SMS 204: Integrative marine sciences.

Assignment #2.

Knowledge base: hydrostatic pressure, ideal gas law, ability to apply the continuity principle, computation of volume, mass and momentum flux. Nature of forces in fluids. Skills: algebra, unit conversion, significant digits.

Assignment can be done in a group, but has to be emailed individually and be distinct.

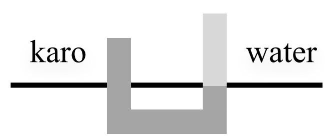
1. (15 pts) Assume that you have a U-shaped, hollow tube (we call it a 'manometer') with Karo syrup (density 1250 kg m^{-3}) in it such that both arms are half filled.
What would happen if you added a given mass of water (density ~1g ml^{-3}) into one of the arms of the manometer? (The mass added has less volume than half the arm of the monometer.) Feel free to add a drawing describing initial and final states.

The fluid in both arms will rise. The fluid in the arm where water was added will be higher than in the other arm.

Extra credit (10 pts): If the cross-sectional area of the manometer is 5 cm^2 and the amount of water added is 20 ml, what will be the height difference between the two arms of the manometer? It may help to assume that the tube is U shaped, though it does not really matter.

The pressure at the base of the water has to be equal to the pressure at the same depth at the other branch. The height of the water is 4.0cm ((20ml=20cm^3)/5cm^2). Lets' call the height of the karo at the other side y. Given that the pressure just below the water is the same as that at the other side (the fluid has the same density and height up to this point):

*4.0cm*1000kg/m^3=y*1250kg/m^3 → y=3.2cm.*
→ The difference in height will be 4.0-3.2=0.8cm.



2. (20 pts) An ingenious inventor decides to use a large chamber with a bottom that can slide in or out but that is impervious to water as a submarine. He feels it with air so its volume at the ocean's surface is 25m^3. The inventor and the submarine start descending down to depth. Assuming no exchange of gas with the surrounding fluid, what will be the sub's volume at 5, 10, and 20 and 100 m?

We use the fact that PV is conserved (assuming no change in temperature, just as with the 15pd weight on the syringe in Lab 2). Every 10m of water adds (nearly) the same pressure as that of the atmosphere (that is another 10^5Pa).

Depth (m)	Pressure (Pa)	Volume (L)	Pressure x volume
0	10^5Pa	25m^3	$2.5\cdot10^6$Pa m^3

5	$1.5 \cdot 10^5$Pa	$16.67m^3$	$2.5 \cdot 10^6$Pa m^3
10	$2 \cdot 10^5$Pa	$12.5m^3$	$2.5 \cdot 10^6$Pa m^3
20	$3 \cdot 10^5$Pa	$8.33m^3$	$2.5 \cdot 10^6$Pa m^3
100	$11 \cdot 10^5$Pa	$2.27m^3$	$2.5 \cdot 10^6$Pa m^3

3. (20 pts) At Old Town, near Indian Island, you measure the average width of the Penobscot river to be 40m, its average depth to be 4m, and the average velocity of the water to be on average 10 cm s^{-1}. Downstream, near Veazie, you measure the averaged width to be 50m, the average depth to be 5m and the average velocity to be 20 cm s^{-1} at the same time. The Stillwater is a tributary that joins the Penobscot river at Orono, between Old Town and Veazie.

a. What are the mass and volume fluxes of the Stillwater into the Penobscot?
Mass flux:
*Old Town (In)=40m*4m*0.1m/s*1000kg/*m^3 *=16,000Kg/s*
*Veazie (Out)=50m*5m*0.2m/s*1000kg/*m^3*=50,000Kg/s*
Stilllwater=out-in=34,000Kg/s

Volume flux:
*Old Town (In)= 40m*4m*0.1m/s =16*m^3*/s*
*Veazie (Out)= 50m*5m*0.2m/s =50*m^3*/s*
*Stilllwater=out-in =34*m^3*/s*

b. If the Stillwater's average width is 10m and its average depth 1m where it joins the Penobscot, what is the average water velocity where it joins the Penobscot?

$\langle v \rangle = 34m^3/s /(10 \times 1\ m^2) = 3.4m/s$

Assume no other sources or sinks of water between Old Town and Veazie and use, if needed, a typical density of fresh water for your calculations.

4. (15 pts) How can water flow up a straw and into a mouth in a direction opposing gravity? Many marine organisms have tubes or siphons. Choose one such organism and discuss how the presence of such tube/siphon affects flow into/out off that organism (use and cite at least one reference from the WWW or a paper you found).
5. (20pts) Report the following values with the appropriate significant digits (see http://misclab.umeoce.maine.edu/boss/classes/SMS_204/Error.pdf or other resources of your choice):

a. 1.3862m when the uncertainty is +/-1cm
b. 3,546ml when the uncertainty is +/-5%
c. 0.004892g when the uncertainty in the value is +/-10%
d. 3,350,698 fish when the uncertainty is +/-50fish

Answer:

a. *1.39 +/-0.01m*
b. *3,500 +/-180ml*
c. *(5.0 +/-0.5) 10^{-3}g*
d. *3,350,700 +/-50 fish*

6. (10 pts) In the movie: 'Fluid dynamics of drag, part II', two types of forces acting on a body or a water parcel within a fluid are described. What are they? Provide one example for each type of force.

The two are body and surface forces. Body forces include gravity and magnetism. Surface forces include pressure and tangential (or shear) stresses.
