Houston Gem and Mineral Society's Home Scavenger Hunt for Economic Minerals and Rocks

Subset 1 of Minerals 1–7

The Houston Gem and Mineral Society assembles Economic Mineral and Rock sets for distribution free to teachers and homeschool groups (information on the set and how to request it are at https://hgms.org/education/mineral-and-fossil-sets/). This set consists of samples of minerals and some rocks that are important economically in our society. The set is a helpful teaching aid, but you do not have to have one to complete this scavenger hunt, which is specifically designed with activities that can be easily done at home or in the classroom with common school supplies and other ordinary objects. The activities are labeled for the grades they align to in the Texas Essential Knowledge and Skills for Science (TEKS).

All activities in this scavenger hunt should be conducted with adult supervision.

Minerals are defined as naturally occurring, inorganic solids with a definite chemical composition and an ordered internal structure. Minerals are the ingredients that make up rocks, and economic minerals and rocks are used to make things—whatever doesn't come from plants was made from economic minerals and rocks. This scavenger hunt will help you learn how economic minerals and rocks are used in our everyday life in our communities.

Minerals are dug from the Earth's crust within an ore deposit. Most of an ore consists of rock of no economic value, called "gangue." An ore is not mined from the Earth unless either the quantity or quality or both of its mineral content are sufficiently high to make a profit from extracting it, either by shaft or open-pit mining.

An economic mineral can be a metal or nonmetallic. Most ore minerals belong to three groups of nonsilicate minerals:

1. Native elements (examples: gold, silver, copper, sulfur, and graphite)
2. Sulfides (examples: galena, pyrite, chalcopyrite, and stibnite)
3. Oxides (examples: hematite, magnetite, rutile, cuprite, and corundum)

The native elements are each a single element, such as gold, which has the chemical symbol Au. The sulfides and oxides are represented by a chemical formula, such as galena, which is lead sulfide (PbS), and rutile, which is titanium dioxide (TiO_2). Nonsilicate minerals are much less abundant in the Earth's crust than its major component of silicate (SiO_4^{2-}) minerals.

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Minerals in Subset 1

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1. Galena (lead sulfide or PbS)

Galena is the most important ore mineral of lead (Pb). Notice the lead-gray color, high specific gravity (it feels heavy when you pick it up compared with a same-size piece of most other minerals), and metallic surface luster. If you rub galena on a streak plate (which is an unglazed ceramic tile), it has a gray streak.

Lead was used in making paint, for making water pipes because it is easy to shape, and as an additive to gasoline to improve engine performance. It is no longer used in these products because it can be toxic, even in small amounts. Lead pollution is documented as the cause of learning disabilities in children. It is still used in car and other types of batteries and lead crystal glass. Lead-lined aprons keep us safe from stray X-rays at the dentist's office or in the hospital.

Activities:

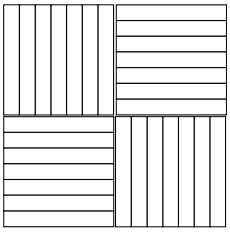
K-5: Galena is composed of lead and sulfur and is one of the heaviest minerals. It has a density of 7.6 gram/cm^3. That means that it is about 8 times denser than water, which has a density of 1 g/cm^3. A typical rock is about 2.5 times denser than water. To demonstrate how density can be used to identify minerals, take two 500-mL plastic water bottles. Leave one bottle full but take the cap off the second bottle and use a graduated liquid measuring cup to pour 335 mL of water out of it, leaving 165 mL in the bottle. Put the cap back on the second bottle and put each bottle into a clean sock so that you cannot see which is the full bottle. Now, compare the weight of the two bottles. One bottle is noticeably heavier, even though both bottles are the same size. Remove the bottles from the socks to see which bottle is heavier. Circle the answer:

