MINERALS, GEMS, AND ROCKS:
QUESTIONS, ANSWERS, AND ACTIVITIES
by
Susan Ward Aber

Sparkling to Practical:
Minerals and Gems
1. What puts the "SparkleFun" in Crest™ toothpaste?
2. What puts the "sparkle" in fireworks?
3. What puts the "sparkle" in snowflakes?
4. What are some physical properties that are responsible for the sparkle or shine in minerals and gems?
5. What are the primary uses of some of the following minerals?
   Muscovite  Copper  Rutile
   Barite  Graphite  Bauxite
   Hematite  Halite  Diamond
6. What is diamond made of and how is it different from its counterpart graphite?
7. Do all snowflakes look alike?
8. What is the definition of a mineral? a gem? a mineraloid?
9. Tell the difference between brilliance, scintillation, and dispersion?
10. Is red a common diamond color?
11. If diamond is the hardest known substance on Earth, how is it cut and faceted?
12. Diamond cannot be scratched easily so why is it not indestructible?
13. What is one way to separate diamond from other rocks and minerals at the mine? And what does this have to do with doing the dishes?
14. Which countries are the big producers of diamonds today?
15. Are diamonds the only “pretty” gemstone?

3. Ice is a mineral, which interacts with light in such a way to produce a sparkle; specifically, ice sparkle demonstrates an optical property of minerals.
4. Cleavage, crystal form or habit, luster, hardness, and cut (faceting and proportions) can all make minerals shine or sparkle.
5. Primary uses of each of the minerals are: muscovite-toothpaste, wallpaper and insulators; copper-electrical purposes; strontium-fireworks and flares; barite-oil and gas-well drilling heavy mud; graphite-lubricant; bauxite-aluminum products; hematite-steel manufacturing; halite-food preservative; diamond-industrial cutting (3/4 of all diamonds go industrial, 1/4 for jewelry).
6. Carbon atoms make up diamond and graphite but in each crystalline structure, the atoms are arranged in a special way. The two minerals differ in use, hardness, luster, cleavage, crystal form or habit, economic value, and more.
7. Snowflakes are a collection of ice crystals and recent studies have shown close appearances for some crystals.
8. A mineral is a naturally occurring, homogeneous solid with a definite (but not fixed) chemical composition, ordered crystalline structure, usually inorganic in origin. A gem is something for personal adornment that possess beauty, rarity, and durability. A mineraloid is a term applied to substances that do not match exactly with the definition of a mineral.
9. Brilliance is the intensity of returning light; scintillation refers to the flashes, twinkling, or sparkle of returning light; and dispersion or fire is the spectral colors of the returning light.
10. Red diamonds are the most rare, with only five known in the world today.

ANSWERS
1. Specifically it is muscovite’s cleavage, a physical property, that is responsible for that sparkle.
2. Fireworks sparkle because elements and compounds extracted from minerals are ignited; specifically, fireworks exploit a chemical property of minerals.
11. Diamond must be used to cut itself. Diamond impregnated saws and diamond dust on grinding and polishing wheels cut and facet other diamonds.

12. Diamond can be cut with another diamond and it is easily broken because of its well-defined, perfect, four-directional cleavage.

13. Diamond can be separated on greased conveyor belts because diamond has an affinity to grease. A diamond submerged in greasy dishwater will be coated with grease and appear dull and lifeless.

14. South Africa was a major producer of diamonds until the 1980’s when Australia became the number one producer of diamonds, by weight. Zaire, Botswana, Russia, and South Africa are the next four big diamond producing countries.

15. Diamonds are valued for their extreme hardness and resulting beauty, but they are not the only pretty gemstones. Beauty is in the eye of the beholder!

Diamonds Eternal

Diamonds have been a source of intrigue and utility for hundreds of years. As the hardest natural substance on Earth, industrial quality diamonds play a key role in science and industry. Finely crushed diamonds coat the edges of saw blades and drills to help cut through the hardest of metals. Diamond’s ability to reflect, refract and disperse light, creating superior brilliance, scintillation and fire, makes it valued as a gem. After mining, gem-quality diamonds are sorted, cut, polished, and set.

