Name_____

Please write all answers to the short items in the space to the left of the question.
(1 through 18 are worth two points each)

_____1. A certain reaction has a rate constant of 3.5×10^{-4} atm^{-3}/s . It is most likely that the overall reaction order of this reaction is A) second B) third C) fourth D) fifth

_____2. For the second order reaction $2\ A \rightarrow A_2$, the instantaneous rate of appearance of A_2 is 0.040 M/sec when [A] is 0.20 molar. What is the rate of appearance of A_2 at the same temperature, when the concentration of A is 0.60 molar?
A) 0.12 M/sec B) 0.24 M/s C) 0.36 M/s D) 0.48 M/s

_____3. A certain reaction has an activation energy, Ea, of 8310 joules. If the natural log of the rate constant, ln k, is plotted against 1/T, what is the slope of the resulting line?
A) 1000 B) 8310 C) –8310 D) –1000

Information for questions 4 to 6.
The gas phase reaction $2\ A + 3\ B \rightarrow D + 2\ E$ is studied. It is found that when 2.00 moles of A and 2.00 moles of B are placed in a 1.00 liter container, the initial rate of formation of D is 0.0020 M/sec. The rate law is determined to be rate = $k[A]^2[B]^2$

____4. What is the value of the rate constant, k ? A) 1.25×10^{-4} B) 0.00100
C) 0.0080 D) 0.0320

____5. In the reaction above, what is the rate of disappearance of B, when [A] and [B] are both 4.00 molar? A) 0.032 M/s B) 0.096 M/s C) 0.010 M/s D) 0.024 M/s

____6. What effect would it have on the instantaneous rate of this reaction if the volume of the container was suddenly halved ? A) Rate would be 4 times greater
B) Rate would be 8 times greater C) Rate would be 16 times greater.
D) Rate would not change.

____7. What is the rate constant of a first order system that has a half life of 600. seconds?
A) 416 /s B) 866/s C) 0.00116 /s D) 0.00167

In the reaction $C(s) + CO_2(g) \rightarrow 2\ CO(g)$ ΔH^o is + 173 kJ
For each of the following questions, write "I" for "increase" "D" for "decrease" or "R" for "Remain the same."

____8. The addition of $CO_{2(g)}$ to the equilibrium system will cause the amount of carbon to...

____9. A decrease in the volume of the container will cause the amount of carbon to...

____10. The addition of C(s) to the equilibrium system will cause the amount of CO to....

____11. An increase in the temperature of the equilibrium system will cause the amount of CO to .....

Base your answers to questions 12 to 15 on the following four equilibrium systems:

A. $N_{2(g)} + 3\ H_{2(g)} \rightarrow 2\ NH_{3(g)} + 92\ kJ$

B. $H_2(g) + Br_{2(g)} \rightarrow 2\ HBr(g) + 72\ kJ$

C. $2\ SO_{3(g)} + 251\ kJ \rightarrow 2\ SO_{2(g)} + O_{2(g)}$

D. $C_3H_8(g) + 5\ O_2\ (g) \rightarrow 3\ CO_{2(g)} + 4\ H_2O(g) + 2041\ kJ$

_____12. Which of these systems is not affected by an increase in total pressure? (choose one)

_____13. In which of these reactions would an increase in temperature increase the value of the equilibrium constant? A) A, B, and D only B) C only C) all of them D) none of them

_____14. In which of these reactions would an increase in pressure increase the value of the equilibrium constant? A) A only B) B, C, and D only C) all of them D) none of them

_____15. In which of these reactions, is the quantity of product maximized at low temperature and low pressure? (choose one.)

_____16. A reaction that occurs at a constant rate is most likely to be
A) 0 order B) first order C) second order D) third order

_____17. A reaction that has a constant half life is
A) 0 order B) first order C) second order D) third order.

_____18. A reaction in which a plot of concentration of reactant against time produces a straight line is A) 0 order B) first order C) second order D) third order.

Fill in questions.

19. The reaction $2\ H_2O_{2(aq)} \rightarrow 2\ H_2O_{(l)} + O_{2(g)}$ is catalyzed by the addition of an aqueous solution of HBr. Describe the effect of the catalyst on...
(2 points each part)

A. the reaction rate. _____

B. the activation energy of the reaction _____

C. the equilibrium constant of the reaction._____

D. The heat of reaction, ΔH^o._____

Problem I. A certain reaction occurs through the following two step mechanism.