Full bottle

165-mL bottle

1. Galena continued

2-4: The definition of a mineral includes that it has a definite chemical composition and an ordered internal structure, which determines the shape of the mineral's crystals. One of the ways that galena can be easily identified is by its cubic crystal structure, which means that galena crystals grow as cubes if they are forming in a roomy enough environment. Galena can also be identified by the way that it breaks along surfaces parallel to the cubic crystal faces. This is called cubic cleavage. To demonstrate this, stack some cubic dice or cubic wooden blocks together into a larger cubic block structure. Notice how the surfaces of the component dice or wooden block cubes are parallel to the outside surfaces of the larger block structure. Gently nudge the block structure with your hand to slightly separate the dice or wooden blocks. As they come apart, are the "fracture" surfaces of separation parallel to the outside faces of the larger block structure? Circle the correct answer:



Parallel

Nonparallel

All grade levels: Some metallic minerals are magnetic. If you have the Economic Rocks and Minerals set, use a magnet from your refrigerator to see if it is attracted to the galena sample. The property of magnetism can be used to identify minerals. Is galena magnetic? Circle your answer: Yes No

5+: What is the symbol for lead on the periodic table of the elements? _____
What element is in the same column, but one row higher than lead? _____

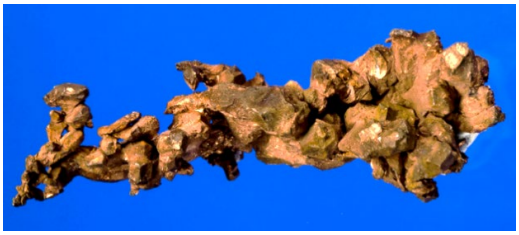
8+: What group is lead in on the table: _____. What does this position tell you about the characteristics of lead?

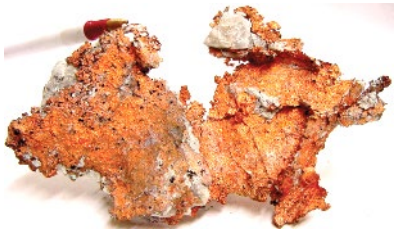
_____

_____

_____

2. Copper (Cu)





Copper is an important economic metal because it is a good conductor of electricity, so it is used in the power lines that bring electricity to your home, the wiring in your walls to the light switches and outlets, and the cords we plug in to the outlets. Copper is used in many industries besides for conducting electricity. Currently, copper is of interest because of its biocidal properties, which means that it can be used for disinfection purposes. Copper is used for the US penny coin—before 1982, it formed 95% of the penny, but to save money, the US Mint now manufactures pennies that contain only 2.6% copper as a coating on a zinc alloy coin. Copper is often alloyed with other metals to produce harder composites such as brass and bronze. Copper can be mined even in low concentrations that would not be economic with conventional mining methods by using solution mining, which uses water or dilute acid to leach the copper from the ore body.

Activities:

K: Find a penny coin and make a rubbing of it by putting the coin under this paper and rubbing the side of your pencil point over it:

K-3: Copper is useful because it is a good conductor of heat and electricity. Look at the cooking pots in your kitchen or at a store or online retailer. Do any of the pots have copper on the bottom of the pot? Circle your answer: Yes No

Why do you think that copper is on the bottom of cooking pots? _____

_____.

2-5: One of the ways that elemental copper is identified is by a property called malleability. All true metals are malleable. That means that when they are pounded with a hammer, they bend instead of break. The opposite of malleability is brittleness. Most nonmetallic minerals are brittle, which means they easily break or form a powder where scratched. First, to demonstrate brittle fracture, put on safety glasses, place a dried macaroni noodle on a concrete or asphalt sidewalk or driveway, and lightly tap it with a hammer. Then, make a small ball of aluminum foil and tap it the same way with a hammer. Label which one broke and which one flattened out without breaking? Circle the answer for each one:

2. Copper continued

Dried noodle: Brittle or malleable?

Aluminum foil ball: Brittle or malleable?

