GEMSTONES

Teacher Guide

including
Lesson Plans, Student Readers, and More Information

Lesson 1 - What is a gemstone?

Lesson 2 - Describing gemstones

Lesson 3 - Gem lab

Lesson 4 - Hope Diamond

Lesson 5 - Gemstones Myths and Stories

designed to be used as an Electronic Textbook
in class or at home

materials can be obtained from the Math/Science Nucleus

EARTH SCIENCES - GEMSTONES

Lesson 1 - What is a Gemstone?

MATERIALS:

reader

Objective: Students learn the definition of a gemstone.

Teacher note

Gemstones fascinate students and adults. Some students may think that certain types of jewelry make the wearer appear to be rich or fashionable. Students may even wonder why people spend so much money on something that just looks pretty. Students basically think gems are pretty, shining, and just cool to wear.

Gems are stones or other materials that have value. Gems can be fashioned into jewelry. The use of stones in jewelry is usually referred to as the art of lapidary. The study of the gems is called gemology.

The following lessons can help students be astute buyers of gems. Many people spend too much money for jewelry, because most sellers realize that the public does not really understand the value of gems.

You may want to start this Gemstone unit with a discussion of what gems students think are expensive and why. You may want to have different samples of gemstones available for students to look at or even a jewelry catalog with gem prices.

The following websites may provide you with more information.

http://www.gemsociety.org - International Gem Society.
http://www.geogem.com - GeoGem International
http://www.gemstone.org/ International Colored Gemstone Association.
http://www.minerals.net/gemstone/index.htm - Mineral and Gemstone Kingdom
http://www.geocities.com/Yosemite/Trails/3085/Gemmology.htm - a link page
http://www.bsu.edu/teachers/academy/gems/ - " A Gem of a Story Online" - a virtual tour of the Smithsonian Institution's Gem and Mineral Hall.

"Diamonds are a girl's best friend," was popularized by Marilyn Monroe as a symbol of love and riches. But long before the movies, the early kingdoms of the world, were enhanced by the riches of the crown jewels.

Star ruby

The sparkle and brilliance of rubies, sapphires, and emeralds embedded in gold was the essence of power. The King and Queen's crown, was adorned with jewels and the symbol of their rule. The more jewels a kingdom possessed the more influence they had.

Star sapphire

But do gems really have power or is it just an illusion? Before we understood how gems were formed scientifically, it was easy to mistake gems as "gifts from gods." Gems were rare to find and the people who owned them were perceived to hold supernatural powers.

Gems are an oddity of nature. Throughout the ages humans have attributed special significance to gems and the jewelry they made from them. Charms made from gems, were thought to prevent evil from entering your body. Every month has a birthstone to provide good luck to its wearer. Beads, necklaces, earrings, and bracelets were all created to display gemstones.

Malachite necklace

Today gems are pretty to look at and are durable, but humans place the value on them depending on the fashion of the time. For example, in Renaissance times, green turquoise was greatly admired and cost more than other varieties. Today the blue turquoise is fashionable and has more value. In ancient Greece, only blue gems were valued, while in ancient Rome, green gems were prized.

Charm bracelet

A gem can be organic or inorganic, natural or human-made. They can be minerals, rocks, or anything that has been given monetary value. Only about 80 minerals are considered gemstones, and probably only about 30 are commonly found in jewelry stores. Examples of mineral gemstones include garnet, hematite, and diamond.

Some minerals are given a specific gem name which is different from its mineral name. For example beryl is the mineral name, while the green variety is called an emerald. Corundum is the mineral name for both sapphires (blue variety) and rubies (red variety).

Some minerals are not minerals because they are organic in nature. A pearl, although mainly calcium carbonate, is produced by a mollusk. Amber, or fossilized tree resin is also considered a gemstone. Other gemstones are really rocks, which are multiple minerals. An example is polished granite or obsidian. Finally, some gemstones aren't technically minerals because they are amorphous materials or lacking a regular crystal structure. Water within the chemical make-up of opal, creates an unorganized crystal structure.


Pegmatite with garnets from San Diego

Mineral gemstones form through igneous, metamorphic and sedimentary processes. Many gemstones are found in **pegmatites** which is a vein of concentrated minerals. It usually forms when magma cools inside the Earth's crust (**plutonic**). Elements and compounds become concentrated and "squeezed" through cracks of the surrounding cooled rock. Emerald, ruby, gold and silver and many other gems are produced in this way. In contrast, jadeite a beautiful green rock gemstone, and most garnets, are produced by **metamorphism** (high pressure and temperature).

