**Lesson Plan Template**

**Modified 5/08/13 from** [**LEARN NC**](http://www.learnnc.org/) **(**[www.learnnc.org](http://www.learnnc.org))

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For LEARN NC partners

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| **Title (Required)** | **Activity 4 – Biodiesel Testing** |
| **Introduction (Required)** | In this activity, students have the opportunity to test small samples of prepared biodiesel from activity 3. The tests use physical properties and demonstrate the need to have fuel standards to protect consumer automobiles. Students make a determination, from collected data, whether their fuel can be used or if it requires more purification. |
| **Learning Outcomes (Required)** | **Students will*** Analyze the quality of the prepared biodiesel.
* Compare and evaluate the usefulness of alternative fuel sources.
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| **Curriculum Alignment (Required)** | From the Next Generation Science Standards (<http://www.nextgenscience.org/>):

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| HS-ETS1-3. | Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. |

From the NC Essential Standards “unpacked” content for chemistry:* **3.1.1** Explain the factors that affect the rate of a reaction (temperature, concentration, particle size and presence of a catalyst)
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| **Critical Vocabulary (Required)** | * Transesterification – a chemical reaction between an alcohol and a triglyceride to produce biodiesel and glycerin
* Triglyceride – oils or fats found in plants and animals; composed of a glycerol (3 carbon chain) backbone with three fatty acid chains (long straight chains of carbon atoms) attached
* Methyl ester – a compound formed from the reaction between an acid and an alcohol
* Biodiesel – a diesel fuel produced from organic sources, such as cooking oil, animal fat, or plant seeds (canola, sunflower, soybean)
* Catalyst – a substance used to speed up the rate of a chemical reaction without being used up during the process; similar to an enzyme in a biological system

The US Department of Energy maintains a full text glossary of terms related to the Biomass Program. The link is www1.eere.energy.gov/bioenergy/glossary\_full\_text.html |
| **Classroom Time Required (Required)** | **Activity 4** – 30-45 minutes |
| **Materials Needed (Required)** | **Activity 4 Materials:**Teacher: Quality Tests for Biodiesel answer keyStudents: Quality Tests for Biodiesel handout, Goggles, gloves and apron for labLab Materials (per lab group):* 15 mL sample of prepared biodiesel
* 10 mL methanol
* 10 mL deionized water
* Stirring rod
* Graduated cylinder
* Thermometer
* pH paper
* 3 test tubes with stoppers
* Balance
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| **Pre-activities (Required)** | **Activity 4 – Biodiesel Testing**Equipment and materials need to be set up before class begins. The teacher can collect the biodiesel from the separatory funnel and divide it into student samples if time is an issue. |
| **Activities (Required)** | **Activity 4 – Biodiesel Testing**In this activity, students will test the quality of the biodiesel prepared in Activity 3. The tests use physical properties and can be done with small samples (20 mL) of biodiesel.Each student will need the Quality Analysis of Biodiesel handout. There are five tests that students will run on their sample of biodiesel and a data table for them to complete as the tests are run. In the end, students will decide if their biodiesel could be sold for fuel.  |
| **Assessment (Required)** | Teachers can use a variety of formative assessments that are not graded, but will inform instruction after each activity. The following are some suggestions for these informal assessments.* Entrance/exit tickets – each student fills out a small ticket. The teacher can ask a content question, such as “Name two things you have learned about energy” or an open-ended question, such as “Write one question that you still have about calorimetry.” The teacher can then use the responses to guide future instruction.
* Starter question – The teacher can make a quick power point slide with a heat problem for students to work out.
* Thumbs up/thumbs down – A quick poll of understanding by a show of “thumbs up” or “thumbs down” can let the teacher know if students are confused. If students are not likely to give responses in this way, polleverywhere.com or gosoapbox.com are websites that have similar functions.
* Whiteboarding – students may work in small groups. The teacher assigns one problem from the homework sheet and the group puts the solution on the board and explains it to the rest of the class. This provides an easy way to uncover misconceptions.
* Electronic feedback – padlet.com allows teachers to build a wall and students to post comments. In this unit, a padlet could be created to post student questions or student feedback from each activity. Gosoapbox.com is a student management site where students can post questions, teachers can give quizzes or polls, and students can post discussion comments during class.

