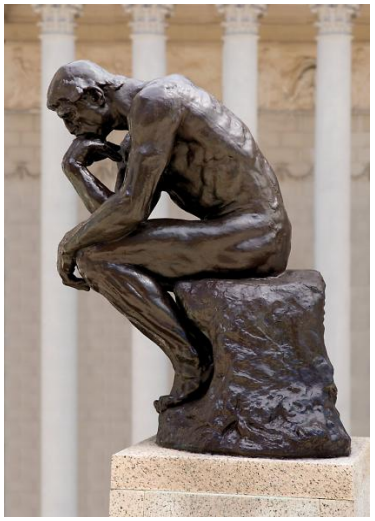
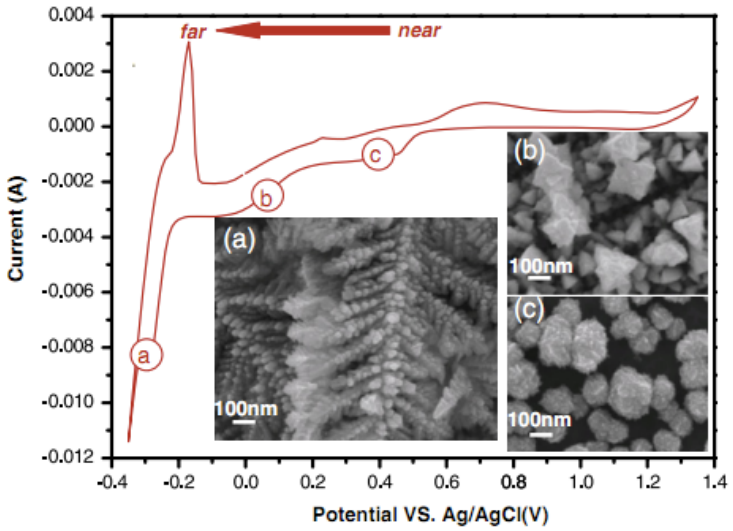
Learning Logic: Units for Introducing and Developing Reasoning and Communication



Julia Pustizzi
Fesler Junior High School
MRL
Summer 2013 RET 2

RET 1 Project



Lab Goals:

- Hydrogen fuel cells- reducing platinum load

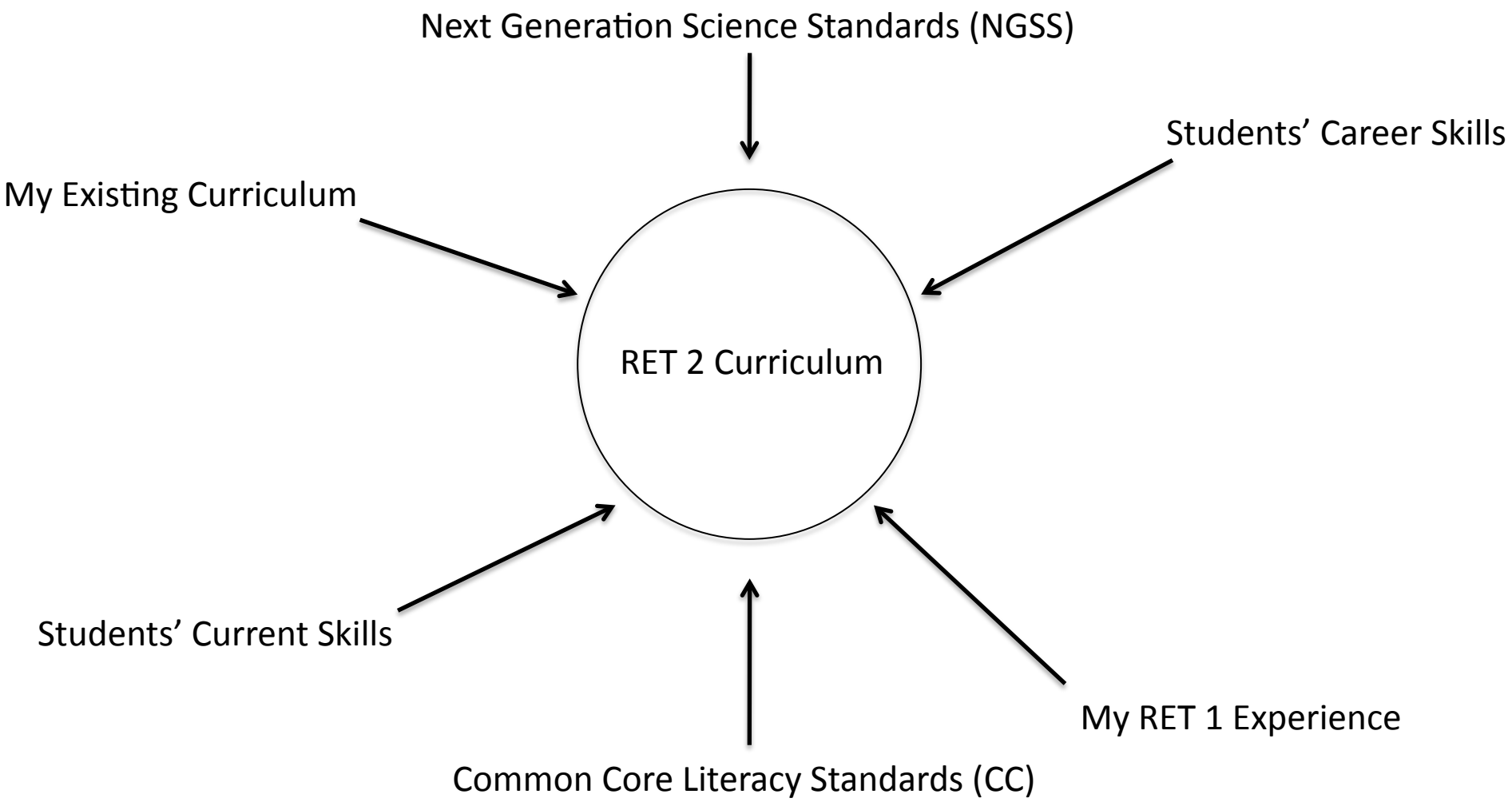
Summer Goals:

- Deposited platinum on Nafion membrane
- Looked at morphology and deposition patterns

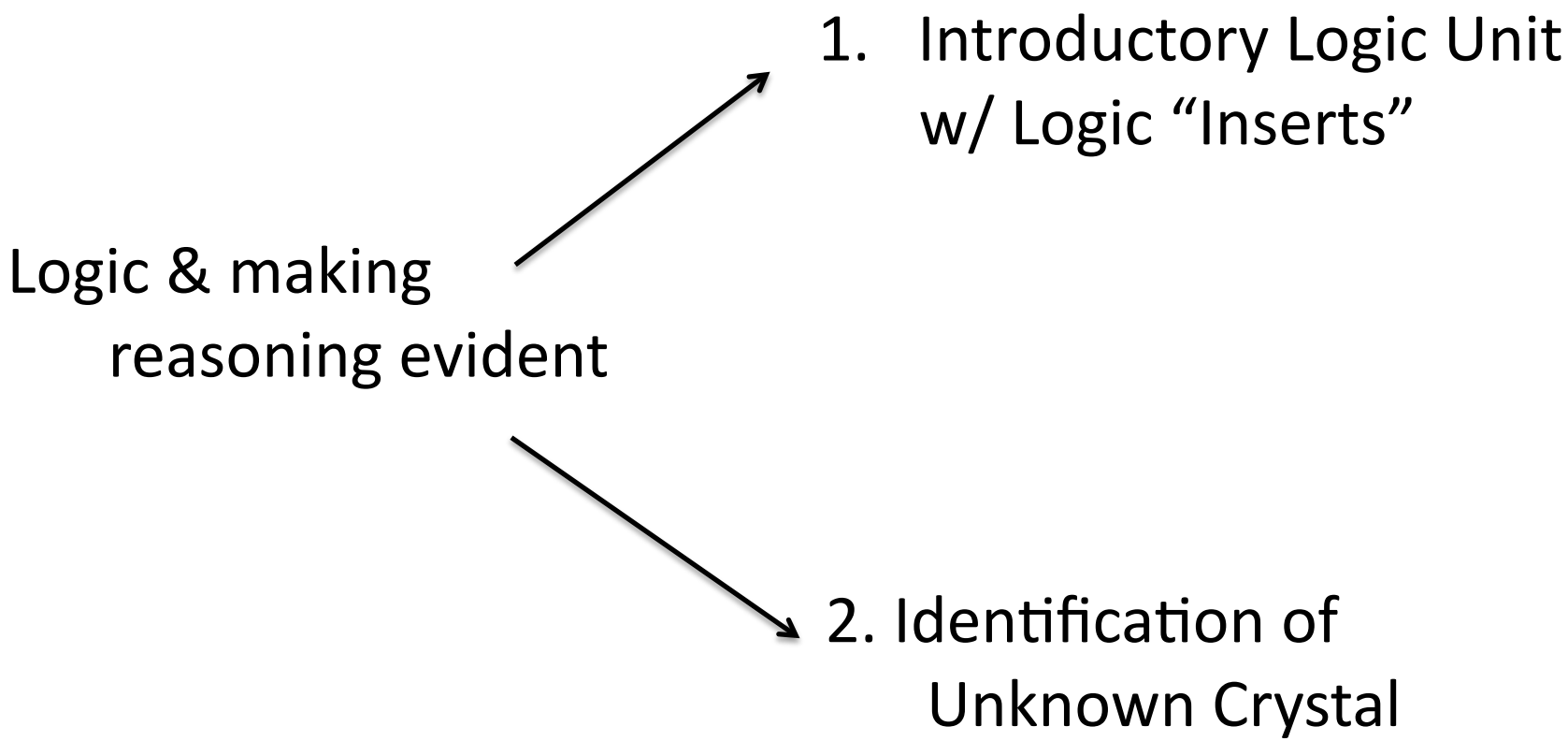
RET 1 Lab Skills

- Reading complex texts
- Talking with experts
- Logic & reasoning
- Making reasoning evident
- Working with unknowns
- Collecting relevant data
- Analyzing data for relevant points
- Considering a material's properties when using in engineering

