The work is calculated using eq. (3.36), which we write as

$$W = \int_{T_A}^{T_B} \left(C_P^{\text{ig}} - R\right) dT = \int_{T_A}^{T_B} C_P^{\text{ig}}\, dT - R(T_B - T_A).$$

The integral is evaluated using the polynomial expression for the heat capacity:

$$\int_{T_A}^{T_B} C_P^{\text{ig}}\, dT = R\left(a_0(T_2 - T_1) + \frac{a_1}{2}(T_2^2 - T_1^2) + \frac{a_2}{3}\left(T_2^3 - T_1^3\right) + \frac{a_3}{4}\left(T_2^4 - T_1^4\right) + \frac{a_4}{5}\left(T_2^5 - T_1^5\right)\right)$$
$$= -5,374.21 \text{ J/mol}.$$

The work is

$$W = -5,374.21 \text{ J/mol} - (8.315 \text{ J/mol K})(500 \text{ K} - 316.688 \text{ K}) = -3,850.2 \text{ J/mol}.$$

The path of this process is shown in Figure 3-12 by the line ~~AC~~. AD

Comments The heat capacity of nitrogen changes little between the initial and final temperature, and this is the reason that the final temperature is not much different from that obtained after just one iteration.

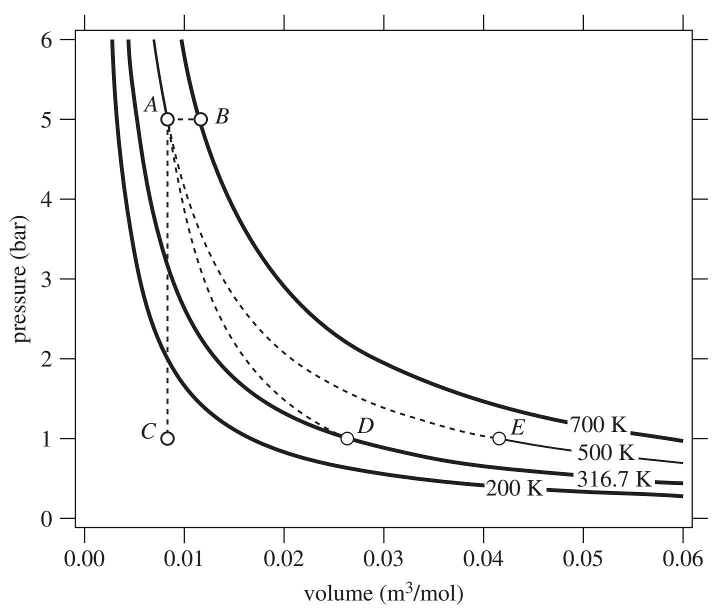

Figure 3-12: Elementary paths in the ideal-gas state (data for nitrogen): constant-pressure (AB), constant-volume (AC), reversible adiabatic (AD), isothermal (AE).