Lesson Plan for In School Visits: "Crystals!"

Target Audience: Elementary School, 5th grade specifically

Design of Program:

To deliver a 4 hour hands-on program to 5th grade students and their teachers. This program will incorporate information about crystals, crystal growth, geometry of crystals, and optical properties of crystals.

Objectives:

The facilitator will:

- Explain the science and mathematics of crystals and crystal growth
- Provide hands-on activities for crystal growing and examining of the crystals, to include a hardness test of minerals and fluorescence.
- Provide opportunities for students to "examine crystal structures" (Styrofoam ball and stick models and computer visualization) in order for the student to understand the concepts of unit cell and crystal symmetry

The student will:

- Participate in all hands-on activities to include: crystal growth and examination, as well as modeling of crystals
- Develop an understanding of crystals, crystal growth, vocabulary related to crystals, and crystal symmetry
- Extend their learning through activities provided to the student and teacher

Standards Covered:

Virginia Department of Education, Standards of Learning:

<u>*Science:*</u>

5.1 The student will plan and conduct investigations in which

c) appropriate instruments are selected and used for making quantitative observations of length,
mass, volume, and elapsed time;
d) accurate measurements are made using basic tools (thermometer, meter stick, balance,
graduated cylinder);
e) data are collected, recorded, and reported using the appropriate graphical representation
(graphs, charts, diagrams);
f) predictions are made using patterns, and simple graphical data are extrapolated;
h) an understanding of the nature of science is developed and reinforce

5.4 The student will investigate and understand that matter is anything that has mass, takes up space,
and occurs as a solid, liquid, or gas. Key concepts include

a) atoms, elements, molecules, and compounds;
b) mixtures including solutions; and
c) the effect of heat on the states of matter.

5.7 The student will investigate and understand how the Earth's surface is constantly changing. Key
concepts include

a) the rock cycle including identification of rock types;

Math - Geometry
Focus: Classification and Subdividing

5.12 The student will classify
a) angles as right, acute, obtuse, or straight; and
b) triangles as right, acute, obtuse, equilateral, scalene, or isosceles.

5.13 The student, using plane figures (square, rectangle, triangle, parallelogram, rhombus, and trapezoid), will
a) develop definitions of these plane figures; and
b) investigate and describe the results of combining and subdividing plane figures.

*** Please note: not all components of each of the Standards will be addressed independently, but are included in a broader scope of concepts.

National Science Education Standards (1996)

Content A:

As a result of activities in grades 5-8, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content B:

As a result of their activities in grades 5–8, all students should develop an understanding of

- Properties and changes of properties in matter

Day One:

Participants: PI, College Students, 5th graders and teacher

Objectives:

The facilitator will provide information and activities for the growing and examination of crystals. This will include lab activities measuring fluids as well as solids.

The student will:

- actively participate in a lecture and discussion of crystals, the formation of crystals and tests that scientists conduct on crystals.
- participate in laboratories for the growing of crystals
- understand the vocabulary associated with crystals to include lattice, unit cell
- understand the similarities and differences among types of solutions to include saturated and supersaturated solutions
- Understand types of tests on crystals to include hardness and fluorescence

Materials for lesson:

- ➢ Styrofoam cups (8.5 oz)
- ➢ plastic cups
- ➢ permanent marker
- ➢ Graduated cylinders (1 per lab group)
- ➢ Hot plate or other heat source
- ➢ Deionized water
- ➢ plastic spoons
- ➢ String
- ➢ Scissors
- ➢ alum solution, potassium chrominum sulfate solution, copper(II) sulfate, nickel(II) sulfate, ferrous ammonium sulfate, Rochelle salt, sodium borate
- ➢ minerals kit, harness and fluorescence
- ➢ nails

- UV light
- lab, data, and safety sheets

Engage and Hook: (aka. Anticipatory Set)

What is a crystal? (Power point opening slide)

Have an entry slip waiting: Yes, no ticker for Power point slide

Slide: Will flash pictures of crystals and crystal glassware

Introduce which one is a crystal to the students.