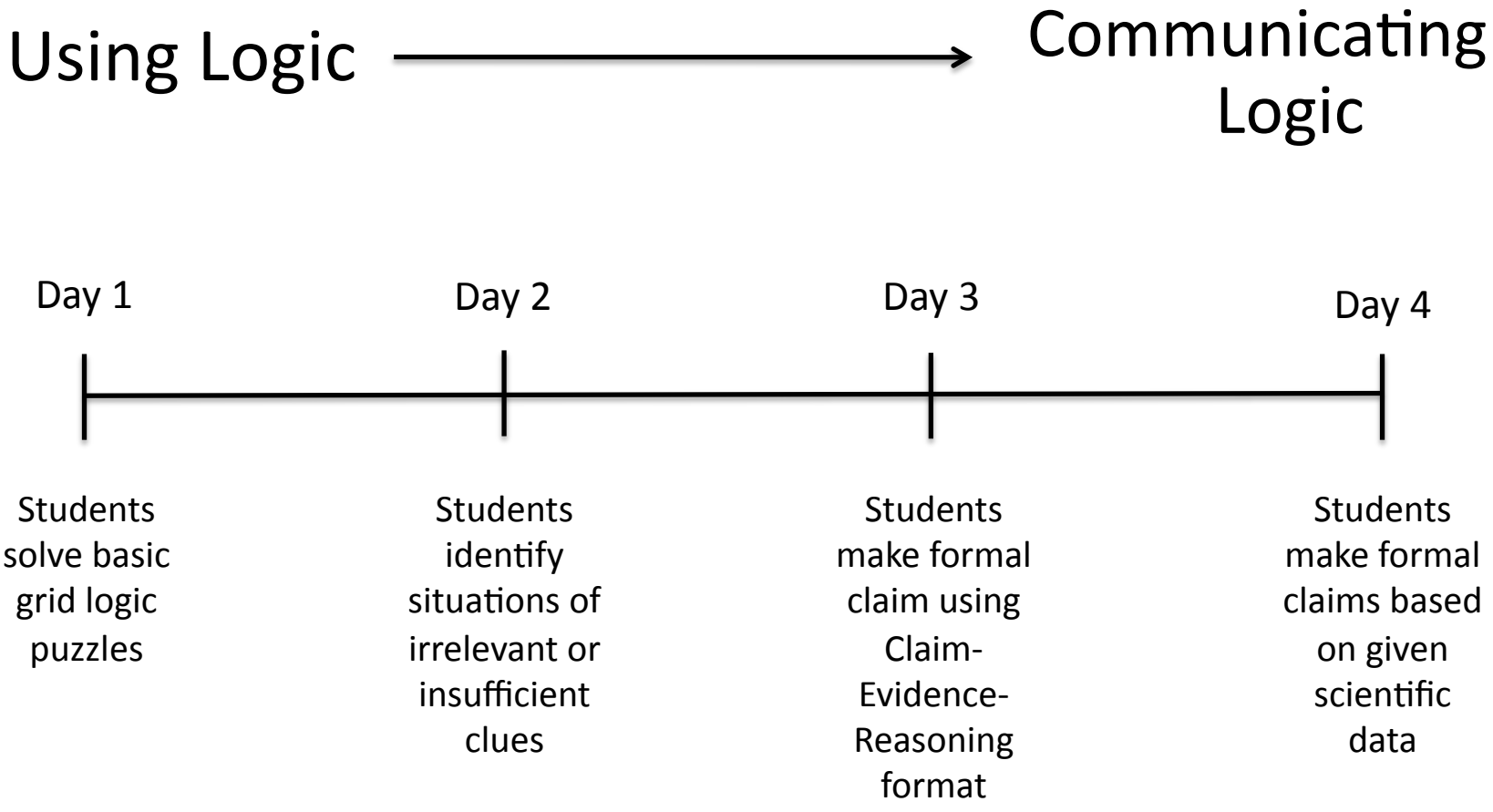
RET 2 Curriculum Goals



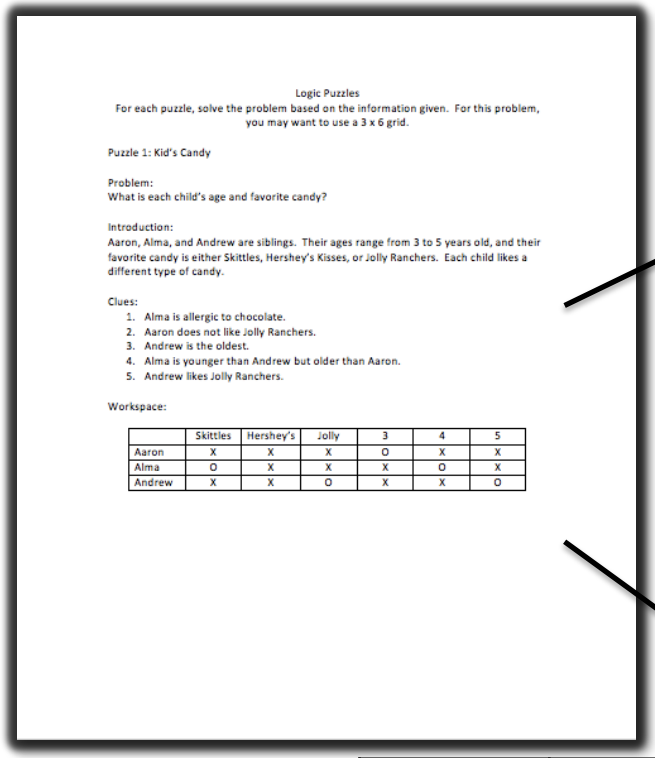
Lab Skill → Lesson



Introductory Logic Unit: Outline



Day 1: Logic Grid Puzzles



Logic Puzzles

For each puzzle, solve the problem based on the information given. For this problem, you may want to use a 3 x 6 grid.

Puzzle 1: Kid's Candy

Problem:
What is each child's age and favorite candy?

Introduction:
Aaron, Alma, and Andrew are siblings. Their ages range from 3 to 5 years old, and their favorite candy is either Skittles, Hershey's Kisses, or Jolly Ranchers. Each child likes a different type of candy.

Clues:
1. Alma is allergic to chocolate.
2. Aaron does not like Jolly Ranchers.
3. Andrew is the oldest.
4. Alma is younger than Andrew but older than Aaron.
5. Andrew likes Jolly Ranchers.

Workspace:

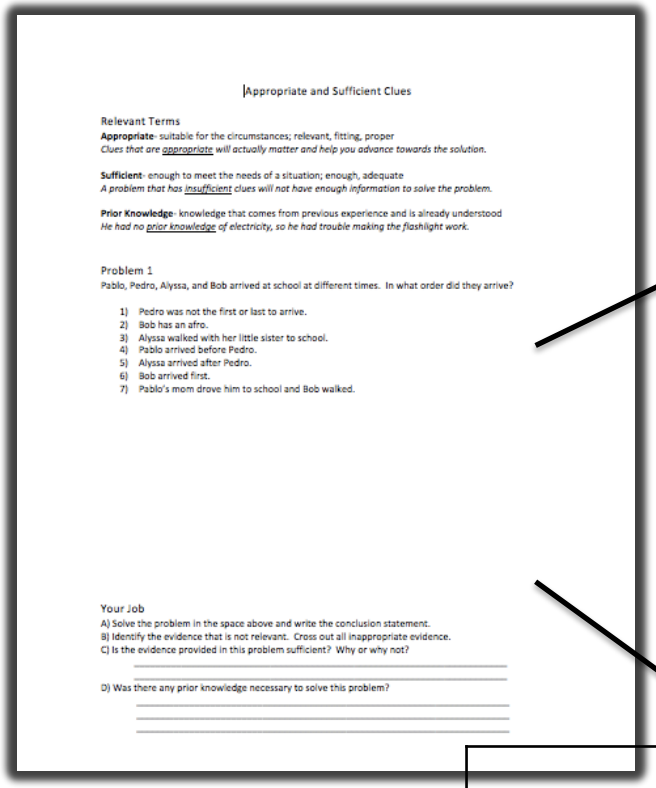
	Skittles	Hershey's	Jolly	3	4	5
Aaron	X	X	X	O	X	X
Alma	O	X	X	X	O	X
Andrew	X	X	O	X	X	O

What is each child's age and favorite candy?

1. Alma is allergic to chocolate.
2. Aaron does not like Jolly Ranchers.
3. Andrew is the oldest.
4. Alma is younger than Andrew but older than Aaron.
5. Andrew likes Jolly Ranchers.

	Jolly	Skit	Hersh	3	4	5
Alma	X	O	X	X	O	X
Aaron	X	X	O	O	X	X
Andrew	O	X	X	X	X	O

Day 2: Irrelevant or Insufficient Clues



Appropriate and Sufficient Clues

Relevant Terms

Appropriate- suitable for the circumstances; relevant, fitting, proper
Clues that are appropriate will actually matter and help you advance towards the solution.

Sufficient- enough to meet the needs of a situation; enough, adequate
A problem that has insufficient clues will not have enough information to solve the problem.

Prior Knowledge- knowledge that comes from previous experience and is already understood
He had no prior knowledge of electricity, so he had trouble making the flashlight work.

Problem 1

Pablo, Pedro, Alyssa, and Bob arrived at school at different times. In what order did they arrive?

1) Pedro was not the first or last to arrive.
2) Bob has an afro.
3) Alyssa walked with her little sister to school.
4) Pablo arrived before Pedro.
5) Alyssa arrived after Pedro.
6) Bob arrived first.
7) Pablo's mom drove him to school and Bob walked.

Your Job

A) Solve the problem in the space above and write the conclusion statement.
B) Identify the evidence that is not relevant. Cross out all inappropriate evidence.
C) Is the evidence provided in this problem sufficient? Why or why not?

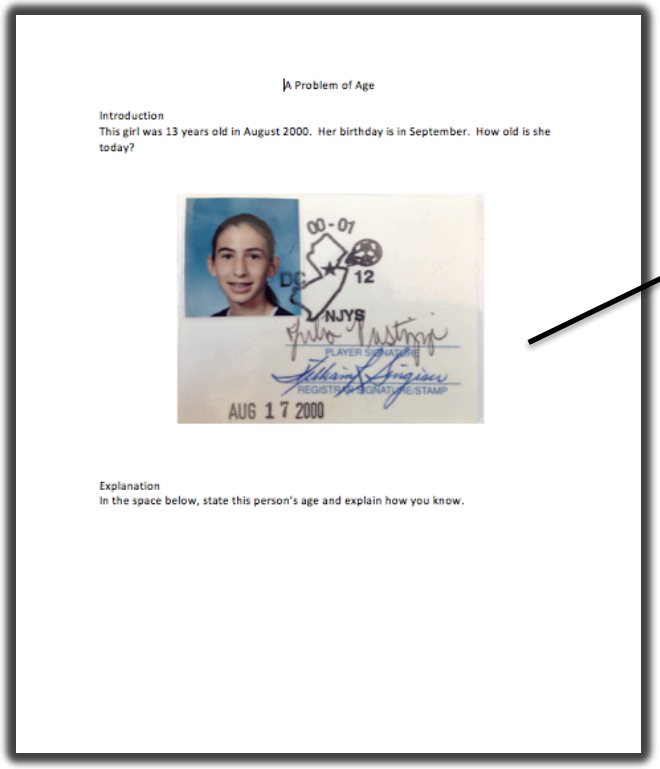
D) Was there any prior knowledge necessary to solve this problem?

In what order did the students arrive?

1. Pedro was not the first or last to arrive.
2. ~~Bob has an afro.~~
3. Alyssa arrived after Pedro.
4. Pablo arrived before Pedro.

