CHE 362 **HW #4** **Due 6/6/23**

#1 A 1 cm gas bubble containing methanol in nitrogen floats up through water at 25 °C. At one point in the column, the average mole fraction of methanol inside the bubble is 1 mole% and in the water outside of the bubble is 0.5 mole%, The pressure inside the bubble can be assumed to be 1 atm. The methanol is absorbed by the water. The Sherwood number for the gas inside the bubble is 10 and in the liquid outside the bubble is 36. The vapor pressure of methanol is 126 mm Hg at 25 °C and the activity coefficient at infinite dilution (γ_1^∞) is 1.725. (Recall that $pp_1 = x_1\ \gamma_1^\infty\ vp_1$)

a) Find the mole fraction of methanol in the liquid and gas at the interface.

b) Find the molar flux of methanol in mole/cm^2 s.

c) Find the overall mass transfer coefficients, K_x and K_y in mole/cm^2 sec.

d) Find the % resistance to mass transfer in the liquid and gas phases.

#2 Methanol is to be removed from a nitrogen gas stream by absorbing the methanol into water is a cocurrent absorber. The gas enters at 2 mol% methanol at a rate of 100 kmol/hr. Pure water is fed to the absorber. The unit is operated at 25 °C and 1 atm pressure. The mole fraction of methanol in the gas is to be reduced to 0.1%. You can use thermodynamic information from problem #1 for equilibrium calculations.

a) Create an equilibrium mole ratio (Y-X) diagram for this system.

b) Draw a diagram of this process labeling the streams with all of the known information assuming the process is a cocurrent process. Assume the water phase is the L phase and the gas phase is the V phase. Label the streams with both mole fractions and mole ratios.

c) If a co-current process were to be used, what minimum water flow rate would be required? Show your solution graphically. (Note: Please scale your X-Y diagram in Excel to get the highest resolution for your operating line.)

d) If 2 times the minimum water flow rate is used, what would be the exiting mole fraction of methanol in the water phase? Show your solution graphically.

e) If 1.4 times the minimum water flow rate is used, what would be the exiting mole fraction of methanol in the water phase? Show your solution graphically.