Exercise 3.1

Sunday, 26 April 2020 12:26

$n = 10\ \text{kmol}$

$dT = 0$

reversible: $dU = dQ - dW = dQ - PdV$ ← configuration work

$T = 300\ K$

$P_i = 1\ \text{atm} = 1.01 \times 10^5\ Pa$

$P_f = 10\ \text{atm} = 1.01 \times 10^6\ Pa$

ideal gas: $PV = nRT$, $\beta = \frac{1}{T}$, $\kappa = \frac{1}{P}$

$R =$

exact differential of $V(T, P)$:

$$dV = \left(\frac{\partial V}{\partial T}\right)_P dT + \left(\frac{\partial V}{\partial P}\right)_T dP$$

$dT = 0$

$$\kappa = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$$

$$dV = -\kappa V dP$$

$$PdV = -\kappa PV dP$$

$$dW = -\kappa PV dP$$

$$W = -\int \kappa PV dP$$

$$= -\int \kappa P\, nRT\, dP$$

$$= -\,nRT \int \frac{1}{P} dP$$

$$= \left[-nRT \ln(P)\right]_{P_i}^{P_f}$$

$$= nRT \ln\left(\frac{P_i}{P_f}\right)$$

$$= 10 \cdot 8{,}314 \cdot 10^3 \cdot 300 \ln\left(\frac{1}{10}\right)$$

$$= -3 \cdot 8{,}314 \cdot 10^6 \ln(10)$$

$$\kappa = -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T$$

$$= -\frac{P}{nRT}\left(\frac{\partial}{\partial P}\frac{nRT}{P}\right)_T$$

$$= -\frac{P\, nRT}{nRT} \cdot -\frac{1}{P^2}$$

$$= \frac{1}{P}$$