Survey of Physics

Lab 10: Buoyancy and Specific Gravity

Name:______________________

partner name(s):______________________

Theory:

Archimedes' principle states that when an object is immersed in a fluid, it is buoyed up by a force equal to the weight of the fluid which it displaces.

We will measure the mass of an object normally (when it is in air) and call this m_{air}. We will then measure the apparent mass of the same object when it is submerged, and call this m_{sub}.

Due to the buoyant force, you will see that $m_{\mathrm{sub}} < m_{\mathrm{air}}$. The difference will be the mass of the displaced water: $m_{\mathrm{disp}} = m_{\mathrm{air}} - m_{\mathrm{sub}}$.

You will verify Archimedes' principle for several metal samples. The metals we will use are any three of the following: copper (Cu), lead (Pb), tin (Sn) or zinc (Zn). Their densities are as follows

copper (Cu)	8.93 g/cc
lead (Pb)	11.34 g/cc
tin (Sn)	5.765 g/cc
zinc (Zn)	7.13 g/cc

Part 1: *Measuring the Buoyant Force*

Obtain three different metal samples, a balance with a tray for measuring submerged weight, and a string loop to hang the samples while weighing. The metals should be

Zero the balance with the string loop attached. Measure the mass in air $(m_{\rm air})$ and then carefully submerge the sample in a beaker of water, and measure the mass again $(m_{\rm sub})$. Enter your data in the table below, including the buoyant force (in mass-equivalent units).

material	$m_{\rm air}$ (grams)	$m_{\rm sub}$ (grams)	$m_{\rm disp} = m_{\rm air} - m_{\rm sub}$

Next, measure the volume of each sample by observing the amount of fluid displaced when it is submerged. For each of the samples used above, record the initial fluid level (V_1) and the final fluid level after submerging the object (V_2). The difference ($V_2 - V_1$) is the volume displaced. Since the density of water is $D = 1.0$ g/cc, this number is also the mass displaced in grams ($m_{\rm disp}$).

Enter your data in the table below. In the final column find the percent difference between the $m_{\rm disp}$ from the previous table, and the $m_{\rm disp}$ measured directly.

material	V_1 (cc)	V_2 (cc)	$m_{\rm disp}$ (grams)	% difference

Note: the % difference between a and b is given by $\frac{b-a}{a} \times 100$%

If your % differences are over 25%, please check with the instructor.

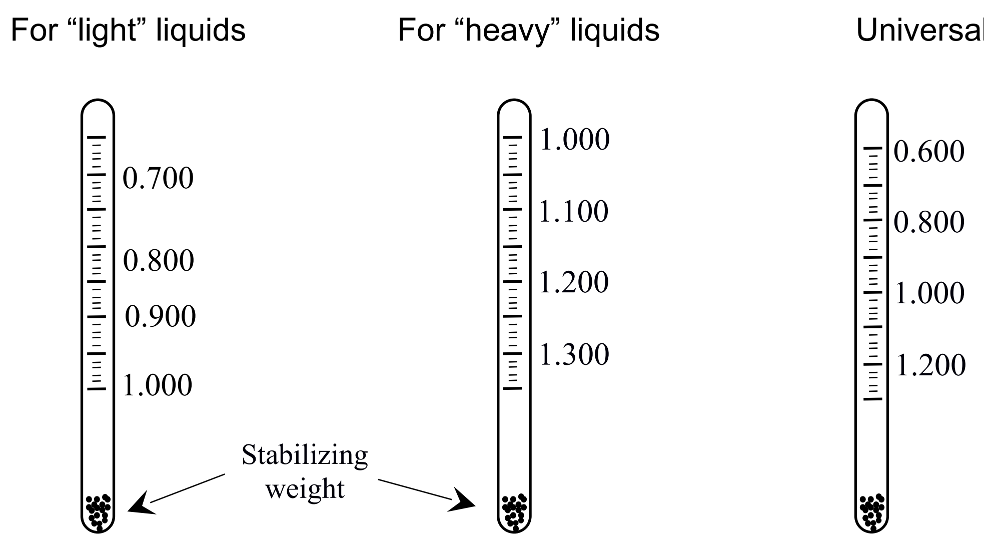
Part 2: *Specific Gravity of Liquids using a Hydrometer*

If an object floats in a liquid, that means that the buoyant force is equal to the weight of the object. According to Archimedes' principle, the volume of the body that is submerged will displace a volume of fluid whose weight is equal to the weight of the body.

This means that one could calibrate a floating uniform cylinder to measure specific gravity and the cylinder length could be marked in units of specific gravity. If the submerged length is large (cylinder sinks deep), the specific gravity will be small. If the submerged length is small (cylinder floats high), the specific gravity is large. Such a calibrated instrument is called a hydrometer, and is used as a device to very rapidly determine the specific gravity of liquids.

Procedure:

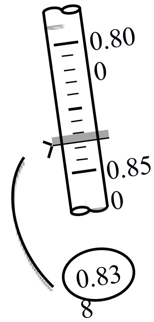
Examine the diagram below, which is a sketch of the types of hydrometers available, and how to read them.



In all cases, a hydrometer immersed in water should read 1.000. You will find several glass cylinders with various liquids in them. For each hydrometer used, make a sketch of the hydrometer scale and label the value of one small division on the scale. Show one major division above and below the level of liquid, as shown in the example. Be sure your reading reflects the available accuracy of the scale. Enter the correct hydrometer readings for each liquid to be tested in the data table. Again, look up and record the accepted values where possible and calculate your percent error.

Sketches:

Example:



1	2	3	4	5

	Liquid	sp. gr. (calculated)	sp. gr. (accepted)	% error
1.				
2.				
3.				
4.				
5.				