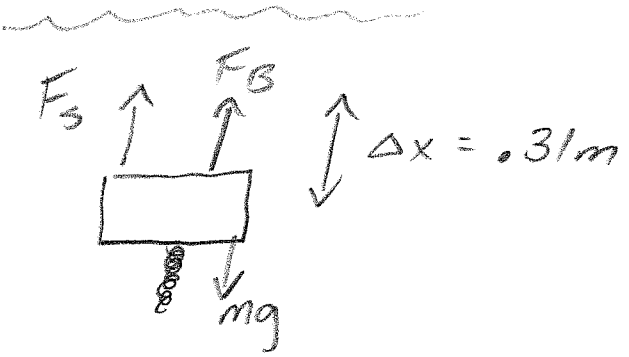
Physics 10154 - Exam #9C

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 12-kg metallic block is placed on a spring (k = 350 N/m), and the whole system is immersed in water. The spring is compressed by 31 cm by the block.

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



$$\rho_b V_b = 12\ kg$$

$$\Sigma F_y = k\Delta x + \rho_f V_b g - 12(9.8) = 0$$

$$(350)(.31) + (1000)V_b(9.8) - 12(9.8) = 0$$

$$9800 V_b = 117.6 - 108.5$$

$$V_b = \frac{9.1}{9800} = \boxed{9.3 \times 10^{-4}\ m^3}$$

$$\rho_b = \frac{12}{9.3 \times 10^{-4}} = \boxed{13000\ kg/m^3}$$

2. A syringe of length 15 cm is held vertically, and a force of 1.2 Newtons is applied to the barrel (the bottom of the syringe), which has a cross-sectional area of 0.30 cm^2. Determine the speed at which water will emerge from the tip of the syringe.

You may assume the external pressure of the atmosphere is the same at the top and bottom of the syringe, but do not neglect the force being applied at the bottom. You may also assume that the cross-sectional area of the tip of the needle is very small compared to the barrel.

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

$P_t = 1\,atm$

$P_b = 1\,atm + 1.2/.30\times10^{-4}$

$P_t - P_b = -40000$

$$-40000 + \rho g(.15) + \tfrac{1}{2}\rho v_t^2 = 0$$

$$\tfrac{1}{2}\rho v_t^2 = 40000 - \rho g(.15)$$

$$\tfrac{1}{2}(1000)v_t^2 = 40000 - (1000)(9.8)(.15)$$

$$v_t^2 = \frac{38530}{500} \Rightarrow \boxed{v_t = 8.8\ m/s}$$