1. $NO(g) + NO(g) \rightarrow N_2O_2(g)$

2. $N_2O_2(g) + H_{2(g)} \rightarrow N_2O(g) + H_2O(g)$

A. Write the overall balanced equation for the net reaction. (2)

B. Write a rate law for each of the two elementary steps shown above. (4)

1.

2.

C. Identify any intermediate in the mechanism. (2)

D. If the observed rate law is Rate = $k[NO]^2[H_2]$, which of the two steps is the slow, rate determining step? (2)

II. In the following mechanism, the letters A through F each represent a gaseous substance.

1. $A \rightarrow B + C$ (fast)

2. $B \rightarrow D + E$ (slow)

3. $D + C \rightarrow F$ (fast)

a. Write the overall reaction. b, Write the rate law for this reaction.

(4)

III. If the decomposition of H_2O_2 were found to be first order, with a rate constant of $0.0500\ M^{-1}/s$, how long would it take for a 2.00 molar solution of H_2O_2 to decompose to a concentration of 0.500 molar? (show work) (4 pts)

IV. If the Keq for the reaction $2\ SO_{2(g)} + O_{2(g} \rightarrow 2\ SO_{3(g)}$ is 4.0×10^4 at a certain temperature, what pressure of SO_2 will maintain equilibrium in a system in which $[SO_3]$ is 4.0 atm and O_2 is 5.0 atm ? (3 pts)

V. Consider the following reaction between $HgCl_{2(aq)}$ and $C_2O_4^{2-}$

$2\ HgCl_{2(aq)} + C_2O_4^{2-}(aq) \rightarrow 2\ Cl^-(aq) + 2\ CO_{2(g)} + Hg_2Cl_{2(s)}$

The initial rate was determined for several concentrations of $HgCl_{2(aq)}$ and $C_2O_4^{2-}$, and the following rate data were obtained for the **rate of disappearance of $C_2O_4^{2-}$:**

Experiment	$[HgCl_2]$ (M)	$[C_2O_4^{2-}]$ (M)	Initial Rate (M/s)
1	0.150	0.300	$4.5x10^{-5}$
2	0.150	0.100	$5.0x10^{-6}$
3	0.450	0.100	$1.5x10^{-5}$
4	2.00	??	4.2×10^{-2}
5	0.100	0.300	??

a. Write the rate law for the reaction. (3 pts)
b. Find the value of the rate constant k. Include correct units. (3 pts)
c. Find the initial $[C_2O_4^{2-}]$ in experiment 4. (3 pts)
d. Find the initial rate in experiment 5. (3pts)

VI 0.200 mol of N_2 and 0.200 mol of H_2O are placed in a

2.0 liter vessel. The following equilibrium is established:
$2\ NO(g) + 2\ H_{2(g)} \rightarrow N_{2(g)} + 2\ H_2O\ (g)$

At equilibrium, the **concentration** of NO is 0.062 molar.
(6) a) calculate the equilibrium concentrations of $H_{2(g)}$, $N_{2(g)}$, and H_2O (g)
(3) b) Find the Kc of the reaction.

VII. At 800 K, the Keq for the reaction
$CH_{4(g)} + 2\ O_2(g) \rightarrow CO_{2(g)} + 2\ H_2O(g)$ is 4.0×10^{-6} .

If the pressures of the two reactants are each 2.00 atm before the reaction occurs, find the **equilibrium** pressures of each of the two products. (6 pts)

VIII. $H_{2(g)} + CO_{2(g)} \rightarrow H_2O_{(g)} + CO_{(g)}$

When H_2 is mixed with CO_2 at 2000 K, equilibrium is achieved according to the equation above. In one experiment, the following equilibrium concentrations were measured.

$[H_2] = 0.20$ mol/L $[CO_2] = 0.30$ mol/L $[H_2O] = [CO] = 0.55$ mol/L

a) What is the mole fraction of CO in the equilibrium mixture? (2pts)

b) Using the equilibrium concentrations given above, calculate the value of Kc , the equilibrium constant for the reaction. (2pts)

c) Determine Kp in terms of Kc for this system. (2)

d) When the system is cooled from 2000 K to a lower temperature, 30.0 percent of the CO is converted back to CO_2 . Calculate the value of Kc at this lower temperature. (3)

e) In a different experiment, 0.50 mole of H_2 is mixed with 0.50 mole of CO_2 in a 3.0 liter reaction vessel at 2000 K. Calculate the equilibrium concentration, in moles per liter, of CO at this temperature. (3)