

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 1400 kg m^{-3}) in it such that both arms are half filled. What would happen if you added a given mass of water (density $\sim 1 \text{ g ml}^{-3}$) 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.

Extra credit (10 pts): If the cross-sectional area of the manometer is 1 cm^2 and the amount of water added is 5 ml, what will be the height difference between the two arms of the manometer?

2. (20 pts) An ingenious inventor decides to use a large chamber with a bottom that is open as a submarine. He fills it with air so its volume at the ocean’s surface is 40 m^3 . The inventor and the submarine starts descending down to depth. Assuming no exchange of gas with the surrounding fluid, what will be the chamber’s air volume at 5, 10, and 20 40m and 80 m?

3. (20 pts) At Old Town, near Indian Island, you measure the average width of the Penobscot river to be 100m, its average depth to be 3m, and the average velocity of the water to be on average 20 cm s^{-1} . Downstream, near Veazie, you measure the averaged width to be 50m, the average depth to be 6m and the average velocity to be 25 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 in SI units?

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 in cm s^{-1} ?

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. A. (5 pts) How can water flow up a straw and into a mouth in a direction opposing gravity?

B. (10 pts) Many marine organisms have tubes or siphons. Choose one such organism and discuss how the tube/siphon generates 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 (2.5pts each, see http://misclab.umeoce.maine.edu/boss/classes/SMS_204/Error.pdf or other resources of your choice, such as https://en.wikipedia.org/wiki/Significant_figures, and <https://www.khanacademy.org/math/arithmetic-home/arith-review-decimals/arithmetic-significant-figures-tutorial/v/more-on-significant-figures>):

- a. 61.3699m when the uncertainty is +/-1cm
- b. 4,544ml when the uncertainty is +/-5%
- c. 0.003951g when the uncertainty in the value is +/-10%
- d. 5,321,652 fish when the uncertainty is +/-1,000fish

Convert the following units (see <https://www.khanacademy.org/tag/unit-conversion/algebra> to learn more about this critical skill).

1. (2pt). How many ml are there in 5m^3 ?
2. (2pt). A tuna swims at 50cm s^{-1} . How many km does he swims in an hour?
3. (6pt). A seal weighing 120lb needs to be administered drug X at 33mg per kg of bodyweight twice a day. The drug comes in a solution of density 1.2g/ml. How many ml should we administer twice a day?

6. (5 pts) Watch the movie: ‘The science of water pressure | History’ (<https://www.youtube.com/watch?v=0B0EhuxJsts>). Convert all the magnitudes that are given in non-SI units to SI units (e.g. atmospheric pressure etc’).

7. (5pts) Watch the movie: ‘The science of diving – Understanding pressure’ (<https://www.youtube.com/watch?v=6IPFLixjqVg>). How will the density of air in your lungs change if you dove to 20m (e.g. when taking the PADI deep diver course)?