	1	2	3	4
Pedro	X			X
Bob				
Alyssa	X			
Pablo				X

Day 3: Making Formal Claims



A Problem of Age

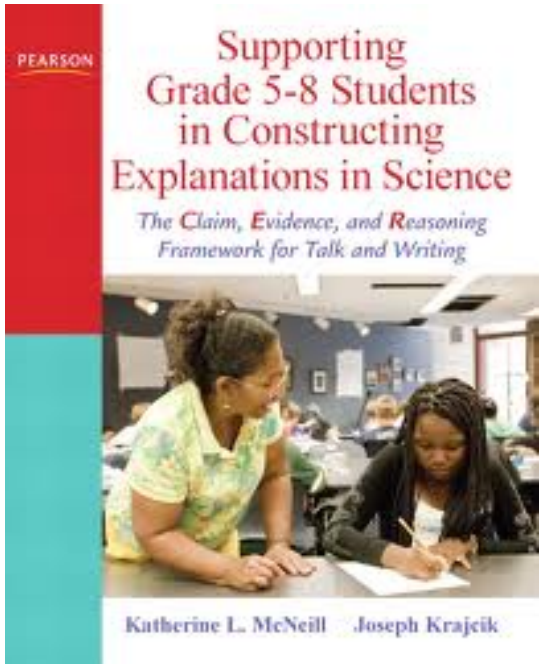
Introduction
This girl was 13 years old in August 2000. Her birthday is in September. How old is she today?

Explanation
In the space below, state this person's age and explain how you know.

How old is she today?

1. She was 13 in August 2000.
2. Her birthday is in September.

Day 3: Making Formal Claims



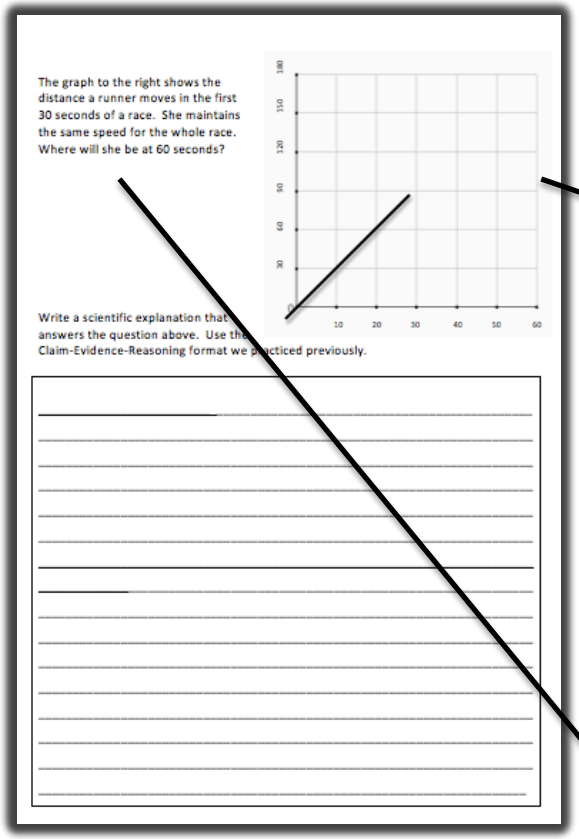
Claim-Evidence-Reasoning Framework:

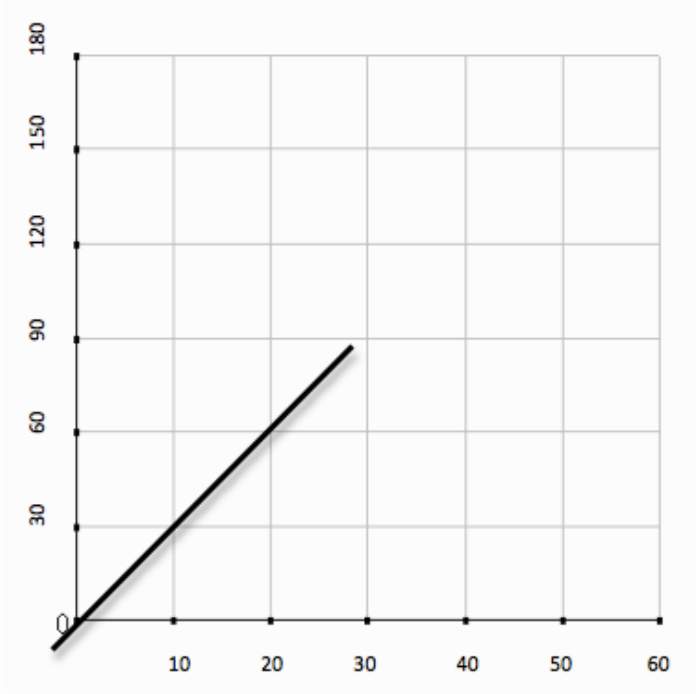
Claim- conclusion

Evidence- data

Reasoning- justification

Day 4: Formal Scientific Claims



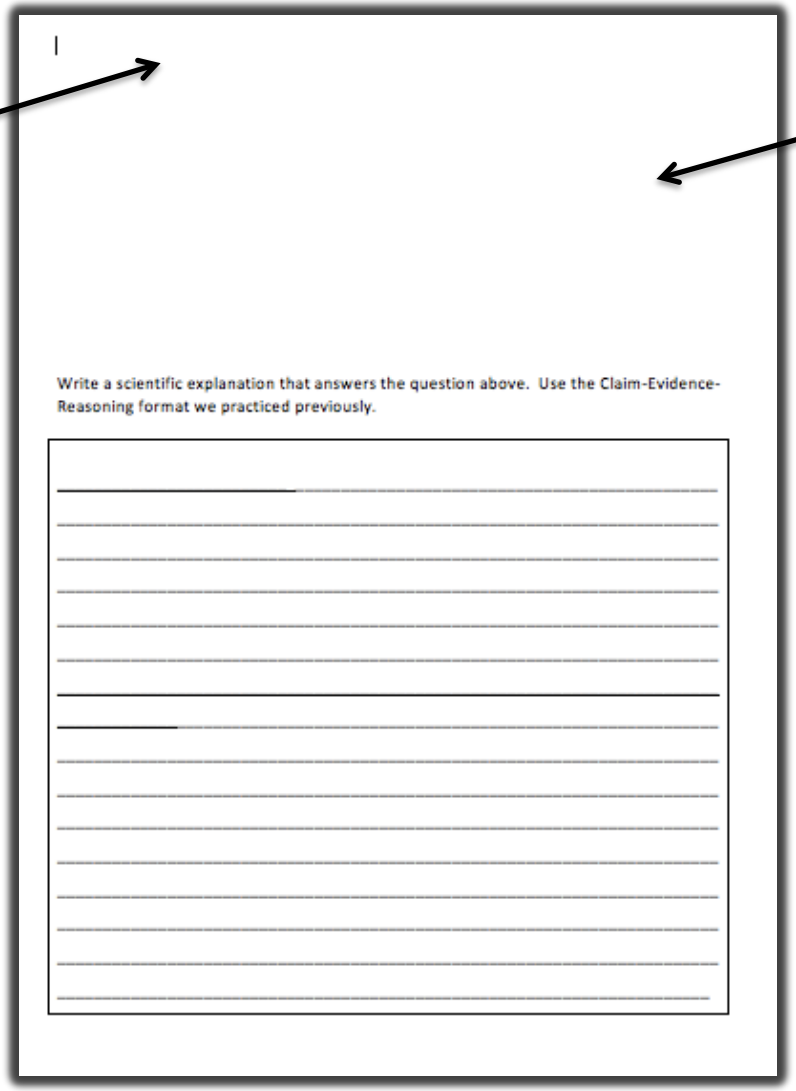


A runner maintains the same speed for an entire race. Where will she be at 60 seconds?

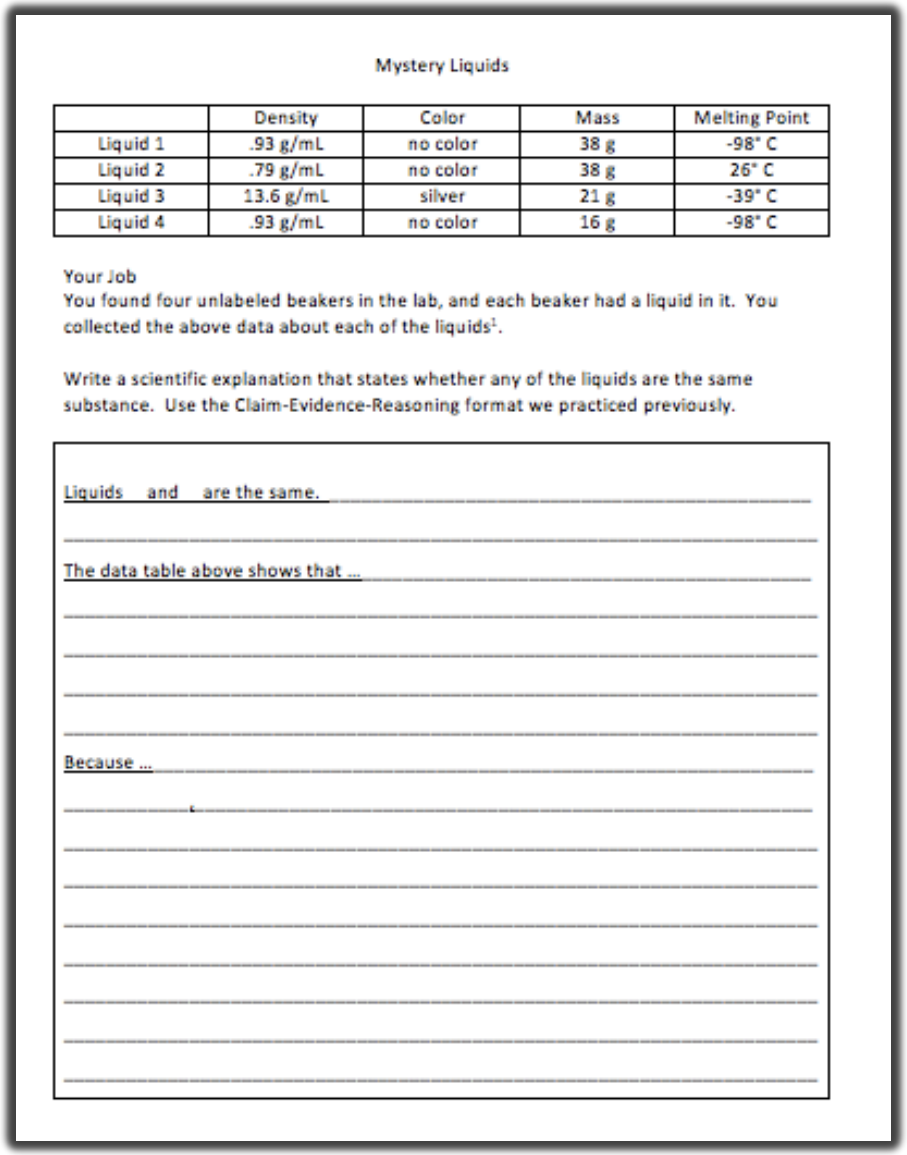
Template for Inserts

mystery

data



Insert 1: Mystery Liquids



Mystery Liquids

	Density	Color	Mass	Melting Point
Liquid 1	.93 g/mL	no color	38 g	-98° C
Liquid 2	.79 g/mL	no color	38 g	26° C
Liquid 3	13.6 g/mL	silver	21 g	-39° C
Liquid 4	.93 g/mL	no color	16 g	-98° C

Your Job
You found four unlabeled beakers in the lab, and each beaker had a liquid in it. You collected the above data about each of the liquids[1].

