Supermarket Chemical Reactions in Zip Lock Bags

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The 2-part lesson on chemical reactions follows the 5 E template: engage, explore, explain, extend, and evaluate. The materials used in this lesson allow students to safely conduct their investigations, as well as allow for safe and convenient disposal of materials. All materials are available in supermarkets or educational suppliers. The entire lesson will require approximately 3 hours to complete, and is suitable 4th grade and above.

CA Science Standards and National Science Standards:

NS K-4: Properties of objects and materials; heat
NS 5-8: Properties and changes of properties in matter
NS 9-12: Chemical reactions; transfer of heat

CA 1st grade: 1b - Properties of substances can change when the substances are mixed, cooled, or heated
CA 5th grade: 1a – During chemical reactions, the atoms in the reactants rearrange to form products with different properties
CA 8th grade: 5a – Reactant atoms and molecules interact to form products with different chemical properties
5b – Conservation of matter: in chemical reactions, the number of atoms stays the same no matter how they are arranged, so their total mass stays the same
5c – Chemical reactions usually liberate heat or absorb heat
CA High School: 3 - The conservation of atoms in chemical reactions leads to the principle of conservation of matter and the ability to calculate the mass of products and reactants
3a - Describe chemical reactions by writing balanced equations
7 - Energy is exchanged or transformed in all chemical reactions and physical changes of matter
7b - Chemical processes can either release (exothermic) or absorb (endothermic)thermal energy
All grade levels: Investigation and Experimentation/Science Inquiry

Objectives and Overview:

In part 1, students will work in pairs to discover the indicators of chemical reactions. Teacher demonstrates the instructions by pantomime to engage and direct students to focus on procedures. Each pair of students is assigned either an exothermic or endothermic reaction. Based on their observations, students are then asked to explain the evidence that a chemical reaction occurred. For higher grade levels, the lesson may be modified to use appropriate equipment to demonstrate the conservation of matter.

In part 2, students continue to further explore chemical reactions by investigating the cause and effect of their observations from part 1. Working in pairs or groups, students are directed to mix materials to form a testable question and then test their hypothesis to uncover which materials will react to produce a particular result. At the conclusion of this activity, students are asked to extend and apply their knowledge to mechanisms of lightsticks and stars.

The lesson begins with a pair of chemical reactions – one that is exothermic and the other that is endothermic. [The zip lock bags can pre-filled with the powders to save time.] Half of the students are provided with the chemicals for the exothermic reaction, and the other half are provided with the chemicals for the endothermic reaction.

Exothermic (heat releasing) reaction:

- Place a teaspoon of calcium chloride powder into a zip-lock bag.
- Place a teaspoon of baking soda (hydrogen sodium carbonate) powder into the same bag.
- Approximately ½ oz of purple cabbage juice is placed into a small condiment cup.
- The cup with purple cabbage juice is placed into the zip-lock bag (be careful not to spill the liquid).
- Squeeze out as much air as possible, and then zip the bag shut.
- Empty the liquid into the bag (shaking works).
- Observe what happens.

Endothermic (heat absorbing) reaction:

- Place a teaspoon of citric acid powder into a zip-lock bag.
- Place a teaspoon of baking soda (hydrogen sodium carbonate) powder into the same bag.
- Approximately ½ oz of purple cabbage juice is placed into a small condiment cup.
- The cup with purple cabbage juice is placed into the zip-lock bag (be careful not to spill the liquid).
- Squeeze out as much air as possible, and then zip the bag shut.
- Empty the liquid into the bag (shaking works).
- Observe what happens.

The Main Event – Experimentation!

Students are then instructed to obtain another zip lock bag, add one teaspoon of any powder and another teaspoon of a different powder to their bag. Students will then select a liquid and pour approximately ½ oz into a small condiment cup. After recording which ingredients they have chosen (e.g. A+C+3) and observations of the individual ingredients, students are instructed to add the cup with the chosen liquid to their bag with powders, press out the air from the bag, seal the bag, mix, and observe what happens and record their observations. Students are asked to make a data table to record their chemical combinations on one side and observations on the other. Each group (approximately 4-6 students) is then instructed to perform a minimum of 10 reactions.

Chemical Reactions (Mix and Match)

Powders*:	**Liquids*:**
A=Flour	**1**=Water
B=Epsom salts	**2**=Water with purple cabbage juice
C=Powdered lemonade	**3**=Vinegar with purple cabbage juice
D=Calcium chloride	**4**=Sodium carbonate solution with purple cabbage juice
E=Washing soda (sodium carbonate)	**5**=Diluted lemon juice with purple cabbage juice
F=Corn starch	**6**=Diluted tincture of iodine solution

*** Note that chemical substances are purposefully not identified.**

Once students have finished, have them to publicly display their data, and walk around the room to see what others have discovered. Then ask each group to develop a testable question based upon all of the data collected by the student groups. [Make sure each group has a different question!] Then have them answer their question by performing more experiments.

Lastly, have them write how they know when a chemical reaction has occurred (or the indicators of chemical reactions).

Student Directions:
Place a teaspoon each of two different powders (or solids) into a zip-lock bag.
Place ½ oz of a liquid into a small condiment cup.

