

MOLYBDENUM

HELPING TO BUILD
A STRONGER FUTURE



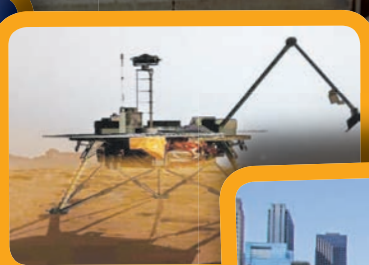
Molybdenum

Used in the
production of:

Wind turbines



Robotic arm motors



Flat panel TV's



Metal bridge



 **FREEPORT-McMoRAN**
COPPER & GOLD FOUNDATION

 **Climax Molybdenum**
A Freeport-McMoRan Company

DENVER POST
EDUCATIONAL SERVICES 



MOLYBDENUM

(MO-LYB-DE-NUM)

Ever heard of it?

Did you know that molybdenum (often called moly) is one of the world's most important natural resources?

Do you know anything about molybdenum? List what you know. It's ok to guess.



What is molybdenum?

Molybdenum is a metallic, gray element.

The most important ore source of molybdenum is the mineral molybdenite.

A few things moly can naturally be found in are:

- Rocks and soil
- Plants
- Water
- And even the human kidneys and liver



If it can't grow, it has to be mined.



Minerals are a very important natural resource.

Without them we couldn't live the lifestyle we have today. Minerals are obtained through **mining**. Look around you. Look at the walls, ceilings, lights, furniture, appliances and all the other things around you.

When you go outside, look at the buildings, cars, power lines, streets, sidewalks and windows. All these things are made from minerals.

Did you know that **if something can't be grown, it has to be mined?**

Uses for molybdenum

- Incandescent light bulbs
- Flat panel televisions
- Solar electric systems
- Helps remove sulfur from diesel and gas
- Wind turbines
- Personal computers
- Paint pigments
- Motor oil and antifreeze
- Machine parts
- Rifle barrels
- High Strength Steel
- Buildings and bridges
- Auto parts
- Dry lubricants on space vehicles
- Water distribution systems
- Hospital and laboratory equipment
- Furnace parts
- Orange reflective pigments found in safety cones and hunting vests

Timeline of History of Mining in Colorado

Spaniard, Juan Rivera, traveled northward into what was to become Colorado in 1765, looking for gold and silver in the Rocky Mountains. He took ore samples to Santa Fe but they did not impress the authorities that were looking for a "City of Gold." In 1848-49, the excitement of the California gold rush struck the nation. Prospectors on their way to California stopped to see what might be found along the streams of the central Rockies. It was July 1858 when the Russell brothers and ten others found "good diggings" at the mouth of Dry Creek. That was the beginning. Mining has evolved from pans, pick axes and the all-important pack mule into one of the most important, high tech industries in Colorado and the world. Follow the timeline of Colorado's mining history at the bottom of these pages.

Minerals...and You

You wake up in the morning and switch on the light. You wash your face, brush your teeth and get dressed. You turn on the radio and eat breakfast – a bowl of cereal, a glass of juice and perhaps some toast. You look out the window and then head for the door ready to start the day. Almost everything you've done so far, and everything you will do for the rest of the day would be impossible without minerals. Minerals are found in:

- **Water pipes and electric wiring**
- **Sheets, towels and clothing**
- **Soap and toothpaste**
- **Windows, cereal bowls, pots and pans, juice glasses, coffee cups**
- **Water faucets, spoons, and doorknobs**
- **And much, much, more**



Foods especially rich in molybdenum

- **Beans**
- **Dark green leafy vegetables**
- **Peas**
- **Cereals**
- **Rice**
- **Yeast**
- **Whole grains**
- **Liver**
- **Kidney**
- **Low-fat milk**
- **Hard tap water (hard means the water contains a lot of minerals)**

The human body needs molybdenum

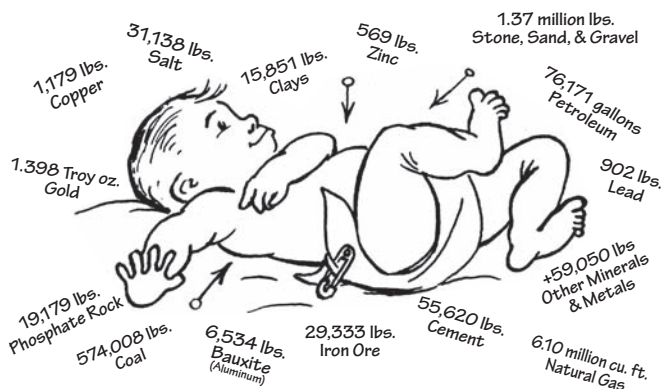
Moly is necessary for good health. Molybdenum is found in all tissues of the human body, but mostly in the liver, kidneys, skin and bones.

It is required for the proper function of several chemicals in the body. Some of these chemicals have the very important job of allowing the body to process the iron and nitrogen in our diets. It is included in our daily vitamins. Molybdenum is believed to be important in helping our cells grow. Also, small amounts of dietary molybdenum have been credited with promoting healthy teeth. Some evidence shows that molybdenum might reduce the risk of some types of asthma attacks.

Like many of the other minerals, molybdenum is necessary for the body's ability to carry out the metabolization of fats, carbohydrates, copper and nitrogen. Molybdenum is needed to produce many different enzymes.

Cells need molybdenum in order to function properly. In addition, this mineral helps the body fight off cancer development. Molybdenum helps keep a person alert. It plays a crucial role in the body's ability to keep blood

Every American Born Will Need...