Sedimentary rocks can also produce gemstones through precipitation. Many gemstones composed of quartz, such as amethyst, jasper, agate, and tiger-eye are examples. They form by water circulating just below the surface of the Earth with high concentration of dissolved silica. When the water passes through gaps in the rock, the silica precipitates slowly (hundreds to thousands of years) to form quartz minerals.


Agate

Amber

Other types of organic gems are all made in a different process. Amber is fossilized resin of ancient trees. It is brown to black and usually includes inclusions of ancient bugs that may have gotten trapped when the sticky resin was hardening. Amber is soft enough to be carved into artistic jewelry.

Ammonite

Fossils can be cut into gems to highlight their natural symmetry, like an ammonite. A jeweler can arrange the fossils in a necklace or bracelet to look very fashionable.

Coral

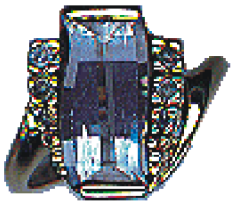
Coral are animals that produce a skeleton of calcium carbonate. When they die, their skeleton can be carved easily. Many forms of coral exist but only high quality red, pink, blue, black and white corals are used in jewelry.

Larry Wood, an artist, carved this amber

A pearl is formed when a particle enters the shell of a Pearl Oyster. The irritation caused by the particle secret calcium carbonate around the particle to ease the irritation. In 3 to 6 years a pearl is produced.

Pearl earring

How do you value a gem? One factor in valuating gems is its weight. Gem weight is measured and valued in carats. One metric carat equals 0.2 grams (.007 ounces). The word carat comes from carob, a Mediterranean tree whose seed was for centuries the standard for weighing precious stones. The price depends on that particular gem on the open market.



Sapphire ring

There are certain properties that will influence the price. The gem is worth more if it is natural versus synthetic. The natural color and how the coloring is distributed throughout the stone in important. If the stones have any flaws or inclusions, that could affect the durability of the stone, the value will decrease.

The three main factors on the quality of a gemstones are color, clarity, and color. Color should be determined under normal daylight, fluorescent, and incandescent to notice if there are any changes. The clarity of a gem can be determined by eye examination and by using a 10X magnifier to notice any inclusion or blemishes by looking at all angles of the gemstone. The cut of the stone is determined by its beauty, appeal, and symmetry.

Ruby and diamond ring

The price of the gem increases or decreases in value depending on how a jeweler arranges the gem on a ring, earring, bracelet or necklace.

EARTH SCIENCES - GEMSTONES

Lesson 2 - Describing gemstones

MATERIALS:

reader

Objective: Students learn about the classification and business of gemstones.

Teacher note

Gemology is the study of gems. A licensed gemologist can valuate different gems. They look at the cut, the lack of flaws, and the color. Each gem possesses different characteristic that increase or decrease of value of the gem. A deep purple amethyst will cost more than a slightly purple variety.

This classification will help students describe and critique the gems they will

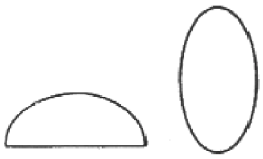
Gemstones can be divided into groups based on how they are formed. The most common groups are minerals, human-made gemstones, rocks, organic materials, or amorphous materials. The mineral groups are further divided into mineral families. For example, all the gemstones that have silica (SiO_2) as a building block are silicate gemstones**.**

Gemologists, or people who specialize in the study of gems are concerned with the identification, quality, and cut of gemstones. Lapidary is the craft of working with stone, especially gemstones**. Lapidarists** are the people responsible for the setting of the cutting of the gems. **Jewelers** are people who set the stones so people can wear the gems in a bracelet, ring, earring, or necklace.

Blue Topaz

Lapidarists work with gemstones in several different ways. The simplest method is called **tumbling**. The gemstone is put in a revolving barrel with sand. This rounds off the gemstone's corners and polishes it to a bright shine.

Gemstones can also be cut. The cutting style used for a particular gem is mainly determined by the optical properties of that gem. The simplest type of cut is known as a **cabochon**. The gem is cut with a flat bottom and a curved top. Gems with color like agate, hematite, and malachite are best suited for this style.



