Future Fuel Investigations: Using Chemistry to Make Informed Decisions
By Nicole Olszowy

Target Grade and Subject: 10th-12th grade, Chemistry

Unit Overview:
The major goal of this unit is for the students to use the results from the various investigations and research to form their own opinions (based on facts and observations) of various types of fuels (specifically fossil fuels and ethanol). The students will be learning about chemical reactions and the energy released in combustion throughout the various investigations. The difference from a conventional lesson is that the students will be learning these chemistry concepts for the purpose making an informed decision about fuel sources. This unit strives to give purpose to the lessons, and also gives students some ideas for possible careers in science and engineering. Ultimately, the students should be able to answer the following question: In your opinion, what type of fuel should we be utilizing in mid-Michigan and why?

Sources Consulted:

From MTU Teacher Institute

GIS Use in the Classroom, presented by Melissa Jaeger
Lakeshore Middle School
Grand Haven, MI

LAB-AIDS Kit 39S – Biofuels, presented by Melissa Jaeger
LAB-AIDS
Ronkonkoma, New York
www.lab-aids.com

Other Resources
Oil Production Map, Michigan Department of Environmental Quality (DEQ)
http://www.michigan.gov/deq/0,1607,7-135-3311_4111_4231-14421--,00.html

Learning Objectives:
Lesson 1
TSWBAT participate in a group discussion about energy.
TSWBAT list their previous knowledge of fossil fuels and ethanol.
TSWBAT summarize their current knowledge and opinions of fossil fuels and ethanol.

Lesson 2
TSWBAT use the internet to research conventional (corn/soy) ethanol versus cellulosic ethanol, and basic energy information about fossil fuels.
TSWBAT summarize their current knowledge and opinions of fossil fuels and ethanol.

Lesson 3
TSWBAT use GIS maps to determine if lower/mid Michigan has better resources for conventional or
cellulosic ethanol, and compare to the resources for fossil fuels.
TSWBAT summarize their current knowledge and opinions of fossil fuels and ethanol.

Lesson 4
TSWBAT make observations of the fermentation of corn and sugar.
TSWBAT perform a distillation of corn and sugar to produce ethanol and record data and observations.
TSWBAT summarize their current knowledge and opinions of fossil fuels and ethanol.

Lesson 5
TSWBAT compare the energy stored in kerosene and ethanol with calculations and observations.
TSWBAT summarize their current knowledge and opinions of fossil fuels and ethanol.

Lesson 6
TSWBAT compare the combustions by-products from kerosene and ethanol.
TSWBAT summarize their current knowledge and opinions of fossil fuels and ethanol.

Lesson 7
TSWBAT work with a group to organize their information from all sources in order to develop a personal opinion on energy.
TSWBAT design a persuasion essay, brochure, flyer, or newsletter that will convince the public of their personal opinion on energy based on the information they found.

**Michigan High School Content Expectations Addressed**

**Science Inquiry, Reflection, and Social Implications**
C1.1E - Describe a reason for a given conclusion using evidence from an investigation.
C1.2B - Identify and critique arguments about personal or societal issues based on scientific evidence.
C1.2C – Develop an understanding of a scientific concept by accessing information from multiple sources.
      Evaluate the scientific accuracy and significance of the information.
C1.2E – Evaluate the future career and occupational prospects of science fields.
C1.1g – Identify scientific tradeoffs in design decisions and choose among alternative solutions.
C1.2k – Analyze how science and society interact from a historical, political, economic, or social perspective.

**Chemistry Content**
C2.2B - Describe the various states of matter in terms of the motion and arrangement of the molecules (atoms) making up the substance.
P4.p2C - Separate mixtures based on the differences in physical properties of the individual components.
C5.2A - Balance simple chemical equations applying the conservation of matter.
C3.1c - Calculate ΔH for a chemical reaction using simple coffee cup calorimetry.
C3.1d - Calculate the amount of heat produced for a given mass of reactant from a balanced chemical reaction.
C3.2a - Describe the energy changes in photosynthesis and in the combustion of sugar in terms of bond breaking and bond making.
C3.4c - Write chemical equations including the heat term as a part of equation, or using ΔH notation.
C5.6b - Predict products of reactions.
Social Studies Content – Civics

P1.1 - Use close and critical reading strategies to read and analyze complex texts pertaining to social science; attend to nuance, make connections to prior knowledge, draw inferences, and determine main idea and supporting details.

P1.4 - Communicate clearly and coherently in writing, speaking, and visually expressing ideas pertaining to social science topics, acknowledging audience and purpose.

P1.5 - Present a coherent thesis when making an argument, support with evidence, articulate and answer possible objections, and present a concise, clear closing.

P2.1 - Understand the scientific method of inquiry to investigate social scientific and historical problems.

P3.2 - Deeply examine policy issues in group discussions and debates to make reasoned and informed decisions.

