Chapter 14 marks the beginning of the end of this class. It is the beginning chapter of a series of chapters that will compose the majority of free response questions on the AP Chemistry test. It is important that you master both the quantitative and qualitative information covered. The list below cover the main ideas covered in this chapter and will greatly help you prepare for my exam as well as the AP exam. This list does NOT cover all the information that may be valuable to you, it simply covers the most important topics presented in chapter 14. The answers to the practice problems can be found online.

Big Ideas-

Know what a rate law is and how to determine the rate law from experimental data.

Given the mechanism of a reaction write the balanced chemical reaction, identify intermediates and molecularity of each step, determine the rate law, and rate determining step.

Given initial conditions determine the concentration at a given time, or use concentrations to determine the change in time.

Calculate the rate constant given required information.

Determine the order of reaction by interpreting graphs

Given a chemical equation determine the rate of appearance and disappearance of reactants and products.

Be able to explain the factors that affect reaction rates given an example.

Solve problems using the differential and integrated rate laws for first and second order reactions.

Sample problems-

$$2\ NO(g) + 2\ H_2(g) \rightarrow N_2(g) + 2\ H_2O(g)$$

1- Experiments were conducted to study the rate of the reaction represented by the equation above. Initial concentrations and rates of reaction are given in the table below.

Experiment	Initial Concentration (mol/L) [NO]	[H_2]	Initial Rate of Formation of N_2 (mol/L·min)
1	0.0060	0.0010	1.8×10^{-4}
2	0.0060	0.0020	3.6×10^{-4}
3	0.0010	0.0060	0.30×10^{-4}
4	0.0020	0.0060	1.2×10^{-4}

(a) (i) Determine the order for each of the reactants, NO and H_2, from the data given and show your reasoning.
(ii) Write the overall rate law for the reaction.

(b) Calculate the value of the rate constant, *k*, for the reaction. Include units.

(c) For experiment 2, calculate the concentration of NO remaining when exactly one-half of the original amount of H_2 had been consumed.

(d) Describe the appearance of Nitrogen gas to the disappearance of Hydrogen gas.

(e) The following sequence of elementary steps is a proposed mechanism for the reaction.

I. $NO + NO \leftrightarrow N_2O_2$
II. $N_2O_2 + H_2 \rightarrow H_2O + N_2O$
III. $N_2O + H_2 \rightarrow N_2 + H_2O$

Based on the data presented, which of the above is the rate-determining step? Explain your reasoning.

2- The reaction between NO and H_2 is believed to occur in the following three-step process.

$NO + NO \rightarrow N_2O_2$ (fast)

$N_2O_2 + H_2 \rightarrow N_2O + H_2O$ (slow)

$N_2O + H_2 \rightarrow N_2 + H_2O$ (fast)

(a) Write a balanced equation for the overall reaction.

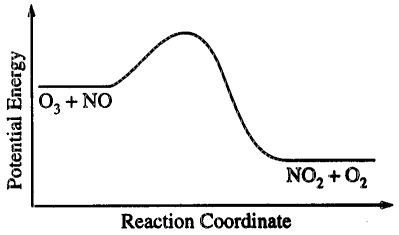
(b) Identify the intermediates in the reaction. Explain your reasoning.

(c) From the mechanism represented above, a student correctly deduces that the rate law for the reaction is rate = $k[NO]^2[H_2]$. The student then concludes that (1) the reaction is third-order and (2) the mechanism involves the simultaneous collision of two NO molecules and an H_2 molecule. Are conclusions (1) and (2) correct? Explain.

(d) Explain why an increase in temperature increases the rate constant, *k*, given the rate law in (c).

3- Answer the following questions regarding the kinetics of chemical reactions.

(a) The diagram below at right shows the energy pathway for the reaction $O_3 + NO \rightarrow NO_2 + O_2$. Clearly label the following directly on the diagram.

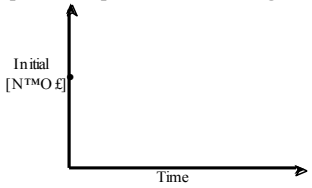


(i) The activation energy *(E_a)* for the forward reaction

(ii) The enthalpy change (ΔH) for the reaction

(b) The reaction $2\ N_2O_5 \rightarrow 4\ NO_2 + O_2$ is first order with respect to N_2O_5.

(i) Using the axes at right, complete the graph that represents the change in $[N_2O_5]$ over time as the reaction proceeds.

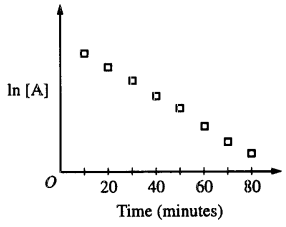


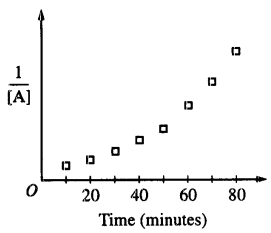
(ii) Describe how the graph in (i) could be used to find the reaction rate at a given time, *t*.

(iii) Considering the rate law and the graph in (i), describe how the value of the rate constant, *k*, could be determined.

(iv) If more N_2O_5 were added to the reaction mixture at constant temperature, what would be the effect on the rate constant, *k* ? Explain.

(c) Data for the chemical reaction $2A \rightarrow B + C$ were collected by measuring the concentration of A at 10-minute intervals for 80 minutes. The following graphs were generated from analysis of the data.





Use the information in the graphs above to answer the following.

(i) Write the rate-law expression for the reaction. Justify your answer.

(ii) Describe how to determine the value of the rate constant for the reaction.