical changes are also called chemical reactions. Explain what observations are a sign that a chemical reaction has taken place.

**II. Safety Concerns**

Discuss safety issues.Demonstrate how students will use the test tubes and test tube holder, as well as how to dispense the chemicals.

**III. Experiments for Evidence of Chemical Reactions**

Tell students that they will do a series of experiments that will indicate that a chemical reaction has taken place. Guide the students through the procedures. Make sure they understand the instructions.Discuss results with students after they finish each experiment. (Chemical equations are provided for VSVS member background information only).

1. Energy Changes
   1. Heat given off (hotter solution)
   2. Light given off
2. Gas given off
3. Color change
4. Precipitate formation

**IV. Analyzing Results**

Go through each chemical reaction in each test tube and discuss with the students their observations. Discuss what type of evidence made in their observations confirms that a chemical reaction has taken place.

**V. Review Questions**

**Materials**

34 safety goggles for students and VSVS members (in a separate box)

10 test tube holders each containing:

4 opaque test tubes, labeled A, B, C, D

4 test tube caps

10 plates

1. demo test tube

11 lightsticks

10 taster spoons

10 mini-spoons

10 small jars of CaCl2 solid

10 small jars of NaHCO3 solid

1 250 mL stock bottle of regular vinegar

1 250 mL stock bottle of water

10 dropper bottles of Iodine

10 1 oz bottles half filled with starch solution

10 dropper bottles of sodium carbonate

10 1 oz bottles of CaCl2 solution

1 binder containing:

20 Student observation sheets

Powerpoint presentation

1 roll of paper towels

### Introduction

While one team member starts the introduction, another should write the following vocabulary words on the board:

**physical change chemical change chemical reaction precipitate**

All other VSVS members should be filling up:

10 1oz cups up to the marked line with water

10 1oz cups up to the marked line with vinegar

(KEEP THESE SEPARATE).

Ask students: What is a physical change? *Note: they may not have been taught this. In that case go straight to explaining what a physical change is.*

Be sure to include the following information in the discussion:

**In a physical change,**

* + No new substance is formed.
  + Only the physical properties are changed.
  + You begin and end with the same type of matter.
  + Examples of physical changes include changes in the size, shape, or state of matter. For example, ice, liquid water, and steam. In each of these states, water has physically changed (from solid, liquid, gas), but not chemically (it is still water). Simpler examples include crushing paper, breaking a bottle, crushing an aluminum can.

Ask students: What is a chemical change? *Note: they may not have been taught this. In that case go straight to explaining what a chemical change is.*

Be sure to include the following information in the discussion:

**In a chemical change,**

* + You start with one kind of matter and, after the reaction, get a new kind of matter. This new matter has new properties that are different from the matter you started with.
  + One or more new substances are formed in a chemical change.
  + A chemical change cannot be easily reversed.
  + Examples include: burning paper, digestion of food, bananas browning

Ask students: How can you tell when a chemical change/chemical reaction has occurred? *Some possibilities include: a gas given off, color change, precipitation, explosion, burning, etc.*

Tell students what to look for to determine if a chemical change has occurred:

When solutions of two compounds are mixed, it is often possible to determine whether or not a chemical reaction has occurred through visual observation.

Evidence of a chemical change might be:

(Write these on the board.)

1. a color change
2. a gas given off (it may smell)
3. the formation of a precipitate (a new solid)
4. an energy (temperature, light) change

Explain to the students what exactly each observation above looks like or what it involves.

* A **color change** occurs when two solutions are mixed and a new color is produced.
  + BUT, if the color of one solution becomes a paler shade, that change is caused by dilution from the other solution and does not qualify as a color change.
* Bubbles or fizz indicate that a **gas is given off**.
  + BUT, make sure that students understand that the bubbles given off in a soda pop drink is NOT evidence of a chemical change This is just excess gas that is released when the top is opened. Carbonated beverages contain carbon dioxide gas dissolved under pressure and removing the top lowers the pressure and allows carbon dioxide bubbles to escape.
* A **precipitate** forms when two substances react to give a new solid compound that does not dissolve in water.
  + A precipitate may look like a cloudy solution, fine grains in a solution, a swirl, or a fluffy solid.
* An **energy change** can be temperature or light related. When two substances mix, the overall temperature of the new substance can increase (become warmer) or decrease (become colder). Or light can be given off.

