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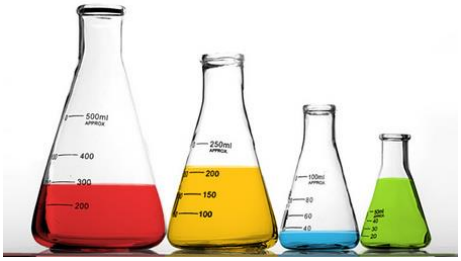
BEAMING STEM LABS

Introduction to Science and Chemistry in a Ziploc Bag

Grades 3 -6



NGSS: 5-PS1-2, 5-PS1-4

KEY WORDS

chemistry	bicarbonate	carbon dioxide
endothermic	ion	calcium carbonate
exothermic	hydrogen	observation

MATERIALS CHECK LIST

Students work in pairs. Each pair needs

1	plates
2	Observation Sheets
1	3.5 oz cup marked with line at 15 mL
1	Ziploc sandwich bags containing one spoonful of baking soda
1	pencils (students use their own but need to have them ready to record observations)

VOLUNTEER DEMO BAG

- 1 plate
- 1 3.5 oz cup marked with line at 15 ml
- 1 Ziploc sandwich bags containing one spoonful of baking soda

To share with the entire class:

2	250 mL containers of phenol red solution
2	spoons
2	containers of anhydrous calcium chloride
1	roll of paper towels
1	trash bag

I. Processes and Methods used in science (5 minutes)

We often talk about following the scientific method. This is a fine method to use when conducting some types of science but there is a common myth that all scientists follow the scientific method. However, there is actually no one single method or pattern that all scientists follow. Scientists can make observations, ask questions, gather data, interpret data, build on the work of other scientists, use models, carry out experiments – and they will carry out such processes in many different ways.

In order for science to progress, scientists will use whatever method suits the particular circumstances, the nature of the problem, the theory available, the facilities for observation and experimentation and their own personality and imagination, so there will be a myriad of starting points in scientific investigation and many different ways of carrying out any investigation.

With all the differences among fields of science, they are too diverse for there to be a single universally applicable method. Scientists use aspects of the scientific method but its restrictive in its approach.

Can you think of some different fields of science?
Ecology, biology, astronomy, meteorology

<<Teacher can briefly talk about their experiences in the field & the chart on the next page if they would like to use it; use discretion regarding depth of conversation based on age – with older students may briefly talk about peer review, how science informs policy, etc.>>

Studies in which no experimentation is performed are also valid scientific studies, but do not follow the scientific method. For example: Jane Goodall observed the behavior of the apes in Africa and did not experiment on them, yet her research is still considered science.

II. Making Observations (15 minutes)

Expert observation is an essential part of science. Today we will do some activities to begin your training as scientists and build your skills at making observations. Making an observation goes beyond just "seeing" something, you will need to use knowledge that you have and critical thinking skills to make good scientific observations.

What to do

1. Have students view image of Spring Peeper Frog.

2. Ask them to carefully observe the image and make a list of their observations. Have the students feed back to the class and make a list on the board.

3. Watch the video clip Observation in science (1 minute 15 seconds)
   - What senses help to make good observations?
   - Why do you think observation is an important skill for scientists?
   - What other methods do scientists use to collect information about animals?
   - What is the difference between an everyday observation and a scientific observation?
   - How does a scientist's background knowledge about an animal help them to make better observations?
   - If appropriate for your students, discuss the difference between an observation and an inference.

4. Give students the opportunity to research the Spring Peeper (*Pseudacris crucifer (Hyla crucifer)* or classroom teacher will pass out information about them. Discuss information.

5. Give students the opportunity to look at the Spring Peepr image again and record their observations for a 2nd time.
   - Did you make any new observations?

- Did you change any of your initial observations?
- Did your research help you to make more detailed observations? Why? Why not?
- How would this activity be different if you were observing a live frog (not a photo)?
- How do you think you could improve your observation skills?

III. Introduction to Chemistry in a Ziploc bag & Making Hypothesis (less than 5 minutes)

- Organize students in pairs.
- Give each student an Observation Sheet.
- The onsite teacher should add phenol red solution to 15 x 3.5 oz cups marked with a line. (15 mL)

Explain to students about the importance of making careful observations and recording them:

This is how scientists do experiments. New discoveries and advances in science depend on having a careful and **accurate record of observations** made while doing an **experiment**. After the **experiment** is over, scientists think about the **observations** and data they have collected and try to come up with an explanation of what happened (**hypothesis**).

Tell the students that today you will make chemical reactions and observe what happens!

IV. Experiment (25 minutes)

Give each pair one ziploc bag containing baking soda, one 3.5 oz cup containing 15 mL of phenol red solution, and one plate.

PROCEDURE

- One of the pair of students should hold the bag upright over the plate while the other student adds the 15 mL of phenol red solution to the bag.
- The student holding the bag should seal the bag.
- ***Tell the students*** to feel the bag while keeping it upright, and record their observations of the color and how the bag feels.
- Tell the student holding the bag upright over the plate to be ready to open the Ziploc bag when a teacher comes around to add a spoonful of anhydrous calcium chloride.

