Are Biofuels Better?

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Are Biofuels Better?

Target grade: 10 – 12th grade

Subject: Chemistry

Note: The setup of this unit assumes that the students will already know the basics of chemistry such as how to write a reaction, balance it and perform stoichiometry. If this is not the case the lessons will need to be separated out into more days in order to leave time for the instruction of each topic. If it is not feasible to add more days into this unit feel free to separate it out throughout the year and place the different lessons throughout each topic that is normally introduced throughout the year. I would recommend that the final assessment is run at the end of the school year though as a full review of the chemistry curriculum.

Unit Overview: This unit has been designed to give students a basic understanding of biofuels as well as fossil fuels. Students will begin the unit by defining sustainability and comparing their own to other scientifically accepted definitions. Continuing along the lines of sustainability the students will study carbon dioxide output emitted through their daily lives. The students will measure their own carbon footprint as well as determine what in their lives they can do to decrease the amount of fuels that they consume. Also as part of this lesson, students will use stoichiometry to determine which fuel, ethanol or fossil, are better for the environment. In lesson three students will begin to understand the difference between renewable resources and fossil fuels. Lesson four will have students test different materials through calorimetry to determine which substance is able to release the most energy through its combustion. Finally in a unit assessment the students will write a persuasive essay that explains their stance on changing over to ethanol rather than using fossil fuels. This assessment will tie together all information learned through this unit.

Lesson 1 Overview: This lesson will begin by having students write their own definition of sustainability, joining these individual definitions together to create a class definition, and finally researching true scientific definitions to determine the differences between them all. This discussion will lead to the topic of how to become a more sustainable society, including at home, at school, and what a "green" building is. Students will create a plan using the internet to determine how they can have a more "green" life, in which the ideas will be discussed by all of the students. Finally the class will create a list of how the class can become more sustainable and "green" in our own classroom.

Lesson 2 Overview: Begin with writing the chemical reaction for the combustion of gasoline, octane, and ethanol. From this reaction, using stoichiometry, calculate the amount of carbon dioxide that would be emitted using different amounts of fuel. As a class, discuss the differences between the two different types of fuels, in terms of the types of polymers that they are. Finally have each student use the internet and calculate their carbon footprint, which will show the students how much fuel they use each year, and the affect on the environment.

Lesson 3 Overview: Now that the students know the difference in the amounts of air pollution that is released by the combustion of gasoline compared to ethanol, they will begin to understand another plus of ethanol consumption, renewability. During this lesson the students will do two different laboratory activities to help them understand that it is important for population to use renewable resources, and what this means for our future.

Lesson 4 Overview: During this lesson students will be studying the amount of energy that can be released when burning different substances. The students will set up a calorimeter in which they will burn different types of wood, paper, foods etc. to determine what type of substance will give off the most energy during the combustion process.

Lesson (Assessment): The assessment for this unit is for the students to create a critical analysis essay that describes their opinion of renewable resources and fossil fuels. They will need to use proper writing skills to show the reader what they feel about using these different types of resources as energy sources in our society. Along with their opinions they must provide examples that show their understanding of all topics that were covered throughout this unit.

Teaching and Learning Objectives

Teaching Objective: As the economic status of our country is constantly changing and much of the time spent on the news daily is spent on fuel consumption, it is important that students are educated as to the importance of this topic. Our dependence of fossil fuels is creating a weak infrastructure within our country, and many scientists and politicians believe that the answer lies in our investigations of ethanol. By creating ethanol instead of fossil fuels, many people believe that our dependence on foreign fossil fuels will be driven downward and will help create a safer country. Along with the production of ethanol, there needs to be an understanding of how the ethanol is produced as well as downfalls on our environment by its production. By presenting students will all of the pros and cons of ethanol production, students will be able to create an educated conclusion as to whether this research is track that scientists should be taking.

Learning Objectives for Lesson 1:

- Each student is to create a personal definition for sustainability
    - Use each individual definition to create a classroom definition
- Use the internet to look up many different definitions for sustainability as well as a "green" building
        - GUND
        - ISEES
        - DOE
        - EPA
- As a class discuss how different topics can affect sustainability.
    - Population growth
    - New technology
    - "Normal" social life
        - Discuss what students can do to become more sustainable at home
        - Discuss what students can do to become more sustainable at school
        - Discuss what it means to be a "green building"
            - Develop a personal plan to become more "green" in your personal life
            - Create a culminating plan to become more "green"
            - Create a "green" plan for use in the classroom

Learning Objectives for Lesson 2:

- Discuss what is needed and what is produced in every combustion reaction of a hydrocarbon.

    - Write the reaction for the combustion of gasoline, octane.
    - Write the reaction for the combustion of ethanol.
- Define polymer
    - Discuss the differences between the two polymers
- Use stoichiometry to determine the amount of carbon dioxide created in each reaction.
    - Discuss the different amounts created
- Using the internet calculate carbon footprints
    - Discuss what changes the size of the carbon footprint
    - Discuss what can be done to decrease the size of the carbon footprint

Learning Objectives for Lesson 3:

- Students will do popcorn kernel activity (described in teacher discussion)
    - Discuss as a class why early generations get more resources
    - Determine why this is a nonrenewable resource
        - Determine the pros and cons of fossil fuels
- Define renewable resource
    - Each student will define renewable resource in their own words
    - Compare the definitions with all the class
        - Define:
            - Feedstock
            - Biodiversity
            - Productivity
            - Bioenergy
            - Biofuel
            - Biomass
                - Create a concept map using the above mentioned vocabulary words
                    - Write an explanation of placement
- Students will do the "Renewable Resources!" lab
    - Discuss the difference between renewable and fossil fuels
        - Determine the pros and cons of renewable resources
        - Discuss future impacts of using too many renewable resources
            - Destroying rainforests in Brazil
            - Using food for fuel

