

# Chapter 13 Part 3

Dr. Turner

# Relating K to Equilibrium Quantities

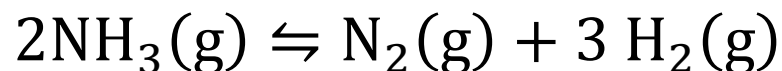
- If you are given all of the equilibrium concentrations, K can be found by plugging in the equilibrium concentrations into the equilibrium expression

# Determining $K_c$ from Equilibrium Quantities

Equilibrium is established in the reaction  $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2 \text{NO}_2(\text{g})$  at 25 °C. The quantities of the two gases present in a 3.00 L reaction vessel are 7.64 g  $\text{N}_2\text{O}_4$  (92.01 g/mol) and 1.56 g  $\text{NO}_2$  (46.01 g/mol). What is the value of  $K_c$  for this reaction?

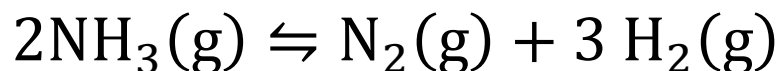
# Relative Changes in Concentration

Consider the equation



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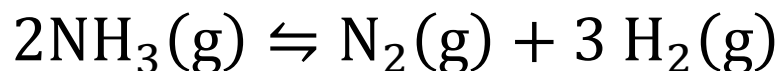
Consider the equation



For every 2 moles of  $\text{NH}_3$  that decompose, how many moles of  $\text{N}_2$  will be formed?

# Relative Changes in Concentration

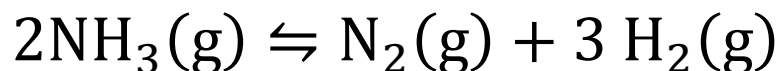
Consider the equation



For every 2 moles of  $\text{NH}_3$  that decompose, how many moles of  $\text{H}_2$  will be formed?

# Relative Changes in Concentration

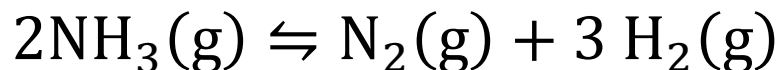
Consider the equation



If 10 moles of  $\text{NH}_3$  are put into an evacuated flask and equilibrium is reached when the number of moles of  $\text{NH}_3$  decreases to 6, how many moles of  $\text{N}_2$  and  $\text{H}_2$  are formed?

# Relative Changes in Concentration

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

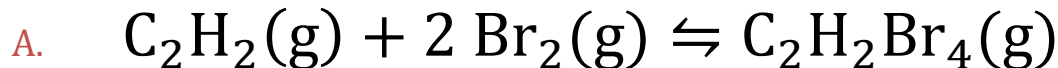


Change:	$-2x$	$x$	$3x$
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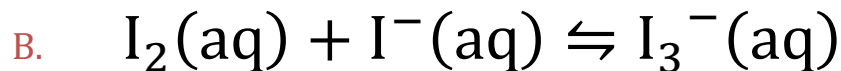


# Relative Changes in Concentration

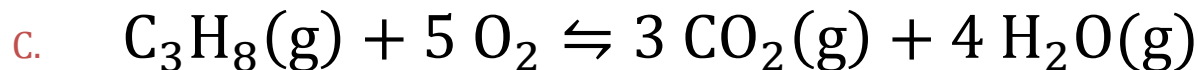
Complete the changes in concentration for each of the following reactions?



X                      \_\_\_\_\_                      \_\_\_\_\_



\_\_\_\_\_                      \_\_\_\_\_                      X



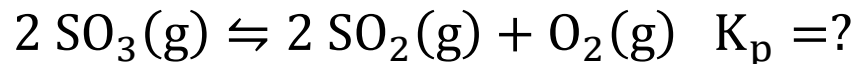
X                      \_\_\_\_\_                      \_\_\_\_\_                      \_\_\_\_\_

# 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  $\text{SO}_3$  is introduced into an evacuated 1.52 L vessel at 900 K, 0.0142 mol  $\text{SO}_3$  is found to be present at equilibrium. What is the value of  $K_p$  for the dissociation of  $\text{SO}_3(\text{g})$  at 900 K?



# Determining Equilibrium Partial and Total Pressure from $K_p$

A sample of  $\text{NH}_4\text{HS(s)}$  is introduced into an evacuated flask at  $25\text{ }^\circ\text{C}$ . What is the partial pressure of each gas at equilibrium? What is the total gas pressure at equilibrium?



# ICE Tables

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

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

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

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

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

$\text{Cl}_2 \rightleftharpoons 2 \text{Cl}$		
Initial	0.5	0
Change		
Equilibrium		

# Using $Q_c$ in an Equilibrium Calculation

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



# Solution Starting Close to Equilibrium

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



## Equilibrium Concentrations from Initial Conditions

A 0.0240 mol sample of  $\text{N}_2\text{O}_4(\text{g})$  is allowed to come to equilibrium with  $\text{NO}_2(\text{g})$  in a 0.372 L flask at 25 °C. Calculate the moles of  $\text{N}_2\text{O}_4$  present at equilibrium.

