Pressure and Buoyancy Lab – 2/17/12

Pre-Lab – Copy the Following
Buoyancy

The buoyant force is responsible for objects floating in water and in air. There is even a buoyant force working on you due to the fact that you are displacing air. The buoyant force is defined as

$$F_b = \text{(density of fluid)(gravity)(volume of fluid displaced)}$$

PART I – TO BE DONE ON 1ST DAY OF LAB

Will it float?

1. At your lab station should be three objects. Identify each and fill in the following table using grams and cm^3.

Object	Mass (g)	Volume (cm^3)	Density (g/cm^3)	Floats?
Golf Ball				
Wood				
Styrofoam				

Which one(s) will float in water? Try it and see. Fill in the last column of the above table.

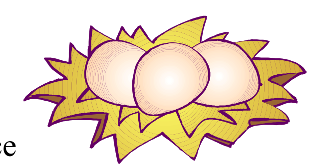
2. Try floating two different cans of soda pop. Which one floats? _________ Which one sinks? ______

3. Why does one float and the other one sink?

4. Measure the mass of an egg. ____________

5. Determine the volume by displacement using the graduated cylinder at your table. _________

6. What is the density of the egg? ______________



7. Will the egg float? ________ Try it and see. Place the egg in the 600 mL container and fill it with water to about 150 mL. Write your observations in the space below.

8. What can you do to get the egg to float? (There should be salt at your station.) Try it and see! Discuss your observations. Explain why the egg floats in terms of the equation given above.

9. Now pour fresh water ***slowly*** on top of the egg so that the fresh and salt water do not mix, until the container is full. Does the egg remain suspended in the middle of the liquid? Why is this true?

10. The Dead Sea near Israel is six times saltier than the ocean. It is practically impossible to swim beneath the surface. Explain why!

11. Salad tastes great with Italian dressing on it. After pulling it out from the fridge, I notice that the dressing has "separated" into two parts - one oil and the other water. Which one floats on the top?

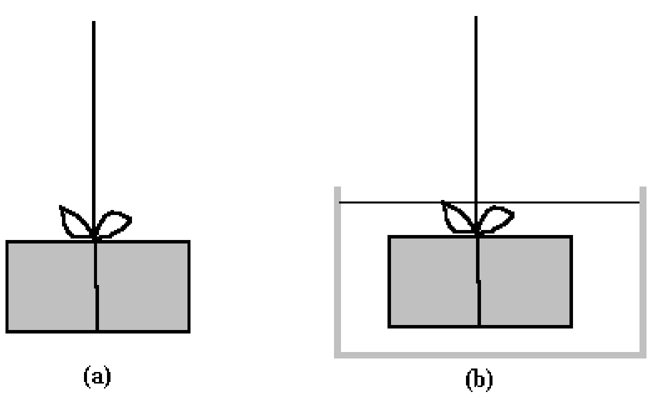
12. Perhaps you saw Arnold in the movie "True Lies." In one scene, oil and gas are spread over a large surface of water and catches on fire. Arnold jumps through the fire and swims under the surface to reach the other side unscathed. Why does the burning oil and gas remain on top?

<u>The Buoyant Force (Write the Name of Your Object Here:)</u>

13. Find the ***weight*** in Newtons (you may have to convert the mass to kilograms first!).

14. What is the ***"apparent" weight*** of the object when it is completely submersed in water (this is actually the tension that the spring balance reads and is not the real weight of the object which remains unchanged)?

15. Study the diagrams below. Draw the forces (as arrows) and label the forces on the object (a) out of the water and (b) in the water. You should have two forces for (a) and three forces shown for (b). Hint: Use labels such as T for tension, *w* for weight and F_b for buoyant force. Pay careful attention to the lengths of the arrows – make them match the situation!



16. In which direction does the buoyant force always act?

17. Compare part (a) and (b). Why is tension less in (b) compared to (a)?

18. Think here: The difference in measured values for tension between (a) and (b) is due to the buoyant force alone - so what is value of this buoyant force (in Newtons!)?

19. If water has a density of 1000 kg/m^3, find the volume of the object using the formula on the first page. Hint: $F_b = \rho g V$ = your answer in 18. Solve for V (it will be a small value since the units are in m^3).

20. Go back to your previous work with the Styrofoam block. You know its volume. If the buoyant force equals the weight of water displaced, how much additional **mass** could be added to the top of the block without sinking (top of the block is at the surface with the weight on top).

PART II – TO BE DONE ON 2ND DAY OF LAB

Pressure

Pressure (units of Pa, Pascals) is defined as **$p = \rho g h$**, where ρ is density of the liquid/gas, g is gravity and h is the depth. In an open container of water, pressure in the water is not only due to the water depth but to the pressure of the atmosphere above it. The standard atmospheric pressure is 1.013×10^5 Pa. Therefore, at a depth of 20 cm, the pressure is $1.013 \times 10^5 + (1000\ kg/m^3)(9.8 m/s^2)(.2m) = 1.032 \times 10^5$ Pa.

21. At your station should be a plastic soda cup with two holes. If water is filled to the very brim of the cup, calculate the pressure at the top hole and the pressure at the bottom hole.

22. Fill the cup to the brim with water covering the holes with your fingers. Release your fingers. In which hole does the water squirt out farther? Why is this true?

23. If you had a 10-lb brick on your head, you would definitely feel its weight. If you jumped off a 2 story building with the brick on your head, would you feel its weight? Why?

24. Fill the cup to the brim covering the holes with your fingers. Go outside and let the cup freefall from a good height. What do you **observe as the cup freefalls**? Why is this true?

Bernoulli's Equation

Bernoulli came up with the notion that when the velocity of air particles or water is increased, the pressure goes down. In other words,

If velocity ⇑, then pressure ⇓

Likewise,

If velocity ⇓, then pressure ⇑.

This is why airplanes can fly (curved wing), why the shower curtains rub your leg when the water's on, etc.

25. Take a sheet of paper and hold it to your lower lip. Blow hard across the top of the card and describe what happens. Why is this true? Explain carefully.

26. Take the Ping-Pong ball with the string attached and hold the Ping-Pong ball under a steady stream of water. Pull the string slightly off to the side and describe what happens. Explain this in terms of Bernoulli's principle describing the pressure and velocities around and to the outside of the ball. Explain carefully.

27. Take another ping pong ball (with no string attached) and use the air blower to play with the ball up in the air. At what estimated angle can you turn the direction of the airflow before the ball falls to the ground?