Homework (I)

1.What is the essential feature of separations?

2. What is the driving force for separative transport?

3.What are the basic limitations for separation?

4. Compare analytical and preparative separations.

5. Calculate the entropy change that accompanies the separation of four components from one another in an ideal solution containing one mole of each. When separated, each component occupies one-quarter of original volume. Deduce from your results whether or not the separation is thermodynamically spontaneous.

6. Sufficiently diluted, ethyl acetate has an equilibrium concentration at 20 ^{o}C in an isobutanol-rich phase that is 7.2 times higher than that in a water-rich phase. What is the value $\Delta\mu^{o}$ of for the transfer other ethyl acetate from water to isobutanol solutions?

7. Explain the intermolecular interactions: London force, Dipole-dipole interaction, Induction interaction, Hydrogen bonds, and acid-base interactions.

8. Explain the mathematical physical basis for each of the following statement. Be as specific as possible in your answers, using equations where appropriate.
(a) Acetic acid (CH_3COOH) has much a higher boiling point and melting point than ethane (CH_3CH_3). (b) “like” dissolves “like”.

9. The following data is give for a series of n-alkanes (ethane…octane) and other miscellaneous compounds:

Compound	MW (g/mol)	Density (g/mL)	Refractive Index	Boiling Points (°C)
Ethane	30.07	0.572	1.0377	-88.6
Propane	44.11	0.5853	1.2898	-42.1
Butane	58.12	0.6012	1.3326	-0.5
Pentane	72.15	0.6262	1.3575	36.1
Hexane	86.18	0.6603	1.3751	69.0
Heptane	100.21	0.6837	1.3878	98.4
Octane	114.23	0.7025	1.3974	125.7
CCl_4	153.81	1.5867	1.4601	76.8
Br2	159.81	3.1190	1.6610	58.8
CS2	76.14	1.2632	1.6319	46.2
H20	18.02	1.0000	1.3330	100.0
Methanol	32.04	0.7914	1.3288	65.0
Benzene	78.12	0.8765	1.5011	80.1

(a) Using this data, calculate the value of V_i and $(\alpha_i)_v$ for each compound. which of these compounds are the most polarizable? The least polarizable?
(b) Make a polt of V_i vs. carbon number (n) for the n-alkanes. What is the response Obtained?
(c) Calculate the value of E_L/C_L for each compound.

(d) Make a plot of boiling point vs. E_L/C_L for the n-alkanes. What is the response obtained?

(e) For the other compounds listed in the table, use the plot made in "d" to estimate The value of their boiling pints. How do these estimates compare with the true boiling Point values? Which compounds show good agreement and with show poor agreement? How do you explain these differences?

10. Rank the following solvents in terms of their solubility for dimethyl sulfoxides (δ = 12.0 $(cal/cm^3)^{1/2}$): Water, Methanol, Cyclohexane, Carbon tetrachlotide. Use calculations to prove your answers.

11. What is the maximum solubility of trichloromethane (δ = 9.3) in water and benzene at 25 ^{0}C? How do those results compare? Explain the results obtained.

12. Iodine has a solubility of 1.32 X 10-3 M in water and 0.115 M in carbon tetrachloride. Estimate the value of the distribution constant when iodine is placed in a mixture of these two solvents. How does this value compare to the true distribution constant of 82.6?

13. A solute with a value of δ = 14.3 is to be extracted from water with carbon tetrachloride. The extraction is t be performed at 25 ^{0}C. The molecular weight and density of the compound are 165 g.mol and 1.25 g/ml, respectively. Calculate the distribution coefficient for this compounds.

14. Put a nanotube with uniform pore of square cross section (length of the tube =20*μm,* side length of the pore=80 nm) in a solution containing 1nM of polystyrene latex pheres (diameter=20 nm). Assuming no interactions between the spheres and the nanotube, calculate the amount of polystyrene latex spheres inside the nanotube. If decrease the diameter of the polystyrene latex spheres, what is the results?

15. For thin rods of length l, it can be shown that L = l/2. Estimate K for fibrinogen, which can be approximated as a thin rod of length 70 nm, partitioning into a porous solid with s= 0.12/nm. What does K change to if all pore dimensions are exactly doubled in size? Assume the applicability of the random-plane of pore space.