Learning Objectives for Lesson 4:

- Create a list of what you ate yesterday
    - Discuss the types of foods (fats, carbohydrates, protein, sugar)
- Discussion about types of renewable resources
- Run calorimetry laboratory
    - Create chart showing results
    - Create bar graph showing results

Learning Objectives for Assessment:

- Create a critical analysis
    - Discuss pros and cons of fossil fuels
    - Discuss pros and cons of ethanol
    - Discuss other possible energy sources
- Create a presentation

- Include main points from critical analysis

Sources Consulted and Use of Books

Lesson 1:

- Institute for Social, Economic and Ecological Sustainability (ISEES). Retrieved July 14, 2008, from: http://fwcb.cfans.umn.edu/isees/ This site describes their initiative toward a sustainable world.
- Gund Institute for Ecological Economics (GUND). Retrieved July 14, 2008, from: http://www.uvm.edu/giee/?Page=default.html This site describes the Gund Institute at the University of Vermont and their work for environmental sustainability.
- Department of Energy (DOE). Retrieved July 14, 2008, from: http://www.eia.doe.gov/kids/energyfacts/saving/efficiency/savingenergy.html#EfficiencyConservation This site is written for students so that they can understand the basic idea of energy sustainability.
- Environmental Protection Agency (EPA). Retrieved July 14, 2008, from: http://www.epa.gov/sustainability/ This site describes the EPA and their beliefs of sustainability for the environment.

Lesson 2:

- CDIAC Communications virtual newsletter. This site contains an extensive database showing estimates of carbon dioxide emissions from fossil fuels consumption as well as annual emissions reports for the USA. Retrieved on July 14, 2007, from http://cdiac.ornl.gov/newsletr/virtual/virtual_cdiac.html
- Carbon dioxide calculators to be used by the students to determine how much their yearly carbon dioxide emissions are. Retrieved July 6, 2007, from:
  - http://safeclimate.net/calculator/
  - http://www3.iclei.org/co2/co2calc.htm
  - http://airhead.org/Calculator/
  - http://ans.ep.wisc.edu/~eic/personal.impact.html
  - http://www.travelmatters.org/
  - http://www.carboncounter.org/
  - http://www.pbs.org/wgbh/warming/carbon/
  - http://myfootprint.org/
  - http://epa.gov/climatechange/emissions/ind_calculator.html
  - http://www.climatecare.org/index.cfm

Lesson 3:

- MSN dictionary. Retrieved July 16, 2008 from: http://encarta.msn.com/dictionary_1861700446/renewable_resource.html
- Wikepedia free encyclopedia. Retrieved July 16, 2008 from: http://en.wikipedia.org/wiki/Main_Page

Lesson 4:

- Food calorimetry, The Heat Content of Nuts and Snack Foods. Retrieved July 16, 2008 from: http://www.woodrow.org/teachers/ci/1988/foodheat.html.
- Flinn Chemtopic Labs – Thermochemistry. (2002) Measuring Calories lab. pp. 39-49.

Content Benchmarks Addressed

Lesson 1:

- Language Arts: S7.3a: Prepare and deliver short presentations on ideas, images and topics obtained from various common sources.
- Earth Science: E2.4A: Describe renewable and nonrenewable sources of energy for human consumption (electricity, fuels), compare their effects on the environment, and include overall costs and benefits.
- Earth Science: E2.4B: Explain how the impact of human activities on the environment (e.g., deforestation, air pollution, coral reef destruction) can be understood through the analysis of interactions between the four Earth systems.
- Earth Science: E2.4d: Describe the life cycle of a product, including the resources, production, packaging, transportation, disposal, and pollution.
- Earth Science: E2.2B: Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear [U-235]) sources of energy.

Lesson 2:

- Language Arts: S7.3a: Prepare and deliver short presentations on ideas, images and topics obtained from various common sources
- Chemistry: C5.2d: Calculate the mass of a particular compound formed from the masses of starting materials
- Earth Science: E5.4A: Explain the natural mechanism of the greenhouse effect, including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone).
- Chemistry: C5.6b: Predict single replacement reactions
- Chemistry: C4.2A: Name simple binary compounds using their formulae.
- Chemistry: C4.2B: Given the name, write the formula of simple binary compounds.
- Chemistry: C4.2e: Given the formula for a simple hydrocarbon, draw and name the isomers.
- Chemistry: C5.2d: Calculate the mass of a particular compound formed from the masses of starting materials.
- Chemistry: C5.8A: Draw structural formulas for up to ten carbon chains of simple hydrocarbons.
- Chemistry: C5.8C: Recognize that proteins, starches, and other large biological molecules are polymers.
- Earth Science: E5.4A: Explain the natural mechanism of the greenhouse effect, including comparisons of the major greenhouse gases (water vapor, carbon dioxide, methane, nitrous oxide, and ozone).
- Chemistry: C5.7f: Write balanced chemical equations for reactions between acids and bases and perform calculations with balanced equations.

Lesson 3:

- Chemistry: C1.1B: Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables,

accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.

- Chemistry: C1.1E: Describe a reason for a given conclusion using evidence from an investigation.
- Chemistry: C1.2: The integrity of the scientific process depends on scientists and citizens understanding and respecting the "Nature of Science." Openness to new ideas, skepticism, and honesty are attributes required for good scientific practice. Scientists must use logical reasoning during investigation design, analysis, conclusion, and communication. Science can produce critical insights on societal problems from a personal and local scale to a global scale. Science both aids in the development of technology and provides tools for assessing the costs, risks, and benefits of technological systems. Scientific conclusions and arguments play a role in personal choice and public policy decisions. New technology and scientific discoveries have had a major influence in shaping human history. Science and technology continue to offer diverse and significant career opportunities.