Scientists at General Electric were the first to synthesize industrial quality diamond in 1955. Gem-quality diamond was synthesized by 1970, but at that time was more expensive to produce than natural diamond. Synthetics have identical physical, optical, and chemical properties as their natural counterparts. It is difficult, but not impossible, to tell synthetic from real diamond.

The chemical composition of diamond is pure, natural carbon, the same element that forms the basis of such common substances as sugar, coal and graphite. The crystal structure is organized in a tetrahedral arrangement that results in the mineral’s extreme hardness and perfect four-directional cleavage.

Learn more interesting facts about diamond while recalling your knowledge of world history. Match the time (using the correct letter) and diamond event.

A. 2 billion years BC  F. 1600
B. 10,000 BC  G. 1824
C. 800 BC  H. 1905
D. 1300 AD  I. 1962
E. 1477

1. In the time of Shakespeare, London became a major center for sorting rough diamonds.

2. At the time of early human civilizations, diamonds were being deposited on some ancient beaches and in riverbeds.

3. A few years after history’s first airplane flight, the world’s largest rough diamond, the Cullinan Diamond, was mined in South Africa.

4. As some of Europe’s great cathedrals were being built, diamonds were first cut for jewelry purposes.

5. About a billion years after life appeared in the form of bacteria and blue-green algae (cyanobacteria), carbon crystallized into diamond deep beneath the Earth’s surface.

6. During the Space Age, diamonds were first mined on the ocean floor.

7. The year Beethoven completed his Ninth Symphony, Friedrich Mohs developed the mineral scale of hardness.

8. Fifteen years before Columbus landed in the New World, an Austrian archduke gave the first diamond engagement ring to Mary of Burgundy.

9. Around the time of the first Olympic Games in Greece, diamonds were first mined in India.

Answers at the end of this exercise.

If diamonds are properly cut and proportioned, beauty results from unique optical properties (Fig. 2-1). These optical properties

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²Adapted from: “DIAMOND IS FOREVER”, Lifetime Learning Systems, Inc. 79 Sanford Street, Fairfield, CT 06430 (203-259-5257) and Diamond Information Center, NW Ayer Inc., Worldwide Plaza, 825 8th Ave., NY, NY 10019-7498.
lead to diamond brilliance, scintillation and fire. The diamond cutter uses laws of physics to maximize each of these properties.

Examine the paths of light shown in Fig. 2-2. The lower facets on cut stones act like mirrors and prisms, taking the light and reflecting, refracting and dispersing it into rainbow colors. Identify the ray and fill in the matching letter.

Answers at the end of the exercise.

Students can do a follow-up project on a diamond event from the world history matching exercise or independent research on: the similarities and differences between diamond-mining methods or sketch and detail a poster of the various ways diamonds are mined, like open-cast mines, deep (pipe) mines or alluvial mines.

Additional study can divide the students into small groups and research the stories of famous diamonds, such as: the Cullinan (the Cullinan I, II, III, IV, V, VI, VII, VIII, IX), Koh-i-noor, the Hope Diamond, Jacobus Jonker, Regent (a.k.a. Millionaire Diamond), Orloff (a.k.a. Orlov, Amsterdam, Lasarev, Sceptre, or Scepter), Jubilee, Star of Sierra Leone, Excelsior, Sancy Diamond (a.k.a. Astor Sancy), Nassak Diamond (a.k.a. Eye of Siva, Nasik, Nassac, Nassack or Nessuck), Star of South Africa (a.k.a. Dudley Diamond), Star of the South, Uncle Sam Diamond, Darya-I-Nur Diamond (a.k.a. Durria-I-Nur, Darya-e-Nur, or Darya-eye-Noor), or any more the student finds! [The Diamond Dictionary (reference shown on p. 15) is a good beginning source for this project, though many general reference works could be consulted.]

