Technology & Society

Scale Models

A scale factor is a ratio that equals the ratio of the model's dimensions to the structure's dimension. Ask, **What is the height of a building if it is represented by a 1.30 m model using a scale factor of 1:48?** *(62.4 m)* Computerized design (CAD) programs have replaced many tedious aspects of technical design. A CAD program usually permits a designer to begin with a few important elements and measurements of the object being designed. As the design progresses, the program computes the dimensions of the added elements and produces drawings of the object from any perspective. The introduction of CAD programs has reduced the time needed to design complex items as well as the number of errors that plague such projects.

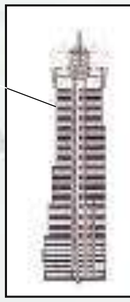
Technology & Society

Scale Models

A scale model is a physical or conceptual representation of an object that is proportional in size to the object it represents. Examples include model trains, model airplanes, and dollhouses. Most model trains are built to a scale of 1:87. This ratio means that the model is $\frac{1}{87}$ the size of an actual train. This fraction can be used as a conversion factor. On the model, 1 cm represents 87 cm on the train.

Scale models aren't just for hobbyists—scientists and engineers use them, too. A simple scientific model in the classroom is a globe, which is a small-scale model of Earth. (A globe with a diameter of 30 cm has a scale of 1:42,500,000.) **Applying Concepts** ***How do you use the scale of a model as a conversion factor?***

Scale model
4.5 ft tall, scale 1:192



Architectural drawing

Condé Nast Building
New York City
866 ft (264 m) tall, 48 floors

Computer modeling
By testing a model, engineers can make a product better before it is built. Engineers often design scale models on computers. These automotive engineers are using a computer-aided design (CAD) program to view a digital scale model of a car. Physical models of the car's wheels are on the desk.

Model building
Architects use both two-dimensional and three-dimensional scale models to design buildings. A common scale for floor plans is 1: 48.

Differentiated Instruction

Gifted and Talented L3

Have students prepare a display on current CAD applications. Local colleges or technical schools that teach CAD are good sources of information. Other possibilities include library research or articles in magazines or newspapers.

Answers to...

Applying Concepts The scale of a model can be used as a conversion factor by expressing it as a fraction of equivalent measurements. For example, if a globe has a scale of 1:42,500,000, you can write the conversion factor 42,500,000 cm (actual)/1 cm (model). If the globe has a 30-cm diameter, you can calculate the actual diameter of Earth as follows:

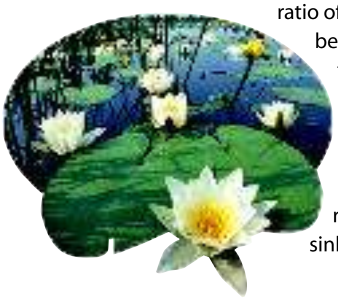
$$3.0 \times 10^{1}\ \text{cm} \times \frac{42{,}500{,}000\ \text{cm}}{1\ \text{cm}} = 1.3 \times 10^{9}\ \text{cm}$$

Figure 3.13 lead

3.4 Density

Connecting to Your World

Have you ever wondered why some objects float in water, while others sink? If you think that these lily pads float because they are lightweight, you are only partially correct. The ratio of the mass of an object to its volume can be used to determine whether an object floats or sinks in water. For pure water at 4°C, this ratio is 1.000 g/cm^3. If an object has a mass-to-volume ratio less than 1.000 g/cm^3, it will float in water. If an object has a mass-to-volume ratio greater than this value, it will sink in water.



Guide for Reading

Key Concepts

- What determines the density of a substance?
- How does a change in temperature affect density?

Vocabulary

density

Reading Strategy

Identifying Main Ideas As you read, write the main idea of the text that follows each heading.