Write a scientific explanation that states whether any of the liquids are the same substance. Use the Claim-Evidence-Reasoning format we practiced previously.

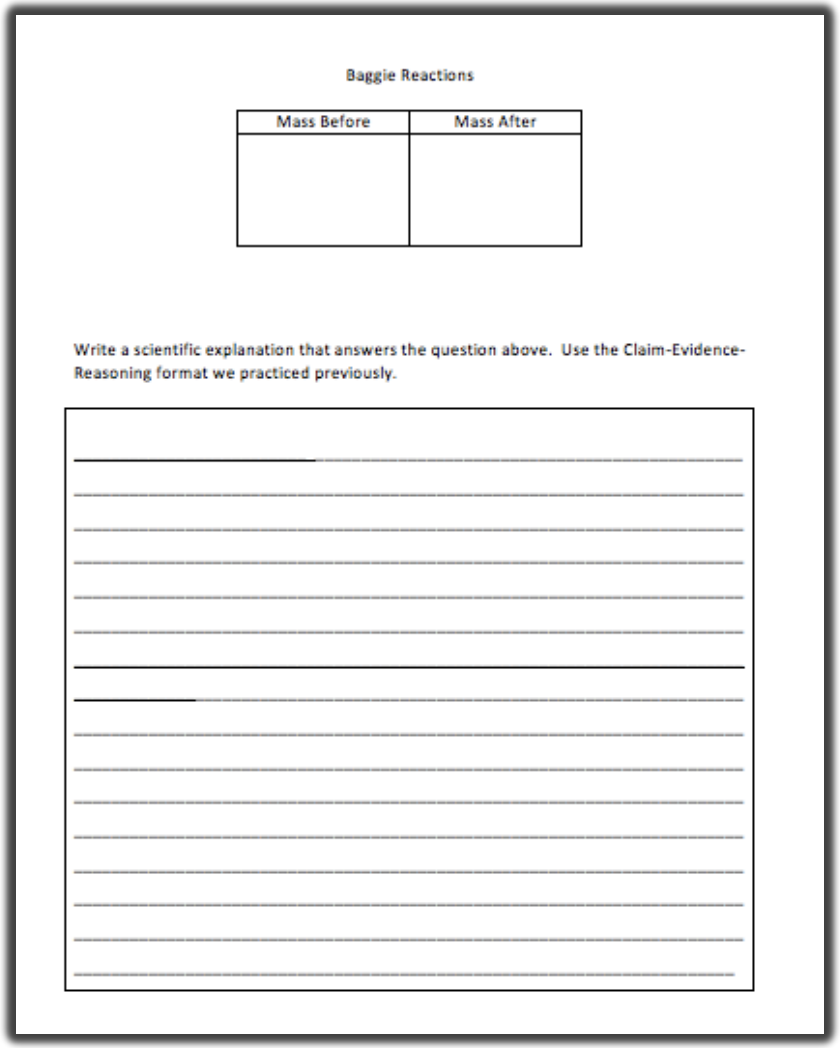
Liquids and are the same.

The data table above shows that …

Because …

- Krajick and McNeil
- Density, color, mass, melting point
- Are any liquids the same substance?

Insert 2: Conservation of Matter



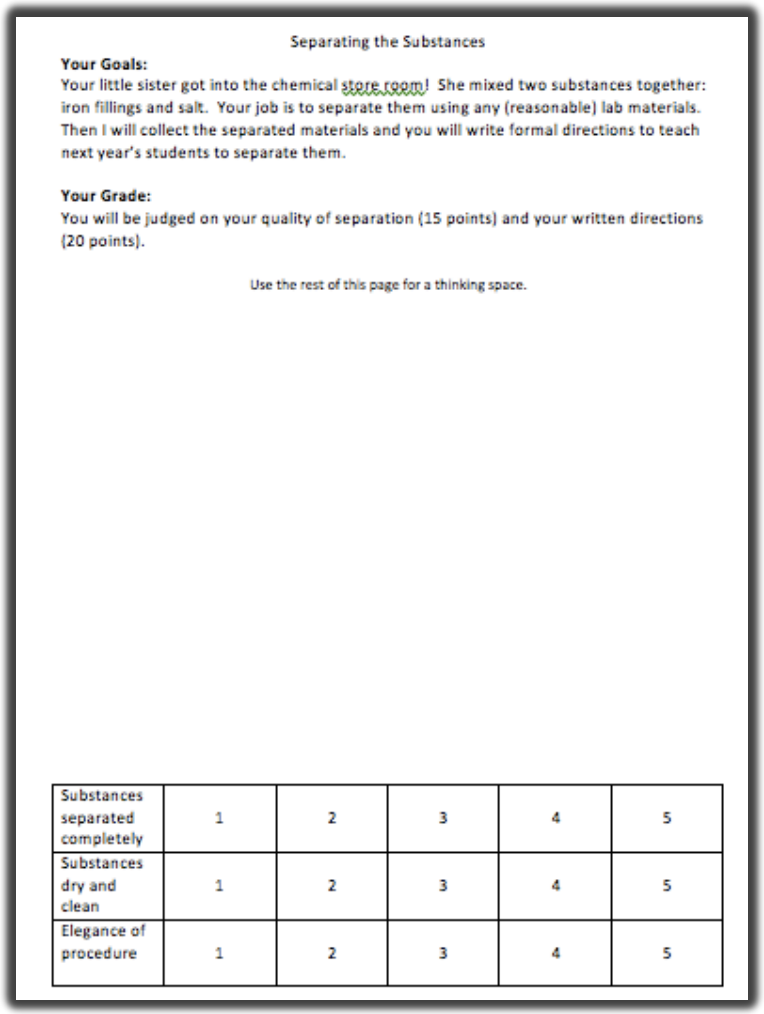
Baggie Reactions

Mass Before	Mass After

Write a scientific explanation that answers the question above. Use the Claim-Evidence-Reasoning format we practiced previously.

- Alka seltzer and water
- Mass before and after
- Has the number of atoms changed?

Insert 3: Separating Mixtures



Separating the Substances

Your Goals:
Your little sister got into the chemical store room! She mixed two substances together: iron fillings and salt. Your job is to separate them using any (reasonable) lab materials. Then I will collect the separated materials and you will write formal directions to teach next year's students to separate them.

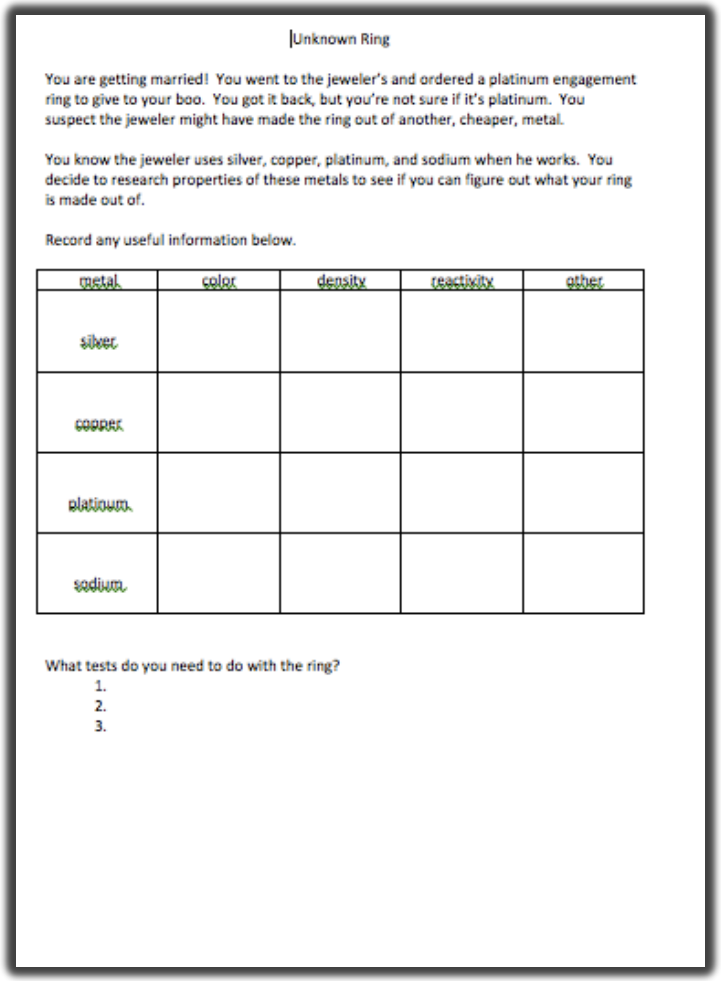
Your Grade:
You will be judged on your quality of separation (15 points) and your written directions (20 points).

Use the rest of this page for a thinking space.

Substances separated completely	1	2	3	4	5
Substances dry and clean	1	2	3	4	5
Elegance of procedure	1	2	3	4	5

- Iron filings, sulfur, and salt mixed
- How do you separate theses substances?

Insert 4: Unknown Ring



Unknown Ring

You are getting married! You went to the jeweler's and ordered a platinum engagement ring to give to your boo. You got it back, but you're not sure if it's platinum. You suspect the jeweler might have made the ring out of another, cheaper, metal.

You know the jeweler uses silver, copper, platinum, and sodium when he works. You decide to research properties of these metals to see if you can figure out what your ring is made out of.

Record any useful information below.

metal	color	density	reactivity	other
silver				
copper				
platinum				
sodium				

What tests do you need to do with the ring?

1.
2.
3.

- Students are given a ring
- Is the ring is made out of silver, sodium, copper, or platinum?