3.3 million pounds of minerals, metals, and fuels in their lifetime

Learn more at www.mii.org

sugar levels in balance. And finally, it is believed that this mineral helps in the fight against dental cavities and tooth decay.



Newspaper ACTIVITY

Look at the list on Page 2 of how molybdenum is used.

How do you think moly is used in the production of newspapers?

1858
Colorado gold is discovered at Dry Creek in the Denver area

1859 Gold is found along Chicago Creek (Idaho Springs). Mining camps established at Black Hawk, Central City, Nevadaville, Boulder, Colorado City, Gold Hill, Hamilton, Tarryall, and Pueblo

1860 Placer Gold found at Leadville.

1862 First oil well drilled near Florence

1864 First coal mined in Jefferson and Boulder Counties

WHERE DOES MOLYBDENUM COME FROM?



Molybdenum, often called moly, is an element. Molybdenum and sulfur combine to make the mineral **Molybdenite**. Molybdenite is found in igneous rock, which is formed deep under the crust of the Earth where hot magma is found. As magma rises to the Earth's surface, it cools into rock and these rocks contain Molybdenum. Molybdenite is one of those minerals. It has a metallic gray color, a greasy feel, and is very soft on the **Mohs Hardness Scale**. In fact, its color and softness led early scientists to mistakenly believe it was a lead mineral.

In 1778, a Swedish apothecary (pharmacist), Carl Wilhelm **Scheele** (pictured left), was studying what he thought was lead in the mineral molybdenite. Molybdenite was named after the Greek word **molybdos**, which means **lead**. Scheele's studies led

him to the conclusion that this mineral did not contain lead, but some other **element**.

He named this new element molybdenum after the mineral molybdenite.



Scheele did not realize it at the time, but molybdenum would become part of an important **alloy**. That means that it partners or mixes well with iron and steel to make them stronger and more highly resistant to heat.

Molybdenum has a very high melting temperature at 4,730 F. This is 2,000 degrees higher than the melting point of steel.

It is 1,000 degrees higher than the melting temperature of most rocks. Because of its strength and heat resistance, it is often used to make the filaments for light bulbs and airplane parts.

Every person in the United States uses about 24.78 pounds of molybdenum per year.



Henderson Mine in Empire, Colorado

Molybdenum is used in stainless steels because of its strength and resistance to corrosion (rust).

Molybdenum is a needed element in plants and animals. In plants, for example, the presence of moly allows the plant to absorb nitrogen.

Soil that has no molybdenum at all cannot support plant life.

Colorado, New Mexico and Idaho are the largest producers of moly in the United States. The largest known deposit of moly in the world can be found in Climax, CO. The largest producing mine in the world is in Empire, CO. Molybdenum can also be found in large quantities in Canada, China, Chile, Mexico, Peru, Russia and Mongolia.

So how do we get all the molybdenum we need out of the rock?



1871

Colorado School of Mines established at Golden

1878

Rich silver strikes on Iron, Carbonate, and Fryer Hills in Leadville District.

1879

Molybdenum found at Climax north of Leadville



MINING

Exploration

Before any mining can happen, a mineral deposit must be located through the process of **exploration**. Once a deposit is found, **drilling**, testing and engineering are done to see if a mine should be developed. But a mineral deposit does not automatically make a mine. Some deposits are too deep, too complex or the quality of the ore is not high enough to be mined. Rock is considered to be ore when enough minerals are present to make mining worthwhile.

Mining companies have to consider many factors including: environmental impact, safety, political issues, geology, transportation, as well as mining and processing methods to name a few. This process usually takes many years. In fact it can take up to 30 years before a mine is opened.

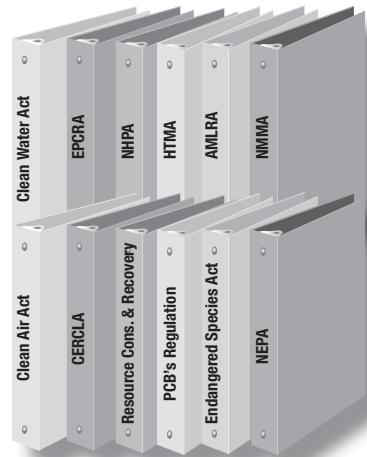
The Mining Process

Molybdenum is obtained from the ore or host rock at the mines by a series of crushing, grinding and flotation operations, which produce a concentrate of molybdenite.

Blasting and Crushing

Host rock must be blasted with explosives to break it into smaller pieces. Most of the host rock has a small percentage of molybdenum in each ton - kind of like a chocolate chip cookie with only one or two chocolate chips. It takes one ton of host rock to produce approximately 2 to 4 pounds of moly.

After the rock is **blasted** into smaller pieces, it is loaded onto muckers or huge haul trucks and taken to the **crusher** where it is broken into even smaller pieces. Now it is loaded onto a **conveyor** belt. The conveyor belt is kind of like the place where you put your groceries at the check out counter at the grocery store. It moves your items to the cashier. The conveyor belt at the Henderson Mine moves the ore 15 miles through the mountain to the mill where it is transferred to huge machines called **grinding mills**.



