Physics 260 Homework Assignment 1

Chapter 14

1 PSE6 14.P.008

Since the pressure is the same on both sides, we have

$$P = \frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$F_2 = \frac{F_1 A_2}{A_1}$$

2 PSE6 14.P.020

Let h be the height of the water column added to the right side of the U-tube. Consider two points on the tube. One is the mercury-water interface on the left tube, call it point A. The point on the right column at the same height call it B. By Pascal's Principle, the absolute pressure at these two points are the same. We have

$$P_A = P_B$$

$$P_0 + \rho_{H_2O} g(h_1 + h + h_2) = P_0 + \rho_{H_2O} gh + \rho_{Hg} gh_2$$

Cancel out P_0 and $\rho_{H_2O} gh$ from both sides of the equation. So

$$h_1 = (\frac{\rho_{Hg}}{\rho_{H_2O}} - 1)h_2$$

3 PSE6 14.P.025

a. before the metal is immersed in the water, the forces acting on it are upward tension T_1 and downward gravitational force Mg. Since the metal is in equilibrium, these two forces should cancel each other. Therefore, $T_1 = Mg$.

b. after the metal is immersed in the water, the downward force acting on it is still the gravitational force Mg. The upward forces include buoyant force **B** due to water and tension T_2 provided by the string. Again, the metal is in equilibrium in the water. So the upward force should equal to the downward force in magnitude.

$$\mathbf{B} + T_2 = Mg$$

Also, $\mathbf{B} = \rho_{water} g V_{Al}$. We can find the volume of metal V_{Al} by dividing the mass of metal by the density of the metal. Plug both equations into the equilibrium equation, T_2 can then be determined.

4 PSE6 14.P.046

a. For upward flight of a water-drop projectile from geyser vent to fountain-top, we have

$$v_{yf}^2 = v_{yi}^2 + 2a_y \triangle y$$

Since the velocity of the water drop at the top of the flight is 0m/s, the initial speed can be calculated as follows,

$$v_{yi} = \sqrt{2a_y \triangle y}$$

b. Between geyser vent and fountain-top

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

Air is very low in density so we can assume that $P_1 = P_2 = 1$atm. Also, $y_1 = 0$m at the ground level, and $v_2 = 0$m/s at the fountain-top. Hence the initial speed is $v_1 = \sqrt{2gy_2}$, which gives the same result as in part (a).

c. Apply Bernoulli's equation between the chamber and the fountain-top:

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

What we are looking for here is $P_1 - P_2$. We know that both velocities equal zero. Therefore,

$$P_1 - P_2 = \rho g(y_2 - y_1)$$

Remember y_1 is negative if we say $y = 0$m at the ground level.

5 PSE6 14.P.047

Using Bernoulli's equation with $y_1 = y_2 = 0$, we have

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

From the equation of continuity for fluids, $A_1 v_1 = A_2 v_2 =$ flow rate. Express v_1 in terms of v_2 and plug it into the Bernoulli's equation, get

$$v_2 = A_1 \sqrt{\frac{2(P_1 - P_2}{\rho(A_1^2 - A_2^2)}}$$

So the flow rate is $A_2 v_2$.