Insert 5: Sick at a Party

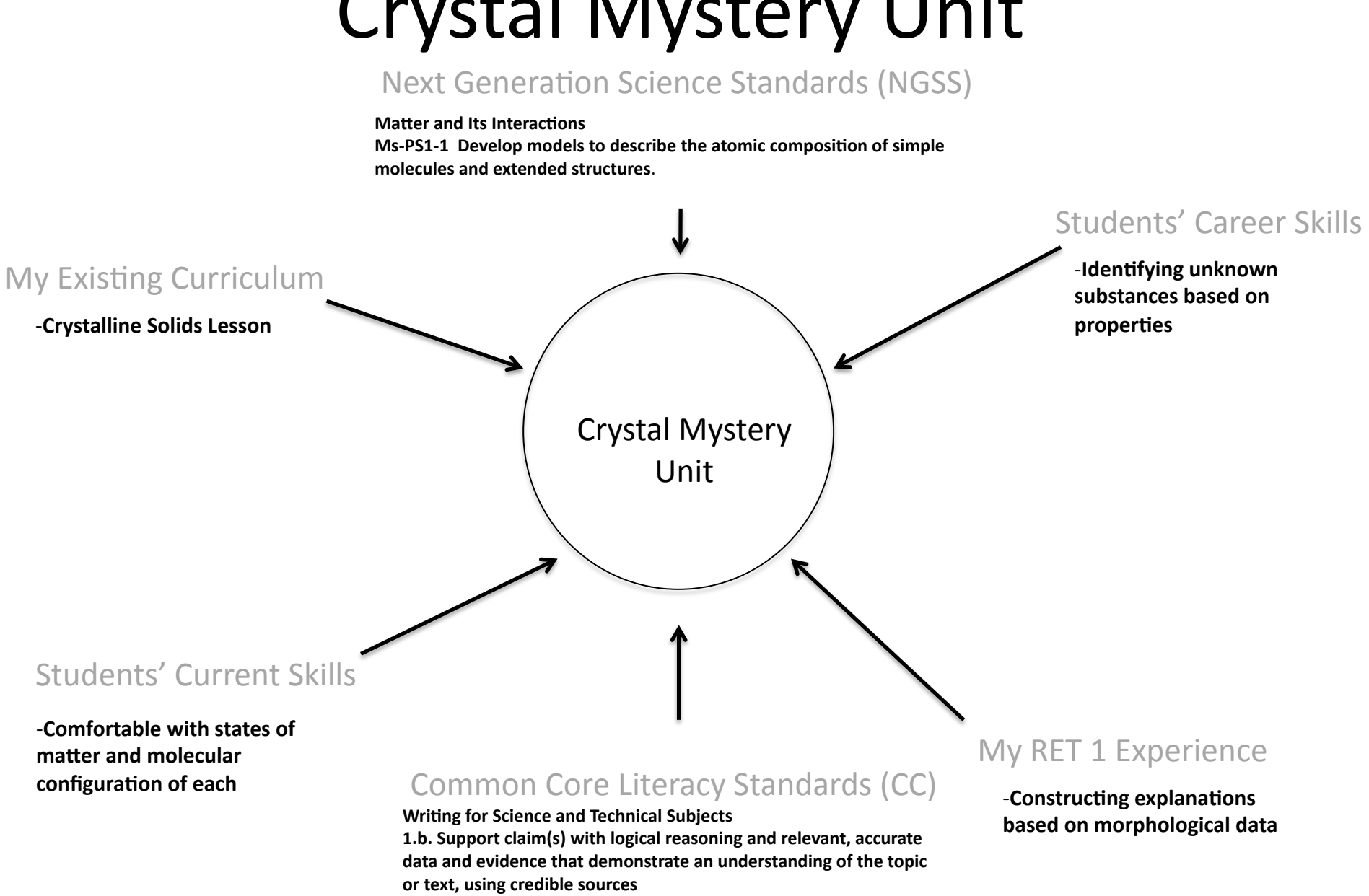
There was a party on Sunday! Unfortunately, some of the guests got sick afterwards. You suspect that some of the food they ate was bad. Your need to figure out which food was contaminated.

You interviewed the guests, and compiled a list of what each guest ate. Now you must find the contaminated food!

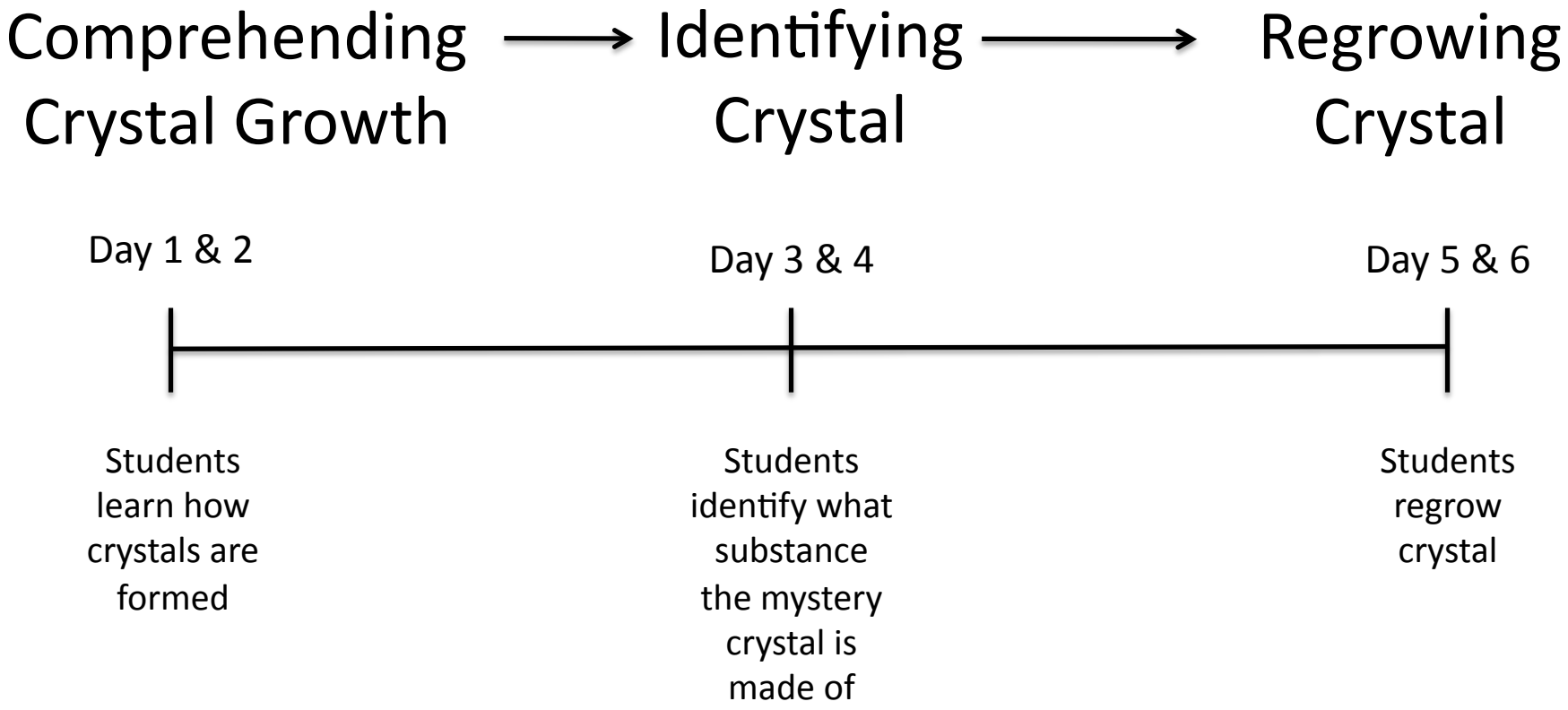
Bryce- Potato Salad, Green Beans, Carne, Rice, Takis --- Sick
Maria- Carne, Rice, Green Beans, Takis, Juice, Ice Cream ------ Sick
Jose- Potato Salad, Takis, Ice Cream, Carne ------- Sick
Richard- Potato Salad, Juice, Rice, Salsa ----- Not Sick
Alex- Carne, Rice, Salsa, Potato Salad, Takis, Juice --- Sick
Isaiah- Ice Cream, Salsa --- Not Sick
Diana- Potato Salad, Green Beans, Carne, Ice Cream ---- Not Sick

- List of guests and what they ate at the party
- What food made the guests sick?

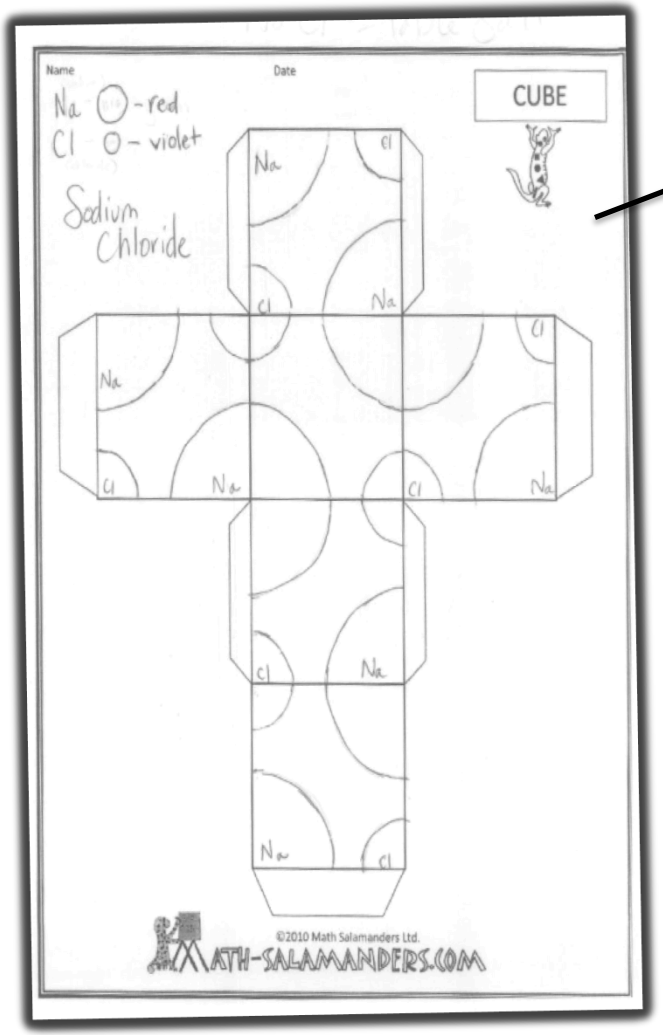
Crystal Mystery Unit

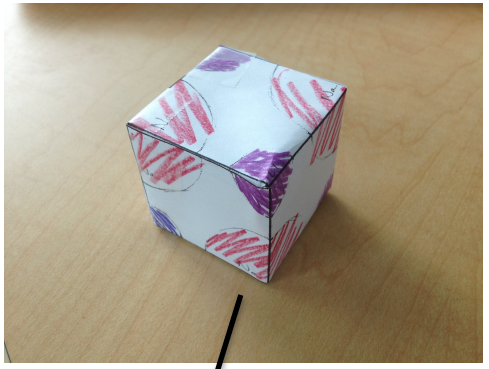


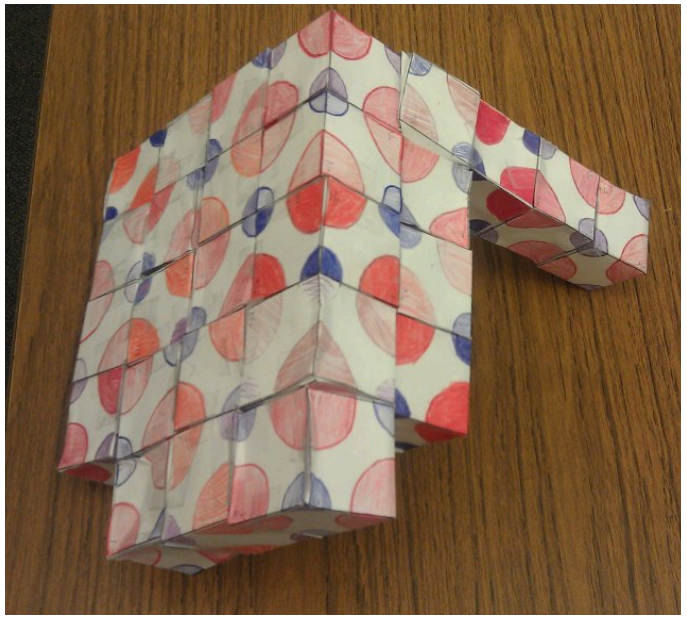
Crystal Mystery Unit: Outline



Day 1: Crystalline Structure







Day 2: Guided Reading

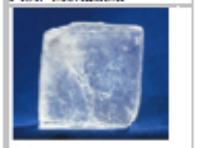
Kids Britannica *Crystals*

crystals

Britannica Student Encyclopedia

Three of sulfur's crystal forms appear in this photomicrograph. The shape of each grain is …
Courtesy of Carl Zeiss, Inc.; photo, Manfred Kage

Quartz crystals.
Piotr Menducki



Salt crystal (magnified).
U.S.Geological Survey

The ancient Greeks used the word *krystallos* to mean both ice and quartz. They thought that quartz was simply another form of ice that had become permanently solid. Today a crystal is commonly considered to be a solid object with symmetrically arranged flat surfaces that meet in straight lines and sharp corners. Everyone has seen examples of such crystals. Diamonds, snowflakes, and rock salt are among the best known.

