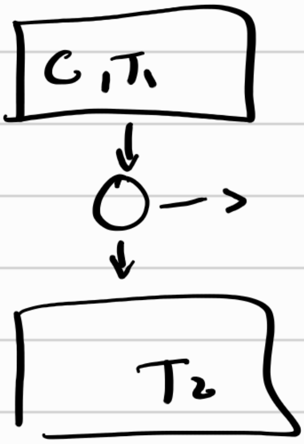
1)



$$W = Q_1 - Q_2$$

$$\frac{Q_1}{Q_2} = \frac{T_1}{T_2} \to Q_1 = \frac{T_1}{T_2} Q_2$$

$$\to Q_2 = \frac{T_2}{T_1} Q_1$$

$$đQ_1 = c\,dT$$

$$đQ_2 = \frac{T_2}{T_1} đQ_1 = T_2\,dS_1$$

$$= T_2 \frac{c}{T} dT$$

$$đW = đQ_1 - đQ_2$$

$$= c\,dT - T_2 \frac{c}{T} dT$$

$$W = \int_{T_1}^{T_2} c\,dT - T_2 \int_{T_1}^{T_2} \frac{c}{T}\,dt$$

$$= c\,(T_2 - T_1) - \left(c\,T_2 \ln\left(\frac{T_2}{T_1}\right)\right)$$

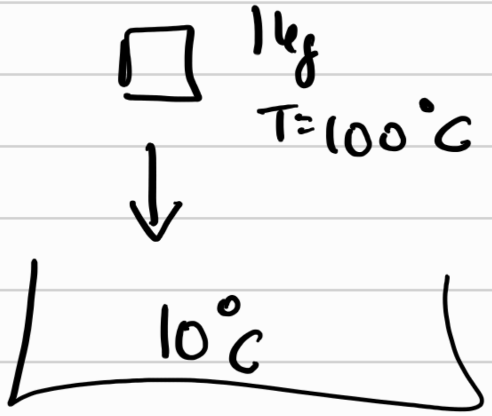
probs [illegible] being AG

$$W = \Delta U_1 - T_2 \Delta S_1$$

$DU = c\,dT$ $\qquad Q_2$

$\Delta U = c(T_2 - T_1)$ $\qquad dS_1 = \frac{c}{T}\,dT$

2) a)



$c = 0.4\,J\,g^{-1}K^{-1}$

$\Delta S = nR\ln\frac{V_f}{V_i}$ $\underbrace{}_{\text{equiv (lake)}}$

$\Delta S = \frac{đQ_{rev}}{T} = \frac{Q_{AS}}{T}$

$\Delta S = \frac{\Delta H}{T} = \frac{Q}{T}$ — no changes

$\cancel{\Delta S \geq 0}$

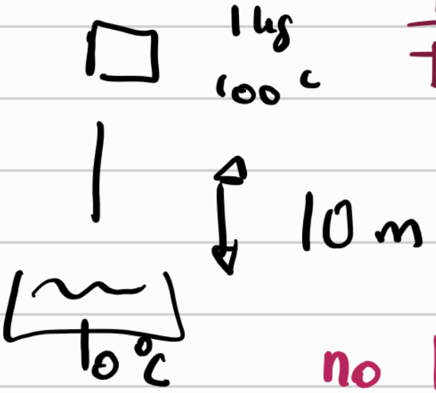
$\Delta S = \Delta S_{lake} + \Delta S_{block}$

$= \int_{T_0}^{T_f} c\frac{dT}{T} + \int_{T_0}^{T_f} c\,dT/T$

$\cancel{= c\,\frac{T_i - T_f}{T_f} - c\ln\frac{T_f}{T_i}}$

if body = lake $\to \frac{1}{T_f}\int_{T_0}^{T_f} c\,\frac{dT}{T} = c\,\frac{T_i - T_f}{}$

b)