Moly Quiz

1. Molybdenum is a metal. (True or False)
2. Name a molybdenum-bearing mineral.
3. Molybdenum comes from igneous rock. (True or False)
4. Human cells need molybdenum to function properly. (True or False)
5. Who is the man who discovered the element molybdenum?
6. What state is the largest producer of molybdenum in the world?
7. What is an element?
8. What is reclamation?
9. It is safe to explore old, abandoned mines. (True or False)
10. The exploration process can take up to 30 years. (True or False)
11. How many natural elements are there?
12. Molybdenum has a melting temperature higher than the melting point of steel. (True or False)
13. Molybdenum is used as a dry lubricant on space vehicles. (True or False)
14. Molybdenum helps stainless steel resist corrosion. (True or False)
15. Every person in the United States uses about 24.78 pounds of molybdenum per year. (True or False)

Answers on pg. 16

Core Drilling Activity

MATERIALS NEEDED:

- Clear drinking straws
- Paper towels
- 9 x 13 in. rectangular cake pan
- White cake mix
- Chocolate cake mix

- 1 tube or container of colored frosting (red or green – any color)
- 1 gallon-size zip-lock bag
- Paper
- Marker
- Ruler

PROCESS:

The night before doing this activity the teacher or a parent should prepare the cake mixes in separate bowls according to package directions. Pour $\frac{1}{2}$ of the white cake mix into the prepared pan. With a spoon, using about $\frac{1}{2}$ cup of the chocolate cake batter, drizzle the chocolate randomly over the white batter in the pan. Be sure some areas have lots more chocolate drizzle than others. Pour the remaining white cake batter into the pan. Smooth out with a spatula and bake as directed on the package. Don't worry if some of the chocolate batter smears on the top. Let cake cool.

Do not frost the cake!

(Suggestion: use the remaining chocolate batter to make cupcakes for your family or class.)

Take the cake to class the next day.

The cake represents land that geologists will explore for mineral deposits by drilling core samples. The white cake represents rock without good mineral deposits. The chocolate represents rich veins or deposits of minerals.

Geologists prepare a grid to record their findings. You are going to create a grid on top of the cake using the colored frosting.

Put the colored frosting into the zip-lock bag. Clip a small piece of the corner off the bag.

Twist the top so it is like a chef's decorator bag. Squeeze the frosting onto the top of the cake in a grid pattern. Each student should copy the pattern on the cake onto a piece of paper. Label the grid North, South, East, West and number each box on the grid.

Give each student a straw. Demonstrate "drilling" technique by inserting your straw into one of the squares on the cake. Put the straw into the square and turn it as you push it into the cake. Then pull it out of the cake. Show the students the "core sample" you pulled from the "Earth". What colors of cake are in the straw? Did you find a significant sample of ore (chocolate)? Label the "core sample" with a marker or tape (i.e., N-5-+ or E-2-T), and record your finding in the corresponding square on your paper grid and place the core samples. Use + for large amount of ore deposit. Use 0 for no ore deposit. Use T for trace deposit. "Drill" one at a time, recording your findings on your paper grid and placing your "core sample" next to the others.

Shade in the areas on the grid that appear to have the richest veins or deposits of ore. Is it worth the cost for the mining company to begin a mining operation in this area?

AT THE MILL

Grinding

Mills look like giant rock tumblers that grind the ore smaller and smaller until it is the size of sand. In the mills, the sand is mixed with water to form a muddy substance called **slurry**.

Flotation & Concentration

Next, chemicals are added to the slurry. These are called **collectors** and **frothers**. The collectors attach to the surface of the molybdenite causing it to become **hydrophobic** or "water hating." The slurry is poured into giant mixing tanks called flotation cells. Air is introduced to the mixing process to create air bubbles. The hydrophobic moly sticks to the air bubbles and floats to the surface of the tank where they are skimmed off. The frother that was added earlier makes sure that the bubbles are stable and don't burst before the moly can be skimmed off. This separation process is called **flotation**.

The final concentrate, still in the form of a slurry, is processed through many filters where the water is removed. A vacuum pulls the water away and a "cake" of molybdenite is left behind. These cakes go through a heat drying process to make sure any remaining water is removed. A dry, concentrated gray-black powder remains. The powder is packaged into giant bags that weigh about 3,750 pounds when they are full. The bags are shipped to a "roasting" plant for further processing.

The waste or tailings from the milling process is still in the form of slurry.

It flows down into an area where the particles settle out of the water and create a tailings dam. The water is returned to the mill and is recycled over and over again.

Roasting

The roasters are huge – tall as a six-story building and 21 feet in diameter. They run twenty-four hours a day at a temperature of approximately 1200 degrees Fahrenheit. At the roasting plant, about 120,000 pounds of molybdenum concentrate are processed daily.



Even though the moly can be 98% pure when it leaves the mill, it needs to be purified even more so it can be used in hundreds of products. The heat of the roasting process removes all remaining impurities.



FACTOIDS

■ An **open pit mine** is "an excavation or cut made at the surface of the ground for the purpose of extracting ore and which is open to the surface for the duration of the mine's life." (mine-engineer.com)

The Climax Mine near Leadville, Colorado, is an open pit mine. That means that the rock is removed in layers called benches. When blasting clears each layer, electric powered shovels pick up broken ore and load it into a haul truck. The shovels can load over 100 tons with each scoop. Haul trucks are huge – over two stories high! They can carry up to 150 tons of ore (an "average" pickup truck holds 1/2 ton). The haul trucks take the ore to the crusher where it is reduced to rocks that average eight inches in diameter - about the size of a soccer ball.

■ **Underground mining** is done when an ore body lies a considerable distance below the surface. The amount of waste that has to be removed in order to uncover the ore through surface mining becomes prohibitive, and underground techniques must be considered. (Encyclopedia Britannica Online)

The Henderson Mine in Colorado is an underground molybdenum mine. At this location there is a huge deposit of moly that is best reached through underground mining. Men and women take an "elevator" down a shaft into the earth to work in the mine. Tunnels have been blasted. The blasting breaks up the ore which is then scooped up by **muckers**, then dumped into huge haul trucks that transport it to a massive underground crusher.

