CHMY 361 **HANDOUT#7**

Oct. 29, 2017 **HOMEWORK #5**

<u>Homework #5:</u> **Due Fri., Nov. 3**

1. For a hypothetical molecule in gas phase with **molar mass = 70.0 g/mol,** and **collision diameter *d* = 5.50 Å** at a temperature of 300 K:

(a) calculate the root mean square molecular speed (v_{rms}). C

(b) calculate the number of molecules per m^3 at 1 bar pressure.

(c) calculate σ, the collision cross section = πd^2 in m^2.

(d) estimate the number of collisions ***per molecule*** by multiplying the together the 3 numbers found in a-c. Compare with the "rule of thumb" number of 10^{10} collisions per second per molecule, which comes from N_2 gas, and explain any ***major*** difference you find.

(e) Find the 3-dimensional root mean displacement in cm after **1000** seconds using Eqn. 8.6.

(f) Using equation **8.12b** (page 271), determine the 3D diffusion coefficient, D, in $cm^2 s^{-1}$ **and** in $m^2 s^{-1}$.

2. (a) Calculate the sedimentation coefficient in seconds, and in Svedbergs for a small piece of dust that fell off a ceiling in a quiet room and was observed to fall at a steady speed of 1 millimeter per second.

(b) Assuming a mass of 1×10^{-6} g, what is the frictional coefficient of the piece of dust in (a)? Assume the altitude is sea level.

3. Suppose a virus particle with a molecular weight of 3×10^8 g/mol was moving in an ultra centrifuge at an acceleration of 2.0×10^5 times that of earth's gravity (200,000 g's) at a speed of 0.50 cm/hr, and its partial specific volume is 0.77 $cm^3 g^{-1}$ at 20 ^oC.

(a) what is the diffusion coefficient?

(b) what is the frictional coefficient?

4. If for a certain protein molecule, $s^0_{20,w}$ = 20.0 S , $D^0_{20,w}$ =5.0×10^{-10} $m^2 s^{-1}$, and the partial specific volume is 0.765 ml/g, calculate the molecular weight in **g/mol**. (assuming the density of water is, 1.000 g/ml)

5. What are the ratios of sedimentation coefficients, s_A/s_B , diffusion coefficients, D_A/D_B , and electrophoretic mobilities, μ_A/μ_B for proteins A and B if:
the $\mathbf{f_A=3f_B}$, $\mathbf{q_A = 0.25q_B}$, and $\mathbf{m_A=0.5m_B}$.

6. (a) Fill in the following table for a peptide with 1 histidine, 1 aspartic acid, 1 glutamic acid, 1 lysine, and one arginine when the **pH = 6**. Calculate the charges to **2 significant figures**.

(b) Toward which electrode will the peptide move at **pH 6**, positive, negative, or not possible to be sure with 2 significant figures?

Amino acid	pK_a	Charge when protonated	Charge at pH 6
Histidine	6	____	____
Aspartic acid	4	____	____
Aspartic acid	4	____	____
Arginine	11	____	____
Lysine	10	____	____
Amino at N-terminus	10	____	____
Carboxylic acid at C-terminus	3	____	____

Total Charge =_______

7. A certain protein consists of 2 chains held together by non-covalent interactions. Chain **A contains 100 a**mino acids whose charged side chains are predominately **lysine and arginine.** Chain **B contains 200** amino acids whose charged side chains are predominately **aspartic acid and glutamic acid**.

(a) In an SDS PAGE gel electrophoresis, what will be the ratio of forces on the two chains:
(force on A)/(force on B) ?

(b) Which chain (A or B) will have the larger frictional coefficient?

(c) Draw a rough picture of the 2D gel electrophoresis pattern expected for this protein, in which the pH gradient in the 1^{st} stage decreases from 11 to 2 going from left to right, with the positive electrode on the right, and in the 2^{nd} stage, the positive electrode is at the bottom of the gel.

Reading Guide for Chapters 5 and 8

Chap. 5 pp 155-56: skip derivations but **know Eqn 5.17** and **understand Fig. 5.3** qualitatively;
Chap. 8 pp 264-276: **Know Eqns. 8.6, 8.8, 8.9, 8.12a,b, 8.21, 8.22**
Sedimentation: pp 278-285: Know how to use **eqns. 8.31, 8.32, 8.34, 8.42**
Viscosity: skim pp 285-286.
Electrophoresis: pp 286-295: **know Eqn. 8.50**