



DIG INTO MINING

THE STORY OF COPPER

Mineral Mixtures and Mining

Overview

In this activity students will plan and carry out an investigation to separate out several items that were mixed together back to their original pure substances. Students will have to determine how best to separate each material, write a procedure, and perform the separation procedure, recording their findings.

Topics: Developing Possible Solutions
Characteristic Properties of Matter

Real World Science Topics

- Separation of Mixtures
- Mining

Objective

Students will be able to:

- Use knowledge of characteristic properties to explain how each substance can be separated from the mixture
- Analyze the relationship between their lab investigation and separation techniques in mining
- Explain how their lab investigation is a model for extraction techniques

NGSS Three-Dimensions

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Developing and Using Models <ul style="list-style-type: none"> • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. 	ETS1.B: Developing Possible Solutions <ul style="list-style-type: none"> • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. 	Cause and Effect <ul style="list-style-type: none"> • Cause and effect relationships may be used to predict phenomena in natural or designed systems.



DIG INTO MINING

THE STORY OF COPPER

Background Information

What mixtures are found on Earth?

Earth's crust and mantle contain many different types of rocks and minerals. Various minerals can be found in sedimentary, igneous, and metamorphic rocks. Humans mine mineral resources to manufacture items we use every day. The extraction process requires the removal of the minerals with commercial value from the surrounding rock and from minerals that have little or no value.

How are mixtures separated?

Separating substances that make up a mixture requires an understanding of the characteristic properties of these substances. A characteristic property is independent of the amount of the substance—so mass or volume are not characteristic properties. Characteristic properties may be either physical properties or chemical properties. Physical properties include appearance, density, and magnetic properties. Chemical properties include reactivity with other substances, chemical stability, and solubility in different solvents.

In mining operations engineers use their knowledge of the characteristic properties of minerals to separate valuable substances from the surrounding rock. This involves a variety of physical and chemical processes. Physical processes include sieving, sedimentation, flotation, magnetic separation, filtration, and evaporation. Chemical processes include using chemical reactions to make the minerals soluble and dissolving the newly formed substances—dissolution. Most separation processes involve a number of stages.

Key Vocabulary

Copper – Chemical element that is a ductile metal with very high thermal and electrical conductivity

Copper minerals – naturally occurring solid compounds containing copper and other elements in a specific chemical formula, such as chalcopyrite (CuFeS_2)

Mining – A method to extract minerals or other geological materials from the surrounding rock

Mixture – A combination of substances that can be physically separated from one another

Physical Change – A change in matter that does not affect its chemical composition

Chemical Change – A process that changes substances into new substances



DIG INTO MINING

THE STORY OF COPPER

Materials

- Safety equipment:
- Latex/nitrile gloves
- Safety goggles/glasses
- Mixture of iron filings, sand, beads (that will float in water-but too small to pick out by hand), and salt
- Water
- Magnet
- Bunsen burner or hot plate
- Evaporation dish
- Filter paper
- Beaker
- Medicine cups
- Paper towel
- Funnel
- Striker
- Water
- Apron

Safety Reminders:

- A hot plate is recommended for this investigation. Instruct students to use the following guidelines when working with a hot plate:
 - Keep flammable or combustible materials away.
 - Be careful when removing hot glassware and liquids.
 - Use tongs or gloves to protect yourself from the heat.
 - Turn off the hot plate when not in use.
 - Be careful handling the hot plate after use. The hot plate will stay hot for several minutes after turning off.
- Be sure to adhere to the following guidelines for safety:
 - Wear safety gloves and safety goggles to protect hands and eyes.
 - Tie back long hair.
 - Wear close-toed shoes.

Procedure

- 1. Warm-Up Activity:** Display images of fruit salad, sponge cake, beach sand, rusted car, and salt water. Ask students which of these can be separated and how they would go about separating them. Students should identify that cake and rust cannot be separated. Salt water can be separated by evaporating the water, beach sand can be separated by its different rocks and minerals, and a fruit salad can be separated by different kinds of fruit.
2. Provide the definitions of physical and chemical changes:
 - Physical Change: Rearranges molecules but does not change them
 - Chemical Change: Forms a new substance
3. Ask students to revisit the images from the warm-up and sort the items under physical and chemical changes. Students should place the fruit salad, cement, and salt water under physical change. They should sort cake and water under chemical change. Clarify that in a chemical change new substances are formed. In a physical change no new substance is formed.
4. Explain to students that in mining-extraction processes different pieces of equipment separate mixtures of rock from copper mineral. Share the video of a Spiral Classifier in action from the widget and ask students how that piece of equipment separates a mixture.
5. Clarify with students a Spiral Classifier separates solid particles, after they are ground down, from a mixture of solids and liquids based on density. Denser materials will sink to the bottom and less dense materials will rise to the top.
6. Explain that humans mine mineral resources to manufacture items we use every day. The extraction process requires the separation of the unwanted minerals that make up the rock to get to the good stuff we do want! There are several physical and chemical separation techniques that are used to separate materials from Earth. Today students will explore some of these techniques.
7. Explain to students that they will be challenged to separate a mixture themselves using different techniques. Each group of three students will be given a mixture of salt, sand, beads, and iron filings. They will need to use available materials to separate the different mixture from one another.



DIG INTO MINING

THE STORY OF COPPER

8. Guide students to first come up and observe the materials available. Not all items are used. Then, as a group write a procedure on how they will separate the mixture. The teacher should circulate around the room and initial final approved student procedures. If students are not sure how to get started demonstrate a couple techniques they will use in their procedure or set up stations for them to explore.

Teacher Notes: Suggested Procedure

- Use a magnet to remove the iron
- Mix the remains with water, beads will float to the top, salt will dissolve
- Pour off the salty water, sand is left
- Evaporate the water, salt is left

9. Allow students to follow their procedure. Circulate around the room to monitor student progress. Ask questions to help them solve any problems they may encounter.

10. **Evaluate:** Summarize using provided conclusion question on lab and guiding questions below:
- What if your mixture included pepper? What additional step would you include to separate the mixture?
 - What property enabled you to separate the sand from salt?
 - What separation techniques utilized the physical properties of the materials?
 - What separation techniques targeted the chemical properties of the materials?
 - Ice cubes stored in individual trays lose their shape and shrink in size over time. Why do you think this happens?

Extension Activity

Chromatography is another example of how mixtures can be separated, this time by separating pigments. Ask students to each bring in a black marker or provide different brands of black, water soluble, markers. Using water, filter paper or coffee liners, a pencil, and marker invite students to set up a small experiment to see how the ink will dissolve slowly up the paper and separate into different components. Per the evaluation above, ask the guiding questions, is this a physical or chemical process, and why?

Additional Resources

Link to widget

<http://www.propertiesofmatter.si.edu/goldpanning.html>

Note: Although panning for gold is not the same as the process of mining, this resource may help students build understanding of the concepts in this lesson.