ANSWERS

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

A. Refractive B. Reflective C. Dispersive

Glittering Gold

Background

What was the largest, pure gold nugget ever found? The "Welcome Stranger" gold nugget, found in Victoria, Australia, weighed 2,280 ounces (about 142 pounds) and was two feet long!

Gold, one of the world's noble metals, is found in a free state in nature and has an exceptional resistance to corrosion and oxidation. Gold combines beauty, easy workability, and rarity, with virtual indestructibility. Gold was fashioned only for royalty and the very wealthy in past times because of a lack of sophistication in gold mining and few goldsmiths.

The price of gold is expressed in troy

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ounces, but most countries measure it in grams (1 troy oz. ≈ 31 grams). The term "troy ounce" is British, even though the word is derived from Troyes, France. One troy ounce is equal to 480 "grains". Grain is the standard unit of weight used in ancient Mesopotamia, as well as the average weight of a grain of barley or wheat.

Karat is a measurement of the fineness or purity of gold. Pure or fine gold is 24 karats or by the European system, 999 points fineness. The word karat derives from several different words meaning the seed of the fruit from a carob tree. These seeds were used much like the "grain" as a standard measurement unit. Do not confuse karat, a measurement for metals, with carat, a measurement for gems (one gem carat equals 200 milligrams or 0.2 grams; a standard adopted in the U.S. in 1913).

Pure gold is too soft for use in jewelry; therefore, it is mixed or alloyed with other metals, such as copper, nickel, zinc, silver, or palladium. When gold jewelry turns skin colors and causes a rash, it is usually an allergic reaction to the nickel or copper. Table 3-1 shows the purity of gold, gold content, and fineness. Table 3-2 lists the metals alloyed with gold to produce color.

<table>
<thead>
<tr>
<th>Karatage</th>
<th>Gold Content</th>
<th>Fineness</th>
</tr>
</thead>
<tbody>
<tr>
<td>24K</td>
<td>100%</td>
<td>999</td>
</tr>
<tr>
<td>18K</td>
<td>75%</td>
<td>750</td>
</tr>
<tr>
<td>14K</td>
<td>58%</td>
<td>585</td>
</tr>
<tr>
<td>12K</td>
<td>50%</td>
<td>500</td>
</tr>
<tr>
<td>10K</td>
<td>41%</td>
<td>416</td>
</tr>
</tbody>
</table>

Table 3-1. Gold content measurements.

<table>
<thead>
<tr>
<th>Gold Color</th>
<th>Alloying Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>yellow gold</td>
<td>gold, copper, silver</td>
</tr>
<tr>
<td>white gold</td>
<td>gold, copper, zinc, nickel, palladium</td>
</tr>
<tr>
<td>green gold</td>
<td>gold, copper, silver, zinc, palladium</td>
</tr>
<tr>
<td>pink gold</td>
<td>gold, copper</td>
</tr>
</tbody>
</table>

Table 3-2. Gold colors and alloying metals.

The minimum legal standard of karatage in the U.S. for something to be called "gold" is 10K. The minimum standard in Canada is 9K; in Mexico, 8K. Legally in the U.S., gold articles do not have to carry the quality or karat mark. However, if the karat mark is applied, then it must be accurate and registered.

Various non-karat gold techniques are used: gold filled, gold plate, gold electroplate, and vermeil. Gold filled is 10K gold or better mechanically bonded to the surface. The layer of gold must be at least 1/20th of the total metal weight (typical marking: 1/20th 12K GF or 12 Karat Gold Filled). Gold plate or rolled gold is the same as gold filled but the karat gold can be less than 1/20th (typical marking: 1/40th 12K RGP). Gold electroplate is an electrolytic process where a gold coating is applied, not less than 10K fineness, and a minimum thickness of 7 millionths of an inch. Vermeil is electroplated or mechanically bonded 10K (minimum) over a base of sterling silver; the thickness must be at least 120 millionths of an inch.

Materials

Make a copy of the essay and questions for each student. Have samples or pictures of gold for students to see: jewelry, electronic circuitry, astronaut helmet, teeth, art objects, etc. Have at least 500 grains of wheat or barley and a sugar cube for a demonstration.