Lesson 4:

- Chemistry: C1.1 A: Generate new questions that can be investigated in the laboratory or field.
- Algebra I: S1.1.1: Construct and interpret dot plots, histograms, relative frequency histograms, bar graphs, basic control charts, and box plots with appropriate labels and scales; determine which kinds of plots are appropriate for different types of data; compare data sets and interpret differences based on graphs and summary statistics.
- Language Arts: L1.2.4: Organize and summarize a data set in a table, plot, chart, or spreadsheet; find in a display of data; understand and critique data displays in the media.
- Chemistry: C1.1B: Evaluate the uncertainties or validity of scientific conclusions using an understanding of sources of measurement error, the challenges of controlling variables, accuracy of data analysis, logic of argument, logic of experimental design, and/or the dependence on underlying assumptions.
- Chemistry: C1.1C: Conduct scientific investigations using appropriate tools and techniques (e.g., selecting an instrument that measures the desired quantity—length, volume, weight, time interval, temperature—with the appropriate level of precision).
- Chemistry: P2.p1A: Describe energy changes associated with changes of state in terms of the arrangement and order of the atoms (molecules) in each state. *(prerequisite)*
- Chemistry: C2.1b: Describe energy changes associated with chemical reactions in terms of bonds broken and formed (including intermolecular forces).

Assessment:

- Language Arts: S7.4a: Prepare and deliver presentations and reports in various content areas, including a purpose, point of view, introduction, coherent transitions, and appropriate conclusions.
- Language Arts: S7.3a: Prepare and deliver short presentations on ideas, images and topics obtained from various common sources.
- Chemistry: C1.1E: Describe a reason for a given conclusion using evidence from an investigation.

Classroom Activities

Day 1

Learning Objectives for Lesson 1:

- Each student is to create a personal definition for sustainability
    - Use each individual definition to create a classroom definition
- Use the internet to look up many different definitions for sustainability
        - GUND
        - ISEES
        - DOE
        - EPA
- As a class discuss how different topics can affect sustainability.
    - Population growth
    - New technology
    - "Normal" social life
        - Discuss what students can do to become more sustainable at home
        - Discuss what students can do to become more sustainable at school
        - Discuss what it means to be a "green building"
            - Develop a personal plan to become more "green" in your personal life
            - Create a culminating plan to become more "green"
            - Create a "green" plan for use in the classroom

Anticipatory Set (5 – 10 minutes): Begin the class by having the word *Sustainability* on the board. Without giving the students any time to discuss this word or ask any questions of what the word means, have them write a definition on a piece of paper. Once the students are completed with their individual definitions, have one student begin by writing their definition on the board. Continue by having other students add and change words until the entire class has reached a consensus as to a class definition. Pass out the student page. The class definition should be written at the top of the student page for the investigation. Using the internet the students are to look up the definition of sustainability and "green" energy at the different web-sites and filling out the student laboratory worksheet.

Advanced preparation:

- Copy the laboratory worksheet, "What's Sustainability?"
- Prepare your presentation as necessary.
- Sign out computer lab for use at the beginning of the class period.

Teacher Discussion:

Everyday in the news we hear about how our society uses too much fuel, how expensive gasoline is as well as problems that are arising in our world in the countries where fossil fuels are gathered. Scientists over the past several years have been looking for new and improved fuels that we can create within our country without destroying our environment or putting us at risk in another country. Just recently due to these many problems of getting foreign fuels, President Bush removed his ban for off shores drilling. It

is thought that by removing this ban the United States will be able to pay a smaller price for gasoline and thus help the dwindling economy.

(Complete Anticipatory Activity)

Today we will create our own definition for sustainability as well as comparing this to the definitions created by different scientific communities. As seen by each of these different definitions, the general idea of sustainability is the same in each situation. Each scientific organization believes that generally sustainability is the ability to meet our needs now, but to leave resources that can be used in the future. When using this general definition, are fossil fuels sustainable? The reason that they are not is that in order to make more of this resource it takes billions of years. In order to meet our needs in the present time, as well as in the future, we would need to have a fuel that regenerates more quickly.

There are many different types of fuels that are being studied at the current time, such as hydrogen power and ethanol as a biofuel. In this unit we are going to study ethanol production. Ethanol can be created by using many different operations, such as using biological waste, such as manure, or trees. Cellulosic ethanol, created by trees, is what we are going to study for the next week. After studying the many different aspects of creation, you will determine whether this fuel is beneficial in the long run.

Now that we know the definition for sustainability, how do you think that the following changes in our lives will affect sustainability? The first that I would like to discuss is population growth. How do you feel that different aspects of our lives will change? The second is the creation of new technology. The final topic is our normal social life. As we just discussed, there are many different changes to our environment, animals, people and the Earth as we make changes to how we live now, or as we continue down the same path.

(Complete the student activity section of a sustainability plan)

Now that you have many different ideas of what you can do in order to create a sustainable life, I would like to compare all of our ideas. I would like to go through the class and have each of you give me a different idea, and we will write all of the ideas on the board. Now that we have a main list of all different types of changes that we can make in our everyday lives, I would like for us to create a list of changes that we can make in this classroom in order to help the sustainability of our world. For the remainder of the year, and hopefully our lives, we will continue to fulfill this promise.

Tomorrow we are going to begin discussing hydrocarbons and the effects of our actions on the amounts of greenhouse gasses that are produced. In order to do this you will need to bring in some information from home. We will need: the number of miles that are driven each month in your family, miles per gallon that the vehicle travels, your electric bill, your gas bill, and other sources of natural gas.

