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| **Lesson Title :**  Introduction to Organic Chemistry and Fuels | **Unit #:**  **1** | **Lesson #:**  **1** | **Activity #:**  **1** |
| **Activity Title:** The Big Idea: Carbon-Based Fuels |

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| **Estimated Lesson Duration:** | 5 class periods (47 minutes each) |
| **Estimated Activity Duration:** | 2 class periods on separate days (47 minutes each) |

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| **Setting:** | The chemistry classroom. |

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| **Activity Objectives:** |

Upon completion of the activity, students will be able to:

* communicate what they already know about fuels.
* generate essential questions from the big idea.
* evaluate the collection of essential questions and vote on one.
* identify several challenges that face our society today regarding the big idea.
* generate guiding questions related to the classroom challenge chosen.

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| **Activity Guiding Questions:** |

* How does a car engine work?
* What does octane rating mean?
* Why do different fuels cost different amounts of money?
* How is gasoline produced/refined?
* What is gasoline made of?
* How exactly does fuel generate energy in a car?
* Does the chemical structure of a fuel affect the way it works in an engine?
* Do different fuels generate different amounts of energy?
* Is it safe to burn a mixture of fuels in a car’s engine?
* Is it helpful to add ethanol to the gasoline in a car?
* Does the addition of ethanol improve gas mileage?
* Do different fuels ever hurt the car? If so, how?
* Are different fuels, such as ethanol and gasoline, readily available?
* Do different fuels have the same environmental impact?
* Can the environmental impact of a fuel be mitigated in any way(s)?

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| ☒ Asking questions (for science) and defining problems (for engineering) | ☐ Patterns |
| ☐ Developing and using models | ☐ Cause and effect |
| ☐ Planning and carrying out investigations | ☐ Scale, proportion, and quantity |
| ☐ Analyzing and interpreting data | ☐ Systems and system models |
| ☐ Using mathematics and computational thinking | ☐ Energy and matter: Flows, cycles, and conservation |
| ☐ Constructing explanations (for science) and designing solutions (for engineering) | ☐ Structure and function. |
| ☐ Engaging in argument from evidence | ☐ Stability and change. |
| ☒ Obtaining, evaluating, and communicating information |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| ☐ Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| ☒ Demonstrating Science Knowledge **(D)** |
| ☒ Interpreting and Communicating Science Concepts **(C)** |
| ☒ Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| ☐ Make sense of problems and persevere in solving them | ☐ Useappropriate tools strategically |
| ☐ Reason abstractly and quantitatively | ☐ Attendto precision |
| ☐ Construct viable arguments and critique the reasoning of others | ☐ Look for and make use of structure |
| ☐ Model with mathematics | ☐ Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):** |

AP Chemistry Curriculum Framework 2013-14

* Science Practice 3: The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

* A slide show is developed as a “hook” to be shown at the start of class—including photos of gas pumps with the octane ratings, advertisements for new “flex-fuel” vehicles, a caution notice regarding leaded gasoline, etc.
* Prepared handouts are used to guide students from the “big idea” through the brainstorming, essential question, challenge, and guiding question generation process.

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| **Teacher Advance Preparation:** materials shown above |

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| **Activity Procedures:** |

* After the “hook” is shown, students will be told what the “big idea” is (carbon-based fuels).
* Then, students will be asked what they already may know about the topic.
* After sharing a few of these ideas, students will brainstorm in their group what some essential questions may be. They will select the best one to offer to the class.
* The class will then vote by secret ballot on what each person thinks is the most interesting/meaningful essential question to pursue.
* Then, back in small groups, the class will be asked to identify some societal challenges related to the big idea, and we will share some of those.
* If there is time, the students will be asked to come up with a challenge they think would be interesting and possible to pursue in the classroom.
* The next day, after being told the challenge, they will be asked to brainstorm in groups what some of the guiding questions would be.
* As a class, we will share guiding questions and identify several that we had in common.
* Students will be shown a “schematic diagram” of the lingo used in this activity, including “big idea,” “essential questions,” “challenge,” and “guiding questions.”
* Then the students will be given a pre-test as well as a survey.

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

* A pre-test was administered on the second day of the activity.
* A survey was also administered.

**Summative Assessments:** These are optional; there may be summative assessments at the end of a set of Activities or only at the end of the entire Unit.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.  Refer to Activity Template for details. |

* I supported different learners by moving around the room from group to group, listening in to their conversations and offering clarification or support if any individual students seemed overly confused or concerned.

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| **Reflection:** Reflect upon the successes and shortcomings of the lesson. |

* On the first day, it was unbelievable the sophisticated level of some of the questions the students came up with.
* It was equally surprising that the essential question(s) they converged on as a class were so close to the one I had thought about ahead of time!
* One of the groups was keenly aware and a little worried about how little their knowledge about engines is – compared with another group near them. I reassured them that the power of this project is that it will be able to “meet them where they are” in their current understanding and enable them to move forward in learning what they are interested in learning about—even if it is not as “sophisticated” as what another group is exploring.
* I do wonder if I should have divided the groups differently – so that there is not one group with all of the students who seem to know about engines already. I chose these groups because they were already together for “POGILing,” and they have a comfortable working relationship. The groups were originally put together randomly, with the idea that they need to learn to work with people of all types—and people who may have very different personalities and learning styles.
* It was amazing to see the high level of engagement by the time the students left class. I overheard one girl say: “I need to go home right now and look up some things about how engines work! I really don’t know anything about it…” I daresay that comment would never have followed a typical “lecture” about the same topic. In fact, most students would have dreaded an assigned task of researching engines! I really feel that taking the time to allow the students to *generate their own questions* resulted in a much greater *ownership* on their part in the learning process. They felt motivated to learn about how combustion engines work, not because some curriculum dictated it, but because they felt they wanted to understand it better in order to tackle the upcoming challenge—which they had a stake in.