Discovering the Story: A City and Its Culture

IT'S ELEMENTAL!

A Science Lesson

for Grades 9-12

Mary Louise McLaughlin (1847-1939), The Cincinnati Pottery Club
(1879-1890), Frederick Dallas Hamilton Road Pottery (1865-1882),
United States (Cincinnati)
Ali Baba Vase, 1880
Gift of the Women's Art Museum Association, 1881.239

Maria Longworth Nichols Storer (The Rookwood Pottery Company)
Aladdin Vase, 1882
Gift of Mr. and Mrs. James J. Gardner, 2002.94

The lesson *It's Elemental!* is based on

Aladdin Vase
by Maria Longworth Nichols Storer

and

Ali Baba Vase
by Mary Louise McLaughlin

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IT'S ELEMENTAL!

A Science Lesson for Grades 9-12
Based on *Aladdin Vase* by Maria Longworth Nichols Storer
and *Ali Baba Vase* by Mary Louise McLaughlin

CONCEPT

Through close investigation of the Museum's *Ali Baba Vase* and *Aladdin Vase,* students will understand the chemical make-up of ceramic glazes. Students will understand that all elements represented in the periodic table are composed of atoms, and the combination of these atoms creates compounds, which are then combined to create ceramic glazes. Students will investigate several glaze compounds and in doing so will understand and identify the three principle components of all ceramic glazes and their functions. Students will then "create" several ceramic glazes through the completion of a *Glaze Compound Worksheet.*

The teacher will facilitate students in hands-on applications and study through pre-videoconferencing classroom activities, a videoconference visit with Cincinnati Art Museum Staff and post-videoconferencing lesson activities.

OBJECTIVES

- Students will understand that all elements represented in the periodic table are composed of atoms, and the combination of atoms creates compounds, which are then combined to create ceramic glazes.
- Students will understand that all glaze compounds are the combination of three smaller compounds.
- Students will understand and will be able to identify the components of several ceramic glaze compounds.
- Students will "create" several ceramic glaze compounds through the completion of the *Glaze Compound Worksheet.*

"Every child is an artist. The problem is how to remain an artist once he grows up."

Pablo Picasso

Teacher Preparation

Class Periods Required

1 – 3 (30-50 min.) class periods for Pre-Lesson Activities
1 50-min. class period for Videoconference
1 to 3 (30-50 min.) periods for Post-Lesson Activities
1 to 2 (30-50 min.) periods for Art Enrichment Activity (optional)

Background Information

Refer to Background Information for more on the *Ali Baba Vase* and the *Aladdin Vase* and the artists who created them. Background Information has been written for teachers to review before the lesson and then share with students.

Video

Share the ceramics video with your students prior to the videoconference. The video depicts archival film from Rookwood Pottery and an interview with a Museum curator on the two vases. This video is an excellent resource that will help to prepare students for the videoconference.

Video Duration – approx. six and a half minutes.

"He who works with his hands is a laborer. He who works with his hands and his head is a craftsman. He who works with his hands and his head and his heart is an artist."

St. Francis of Assisi

Pre- Videoconference

Vocabulary

Definitions can be found in the Glossary on the *Discovering the Story* Website.

Alumina
Atom
Ceramics
Compound
Element
Flux
Glaze
Kiln
Periodic Table
Silica

Guiding Questions

- What is ceramic glaze?
- How are ceramic glazes created?

Materials

- Print Reproductions of the Museum's *Ali Baba Vase* and *Aladdin Vase* (downloaded from www.discoveringthestory.com)
- Copy of the periodic table
- Pencil

Procedure

Teacher will:

- Share with students print reproductions of the Museum's *Ali Baba Vase* and *Aladdin Vase.* Share with students the Background Information and video on these vases.
- Ask students to describe each work and discuss how each was created. Tell students that the substance on the outside of each pot that makes it shiny is referred to as glaze. Share with students that glaze is a thin glasslike coating that is fused to the clay surface of a pot by the heat of a kiln. Glazes are the combination of several elements in the form of a compound.

- Introduce/review with students the following:
  - Atom (structure--neutrons, electrons, protons)
  - Elements
  - Periodic Table (structure, atomic numbers, relative mass)
  - Compounds (structure, formation, formulas, naming rules)
- Ensure that, before moving on, students have a firm understanding of the above. Students should specifically understand the components of atoms and how these components dictate which elements can combine to create compounds. It is also important that students are able to identify and read compound formulas. Students will apply this knowledge in the post-lesson.
- Tell students that they are going to participate in a videoconference with the Cincinnati Art Museum. They will learn more about these vases and their construction.

"Science and art belong to the whole world, and before them vanish the barriers of nationality."

