Crystallization

Katie Cofrin
8th Grade
Chemistry

OBJECTIVE, BACKGROUND INFORMATION, & REFERENCES

Standard(s)
Benchmark: (2)

- Know that mass is conserved in a chemical or physical change.
- Identifying and predicting what will change and what will remain unchanged when matter experiences an external force or energy change.
- Describing, measuring, and calculating quantities before and after a chemical or physical change within a system.

Background: Students have received instruction on elements, compounds, mixtures, solubility, ionic substances, covalent compounds, endothermic -vs- exothermic reactions,

References:
http://webmineral.com/
Borax snowflake directions: http://chemistry.about.com/cs/howtos/ht/boraxsnowflake.htm
Pamukkale Ppt: http://www.authorstream.com/Presentation/Shalini-257-pamukkale-travel-places-tourist/

VOCABULARY, MATERIALS, PREPARATION, SAFETY

Vocabulary: Solution, solubility, ionic, covalent, endothermic, exothermic, crystallization, supersaturated, activation energy, enthalpy, heat of solution

Materials: Mineral crystal samples, sugar, Calcium chloride, Ammonium chloride, sterile containers for making borax crystal snowflakes, Vinegar, Baking Soda

Safety: Safety goggles

5 E'S

Describe how each of the 5 E's will be accomplished:

Engage (Day 1): Provide students 10 different stations with the following crystal/mineral samples: granite, lead sulfide, iron sulfide (fools gold), sodium chloride, gypsum, schist (with embedded garnet), calcite, amethyst, dichromate, and two minerals that have different sizes and colors. This was set up prior to the lesson and took about 30 minutes prep time. These samples were used to answer questions on a worksheet (see Cofrin_Crystal Structure Stations Worksheet).

Explore (Day 2): Students observed the dissolution of samples of Calcium chloride and Ammonium Chloride* in water. A volunteer student came to the front of the room and announced the temperature of the ammonium chloride solution at minute intervals for 5 minutes. (The ammonium chloride solution was a demo I presented due to not having enough NH_4Cl for each group to perform the experiment at their desks). Each group of students received 1g of calcium chloride and used a test tube for the dissolution. The students were then asked to make qualitative observations in their science notebooks of the appearance of both solids and also energy involved in the reactions. Students are then asked a series of questions (see below) comparing endothermic and exothermic reactions and their associated energy diagrams. Students will records their responses in science notebook.

Questions: Is this reaction exo/endothermic?
How do you know? or What evidence do you have to support this conclusion?
What does endo/exothermic mean?
What would the energy diagram look like for this reaction?
How would it be different for the alternative reaction?

***Lead Teacher had calcium chloride in stock, and the ammonium chloride was obtained from UC-Denver and used as received.**

Crystallization

Katie Cofrin
8th Grade
Chemistry

Explain (Day 3): Present Pamukkale Powerpoint (see resource section) on stalagmites and stalactites illustrating solubility.

Elaborate (Day 4): Have students create their own borax snowflakes to reiterate solubility rules/curve and crystallization. http://chemistry.about.com/cs/howtos/ht/boraxsnowflake.htm

This lesson was supported in the math classroom by a short presentation I gave on the math of crystals. I related crystals to fractals (Resident Mathematician's lesson) and showed examples of crystals that follow fractal patterns. This discussion was approximately 5-10 minutes.

Evaluate Elements, Compounds, and Mixtures quiz. Other labs were also used to evaluate their understanding of these topics. See below.

The Math of Crystals

Katie Cofrin
Resident Scientist

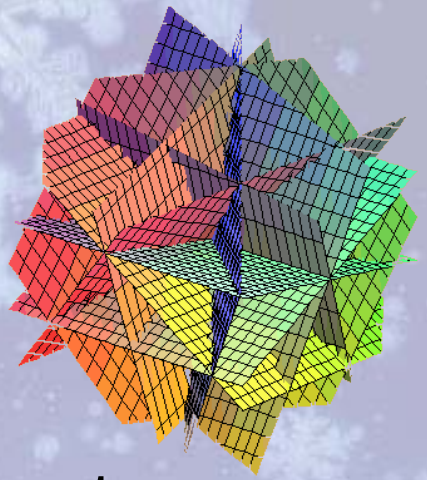
What makes a crystal?

