#1 Density of Solids

Purpose: The object of this experiment is to identify a metal by measuring its density.

Introduction

In this experiment, the mass (m) and volume (V) of a solid metal object will be measured, and its density (D) calculated. The units are g/mL (the same as g/cm^3).

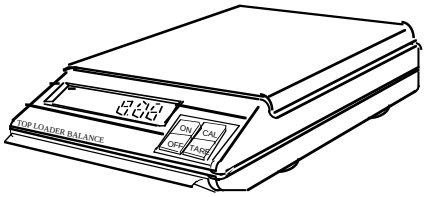
$$D=m/V$$

Note that density is an *intrinsic property*, which is the same regardless of the quantity of the substance. Therefore, density can be used to aid in the identification of a substance.

Apparatus:

The mass in grams will be measured using a top loading balance (nearest 0.01 g). Solids such as the metal objects used here can be weighed directly. The balance is reset by pressing the "ZERO" or "TARE" key on the front face, giving a digital display of 0.00 g.

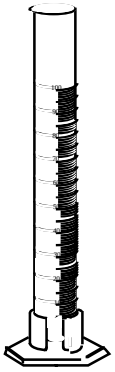
CAUTION: Do not overload balances. Maximum load without damaging the top loader is 400 g.



Top Loading Balance

Procedure:

1. Take a metal sample and record the code letter. Weigh the sample to the nearest 0.01 g.



2. Select a graduated cylinder (shown on the right) into which the sample will fit. The sample ***must*** have a volume of at least 10 mL; *if needed use two identical samples*. Before placing the sample in the cylinder, be sure it contains enough water to cover the sample. (30-35 mL) Record the volume of water. Then place your sample into the graduated cylinder. Record the new volume. *Note*: Remove bubbles attached to the sample by shaking or tapping the cylinder.

3. Calculate the density (g/mL) of the sample and record. Because of the error in the volume measurement, the density may be off by as much as 0.2 to 0.3 g/mL. With this in mind, use the data in the table below to identify your unknowns. Make use of the color of the metal if needed; record under observations.

Densities of Metals

Metal	Density g/mL	Metal	Density g/mL
Lead	11.30	Tin	7.28
Nickel	8.90	Manganese	7.20
Copper	8.92	Zinc	7.10
Brass	8.5	Aluminum	2.70
Steel	7.8		

Data and Results (Density of Solids)

Name(s) _____

Identifying a Metal from its Density

Record Code Letter of your unknown(s)

Code Letter	Mass (g)	Vol. H_2O in grad. (mL)	Vol. H_2O + metal (mL)	Vol. of metal (mL)	Density (g/mL)	Identity of metal

Observations:

Questions:
1. Why must the volume of the metal sample be at least 10 mL?
2. Are there any metals listed in the table that you could not identify using this procedure? What simple physical properties could be used instead?
_____

Instructor's Guide
Density of Solids

(**Data and Results**)

Identifying a Metal from its Density

Record Code Letter of your unknown(s)

Code Letter	Mass (g)	Vol. H_2O in grad. (mL)	Vol. H_2O + metal (mL)	Vol. of metal (mL)	Density (g/mL)	Identity of metal
A	*111.10*			*13.0*	*8.55*	*brass*
B	*116.62*			*13.0*	*8.90*	*copper*
C	*35.01*			*13.0*	*2.69*	*aluminum*
D	*99.99*			*13.0*	*7.69*	*steel*

Observations:

Questions:
1. Why must the volume of the metal sample be at least 10 mL?
2. Are there any metals listed in the table that you could not identify using this procedure? What simple physical properties could be used instead?

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1. *The 50-mL graduated cylinder can be read to the nearest 0.2 mL at best, so to preserve three significant figures, the metal object must have a volume greater than 10 mL.*

2. *The densities of Ni and Cu are identical to 3 significant figures. However, copper is reddish in color and nickel is magnetic, so there are other ways to distinguish Ni and Cu from one another.*

Instructor's Guide
Density of Solids (cont'd)

Time: 30 min. This could be done by itself to fill a short class or combined with "Density of Liquids" if at least an hour is available.

Equipment and Materials: Per group:

Items	**Number**	**Comment**
50-mL graduates	1	Plastic
wash bottles	1	
top loading balances	1	
metal slugs	2 ea	aluminum, brass, steel, copper
kimwipes	1 box	
safety glasses	30	per class

Ideas/ Information

Another way to measure the volume of the metal slug is by finding the diameter and height and using the volume of a cylinder.
According to the company that supplied the slugs the measurements are "about":
12.5 to 12.7 cm diameter (d)
50 ± 1 mm length (l)
Thus the volume, $V = \pi r^2 l$ can range from 6.01 mL to 6.46 mL.

Brass is an alloy of copper and zinc, Cu and Zn.
Bronze is an alloy of copper and tin, Cu and Sn.