P3.3 - Write persuasive/argumentative essays expressing and justifying decisions on public policy issues.

Pre-Activity for Instructor: Fermentation (2 days before Lesson 1)

Supplies – Lab-Aids Biofuels Kit and student guide sheets

1. Set up the fermentation from the Lab-Aids Biofuels Kit. This will need to be already running the morning before Lesson 1.
2. You will need to spend 5-10 minutes with the students to explain to them what the fermentation set-up is, and have them write their initial observations of the corn syrup and table sugar in the student guide sheet for the lab. Record daily observations.

Lesson 1: Previous Knowledge and Opinions (1 class period)

Supplies – Whiteboard/chalkboard, Learning & Opinions page

1. Explain to students that we will be starting a unit on fuels and we will be studying this through investigations.
2. Start out with asking the students to state things that they know about ethanol or fossil fuels. This is a time where they can list everything and anything. Record all answers on board for everyone to see.
3. Next, it is time for the students’ opinions. On a different section of the board, list their current opinions about ethanol or fossil fuels. Again, everything and anything is acceptable.
4. Facilitate a short class discussion about the fuel investigation that students seem to have strong opinions about. (Many of my students’ family members currently or have previously worked in the auto industry or have farms.)
5. Hand out the Learning & Opinions page for the unit. Explain to students that this will be where they record anything they learned that day, or how their opinions have changed. The final assessment for this lesson will be an opinion essay, so they will need to have their information organized.
6. Explain fermentation set-up and student observations.
   a. Show students Equation 1 and 2 from Lab-Aids and point out the reactants and products of the chemical reaction and have students check that the equations are both balanced correctly. These should be topics that have been previously learned by the students, so it should be a review.
   b. Students will need to predict if corn syrup or table sugar will produce the most ethanol in the fermentation process.
   c. Students will record their observations of the fermentation process for 5 days, and recording their observations in Table 1 of Lab-Aids student guide.
7. Summary – Students will need to write a short summary of what they learned that day and their opinions of ethanol and fossil fuels. This will be used as a study guide for the final assessment.
**Fuel Investigations: Learning & Opinions**

**Pre-Opinion:** What are your current opinions and knowledge of fossil fuels and ethanol?

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Lesson 2: Research *(1 class period)*  
Supplies: Lab-Aids student guide, Computers (at least 1 for every group), Research Guide page  
1. Split students into groups of 3-4 for the rest of the investigations.  
2. Have students write their daily observations of the fermentation process in the Lab-Aids student guide sheet.  
3. Hand out Energy research guide. Students will be instructed to research ethanol, specifically conventional ethanol versus cellulosic ethanol, and fossil fuels using the internet.  
4. At the end of the hour, all students should fill-in the Learning & Opinions page for the day.  

__________________________________________________________________________________________  
Name ________________________  Hour _______  

**Fuel Investigations: Research Guide**  

**Introduction:** At the conclusion of this unit, you will be expected to write an opinion essay answering the question, “In your opinion, what type of fuel should we be utilizing in mid-Michigan and why? Explain your answers using solid reasons and backed with many examples from the various investigations.” Today is devoted to use of the internet to help you answer this question. I have included some broad information that might be helpful for you to obtain, however, you are going to determine where your specific research leads you.  

What are the general kinds of energy for fuel currently?  

How much energy do we current obtain from fossil fuels? ethanol? other types?  

What are the resources used/needed for the different types of fuels? Do we have though resources readily available in mid-Michigan?  

**Basic Info**  

| Fossil Fuels | Corn Ethanol | Cellulosic Ethanol |
Lesson 3: Using GIS Maps to determine how much land is available for corn ethanol (corn/farm fields) and how much land is available for cellulosic ethanol (trees). (10-15 minutes)

Supplies: GIS Maps (1 for tree coverage in your area, 1 for farm fields in your area) on overhead sheet
Search Michigan Geographic Data Library for access to GIS maps, or contact a local forestry department.

Oil Production Map for Michigan (from DEQ)

1. Hand out GIS maps of the local area on overhead sheets, and blank map of same area to each group.
2. The students will need to use the GIS maps to determine how much land is available for corn ethanol (corn/farm fields) and how much land is available for cellulosic ethanol (trees).
3. Students need to compare land available for ethanol, to the number of oil producing wells in the area (see DEQ map)
4. Students should discuss in their groups, what type of ethanol is most convenient for their area, in terms of land use.

