GROUND**RULES**

MINERALS AND REAL LIFE

Minerals and Everyday Life

AGES 11-13

INTRODUCTION

As the demand for mined minerals increases, everyone—from students, to miners, to governments and global corporations—must understand how to work together to meet those needs while protecting the world in which we live.

Ground Rules: Mining Right for a Sustainable Future is a documentary film created by Caterpillar and Science North. It follows the development of new and operating mines as geologists, engineers and mine managers tackle complex problems. It draws on the experiences and achievements of modern mine sites to illustrate creative and core concepts of sustainable development and social responsibility.

This set of lesson plans was developed by Science North, commissioned by Caterpillar to accompany the *Ground Rules* film. It provides a tool for educators to further examine the themes and concepts presented in the film through a series of "hands-on" classroom activities. It introduces students to the various phases involved in mining, different types of mines, how ore is processed, how mineral deposits were formed, how modern mines can operate safely and sustainably, and why minerals are important to our everyday lives. This material also introduces students to a wide variety of mining careers.

The lesson plans have been designed to broadly complement the curriculum objectives for the United States, Canada, and Australia. However, the lesson plans are not region-specific and can be used by educators throughout the world. All of the lesson plans have strong linkages to the earth science curriculum, but many of the activities incorporate additional linkages to math, chemistry, data management, mapping, environmental studies, electricity, magnetism and problem-solving. The lesson plans can be easily adapted to meet specific local curriculum goals.

In each lesson plan, an introductory section provides the appropriate film chapter reference and describes the key concepts for the lesson. One or two activities are then described in a step-by-step format. These activities include experiments, demonstrations, games, building activities, and research projects. The lesson plans end with a discussion section that provides possible follow-up topics and questions for classroom discussion. Each lesson plan also includes curriculum linkages, a vocabulary list, a materials list, and approximate timelines for completion of each section. Teacher answer sheets or data sheets are appended, where appropriate.

The lesson plans are organized into five broad themes: Geology; Mining; Mining Processes; Ore Processing; and Minerals and Everyday Life. The lesson plans are further sub-divided into three age categories: 11 to 13 years; 13 to 15 years; and 15 to 18 years. In many cases, the same topics are covered in each age category. However, lesson plans in the older age categories contain additional activities, alternative age-appropriate activities, and/or enhanced complexity.

Theme: Minerals and Everyday Life

This theme shows students how important minerals are in their everyday lives. It also examines some of the properties of minerals that make them useful. Younger students will investigate the minerals present in food, toothpaste and different objects in their home and school. They will identify the resources used to make a pencil, whether these resources are mined or grown, and how many countries it takes to make a pencil. They will explore the properties of copper by building a flashlight with copper wire. Older students will research the minerals and metals that are used to make various components of a computer. They will determine why these mined resources are useful to computers and extrapolate their findings to other electronic devices. They will keep a diary of items and associated minerals they use in a day to determine their daily "mineral consumption". The 15 to 18 year-old students will explore the benefits and impacts of coal. They will research the new technologies of methane capture, liquid gasification and carbon capture/sequestration, which are designed to reduce greenhouse gases generated by coal combustion.

Ground Rules – Online Viewing and Learning Resources

As noted, these lesson plans are designed to be used with *Ground Rules: Mining Right for a Sustainable Future*. Multiple options are available for using the film in your classroom:

- **Order a free copy of the Ground Rules DVD**, containing both the English, Spanish and French versions of the film, from the Caterpillar web site, http://www.cat.com/groundrules.

- **View the full-length version of the film** in English, Spanish, French, as well as English with Chinese subtitles, online at http://www.cat.com/groundrules.

- **View individual chapters of the film** in English, Spanish and French, as referenced by individual lesson plans, on our You Tube channel, http://youtube.com/catgroundrules.

The full set of these lesson plans is available at http://www.cat.com/groundrules, and additional information and activities will be posted there as they become available.

Finally, follow *Ground Rules* online! Share your classroom experiences, feedback and ideas with us. Post photos of your projects and tell us about your successes!

