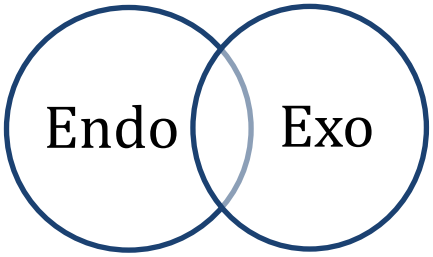
UC Irvine FOCUS!
5 E Lesson Plan

Title: Exothermic verses Endothermic
Grade Level and Course: 8th Grade Physical Science & 9-12 High School Chemistry
Materials: • 100 ml beakers or plastic cups • .1 M CH_3COOH (acetic acid/Vinegar) • H_2O_2 (Hydrogen peroxide) • Yeast • $NaHCO_3$ (Baking soda) • Thermometer • Graph paper
Instructional Resources Used: (concept maps, websites, think-pair-share, video clips, random selection of students etc.) • Video clips: http://www.youtube.com/watch?v=YIfV2Z-4M5E http://www.youtube.com/watch?v=MyAzjSdc3Fc&feature=related • Place students into predetermined groups to maximize learning. • During engage piece of lesson, students will participate in think-pair-share. • Venn diagram as a product for English Language Learners.
California State Standards: (written out) 8th Grade Physical Science: Reactions 5. Chemical reactions are processes in which atoms are rearranged into different combinations of molecules. As a basis for understanding this concept: a: Students know reactant atoms and molecules interact to form products with different chemical properties. c: Students know chemical reactions usually liberate or absorb heat. High School Chemistry: Chemical Thermodynamics 7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept: a. Students know how to describe temperature and heat flow in terms of the motion of molecules (or atoms). b. Students know chemical processes can either release (exothermic) or absorb (endothermic) thermal energy.
Lesson Objectives: • Students will be able to determine if a reaction is exothermic (energy losing) or endothermic (energy gaining) based on quantitative and qualitative analysis. • Students will successfully conduct detailed experiments involving the collection of qualitative and quantitative data.
Differentiation Strategies to meet the needs of diverse learners:

- English Learners: In mixed ability groupings, students will be asked to define the terms endothermic and exothermic prior to this lesson. After defining the terms, students identify which of the reactions is exothermic and which is endothermic, and explain why.
  $2H_2 + O_2 \rightarrow 2H_2O$ + heat
  $N_2 + 3H_2$ + heat $\rightarrow 2NH_3$



Based on the above two equations, have students fill in the diagram.

- Special Education: Students watch the following two videos: http://www.youtube.com/watch?v=YIfV2Z-4M5E and http://www.youtube.com/watch?v=MyAzjSdc3Fc&feature=related . Write the reactions as the students are watching, leaving heat out. After the videos, have the students identify on which side of the reaction heat belongs as a product (given off) or as a reactant (absorbed).
- GATE: Students will calculate heat gained or lost based on mass of baking soda used, calculate the heat gained or lost of a different quantity and then conduct an experiment to confirm.

ENGAGE

- Describe how the teacher will capture the students' interest.
  - Have each student hold a piece of ice.
  - Using think-pair-share, have them theorize why they are feeling what they are feeling. Pair with another student and share their thoughts. Groups will them report out to the class.
  - Ask how this is the same or different from standing in front of an open refrigerator.
  - Students will share with each other in pairs and then report out to the teacher who will record all answers on the board.

- What kind of questions should the students ask themselves after the engagement?
  a. What is happening to the ice?
  b. Why does your hand feel cold?
  c. In what direction does energy flow?

EXPLORE

- Describe the hands-on laboratory activity that the students will be doing.

a. Students will have prepared a lab write-up prior to class. Students will draw the procedure, labeling all materials in the lab write up. Drawing the lab will assist the English Language Learner and Special Ed student by having them understand the materials being used (terminology) as well as making sure that the lab procedure is understood. Copying the procedure may or may not mean the student understands the procedure.
b. Students will follow the procedure for ~~the~~ two reactions: ~~the first being~~ the endothermic reaction of baking soda and vinegar, and the ~~second~~ exothermic reaction of hydrogen peroxide and yeast. ~~which is exothermic.~~
c. Students will perform three trials for each.
d. Students will build a data table and record all qualitative and quantitative data.

