Lesson Title: Alternative Fuels – Splitting Atoms
Unit: Kinetics and Thermodynamics
Subject: Agriculture Science/Agriculture Chemistry/Agriculture Biology
Learning Standard and Learning Benchmark: *California State Standards Addressed:*

ESSENTIAL STANDARD: KINETICS AND THERMODYNAMICS
STUDENTS WILL DESCRIBE THE DYNAMICS OF CHEMICAL PROCESSES, INCLUDING ENERGY CHANGE, REACTION RATES AND EQUILIBRIUM.

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.
c. *Students know* energy is released when a material condenses or freezes and is absorbed when a material evaporates or melts.
d. *Students know* how to solve problems involving heat flow and temperature changes, using known values of specific heat and latent heat of phase change.
e. *Students know* the rate of reaction is the decrease in concentration of reactants or the increase in concentration of products with time.
f. *Students know* how reaction rates depend on such factors as concentration, temperature, and pressure.
g. *Students know* the role a catalyst plays in increasing the reaction rate.
h. *Students know* how to use LeChatelier's principle to predict the effect of changes in concentration, temperature, and pressure.
i. *Students know* equilibrium is established when forward and reverse reaction rates are equal.

Objectives - Instruction in this lesson should result in students achieving the following objectives:

1. Students will be able to identify and discuss the importance of alternative fuels
2. Students will be able to distinguish between nuclear fission and nuclear fusion.

Resources

http://www.propane.tx.gov/education

Materials (per student/group)
250 ml beaker
125 ml rubbing alcohol (isopropyl alcohol)
50 ml water
1-2 ml of cooking oil
Teaspoon
Small dropper or pipette

Terms		
alcohol	*aliphatic*	*ambient*
benzene	*biochemical conversion*	*conversion*
biofuel	*biogas*	*biomass*
British Thermal Unit	*butane*	*carbon dioxide*
carbon monoxide	*catalytic conversion*	*clean diesel*
coal	*diesel*	*fission*
formaldehyde	*fuel oil*	*fusion*
furnace	*gasoline*	*incinerator*
jet fuel	*kerosene*	*landfill*
methyl tertiary butyl	*ether*	*municipal solid waste*
nuclear energy	*nuclear reaction*	*oxygenate*
oxygenated gasoline	*reformulated gasoline*	*refuse*
syngas	*thermochemical*	*transesterification*
vapor lock	*volatility*	*waste to energy plant*

Objective 1

Interest Approach

Descartes Moment (Included in power point)

Summary of Content and Teaching Strategies

Objective 1 – Students will be able to identify and discuss alternative fuels and their importance (Use power point).

Anticipated Problem: What are the alternative energy sources that are used throughout the United States?

1. **What is Biodiesel?**
    a. **Biodiesel** is derived from vegetable oils in an inexpensive process called **transesterification**, in which vegetable oil reacts with methanol or ethanol in the presence of a **catalyst**. The catalyst is used to speed up the reaction. The process yields about 96 percent biodiesel. Many vegetable oils, both those used as foods and those unsuited for human consumption, can produce oil for biodiesel. Soybean oil is currently the main source of biodiesel, but considerable interest has been shown in **rapeseed** oil because of its high oil yield and the value of its by-products as livestock feed. Biodiesel has physical properties similar to diesel. Emissions properties, however, are better for biodiesel than for petroleum diesel. High crude oil prices and diminishing U.S. fossil-fuel resources could make manufacturing diesel from vegetable oils more attractive economically.
2. **What is Ethyl Alcohol?**
    a. **Ethyl alcohol (ethanol)** has long been used as a fuel. One version of Henry Ford's Model T was designed to run on ethanol. Ethanol can be made from many different sources of starches or sugars. By far the greatest amount of ethanol worldwide is made from sugar cane. The world's leading ethanol producer is Brazil, where billions of gallons of fuel ethanol are produced from sugar cane each year. In the United States, the price of sugar is too high to produce ethanol economically, so other sources are used. Corn is used to produce well over 90 percent of U.S. ethanol.
3. **What is hydrogen?**
    a. **Hydrogen** is produced from water through **electrolysis**, but it can also be processed from other hydrocarbon fuels and biomass sources. Hydrogen is an efficient energy source with high energy content that produces few emissions. Though some automakers are testing hydrogen-burning cars, they are currently not feasible or economical. Possibly the greatest potential use for hydrogen as a transportation fuel is when used in a fuel cell to generate electricity to power a vehicle.
4. **What is Methanol?**
    a. **Methanol**, or methyl alcohol, is a colorless, odorless liquid. In the United States, it is most commonly used as a chemical feedstock, solvent, or to produce the gasoline additive methyl tertiary butyl ether (MTBE). Methanol can be used straight (**M100**) as a gasoline or diesel substitute or blended with 15 percent gasoline (**M85**). In 2000, U.S. industry produced 10.1 billion pounds of methanol. 3.2 billion pounds was consumed as MTBE and transportation fuel. The rest went to nontransportation uses. Most methanol produced in the United States is made from natural gas. To make methanol, natural gas is reacted with a catalyst at high temperatures and