The scientific definition of a crystal is based on its internal structure rather than its outward appearance. All matter on Earth is made up of atoms or, more frequently, combinations of atoms called molecules. If the molecules of a substance are arranged in a regular repeating pattern, the substance is a crystal. The segment of the pattern that is repeated over and over is called the unit cell. The three-dimensional pattern, made up of many unit cells lined up in all directions, is called the crystal lattice. The form of the crystal depends on the arrangement of the molecules within it. For example, the molecules of sodium chloride (table salt) are arranged in a cubic pattern. As a result, sodium chloride crystals are cubic in appearance.

Most solids are composed of crystals. Nearly all metals and many other minerals are crystalline solids. On the other hand, glass, most plastics, and rubber belong to a different class of solids. These noncrystalline, or amorphous, solids have a less orderly arrangement of their molecules. Many substances, including rocks, dirt, and concrete, are mixtures of different kinds of solids. Various organic materials—wood, wheat, and

Day 2

Guided Reading

Consider the article at http://kids.britannica.com/comptons/article-9273872/crystals . For this assignment, you are only using the first 5 paragraphs. How might this article help you with the task at hand? Briefly discuss with your neighbor, and then work with your neighbor to complete the task at hand.

Part 1- Read each of the paragraphs and write a sentence explaining what each paragraph is about.

1 _____

_____

2 _____

_____

3 _____

_____

4 _____

_____

5 _____

Part 2- Using the correct paragraph found above, graphically explain the connection between molecules and the crystal lattice.

molecules

↓

↓

crystal lattice

Part 3- Underline the 3 sentences that discuss single crystals. Rephrase those sentences so that it is clear that you understand what they mean.

Part 4- Look at the attached chart "Crystal Shapes"

List the 7 categories of unit cells:

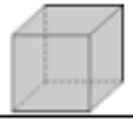
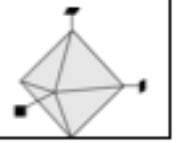
1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____

Write down and sketch any 2 crystal shapes:

&

Write down the name of the unit cell that you made yesterday:

Day 3: Identifying the Substance

Substance Name	Solubility at 20 °C	Crystal Color	Crystalline Micro-structure	Crystalline Macro-structure
Epsom Salt	71 g/100 mL	Clear	Monoclinic	sphenoid 
Table Salt	35.7 g/100 mL	Clear	Cubic	Cube 
Alum	14.0 g/100 mL	Clear	Cubic	Octahedron 

Day 4: Making a Formal Claim

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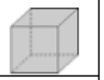
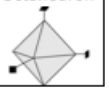
Substance Name	Solubility at 20 °C	Crystal Color	Crystalline Micro-structure	Crystalline Macro-structure
Epsom Salt	71 g/100 mL	Clear	Monoclinic	sphenoid 
Table Salt	35.7 g/100 mL	Clear	Cubic	Cube 
Alum	14.0 g/100 mL	Clear	Cubic	Octahedron 

Day 4
Formal Claim
In the space below, explain which substance the crystal is made of, and how you know.
Make sure to use the claim-evidence-reasoning format to fully support your claim.

The crystal is made of …

The data in the above shows that …

Because …

Day 5: Developing Crystal Growth Procedures

wool, for example—are complex mixtures, containing long chains of molecules. Simpler organic compounds, and even some viruses, are often crystalline in structure.

Liquid crystals are not actually crystals but substances that have some properties of liquids and some of crystalline solids. They can flow like liquids but also display some of the ordered structure of a crystal.

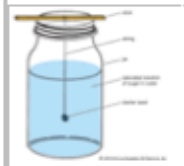
Some solid materials, such as metals, salts, and powders, do not fit the common notion of crystals but do fit the scientific definition. The solids that fit the common notion of crystals are all large single crystals. In a single crystal the same orientation of the crystal pattern extends throughout the specimen. When this occurs, the symmetrical arrangement of the unit cells can show up in the overall appearance of the crystal.

Most common solids are polycrystalline, composed of many crystals. Their molecules are arranged in a pattern, but a given orientation of the pattern extends over only a small area, called a grain. Each grain shows the symmetry that is observed in large single crystals.

Crystal Growth

Growing Crystals at Home

Originally, the study of crystal structure was limited to naturally occurring single crystals such as the precious and semiprecious gems. It is now possible to produce synthetic single crystals that are often larger and purer than natural crystals. They are prepared by various methods, all of which can use the process of growth from a seed. A small single crystal, the seed, grows in size as additional molecules of the material settle on it.



Crystals can be grown at home with simple equipment. In this case, dissolved sugar molecules settle … *Encyclopædia Britannica, Inc.*

One method for growing crystals is called growth from solution. It is the easiest way to grow large crystals at home. The major trick to this method is to allow the solvent to evaporate slowly. This often means leaving it undisturbed for several days.

Such household chemicals as alum, table salt, borax, and sugar are recommended. Alum works best, but the others are more commonly available. Specific instructions and measurements for each compound can be found in books on crystals and crystal growing. The basic procedure, however, is the same for most crystals that dissolve in water.

The substance is stirred into hot water until no more of it

Day 5

Learning to Regrow the Crystal

Use the Kid Britannica *Crystal* article to complete the Guided Reading.

Solution- a mixture of two substances where one is dissolved in the other
Solvent- the liquid that a solute is dissolved in
Solute- the substance that is dissolved in the solution

1. Identify the paragraphs that discuss crystal growth. Circle these paragraphs.
2. Partner A should read the first paragraph of that section. Partner B should listen and then explain to Partner A how the seed grows.
3. Read the second paragraph out loud to your neighbor.
   What is the easiest way to grow crystals called? _____
   Read the definition of *solvent* above. When the solvent evaporates, as is explained in this paragraph, what is left behind? _____
4. Read the third paragraph to yourself.
   What household chemical works the best for growing crystals? _____
5. Read the final paragraph of this section. Partner A should read the first sentence, then Partner B will read the same sentence. Repeat for all sentences. When you are finished, write a set of procedures so that someone who knows nothing about crystals can make their own large, single crystal.

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____
   _____
7. _____
   _____

Day 6: Growing the Crystal

Day 5
Learning to Regrow the Crystal

Use the Kid Britannica *Crystal* article to complete the Guided Reading.

Solution- a mixture of two substances where one is dissolved in the other
Solvent- the liquid that a solute is dissolved in
Solute- the substance that is dissolved in the solution

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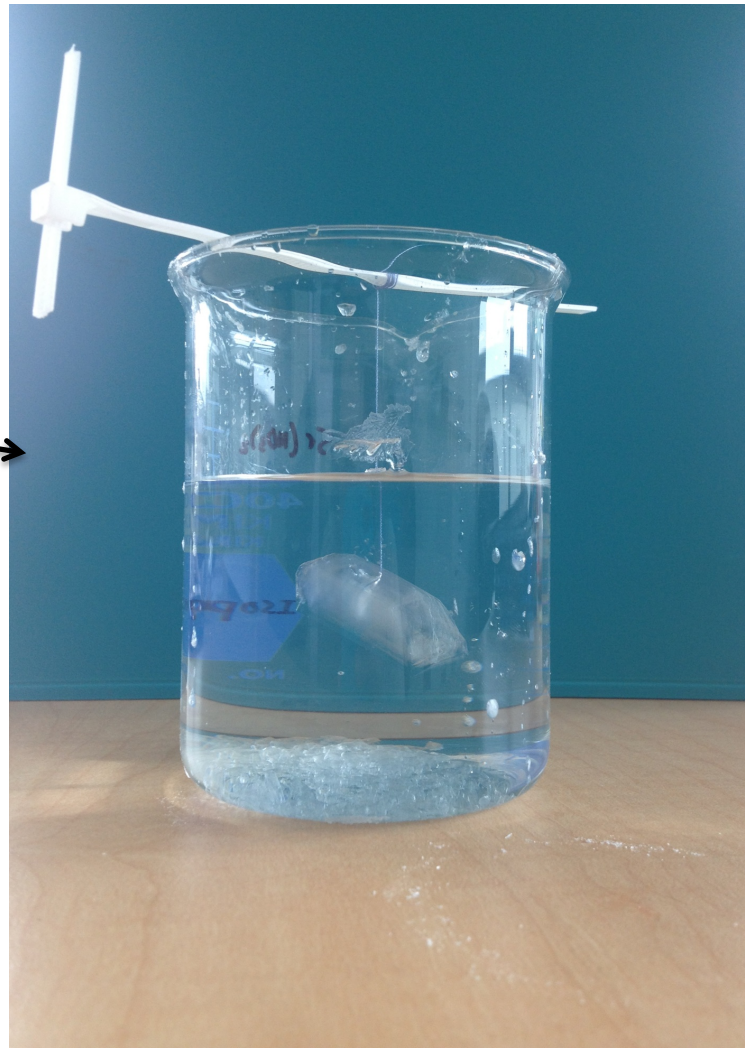
   1. _____
   _____
   2. _____
   _____
   3. _____
   _____
   4. _____
   _____
   5. _____
   _____
   6. _____
   _____
   7. _____
   _____



Day 4: Making a Formal Claim: Analysis

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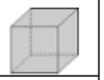
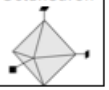
Substance Name	Solubility at 20 °C	Crystal Color	Crystalline Micro-structure	Crystalline Macro-structure
Epsom Salt	71 g/100 mL	Clear	Monoclinic	sphenoid 
Table Salt	35.7 g/100 mL	Clear	Cubic	Cube 
Alum	14.0 g/100 mL	Clear	Cubic	Octahedron 

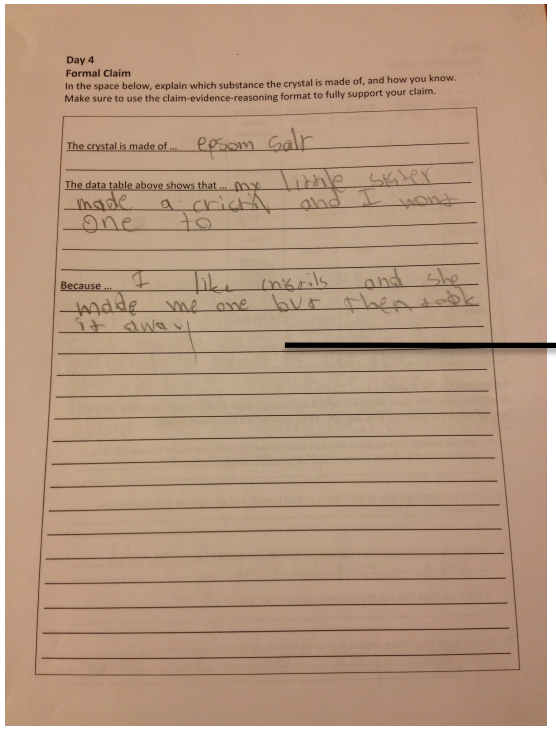
Day 4
Formal Claim
In the space below, explain which substance the crystal is made of, and how you know.
Make sure to use the claim-evidence-reasoning format to fully support your claim.