Cabochon

Tumbled gemstone

Cabochons emphasis the color texture, and are usually cut with a diamond coated saw blade.

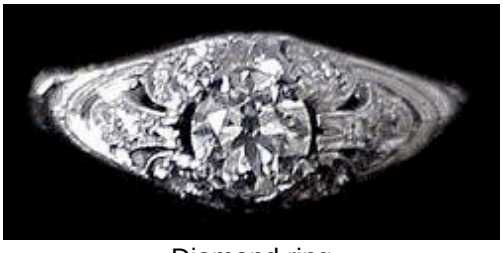
Polishing a cabochon

Gemstones can also be shaped by faceting. In this style, the gemstone is cut so that it has a large number of flat faces, or **facets**. Faceting takes advantage of cleavage, the natural planes of weakness in minerals. For example, an uncut diamond is difficult to cut, since it is one of the hardest substances known. A lapidarist has to take into account the different natural cleavage planes to assist in cutting the diamond. An uncut diamond is not pretty to wear. But a correctly faceted diamond can make a rainbow of every ray of light.

Uncut diamond

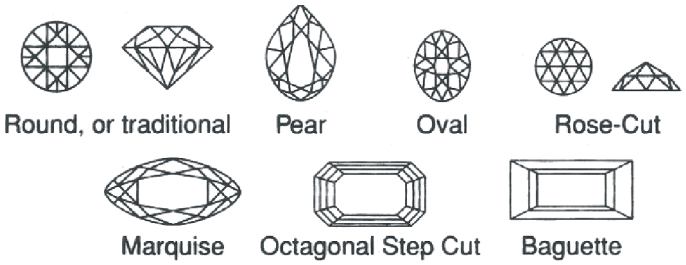
A lapidarist at work

A jeweler adds value to a faceted gem by setting it in an appealing ring or bracelet.



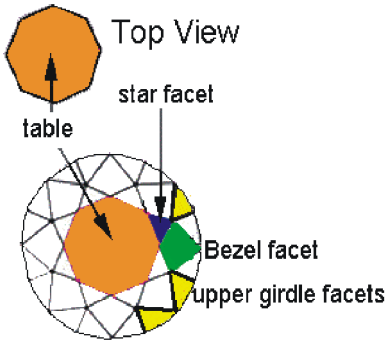
Diamond ring

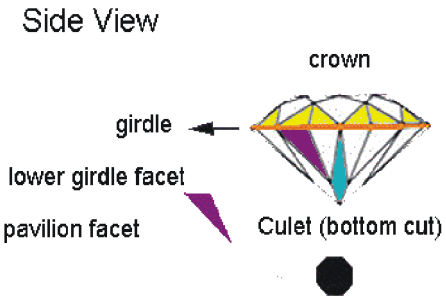
Faceting is the most complicated kind of cut, and creates the most valuable gemstones. The gemstone can be faceted in such a way that it sparkles. Patience is also important to fashion the various shapes shown.



Shapes of faceted gemstones

The cut faces of a gemstone have different names. The top of the gemstone is called the **crown** and the bottom is called the **pavilion**. The widest part of the gemstone is its **girdle**. The facets on the crown and pavilion have different names, depending on where they are located.





Softer gems emphasize the surface of the gem, not the internal play of light. These gems are carved by an artist to create their beauty. Designs or words can be engraved into the surface of the gemstone. The design is dependant on the artist.

Jade is an example of a gemstone that can be carved. It is usually the mineral jadeite or nephrite that is used to produce the characteristic green color. Jade is especially used to create decorative pendants.


Jade turtle


Cameo

A cameo is actually from a **mollusk** shell. Certain shells (especially conch type shells) have two different colored layers. The artist carves an image in one layer and the other layer is the background. Different types shells have different colors. Carvers work with a carving tool called a bullino, introduced by Italian carvers several hundred years ago, or small dental drills, to grind away the outside shell.

EARTH SCIENCES - GEMSTONES

Lesson 3 - Gemstone Lab

MATERIALS:

reader
gemstone chart
magnifying glass
Swift GH microscope
Earth Sciences - Gem Kit

Objective: Students describe different types of gems.

Teacher note

In this lab students should look at the gems in the kit and describe them. Some of the information can be taken from the Gem Chart. We recommend using a magnifying glass and a Swift GH (or other reflecting type microscope) to look at the specimens. The reader provides background information on each gem.