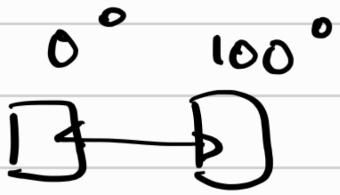


$\Delta S = \frac{\Delta H}{T} = \frac{đQ_{rev}}{T}$ T_f

no heat flow $\Rightarrow \Delta S = \frac{mgh}{}$

$\bar{d}W = -F\,dx \overset{T_f}{=} \bar{d}Q$

c)



$\cancel{c\,\alpha\,T}$

$$T_f = \frac{C_1T_1 + C_2T_2}{C_1 + C_2} = \frac{\cancel{C}\,T_2}{2\cancel{C}} = 50$$

$$\Delta S = \Delta S_0 + \Delta S_{100}$$

$$= c\,\frac{T_{i_0} - T_f}{T_f} - c\ln\frac{T_f}{T_{i_{100}}}$$

$$= \cancel{\frac{0-50}{50}}^{\,-1} - \ln\left(\frac{1}{2}\right)$$

$$= -0.3\ \boxed{[J/K]} \leftarrow \Delta S$$

3) $B \Rightarrow dU = T\,dS + B\cdot dm$

$dU = \bar{d}Q + \bar{d}W$

$\bar{d}Q = T\,dS$

$\bar{d}W = X\,dx$ generalized $\therefore$ $\bar{d}W_B = B\,dm$

Thus $dU = \bar{d}Q + \bar{d}W$ ✓

4) $G = U - TS - B\cdot m$

$$dG = dU - T\,dS - S\,dT - B\,dm$$

$- \, m\,dB$

$$dU = TdS + B\,dm$$

$$\Rightarrow dG = \cancel{TdS} + \cancel{B\,dm} - \cancel{TdS} - SdT - \cancel{B\,dm} - m\,dB$$

$$= -SdT + m\,dB$$ ✓

5) $dB = \dfrac{dG + SdT}{-m}$

$dT = \dfrac{dG + m\,dB}{-S}$

$\dfrac{dB}{dT} = \dfrac{dG + SdT}{+m} \cdot \dfrac{+S}{dG + m\,dB}$

$= \dfrac{dG + S\,dT}{dG + m\,dB} \cdot \dfrac{S}{m}$

Clausius - Clapeyron

$$\left(\frac{dp}{dT}\right)_{\text{bound}} = \frac{S_2 - S_1}{V_2 - V_1}$$

$$\sim \frac{dB}{dT} = -\left(\frac{S_2 - S_1}{m_2 - m_1}\right) \sim$$

$$dG = -S\,dT - m\,dB$$

$$dG = -S\,dT + V\,dp$$

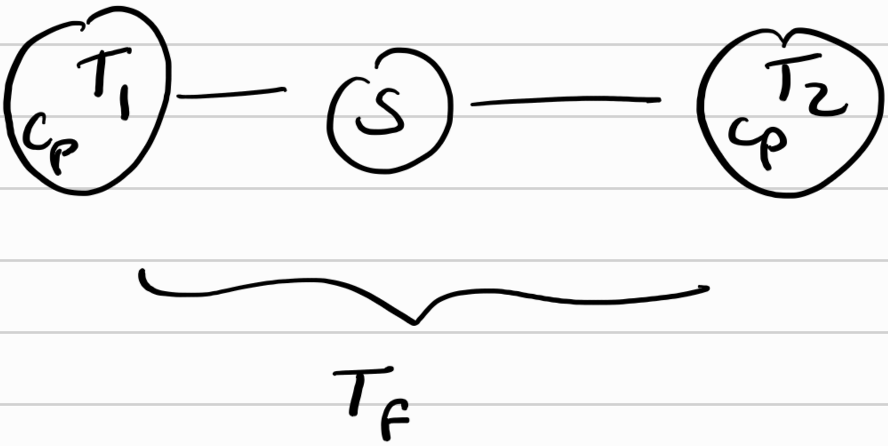
At boundry

$$S_1\,dT + m_1\,dB = S_2\,dT - m_2\,dB$$

$$\therefore (m_1 - m_2)\,dB = (S_2 - S_1)\,dT$$

$$\frac{dB}{dT} = \frac{S_2 - S_1}{m_1 - m_2}$$

b)



