Q. What is the total pressure exerted by a mixture of the dry air and water vapor at high 3 km. if the temperature at the surface 10 ^{0}C. ($\rho_d = 1.4\ kg\ m^{-3}$, $\rho_v = 5 \times 10^{-3}\ kg\ m^{-3}$, $M_d = 28.97$ g, $M_w = 18.016$ g).

$$P = P_0\, e^{-\frac{z}{H}}$$

$$P_0 = P'_d + e \quad , \quad z = 3\ km = 3000\ m\ , \quad H = \frac{R^* T}{M_{air}\, g} \quad , \quad \text{T} = 10 + 273 = 283\ \text{K}$$

$$R_d = 1000\frac{R^*}{M_d} = 1000\frac{8.3145}{28.97} = 287.0\ JK^{-1}Kg^{-1}$$
$$R_v = 1000\frac{R^*}{M_w} = 1000\frac{8.3145}{18.016} = 461.51\ JK^{-1}Kg^{-1}$$

$$P'_d = \rho'_d R_d T \longrightarrow P'_d = 1.4 * 287 * 283 = 113.709 * 10^3\ Pa = 1137.09\ hPa$$
$$e = \rho'_v R_v T \longrightarrow e = 5 * 10^{-3} * 461.51 * 283 = 653.03 Pa = 6.53\ hPa$$
$$P_0 = P'_d + e \longrightarrow 1137.09 + 6.53 = 1143.62\ hPa$$

$$M_{air} = M_d + M_w \longrightarrow M_{air} = 28.97 + 18.016 = 46.986\ g = 0.047\ kg$$

$$H = \frac{R^* T}{M_{air}\, g} \longrightarrow H = \frac{8.3145 * 283}{0.047 * 9.8} = 5108.6$$

$$P = P_0\, e^{-\frac{z}{H}} \longrightarrow P = 1143.62\ e^{\left(-\frac{3000}{5108.6}\right)}$$

$$P_{at\ 3\ km} = 635.85\ hPa$$