REED GOLD MINE
AMERICA'S FIRST GOLD DISCOVERY

Teacher's Guide:

Science

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Science

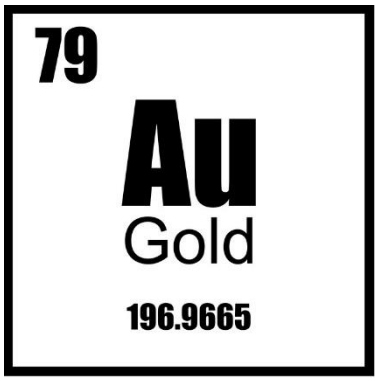
Section I: Formation of North Carolina Gold Deposits

Objective: Students will learn how gold ended up in North Carolina's Piedmont region and can complete a related matching game.

Formation of North Carolina Gold Deposits

Gold is a naturally found element on earth, which means it was present when the earth was formed. An element is one of the basic substances that is composed of atoms of a single kind and is unable to be separated into simpler substances through ordinary chemical means.

In other words, gold cannot be broken down into other material or matter. Gold is a soft, heavy isometric mineral. It is the native element Au. Gold is widely found as nuggets or grains in alluvial deposits or in veins of quartz.



Gold is number 79 on the Periodic Table of Elements. The symbol is Au, which stands for Aurum, the Latin word for gold. The number at the bottom is the atomic weight, also known as relative atomic mass.

Volcanoes, or at least volcanic action, played a role in the discovery of gold in Cabarrus County, North Carolina. Well below the surface is gabbro, a dark-colored, basic intrusive igneous rock. Gabbro is commonly called greenstone due to its green color and mineral properties. At some point in the earth's development, the gabbro rock was forced upward through the crust, opening large fissures and smaller cracks from magma moving underneath the surface.

The gabbro material contained traces of gold as well as silicates, which form quartz. The chemical composition of quartz is SiO2, or silicon dioxide. While the gabbro rock was still molten, but starting to cool, the gold and silicates started to fill those fissures and cracks, forming milky white quartz veins, and trapping the gold. The white color was caused by bubbles of gas and liquid as the quartz crystals formed filling in the open spaces.

As the quartz veins eroded away, the gold settled either into larger fissures or along the surface near sources of water. Water was the main source of the erosion, the process by which the surface of the earth—minerals, rocks, and soil—are worn away. Water also caused the gold to be carried downstream and deposited along the route.

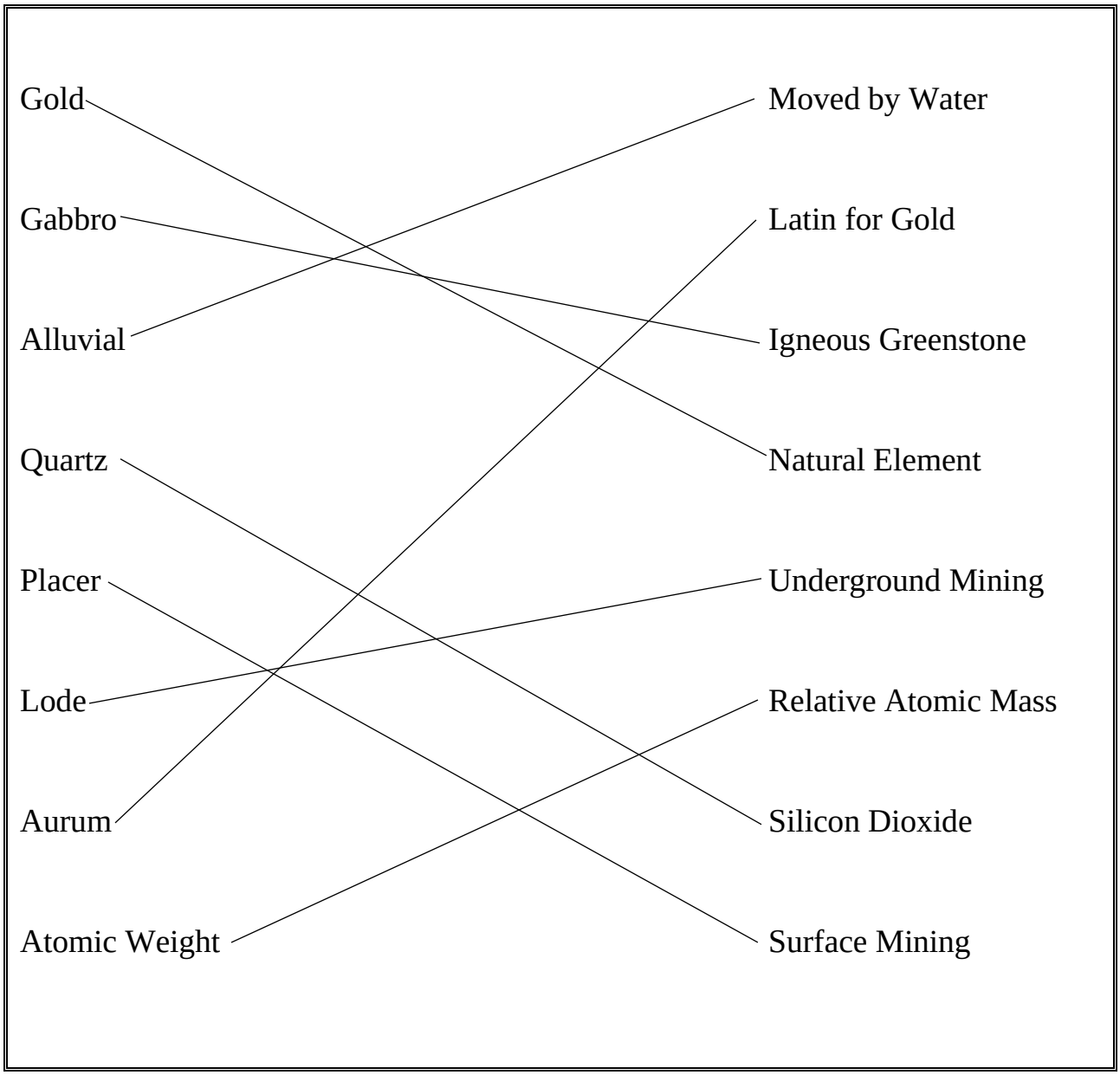
The gold along the surface became known as placer deposits, while the underground quartz veins utilized lode mining. Placer mining found loose gold, from smaller flakes to large nuggets, while lode mining required machinery to process the quartz to extract the gold.

