Physics 131.01 Monday November 8, 2010 Quiz number 7

Cooperative Learning: work together, and submit one solution to each problem. A "solution" is not just a number. The reasoning needs to be indicated. The units of the number need to be specified. If the answer is a vector, the vector needs to be specified. Magnitude alone is not usually enough. **Write all 3 names on each page you submit.**

ρ_{air} = 1.2 kg/m^3; $\rho_{seawater}$ = 1040 kg/m^3 P_{atm} = 101.3 kPa

1. **Pressure and density.** (1 point each part) Liquid mercury has a density of 1.36 x 10^4 kg/m^3. You have a cylindrical jar of radius 0.060 m and height taller than necessary. It is filled to a height of 0.20 m with liquid mercury.

a. What is the mass and the weight of the mercury? You can neglect the mass of the jar.
$V = \pi r^2 h$ = 0.00226 m^3; m = ρV = 30.8 kg; W = mg = 301. kg.

b. The jar sits vertically on the floor. The pressure on the top surface is 1.00 atm. What is the pressure on the bottom surface, in Pa and in atm? $P = P_0 + \rho gh$ = (1.013 + 0.267) x 10^5 Pa = 1.28 x 10^5 Pa = 1.26 atm

c. Suppose a 5.00 kg slug of lead floats in the mercury. The density of lead is 1.13 x 10^4 kg/m^3. What fraction of the lead is higher than the surface of the liquid mercury?
mass of lead = $\rho_{lead} V_{lead} g$ = mass of mercury displaced = $\rho_{Hg} V_{disp} g$; f = 1-V_{disp}/V_{lead} = 1 – ρ_{lead}/ρ_{Hg} = 1-0.831 = 0.169

d. What is the pressure (in Pa) under the jar now? The pressure increases by $m_{lead}g$/area = $m_{lead}g/\pi r^2$ = .04332 x 10^5 Pa, so P = 1.32 x 10^5 Pa.

2. **Pressure and velocity.** (3 points) You hold a drinking straw horizontally, and blow on one end. suppose the pressure you can supply is enough to raise the pressure inside your mouth from 1.00 atm to 1.01 atm. How fast does the air travel at the other end of the straw, if you neglect viscosity, and neglect the velocity of the air in your mouth?
$P_{mouth} = P_{atm} + ½\rho_{air}v^2$; v = 41 m/s. The truth is that viscosity is not negligible.

3. **Bernoulli's principle.** Suppose a bullet train has an air-tight passenger car with pressure 1.00 atm inside. The train travels at 220 km/h.

a. (2 points) What is pressure on the outside surface of the passenger car? The pressure is reduced by $\Delta P = ½\rho_{air}v^2$; v = 220/3.6 = 61.1 m/s; ΔP = 2240 Pa = 0.0221 atm P = 0.979 atm.

b.(1 point) How much force does a window of area 0.800 m^2 experience, and in what direction? F = ΔPA = 1790 N (outward force)