Facebook: http://tinyurl.com/yzhxrva

Twitter: http://twitter.com/catgroundrules

About Caterpillar
For more than 80 years, Caterpillar Inc. has been building the world's infrastructure and, in partnership with its worldwide dealer network, is driving positive and sustainable change on every continent. With 2008 sales and revenues of $51.324 billion, Caterpillar is a technology leader and the world's leading manufacturer of construction and mining equipment, diesel and natural gas engines and industrial gas turbines. More information is available at www.cat.com.

About Science North
Science North, which opened in 1984 and is located in Greater Sudbury, is Northern Ontario's most popular tourist attraction and an educational resource for children and adults across the province of Ontario, Canada. Science North's drawing power lies with its unique approach to learning. The science centre has become world-renowned for its unique brand of hands-on science education and entertainment experiences which involve people in the relationship between science and everyday life.

Science North's attractions include a science centre, IMAX® theatre, butterfly gallery, special exhibitions hall, a digital Planetarium, and Dynamic Earth – a second science centre that offers visitors an up-close look at mining and the geological forces that continually shape the Earth. The same philosophies used to teach visitors about science at Science North are incorporated into every exhibit at Dynamic Earth, which first opened in 2003. This mining and geology centre combines above and underground experiences that allow visitors to work and play with real mining equipment and technologies. The site is also home to Sudbury's famous Big Nickel.

An agency of the provincial government of Ontario, Science North is overseen by the provincial Ministry of Culture. More information is available at http://sciencenorth.ca.

MINERALS AND EVERYDAY LIFE | AGE: 11 TO 13 | LENGTH: 1 HR | CURRICULUM: mineral, nutrition/health, magnetism

MAGNETIC CEREAL

Description

Students will learn that some minerals are essential nutrients for human health. They will identify essential macro-minerals and micro-minerals and confirm the presence of iron in breakfast cereal.

VOCABULARY:

1. Essential minerals
2. Macro-minerals
3. Micro-minerals
4. Magnetism
5. Friction
6. Crushing process
7. Iron

MATERIALS:

- *Ground Rules* film
- Flaked cereal that is fortified with iron (Total works well)
- Nutrition labels and ingredient lists from a variety of breakfast cereals
- A strong magnet
- Small zip-lock bags
- Plates or shallow bowls
- Water
- Clear plastic cups
- Plastic straws or stir sticks
- Hand lenses or magnifying glasses

Introduction (Length: 15 minutes)

Watch Chapter 3 “Mining and the Modern World” of the *Ground Rules* film. Discuss the importance of minerals in our daily lives. Minerals have specific properties that make them useful to humans. All minerals come from the Earth’s crust and must be mined.

Ask the class whether they have ever eaten a mineral? What minerals can we eat? Why do we eat minerals?

Have the students bring in nutrition labels and ingredient lists from several different brands of cereal. Identify the minerals.

Minerals only represent about 0.3% of our total intake of nutrients, but they are very important. Without these mineral nutrients, we wouldn’t be able to utilize the other 99.7% of the food we consume.

Macrominerals are minerals that we require in substantial amounts for proper nutrition. These include calcium, chloride, magnesium, phosphorus, potassium, sodium, sulfur and zinc. Microminerals are minerals that we require only in trace amounts. These include chromium, cobalt, copper, fluorine, iodine, iron, manganese, molybdenum, selenium, silicon and zinc. These minerals can be found in various foods and in supplements.






Activity (Length: 30 minutes)

The objective of this activity is to determine whether there is actually iron in breakfast cereal.

Activity:

1. Use a magnifying glass to examine a single flake of cereal closely. Can you see any visible traces of iron? No.
2. Place a few flakes of cereal on the table. Bring your magnet near the flakes and see if they are attracted or repelled by the magnet. You likely will not get a reaction.
3. Fill a plate or shallow bowl with water and float a few flakes of cereal on the surface. Hold the magnet close to the flakes and watch closely for any movement. Any movement that occurs will be slight, so they will need to be patient. With practice, you should be able to make the flakes rotate or move them around the bowl in a pattern.
4. Fill a zip-lock bag half full with cereal. Seal the bag and crush the cereal into a fine powder.
5. Pour enough water into the bag to make a thin cereal paste. It should be about the consistency of thick soup.
6. Pour your cereal mixture into a clear plastic cup.
7. Hold the magnet against the outside of the cup in one location. Stir the mixture gently with a straw or stir-stick (nothing magnetic). After two or three minutes, you should see an accumulation of iron particles on the side of the cup near your magnet. Use a magnifying glass to see the particles better.