Map of Oil Producing Wells in Michigan (2006, DEQ)
http://www.michigan.gov/deq/0,1607,7-135-3311_4111_4231-14421--,00.html
Lesson 4: Distillation of Corn and Sugar (40-45 minutes)
Supplies: Lab-Aids Biofuels Kit, balances, beakers, graduated cylinders, safety goggles
1. Set up distillation at the beginning of class as a demonstration.
2. Perform the two distillation apparatuses according to the Lab-Aids directions.
3. As distillation is occurring, students will need to record observations in Table 2: Results of Distillation.
4. After distillation, students will need to answer the analysis questions for Procedure: Part B.
5. Have students discuss in their groups what conclusions they can make from their observations of the investigations.
6. Go over the students’ answers to the analysis questions as a class, to ensure that every student is obtaining the same information.
7. Students should fill in their Learning & Opinions for the day, including information from the GIS maps and distillation.

Lesson 5: Compare Energy Stored in Two Fuels (1 class period)
Supplies: Lab-Aids Biofuels Kit, matches, graduated cylinder, rulers, pop can, ring stand, clamp, paper clips, thermometers, balance, safety goggles
1. Set up lab stations for 3-4 students for Lab-Aids Biofuels Investigation 2: Comparing Energy Stored in Two Fuels.
2. Students will perform the investigation (pop-can calorimetry) according to the Lab-Aids directions.
3. Students will need to record all of their data in the tables provided and perform all calculations.
4. At the Conclusion of the lab, students will need to answer the analysis questions.
5. Have students discuss in their groups what conclusions they can make from their observations of the investigation.
6. Go over the students’ answers to the analysis questions as a class, to ensure that every student is obtaining the same information.
7. Students should fill in their Learning & Opinions for the day, including information from the GIS maps and distillation.

Lesson 6: Compare Combustion By-Products from Two Fuels (1 class period)
Supplies: Lab-Aids Biofuels Kit, tongs, aluminum foil, plastic bottle with cap, graduated cylinders, safety goggles
1. Set up lab stations for 3-4 students for Lab-Aids Biofuels Investigation 3: Comparing Combustion By-Products from Two Fuels.
2. Students will perform the investigation according to the Lab-Aids directions.
3. Students will need to record all of their data in the tables provided and perform all calculations.
4. At the Conclusion of the lab, students will need to answer the analysis questions.
5. Have students discuss in their groups what conclusions they can make from their observations of the investigation.
6. Go over the students’ answers to the analysis questions as a class, to ensure that every student is obtaining the same information.
7. Students should fill in their Learning & Opinions for the day, including information from the GIS maps and distillation.

Lesson 7: Summaries (1 class period)
Supplies: Students’ completed Learning & Opinions, all completed activities
1. In their groups, students will need to compile all of their information to discuss their final opinions on the type of fuel that should be used in mid-Michigan. They should also be discussing what the major supports for their opinions are.

2. All students will need to decide if they would like to write the persuasions essay, or if they would like to make an persuasion brochure, both with the purpose of convincing the reader of the their opinions based on facts and observations.

Assessment Plan

Formative Assessments:
All of the activities listed above are part of the formative assessments for this lesson, and therefore the students will get feedback on them, but will not be graded on them. This allows the students to learn without being punished with grades. The instructor is responsible for providing immediate, descriptive feedback to students, to ensure they know where they are at with their learning.

Summative Assessment:
The purpose of the lesson is to teach the students about making informed decisions based on scientific facts and observations. Students will only be graded on their understanding of this concept.

Students will be required to write a persuasive essay or brochure/flyer/newsletter answering the following question:
“In your opinion, what type of fuel should we be utilizing in mid-Michigan and why?”

See below for grading rubric and specific instructions.
Fuel Investigations: Final Assessment

The purpose of this unit is for you to be able to take the information you obtained from various sources and experiments, and use that information to form an opinion on a particular scientific issue. This opinion must be backed with solid examples and reasons, also based on your observations and sources. As you get older, your opinions will influence how you vote on particular issues, and who you vote for in elections. To make the most informed decisions, you have to be informed on the issues.

There are two options listed below for you to choose from for the final assessment. Both assessments are based on results from fossil fuel, corn ethanol, and cellulosic ethanol investigations.

Option 1: Persuasion Essay

Write a persuasion essay answering the following question:
“In your opinion, what type of fuel should we be utilizing in mid-Michigan and why?”

Explain your answers using solid reasons and backed with many examples from the various investigations.

Grading Rubric
Answers question – 5 points
Uses specific examples from investigations – 15 points
Convinces reader of opinion – 10 points
Strong introduction – 10 points
Strong conclusion – 10 points

Option 2: Persuasion Brochure/Flyer/Newsletter

Create an opinion brochure, flyer, or newsletter, in which you will be convincing the reader of your opinion of what type of fuel we should be utilizing in mid-Michigan and why.

Keep in mind that people are not convinced unless they are presented with convincing evidence, so you must include many examples from the various investigations.

Grading Rubric
States opinion on issue clearly – 5 points
Uses specific examples from investigations – 15 points
Convinces reader of opinion – 10 points
Strong introduction – 10 points
Strong conclusion – 10 points