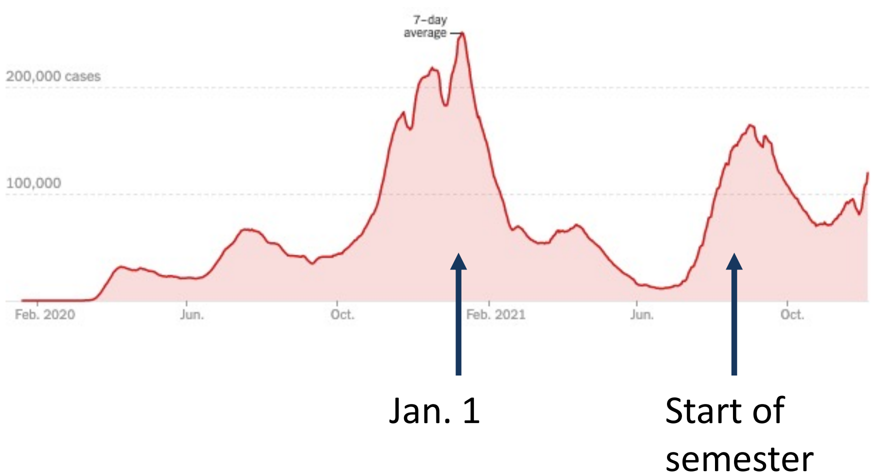
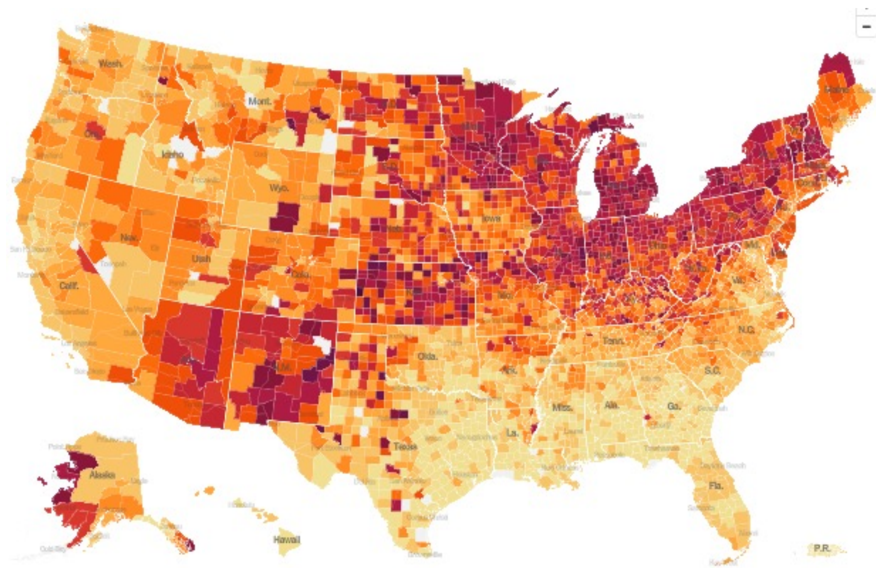
Reminders:

Exam: Will be in room 203, on Friday at 12:30 PM. You can prepare a 1 page formula sheet again (both sides as before).
Other notes: I will post HW 11 solutions tomorrow.

Additional reminder: Be careful & safe especially if visiting family/ traveling over the holidays.





Q: $U = AS^{5/2}/(NV^{1/2})$. Find equations of state?

Also what *external conditions* are addressed in this question? What quantity is *maximized*? What are the conditions on the *chemical potential* that are established at the maximum?

Q: $U = AS^{5/2}/(NV^{1/2})$. Find equations of state?

Follow-up, suppose $F = BT^{5/2}/(NV^{1/2})$. Find S?

Fill in the X's:

$F = U - X$

$H = U + X$

$G = U - X + X$

$\Psi = U - X - X$

And, under what conditions are each minimized at equilibrium?

Also, derive two Maxwell relations from differential forms for Ψ? For H?

Fill in the X's:

