Chapter 13 Part 3

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Relating K to Equilibrium Quantities

- If you are given all of the equilibrium concentrations, K can be found by plugging in the equilibrium concentrations into the equilibrium expression

Determing K_c from Equilibrium Quantities

Equilibrium is established in the reaction $N_2O_4(g) \leftrightharpoons 2\ NO_2(g)$ at 25 °C. The quantities of the two gases present in a 3.00 L reaction vessel are 7.64 g N_2O_4 (92.01 g/mol) and 1.56 g NO_2 (46.01 g/mol). What is the value of K_c for this reaction?

Relative Changes in Concentration

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For every 2 moles of NH_3 that decompose, how many moles of N_2 will be formed?

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For every 2 moles of NH_3 that decompose, how many moles of H_2 will be formed?

Relative Changes in Concentration

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

If 10 moles of NH_3 are put into an evacuated flask and equilibrium is reached when the number of moles of NH_3 decreases to 6, how many moles of N_2 and H_2 are formed?

Relative Changes in Concentration

Thus, we can classify the change of the reactants and products as follows

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

Change:	$-2x$	x	$3x$

Relative Changes in Concentration

Complete the changes in concentration for each of the following reactions?

A. $C_2H_2(g) + 2\ Br_2(g) \leftrightharpoons C_2H_2Br_4(g)$

x _____ _____

B. $I_2(aq) + I^-(aq) \leftrightharpoons I_3^-(aq)$

_____ _____ x

C. $C_3H_8(g) + 5\ O_2 \leftrightharpoons 3\ CO_2(g) + 4\ H_2O(g)$

x _____ _____ _____

Relating K and Initial Quantities to Equilibrium Quantities

- If you have initial concentrations and K, equilibrium concentrations can be found by using an ICE table to relate the initial concentrations to the equilibrium concentrations.

Determining K_p and relating K_p and K_c

When a 0.0200 mol sample of SO_3 is introduced into an evacuated 1.52 L vessel at 900 K, 0.0142 mol SO_3 is found to be present at equilibrium. What is the value of K_p for the dissociation of $SO_3(g)$ at 900 K?

$$2\ SO_3(g) \leftrightharpoons 2\ SO_2(g) + O_2(g) \quad K_p = ?$$

Determining Equilibrium Partial and Total Pressure from K_p

A sample of $NH_4HS(s)$ is introduced into an evacuated flask at 25 °C. What is the partial pressure of each gas at equilibrium? What is the total gas pressure at equilibrium?

$$NH_4HS(s) \leftrightharpoons NH_3(g) + H_2S(g) \qquad K_p = 0.108 \text{ at } 25\ ^\circ C$$

ICE Tables

Consider this partially completed ICE table. Complete the table and identify the correct K expression.

A. $\dfrac{-x}{0.5+x}$

B. $\dfrac{x^2}{0.5-x}$

C. $\dfrac{(2x)^2}{0.5-x}$

D. $\dfrac{(-2x)^2}{0.5+x}$

	$Cl_2 \rightleftharpoons$	2 Cl
Initial	0.5	0
Change		
Equilibrium		

Using Q_c in an Equilibrium Calculation

The reaction below has the initial concentrations $[N_2] = 0.200$ M, $[O_2] = 0.200$ M, and $[NO] = 0.0300$ M. (A) Which direction will the reaction shift in order to establish equilibrium? (B) What are molar concentrations when equilibrium is established?

$$N_2(g) + O_2(g) \leftrightharpoons 2\,NO(g) \quad K_c = 4.7 \times 10^{-4}$$

Solution Starting Close to Equilibrium

What are the concentrations at equilibrium of a 0.15 M solution of HCN?

$$HCN(aq) \leftrightharpoons H^+(aq) + CN^-(aq) \quad K_c = 4.9 \times 10^{-10}$$

Equilibrium Concentrations from Initial Conditions

A 0.0240 mol sample of $N_2O_4(g)$ is allowed to come to equilibrium with $NO_2(g)$ in a 0.372 L flask at 25 °C. Calculate the moles of N_2O_4 present at equilibrium.

$$N_2O_4(g) \leftrightharpoons 2\ NO_2(g) \quad K_c = 4.61 \times 10^{-3} \text{ at } 25\ ^\circ C$$