Gold Matching Game

Match the word on the left with the correct definition or word on the right.

Gold	Moved by Water
Gabbro	Latin for Gold
Alluvial	Igneous Greenstone
Quartz	Natural Element
Placer	Underground Mining
Lode	Relative Atomic Mass
Aurum	Silicon Dioxide
Atomic Weight	Surface Mining

Gold Matching Game Answer Key



Science

Section II: Uses of Gold

Objective: Students will learn about the many uses of gold and can complete a related worksheet.

Uses of Gold

Gold has many uses for everyday life. Everything from money to space travel utilizes gold in a unique way.

Gold has been used for money for thousands of years, dating back to 1091 B.C. in China. The rarity of gold gives it value, allowing countries to base entire banking systems by how much they keep stored around the world. Gold coins would be produced to use as money to purchase goods and services. While gold is still used as currency today, it is mostly for collectors hoping the value of gold remains high even when other investments lose their value.

Gold is ductile, meaning it can be shaped by drawing or pulling, which makes it useful in creating various forms of jewelry. An ounce of gold can be formed into a wire five miles long. Gold is also malleable, meaning it can be hammered very thin, to the point it is transparent. These properties allow goldsmiths to shape this metal into intricate rings, necklaces, earrings, eyeglasses, or ornamental art.

Gold is also often used in medicine because the metal has potential healing properties for the body. One major use was for rheumatoid arthritis, in the form of gold shots. Myochrysine, which contains gold sodium thiomalate, is used to help treat and potentially stop further progression of this disease in both children and adults. Gold is also used in the treatment of cancer, malaria, and certain laser eye treatments.

One of the largest uses of gold today is electronics, specifically in circuit boards and other components that control powered devices. Gold is one of the best conductors of electricity since the metal will not corrode or tarnish. A thin layer of gold along the edge of a circuit board where connections are made will remain just as bright and strong as the day it was made. Other metals, such as copper and silver tarnish rather easily, and may start to slowly erode, causing breaks in the electrical contacts. The electronic recycling industry helps collect gold from used electronics to be processed and repurposed into other uses around the world.

One of the most interesting uses of gold is in the space industry. Even when gold is hammered so thin it is transparent, it still can reflect heat, including harmful UV rays which can damage eyes. Most space helmets have a thin layer of gold across the face shield to protect astronauts while conducting space walks or maintaining the space station. Satellites, solar panels, and other equipment in space exposed to the unprotected harmful rays of the sun also use gold to protect their surfaces and electronics.

Uses of Gold Worksheet

Fill in the missing words based on descriptions in the sentences.

