Two moles of a perfect gas occupy a volume 5 of 0.065 m3 and exert a pressure of 3.0 x 105 N m - 2. It is compressed isobarically to 0.050 m3. Determine the work done by the gas and the fall in its temperature. Take R=8.3 JK - I mol -1.

Solution

The work done by the gas that isobarically compressed:

$$W = P\Delta V = P(V_2 - V_1),$$

where P – pressure, V_1 – initial volume of a perfect gas, V_2 – final volume of a perfect gas.

So

$$W = 3.0 \text{ x } 10^5 \frac{\text{N}}{\text{m}^2}(0.050 \text{ m}^3 - 0.065 \text{ m}^3) = -4.5 * 10^3 J.$$

A sign "-" means that the work done on the gas.

Let's write state equation of perfect gas for initial and final states:

$$PV_1 = \upsilon RT_1 \ and \ PV_2 = \upsilon RT_2.$$

The fall in the temperature of perfect gas:

$$T_1 - T_2 = \frac{PV_1 - PV_2}{\upsilon R} = \frac{3.0 \text{ x } 10^5 \frac{\text{N}}{\text{m}^2}(0.065 \text{ m}^3 - 0.050 \text{ m}^3)}{2 \text{ mol} * 8.3 \frac{\text{J}}{\text{K} * \text{mol}}} = 271 \ K.$$

Answer: $\mathbf{-4.5 * 10^3 J; 271\ K}$.