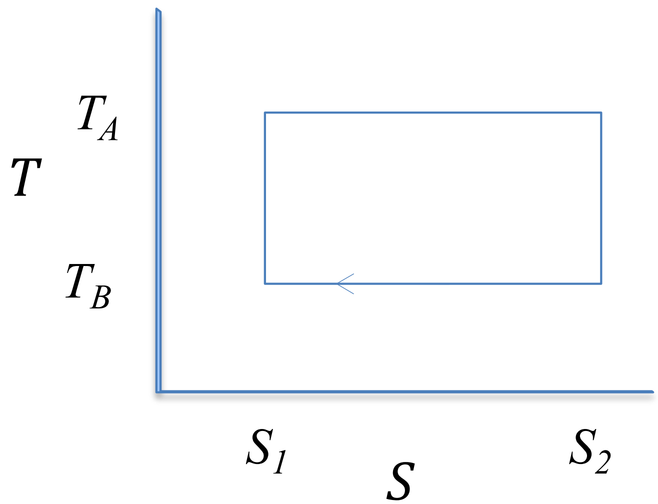
$F = U - X$

$H = U + X$

$G = U - X + X$

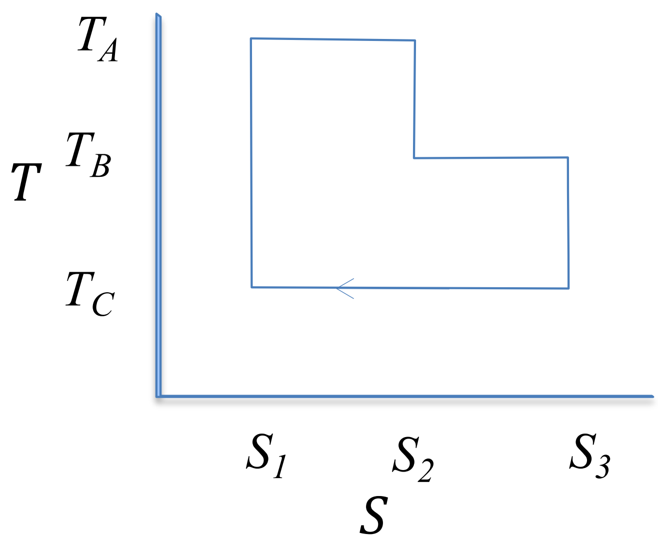
$\Psi = U - X - X$

cycles:



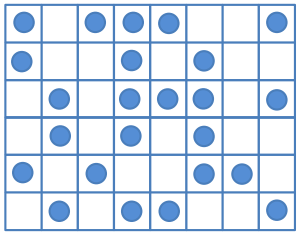
This cycle –

- Ideal gas, or general process?
- Identify the adiabatic processes? Isochoric processes?
- If reservoirs are at temperature T_A, T_B, show that the power produced by this heat engine is zero.
- what is the entropy change of the universe per cycle?

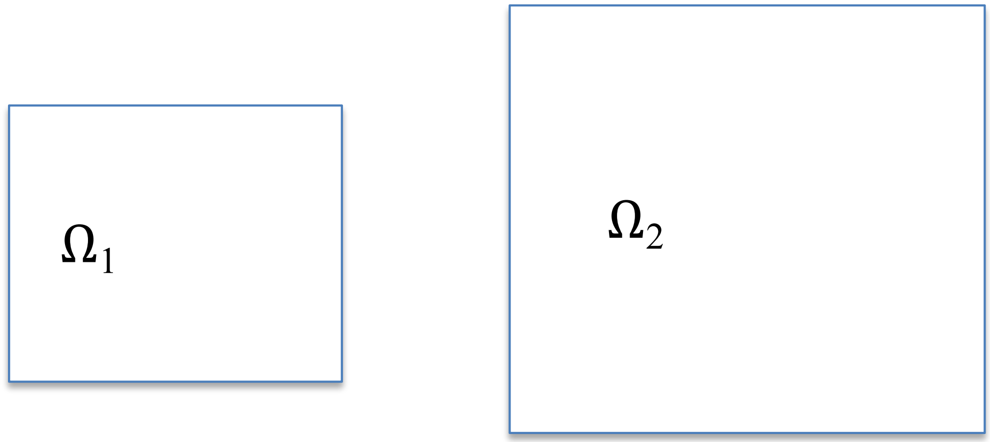


This cycle –

- If 3 reservoirs are at temperatures T_A, T_B, T_c, find the efficiency.
- what is the entropy change of the universe per cycle? (or what if the reservoirs are only T_A, T_c?
- which of the strokes have *no work* done?



N_1 identical particles occupy N lattice sites, what is the entropy?
Sketch the entropy curve, for large N.
What *magnetic* system would have same S?
Same question, if all particles are *distinguishable*?



What is total entropy if two systems brought together but don't interact?

Is this a question for a canonical, microcanonical, grand canonical, etc. picture?

Suppose they interact irreversibly, how will the total multiplicity change?

For this set of equations, show how 2nd derives from the first.
What system is this?
Find the total energy?

Find, $S = k_B\left[3N\ln\left(1+\frac{q}{3N}\right)+q\ln\left(1+\frac{3N}{q}\right)\right]$

$$\frac{1}{T}=\frac{k_B}{\hbar\omega_o}\ln\left(1+\frac{3N}{q}\right)$$

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$$\frac{1}{T} = \frac{k_B}{\hbar\omega_o} \ln\left(1 + \frac{3N}{q}\right)$$

For Debye approx. we used Canonical ensemble instead.
Derive the single-oscillator partition function in that case?
You should recall the differences between these approximations.

