

# Yellow/Blue Switcheroo

Through an exciting experiment, students are introduced to the steps of the scientific method and apply their knowledge to make hypotheses and detailed observations.

**Grade Level:** 1st

## Objectives:

- Students will discuss steps of the Scientific Method.
- Students will predict outcomes of a set experiment
- Students will evaluate the importance of following safety procedures while experimenting
- Students will draw conclusions based on the outcomes of a set experiment
- Students will create an illustration showing steps in the Scientific Method

## Materials:

- Hydrogen peroxide solution, potassium iodate, sulfuric acid, soluble starch, malonic acid, manganese (II) sulfate, water (distilled or deionized)
- *Or pre-made solutions (with mixtures and concentrations needed) can be purchased from Flinn Scientific, Inc.*
- Graduated cylinders - 3
- Beaker, stir stick, rubber gloves, goggles
- *The Scientific Method* song

## Appendixes:

- *The Scientific Method* song: Page 4

## Time Considerations:

Preparations: 15-20 minutes

Lesson Time: 45-60 minutes

*Introduction: 15 minutes*

*Activity 1: 15-20 minutes*

*Conclusion: 15-20 minutes*

## Related Lesson Plans:

Flubber, Mentos Super Fountain, Egg-plosion, H<sub>2</sub>Olympics, Blood-Typing, Mystery Box



## Nevada Department of Education Standards

### Scientific Inquiry

**N.2.A.1** Students know how to make observations and give descriptions using words, numbers and drawings.

## Excellence in Environmental Education Guidelines

### Strand 1— Questioning, Analysis and Interpretation Skills

- A)** Learners are able to develop questions that help them learn about the environment and do simple investigations.
- C)** Learners are able to locate and collect information about the environment and environmental topics.

This lesson has been adapted from Flinn Scientific, Inc.'s *The Yellow and Blue Switcheroo*:

Flinn Scientific, Inc. (2010). The Yellow and Blue Switcheroo. *Chem Fax!*, 8660

## Background

Students will think you are the master of chemistry when you do this exciting demonstration. Three colorless solutions are mixed to produce a yellow solution which suddenly turns blue and then yellow again. The solution will oscillate between yellow and blue for several minutes. This oscillating reaction is known as the Briggs-Rauscher (BR) reaction and was developed by Thomas S. Briggs and Warren C. Rauscher of Galileo High School in San Francisco. The reaction mechanism is very complex. During the reaction, oscillations occur in the concentrations of iodine and iodide ions. The yellowish

color is attributed to the rise in I<sub>2</sub> concentration; the blue/black color of the starch-iodine complex results from the rise in both I<sup>-</sup> and I<sub>2</sub> concentrations. The colorless solution is caused by the decline in I<sub>2</sub> concentration and the continued rise in I<sup>-</sup> concentration.

The dark blue starch iodine complex is amylose-iodine. The dark blue color comes from the pentaiodide anion, I<sub>5</sub><sup>-</sup> formed when I<sub>2</sub> and I<sup>-</sup> concentration are elevated. Though normally an unstable anion, it becomes stable as a part of the starch complex.

These two reactions are very complex, consisting of ten

steps. Iodine ( $I_2$ ) and iodide ions ( $I^-$ ) are produced as intermediates in various steps along the reaction pathway. In the reaction mechanism, the concentration of HOI rises and falls, triggering oscillations in the  $I^-$  and  $I_2$  concentrations in solution. When  $I_2$  and  $I^-$  concentrations are high, the solution is blue; when  $I_2$  and  $I^-$  is low, the solution is yellow; and when  $I_2$  is low and  $I^-$  is high, the solution is clear. The oscillations continue until either malonic acid or iodate ions are consumed.

This advanced chemical reaction will be used as a tool to introduce the scientific method and importance of making precise and accurate observations to students.

The scientific method is a process for experimentation that is used to explore observations and answer questions. Scientists use the scientific method to search for cause and effect relationships in nature. Conclusions are reached through asking questions, formulating guesses, creating and performing experiments, and analyzing the result (*Science Buddies*).

## Preparation

If you have purchased pre-mixed solutions, then skip ahead to “doing the activity”.

### How to Prepare Solutions:

Prepare 8.6% hydrogen peroxide solution by adding 29 mL of 30%  $H_2O_2$  to distilled water and diluting to 100mL.

Prepare 0.2M potassium iodate acidified solution by adding 10 mL of 1M sulfuric acid  $H_2SO_4$ , to 90 mL distilled water. Add 4.3 g  $KIO_3$  and stir to dissolve.

