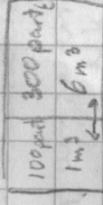


Lecture 4: Entropy, temperature, equilibrium

Equilibrium position of partition

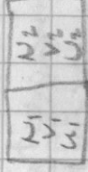


Maximize entropy:

$$\frac{dS_1}{dV_1} = \frac{dS_2}{dV_2}$$

Def of Temp: Why heat flows hot to cold

Two boxes can exchange energy, but not particles or volume.



Constraint:

$$U_1 + U_2 = \text{const}$$

Maximize entropy to find equil: $\frac{dS_1}{dU_1} = \frac{dS_2}{dU_2}$

$$\rightarrow T_1 = T_2$$

$$\frac{dS}{dU} = \frac{1}{T}$$

Relationships:

$$\frac{1}{T} = \left(\frac{dS}{dU} \right)_{V,N}$$

Temp is deriv of entropy. If 2 systems exchange energy, equil is achieved when temps are equal.

$$C_V = \left(\frac{dQ}{dT} \right)_{V,N} = \left(\frac{dU}{dT} \right)_{V,N}$$

Getting change in U:

$$\left(\frac{dU}{dV} \right)_{V,N}$$

$$\frac{1}{T} = \left(\frac{dS}{dU} \right)_{V,N} = \frac{dS(U,V,N)}{dU}$$

$$\Delta S = \int_{U_1}^{U_2} \frac{1}{T} dU$$

$$\Delta U = \int_{T_1}^{T_2} C_V dT \Rightarrow$$

$$\Delta S = \int_{U_1}^{U_2} \frac{C_V(T)}{T} dT$$

Note:

$$\frac{dS}{dV} = \frac{P}{T}$$

$$dS = \frac{dU}{T} + \frac{P}{T} dV = \frac{dQ}{T}$$

$$dU = dQ - PdV$$

$$\Delta U = \int C_V dT - \int PdV$$

$$\Leftarrow dU = dQ - PdV$$

$$dU = C_V dT - PdV$$

Homework 3: Entropy

1) $\frac{1}{T_2} \approx \frac{1}{2.44 \times 10^4}$

2) $C_V = \frac{12!}{2! (12! - 2!)} \approx 0.193$

3) $12 C_6 / 12 \approx 10.2256$

2) 30mg silicon $C_V = 705 \frac{J}{kg \cdot K}$

$\frac{dQ}{dT} = 8mW = 8 \times 10^{-3} W$

$\frac{dT}{dt} = ?$

3) $1.4m \times 1.4m \times 5.2mm$

$k = 0.05 W/m \cdot K$ $T_{in} = 20^\circ C$ $T_{out} = -10^\circ C$

$C_V = C_V \cdot m$

$(8 \frac{J}{K}) \left(\frac{1}{dV \cdot m} \right) = (8) \left(\frac{1}{25.38} \right) \approx 0.3152 \frac{J}{K}$

$\frac{Q}{t} = k A \left(\frac{T_{in} - T_{out}}{L} \right) = 0.05 \left(\frac{1.4 \times 2 \times 10^{-2}}{1.4 \times 10^{-3}} \right) \left(\frac{20 - (-10)}{5.2 \times 10^{-3}} \right) \approx 1009 W$

$\frac{Q}{t} = \frac{W}{m \cdot K} \cdot m^2 \cdot \frac{1}{m} \cdot K$