Homework No 2 (Mass transfer)

1. Oxygen (O_2) and nitrogen (N_2) are mixed at a 1:1 mole ratio. Calculate the mass fractions of each components. The mixture is at 400 K and 1 bar. Calculate the mixture density ρ and the mixture molar concentration (in mole/m^3).

2. Liquid water is contained in a 2-cm-diameter tube and maintained at 5 cm below the opening. Water temperature is 60°C ($p_{sat@60°C} = 19.95kPa$), and the atmospheric temperature is 300K, pressure is 1 bar. How long does it take for 1 cm^3 of water to evaporate? Assume $D_{H_2O-air} = 2.6 \times 10^{-5}\ m^2/s, \rho_{\text{water}} = 1000kg/m^3$.

3. Calculate the evaporation rate constant for a 1-mm-diameter water droplet at 85°C ($p_{sat@85°C} = 57.9\ kPa$) evaporating into dry, hot air at 500K and 1 bar. Determine the droplet lifetime. Use the values given in the last question.