1. $W = Q_1 - Q_2$.

$\eta = \frac{W}{Q_1} = 1 - \frac{T_2}{T_1}$.

$C_V \cdot 0.01 = 2\times10^{13} J \times 60\times60\times24\times365\times1000 = 6.307\times10^{22}$

$W = \int_{T_2}^{T_1} \left(1-\frac{T_2}{T}\right) C_V dT = C_V \left(T_1 - T_2 - T_2 \ln\frac{T_1}{T_2}\right) \approx 1.13\times10^{7} J$.

2. $T = \frac{T_1+T_2}{2}$

$S = \int_{T_1}^{T} \frac{Cm\,dT}{T} + \int_{T_2}^{T} \frac{cm\,dT}{T} = mc\ln\frac{T}{T_1} + mc\ln\frac{T}{T_2} = mc\ln\frac{(T_1+T_2)^2}{4T_1T_2}$.

若$S<0$，则$(T_1+T_2)^2 < 4T_1T_2 \rightarrow (T_1-T_2)^2<0$. 不可能.

$\Delta S_1 = \int_{T_1}^{T_0} \frac{cm\,dT}{T}$. $\Delta S_2 = \int_{T_2}^{T_0} \frac{cm\,dT}{T}$. $\Delta S = mc\ln\frac{T_0^2}{T_1T_2} \geq 0. \rightarrow T_0^2 \geq T_1T_2$.

$cm(T_1 - T_0) = A + cm(T_0 - T_2) \rightarrow T_0 = \frac{\frac{-A}{cm} + T_2 + T_1}{2} \geq \sqrt{T_1T_2}$.

$A \leq cm(T_2 + T_1 - 2\sqrt{T_1T_2})$. $A_{max} = cm(T_1 + T_2 - 2\sqrt{T_1T_2})$.

5.

$\Delta S_{物1} = \int_{T_i}^{T_2} \frac{C_p\,dT}{T} = C_p\ln\frac{T_2}{T_i}$

$\Delta S_{物2} = C_p\ln\frac{T_1}{T_i}$

$\Delta S = C_p\ln\frac{T_1T_2}{T_i^2} \geq 0 \rightarrow T_1T_2 \geq T_i^2$.

$C_p(T_i - T_2) + A = C_p(T_1 - T_i)$.

$\rightarrow A = C_p(T_1 - 2T_i + T_2) \rightarrow T_1 = \frac{A}{C_p} + 2T_i - T_2$

$\rightarrow \frac{T_2A}{C_p} + 2T_2T_i - T_2^2 \geq T_i^2$　　$A \geq C_p\left(\frac{T_i^2}{T_2} + T_2 - 2T_i\right)$.

$A_{min} = C_p\left(\frac{T_i^2}{T_2} + T_2 - 2T_i\right)$.

1 (1) $\bar{x} = \sum_{n=0}^{N} C_N^n \cdot p^n (1-p)^{N-n} (2n-N)$

$= 2\sum_{n=0}^{N} n C_N^n p^n (1-p)^{N-n} - N$

$= 2Np - N$

(2) $\cancel{\overline{x^2} = 4N^2p^2 + 4N^2p}$

$E(x) = Np. \quad D(x) = Np(1-p) = E(x^2) - E(x)^2$

$\rightarrow \sum_{n=0}^{N} n^2 C_N^n p^n (1-p)^{N-n} = Np - Np^2 + N^2p^2$

$\overline{x^2} = \sum_{n=0}^{N} C_N^n p^n (1-p)^{N-n} (2n-N)^2$

$= 4\sum_{n=0}^{N} n^2 C_N^n p^n (1-p)^{N-n} - 4N\sum_{n=0}^{N} n C_N^n p^n (1-p)^{N-n} + N^2$

$= 4Np - 4Np^2 + 4N^2p^2 - 4N^2p + N^2$

$\bar{x}^2 = 4N^2p^2 - 4N^2p + N^2$

$\overline{x^2} - \bar{x}^2 = 4Np - 4Np^2$