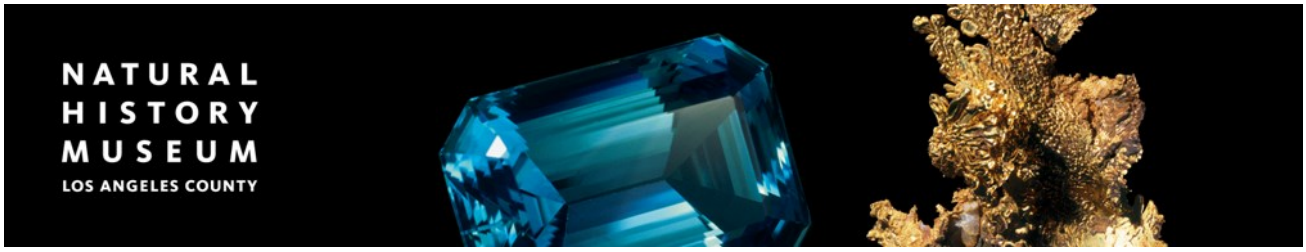


Building Blocks of Minerals

8th Grade

Duration
2-3 classes and a Museum visit

Location
Gem & Mineral Hall

Supplies
- See individual lessons

Standards
NGSS
MS-PS1-1, PS1.A, MS-PS1-2, MS-PS1-3, M-ESS3-1, ESS3.A
S+E Practices
4, 8
CCSS
L.4.b, RST.4
CA State
Science 3.b.c.f, 7.a

Vocabulary
Polyatomic ion · Ionic bond · Anion · Cation · Metal · Nonmetal · Covalent bond · Classification · Trace · Rare · Transparent · Translucent · Opaque

Student Work

Module Overview

This module explore elements that are common in minerals and what types of bonds hold minerals together

Module Purpose

This lesson set allows students to see "elements in action" and use the periodic table to identify the compounds present in minerals and gems. Students engage in inquiry as they collect data in the Museum, and make conclusions that different elements are present in different abundances in the Earth and that they most minerals are composed of metallic and nonmetallic elements, meaning they are ionic compounds.

Module Outline

1. In one pre-visit session students review how to use the periodic table to identify elements in simple compounds and learn about polyatomic ions to help them comprehend the basic structure of matter in the minerals they will see at the Museum.

2. During a visit to the Museum students collect data on the types of elements that are found in minerals in the Gem and Mineral Hall.

3. In one or two post-visit sessions, students organize and analyze data back in the classroom according .

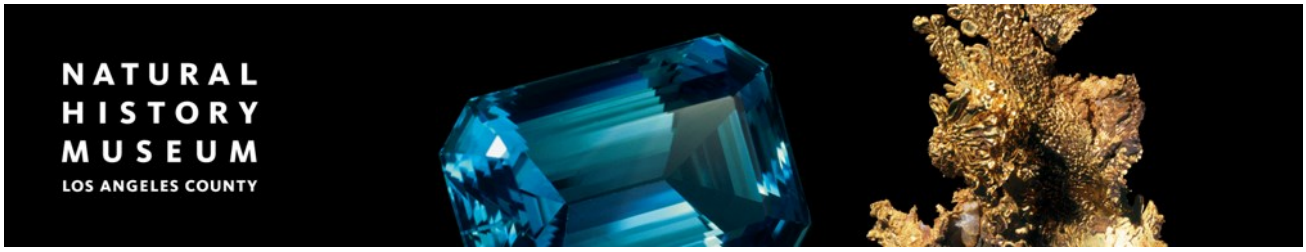
Module Prerequisite Skills & Concepts

- Student use the periodic table to identify elements in simple compounds.

- Students explain how positive and negative ions form.

Assessment Opportunities

	Before and During the Lesson		End of Lesson
Lesson/Phase	*Uncovers Student Ideas*	*Checks for Understanding*	*Evaluates Learning*
Pre-Visit	Worksheet	Elements in compounds	
Museum		informal observations	Data collection
Post-Visit			Analysis and conclusions



Background and Vocabulary

Pre-Visit

Duration
30-60 minutes

Location
Gem & Mineral Hall

Supplies
- Worksheet
- Pencils

Student Work

Purpose

Before visiting the museum, this phase ensures students will benefit from the activity by assessing and developing their background knowledge and vocabulary. It also ensures students fully comprehend the directions for the activity, as this is a rather complex assignment.

Objectives

- Students will define the words trace, rare, and polyatomic.
- Students will use the periodic table to identify the elements present in simple compounds and compounds that contain polyatomic ions.
- Students will state the goal of the project and explain the directions to a partner.

Outline

1. Give students 5 minutes to work on the worksheet. Then, have them share responses with their neighbors, then the whole class.

