Bay Area Scientists in Schools Presentation Plan

Lesson Name The Chemical Workout/Blow it Up
Presenter(s) Chemistry Graduate Students from the Maimone Group at UC Berkeley

Grade Level 5th

Standards Connection(s): Atoms, Elements and Periodic Table and Molecular properties. During chemical reactions atoms rearrange into different products with different properties. All matter is made of atoms, which combine to form molecules. Each element is one kind of atom, organized in Periodic Table. Properties of common molecules and common properties of salts.

FOSS Connections:

Grade 5 Module: *Mixtures and Solutions*

Common Core Standards:

ELA/Literacy:

W.5.8 Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work, and provide a list of sources.

Mathematics:

MP.2 Reason abstractly and quantitatively.

MP.5 Use appropriate tools strategically.

MP.4 Model with mathematics.

Next Generation Science Standards:

5-PS1-3. Make observations and measurements to identify materials based on their properties.

5-PS1-4. Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

(Engineering) 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

(Engineering) 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Next Generation Science Standards (continued):

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions. Conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered. (**5-PS1-4**) Make observations and measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon. (**5-PS1-3**) Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design problem. (**3-5-ETS1-2**)	*PS1.A: Structure and Properties of Matter* Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (**5-PS1-1**) The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (**5-PS1-2**) Measurements of a variety of properties can be used to identify materials. (Boundary: At this grade level, mass and weight are not distinguished, and no attempt is made to define the unseen particles or explain the atomic-scale mechanism of evaporation and condensation.) (**5-PS1-3)** *PS1.B: Chemical Reactions* When two or more different substances are mixed, a new substance with different properties may be formed. (**5-PS1-4)**	*Cause and Effect* Cause and effect relationships are routinely identified, tested, and used to explain change. (**5-PS1-4**) *Connections to Nature of Science* Scientific Knowledge Assumes an Order and Consistency in Natural Systems Science assumes consistent patterns in natural systems. (**5-PS1-2**)

Teaser: Students will enjoy a hands-on activity that teaches basic manipulation of variables in addition to the link between chemical and physical energy.

Objective: Students will learn about the relationship between chemical and physical energy, and, most importantly, will understand experimental design and be able to apply it generally to future scientific topics.

Vocabulary/Definitions: *3 – 6 important (new) words*

- **Molecule:** Atoms connected together to form repeated units.
- **Substance:** An assortment of molecules.
- **Chemical Reaction/Chemical Change:** Atoms change how they're connected, leading to new substances with sometimes interesting properties.
- **Physical Change:** The arrangement of molecules within a substance is altered, without changing their atomic connectivity.
- **Work:** The transfer of energy; in this case, from a chemical reaction to an observable outcome!

New:

- **Variable:** Something changed in an experiment
- **Hypothesis:** What you think will happen when you change one variable in an experiment
- **Independent Variable:** Controlled by the experimenter
- **Dependent Variable:** Changes based on the independent variable
- **Control Variable:** Purposefully held constant during the experiment

Materials:

What will you bring with you?

- Alka-Seltzer Tablets
- Vinegar
- Baking soda
- Funnel for baking soda
- Kim-Wipes
- Small cups
- Heating pad
- Handouts for experimental write up
- Rubber Bands
- 20 oz. soda bottles
- Balloons
- Safety glasses
- Container suitable to create an ice-water bath for a 20 oz bottle.
- Ice

What should students have ready (pencils, paper, scissors)?

- pencils

Classroom Set-up:

- Students should be split into 3 groups
- Whiteboard/Chalkboard to make notes

Classroom Visit

1. **Personal Introduction:** __5_____ **Minutes**

   Introduce selves, ask kids if they wondered about the usefulness of chemical reactions, talk about the general link between chemical a physical energy (I think from food to moving around is a good one, gas in a car, among others).

   Topic Introduction: ____5-10_____ **Minutes**

   Introduce the concept of a chemical/physical change and the appropriate vocabulary to describe each. Take a tablet of the Alka-Seltzer and bust it in half to demonstrate a

physical change. Drop it in a glass of water and comment on the formation of gas as a chemical change. Hint at what the gas might be useful for, leading into the link between chemical energy produced and the work done. Actually demonstrate what they will be doing by dropping the tablet into a bottle with a certain amount of water, securing a balloon over the top with a rubber band, and allowing the balloon to inflate. Introduce as well the idea of experimentation and variables and the different forms of variables in an experiment. Mention they shouldn't eat anything used during experimentation and should take care to wear their safety glasses. The activities that follow will help reinforce the ideas of experimental design.

