NAME_____
S2014/CHEM1451/Exam 2/Dr. Dooley
7/19/2013

Multiple Choice: (3 Points each) Place the letter associated with the correct answer in the blank to the left of each number.

_____1. Given the following balanced equation, determine the overall rate of reaction.

$$2\ SO_2\ (g) + O_2(g) \rightarrow 2\ SO_3(g)$$

a) Rate = $-\frac{1}{2}\frac{\Delta[SO_3]}{Dt}$
b) Rate = $+\frac{1}{2}\frac{\Delta[SO_3]}{\Delta t}$
c) Rate = $-\frac{\Delta[SO_3]}{Dt}$
d) Rate = $+\frac{2\ \Delta[SO_3]}{\Delta t}$
e) It is not possible to determine without more information.

_____2. What is the overall order of the following reaction, given the rate law?

$2NO(g) + H_2(g) \rightarrow N_2(g) + 2H_2O(g)$ Rate = $k[NO]^2[H_2]$

a) 1st order
b) 2nd order
c) 3rd order
d) 4th order
e) 0th order

_____3. If the concentration at a certain time of a reactant is 6.25% of its initial value, how many half-lives has it gone through?

a) 7
b) 6
c) 3
d) 4
e) 5

_____4. The first-order decomposition of N_2O_5 at 328 K has a rate constant of 1.70×10^{-3} s^{-1}. If the initial concentration of N_2O_5 is 2.88 M, what is the concentration of N_2O_5 after 12.5 minutes?

a) 0.124 M
b) 0.805 M
c) 2.82 M
d) 0.355 M
e) 0.174 M

_____5. Which rate law for an elementary reaction is termolecular?

a) rate = $k[A][B]^2$
b) rate = k [A][B]
c) rate = k [A]
d) rate = k [A][B][C][D]
e) rate = $k[A]^2$

_____6. If the following is an accepted mechanism, predict the rate law for the overall reaction.

$2NO_2 + Cl_2 \rightarrow 2NO_2Cl$ (overall reaction)

Mechanism

$NO_2 + Cl_2 \rightarrow NO_2Cl + Cl$ slow

$NO_2 + Cl \rightarrow NO_2Cl$ fast

a) Rate = $k[NO_2][Cl_2]$
b) Rate = $k[NO_2]^2[Cl_2]$
c) Rate = $k[NO_2][Cl]$
d) Rate = $k[NO_2Cl][Cl]$
e) The rate law must be determined experimentally

_____7. In aqueous solution, hypobromite ion, BrO^-, reacts to produce bromate ion, BrO_3^- and bromide ion, Br^-, according to the following chemical equation.

$$3\ BrO^-(aq) \rightarrow BrO_3^-(aq) + 2\ Br^-(aq)$$

A plot of $1/[BrO^-]$ vs. time is linear and the slope is equal to 0.056 $M^{-1}s^{-1}$. If the initial concentration of BrO^- is 0.80 M, how long will it take one-half of the BrO^- ion to react?

a) 4.5×10^{-2} s
b) 7.1 s
c) 12 s
d) 22 s
e) 30 s

_____8. Which of the following statements is FALSE?

a) When $K >> 1$, the forward reaction is favored and essentially goes to completion.
b) When $K << 1$, the reverse reaction is favored and the forward reaction does not proceed to a great extent.
c) When $K \approx 1$, neither the forward or reverse reaction is strongly favored, and about the same amount of reactants and products exist at equilibrium.
d) $K >> 1$ implies that the reaction is very fast at producing products.
e) None of the above

_____9. The equilibrium constant is given for two of the reactions below. Determine the value of the missing equilibrium constant.

$A(g) + 2B(g) \leftrightarrow AB_2(g)$ $\quad K_c = 59$
$AB_2(g) + B(g) \leftrightarrow AB_3(g)$ $\quad K_c = ?$
$A(g) + 3B(g) \leftrightarrow AB_3(g)$ $\quad K_c = 478$

a) 3.5×10^{-5}
b) 2.8×10^{4}
c) 8.1
d) 0.12
e) 89

_____10. In which of the following reactions will $K_c = K_p$?

a) $H_2(g) + I_2(g) \leftrightarrow 2\ HI(g)$
b) $CH_4(g) + H_2O(g) \leftrightarrow CO(g) + 3\ H_2(g)$
c) $N_2O_4(g) \leftrightarrow 2NO_2(g)$
d) $CO(g) + 2\ H_2(g) \leftrightarrow CH_3OH(g)$
e) $N_2(g) + 3\ H_2(g) \leftrightarrow 2\ NH_3(g)$