Discussion (Length: 15 minutes)

Why did we use a magnet to test for the presence of iron? Were you able to see the iron in the cereal flake? Why not?

Why was it easier to move the flakes around when they were floating on the water than when they were on the table? Friction between the flakes and the table surface was too great to be overcome by the attraction of the iron to the magnet. By floating the flakes on the surface of water, friction was reduced.

What step in the mining process was simulated by crushing the cereal into a powder? This process simulates the crushing process used in mining to extract minerals (such as iron) from the surrounding waste rock.

What is the function of iron in the human body? Iron carries oxygen to the cells and is necessary for the production of energy, the synthesis of collagen, and the functioning of the immune system. Iron is found in meat, fish, beans, spinach, molasses, brewer's yeast, broccoli and seeds. It can also be added to various foods, such as cereal.

Visit cat.com/groundrules for more information, to provide feedback, to view the *Ground Rules* film on-line, or to order a copy of *Ground Rules* on DVD.

MINERALS AND EVERYDAY LIFE | AGE: 11 TO 13 | LENGTH:1 HR | CURRICULUM: electricity, mineral properties, art

MAKING A FLASHLIGHT

Description

Students will identify some of the properties of copper, two of its common alloys, and several of its main uses. They will explore the electrical and malleable properties of copper by building a flashlight using copper wire and by creating an art sculpture.

VOCABULARY:

1. Copper
2. Electricity
3. Circuit
4. Tarnish
5. Bronze
6. Brass
7. Conductor
8. Malleable

MATERIALS:

- *Ground Rules* film
- D cell batteries
- Copper wire
- Small light bulbs
- Examples of objects made of copper (optional)
- Cards with names of common objects written on them

Introduction (Length: 15 minutes)

Watch Chapter 2 "Modern Mining" and Chapter 3 "Mining and the Modern World" of *Ground Rules* film. Chapter 2 explores the process of copper mining at a modern mine in Chile. Chapter 3 shows how minerals, including copper, are used to make a variety of products we use in our everyday lives.

After watching the film, make a list of everyday items that use copper. Discuss some of the major uses of copper and some of its important properties. Pass around some objects that are made of copper (optional).

Copper conducts heat and electricity better than any other metal, except silver. Copper is used in wires to conduct electricity. Copper is also used in cookware to conduct and retain heat. It is also used in a variety of electronics products.

Copper is also malleable and does not corrode easily. This makes it an ideal element for making pipes for plumbing, parts for automobiles and airplanes, tools, and pieces of art.

When copper tarnishes, it turns green on the surface. Ask if anyone has seen green roofs on old buildings. When you see a green roof, you know it is made of copper. Some of the biggest deposits of copper in the United States were found by accident when prospectors noticed greenish rock sticking out of the ground.

Two common alloys of copper are bronze (a mixture of tin and copper) and brass (a mixture of zinc and copper). Brass and bronze are stronger than pure copper and do not corrode in air or water except for a small amount of tarnishing.

Copper can be recycled and reused. Approximately one-third of the copper used today is recycled. The rest comes from recently mined copper ore.






Copper is mined in many countries around the world. The biggest producer of copper is Chile, followed closely by the United States. Canada, Russia, Indonesia, Australia, Peru, China and Zambia are also large copper producers. In the United States, most of the copper mining is conducted in Arizona, Utah, New Mexico, Nevada and Montana. In Canada, copper is mined in British Columbia, Ontario, New Brunswick and the Northwest Territories.

Activity I (Length: 15 minutes)

The objective of this activity is to build a flashlight using copper wire.

1. Give every student a D cell battery, two small pieces of copper wire and a small light bulb.
2. Connect one piece of the wire to the light bulb at one end and the positive end of the battery at the other.
3. Connect the second wire to the light bulb and touch it to the negative end of the battery. What happens?

Activity II (Length: 15 minutes)

The objective of this activity is to discover the malleable property of copper.

1. Divide the class into groups of 3 or 4.
2. Give each group some copper wire and a card with the name of an object written on it.
3. Ask each group to use their copper wire to build the object that is written on their card.

Discussion (Length: 15 minutes)

Activity I:
What happens when the wires are connected to the battery? Discuss the flow of electricity through the wire and what happens when one wire is disconnected. Introduce the terms “circuit” and “electrical conductor”. Copper is an electrical conductor because it lets electricity travel through it.

