10.2 已知：$Q_{acb} = 560J$，$W_{acb} = 356J$，$W_{adb} = 220J$，$W_{ba} = -282J$

求：Q_{adb}，Q_{ba}

解：$Q_{adb} = E_b - E_a + W_{adb} = Q_{acb} - W_{acb} + W_{adb} = 560 - 356 + 220 = 424J$

$Q_{ba} = E_a - E_b + W_{ba} = -(Q_{acb} - W_{acb}) + W_{ba} = -(560-356) + (-282) = -486J$

10.5 已知：$p = 4\times10^5 Pa$，$Q_0 = 6\times10^4 J$，$T_1 = 0°C = 273K$，$T_2 = 50° = 323K$

求：ν，ΔE，W，Q

解：由 $Q_0 = \nu C_{p,m}(T_2-T_1) \Rightarrow \nu = \frac{Q_0}{C_{p,m}(T_2-T_1)} = \frac{2Q_0}{(i+2)R(T_2-T_1)} = \frac{2\times6\times10^4}{(5+2)\times8.31\times(323-273)} = 41.3mol.$

$\Delta E = \nu . C_{v,m}(T_2-T_1) = \nu \cdot \frac{i}{2} R(T_2-T_1) = 41.3\times\frac{5}{2}\times8.31\times(323-273) = 4.29\times10^4 J$

$W = Q_0 - \Delta E = 6\times10^4 - 4.29\times10^4 = 1.71\times10^4 J$

$Q = \Delta E = 4.29\times10^4 J$.

10.15. 已知：$pV^n=C, n=0,1,\gamma,\infty$

求：A'，C_m

解：(1) $pV^0=p$，等压过程

$pV^1=pV$，等温过程

pV^γ，绝热过程

$pV^\infty=$常量 $\Rightarrow p^{\frac{1}{\infty}}\cdot V=$常量．$\because p^{\frac{1}{\infty}}\to 1$，故 pV^∞ 是等体过程．

(2)
$$A'=-\int_{V_1}^{V_2} p\,dV=-\int_{V_1}^{V_2}\frac{C}{V^n}dV=\frac{C}{n-1}(V_2^{1-n}-V_1^{1-n})$$

$$=\frac{p_2V_2^nV_2^{1-n}-p_1V_1^nV_1^{1-n}}{n-1}=\frac{p_2V_2-p_1V_1}{n-1}$$

(3)
$$C_m=\frac{Q}{T_2-T_1}=\frac{\Delta E+A}{T_2-T_1}=\frac{\Delta E-A'}{T_2-T_1}=\frac{C_{V,m}(T_2-T_1)-\frac{R}{n-1}(T_2-T_1)}{T_2-T_1}$$

$$=C_{V,m}-\frac{R}{n-1}=C_{V,m}-\frac{\gamma C_{V,m}-C_{V,m}}{n-1}=C_{V,m}\cdot\left(\frac{\gamma-n}{1-n}\right)$$

$n=0$，$C_{p,m}=\gamma C_{V,m}$

$n=1$，$C_{T,m}=\infty$，吸热不会使温度升高

$n=\gamma$，$C_{S,m}=0$ 不吸热温度也能升高。

$n=\infty$，$C_{V,m}=C_{V,m}$．

10.16. 已知：$V_{A0}=2\times10^{-2}m^3$，$V_{B0}=2\times10^{-2}m^3$，$\nu_A=\nu_B=1mol$，$P_{A0}=P_{B0}=1.013\times10^5 Pa$

$V=4\times10^{-2}m^3$，$V_{A1}=1\times10^{-2}m^3$，$V_{B1}=3\times10^{-2}m^3$

求：(1) B的气体过程方程，(2) T_{A1}，T_{B1}，(3) Q_B

解：(1) A中进行绝热过程：

$$P_AV_A^\gamma=C=P_{A0}V_{A0}^\gamma=1.013\times10^5\times(2\times10^{-2})^{1.4}=4.24\times10^2$$

隔板上升时：$P_A=P_B$，$V_A=V-V_B=4\times10^{-2}-V_B$

故B的气体过程方程为：

$$P_B(4\times10^{-2}-V_B)^\gamma=4.24\times10^2 \quad ①$$

(2)
$$T_{A1}=T_{A0}\left(\frac{V_{A0}}{V_{A1}}\right)^{\gamma-1}=\frac{P_{A0}V_{A0}}{\nu_AR}\left(\frac{V_{A0}}{V_{A1}}\right)^{\gamma-1}=\frac{1.013\times10^5\times2\times10^{-2}}{1\times8.31}\times\left(\frac{2\times10^{-2}}{1\times10^{-2}}\right)^{1.4-1}=322K.$$

①式中代 $P_B=\frac{\nu_BR\cdot T_B}{V_B}$ $\Rightarrow T_B(0.04-V_B)^\gamma=51V_B$

$$T_{B1}=\frac{51V_{B1}}{(4\times10^{-2}-V_{B1})^{1.4}}=\frac{51\times3\times10^{-2}}{(4\times10^{-2}-3\times10^{-2})^{1.4}}=965K$$