2. Introduce the word *polyatomic*. Call on a student to break the word into its prefix and root (poly, atomic). Call on another student to explain what *poly* means, an then another to explain what *polyatomic* must mean. Explain that a *polyatomic ion* is an ion (review this word if necessary) that has more than one atom in it. Give examples of polyatomic ions:
   - Hydroxide: OH^-
   - Sulfate: SO_4^{2-}
   - Carbonate: CO_3^{2-}

3. Ask students to count the number of atoms in each polyatomic ion.

4. Give examples of *compounds* that contain polyatomic ions
   - Sodium carbonate: Na_2CO_3
   - Calcium hydroxide: $Ca(OH)_2$
   - Zinc sulfate: $ZnSO_4$

5. Model for students how to identify elements in simple and slightly more complex compounds when given their name, a table of polyatomic ions, and a periodic table

6. Have students practice this skill. You may have them work in small groups, or individually.

7. Students should also practice identifying the symbol for each element, and whether it is a metal, nonmetal, or inert gas.

8. Introduce the Museum activity. Explain that while they are at the Museum, they may see some elements described as being present in trace quantities. Explain that trace means there is an extremely small amount of the element present, and it is not considered a part of the main compound. Students should still include the element in their data, but they should make note that it is in a trace amount. Similarly, explain that rare means there is very little of it present in the earth.

9. Go over your behavioral and academic expectations for your trip to the museum and explain the activities students will be completing while there.

Elements and Compounds

Name those elements!

Using a periodic table, name the elements present in each compound. Then, write the symbol for each element. The first one is done for you.

Compound	Elements	Symbols
sodium chloride	sodium chloride	Na Cl
magnesium iodide		
zinc fluoride		
potassium oxide		
hydrogen dioxide		
strontium bromide		

Poly-wha?

Use the space below to record what a *Polyatomic ion* is.

Definition:	**picture**
examples:	

Practice with Polyatomics

Repeat the first exercise, and identify the compound as a metal, nonmetal, or inert gas.

Compound	Elements	Symbols	Meta/Nonmetal/Inert Gas
calcium carbonate			
sodium sulfite			
lead arsenate			
strontium hydroxide			
calcium sulfate			
barium aluminum silicate			
rubidium hydroxide			
potassium nitrate			
iron nitrite			
magnesium phosphate			
copper aluminum phosphate hydroxide (NOTE: this is ONE compound!)			

Elements and Compounds

Periodic Table of the Elements

Chemistry Reference Sheet

California Standards Test

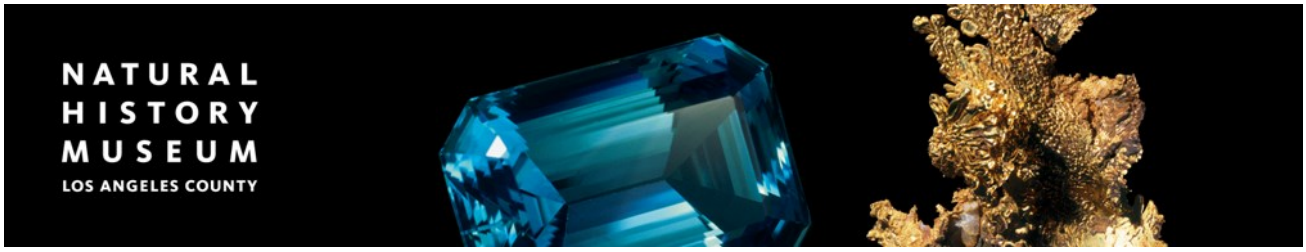
Table of Some Polyatomic Ions

NH_4^+	ammonium		PO_4^{-3}	phosphate
AsO_4^{-3}	arsenate		SiO_4^{-4}	silicate
CO_3^{-2}	carbonate		SO_3^{-2}	sulfite
OH^-	hydroxide		SO_4^{-2}	sulfate
NO_3^-	nitrate		VO_4^{-3}	vanadate
NO_2^{-2}	nitrite			

	1 1A		3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 H Hydrogen 1.01	2 2A																2 He Helium 4.00
2	3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
4	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
5	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
6	55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)									

58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97
90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.



Observation & Data Collection

Museum Visit

Duration
30-45 minutes

Location
Gem & Mineral Hall

Supplies
- Worksheet
- Clipboards with LED or similar lights (optional: it is quite dark in the Mineral Hall)
- Pencils

Student Work

Purpose

The Museum visit allows students to use the periodic table for an authentic purpose and provides them with an opportunity to collect data for analysis.