Activity II:
Have each group try to guess what objects the sculptures represent. What property of copper makes it ideal for creating sculptures?

Visit cat.com/groundrules for more information, to provide feedback, to view the *Ground Rules* film on-line, or to order a copy of *Ground Rules* on DVD.

MINERALS AND EVERYDAY LIFE | AGE: 11 TO 13 | LENGTH:1.5 HR | CURRICULUM: minerals, composition of objects

MINERAL CONTENT MATCHING GAME

Description

Students will explore items within their classroom, school or schoolyard and determine which minerals were used to make them.

VOCABULARY:

1. Minerals
2. Properties

MATERIALS:

- *Ground Rules* film
- Sets of "mineral content" cards
- Masking tape
- Timer
- Resource books or information sheets (optional)

Introduction (Length: 10 minutes)

Watch Chapter 3 "Mining and the Modern World" of the *Ground Rules* film. Discuss the importance of minerals in our daily lives. Minerals have specific properties that make them useful to humans. All minerals come from the Earth's crust and must be mined.

Explain that a variety of minerals have been used to make common items in their classroom, school and schoolyard. Select an example of a classroom object that will not be used in the activity. Ask the students what minerals are used to make that object. Why were those minerals selected? What properties of those minerals made them useful for the purpose of creating that item?

Activity (Length: 50 minutes)

The objective of this activity is to determine the mineral content of common items around the classroom, school or schoolyard.

Preparation:

1. Create 10 stations inside the classroom, school and/or schoolyard that highlight different items, such as foundation/sidewalk, bricks, nails, wall board, paint, windows, door knobs, floor tiles, plumbing, wiring, toilets/sinks, desks, chairs, playground equipment, television, computers, pencils, blackboards, etc.
2. Prepare sets of 10 "mineral content" cards that list the key minerals used in each item (1 set per group). Each set should be a different color.
3. Optional: put out some resource books or information sheets at the front of the class.

Activity:

1. Divide the class into groups of 3 or 4 students.
2. Give each group a set of colored mineral content cards and a roll of masking tape.






3. Set the timer for 30 minutes.
4. Each group must visit each station and attach the correct mineral content card to the station with masking tape (face down, so the other groups can't see the answer).
5. Each group must successfully match their mineral content cards with the correct stations. They can revisit stations and change their cards as often as they want within the allotted time. Optional: they can consult the resource materials at the front of the class for assistance.
6. Have all groups return to their desks when the timer goes off.

Discussion (Length: 30 minutes)

Which group correctly matched the most mineral content cards? Which items were the most difficult to determine? Which were the easiest? Can you find one object in the classroom that does not include items that are mined? Discuss the importance of mines to our everyday lives.

Pick one or two of the items evaluated in this exercise and discuss the properties of the minerals used to make those items. Why were those minerals chosen to make the item? For example, why is copper used in electrical wires?

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Mineral content of some common items at school:

Windows: sand, silica and feldspar
Nails and screws: iron and steel
Bricks: clay
Wallboard: gypsum
Doorknobs, locks and hinges: steel, brass, copper, zinc, and iron
Blackboards: slate particles
Paint: zinc
Galvanized Gutters/Eavestroughs: iron and zinc
Concrete foundation: clay, shale, gypsum, and limestone
Insulation: vermiculite, silica and feldspar
Toilets: porcelain, clay, and feldspar
Sewer pipes: clay and iron
Plumbing: copper and zinc or stainless steel (made of: iron, nickel and chromite)
Playground equipment: steel (made of: iron, nickel and chromite)
Wiring: copper or aluminum
Pencil: graphite, aluminum or brass for the metal ring that holds the eraser

MINERALS AND EVERYDAY LIFE | AGE: 11 TO 13 | LENGTH:1.5 HR | CURRICULUM: minerals, experiment, health

TOOTHPASTE EXPERIMENT

Description

Students will learn that a variety of minerals are used to make toothpaste. They will discover how the mineral fluorite in toothpaste helps protect against tooth decay.