The crystal is made of …

The data in the above shows that …

Because …

Day 4: Making a Formal Claim: Analysis



Day 4
Formal Claim
In the space below, explain which substance the crystal is made of, and how you know.
Make sure to use the claim-evidence-reasoning format to fully support your claim.

The crystal is made of … epsom salt

The data table above shows that … my little sister made a cristil and I wont one to

Because … I like cristils and she made me one but then took it away

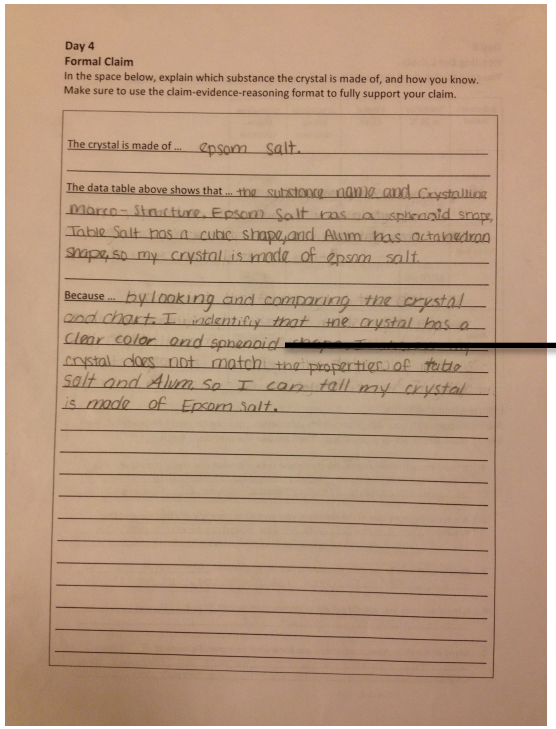
In the space below, explain which substance the crystal is made of, and how you know. Make sure to use the claim-evidence-reasoning format to fully support your claim.

The crystal is made of… epsom salt

The data table above shows that… my littile sister made a cristil and I wont one to

Because… I like cristils and she made me one but then took it away

Day 4: Making a Formal Claim: Analysis



Day 4
Formal Claim
In the space below, explain which substance the crystal is made of, and how you know.
Make sure to use the claim-evidence-reasoning format to fully support your claim.

The crystal is made of ... epsom salt.

The data table above shows that ... the substance name and crystalline macro-structure. Epsom salt has a sphenoid shape, Table Salt has a cubic shape, and Alum has octahedron shape, so my crystal is made of epsom salt.

Because ... by looking and comparing the crystal and chart. I identify that the crystal has a clear color and sphenoid shape. I observe my crystal does not match the properties of Table salt and Alum, so I can tell my crystal is made of Epsom salt.

In the space below, explain which substance the crystal is made of, and how you know. Make sure to use the claim-evidence-reasoning format to fully support your claim.

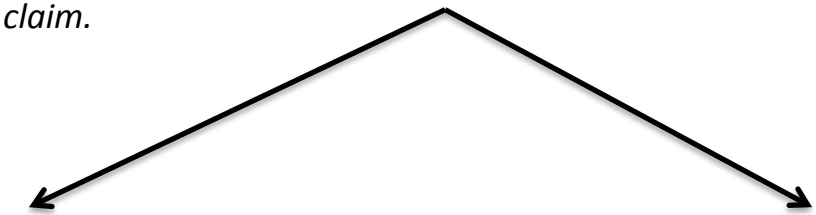
The crystal is made of… epsom salt.

The data table above shows that… the substance name and crystalline macro-structure. Epsom salt has a sphenoid shape, Table Salt has a cubic shape, and Alum has octahedron shape, so my crystal is made of epsom salt.

Because… by looking and comparing the crystal and chart. I identify that the crystal has a clear color and sphenoid shape. I observe my crystal does not match the properties of Table Salt and Alum, so I can tell my crystal is made of epsom salt.

Day 4: Making a Formal Claim: Analysis

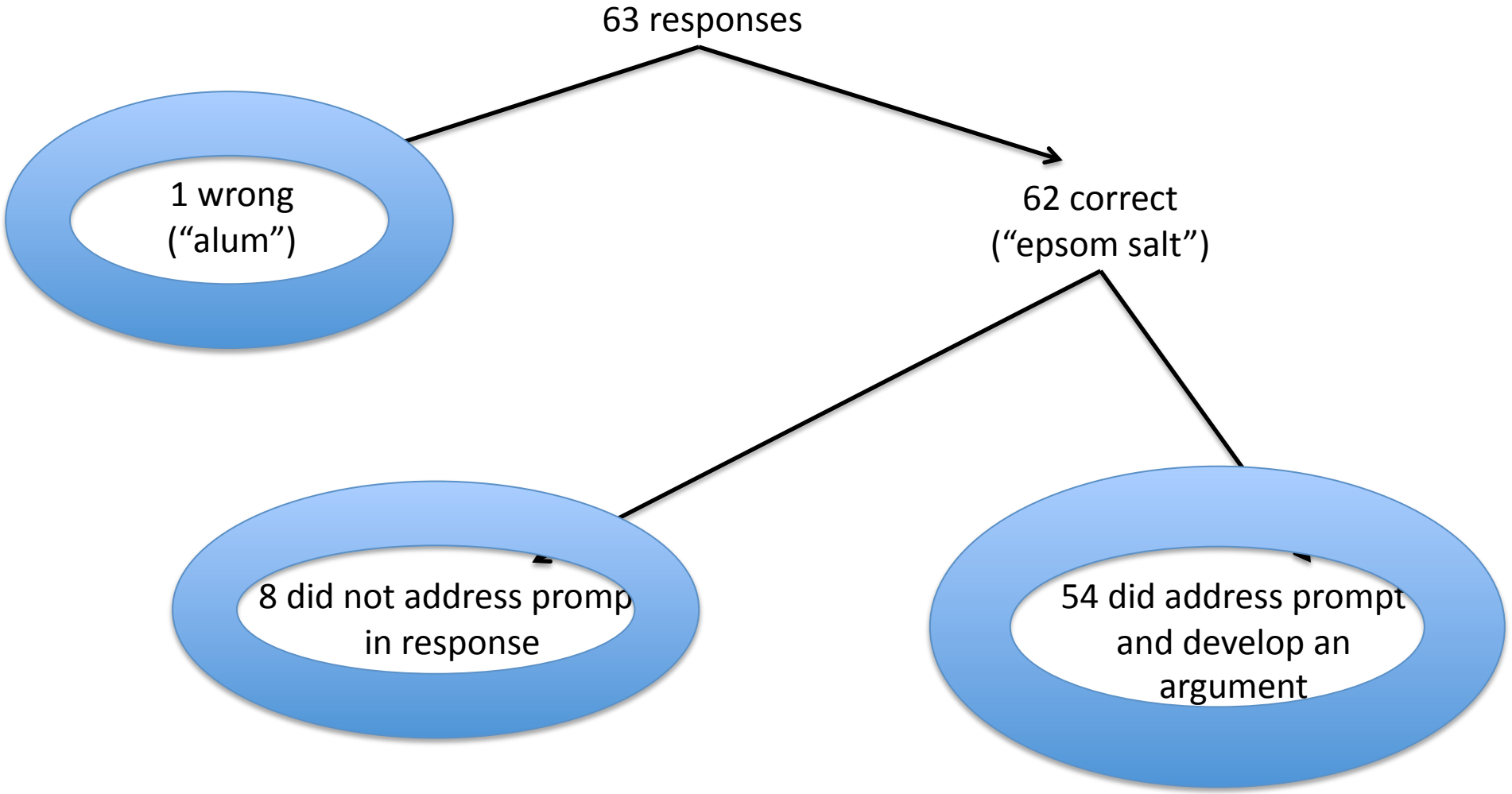
In the space below, explain which substance the crystal is made of, and how you know. Make sure to use the claim-evidence-reasoning format to fully support your claim.



Logic & reasoning

Making reasoning evident (writing)

Day 4: Making a Formal Claim: Analysis: Logic



Day 4: Making a Formal Claim: Analysis: Logic

54 did address prompt and develop an argument

a. Confirmative data (mention shape) → 54/54

b. Eliminative data (not octahedral/cubic) → 36/54

c. Irrelevant data (color/solubility) → 3/54

d. Unhelpful information mentioned → 5/54
("epsom salt is easy to find at the store")

Day 4: Making a Formal Claim: Analysis: Logic

Student makes reasonable claim	1	2	3
Student provides confirmative data, if possible	1	2	3
Student provides eliminative data, if possible	1	2	3

Day 4: Making a Formal Claim: Analysis: Logic

Student makes reasonable claim	1	2	3
Student provides confirmative data, if possible	1	2	3
Student provides **extra** confirmative data, if possible	1	2	3
Student provides eliminative data, if possible	1	2	3
Student mentions irrelevant data	1	2	3
Explanation contains no “unhelpful” data	1	2	3

Day 4: Making a Formal Claim: Analysis: Writing

Organization of claim and evidence	1	2	3
Grammar: run ons	1	2	3
Grammar: spelling	1	2	3
Use of formal tone	1	2	3
Not defining “it” or “they”	1	2	3

