



Title: Natural Gas in Arkansas WebQuest	
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Course: Science, Social Studies, Literacy/Writing and Technology, Math	Duration: Tasks: Elementary 3-4 hours Middle and higher 1-3 hours Assessments: Elementary 1-2hours Middle and higher 1-2 hours
Grade Level: 4 th and Higher	
Objective: Students will explore the properties of natural gas, how it is extracted, and the economic impact of natural gas on Arkansas through the use of technology. They will pose a question about geology to a real geologist and receive a response to their questions.	
Summary of Lesson: This WebQuest will help students of various ages gather information to understand the natural gas industry in Arkansas. Students will work in small groups or as individuals to build a foundation of knowledge about the industry. There are 4 tasks to be completed to help students to understand the natural gas industry, why it is important to Arkansas and to gain knowledge about the fracturing that is used to extract the gas from the shale in our state. Students will use a template/informational text sheet to record the information they gather. The 4 tasks involve students in exploring the science and economics behind the production and the impact to Arkansas. The 1 st task will explain how natural gas occurs. The 2 nd task explains why it is important to Arkansas. The 3 rd task allows students to discover the properties of shale and the 4 th task explores the steps completed to extract natural gas from the earth through hydraulic fracturing. There are two assessment options beyond the student information sheets. The students will have the opportunity to ask a geologist a question about the knowledge they have gained and receive a response from a real geologist via email. Students may also complete a persuasive essay about the issues concerning hydraulic fracturing.	
Standards: CCSS, Arkansas State Frameworks, Next Generation Science Standards, Other	
Code: CCSS.ELA-Literacy.CCRA.R.1	Standard: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing



	or speaking to support conclusions drawn from the text.
CCSS.ELA-Literacy.CCRA.R.7	Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words
CCSS.ELA-Literacy.CCRA.R.8	Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.
CCSS.ELA-Literacy.CCRA.R.10	Read and comprehend complex literary and informational texts independently and proficiently.
CCSS.Math.Content.4.OA.A.3	Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
CCSS.Math.Content.4.NBT.A.2	Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits in each place, using $>$, $=$, and $<$ symbols to record the results of comparisons.
CCSS.Math.Content.4.NBT.A.3	Use place value understanding to round multi-digit whole numbers to any place.
CCSS.Math.Content.4.NBT.B.5	Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.
CCSS.Math.Content.4.NBT.B.6	Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.
CCSS.Math.Content.4.MD.A.2	Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including



	problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.
Science and Engineering Practices	<ul style="list-style-type: none"> • Asking questions (for science) and defining problems (for engineering) • Constructing explanations (for science) and designing solutions (for engineering) • Engaging in argument from evidence • Obtaining, evaluating, and communicating information
Social Studies/Economics	
Choices	Students shall analyze the costs and benefits of making economic choices.
Resources	Students shall evaluate the use and allocation of <i>human, natural, and capital resources</i> .
Markets	Students shall analyze the exchange of <i>goods and services</i> and the roles of governments, businesses, and individuals in the <i>market</i> place.
Physical and Spatial	Students shall develop an understanding of the physical and spatial characteristics and applications of geography.
Interaction of People and their Environment	Students shall develop an understanding of the interactions between people and their environment.
Science	
Matter: Properties and Changes	Students shall demonstrate and apply knowledge of matter, including properties and changes, using appropriate safety procedures, equipment, and technology.
Earth Systems	Students shall demonstrate and apply knowledge of Earth's structure and properties using appropriate safety procedures, equipment, and technology.
Teacher Excellence and Support System:	
1c: Setting instructional outcomes, 1d: Demonstrating knowledge of resources, 1e: Designing coherent instruction,	



1f: Designing student assessments, 3b: Using questioning/prompts and discussion, 3c: Engaging students in learning, 3d: Using assessment in instruction.

Instructional Strategies and Practices:

Included in the standards section above.

Bloom's Level(s):

Knowledge, Comprehension, Application, Analysis, Synthesis, Evaluation

Materials and Resources:

The student information sheets and assessments are included at the bottom of the lesson.

Formative Assessment:

Student information sheets for all 4 tasks, *Ask a Geologist* question and the response from a geologist, and a persuasive essay.

Teaching Notes:

Teachers may decide the grouping of students based on levels of independence and the available technology. Differentiation may include completing tasks as whole group, small teams or as individuals.

Previous knowledge built upon, grouping suggestions, points of interest, technology connections, differentiations, key vocabulary, arrangement of classroom, safety procedures, progression etc...

Student Activity:

Teacher will establish work groups then distribute WebQuest Tasks in print (see **Student Handout**) or electronic format. Students will use the information to build a foundation of knowledge about the natural gas industry in Arkansas and to explore the science and economic impact of the industry on the state. Printable WebQuest Tasks Handouts are included in the Student Handout section.

