CHAPTER 10
THE RATES OF REACTIONS
CHAPTER OUTLINE

HW: Questions are below. Solutions are in separate file on the course web site.

Sect.	**Material**
1.	Basic Concepts
2.	The Initial Rate Method
3.	Use of the Integrated Rate Equation: First Order Reactions
4.	Second Order Reactions
5.	Additional Reaction Orders
6.	Generalizations
7.	The Half-Life Method
8.	Radiocarbon Dating + Geological Dating (Rocks)
9.	Temperature Dependence of the Rate Constant

Chapter 10 Homework

10.1 The rate law for a reaction is reported as: rate = k[A][B][C], with the Molar Concentrations in mol/L (M) and the time in seconds. What are the units of k?

10.2 In a study of the alcohol dehydrogenase catalysed oxidation of ethanol, the Molar concentration decreased in the first-order reaction from 220 mmol/L to 56.0 mmol/L in 1.22×10^4 s. What is the rate constant of the reaction?

10.3 In the study of a second-order gas phase reaction, it was found that the Molar concentration of a reactant fell from 220 mmol/L to 56. mmol/L in 1.22×10^4 s. What is the rate constant for the reaction?

10.4 The reaction $2\ A \rightarrow P$ has a second-order rate law with $k = 1.24 \times 10^{-3}\ M^{-1}s^{-1.}$ Calculate the time required for the concentration of A to change from 0.260 mol/L to 0.026 mol/L.

10.5 The Activation Energy for the decomposition of benzene diazonium chloride is 99.1 kJ/mol. At what temperature will the rate be 10% greater than its rate at 25 ^oC?

10.6 The Activation Energy of the first-order decomposition of dinitrogen oxide into N_2 and O is 251 kJ/mol. The half-life of the reactant is 6.5×10^6 s at 455 ^oC. What will the half-life be at 550 ^oc?

10.7 The rate law for the reaction, $A + B \rightarrow$ Products, is of the form, $r = k[A]^x[B]^y$. From the initial rate data for this reaction given below, determine the reaction orders, "x" and "y", and the rate constant, k (give units).

$[A_o]$	$[B_o]$	r_o
0.10 M	2.0 M	8.50 Ms^{-1}
0.30	2.0	2.83
0.30	3.0	7.80

10.8 The rate of a reaction, $A \rightarrow$ Products, is second order with respect to [A]; i.e. $d[A]/dt = -k[A]^2$. When the initial concentration is 0.60 M, it takes 45 seconds for the concentration to decrease to 0.30 M.

(a) Calculate the rate constant for this reaction.

(b) Calculate the concentration, [A], 70 seconds after the start of the reaction.

(c) Calculate the time it takes for [A] to decrease from 0.60 M to 0.15 M.

10.9 The natural abundance of ^{14}C in living matter is 1.1×10^{-12} mol %. Radiochemical analysis of an object obtained in an archaeological excavation revealed to the ^{14}C isotopic abundance to be 7.2×10^{-13} mol %. Calculate the age of the object ($t_{1/2}[^{14}C] = 5730$ years).

10.10 The half-life for the decay of $^{40}K(sol)$ to $^{40}Ar(g)$ is 1.25 billion years.

(b) If a rock is 3.2 billion years old, the ratio, $[^{40}Ar]/[^{40}K]$, is:

(i) 0.75 (ii) 2.85 (iii) 4.90 (iv) 7.25

(b) If the ratio, $[^{40}K]/[^{40}Ar] = 0.75$, for a rock, the age of the rock is:

(i) 0.90 by (ii) 1.50 by (iii) 2.45 by (iv) 4.50 by

10.11 The reaction, A $\rightarrow$ Products, is of order "x" with respect to [A]; i.e. $d[A]/dt = -k[A]^x$. When $[A_o] = 0.90$ M, the half-life is 150 seconds. When $[A_o] = 0.30$ M, the half-life is 260 seconds. Calculate the order of the reaction, x.

10.12 The rate constant for a first order reaction is 1.5×10^{-3} s^{-1} at 40 ^oC and 8.6×10^{-2} s^{-1} at 80 ^oC.

(a) Calculate the Arrhenius parameters, A and E_a, for this reaction.

(b) Calculate the rate constant of this reaction at 130 ^oC.

(c) Calculate the temperature at which the half-life of this reaction is 200 s.

10.13 The rate constant for a first order reaction was measured as a function of temperature, and the Arrhenius plot (ln(k) vs. 1000/T) is shown below.

Analysis of the graph shows that the Slope = 5000 K and Intercept = +19.0

Note: Determination of the slope and intercept is given in the solution. However, you will not be asked to perform the graphical analysis on a test.

Determine the Activation Energy, E_a, and Pre-Exponential Factor, A, for this reaction.