Students should look at shape, color, and internal flaws in the cut gemstones. The tumbled gemstones should be mainly described by their color, luster, and other unique characteristics.

Amethyst

Quartz has the most semiprecious gemstones of all minerals. Pure quartz is clear, so any impurity will allow the gem to have that color. Amethyst, is prized for it's deep purple color. The color caused by traces of ferric iron, determines the price of amethyst, the more intense and pure the color is the higher the price. However, some pale lilac, which was once considered low grade, has been recently marketed as "Rose de France." With its unusual cuts, it is gaining popularity and hence value.

Amethyst geode

Citrine is a yellow, brown color that is naturally caused by traces of organic matter. However, if you heat up clear quartz you can reproduce this yellowish color. Natural pale yellow citrine gemstones are rare compared to the brownish treat heated quartz.

Citrine

Tiger eye

Tiger eye quartz exhibits an **chatoyant** effect which is the shifting of light when the gem is moved, caused by fibrous **inclusions**. A skilled gemologist can craft a beautiful gem to capture this effect. Tiger eye should not be confused with the expensive Cat's Eye, a variety of chrysoberyl, the third hardest mineral.

Cat's Eye

Agate

Agate is a layering of quartz caused by the precipitation of the mineral in layers. Each layer has slightly different trace elements, so the color changes. Imagine a **geode** forming in a large void in volcanic rocks. Water, supercharged with silica, precipitates from the sides of the void toward the inside. This gives a layer affect. If the entire geode fills up (then it is called a **thunderegg**) and broken into pieces and tumbled, you can form beautiful layered stones. Many of the cheaper agates have brilliant colors, but these are artificially created.

Adventurine has a green color caused by hematite inclusions. Many mystics feel that adventurine contains the healing power of the green Earth and to release emotional stress. Adventurine is sometimes marketed as a jade-like gem.

Adventurine necklace

Opal is a prized gemstone because of its ability to refract light into milky or **opalescent** colors. Water is within its matrix so the silicon and oxygen are not securely bonded like in quartz. Opal is not as hard as quartz. The color changes depending on the angle you look at it, delighting the owner with an ever changing array of colors.

The Romans considered opal a symbol of hope because they felt a rainbow was locked inside the stone. Opals were raindrops from heaven in some Arab legends, falling in flashes of lightning, thus acquiring their fiery colors. Once considered the stone of kings, it was the second most prized gem only to emeralds. Other legends on the opal's power persist. Some feel the opal, if worn can cure diseases of the eyes. Today, some feel the black opal is unlucky but provides magicians with their powers.

Black opal from Australia

Peridot is actually a transparent green variety of olivine. Peridot has been mined as a gemstone for an estimated four thousand years. Cleopatra is said to favor the green stone. Pliny (a Roman) even wrote about the green stone form Zagbargad Island in 1500 B.C.

Peridot

The garnet is a family of gems rather than a single gemstone. Garnets consist of many varieties from brown, yellow, white, green to black. Only the deep red are used as precious gems, and sometimes the green. They were very popular in the Victorian times.

Garnet

Hematite is not a common gemstone because it is an ore of iron and is very heavy. Some varieties of specular hematite have a pretty metallic luster.

Hematite

EARTH SCIENCES - GEMSTONES

Describing Gemstones

Problem: How do you describe gems?

Hypothesis:
Procedure: Look at the gems with your microscope or hand lens. Describe the characteristics of each specimen. You may wish to consider such features as color, shape, or other mineral key characteristics. Be sure to describe the cut of each faceted gemstone. Use the information on the gemstone chart to guide you. Draw your specimen in the space provided. Use the "gem cut" diagram in the reader to describe the overall shape.

GEMSTONE NAMES	DRAW YOUR SPECIMEN
citrine **Formula:** **Describe:**	
opal **Formula:** **Describe:**	
garnet **Formula:** **Describe:**	
peridot **Formula:** **Describe:**	
amethyst **Formula:** **Describe:**	

hematite **Formula:** **Describe:**	
agate **Formula:** **Describe:**	
adventurine **Formula:** **Describe:**	
tiger eye **Formula:** **Describe:**	
plastic gem **Describe:**	

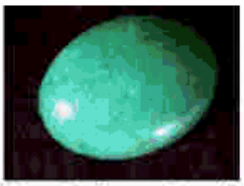
CONCLUSION: Based on your observations, how are minerals different than gemstones?

