PROJECT REPORT

Northern Wyoming Community College District / National Science Foundation
Summer Energy Education Program 2012

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TITLE

Can You Isolate the Uranium?

SUMMARY

Simulation of Isolation of Uranium from Mined Ores

This lesson will guide students through a simulation of some of the steps and challenges in isolating this valuable fuel and then compare the quantity of energy obtained from Uranium to the amount of energy obtained from coal.

ENERGY CONTEXT

Challenge of Isolation vs. Benefit of Use

The steps involved in isolating uranium are challenging and expensive. Is it worth it? Students will conclude this activity with a comparison between the fuel equivalence between Uranium and coal.

ANTICIPATED TIME REQUIRED

Two hours, divided (plus teacher prep time)

This project will require:

TEACHERS:

- Lab prep time: 30 to 60 minutes (students can be used to decrease teacher lab prep time)
- Lab clean time: 30 to 60 minutes (students can be used to decrease lab clean time)

STUDENTS (class time)

- Introduction of lesson on day 1 and the assigning of article with worksheet homework – 20 minutes
- Introduction of lab
- – Time for students to read over lab – 10 minutes
- - Time for teacher review of procedure – 10 minutes
- Conduct experiment
  - Isolation lab – 30 to 40 minutes

  Uranium vs. coal comparison activities – 20 minutes
- Summarize and discuss results – 10 - 20 minutes

INTENDED STUDENT LEVEL

This lesson is designed for 8th grade students taking Physical Science.

ASSUMED PRIOR KNOWLEDGE

This project will assume that students have prior knowledge of:

- Basics of chemical reactions including precipitation reactions
- Basics of Acid/Base chemistry, including pH scale
- Proper and safe lab techniques

LEARNING OBJECTIVES

- State the role uranium plays in production of electricity.
- Describe some of the challenges involved in the mining and processing of uranium
- Use standard and safe lab techniques in a simulation of the isolation and identification of a specified substance.
- Discuss the relative energy equivalence of uranium versus coal.

MATERIALS

Each student needs:

- Access to the article "Reversing Mother Nature" from http://uraniumenergy.com/uranium/in_situ_leach/
- Worksheet of questions to guide students through that article
- Lab sheets (procedure, answer sheet, homework ½ sheet)

Each lab group needs:

30 small test tubes with stoppers
Test tube rack or small beakers to hold test tubes
Tincture of iodine (KI or I_2)
0.2 M NaOH solution
White vinegar
1% phenolphthalein solution
Isopropyl alcohol
Deionized water
Boric acid (solid)
Sodium bicarbonate
Sodium carbonate
Sodium chloride
Sodium hydroxide (solid)
Calcium carbonate
Magnesium sulfate
Sucrose
Cornstarch
200 or more toothpicks or other small object available in large quantities
Access to a computer and the internet

INTRODUCTION / MOTIVATION FOR STUDENTS

Twenty percent of the electricity generated in Georgia comes from nuclear energy. More is promised in the future as two new nuclear generators finish construction and come online. These power plants rely on uranium as their fuel. In this lesson, you will get a simulated experience in the process of harvesting uranium from the rocks and dirt that contain it.

Uranium is a metallic element found in the Actinide series of the Rare Earth elements on the Periodic Chart. Though it is a metal, it is not found in that state in nature. Uranium is found reacted into compounds such as uranium phosphates, uranium sulfates, uranium fluorides, and uranium oxides. To process uranium into fuel, mining and processing companies need to isolate uranium compounds from the other minerals brought up from the mine and then convert it to triuranium octoxide (U_3O_8). It is the U_3O_8 that is the most safely transported and then easily converted to enriched fuel grade uranium hexafluoride (UF_6). The processing of the ores that contain uranium compounds involves a series of chemical reactions that identifies which compounds contain uranium, separating them from the other compounds, and then converting the various uranium compounds to the U_3O_8. The finished product, U_3O_8, is commonly called "yellow cake." Though the steps involved in mining and processing the uranium ores to the yellow cake state are challenging, it makes financial sense to the companies involved. As of June 2012, a 55 gallon barrel of yellow cake sells for over $30,000.