Student Activity: Have the students use the internet to research how different scientific communities define the word sustainability as well as “green”. After this research is concluded the class will discuss how each of the definitions are similar to one another as well as the class definition, and how they are different. Upon an understanding of what these two words mean, students will draw conclusions as to how population growth, technology, and normal social lives can affect our sustainability. This discussion will lead to students creating a plan, using the internet, to determine how they can create a more “green” life. Together using these ideas, the class will develop a plan for a more sustainable and “green” life in the classroom.

Answer key for the following student activity:

Classroom definition: Answers will vary

ISEES definition: The challenge of sustainability is to reconcile social and economic activities with the long term health of the Earth's interconnected ecosystems.

GUND: Implementing innovative methods and models that reflect the need to integrate the social, built, natural, and human capital components of our world.

DOE: the concept that every generation should meet its energy needs without compromising the energy needs of future generations. Energy sustainability focuses on long-term energy strategies and policies that ensure adequate energy to meet today's needs, as well as tomorrow's.

EPA: meeting the needs of the present without compromising the ability of future generations to meet their own needs.

Sustainability plan: Answers will vary, but may include turning off lights, not wasting food, recycling, not wasting water, etc.

1. Answers will vary
2. Answers will vary
3. Answers will vary
4. Answers will vary

What's Sustainability?

Introduction: Today we are going to study what sustainability means. Not only will you write an individual definition, we will create a working definition as a class. From this definition we will learn how in our everyday lives we can become more "green" and sustainable.

Class definition for sustainability: _____
_____
_____

Use the internet to search for each of the identified scientific communities listed below. Write the definition of sustainability for each of them.

Definition from ISEES (Institute for Social, Economic and Ecological Sustainability):
_____
_____
_____

Definition from GUND (Institute for Ecological Economics, University of Vermont):
_____
_____
_____

Definition from DOE (Department of Energy):_____
_____
_____

Definition from EPA (Environmental Protection Agency): _____
_____
_____

Using any reliable website, write the definition for "Green" energy.

Definition for "Green" energy: _____
_____
_____

Sustainability Plan: Use the internet to create a plan showing how you will change actions in your life to help create a more sustainable use of energy.

Now write at least three ideas of how you feel that we can become more sustainable in our own classroom.

Conclusion Questions:

1. What are the similarities that you see when comparing all of the definitions of sustainability?

2. Now that you know the definition of sustainability for many communities, do you still agree that the class definition is substantial enough? Give examples.

3. How does your plan for creating sustainability in your life compare to other plans created within your class?

4. Do you believe, with what you know now, that we as a society need to make changes in how we live, in order to reach sustainability?

Day 2

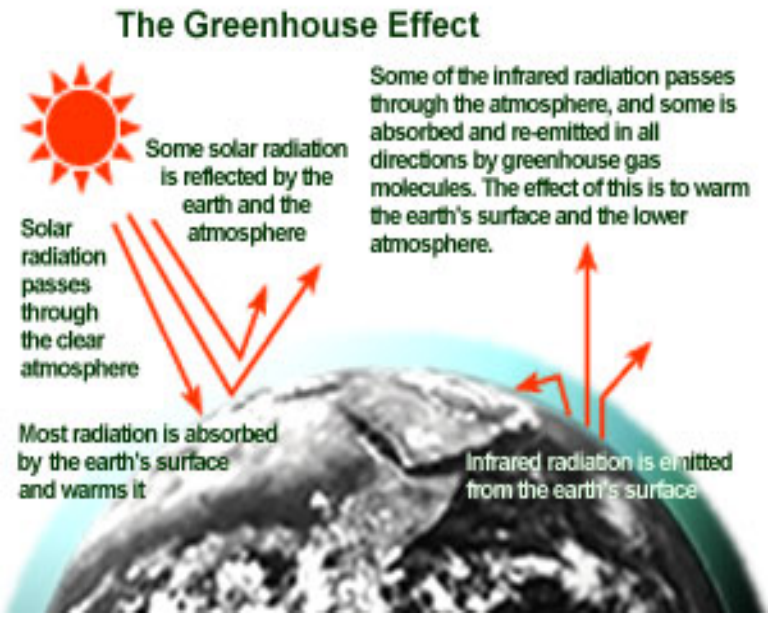
Learning Objectives for Lesson 2:

- Discuss what is needed and what is produced in every combustion reaction of a hydrocarbon.
  - Write the reaction for the combustion of gasoline, octane.
  - Write the reaction for the combustion of ethanol.
- Define polymer
  - Discuss the differences between the two polymers
- Use stoichiometry to determine the amount of carbon dioxide created in each reaction.
  - Discuss the different amounts created
- Using the internet calculate carbon footprints
  - Discuss what changes the size of the carbon footprint
  - Discuss what can be done to decrease the size of the carbon footprint

Anticipatory Set (5 – 10 minutes): Review with the students the different types of reactions. These should include: synthesis, decomposition, single replacement, double replacement and combustion. Remind the students that in any combustion reaction that the hydrocarbon reacts with oxygen, O_2, in order to produce water vapor, H_2O, and carbon dioxide, CO_2. It might be helpful for your class to run through a couple of these different types of reactions on the board to remind them of the differences in a visual form.