Interactive Textbook

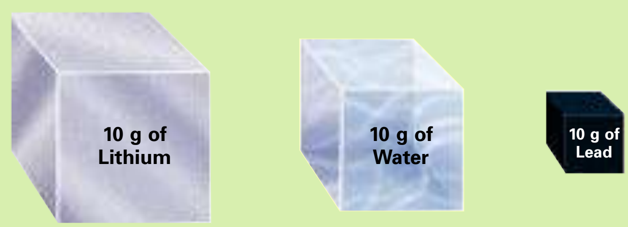
Simulation 1 Rank materials according to their densities.

with ChemASAP

Determining Density

Perhaps someone has tricked you with this question: "Which is heavier, a pound of lead or a pound of feathers?" Most people would not give the question much thought and would incorrectly answer "lead." Of course, a pound of lead has the same mass as a pound of feathers. What concept, instead of mass, are people really thinking of when they answer this question?

Most people are incorrectly applying a perfectly correct idea: namely, that if a piece of lead and a feather of the same volume are weighed, the lead would have a greater mass than the feather. It would take a much larger volume of feathers to equal the mass of a given volume of lead.



	10 g of Lithium	10 g of Water	10 g of Lead
Volume	19 cm^3	10 cm^3	0.88 cm^3
Density	0.53 g/cm^3	1.0 g/cm^3	11.4 g/cm^3

Figure 3.13 A 10-g sample of pure water has less volume than 10 g of lithium, but more volume than 10 g of lead. The faces of the cubes are shown actual size. **Inferring** ***Which substance has the highest ratio of mass to volume?***

Section Resources

Print

- **Guided Reading and Study Workbook,** Section 3.4
- **Core Teaching Resources,** Section 3.4 Review
- **Transparencies,** T38–T42
- **Laboratory Manual,** Lab 4

Technology

- **Interactive Textbook with ChemASAP,** Simulation 1, Problem-Solving 3.47, 3.48, Assessment 3.4
- **Go Online,** Section 3.4

3.4

1 FOCUS

Objectives

3.4.1 **Calculate** the density of a material from experimental data.

3.4.2 **Describe** how density varies with temperature.

Guide for Reading

Build Vocabulary L2

Paraphrase After students have read the key concept on page 90, point out that mass, unlike density, is not an intensive property. On the contrary, it is an extensive property. Have students infer the meaning of the term *extensive property. (a property that depends on size)*

Reading Strategy L2

Using Context Clues Have students read the key concept statement on page 90. Ask, **What is the meaning of the term intensive property.** *(a property that does not depend on the size of the sample)* **What other properties may be intensive?** *(Acceptable answers include temperature and color.)*

2 INSTRUCT

Connecting to Your World

Have students study the photograph and read the text that opens the section. Ask, **Why do lily pads float in water?** *(The pads are less dense than water.)* **What measurements would you need to make to determine whether an object would float in water?** *(Measure the object's volume and mass; then compute its density and compare the result to the density of water.)*

Determining Density

Use Visuals L1

Figure 3.13 Ask, **What would be the volume of a 10-g sphere of each of the substances shown?** *(Li, 19 cm^3; H_2O, 10 cm^3; and Pb, 0.88 cm^3)*

Relate L2

If students performed the *Mass of a Penny* activity on page 76, have them refer to the explanation of the results. Ask, **How can you use density to test the hypothesis that the composition of the penny changed?** *(Determine the volume and mass of a pre- and post-1982 penny. Calculate the density of each and compare them. If the densities changed, the composition of the penny must have changed.)*

TEACHER Demo

Density Calculations L2

Purpose To calculate density from a mass-volume graph

Materials 3 or 4 different-sized cubes of a material such as wood, metal, or marble; metric ruler; balance

Procedure Have student volunteers measure the masses of the cubes, measure the lengths of the cubes and calculate their volumes. On the board or an overhead projector, record the masses and volumes. Construct a mass-volume graph (mass on the *y*-axis) and plot the data. Show students how to calculate the slope of the line. Explain that the slope of the line is the ratio of mass/volume and has the unit, g/cm^3, which is the unit of density.