a) $W = c(T_1 + T_2 - 2T_f)$

$$w = Q_1 - Q_2$$

$$đw = đQ_1 - đQ_2$$

$$= -\left| \int_{T_1}^{T_f} c\,dT \right| - \left| \int_{T_2}^{T_f} c\,dT \right|$$

$$= -c(T_f - T_1) - c(T_f - T_2)$$

$$= c(T_1 + T_2 - 2T_f)$$

b) $đQ = T\,dS$

$$đQ_1 = T_1\,dS$$

$$đQ_2 = T_2\,dS$$

$$đw = c(T_1 + T_2 - 2T_f) = T_1\,dS - T_2\,dS$$

$$dS\,(T_1 - T_2) = c\,(T_1 + T_2 - 2T_f)$$

$$(T_1 - T_2)\,dS = c(T_1 + T_2) - 2T_f c$$

$$(T_1 - T_2)\,dS - c(T_1 + T_2) = -2T_f c$$

$$\left[(T_2 - T_1)\frac{dS}{c} + T_1 + T_2\right]\frac{1}{2} = T_f$$

correct but not desired dee

$$\Delta S = \int_{T_i}^{T_f} c \frac{dT}{T}$$

$$\Delta S_1 = c \ln\left(\frac{T_f}{T_1}\right)$$

$$\Delta S_2 = c \ln\left(\frac{T_f}{T_2}\right)$$

$$\Delta S = \Delta S_1 + \Delta S_2 = c \ln\left(\frac{T_f^2}{T_1 T_2}\right)$$

relat° α > or <

$$\Delta S \geq 0$$

$$c \ln\left(\frac{T_f^2}{T_1 T_2}\right) > 0$$

$$\ln\left(\frac{T_f^2}{T_1 T_2}\right) > 0$$

$$T_f^2 > T_1 T_2$$

$$T_f \geq \sqrt{T_1 T_2}$$

c) initial temp: T_1, T_2

max W: $W = c(\sqrt{T_1} - \sqrt{T_2})^2$

Max work => $W \uparrow$ possible

thus, $T_f \downarrow$ thus

$$T_f = \sqrt{T_1 T_2}$$

$$W = c\left(T_1 + T_2 - 2\sqrt{T_1 T_2}\right)$$

$$\left(\sqrt{T_1} - \sqrt{T_2}\right)^2 = T_1 + T_2 - 2\sqrt{T_1 T_2}$$

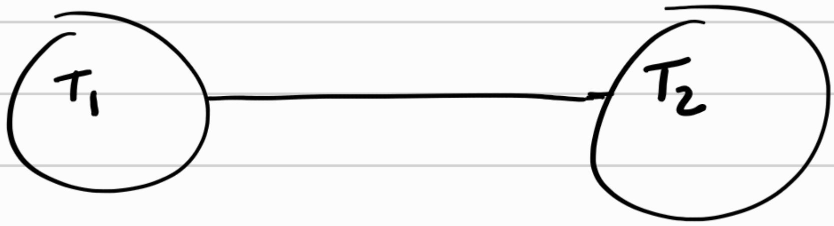
Thus $\Rightarrow$ $W = c\left(\sqrt{T_1} - \sqrt{T_2}\right)^2$ ✓

7) $\Delta S = c_p \ln\left(\frac{T_f}{T_i}\right)$

$$\Delta S = \int_{T_i}^{T_f} c \frac{dT}{T}$$

$$\Delta S = c_p \left(\frac{T_f}{T_i}\right)$$ ✓

8)



Equilibrium $\Rightarrow$ $T_1 = T_2 = T_f$ ⊛

$$\Delta S = \Delta S_1 + \Delta S_2$$

$$= c_p \ln\left(\frac{T_f}{T_1}\right) + c_p \ln\left(\frac{T_f}{T_2}\right)$$

(*) $= c_p \ln\left(\frac{T_1}{T_1}\right) + c_p \ln\left(\frac{T_2}{T_2}\right)$