5+: When the atoms of copper join with oxygen in the air, they form the molecule copper oxide (CO). This formation on the surface of pennies makes them look dirty. Assemble the following materials:

- 10 dirty pennies
- 4 tablespoons lemon juice
- 8 tablespoons vinegar
- 1 teaspoon salt
- Small bowl (not made of metal)
- Spoon (not made of metal)
- Paper towels

1. Mix the lemon juice, vinegar, and salt in the bowl with the spoon until dissolved.
2. Dip a penny hallway into the mixture for 20 seconds. Take it out and describe what happened: _____.
3. Put the other nine pennies into the mixture. Watch carefully and describe what happens: _____ _____
4. After 5 minutes, remove four of the pennies from the mixture and lay them on a paper towel to dry. Take the remaining pennies out and rinse them thoroughly under running water. Lay them to dry on a paper towel. What is different between the pennies that weren't rinsed and those that were?

   _____

   The acidic mixture of lemon juice, vinegar, and salt dissolved the copper oxide on the surface of the pennies, but when that coating was removed from the pennies it was easier for the copper atoms to bond with oxygen and chlorine in the salt, forming a new mineral compound called malachite on the pennies that weren't rinsed.

6-8: Copper has antimicrobial properties, which means that it kills bacteria. You may have seen this mentioned in the news or on TV or online advertising of copper-infused products? Why do you think companies would want to put copper into products? _____

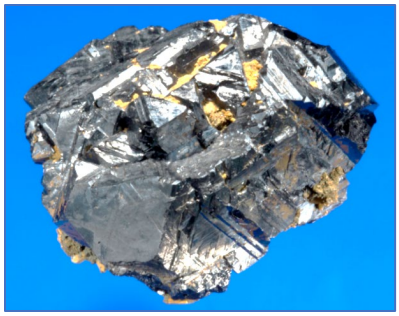
_____.

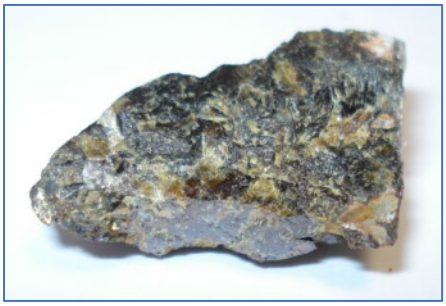
9+: An alloy is a metal made by combining two or more metallic elements, typically to give greater strength or resistance to corrosion. The two most common alloys using copper (there are more than 400!) are brass and bronze. Research what is the primary metal combined with copper for each and list some properties of these alloys.

Brass: Copper combined with _____. Properties: _____.

Bronze: Copper combined with _____. Properties: _____.

3. Sphalerite (zinc sulfide or ZnS)





Sphalerite is the most important ore mineral of the metal zinc. Its name comes from the Greek word *sphaleros,* which means deceiving, because sphalerite has a wide variety of appearances and can be difficult to identify in hand specimen. Its luster can range from submetallic to resinous, which means that the surface has the same appearance as resin (such as amber, which is fossilized resin) or a smooth-surfaced plastic. The zinc component can also be substituted for by variable amounts of iron, and the streak of sphalerite when rubbed on an unglazed ceramic streak plate can range from black to yellow. Nicknames of sphalerite are zinc blende and blackjack.

The metal zinc is silvery white in color and has many industrial uses. Adding a protective layer of zinc to steel and iron is called “galvanizing” and protects from rust and corrosion. Zinc oxide (ZnO) is commonly used as a paint pigment, in batteries, and for topically treating a variety of skin conditions, including itching, diaper rash, and dandruff. Zinc oxide is also used in sunscreen to physically block the damaging UV rays, and unlike chemical sunscreens, it is reef-safe, which means that the nanoparticles do not pose a danger to marine ecosystems. In US penny coins made after 1982, the center of the coin is made from a zinc alloy. Zinc chloride (ZnCl) is used for preserving wood.

Activities:

1-3: Check the date on a penny coin. Write the date here: _____ From what you read about the US penny (see 2. Copper), circle whether the penny has a zinc alloy center: Yes No

K-4: Look at some different types of nails at home or at a hardware store. Do they have a rough, silvery coating? Circle your answer: Yes No If yes, they are galvanized, which means they have a coating of zinc that helps prevent rust. If the package for the nails is available, check it to confirm your answer.