Demonstration

Grains of wheat and barley vary in weight depending on the moisture content and are therefore not a reliable standard. It is stated in the essay that one troy ounce of gold is approximately equal in size to a sugar cube. Count out 480 actual grains of wheat or barley, weigh them, and compare the results and volume difference.

Activity

Read the following essay taken from Out of the Rock, by National Energy Foundation, 1994:

All That Glitters

Since the beginning of civilization, no metal has both inspired and corrupted more people than gold. Its many uses include religious worship, artistic decoration, coins, jewelry, and
electronics. It is essential in the aerospace industry, and it was the substance used to create our first human artifact to leave the solar system. The artifact was a plaque mounted on the Pioneer 10 spacecraft. What makes gold so unique? Why have so many people risked their lives in exploration and war to obtain this metal that is not necessary for survival?

Perhaps primitive man was first captivated by gold's beauty. Its bright yellow color and gleaming luster must have made it something of a treasure, even though it is too heavy (nineteen times as heavy as water) and too soft to be used for tools. Its beauty is still the property that makes it the most popular metal for jewelry and other decorative items.

In addition to being beautiful, gold is also extremely durable. It does not corrode when exposed to air, water, and most common acids and alkalis. When underwater explorers search old shipwrecks, most of what they find is rusted and decomposed, but objects made of gold remain bright and shiny even after many years under water. Gold fillings and caps on teeth are unaffected by the chemicals in food, beverages, and saliva.

Gold is also an excellent conductor of electricity, making it a valuable component in electronic equipment. It is frequently used in switches where the electrical connection is exposed to air but must not corrode. For instance, you can see gold wires in the little plug that attaches your phone cord to your phone. The computer industry relies heavily on such connections. Its conductivity also enables jewelers to electroplate gold onto another metal, thus giving the appearance, but not the expense, of pure gold.

Two other properties that make gold particularly useful are its ductility and malleability. Ductility refers to its ability to be pulled into thin strands without breaking. One troy ounce of gold (about the size of a sugar cube) can be pulled into a thread fifty miles long! That's a lot of electrical wire. Malleability refers to gold's ability to be hammered into thin sheets without breaking. A troy ounce can be made into a sheet which can cover 108 square feet. It would take about one thousand of these sheets to equal the thickness of a sheet of paper. Gold in this form, known as "gold leaf," has been used to overlay furniture, picture frames, mummy cases, windows, and even entire buildings. Gold foil is used by NASA as sheathing to protect spacecraft, satellites, and astronauts themselves from the sun's radiation.

Gold's initial popularity was based on beauty and mythological association with the gods and with the sun. Now it has become a necessary part of our modern, technological society. (Level 3, p. 42)

Precede or follow this lesson with a Bureau of Mines video tape: "Gold in Modern Technology" (see page 30). Read the activity and essay, answer the following.

Questions from essay:
1. Why is pure gold unsuitable for tools?
2. What is meant by "ductility"?
3. What is meant by "malleability"?
4. Why is gold so important in a modern technological society?
5. Make a list of five items in a home which contain gold.

Questions from background material:
6. What is the difference between 14K gold and 24K gold?
7. What metals must be alloyed with gold to result in the white color? green? pink? yellow?
8. What is meant by vermeil?
9. What is the minimum legal karatage for gold in the U.S.?
10. What is the difference between the gold terms karat and troy ounce?

ANSWERS

1. It is too soft.
2. Ductility is the ability to be pulled into thin strands without breaking.
3. Malleability means gold is readily shaped or hammered into thin sheets without breaking.
4. Gold has many uses in modern society in space and industrial applications, where other substances would corrode or decompose.
5. This is an answer the students will arrive at, though some possibilities are: furniture overlay (say table legs or clock decorations?),...
picture or mirror frames, jewelry and watches, teeth, money, components in electronic equipment and telephones, dishes and decorative items or as a mineral on display.

