Unit 2 Projects

Inquiry Project
"Mining" Copper in the Laboratory (Student textbook pages 256 to 257)

Pedagogical Purpose

This investigation allows students to apply their knowledge of chemical reactions to solve the real-world problem of how to recover copper from a compound. This is an opportunity for students to demonstrate the understanding and skill they have developed in this unit about chemical properties and reactions. The simplicity of this procedure helps explain how copper was discovered and led to the copper and bronze ages.

Planning	
Materials	**BLM A-3 Designing an Experiment Checklist** (optional) Arrange time in the library for book or Internet research.
Time	2 weeks (in and out of class) for research 1 or 2 periods for presentations

Background

Copper is Earth's 25th most abundant element. Since antiquity, copper has been used for tools and decoration. It remains one of our most valued materials. More reactive than silver or gold, copper is not usually found in its pure state. Copper(II) compounds are generally blue or green and soluble in water. Many of these compounds are toxic, making them useful in weed-killers and insecticides. Its largest use today is in electrical wiring, followed by plumbing.

The method used to extract copper from its ores depends on the type of ore and the desired purity of the final product. Copper(II) carbonate is also called malachite (green copper ore) and is often the source for pure copper.

Copper can be extracted from its ores by undergoing a process called reduction where the positive metal ion gains an electron to become neutrally charged or the oxide of the metal loses oxygen to form free metal atoms. The process is called reduction because the metal ion's charge has been reduced.

In order to extract copper from copper(II) carbonate, the copper ore can be heated (roasted) in order to concentrate the copper as an oxide. The water remaining in the oxide can be removed through further heating (distillation). The formed copper(II) carbonate will undergo a decomposition reaction upon heating.

copper(II) carbonate → copper(II) oxide + carbon dioxide

$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$

Carbon can then be used for a single displacement reaction in which the CuO forms Cu and CO_2.

copper(II) oxide + carbon → copper + carbon dioxide

$2CuO(s) + C(s) \rightarrow 2Cu(s) + CO_2(g)$

Activity Notes and Troubleshooting

- Introduce the activity by brainstorming properties of copper and an application for each property.
- Outline the expected procedure to steer students away from complicated procedures such as electrolysis, which are beyond the scope of this course.
- You may wish to have groups review each other's procedures before submitting them to you for a safety check.

- As a class, decide on and communicate the criteria on which products will be assessed. You may wish to use the rubric on the next page, or work together to determine the criteria for assessment.
- Students may find that **BLM A-3 Designing an Experiment Checklist** helps them get started.
- To assess students' process of designing the investigation, use **BLM A-31 Designing Experiments Rubric.**

Additional Support

- ELL Have students note unfamiliar words such as *comprehensive* and *refute*, adding definitions to their glossary in their notes.
- Encourage students to include graphic organizers and illustrations.
- Refer students to the activity series.
- Allow students to prepare materials by hand or using computers.
- Pair more artistic students with more analytic or verbal students to complement each other's strengths.
- To challenge, have students research other methods of extracting copper from malachite, such as by reaction with sulfuric acid followed by electrolysis.

Rubric

Achievement Chart Category	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding	The important skills and concepts from each investigation are identified with limited accuracy.	The important skills and concepts from each investigation are identified with some accuracy.	The important skills and concepts from each investigation are identified with considerable accuracy.	The important skills and concepts from each investigation are identified with a high degree of accuracy.
Thinking and Investigation	The hypothesis is formulated with limited accuracy. Executes a procedure controlling appropriate variables and using equipment and materials safely, accurately, with limited effectiveness. The theoretical mass of copper extracted is determined with limited accuracy. Identifies sources of error and proposes suggestions for improvements in limited detail.	The hypothesis is formulated with some accuracy. Executes a procedure controlling appropriate variables and using equipment and materials safely, accurately, with some effectiveness. The theoretical mass of copper extracted is determined with some accuracy. Identifies sources of error and proposes suggestions for improvements in some detail.	The hypothesis is formulated with considerable accuracy. Executes a procedure controlling appropriate variables and using equipment and materials safely, accurately, with considerable effectiveness. The theoretical mass of copper extracted is determined with considerable accuracy. Identifies sources of error and proposes suggestions for improvements in considerable detail.	The hypothesis is formulated with a high degree of accuracy. Executes a procedure controlling appropriate variables and using equipment and materials safely, accurately, with a high degree of effectiveness. The theoretical mass of copper extracted is determined with a high degree of accuracy. Identifies sources of error and proposes suggestions for improvements in thorough detail.
Communication	Data is organized using a format appropriate for audience and purpose with limited effectiveness. Communicates using appropriate scientific vocabulary with limited effectiveness.	Data is organized using a format appropriate for audience and purpose with some effectiveness. Communicates using appropriate scientific vocabulary with some effectiveness.	Data is organized using a format appropriate for audience and purpose with considerable effectiveness. Communicates using appropriate scientific vocabulary with considerable effectiveness.	Data is organized using a format appropriate for audience and purpose with a high degree of effectiveness. Communicates using appropriate scientific vocabulary with a high degree of effectiveness.