5+: The first commercial dry batteries were zinc-carbon batteries. Because these batteries work in any position, they enable portability of the devices they power. Check the batteries you have at your home or look at some in a store or online retailer. Do you find any zinc-carbon or zinc-chloride batteries (Hint: they are usually labeled “heavy duty”). Research why alkaline batteries were developed to substitute for zinc-carbon batteries in primary (nonrechargable) applications:

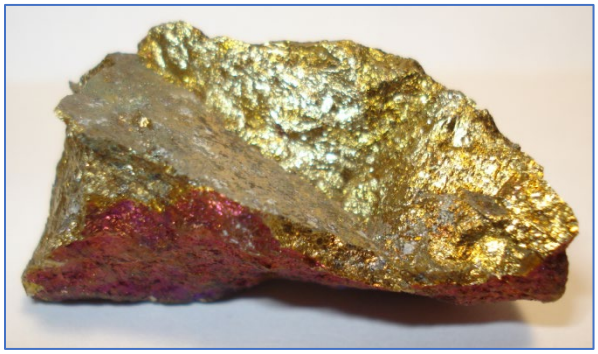
_____
_____.

3. Sphalerite continued

8+: Find zinc on the periodic table of the elements. Which would be heavier, a cubic centimeter of pure copper or a cubic centimeter of pure zinc? Explain how you know by the arrangement of the elements on the table: _____

_____.

4. Chalcopyrite (copper iron sulfide or $CuFeS_2$)



Chalcopyrite is the most important ore mineral of copper. It loses its metallic luster and tarnishes from a brassy yellow color upon weathering to a dull gray-green color. The streak on an unglazed ceramic plate is greenish black. Copper is used in many industries (read more at 2. Copper). The electrical power industry relies on copper wires to conduct electricity. Copper was formerly used for the US penny coin, but now is only a coating on the penny. It is often alloyed with other metals to produce harder composites such as brass and bronze. Copper is also widely used in analytical chemistry.

Chalcopyrite is often associated with bornite (Cu_5FeS_4), which is also a mixture of copper, iron, and sulfur. Bornite has a copper-red color on fresh broken surfaces but tarnishes to multiple iridescent colors, earning it the nickname peacock ore.

Activities:

K-1: Do you have any doorknobs or lamps in your home that have a bright, shiny gold-colored finish? This is brass, which is an alloy (mixture) of copper and zinc. Write or draw what you found that is made of brass: _____

_____.

1-4: Chalcopyrite crystals are in the tetragonal crystal system, which means that the crystal looks like a square if you look at it from the top and like a rectangle from the side. Draw what is called an “exploded view” of the crystal as a square and a rectangle that share one short side of the rectangle:

5-8: Draw a 3D rectangular prism to represent the chalcopyrite crystal in the tetragonal crystal system. Put the square on top and size the rectangular sides as 1.5 cm wide, 1.5 cm deep, and 5 cm in height.

4. Chalcopyrite continued

9+: The composition of chalcopyrite is $CuFeS_2$, bornite is Cu_5FeS_4, and pyrite, which is often confused with chalcopyrite, is FeS_2. These minerals are often found associated with each other. Copper is the most valuable element of the three that make up these minerals. Iron and sulfur are typically waste byproducts of mining copper minerals. Answer which of the three minerals would produce the most copper if you mined 100 kg of each and explain how you determined the answer:

_____

_____.

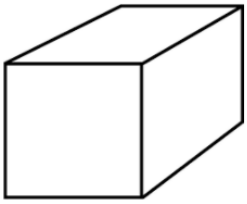
5. Halite (sodium chloride or NaCl)

Halite is the mineral name for what we know as table salt. Halite crystallizes as cubes and is usually white, but can be gray or pink. Halite is found in certain sedimentary environments as a result of evaporation of briny (salty) water and can accumulate in large beds that can be mined commercially. It is also extracted by evaporation from seawater in many places around the world.

