TIME FRAME: to be taught early March

LESSON RATIONALE:

This three day lesson plan revolves around the driving question, "What happens when you break a cold/hot pack?" and reinforces the concept of science as inquiry. Inquiry requires students to think, engaging their cognitive abilities to try to pass from the concrete operational stage of thinking to the formal operational stage. Research shows that teachers who spend time helping their students to develop a qualitative understanding of concepts also increases the students' ability to solve quantitative problems. On the other hand, students who are able to solve problems quantitatively do not necessarily have a qualitative understanding.

In this class the students will have previously learned about heat transfer and systems and their surroundings. Students will take this previous knowledge to try to reason their way through the heat changes when activating a cold/hot pack. After collecting their thoughts, the students will then in groups complete a series of stations that involve heat transfer, record their results and explain the changes in energy. The students will finally have to categorize the reactions into groups based on their observations. This allows students to understand concepts qualitatively before being told specifically what endothermic and exothermic reactions are.

This lesson plan follows the activity model for scientific inquiry in that students experience the scientific method through prediction, investigation of the known, carrying out the study, observing, examining the results, reflecting on their findings and communicating with others. Investigation of the known is done when students access their prior knowledge and present their previous ideas about the system. Students then have to carry out the study by designing the experiment and how data is to be recorded. Observation occurs as students do the experiment and record the results. The students then have to examine their results categorizing them, and then reflecting on how to categorize the reactions. Communication with others is done throughout the lesson and students share their prior knowledge, work together to create and implement the laboratory design and decide what the results mean.

CALIFORNIA CONTENT STANDARD:

Our standard is Chemistry 7b
7. Energy is exchanged or transformed in all chemical reactions and physical changes of matter. As a basis for understanding this concept:

b. Students know chemical processes can either release (exothermic) or absorb (endothermic) thermal energy

LEARNING OBJECTIVES

Given several physical and chemical reactions, students will complete an investigation of exothermic and endothermic reactions where they collect and analyze data that illustrate these reactions.

Given a background discussion on thermal energy, heat, and lab results; students will write a paragraph demonstrating their understanding of both exothermic and endothermic reactions through relating these terms to the phenomenon of a hot and cold pack.

ASSESSMENT –

Assessment Activity	Evaluation Criteria	What is Assessed	Student Feedback
Pretest to elicit preconceived ideas regarding heat/energy/etc.	Completion of pretest	Provided appropriate response to each of the questions	This assessment piece will be used to guide instruction. I will address the specific ideas students have.
Warm Up and Homework Questions that build toward laboratory activity	Completeness of both	Adequate thoroughness in response to proposed questions	1. Stamp on assignment 2. Class discussion guided by student questions
Experimentation skills – are the students able to follow procedures and create their own ideas.	Ability to follow procedure, record data	Whether the students were able to complete the data collection as directed, how well they documented observations and answered questions.	The teacher reviews the datasheets for completion prior to clean-up. Guided questions such as "what happened here" or "what did you find out" may be necessary.
Concept understanding – are students able to correctly describe the change in energy that occurs during a spontaneous endothermic reaction	Ability to relate observations to scientific vocabulary and concepts	1: Ability to relate this analysis to the posed question. 2: Understand and relating the scientific language for their experiment.	1: Guidance if there are questionable results. 2: Students provide 3x5 card teacher with their definition of reaction in the hot/cold pack. 3: Students create diagram, energy graph and paragraph describing a common cold pack.

INSTRUCTIONAL STRATEGIES AND TASKS TO SUPPORT LEARNING

Day 1 Time: 45 minutes Period 1: Engage and Connect
8:00 – 8:10 (10 minutes) Warm Up

- An overhead is projected on the screen which instructs to students to sit with their lab partners today and to answer the following questions
- Students are given (Living By Chemistry Unit 5 Investigation 1 Lesson 3 pg 37) Questions 1-3 related to melting ice cube to complete independently.
- After working for approximately five minutes students are instructed to share their ideas with their lab partners and compare. The lab groups then share with the class as a whole

8:10-8:30 (20 minutes) Develop and Instruct

- Students then given a handout with the following chart

Before	After

- The driving question of the unit is posted on the overhead as well above the chart: "What happens when you break a cold/hot pack?" Each lab group is given a hot pack of the type that you snap
- Students are instructed verbally to record observations describing the hot pack as they have received it (without snapping) in "Before" column
- Students then break the hot pack and record observations describing the hot pack now in the "After" column
- The class works together to answer the questions on the handout relating to heat transfer, molecular motion and changes in kinetic, interaction, and chemical energy (also create graph)
- A diagram of the hot pack is drawn on the board and the instructor asks a volunteer to draw (using arrows) the direction of heat flow. The instructor asks students where the heat is moving, where heat is coming from, what is the system vs. the surroundings.
- Students then complete similar questions on sugar & conc. sulfuric acid demo, done by me!! On same handout

Purpose: There are several main goals in this warm up. First, the driving question for the three day unit is introduced. Second, students revisit information and vocabulary introduced in the days leading up to this activity (systems/surroundings) and attempt to apply it in a new context. Third, this allows the teacher to assess their current conceptions about the thermal energy changes in this system. Fourth, by assessing prior knowledge of the students they will have a context in which to place the information they will be given. Fifth, the students are given the question hence this is a guided rather than open inquiry activity but in order for it to be inquiry it is important that students are allowed to make predictions and engage in higher level thinking.