Goethe

VIDEOCONFERENCE

OBJECTIVES

- Students will interact with the Cincinnati Art Museum staff through a sixty-minute videoconference.
- Students will learn about Cincinnati history from 1850 to 1900.
- Students will use Museum objects to reinforce activities completed in preparation for this videoconference.

CONCEPT

A videoconference conducted by the Cincinnati Art Museum staff extends student learning through emphasis on the viewing and discussion of art objects. During this videoconference with the Museum, students will explore Cincinnati art history and the methods and practices of many of the artists working in the city.

SCHEDULE

- **5 minutes** Introduction to CAM staff *(This is also buffer time in case of connection complications)*
- **10 minutes** Brief discussion of student pre-videoconferencing activities.
- **10 minutes** Museum staff will lead an interactive discussion with students on the history of Cincinnati from 1850-1900
- **20 minutes** Museum staff will lead students in an in-depth investigation of selected Museum objects.

  Objects Include
  - *Bedstead* by Benn Pitman, Adelaide Nourse Pitman, and Elizabeth Nourse
  - *Reception Dress* by Selina Cadwallader
  - *Aladdin Vase* by Maria Longworth Nichols Storer
  - *Ali Baba Vase* by M. Louise McLaughlin
  - *Vase and Dedication Medallion* by Tiffany & Co.
- **10 minutes** Questions and student sharing of art projects.
- **5 minutes** Closing *(This is also buffer time in case of connection complications)*

POST- VIDEOCONFERENCE

MATERIALS

- Print Reproductions of the Museum's *Ali Baba Vase* and *Aladdin Vase*
- Copy of the periodic table
- Glaze Compound Worksheet
- Paper
- Pencil

PROCEDURE

Teacher will:

- Review with students information obtained during the videoconference with the Museum.
- Share with students that they are now going to learn about the chemical compounds that make up ceramic glazes.
- Tell students that every glaze compound actually needs to have three compounds in order tro fuse properly to a ceramic pot and that each of these compounds makes up the compound that is the finished glaze.
    - All glazes must have silica (or silicon dioxide SiO_2). This is an acidic element typically used in most glazes. It gives the glaze its glassy, transparent quality. For the exercises on the "Glaze Compound Worksheet," Silica will be a constant.
    - All glazes must have an Alumina. This component gives the glaze its refractory element, which allows for abrasion resistance. Alumina are normally refractory elements that form their oxide by combining two of their atoms with three atoms of oxygen.
      – an example of common Alumina compounds could be aluminum trioxide (AI_2O_3) or chrominum trioxide (Cr_2O_3). All Alumina compounds, at least for this lesson, will follow the R_2O_3 (R being the element).
    - All glazes must have a Flux. This compound lowers the melting point of the glaze. Silica and Alumina will not melt at temperatures below 3100°F, and many kilns do not reach that temperature. Therefore, a Flux is needed to form the hard glassy coat on the ceramic body. Fluxes are normally metallic or alkaline elements that form their oxide by combining with an atom of oxygen. Examples of common Fluxes could be calcium oxide (CaO) or lead oxide PbO. All Flux compounds, at least for this lesson, will follow the RO formula (R being the element that changes).
- Tell students that they are now going to translate several glaze compounds into their core elements using the "Glaze Compound Worksheet."
- Have students complete Part One of the "Glaze Compound Worksheet" in which they will correctly identify and name the core elements and atomic qualities needed to create several glaze compounds. Students will also decipher which core compounds are the Silica, the Alumina, and the Flux components of the glaze. The glaze compounds will be given. *Teachers may wish to review naming rules for compounds with students.*

- Have students complete Part Two of the "Glaze Compound Worksheet" in which they will be asked to "create" several glaze compounds. Student understanding of the formulas for each glaze compound component (Silica, Alumina and Flux) is crucial. Once students create their glaze compounds they will be asked to break each into its core elements and atomic qualities.

Assessment Objectives

- Students understand that all elements represented in the periodic table are composed of atoms and the combination of atoms creates compounds, which are then combined to create ceramic glazes.
- Students understand and are able to identify the three components of all ceramic glaze compounds.
- Students correctly complete the "Glaze Compound Worksheet."

Academic Content Standards

National Standards: Physical Science

Standard 8: Understands the structure and properties of matter.

Benchmark 1: Knows the structure of an atom (e.g., negative electrons occupy most of the space in the atom; neutrons and positive protons make up the nucleus of the atom; protons and neutrons are almost two thousand times heavier than an electron; the electric force between the nucleus and electrons holds the atom together).