Advanced preparation:

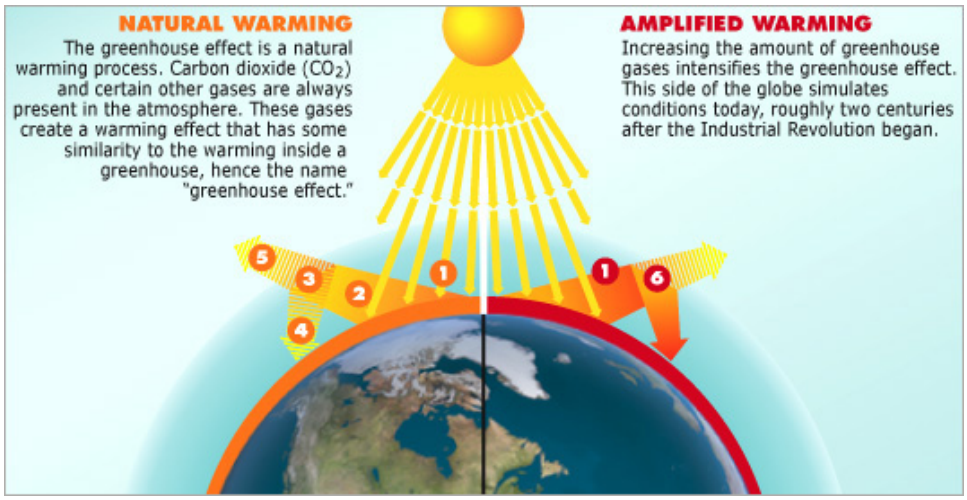
- Copy the activity worksheet, "How Big is Your Footprint?"
- Prepare your presentation as necessary.
- Sign out the computer laboratory



Teacher Discussion:

In the news everyday we hear about how our environment is changing. We hear about something called global warming. So what does the term global warming mean to you? For most people it is simply the warming of the Earth. So using this simple definition lets discuss how this is actually happening.

First of all we need to understand what is actually creating this change to our environment. A global change discusses the changes to our atmospheric environment, which could be caused by a series of different atmospheric gasses, called greenhouse gasses. These gasses, for example are carbon dioxide, ozone, sulfates, nitrous oxides and phosphorous oxides can contribute to changes in temperature and other climatic measures. In this lesson we are only going to be interested in one type of greenhouse gas, carbon dioxide.



Although Carbon dioxide is created by natural means, such as human respiration, volcanic eruptions, as well as many others, the largest contributor is from burning fossil fuels and other organic substances. Because of this fact, it has been proposed that the reason for global warming and the change climate around the world is due to humans. Today we will be taking a test to calculate the amount of carbon dioxide that you release yearly. Depending upon what type of area you live in, your climate is usually set. Depending on the types of water around your area and the types of winds that blow over the region, your temperature is usually the same year after year. This set climate is important to plant growth as well as animal and human survival. The changes in our climate is making life difficult for farmers for deciding when to plant crops to gain the most profit.

Let's each go through and use carbon footprint calculators to determine the amount of carbon dioxide you and your family emits into the environment each year. We now know that carbon dioxide is believed to one of the main culprits of the greenhouse effect and global warming, so we should be trying to release the minimum amount of carbon dioxide possible. Let's try it out. (Run the Carbon Footprints website)

So, what were your results? How many people showed that they had a carbon release of less than 10 planets? How many of you had more than 20? So what does this tell you about how you live your life everyday? What changes according to these sources should you take into consideration?

Answer Key for the following student activity:

Octane: $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$

Ethanol: $C_2H_5OH + 3\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$

1. A polymer is a long chain of carbon atoms that are connected together. The type of polymer that has the most energy is the longer one. The energy that can be released is stored within the bonds.
2. Answers may vary. Generally the two calculations will be slightly different.
3. The calculations are different, due to certain numbers that you have to provide being rounded during the calculations.
4. Octane: (20kg C_8H_{18}) (1000g/1kg) (1 mol C_8H_{18}/ 114 g C_8H_{18}) (16 mol CO_2/ 2 mol C_8H_{18}) (22.4 L CO_2 / 1 mol CO_2) = 31,438 L CO_2

   Ethanol: (20kg C_2H_5OH) (1000g/1kg) (1 mol C_2H_5OH / 34 g C_2H_5OH) (2 mol CO_2/ 1 mol C_2H_5OH) (22.4 L CO_2 / 1 mol CO_2) = 26,352 L CO_2

5. Answers may vary, but both sites may draw the conclusion that carbon dioxide is the only, or at least the most important of the greenhouse gasses.

How Big is Your Footprint?

Introduction: Today we will take a look at different websites to determine how large your carbon footprint is. As we already discussed, carbon dioxide is a gas that contributes to global warming. When we burn different types of hydrocarbons one of the products of the reaction is carbon dioxide. The purpose of this investigation is to determine how much carbon dioxide you and your family release, as well as to come up with different ideas of what you can do to reduce the amount emitted.

Question: _____

_____

Hypothesis: _____

_____

So we don't forget the combustion reaction, let's begin by rewriting the balanced reaction for the combustion of octane and ethanol.

Octane:

Ethanol:

Investigation Steps:

1. Log onto a computer using your username and password.
2. Go to Ecological Footprint Quiz by Redefining Progress. http://www.myfootprint.org/en/
3. Answer the prompted questions. Include that you would like the measurement in U.S.
4. Make note of the amount of carbon dioxide that you produce yearly.

   _____
5. Go to http://www3.iclei.org/co2/co2calc.htm, and once again input your data into the prompts.
6. Calculate your emissions and make note here _____.
7. If time permits come and see me to find out other websites that you can go to in order to calculate your carbon footprint.

Conclusion Questions:

1. What is a polymer? What type of polymer would have the most energy stored? Where is the energy stored?

2. Was there a difference in your carbon footprints from the two different sites? Explain.

3. What do you think might have created the difference in the amounts of carbon dioxide that you create according to the carbon dioxide calculator?

4. Using the balanced equation for the complete combustion of octane and ethanol, how many liters carbon dioxide would be produced if 20 kg of each were burned.