Expected Outcome The mass and volume data should lie along a straight line. Ask, **What is the ratio of mass to volume of a substance?** *(density)*

Table 3.6

Densities of Some Common Materials

Solids and Liquids		Gases	
Material	**Density at 20°C (g/cm^3)**	**Material**	**Density at 20°C (g/L)**
Gold	19.3	Chlorine	2.95
Mercury	13.6	Carbon dioxide	1.83
Lead	11.4	Argon	1.66
Aluminum	2.70	Oxygen	1.33
Table sugar	1.59	Air	1.20
Corn syrup	1.35–1.38	Nitrogen	1.17
Water (4°C)	1.000	Neon	0.84
Corn oil	0.922	Ammonia	0.718
Ice (0°C)	0.917	Methane	0.665
Ethanol	0.789	Helium	0.166
Gasoline	0.66–0.69	Hydrogen	0.084

The important relationship in this case is between the object's mass and its volume. This relationship is called density. **Density** is the ratio of the mass of an object to its volume.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

A 10.0-cm^3 piece of lead, for example, has a mass of 114 g. What, then, is the density of lead? You can calculate it by substituting the mass and volume into the equation above.

$$\frac{114\text{ g}}{10.0\text{ cm}^3} = 11.4\text{ g/cm}^3$$

Note that when mass is measured in grams, and volume in cubic centimeters, density has units of grams per cubic centimeter (g/cm^3).

Figure 3.13 on page 89 compares the density of three substances. Why does each 10-g sample have a different volume? The volumes vary because the substances have different densities. **Density is an intensive property that depends only on the composition of a substance, not on the size of the sample.** With a mixture, density can vary because the composition of a mixture can vary.

What do you think will happen if corn oil is poured into a glass containing corn syrup? Using Table 3.6, you can see that the density of corn oil is less than the density of corn syrup. For that reason, the oil floats on top of the syrup, as shown in Figure 3.14.

You have probably seen a helium-filled balloon rapidly rise to the ceiling when it is released. Whether a gas-filled balloon will sink or rise when released depends on how the density of the gas compares with the density of air. Helium is less dense than air, so a helium-filled balloon rises. The densities of various gases are listed in Table 3.6.

Figure 3.14 Because of differences in density, corn oil floats on top of corn syrup.

Checkpoint ***What quantities do you need to measure in order to calculate the density of an object?***

Differentiated Instruction

Less Proficient Readers L1

Have students write definitions of density in English and, if appropriate, in a native language. Make sure they include the expression density = mass/volume. Have them find photos of objects containing substances from Table 3.6. They could label each photo with the substance's name in multiple languages and the density, whose units are part of a universal language.

Density and Temperature

Experiments show that the volume of most substances increases as the temperature increases. Meanwhile, the mass remains the same despite the temperature and volume changes. Remember that density is the ratio of an object's mass to its volume. So if the volume changes with temperature (while the mass remains constant), then the density must also change with temperature. **The density of a substance generally decreases as its temperature increases.** As you will learn in Chapter 15, water is an important exception. Over a certain range of temperatures, the volume of water increases as its temperature decreases. Ice, or solid water, floats because it is less dense than liquid water.

Go Online NSTA SCILINKS
For: Links on Density
Visit: www.SciLinks.org
Web Code: cdn-1034

SAMPLE PROBLEM 3.10

Calculating Density

A copper penny has a mass of 3.1 g and a volume of 0.35 cm³. What is the density of copper?

1 Analyze ***List the knowns and the unknown.***

Knowns
- mass = 3.1 g
- volume = 0.35 cm³

Unknown
- density = ? g/cm³

Use the known values and the following definition of density.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

2 Calculate ***Solve for the unknown.***

The equation is already set up to solve for the unknown. Substitute the known values for mass and volume, and calculate the density.

$$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{3.1\text{ g}}{0.35\text{ cm}^3} = 8.8571\text{ g/cm}^3$$

$$= 8.9\text{ g/cm}^3 \text{ (rounded to two significant figures)}$$

3 Evaluate ***Does the result make sense?***

A piece of copper with a volume of about 0.3 cm³ of copper has a mass of about 3 grams. Thus, about three times that volume of copper, 1 cm³, should have a mass three times larger, about 9 grams. This estimate agrees with the calculated result.

