CHMY 361 **HANDOUT#7**

Oct. 30, 2018 **HOMEWORK #5**

<u>Homework #5:</u> **Due Mon., Nov. 5 (updated Tue Oct30 10:30 am)**

1. For a gas of Buckminster Fullerene molecules, C_{60} (shown above), with **molar mass = 720.66 g/mol,** and **collision diameter *d* = 8 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 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 under these conditions, 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^2s^{-1} **and** in m^2s^{-1}.

2. (a) Calculate the sedimentation coefficient in seconds, and in Svedbergs for a small rock that was observed to fall at a steady speed of 20 meters per second in earth's gravity at sea level.

(b) Assuming a mass of 5 g, what is the frictional coefficient of the rock in (a)? Include correct units.

3. Suppose a virus particle with a molecular weight of 2×10^9 g/mol moves under an acceleration of 1.5×10^5 times that of earth's gravity (150,000 g's) in an ultracentrifuge at a speed of 0.30 cm/hr, and its partial specific volume is 0.80 cm^3g^{-1} at 20 °C.

(a) what is it's diffusion coefficient?

(b) what is it's frictional coefficient?

4. If for a certain protein molecule, $s^0_{20,w}$ = 30.0 S , $D^0_{20,w}$ =9.0×10^{-10} m^2s^{-1}, and the partial specific volume is 0.67 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: $\mathbf{f_A=3f_B}$, $\mathbf{q_A = 2.5\ q_B}$, and $\mathbf{m_A=3\ m_B}$. (f =frictional coefficient, q = charge, and m = mass)

6. (a) Fill in the following table for a peptide with 1 histidine, 1 aspartic acid, 1 glutamic acid, 1 tyrosine, l lysine, and one arginine when the **pH = 4**. Calculate the charges to **2 significant figures**.

(b) Toward which electrode will the peptide move at **pH 4**, positive, negative, or not possible to be sure with 2 significant figures?

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

Total Charge =_____

7. Consider 2 proteins. **Protein 1 contains 200** amino acids and **Protein 2 contains 50** amino acids. The charged side chains of the two proteins have only lysine and glutamate, and both proteins have the same isoelectric point = 7.0.

(a) In an SDS PAGE gel electrophoresis, what will be the ratio of forces on the two proteins: **(force on 1)/(force on 2) ?**

(b) Which protein (1 or 2) will have the larger frictional coefficient?

(c) Protein 1 is known to contain more lysine than protein 2. What does this say about the amino acid content of protein 2?

Reading Guide for Chapters 5 and 8

Chap. 5 pp 155-56: skip derivations but **know how to find the Eqn. 5.17 result simply from knowing that the average translational kinetic energy =** (3/2)RT and **understand Fig. 5.3** qualitatively;

Chap. 8 pp 264-276: **Know Eqns. 8.6, 8.8, 8.9, 8.12a,b** (the 1 and 3 dimensional diffusion coefficients), **8.21, 8.22**

Sedimentation: pp 278-285: Know how to obtain **eqns. 8.31, 8.32, 8.34, 8.42** from:
terminal speed = force/frictional coefficient.

Viscosity: skim pp 285-286.

Electrophoresis: pp 286-295: **know how to obtain Eqn. 8.50 from** terminal speed = force/frictional coefficient.