XV. PB 1 THEMAL

- •——• string: length, temperature, tens° (, diameter)
  2° (3°)
- $f(x, y, z) = 0 \to x(y, z)$

  $dy = \left(\frac{\partial y}{x}\right) dx + \left(\frac{dy}{\partial z}\right) dz$ } same x, z)

  U can set 1 out of dx, dy, dz to = 0 at a time (can S a diff one for diff q's t°s)
- $\int \ell^2 d\ell = -\frac{1}{\ell}$: perhaps some key $\int$ reminders would be useful in an A4 ⊛
- $\Delta Q = -\Delta U - \Delta W$
- Linear coef of thermal expans° ← not in handwritten notes FIND MORE!

  $\alpha = \frac{1}{\ell} \frac{d\ell}{dT}$
- $\alpha \, dT = \frac{1}{\ell} d\ell$

  $\int \alpha \, dT = \int_{\ell_0}^{\ell} \frac{1}{\ell} d\ell$

  $\alpha (T - T_0) = \ln(\ell/\ell_0) \Rightarrow \ell = \ell_0 e^{\alpha \Delta T}$
- $\alpha = 0$ possible
  - ↳ water < 4°
  - ↳ phone screens
- $c_1 \int_{T_1}^{T_f} dT = c_2 \int_{T_2}^{T_f} dT \Rightarrow T_f = \frac{c_1 T_1 + c_2 T_2}{c_1 + c_2}$

→ have a unit table in A4 + $\int$ key table ← EVERY A4 !

- $W_{out} + Q_{out} = Q_{in}$ } always check for 1st law violat°s
- [T_1, c_1 | T_2, c_2] ↳ O ↑ ↓ $\frac{T_1}{T_2} = \frac{Q_1}{Q_2}$ $W = Q_1 - Q_2$

XVI PB 2 THERMAL

- Joule - Kelvin effect: compressed gas ↓ bigger space } inversion temp ⇓ warm up ⇓ INTEAT° } goes down / goes cools

- [c_1, T_1] ↓ O → ↓ [c_2, T_2]

  $đQ_1 = c\,dT$

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

  ⇓

  $đW = đQ_1 - đQ_2 = c|T_2 - T_1| - |c T_2 \ln\left(\frac{T_2}{T_1}\right)|$

  $\Delta U = c(T_2 - 1)$
  $dS_1 = \frac{c}{T} dT$ } $\Delta U = c(T_2 - T_1)$
- $\Delta S \xrightarrow{\text{heat flow}} \Delta S_1 + \Delta S_2 = \int_{T_{f_{0,1}}}^{T_{f,1\&2}} \frac{c}{T} dT + \int_{T_{f_{0,2}}}^{T_{f,1\&2}} \frac{c}{T} dT$
  (dif heat object 1 & 2)

  $T_{f(1\&2)} = \frac{c_1 T_1 + c_2 T_2}{c_1 + c_2}$

  If body = lake → $\Delta S_{lake} = \frac{1}{T_f} \int_{T_0}^{T_{f,1\&2}} c \, dT = c \frac{T_0 - T_f}{T_f}$

  $\Delta S \xrightarrow{\text{no heat flow}} \frac{mgh}{T_f}$

  with $đW = -F dx = đQ$
- $\Delta S \, [J/K] = \int_{T_i}^{T_f} c \frac{dT}{T} \geq 0$
- $dG = -S\,dT - m\,dB \overset{\alpha}{\Leftrightarrow}$ Clausius - Clapeyron $\left(\frac{dp}{dT}\right)_{bound} = \frac{S_2 - S_1}{V_2 - V_1}$
- Max Work ⇒ $T_f = \sqrt{T_1 T_2}$
- $\Delta Q = \int_{T_1}^{T_f} c \, dT$
- Work done on [phase change] → $đW = -p\,dV$
- $\frac{dp}{dT} = \frac{\Delta S}{\Delta V} = \frac{L}{T} \frac{p}{nRT}$

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

  $\int \frac{1}{p} dp = \int \frac{L}{nRT^2} dT$] ⇒ $p = p_0 e^{-\frac{L}{nRT}}$; $\ln\frac{p}{p_0} = -\frac{L}{nRT}$

  → $dV = V_g - V_L$

  → $V_g = \frac{nRT}{p}$

  → $V_L = \frac{m}{\rho_L} = \frac{nM}{L}$

  → $đQ = L_n M$

  → $\Delta H = đQ + V dp$

  → $\Delta U = đQ + đW$ } [kJ]

  → $\Delta S = \frac{đQ}{T}$

  → $dG = -S\,dT + V\,dp$