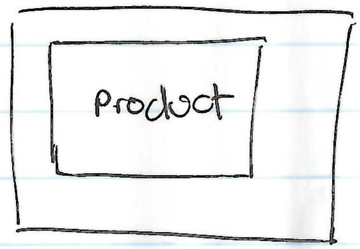
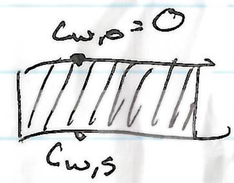
OFFICE HOURS — TUESDAY 4/10/2018

PROB. ONE

$M = 0.05$

$\longrightarrow$ Air = 0% moisture





$$N_{w,x} = D_{x,w} A \frac{C_{w,s} - C_{w,o}}{L}$$

$a_w = 0.021$

$RH = \underbrace{21\%}$

$P_{w,s}^{\circ}$ @ $30^{\circ} = 0.042\,\text{barr}$

$$RH\% \equiv \frac{P_w}{P_{w,s} @ 30^{\circ}C}$$

$$\underbrace{P_w} = \frac{RH\, P_{w,s}^{\circ}}{100} \quad [\text{barrs}]$$

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

$$\frac{m_w}{V_w} = C_w = \frac{P_w M_w}{RT}$$

$$C_w = \frac{P_w \cdot MW}{RT}$$

total surface area

$$N_{w,x} = D_{xw} A \frac{C_w S - 0}{L}$$

Cannot use MC·ρ

$\frac{\text{kg water vapor}}{\text{kg dry air}} \cdot \rho \frac{\text{dry air}}{\text{m}^3}$

$\frac{\text{dry air}}{\cancel{\text{water}}}$

$C = \frac{\text{kg}}{\text{m}^3}$ Not water vapor

$$\text{Moisture content} = \frac{\text{mass water in sample}}{\text{mass dry solids}} \neq C_w$$

$\frac{\text{kg water}}{\text{kg dry solids}} \cdot \rho \frac{\text{kg dry air}}{\text{m}^3 \text{ dry air}}$

PROB TWO:

(1)

$$N_A = \frac{C_{A1} - C_{A2}}{R} \longrightarrow R_1 = \frac{R_o - R_i}{4\pi D_{eff} R_i R_o}$$

$$\cancel{\frac{\partial C_A}{\partial t} = D\left[\frac{1}{r^2}\partial C_A\right]}$$

$$\frac{\partial \cancel{C_A}}{\cancel{\partial} t} = D\left[\frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial C_A}{\partial r}\right)\right]$$

$$0 = D\left[\frac{1}{r^2}\frac{d}{\partial r}\left(r^2\frac{\partial C_A}{\partial r}\right)\right]$$

$$r^2\frac{dC_A}{dr} = C_1$$

$$\frac{dC_A}{dr} = \frac{C_1}{r^2}$$

$$C_A(r) = -\frac{C_1}{r} + C_2$$

plug in (BC) solve for C_1, C_2

Mass profile

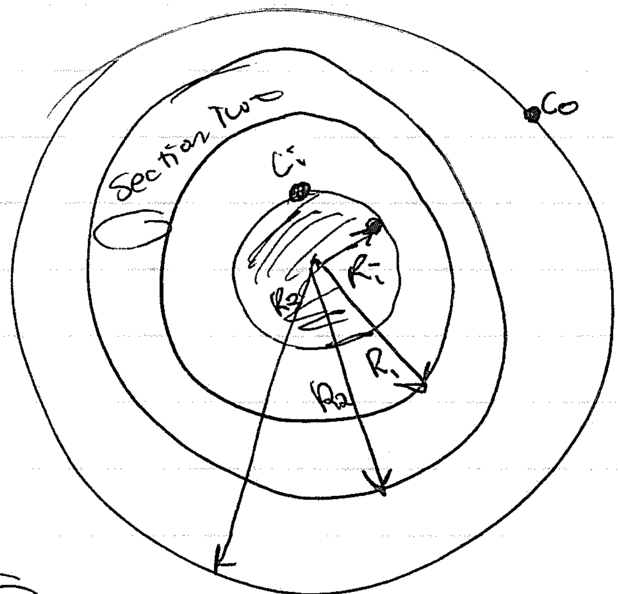
$$C_A(r) = f(r)$$

(2) Flux:

$$N_A = D_A A \frac{dC_A(r)}{dr}$$

Sphere: $A = 4\pi r^2$

Take derivative of $C_A(r) = \frac{dC_A(r)}{dr}$



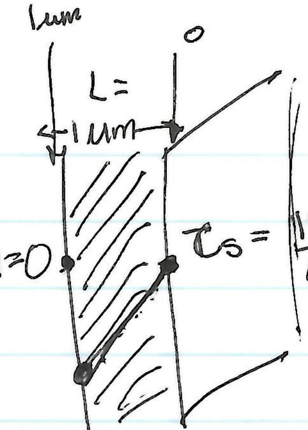
$$N_A = \frac{C_i - C_o}{R_1 + R_2 + R_3} \qquad C_o = 0$$

$$R_2 = \frac{R_2 - R_1}{4\pi D_{diff} R_1 R_2}$$

PROB THREE

Steady state

$\frac{\partial C}{\partial t} = 0$



$D = 10^{-10} \frac{cm^2}{s}$

$N_D = -D \frac{dC_D}{dx} = D \cdot \frac{(C_s - C_D)}{L}$

$N_D = \frac{Mg}{s \cdot cm^2}$

$\int \frac{d^2 C_D}{dx} = \int 0$

(a) $X = 0, \ C_s = C_D(0)$

(a) $X = L, \ C_D = C_D(L)$

$\frac{d}{dx} C_D(x) = C_1$

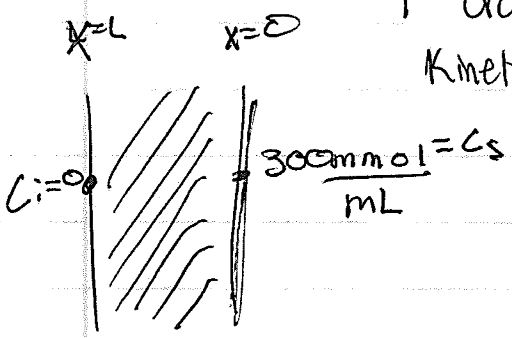
$C_D(x) = \int_0^L C_1 X + C_2$

Plug in BC and find C_1, C_2

$\int_0^L C_D(x) =$ ____________

equation

PROB FOUR

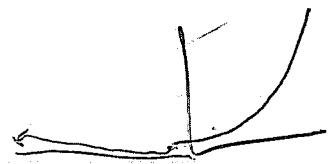


1^{st} order rxn

Kinetics: $-k''C = \frac{dC}{dt}$

$K = 1000\,\frac{1}{min} \cdot \frac{1\,min}{60s}$

$D = 2e^{-10}\,\frac{m^2}{s}$



steady state, rxn, 1-D, no convection

$300 = C = C_s$ @ $x=0$

$0 = C = C_i$ @ $x = L$

$r_A = \frac{dC}{dt} = -kC$

$$0 = D\frac{d^2C}{dx^2} \overset{(-)}{\cancel{+}} kC$$

$m^2 = \frac{k}{D}$

$m = \sqrt{\frac{k}{D}}$

$m = \sqrt{\frac{1000}{2e^{-10}}}$

$= 2.9e^{5}$

$$\frac{C(x)}{C_s} = e^{-mx} - \cancel{\frac{e^{-mL}}{e^{mL} - e^{-mL}}\left[e^{mx} - e^{-mx}\right]}$$

$$\frac{C(x)}{C_s} = e^{-mx}$$

$$\frac{C(x)}{C_s} = e^{-2.9e^{5}x}$$

C_s

$0.1 \cdot C_s$

3) $\frac{0.1C_s}{C_s} = e^{-2.9e^{5}x}$

We ~~make~~ have

4) $N_A = D\left.\frac{dC(x)}{dx}\right|_{x=0}$

$\underline{N_A} = \cancel{A}DC_s\cancel{(A)}me^{-mx}$