- ***The teacher*** should take a plastic spoon and one of the anhydrous calcium chloride containers and put one spoonful in each Ziploc bag.
- **The student holding the bag should seal the bag as quickly as possible after the calcium chloride is added.**
- The student holding the bag should keep the bag upright and sealed while **gently** shaking the bag back and forth to mix the contents.
- ***Tell students to observe*** what happens after the calcium chloride was added – color, whether the bag is cold or warm (or both since there can be localized heating), foaming, change in bag size, etc.
- The reaction takes about three to five minutes. During this time the student not holding the bag should write down any observations that the pair has made.

NOTE: There is no danger of the bag exploding if the correct amounts of chemicals are used. Since everything is pre-measured, you should have no problems. In the event one does explode or leak, use paper towels to clean up any mess. If the students have followed your directions, any spilled liquid will be on the plate, which can be easily wiped up with paper towels. Assure the students that the chemicals are safe.

Possible Student Observations:

(1) When phenol red solution is added to the baking soda bag, it remains red.
(2) The bag feels cold.
(3) When the calcium chloride is added, the phenol red turns yellow. Students may feel a short-lasting warming while the anhydrous calcium chloride dissolves in water.
(4) The bag fills up with gas and continues to feel cold.

Explanation for the student's observations of the chemical reactions:

Note: For purposes of your classroom discussion, you can mention the following points (Equations for the chemical reactions are given at the end of the lesson).

(1) Phenol red is red in basic solution and yellow in acidic solution. Baking soda is a base so the phenol red remains red when it is added to the baking soda.
(2) The bag feels cold because baking soda absorbs heat when it dissolves.
(3) Acidic conditions are produced when calcium chloride reacts with baking soda, so the phenol red turns yellow. The mixture gets warm at first because anhydrous calcium chloride gives off heat when it dissolves in water.
(4) Carbon dioxide is produced when baking soda reacts with acid so the bag fills up with carbon dioxide gas. (This is similar to the reaction that happens when vinegar is added to baking soda.)
(5) The bag continues to feel cold because heat is being absorbed.

Ask students: How can you tell when a chemical change has occurred?

Accept responses. Possibilities include: a gas given off, color change, explosion, burning, etc.

Tell students what evidence to look for to determine if a chemical reaction occurs:
a **color change,** a **gas given off**, or the **formation of a precipitate**.

Ask the students what evidence for chemical changes did they observe in today's experiment?

Answers: 1. *A color change*
2. *A gas given of*

V. Background Information

Student Observations

During an observation activity, you may notice that your students focus on the surface features of the object, for example, color and size. However, as they learn more and increase their background knowledge, they may be able to make more detailed observations, and this, in turn, can lead to making inferences about other factors such as age, behavior and habitat (Eberbach & Crowley, 2009).

Drawing inferences from observations is an important skill. The Science Continuum website (State of Victoria, 2009) makes the following distinction between observations and inferences:

- Observations are descriptive statements about natural phenomena that are directly accessible to the senses (or an extension of the senses) and about which several observers can reach consensus with relative ease. For example, 'chocolate is brown' or 'chocolate is sweet'.
- Inferences are statements about phenomena that are not directly accessible to the senses, for example, 'chocolate is sweet because of the sugar it contains'. This would be an inference as the sugar in the chocolate cannot be seen.

Eberbach & Crowley (2009) suggest that we can help our students to observe more scientifically and make appropriate inferences if:

- their observations are connected with increasing background knowledge on the subject or object or their observation
- they are given the opportunity to share, discuss and debate their observations with others
- their observations are guided by appropriate prompt questions
- they have the opportunity to create and revise their own recording or notational system.

Chemical Reactions

The bicarbonate ion (HCO_3^-) is a weak acid and partially ionizes in solution.

$$HCO_3^- (aq) \rightarrow H^+ (aq) + CO_3^{2-} (aq) \quad (1)$$

Calcium ion (Ca^{2+}) from calcium chloride reacts with sodium bicarbonate to give insoluble calcium carbonate.

$$Ca^{2+} (aq) + CO_3^{2-} (aq) \leftrightarrow CaCO_3 (s) \quad (2)$$

The removal of the carbonate ion from solution shifts the bicarbonate equilibrium (1) to the right, releasing more H^+, which reacts with more HCO_3^- to produce CO_2 gas and H_2O.

$$H^+ (aq) + HCO_3^- (aq) \rightarrow CO_2 (g) + H_2O (l) \quad (3)$$

The indicator changes color because the carbon dioxide dissolves in water to produce an acidic solution.

$$CO_2 (g) + H_2O (l) \rightarrow H_2CO_3^- (aq) \rightarrow H^+ (aq) + HCO_3^- (aq) \quad (4)$$

Sources of Lab:

Reference: *Fun With Chemistry*, Vol. 1, 2nd ed.; Sarquis M., Sarquis, J., Eds.; Publ. 91-005; Institute for Chemical Education, University of Wisconsin: Madison, 1991; pp 147-153.

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Introduction to Science: