CHE 107 **EXAMINATION II** **21 Oct. 1999**

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Name: _____ SID: _____ Seat No.: _____ Room: ___

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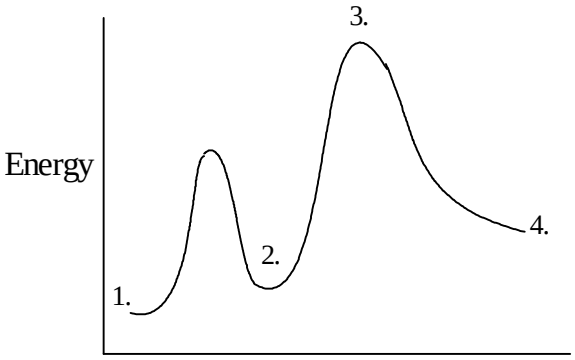
1. An increase in the temperature of the reactants causes an increase in the rate of reaction. Which of the following provides the best explanation for this phenomenon? As the temperature increases,

   A. the activation energy increases.
   B. the activation energy decreases.
   C. the collision frequency increases.
   D. the fraction of collisions with total kinetic energy > E_a increases.

2. With respect to the figure below, which choice correctly identifies all the numbered positions?



	1.	2.	3.	4.
A.	catalyst	intermediate	activated complex	product
B.	reactants	activated complex	intermediate	product
C.	reactants	activated complex	catalyst	product
D.	reactants	intermediate	activated complex	product

3. The rate law for the reaction

$$H_2O_2 + 2\,H^+ + 2\,I^- \longrightarrow I_2 + 2\,H_2O$$

is rate = $k[H_2O_2][I^-]$. The following mechanism has been suggested.

$H_2O_2 + I^- \longrightarrow HOI + OH^-$ slow

$OH^- + H^+ \longrightarrow H_2O$ fast

$HOI + H^+ + I^- \longrightarrow I_2 + H_2O$ fast

Identify all intermediates included in this mechanism.

A. H^+ and I^- B. H^+ and HOI C. HOI and OH^- D. H^+ only

4. When the concentration of reactant molecules are increased, the rate of reaction increases. Which of the following provides the best explanation for this phenomenon? As the reactant concentration increases;

A. the average kinetic energy of molecules increases.
B. the frequency of molecular collisions increases.
C. the rate constant increases.
D. the activation energy increases.

5. The rate law for the reaction

$$2\ NO_2 + O_3 \longrightarrow N_2O_5 + O_2$$

is rate = $k[NO_2][O_3]$. Which one of the following mechanisms is consistent with this rate law?

A. $NO_2 + NO_2 \longrightarrow N_2O_4$ (fast)
$N_2O_4 + O_3 \longrightarrow N_2O_5 + O_2$ (slow)

B. $NO_2 + O_3 \longrightarrow NO_5$ (fast)
$NO_5 + NO_5 \longrightarrow N_2O_5 + 5/2\ O_2$ (slow)

C. $NO_2 + O_3 \longrightarrow NO_3 + O_2$ (slow)
$NO_3 + NO_2 \longrightarrow N_2O_5$ (fast)

D. $NO_2 + NO_2 \longrightarrow N_2O_2 + O_2$ (slow)
$N_2O_2 + O_3 \longrightarrow N_2O_5$ (fast)

6. Which of the following is a true statement about chemical equilibrium in general?

A. At equilibrium, the total concentration of products equals the total concentration of reactants, that is [products] = [reactants].
B. Equilibrium is the result of the cessation of all chemical change.
C. There is only one set of equilibrium concentrations that equals the K_c value.
D. At equilibrium, the rate of the forward process is the same as the rate of the reverse process.

7. Identify the equilibrium constant expression (K_c) for the following reaction

$$H_2O(g) + C(s) \rightleftharpoons CO(g) + H_2(g)$$

A. $\dfrac{[CO][H_2]}{[C][H_2O]}$

B. $\dfrac{[CO][H_2]}{[C]}$

C. $\dfrac{[CO][H_2]}{[H_2O]}$

D. $\dfrac{[CO][H_2]^2}{[H_2O]}$

8. Consider the two gaseous equilibria

$SO_2(g) + 1/2\ O_2(g) \rightleftharpoons SO_3(g)$ K_1

$2\ SO_3(g) \rightleftharpoons 2\ SO_2(g) + O_2(g)$ K_2

The values of the equilibrium constants K_1 and K_2 are related by

A. $K_2 = (K_1)^2$ B. $K_2^2 = K^1$ C. $K_2 = (K_1)^{-2}$ D. $K_2 = (K_1)^{-1}$

9. At 25°C, $K_c = 3.5 \times 10^8$ for the reaction

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$$

What is K_c at 25°C for the reaction?

$$1/2\ N_2(g) + 3/2\ H_2(g) \rightleftharpoons NH_3(g)$$

A. 1.9×10^4 B. 1.2×10^{15} C. 3.5×10^8 D. 1.75×10^8

10. The brown gas NO_2 and the colorless gas N_2O_4 participate in the following equilibrium.

$$2\ NO_2 \rightleftharpoons N_2O_4$$

In an experiment, 0.625 mole of N_2O_4 was introduced into a 5.00 L vessel and was allowed to decompose until it reached equilibrium with NO_2. The concentration of N_2O_4 at equilibrium was 0.0750 M. calculate K_c for the reaction.

A. 7.5 B. 0.125 C. 0.0750 D. 0.10

11. Equilibrium is established for the reaction at 35°C

$2\ NOCl(g) \rightleftharpoons 2\ NO(g) + Cl_2(g)$ $K_c = 1.6 \times 10^{-5}$

What is the equilibrium concentration of $NOCl(g)$ at 35°C when the equilibrium concentrations of NO and Cl_2 are 1.0×10^{-2} M and 1.2×10^{-2} M, respectively, at 35°C?

A. 0.27 M B. 3.7 M C. 0.075 M D. 2.7 M

12. For the equilibrium

$$3\ O_2(g) \rightleftharpoons 2\ O_3(g) \quad \text{Ä}H^\circ = 284\ \text{kJ}$$

What would be the effect of increasing the pressure on the system by decreasing the volume?

A. Forward reaction will be favored.
B. Reverse reaction will be favored.
C. The equilibrium constant increases.
D. The equilibrium constant decreases.

13. For the equilibrium reaction

$$2\ SO_2(g)\ +\ O_2(g)\ \rightleftharpoons\ 2\ SO_3(g) \qquad \text{Ä}H^\circ_{r\,xn} = -198\ kJ$$

Which one of the following factors would cause the equilibrium constant value to increase?

A. Decrease the temperature.
B. Add SO_2 gas.
C. Remove O_2 gas.
D. Add a catalyst.

14. In the following reaction system at equilibrium

$$CO(g)\ +\ 3\ H_2(g)\ \rightleftharpoons\ CH_4(g)\ +\ H_2O(g)$$

The result of removing some $CH_4(g)$ from this system is

A. H_2O is consumed.
B. more CH_4 and H_2O are produced.
C. K_p decreases.
D. more CO is produced.

15. At the start of a reaction, there are 0.249 mol N_2, 3.21×10^{-2} mol H_2, and 6.42×10^{-4} mol NH_3 in a 3.50 L reaction vessel at 375°C. K_c for the reaction

$$N_2(g)\ +\ 3\ H_2(g)\ \rightleftharpoons\ 2\ NH_3(g)$$

is 1.2 at this temperature, decide if the system is at equilibrium. If it is not, predict which way the net reaction will proceed.

A. Reaction is at equilibrium.
B. Towards products.
C. Towards reactants.
D. No change.

16. The conjugate acid–base pairs in the following reaction are

$$NH_3(aq)\ +\ HF(aq)\ \rightleftharpoons\ NH_4^+(aq)\ +\ F^-(aq)$$

A. NH_3/NH_4^+ and HF/F^-
B. NH_3/HF and NH_4^+/HF^-
C. NH_3/F^- and NH_4^+/HF^-
D. NH_3/F^- and F^-/HF^-

17. If the hydronium ion concentration in vinegar is 1.6×10^{-3} M. Calculate the pH.

A. 2.80 B. 11.2 C. 5.6 D. 14

18. What is the pH of a 0.400 M ammonia solution? K_b for ammonia is 1.8×10^{-5}.

A. 12.57 B. 12.7 C. 11.43 D. 9.8

19. In which one of the following acid–base reactions does the Lewis acid appear first?

A. $6\ CN^- + Fe^{3+} \longrightarrow Fe(CN)_6^{3-}$
B. $NH_3 + BF_3 \longrightarrow H_3NBF_3$
C. $B(OH)_3 + H_2O \longrightarrow B(OH)_4^- + H^+$
D. $H_2O + HCl \longrightarrow H_3O^+ + Cl^-$

20. The following four acids, identified by numbers, have the listed K_a's. Which of these is the strongest acid?

1. 1.0×10^{-3} 2. 3.0×10^{-5} 3. 2.6×10^{-7} 4. 4.0×10^{-9}

A. 1 B. 2 C. 3 D. 4

21. When comparing acid strength of binary acids HX, as X varies within a particular group of the periodic table, which one of the following factors dominates in affecting the acid strength?

A. bond strength
B. electron withdrawing effects
C. percent ionic character of H–X bond
D. solubility

22. The pH of a $Ba(OH)_2$ solution is 10.0. What is the H^+ ion concentration?

A. 4.0×10^{-11} M B. 1.6×10^{-10} M C. 1.3×10^{-5} M D. 1.0×10^{-10} M

23. Acid strength decreases in the series: strongest HSO_4^-, HF, to HCN weakest. Which of the following is the weakest base?

A. HF B. SO_4^{2-} C. F^- D. CN^-

24. Calculate the pH of 1.6 M KOH.

A. 1.6 B. –0.20 C. 0.20 D. 14.20

25. Calculate the H^+ ion concentration in lemon juice of pH = 2.4.

A. 4.0×10^{-2} M B. 250 M C. 0.38 M D. 4.0×10^{-3} M