Ans key

CH 117 Session 5
January 31, 2014

*Note that the Equil. Constant and numbers used in the questions for this exercise were made up.

1. Write the equilibrium expression for the following reactions:

N2 (g) + 3 H2 (g) ←→ 2 NH3 (g)

$K_c = \frac{[NH_3]^2}{[H_2]^3[N_2]}$

$CH_3COOH + H_2O$ (l) ←→ $CH_3CHOO^- + H_3O^+$

$K = \frac{[CH_3CHOO][H_3O]}{[CH_3COOH]}$

$CaCO_3$ (s) ⇌ $CaO(s) + CO_2(g)$

$K = [CO_2]$

2. For the reaction, $CO(g) + 2\ H_2$ (g) ⇌ $CH_3OH(g)$, K_{eq} is $1.45E^{-3}$. What would the K_{eq}. be for $2CO(g) + 4\ H_2$ (g) ⇌ $2CH_3OH(g)$.

$(1.45 \times 10^{-3})^2$

b. What would the K_{eq} be for $2CH_3OH(g)$ ⇌ $2CO(g) + 4\ H_2$ (g).

$\frac{1}{(1.45 \times 10^{-3})^2}$

3. For the reaction N2 (g) + 3 H2 (g) ←→ 2 NH3 (g), K_c is $4*10^5$. Find K_p at 400C.

+273
673K

b. Under what conditions would $K_p = K_c$

when moles of gas on both sides are equal

4. True or False: When Kc is greater than 1, reaction is product favored.

True

b. When Qc > Kc, the reaction will shift in which direction.

right

5. $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$. At equilibrium there contains 1.5 moles of N_2, 2 moles of H_2, and 3 moles of NH_3 in a 1.5L container. Find K_c.

$\frac{3}{1.5} = 2$

$\leftarrow \frac{[NH_3]^2}{[H_2]^3[N_2]} = \frac{[2]^2}{[1.33]^3[1]} = \frac{4}{2.35 \times 1} = 1.70$

$\frac{1.5}{1.5} = 1 \quad \frac{2}{1.5} = 1.33$

Skip 6

Unless you have a graphing calculator

6. Suppose you mix 1 M of CO and 1 M of H_2 together. What would the equilibrium concentration of all reactant and product be?

$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ K_c is $1.45E^{-2}$

1	1	0
$-x$	$-2x$	$+x$
$(1-x)$	$(1-2x)$	x
$1-.014$	$1-2(.014)$	
.987	.972	.014

Ans:

$\frac{x}{(1-x)(1-2x)(1-2x)} = 1.45 \times 10^{-2}$

$x = .0135$

7. Consider the following reaction. $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH$ $K_c = 3.01 * 10^{-4}$
If you started with 1 M of CO, 1 M of H_2, and 1 M of CH_3OH, which direction would the reaction shift? Would the conc. of H_2 be greater than 1 M?

$\frac{[CH_3OH]}{[H_2]^2[CO]} = Q = \frac{1}{[1]^2[1]} = 1$

$Q > K_c$
reaction shifts left

Yes, since you started with 1 M of H_2 and the reaction shifts left, $[H_2]$ will increase

8. Consider the reaction 2 N2 (g) + 3 H2 (g) ←→ 2 NH3. What happens to K_{eq} when the conc. of NH_3 is decreased?

Nothing, K_{eq} only changes due to temp changes

b. Which way doe the reaction shift if H_2 concentration is decreased?

left

9. Consider the reaction 2 N2 (g) + 3 H2 (g) ←→ 2 NH3 (g). How would reduce volume by half shift the reaction?

$\frac{moles}{L}$ = conc.

Reducing volume increases conc. since

$K = \frac{[1]^2}{[1]^2[1]^3}$

$K = 1$

$Q = \frac{[1/2]^2}{[1/2]^3[1/2]^2} = \frac{.5}{.125 \times .25} = 16$

$Q > K_c$

reaction shifts left

10. Consider the reaction $2HI_{(g)} \leftrightarrow H_{2(g)} + I_{2(g)}$. How would increasing the volume shift the reaction?

Reaction would not shift, equal # of moles of gases on both sides

b. True/False: K_p and K_c are equal. Explain reasoning.

Yes, $K_p = K_c(RN)^{\Delta n}$

$\Delta n = 0$, thus $(RN)^0 = 1$

which means $K_p = K_c$

11. Consider the reaction $CH_3COOH + H_2O$ (l) ←→ $CH_3CHOO^- + H_3O^+$. How would the reaction shift if H_2O was evaporated so that half the volume disappeared.

volume decreases by half increases conc by 2

$K_c = \frac{[1][1]}{[1]}$

$K_c = 1$

$Q = \frac{[2][2]}{2}$

$Q = 2$

$Q > K_c$

reaction shifts left

12. Consider the reaction H2(g) + Cl2(g) <==> 2HCl(g). ΔH= -55kj/mol. What would happen to Kc if temperature increased?

K_c will decrease since reaction is exothermic

13. Consider the reaction 2 N2 (g) + 3 H2 (g) ←→ 2 NH3 (g). Predict whether entropy increases or decreases when products are formed.

Decreases, there are more moles on reactant side

b. At higher temperature, which effect determines the position of equilibrium more, energy effect or entropy effect?

entropy