SMS-204: Integrative marine sciences

Homework 3

For homework- remember to provide uncertainties in graphs and display only significant figures for all your results.

1. (25pts) <u>Using results from lab station 1</u>(Archimedes' ball):

Work out mathematically how much air needs to be pulled out of the ball by the syringe in order for the ball to barely start sinking in the surrounding water. How does it compare to your observations (are they within the observation uncertainties)?

2. (30pts) <u>Using results from lab station 4</u>:

a. Report the cross-section area, volume and weight of the empty box.
b. For the four box weights for which the box floated create a table showing the weights added, the box weight in air, the box weight in water, and the depth to which the box was immersed in water.

Mass of add weights	Weight in air	Weight in water	Immersion depth
0g			
25g			
50g			
75g			

c. Plot the depth to which the box is immersed in water as function of the weight of the box in air (5pts).
d. Obtain the slope of the best-fit line. (5pts)
e. What should the slope be based on Archimedes's principle (5pts)?
f. How does it compare to the slope of your plot? (5pts)
g. Consider the final trial when you added enough weight so that the box *sinks* in water. In that case, what is the weight of the box when immersed in water and when outside water? What is the difference between them? (5pts)
h. Is this difference reasonable given what you know about buoyancy? Explain. (5pts)

3. (25pts) In the 2nd station of the 2nd lab you were studying water squirting out from a hole in a cylinder filled with water into a tub. Just as a falling ball converts potential energy to kinetic energy, water pressure pushed water out of the hole by converting potential energy per unit volume ($\rho g h$) to kinetic energy per unit volume ($\rho v^2/2$). Assume you have a 40 cm head of water above the hole and that the hole is 20 cm above ground.
1. (5pts) What is the horizontal speed at which the water leaves the hole?
2. (5pts) How long will it take it to reach the ground (think mechanics)?
3. (5pts) How far will the water reach by the time it hits the ground?
4. (5pts) How does the place where the water reaches change with the height of *the water surface* above the hole (provide an equation or a relationship)?
5. (5pts) How does the place where the water reaches change with the height of *the hole* above ground (again, provide an equation or a relationship)?

4. (20pts) Working with data from profiling float:
a. Go to: http://www.mbari.org/science/upper-ocean-systems/chemical-sensor-group/floatviz/ Select a float in the 'Select Float' window. Choose density anomaly (=density-1000kg/m^3 called Sigma_theta) in the 'select one X Variable' window. Choose depth in the 'Select Y variable'. On the left most part, click on 'plot' to generate a plot of all the density anomalies and click on 'Send'. Copy the image to your homework.
b. (5pts) On average, what is the difference in water density between the surface and depth? In what part of the water column is density most variable?
c. (5pts) Given that a float profiles typically from 2000m (~10 days between profiles) to the surface, in the least, what is the range of densities it should be able to accommodate (in terms of its own density so it can float and sink)?
d. (5pts) The float is a perfect cylinder with a 35cm diameter and 1.5m length. What should be its mass, such that its own density without inflating a bladder, matches the density at depth?
e. (5pts) Given the above mass and volume, how much should the bladder be inflated (in cm^3), to allow the float to reach the surface for all the conditions it encountered?