Explain and Model: (Part One)

Present a power point with information about crystals and crystal growth, to include:

- pictures of crystals
- definition of a crystal
- basic information on lattice and unit cell. (Just definition, the extended discussion is on day two.)
- how crystals are formed
- types of solutions
- instructions for making a measurement standard (marked cup)
- instruction for growing crystals to include cup, spoon and string pictures
- A review of safety procedures for the day

Explore and apply: (Part One)

<u>Crystal Labs (The Kitchen Chemistry Version):</u>

Sodium Borate Crystal:

Materials:

- marked plastic cup
- Styrofoam cup

- 50 mL of deionized water
- 2 teaspoons of sodium borate
- String
- plastic spoon
- Scissors

Procedure:

1. Label a Styrofoam cup, "Sodium borate solution".
2. Place 2 teaspoons of sodium borate in the Styrofoam cup.
3. Place 50 mL of water that has been warmed into the cup as well.
4. Using a plastic spoon, stir solution until all of the sodium borate is dissolved.
5. Using scissors cut a piece of string slightly longer than the height of the cup and tie to the plastic spoon.
6. Place the string into the mixture and rest the plastic spoon across the top of the cup.
7. Place a piece of paper over the beaker and let sit undisturbed overnight to one week.
8. Remove string to reveal crystals.
9. If a microscope is available, place string under microscope to observe the structure of the crystals. If a microscope is not available, use a hand lens to determine the shape of the crystal and observe its structure.

Nickel (II) Sulfate Crystals:

Materials:

- 6 teaspoons of Nickel sulfate hydrate
- marked plastic cup
- Styrofoam cup
- 50 mL of deionized water
- plastic spoon

- String
- scissors

Procedure:

1. Label a Styrofoam cup, “Nickel (II) sulfate solution”.
2. Place 6 teaspoons of Nickel II sulfate in a Styrofoam cup.
3. Place 50 mL of deionized water, which has been warmed, into the Styrofoam cup.
4. Using scissors cut a length of string slightly longer than the height of the cup.
5. Place the string into the mixture, resting the spoon across the top of the cup.
6. Cover with a piece of paper and let sit undisturbed overnight to one week.
7. Remove string from mixture to reveal crystals.
8. If a microscope is available, place string under microscope to observe the structure of the crystals. If a microscope is not available, use a hand lens to determine the shape of the crystal and observe its structure.

Chrome Alum Crystals:

Pre-lab Preparation:

Materials:

- 30 gram of Potassium Chromium sulfate
- 45 g of alum (potassium aluminum sulfate)

Procedure:

In preparation for the lab make solutions of potassium chromium sulfate and potassium aluminum sulfate according to the instructions below.

1. Make a saturated solution of potassium chromium sulfate by placing 30 grams of potassium chromium sulfate into 50 mL of deionized water in a 100 mL beaker, stirring constantly while heating.
2. Make a saturated solution of potassium aluminum sulfate (alum) by placing 45 grams of alum into 150 mL in a 250 mL, while heating and stirring constantly.

Lab for Students:

Materials:

- saturated solution of alum
- saturated solution of potassium chromium sulfate
- 10 mL graduated cylinder
- 50 mL graduated cylinder
- Styrofoam cups
- plastic spoons
- string
- scissors

Have each group grow a different percentage of chrome alum crystal. For group one have them do 5%, group 2, 10% and so one. The percentages to use are 5%,10%, 25% and 50%, either the PI or a group will need to create a 0% solution for a standard.

1. Label the Styrofoam cup with the percentage of potassium chromium sulfate solution to be added.
2. Based on the percentage that the student group will be making, have the group measure out the amount of potassium chromium sulfate solution needed in a graduated cylinder.

   5% - 1 mL potassium chromium sulfate

   10% - 5 mL potassium chromium sulfate

   25% - 12.5 mL potassium chromium sulfate

   50% - 25 mL potassium chromium sulfate

3. Add potassium aluminum sulfate solution to each of the cups to the marked line of the plastic cup.
4. Stir all solutions well and pour into Styrofoam cups that have been labeled with the percentages.
5. In the cup labeled 0%, place 50 mL of alum solution in the cup.
6. Cut a piece of string slightly longer than the height of the Styrofoam cup and tie to the spoon.
7. Lay the spoon across the cup allowing the string to dangle into the solution.
8. Cover and let stand overnight to one week.
9. Remove string from mixture to reveal crystals.
10. Denote any difference in the color of the crystals.
11. If a microscope is available, place string under microscope to observe the structure of the crystals. If a

microscope is not available, use a hand lens to determine the shape of the crystal and observe its structure.

