Phys 214 Exam 1 practice

10/1

Lecture 4: Entropy, temperature, equilibrium

Equilibrium position of partition:

100 part, $1 m^3$	300 particles, $6 m^3$

Maximize entropy: $\frac{dS_1}{dV_1} = \frac{dS_2}{dV_2}$

Def of Temp: Why heat flows hot → cold

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

N_1, V_1, U_1	N_2, V_2, U_2

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: (for const V, n)

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

$\Delta S = \int_{U_i}^{U_f} \frac{1}{T}\, dU \qquad \Delta U = \int_{T_i}^{T_f} C_V\, dT \Longrightarrow \boxed{\Delta S = \int_{U_i}^{U_f} \frac{C_V(T)}{T}\, dT}$

Note: $\frac{dS}{dV} = \frac{P}{T}$. $\qquad dS = \frac{dU}{T} + \frac{P}{T} dV = \frac{dQ}{T} \qquad dU = dQ - pdV$

$\Delta U = \int C\, dT - \int p\, dV \Longleftarrow dU = dQ - pdV \qquad dU = CdT - pdV$

Homework 3: Entropy

1)

1. $\frac{1}{2^{12}} \approx 2.44 \times 10^{-4}$

2. ${}_{12}C_7 = \frac{\frac{12!}{7!(12!-7!)}}{2^{12}} \approx 0.193$

3. ${}_{12}C_6 / 2^{12} \approx 0.2256$

2) 35mg silicon $\quad c_v = 705 \frac{J}{kg \cdot K} \qquad C_V = c_V \cdot m$

$\frac{dQ}{dt} = 8mW = 8\, J/s$

$\frac{dT}{dt} = ? \qquad (8\, J/s)\left(\frac{1}{c_V \cdot m}\right) = (8)\left(\frac{1}{25.38}\right) \approx 0.3152\ K/s$

3) 1.4m × 2.5m, wall = 5.2mm

k: conductivity = 0.05 W/mK $\qquad T_{in} = 20°C \qquad T_{out} = -10°C$

$\frac{Q}{t} = kA\left(\frac{T_1 - T_2}{L}\right) = 0.05(1.4 \cdot 2.5)\frac{(20-(-10))}{5.2 \times 10^{-3}} \approx 1009\ W$

$\frac{J}{s} = \frac{W}{m \cdot K} \cdot m^2 \cdot \frac{1}{m} \cdot K$