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| <b>Title:</b> A Unit on the Chemistry of “Fracking”   |  |
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| <b>Course:</b> General Chemistry<br>Physical Science  | <b>Duration:</b> 6 class periods / 3 lessons |
| <b>Grade Level:</b> 11-12   |  |
| <p><b>Objectives for Unit:</b></p> <ol style="list-style-type: none"> <li>1. Students will learn about the process of hydraulic fracturing (fracking) as a component of horizontal drilling for natural gas resources.</li> <li>2. Students will learn about the chemicals used in the fracking process and study their reactivity and uses in other industry as well.</li> <li>3. Students will learn about the retrieval of ethylene during horizontal drilling and uses of ethylene in chemical industry.</li> <li>4. Students will learn about horizontal drilling, chemistry of the industry, and its ties to US and Arkansas economy.</li> </ol>  |  |
| <p><b>Summary of Lessons in Unit:</b></p> <p>This unit will consist of three separate lessons spanning at least six class periods.</p> <p>The first lesson will introduce the process of horizontal drilling and fracking with videos, articles, and information available at Arkansas Energy Rocks, AIPRO and Arkansas Petroleum Council/American Petroleum Institute websites as well as others listed in the lessons. It will be teacher led discussion and review of information to provide background on the topic</p> <p>The second lesson will focus on students’ research and summary of concise details in articles related to the science behind drilling and fracking, as well as the chemistry involved in each. Students will read and summarize the articles in writing and present the article summaries to the class in groups.</p> <p>In the third lesson students will research the materials found in fracking fluids and their chemical components. They will identify the types of compounds in the fluid, other common uses for the chemical, and any hazards related to the compound and its use in natural settings or near water supplies. Students will research fracking materials using computers, iPads, phones etc. The second portion of this lesson will be devoted to class presentations of the information that is gathered. Students will build a class chart detailing the information they gathered with special emphasis on ethylene and its prominence in the chemical industry around the world. The final part of the lesson will be assessment. Each student will present one question related to the unit. Students will respond individually in writing. All questions and</p> |  |



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| responses will be submitted to the teacher for evaluation.  |   |
| <b>Standards:</b><br>Common Core State Standards, Arkansas State Frameworks   |   |
| <b>CODE</b>   | <b>STANDARD</b>   |
| <b>Common Core</b>  |   |
| <a href="#">CCSS.ELA-Literacy.RST.11-12.1</a>   | Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.    |
| <a href="#">CCSS.ELA-Literacy.RST.11-12.2</a>   | Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.     |
| <a href="#">CCSS.ELA-Literacy.RST.11-12.7</a>   | Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. |
| <b>Chemistry</b>  |   |
| OC.29.C.2   | Describe the manufacture of polymers from different organic compounds including crosslinking and polymerization.  |
| OC.28.C.1   | Describe the functional groups in organic chemistry   |
| OC.28.C.2   | Name and write formulas for hydrocarbons  |
| OC.27.C.1   | Examine the bonding, structural and chemical behavior differences in organic compounds including hydrocarbons.  |
| <b>Teacher Excellence Support System (TESS) addressed in the unit:</b><br>1a: Demonstrating knowledge of content and pedagogy<br>1b: Demonstrating knowledge of students for grouping and group assignments<br>1d: Demonstrating knowledge of resources<br>1e: Designing coherent instruction |   |



1f: Designing Student Assessments  
3b: Using Questioning and prompts and discussion  
3c: Engaging students in learning  
3d: Using Assessment in Instruction

### **Instructional Strategies and Practices**

Lesson One is teacher and technology driven for research and background knowledge on the drilling and fracking process to build a connection to chemistry frameworks.

Lesson Two is student led research to review scientific articles/journals and online videos on the fracking process and fluids used in the process. Students will summarize the process and gain working knowledge of fracking fluids after examining all views on the topic

Lesson three is student driven collaboration of research related to the chemical nature and behavior of all fracking fluids used in the industry. Students will determine other common uses for those fluids.