Copper II Sulfate Crystals:

Materials:

- 4 teaspoons of copper II sulfate hydrate
- marked plastic cup
- 50 mL of deionized water
- Styrofoam cup
- plastic spoon
- string
- scissors

Procedure:

1. Label a Styrofoam cup "Copper sulfate solution".
2. Place 4 teaspoons of copper sulfate into a Styrofoam cup. (Use your plastic spoon for this.)
3. Obtain 50 mL of warmed deionized water from the lab station, using your marked plastic cup.
4. Pour the warm water into the Styrofoam cup and stir with the plastic spoon until all solid is dissolved.
5. Cut a piece of string slightly longer than the height of the Styrofoam cup and tie to the spoon.
6. Lay the spoon across the cup allowing the string to dangle into the solution.
7. Cover and let stand overnight to one week.
8. Remove string from mixture to reveal crystals.
9. Denote any difference in the color of the crystals.
10. If a microscope is available, place string under microscope to observe the structure of the crystals. If a microscope is not available, use a hand lens to determine the shape of the crystal and observe its structure.

Ferrous Ammonium Sulfate Crystals

Materials:

- three teaspoons of ferrous ammonium sulfate
- marked plastic cup
- Styrofoam cup
- plastic spoon
- 50 mL of deionized water

Procedure:

1. Label a styrofoam cup, "Ferrous Ammonium Sulfate solution".
2. Place three teaspoons of ferrous ammonium sulfate in the Styrofoam cup.
3. Place warmed water in the plastic cup to the mark.
4. Place the warmed water from the plastic cup into the Styrofoam cup.
5. Using the plastic spoon stir until the ferrous ammonium sulfate is dissolved.
6. Using scissors, cut a length of string slightly higher than the cup.
7. Tie the string to the plastic spoon.
8. Lay the spoon across the cup allowing the string to dangle into the solution.
9. Cover and let stand overnight to one week.
10. Remove string from mixture to reveal crystals.
11. Denote any difference in the color of the crystals.
12. If a microscope is available, place string under microscope to observe the structure of the crystals. If a microscope is not available, use a hand lens to determine the shape of the crystal and observe its structure.

Rochelle Salt Crystals:

Materials:

- 10 teaspoons of Rochelle Salt (Potassium sodium tartrate)
- 50 mL of deionized water
- marked plastic cup
- Styrofoam cup
- marked plastic cup
- plastic spoon
- string
- scissors

Procedure:

1. Label a styrofoam cup, "Rochelle Salt solution".
2. Place 10 teaspoons of Rochelle Salt in a Styrofoam cup.
3. Measure out 50 mL of warmed water in the marked cup and pour into the Styrofoam cup.
4. Stir the salt until dissolved in water.
5. Using scissors cut a length of string slightly longer than the height of the Styrofoam cup.
6. Tie one end of the string to the plastic spoon.
7. Place the other end of the string into the solution and rest the spoon on top of the cup.
8. Cover with a piece of paper and let stand undisturbed overnight to one week.
9. Remove string from solution and observe any crystals that form.
10. If a microscope is available, place string under microscope to observe the structure of the crystals. If a microscope is not available, use a hand lens to determine the shape of the crystal and observe its structure.

Note: If hot plates are not allowed or electrical sources are not readily available for a large number of hot plates, heat water for the class and measure into beakers.

Explain and Model: (Part Two)

Power point explaining other tests that scientists do on crystals and minerals. (Hardness and Fluorescence, color, x-ray referencing medical)

Explore and Apply: (Part Two)

Mineral Hardness Test

Materials:

- Nail
- Copper penny
- Mineral sample
- Finger nail
- Magnifying glass

Procedure:

1. Using the nail, attempt to scratch the mineral, by dragging the nail across the mineral. Observe the mineral using a magnifying glass if necessary.
2. If the mineral was scratched, repeat the procedure for number 1, using the copper penny instead of the nail.
3. If the mineral is scratched again, repeat with your finger nail.
4. Make a statement about the hardness of your mineral. For example, a nail has the hardness of 5, if it scratched the mineral then the mineral's hardness is less than 5, however a copper penny has a hardness of 3. If the mineral was not scratched by the copper penny, then the hardness of

the mineral was 3.5 to 4.5. A finger nail has the hardness of 2.5.