Are the differences easy to recognize?

Why can a “plastic gem” be considered a gemstone?

Gemstones

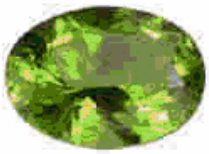
Silicate Gems



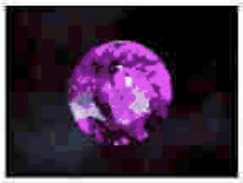
Adventurine - Quartz
SiO_2

Emerald - Beryl
$Al_2Be_3(Si_6O_{18})$

Agate - Quartz - SiO_2

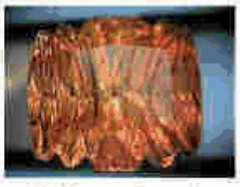


Peridot - Olivine
$(Fe,Mg)_2SiO_4$



Amethyst - Quartz
SiO_2

Opal - Opal
$SiO_2 \cdot H_2O$



Citrine - Quartz
$-SiO_2$

Almandite - Garnet
$Fe_3Al_2(SiO_4)_3$

Tiger Eye - Quartz -
SiO_2

Organic Gems

Pearl -
obtained
from a mollusk

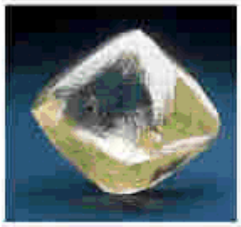
Amber -
a resin of fossil trees

Other Gems

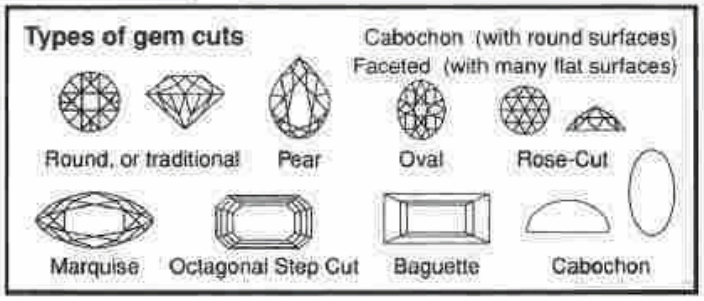
Ruby - Corundum
Al_2O_3

Sapphire - Corundum
Al_2O_3

Hematite -Hematite
Fe_2O_3



Diamond - Diamond
C



EARTH SCIENCES - GEMSTONES

Lesson 4 - Hope Diamond

MATERIALS:

reader

Objective: Students read about diamonds.

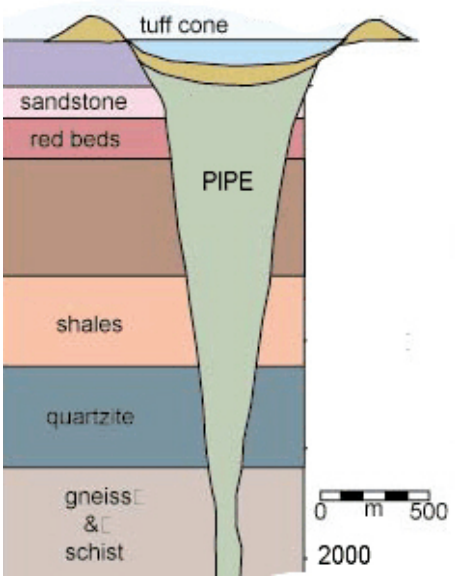
Teacher note

Diamonds were first discovered in India. The next large deposit was found in 1720 in Brazil, followed by the large kimberlite mines in South Africa in 1867. Diamonds are formed under extreme pressure. Kimberlite pipes are thought to be very deep pockets of the upper mantle that erupt as a rare type of volcanic vent referred to as a "pipe."

This reader introduces students to diamonds and the most famous diamond, called Hope. Hopefully this can lead into a discussion about the diamond trade.

Diamonds are beautiful, dazzlingly bright gemstones that are composed of **carbon**. Diamond is the hardest known substance due to carbon atoms forming a tightly bound three dimensional structure. It is strange that a soft mineral, graphite is also made of carbon, but the atoms are far apart.