Assessment will be student driven. Students will provide individual questions related to the entire week's unit of study for class response

### **Bloom's Level:**

Lesson One– Knowledge and Comprehension: describe, name, recognize, explain, review, predict, identify, infer

Lesson Two– Application: apply, discover, demonstrate, interpret, relate, prepare, write

Lesson Three– Analysis, Synthesis, and Evaluation: analyze, compare, contrast, discriminate, arrange, collect, combine, develop, generate, summarize, assess, defend, evaluate, support

### **Materials and Resources:**

Student Handout 1: A Unit on the Chemistry of Fracking--Group Article Summary

Student Handout 2: A Unit on the Chemistry of Fracking--Fracking Fluids Research Table

Background Information for all lessons

- <http://www.arkansasenergyrocks.com>
- <http://aipro.org/>
- <http://www.api.org/>
- <http://energyfromshale.org/hydraulic-fracturing>
- <http://www.need.org/>
- <http://chemistry.need.org/>
- <http://www.oerb.com/Default.aspx?tabid=245>



Websites for articles/videos to use in Lesson 2

- [http://www.chemistryviews.org/details/education/1316813/What\\_is\\_Shale\\_Gas\\_How\\_Does\\_Fracking\\_Work.html](http://www.chemistryviews.org/details/education/1316813/What_is_Shale_Gas_How_Does_Fracking_Work.html)
- <http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process>
- <http://fracfocus.org/chemical-use/what-chemicals-are-used>
- <http://phys.org/news/2013-03-physical-chemistry-fracking.html>
- <http://www.nature.com/news/secrets-of-fracking-fluids-pave-way-for-cleaner-recipe-1.13719>
- <http://www.essentialchemicalindustry.org/chemicals/ethene.html>
- <http://www.bloomberg.com/news/2012-10-15/cheap-gas-from-fracking-fuels-profits-at-lyondellbasell-energy.html>

**Formative Assessment:**

Lesson One – Discussion in class, notes, videos online and printouts/handouts for students from websites on background information related to horizontal drilling, natural gas in Arkansas, and fracking process.

Lesson Two – Student written summaries of all articles online using the student article summary handout in Lesson Two.

Lesson Three – Student created chart of fracking fluids, group collaboration of all fracking fluids and ethylene produced in natural gas wells, student assessment where students make exam items ( one per student)

**Notes to Teacher:**

Students will need access to internet/online sources used in background information, research, and in all portions of Lesson Three.

Students must have a prior working knowledge of naming compounds and writing formulas to begin this unit.

**Student Activity**

**A Unit on the Chemistry of Fracking – Lesson One**

1. The first lesson in this unit is to introduce the process of horizontal drilling and fracking with videos, articles, and information available at Arkansas Energy Rocks, AIPRO and Arkansas Petroleum Council/American Petroleum Institute websites as well as others listed below.
2. Use the following online sources to select videos and PDF versions of handouts/printouts for background information.

<http://www.arkansasenergyrocks.com>

<http://aipro.org/>



<http://www.api.org/>  
<http://energyfromshale.org/hydraulic-fracturing>  
<http://www.need.org/>  
<http://chemistry.need.org/>  
<http://www.oerb.com/Default.aspx?tabid=245>  
<http://geology.com/articles/horizontal-drilling/>  
[http://www.crzo.net/flash/shale\\_video.htm](http://www.crzo.net/flash/shale_video.htm)

3. After students view the selected resources, the teacher will lead a classroom discussion on the information presented. Emphasize the economic impact horizontal drilling and hydraulic fracturing have on the petroleum industry in Arkansas and the U.S.

### **A Unit on the Chemistry of Fracking – Lesson Two**

1. This lesson will focus on student research of the resources listed below. Students will read assigned articles for concise details and summarize in writing the facts related to the science behind drilling and fracking processes as well as the chemistry involved in each.
2. Divide the students into 7 groups and assign each group an article from the following list of online resources related to hydraulic fracturing (fracking):

[http://www.chemistryviews.org/details/education/1316813/What\\_is\\_Shale\\_Gas\\_How\\_Does\\_Fracking\\_Work.html](http://www.chemistryviews.org/details/education/1316813/What_is_Shale_Gas_How_Does_Fracking_Work.html)

<http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process>

<http://fracfocus.org/chemical-use/what-chemicals-are-used>

<http://phys.org/news/2013-03-physical-chemistry-fracking.html>

<http://www.nature.com/news/secrets-of-fracking-fluids-pave-way-for-cleaner-recipe-1.13719>

<http://www.essentialchemicalindustry.org/chemicals/ethene.html>

<http://www.bloomberg.com/news/2012-10-15/cheap-gas-from-fracking-fuels-profits-at-lyondellbasell-energy.html>