NOTE: FOR VSVS BACKGROUND INFORMATION ONLY

**An energy change** can be either a physical or chemical change. A chemical energy change occurs in a lightstick when chemicals mix to produce light. A physical energy change occurs when you freeze water. Energy is removed from water, causing the water to freeze and its temperature to change. There might be some confusion about the reactions that undergo heat changes in this lesson to illustrate chemical changes. Two solids are dissolved, a common physical change, and in the process absorb or give off heat. However, when the CaCl2 dissolves, it is hydrated to form a new substance, which is a chemical change.

### Safety

* Tell students they **must** put on safety goggles before mixing any solutions and that they **Must wear them until the end of the lesson.**
* Tell them that they should not eat, drink, or touch any of the liquids or solids unless they are told it is OK (eg the polymer worm is safe to touch).
* Emphasize to students how **important** it is for them **to follow directions**.

**NOTE: VSVS Volunteers - pay close attention to all students and make sure they follow these safety instructions.**

* Once you have reviewed safety rules, separate the class into groups of two.
* Pass out the test tube holders, test tubes (labeled A, B, C, D) with caps on and plates to each pair.
* Have the students place the test tubes in the test tube holder in alphabetical order and put all on a plate.
* Tell the students they will now conduct a series of experiments.
* Demonstrate how students will use the test tubes and test tube holder, as well as how to dispense the chemicals.

### Experiments: Evidence of Chemical Reactions

**Experiment 1a: Chemical Reactions Involving Energy (Temperature) Changes.**

Tell the students that since one of the chemical reactions they will observe involves heat loss or heat gain, they will need to touch each test tube to see if any of those happen.

Pass out 1 oz cup filled with water, a jar of CaCl2 SOLID, and a taster spoon to each pair.

Tell students to:

1. Take off the cap off Test Tube A.
2. Empty the 1oz cup of water in to the test tube.
3. Feel the test tube and write down any observations.
4. Open up the CaCl2 jar and add three taster-spoons of CaCl2 to the test tube.
5. Cap the test tube.
6. Gently shake the test tube to mix the contents.
7. Feel the test tube and to make any new observations.
8. Record them on their sheet.

The test tube should become warmer.

Tell students that the scientific term for this kind of reaction is **exothermic.**

**Tell students that calcium chloride is sometimes used on icy/snowy roads to melt the ice.**

**VSVS students should collect the chemicals before moving on to the next experiments.**

**Experiment 1b. Chemical Reactions Involving Energy (Light) Changes.**

**Tell students that another energy change could involve LIGHT.**

**Materials**

11 mini lightsticks

* Pass out the lightsticks to pairs of students.
* (Ask the teacher if it is fine to turn off the lights. If not continue with lights on.)
* Bend the plastic tube to break the thin vial inside.
* Shake the lightstick.
* Share the following explanation with the students.

**Explanation:**

* There are two chemicals in the lightstick, one encased in a vial. When the lightstick is bent, the vial breaks and two chemicals mix and react.
* Ask students if they know of any other chemical reactions involving light? *Some examples are burning wood in fireplaces, a lit match, and fireworks. Another example in nature is the glow of the firefly or lightning bug. In a biochemical reaction within the body of the firefly, light is produced through the action of an enzyme (luciferase) on luciferin. This is called* ***bioluminescence.***

**Note:** The lightstick is an example of a **chemiluminescent** reaction. **Chemiluminescence** occurs when a chemical reaction produces a molecule in an **excited** state. When this excited molecule changes to a more stable form, it emits light. **Bioluminescence** is an example of **chemiluminescence** in a biological system, generally an animal or bacterium.