8:30 – 8: 40 (10 minutes)
Intro to tomorrow's activity:

- give instructions on stations
- ask them to review types of questions they will be asked during lab
- ask students to develop questions that would be helpful to them in order to complete an energy diagram

8: 40 – 8:45 (5 minutes)

- If time available allow students to begin homework which consists of two more scenarios similar to group activities, one physical and one chemical

Day 2 (8:00 – 9:20)

8: 00 – 8: 10 Warm Up (10 minutes)

- Students answer question reviewing difference between heat, energy and temperature

- Review from yesterday: Question and Answer between the teacher and students involving questions like the following:
    - What does it mean when something is cold (at the molecular level)?
    - Why do things feel cold?
    - How does something become cold – in terms of molecular motion?
    - Is coldness added to the system or is heat taken away?

  These questions would be modified depending on how much of this material was already correctly explained by their warm up descriptions.
- Ask if questions from last night's homework

Develop & Instruct

(8:10- 8:15) 5 minutes Review

- The teacher reminds the students orally of the driving question. They also give any safety precautions necessary for the day
- The teacher also instructs students as to where they can locate the chemicals and glassware they may need and how much of each chemical is an appropriate amount to use. Students should receive a reminder that they are to be thinking about how heat is moving in each one of their reactions.

Purpose: It is essential that the teacher touch base with students at the start of the day. Many students may need to be reminded what it is they are engaging in and why they are doing it. It is also crucial that safety issues be addressed to prevent injury or accidents.

(8:15-9:00) 45 minutes Experimentation

- Students rotate through a series of stations, they must all complete all of them
- Stations include: $CaCl_2$ in water (exo), HCl & NaOH (exo), evaporating alcohol (endo), NH_4Cl & $Ba(OH)_2$ (endo), ppt rxn. (no change), KCl in water (endo)
- These chemicals can be combined safely to create exothermic, endothermic and energetically neutral reactions.
- Students should record any changes in temperature that occur but also other observations as well. Color changes etc.
- The teacher monitors each group for safety concerns and to assist in any questions they may have. The teacher will also be monitoring progress on the assignment.

Purpose: This is the time in which students perform their actual experiments and collect data to be analyzed. The students work in their groups to follow their own procedure which creates ownership of the material. By observing the reactions they create their own ideas about what is possible.

Assess and Close

(9:00 – 9:20) 20 minutes Clean Up and Closure

- Students wash and return glassware and ensure that they have all the necessary data recorded.

Group and Label

- Each student is asked to individually create groupings of the reactions from the day's lab that occurred based upon heat transfer in lab handout (All of the reactions that lost energy would be in the same grouping)
- Students then compare their reaction groupings with their lab partners. As a group they are asked to create a name for each group that describes the characteristic of that group. For example the labels might be Heat Lost, Heat Gained, No Heat Transfer. In addition they need to draw a sample diagram for each three showing heat transfer.
- Students are required to write on a 3 by 5 card the reaction that most resembled the hot pack demo they observed yesterday.
- Students turn in these 3 by 5 cards
- The teacher asks for each groups' labels to create a whole class list.
- The teacher then introduces the scientific labels for each of these groups: endothermic and exothermic. Some discussion of the Latin roots of these terms may prove helpful to students.

Assess and Close

Application to New Situation

- Each class observes a cold pack.
- Their homework assignment is to **Draw a diagram showing heat transfer and label the system and surroundings in the cold pack reaction. Write a paragraph explaining the phenomenon of the cold pack using the terminology of exothermic, endothermic, system and surroundings. Be sure to include how you know whether it is an exothermic or endothermic reaction (give evidence). Compare what occurred in the hot pack demonstration with the cold pack.**

Purpose: The closure activity is designed to provide students with an opportunity to practice using their new vocabulary with a similar but new situation. This will allow the instructor to assess how comfortable students are with the new terminology and whether they can analyze a new system with the information they have learned.

The following day we will discuss students' responses, they will share with the class and then have a discussion around the questions "If you believe that heat is entering the system, why does the temperature of the cold pack go down? What is the energy being used for if it isn't being used to raise the temperature?"

Materials we will bring to Spring/Summer meeting

- Videotape of at least one (most likely two) days of teaching
- Student work – at least two, including 3 x 5 cards, and handouts
- Katie's & Holly's reflections
- Notes/reflections from Katie's and Holly's thoughts

Scaffolding Steps that must come before this lesson in order to prevent against disaster:

- Know how to record qualitative and quantitative observations – experience reading thermometers, comparing data and describing reactions
- Preliminary knowledge of the kind of information included in a procedure
- Practice writing in science class about scientific phenomenon, and explaining observations and thought processes