An Issue to Analyze
Urban Gold "Mining" (Student textbook page 257)

Pedagogical Purpose

In the process of becoming scientifically literate, students are asked to draw on their scientific knowledge and skills to assist in making personal choices.

Planning	
Materials	**BLM G-4 Analyzing Issues–Science, Technology, Society, and the Environment** (optional) **BLM G-18 How to Do a Research-Based Project** (optional) **BLM G-20 Research Worksheet** (optional) Arrange time in the library for book or Internet research.
Time	2 weeks (in and out of class) for research 1 or 2 periods for presentations

Background

North Americans discard more than 100 million computers, cellphones, and other electronic devices each year. Public awareness about the hazards of e-waste is growing. Gold is often used in electrical systems because it is easy to work with, doesn't corrode, and conducts electricity efficiently. Because gold is both costly and scarce, recycling it is a valuable process. Other metals used in electronics also have value, and threaten to pollute the environment as the products decay in the garbage.

An argument has been made that landfill "mining" would actually be cheaper than traditional mining. This would also save the environment from the effects of traditional mining processes.

As a result of public pressure, some manufacturers have started recycling programs, raising many issues themselves. For example, inconvenience and disillusionment reduce consumer participation, and recycling can occur in an unsafe manner. In some countries, retailers that sell electronic equipment containing hazardous waste must pay some of the recycling costs.

Activity Notes and Troubleshooting

- Ask the class how many times they have replaced their cellphone, game system, computer, camera, and music player. Ask what happened to the old item. Did they know it contained precious metals? Did they know it could pollute the environment? Define *e-waste* and *urban mining*. Then, have students read the project independently.
- Tell students that all of the gold ever mined would only make a cube that could fit inside a basketball court. Ask them to consider how much gold is thrown out with discarded electronics. Should we be worried about a gold shortage in the same way the media reports an "oil crisis"?
- Direct students to use a variety of sources for their research such as electronic, print, and public broadcast.
- Discuss the meaning of "bias" in terms of researching current issues.
- Students may find that **BLM G-18 How to Do a Research-Based Project** or **BLM G-20 Research Worksheet** helps them get started. **BLM G-4 Analyzing Issues—Science, Technology, Society, and the Environment** may help them structure their point of view.
- As a class, decide on and communicate the criteria on which products will be assessed. You may wish to use the rubric on the next page, or work together to determine the criteria for assessment.

- To assess students' on the various processes and skills used in this inquiry, you may wish to use **BLM A-44 Research Project Rubric,** or **BLM A-45 Collecting Information Rubric**.
- To assess students' products, you may wish to use **BLM A-46 Presentation Rubric** or **BLM A-47 Communication Rubric.**

Additional Support

- This could be structured as a debate or panel discussion of stakeholders with a team of classmates for research and support of one debater per team.
- Students may find that an OCI chart helps structure their research. Opportunities are the potential benefits, Challenges are the potential negative implications or hurdles to be overcome, and Interesting Implications are related to the unintended or indirect impacts.

Rubric

Achievement Chart Category	Level 1	Level 2	Level 3	Level 4
Knowledge and Understanding	Mining e-waste for gold is described with limited accuracy.	Mining e-waste for gold is described with some accuracy.	Mining e-waste for gold is described with considerable accuracy.	Mining e-waste for gold is described with a high degree of accuracy.
Communication	Research is organized with limited effectiveness. Data is organized using an appropriate format and academic documentation with limited effectiveness. Presents a final report using a format for a chosen audience and purpose with limited effectiveness. Communicates using scientific vocabulary with limited effectiveness.	Research is organized with some effectiveness. Data is organized using an appropriate format and academic documentation with some effectiveness. Presents a final report using a format for a chosen audience and purpose with some effectiveness. Communicates using scientific vocabulary with some effectiveness.	Research is organized with considerable effectiveness. Data is organized using an appropriate format and academic documentation with considerable effectiveness. Presents a final report using a format for a chosen audience and purpose with considerable effectiveness. Communicates using scientific vocabulary with considerable effectiveness.	Research is organized with a high degree of effectiveness. Data is organized using an appropriate format and academic documentation with a high degree of effectiveness. Presents a final report using a format for a chosen audience and purpose with a high degree of effectiveness. Communicates using scientific vocabulary with a high degree of effectiveness.
Application	States a position on the issue with limited clarity. Identifies various perspectives and stakeholders with limited effectiveness. Proposes alternate courses of action with limited effectiveness.	States a position on the issue with some clarity. Identifies various perspectives and stakeholders with some effectiveness. Proposes alternate courses of action with some effectiveness.	States a position on the issue with considerable clarity. Identifies various perspectives and stakeholders with considerable effectiveness. Proposes alternate courses of action with considerable effectiveness.	States a position on the issue with a high degree of clarity. Identifies various perspectives and stakeholders with a high degree of effectiveness. Proposes alternate courses of action with a high degree of effectiveness.