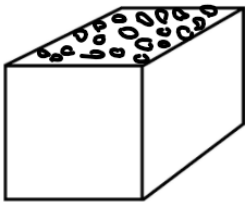
Halite is necessary in the human diet. In fact, your body contains about 100 cm^3 (20 teaspoons) of salt, which is stored in your bones and bodily fluids, such as blood and sweat. But too little or too much salt is not good for you. In addition to flavoring and preserving food, salt is used to tan leather and to make glass and ceramics. The biggest industrial use of salt is in the chemical industry to produce chlorine for chemical processes and also soda ash (sodium). In northern climates "rock salt" is used to melt ice and snow on highways. The halite sample in the economic rocks and minerals set comes from Hockley, in Waller County, Texas, where an underground operation mines a salt dome near the surface.

Activities:

K-3: Take two ice cubes and put each in a bowl. Heavily sprinkle one ice cube with salt. Check the ice cubes every 5 minutes for a total of 15 or 30 minutes. Circle which ice cube melted faster:



Ice cube



Ice cube with salt on it

As the ice cube starts to melt, the water dissolves the salt, and the component ions of the salt interfere with the chemical structure of the water to lower the freezing point (usually 0°C or 32°F). This is why salt is put on icy roads to speed the ice melting and delay any refreezing to make driving safer.

2-4: Halite is soluble in water. Put a teaspoon of salt in a glass of water. Stir the mixture of salt crystals and water and watch the salt crystals. What happens to the salt crystals?

_____

Now take a tiny sip of the water in the glass. Although you cannot see the salt crystals because they dissolved in the water, can you taste them? Circle your answer: Yes No

5. Halite continued

3-4: The mineral halite is in the cubic crystal system, which means that all three sides of the crystal look like a square. Draw a cubic crystal:

5-6: Put a small amount of table salt (not flaky finishing salt) onto a dark surface. Look at the crystals with a magnifying lens or with a cell phone camera. What shape are the crystals? _____

Crystal shapes are used to identify minerals because the atoms that make up the mineral crystals have a repeated orderly pattern.

5+: Halite forms when seawater evaporates, leaving the salt crystals behind. Put about 120 mL (half a liquid measuring cup) of water in a cooking pot and warm it (boiling is not necessary). Keep adding salt and stirring it until no more salt dissolves in the water. Let it cool and then pour the water into a clean bowl. Let it sit uncovered for a few days without disturbing it and look for crystals forming around the edge of the bowl. What shape are the crystals: _____. To make the crystals more interesting, add some food coloring to the mixture of salt and water while you are stirring it.

Where did the crystals first start forming? _____.

Why do you think they formed there? _____

_____.

8+: Adding salt to water changes the density of the water as the salt dissolves in it. Pour water into a tall clear glass until it is half full. Stir in about 6 tablespoons of salt. Wait for the water to stop swirling and pour in plain water without disturbing or mixing with the salty water until the glass is nearly full. Gently lower an egg into the water. Describe what happens:

_____

_____.

Is the salt solution more or less dense than the fresh tap water layer? Circle your answer:

More dense Less dense

How do you know? _____

_____

6. Gypsum (calcium sulfate dihydrate or $CaSO_4 \cdot 2H_2O$)

Gypsum is a common sedimentary mineral that is the same chemically as anhydrite ($CaSO_4$) with the addition of water in its crystal structure. It forms in large deposits where ocean and other waters with a high content of sulfate and calcium were concentrated and dried up to deposit the sulfate and calcium. Gypsum is usually white but can be clear also. Its monoclinic crystal system (three unequal axes with two of them perpendicular to each other) makes it easy to break gypsum into flat sheets along one direction, similar to the mineral mica. There are large gypsum mines in West Texas.

You live surrounded by gypsum: it is ground up and used to make the drywall or sheetrock on the walls of your home and other buildings. It is used as a fertilizer and soil conditioner for agriculture. Plaster of Paris is made from gypsum and is used in surgical splints for broken bones and casting molds. Gypsum is a very soft mineral that you can scratch with your fingernail. Likewise, the sheetrock made from it on the walls is also easily scratched or dented.