(3)
$$Q_B=\Delta E_B+W_B=\frac{i}{2}R(T_{B1}-T_{B0})+\int_{V_{B1}}^{V_{B2}}P_B\,dV_B=\frac{i}{2}R\left(T_{B1}-\frac{51V_{B0}}{(4\times10^{-2}-V_{B0})^{1.4}}\right)+\int_{V_{B1}}^{V_{B2}}\frac{4.24\times10^2}{(4\times10^{-2}-V_B)^{1.4}}dV$$

$$=\frac{5}{2}\times8.31\times\left(965-\frac{51\times2\times10^{-2}}{(4\times10^{-2}-2\times10^{-2})^{1.4}}\right)+\frac{4.24\times10^2}{1-1.4}\times\left((2\times10^{-2})^{-0.4}-(10^{-2})^{-0.4}\right)$$

$$=1.66\times10^4 J$$

10.18. 已知：ab，cd 绝热过程，bc 等压过程，da 等容过程

求：η

解：bc 过程吸热 $Q_1 = \nu C_{p,m}(T_c - T_b)$

da 过程放热 $Q_2 = \nu C_{V,m}(T_d - T_a)$

此时 $\eta = 1 - \frac{Q_2}{Q_1} = 1 - \frac{C_{V,m}(T_d - T_a)}{C_{p,m}(T_c - T_b)} = 1 - \frac{1}{\gamma} \frac{\left(\frac{T_d}{T_a} - 1\right)}{\frac{T_b}{T_a}\left(\frac{T_c}{T_b} - 1\right)}$

注意到 ab 为绝热过程，故：$\frac{T_b}{T_a} = \left(\frac{V_1}{V_2}\right)^{\gamma-1}$

同理，cd 为绝热过程，$\frac{T_c}{T_d} = \left(\frac{V_1}{V_1'}\right)^{\gamma-1}$

又因为 bc 为等压过程，$\frac{T_b}{T_c} = \frac{V_2}{V_1'}$

$\therefore \frac{T_d}{T_a} = \frac{T_d}{T_c} \times \frac{T_c}{T_b} \times \frac{T_b}{T_a} = \left(\frac{V_1'}{V_2}\right)^{\gamma}$

$\therefore \eta = 1 - \frac{1}{\gamma} \cdot \frac{\left(\frac{V_1'}{V_2}\right)^{\gamma} - 1}{\left(\frac{V_1}{V_2}\right)^{\gamma-1}\left(\frac{V_1'}{V_2} - 1\right)}$

10.19. 已知：ab，cd，ef 等温过程，bc，de，fa 绝热过程，$Q_{cd} = Q_{ef}$

求：η

解：ab 过程吸热：$Q_{ab} = \nu RT \ln \frac{V_b}{V_a}$

cd 过程吸热：$Q_{cd} = \nu RT_2 \ln \frac{V_d}{V_c}$

ef 过程放热：$Q_{ef} = \nu RT_1 \ln \frac{V_e}{V_f}$

bc 绝热：$\frac{T}{T_2} = \left(\frac{V_c}{V_b}\right)^{\gamma-1}$

de 绝热：$\frac{T_2}{T_1} = \left(\frac{V_e}{V_d}\right)^{\gamma-1}$

fa 绝热：$\frac{T_1}{T} = \left(\frac{V_a}{V_f}\right)^{\gamma-1}$ $\Rightarrow$ $\frac{V_b}{V_a} = \frac{V_c}{V_f} \cdot \frac{V_e}{V_d}$ $\Rightarrow \ln \frac{V_b}{V_a} = \ln \frac{V_e}{V_f} - \ln \frac{V_d}{V_c}$

$\eta = 1 - \frac{Q_{ef}}{Q_{ab} + Q_{cd}} = 1 - \frac{T_1 \ln \frac{V_e}{V_f}}{T \ln \frac{V_b}{V_a} + T_2 \ln \frac{V_d}{V_c}}$

由于 $Q_{cd} = Q_{ef}$，故 $T_2 \ln \frac{V_d}{V_c} = T_1 \ln \frac{V_e}{V_f}$

故 $\eta = 1 - \frac{T_1 \ln \cdot \frac{V_e}{V_f}}{T\left(\ln \frac{V_e}{V_f} - \frac{T_1}{T_2} \cdot \ln \frac{V_e}{V_f}\right) + T_1 \cdot \ln \frac{V_e}{V_f}} = 1 - \frac{T_1 T_2}{T \cdot T_2 - T \cdot T_1 + T_1 \cdot T_2} = \frac{T \cdot T_2 - T \cdot T_1}{T \cdot T_2 - T \cdot T_1 + T_1 \cdot T_2}$

10.21 已知：$T_1 = 25^\circ C = 298K$　$T_2 = 5^\circ C = 278K$，$W = 1MW = 10^6 W$

求：η，Q_2，Q_1，m_1

解：$\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{278}{298} = 6.71\%$

注意到 $Q_1 = W + Q_2$ 和 $\eta = 1 - \frac{Q_2}{Q_1}$

故 $Q_2 = \frac{(1-\eta)W}{\eta} = \frac{(1-6.71\%) \times 10^6}{6.71\%} = 1.39 \times 10^7 J$

又 $\because Q_1 = Cm_1\Delta T = W + Q_2$，

$\therefore m_1 = \frac{W+Q_2}{C\Delta T} = \frac{10^6 + 1.39\times10^7}{4.18\times10^3\times(298-278)} = 178 kg$.

$\therefore$ 以 178 kg/s 的速率取水.