Benchmark 2: Understands how elements are arranged in the periodic table and how this arrangement shows repeating patterns among elements with similar properties (e.g., numbers of protons, neutrons and electrons; relation between atomic number and atomic mass).

Benchmark 3: Knows how the electron configuration of atoms governs the chemical properties of an element as atoms interact with one another by transferring or sharing the outermost electrons.

Benchmark 4: Knows that atoms may be bonded together into molecules or crystalline solids, and compounds are formed from chemical bonds between two or more different kinds of atoms.

National Standards: Visual Arts

Standard 4: Understands the visual arts in relation to history and cultures.

Benchmark 1: Knows a variety of historical and cultural contexts regarding characteristics and purposes of works of art.

Benchmark 2: Knows the function and meaning of specific art objects within varied cultures, times, and places.

Benchmark 3: Understands relationships among works of art in terms of history, aesthetics and culture.

Ohio Standards: Science

Physical Sciences: Students demonstrate an understanding of the composition of physical systems and the concepts and principles that describe and predict physical interaction and events in the natural world. This includes demonstrating an understanding of the structure and properties of matter, the properties of materials and objects, chemical reactions and the conservation of matter. In addition, it includes understanding the nature, transfer and conservation of energy, as well as motion and the forces affecting motion, the nature of waves and interaction of matter and energy. Students also demonstrate an understanding of the historical perspectives, scientific approaches and emerging scientific issues associated with the physical sciences.

Grades: 9-10

Benchmark A: Describes that matter is made of minute particles called atoms and atoms are comprised of even smaller components. Explains the structure and properties of atoms.

Benchmark B: Explains how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances.

Ohio Standards: Visual Arts

Historical, Cultural and Social Contexts: Students understand the impact of visual art on the history, culture and society from which it emanates. They understand the cultural, social and political forces that, in turn, shape visual art communication and expression. Students identify the significant contributions of visual artists to cultural heritage. They analyze the historical, cultural, social and political contexts that influence the function and role of visual art in the lives of people.

Benchmark A: Explains how and why visual art forms develop in the contexts (e.g., cultural, social, historical and political) in which they were made.

Benchmark B: Compares works of art to one another in terms of the historical, cultural, social and political influences evident in the works.

Glaze Compound Worksheet

Part One: Glaze Compound Identification

Sample: Glaze Compound: $PbO - Al_2O_3 - SiO_2$

Flux: **PbO – Lead Oxide** (symbol and name)
Core Elements and Atomic Quantities: 1 atom(s) of **Lead** and 1 atom(s) of **Oxygen**

Alumina: **Al_2O_3 - Aluminum Oxide** (symbol and name)
Core Elements and Atomic Quantities: 2 atom(s) of **Aluminum** and 3 atom(s) of **Oxygen**

Silica: **SiO_2 – Silicon Oxide** (symbol and name)
Core Elements and Atomic Quantities: 1 atom(s) of **Silicon** and 2 atom(s) of **Oxygen**

1. Glaze Compound: $BaO - B_2O_3 - SiO_2$

Flux: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

Alumina: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

Silica: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

2. Glaze Compound: $ZnO - Fe_2O_3 - SiO_2$

Flux: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

Alumina: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

Silica: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

3. Glaze Compound: $MnO - Sb_2O_3 - SiO_2$

Flux: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

Alumina: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

Silica: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____ and _____ atom(s) of _____

Part Two: "Create" Your Own Glaze

Sample:
Choose from the following:

Cd O Cr_2 O_3 Si O_2

Glaze Compound: $CdO - Cr_2O_3 - SiO_2$

Flux: CdO – Cadmium Oxide (symbol and name)
Core Elements and Atomic Quantities: 1 atom(s) of Cadmium and 1 atom(s) of Oxygen

Alumina: Cr_2O_3 - Chromium Oxide (symbol and name)
Core Elements and Atomic Quantities: 2 atom(s) of Chromium and 3 atom(s) of Oxygen

Silica: SiO_2 – Silicon Oxide (symbol and name)
Core Elements and Atomic Quantities: 1 atom(s) of Silicon and 2 atom(s) of Oxygen

Choose from the following:

Na_2	O_3	Zn	Si	Al_2	
O	C_2	Zr	Ti	Pb	
O_2	B_2	Sb	Ca	Fe_2	Sb_2

1. Glaze Compound:

Flux: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

Alumina: _____(symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

Silica: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

2. Glaze Compound:

Flux: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

Alumina: _____(symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

Silica: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

3. Glaze Compound:

Flux: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

Alumina: _____(symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____

Silica: _____ (symbol and name)
Core Elements and Atomic Quantities:
_____ atom(s) of _____and _____ atom(s) of_____