1. Gold wire can be created due to being _____ which pulls it out into thin strands.

2. Since gold cannot rust or tarnish, it is resistant to _____, unlike copper or silver.

3. Gold can usually be found on an electronic _____, which controls the functions of any powered device.

4. Just like carrying quarters today in a pocket, _____ could be used to purchase items in a store or to pay a bill years ago.

5. Astronauts require a _____ to be placed over their face shields to protect them from the harmful rays of the sun.

6. The _____ of gold around the world helps determine the value and investment capabilities.

Uses of Gold Worksheet Answer Key

1. Gold wire can be created due to being **ductile** which pulls it out into thin strands.

2. Since gold cannot rust or tarnish, it is resistant to **corrosion**, unlike copper or silver.

3. Gold can usually be found on an electronic **circuit board**, which controls the functions of any powered device.

4. Just like carrying quarters today in a pocket, **gold coins** could be used to purchase items in a store or to pay a bill years ago.

5. Astronauts require a **thin layer of gold** to be placed over their face shields to protect them from the harmful rays of the sun.

6. The **rarity** of gold around the world helps determine the value and investment capabilities.

Science

Section III: Properties of Gold

Objective: Students will learn about the properties of gold and can complete a related laboratory experiment.

Properties of Gold

When the early miners dug along the banks of creeks and panned for gold, they were taking advantage of several scientific properties of gold, including mass, volume, density, and specific gravity.

One of those is a scientific property called density. If you had two rocks that were the same size, but one rock was much heavier than the other, the heavier rock would be denser. Density means that the rock's materials are more closely compacted together, which also affects its specific gravity.

Determining the density of a material is also determining how many grams each cubic centimeter of the material weighs. When the material is weighed, that provides the mass, versus the number of cubic centimeters of space the material uses, which is the volume. When volume is divided into the mass, the equation determines the density of the material. The formula to calculate density is:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

It is easy to tell that some minerals seem heavier than others, which helps in identifying certain characteristics. When attempting to determine whether one mineral is heavier than another, geologists use a property called specific gravity. This is the number of times a mineral is as heavy as an equal volume of water. Regarding gold, one ounce of pure gold has a specific gravity of 19.3, which means that ounce is 19.3 times heavier than an ounce of water.

Archimedes, a famous Greek mathematician, developed a formula for finding specific gravity:

$$\text{Specific Gravity} = \frac{\text{Mass of Mineral in Air}}{\text{Mass of Mineral} - \text{Mass of Mineral in Water}}$$

The early miners knew a piece of gold was much heavier than a rock of the same size. They determined that by adding water to the dirt and rocks in the pan and sloshing the mixture around, the heavier gold would eventually work to the bottom of the pan. After giving the gold time to settle at the bottom of the pan, the miner would remove all the other materials and hopefully see the gold. This may sound simple, but takes patience, practice, and some scientific knowledge of density to become a panning expert.

The following activity will demonstrate density with various materials, which can then be compared to the density of gold.

Properties of Gold Experiments

Materials:

- Graduated cylinder (try a baby bottle marked in milliliters)
- Water
- String
- Balance scale with weights
- Calculator
- Materials to measure (copper pennies, lead fishing weights, iron carpenter's nails, quartz, or granite, etc.)

Step 1: Mass

1. Use a balance scale to weigh each specimen to the nearest gram.
2. Record the weight in grams.

Step 2: Volume

1. Put water into graduated cylinder until it reaches an even number and is deep enough to submerge each specimen.
2. Tie a string to the specimen and completely submerge it into the cylinder.
3. Count the number of milliliters the water rises. This tells how much space the specimen replaces in the cylinder.
4. Each milliliter of water is equal to one cubic centimeter.
5. Record the number of cubic centimeters (cc) of volume.

Step 3: Density

1. Using your calculator:
2. Enter the mass of the material, then press the "division" key.
3. Enter the volume of the material and press the "equals" key. The total will be the number of grams per cc, or the density of the material.
4. Round the number off to the nearest tenth, if applicable. Record the answer.

Step 4: Specific Gravity

1. Use the information from Step 1.
2. Put water into the graduated cylinder until it reaches an even number and is deep enough to submerge each specimen.
3. Place each specimen into the cylinder separately.
4. Use the balance scale to weigh the cylinder with each specimen, separately.
5. Record the masses for the water, cylinder, and the specimen.
6. Using the formula for specific gravity, your information, and a calculator, calculate the specific gravity for each person.

Note: Use enough of each material to register several cc's in the cylinder. If you bundle several pennies or nails, be sure to weigh all of them together on the scale.