Flotation Activity

MATERIALS NEEDED:

- Dry roasted peanuts
- Raisins

INSTRUCTIONS:

Mix 1/2-cup dry roasted peanuts with 1/2-cup raisins. Add 1/2 of the mixture to each drinking glass. Fill the first glass 2/3 full of plain water. Fill the second glass 2/3 full of the clear soda water. Which objects float?

EVALUATION:

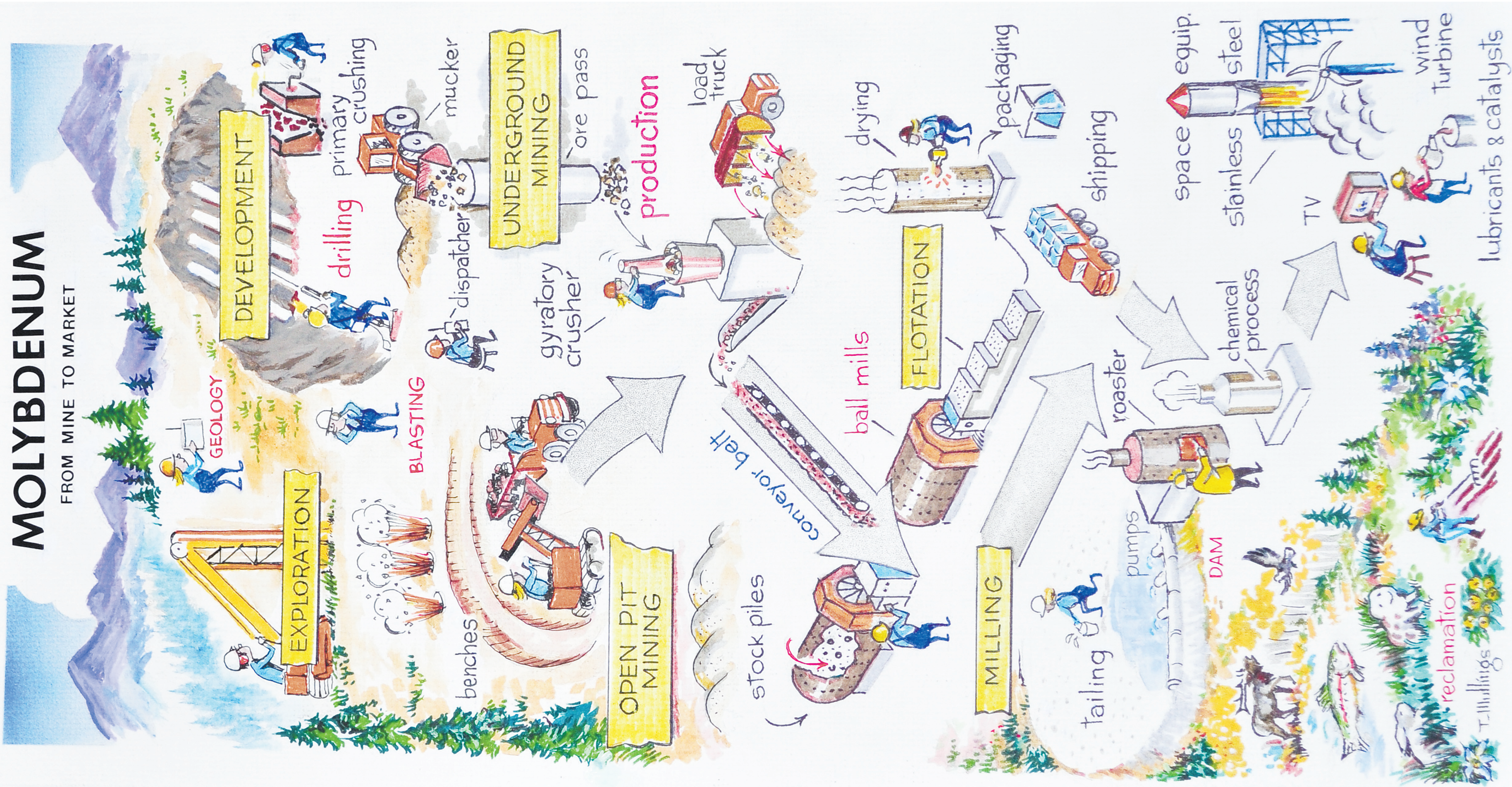
Why does this work? The density of raisins and peanuts is greater than water, so they sink. In soda water, the bubbles attach to the peanuts and the overall density of this combination is less than water, so

- Clear Soda Water
- Drinking Water
- 2 clear drinking glasses for each student or group

they float. Even with bubbles, the overall density of the raisins is greater than the water. Why is this application important to the minerals industry? Flotation is one of the methods used in the industry for extraction of minerals. Frothers are added to the solution to lower the surface tension of the water. The froth must be strong enough to support the mineral but weak enough to break down in launders. Common frothers are alcohols and glycols.