6. 14K gold is 58% gold and 42% other alloying metals, whereas 24K gold is pure gold.
7. White gold is made of gold, copper, zinc, nickel, and palladium. Green gold is gold, silver, zinc, and copper. Pink gold is gold and copper. Yellow gold is gold, alloyed with copper and silver too.
8. Vermeil is gold electroplated or mechanically bonded over a base of sterling silver.
9. The minimum legal karatage of gold in the U.S. is 10K, to be called gold.
10. Karat is a unit of measure of the purity of gold, whereas troy ounce is a British weight term.

Make a Collection!

Students love to collect minerals, gems, and rocks, but may need some help in organizing a collection. They should identify the specimens, create labels and group the specimens in some way. Most specimens can be identified using reference books (see pages 26-27) but you may wish to enlist the aid of an "expert". Check in your area for members of local rockhound clubs, college or university resource people, gem society members/local jewelers, or individuals that help with geology 4-H or scouting programs. Invite a knowledgeable person on the same day the students bring their collections or before they start work on them. Besides a guest speaker, Internet surfing or videos can spark students' interest (see pages 27, 29, 30). Students can be encouraged to attend a gem and mineral show in the area, for example the Kansas City Gem & Mineral Show held each year in March and November.

The collection will be more useful and interesting if there is proper identification, information on the collector, locality, age of specimen (if rock, this information is found on geologic maps), and date of collecting. One can also include the specimen's use such as the mineral, halite, is table salt, used for food preservation and flavoring.

A collection can also be organized by origin (rocks are either sedimentary, igneous, or metamorphic), mineral classifications (native elements, sulfides, oxides, etc.) or by locality (country, province, state or county).

Materials

An assortment of rocks and minerals to show the class would be a good way to begin. Have resource books available and a "label master". Shallow boxes (soda pop "flats" or egg cartons) work well for displays.

<table>
<thead>
<tr>
<th>ROCK TYPE</th>
<th>SPECIMEN NAME</th>
<th>COLLECTOR</th>
<th>LOCALITY</th>
<th>AGE OF ROCK</th>
<th>DATE</th>
<th>USE</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>MINERAL</th>
<th>CLASSIFICATION</th>
<th>SPECIMEN NAME</th>
<th>COLLECTOR</th>
<th>LOCALITY</th>
<th>DATE</th>
<th>USE</th>
</tr>
</thead>
</table>

A Burst of Light

The colors in a fireworks display are produced by mineral compounds or mixing these compounds. Two-thirds of our fireworks are used by private consumers, usually small displays. The other third is used for the spectacular public displays. Most of the consumer fireworks and half of the special displays are imported from China, Japan, Korea, France, and Italy.

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Materials
Extreme caution is needed for this activity and it is not suitable for large groups or younger grade levels.

You will need a gas jet or Bunsen burner, wooden splints or nichrome wire (with a cork on one end to allow safe holding), small beakers, and ionic solutions. Solutions used contain: sodium (Na+), calcium (Ca2+), barium (Ba2+), iron (Fe3+), nickel (Ni2+), strontium (Sr2+), copper (Cu2+), potassium (K+), and lithium (Li+). Be sure to label the beakers of solutions and have a squirt bottle of water and a beaker of water (if splints used).

Activity
Make separate saturated solutions by stirring the relevant chloride solids, NaCl, CaCl2, etc. into a small amount of distilled water until dissolved. Soak wooden splints or skewer sticks overnight before executing this activity. If nichrome wires are used simply immerse and begin. Note: Dilute HCl must be used to clean the wire at the start of each immersion (dip in HCl and then burn this off in the flame).

Precede this flame test with a discussion on how minerals are used by society (see pages 28, 29), where and when fireworks used (July 4th and other celebrations, concerts, sporting events, etc.), and show these elements on the periodic table.

