M3.8 (5.4a, 7th Ed.) - ANSWER

Express $\left(\frac{\partial S}{\partial V}\right)_T$ in terms of α and κ_T.

$$\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial p}{\partial T}\right)_V \qquad \boxed{\text{M.R.}}$$

$$\left(\frac{\partial p}{\partial T}\right)_V \left(\frac{\partial T}{\partial V}\right)_p \left(\frac{\partial V}{\partial p}\right)_T = -1 \qquad \boxed{\text{CR}}$$

$$\left(\frac{\partial p}{\partial T}\right)_V = -\frac{\left(\frac{\partial V}{\partial T}\right)_p}{\left(\frac{\partial V}{\partial p}\right)_T}$$

$$\alpha = \frac{1}{V}\cdot\left(\frac{\partial V}{\partial T}\right)_p$$

$$\kappa_T = -\frac{1}{V}\left(\frac{\partial V}{\partial p}\right)_T$$

$$\left(\frac{\partial p}{\partial T}\right)_V = \boxed{+\frac{\alpha}{\kappa_T}}$$

M.3.8b (5.4b, 7th Ed.)

$\left(\frac{\partial S}{\partial p}\right)_T$ in terms of α

$$\left(\frac{\partial S}{\partial p}\right)_T = -\left(\frac{\partial V}{\partial T}\right)_p = -V\underbrace{\frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p}_{\alpha} = \boxed{-V\alpha}$$

M3.10a (5.14a, 7th Ed)

Molar Helmholtz energy of a gas given as:

$$A_m = -\frac{a}{V_m} - RT\ln(V_m - b) + f(T)$$

Obtain EOS of gas.

$\boxed{\text{FET}}$ $dA_m = -SdT - pdV_m$

$\boxed{\text{Th D.}}$ of p: $p = -\left(\frac{\partial A_m}{\partial V_m}\right)$

Hence, substitute in for A_m to make the EOS:

$$p = -\frac{\partial}{\partial V_m}\left[-\frac{a}{V_m} - RT\cdot\ln(V_m - b) + f(T)\right]$$

$$= -\frac{a}{V_m^2} + RT\frac{1}{V_m - b} = \boxed{-\frac{a}{V_m^2} + \frac{RT}{V_m - b}}$$

note: this is the VdW eqn!

M3.10b (5.14b, 7th)

$G = RT\ln p + A + Bp + \frac{1}{2}Cp^2 + \frac{1}{3}Dp^3$. Find EOS.

$dG = -SdT + Vdp$, so Th D. $V = \left(\frac{\partial G}{\partial p}\right)_T$

$$V = \frac{d}{dp}(G) = \boxed{\frac{RT}{p} + B + Cp + Dp^2}$$ VIRIAL EQU'N