MOLYBDENUM

FROM MINE TO MARKET



Mines are good neighbors

The Beginning

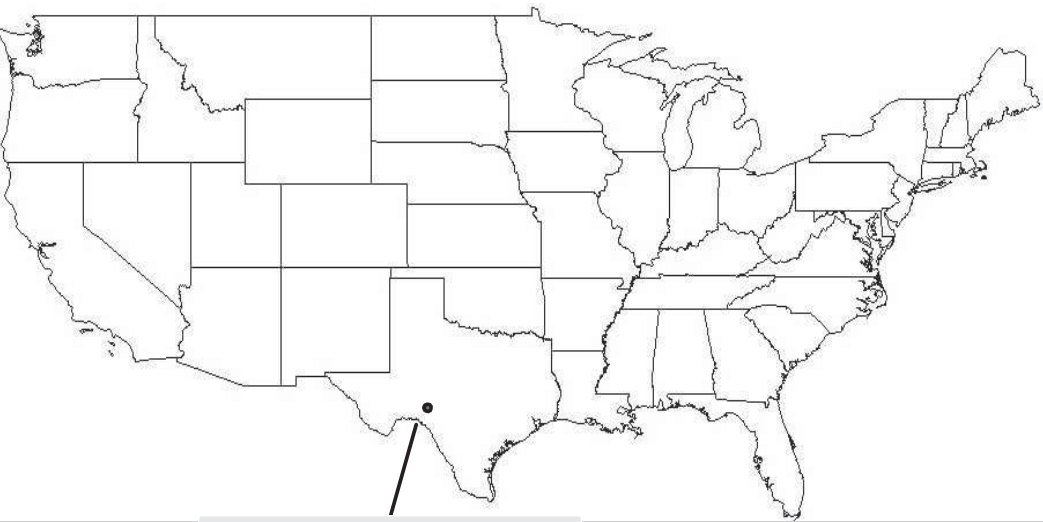
Have you ever thought about what came first, the mine or the mining town? When miners first found deposits of ore, they set up camps to be able to work the site. As their numbers grew, their needs did too. Other people with big dreams joined them. Some opened stores, cafes, saloons, churches, and blacksmith shops. Soon the camp populations and services grew and camps became towns. It was not long before banks and post offices were needed. Laws were made and enforced. Doctors came to provide medical care and teachers arrived to teach in the new schools. Newspapers printed the news of the day. All this happened because of a few miners who found an ore deposit. So which came first, the mine or the town?

In those early days, folks didn't know how to mine safely and many miners were injured or became ill. Miners and townspeople alike had no idea what the impact of mining and daily living would be on the environment. Mistakes were made. It has only been in the last 50 years that people all over the world have begun to understand about pollution of the air and water, endangered wildlife, the power of recycling, safety in industry and at home and the underlying causes of many diseases.

Miners take all of these things very seriously. After all, they live here and this is their environment too. They are determined to preserve and protect it.

Recycling at Mines

We all know that recycling at home and school is very important. Recycling is important for businesses too, especially mines. For example, water at Henderson and Climax is collected, recycled and reused.



- Land area used by 50 years of metal mining

Less than .0002 of the land area of the United States is used by mining to produce the metal materials we use every day!

Source: American Geological Institute

Mines have waste recycling programs that reduce the volume of trash and industrial waste material. These programs recycle scrap metal, spent oil and petroleum products, light bulbs, empty aerosol cans, scrap lumber, tires and other materials.

- The type of mining being done
- The land and water make-up at the mine location
- The manner in which the mining and processing operations are undertaken

How Much Land Does Mining Use?

Because mining can impact our surroundings, mining companies follow strict regulations to take effective, responsible steps to protect the environment.

How Much of an Impact?

A modern world relies upon mining for raw materials that are used to make many products. While it is important to understand that all mining impacts the environment, it is an interesting fact that metal mining has touched less than one quarter of 1% of all the land in the United States.

Impacts of Mining:

It is inevitable that there will be some sort of environmental impact accompanying the exploration, extraction and processing of minerals. Impact varies based on:

1881 Radium, Vanadium and Uranium discovered near Montrose

1882 Steel Mill opened in Pueblo



1890 Sherman Silver Purchase Act raises price of silver to more than \$1.00 per ounce

1891 Colorado's largest gold discovery at Cripple Creek

RECLAMATION

One hundred or more years ago, mining companies did not realize the impact mining could have on the environment. Today, miners are very serious about taking care of the land, water, wildlife and human health.

Before a mine is ever opened, extensive plans must be approved explaining how the mine will keep the surrounding environment safe and healthy for humans, animals and vegetation. In addition, detailed plans must be made and approved that show how the mine operators will return the land to a healthy, beautiful and natural state after the mine is closed. In order to create these reclamation plans, miners work closely with environmental experts, local communities and government agencies.

Reclamation projects cost millions of dollars every year and are too numerous to mention in detail. In Colorado, both the Climax and Henderson molybdenum mines and mill have won awards for many of their **reclamation** projects.

Climax receives **biosolids** from local wastewater facilities. Biosolids are like fertilizer. They are mixed into the soil to help new plants grow.

Several historic mining areas have been cleaned up. This means that pollution and contaminants have been removed from the soil, groundwater and sediment or surface water.



Another environmental project was created in response to the pine beetle infestation that has swept through the Arapahoe National Forest. The beetles left countless numbers of lodge pole pines dead or dying, creating a huge fire hazard. The Henderson Mill formed various partnerships to cut and clear thousands of acres of these trees. In their place, the Henderson Mill has planted more than 80,000 fir and aspen seedlings – trees the pine beetles do not like.

Once again, the forest will be lush, green and healthier than it was before the beetles arrived.

Areas around both mines show environmental successes with thriving wildlife populations and areas blossoming with new plant growth.

Old mine sites have been sealed and the areas replanted. All this is done to protect human health, wildlife and the environment.

Because of its location, the most important environmental issue at the Henderson Mine is the protection of water quality. All of the industrial wastewater is cleaned at a water treatment plant.



