MSE 151 | Spring 2018 | HW 2 | Due: March 5, 2018

(If you work in groups, please be sure to include the name(s) of your colleague(s). Each student is expected to write up and submit their own original work.)

1. Calculate the root mean square end-to-end distance for polystyrene with DP=300 for the freely jointed chain as well as the freely rotating chain assuming theta=70.5°. (6 points)
2. Calculate $<h^2>$ for a polymer with assuming it is (a) flexible and (b) worm-like for n=200, C_∞=9.0, and ℓ_p=6.9. (8 points)
3. For freely jointed copolymers with n_A steps of length l_A and n_B steps of length l_B, find the average end-to-end distance $<h^2>$ (large n limit) for strictly alternating, random, and diblock copolymer architectures. Are the answers the same or different ? Why ? (6 points)
4. What is the radius of gyration, and how is different from the root mean square end-to-end distance of a polymer? (4 points)
5. Explain the statistical segment length, Kuhn monomer, and Kuhn length. (6 points)
6. Consider a polymer containing N Kuhn monomers of length b in a dilute solution at a temperature where ideal chain statistics apply. Answer the following questions symbolically before substituting numerical values in part e. (10 points)
   a. What is mean square end-to-end distance $<h^2>$ of the polymer?
   b. What is fully extended length R_{max}, i.e. contour length ?
   c. What is mean square radius of gyration R_g^2 of this polymer?
   d. What is the ratio of its fully extended length to root mean square end-to-end distance $R_{max}/<h^2>^{1/2}$?
   e. Consider an example of a polymer with molar mass M = 10^4 g/mol consisting of N = 100 Kuhn monomers of length b = 10 Å. Determine $<h^2>$, R_g, R_{max}, and $R_{max}/<h^2>^{1/2}$
7. Miyaki, Einaga and Fujita reported measurements of R_g for very high molecular weight of polystyrene in benzene at 25°C (a good solvent) and cyclohexane at 34.5°C (theta condition). Find the relation between the R_g and M_w in the case of benzene and cyclohexane. How does the exponent compare with the expectations? If you extrapolate to lower M, by what degree of polymerization would excluded volume increase R_g (i) by 10% and (ii) by a factor of 2? (10 points)

M_w X10^{-6}	R_g (nm), Benzene	R_g (nm), cyclohexane
56.2±1	506 ±10	228±5
39.5±1	392±8	183±4
32.0±0.6	353±7	167±4
23.5±0.5	297±9	145±3
15.1±0.5	227±7	116±2
8.77±0.3	164±4	87.9±2

8. **Bonus**: What is the importance of knowing polymer chain conformation? How is this information used for real-life applications? (5 points)