1-7. $\alpha = \frac{1}{V}\left(\frac{\partial V}{\partial T}\right)_p$

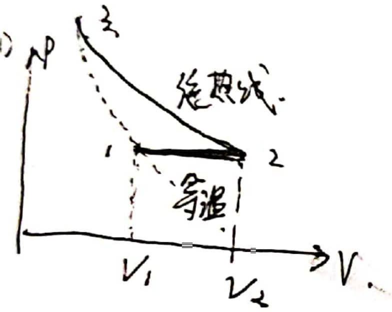
$(p+\frac{a\gamma^2}{V^2})(V-\gamma b)=\gamma RT = pV - p\gamma b + \frac{a\gamma^2}{V} - \frac{a\gamma^3 b}{V^2}$

$(-\frac{2a\gamma^2}{V^3}(V-\gamma b)+p+\frac{a\gamma^2}{V^2})dV=\gamma R dT$

$= (-\frac{a\gamma^2}{V^2}+\frac{2a\gamma^3 b}{V^3}+p)dV=\gamma R dT \rightarrow \frac{dV}{dT}=\frac{\gamma R V^3}{-a\gamma^2 V+2a\gamma^3 b+pV^3}$

$\alpha = \frac{\gamma R V^2}{-a\gamma^2 V+2a\gamma^3 b+pV^3}$

2-1. (1)



$p_1 = \frac{\gamma RT}{V} = \frac{2R\times 300}{20\times10^{-3}} = 6R\times10^4\ \text{Pa} = 4.986\times10^5\ \text{Pa}$

(2) $Q = W_{12}+\Delta U_{12}$

$= p(V_2-V_1)+\frac{5}{2}(pV_2-pV_1) = \frac{7}{2}\times p\times 20\times10^{-3}$

$= 3.5\times10^4\ \text{J}$

(3). $\Delta U = 0$.

(4). $W = Q = 3.5\times10^4\ \text{J}$

2-3.

$p(V-b)=RT$

$\rightarrow pd(V-b)+(V-b)dp = RdT$

$dU_m + pdV = 0 \rightarrow C_{V,m}dT = -pdV$

$\rightarrow pd(V-b)+(V-b)dp = -\frac{Rp}{C_{V,m}}dV = -\frac{Rp}{C_{V,m}}d(V-b)$

$\rightarrow \frac{C_{V,m}+R}{C_{V,m}}\cdot pd(V-b)+(V-b)dp=0$

$\rightarrow p(V-b)^{\frac{C_{p,m}}{C_{V,m}}} = C \rightarrow p(V-b)^{\gamma}=C.$

2-5.

等压：$dQ = dU + pdV$

$(p+\frac{a}{V^2})(V-b) = RT.$

$pdV + \frac{a}{V^2}dV - \frac{2a}{V^3}(V-b)dV = RdT.$

$pdV - \frac{a}{V^2}dV + \frac{2ab}{V^3}dV = RdT.$

$dQ = CdT + \frac{a}{V^2}dV + pdV$

$= CdT + (\frac{a}{V^2}+p)\cdot\frac{R}{(p - \frac{a}{V^2} + \frac{2ab}{V^3})}dT.$

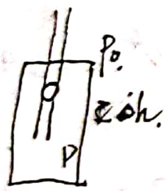
$C_{p,m} = \frac{dQ}{dT} = C + \frac{(\frac{a}{V^2}+p)R}{p-\frac{a}{V^2}+\frac{2ab}{V^3}}.$

等体：$dQ = dU$

$dQ = CdT$

$C_{V,m} = C.$

2-7.



平衡位置：$(p-p_0)A = mg.$

$(p_0+mg)V = nRT.$

$p_1\cdot(V-A\Delta h) = nRT.$

$\rightarrow p_1 = \frac{(p_0+mg)V}{V-A\Delta h}.$

$F = (p_1-p)A = \frac{(p_0+mg)VA - pAV + pA^2\Delta h}{V-A\Delta h}.$

$= \frac{(p_0+mg)A^2\Delta h}{V-A\Delta h} = ma$

$\approx \frac{(p_0+mg)}{V}A^2\Delta h$

$T = 2\pi\sqrt{\frac{mV}{(p_0+mg)A^2}}$