1893 Sherman Silver Purchase Act repealed causing massive unemployment

1900 Cripple Creek produces \$20 million worth of gold

1903 Mine, mill and smelter workers strike in many camps for higher wages and better working conditions. Life lost and property damaged at Cripple Creek Camp

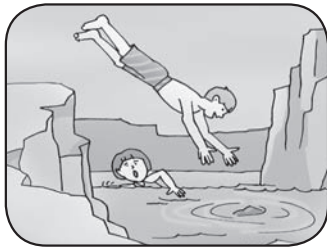
SAFETY

Stay Out-Stay Alive!

Every year, dozens of people are injured or killed while playing on mine property. Mines, whether they are old, abandoned or still operating, are very dangerous places. The only safe thing to do is STAY OUT and STAY ALIVE! Fences and "No Trespassing" signs are sometimes found on mine properties. You should never climb these fences to enter mine property. Some old abandoned mines may not have signs or fences. If you should find yourself at an old mine, quarry or gravel pit, leave immediately and stay away.



Do not walk anywhere near mine openings. The ground around shafts, open pits and caves can collapse without warning, and you could fall hundreds of feet down into these underground holes. At the surface, they may be hidden by plants or covered by rotting boards.



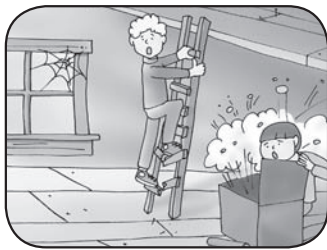
Do not swim in quarries, pits or mines. You could break your neck diving into the water. There could be sharp rocks or equipment near the surface, and the steep sides make it difficult to get out once you get in. Also, the water may be contaminated with chemicals.



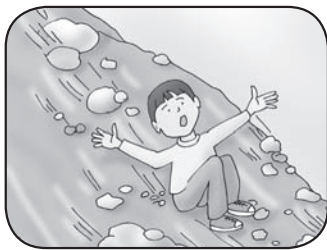
Do not walk through or touch horizontal mine openings or supports. Timbers are used to support the mine's roof or walls and can rot easily. They may seem sturdy, but you could brush against them and cause the entire area to collapse or cave in.



Do not touch equipment or wires on the ground. They might explode. Unused explosives such as dynamite, black powder and blasting caps can be set off by your voice, a touch or a step.



Do not go into old mine buildings. Stairs, ladders or floors may collapse. Never play with equipment. Old buildings might contain explosives, electric hazards or other dangerous materials or equipment.

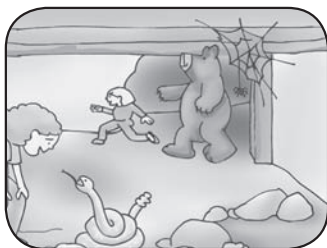


Do not climb or play on or around piles of tailings, rocks or sand. The entire pile can collapse or slide, hurting you or someone below you.

Never go inside underground mines



...you could get lost or trapped and starve to death or die from thirst, exhaustion or exposure to the elements.



...you might get bitten by poisonous snakes, scorpions or spiders that often live in abandoned mines. Bears and mountain lions may make their homes there too.



...you might encounter poisonous gases in an abandoned mine. You can come upon these dangerous gases without warning as they are odorless and colorless.

Safety at home & at school

Safety is so important at the mines that they start every day with a meeting called a "Safety Share." Members of each team sit down together and talk about safety issues at the mine, at home or anywhere that people might be in danger. Someone may share that he noticed some loose cords in a corridor that someone might trip over. Those will be fixed right away but, in the meantime, people will know to look out for those cords when walking down that corridor. Another person may share that she didn't wear protective glasses when mowing her lawn over the weekend and a piece of grass hit her in the eye. As a result of these daily meetings, staff at the mines are safer both in the workplace and at home.

Did you see anything today that might be unsafe? Maybe it would be a good idea to start the day in the classroom with a safety share.

Activity

As a class, discuss things you see in the classroom, on the playground, or at home, that could be made safer. Make a list. Do you think this is a good way to make everyone aware of safety at school and at home?

How can you be safer in these situations?

Playground

On the Internet

Pool/Water

Bike/Skateboard/Scooter

Fire

Car/Bus/Driving

Sledding/Skiing

Other



Newspaper ACTIVITY

Find an example of how safety awareness or lack of safety awareness played an important role in today's news.

Mining Careers

Pick Ax & Donkey?

Not anymore! Mining has gone high tech. Mining relies heavily on technology and continually explores ways to further advance technology to improve the process for mining copper. There is always a need for talented people with technology skills to join the fascinating world of mining.

Working in the mining industry gives people the opportunity to travel and live in unique places around the world, to work outside and to help humanity by producing a resource we all need.



Newspaper ACTIVITY

Look through the classified section of today's newspaper for job listings. Find at least five jobs that look interesting. What skills are needed for each job? Is a degree required? If so, what kind of degree is needed? Is there an age requirement? Does the position require previous experience? Does the ad mention salary or benefits? Is this a part-time or full-time position?

Go to the Freeport-McMoRan website, www.fcx.com, and look at the job listings. What positions are open? Find five that look interesting. What skills are needed for each of these positions? Is a degree required? If so, what kind of degree is needed? Is there an age requirement? Does the position require previous experience? Does the ad mention salary or benefits? Is this a part-time or full-time position?

Would you be interested in any of these jobs?

