**Chemical Energy:**
Grades 5-8 Saturday Science Lesson Plan

**Objectives:**

* After completing activities in which they have the opportunity to make their own chemical reactions, students will begin to understand the indicators of a chemical reaction. Students will be responsible for listing at least three indicators of a chemical reaction.
* After completing activities in which they have the opportunity to make their own chemical reactions, students will begin to understand the differences between endothermic and exothermic chemical reactions. Students will be responsible for defining both endothermic reactions and exothermic reactions by describing whether or not the reaction absorbs heat or produces heat and giving an example of each type of reaction.
* After completing an activity on food chains, students will begin to understand how energy is transported and transferred in nature. Students will be responsible for creating their own food chains. Their food chains must contain five levels and show which way the energy is flowing. They must identify the specific animal at each level as well as the “type” of animal (herbivore, carnivore, etc.)
* After completing the activities and brainstorming as a class about how the sun contributes to the production of chemical energy, students will begin to make connections between solar energy and other forms of energy, specifically chemical energy. Students will be responsible for taking notes on the connections but the final assessment strategies will occur during the final lessons when students construct a flow chart showing how the energy from the sun is used for many different purposes and how it is transformed to different forms of energy.

**Standards:**

* 6.3.17 - Recognize and describe that energy is a property of many objects and is associated with heat, light, electricity, mechanical motion, and sound. **(Core Standard)**
* 6.3.18 - Investigate and describe that when a new material, such as concrete, is made by combining two or more materials, it has properties that are different from the original materials. **(Core Standard)**
* 7.3.14 - Explain that energy in the form of heat is almost always one of the products of an energy transformation, such as in the examples of exploding stars, biological growth, the operation of machines, and the motion of people. **(Core Standard)**
* 7.3.16 - Recognize and explain that different ways of obtaining, transforming, and distributing energy have different environmental consequences. **(Core Standard)**
* 8.3.13 - Explain that energy cannot be created or destroyed but only changed from one form into another. **(Core Standard)**
* 8.3.15 - Identify different forms of energy that exist in nature. **(Core Standard)**

**Teacher Content Knowledge:**

Teachers should have a strong understanding of:

* Chemical energy –
	+ Chemical energy is energy stored in the bonds of atoms and molecules. It is the energy that holds these particles together. Biomass, petroleum, natural gas and propane are examples of stored chemical energy; batteries are an example of a man-made object with stored chemical energy. Solar energy contributes to the production of potential chemical energy through its role in the food chain.
* Energy transfer –
	+ Energy can be transferred from one location to another, as in the sun's energy travels through space to Earth. The two ways that energy can be transferred are by doing work and heat transfer.
* Endothermic reaction –
	+ A chemical reaction that absorbs heat from its surroundings as the reaction takes place. Examples of endothermic reactions include melting ice cubes, evaporation of water, and producing sugar through photosynthesis.
* Exothermic reaction –
	+ A chemical reaction that releases heat into its surroundings as the reaction takes place. Examples of exothermic reactions include condensation of rain from the water vapor in clouds, burning a candle, and mixing water and strong acid.
* Food chain –
	+ In a food chain, the parts are the Sun, plants, herbivores and carnivores. (Humans can be considered the final link in the chain.) There are two main processes taking place in the food chain. The first involves the movement of energy in the form of radiation from the Sun to the plants. The second process involves the movement of energy in the form of organic molecules from plants to herbivores, and then finally to carnivores and humans through biomass consumption.
* Potential energy –
	+ Potential energy is energy stored in an object or energy that an object has because of its position. Chemical energy is a type of potential energy (through chemical bonding).

