Physics 10154 - Exam #9B

Answer the following two questions. Be sure to clearly indicate your answer with a circle or box. Show all work. If I cannot see how you arrived at an answer, I will deduct points!

1. A block of unknown material weighs 550 Newtons in air and 370 Newtons when immersed in a liquid solution (density of the fluid is 870 kg/m3).

What is the volume of the block and the density of the block?

$$\rho_o V_o g = 550$$

$$550 - \rho_f V_o g = 370$$

$$\rho_f V_o g = 180$$

$$V_o = \frac{180}{(870)(9.8)} = \boxed{.021\ m^3}$$

$$\rho_o = \frac{550}{(.021)(9.8)} = \boxed{2700\ kg/m^3}$$

2. An oil tanker runs into a bridge and develops a small hole in its side. Oil in the tanker has a density of 1150 kg/m3 and a depth of 7.0 meters. Every minute, 12 gallons of oil flow from the hole.

You may assume that the external pressure on the oil is 1.0 atm everywhere, and you may assume that the container diameter is very large compared to the diameter of the hole.

Determine the speed with which the oil leaves the hole, and also determine the diameter of the hole.

$$(P_t - P_b) + \rho g(y_t - y_b) + \frac{1}{2}\rho(v_t^2 - v_b^2) = 0$$

$$0 + \rho g(7.0) + 0 - \frac{1}{2}\rho v_b^2 = 0$$

$$v_b = \sqrt{2gh} = 11.7 \text{ m/s}$$

$$A_v = 12 \frac{\text{gal}}{\text{min}} \cdot \frac{1 \text{ min}}{60 \text{ s}} \cdot \frac{3.786 \times 10^{-3} \text{ m}^3}{1 \text{ gal}}$$

$$= 7.57 \times 10^{-4} \text{ m}^3/\text{s} = A v$$

$$A = \frac{7.57 \times 10^{-4}}{11.7} = 6.47 \times 10^{-5} \text{ m}^2$$

$$\frac{\pi d^2}{4} = 6.47 \times 10^{-5}$$

$$d = \boxed{9.1 \times 10^{-3} \text{ m}} \text{ or } 9.1 \text{ mm}$$