Answer on Question #51584, Physics, Mechanics | Kinematics | Dynamics

A narrow uniform glass tube 80cm long and open at both ends is half immersed in mercury. Then top of tube is closed and it is taken out of mercury. If column of mercury 22 cm long remain in tube, then the atmospheric pressure is..

1) 50. 2) 100. 3) 80. 4) 70.

Solution:

Let the cross-sectional area of the tube is S.

Once we plugged tube, in the tube remain left air $V_0 = (L / 2) S$ with pressure p_0.

After the tube was removed from mercury air volume inside the tube is changed and become $V = (L - h) S$.

Assuming an isothermal process, and the ideal gas, we have

$$pV = const$$

and

$$p = p_0 * \frac{V_0}{V} = p_0 * \frac{L/2}{(L - h)}$$

Mercury pressure column and the air pressure inside the tube must compensate for the atmospheric pressure.

$$p + \rho g h = p_0$$

$$p_0 * \frac{L/2}{(L - h)} + \rho g h = p_0$$

If $p_0 = \rho g h_0$ (ρ - the density of mercury, h_0 - the unknown quantity), we can write the equation

$$\rho g h_0 \frac{L/2}{(L - h)} + \rho g h = \rho g h_0$$

$$h_0 \frac{L/2}{(L - h)} + h = h_0$$

$$h_0 - h_0 \frac{L/2}{(L - h)} = h$$

$$h_0 \left(\frac{L - 2h}{2L - 2h}\right) = h$$

$$h_0 = \frac{2h(L - h)}{L - 2h} = \frac{2 * 22 * (80 - 22)}{80 - 44} = 70.9 \text{ cm} = 709 \text{ mmHg}$$

Answer: 4) 70 cm Hg