Practice Problems

46. A student finds a shiny piece of metal that she thinks is aluminum. In the lab, she determines that the metal has a volume of 245 cm³ and a mass of 612 g. Calculate the density. Is the metal aluminum?

47. A bar of silver has a mass of 68.0 g and a volume 6.48 cm³. What is the density of silver?

Math Handbook
For help with algebraic equations, go to page R69.

Interactive Textbook
Problem-Solving 3.47 Solve Problem 47 with the help of an interactive guided tutorial.
with ChemASAP

Discuss L2

Show how the density equation can be used to determine the mass or volume of an object. For example,
density = mass/volume
(volume)(density) = (mass/volume) × volume
volume × density = mass

Density and Temperature

Relate L2

Have students refer to the Galileo thermometer shown in Figure 3.8 on page 77. Explain that each partially filled, sealed glass bubble and its attached metal tag are weighted so that it will float at the temperature indicated on the tag. If the air temperature rises, it warms the water in the thermometer and eventually the water reaches the temperature of the air. As liquid water warms, it expands and so its density decreases. Therefore, the glass bubbles that are calibrated to float at lower temperature water will remain at the bottom of the container. Those that are made to float in water at or above the present water temperature will float. Thus, the temperature of the water and the surrounding air is the lowest value of the tag on a floating bubble. Ask, **In the Galileo thermometer shown in Figure 3.8, in what unit is the thermometer most likely calibrated?** *(degree Fahrenheit)*

Sample Problem 3.10

Answers

46. density = 2.50 g/cm³; no
47. 10.5 g/cm³

Practice Problems Plus L2

The density of gold is 19.3 g/cm³ at 20°C. **What is the mass of a 0.18-cm³ gold ring?** *(3.5 g)*

Math Handbook
For a math refresher and practice, direct students to algebraic equations, page R69.

Go Online NSTA SCILINKS
Download a worksheet on **Density** for students to complete, and find additional support for NSTA SciLinks.

Answers to...
Checkpoint mass and volume

TEACHER Demo

The Hydrometer **L2**

Purpose To show the use of a hydrometer

Materials hydrometer, 2 graduated cylinders, water, concentrated solution of sodium chloride

Safety Have students wear goggles to emphasize safety in the laboratory.

Procedure Explain to students that a hydrometer measures the specific gravity of a liquid. Point out that the specific gravity is the ratio of the density of a material to that of water. Float the hydrometer in the water and have students note the submerged height. Read the value of the hydrometer. Now place the hydrometer in the solution and have students note the submerged height. Ask students which liquid is denser.

Expected Outcome Students should predict that the second solution is denser because the hydrometer floated higher in the liquid. Confirm the answer by reading the value of the hydrometer.

Sample Problem 3.11

Answers

48. a. 6.32 cm^3 **b.** 0.342 cm^3

49. See answers for problem 48.

Practice Problems Plus **L2**

Make the following conversions.

a. 2.53 cm^3 of gold to grams (density of gold = 19.3 g/cm^3) *(48.8 g)*

b. 1.6 g of oxygen to liters (density of oxygen = 1.33 g/L) *(1.2 L)*

c. 25.0 g of ice to cubic centimeters (density of ice = 0.917 g/cm3) *(27.3 cm^3)*

Math Handbook

For a math refresher and practice, direct students to scientific notation, page R56.

SAMPLE PROBLEM 3.11

Using Density to Calculate Volume

What is the volume of a pure silver coin that has a mass of 14 g? The density of silver (Ag) is 10.5 g/cm^3.

