Problem Set X- Assign November 15, 2006 Due November 27, 2006.
Fall 2006 Physics 200a
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1. A vertical tube of radius 1 cm, open at the top to the atmosphere, contains 2 cm of oil ($\rho_{oil} = 0.82\rho_{water}$) floating on 3 cm of water. What is the gauge pressure (i.e., pressure in excess of the atmospheric) at the bottom.

2. A person wants to suck water through a straw 120 cm tall. What is the minimum pressure difference between the atmosphere and the inside of the person's mouth?

3. A wide can of water is filled to height h. At what height from the base should I drill a hole to (i) get the maximum range for the jet that comes out (ii) ensure that the jet travels a horizontal distance equal to the vertical distance. (iii) What is the maximum horizontal distance the jet can travel?

4. A rectangular hole is made on the side of a cylindrical container of water. The hole has width w and its upper and lower edges (parallel to the base of the cylinder) are at depths d_1 and d_2 respectively measured from the water level.

   (i) Show using integration that the initial flow rate out of this hole is

   $$\frac{2w}{3}\sqrt{2g}\left[d_2^{3/2} - d_1^{3/2}\right] \quad m^3/s.$$

   Neglect the motion of water at the top of the tank.

   (ii) Suppose $d_2 = d_1 + \delta$, where δ is very small, so that we can ignore the variation of the depth from the top to the bottom of the hole. What would you expect the rate to be in that case and show that the exact answer above answer reduces to that in that limit. (Remember $(1+x)^n = 1 + nx + \ldots$)

5. A piece of cork of density $\rho = .22\ \rho_{water}$ is held down fully submerged in water by a thread anchored at the base of the container. What is T/mg, where T is the tension of the thread and mg is the mass of the piece of cork?

6. A cylinder of cross section A and mass m floats vertically in a fluid of density ρ (in other words, the cross section is parallel to the surface). If disturbed from this equilibrium, what will be the period of small (vertical) oscillations?

7. A horizontal pipe of diameter $d_1 = 10cm$ carrying water has a constriction of diameter $d_2 = 4cm$. If $P_1 = 10^5$ Pascals and $P_2 = 8 \cdot 10^4$ Pascals, what is the flow rate?

8. Find the lift on an airplane wing of area 50 m^2 if the velocity of air at the upper and lower parts is 90 m/s and 70 m/s respectively. Assume $\rho_{air} = 1.16kg/m^3$.

9. A wall of an outdoor pool is $10m$ long and $2m$ deep. What force is needed to keep it in place?

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