Activities:

K-2: Gypsum is commonly used in sidewalk chalk because it is so soft. Take some sidewalk chalk and draw a picture of a monoclinic crystal on the sidewalk, driveway, or chalk board:

K-2: Can you find a dent or a scratch in the sheetrock in your home? Circle one: Yes No

Do you know how it happened? _____.
If you don't find dents and scratches, you do a good job treating it gently to keep it in good shape.

4-7: Gypsum is one of the softest minerals, rated at 2 on the Moh's hardness scale of 1 for the softest (talc) to 10 for the hardest (diamond). Collect a bar of soap, a penny, and a nail to demonstrate relative hardness testing by scratching something soft with something hard. Try to scratch the soap with the nail, then try to scratch the penny with the nail.

Was it easy to scratch the soap with the nail? Circle your answer: Yes No

Was it easier or harder to scratch the penny with the nail? Circle your answer: Easier Harder

6. Gypsum continued

8+: Find calcium on the periodic table of the elements. What is its element number? _____ How many protons are in each atom of calcium? _____ What else do you know about calcium from its position on the table? _____

_____.

9+: One way of identifying gypsum is by its crystal system shape. It crystalizes in the monoclinic crystal system, which has a parallelogram for one of the faces. The description of a monoclinic crystal is that it has three unequal axes with two of them perpendicular to each other. Draw the three axes for this monoclinic crystal:

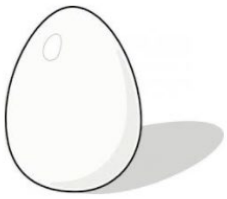
7. Sulfur (S)

Sulfur is a nonmetallic element found usually as deposits from gases at volcano vents or produced by anaerobic bacteria. Sulfur itself has no odor, but sulfur minerals easily weather in the presence of oxygen to form compounds that have a very distinctive annoying smell, like a skunk or a rotten egg! Sulfur is unusual because not only is it the only common mineral that is yellow but it is bright yellow. It is in the orthorhombic crystal system, which has three axes at 90° to each other that are unequal in length.

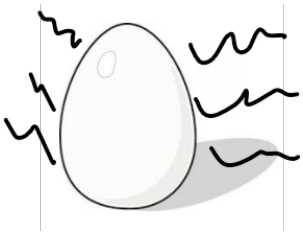
Sulfur is used to make many chemicals, including sulfuric acid, which is important for making fertilizer to help plants grow and as a highly effective electrolyte in car batteries. Sulfur is commonly used as a bleaching agent and for food preservation, in pesticides and fungicides, and to vulcanize rubber, which improves the hardness, elasticity, and durability. Sulfur is an essential component of the antimicrobial medicines developed in the early 20th century called sulfa drugs.

Activities:

K-2: If you have eggs in the refrigerator, give them a sniff to make sure one hasn't gone bad, which you would detect by the sulfurous smell. If you have boiled eggs in the refrigerator, give them a sniff, because the sulfur and iron in the egg can react to have a sulfurous odor (this does not mean that the boiled egg is rotten). Did you find an egg with a sulfur smell? Circle your answer:



No sulfur odor



Sulfur smell

3-5: Sulfur can be recognized by its bright yellow color. Draw a picture of what you think a sulfur crystal might look like, using a bright yellow color. Remember it is in the orthorhombic crystal system, so all the sides are rectangles of different sizes:

7. Sulfur continued

6+: Sulfur crystallizes in the orthorhombic crystal system. The most common crystal pattern has the shape of a trapezoidal prism. Make a 2D view by drawing two trapezoidal prisms, one on top of the other, with the widest parts of the trapezoids sharing the same border (one trapezoid is right side up, the other is upside down, touching each other). Color it yellow.

8+: Find sulfur on the periodic table of the elements. What is its atomic number? _____. What element is above it on the periodic table? _____. What else do you know about sulfur from its position on the table? _____
_____.