1 Analyze ***List the knowns and the unknown.***

Knowns	**Unknown**
• mass of coin = 14 g	• volume of coin = ? cm^3
• density of silver = 10.5 g/cm^3	

You can solve this problem by using density as a conversion factor. You need to convert the mass of the coin into a corresponding volume. The density gives the following relationship between volume and mass.

$$1\ cm^3\ Ag = 10.5\ g\ Ag$$

Based on this relationship, you can write the following conversion factor.

$$\frac{1\ cm^3\ Ag}{10.5\ g\ Ag}$$

Notice that the known unit is in the denominator and the unknown unit is in the numerator.

2 Calculate ***Solve for the unknown.***

Multiply the mass of the coin by the conversion factor to yield an answer in cm^3.

$$14\ \cancel{g\ Ag} \times \frac{1\ cm^3\ Ag}{10.5\ \cancel{g\ Ag}} = 1.3\ cm^3\ Ag$$

3 Evaluate ***Does the result make sense?***

Because a mass of 10.5 g of silver has a volume of 1 cm^3, it makes sense that 14.0 g of silver should have a volume slightly larger than 1 cm^3. The answer has two significant figures because the given mass has two significant figures.

Math Handbook

For help with significant figures, go to page R59.

Practice Problems

48. Use dimensional analysis and the given densities to make the following conversions.

a. 14.8 g of boron to cm^3 of boron. The density of boron is 2.34 g/cm^3.

b. 4.62 g of mercury to cm^3 of mercury. The density of mercury is 13.5 g/cm^3.

49. Rework the preceding problems by applying the following equation.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Interactive Textbook

Problem-Solving 3.48 Solve Problem 48 with the help of an interactive guided tutorial.

with ChemASAP

Mercury

Facts and Figures

Specific Gravity

Specific gravity is the ratio of the density of a substance to the density of a reference substance, usually at the same temperature. Water at 4°C is often the reference substance. Physicians use the measured specific gravity of a patient's urine to help diagnose certain diseases, such as diabetes. Auto mechanics measure the specific gravity of antifreeze in radiators during tune-ups.

Go Online PHSchool.com

Have students research chemistry-related careers on the Internet. Students can then construct a table that describes the nature of the job, educational requirements, and other necessary information.

Careers in Chemistry

Analytical Chemist

Analytical chemists focus on making quantitative measurements. They must be familiar with many analytical techniques to work successfully on a wide variety of tasks. As an analytical chemist, you would spend your time making measurements and calculations to solve laboratory and math-based research problems. You could, for example, be involved in analyzing the composition of biomolecules. Pharmaceutical companies need people to analyze the composition of medicines and research new combinations of compounds to use as drugs. As an analytical chemist, you must be able to think creatively and develop new means for finding solutions.

Many exciting new fields, such as biomedicine and biochemistry, are now hiring analytical chemists. More traditional areas, including industrial manufacturers, also employ analytical chemists. The educational background you need to enter this field is quite extensive. You would need advanced chemical training, including organic chemistry and quantitative chemistry, as well as some training in molecular biology and computer operation. A master's degree in chemistry may be required, and certain positions require a Ph.D.

Go Online PHSchool.com
For: Careers in Chemistry
Visit: PHSchool.com
Web Code: cdb-1034

3.4 Section Assessment

50. **Key Concept** What determines the density of an object?

51. **Key Concept** How does density vary with temperature?

52. A weather balloon is inflated to a volume of 2.2×10^3 L with 37.4 g of helium. What is the density of helium in grams per liter?

53. A 68-g bar of gold is cut into 3 equal pieces. How does the density of each piece compare to the density of the original gold bar?

54. A plastic ball with a volume of 19.7 cm^3 has a mass of 15.8 g. Would this ball sink or float in a container of gasoline?

55. What is the volume, in cubic centimeters, of a sample of cough syrup that has a mass of 50.0 g? The density of cough syrup is 0.950 g/cm^3.

