

1125 Review Session

Q center

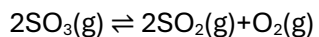
Exam 5

1. Consider the following reaction: $\text{BF}_3(\text{g}) + \text{NH}_3(\text{g}) \rightarrow \text{BF}_3\text{NH}_3(\text{g})$

The reaction is first order in BF_3 and first order in NH_3 . Write the rate expression for the reaction:

$$\text{Rate} = k[\text{BF}_3][\text{NH}_3]$$

2. At a certain temperature, 0.860 mol SO_3 is placed in a 3.00 L container.



At equilibrium, 0.140 mol O_2 is present. Calculate K_c .

Initial	0.860	0	0
Change	$-2x = -2(0.140)$	$+2x = 2(0.140)$	$+0.140 = x$
Equilibrium	$0.860 - 0.280 = 0.580$	0.280	0.140

Molarity:

$$[\text{SO}_3]_{eq} = \frac{0.580 \text{ mol}}{3.00 \text{ L}} = \mathbf{0.193 \text{ M}}$$

$$[\text{SO}_2]_{eq} = \frac{0.280 \text{ mol}}{3.00 \text{ L}} = \mathbf{0.0933 \text{ M}}$$

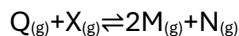
$$[\text{O}_2]_{eq} = \frac{0.140 \text{ mol}}{3.00 \text{ L}} = \mathbf{0.0467 \text{ M}}$$

K

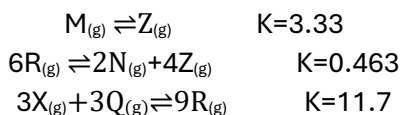
$$K_c = \frac{[\text{SO}_2]_{eq}^2 [\text{O}_2]_{eq}}{[\text{SO}_3]_{eq}^2}$$

$$K_c = \frac{0.0933^2 * 0.0467}{0.193^2} = \mathbf{0.0109}$$

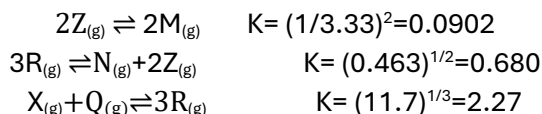
3. Calculate the equilibrium constant for the reaction:



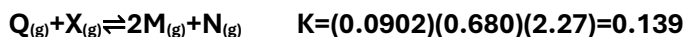
Given that:



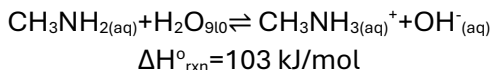
To get the desired reaction it is necessary to modify the given reactions. First, the desired reaction has Q and R as reactants with a coefficient of 1. Reaction 3 has Q and R as reactant but with a coefficient of 3. Thus, Reaction 3 needs to be divided into 3 (factor of 1/3). Then, M is a product in the desired reaction with a coefficient of 2. Reaction 1 has M as a reactant with a coefficient of 1. Therefore, Reaction 1 is reversed and multiplied by 2. Finally, the desired reaction has N as a product with 1 as a coefficient so Reaction 2 needs to be divided by 2 (factor 1/2). Thus:



And:

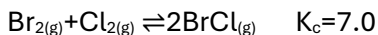


4. Which of the following will increase the concentration of reactants for the following reaction:



- Adding more KOH
- Adding KBr
- Increasing the temperature
- Adding $\text{CH}_3\text{NH}_3\text{Br}$
- Adding HBr

5. Consider this equilibrium reaction:



If the composition of the reaction mixture at 400 L is $[\text{BrCl}] = 0.00581 \text{ M}$, $[\text{Br}_2] = 0.00216 \text{ M}$, and $[\text{Cl}_2] = 0.000396$, predict to what side the reaction shifts to get to the equilibrium.

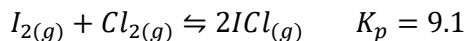
$$Q = \frac{[\text{BrCl}]^2}{[\text{Br}_2][\text{Cl}_2]} \\
 Q = \frac{0.00581^2}{(0.00216)(0.000396)} = 39.6$$

Q > K reaction shifts to the left, reactants.

6. For the following reactions determine whether the forward or reverse reaction is favored:

- $\text{Ag}_2\text{CrO}_{4(\text{s})} \rightleftharpoons 2\text{Ag}^+_{(\text{aq})} + \text{CrO}_4^{2-}_{(\text{aq})} \quad K = 1.1 \times 10^{-12}$
Reverse reaction favored
- $2\text{NO}_{(\text{g})} + \text{O}_{2(\text{g})} \rightleftharpoons 2\text{NO}_{2(\text{g})} \quad K = 2.5 \times 10^{10}$
Forward reaction favored
- $\text{HCN}_{(\text{aq})} + \text{OH}^-_{(\text{aq})} \rightleftharpoons \text{CN}^-_{(\text{aq})} + \text{H}^+_{(\text{aq})} \quad K = 5.1 \times 10^{-8}$
Reverse reaction favored

7. At 25 °C gaseous I₂ and Cl₂ react to form ICl.



Suppose that a sealed container initially contains 0.250 atm of I₂ and 0.250 M of Cl₂. Calculate the equilibrium partial pressures of I₂, Cl₂ and ICl at this temperature:

Initial	0.250	0.250	0
Change	-x	-x	+2x
Equilibrium	0.250-x	0.250-x	2x

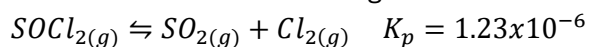
$$\begin{aligned}
 K_p &= \frac{P_{2ICl}}{P_{I_2}P_{Cl_2}} = 9.1 \\
 \frac{(2x)^2}{(0.250 - x)^2} &= 9.1 \\
 \frac{2x}{0.250 - x} &= 3.017 \\
 2x &= 3.017(0.250 - x) \\
 2x &= 0.754 - 3.017x \\
 2x + 3.017x &= 0.754 \\
 5.017x &= 0.754 \\
 x &= 0.150
 \end{aligned}$$

$$[I_2]_{eq} = 0.250 - 0.100 = 0.100 \text{ atm}$$

$$[Cl_2]_{eq} = 0.250 - 0.100 = 0.100 \text{ atm}$$

$$[ICl]_{eq} = 2 * 0.150 = 0.300 \text{ atm}$$

8. SOCl₂ dissociates into SO₂ and Cl₂ via the following reaction:



At 500 K.

Calculate K_c for this reaction at 500 K

$$\begin{aligned}
 K_p &= K_c(RT)^{\Delta n} \\
 K_c &= \frac{K_p}{(RT)^{\Delta n}} \\
 K_c &= \frac{1.23 \times 10^{-6}}{(0.08206 * 500)^1} \\
 K_c &= 2.998 \times 10^{-8}
 \end{aligned}$$