

# ENGR 3030: Density Experiment

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## Lesson Plan for the Penny Density Experiment

**Grade Level:** Grade 6 and up

**Subjects:** Physical Science

**Duration:** 30 minutes

**Description:** Students will first listen to a brief lecture on density. This lecture will then be followed up by an experiment that will help students see how density applies to their everyday life.

**Goals:** Students will be able to see the importance of density and how they can use it to help them explore the world around them. Students should be able to explain the change that occurred in pennies in 1982 using only the principle of density.

### Objectives (MICLIMB only):

- 1) (PME) IV.m.1) Describe and compare objects according to their density
- 2) (PME) IV.m.2) Be able to describe why density is an important property in evaluating materials
- 3) (C) I.1.m.2) Conduct a scientific investigation
- 4) (C) I.m.1) Be able to answer a scientific question by gathering and analyzing evidence

### Materials:

- pennies from pre- and post- 1982
- graduated cylinders
- scale
- calculators

### Vocabulary:

- volume – the amount of space an object occupies
- density – mass per unit volume or the ratio of the mass of an object to its volume
- displacement – occurs when an object is immersed in a fluid, pushing the fluid out of the way and taking its place
- mass – the amount of matter an object contains

### Procedure:

**Intro:** We recommend that you begin by asking people in the class if they have any pennies in their pockets. Then proceed to ask them to read off the years when the penny was made. Make a list on the board of these dates.

Then take one penny from one pre-1982 and one penny post-1982 and ask two students to if there is any difference between the two pennies. You may even wish to have the pennies passed around the room. Make another list on the board and have students list the properties that they can see and feel from the pennies.

**Lesson focus / setting up the experiment:** It may be helpful in this case to ask the class what density is. Listen to how the class defines density. Then, if the students fail to bring up anything resembling “density is the mass over volume” then you can show the class that “density has heart.” (The equation for density,  $D=m/v$  forms a heart shape with the  $m$  on top and the  $v$  below).

Inform the class that today we will be doing an experiment involving density and pennies. In order to find density they must first find the mass and the volume of the pennies, which can be done by using the following methods:

- Fill a graduated cylinder to a certain point with water and drop in a penny to see the volume rise. The volume change will be small with just one penny so we recommend that students drop several pennies into the graduated cylinder and then examine the volume again. Students should then take the volume difference observed and divide it by the number of pennies dropped into the graduated cylinder. All pennies have the same volume, so any group of them will work... OR
- Using a scale, weigh each penny individually and record it’s weight in grams.

Have students do this with their bag of pennies, which contains exactly ten pennies, five pre-1982 and five post-1982. Make sure there is the same number of pennies in each group. Students should then be able to calculate density by dividing the penny’s specific weight by the volume of one penny.

**Evaluating the data:** We recommend that the students record the results of their measurements of each group of pennies in a table. If the experiment is done correctly there should be a difference between the two groups. Have the students write their results on the board. Ask the students to write a short essay explaining what happened. Topics they might want to consider are that the pennies are made from different materials, possible experimental error, or simply a faulty calculator.

Discuss the results the next day and explain to the class that in 1982 the government changed the composition of materials that pennies were made from. Before 1982, pennies were made of 95% copper and 5% zinc. After 1982, the composition became 97.6% zinc and 2.4% copper. Pennies made in 1982 can have either composition. A good extra credit assignment would be to have students research and find out why the change happened.

**Optional:** It might be a good idea to tell the class the story of Archimedes and the Crown of Syracuse. Since the object of the of the experiment is to discover that there is a difference in the density of pennies, both pre-1982 and post-1982, this story, which operates along similar lines might give the class an idea of what they will be looking for.

**Assessment:** This is an experiment that is designed to get students to think about density and how it relates to something that they see everyday, in this case pennies. Students can also see that different materials have different densities

**Suggested Websites (References):**

For further reading on density and the story of Archimedes, the following websites are highly recommended:

[http://en.wikipedia.org/wiki/Main\\_Page](http://en.wikipedia.org/wiki/Main_Page)

(Here you can find information on density, such as what it is and where it comes from)

<http://www.mcs.drexel.edu/~crorres/Archimedes/Crown/CrownIntro.html>

(Here you can read a story about Archimedes and Gold Crown; this website features pictures of gold crowns from the time of Archimedes and details how he might have discovered the forgery)

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### Penny Density Lab

**Objective:** To discover the composition of pennies using the property of density.

#### You Will Need at your Table:

- 1 50mL graduated cylinder
- 1 pipette
- 1 baggie of pennies
- 1 digital scale
- 1 pitcher of water
- 1 calculator

#### Facts and Equations:

**\*All pennies have the same volume**

Density of Copper: 8.92 g/mL

Density of Lead: 11.3 g/mL

Density of Zinc: 7.14 g/mL

Density of Sulfur: 2.07 g/mL

$$1PennyVolume = \frac{EndingV - BeginningV}{totalpennies}$$

$$Density = \frac{Mass}{Volume}$$

#### Procedure:

##### 1. Find the mass of each individual penny:

- a. Weigh each penny on the scale individually
- b. Record its year and weight in the attached table

##### 2. Find the volume of a penny:

- a. Fill the graduated cylinder with EXACTLY 25 mL of water
- b. Place 10 pennies in the water in the graduated cylinder
  - i. Beginning Volume: 25.00 mL
  - ii. Ending Volume (carry out number to two decimals): \_\_\_\_\_
  - iii. Calculate the volume of one penny using the formula listed below and record it in the attached table

$$1PennyVolume = \frac{EndingVolume - BeginningVolume}{totalpennies}$$

##### 3. Find the density:

- a. Using the equation below, calculate the density of each penny

$$Density = \frac{Mass}{Volume}$$

- b. Record values in the attached table

#### Question

Are all of the densities the same? Using the facts and equations above, write a short essay on reasons for the similarities or differences between pennies.

### Penny Density Data Table

Volume of *one* Penny: \_\_\_\_\_

	Year	Mass	Density = M/V
<b>1</b>			
<b>2</b>			
<b>3</b>			
<b>4</b>			
<b>5</b>			
<b>6</b>			
<b>7</b>			
<b>8</b>			
<b>9</b>			
<b>10</b>			

Now group the pennies into the two tables below based on their like masses:

Mass of _____		Mass of _____	
Year	Density	Year	Density

**Use the tables and the facts below to answer the question on the first page of the experiment:**

Density of Copper: 8.92 g/mL

Density of Lead: 11.3 g/mL

Density of Zinc: 7.14 g/mL

Density of Sulfur: 2.07 g/mL