5. Repeat with several other minerals.

Procedure for Fluorescence test

1. Display the crystals.
2. Hand the crystals out to the students to look at and touch while making observations of the crystals to include the number on each.
3. Collect the crystals, then darken the room and use a black light to display the crystals in their box.
4. Make sure that each student has an opportunity to identify the number of the crystal that they originally observed with the fluorescent crystal that they are now observing. Do this by holding each crystal under the black light and letting the students know what number each crystal is.

Evaluate:

After labs are set up and placed in an area where they will not be disturbed, questioning and a closure activity is to be done.

1. Review the procedure of the lab.
2. Distribute handout on crystals and vocabulary.

Day 2: Understanding Crystals

Objectives:

The facilitator will:

- Provide information and activities for the examination of crystal properties to include: symmetry, atoms, attractive forces and optical properties.

The student will:

- Isolate and examine their crystals
- view crystals through magnifying glasses and a microscope
- compare their crystals to other crystals made in class and the pictures from the power point presentation.
- Examine crystals provided by the P.I.
- Understand the packing of atoms/ions and the covalent and ionic forces at work
- understand the similarities and differences between macroscopic and microscopic crystal shapes
- Understand crystal symmetry and geometry
- gain an introduction of the optical properties of crystals

Engage and Hook (Anticipatory Set):

Recap of last meeting and listing of observations of crystals.

Explain and Model (Part One):

- Instructions about decanting and removal of crystals as well as how to examine crystals given.

Explore and Apply:

- Examine the individual group's crystals and make observations

- Examine other groups' crystals and make observations comparing the two sets of crystals
- Examine other crystals supplied for differences and similarities among crystals.

Procedure for Examining Crystals (Day 2)

Materials:

- cups of crystals formed from Day 1
- microscope
- magnifying glasses
- funnel for waste container
- waste container
- paper towel

Procedure:

1. Have the students form their groups from Day 1.
2. Have the students remove string and place crystals on a paper towel.
3. Instruct the students on how to decant the liquid from the cup into the waste container. Making sure they understand to only pour the liquid not any of the crystals from the bottom of the cup.
4. Have the students observe the cups to determine if any crystals formed on the bottom of the cups. Have the students write down observations of the cups.
5. Have the students observe the crystals on the paper towel and write down these observations.
6. Next have the students make observations of their crystals using a magnifying glass and write down observations about shapes or angles, etc.

7. Have the students then observe a neighboring group's crystals, paying special attention to the differences in the chrome alum crystals.
8. Pick several crystals from different groups and display each on a projection microscope, if available. Discuss each crystal and how they are formed and what types of shapes, faces, etc. that are characteristic to them.
9. After the discussion have the students dispose of the cups and other materials.

Procedure for Examining Purchased Crystals

Materials:

- selected crystals for viewing to include: bismuth, pyrite (in matrix and cube), ulexite, Iceland spar (calcite), quartz, and fluorite

Procedure for Crystal Examination:

1. Display pictures of each of the crystals and discuss their properties.
2. Pass the sample crystals to each group for examination. Give time to the students to allow them to write down observations. Have the groups exchange crystals so that each group observes all of the crystals.
3. Collect crystals and have the students list the properties that they saw for each crystal. Make a list for each crystal on the board or post it note pad or discussion flip chart.
4. Conclude this section with a wrap up discussion of their list and how the properties of a crystal define the crystal.

Explain and Model (Part Two):

- Power point on crystal symmetry, atoms/ions, attractive forces and optical properties.

Explore and Apply (Part Two):

- Ball and stick model
- computer modeling

Evaluation:

- Debriefing of the two day lesson
- Quick evaluation of what was learned – mini quiz – collected and reviewed by team

Sources:

Holden, A. and Morrison, P. Crystals and Crystal Growing. MIT Press. Cambridge, Mass. 1982

Squire, Ann O. A True Book, Growing Crystals. Children's Press, New York. 2002

National Science Education Standards, *National Committee on Science Education Standards and Assessment, National Research Council, 1996*

Virginia Standards of Learning:
http://www.doe.virginia.gov/VDOE/Instruction/sol.html#general