_____11. The reaction below has a K_p value of 41. What is the value of K_c for this reaction at 400 K?

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

a) 2.4×10^{-2}
b) 4.4×10^{4}
c) 41
d) 2.3×10^{-5}
e) 1.9×10^{4}

_____12. Express the equilibrium constant for the following reaction.

$$2\ Na(s) + 2\ H_2O(l) \leftrightarrow 2\ NaOH(aq) + H_2(g)$$

a) $K = \dfrac{[NaOH]^2[H_2]}{[Na]^2[H_2O]^2}$

b) $K = [H_2][NaOH]^{-2}$

c) $K = \dfrac{[Na]^2[H_2O]^2}{[NaOH]^2[H_2]}$

d) $K = [H_2][NaOH]^2$

e) $K = \dfrac{[NaOH]^{1/2}[H_2]}{[Na]^{1/2}[H_2O]^{1/2}}$

_____13. Consider the following reaction and its equilibrium constant:

$$SO_2(g) + NO_2(g) \leftrightarrow SO_3(g) + NO(g) \qquad K_c = 0.33$$

A reaction mixture contains 0.39 M SO_2, 0.14 M NO_2 , 0.11 M SO_3 and 0.14 M NO. Which of the following statements is TRUE concerning this system?

a) The reaction will shift in the direction of reactants.
b) The equilibrium constant will decrease.
c) The reaction will shift in the direction of products.
d) The reaction quotient will decrease.
e) The system is at equilibrium.

_____14. The following reaction is exothermic. Which change will increase the concentration of SO_2?

$$2\ SO_2(g) + O_2(g) \leftrightarrow 2\ SO_3(g)$$

a) raising the temperature
b) adding SO_3
c) removing O_2
d) all of the above
e) none of the above

_____15. Consider the following reaction at equilibrium. What effect will increasing the volume of the reaction mixture have on the system?

$$2\ H_2S(g) + 3\ O_2(g) \rightleftharpoons 2\ H_2O(g) + 2\ SO_2(g)$$

a) The reaction will shift to the right in the direction of products.
b) No effect will be observed.
c) The reaction will shift to the left in the direction of reactants.
d) The equilibrium constant will decrease.
e) The equilibrium constant will increase.

_____16. For the above reaction, what effect will doubling the pressure by adding N_2 to of the reaction mixture have on the system?

$$2\ H_2S(g) + 3\ O_2(g) \rightleftharpoons 2\ H_2O(g) + 2\ SO_2(g)$$

a) The reaction will shift to the right in the direction of products.
b) No effect will be observed.
c) The reaction will shift to the left in the direction of reactants.
d) The equilibrium constant will decrease.
e) The equilibrium constant will increase.

Problems: Show your work for credit! For problems not requiring mathematical work, provide clear reasoning.

1. (10 Points) A reaction is found to have an activation energy of 108 kJ/mol. If the rate constant for this reaction is $4.60 \times 10^{-6}\ s^{-1}$ at 275 K, what is the rate constant at 366 K?

2. (10 Points) Consider the following reaction:

$$Xe(g) + 2\ F_2(g) \rightarrow\ XeF_4(g)$$

A reaction mixture initially contains 2.24 atm Xe and 4.27 atm F_2. If the equilibrium pressure of Xe is 0.34 atm, find the equilibrium constant (K_p) for the reaction.

3. (12 Points) Determine the **rate law and the value of k** for the following reaction using the data provided.

$$S_2O_8^{2-}(aq) + 3\ I^-(aq)\ \rightarrow\ 2\ SO_4^{2-}(g) + I_3^-(aq)$$

$[S_2O_8^{2-}]_i$ (M)	$[I^-]_i$ (M)	Initial Rate ($M^{-1}s^{-1}$)
0.30	0.42	4.54
0.44	0.42	6.65
0.44	0.21	3.33

4. (10 Points) Consider the following reaction:

$$CuS(s) + O_2(g) \leftrightarrow Cu(s) + SO_2(g)$$

A reaction mixture initially contains 2.9 M O_2. Determine the equilibrium concentration of O_2 if K_c for the reaction at this temperature is 1.5.

5. (10 Points) Consider the following reaction:

$$2\ H_2O(g) + 2\ SO_2(g) \leftrightarrow 2\ H_2S(g) + 3\ O_2(g)$$

A reaction mixture initially contains 2.8 M H_2O and 2.6 M SO_2. Determine the equilibrium concentration of H_2S if K_c for the reaction at this temperature is 1.3×10^{-6}.