56. What is the mass, in kilograms, of 14.0 L of gasoline? (Assume that the density of gasoline is 0.680 g/cm^3.)

Elements Handbook

Density Look up the densities of the elements in Group 1A on page R6. Which Group 1A elements are less dense than pure water at 4°C?

Interactive Textbook

Assessment 3.4 Test yourself on the concepts in Section 3.4.

with ChemASAP

Careers in Chemistry

Analytical Chemist

Analytical chemists ask the important question "How much?" They must make very careful measurements because they deal with small quantities of material. Analytical chemists are employed in a wide range of industrial and research occupations. Encourage students to connect to the Internet address shown on this page to find out more about careers in analytical chemistry.

3 ASSESS

Evaluate Understanding L2

Ask, **What are the most common units for expressing the density of a substance?** *(g/cm³)* **How can density be used to determine whether a metal washer is aluminum or zinc?** *(Measure and compare the density of the washer to the accepted density values of aluminum and zinc.)*

Reteach L1

Remind students that the density equation can be rewritten as *mass = density × volume*, or *volume = mass/density*. Have students examine the application of these alternate equations by providing students with aluminum squares and asking them to measure the area and mass of each. Have students use the density of aluminum in Table 3.6 to calculate the thickness of the foil.

Elements Handbook

Li, Na, and K are less dense than water.

Interactive Textbook

If your class subscribes to the Interactive Textbook, use it to review key concepts in Section 3.4.

with ChemASAP

Section 3.4 Assessment

50. Density is an intensive property that depends only on the composition of a substance, not on the size of the sample. density = mass/volume

51. Density generally decreases when temperature increases.

52. 1.7×10^{-2} g/L

53. All the densities are equal.

54. It would sink because the density of the ball, 0.802 g/cm^3, is greater than the density of gasoline.

55. 52.6 cm^3

56. 9.52 kg

Small-Scale LAB

Now What Do I Do? L2

Objective After completing this activity, students will be able to
- solve problems in divergent ways.

Skills Focus Measuring, calculating, evaluating, designing experiments

Prep Time 1 hour

Materials Calculators, small-scale pipets, meter sticks, water, mass balances, pre- and post-1982 pennies, dice, 8-well strips, aluminum cans, plastic cups

Advance Prep A day before doing the lab, obtain soda cans from the cafeteria. Wash and let air-dry overnight.

Class Time 40 minutes

Expected Outcome

Students should find that the mass of the pre-1982 penny is 3.11 g and the mass of the post-1982 penny is 2.50 g.

Analyze

1. 19 mg
2. 0.019 cm^3; 0.019 mL; 19 μL
3. 1000 mg/cm^3; 1000 mg/mL
4. 2.95 g Cu; 0.16 g Zn
5. 0.060 g Cu; 2.44 g Zn
6. The new penny is mostly zinc, which has a lower density than copper.