Day 4: Making a Formal Claim: Next Steps

- Re-implement this semester
- Provide students with rubrics before writing
- Outline explanation with students
- Peer-edit step
- Final draft step
- Repeat 3-4 times during semester


weight fluid displaced


Materials Research Laboratory

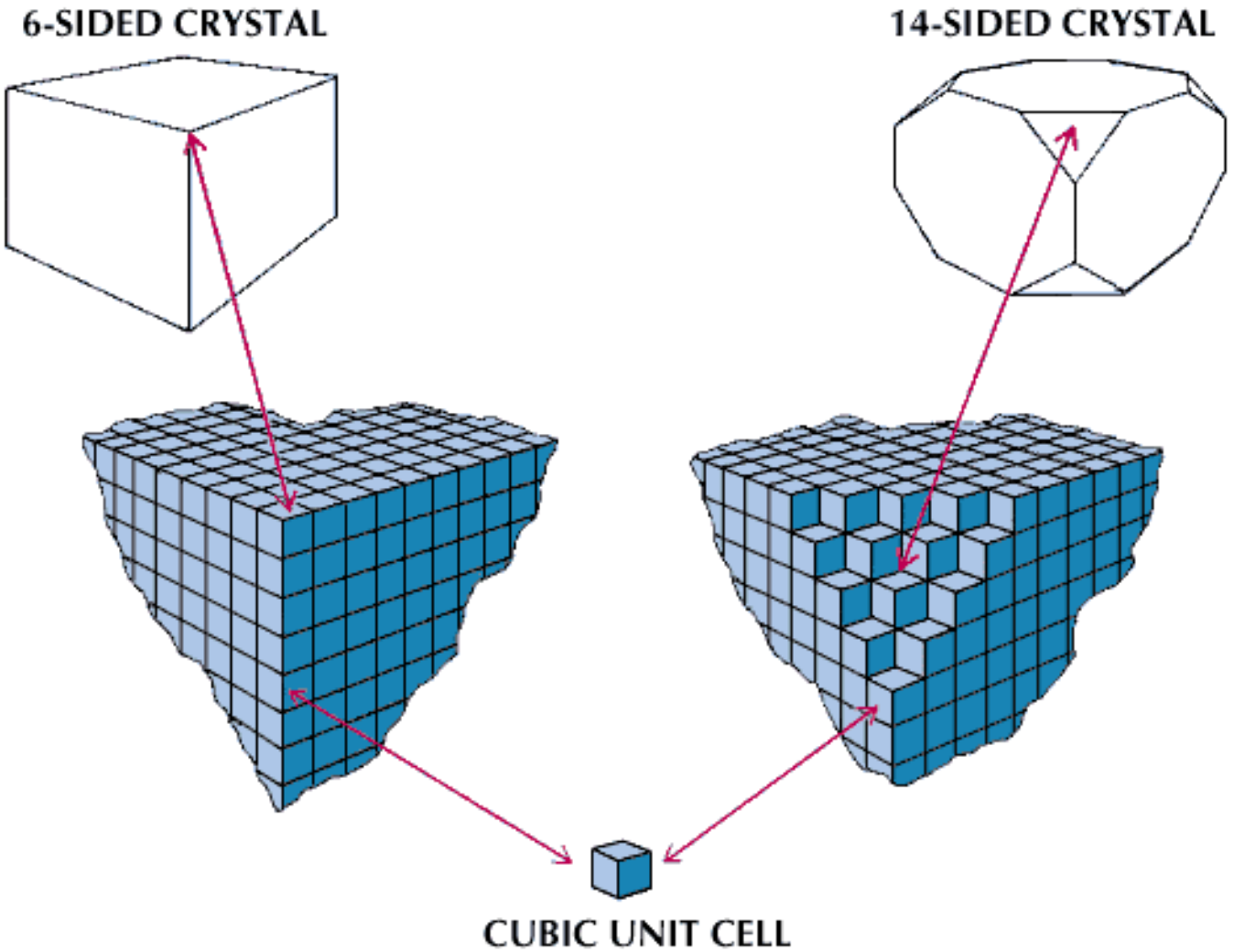
Thank You

Frank Kinnaman
Marilyn Garza
Mary McGuan
Javier Cervantes
Kyla Gupta
Jessica Thompson

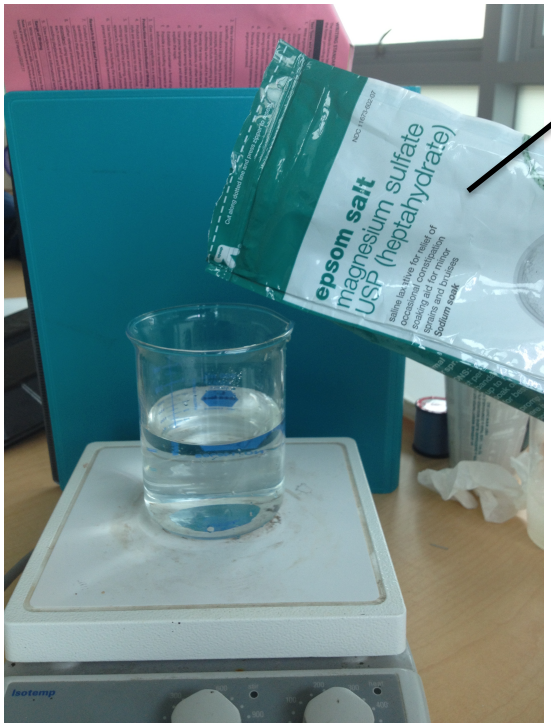
Jon Burk
Nick Economou
Graham Hagen-Peter
David Hosking
Michelle Bayly

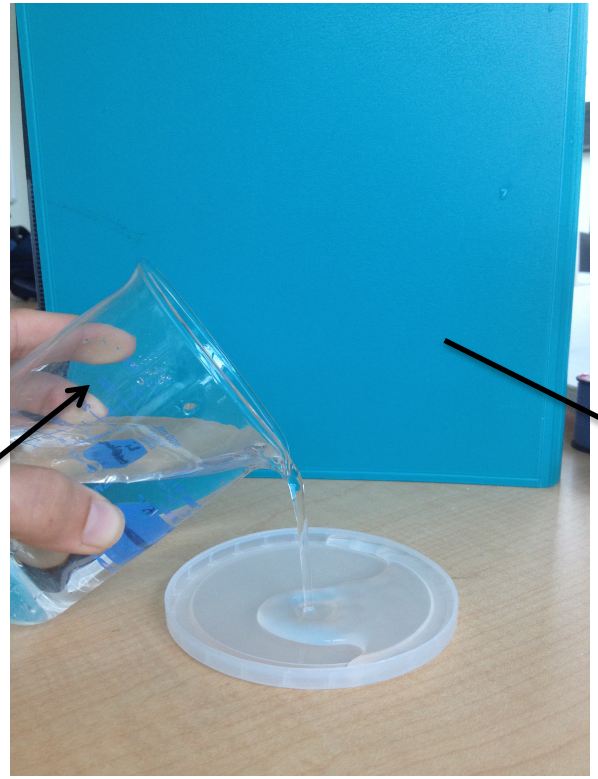
MRL
UCSB
NSF

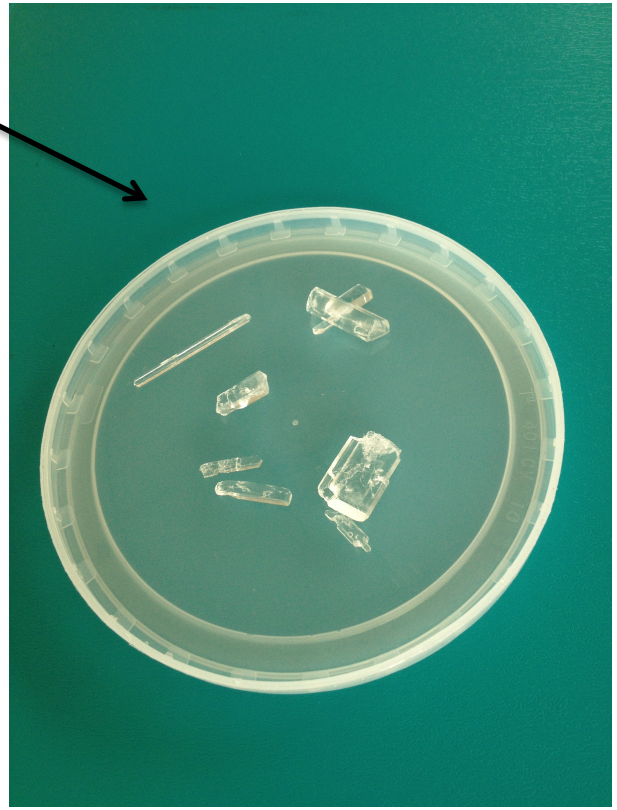
Unit Cell → Crystal Lattice



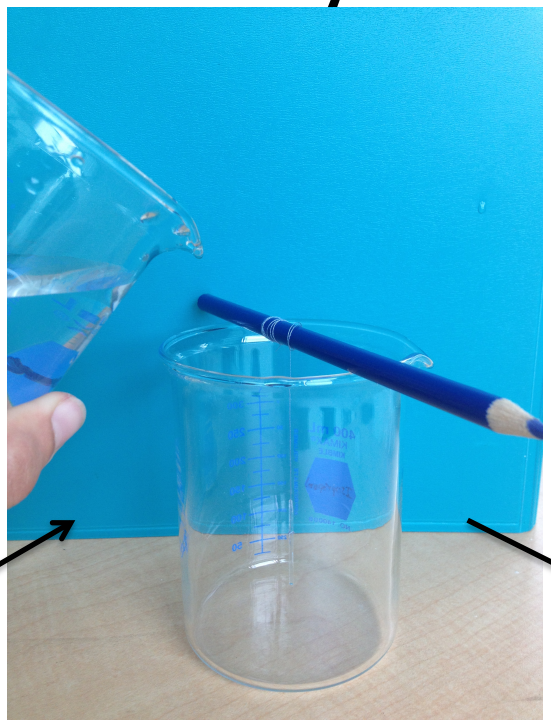
How to Grow a Seed Crystal

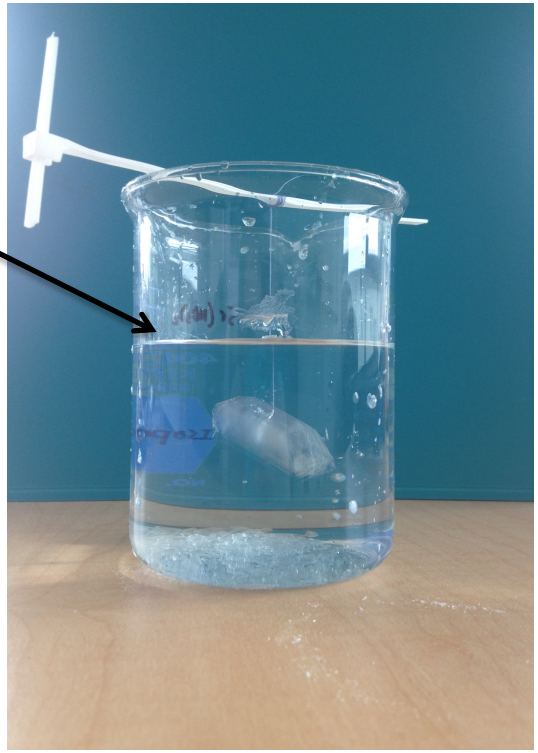






How to Grow a Large Crystal from a Seed Crystal





Classroom Context

Course:

- 8th grade physical science
- One semester
- All students

Location:

- Fesler Junior High School, Santa Maria, CA
- College-bound culture via AVID