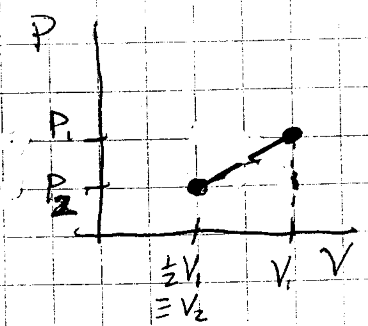
Assignment 2 due May 23, 2007

Problems from Carter 3-3,4,6,8,10,11

3-3) Reversible compression of ideal gas keeping $P = AV$

(a)




(b) $\left.\begin{array}{l} P_1V_1 = nRT_1 \\ P_2V_2 = nRT_2 \end{array}\right\} \quad T_2 = T_1 \dfrac{AV_2^2}{AV_1^2} = T_1\left(\tfrac{1}{2}\right)^2 = \dfrac{T_1}{4}$

(c) $W = \int_1^2 P\,dV = \int_1^2 AV\,dV = \frac{A}{2}\left(V_2^2 - V_1^2\right) = P_1V_1\left(-\frac{3}{8}\right)$

work done by the gas = −(work done on the gas)

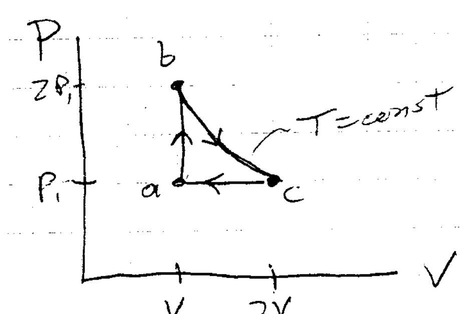
3-4) 10 kg of ice has volume $V = \frac{m}{\rho} = 1.09 \cdot 10^{-2}\ m^3$

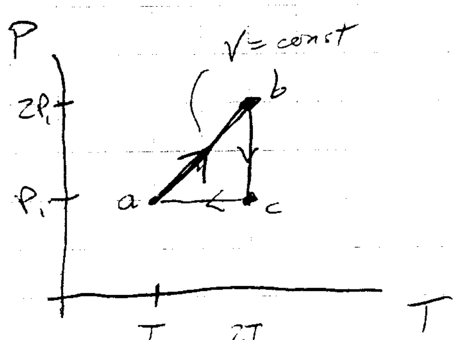
" " water " " $1.00 \cdot 10^{-2}\ m^3$

upon melting, $\Delta V = 0.9 \cdot 10^{-3}\ m^3$

Pressure = 1 atm $\simeq 10^5\ N/m^2 \rightarrow W = +90\ J$ by the $H_2O$ on the atmosphere

3-6) (a)




(b) $n = 2$ kilomoles, $P_1 = 2atm$, $V_1 = 4m^3$

$W_{ab} = 0 \quad (V = const)$

$W_{bc} = \int_{V_1}^{2V_1} \frac{nRT}{V}\,dV = nRT\ln 2 = 2P_1V_1\ln 2 = 2(0.56\ MJ) = 1.12\ MJ$

$W_{ca} = P_1(-2V_1 + V_1) = (-0.41\ MJ)\cdot 2 = -0.81\ MJ$

$W_{net} = (0.15\ MJ)\cdot 2 = 0.31\ MJ$

Assignment 2 continued

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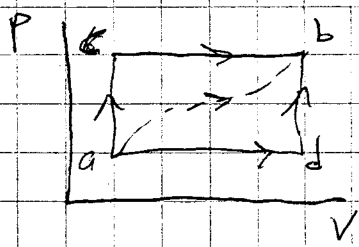
3-8) Path a-c-b $\Rightarrow Q_{acb} = 80J$, $W_{acb} = 30J$




$\therefore U_b - U_a = Q_{acb} - W_{acb} = 50J$

(a) $W_{adb} = 10J \Rightarrow Q_{adb} = W_{adb} + \Delta U$
$= 10J + 50J = 60J$

(b) $W_{ba} = -20J \rightarrow Q_{ba} = -50J - 20J = -70J$

(c) Given $U_d = 40J$, $U_a = 0J \Rightarrow U_b = 50J$

$Q_{ad} = 40J + W_{ad} = 40J + 10J = 50J$

$Q_{db} = 10J + W_{db} = 10J$ ($W_{db} = 0$ since $V_b = V_d$)

3-10) T constant, $P_o = 1atm$, $P_f = 500atm$, $m = 0.100kg$

$\rho = 8.90 \cdot 10^3 kg/m^3$, $\kappa = 6.75 \cdot 10^{-12} Pa^{-1}$

$dv_T = -\kappa v dP_T = -\kappa \frac{m}{\rho} dP_T \longrightarrow W = \int P dv = \int_{P_o}^{P_f} P\left(-\frac{\kappa m}{\rho}\right) dP$

$W_{\text{by system}} = \frac{\kappa m}{2\rho}(P_o^2 - P_f^2) = -0.097J = -W_{\text{on system}}$

3-11) $V_1 = 1.0m^3$, $V_2 = 1.8m^3$, $P_1 = 1bar$, $P_2 = \frac{1}{2}bar$, $U = 800T$

(a) $V = AP + B$ $\quad \Delta V = A\Delta P \rightarrow A = -1.6 \cdot 10^{-5} \frac{m^5}{N}$, $B = 2.6m^3$

(b) $T_2 = T_1 \frac{P_2 V_2}{nR}\left(\frac{nR}{P_1 V_1}\right) = 300K \cdot 0.9 = 270K$

(c) $+W_{\text{by gas}} = +\int_{V_1}^{V_2} P dV = +\int_{V_1}^{V_2} \left(\frac{V - B}{A}\right) dV = \frac{2B - V}{2A} \cdot V \Big|_{V_2}^{V_1} = +6.0 \cdot 10^4 J$

d) $Q = \Delta U + W = 800(270K - 300K) + 6.0 \cdot 10^4 J = 3.6 \cdot 10^4 J$