

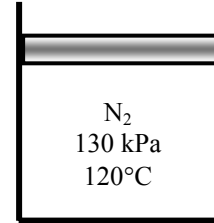
5-8 A piston-cylinder device contains nitrogen gas at a specified state. The boundary work is to be determined for the polytropic expansion of nitrogen.

Properties The gas constant for nitrogen is 0.2968 kJ/kg.K (Table A-2).

Analysis The mass and volume of nitrogen at the initial state are

$$m = \frac{P_1 V_1}{RT_1} = \frac{(130 \text{ kPa})(0.07 \text{ m}^3)}{(0.2968 \text{ kJ/kg.K})(120 + 273 \text{ K})} = 0.07802 \text{ kg}$$

$$V_2 = \frac{mRT_2}{P_2} = \frac{(0.07802 \text{ kg})(0.2968 \text{ kPa.m}^3/\text{kg.K})(100 + 273 \text{ K})}{100 \text{ kPa}} = 0.08637 \text{ m}^3$$



The polytropic index is determined from

$$P_1 V_1^n = P_2 V_2^n \longrightarrow (130 \text{ kPa})(0.07 \text{ m}^3)^n = (100 \text{ kPa})(0.08637 \text{ m}^3)^n \longrightarrow n = 1.249$$

The boundary work is determined from

$$W_b = \frac{P_2 V_2 - P_1 V_1}{1 - n} = \frac{(100 \text{ kPa})(0.08637 \text{ m}^3) - (130 \text{ kPa})(0.07 \text{ m}^3)}{1 - 1.249} = \mathbf{1.86 \text{ kJ}}$$