1. Extreme caution and close supervision is needed for this exercise.
2. The wood splints should have soaked in the solutions overnight. It is important to keep the wood splint properly identified with the ionic solution in which it was soaked.
3. Light the Bunsen burner and place the splint or nichrome wire just above the flame, observing the different flame reactions. Some of the reactions burn out quickly and the splint will catch fire (have beaker of water to plunge wood splint in to). (Remember: if the nichrome wire is used, it must be thoroughly cleaned in HCl and burned off between solutions.)
4. Some of the solutions tested will not react.

This shows that not all elements produce color. Repeat the activity for each solution.
5. Record the observations and note the color each solution produces when heated.

ANSWERS
K=pale lavender Ca=orangy red
Sr=orangy-red Cu=kelly green
Ni=no reaction Li=crimson red
Fe=no reaction Na=orange-yellow
Ba=pale green

Snowflakes

When water molecules are frozen into ice they adopt a crystalline structure that is six-sided or in various hexagonal shapes. Ice crystals can form from water droplets freezing directly onto blades of grass or when water vapor condenses as frost on window glass. Snowflake is a term reserved for ice crystals or snow particles that fall from the atmosphere and these fresh snow crystals can be captured for study.

Changing temperature conditions affect the symmetry of the crystal formation. It takes 15-30 minutes for a snow crystal to form; the largest are about 4 mm in diameter. The best time to do this activity is when the ground air temperature is below 0°C and cloud temperatures from -15 to -10°C. Different temperatures will produce different snowflake shapes (Table 6).

<table>
<thead>
<tr>
<th>Snowflake shape</th>
<th>Cloud temperature range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat six-sided flakes</td>
<td>-24°C to -8°C</td>
</tr>
<tr>
<td>Needle-shaped flakes</td>
<td>-8°C and above</td>
</tr>
<tr>
<td>Hexagonal pillar flakes</td>
<td>-24°C and below</td>
</tr>
</tbody>
</table>

Table 6. Characteristic shapes of snowflakes.

Over 80 snowflake shapes or snow crystal structural categories are listed by atmospheric scientists. Basically all snow crystals can be grouped into one of seven

different types, according to the International Snow Classification System (Fig. 6.):

Stellar: six-pointed stars

Dendrite: branches stick out at right angles from a flat crystal surface

Plate: smooth-sided hexagons

Irregular: plate-like, commonly joined

Column: six-sided tubes, either flat or pointed ends.

Capped column: column crystals with a plate crystal at either end

Needle: long, slender, six-sided columns

Fig. 6. Snow crystals. Taken from Bentley & Humphrey's *Snow Crystals*, by Bentley and Humphreys, 1962, New York, NY: Dover Publications.

**Materials**

Students can capture their own snowflake collection, searching for the different types listed above or for matching crystals, snowflake twins. You need cold, snowy weather (help from Mother Nature!), embroidery hoops (one per student or team), clear plastic wrap, clear acrylic spray (or hairspray) and boxes with lids. A hand-held magnifier, glass slide and cover plate, microscope, and camera can all be used to view your collection.

**Activity**

All materials used in this experiment should be kept outdoors in a covered box, 24 hours before and after the snowflake catch; preferred temperature for this experiment is 0°C or below.

1. Secure the plastic wrap in the embroidery hoop. This is the snowflake capture surface.
2. Let the snowflakes fall on the plastic. Spray on the acrylic coating, holding the can about 30 cm away. A permanent impression will be made as the snowflakes evaporate. Remember
to leave the specimen collection in a covered box outside for 24 hours after you spray the plastic and snowflakes.
3. Bring the samples inside and view larger impressions with a hand-held magnifier. Smaller snowflake impressions can be placed on a glass slide and topped with a cover plate; cut a 2 cm border around the best snowflake impressions on the plastic wrap and mount for viewing.
4. You can even photograph the snow crystals with a 35-mm camera lens, supported by a ring stand, over the microscope eyepiece. No flash is needed if the microscope has a lighted stage. If you have superior snowflake impressions, consider sending them to a laboratory for professional photomicrography.