Laboratory Data Sheets

Material	Mass	Volume
_____	_____ g	_____ cc
_____	_____ g	_____ cc
_____	_____ g	_____ cc
_____	_____ g	_____ cc
_____	_____ g	_____ cc
_____	_____ g	_____ cc

Material	Density	Specific Gravity
_____	_____ g/cc	_____
_____	_____ g/cc	_____
_____	_____ g/cc	_____
_____	_____ g/cc	_____
_____	_____ g/cc	_____
_____	_____ g/cc	_____

1. Rank the materials on your chart from the least dense to the densest.
   a. _____ d. _____
   b. _____ e. _____
   c. _____ f. _____

2. Do you notice any differences between the least dense and most dense materials? Yes_____ No_____. If so, what did you notice? _____
   _____
   _____

3. If gold were <u>not</u> a very dense material, would panning have been a good way to find the Nuggets? Yes _____ No _____. Why? _____
   _____
   _____

4. If gold would have been the <u>least dense</u> material, where would it have been found in the pan? _____
   _____

5. Rank the materials on your chart from the lowest specific gravity to the greatest specific gravity.
   a. _____ d. _____
   b. _____ e. _____
   c. _____ f. _____

6. Do you notice any differences between the material with the lowest specific gravity and the material with the highest specific gravity? Yes _____ No _____. If so, what did you notice?_____
   _____
   _____

Science

Section IV: Amalgam

Objective: Students will learn about amalgams and can perform a simple science experiment to better understand the concept.

Amalgam

The miners discovered gold will bond with mercury, which is called an amalgam. While the two metals—mercury is a liquid metal in its normal state—join, they do not change chemically into a new substance, and can later be separated by heat.

Once this discovery was made, miners began to coat pans and copper plates to trap the gold. Mercury would not stick to the copper and would be scraped off and sent to be boiled off in a retort, which was like a still. Mercury boils at roughly 675° Fahrenheit, or 357° Celsius. Gold, on the other hand, has a boiling point of 5,000° Fahrenheit or 2,700° Celsius. The mercury would be boiled away and then recondensed into a liquid to be reused, which the gold residue would be further processed and purified.

While mercury was very beneficial to the mining industry, it was also a poison to those who used it on a regular basis. The symptoms of mercury poisoning vary greatly but can have long term negative effects on the human body and brain.

Copper and Steel Experiment

Materials:

- 20 dull brown pennies (pre 1990 dates work better because they contain more copper)
- 1 clean steel nail
- 1 tablespoon of salt
- ¼ cup of white vinegar
- Clear drinking Glass (not plastic)
- Plastic Spoon
- Paper Towels
- Non-metal bowl full of clean water for rinsing

Step 1: Put the vinegar and salt into the clear drinking glass and stir until the salt is dissolved. This creates an acid solution.

Step 2: Put the 20 pennies into the acid solution and observe what happens. Leave them in the solution for a minimum of 5 minutes.

Step 3: After a minimum of 5 minutes, use the plastic spoon to remove the pennies from the solution. **Do not dump out the solution**. Rinse the pennies with water and leave them on paper towels to dry.

Step 4: Place the clean steel nail in the acid solution so that part of the nail is in the solution and part is above the solution. Leave it in place for 15 to 20 minutes then remove from the glass. What does the nail look like now? Are there two different colors? Do you see a light copper color to the section that was in the solution? If not, put the nail back into the solution for a while longer.

Once the nail is finished in the solution, place on paper towels to dry before handing the part in the solution. The copper coating should remain once the nail has dried.

What happened to make the copper bond to the steel? See the following page for the answer.

What Happened?

Pennies are made of copper atoms. When oxygen atoms encounter the copper atoms, molecules called copper oxide are formed. Copper oxide gives the pennies that dull brown color. The acid that was formed by mixing the white vinegar with table salt caused the copper oxide to dissolve. With the copper oxide gone, the pennies looked clean again.

When the acid dissolved the copper oxide, it also dissolved some of the copper atoms that were on the pennies. Those copper atoms left the pennies and floated around in the acid, but some of their electrons were left behind, still attached to the pennies. That caused the floating atoms to have a positive charge, which are known as copper ions.

When the nails were added to the solution, some of the iron atoms left the nail just like the copper atoms left the pennies. The iron atoms also left some of their electrons behind. This caused the nail to have a negative charge. Since opposite charges attract each other, the positively charged copper ions that were left behind in the acid were attracted to the negatively charged nail. Therefore, the part of the nail that was left in the solution gained a light copper coating.