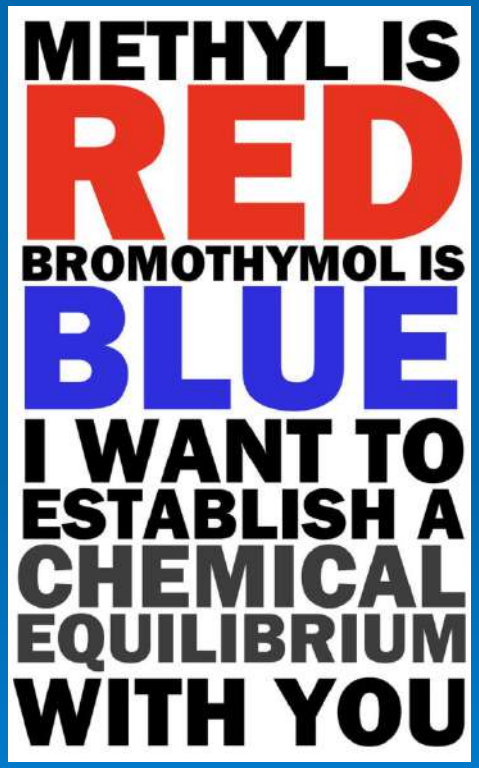
AP Chemistry
Chapter 15 Jeopardy



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Round 2 – Chapter 15

K	Q	Calculating Equilibrium Constants	Applications of K	Le Chatelier's Principle	Surprise
200	200	200	200	200	200
400	400	400	400	400	400
600	600	600	600	600	600
800	800	800	800	800	800
1000	1000	1000	1000	1000	1000

K 200

Write the equilibrium constant expression for the following reaction:

$2C_2H_{4(g)} + 2H_2O_{(g)} \leftrightarrow 2C_2H_{6(g)} + O_{2(g)}$

$$K_c = \frac{[C_2H_6]^2[O_2]}{[C_2H_4]^2[H_2O]^2}$$

K 400

Write the equilibrium constant expression for the following reaction:

$$4HCl_{(aq)} + O_{2(g)} \leftrightarrow 2H_2O_{(l)} + 2Cl_{2(g)}$$

$$K_c = \frac{[Cl_2]^2}{[HCl]^4[O_2]}$$

K 600

For the reaction represented below, the value of the equilibrium constant, K_{eq}, is 240 at 25°C. From this information, correct deductions about the reaction at 25°C include which of the following?

$$Fe^{3+}_{(aq)} + SCN^{-}_{(aq)} \leftrightarrow Fe(SCN)^{2+}_{(aq)}$$

I. The reaction is quite rapid.

II. The product is favored over the reactants at equilibrium.

III. The reaction is endothermic.

d. I only

e. II only

f. I and II only

g. II and III only

h. I, II, and III

b

K 800

A 0.10 mol sample of each of the four species in the reaction represented below is injected into a rigid, previously evacuated 1.0 L container. Which of the following species will have the highest concentration when the system reaches equilibrium?

$2\ H_2S_{(g)} + CH_{4(g)} \leftrightarrow CS_{2(g)} + 4\ H_{2(g)} K_c = 3.4 \times 10^{-4}$

a. $H_2S_{(g)}$

b. $CH_{4(g)}$

c. $CS_{2(g)}$

d. $H_{2(g)}$

a

K 1000

Consider the equilibrium

$N_2 + O_2 + Br_2 \leftrightarrow 2NOBr$

Calculate the equilibrium constant K_p for this reaction, given the following information at 298K:

$2NO + Br_2 \leftrightarrow 2NOBr \quad K_c = 2.0$

$2NO \leftrightarrow N_2 + O_2 \quad K_c = 2.1 \times 10^{30}$

$K_p = 3.89 \times 10^{-32}$

Q 200

If $Q_c > K_c$, how must the reaction proceed to reach equilibrium?

left

Q 400

What is the difference between Q and K?

K uses equilibrium concentrations or partial pressures and Q uses concentrations or partial pressures at any time.

Q 600

a

At a certain time, the partial pressure of the gases in the reaction mixture represented below had the values shown in the table below.

$CO_{(g)} + 3\ H_{2(g)} \leftrightarrows CH_{4(g)} + H_2O_{(g)}$ $K_p = 66$ at 500^oC

Based on the information above, which of the following occurred as the reaction mixture moved toward equilibrium?