Explain how this quantity applies for Einstein oscillators? Debye systems? Blackbody radiation? Bose particles?

$$\frac{1}{(e^{\beta \varepsilon_i} - 1)}$$

Suppose $D(E) = AE^{1/3}$ is given for a system of N independent identical particles. Find U vs. T in the classical limit? (Use the canonical ensemble, solve via the partition function.)

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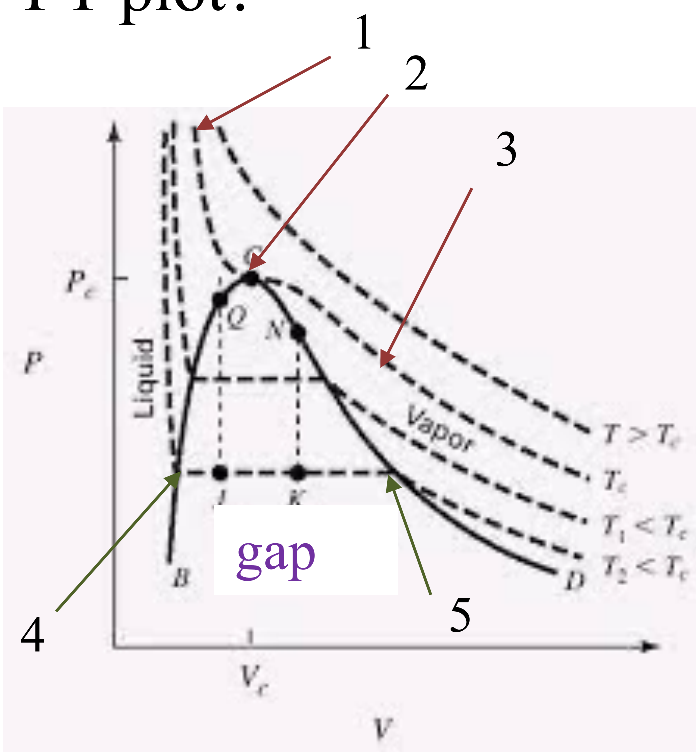
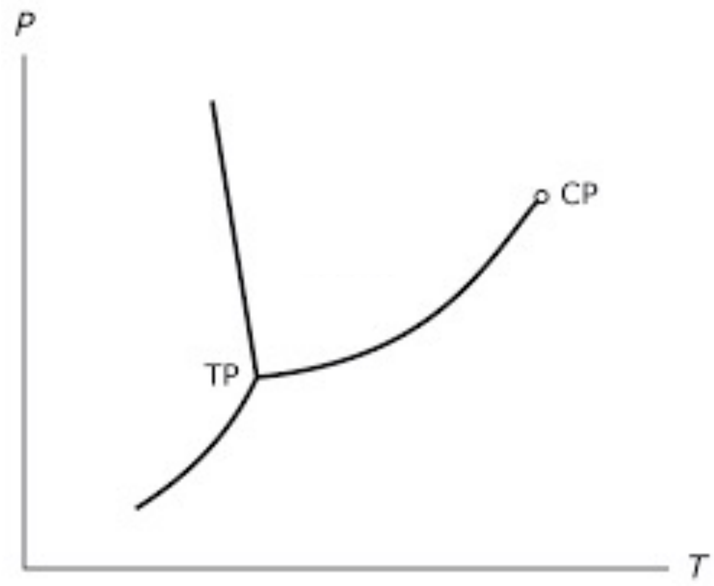
Or, for a Fermi gas of N similar particles, find E_F, and the energy per particle at $T = 0$.

Where is the "gap" region on the plot on the right? (And why no gap on the right?)
Which has the largest G: 1, 2, or 3?
Same question, 4 vs. 5?
What if phases have same molar volume, what happens to the PT plot?





Find the chemical potential based on this entropy?
Suppose then there is a cylinder divided in half with a fixed barrier, at thermal equilibrium, with the barrier permeable to ideal gas #1 but not gas #2. What are the pressures?

$$S = Nk_B ln\left[\frac{V}{N}\left(\frac{4\pi mU}{3Nh^2}\right)^{3/2}\right] + \frac{5}{2}Nk_B$$

Based on these relations find S? What system is this?

$$U = \frac{V\pi^2 (kT)^4}{15(\hbar c)^3} \qquad P = U/(3V)$$

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Look for S proportional to U/T, and from the result show that the overall entropy is increased by the process of the earth absorbing solar radiation, and emitting thermal radiation.