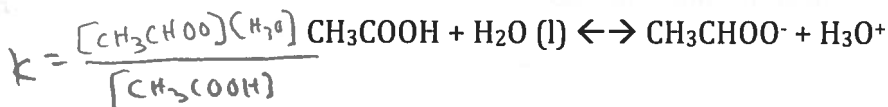
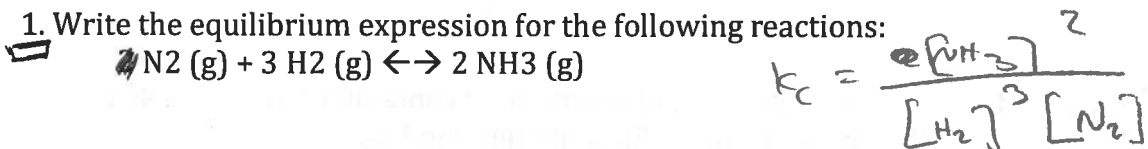


# Ans key

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:



$$K = [\text{CO}_2]$$

2. For the reaction,  $\text{CO}(\text{g}) + 2 \text{H}_2(\text{g}) \rightleftharpoons \text{CH}_3\text{OH}(\text{g})$ ,  $K_{\text{eq}}$  is  $1.45 \times 10^{-3}$ . What would the  $K_{\text{eq}}$  be for  $2\text{CO}(\text{g}) + 4 \text{H}_2(\text{g}) \rightleftharpoons 2\text{CH}_3\text{OH}(\text{g})$ .

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

b. What would the  $K_{\text{eq}}$  be for  $2\text{CH}_3\text{OH}(\text{g}) \rightleftharpoons 2\text{CO}(\text{g}) + 4 \text{H}_2(\text{g})$ .

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

3. For the reaction  $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \leftrightarrow 2 \text{NH}_3(\text{g})$ ,  $K_c$  is  $4 \times 10^5$ . 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  $K_c$  is greater than 1, reaction is product favored.

True

b. When  $Q_c > K_c$ , the reaction will shift in which direction.

right

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

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

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

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

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?



1	1	0
-x	-2x	+x
(1-x)	(1-2x)	x

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

$$x = .0135$$

1-.014	1-2(.014)	.014
.986	.972	.014

Ans:

7. Consider the following reaction.  $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH$   $K_c = 3.01 \times 10^{-4}$

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

SKIP 6

unless you have a graphing calculator

8. Consider the reaction  $2 \text{N}_2 (\text{g}) + 3 \text{H}_2 (\text{g}) \leftrightarrow 2 \text{NH}_3$ . What happens to  $K_{\text{eq}}$  when the conc. of  $\text{NH}_3$  is decreased?

Nothing,  $K_{\text{eq}}$  only changes due to temp. changes

b. Which way does the reaction shift if  $\text{H}_2$  concentration is decreased?

left

9. Consider the reaction  $2 \text{N}_2 (\text{g}) + 3 \text{H}_2 (\text{g}) \leftrightarrow 2 \text{NH}_3 (\text{g})$ . How would reduce volume by half shift the reaction?

$$K = \frac{[\text{NH}_3]^2}{[\text{N}_2]^2 [\text{H}_2]^3}$$

$K = 1$

Reducing volume increases conc. since  $\frac{\text{moles}}{L} = \text{conc.}$

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

$Q > K$   
reaction shifts left

10. Consider the reaction  $2 \text{HI} (\text{g}) \leftrightarrow \text{H}_2 (\text{g}) + \text{I}_2 (\text{g})$ . 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,  $K_p = K_c (RT)^{\Delta n}$

$\Delta n = 0$ , thus  $(RT)^0 = 1$   
which means  $K_p = K_c$

11. Consider the reaction  $\text{CH}_3\text{COOH} + \text{H}_2\text{O} (\text{l}) \leftrightarrow \text{CH}_3\text{COO}^- + \text{H}_3\text{O}^+$ . How would the reaction shift if  $\text{H}_2\text{O}$  was evaporated so that half the volume disappeared.

Volume decreases by half  
increases conc. by 2

$$K_c = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]}$$

$K_c = 1$

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

$Q = 2$

$Q > K_c$   
reaction shifts left

12. Consider the reaction  $\text{H}_2 (\text{g}) + \text{Cl}_2 (\text{g}) \rightleftharpoons 2 \text{HCl} (\text{g})$ .  $\Delta H = -55 \text{ kJ/mol}$ . What would happen to  $K_c$  if temperature increased?

$K_c$  will decrease since reaction is exothermic

13. Consider the reaction  $2 \text{N}_2 (\text{g}) + 3 \text{H}_2 (\text{g}) \leftrightarrow 2 \text{NH}_3 (\text{g})$ . 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