The mining industry has a wide variety of jobs available for folks with a high school education or college degrees. Unfortunately, there is no way to list every career opportunity in mining in this short space. From Equipment Operators and Chemists to Engineers and Geologists, here are just a few:

- **Blasters**
- **Drill Operators**
- **Environmental Engineers**
- **Chemists**
- **Belt Maintainers**
- **Environmental Services**
- **Exploration**
- **Electricians**
- **Geologists**
- **Hydrologists**
- **Mine Engineers**
- **Haul Truck Drivers**
- **Mechanics**
- **Metallurgists**
- **Operation Managers**
- **Shovel Operators**
- **Accountants**
- **Administrative Assistants**
- **Attorneys**
- **Government Relations**
- **Business Development**
- **Treasury**
- **Computer Information Systems**
- **Computer Programmers**
- **Community Affairs**
- **Communications**
- **Health and Safety**
- **Human Resources**
- **Pilots**
- **Purchasing Agents**
- **Sales**
- **Security Officers**



1914 Coal miners strike in southern Colorado results in famous "Battle of Ludlow."

1916 Mining of tungsten causes excitement in Boulder-Nederland area

Activity: "Erosion Landscape"

You will need:

- 2 large plastic trays (such as kitty litter boxes)
- a portable hand drill with 3/8" drill bit
- 1 watering can with a sieve style head
- soil mix (soil, sand, and gravel)
- grass seed (rapid growth)
- 2 coffee filters and coffee filter holders
- 2 empty juice cans or cartons of about 240 ml capacity
- wooden blocks to support the trays
- water

Procedure:

Part One

1. Drill a small hole at the end of each tray at the center 2.5 cm from the top.
2. Fill the two trays with soil mix to just below the drilled holes. Pack the soil mix slightly, but don't overdo it.
3. Leave one tray as it is, containing just the soil.
4. In a second tray, evenly spread a thin layer of rapid-growth grass seed over the entire area. Gently press the seed into the soil. Place the seeded tray on a sunny windowsill.
5. Using the watering can, gently water the grass seed daily. When the grass is firmly rooted, you are ready to conduct the experiment.

ACROSS

1. Moly helps fight against _____ and tooth decay.
3. There are 92 natural _____ that are the building blocks or ingredients of everything we find on Earth.
6. _____ is the largest source for molybdenum in the world.
7. Moly is used in paint pigments, smoke and flame retardants and as dry lubricant on _____ vehicles.
9. _____ is a metallic element that occurs in nature.
13. Molybdenum can be combined with other metals to form an _____.
14. In 1822 Friedreich Mohs designed a scale to rank minerals according to _____.
15. If something can't be grown, it must be _____.

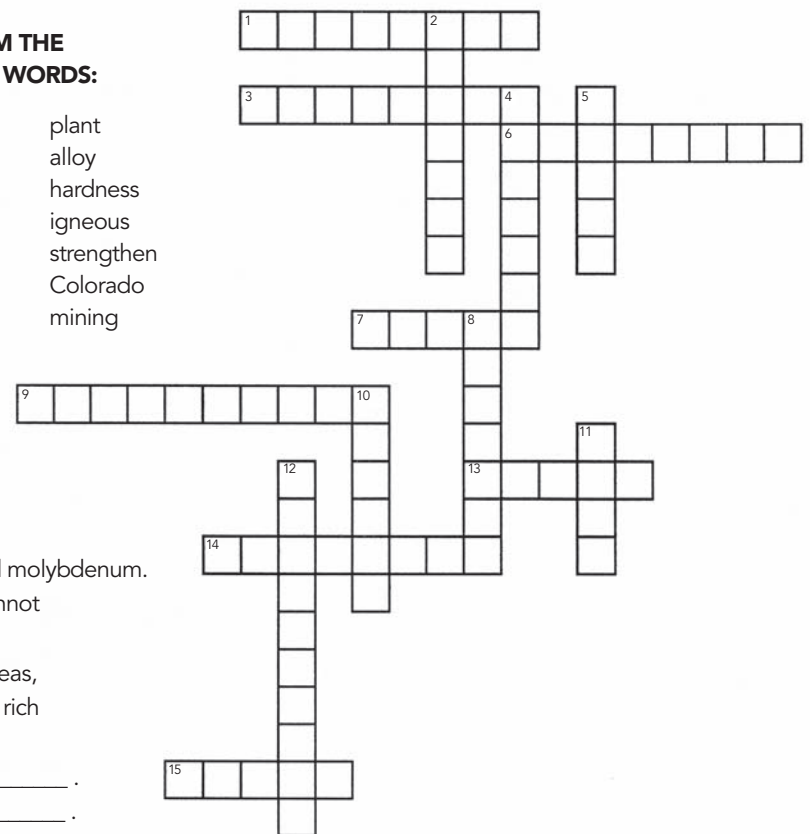
Part Two

1. Place both trays side-by-side on a table with the ends with the holes lined up near the table edge.
2. Place a wooden block under each tray at the end opposite the one with the hole.
3. Place a bench at the end of the table to serve as a platform for two coffee cans, which will serve as water catchments for water draining from the two trays.
4. Rest a coffee filter holder inside each coffee can. Place a filter in each filter holder.
5. Using waterproof tape, attach small "troughs" made from empty juice cartons or cans to the ends of the trays to guide the runoff from the trays to the filters.
6. Gently pour about 500 ml of water over the tray containing just the soil.
7. Record your observations.
8. Measure and record the volume of soil that drained into the coffee filter.
9. Gently pour the same quantity of water over the tray planted with grass seed.
10. Record your observations.
11. Measure the volume of soil runoff.
12. Compare the movement of water through sites that have plant cover to those that do not.

Moly crossword

SELECT FROM THE FOLLOWING WORDS:

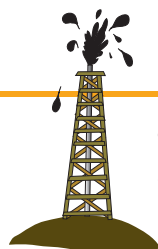
- | | |
|------------|------------|
| molybdenum | plant |
| space | alloy |
| elements | hardness |
| cereals | igneous |
| cavities | strengthen |
| Scheele | Colorado |
| moly | mining |
| mined | |



DOWN

2. Moly is found in _____ rock.
4. Carl Wilhelm _____ discovered molybdenum.
5. Soil that has no molybdenum cannot support _____ life.
8. Beans, green leafy vegetables, peas, _____ liver and other foods are rich in molybdenum.
10. Minerals are obtained through _____.
11. Molybdenum is also known as _____.
12. Moly is used as an alloy to _____ iron and steel.

