Recitation Worksheet 5 - Equilibrium Part 1

Name: UGA ID:

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname).
- Your UGA myID is a combination of letters and numbers (example: mine is wpe29548). Do not use your 81x number.
- If you do not have a printer, type your answers in the then upload the worksheet template to Gradescope by Tuesday, March 9 at 11:59 p.m. Write your work on separate sheets of paper, convert to a PDF and upload to eLC.
- If you have a printer download the worksheet, convert it to a PDF and upload to Gradescope by Tuesday, March 9 at 11:59 p.m. You do not need to upload anything to eLC.
- For full credit, show your work.

1. At equilibrium

A. All chemical processes have ceased

B. The rate of the forward reaction equals that of the reverse

C. The rate constant for the forward reaction equals that of the reverse

D. Both the rate of the forward reaction equals that of the reverse and the rate constant for the forward reaction equals that of the reverse

E. None of the above

2. Which of the following statements are false regarding the following reaction, given the equilibrium constant shown?

$$A\ (g) \leftrightharpoons B\ (g) \quad K_c = 10$$

A. At equilibrium, the reaction is product favored

B. If [A] = 1.0 M and [B] = 1.0 M, then the reaction is not at equilibrium; the concentration of [B] will increase as the reaction moves toward equilibrium

C. If [A] = 0.1 M and [B] = 1.0 M, then the reaction is already at equilibrium, and the concentrations of products and reactants will not change

D. If [A] = 1.0 M and [B] = 1.0 M, then the reaction is not at equilibrium; the concentration of [A] will increase as the reaction moves toward equilibrium

3. Which one of the following will change the value of an equilibrium constant?

A. changing temperature

B. changing the volume of the reaction container

C. varying the initial concentrations of reactants

D. varying the initial concentrations of products

4. Identify the correct equilibrium expression for the following reaction.

$$6\ CO_2(g) + 6\ H_2O(l) \leftrightharpoons C_6H_{12}O_6(s) + 6\ O_2(g)$$

A. $[C_6H_{12}O_6]\ [O_2]^6 / [CO_2]^6\ [H_2O]^6$

B. $[CO_2]^6 / [O_2]^6$

C. $[O_2]^6 / [CO_2]^6$

D. $[O_2]^6 / [CO_2]^6\ [H_2O]^6$

5. The value of $K_c$ for the reaction is

$$COCl_2\ (g) \leftrightharpoons CO\ (g) + Cl_2\ (g) \qquad K_c = 2 \times 10^{-10} \text{ at } 100^\circ C.$$

What is the value of Kc for the reaction shown below?

$$CO\ (g) + Cl_2\ (g) \leftrightharpoons COCl_2\ (g)$$

A. $-2 \times 10^{-10}$

B. $5 \times 10^{9}$

C. $2 \times 10^{10}$

D. $-5 \times 10^{9}$

6. At equilibrium, the concentrations of $H_2$, $I_2$, and HI were found to be 0.15 M, 0.33 M, and 0.55 M respectively. What is the value of $K_c$ for this reaction?

$$H_2\ (g) + I_2\ (g) \leftrightharpoons 2HI\ (g)$$

7. What is the equilibrium concentration of C4H10 if the equilibrium concentrations of $C_2H_6$ and $C_2H_4$ are both 0.035 M?

$$C_4H_{10}\ (g) \leftrightharpoons C_2H_6\ (g) + C_2H_4\ (g) \qquad K_c = 0.070$$

8. Which of the statements are true, regarding the equilibrium constant K for a reaction and the reaction quotient Q:

1) If Q > K, the reaction is not at equilibrium, and will reach equilibrium by shifting some products over to reactants

2) If $K = 3.2 \times 10^{-6}$, the reaction is product favored

3) If $K = 5.2 \times 10^{4}$, the reaction is product favored

4) If Q = K, the reaction is already at equilibrium.

