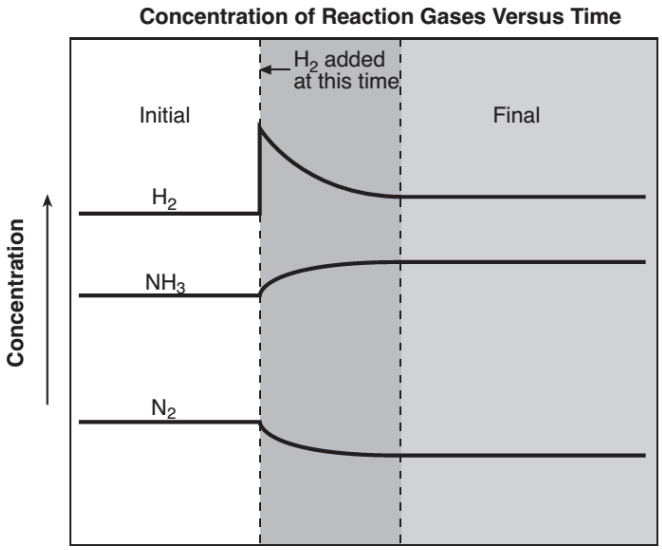
AP Chemistry
Ms. Ye

Name _____
Date _____Block _____

Nitrogen gas, hydrogen gas, and ammonia gas are in equilibrium in a closed container at constant temperature and pressure. The following equation represents this equilibrium:

$$\mathbf{N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g).}$$

The graph shows the initial concentration of each gas, the changes that occur as a result of adding $H_2(g)$ to the system, and the final concentrations when equilibrium is reestablished.



1. What information on the graph indicates that the system was initially at equilibrium?

2. Explain, in terms of Le Chatelier's principle, why the final concentration of $NH_3(g)$ is greater than the initial concentration of $NH_3(g)$.

3. Explain, in terms of collision theory, why the concentration of $H_2(g)$ begins to decrease immediately after more $H_2(g)$ is added to the system.

<u>Equilibrium Constant, K</u>

- $K_{eq} = \frac{[products]}{[reactants]}$
- If you know the value of the equilibrium constant, you can calculate the concentrations of the reactants and products at equilibrium, and vice versa.
- Meaning of K:
  - If K < 1, the reaction favors the reactants
  - If K > 1, the reaction favors the products

<u>Calculations involving K_{eq}</u>

1. $PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$.

What is the equilibrium constant if the equilibrium concentrations are as follows:
PCl_5 is 0.0096 mol/L, PCl_3 is 0.0247 mol/L and Cl_2 is 0.0247 mol/L? (Ans: 0.064)

2. $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$.

At $1000^{o}C$, a 1.00 L container has an equilibrium mixture consisting of 0.102 mol of ammonia, 1.03 mol of nitrogen, and 1.62 mol of hydrogen. Calculate the K_{eq} for the equilibrium system.

(Ans: 0.00238)

3. At a given temperature, the K_{eq} for the reaction $2HI(g) \leftrightarrow H_2(g) + I_2(g)$ is 1.40×10^{-2}. If the concentration of both H_2 and I_2 at equilibrium are 2.00×10^{-4}M, find the concentration of HI.

Ans: 0.00169M

4. Acetic acid dissociates in water: $HC_2H_3O_2(aq) \leftrightarrow H^+(aq) + C_2H_3O_2^-(aq)$. If $K_{eq} = 1.80 \times 10^{-5}$ and the equilibrium concentrations of acetic acid is 0.09986M, what is the concentration of $H^+(aq)$ and $C_2H_3O_2^-(aq)$? (Ans: 0.00134M)

5. At $60.2^{o}C$ the equilibrium constant for the reaction $N_2O_4(g) \leftrightarrow 2NO_2(g)$ is 8.75×10^{-2}. At equilibrium at this temperature a vessel contains N_2O_4 at a concentration of 1.72×10^{-2}M. What concentration of NO_2 does it contain? (Ans: 0.0388M)

7. At equilibrium, K for the decomposition of HI(g) was found to be 1.07×10^{-5}. The equilibrium concentration of HI(g) was found to be 0.129M. Calculate the concentration of I_2 at equilibrium. $2HI(g) \rightarrow H_2(g) + I_2(g)$

(Ans: 0.000422M)

8. rank the reactions in order of increasing tendency to proceed toward completion.