2. Learning Experience(s): ____30_____ **Minutes**

Station #1) Different substances:

Independent variable: What will be mixed in the bottle
Dependent variable: How quickly the balloon inflates
Controls: size of the bottle, size of the balloon, temperature, amounts of acid and base (we will assure them that the same chemical amounts of the seltzer/ baking soda and vinegar have been provided), and, most importantly, a bottle with no additives.

Group One: Two 3.2 g tablets of Alka-Seltzer, one cup of water, one balloon, one bottle, one rubber band.

Group Two: 3.8 g of baking soda (which we have calculated and pre-measured) and 38 mL of 5% acetic acid (vinegar) which we will also measure, one cup of water, one balloon, one bottle, and one rubber band.

Group Three: One cup of water, one balloon, one bottle, one rubber band.

Have the kids hypothesize which bottle will react most quickly; ask them to list/classify variables to be tested; also reiterate the importance of the experimental design.

Instruct the students to add all liquids their bottles. Then, acting as though it's a race (on your mark, get set, go!), tell them to add their solids (maybe need a funnel for the baking soda) and quickly pull a balloon over the top of the bottle and rubber band it down as we did in the introduction. Tell them to raise their hands when their balloons start to inflate; discuss the relative rates of inflation observed for given bottles and what they suggest about the reactivity of the chemicals therein. Discuss the work being done (the physical change of the balloon's shape); stress the importance of the control group (and reassure them that they'll have fun as well).

Station #2) Different concentrations of one substance:

Independent variable: How much will be mixed into one bottle

Dependent variable: How quickly the balloon inflates
Controls: size of the bottle, size of the balloon, type of acid and base, temperature
Group One: Two 3.2 g tablets of Alka-Seltzer, one cup of water, one balloon, one bottle, one rubber band.

Group Two: Four 3.2 g tablets of Alka-Seltzer, one cup of water, one balloon, one bottle, one rubber band.

Group Three: Eight 3.2 g tablets of Alka-Seltzer, one cup of water, one balloon, one bottle, one rubber band.

Have the kids hypothesize which bottle will react most quickly; ask them to list/classify variables to be tested; also reiterate the importance of the experimental design.

Instruct the students to add all liquids their bottles. Then, acting as though it's a race (on your mark, get set, go!), tell them to add their solids and quickly pull a balloon over the top of the bottle and rubber band it down as we did in the introduction. Tell them to raise their hands when their balloons start to inflate; discuss the relative rates of reaction observed as they relate to concentration.

Station #3) Different temperatures of one substance:

Independent variable: Temperature
Dependent variable: How quickly the balloon inflates
Controls: size of the bottle, size of the balloon, type of acid and base, amount of substance added

Group One: Two 3.2 g tablets of Alka-Seltzer, one cup of water, one balloon, one bottle, one rubber band, ice-water bath.

Group Two: Two 3.2 g tablets of Alka-Seltzer, one cup of water, one balloon, one bottle, one rubber band.

Group Three: Two 3.2 g tablets of Alka-Seltzer, one cup of water, one balloon, one bottle, one rubber band, heating pad.

Have the kids hypothesize which bottle will react most quickly; ask them to list/classify variables to be tested; also reiterate the importance of the experimental design.

Instruct the students to add all liquids their bottles. Then, acting as though it's a race (on your mark, get set, go!), tell them to add their solids and quickly pull a balloon over the top of the bottle and rubber band it down as we did in the introduction. Instruct the group one students to immerse their bottle in the ice bath. Instruct the

group three students to place their bottle on the heating pad. Tell them to raise their hands when their balloons start to inflate; discuss the relative rates of reaction observed as they relate to temperature.

General: Have students pour all liquid wastes down the sink and generally clean up.

3. Wrap-up: Sharing Experiences ____5_____ **Minutes**

Reiterate the importance of the experimental design, point out the changes unseen to the eye can produce meaningful, physical results and how you can manipulate conditions to change the production of chemical energy to influence the resulting observed macroscopic changes.

4. Connections & Close: ___5_____ **Minutes**

Stress the human metabolism/ gas-in-the-car examples, and ask the kids if they can think of more examples in which chemical energy becomes physical energy. Tell them that if they think about how the things around them work, they'll be surprised at the amount of them that start with chemical changes. Also suggest that they think of ways to control these links as they see them in everyday life. Tell them thanks and depart!

Total 50 – 60 Minutes

Follow-up – After Presentation

Suggest students write a letter explaining "How we learned about _____?"
List or attach examples of activities, websites, connections for additional learning.
Attach worksheets, hand-outs, visuals used in classroom presentation.

Colby College CH151 Outreach 2010.
http://www.colby.edu/chemistry/CH151_2010/CH151_2010/Activities_1.html