After students complete WebQuest Tasks, they will complete the assessment opportunities included at the end of the WebQuest handout.

Natural Gas in Arkansas WEB Quest FACILITATOR KEY and ASSESSMENT

Task 1: What is Natural Gas?

Go to: <http://www.energyfromshale.org/hydraulic-fracturing/shale-gas> and review the poster titled, "What is Natural Gas?"

Complete the following:

1. What is natural gas?



Natural gas is primarily composed of a mixture of 4 naturally occurring gasses that have different molecular structures. These gasses are used for an amazing variety of purposes in our modern lives.

2. What are the 4 primary gasses that make up natural gas?

Methane, Ethane, Butane and Propane

3. Name four ways natural gas is used?

Transportation, Manufacturing, Heating and Electricity Generation.

Task 2: Why is Natural Gas Production Important to Arkansas?

Go to: <http://www.aipro.org/EconomicImpactStudy.pdf>

Complete the following:

4. In 2008, there were (9164) employees working in (564) oil and gas industry establishments in Arkansas.

5. Using the data you collected during your WEB quest, what would be the average number of workers in each establishment? **(16.248 = 16 workers per establishment)**

6. The average annual pay for the oil and gas industry was \$64,039 in Arkansas in 2008 while the annual state average for the state was \$34,909.00.

7. What is the difference between the 2008 Arkansas average annual pay and the oil and gas industry average pay? **(\$29,130.00)**

8. Using numbers and symbols, is the oil and gas industry average annual pay greater than (>), less than (<) or equal to (=) Arkansas' 2008 average annual pay? **(>)**

9. Based on the oil and gas industry average annual pay, what would an oil and gas industry employee make over the course of ten years?

10. How much severance tax revenue did Arkansas collect from natural gas during the first half of 2009?
13.6 million dollars

Go to: <http://www.aipro.org/AIPROfactsheet2010.pdf>

11. In 2008 the market value of oil and natural gas produced in Arkansas was **greater than** the combined market value of rice, soybeans and cotton.

Task 3: What is Shale and Why is it Important?



Go to: http://www.kidsloverocks.com/html/types_of_rocks.html

Find the following:

12. Is shale an igneous, metamorphic or sedimentary rock? ***Sedimentary***

13. Sedimentary rocks are formed at the ***surface of the Earth***, either in ***water or on land***. They are layered accumulations of sediments—fragments of ***rocks, minerals, or animal or plant*** material.

Go to: <http://www.shaletec.org/whatis.htm>

Find the following:

14. Shale gas refers to ***natural gas*** that is trapped within shale formations. Shales are fine-grained ***sedimentary rocks*** that can be rich resources of ***petroleum and natural gas***. Sedimentary rocks are rocks formed by the accumulation of ***sediments*** at the Earth's surface and within bodies of water. Common sedimentary rocks include sandstone, limestone, and shale.

Go to: <http://lingo.cast.uark.edu/LINGOPUBLIC/about/index.htm>

Complete the following:

15. The Fayetteville Shale is a deposit of sedimentary shale rock formation. The Fayetteville Shale play stretches across Arkansas from approximately ***Fort Smith*** east to beyond ***Little Rock***, Arkansas. The Fayetteville Shale is approximately ***50 miles*** wide and is ***1,500*** to ***6,500*** feet deep. ***A single mile is 5,280 feet. (264,000)***

16. How wide is the Fayetteville Shale in feet?

Task 4: What is fracturing?

Go to: <http://ngm.nationalgeographic.com/2013/03/bakken-shale-oil/fracking-animation-video> and watch the National Geographic Video, “What is Fracking.” This video gives a brief overview of fractured drilling in South Dakota.

Go to: <http://issuu.com/aipro/docs/arkansasoilandgasbook> and read about hydraulic fracturing on pages 6 and 7.

Complete the following:



17. What is in fracturing fluid?

90% Water, 9.5% Sand and .5% Chemical Additives

18. Does hydraulic fracturing cause earthquakes in Arkansas? Explain your answer.

No, drilling and hydraulic fracturing of production wells have not been found to have any correlation or connection with earthquakes in Arkansas.

19. Is hydraulic fracturing safe? Explain your answer.

Yes; Hydraulic fracturing has a 60-year track record of safe operations.

20. What are the four benefits of horizontal drilling and hydraulic fracturing?

Less Surface Area, Fewer Wells, Increased Water Efficiency, Reduced Air Emissions.

Assessment #1:

Go to: <http://walrus.wr.usgs.gov/ask-a-geologist/>

After completing this web quest each student will compose a question to ask a geologist to extend their knowledge. The response must be printed and turned in as an assignment. Students will receive an answer within 4 days and will share with the rest of the class.

Assessment #2:

Students will complete a persuasive essay from the viewpoint of the natural gas industry explaining why Arkansas should continue drilling for natural gas using the current technologies.

See Student Handouts