Quiz #9A

Clearly indicate (with a box) your answers to the following questions. SHOW ALL WORK.

1. A 2100-kg wooden block is 1.200 meters tall and has a cross sectional area of 2.400 square meters. It is partially submerged in liquid water (density of 1.000×10^3 kg/m^3).

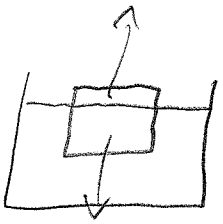
a) What fraction of the block is submerged? Answer with 2 SF.

b) If the surface of the water is at atmospheric pressure (1.013×10^5 Pa), what is the pressure of the water at a depth equal to where the bottom of the block is located? Answer with 4 SF.

$M = 2100\,kg$

$V = (1.2)(2.4) = 2.88\,m^3$

$\rho = 2100/2.88 = 729\ kg/m^3$



$\Sigma F_y = \rho_o V_o g - \rho_f V_f g = 0$

$\rho_o V_o = \rho_f N V_o$

$N = \frac{\rho_o}{\rho_f} = 0.729 = 73\%$

b) $h = (0.73)(1.2) = 0.876\,m$

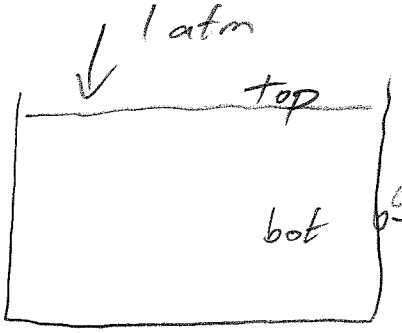
$P_{bot} = 1.013 \times 10^5 + (1000)(9.8)(.876)$

$= \boxed{1.099 \times 10^5\ Pa}$

2. A very large above-ground pool of water is open to the air and develops a leak 1.2 meters below the surface of the water (which has the same density as in problem 1). The hole has a radius of 2.5 millimeters. Determine how many gallons per minute are being lost from the pool.

IT IS IMPORTANT THAT YOU CLEARLY INDICATE ALL OF YOUR ASSUMPTIONS ABOUT VALUES IN THIS PROBLEM. Briefly explain any values you will set equal to each other or ignore.

1.000 gallon = 3.786 Liters = 3.786 x 10^{-3} m^3



$A_{bot} = \pi (.0025)^2$

$= 1.96 \times 10^{-5} m^2$

$\Delta P + \rho g \Delta y + \frac{1}{2}\rho V_b^2 - \frac{1}{2}\rho V_t^2 = 0$

$\Delta P = 0$ (1 atm at top + bottom)

$V_t \approx 0$ since $A_{top} \gg A_{bot}$ $V_t = \frac{A_b}{A_t} V_b \approx 0$

$\Delta y = -1.2 m$

$\rho g (-1.2) + \frac{1}{2}\rho V_b^2 = 0$

$V_b = \sqrt{2g(1.2)} = 4.85 \ m/s$

$Q = A V_b = 9.51 \times 10^{-5} \ m^3/s \cdot \frac{1 \ gal}{3.786 \times 10^{-3} m^3}$

$= \boxed{.025 \ gal/s}$

$= \boxed{1.5 \ gal/min}$