In this lab, you will **not** be working with uranium compounds. This lab involves a series of reactions designed to simulate some of the steps uranium processing companies have to go through to get their desired final product and to know that they have it. You will begin with nine substances that look very similar to each other. Along the way, you will add substances that will cause precipitation, to raise the pH or lower the pH, and to identify the substance present in a particular portion of the sample. Hopefully, at the end, you will be able to state which sample contains the mock uranium and give evidence to support your identification.

Uranium is just one fuel used to supply our country with electricity. The mining and processing of uranium can be challenging. At the conclusion of this activity, you will predict and investigate a comparison between uranium as a source of fuel and another commonly used mineral.

PROCEDURE

Note to Teachers: *This activity is designed to be done as a culminating activity at the end of the chemistry portion of a physical science course. In addition to reviewing many concepts in chemistry, the energy concepts and investigations provide a transition to the physics portion of the course. This project was written with an emphasis on Georgia. Teachers may adjust it to reflect different states.*

- During the class before the lab is to be done, introduce the topic of uranium as a source of fuel for the production of electricity. Give the students a copy of the "Reversing Mother Nature" article along with the worksheet. Have the students complete the worksheet as they read the first five pages of the article. This assignment could occur during class or be given as a homework assignment.

- On the day of the lab, talk to the students about the challenges and methods of mining and isolating uranium as discussed in the article.
- Pass out a copy of the lab sheets. Allow time for students to read over the lab to become familiar with what they are to be doing.
- Go over the procedures with the students, pointing out safety concerns, where materials are located, how to dispose of used materials, and clean up materials.
- Allow the students to perform the lab, supervising them for proper and safe techniques. Some of the color changes may be slight; encourage students to take the time necessary to make proper observations.
- At the conclusion of the lab, the students should make a prediction about the energy equivalence of uranium and coal. (How much coal would produce an equal amount of energy as this small amount of uranium did?) Students should create a physical model of this predicted ratio using toothpicks. 1 uranium toothpick contains the same amount of energy as how many coal toothpicks? Students should show this model to the teacher and record the prediction on the lab sheet. (Though you will supply many toothpicks, it is unlikely you will have enough to accurately display this ratio but it is also unlikely that the students will notice this.)
- As a homework assignment, students should use appropriate websites on a computer to look up the actual ratio of energy from uranium versus coal. This true ratio along with website used for the information should also be recorded on the half page homework sheet. (If time and resources permit, this could be done in class.)
- At the conclusion of this activity, the teacher should lead the class in a discussion of the techniques used in the lab as well as the difference between the energy released from uranium and coal.
- This lesson could lead to further investigations into the pros and cons of different fuels used for the generation of electricity.

SAFETY ISSUES

Students should wear proper lab attire including closed toe shoes, lab apron, and lab goggles. Sodium hydroxide is corrosive both as the solid and in solution; skin burns are possible; avoid all body tissue contact. Iodine tincture, phenolphthalein solution, and isopropyl alcohol solution are flammable liquids and are toxic by ingestion and inhalation. Those substances should never be placed near candle flame. All other reagents and unknowns are considered non-hazardous; however, all may cause slight irritation to the skin, eyes, or respiratory tract; avoid all body tissue contact.

TROUBLESHOOTING TIPS

The reading level of the “Reversing Mother Nature” article is advanced. The worksheet is designed to help students work through the text however having an audio recording of the article available to students who need such assistance would be a good idea.

Teachers should work through the lab before the students attempt it to become familiar with the procedure and results.

ASSESSMENT

Pre-Activity Assessment

- *Students will complete the worksheet that guides the reading the first five pages of the "Reversing Mother Nature" article.*

Mid-Activity Assessment

- *Lab: Students will complete the identification chart as they work through sorting out the 9 white powders.*
- Students will make a prediction and use quantities of toothpicks to illustrate the relative energy equivalence of uranium and coal.
- Students will use reliable internet sites to find and record the actual ratio of energy equivalence of uranium and coal.

Post-Activity Assessment

Question/Answer: Ask the students and discuss as a class the challenges of producing uranium and why or why not it might be worth it.

SUGGESTED EXTENSIONS

Uranium and coal are just two of the fuels used to generate electricity in Georgia and in other parts of the world. Have students investigate other fuels and evaluate them as better (or worse) alternatives to coal and uranium.

More advanced students should read the complete "Reversing Mother Nature" article to learn about the clean up procedures and requirements for an ISR uranium mine and compare that to similar needs at other fuel mining sites.