**Experiment 2 – Chemical Reactions Involving Bubbles/Gas given off.**

Pass out a 1 oz cup filled with vinegar, a jar of NaHCO3 (baking soda or sodium bicarbonate), and a MINI spoon to each pair.

Tell the students to

1. Take off the cap off Test Tube B.
2. Put in ONE mini-spoonful of baking soda (sodium bicarbonate).
3. Add the vinegar that is in the 1 oz cup.
4. Write down any observations.

The reagents will foam/bubble up.

**VSVS students should collect the chemicals before moving on to the next experiments.**

**Experiment 3 – Chemical Reactions Involving Color Change**

Pass out 1 oz bottle half filled with starch solution and an iodine dropper bottle to each pair.

Tell the students to:

1. Take off the cap off Test Tube C.
2. Add the starch solution into the test tube.
3. Add a squirt of iodine.
4. Tell them to cap the test tube, invert it and write down any observations.

The solution should turn purple.

**Experiment 4- Chemical Reactions Involving Precipitate**

Pass out the bottle containing CaCl2 SOLUTION and the dropper bottle containing sodium carbonate solution.

Tell students to:

1. Take off the cap off Test Tube D.
2. Add the CaCl2 solution into the test tube.
3. Ask students to tell you if the solution is clear or cloudy.
4. Slowly add a few drops of sodium carbonate solution.
5. Ask students to tell you what they see.
6. Add a squirt of the sodium carbonate solution and record observations.

### Analyzing Results

Ask the students what happened in Test Tube A? B? C? D? and cup? Discuss and comment on their observations. *The answers for the observations are found in the Observation Answer Sheet at the end of the manual*.

Discuss what type of evidence made in their observations confirms that a chemical reaction has taken place. *The answers for the observations are found in the Observation Answer Sheet at the end of the manual.*

### Review

Ask students: what is a physical change? *A change in a substance that changes its physical properties like shape and size.*

Ask students: what is a chemical change? *A change in matter that causes it to change to a new substance.*

Ask students: what kinds of evidence are there for chemical changes/chemical reactions? *Gas given off (bubbles), precipitation (solid formation), color change, energy change.*

**CLEAN UP:** All the contents in the test tube are safe enough to dispose of in the sink. Ask the teachers permission if you can dispose of the liquids in the sink. If not, make sure all test tubes are properly and tightly capped before putting them in the kit. Collect ALL 1 oz bottles and ALL 1 oz cups, and taster spoons and return to kit.

Evidence of Chemical Reactions

Observation Sheet

Lesson written by:

Vanessa Arredondo, Vanderbilt University undergraduate student, 2012

Pat Tellinghuisen, VSVS Director

**Evidence of Chemical Reactions (4th grade)**

**Observation Sheet**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test Tube** | **Chemicals/ Reactants/ Compounds** | **Observation** | **What type of evidence?** |
| A. | CaCl­2­ and H2O  (Calcium chloride **solid** and water) |  |  |
| B. | Vinegar and baking soda |  |  |
| C. | Starch and Iodine |  |  |
| D. | Sodium carbonate liquid plus CaCl2 **liquid** |  |  |

**Evidence of Chemical Reactions (4th Grade)**

**Observation Answer Sheet**

|  |  |  |  |
| --- | --- | --- | --- |
| **Experiment** | **Chemicals/ Reactants/ Compounds** | **Observation** | **What type of evidence?** |
| A. | CaCl­2­ and H2O  (Calcium chloride **solid** and water) | Solution becomes warmer | Energy change |
| B. | Vinegar and baking soda | Bubbles/ or gas is given off | Gas given off |
| C. | Starch and Iodine | Color change from clear to brown/black | Color change |
| D. | Sodium carbonate plus CaCl2 **liquid** | A new solid forms | Precipitation |