5. From the information that you found by looking through the websites, are there any other greenhouse gasses that are as large of a contributor as carbon dioxide? Why or why not?

Day 3

Learning Objectives for Lesson 3:

- Students will do popcorn kernel activity (described in teacher discussion)
    - Discuss as a class why early generations get more resources
    - Determine why this is a nonrenewable resource
        - Determine the pros and cons of fossil fuels
- Define renewable resource
    - Each student will define renewable resource in their own words
    - Compare the definitions with all the class
        - Define:
            - Feedstock
            - Biodiversity
            - Productivity
            - Bioenergy
            - Biofuel
            - Biomass
                - Create a concept map using the above mentioned vocabulary words
                    - Write an explanation of placement
- Students will do the "Renewable Resources!" lab
    - Discuss the difference between renewable and fossil fuels
        - Determine the pros and cons of renewable resources
        - Discuss future impacts of using too many renewable resources
            - Destroying rainforests in Brazil
            - Using food for fuel

Anticipatory Set: Students will learn what the difference between renewable resources and fossil fuels. By doing an activity showing different generations as well as fossil fuels the students will draw their own conclusions. For directions look to the first half of the teacher discussion.

Advanced Preparation:

- Copy the laboratory worksheet.
- Prepare your presentation as necessary.
- Set up the lab with necessary equipment.
    - 8 lunch bags (2 say: first generation, 4 say: second generation, 8 say: third generation)
    - Bucket of popcorn kernels
    - Bags of 100 M&M's total. 8 of one color, 92 of another
    - Paper towels

Teacher Discussion: (Complete Anticipatory Activity)
I need to have a few volunteers for the first half of today's activity. First I need two people to be part of our first generation. (Give these students the first generation bags) I need four students to be part of our second generation. (Give these students the second generation bags) Finally we need eight students to be our third generation. (Give these students the third generation bags)

For this activity you all need to understand that a generation is considering a generation of people. So an example of this would be your parent's generation. Now I need the two students with the first generation bags to come up. From the bucket of popcorn kernels I want you to take as many of them as you would like and put them in your bag. Now that you are finished I would like to have you take your seats and I need the second generation students come up and do the same. You are representing your generation. You may also take as many of the kernels that you would like. Put the kernels into your paper bags. As you take your seats, finally, I need to have the third generation students to come up. You are representing the generation of your children. Each of you are to follow in suit and take as many kernels as you would like, and place them in your bags. Once you are finished, take your seat.

So let's take a look at what this means. Which generation on average got the most resources? Which generation got the least? So what does this mean to us? If the first generation takes the majority of the resources there will not be enough left for the next. If I was to say that in order to survive how society's are used to that we need to have at least 500 kernels of fuel to burn, would each generation have enough to survive? Would there be enough energy left for the fifth generation? So what happens when the resources are gone? What will people have to do for fuel?

This leads us to another great discussion. Is this type of fuel renewable? Would these kernels be examples of fossil fuels? Why? That is right this activity shows us how fossil fuels are used. Each generation we use fossil fuels such as oil and it takes billions of years for it to be replenished. As we are finding, if we continue to use these fuels as much as we do now, there will only be enough of them left for society for about 40 more years. So what does the next generation do?

For this reason, scientists are looking to renewable resources. These are the resources that we are looking at in today's laboratory experiment. First of all we need to understand some important vocabulary.

(Have each of the students in their notes write a short definition for renewable resources. Once completed have students share some of the definitions) Overall we had pretty much the same definition: a resource that can be renewed as quickly as it is used up and can, in theory, last indefinitely. (from MSN dictionary) There are many other scientific terms that are very important to the creation of renewable resources. In your notes we need to include the definitions for the following words as well. **Feedstock**: raw material used to make bioenergy (ex. Corn, switchgrass). **Biodiversity**: diversity of organisms with in a given environment. **Productivity**: the amount of biomass that is made on a given land, basically the number that is produced. **Bioenergy**: energy created from biomass. **Biomass**: wood, rubbish, crops, landfill gas etc. that can be used to release bioenergy. **Biofuel**: fuel from biomass that releases bioenergy. Now to show that you understand how each of these words are linked together you need to get into your groups and create a large concept map. Be sure to use a logical process to determine the placement of each word. When you are finished I would like you to write a short explanation for each of your placements.

(Pass out the "Renewable Resources!" worksheet)

Now we are going to do the first half of today's laboratory.

Answer Key for the following student activity:

1. Procedure 1. Society uses more fuels each year as new technologies start. Procedure 2.

2. Answers will vary.

3. Using food as fuel, we will see an increase in the cost of vegetation. This will make it more difficult for the poor to feed themselves properly.

4. Answers will vary.

Renewable Resources!

Introduction: As we saw in the popcorn kernel activity, it is important that we begin to use renewable resources. If society does not begin doing this we will eventually run out of fossil fuels. In this laboratory activity we are going to take a look at exactly how quickly these resources can run out, as well as the importance of renewable resources.

Question: How many generations (trials) will it take to deplete the nonrenewable M&M's in the bag?

Hypothesis: _____

_____

Laboratory Steps:

1. Divide back into your groups of three students and obtain a bag of M&M's, 92 of one color and 8 of another color. Verify this.
2. Lay out the paper towel onto the laboratory table and be sure to have everyone wash their hands with antibacterial gel.
3. Choose one person who will be blindfolded. This will represent the part of society that is using energy without thinking about any consequences that may arise.
4. Discuss within your group and write a hypothesis that will answer the given question.
5. Follow the procedures that are written by each chart. You will be running two different types of generations laboratories.

