Answer on Question #43121-Physics-Molecular Physics-Thermodynamics

Derive an expression describes the change in entropy by an isobaric thermodynamics process in term of the initial and final volumes of the ideal gas

Solution

In the isobaric process of an ideal gas, the infinitesimal amount of heat is given by

$$\delta Q = dU + pdV = C_V dT + pdV.$$

From the equation of state of the ideal gas

$$pV = nRT$$

follows

$$T = \frac{pV}{nR}, dT = \frac{pdV}{nR}.$$

Substituting this into

$$dS = \frac{\delta Q}{T},$$

one obtains

$$dS = \frac{C_V \frac{pdV}{nR} + pdV}{\frac{pV}{nR}} = (C_V + nR)\frac{dV}{V} = C_P \frac{dV}{V}.$$

The change in entropy is given by

$$\Delta S = \int_{V_i}^{V_f} C_P \frac{dV}{V} = C_P \ln\left(\frac{V_f}{V_i}\right),$$

where V_f is the final volume of the ideal gas, V_i is the initial volume of the ideal gas, C_P is the heat capacity of the ideal gas at constant pressure.