- List the "big idea" conceptual questions that the teacher will ask to focus the student exploration.

  a. How can exothermic and exothermic reactions be identified?
  b. In nature, which way does heat flow? (high school)

EXPLAIN

- What is the "big idea" concept that students should have internalized from doing the exploration?

  In chemical reactions, atoms of reactants are rearranged into different molecules as products. The new molecules have different bonds, sometime containing less total energy than the reactants and sometimes more. Since energy is always conserved, if the products contain less energy than the reactants, energy is left over and the reaction is exothermic. If the bonds of the products contain more energy than the reactants, then energy must be absorbed and the reaction is endothermic. This energy may take many forms, including light, heat and sound.

  Often, energy that is written as a reactant or product in a formula, as is illustrated below:

  $2H_2O$ + energy $\longrightarrow$ $2H_2$ + O_2

- List the higher order questions that the teacher will ask to solicit student explanations for their laboratory outcomes, and justify their explanations.

  a. If a reaction is exothermic, where does the extra energy go?
  b. If a reaction is endothermic, where does the energy come from?
  c. If energy is always conserved, what does mean for the previous two questions?

EXTEND

- Explain how students will develop a more sophisticated understanding of the concept.

  - In every exothermic or endothermic reaction, energy comes from or goes to the surroundings. The surroundings can be a gas, solid or liquid. For a reaction to gain some amount of energy, something must lose that amount of energy. The same is true for exothermic reactions.

Something must gain energy. The surroundings must gain the energy given off or lost.
    - After watching the video, http://www.youtube.com/watch?v=MyAzjSdc3Fc&feature=related, have students articulate why the beaker froze to the wooden board.

- How is this knowledge applied in our daily lives?
    - Opening a refrigerator door does not allow cold air out. Instead, the heat from the outside air goes into the cold air inside. The loss of heat from the outside air makes it colder.
    - Students will research and then build a presentation board describing an exothermic or endothermic reaction that occurs in nature. Students must include reactions relevant to their own lives.

EVALUATE

- How will the student demonstrate their new understanding and/or skill?
    - Along with answering the questions attached to the lab, students will answer questions in the chapter test.

- What is the learning product for the lesson?
    a. Successful completion of the lab.
    b. Correctly answering the lab questions.
    c. Accurate completion of the graph and presentation board.

Background Knowledge for the Teacher:

In endothermic reactions, energy is drawn in from the external environment, causing its surroundings to loose heat, or "cool down." The endothermic chemical reaction creates a product that has a higher energy level than the original materials, causing the reactant's stored energy to decrease. (In scientific terms, the reactants have "less total enthalpy" than the product.) The resulting product of the reaction is less stable because, the higher the energy bond, the less strength its molecules possess. Most endothermic reactions are not spontaneous.
In exothermic reactions, chemical reactions cause their surroundings to warm up by giving off heat. The reactants contain more stored energy than the product because energy from external sources is not required, but given off. This gives the product more stability due to the lower amount of energy needed. (In this case, the reactants have a "greater total enthalpy" than the product.) Exothermic reactions are usually spontaneous. The melting of ice is an endothermic process because the ice gains energy. Your hand feels cold because it is losing heat to the ice.

Dawn R. Cole, The difference between exothermic and endothermic chemical reactions. http://www.helium.com , July 10, 2008.

Student pages are attached.

Endothermic vs. Exothermic

Materials:

100 ml beakers or plastic cups
.1 M CH_3COOH (acetic acid/Vinegar)
H_2O_2 (Hydrogen peroxide)
Yeast
$NaHCO_3$ (Baking soda)
Thermometer
Graph paper

Procedures:

Vinegar and baking soda:

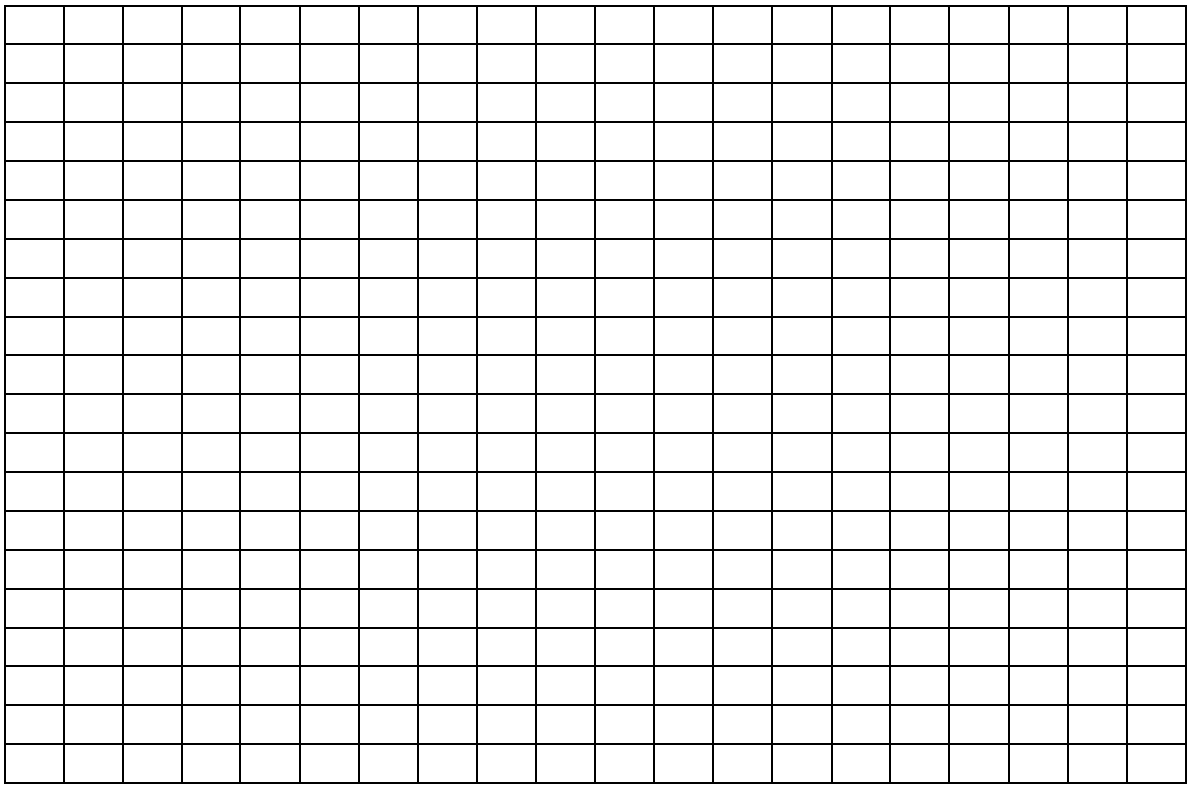
1. Pour 50 mL of vinegar into a plastic cup. Measure and record the temperature.
2. Select a specific mass (under 10 grams) of baking soda to react with the vinegar.
3. Add the baking soda to the vinegar. Record the temperature of the reaction every 10 seconds until it equilibrates.
4. Repeat steps 1-3 twice more, increasing the mass 5g for each trial (keeping the volume of vinegar constant).
5. Observe and record your data on a chart (you design it!)

Hydrogen peroxide and yeast:

1. Pour 50 mL of hydrogen peroxide into the beaker. Measure and record the starting temperature.
2. Select a specific mass (under 10 grams) of yeast to react with the hydrogen peroxide.
3. Add the yeast to the hydrogen peroxide. Record the temperature of the reaction every 10 seconds until it equilibrates.
4. Repeat steps 1-3 twice more, each time with a different mass of yeast added each time (keep the volume of hydrogen peroxide constant).
5. Observe and record your data on a chart (you design it!)

Data Table: (Student created)

Graph: Graph temp verses mass for all six trials. Use different colors for all six trials.



1. Did changing the concentration of the solid affect the change in temperature of the reaction? Why do you believe this is so?

2. Which of the reactions was endothermic? How do you know?

3. Which reaction was exothermic? How do you know?

6. Does graphing your data result in a straight line? Explain.