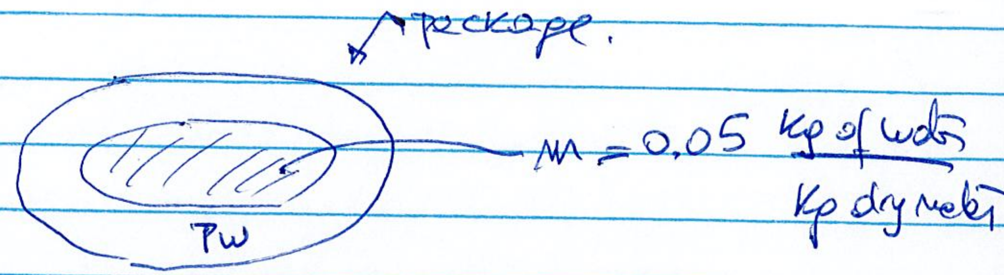
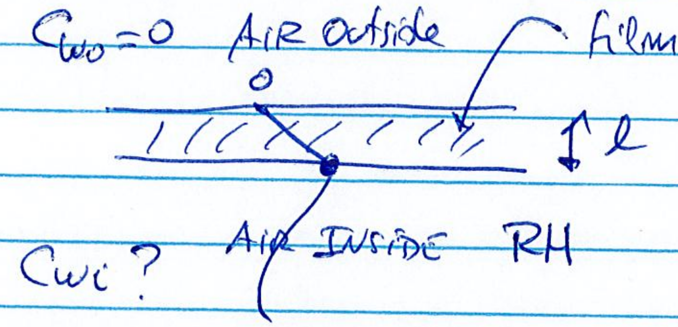
OFFICE HOURS 4-11-2018 (1)

Problem 1

Part 2



Assume.



C_{wi}

$RH = \frac{P_w}{P_w^0}$ Pressure of water vapor in the space.

P_w^0 ← vapor pressure of water at 30°C
can get from tables.

$P_w V = n_w RT = \frac{m_w}{M_w} RT$

m_w: mass of water in the air surrounding the material

M_w ← molecular weight of water

P_w: $RH \times P_w^0$

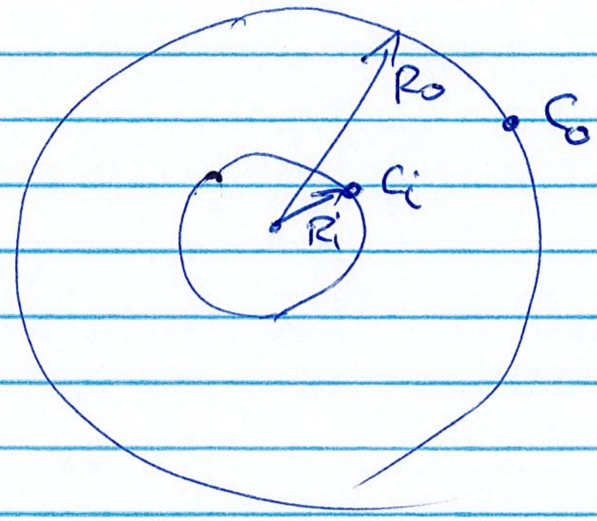
$\frac{P_w M_w}{RT} = \frac{m_w}{V} = C_{wi}$

$n_w = D_{w,p} \frac{C_{wi} - C_{wo}}{l}$

_Problem 2

part 2

$$\begin{cases} \dfrac{1}{r^2}\dfrac{d}{dr}\left(r^2 \dfrac{dC}{dr}\right) = 0 & (1) \\ C = C_i \text{ at } r = R_i & (1a) \\ C = C_o \text{ at } r = R_o & (1b) \end{cases}$$



integrating once $\quad r^2 \dfrac{dc}{dr} = C_1 \quad \Rightarrow \quad \dfrac{dc}{dr} = \dfrac{C_1}{r^2}$

integrating again $\quad C(r) = -\dfrac{C_1}{r} + C_2$

at $r = R_i$ $\quad C_i = \frac{C_1}{R_i} + C_2$ $\quad$ (2) $\quad$ (3)

at $r = R_o$ $\quad C_o = -\frac{C_1}{R_o} + C_2$ $\quad$ (3)

$$C_i - C_o = -C_1 \left[\frac{1}{R_i} - \frac{1}{R_o} \right]$$

$$C_1 = -\frac{C_i - C_o}{\left[\frac{1}{R_i} - \frac{1}{R_o} \right]}$$

from Eq. (2)

$$C_2 = C_i + \frac{C_1}{R_i} \quad (\cancel{4})$$

$$C_2 = C_i - \frac{C_i - C_o}{\left[\frac{1}{R_i} - \frac{1}{R_o} \right]}$$

$$C(r) = \left[\frac{C_i - C_o}{\frac{1}{R_i} - \frac{1}{R_o}} \right] \frac{1}{r} + C_i - \frac{C_i - C_o}{\frac{1}{R_i} - \frac{1}{R_o}}$$

$$C_A(r) = C_{iA} + \frac{C_{iA} - C_{oA}}{\frac{R_o - R_i}{R_i R_o}} \left[\frac{1}{r} - 1 \right]$$