An orderly and symmetrical atomic structure.

A definite external geometrical shape bounded by plane faces.

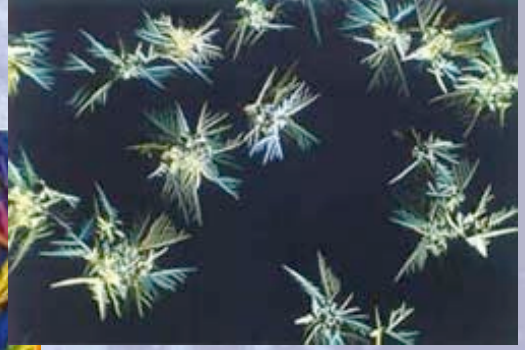
http://mathforum.org/alejandre/workshops/chart.html

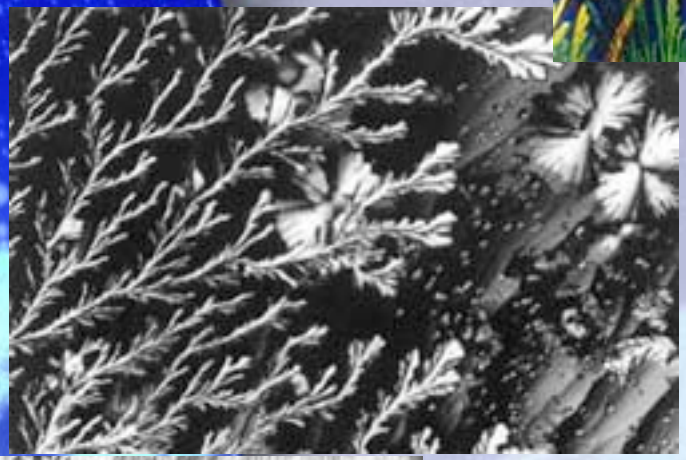
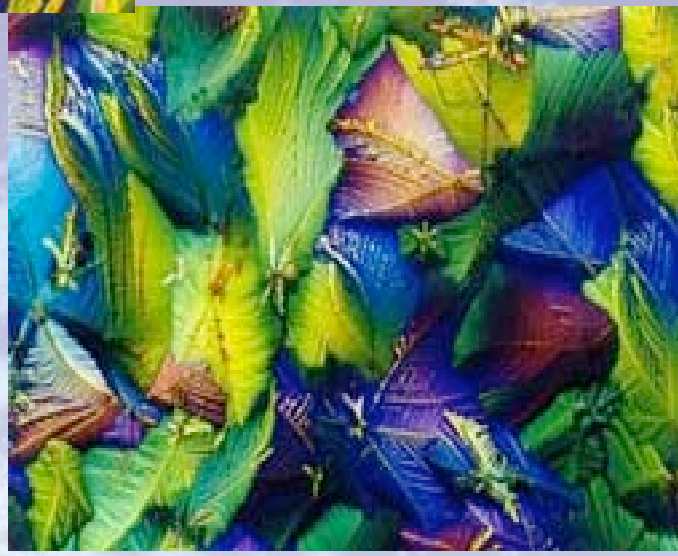
Classification



- Crystals are named (classified) by different mathematical properties:
  - Planes of symmetry
  - Axes of symmetry
  - Right angles (and other angles)
  - Faces (sides of the crystal)





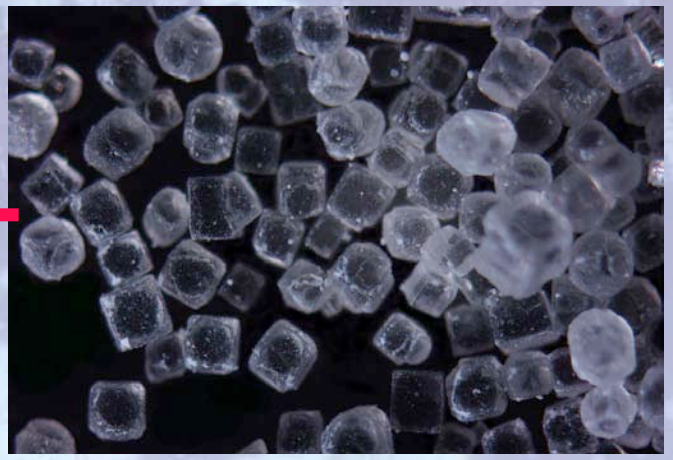




How do they form?

