The apparatus below is used to collect hydrogen gas from the reaction

\[
\Delta H^\circ_{\text{rxn}} = -1039.7 + \frac{3}{2} (0) - [0 - (3)(-167.2)]
\]

When 1.50 g of solid aluminum are put into 120.0 mL of 0.300 M HCl in an Erlenmeyer flask. In order to determine \(\Delta H^\circ_{\text{rxn}}\), you'll need to know that \(\Delta H^\circ_{\text{AlCl}_3(aq)}\) is -1039.7 kJ/mol.

1. \(Q_{\text{soln}} = m_s C_p s \Delta T_{\text{soln}}\)
   \(Q_{\text{rxn}} = +\Delta H^\circ_{\text{rxn}} \text{ (mol reacted)}\)
   \(Q_{\text{rxn}} = -Q_{\text{soln}}\)

1. If the initial temperature of the solution in the Erlenmeyer flask is 25.0 °C, what is the final temperature of the solution in the Erlenmeyer flask? You may assume that the solution has the combined mass of the metal and HCl solution and that the solution has the properties of water. You may also assume that all of the heat generated by the reaction goes to heating the solution.

\[
\frac{1.50 \text{g Al}}{26.98 \text{g Al}} = 0.054 \text{ mol Al}\]
\[
\frac{1 \text{ mol Al}}{\frac{3}{2} \text{ mol H}_2} = 0.083 \text{ mol H}_2
\]
\[
\frac{0.120 \text{ L}}{0.300 \text{ mol HCl}} = \frac{0.032 \text{ mol HCl}}{1 \text{ mol HCl}} = 0.010 \text{ mol H}_2
\]

HCl is LR (over)

2. What is the volume of H\(_2\)(g) collected in the bottle at 25.0 °C and an atmospheric pressure of 1.06 atm? Don't forget to account for the fact that the hydrogen is being collected over water.

\[
P_{\text{atm}} = P_{\text{H}_2} + P_{\text{H}_2O}
\]
\[
1.06 \text{ atm} = P_{\text{H}_2} + \frac{23.78 \text{ mm Hg}}{760 \text{ mm Hg}}
\]
\[
P_{\text{H}_2} = 1.03 \text{ atm}
\]

\[
P_{\text{H}_2} V = n_{\text{H}_2} RT
\]
\[
V = \frac{n_{\text{H}_2} RT}{P_{\text{H}_2}} = \frac{(0.0180 \text{ mol H}_2)(0.08206 \text{ L atm/mol K})(298 \text{ K})}{1.03 \text{ atm}}
\]
\[
V = 0.427 \text{ L}
\]
\[ Q_{\text{rxn}} = \Delta H_{\text{rxn}} \text{ (mol reacted w/ a 1 coeff)} \]

\[
\frac{0.120 \text{ L} | 0.300 \text{ mol HCl} | 1 \text{ mol Al}}{1 \text{ L soln} | 3 \text{ mol HCl}} = 0.0120 \text{ mol Al}
\]

\[ Q_{\text{rxn}} = (-538,100 \frac{J}{\text{mol}})(0.0120 \text{ mol}) = -6457 \text{ J} \]

\[ Q_{\text{soln}} = -(-6457 \text{ J}) = +6457 \text{ J} = \frac{(121.5 \text{ g})(4.184 \text{ J/g°C})(T_f-T_i)}{(121.5)(4.184)} \]

\[ 12.7 = T_f - 25.0 \]

\[ T_f = 37.7 \text{ °C} \]