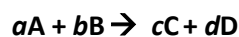


I. Chemical quotient:



$$Q = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

$Q > K$, move to reactant

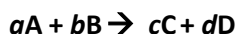
$Q < K$, move to product

K_c (use mole/L for [A], [B], [C], and [D])

K_p (use atm for P_A , P_B , P_C , and P_D)

$$K_p = K_c (RT)^{\Delta n}, \Delta n = (c+d) - (a+b), R = 0.08206 \text{ L} \cdot \text{atm} / (\text{K} \cdot \text{mol})$$

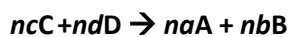
II. Equilibrium constant calculation:



$$K_1$$



$$K_2 = K_1^{-1}$$



$$K_3 = K_1^{-n}$$

Combine two equations (K_1 and K_2), $K_{\text{new}} = K_1 \times K_2$

III. ICE table (small x approximation):

$K > 10^4$ or $K < 10^{-4}$, small x approximation, otherwise $x = (-b \pm \sqrt{b^2 - 4ac}) / 2a$

IV. Le Chatelier's principle: predict how the reaction direction is affected by

1. Concentration, 2. pressure, and 3. Temperature (catalyst)

Ch 12

12.I

1. **(L7_C)** Consider the gas-phase reaction, $\text{Cl}_2(\text{g}) + \text{Br}_2(\text{g}) \rightleftharpoons 2 \text{BrCl}(\text{g})$, for which $K_p = 32$ at 500 K. If the mixture is analyzed and found to contain 0.49 bar of Cl_2 , 0.29 bar of Br_2 and 2.1 bar of BrCl , describe the situation: [**$Q < K$ and more products will be made to reach equilibrium**]

12.II

2. **(L7_C)** At a certain temperature, K_p is 0.25 for the reaction,
 $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightleftharpoons 2 \text{HBr}(\text{g})$.
Calculate the value of K_p for the reaction,
 $\text{HBr}(\text{g}) \rightleftharpoons \frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{Br}_2(\text{g})$
[2]
3. **(L7_C)** Given the values of K shown below, determine the value of K for the reaction,
 $\text{N}_2(\text{g}) + 2 \text{O}_2(\text{g}) \rightleftharpoons 2 \text{NO}_2(\text{g})$.
 $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2 \text{NO}(\text{g}) \quad K_1 = 2$
 $\text{NO}_2(\text{g}) \rightleftharpoons \text{NO} + \frac{1}{2} \text{O}_2(\text{g}) \quad K_2 = 3$
Give your answer to the 4 decimal places.
[0.2222]

12.III

4. **(L7_A)** At 700 K, the reaction below has a K_p value of 54. An equilibrium mixture at this temperature was found to contain 0.5 atm each of H_2 and I_2 . Calculate the pressure of HI at equilibrium.
 $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI}(\text{g})$. Use 2 decimal places. [3.68]
5. **(L8_C)** At a given temperature, 2 atm of H_2 and 1 atm of I_2 are mixed and allowed to come to equilibrium. The equilibrium pressure of HI is found to be 1 atm. Calculate K_p for the reaction at this temperature.
 $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI}(\text{g})$. Give your answer to 3 decimal places. [1.333]
6. **(L8_C)** In the reaction below, 0.5 atm each of H_2 and Br_2 were placed into a 1.00 L flask and allowed to react:
 $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightleftharpoons 2 \text{HBr}(\text{g})$
Given that $K_c = 4$, calculate the equilibrium pressure of HBr . [0.5]

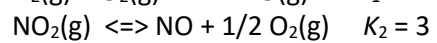
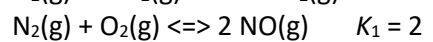
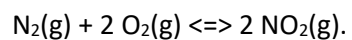
12.IV

7. **(L8_A)** Consider the reaction $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$, which is exothermic as written. What would be the effect on the equilibrium position of removing $\text{N}_2(\text{g})$? [Reaction would go to the left, making more "reactants"]

1. Consider the gas-phase reaction, $\text{Cl}_2(\text{g}) + \text{Br}_2(\text{g}) \rightleftharpoons 2 \text{BrCl}(\text{g})$, for which $K_p = 32$ at 500 K. If the mixture is analyzed and found to contain 0.49 bar of Cl_2 , 0.29 bar of Br_2 and 2.1 bar of BrCl , describe the situation: [**$Q < K$ and more products will be made to reach equilibrium**]

2. At a certain temperature, K_p is 0.25 for the reaction,
 $\text{H}_2(\text{g}) + \text{Br}_2(\text{g}) \rightleftharpoons 2 \text{HBr}(\text{g})$.
Calculate the value of K_p for the reaction,
 $\text{HBr}(\text{g}) \rightleftharpoons \frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{Br}_2(\text{g})$
[2]

3. Given the values of K shown below, determine the value of K for the reaction,



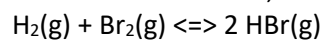
Give your answer to the 4 decimal places.

[0.2222]

4. At 700 K, the reaction below has a K_p value of 54. An equilibrium mixture at this temperature was found to contain 0.5 atm each of H_2 and I_2 . Calculate the pressure of HI at equilibrium.
 $H_2(g) + I_2(g) \rightleftharpoons 2 HI(g)$. Use 2 decimal places. **[3.68]**

5. At a given temperature, 2 atm of H_2 and 1 atm of I_2 are mixed and allowed to come to equilibrium. The equilibrium pressure of HI is found to be 1 atm. Calculate K_p for the reaction at this temperature.
 $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2 \text{HI}(\text{g})$. Give your answer to 3 decimal places. [**1.333**]

6. In the reaction below, 0.5 atm each of H_2 and Br_2 were placed into a 1.00 L flask and allowed to react:



Given that $K_c = 4$, calculate the equilibrium pressure of HBr. **[0.5]**

7. Consider the reaction $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightleftharpoons 2 \text{NH}_3(\text{g})$, which is exothermic as written. What would be the effect on the equilibrium position of removing $\text{N}_2(\text{g})$? **[Reaction would go to the left, making more "reactants"]**