- Crystals form everywhere.
- Each crystal forms under specific conditions (temperature, pressure, location)

Can you think of any crystals you might have in your home?

SALT



SUGAR

All images from images.google.com

Name _____ Date_____

Solids: Crystal Structure

Use the following study guide as you move from station to station.

Station 1 – Rocks are formed from combinations of substances called minerals. Granite is a rock formed from the crystals of the minerals quartz (white or clear), feldspar (pink to red), and mica (dark grey to black). Granite is classified by both the size of the mineral crystals and amount of each type of mineral. Write down three observations about the similarities and/or differences in the two granite samples provided.

1. _____
2. _____
3. _____

Station 2 – This is a sample of the mineral galena which is a compound made of the elements lead and sulphur. Its chemical formula is PbS, lead sulfide. Write down two observations about the appearance of the galena crystals.

1. _____

2. _____

Station 3 – This mineral sample contains crystals of the compound iron sulfide, FeS_2. It is known by the mineral name pyrite and by the common name "Fool's Gold". Write two observations of the crystals and write a brief explanation of why it might have that particular common name.

1. _____

2. _____

3. It is called "Fool's Gold" because
   _____
   _____

Station 4 – Table salt is a common substance with the chemical formula NaCl, sodium chloride. Observe the salt crystals under the microscope and draw what you see below.

Station 5- This sample of fibrous gypsum is composed of crystals of calcium sulfate, $CaSO_4$. Use the hand lens to examine the crystal structure. Write your observations below.

Station 6 – These samples are of a rock called schist with garnet crystals included into it. Garnets of good size and clarity are often used as gemstones in jewelry. These particular garnets have the chemical formula $Fe_3Al_2(SiO_4)_3$ or iron aluminum silicate. Look at the sample under the stereoscope. Are garnets the only crystals in the rock?
Explain.

Station 7 – These samples are of the mineral calcite. With a very transparent sample of calcite you can see a special optical property of calcite called birefringence. Place the clear sample of calcite over the writing on this paper and observe. In your own words, write below what birefringence looks like.

Station 8 – Amethyst is a type of quartz crystal whose violet color comes from impurities of iron and aluminum. Upon heating, the violet color will turn to yellow gold or brown. How many sides does an amethyst crystal have and has either of these samples been heated?

Station 9 – Describe the crystals in these two mineral samples.

Station 10 - **Chromates** and **dichromates** are salts of chromic acid and dichromic acid, respectively. Chromate salts contain the chromate anion, $CrO_{4\text{-}7}$, and usually have an intense yellow color. Dichromate salts contain the dichromate anion, Cr_2O_{2-7}, and usually have an intense orange color. Is this sample sodium chromate or sodium dichromate?

Name _____ Date _____

Saturation Lab

Question: How does raising water temperature affect saturation of sugar dissolved in water?

Background Information:

- Saturation occurs when a solution can no longer dissolve any more solute and the further addition of solute will result in solute precipitating out. (Maximum concentration)
- Sugar is highly soluble in water.

Hypothesis:

Procedure:

Materials

- 2 50ml Beakers
- 10 ml cold and hot water
- Triple beam balance
- Sugar
- Stirrer

Procedure:

1. Fill a 50 ml beaker with 10ml of cold tap water. Take the temp.
2. Measure out 25 grams of sugar in the other 50 ml beaker
3. Slowly add the sugar and stir it into the water until no more sugar will dissolve in the water
4. Measure the mass of the remaining sugar left in the beaker
5. Calculate the number of grams of sugar dissolved in the water
6. ?
7. ?
8. ?
9. ?
10. ?

Data Collection:

Data Analysis:
Create a bar graph of your data

Results:

Conclusion:

Name _____ Date _____

Solubility as a Chemical Reaction

Question: How do the solubility of Calcium chloride and Ammonium chloride compare, specifically their heat of solution?