Prepare a starch-malonic acid-manganese (II) sulfate solution by boiling 100 mL of distilled water. Add 0.1g soluble starch to 5 mL of the boiling water. Stir. Add the starch paste to the remaining boiling water while stirring.

Boil for five more minutes. Allow the solution to cool.

Add 1.5g malonic acid and stir. Add 0.4g manganese (II) sulfate,  $MnSO_4 \cdot H_2O$ .

## Doing the Activity

### Introduction:

Ask the students if they have ever done an experiment before. If so, what did they do? What were they trying to find out? What did they use to carry out the experiment?

Before doing the experiment, ask students if they have heard of the scientific method; briefly go over the steps and what they entail.

1. Question: When scientists do experiments, they always begin with a question.

2. Hypothesis/Prediction: After asking the question scientists then try to guess the answer.

3. Research: Randomly combining things from around the house is dangerous so scientists have to do some research by reading, looking on the internet or asking other scientists.

4. Experiment: This is generally the fun part. Scientists do an experiment by following the directions and they have fun! But they are always safe and careful.

5. Results: Scientists keep accurate records of results of their experiment.

6. Conclusion: Examine the meaning of your results.

Teach students *The Scientific Method* song. After going over the song, have students sing it with you.

Explain that you have three clear liquids that you will combine; ask the students what they think will happen. At this point they are making a hypothesis.

### Activity 2: Experiment!

While conducting the experiment wear latex gloves and safety goggles. Have

students evaluate the importance of scientists wearing proper clothing and following



Fig. 1. Experiment oscillates between yellow

directions safely while experimenting.

As you do the experiment, tell students which step of the scientific method you are on and why.

#### *Experiment Procedure*

Use a 50 mL graduated cylinder to measure out 40 mL of 8.6% hydrogen peroxide solution and transfer it to a 250 mL beaker.

Use a clean 50 mL graduated cylinder to measure out 40 mL of the 0.2M potassium iodate acidified solution and add it to

the beaker. Stir using a stirring rod or magnetic stirrer.

Use the third 50 mL graduated cylinder to measure out 40 mL of the starch-malonic-acid-manganese (II) sulfate solution. Add this solution to the beaker and stir.

Bubbles will begin to appear. In a short period of time, the solution will turn to yellow and then to blue and then to colorless. The yellow to blue to colorless oscillation will continue for about 10 minutes.

You may use different quantities

### Conclusion

of the liquids as long as the amounts of all three liquids are equal to each other. Ask the students what they observed. Did the results surprise them? Were any of their hypotheses accurate? Remind the students that it does not matter whether their guesses were right, because the reason for conducting experiments is to find out the answer to a question.

### Vocabulary

**Conclusion:** a decision or answer, based on facts

**Hypothesis:** an educated guess

**Materials:** the tools and other things needed to perform a particular task

**Results:** the outcome(s) of a certain task or procedure

**Scientific Method:** the system of advancing knowledge by formulating a question, collecting data about it through observation and experimentation, and testing a hypothetical answer

### Assessment

Review the steps of the scientific method and the steps that were done in the experiment that was conducted: hypotheses, materials, experiment, conclusions, etc.

Have students draw a picture of their favorite part of the experiment and write which step of the scientific method their favorite part took place during.

### Sources

- Flinn Scientific, Inc. (2010). The Yellow and Blue Switcheroo. *Chem Fax!*, 8660
- Science Buddies. (2010). *Steps of the Scientific Method*. Retrieved Aug. 26, 2010, from [http://www.sciencebuddies.org/science-fair-projects/project\\_scientific\\_method.shtml](http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml)

#### **Images:**

Fig. 1. Science Fair 2010. *Ossilating*. Retrieved Aug. 30, 2011, from <http://fair2010.christnagar.org/fair-2010/exhibition/sample-projects/oscillating-clock-demonstration/>

# **The Scientific Method**

To the tune of: *The Wheels on the Bus*

## **There are six cool steps in the scientific method**

The scientific method

The scientific method

There are six cool steps in the scientific method

When we do an experiment!

### **First we need to ask a question**

Ask a question

Ask a question

First we need to ask a question

When we do an experiment!

### **Second we need to predict an outcome**

Predict an outcome

Predict an outcome

Second we need to predict an outcome

When we do an experiment!

### **Third we need to gather materials**

Gather materials

Gather materials

Third we need to gather materials

When we do an experiment!

### **Fourth we need to follow directions**

Follow directions

Follow directions

Fourth we need to follow directions

When we do an experiment!

### **Fifth we need to look at the results**

Look at the results

Look at the results

Fifth we need to look at the results

When we do an experiment!

### **Sixth we need to wrap it all up**

Wrap it all up

Wrap it all up

Sixth we need to wrap it all up

When we do an experiment!!!

