1. Consider the reaction: \( \text{SiH}_4(g) + 2 \text{Cl}_2(g) \rightleftharpoons \text{SiCl}_4(g) + 2 \text{H}_2(g) \)

A) Write the expression for \( K_c \) in terms of reactants and products.
\[
K_c = \frac{[\text{SiCl}_4][\text{H}_2]^2}{[\text{SiH}_4][\text{Cl}_2]^2}
\]

B) Write the expression for \( K_p \) in terms of reactants and products.
\[
K_p = \frac{P_{\text{SiCl}_4}P_{\text{H}_2}^2}{P_{\text{SiH}_4}P_{\text{Cl}_2}^2}
\]

C) If \( K_c = 56 \), for the reaction above at 120°C, what is \( K_p \)? \( (Δr = 0) \)
\[
K_p = 56
\]

D) If \( K_c = 56 \), for the reaction above at 120°C, what will be the \( K_c \) for the following reactions?

**Look at each CAREFULLY!**

- i. \( \frac{1}{2} \text{SiH}_4(g) + \text{Cl}_2(g) \rightleftharpoons \frac{1}{2} \text{SiCl}_4(g) + \text{H}_2(g) \)
  \[
  K_c = (56)^{\frac{1}{2}} = 7.5
  \]

- ii. \( 3 \text{SiCl}_4(g) + 6 \text{H}_2(g) \rightleftharpoons 3 \text{SiH}_4(g) + 6 \text{Cl}_2(g) \)
  \[
  K_c = 5 \times 10^{-6}
  \]

2. Consider the reaction: \( \text{CO}_2(g) + \text{H}_2(g) \rightleftharpoons \text{CO}(g) + \text{H}_2\text{O}(g) \), for which \( K_c = 5.8 \) for this reaction at 50°C.

A) If a mixture has the following concentrations, it would not be at equilibrium. Will it proceed to the right or the left? Provide a mathematical justification of your answer.

\[
[\text{CO}_2] = 0.45 \text{ M}
\]

\[
[\text{H}_2] = 0.45 \text{ M}
\]

\[
[\text{CO}] = [\text{H}_2\text{O}] = 0.71 \text{ M}
\]

\[
Q = \frac{(0.71)^2}{(0.45)^2} = 2.55
\]

\[Q < K\], **Reaction shifts right**

\( \text{to Products} \)

B) What will be the concentrations of the new equilibrium condition?

\[
\text{CO}_2 + \text{H}_2 \rightleftharpoons \text{CO} + \text{H}_2\text{O}
\]

\[0.45 - x\] \[0.45 - x\] \[0.31 + x\] \[0.31 + x\]

\[
6 \times \frac{(0.31 + x)^2}{(0.45 - x)^2} \Rightarrow 2.608 = \frac{0.31 + x}{0.45 - x}
\]

\[
x = 0.13 \text{ M}
\]

\[
[\text{CO}_2] = [\text{H}_2] = 0.32 \text{ M}
\]

\[
[\text{CO}] = [\text{H}_2\text{O}] = 0.84 \text{ M}
\]

3. Consider the reaction: \( \text{N}_2(g) + 3 \text{Cl}_2(g) \rightleftharpoons 2 \text{NCl}_3(g) \)

A) At 115°C, nitrogen and chlorine gas are mixed in a fixed volume container, with \([\text{N}_2] = 4.50 \text{ M}\) and \([\text{Cl}_2] = 2.00 \text{ M}\), and no \( \text{NCl}_3 \). If the equilibrium concentration of nitrogen trichloride is \([\text{NCl}_3] = 1.00 \text{ M}\), what is the value of \( K_c \) for the reaction?

\[
\text{St.}\: 4.50 \text{ M} \: 2.00 \text{ M} \: 0
\]

\[
\uparrow\: -0.50 \text{ M} \: -1.50 \text{ M} \: +1.00 \text{ M}
\]

\[
\downarrow\: 4.00 \text{ M} \: 0.50 \text{ M} \: 1.00 \text{ M}
\]

\[
K_c = \frac{(1.00 \text{ M})^2}{(0.50 \text{ M})^3(4.00 \text{ M})} = 2.0 \text{ M}^{-2}
\]

B) What is the value for \( K_p \) at the same temperature?

\[
K_p = K_c (RT)^{Δn} = (2.0 \text{ M}^{-2})(0.682)^{\frac{4.00 \text{ M}}{388 \text{ K}}} \text{ M}^{-2}
\]

\[
K_p = 2.0 \times 10^{-3} \text{ atm}^{-2}
\]