Background Information: For ionic substances, dissolving in a solvent is accomplished when the ions that form that substance are separated into their respective parts. This can be represented as a chemical equation. For example:

$$NaCl \rightarrow Na^{+} + Cl^{-}$$

These reactions, like other chemical reactions, can give off energy (exothermic) or absorb energy (endothermic) depending on the substances and ions involved. This change in energy during dissolving is known as the **heat of solution**.

Hypothesis: Predict whether the dissolving of the two substances will be endothermic or exothermic (circle one)

$CaCl_2 \rightarrow Ca^{2+} + 2Cl^{-}$ (endothermic, exothermic)

$NH_4Cl \rightarrow NH_4^{+} + Cl^{-}$ (endothermic, exothermic)

Experimental Design:
Materials – graduated cylinder, 2 grams of calcium chloride, 2 grams of ammonium chloride, distilled water, thermometer

Procedure:

1. Place 20 ml distilled water in a graduated cylinder. Measure the temp.
2. Add 2 grams of calcium chloride to the water and stir with thermometer to dissolve.
3. Record beginning and end temps and your observations.
4. Repeat steps 1-3 for ammonium chloride.

Data Collection: Record your observations below

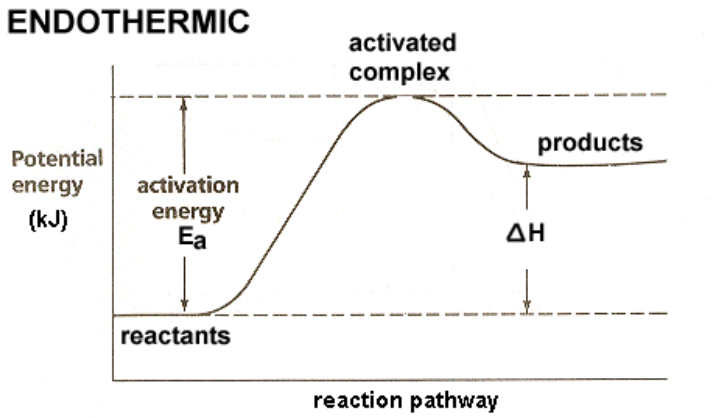
Salt Dissolved	Start Temp(°C)	End Temp(°C)

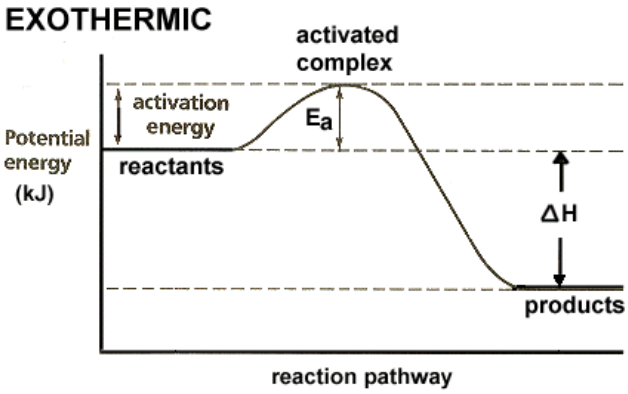
Observations-

Data Analysis: Place the reactions in the title to the correct graph

$CaCl_2 \rightarrow Ca^{2+} + 2Cl^-$

$NH_4Cl \rightarrow NH_4^+ + Cl^-$





Results:

Conclusion:

Name_____ Date _____

Elements, Compounds, Mixtures Quiz

Write the word Element, Compound, or Mixture behind each description.

1. Made of two or more elements in a definite ratio_____
2. Gold is one of these_____
3. Can be separated by filtration_____
4. Found on the periodic table_____
5. Carbon dioxide is one of these_____

Write a method that could be used to separate the following mixtures.