1918 State production of coal reaches 12,500,000 tons. War triggers mining of molybdenum at Climax Mine, near Leadville



1923 Oil discovered in Wellington field north of Fort Collins

1976 Molybdenum mining operations begin at Henderson Mine in Clear Creek County

1980 Coal mining production on the Western Slopes hits all time high

Glossary

- Assay** – to analyze (an ore, alloy, etc.) in order to determine the quantity of molybdenum, gold, silver or other metal in it
- Blasting** – the operation of breaking coal, ore, or rock by boring a hole in it, inserting an explosive charge, and detonating or firing it
- Biosolids** – solid or semisolid material obtained from treated wastewater, often used as fertilizer
- Collectors** – chemicals that attach to the surface of molybdenite causing it to become hydrophobic
- Conveyor** – a mechanical device that transports materials between two places
- Crusher** – a machine for crushing rock or other materials
- Drift** – underground mined tunnel
- Elements** – the building blocks of everything on Earth, identified by number and symbol on the periodic table of elements
- Exploration** – work involved in locating an ore body and gaining knowledge of its size, shape, position and value
- Grinding Mills** – large machine that grinds ore into small pieces until it is the size of sand
- Frothers** – chemicals used in the flotation process to make air bubbles
- Host Rock** – the rock containing an ore deposit
- Hydrophobic** – fear of water or water-hating
- Igneous Rock** – formed deep under the crust of the Earth from hot magma
- Lead** – metallic element, symbol is Pb, #82 on the Periodic Table of Elements
- Minerals** – inorganic substances that occur naturally such as quartz, calcite, and pyrite.
- Mohs Hardness Scale** – a scale from 1-10 used for ranking minerals according to hardness
- Molybdenite** – a silvery-gray mineral consisting of molybdenum and sulfur, is the most important ore source of molybdenum
- Molybdenum** – a metallic, gray element, symbol is Mo, #42 on the Periodic Table of Elements
- Moly** – nickname for molybdenum
- Molybdos** – Greek word meaning lead
- Mucker** – underground front end loader also known as a scoop
- Reclamation** – the restoration of mined land to original contour, use, or more beneficial condition
- Roaster** – large furnace that burns away remaining impurities in molybdenum
- Safety Share** – daily meetings conducted at the mines where employees help one another become aware of and correct possible safety hazards both at home and at work
- Scheele** – Carl Wilhelm Scheele discovered the element molybdenum in 1778
- Slurry** – sand from grinders mixed with water to form a muddy substance

1982 Exxon closes its oil shale development fields in Rio Blanco, Mesa and Garfield counties. Lay offs occurred.

1987 The National Mining Hall of Fame and Museum found a home in Leadville, Colorado.



1995 Cresson Project of the Cripple Creek & Victor Gold Mining Company (AngloGold Colorado) began production as an open pit-cyanide heap-leach operation.

2008 Cripple Creek & Victor Gold poured its 3,000,000th troy ounce of gold.

2009 Climax Molybdenum Henderson Operations produces billionth pound of molybdenum



Resources & References

Henderson and Climax Mines

www.climaxmolybdenum.com

www.climaxmolybdenum.com/WorldwideLocations/USA_Colorado_Henderson.htm

Freeport-McMoRan Copper & Gold Inc.

www.fcx.com

Mineral Information Institute

www.mii.org

American Geological Institute

www.agiweb.org/environment/publications/metalsfull.pdf

Colorado Mining Association

www.coloradomining.org

US Geological Survey

www.usgs.gov

Colorado Geological Survey

www.geosurvey.state.co.us/

National Energy Foundation

www.nef1.org

Women in Mining

www.womeninmining.org

Colorado Foundation for Agriculture

www.growingyourfuture.com

Information about Carl Scheele

www.mattson.creighton.edu/History_Gas_Chemistry/Scheele.html

All About Mining: A Total Concept of the

Mining Industry - A special program for teachers offering 6 recertification credit hours, www.allaboutmining.org

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“Footprints on the Planet: A Search for an Environmental Ethic,” Robert Cahn, foreword by Jacques Cousteau, Universe Books, New York 1978

“Out of the Rock: Integrated Learning Activities for Students,” National Energy Foundation/US Bureau of Mines, 1995

“A Dictionary of Mining, Mineral and Related Terms,”

Paul W. Thrush and Staff of the Bureau of Mines, U.S. Department of Interior 1968

International Molybdenum Association

www.imoa.info

Photos are courtesy of Freeport-McMoRan Copper & Gold, Inc.

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ANSWERS

Moly Quiz page 6

1. True; 2. Molybdenite; 3. True; 4. True; 5. Carl Wilhelm Scheele; 6. Colorado; 7. Elements are the building blocks of everything found on Earth.; 8. Restoration of mined land to original contour, use or more beneficial condition; 9. False; 10. True; 11. Ninety-two; 12. True; 13. True; 14. True; 15. True.

Moly Crossword page 14

Across: 1. Cavities; 3. Elements; 6. Colorado; 7. Space; 9. Molybdenum; 13. Alloy; 14. Hardness

Down: 2. Igneous; 4. Scheele; 5. Plant; 8. Cereals; 10. Mining; 11. Moly; 12. Strengthen