Procedure 1:

1. Have the blindfolded partner draw out the specified number of M&M's from the bag. In this activity each generation will use the same amount of fuel, so always draw 10 M&M's.
2. Count the number of Fossil fuels (majority color) and the number of renewable resources used (minority color) and record this as your percentage, of the fuels drawn, in the chart.
3. Always put the renewable M&M's back into the bag after counting them as used for the generation.
4. Continue with the blindfolded partner drawing another 10 M&M's. Continue the same steps until only renewable resources are left.
5. Keep all M&M's after each drawing. ***DO NOT EAT THEM YET!!***

Consumption level	Gen. 1	Gen. 2	Gen. 3	Gen. 4	Gen. 5	Gen. 6	Gen. 7	Gen. 8	Gen. 9	Gen. 10	Gen. 11
Usage rate	10	10	10	10	10	10	10	10	10	10	10
# M&M's left											
% renewable used											
% nonrenewable											

used											

Procedure 2:

1. Follow the same steps as Procedure 1, with a changing amount of fuels used each year.

Consumption level	Gen. 1	Gen. 2	Gen. 3	Gen. 4	Gen. 5	Gen. 6	Gen. 7	Gen. 8	Gen. 9	Gen. 10	Gen. 11
Usage rate	10	15	20	25	30	35	40	45	50	55	60
# M&M's left											
% renewable used											
% nonrenewable used											

Conclusion Questions:

1. Which procedure allowed for the fossil fuels to last the longest? How does our current society use fuels, the same amount each year, or does it increase? Why?

2. Explain the benefits and disadvantages to changing the main type of fuel to renewable?

3. If we continue using corn and other foods to create renewable resources, what do you think might be the effect on people?

4. In Brazil there are many people who are cutting down the rainforest. These cut trees are being used to create renewable fuels. The problem with this is that new trees when they are planted in this type of area do not take root in the ground and don't survive. Write a response to this information. Do you feel that this can still be considered renewable fuel? Should they continue or stop what they are doing?

Day 4

Learning Objectives for Lesson 4:

- Create a list of what you ate yesterday
  - Discuss the types of foods (fats, carbohydrates, protein, sugar)
- Discussion about types of renewable resources
- Run calorimetry laboratory
  - Create chart showing results
  - Create bar graph showing results

Anticipatory Set: Have the students create a list summarizing everything that they ate the previous day. This should also include what they had to drink, with the exception of water. When the lists are completed have them go through and label each one as to what type of food each is: fats, carbohydrates, protein or sugar. Discuss how they feel after they eat each type of food. Do they feel a surge of energy, do they feel energy throughout many hours, do they feel weighed down, etc? These different types of foods give different amounts of energies to the person who eats them. This is due to the chemical potential energy-or the energy stored in compounds due to their composition and structure. Basically, when you burn a food or digest it you are breaking the bonds between the atoms and releasing the energy.

Advanced Preparation:

- Copy the laboratory worksheet.
- Prepare your presentation as necessary.
- Set up the lab with necessary equipment.
  - Balance
  - Calorimeter and lid (or coffee cups)
  - Soda Can
  - Food holder (cork and pin)
  - Graduated cylinder (50 mL)
  - Matches or butane lighter
  - Foods (nuts, crackers etc.) not candies. Some are listed (feel free to change the ones listed)
  - Stirring rod
  - Thermometer
  - Water
  - Ringstand
- Reserve the computer laboratory for the creation of the graphs

Teacher Discussion: (Complete the Anticipatory Activity)

So, now that we understand why all types of foods give off different amounts of energy, we are going to test them and see quantitatively how different they are. In food, this energy is measured in Calories, a unit for energy. In this laboratory activity we will also measure the energy released, the same way. By definition a Calorie is the amount of energy to raise one gram of water one degree Celsius. The only difference between nutritional calories, like you find on the packaging for your food, is that it is actually a kilocalorie. Remember that kilo- is the prefix for 1000.

Although when you eat you are actually digesting it and your metabolism converts the food into carbon dioxide and water, we are going to see a similar combustion process today in lab. A couple of days ago we wrote the combustion reactions for octane and ethanol. Today we are going to be using a similar combustion reaction; we will be starting with a hydrocarbon and reacting it with oxygen in order to produce carbon dioxide and water as well as heat. The heat that is released will be measured in a device called a calorimeter.

The type of reaction using a calorimeter is called calorimetry, meaning the measurement of the amount of heat energy produced in a reaction (Flinn ChemTopic Labs- Thermochemistry). In this type of experiment a reaction, of known mass takes place, such as a combustion reaction, surrounded by a known quantity of water. As the energy is released from the reaction the temperature of the water changes. Over a period of time the water temperature is taken, which is directly related to the amount of heat energy absorbed. The amount of energy that was released by the reaction can be calculated by the following reaction.

$$q = m \bullet s \bullet \Delta T$$

The symbols are represented as follows:

m = mass of the water
s = specific heat of water (1 cal/g^{O}C)
ΔT = change in temperature
q = the heat energy released by the reaction

Today we will use this equation to determine the amount of energy that is released from different types of foods to determine if any of these would be a good renewable resource for energy. Remember that it must be easily renewable, not destroy the environment, and have no adverse effects.

Answer Key for the following student activity:

1. Answers will vary depending upon set up.
2. Answers will vary depending upon set up.
3. Answers will vary depending upon set up.
4. Answers will vary, but normally a type of nut.
5. None would be a great renewable resource, but students will probably answer the nut would be.
6. Make sure that the calorimeter is more enclosed, and use a more precise thermometer.

You've Got Good Energy!

Introduction: The whole reason that anything eats is to give the body the energy to survive. We burn fuels for the same reason, to give us energy. As we have been discussing renewable resources, which normally are grown on Earth as vegetation, today we will test various types of vegetation to measure how much energy could be released.