VOCABULARY:

1. Acid
2. Plaque bacteria
3. Tooth decay
4. Fluorspar (fluoride)
5. Mica
6. Sodium carbonate
7. Zinc

MATERIALS:

- *Ground Rules* film
- Toothpaste containing sodium fluoride
- Glass measuring cups
- Fresh eggs
- Vinegar
- Spoons
- Plastic wrap
- Marker
- Clear nail polish
- Reusable cloth
- Several tubes of different brands of toothpaste

Introduction (Length: 30 minutes)

Ask the class if they can name a mineral used in toothpaste. Pass around a few tubes of different brands of toothpaste and ask the class to look at the ingredient list. Ask the class to pick out some of the mineral ingredients. Make a list on the blackboard and see which ingredients are most common among the different brands.

Watch Chapter 3 “Mining and the Modern World” of the *Ground Rules* film. Pause the film at the scene where the mother is brushing her teeth. Note that toothpaste is composed of several minerals including calcium carbonate, limestone, sodium carbonate, fluorite, mica and zinc.

Discuss how there are many minerals found in toothpaste and that every brand of toothpaste contains a slightly different mixture of minerals. However, all toothpastes contain abrasive minerals to rub the plaque away. The most common abrasive minerals used in toothpaste include silica, limestone and calcium carbonate. Most toothpaste brands also contain the mineral fluorite, which is composed of calcium fluoride. This mineral makes the tooth more resistant to decay.

Sodium carbonate is used in some toothpastes whiten teeth.

Zinc is sometimes used in toothpastes as an anti-bacterial agent to prevent gingivitis (gum disease).

Toothpastes may also contain other minerals and ingredients to make the toothpaste sparkly (mica), to make it white (titanium), to make it thick (sand), to whiten teeth (sodium carbonate) and to fight bacteria (zinc).






Discuss some of the common minerals found in toothpaste, what types of rocks they are found in, and where they are mined. Here is some information on four common mineral ingredients:

1) Fluorite (also called fluorspar)
   Fluorspar or fluorite are two names given to minerals composed of calcium fluoride (CaF_2). Fluoride makes the entire tooth structure more resistant to decay and promotes remineralization, which aids in repairing early decay before the damage can even be seen. Fluorspar/fluorite is found in a variety of geologic environments. It occurs in granite (igneous rock) and in large deposits in limestone (sedimentary rock). It can also be found in the cracks and holes in sandstone. Fluorspar is not mined in the United States. More than 15 countries produce fluorspar. China, Mexico, and South Africa are the largest producers. There is a fluorspar mine in Newfoundland, Canada. China supplies about two-thirds of the fluorspar used in the United States.

2) Mica
   Mica is the mineral added to toothpaste that makes the substance sparkle. Large flakes and sheets of mica minerals are found in some metamorphic and igneous rocks. The commercially important micas are muscovite and phlogopite. India and Russia are the world's largest producers of sheet mica. A very small amount of mica is produced in the United States. The largest sheet of mica ever mined in the world came from a mine in Quebec, Canada. Sheet, scrap and flake mica are commercially important. Other primary uses for scrap and flake mica are in joint compound, paint, roofing, well drilling additives, and rubber products.

3) Sand (silica)
   Sand is added to toothpaste to make the paste thicker. Most sand and gravel is composed of the mineral quartz, with varying amounts of feldspar, rock fragments, and other mineral materials. The commercial use of sand and gravel falls into two categories: construction sand and gravel, and industrial sand and gravel. Industrial sand and gravel, which is often termed "silica," "silica sand," or "quartz sand," includes sand and gravel with high quartz content. Such sand and gravel is used, for example, in glassmaking. Construction sand and gravel typically has a lower silicon dioxide content than does industrial sand and gravel. It is mixed with other materials, such as cement in concrete foundations, roads, and buildings, or is used as is in road bases. Construction sand and gravel is mined in all U.S. states and industrial sand and gravel is mined in 37 U.S. states. Canada is one of the leading nations processing and producing industrial sand and gravel. The Unites States imports a substantial amount of sand from Canada.

4) Sodium Carbonate
   Sodium carbonate is commonly known as washing soda. It is used as a whitening agent in toothpaste, usually in combination with hydrogen peroxide. Sodium carbonate is soluble in water, but can occur naturally in arid regions, especially in the mineral deposits formed when seasonal lakes evaporate. Sodium carbonate is mined in several areas of the United States and Canada. The most important use for sodium carbonate is in the manufacture of glass. When heated to very high temperatures, combined with sand (silicon dioxide) and calcium carbonate, and cooled very rapidly, glass is produced.

