
TITLE: Roman Alchemy**Audience:**

7 and older

Activity Overview:

Participants conduct a chemical reaction to watch how pennies are coated with zinc to make an alloy or “gold”.

Program/Exhibit Criterion addressed: This demonstration fulfills the following Discovery Place, Inc. Learning Experiences program criteria:

- Guided Inquiry: Programming will provide experiences rather than didactic transmission of information. All programs should be inquiry based.
- Differences and control of variables: Programming will allow participants to choose/control/alter variables to see outcomes.
- Complexity: Participants can be very involved or they can observe the process.
- Novelty: Programming allows the participant to interact with a novel and/or authentic phenomenon, person, object, or experience.
- Comfort: Activity is done behind a protective hood and in a safe area away from the participants.
- Control of Media: Participants have control over the media involved.
- Learning Styles: The experience is visual and kinesthetic. It is cross-curricular as it addresses science and history.
- Big idea: The activity is easily adaptable for audiences of all ages, including those who have limited experience with the content.
- The act of creation: The activity has a themed take-away portion that is made by the participants.

Objectives/Desired Outcomes:

To show participants how an alloy is made and to give participants the opportunity to make their own alloy.

National Standards Addressed:

This activity addressed the following National Science Education Standards:

Science Inquiry

CONTENT STANDARD A:

As a result of activities in grades K-12, all students should develop:

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

CONTENT STANDARD C:

As a result of their activities in grades 5-8, all students should develop understanding of:
Science and technology in society

CONTENT STANDARD E:

As a result of their activities in grades K-12, all students should develop understanding of:

- Understanding about science and technology

CONTENT STANDARD F:

As a result of their activities in grades K-12, all students should develop understanding of:

- Science and technology in local challenges

CONTENT STANDARD G:

As a result of their activities in grades K-12, all students should develop understanding of:

- Science as a human endeavor

Time Involved:

- Prep time: 10 minutes
- Activity time: 5-10 minutes (question and answer time varies)
- Clean-up time: 10 minutes

Materials Needed:

- 20 ml of 6 M NaOH
- 0.1 g zinc dust
- evaporating dish
- hot plate
- tongs
- 200 ml beaker of water
- one penny
- Bunsen burner
- goggles
- protective gloves

Reproducibles:

None

Background:

Alchemists in the Middle Ages believed they could turn ordinary metals into gold. In this activity, guests become “alchemists” and turn pennies into shiny "silver" and "gold".

Brass has been made for almost as many centuries as copper but has only in the last millennium been appreciated as an engineering alloy. Initially, bronze was easier to make using native copper and tin and was ideal for the manufacture of utensils. Pre-dynastic Egyptians knew copper very well and in hieroglyphs copper was represented by the ankh symbol also used to denote eternal life; this symbol was an early appreciation of the lifetime cost-effectiveness of copper and its alloys. While tin was readily available for the manufacture of bronze, brass was little used except where its golden color was required. The Greeks knew brass as ‘oreichalcos’, a brilliant and white copper.

Several Roman writers refer to brass, calling it ‘aurichalum’. It was used for the production of sesterces or coins and many Romans also liked it especially for the production of golden colored helmets. They used graded metals containing from 11 to 28 per cent of zinc to obtain decorative colors for all types for ornamental jewelry. For the most ornate work the metal had to be very ductile and the composition preferred was 18%, nearly that of the 80/20 gilding metal still in demand today.

Before the 18th century, zinc metal could not be made since it melts at 420oC and boils at about 950oC, below the temperature needed to reduce zinc oxide with charcoal. In the absence of native zinc it was necessary to make brass by mixing ground smithsonite ore (calamine) with copper and heating the mixture in a crucible. The heat was sufficient to reduce the ore to metallic state but not melt the copper. The vapor from the zinc permeated the copper to form brass which could then be melted to give a uniform alloy.

Lesson Steps:

Safety Note: NaOH should be handled with great care. It is corrosive and can burn skin. Zinc dust should not be inhaled. Safety goggles and protective gloves should be worn the entire time. This activity should be performed under a fume hood.

1. Place zinc dust in evaporating dish.
2. Add 20 mL of NaOH solution to the dish, on top of the zinc.
3. Set hot plate to medium heat and place the evaporating dish on top.

4. Heat for 5 minutes. Do not boil. When dish is hot, place a penny in it. Heat for two minutes or until the penny is coated and becomes silver in appearance.
5. Remove the penny from the dish with tongs and drop into water. When cool, wipe the penny clean with a cloth to remove excess zinc.
6. Using tongs, hold the penny in the flame of a Bunsen burner and gently heat. The penny should turn "gold" (brass). (Do not overheat the penny.)
7. Dip the penny in the beaker of water until cool to touch.

What Happened?

In Step 4, the penny was coated with zinc atoms. In Step 6, when the penny was heated, the copper atoms of the penny and the zinc atoms coating the penny mixed and turned gold in color, but actually formed the alloy brass.

Disposal of Chemicals:

Pour off NaOH into a 250 mL beaker of water to dilute and pour the mixture down the sink. Wipe zinc residue and evaporating dish with a paper towel and dispose of towel.

Academic Extensions/Modifications:

Participants can use this experiment as a start to learning more about how ancient cultures used different elements in their day-to-day life. This activity also is an opportunity to learn how coins were used to create an economic system in ancient Italy.

Evaluation:

This presentation will be evaluated on the questions asked by the participants and if the participants are able to successfully create an alloy.