pressures. Methanol can also be made from coal, **residual oil**, and high-cellulose biomass.

5. **What is Natural gas?**
    a. A fossil fuel, is a mixture of hydrocarbons, mostly methane. Texas alone produces 28 percent of U.S. natural gas, and Louisiana and Oklahoma combined produce another 29 percent. Natural gas is widely used in stationary applications such as heating and electric generation. Interest in natural gas as a transportation fuel stems mainly from its clean-burning qualities, its domestic origin, and its commercial availability. It is cleaner burning than gasoline or diesel. Natural gas is also lower in sulfur compounds than conventional fuels, and it emits fewer particulates into the air when it is burned. Natural gas can be used in any vehicle with an internal-combustion engine, although the vehicle must be outfitted with a special **carburetor** or **fuel injector** and fuel tanks. Natural gas costs less than gasoline and has a higher **octane rating**. More than 90,000 cars, trucks, and buses run on natural gas in the United States. Because of its gaseous nature, natural gas must be compressed or liquefied to be efficiently stored on board a vehicle. **Compressed natural gas (CNG)** tanks have to be refilled more often than gasoline tanks, and there are few refueling stations. **Liquefied natural gas (LNG)** is made by cooling natural gas to a temperature of -259ºC. At that temperature, natural gas becomes a liquid, and its volume is reduced 615 times, which makes it easier to store and transport.
6. **What is Propane?**
    a. Propane is one of the fossil fuels in liquefied petroleum (LP) gas. **Liquefied petroleum gas** consists mainly of propane, propylene, butane, and butylene in various mixtures. In the United States, the mixture is mostly propane and is sold under that name. Propane is widely used for heating, cooking, and in industry as a raw material for chemical manufacturing. Propane comes from natural gas and petroleum. Despite the “liquefied petroleum” name, roughly two-thirds of the propane used in the United States is extracted from raw natural gas. (Raw natural gas is natural gas that hasn’t been cleaned and processed yet.) Raw natural gas contains about 92 percent methane, and most of the rest is a mixture of ethane and the “LP” gases. Today about 300,000 U.S. vehicles use propane. Like natural gas, propane is clean-burning, leaving no deposits that speed up engine wear. This means less maintenance and a longer engine life. Because propane is a low-pollution fuel, forklift trucks powered by propane can be operated safely inside factories and warehouses.
7. **What is Electricity?**
    a. Electricity can be used as a transportation fuel to power battery electric and fuel cell vehicles. When used to power electric vehicles or EVs, electricity is stored in an energy storage device such as a battery. EV batteries have a limited storage capacity and their electricity must be replenished by plugging the vehicle into an electrical source. The electricity for recharging the batteries can come from the existing power grid, or from distributed renewable sources such as solar or wind energy. Fuel cell vehicles use electricity produced from an electrochemical reaction that takes place when hydrogen and oxygen are combined in the fuel cell "stack." The production of electricity using fuel cells takes place without combustion or pollution and leaves only two byproducts, heat and water.