**Materials List:**

* 50 Ziploc Sandwich Sized Bags
* 2 Boxes of Baking Soda
* 1 Container of Melting Salt
* 16 small vials
* 1 Beaker
* 5 10 ml Graduated Cylinders
* Dropping bottle of red liquid
* Phenol Red in Dropper Bottle
* 5 Teaspoons
* 5 Thermometers
* 75 ml of vinegar
* 2 measuring cups
* 1 Container of Calcium Chloride
* Cold Water
* Three Bags of Popped Popcorn (does not have to be warm)

**Lesson:**

This lesson will consist of activities that will be used to introduce students to chemical energy, how we use chemical energy, and how solar energy is connected to chemical energy. We will also revisit our wind power activity from last week and finish up our discussion and find out whether or not we answered the questions that the students posed as a class. The students will begin the day with a Know, Want to Know, and Learned (KWL) chart. The students will be asked to write anything they know about chemical energy in the “Know” portion of their chart and write down any questions they would like to answer about chemical energy in the “Want to Know” portion of their chart. These questions should be listed on the board for all students to see. As the class completes the activities, they will revisit the questions on the board to see if they have answered any of them and if so, discuss how they were answered. Students should record the answers in their journals or on the back of their charts.

**Engage: KWL Charts and Baggie Chemistry**

Not only will the students begin filling out their KWL charts but they also will participate in a short activity to get them thinking about chemical reactions. Specifically, students will think about what observable changes occur when a chemical reaction takes place. Students will:

1. Mix the following powders together in a Ziploc bag:
	1. 1 teaspoon of baking soda
	2. 2 teaspoons of melting salt
2. Measure 10 mL of red indicator and pour it into a vial.
3. Place the vial into the bag in an upright position and seal the bag (press out as much air from the bag as possible before sealing it; the teacher should explicitly say that the students are pushing out the gas)
4. Tip the bottle of the liquid so that the liquid will have good contact with the powders.
5. Observe – Students should write down their observations and the teacher should encourage their students to observe with all five of their senses.
6. Discuss using these questions.
* What changes have you noticed in the bag?
* What is causing the changes?
* What has disappeared from the bag? Where did it disappear to? Did the items disappear or did they just change to something else?
* What do you think is happening in the bag?

Once the students have had an opportunity to discuss the questions above, have them think about the indicators of a chemical change. These observable indicators are a change in color, the production of heat, and a production of gas, and the most important and fundamental change is the production of new substances.It will be useful to explain the chemical equation that resembles the chemical change that is occurring in their baggies.

**Baking Soda + Melting Salt + Phenol Red Heat + Color Change + Gas**

**Explore and Explain:**

The first two activities listed below will help students begin to understand the concepts of endothermic reactions and exothermic reactions. There is a worksheet to accompany each activity. The students will be required to record some pieces of measurable data in order to answer the questions that are on the worksheet.

**Activity 1: Chemical Reaction 1**

The teacher should begin the activity by passing out the worksheet entitled Chemical Reaction 1 to students. The students should divide into groups of three. They should read the small amount of background information provided at the top and then predict whether or not the chemical reaction between baking soda and vinegar absorbs heat or produces heat. Next, the students should be instructed to work within their groups to follow the procedure listed on their worksheets.

1. Pour 15 ml of vinegar into a clean empty Ziploc bag. Feel the vinegar through the bag to observe its temperature.
2. Carefully place the thermometer in the bag with the bulb in the vinegar and record the temperature of the vinegar. Leave the thermometer in the bag.
3. Carefully pour 15 cc of baking soda into the Ziploc bag. BE CAREFUL! The chemical reaction will foam and fill the bag.
4. Wait 30 seconds and record the temperature of the mixture. Remove the thermometer from the bag and zip the bag closed.
5. Feel the mixture through the bag and observe its temperature.
6. Discuss.
* Is the chemical reaction between the vinegar and baking soda endothermic or exothermic?
* Can you think of a way you could use an exothermic reaction?

Students should place this worksheet in their journals.

**Activity 2: Chemical Reaction 2**

The teacher should begin the activity by passing out the worksheet entitled Chemical Reaction 2 to students. The students should divide into groups of three again. They should predict whether or not the chemical reaction between calcium chloride and water absorbs heat or produces heat. Next, the students should be instructed to work within their groups to follow the procedure listed on their worksheets.

