16. In problem 8-17 we showed that for a vdw gas (see also section 10.7):
\[
\left(\frac{\partial E}{\partial V}\right)_T = \alpha/V^2; \quad \text{for } \text{CO}_2 \quad \alpha = 0.364 \text{ m}^2 \text{ Pa} \text{ mol}^{-1}
\]
\[
\int dE = 0.364/\alpha V^2; \quad \Delta E = -0.364[(1/V_2) - (1/V_1)] =
\]
\[
= -0.364[(1/7.982 \times 10^{-3}) - (1/24.237 \times 10^{-3})]
\]
\[
= - 0.364(0.0402) = - 30.6 \text{ J mol}^{-1}
\]

17. \( \alpha = (1/V)(\partial V/\partial T)_p \); Now using Eq. (8.29) and the result of Prob. 8-15
\[
\left(\frac{\partial C_p}{\partial P}\right)_T = \left(\frac{\partial a}{\partial P}\right) (\alpha/\alpha T) = \alpha^2 H/\alpha T P = \alpha^2 H/\alpha T P = \left(\frac{\partial a}{\partial T}\right) (\alpha / \alpha T) =
\]
\[
= (\partial/\partial T)[V - T(\partial V/\partial T)] = (\partial V/\partial T) - (\partial V/\partial T) + T(\partial^2 V/\partial T^2) =
\]
\[
= T(\partial^2 V/\partial T^2) + V(\partial a/\partial T) + Ta(\partial a/\partial T) (\alpha = 1/T)
\]
\[
= -TV/T^2 + V = -V/T + V/T = 0 \quad (\text{since } \alpha = 1/T)
\]

18. \( \left(\frac{\partial C_p}{\partial P}\right)_T = (\partial a/\partial P)(\partial V/\partial T)_P = \alpha^2 H/\alpha T P = \alpha^2 H/\alpha T P = (\partial a/\partial T)(\partial H/\partial P) \)

(note that \( \partial H/\partial P = V - T(\partial V/\partial T) \) see Eq. (8.29) and Prob. 8-15)

and \( (\partial a/\partial T)[V - T(\partial V/\partial T)] = (\partial V/\partial T) - T(\partial^2 V/\partial T^2) - (\partial T/\partial T)(\partial V/\partial T) \)

thus \( (\partial C_p/\partial P)_T = -T(\partial^2 V/\partial T^2) \)

20. \( \Delta G^o_f = 37,357 + 16.2T - 0.83T^2; \quad (\partial \Delta G/\partial T) = (\Delta G - \Delta H)/T = 16.2 - 1.86T \)

\[
\Delta H = \Delta G - T(\partial \Delta G/\partial T) = 37,357 + 16.2T - 0.83T^2 - T(16.2 - 1.68T)
\]

\[
\Delta H^o_f = 37,357 + 0.83T^2
\]

26. a. Consider the following three step process, each step being reversible:
   
   I. liq(268 K, 421.7 Pa) \rightarrow gas(268 K, 421.7 Pa)

   II. gas(268 K, 421.7 Pa) \rightarrow gas(268 K, 401.7 Pa)

   III. gas(268 K, 401.7 Pa) \rightarrow ice(268 K, 401.7 Pa)

b. \( \Delta G_I = \Delta G_{III} = 0 \) since the two phases are in equilibrium

\[
\Delta G_{II} = -RT \ln (P_1/P_2) = -(8.314)(268) \ln (421.7/401.7) = -108.3 \text{ J mol}^{-1}
\]

For the overall process \( \Delta G = \Delta G_I + \Delta G_{II} + \Delta G_{III} = -108.3 \text{ J mol}^{-1} \)