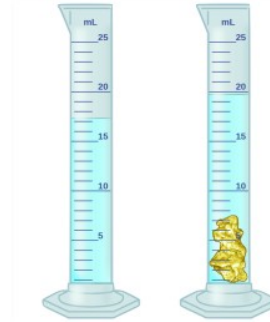


Density of Materials (ANSWERS)



- **Mass:** how much material is in an object, measured with a scale. Heavier objects have more mass.
- **Volume:** how much space an object takes up
- **Density:** mass per volume of an object

Part 1: Describing Materials

1. Pick up and handle the following objects. Discuss which appears to have lower or higher **volume**. Do not measure yet, just estimate.

Arrange the objects from least to greatest volume.



(a) big wooden block



(b) penny



(c) green marble



(d) wooden wedge

least volume _____ penny < marble ≈ wedge < block _____ greatest volume

2. Discuss which of the objects has the biggest or smallest **mass** (estimate!)

List the objects from lower or higher mass.

least mass _____ wedge < penny < marble < block _____ greatest mass

3. Check your estimates of mass by balancing objects against each other on the scale.

4. Discuss which two objects do you think have similar density (circle 2). Why?

big wooden block penny marble wooden wedge

(they are made of the same material - wood)

Part 2: Identifying Materials by Measuring Density

0. You will compare the materials of zinc nuggets, copper nails, pennies, and dimes.

First make a guess (and discuss why you think so):

I think pennies are mostly made of: zinc / copper

I think dimes are mostly made of: zinc / copper

For each object:

1. Use the scales provided to measure mass (in grams).

Put the suggested number of objects on the left side of the scale. Put standard masses on the right side, and slide the slider to balance the scale.

2. Use the graduated cylinder to measure volume (in milliliters: mL).

Fill with water to **exactly** 30 mL. Use a pipette to be precise, look for the meniscus (the level of water in the middle of the tube). Put in the objects (tilt the cylinder and slide down the side to avoid splashing.)

Write down how much the volume **increased above 30 mL**

3. Calculate density: divide the mass by the volume.

(example measurements provided. Exact numbers will vary)

Object	#	Object Mass (g)	Object Volume (mL) (<u>change</u> in water level)	Density (g/mL)	Material
Zinc nuggets	1	14 g	2 mL	7 g/mL	zinc
Copper nails	6	17.1 g	2 mL	8.6 g/mL	copper
Dimes	8	18.2 g	2.1 mL	8.7 g/mL	copper
Pennies	8	20.2 g	3 mL	6.7 g/mL	zinc

Pennies are mostly made of zinc and dimes are mostly made of copper! (the color is just a thin coating on the outside)

4. The actual density of zinc is 7.1 g/mL.

Discuss: did you get exactly this number? Did the group next to you? Why might your numbers be a little different? Measurements will vary, but hopefully the density of the dimes will be closer to copper and the density of the pennies closer to zinc.

All measurements have some error to them. Scientists try to measure as carefully as possible, but always keep in mind the possible errors in their measurements.

If you used 4 pennies instead of 8:

Do you think the mass would change?

Yes / No (more material)

Do you think the volume would change?

Yes / No (takes up more space)

Do you think the density would change?

Yes / No (same material)



Discuss: What if you were to break your zinc nugget in half - do you think its density would change? No - it would have less mass but still be made of the same material, so same density.

Density is a material property. It does not matter how much of that material you have or what shape it is in, the density will stay the same.

5. Follow in Archimedes' footsteps! Use your density measurements to decide what the coins are really made of:

Pennies are mostly made of: zinc copper plastic
 Dimes are mostly made of: zinc copper plastic

Extra Part 3 (if you have time): Identifying More Materials

6. Now try measuring the density of these other objects:

Object	#	Mass (g)	Volume (mL)	Density (g/mL)	Material
Green marbles	2	11.1 g	4.2 mL	2.6 g/mL	glass
Red marbles	2	3.2 g	2.8 mL	1.1 g/mL	plastic
Sparkly rocks		9.7 g	1.9 mL	4.7 g/mL	pyrite

7. Here is a table of densities for a few materials (measured by other scientists):

Material	Density
Glass ¹	2.5 g/mL
Plastic (acrylic)	1.2 g/mL
Gold	19 g/mL
Silver	10.5 g/mL
Pyrite ("fool's gold")	5 g/mL



What material are the green marbles made of? Glass Plastic Copper
 What material are the red marbles made of? Glass Plastic Copper
 What material is the sparkly rock made of? Gold Silver Pyrite

1 Density of glass varies. This is a typical value for common window glass