IDENTIFICATION BY DENSITIES

OBJECTIVES FOR THE EXPERIMENT

The student will be able to do the following:

1. Write or identify the definitions of density, bulk density, and absolute density.
2. Measure mass using an electronic balance.
3. Measure volume using a graduated cylinder.
4. Calculate masses using the procedure called "weighing by differences".
5. Calculate volume using the procedure called "volume by displacement".
6. Given all but one of the following, calculate the one not given: density, mass, and volume.
7. Identify an unknown substance from comparison of the density of the substance with a table of densities of known substances.
8. Report all data from measurements or calculations with the correct units, exponential notation and significant figures.

BACKGROUND ON DENSITY

Density is mass per unit volume.

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

Densities can be used for many purposes. A chemist might use density measurements to help identify an unknown substance by comparing its density with a list of known densities. An engineer might use the density to calculate the mass or volume of a substance that is being used in construction. She might calculate the mass of concrete in a bridge pier of known volume.

There are two types of density. Bulk density is mass divided by the bulk volume. Bulk volume includes the volume of the particles of a substance and the air in between the particles. The bulk volume of sand is the volume of the sand particles and air between the particles.

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

The mass of dry sand divided by its observed volume yields its bulk density.

The absolute density of sand is mass divided by absolute volume. The absolute volume is the actual volume of the particles themselves.

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

The absolute density is used to identity the nature of a substance. The densities given on tables of densities are absolute densities. Any time the term density is used, you can assume it refers to absolute density unless otherwise stated.

PROCEDURE

Determination of the Bulk Density of Sand

a. Weigh a 10-mL graduated cylinder. Report all your data on the data sheet at the end of the experiment. (Report all masses for this experiment to 0.001 g.)
b. Add enough sand to the graduated cylinder to bring its bulk volume to about 5 mL.
c. Weigh the cylinder and the sand and record the mass to 0.001 g.

d. Calculate the mass of the sand by subtracting the mass of the cylinder from the mass of the cylinder and the sand. This is called "weighing by differences."
e. Read and record the bulk volume to 0.1 mL. (Do not tap the sand down. If the sand is packed too tightly, there will be problems in the next steps.)
f. Calculate the bulk density of the sand.

Determination of the Absolute Density of Sand

a. To the graduated cylinder containing the sand used in the previous section, add enough deionized water to completely cover the sand.
b. With the aid of a microspatula, make sure that all of the air is eliminated.
c. If any sand is left adhering to the microspatula or the walls of the cylinder, rinse them down with some additional water. It is important that the water level does not come above the 10.0 mL mark on the graduated cylinder.
d. Weigh the graduated cylinder containing the water and the sand and record its mass to 0.001 g.
e. Calculate the mass of the water that was added.
f. Calculate the volume of water, using the density of water, 0.997 g/mL, as a conversion factor.
g. Read and record the combined volume of the sand and the water.
h. Calculate the absolute volume of the sand granules by subtracting the volume of the water from the volume of the sand and water. This technique is called "volume by displacement".
i. Using the mass of the sand from the previous section, calculate the absolute density of the sand.
j. Keep your sand in the graduated cylinder until you have had your calculations checked by your instructor.

Identification of an Unknown Salt

a. Bring the calculations for the previous section to your instructor. If your calculations are approved, you will be given a test tube containing an unknown salt. Write your unknown number in the space provided on your data sheet.
b. Discard the sand in the container provided. Do not get sand in the sink.
c. Clean the graduated cylinder, rinse it with 1-2 mL of alcohol, and allow it to air dry for about five minutes.
d. Using a long-tipped dropper add about 5 mL of denatured alcohol to your clean, dry 10-mL graduated cylinder. Try to avoid getting any alcohol on the walls of the cylinder. Read and record the volume of the alcohol.
e. Weigh the cylinder and alcohol and record your mass to 0.001 g.
f. Pour enough unknown salt from the test tube into the cylinder to raise the volume about 4 mL. Try to avoid getting salt on the walls of the cylinder above the alcohol.
g. Again, read and record the volume and the mass.
h. Calculate the absolute density of the salt.
i. Compare your density to the densities of the following common salts to determine the identity of your salt.

Formula of salt	**Density (g/mL)**
$Na_2SO_4 \cdot 10H_2O$	1.46
$NaNO_3$	2.26
KBr	2.75
KI	3.13

NAME _____

DATA SHEET FOR IDENTIFICATION BY DENSITIES

Be sure to record the correct units with each value reported. Report each answer with the correct significant figures.

I. DETERMINATION OF THE BULK DENSITY OF SAND

Mass of graduated cylinder	
Mass of cylinder and sand	
Mass of sand	
Volume of dry sand	
Bulk density of sand	

II. DETERMINATION OF THE ABSOLUTE DENSITY OF SAND

Mass of cylinder, water and sand	
Mass of water added	
Volume of water added (calculated)	
Volume of sand and water (measured)	
Volume of the sand granules	
Absolute density of the sand	

III. IDENTIFICATION OF AN UNKNOWN SALT

Unknown number _____

Volume of alcohol	
Mass of cylinder and alcohol	
Volume of alcohol and salt	
Mass of cylinder, salt and alcohol	
Mass of the salt	
Volume of the salt	
Absolute density of the salt	
Identity of the salt	

PROBLEMS

1. How many pounds of sand would you want to buy to fill a sand box with the dimensions of 4.0 ft by 6.0 ft by 6.0 inches? (Use your data.)

2. Some unknown sand granules were measured and the following data were obtained:

Mass of cylinder = 12.354 g
Mass of cylinder and the sand = 25.978 g
Volume of water and sand = 7.9 mL
Mass of cylinder, sand and water = 28.993 g

Using the information given below, determine which of the three sands was in the sample analyzed. Assume the sand to be purely of one type only.

Calcite ..... 2.715 to 2.94 g/mL
Feldspar ..... 2.55 to 2.63 g/mL
Silica ..... 2.65 g/mL

SHOW YOUR CALCULATIONS HERE