You're the Chemist

1. at 90°, mass of 1 drop: 0.019 g
at 45°, mass of 1 drop: 0.0218 g
at 0°, mass of 1 drop: 0.0242 g
Pipets give different results.
2. The pipet is easiest to control at 90°. Expel the air bubble so that the first drop will be the same size as the rest.
3. Find mass of can and divide by density of aluminum. Sample answer: mass of one can: 14.77 g; $density_{Al}$: 2.70 g/cm^3; $V = 5.47\ cm^3$
4. (1) Measure the mass before and after you fill the can with water. Use the mass and density of water to find the volume.
(2) Measure the height and radius and calculate volume. $V = \pi r^2 h$ (Can is not a perfect cylinder.)
(3) Read label: 12 oz = 355 mL
5. Sample answer:
$V = 16.5\ m \times 3.0\ m \times 12.8\ m$
$= 630\ m^3 \times 1000\ L/m^3 = 630{,}000\ L$
Assume 30 people with an average weight of 130 lb (1 kg = 2.2 lb) and a density of about 1.0 kg/L.
Volume of 30 people = 30 × 130 lb × 1 kg/2.2 lb × 1 L/1.0 kg = 1800 L
The volume of 30 chairs, 15 tables, and 2 desks is about that of 30 people or 1800 L.
The volume of people and furniture is 3600 L.
% error = (3600 L/630,000 L)(100%) = 0.57%.
6. If die measures 1.55 cm on a side:
$V = (1.55\ cm)^3 = 3.72\ cm^3$
A die has 21 holes that are hemispheres with a radius of 0.20 cm.
V of hemisphere = $2/3\pi r^3 = 0.017\ cm^3$
V of 21 hemispheres = 0.36 cm^3
V of die = 3.72 cm^3 – 0.36 cm^3 = 3.36 cm^3
Error = 0.36 cm^3
% error = (0.36 cm^3/3.36 cm^3)(100%) = 11%
7. Find weight in pounds and convert to kg.
Assume density = 1.00 kg/L.
$V = weight \times 1\ kg/2.2\ lb \times 1 L/1.00\ kg$

Small-Scale LAB

Now What Do I Do?

Purpose

To solve problems by making accurate measurements and applying mathematics.

Materials

- pencil
- paper
- meter stick
- balance
- pair of dice
- aluminum can
- calculator
- small-scale pipet
- water
- a pre- and post-1982 penny
- 8-well strip
- plastic cup

Procedure

1. Determine the mass, in grams, of one drop of water. To do this, measure the mass of an empty cup. Add 50 drops of water from a small-scale pipet to the cup and measure its mass again. Subtract the mass of the empty cup from the mass of the cup with water in it. To determine the average mass in grams of a single drop, divide the mass of the water by the number of drops (50). Repeat this experiment until your results are consistent.
2. Determine the mass of a pre-1982 penny and a post-1982 penny.

Analyze

Using your experimental data, record the answers to the following questions.

1. What is the average mass of a single drop of water in milligrams? (1 g = 1000 mg)
2. The density of water is 1.00 g/cm^3. Calculate the volume of a single drop in cm^3 and mL. (1 mL = 1 cm^3) What is the volume of a drop in microliters (μL)? (1000 μL = 1 mL)
3. What is the density of water in units of mg/cm^3 and mg/mL? (1 g = 1000 mg)
4. Pennies made before 1982 consist of 95.0% copper and 5.0% zinc. Calculate the mass of copper and the mass of zinc in the pre-1982 penny.
5. Pennies made after 1982 are made of zinc with a thin copper coating. They are 97.6% zinc and 2.4% copper. Calculate the mass of copper and the mass of zinc in the newer penny.
6. Why does one penny have less mass than the other?

You're the Chemist

The following small-scale activities allow you to develop your own procedures and analyze the results.

1. **Design It!** Design an experiment to determine if the size of drops varies with the angle at which they are delivered from the pipet. Try vertical (90°), horizontal (0°), and halfway between (45°). Repeat until your results are consistent.
2. **Analyze It!** What is the best angle to hold a pipet for ease of use and consistency of measurement? Explain. Why is it important to expel the air bubbles before you begin the experiment?
3. **Design It!** Make the necessary measurements to determine the volume of aluminum used to make an aluminum soda can. *Hint:* Look up the density of aluminum in your textbook.
4. **Design It!** Design and carry out some experiments to determine the volume of liquid that an aluminum soda can will hold.
5. **Design It!** Measure a room and calculate the volume of air it contains. Estimate the percent error associated with not taking into account the furniture in the room.
6. **Design It!** Make the necessary measurements and do the necessary calculations to determine the volume of a pair of dice. First, ignore the volume of the dots on each face, and then account for the volume of the dots. What is your error and percent error when you ignore the holes?
7. **Design It!** Design an experiment to determine the volume of your body. Write down what measurements you would need to make and what calculations you would do. What additional information might be helpful?