6. Saw dust and iron filings –

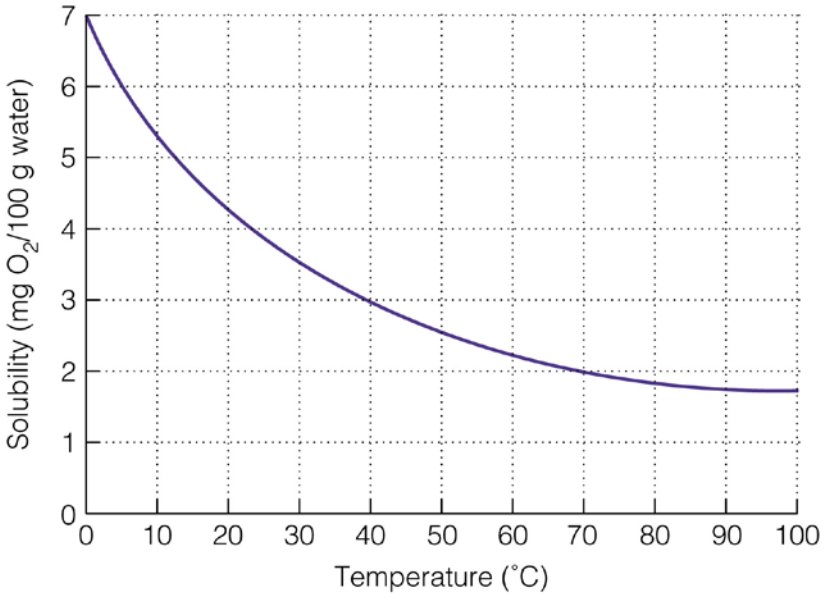
7. Sand and water –

8. Salt and water –

9. Circle the two that are considered pure substances:
   (Mixture , Element, Compound)

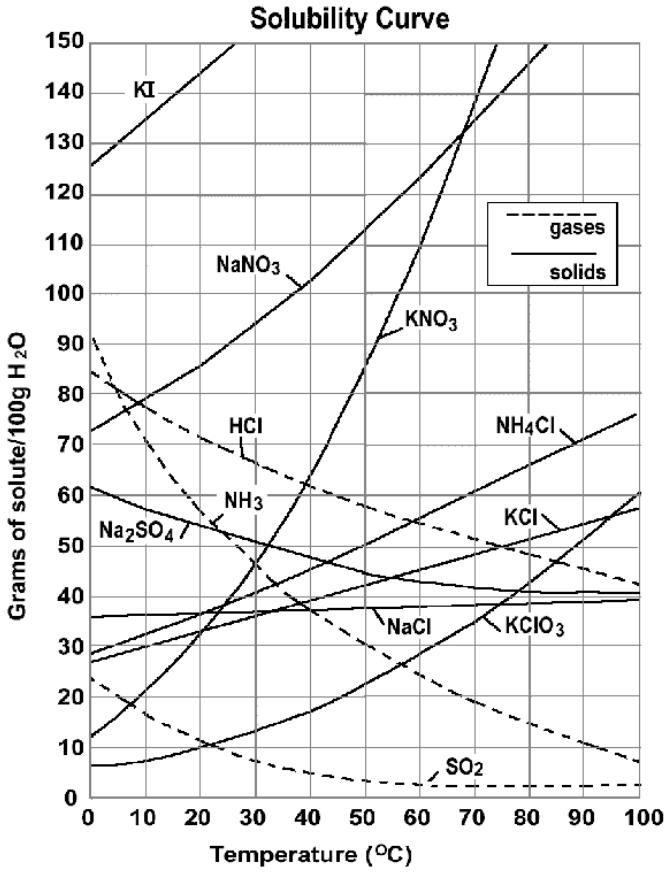
10. Describe two methods you might use to get a sugar cube to dissolve faster in a beaker of water.

11. In a mixture of sugar water, which is the solute and which is the solvent? Water is the _____, Sugar is the _____.



12. Trout found in streams and rivers require high concentrations of dissolved oxygen (O_2) in the water to survive. When a river or stream is dammed, the temperature of the water released downstream from the dam goes up. Using the graph above showing the relationship of dissolved oxygen in water to temperature, explain what effect a dam would have on a trout's ability to breath downstream.

Extended Credit



Using the solubility chart above, answer the following questions.

13. Give the chemical formula for one of the gases on the chart_____

14. For Ammonium Chloride, NH_4Cl, at what temperature is 60 grams of solute able to dissolve in water?_____°C

15. Give the chemical formula for one substance where the solubility in water goes down as the temperature increases._____

16. Which solids solubility in water changes the least as the temperature increases? _____