1. (10 points) A 50 g sample of N\textsubscript{2}(g) (\(C_P = 29.3 \text{ J/K mol}\)) is initially at 25\(^\circ\)C and 10.0 atm and is allowed to expand adiabatically against a constant pressure of 1 atm. Calculate its final temperature, assuming that the gas behaves ideally.

Relevant equations:

\[
PV = nRT \tag{1}
\]
\[
q = 0 \tag{2}
\]
\[
\Delta E = w = -P_{ex} (V_f - V_i) = n\overline{C}_V (T_f - T_i) \tag{3}
\]

From this we can obtain

\[
V_i = \frac{nRT_i}{P_i} \tag{4}
\]
\[
V_f = \frac{nRT_f}{P_f} \tag{5}
\]
\[
P_{ex} = P_f \tag{6}
\]
\[
\overline{C}_V = \overline{C}_P - R \tag{7}
\]

and

\[
-P_f \left( \frac{nRT_f}{P_f} - \frac{nRT_i}{P_i} \right) = n\overline{C}_V (T_f - T_i) \tag{8}
\]
\[
RT_i \frac{P_f}{P_i} + \overline{C}_VT_i = RT_f + \overline{C}_VT_f \tag{9}
\]
\[
T_f = \frac{R\frac{P_f}{P_i} + \overline{C}_V}{R + \overline{C}_V} T_i = 222K \tag{10}
\]