Summative assessments are more formal and are graded. A number of suggested assessments are listed below. Teachers may select work that is appropriate for their classes.* Heat Practice Problems – a power point with four heat problems with answers worked out on the last slide. Can be used as a quiz after Activity 2.
* Quiz – a short quiz can be given after Activity 3.
* Class summary – the entire class can create a KWL-type chart once the activity is complete. Padlet.com is one option to do this electronically. A low-tech option is to create whiteboards. Students can use this as a study guide before the test.
* Written test – a test with multiple choice, heat problems, graphs and short answer questions has been included. This test is best given once the entire unit has been completed.
* Lab report – students can write up formal lab reports for Activity 3 and 4. A suggested format can be found on a prezi. The link is <http://prezi.com/lxl9c0rw81mv/?utm_campaign=share&utm_medium=copy>
* Student presentations – students can create a presentation to support or oppose biodiesel production in the United States. Options for formats include: power point; prezi.com; piktochart.com. Students can also make videos, posters or skits. This will be most effective after Activity 5.
* Class debate – students can be assigned roles (environmentalist, farmer, scientist, congressman, etc.) to help them focus research for the debate. The debate will be most productive if it is held after the completion of the unit.
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| **Community Engagement (Required)** | In North Carolina, there are several sites involved in biofuel production or research. These operations offer education outreach by offering tours or guest speakers to school groups. Teachers should brainstorm.* Piedmont Biofuels – Pittsboro, NC – free public tours on Sunday afternoons and the first Friday of each month
* Patriot Biofuels – Greensboro, NC
* Biofuels Center of North Carolina – Oxford, NC – tours are available or guest speakers can visit schools
* Catawba County landfill site – Newton, NC – free tours can be scheduled
* Guest speakers – North Carolina A&T bioenergy center, Greensboro; North Carolina Biotechnology Center, Research Triangle Park.
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| **Websites (Optional)** | **Introductory Articles** – these have basic information that you will want to read before you start looking at other aspectsA list of common FAQs* http://biodiesel.org/what-is-biodiesel/biodiesel-faq's
* http://www.patriotbiodiesel.com/category\_s/1820.htm

A great introduction to biodiesel* <http://biodiesel.org/what-is-biodiesel/biodiesel-basics>

History of Biofuels* <http://blog.hemmings.com/index.php/2013/07/10/a-brief-history-of-biofuels-from-the-civil-war-to-today/>

A basic dictionary of terms* http://www1.eere.energy.gov/bioenergy/glossary\_full\_text.html

NC State Energy report 2010 – overview of policies, regulations and energy statistics for NC* http://www.energync.net/Portals/14/Documents/Publications/ANNUAL%20NC%20ENERGY%20REPORT%20final%20feb%202010%20v2-1.pdf

**Biodiesel Production**A one-page schematic of how biodiesel is produced* http://biodiesel.org/docs/ffs-production/production-fact-sheet.pdf?sfvrsn=4

US Dept of Energy data – current prices of fuel in different areas of the country* http://www.eia.gov/petroleum/gasdiesel/

**Advantages and Disadvantages**Biodiesel Myths v. Facts brochure (pro-biodiesel)* http://biodiesel.org/docs/default-source/ffs-basics/biodiesel-myths-vs-facts.pdf?sfvrsn=10

Alternative Fuels Data Center – you can compare various types of fuel* http://www.afdc.energy.gov/

Create your own comparison chart for various fuels* http://www.afdc.energy.gov/fuels/fuel\_properties.php

A short article on renewable v. nonrenewable sources of energy* http://www.ecology.com/2011/09/06/fossil-fuels-vs-renewable-energy-resources/

Crunching the Numbers on Alternative Fuels – Popular Mechanics articles* http://www.popularmechanics.com/cars/alternative-fuel/news/2690341
* http://www.popularmechanics.com/cars/how-to/4314657?click=main\_sr

Ending the Food vs. Fuel Debate* http://www.renewableenergyworld.com/rea/news/article/2012/10/ending-the-food-v-fueldebate-researchers-define-surplus-land

Food vs. Fuel Debate – CNBC article* http://www.cnbc.com/id/48477352

**Video Resources –** Each video clip has the time listed at the end of the titleInvention Nation: Biodiesel video (3:38)* http://videos.howstuffworks.com/science-channel/5044-invention-nation-biodiesel-video.htm

Public service announcement – introduces the use of fuel from organic materials (0:30)* http://bcove.me/r6k4gt36

“Here, Now” commercial – use of biodiesel in Dallas (0:37)* http://bcove.me/rwararju

“Fast Track” commercial – a biodiesel truck breaks a land speed record (0:37)* http://bcove.me/9cdwh71s

Jay Leno’s Garage – Jay talks to a scientist about using biodiesel in some of his cars (1:31)* http://bcove.me/316xk1ki

Motorweek segment – interviews farmers and various industries using biodiesel (7:55)* http://bcove.me/3yzusjn6

Biofuel lesson from National Defense Education Program – brief description of how organic materials are being developed into gasoline, biodiesel, and jet fuel* http://www.ndep.us/Biofuel

CNN Story on the Catawba County landfill site* http://www.cnn.com/video/?/video/tech/2009/08/20/wolf.green.town.cnn

**Careers in Biofuels**A US Bureau of Labor Statistics report on biofuel associated careers with salaries and credentials* <http://www.bls.gov/green/biofuels/biofuels.pdf>

Biofuel and Biodiesel product development careers – lists job outlook, salaries, personality traits and has links to other related careers* <http://myfootpath.com/careers/science-careers/biofuel-and-biodiesel-product-developer-careers/>

Green Career Guide – basic information about school and expectations for various biofuel jobs* <http://www.greencareersguide.com/Cellulosic-Biofuels.html>
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| **Author Info (Required)** | Marci Harvey is a chemistry and physics teacher at West Forsyth High School in Clemmons, NC. She has been teaching in NC for 17 years. She has a BS in chemistry from the College of Charleston and a MS in chemistry from the University of South Carolina. Marci earned National Board certification in 2008. This lesson is part of a Kenan Fellowship “Pump New Life into the Classroom with Biofuels.” completed at North Carolina A&T University. |