Objectives

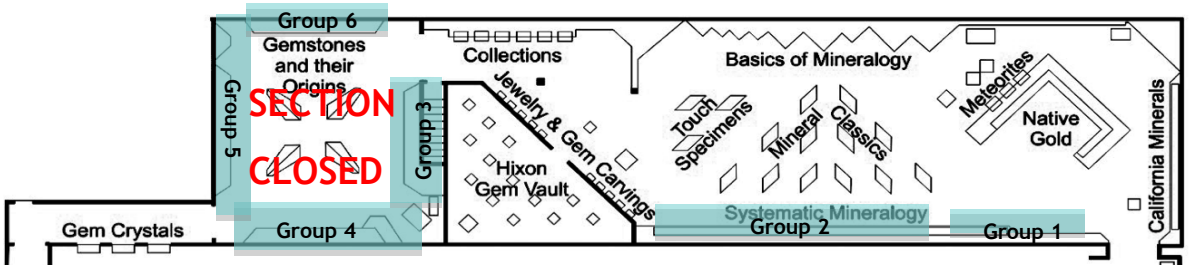
- Students will list chemical formulas of the minerals present in the minerals in their assigned space in the museum.
- Students will observe appearance and structure of minerals.

Outline

1. Review academic and behavioral expectations for the Museum visit.
2. Assign students to groups of 2-3 before arriving at the Museum.
3. **Whole Group:** Gather students in front of the hall, pointing out the general layout. Each student group will be assigned to a different part of the hall while they collect data. Because not all areas of the hall include the chemical formulas, only assign students to the highlighted parts of the map. Make sure each group knows where they are starting and when and where the class will meet up again. (5-10 min)
4. **Small Group:** Students work in groups to complete the assignment, observing the exhibits as they go. (40 min)
5. **Whole Group:** Once it is time for your class to move on to the next part of the Museum, gather the class back at the entrance to the exhibit.
6. **Small Group:** Either on the bus or back in class, allow students time to share their results with another group or two.

Observing Minerals

Gem & Mineral Hall



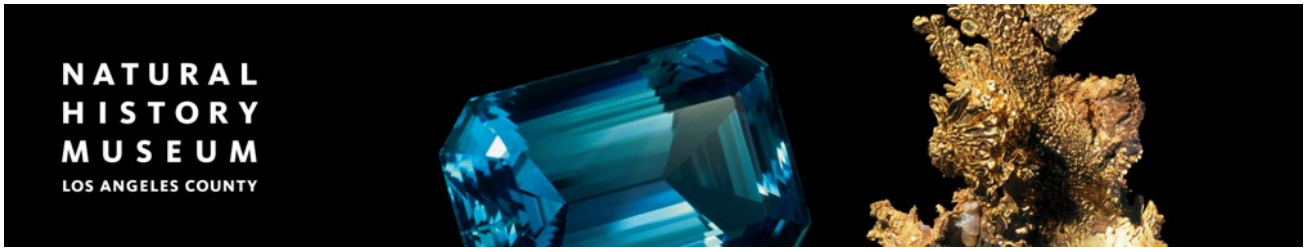
Data Collection

In your assigned section of the exhibit, fill in the following table with your data.

Mineral	Chemical formula and trace elements present	Color/s	Transparency (check one)		
			transparent	translucent	opaque

Observing Minerals

Mineral	Chemical formula and trace elements present	Color/s	Transparency (check one)		
			transparent	translucent	opaque



Data Analysis

Post-Visit

Duration
1–2 classes

Location
Gem & Mineral Hall

Supplies
- Completed Worksheet from Museum visit.
- Access to everyone's data
- Tools for data analysis, such as a journal or notebook, calculators, access to research options, etc.

Student Work

Purpose

Following the Museum visit, students organize and analyze their data, allowing them to draw conclusions. Possible conclusions might be:

- The abundance of various elements in the Gem and Mineral Hall compared to the abundance of these minerals in the earth.
- The type of bond found in most minerals.
- The classification of elements (metal/nonmetal) in minerals.
- The relationship between the elements present in various minerals and their properties (i.e. crystal structure, color etc…)

Objectives

- Students will present possible answers to each other and listen critically to other explanations.
- Students will draw conclusions about the structure of matter from the data they collected at the Gem and Mineral Hall.

Outline

1. Students have collected the following data at the Museum: mineral, chemical formula and trace elements present, appearance (color, transparency).
2. To obtain the most robust results, you will want them to have access to everyone's data. You may choose to make photocopies of their data, or project the data for students to copy.
3. They now need to organize their data, depending on what question you want them to answer. For example:

   What is the abundance of each element in the Gem and Mineral Hall? (Create a list of all the elements found and tally how many times they were found, noting *trace*)

   What kind of bond exists in most natural minerals? (Classify minerals

found as ionic, covalent, or metallic bonds, then count the number of each kind; perhaps compare the macroscale properties of the different kinds bonds).

How does the type of element present in a mineral effect its properties? (Create a list of the elements found and the color and transparency of the minerals in which they are present; analyze the list for patterns.

4. This last activity may be differentiated in many ways; you may want to lead your class through the activity if they have had little practice with inquiry if you are short on time. Alternatively, if your students are skilled at analyzing data and looking for patterns, you may want them to work relatively independently to choose the question they will answer with their data and how they will organize the data.