Diamonds form naturally within the Earth in a rare volcanic occurrence that brings magma from the upper mantle in a pipe. There are only a few places to find **kimberlite pipes** like India, Brazil, South Africa, and even in the state of Arkansas. Many times erosion will cause diamonds to settle in river beds, where they are mined as **placer deposits**. Diamonds can be artificially made, but usually do not have the clarity or brilliance of a natural diamond. The crystal shape of a diamond is octahedral. However, diamonds have many cleavage surface which allows them to be faceted. A diamond cutter is skilled in the **cleavage** planes, and can use diamond dust and oil to smooth the surface to create the splendor that diamonds produce.



Kimberlite pipe


Oppenheimer the largest Uncut diamond (253.7 carats)

The Hope Diamond, surrounded by 16 smaller white diamonds

The Hope Diamond is a special deep blue colored diamond. Its color comes from the presence of small amounts of boron (B) in the crystal structure. The Hope Diamond has an interesting and tragic history. Its story began in India in 1668, when a French traveler, Jean-Baptiste Tavernier, acquired a crudely cut 112 3/16-carat blue diamond. Some sources say Tavernier stole the gem from the eye of a temple statue. Tavernier returned to France, where he sold the gem to King Louis XIV of France in 1668. Tavernier soon went bankrupt. He decided to return to India, but almost drowned during the sea voyage. He died soon after arriving, supposedly being eaten by wild dogs.

Marie Antoinette

Louis XIV had the blue diamond cut into a heart-shaped 67 1/8-carat gem, which he wore during court ceremonies. The gem seems to have been bad luck to Louis XIV's descendants. Louis XVI and his wife Marie Antoinette both wore the diamond. They were killed during the French revolution in 1793. This event was the end of the French kings. The diamond was stolen during the robbery of the French crown jewels. It reappeared in 1812 in a smaller, 44.5 carat size. Supposedly, the cutting was done by a Dutchman named Wilhelm Fals. He is said to have died of grief after his son, Hendrick stole the gem from him. Hendrick Fals later killed himself.

Tragedy continued to affect the owners of the stone. The King of England, George IV soon acquired the diamond. He too went bankrupt and died in 1830. The gem was next bought by Henry Hope of London. Hope had the stone recut into its present shape, hence its name, the Hope Diamond. Hope's descendants also lost all of their money. They sold the stone to a Turkish sultan, Abdul-Hamid II. He was overthrown by an army revolt within a few months, and died penniless.

Abdul-Hamid II, last sultan of Turkey

McLean wearing the Hope Diamond

The Hope Diamond reached the United States in 1912, when it was bought by Evelyn Walsh McLean, a wealthy American. Her subsequent family life was filled with sad events. Her son died in an automobile accident. Her husband went insane. Her daughter died of an overdose of pills. After Mrs. McLean's death in 1947, a jeweler named Harry Winston purchased her jewels, including the Hope Diamond. Winston gave the gem to the Smithsonian Institution in 1958. This end of private ownership seems to have ended the curse of the Hope Diamond.

The Hope Diamond is on display at the National Natural History Museum, a part of the Smithsonian Institution, in Washington, D.C. If you ever go to this museum, you will be able to tell where the Hope Diamond is because of the large crowds of tourists.

The Hope Diamond with its diamond-studded necklace.

EARTH SCIENCES - GEMSTONES

Lesson 5 - Gemstone Myths and Stories

MATERIALS:

reader
Internet
reference books

Objective: Students learn different stories on gems.

Teacher note

There are many people that believe in the powers of gems. This activity has students look at myths, supernatural powers, and science to determine which stories are fact and fiction. It also has students understand that "mysticism" can be fun, but it is not based on fact.

As a teacher, you should be sensitive that some students may have relatives that are believers in some gem's crystal powers. Be careful not to denigrate these groups, but to have the students make up their own mind.

The Internet has many sites devoted to the healing of crystals. Have students do a search on "gem lore, crystals, gems, mysticism" or other words that might get stories from crystals. Some of the information below can help students search a mineral and see if there are any stories (fact or fiction) that might be interesting.

Vogel quartz crystals

The practice of crystal healing claims to use the "power" of gems to aid in physical, metal, emotion, and spiritual healing. There is no scientific evidence that gems have any healing powers. However, there are many people around the world that believe in their mystic powers.

There is no scientific proof that crystals and gems have any supernatural power. However, some interpret a minerals uses, for its power. For example, quartz crystals were used in radios to concentrate the radio signals. This was magic to most people, and hence quartz can do extraordinary things. Stories grow into myths and then into wildly exaggerated stories. For example, Vogel crystals are claimed to be "specially tuned" quantum converters designed to assist in utilizing energies.