$= c_p \ln\left(\frac{T_1 T_2}{T_1 T_2}\right)$

(*) $T_1 T_2 = T_f^2$

9) $\Delta Q = \frac{\gamma}{2}\left(T_2^2 - T_1^2\right) + \frac{A}{4}\left(T_2^4 - T_1^4\right)$

prove

$c(T) = \gamma T + A T^3$

$\Delta Q = \int_{T_i}^{T_f} c \, dT$

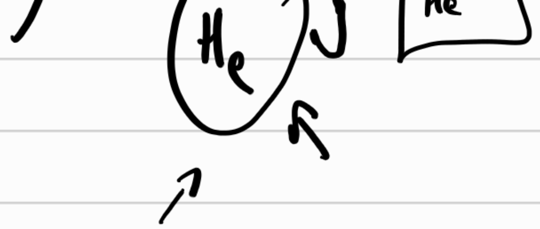
$\Delta Q = \int_{T_1}^{T_2} c \, dT$

$= \int_{T_1}^{T_2} \gamma T + A T^3 \, dT$

$= \left[\gamma \frac{T^2}{2} + \frac{A T^4}{4}\right]_{T_1}^{T_2}$

$= \frac{\gamma}{2}\left(T_2^2 - T_1^2\right) + \frac{A}{4}\left(T_2^4 - T_1^4\right)$

10) Joule - Kelvin effect



compressed gas
$\downarrow$
bigger space

inver.° temp
$\downarrow$
warms up
$\downarrow$
Inflat°

$\geq$ as gas cools this inflat° $\downarrow$

11) $\theta: 100°c \to L_v = 2250$ kJ/kg

$d = 1$ g/cm^3

1 mole

ideal gas

molar mass : 18 g/mol

$\Rightarrow$ working with $18g = 1.8 \times 10^{-2}$ kg

a) Work done phase change (ideal gas): $dW = -pdV$ [kJ]

needs additional work put in

$$dW = -p\,dV$$

$$= -\int p\,dV$$

$$dV = V_g - V_L$$

$$V_g = \frac{nRT}{P} \qquad V_L = \frac{m}{\rho L} = \frac{nM}{\rho L}$$

For the next qst° U need the eqt°s

$$dQ = L n M \quad [kJ]$$

$$\Delta H = dQ + Vdp \quad [kJ]$$

$$\Delta U = dQ + dW \quad [kJ]$$

$$\Delta U = dQ + dW \quad [kJ]$$

$$\Delta S = \frac{dQ}{T}$$

$$dG = -SdT + Vdp$$

12) Clausius - Clapeyron eqⁿ: $\left(\frac{dp}{dT}\right)_{\text{boundary}} = \frac{S_2 - S_1}{V_2 - V_1} = \frac{\Delta S}{\Delta V}$

$$\Delta S = \frac{L}{T}$$

$$pV = nRT$$

$$\Delta V = \frac{nRT}{p}$$

$$\int \frac{dp}{dT}\, dT = \int \frac{\Delta S}{\Delta V}\, dT$$

$$p = \int \frac{L}{T} \frac{p_0}{nRT}\, dT$$

$$= p_0 \int \frac{L}{nRT^2}\, dT$$

$$= p_0 \frac{L}{nR} \int T^{-2}\, dT$$

$$\frac{dp}{dT} = \frac{\Delta S}{\Delta V} = \frac{L}{T} \; \frac{P}{nRT}$$

$$\frac{dp}{dT} = \frac{LP}{nRT^2}$$

$$dp = \frac{LP}{nRT^2} \, dT$$

$$\int dp = \int \frac{LP}{nRT^2} \, dT$$

$$P =$$

$$\frac{dp}{P} = \frac{L}{nRT^2} \, dT$$

$$\int \frac{1}{P} \, dp = \int \frac{L}{nRT^2} \, dT$$

$$\ln(P) = \frac{-L}{nRT} + C$$

not a total der to take note off

$\underbrace{1}_{1\ \text{mole}} =$ $\quad c = \ln(p_0)$

$$\Rightarrow \quad p = p_0 \, e^{-L/RT}$$