

Homework #10
Name _____

Due date: December 8
Chemistry 331

1. The sedimentation coefficient of a certain DNA in 1 M NaCl at 20 °C was measured by boundary sedimentation at 24,630 rpm. The following data were recorded.

time (min)	distance (cm)
16	6.2687
32	6.3507
48	6.4380
64	6.5174
80	6.6047
96	6.6814

- A. Calculate the sedimentation coefficient, s .

- B. The partial specific volume of the sodium salt of DNA is $0.556 \text{ cm}^3/\text{g}$. The viscosity and density of 1 M sodium chloride are 1.104 cP and $1.04 \text{ g}/\text{cm}^3$, respectively. The viscosity of water at 20 °C is 1.005 cP. Calculate $s_{20,w}$ for the DNA.

2. The kinetics of double-stranded formation for a dodecamer containing two G.T base pairs was measured by temperature-jump kinetics. The reaction is:



The following data were obtained:

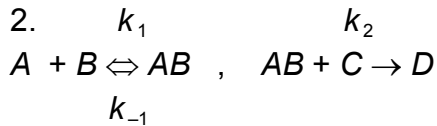
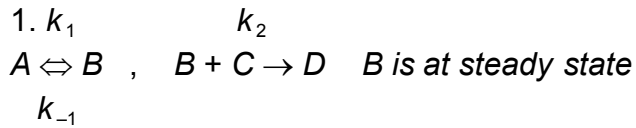
T °C	k_1 ($10^5 \text{ M}^{-1} \text{ s}^{-1}$)	k_{-1} (s^{-1})
31.8	0.8	1.00
36.8	2.3	3.20
41.8	3.5	15.4
46.7	6.0	87.0

- A. Determine E_a , ΔH^\ddagger and ΔS^\ddagger for the forward and reverse processes; assume that the values of E_a , ΔH^\ddagger and ΔS^\ddagger are independent of temperature.

- B. Determine the standard enthalpy, ΔH° and entropy, ΔS° changes for the reaction. You may assume that these quantities are independent of temperature. Determine the equilibrium constant for the reaction at 37 °C.

3. What is the maximum age of a sample that can be measured by ^{14}C dating if the error of measurement is 0.5%?

4. Write an expression for the appearance of D by each of the following mechanisms:



where AB is formed in a rapid pre-equilibrium step.

5. Penicillase is an enzyme secreted by bacteria to inactivate the antibiotic penicillin. The enzyme has a molar mass of 30,000 and a single active site. The catalytic rate constant is 2000 s^{-1} and the Michaelis constant is $K_M = 5 \times 10^{-5} \text{ M}$. In response to treatment with $5 \text{ }\mu\text{M}$ of penicillin, a 1 mL (milliliter) suspension of bacterial cells secretes $0.04 \text{ }\mu\text{g}$ of penicillase.

A. Assuming that the enzyme quickly equilibrates with its substrate, what fraction of the enzyme will be complexed with penicillin in the early stages of the reaction?

B. How long will it take for half of the penicillin to become inactivated?

C. What concentration of penicillin would cause the substrate to react at half its maximum velocity?