Record ingredients.
Carefully place the cup into the bag with the solids (do not spill the liquid).
Squeeze as much air out of the bag as possible, and then zip the bag closed.
Empty the liquid into the bag.
Observe what happens, and record your observations.

Technical information about the chemicals in this experiment:

This experiment is meant to be a "mix and match" experiment. Nothing particularly horrible should happen regardless of which chemicals are mixed together. Do not hesitate to substitute chemicals of the same class if you do not have access to the ones listed. Always make sure you check the Material Safety Data Sheets (or safety information) for each chemical before using it in an experiment.

Purple cabbage juice is an acid-base indicator. To make purple cabbage juice, cut up cabbage into 1 cm square pieces, cover with water, then boil (or microwave) until the liquid has most of the color. Purple cabbage juice is red in acid, purple when neutral, and as it gets more basic it is blue then green then yellow.

These chemicals were chosen to demonstrate some common reactions:

Acid + base $\rightarrow$ neutral last (as long as equal amounts of acid and base are used)

Acid + carbonate $\rightarrow$ H_2CO_3 (carbonic acid) $\rightarrow$ $H_2O + CO_2$ (gas) BUBBLES AND FIZZES!

$I_2 + I^- +$ starch $\rightarrow$ iodine-starch complex (dark blue)

Exothermic reactions (these get hot)

Endothermic reactions (these get cold)

All waste is safe enough to throw in the garbage. All chemicals are available in supermarkets or educational supply stores.

Chemical reactions to demonstrate with atom set for Periodic Table

$AlCl_3 + NH_3 \rightarrow AlN + 3\ HCl$

$2\ H_2 + O_2 \rightarrow 2\ H_2O$

$H_2 + I_2 \rightarrow 2\ HI$

$COH_2 + O_2 \rightarrow CO_2 + H_2O$

$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

$2\ NI_3 \rightarrow N_2 + 3\ I_2$

$HCN + NaOH \rightarrow NaCN + H_2O$

$2\ Al + 3\ Br_2 \rightarrow 2\ AlBr_3$

$CaS + 2\ HCl \rightarrow H_2S + CaCl_2$

$AlN + 3\ HCl \rightarrow AlCl_3 + NH_3$

$Ca_2C + 4\ HCl \rightarrow 2\ CaCl_2 + CH_4$

Application: Light sticks and Stars

Pass out light sticks to students for observation. Ask students, "What do you see/notice inside? What is the purpose of the glass ampoule? Predict how it works, predict what will happen if the light stick is placed in hot water and cold water." You may then ask students to activate their light sticks.

Teacher activates three light sticks and places one light stick in an iced water bath, another light stick in a hot water bath, and the last remains at room temperature. After questioning students about what they think is responsible for the observed differences and what they would like to see happen next, teacher switches light sticks – the cold light stick is now placed in the hot water bath, and the hot light stick is now placed in the cold water bath.

Lights sticks contain two solutions that are separated from each other before it is activated. The ampoule contains hydrogen peroxide. When the ampoule is broken (you hear a "crack" when bending a light stick to activate), the hydrogen peroxide is mixed with the rest of the chemicals in the light stick, and a chemical reaction occurs in which light energy is released (exothermic). The energy given off in this reaction is given off as light instead of heat (cool light – as opposed to the hot light given off in a reaction such as the burning of a candle). Most of the light given off is ultra-violet light; this is absorbed by the dyes that are added to the light stick to give them their color. Different colored light sticks contain different dyes; the different dyes give off different colored light.

The addition of heat (higher temperature) to a chemical reaction increases the speed (rate) of a chemical reaction. The hotter it is, the faster it will react. When heat is removed (lower temperature) from a chemical reaction, the reaction slows down. If two identical light sticks are at different temperatures, the hotter one will use up its chemical faster, resulting in a brighter light color, and will not last as long as the light stick at the lower temperature.

Further Application: Predict the lifespan of the Sun and other stars (blue vs. red)

Final Assessment: Silly Putty (Glurch) and Oobleck

Teacher asks students to describe properties before and after mixing the Silly Putty and Olbleck. Ask them, "Which one appears to be a chemical reaction...the Silly Putty or Oobleck? Support with evidence"

Silly Putty (Glurch):

Pump 25 ml diluted (half glue – half water) into a zip-lock bag or cup.
Add 4% borax solution until all of the glue has reacted and is in a "clump".

The water trapped in the polymer is what makes it pliable. If less water is used, the putty will be stiffer. If the putty is exposed to the air, it will lose its water and become stiffer. Since Elmer's glue is made from milk, you can add water when it gets stiffer to make it more pliable. You can also add food coloring to either the glue or borax to produce a colored putty. If kept in a sealed zip-lock bag, the putty will last for months (depending upon conditions, it may grow mold).

Oobleck:

Oobleck is made by adding water to cornstarch (and mixed) until it is smooth (wetter than a paste).

If your students are having difficulties deciding whether Glurch or Oobleck formed as the result of a chemical change, place a sample of each on a paper towel overnight and reexamine them the following morning. {Glurch has gotten stiffer, but the Oobleck will separate into the water and corn starch powder – its original components.