Question: _____

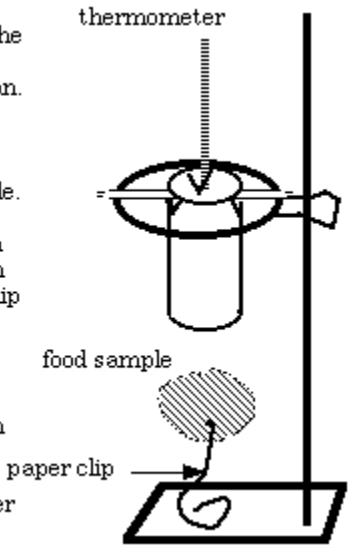
_____

Hypothesis: _____

_____

Laboratory Steps:

1. With a bottle opener, punch out two triangular holes at the top of the soda can so that a stirring rod can be slid through the holes. Mass out 100 g of water in the soda can.
2. Measure the initial temperature of the water.
3. Mass out approximately 2-3 grams of the nut/food sample.
4. Construct a nut/food burner by piercing the nut/food with one end of the paper clip and forming a support base with the other end. Place a piece of aluminum foil under the clip to catch any ash or burning food.
5. Place the soda can on the ring clamp over the nut/food burner, using the stirring rod to support the can. A wire mesh is not needed and would only lower results. Position the can approximately 3-4 cm above the nut/food.
6. Ignite the nut with a match, and allow it to heat the water inside the can, while stirring continuously.
7. Record the change in temperature of the water.
8. Record the final mass of the food substance.
9. Repeat the procedure using a different type of food.



Controls: Identify the controls in this experiment.

_____

_____

Variables: Identify the variables in this experiment.

_____

_____

Observations: Record your observations in the chart below.

Food sample	Initial mass (food sample and holder), g	Final Mass (food sample and holder), g	Initial temperature (water, ^{O}C)	Final temperature (water, ^{O}C)
Peanuts				
Popcorn				
Cheese puff				
Marshmallow				

Analysis: Use Excel or another computer program to create a bar graph showing the changes in water temperature for each of the different foods. Make sure to use labels, titles, and a legend for the colors on the graph. Staple this graph to your laboratory sheet.

Conclusion Question:

1. Use the heat equation to calculate the heat (q) absorbed by the water in the calorimeter for each food samples. Show your work and include units.

2. Subtract the final mass of the food sample and holder from the initial mass to determine the mass in grams of the food sample that burned in each experiment. Show your work and include units.

3. Using the results from questions #1 and #2 determine the energy content of the food sample in units of Calories per gram.

4. From your results in question #3, which of the foods releases the most energy from the mass? Why do you think that this might be the case?

5. Would any of these tested foods be a good renewable resource? Why or why not?

6. What could you do to make this laboratory experiment be more precise?

Assessment

Learning Objectives for Assessment (3 days minimum):

- Create a critical analysis
  - Discuss pros and cons of fossil fuels
  - Discuss pros and cons of ethanol
  - Discuss other possible energy sources
- Create a presentation
  - Include main points from critical analysis

Anticipatory Set: Review all of the different topics that have been studied during this unit. Go around the classroom and have each student tell the class what they feel has been the most important piece of information. As part of this discussion the students should also explain why they feel this way.

Advanced Preparation:

DAY 1

- Copy the activity worksheet.
- Prepare your presentation as necessary.
- Reserve the computer laboratory for writing critical analysis papers

DAY 2

- Reserve the computer laboratory for the creation of presentations

DAY 3

- Have all materials for student presentations ready.
  - Overhead projector
  - Elmo projector
  - Poster board support

Teacher Discussion:

We have discussed many important factors that scientists take into account when they are trying to decide upon which type of fuel to use. Over the next couple of days you are going to create a critical analysis discussing your opinions of the types of fuels that you would like to see the world use. Along with your opinion of this, you will need to prepare facts and reasons to explain your thoughts. As a final portion of this unit you will be creating a presentation that will be given to the class in a couple of days describing your opinion. This presentation may be done by a poster, PowerPoint, or any other means that you see fit.

Answer Key for the following student activity:

Student answers will vary. Grading Rubric on a last page.

What kind of energy?

Introduction: Your job as a fuels scientist is to provide evidence for or against continuing our use of fossil fuels, switching to ethanol, or working to create a new type of renewable resource. In a two to four page critical analysis you are to summarize the work that you have done over this last unit. Along with choosing a type of fuel, you will need to provide evidence. Once your analysis is complete you are to create a five minute presentation that will be given to your colleagues during class.

Student Presentation Rubric

_____ Paper Design **(20 points)**
- Strong introduction paragraph
- Supportive body paragraphs
- Flows in a comprehensive order
- Conclusion paragraph
- Written with proper English techniques

_____ Draws on Bodies of Unit Knowledge **(40 points)**
- Using a variety of sources to show evidence
    - websites
    - books
    - journals
    - science magazines
    - laboratory activities
- Includes information learned during unit activities
- Proves an understanding of basic information from the unit (must include at least 3 of the following)
        - Sustainability
        - Carbon output
        - Deforestation
        - Climate change
        - Renewable resources
        - Fossil fuel consumption
        - Calorimetry

_____ Data Analysis and Conclusions **(10 points)**
- Creates appropriate charts and graphs as needed
- Uses visuals to draw appropriate conclusions as needed
- Strong conclusion is drawn with support

_____ Organization of Presentation **(30 points)**
- Demonstrates work of all group members
- Well organized
- Clear plan was followed
- Uses visual aids

_____ Total points **(100 points)**