Review/Summary
Eyewitness moment

EYE WITNESS NEWS MOMENT
Capturing the news as it breaks helps your students review what they learn.

According to Eric Jensen, a leading translator of brain research for educators, students who talk about what they learn and do what they learn, learn it. This activity maximizes student conversation about the content. Here's how you can use an Eye Witness News Moment.

1. *Establish the two roles each student will play.* Explain that when the students are the expert they stand tall and take on the air of an expert (a know-it-all with a pleasant personality). When they are the interviewer students address an imaginary camera, with microphone (pen) in hand, and welcome the viewing audience to "Moments with Dr. (fill in the student's name)." Then they pose questions to the expert about the content just learned in class. For example: Facing the camera: *Welcome to our show. Today we are interviewing the world renowned expert in* plate tectonics, *Dr. Seth Derner.* Turning to the expert: *Please tell us, Dr. Seth, what is so important about plate tectonics?* Point the microphone in the direction of the expert. Note: This activity works best when students generate appropriate questions prior to the interview.
2. *Establish the process.* Explain that this activity is to aid in understanding and rehearsing today's topic. Share that the power lies in how well students can play the roles and use the information they just learned. It is a timed event and they will switch roles midway through the event. Note: The time allocated is dependent upon the amount of content students will be rehearsing. An average time limit is three to five minutes, switching roles midway through.
3. *Begin Eye Witness Moment.* Have students stand, pair up, and get ready to go "live" at your signal.
4. *Switch roles.* Midway through, get everyone's attention. Students now switch roles. Note: The new expert usually picks up from where the other left off. If the first expert covered all the information, then the new expert simply starts at the beginning.
5. *Conclude the activity.* After everyone has played both roles at least once, students acknowledge each other with "Thank you!" You can now randomly select individuals to tell what their expert said as a way to check for understanding and increasing individual accountability to the content.

Strategies for Great Teaching by Mark Reardon and Seth Derner

Objective 2

Interest Approach

We have recently discussed alternative fuels. You know that these fuels sources are used throughout the United States and are very important in today's society. How though are they an alternative energy source (Wait for student answers)? *How do they work as an alternative fuel* (Wait for student answers)? *Today you are going to stimulate the process of nuclear fission. You are going to be splitting atoms right before your eyes. First find your notebook and capture the notes from the power point.*

Summary of Content and Teaching Strategies

Anticipated Problem: What is the relationship between fusion and fission and how do these things relate to alternative fuels?

Objective 2 – Students will be able to distinguish between nuclear fission and nuclear fusion (Use power point).

1. **Nuclear energy** is released when atomic nuclei split or combine (fuse). The kind of nuclear energy used by people today comes from the power released by the fission of uranium atoms.

2. Nuclear **fission** is the splitting of an atom into two or more parts. When that occurs, a large amount of energy is released in the form of higher energy neutrons. The release can occur very quickly, as in an atomic bomb, or in a more controlled manner, within a **nuclear reactor**, that allows the energy to be transformed for conventional uses. Nuclear power plants initiate and control fission, then use the thermal energy to make steam, which drives turbines. Many countries use this application of nuclear power to generate a significant share of their electricity, and it is now generally considered a conventional energy source. Nuclear power results in almost none of the greenhouse and acid-forming gaseous emissions associated with fossil-fuel power plants. The normal operation of a nuclear power plant does release small amounts of radiation into the environment and creates radioactive material that must be transported and stored. These materials can remain highly radioactive for thousands of years. Fission also has a specialized use as an alternative transportation fuel. Small nuclear reactors drive the engines of some submarines and large ships, such as aircraft carriers. This is a very expensive way to travel, but the small volume of fuel needed allows these vessels to cruise for months without putting in to port.
3. **Fusion** is the other form of nuclear energy. In fusion, smaller nuclei combine to make larger nuclei. As with fission, large amounts of heat, light and other wavelengths of radiation are released when this happens. The sun combines hydrogen atoms into helium atoms by a fusion process, releasing vast amounts of energy.

Review/Summary

Splitting Atoms Lab