Activity (Length: 45 minutes, over 7 days)

The objective of this activity is to demonstrate the ability of the mineral fluorite in toothpaste to protect teeth from decay. This experiment will be conducted in stages over 7 days. Eggs should be room temperature to begin this experiment.

Preparation (5 minutes):

1. Divide the class into groups of 2 or 3.
2. Explain that in this activity, the eggshell will represent a tooth. Eggshells are composed largely of calcium carbonate. Calcium is also a major component in the enamel of our teeth. Therefore, eggshells are a good surrogate to use in this experiment. Both eggshells and teeth can be weakened by acids.
3. Explain that they will be using vinegar in this activity. Vinegar is an acid that is similar to the acids made by plaque bacteria in our mouths. Acids can cause tooth decay and cavities.
4. Ask the students to hypothesize what they think will happen if the egg is immersed in vinegar.
5. Ask the students to hypothesize what they think will happen if the egg is treated with toothpaste and then immersed in vinegar.

Day 1 (15 minutes):

1. Give each group an egg, a measuring cup and a tube of toothpaste.
2. With clean hands, each group should wash their egg with water and dry with a cloth.
3. Groups should empty the entire contents of the toothpaste into the measuring cup and pat down with a spoon to level the toothpaste and remove any air bubbles.
4. Each group should mark one side of the egg with a felt-tipped marker and cover this mark with clear nail polish to protect it from the vinegar.
5. After the nail polish has dried, each group can place their egg into the measuring cup, mark side down. Push the egg gently into the toothpaste, so it covers approximately half of the egg. Make sure egg does not touch the bottom of the cup.
6. Cover the cup tightly with plastic wrap and leave in a safe place at room temperature for at least 4 days.

Day 5 (5 minutes):

1. On day 5, groups should rinse all the toothpaste off the egg with warm water and let the egg dry overnight.
2. Each group should also thoroughly clean their measuring cup.

Day 6 (10 minutes):

1. Each group should pour enough vinegar into a clean measuring cup to cover the egg.
2. They should then put the egg on a spoon and carefully lower the egg into the measuring cup, ensuring that it is fully immersed in vinegar. If not, additional vinegar can be added slowly to the measuring cup.
3. The spoon should be rested on top of the egg to keep it under the vinegar.
4. Cover the cup tightly with plastic wrap and record the time. The egg must be left in the vinegar for at least 7 hours and no more than 12 hours. If you are not going to be in the classroom after 7 hours, take the egg out of the vinegar and wash it in warm water before you leave. Write down how many hours it was in the vinegar. As soon as the students come in the next day, they should put the egg back into the vinegar and continue recording the time.

Day 7 (10 minutes):

1. After 7 hours in the vinegar, groups should remove the egg and gently tap the shell with their finger on the unmarked side. If it is still hard, they should return it to the vinegar and recheck it every hour until the shell begins to soften.
2. When the unmarked side is soft, remove the egg and gently wash it with warm tap water.
3. Check the hardness of the marked side of the eggshell. How does it compare to the unmarked side?

Discussion (Length: 15 minutes)

Discuss the purpose of fluoride in toothpaste. Were the students' hypotheses correct?

Compare the fluoride content of several different brands of toothpaste. Which brand of toothpaste do you think would be most protective of tooth decay? Why?

What are the disadvantages of including more fluoride in toothpaste? Discuss the condition called fluorosis in which excess fluoride ingestion can lead to discoloration of the teeth. This is why toothpaste should never be swallowed and why levels of fluoride in tap water are typically low.

Visit cat.com/groundrules for more information, to provide feedback, to view the *Ground Rules* film on-line, or to order a copy of *Ground Rules* on DVD.

MINERALS AND EVERYDAY LIFE | AGE: 11 TO 13 | LENGTH: 1.5HR | CURRICULUM: earth science, geography, mapping

WHICH MATERIALS IN A PENCIL ARE MINED/GROWN?

Description

Students will determine which raw materials used to make a pencil are mined and which are grown.