Create Crystals\textsuperscript{7}

A mineral crystal assumes a symmetrical shape or form that is a direct reflection of the orderly arrangement of atoms. Different chemical compositions and atomic arrangements create crystals in different shapes. Some may grow as a cube, pyramid, prism, or long thin fibers. Flat sides are called faces, which may be well-developed or not. The faces and crystal shapes are all influenced by temperature, pressure, flow of the solution, and the amount of free space to grow.

Crystals can form from a vapor, a molten melt, or by evaporation of solution. Topaz is a mineral that forms as gases begin to cool and the atoms arrange themselves accordingly. Feldspars crystallize or become solid as molten melt or magma begins to cool. Halite or salt is an example of a mineral that forms when a saturated solution evaporates, leaving the mineral halite or salt.

Within the Earth, hot circulating fluids dissolve material and move through cracks in the rock. New minerals are formed or precipitated out in these cracks. Sometimes these solutions move through volcanic rock where there are circular, hollowed out areas, and crystals have room to grow large forming a crystal or agate geode.

Part I Evaporation Method

The evaporation method for growing crystals is the easiest method of growing crystals for a classroom activity. After dissolving a powder in water, the solution will evaporate slowly, become supersaturated and crystals will begin growing in approximately a week. Constant temperatures and low humidity are two conditions necessary for good crystal growth.

Materials

Rochelle Salt (Potassium Sodium Tartrate—not a mineral, but a crystalline salt with an organic origin—purchased from a pharmacy or chemical supplier), clear glass cup/beaker/jar, string/thread, paper clip, pencil/wooden splint, stirring spoon, magnifying glass, art paper, crayons/markers, and hot water. Mineral crystals or geodes could be shown to the class and shapes observed.

Activity

1. First examine the powder with a magnifying glass, noting any characteristic shapes.
2. Pour 1½ C hot water into a jar (container should be of a size so that the solution is at least 2 inches deep). Add 2 C Rochelle Salt and stir until no more dissolves, which will take some time.
3. Let the solution evaporate or provide a seed crystal, which could be a paper clip, for a crystal to attach to. Tie one end of the string to the pencil or splint and the other to a partially unwrapped paper clip (the length should be such that the paper clip is suspended in the solution but not touching the bottom of the jar). After the solution appears transparent, suspend the paper clip in the solution, resting the pencil or splint across the top of the jar.
4. Set it in a place with no heater, direct sunlight, drafts, or anything else that might

cause a temperature change. Leave it unattended for several days.

5. After crystals have grown, examine them with magnification to compare shapes and any transparent differences. There may be one large crystal, several small crystals, and/or a cluster of crystals. Crystals will be delicate and can easily dissolve in water. Use art paper and have each student draw what they observe.

6. Repeat the process with variations. Use one of the smaller crystals as a seed (although not introduced until the solution has cooled!) or grow some crystals in a warmer place and others in the refrigerator. Compare the results.

Part II Molten Magma Method

Make lollipops with the recipe given to demonstrate a hot liquid turning into a crystalline solid upon cooling. The lollipops may trap air bubbles when they cool, resulting in holes. This happens in minerals and rocks too. If food coloring is added, it is similar to chemical impurities in minerals which result in different colors. Quartz in a pure state is colorless; with impurities or changes in the crystal structure to color, quartz can be pink-rose quartz, yellow-citrine quartz, purple-amethyst, whitish-milky quartz, and brown/black-smoky quartz.

Activity

- Lightly butter and arrange 18 sticks on a baking sheet.
- \( \frac{1}{4} \) C sugar
- \( \frac{1}{4} \) C butter or margarine
- \( \frac{1}{2} \) C light corn syrup
- Few drops of food coloring (optional)
- \( \frac{1}{4} \) t. flavorings (optional)

Combine the butter, corn syrup and sugar in a 1-quart pan. Heat on medium-high until the mixture is boiling, stir occasionally. Reduce the heat and stir continuously until the candy thermometer is at 270 degrees or when a few drops of syrup dropped in cold water form hard threads (but not brittle). Stir in the food coloring (flavoring) and drop by tablespoonfuls over each stick on the baking sheet. Cool thoroughly before removing from the baking sheet.