1. Pour 5 ml of cold water into the Ziploc bag and use the thermometer to measure the temperature of the water.
2. Remove the thermometer from the bag.
3. Pour 1 cc of calcium chloride into the water and observe the mixture.
4. Record your observations. Use the thermometer to record the temperature of the mixture.
5. Pour 1 cc of calcium chloride into the water.
6. Observe the bag for any change and record your observations and the temperature of the mixture.
7. Zip the bag and dispose of it as instructed by your leader. Wash your hands thoroughly with soap.
8. Discuss.
* Is the chemical reaction between calcium chloride and water an endothermic of exothermic reaction?
* Was there a difference in temperature when you added more calcium chloride?
* Can you think of a practical use for calcium chloride in the winter?

Students should place this worksheet in their journals as well.

There is a third worksheet that students can have to reference the chemical equations. The teacher should not pass this out until both activities are done because it explains what the end productions of the reaction are. Once the students have completed the activities and reviewed the chemical equations, the teacher should conduct a recap discussion on endothermic and exothermic reactions. Ask students what they think the difference is between endothermic reactions and exothermic reactions. Once students have shared their ideas, explain that all substances contain energy. When these substances undergo a chemical reaction, new substances are produced. These new substances contain a different amount of chemical energy. Therefore a chemical reaction can release energy (heat and/or light) or absorb energy (heat and/or light). Allow students to pose any remaining questions they have about endothermic and exothermic reactions. These questions should be placed on the board and considered for investigation during later lessons.

*\* Reference the Teacher Content Knowledge section for more specific information on endothermic reactions and exothermic reactions.*

**Activity 3: Leaf Relay**

The teacher should begin this activity by introducing students to a simple food chain. Allow the students to make suggestions. If they are unsure about what goes into a food chain, the teacher can help them understand by writing an example on the board. The students then can help explain how the living things in the food chain are interrelated. The food chain should begin with the sun and end with humans. Next the students should divide into three teams and line up in a single file line. There should be about two to three feet in between each team member. The teacher will place one bag of popcorn at the end of each row of team members. The bag of popcorn should be placed as far away from one end of each row as possible Next, the teacher will assign the following roles to one student on each team: sun, plant, herbivore, carnivore, human. Each player, except the sun, should mark their spots (any item can be used for this). The student who is representing the sun should then walk down to the “energy pile”, or bag of popcorn, and stand behind it while waiting for the activity to begin. The suns will then scoop up as much popcorn as possible in their hands as possible. Once the teacher says “Go!”, the suns will race down to the plants. The plants will then gently grab as much of the sun’s energy as they can. The plants turn, staying in their spots, and the herbivores race to the plants to grab as much energy as they can hold in their hands. The herbivores then return to their spots. Once the herbivores have returned, the carnivores will run to the herbivores to capture the energy from them. The process continues with the humans. When the humans have returned to their marked spots, have the students raise their remaining energy above their heads to show the teacher that they are done.

If time permits, the activity can be done again but this time with the carnivores removed from the food chain. The students can then discuss what this activity shows. Direct the students’ attention to the ground and have them think about what happened during energy transport and transfer. The students should then think about what differences occurred when the carnivores were taken out of the food chain. Students could also consider what sorts of things would have a negative or positive effect on the energy transfer and transport in food chains. Once the students have been able to share their thoughts, the teacher should allow them to pose any new questions they may have about food chains. These questions should be written on the board and considered for later lessons.

**Elaborate:**

The students will further their understanding of chemical energy by brainstorming ideas about how the sun contributes to the production of each type of energy. These ideas will be shared with the entire class and recorded on the board for everyone to see. The teacher will then explain the connections and clear up any misconceptions students may have had.

**Evaluate:**

The students will be evaluated based on their KWL charts. The students will fill in the “Learned” portion of their KWL charts. The charts will make it obvious which students retained the information they learned about during the activities because their charts will be more complete and detailed than others. The teacher should look for the items listed in the objectives at the beginning of this lesson plan. It would also be preferable if students put some of the information they found most interesting to them instead of only including what is expected of them.

**Sources:**

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