VOCABULARY:

1. Graphite
2. Latex
3. Soybean oil
4. Pumice
5. Sulfur
6. Calcium
7. Barium
8. Aluminum
9. Brass (copper, zinc)

MATERIALS:

- *Ground Rules* film
- Traditional wooden pencils with eraser ends
- Access to resource books or internet
- Map of the world, with labeled countries
- Map of home country, with labeled states, provinces or territories
- Multi-colored push-pins and bulletin board

Introduction (Length: 10 minutes)

Watch Chapter 3 "Mining and the Modern World" of the *Ground Rules* film. Discuss the importance of minerals in our daily lives. Minerals have specific properties that make them useful to humans. All minerals come from the Earth's crust and must be mined.

Explain that a variety of minerals have been used to make common items in their classroom, school and schoolyard. Select a common class room object. Ask the students what minerals are used to make that object. Why were those minerals selected? What properties of those minerals made them useful for the purpose of creating that item?

Ask the class if they know how many minerals are used to make a pencil? Explain that they will be participating in an activity to discover the natural resources used to make a pencil.

Activity I (Length: 40 minutes)

The objectives of this activity are to determine which raw materials are used to make pencils, whether they are mined or grown, and where the raw materials come from.

Preparation:

1. Make a list on the board, in random order, of all of the mined or grown resources that are used to make a pencil. These include: graphite, cedar wood, clays, soybean oil, latex, pumice, sulfur, calcium, barium, aluminum or brass (copper and zinc), hematite and limonite.
2. Assign a push-pin color to each resource.
3. Attach the maps to the bulletin board.






Activity:

1. Ask the class to identify the major parts of a pencil and make a list on the board beside the resource list. These include: the part that writes, the wood, the eraser, the metal band that holds the eraser, paint and glue.
2. One at a time, ask a student to come up to the board and draw a line to match a resource with the part of the pencil it is used to make. Continue until all of the resources have been used.
3. As a class identify which of these resources are mined and which are grown.
4. Divide the class into groups. Each group will research one of the resources used to make a pencil. Provide each group with some resource books, information sheets or access to the internet. Ask them to identify a country (either their home country, if applicable, or another country close to their home country) where the resource is mined or grown. If the resource if mined or grown in their home country, ask them to further identify which states, provinces or territories of the country mine or grow the resource.
5. Have each group come up to the bulletin board and place their colored push-pins on the states, provinces or territories within their home country and/or neighbouring countries where the resource is mined or grown.

Activity II (Length: 20 minutes)

1. Using the internet or resource books, each group should research one of the mined resources used to make a pencil in more detail (each group should do a different resource).
2. Determine how the resource is mined in their home country.
3. Identify other uses of this resource.

Discussion (Length: 20 minutes)

Activity I:
Ask the students what they learned in this activity. Review the results plotted on the maps. How many countries does it take to make a pencil? Does any country have all of the natural resources necessary to make a pencil? Ask them to extrapolate what they have learned about pencils, a relatively simple object, to more complex objects like televisions or computers.

Activity II:
Have the groups come to the front of the class and share what they have learned about each of the mined resources used to make a pencil.

Visit cat.com/groundrules for more information, to provide feedback, to view the *Ground Rules* film on-line, or to order a copy of *Ground Rules* on DVD.

Answers (note that this list is not exhaustive)

Cedar wood (or basswood): used to make the wood part of the pencil; cedarwood from California and Oregon (US), Australia; basswood from China
Graphite: for the writing core; from Montana, Mexico, Australia, Ceylon
Clay: used to reinforce the writing core; from Kentucky and Georgia (US), Australia
Soybean oil: used to make eraser; from Brazil, Argentina, China, India
Latex: from trees; used to make eraser; from Latin America, Thailand, Malaysia, Indonesia, India
Pumice: used to reinforce eraser; from California or New Mexico (US), New Zealand
Sulfur, calcium, barium: used to make eraser; throughout United States, Canada, Mexico, Australia
Aluminum or brass (copper and zinc): used to make metal band; mined in 13 US states, 9 Canadian provinces, Australia; copper mined in Chile, United States, Canada and Australia; zinc mined in Mexico, Canada, United States and Australia
Hematite and limonite: natural pigments used to make orange paint (also a variety of synthetic chemicals used in paint and lacquer)

Note that glue is also used to hold the pencil parts together. A variety of natural and synthetic compounds can be used to make glue.