3. Working as a group, the students must use the assigned online resource to complete the following article summary and present their summary to the class. The handout will be turned in for a group grade. A printable copy of the handout is available at <http://www.arkansasenergyrocks.com/educators/index.html>. Select Curriculum, then 9-12 Lesson Plan – student handouts accompany each lesson plan



**Student Handout 1**  
**Group Article Summary Handout**  
**A Unit on the Chemistry of Fracking**

Website / URL for article: \_\_\_\_\_

Author's name: \_\_\_\_\_

Date of Publication: \_\_\_\_\_

Main Topic of Article: \_\_\_\_\_

1. Describe three main points of the article – give an example from the article to support each of the main points you select:
  - 1.
  - 2.
  - 3.
2. Does this article contain factual information? \_\_\_\_\_ Why do you think so (give at least two supporting statements from the article to support your answer)?
3. Does this article contain opinion based information? \_\_\_\_\_ Why do you think so (give at least two supporting statements from the article to support your answer)?
4. Give three pieces of scientific information that you learned from this article related to our unit of study on the chemistry of fracking. Cite specific examples from your article to demonstrate your new knowledge.
  - 1.
  - 2.
  - 3.
5. This is worth a “Google.” – Find two new things from this article you want to learn more about. Give them a “google” to find out more about what they mean – include the meaning and a URL for the information you find.



1.

2.

### **A Unit on the Chemistry of Fracking” - Lesson Three**

1. On the first day of this lesson students will research fracking fluids and their chemical components using the web resources from Lesson 2. They will need online access to complete this research.
2. Students will build a class- wide chart detailing all the information they gather in their individual research. Special emphasis will be given to ethylene and its prominence in the chemical industry around the world. A sample chart is provided in **Student Handout 2: Fracking Fluids Research Table** below. A printable copy is also available at: <http://www.arkansasenergyrocks.com/educators/index.html>. (Select Curriculum, then 9-12 Lesson Plan – student handouts accompany each lesson plan.)

Students can complete this assignment on their own or in collaborative groups based on teacher preference and nature of the class of students.

Students will determine the following information for seven fracking fluids of their choice then contribute their information to the class-wide chart:

- Name
- Chemical formulas,
- Class of chemicals to which they belong
- Purpose of the chemical in fracking process
- Other common uses of the chemical
- Toxicity of chemical in natural environment
- Proper disposal / retrieval of chemical in fracking process
- Amount used in process compared to its other common uses.



**Student Handout 2**  
**A Unit on the Chemistry of Fracking**  
**Fracking Fluids Research Table**

|   |  |  |  |  |  |  |  |
|---|--|--|--|--|--|--|--|
| Chemical name   |  |  |  |  |  |  |  |
| Chemical formula  |  |  |  |  |  |  |  |
| Class of chemicals to which this belongs ( any functional groups) |  |  |  |  |  |  |  |
| Purpose in fracking process                                       |  |  |  |  |  |  |  |
| Other common uses of the chemical                                 |  |  |  |  |  |  |  |
| Toxicity of chemical in nature                                    |  |  |  |  |  |  |  |
| Proper disposal procedures for chemical                           |  |  |  |  |  |  |  |
| Amount used in fracking compared to amount for other common uses  |  |  |  |  |  |  |  |





3. On day two of the lesson students will present the information they gathered in their research on fracking fluids and compile the class-wide chart of all fracking materials included in Student Handout 2.
4. **At home assignment:** Each student will write 3 questions about this unit of study which can be used in a class assessment for the final day of the unit. Each question must include a complete answer as well. These items will be turned in for a homework grade on the day of final assessment.
5. The last day of the lesson will be the student led assessment for the unit. The length of assessment will be determined by the number of students in the class. Each student will stand before the class and ask one of their three questions from the homework assignment. (Do not allow repeat items.)

Every student will submit a written answer to each question. At the end of the question session students will return to the groups they formed for the research in lesson two. Each student will present the correct answer to the item they posed on the assessment. The groups will grade the written assessments for correct responses and discuss any errors made among the members of their group. If the assessment takes the entire period – use another period of class for the groups to grade the assessment. By making use of student items as the assessment and utilizing the group scoring method, students remain in control of the amount of knowledge gained from the overall unit. They will determine the difficulty of the lessons by pushing each other to do their best.