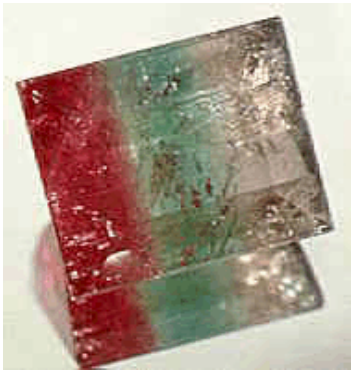
Red quartz crystals from China


Opal

Lists of gems that can heal read like a doctor's prescription. Acne can be aided by rose quartz while anemia can be treated with hematite, garnet, or bloodstone. Pain can be eased by peridot, smoky quartz, or amber. Mystics will use the stones to rub the body to help cure the illness.

Many stones have stories of how they help calm the mind. For example amethyst is used by healers in meditation and spiritual enhancement. It is used to scare away nightmares when placed in one's pillow. Amethyst lends courage and strength to the wearer and sometimes exchanged between lovers and is a symbol of love.

Other stories relate how the gem can cure illnesses. For example aquamarine is said to reduce fluid retention and calms coughs, while protecting the liver. It can prevent baldness. It can be placed in water and allowed to sit in the moonlight, creating a liquid used for purification and psychic enhancement.


Multicolored tourmaline

Many of these stories are not true, but sometimes you can look at some gems like a black opal, and imagine the energy within. The multicolored tourmaline is a bizarre, oddity of nature, so it must have special powers.

Research the internet or reference books and write an essay on a gem that is of interest to you. Fill out the worksheet to guide your topic.

Gemstone Myths and Stories

Gemstones are magical and mythical. Write a story on your favority gem. See if you can find some fun or true facts that will make the gemstone easy to remember. Use a search engine on the internet to find at least 3 sites to help you. Record then in the appropriate place below. Remember not everything you read on the internet is true.

Site	Briefly describe site

Write a paragraph on stories of your favorite gem.

Earth Science- Gemstones - Unit Test

Part 1. Definitions Place the letter of the definition next to the correct word.

Column 1	Column 2
1. mineral	a. something pretty and valuable
2. gemstone	b. a solid material lacking a crystal structure
3. rock	c. a method to round gemstones by polishing
4. amorphous material	d.the cut face of a gemstone
5. gemologist	e. a natural, inorganic, solid crystalline material
6. tumbling	f. the art of making gemstones
7. lapidary	g. a common mineral gemstone
8.crown	h. composed of many mineral crystals
9. facet	i. a person who studies gemstones
10. quartz	j. the top of a gemstone

Part 2. Multiple Choice Choose the best answer to complete each statement.

1. Which of the following is not a property of gemstones
    a. durability
    b. beauty
    c. age
    d. rarity

2. Which of the following can not be made into a gem
    a. mineral
    b. amber
    c. coral
    d. flower

3. Mineral gemstones form in
    a. igneous rocks
    b. metamorphic rocks
    c. sedimentary rocks
    d. all of the above

4. Which is the mineral name of sapphires and rubies?
    a. beryl
    b. corundum
    c. quartz
    d. garnet

5. If a gemstone has many cut faces, it has been made by
    a. tumbling
    b. cutting
    c. carving
    d. natural processes

6. The Hope Diamond
    a. is the world's largest crystal
    b. is the world's largest red diamond
    c. is the world's largest diamond
    d. owner's had many tragic lives

7. Stories about gems that heal people are
    a. based on the movies
    b. based on fact
    c. have not been proven
    d. are true if read on the Internet

8. Gemstones are classified by
    a. where they were purchased
    b. how they formed
    c. who found them
    d. their chemical composition

9. The most common type of gemstones are
    a. organic gemstones
    b. silicate mineral gemstones
    c. amorphous gemstones
    d. diamonds

10. Gemstones and minerals
    a. are easy to tell apart
    b. are always the same
    c. form the exact same ways
    d. are hard to tell apart.

ANSWERS:

PART 1

1. E
2. A
3. H
4. B
5. I
6. C
7. F
8. J
9. D
10. G

PART 2

1. C
2. D
3. D
4. B
5. B
6. D
7. C
8. B
9. B
10. D