P_{CO}	P_{H2}	P_{CH4}	P_{H2O}
0.02 atm	1.0 atm	0.4 atm	0.4 atm

a. More $CH_{4(g)}$ was produced because the rate of the forward reaction was higher than the rate of the reverse reaction.

b. More $H_{2(g)}$ was produced because the rate of the reverse reaction was higher than the rate of the forward reaction.

c. More $CH_{4(g)}$ was produced because the total pressure of the $H_{2(g)}$ and the $CO_{(g)}$ combined was higher than that of the products; thus the reaction shifted to the side with he fewest number of moles of gas.

d. More $H_{2(g)}$ was produced because the pressure of $CO_{(g)}$ was the least and the reaction shifted to the side with he smaller number of moles of gas.

Q 800

At 450°C, 2.0 moles each of $H_{2(g)}$, $I_{2(g)}$, and $HI_{(g)}$ are combined in a 1.0 L rigid container. The value of K_c at 450°C is 50. Which of the following will occur as the system moves toward equilibrium?

a. More $H_{2(g)}$ and $I_{2(g)}$ will form.

b

b. More $HI_{(g)}$ will form.

c. The total pressure will decrease.

d. No net reaction will occurs, because the number of molecules is the same on both sides of the equation.

Q 1000

K_p for the equilibrium $N_{2(g)} + 3H_{2(g)} \leftrightarrow 2NH_{3(g)}$ is 4.51×10^{-5} at 450°C. Indicate whether the mixture is at equilibrium. If it is not at equilibrium, indicate the direction in which the reaction must shift to achieve equilibrium.

13 atm NH_3, 27 atm N_2, and 82 atm H_2

1.14×10^{-5} shifts to the right

Calculating Equilibrium Constants 200

An equilibrium mixture in a 2L vessel is found to contain 0.0406 mol CH_3OH, 0.170 mol CO, and 0.302 mol H_2 at 500K. Calculate K_c at this temperature.

$$CO_{(g)} + 2H_{2(g)} \leftrightarrow CH_3OH_{(g)}$$

10.47

Calculating Equilibrium Constants 400

The equilibrium $NO_{(g)} + Cl_{2(g)} \leftrightarrow NoCl_{(g)}$ is established at 500K. An equilibrium mixture of the three gases has partial pressures of 0.095 atm NO, 0.171 atm Cl_2, and 0.28 atm NOCl. Calculate K_p for this reaction

50.8

Calculating Equilibrium Constants 600

A flask contains 1.5 atm N_2O_4 and 1 atm NO_2 and the following equilibrium is achieved $N_2O_{4(g)} \leftrightarrows 2NO_{2(g)}$. After equilibrium is reached, the partial pressure of NO_2 is 0.512 atm. Calculate the value of K_p for this reaction.

0.1503

Calculating Equilibrium Constants 800

A mixture of 0.2 mol CO_2, 0.1 mol H_2, and 0.16 mol H_2O is placed in a 2L vessel. The following equilibrium is established: $CO_{2(g)} + H_{2(g)} \leftrightarrows CO_{(g)} + H_2O_{(g)}$. At equilibrium $P_{H2O} = 3.51$ atm. Calculate K_p for the reaction at 500K.

0.11

Calculating Equilibrium Constants 1000

A mixture of 1.374g H_2 and 70.31g Br_2 is heated in a 2L vessel at 700K. These substances react as follows: $H_{2(g)} + Br_{2(g)} \leftrightarrows 2HBr_{(g)}$. At equilibrium the vessel is found to contain 0.566g of H_2. Calculate K_c. (keep 4 decimal places)

67.61

Applications of K 200

If P_{N2O4} is 1.33 atm when the system is at equilibrium at 70°C, what is P_{NO2}?

$N_2O_{4(g)} \leftrightarrows 2\ NO_{2(g)}$ $K_p = 3.0$ at 70°C

Colorless Brown

- 0.44 atm
- 2.0 atm
- 2.3 atm
- 4.0 atm

0.162M

Applications of K 400

At 900K the following reaction has K_p = 0.345: $2SO_{2(g)} + O_{2(g)} \leftrightarrow 2SO_{3(g)}$. In an equilibrium mixture the partial pressures of SO_2 is 0.135 atm and O_2 is 0.455 atm. What is the equilibrium partial pressure of SO_3 in the mixture?

0.054 atm

Applications of K 600

At 373K, $K_p = 0.416$ for the equilibrium $2NOBr_{(g)} \leftrightarrows 2NO_{(g)} + Br_{2(g)}$. If the pressures of $NOBr_{(g)}$ and $NO_{(g)}$ are equal, what is the equilibrium pressure of $Br_{2(g)}$?

0.416 atm

Applications of K 800

At 218°C, $K_c = 1.2 \times 10^{-4}$ for the equilibrium $NH_4HS_{(s)} \leftrightarrows NH_{3(g)} + H_2S_{(g)}$. Calculate the equilibrium concentrations of NH_3 and H_2S if a sample of solid NH_4HS is placed in a closed vessel and decomposes until equilibrium is reached.

