Problem 7. \[4 \text{HCl} (g) + \text{O}_2 (g) \rightarrow 2 \text{Cl}_2 (g) + 2 \text{H}_2\text{O} (l)\]

When 0.588 mole HCl (g) is reacted with 0.120 mole O\(_2\) (g) in a closed, expandable container kept at 22\(^\circ\)C, 1 atm, volume of gas decreases by 31.78\%\). Calculate \(K_c\)

\[
V = \frac{nRT}{P} \quad \text{R, T, P are constant. If } V_{\text{gas}} \text{ decreases by 31.78\%, it is because mole gas decreases by 31.78\%}\]

net \(\Delta (\text{mole gas}) = -3X\ (-5 \text{mole gas} + 2 \text{mole gas})\)

\[\therefore 3X = 0.3178 (0.588 + 0.120) \quad X_{\text{act}} = 0.07500\]

Complete "arrow diagram" with \(X_{\text{act}}\)

\[
\begin{array}{ccccc}
4 \text{HCl} & \text{O}_2 & 2 \text{Cl}_2 & \text{H}_2\text{O} (l) \\
0.588 & 0.120 & 0.150 & \\
1 & 1 & & \\
-4 (0.07500) & -0.07500 & +2 (0.075) & \\
\downarrow & \downarrow & & \text{not needed} \\
0.288 & 0.45 & 0 & \\
\end{array}
\]

Total final mole gas = (0.288 + 0.45 + 0.15) = 0.893 mole gas

\[
V = \frac{(0.893 \text{ mole}) (8.31) (295 \text{ K})}{(101.3 \text{ kPa})} = 11.69 \text{ L gas}
\]

\[
K_c = \frac{(0.150 \text{ mole Cl}_2)^2}{(0.288 \text{ mole HCl})^4 (0.045 \text{ mole O}_2) (0.150 \text{ mole})} \approx 1.0 \times 10^5
\]

(variable with round off)

Final numerical set up