



UTAH OFFICE OF ENERGY DEVELOPMENT

Lithium Mining in Utah

Grade/Subject: Chemistry

Stand/Standard CHEM.3.5 Develop solutions related to the management, conservation, and utilization of mineral resources (matter). Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data to make improvements from iteratively testing solutions, and optimize a solution. Emphasize the conservation of matter and minerals as a limited resource. Examples of Utah mineral resources could include copper, uranium, potash, coal, oil, or natural gas. Examples of constraints could include cost, safety, reliability, or possible social, cultural, and environmental impacts. (PS1.B, ESS3.A, ETS1.A, ETS1.B, ETS1.C)

Lesson Performance Expectations:

- Students will design a method to extract a mineral from a solution, similar to the extraction of lithium from underground sources. They will evaluate the environmental impacts and mitigation costs with the societal demand for lithium in energy storage.

Materials per group:

- Flasks of several sizes (one per group)
- Filter paper (filter needs to fit in funnel, usually 6 cm diameter)
- Funnel
- Flat dishes
- Hot plates
- Potassium Nitrate (in place of lithium) solution
- Graduated cylinder

Time: 1-2 class periods

Teacher Background Information: KNO₃ (Potassium Nitrate) is very soluble in hot water and creates a solution that will precipitate out the potassium nitrate as it cools. While lithium salts are not heated the process is much the same, water is evaporated out of the solution leaving behind the lithium. Potassium nitrate is moderately soluble in water, but its solubility increases with temperature. It is insoluble in alcohol and is not poisonous; it can react explosively with reducing agents, but it is not explosive on its own.

<https://www.bbc.com/future/article/20221110-how-australia-became-the-worlds-greatest-lithium-supplier>

<https://www.npr.org/2022/11/12/1131365516/a-proposed-lithium-mine-presents-a-climate-versus-environment-conflict>

Student Background Knowledge:

- Students should know that lithium batteries are increasingly important to battery-powered cars and wireless devices that depend on a battery.
- Students should have had basic safety training in goggle wearing, handling of chemicals and glassware.

Teacher Step by Step: A 3-D lesson should insist that students think deeply. Provide time and space for the students to experience the phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.

1. Set up a flask with 500 mL of water and place it on a hot plate. On a low heat, add KNO_3 until a concentrated solution is reached. Keep it warm as class starts.
2. Students should begin by reading the information on the student sheet.
3. Ask students for questions that they have about the reading.
4. Show students the materials they have available and provide time for them to assemble them. If you wish to provide "sunlight" without a window or going outside, place a heat lamp in a couple of areas in the classroom. Aluminum foil could provide a concentrator.
5. Deliver the KNO_3 to students about the same time. Pour 50 mL into beakers and distribute quickly.
6. Let students know how much time they will have (20 minutes or so). During this time instruct students how to use the filter and funnel. They should pre-weigh their filter.
7. When time is up, students should pour and/or scrape the remainder of their solution into the filter and allow it to drip. The filter should be weighed after it dries. They can begin to report to the class how they set up their experiment to fill in the data table.

Assessment of Student Learning.

1. What condition is lithium found in Utah?
 - a. Dissolved in ground and surface water*
 - b. As a solid inside other rock.
 - c. In volcanic areas
 - d. In high elevations.
2. How is lithium purified for use?
 - a. By evaporating the water out of solution.*
 - b. By blasting away the surrounding rock.
 - c. By searching for areas with melting lava.
 - d. By sending mining operators to mountain peaks.
3. What is the need for better and more efficient lithium batteries? Choose all that apply.
 - a. Storing energy from renewable energy sources.*
 - b. Adding additional weight to electrical devices.
 - c. Collecting and using energy from earth materials.
 - d. Reducing pollution and carbon dioxide production.*
4. Which conditions are necessary to quickly and inexpensively recover lithium found in Utah? Choose all that apply.
 - a. Maximum surface area for evaporation*
 - b. Adding heat from renewable sources*
 - c. Creating deep evaporative basins.
 - d. Adding additional substances to the lithium mixture.
5. What environmental impacts must be considered before allowing a lithium mine to exist in a location? Choose all that apply.
 - a. Damage to land surface*
 - b. Depletion of underground water*
 - c. Transportation distance to manufacturing plant.*
 - d. Ability of lithium to be added to a battery.

Extension of lesson and Career Connections: Magnesium is currently mined in Utah in the same way that Lithium is mined. Research and report on magnesium or lithium mining that is already occurring in Utah.