From the Fick's Law

$$N_A = -D_{A,M} A \frac{dC_A(r)}{dr}$$

$$\frac{dC_A(r)}{dr} = -\frac{C_{iA} - C_{oA}}{\frac{R_o - R_i}{R_i R_o}} \frac{1}{r^2}$$

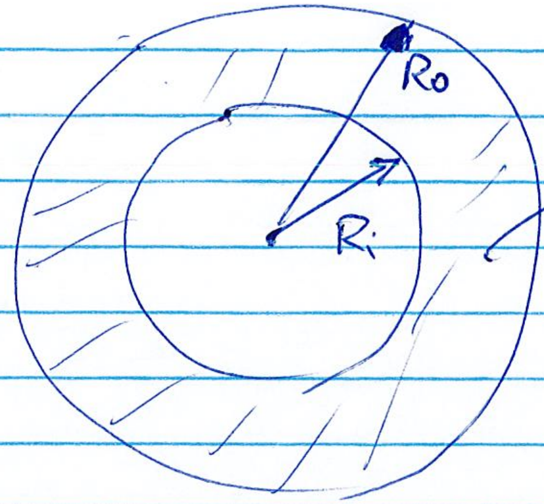
$$N_A = \cancel{-} D_{AM} 4\pi \cancel{r^2} \left[\cancel{-} \frac{C_{iA} - C_{oA}}{\frac{R_o - R_i}{R_i R_o}} \frac{1}{\cancel{r^2}} \right]$$

$$\underbrace{N_A}_{\text{"current}} = D_{AM} \frac{4\pi R_i R_o}{R_o - R_i} \underbrace{\left[C_{iA} - C_{oA} \right]}_{\text{driving force}}$$

Electrical analogy

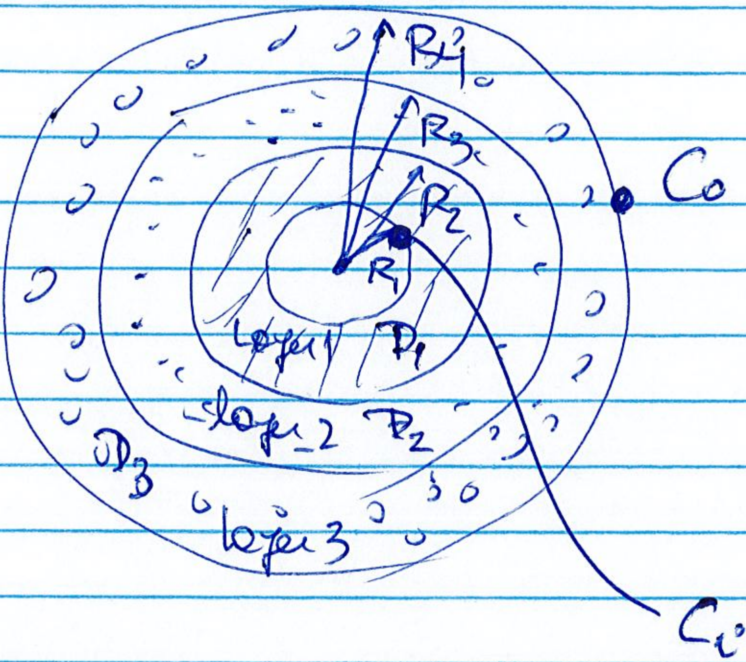
$$\underbrace{I}_{\uparrow} = \frac{V_1 - V_2}{R}$$

$$N_A = \frac{C_{iA} - C_{oA}}{\underbrace{\frac{R_o - R_i}{4\pi D_{AM} R_i R_o}}_{\text{Resistance}}}$$



$$\frac{R_o - R_i}{4\pi D_{AM} R_i R_o} =$$

= Resistance in the layer.



Electrical Analogy

$$I = \frac{V_1 - V_2}{R_1 + R_2 + R_3}$$

MASS TRANSFER

$$N_A = \frac{C_i - C_o}{R_{mass1} + R_{mass2} + R_{mass3}}$$

(6)

For 1 layer. $\text{Resistance} = \frac{R_o - R_i}{4\pi D R_i R_o}$

$$N_A = \frac{C_i - C_o}{\frac{R_2 - R_1}{4\pi D_1 R_1 R_2} + \frac{R_3 - R_2}{4\pi D_2 R_2 R_3} + \frac{R_4 - R_3}{4\pi D_3 R_3 R_4}}$$

<u>HEAT TRANSFER</u>

$Nu = \frac{hL}{K}$

Nusselt Number.

MASS TRANSFER

$Sc = \frac{h_m L}{D}$

Schdmith Number