NAME: HONORS CHEMISTRY

SECTION: Ch. 17 Review Sheet

After studying Chapter 17, you should be able to:

- Interpret and express the meaning of the rate of a chemical reaction.
- Distinguish between thermodynamic stability and kinetic stability.
- Explain how the rate of a chemical reaction is influenced by the temperature, concentration, particle size of reactants, and catalysts using collision theory.
- Distinguish among heterogeneous catalysts, homogeneous catalysts, and inhibitors.
- Interpret potential energy diagrams to find the activation energy, enthalpy change, and activation energy for a chemical reaction.
- Explain how activation energy affects reaction rate.
- Write the rate law for a reaction given the order of each reactant.
- Describe and determine reaction mechanisms for simple reactions.
- Define chemical equilibrium.
- Explain the nature of the equilibrium constant.
- Write chemical equilibrium expressions and carry out calculations involving them.
- Discuss the factors that disturb equilibrium.
- Use Lechatelier's principle to explain the effects of stresses on system equilibrium.
- Use the reaction quotient to determine how a system will proceed to achieve equilibrium.
- Discuss conditions under which reactions go to completion.

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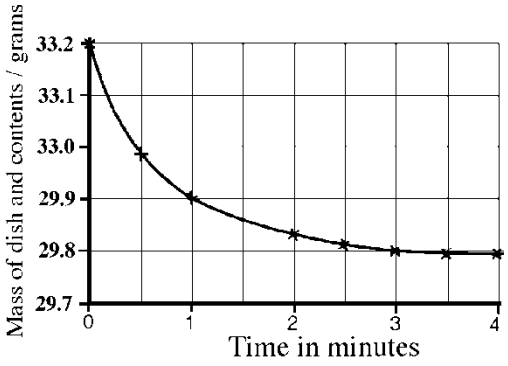
1. A large quantity of dilute nitric acid was added to a 5.0 g sample of marble powder in an evaporating dish, which was placed on the pan of a balance. A chemical reaction occurred, forming calcium nitrate, carbon dioxide, and water. The mass of the dish and its contents was recorded every half minute. The results are shown in the graph below. Using the data in the graph, calculate a) an initial rate of reaction and b) the average rate of the disappearance of gaseous products between one and three minutes. Show all your work and include relevant formulas.



2. For the following reaction, write I if the effect of the given change is an increase in reaction rate, D if the effect is a decrease in the reaction rate, and RS if the reaction rate remains the same.

   Limestone (calcium carbonate) reacts with hydrochloric acid in an irreversible reaction to form carbon dioxide and water: $CaCO_3(s) + 2\ HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$
   What is the effect if:

   ____ a. the temperature is lowered?
   ____ b. the volume of the reaction vessel is increased?
   ____ c. limestone chips are used instead of a block of limestone?
   ____ d. the pressure inside the reaction vessel is increased?
   ____ e. a more dilute solution of HCl is used?

3. Sketch a potential-energy curve for an endothermic reaction. Label the parts representing the activated complex, activation energy, and change in enthalpy. Draw a similar sketch for an exothermic reaction. Show how the diagrams would change if a catalyst were added to each.

4. The following data were collected for this reaction: $NO_2(g) + O_2(g) \rightarrow 2\ N_2O_5$

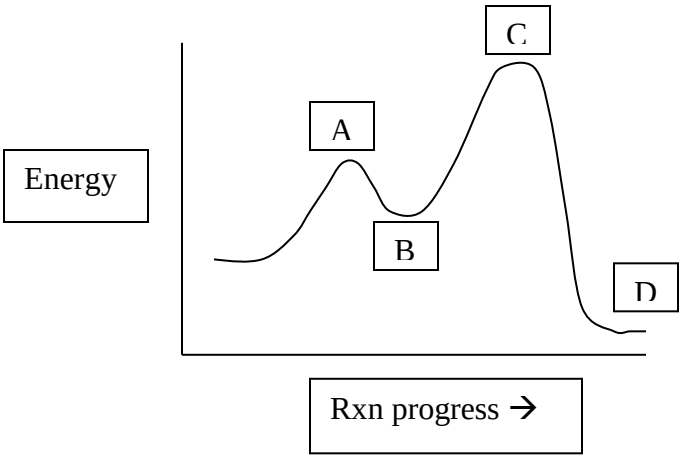
Trial	Initial $[NO_2]$	Initial $[O_2]$	Initial Rate of N_2O_5 formation, M/sec
1	0.025	0.011	3.1×10^{-4}
2	0.025	0.022	6.2×10^{-4}
3	0.050	0.011	6.2×10^{-4}

a) Write the rate law for the reaction. What is the overall order of the reaction?

b) Calculate the value of the rate constant.

c) Using your results from a and b, calculate the initial rate of formation of N_2O_5 formation if the initial concentrations of NO_2 and O_2 were each 0.030M.

5. Below is the reaction progress curve for a complex reaction. Describe the reaction represented by the curve. How many steps occur in the reaction mechanism? What is the significance of points A, B, C, and D?



6. Inspect the following reaction mechanism.

Step 1:	$Cl_2(g)$	$\rightleftharpoons$ 2 Cl(g)	(fast)
Step 2:	$Cl(g) + CHCl_3(g)$	$\rightleftharpoons$ $HCl(g) + CCl_3(g)$	(slow)
Step 3:	$Cl(g) + CCl_3(g)$	$\rightleftharpoons$ $CCl_4(g)$	(fast)

a) Write the net (overall) reaction:

b) What will be the effect on the initial reaction rate if additional $CHCl_3$ is added to the reaction vessel? Why?

c) What intermediates are formed in this reaction?

7. Explain how to write an equilibrium constant expression. Write a K_{eq} for a reaction of your choice, which should include at least one substance that is a solid or pure liquid.

8. For each of the following values for K_{eq}, determine whether the reactants or products will be favored.

a) $K_{eq} = 2.66 \times 10^{4}$

b) $K_{eq} = 3.4$

c) $K_{eq} = 5.772 \times 10^{-13}$

d) $K_{eq} = 1.00$

9. Consider the reaction: $2\ SO_3(g) \rightleftharpoons 2\ SO_2(g) + O_2(g)$
   a) Calculate K_{eq} for this reaction if the equilibrium concentrations are: $[SO_2] = 0.42$. M, $[O_2] = .21$ M, $[SO_3] = 0.072$ M
   b) Are reactants or products favored at equilibrium?

10. What is the difference between Q, the reaction quotient, and $K_{eq,}$ the equilibrium constant?

11. Consider the reaction: $COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$ which has a $K_{eq} = 170$ at 25^oC. If the concentrations of CO and Cl_2 are each 0.15 M and the concentration of $COCl_2$ is 1.1×10^{-3}M, is the reaction at equilibrium? If not, in which direction will it proceed?

12. At 25^oC, the following reaction has an equilibrium constant of 9.0×10^{-4}. Find the concentration of A(g) in moles/L, when the concentration of B(g) is 0.03 M and the concentration of C(g) is 0.06 M.

$$A(g) \rightleftharpoons B(g) + 2\ C(g)$$

13. State LeChatelier's principle.

14. Explain how the equilibrium position of this reaction is affected by the following changes:

$$4\ HCl(g) + O_2(g) \rightleftharpoons 2\ Cl_2(g) + 2\ H_2O(g)$$

a. add Cl_2
b. remove O_2
c. increase pressure
d. use a catalyst

15. Consider the equilibrium equation for the reaction:

$$4\ HCl(g) + O_2(g) + \text{heat} \rightleftharpoons 2\ Cl_2(g) + 2\ H_2O(g)$$

If the temperature of the system is increased, how will the equilibrium shift?

16. What is the molarity of a saturated solution of tin(II) hydroxide, $Sn(OH)_2$? The K_{sp} of tin (II) hydroxide is 5.45×10^{-27}.

17. The concentration of a saturated solution of silver cyanide, AgCN, is 7.73×10^{-9} M. Calculate the K_{sp} of silver cyanide.

Answers to selected problems

4. rate = $k[NO_2][O_2]$; k = 1.1 L/mol sec rate = 9.9×10^{-4} M/sec
9. Keq = 7.1
11. Q = 20; shift to the right
12. [A] = 0.1M
16. 1.11×10^{-9} M
17. 5.97×10^{-17}