9 Thermodynamics

9.1 (a) Calculate the total work done by the gas.

State A: $P_A = 101.3$ kPa, $T_A = 278.15$ K, $n = 1$ mole. Initial volume $V_A = \frac{nRT_A}{P_A} = \frac{1 \times 8.31 \times 278.15}{101.3 \times 10^3} \approx 0.02283$ m^3.

Process A $\to$ B (isochoric): Volume is constant, so $W_{AB} = 0$. **Process B $\to$ C (isobaric):** $P_B = P_A/2$, $V_C = 2V_B = 2V_A$.

$$W_{BC} = P_B(V_C - V_B) = P_B V_B = \left(\frac{P_A}{2}\right) V_A = \frac{1}{2} nRT_A$$

$$W_{BC} = \frac{1}{2}(1)(8.31)(278.15) \approx 1155.7 \text{ J}$$

Total work $W_{\text{total}} = W_{AB} + W_{BC} = 1155.7$ J $\approx$ **1160 J**.

9.2 (b) Determine the work done by the gas for a process from state A to state C at constant temperature.

State C has $P_C = P_A/2$ and $V_C = 2V_A$, which implies $T_C = T_A$. Work done during an isothermal process:

$$W = \int_{V_A}^{V_C} P dV = nRT_A \ln\left(\frac{V_C}{V_A}\right)$$

$$W = nRT_A \ln(2) = (1)(8.31)(278.15)\ln(2) \approx 1601.9 \text{ J} \approx \textbf{1600 J}$$