Phys 10154 - Fall 2006 - Exam #9B

Be sure to answer with the proper units and significant figures. Indicate your answers clearly with boxes. SHOW ALL WORK. Even if your answer is correct, I will deduct points if I can't see how you solved the problem. Both problems are worth 50 points.

#1. A 2.50-kg aluminum block (density = 2120 kg/m^3) is released from the top of a 5.50-meter deep water tank that is open to the atmosphere. The block has a cross-sectional area of [redacted] 43.2 cm^2.

What is the upward-pushing force that the water exerts on the bottom of the block when the top of the block is 1.00 meters below the surface? Answer with 6 SF.

What is the downward-pushing force that the water exerts on the top of the block when the top of the block is at a depth of 1.00 meters (you need to calculate the height of the block)? Answer with 6 SF.

How many seconds after the block is released does it hit the bottom of the tank? For simplicity, just assume the distance traveled is 5.50 meters. Answer with 3 SF.

$V_0 = \frac{m}{\rho} = \frac{2.50}{2120} = .001179\ m^3$ $\quad h = \frac{V_0}{A} = \frac{.001179}{432\times10^{-4}}$

$= 0.273\ m$

$h_{bottom} = 1.00 + 0.273$

$P_{bot} = 1.013\times10^5 + (1000)(9.8)(1.273) = 113,775.4$

$F_{bot} = P_{bot} A = (113\,775.4)(43.2\times10^{-4}) = \boxed{491.510\ N}$

$P_{top} = 1.013\times10^5 + (1000)(9.8)(1.000) = 111,100$

$F_{top} = P_{top} A = (111,100)(43.2\times10^{-4}) = \boxed{479.952\ N}$

$F_B = F_{bot} - F_{top} = 11.558\ N$ $\quad$ check $F_B = (1000)(.001179)(9.8) = 11.554\ N$

$\Sigma F = F_B - mg = ma$

$\frac{11.558 - (2.50)(9.8)}{2.50} = a = 5.18\ m/s^2$, down

$5.50 = 0 + \frac{1}{2}(5.18)t^2$

$t = \sqrt{\frac{5.50}{2.59}} = \boxed{1.46\ s}$

#2. A large tank is open to the air and springs a leak 2.25 meters below the surface. Water flows at a rate that fills up a 1.00 gallon jug in 15.0 seconds. What is the diameter of the hole, in millimeters?

Conversion factors are on your formula sheets.

$$\Delta P + \rho g \Delta h + \Delta \tfrac{1}{2}\rho v^2 = 0$$

$$\Delta P = 0$$

$$\rho g h_{bot} = 0$$

$$\tfrac{1}{2}\rho v_{top}^2 = 0$$

$$-\rho g h + \tfrac{1}{2}\rho v_b^2 = 0$$

$$v_b = \sqrt{2gh} = 6.64 \text{ m/s}$$

$$Q = \frac{1.00 \text{ gal}}{15 \text{ sec}} \cdot \frac{.003785 \text{ m}^3}{1 \text{ gal}} = 2.52 \times 10^{-4}$$

$$A = \frac{Q}{v} = 3.8 \times 10^{-5} = \frac{\pi}{4} d^2$$

$$d = 6.96 \times 10^{-3} \text{ m}$$

$$= \boxed{6.96 \text{ mm}}$$