A. 1 and 2 only

B. 1, 2, and 4 only

C. 1, 3, and 4 only

D. 3 and 4 only

E. 2 and 4 only

9. For the reaction, determine whether the system is at equilibrium when [CO] = 0.50 M and $[CO_2]$ = 0.75 M. The system _____ at equilibrium, because _____.

$$C(s) + CO_2(g) \leftrightharpoons 2\ CO\ (g) \qquad K_c = 168$$

A. Is; the value of Q is 0.33

B. Is not; the value of Q is 0.33

C. Is; the value of Q is 0.67

D. Is not; the value of Q is 0.67

E. More information is needed to answer this question

10. Identify the equation that would give the equilibrium expression shown:

$$K_c = [H_2]^2 [O_2] / [H_2O]^2$$

A. $2\ H_2(g) + O_2(g) \leftrightharpoons H_2O(g)$

B. $H_2O(g) \leftrightharpoons H_2(g) + \frac{1}{2}\ O_2(g)$

C. $H_2O(g) \leftrightharpoons 2\ H(g) + O(g)$

D. $2\ H_2O(g) \leftrightharpoons 2\ H_2(g) + O_2(g)$

11. Consider the following reversible reaction. In a 3.00 liter container, the following amounts are found in equilibrium at 400 °C: 0.0420 mole $N_2$, 0.516 mole $H_2$ and 0.0357 mole $NH_3$. Evaluate $K_c$.

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

12. If the equilibrium constant for the reaction

$$A + 2\ B \leftrightharpoons C + \tfrac{5}{2}\ D$$

has a value of 4.0, what is the value of the equilibrium constant for the reaction at the same temperature?

$$2\ C + 5\ D \leftrightharpoons 2\ A + 4\ B$$

13. At 445 °C, $K_c$ for the following reaction is 0.020.

$$2\ HI(g) \leftrightharpoons H_2(g) + I_2(g)$$

A mixture of $H_2$, $I_2$, and HI in a vessel at 445 °C has the following concentrations: [HI] = 2.0 M, $[H_2]$ = 0.50 M and $[I_2]$ = 0.10 M. Which one of the following statements concerning the reaction quotient, $Q_c$, is TRUE for the above system?

A. $Q_c = K_c$; the system is at equilibrium.
B. $Q_c$ is less than $K_c$; more $H_2$ and $I_2$ will be produced.
C. $Q_c$ is less than $K_c$; more HI will be produced.
D. $Q_c$ is greater than $K_c$; more $H_2$ and $I_2$ will be produced.
E. $Q_c$ is greater than $K_c$; more HI will be produced.

14. For the Haber process,

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

$K_c$ = 9.60 at 300 °C. Calculate $K_p$ for this reaction at this temperature.

15. For which of the following reactions is the ratio $K_p/K_c$ largest at 300 K?

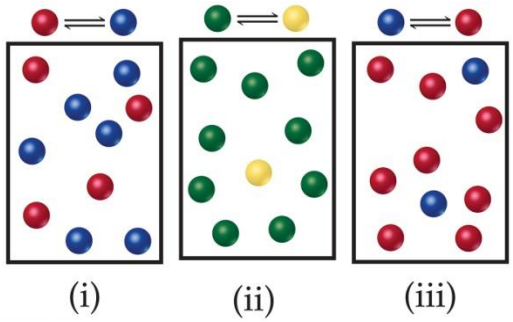
A. $N_2(g) + O_2(g) \leftrightharpoons 2\ NO(g)$

B. $CaCO_3(s) \leftrightharpoons CaO(s) + CO_2(g)$

C. $Ni(CO)_4(g) \leftrightharpoons Ni(s) + 4\ CO(g)$

D. $C(s) + 2\ H_2(g) \leftrightharpoons CH_4(g)$

16. The diagrams represent three systems at equilibrium, all in the same-size containers.



17. The equilibrium constant for the reaction

$$N_2O_4(g) \leftrightharpoons 2\ NO_2(g) \qquad K_c = 2.0 \text{ at } 2\ ^\circ C$$

If each yellow sphere represents 1 mol of $N_2O_4$ and each brown sphere 1 mol of $NO_2$ which of the following 1.0 L containers represents the equilibrium mixture at 2 °C?