$[NH_3] = 0.011M$, $[H_2S] = 0.011M$

Applications of K 1000

Which of the following best predicts how the partial pressures of the reacting species will be affected if a small amount of $Ar_{(g)}$ is added to the equilibrium mixture at constant volume?

$N_2O_{4(g)} \leftrightarrows 2\ NO_{2(g)}$ $K_p = 3.0$ at 70^oC

Colorless Brown

a. P_{NO2} will decrease and P_{N2O4} will increase.

b. P_{NO2} will increase and P_{N2O4} will decrease.

- Both P_{NO2} and P_{N2O4} will decrease.
- No change will take place.

d

Le Chatelier's Principle 200

Consider $4NH_{3(g)} + O_{2(g)} \leftrightarrows 4NO_{(g)} + 6H_2O_{(g)}$, $\Delta H = -904.4kJ$. How does increasing $[NH_3]$ affect the yield of NO at equilibrium?

Equilibrium shifts to the right, so [NO] increases.

Le Chatelier's Principle 400

Consider $4NH_{3(g)} + O_{2(g)} \leftrightarrow 4NO_{(g)} + 6H_2O_{(g)}$, $\Delta H = -904.4kJ$. How does decreasing $[O_2]$ affect the yield of NO at equilibrium?

Equilibrium shifts to the left, so [NO] decreases.

Le Chatelier's Principle 600

Consider $4NH_{3(g)} + O_{2(g)} \leftrightarrow 4NO_{(g)} + 6H_2O_{(g)}$, $\Delta H = -904.4kJ$. How does decreasing the volume of the container in which the reaction occurs affect the yield of NO at equilibrium?

Equilibrium shifts to the left, so [NO] decreses.

Le Chatelier's Principle 800

Consider $4NH_{3(g)} + O_{2(g)} \leftrightarrow 4NO_{(g)} + 6H_2O_{(g)}$, $\Delta H = -904.4kJ$. How does adding a catalyst affect the yield of NO at equilibrium?

No shift in equilibrium, so no change in [NO].

Le Chatelier's Principle 1000

Which of the following statements best explains why the contents of the tube containing the equilibrium mixture turned a lighter color when the tube was placed into an ice bath?

$N_2O_{4(g)} \leftrightarrow 2\ NO_{2(g)}$ $K_p = 3.0$ at 70^oC

Colorless Brown

a. The forward reaction is exothermic.
b. The forward reaction is endothermic. b
c. The ice bath lowered the activation energy.
➢ The ice bath raised the activation energy.

Surprise 200

Based on the information below, what is the value of K_{eq} for the reaction represented below?

$$ICl_{(g)} \leftrightarrow \frac{1}{2} I_{2(g)} + \frac{1}{2} Cl_{2(g)} \quad K_{eq} = 0.1$$

$$I_{2(g)} + Cl_{2(g)} \leftrightarrow 2\ ICl_{(g)} \quad K_{eq} = ?$$

a. 0.01

b. 10

c. 20

d. 100

d

Surprise 400

Consider the following equilibrium: $2H_{2(g)} + S_{2(g)} \leftrightarrows 2H_2S_{(g)}$ $K_c = 1.08 \times 10^7$ at 700°C. Does the equilibrium mixture contain mostly H_2 and S_2 or mostly H_2S?

H_2S

Surprise 600

The value of the equilibrium constant for the reaction represented below if 2.3×10^{11}.

$$Ge_{(g)} + 2\ Cl_{2(g)} \leftrightarrow GeCl_{4(g)}$$

What is the value of the equilibrium constant for the following reaction?

$$2\ GeCl_{4(g)} \leftrightarrow 2\ Ge_{(g)} + 4\ Cl_{2(g)}$$

a. 1.9×10^{-23}
b. 4.3×10^{-12}
c. 2.3×10^{11}
d. 5.3×10^{22}

a

Surprise 800

A mixture of CH_4 and H_2O is passed over a nickel catalyst at 1000K. The emerging gas is collected in a 5L flask and is found to contain 8.62g CO, 2.6g H_2, 43g CH_4, and 48.4g H_2O. Assuming that equilibrium has been reached, calculate K_c for the reaction.

3.74×10^{-3}

Surprise 1000

At 80°C, $K_c = 1.87 \times 10^{-3}$ for the reaction $PH_3BCl_{3(s)} \leftrightarrows PH_{3(g)} + BCl_{3(g)}$. Calculate the equilibrium concentrations of PH_3 and BCl_3 if a solid sample of PH_3BCl_3 is placed in a closed vessel and decomposes until equilibrium is reached.

$[PH_3] = 0.043M$, $[BCl_3] = 0.043M$