Phys 10154 - Fall 2006 - Exam #9A

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 7.50-kg wooden block (density = 742 kg/m^3) is released from the bottom of a 12.0-meter deep water tank that is open to the atmosphere. The block has a cross-sectional area of 543 cm^2.

What is the upward-pushing force that the water exerts on the bottom of the block when the bottom of the block is at a depth of 12.0 meters? Answer with 6 SF.

What is the downward-pushing force that the water exerts on the top of the block when the bottom of the block is at a depth of 12.0 meters (you need to calculate the height of the block)? Answer with 6 SF.

How many seconds after the block is released does it break through the surface of the tank? For simplicity, just assume the distance traveled is 12.0 meters. Answer with 3 SF.

$V_0 = \frac{m}{\rho} = \frac{7.50}{742} = .0101\ m^3$

$V_0 = hA \quad h = \frac{V_0}{A} = \frac{.0101}{543 \times 10^{-4}} = 0,186\ m$

$P_{bot} = 1.013 \times 10^5 + (1000)(9.8)(12)$

$= 218,900\ Pa$

$F_{bot} = P_{bot} A = (218,900)(.0543) = \boxed{11886.3\ N}$

$P_{top} = 1.013 \times 10^5 + (1000)(9.8)(11.814)$

$= 217,077.2\ Pa$

$F_{top} = P_{top} A = (217,077.2)(.0543) = \boxed{11787.3\ N}$

$F_B = F_{bot} - F_{top} = 99N$ check $F_B = (1000)(.0101)(9.8) = 99N$

$\Sigma F = mg - F_B = ma$

$\frac{(7.50)(9.8) - 99}{7.50} = a = 3.4\ m/s^2, up$

$12 = 0 + \frac{1}{2}(3.4)t^2$

$t = \sqrt{\frac{12}{1.7}} = \boxed{2.66\ s}$

#2. A large tank is open to the air and springs a leak 1.50 meters below the surface. Water flows at a rate that fills up a 1.00 gallon jug in 25.0 seconds. What is the diameter of the hole, in millimeters?

Conversion factors are on your formula sheets.

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

$$\Delta P = 0$$

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

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

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

$$v_{bot} = \sqrt{2gh} = 5.42 \text{ m/s}$$

$$Q = \frac{1.00 \text{ gal}}{25 \text{ s}} \cdot \frac{.003785 \text{ m}^3}{1 \text{ gal}} = 1.514 \times 10^{-4} \text{ m}^3/\text{s}$$

$$A = \frac{Q}{v} = \frac{1.514 \times 10^{-4}}{5.42}$$

$$= 2.79 \times 10^{-5} = \frac{\pi}{4} d^2$$

$$d = 5.96 \times 10^{-3} \text{ m}$$

$$= \boxed{5.96 \text{ mm}}$$