Recitation Nuts and Bolts

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(contributions to 20.110, 20.111, and 20.309)

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Goals of a recitation

- Reinforce lecture material
  - stick to essentials
  - reframe, synthesize
- Teach problem-solving skills
  - demos *and* practice!
  - make steps and assumptions transparent
- Provide meaningful opportunities for interaction
  - not just: “any questions?”
  - one option: “think, pair, share” exercises

- More from Rotem this afternoon!

Anatomy of a recitation

- Typical breakdown
  - 1/4 to 1/3 lecture (max 1/2)
  - 2/3 to 3/4 problems (min 1/2)
- Types of problems
  - algorithmic
    - usually similar to pset or exam
    - teach robust, transferrable strategies
  - conceptual
    - may or may not show up directly on exams
    - regardless, will help in novel applications

Writing on the board

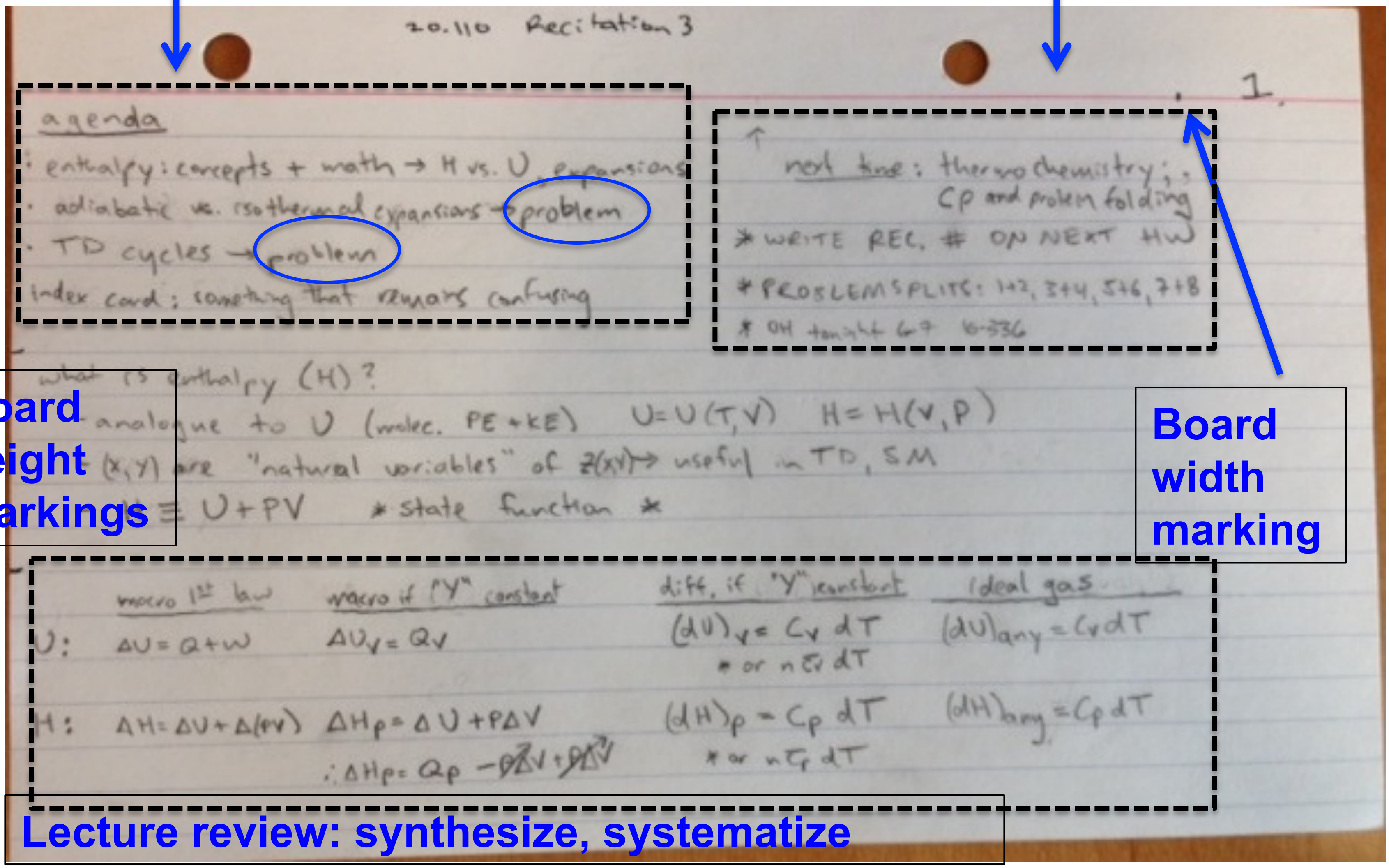
- Board writing order
  - middle board first → stays visible when…
  - … top board next → stays visible when…
  - … bottom board last (if at all; don't write too low).
- Practice! Check from the *back* of the room.
  - big enough?
  - legible?
- Staying within the board neatly
  - see how much content you normally fit on a board
  - map it to a custom-sized index card

Marked up index card examples

- Next few examples come from 20.110 F09
- Layout logistics
- Pedagogical/content tips

Outline for that session
write on board *before* class starts

Announcements
upcoming exams, OH, etc.



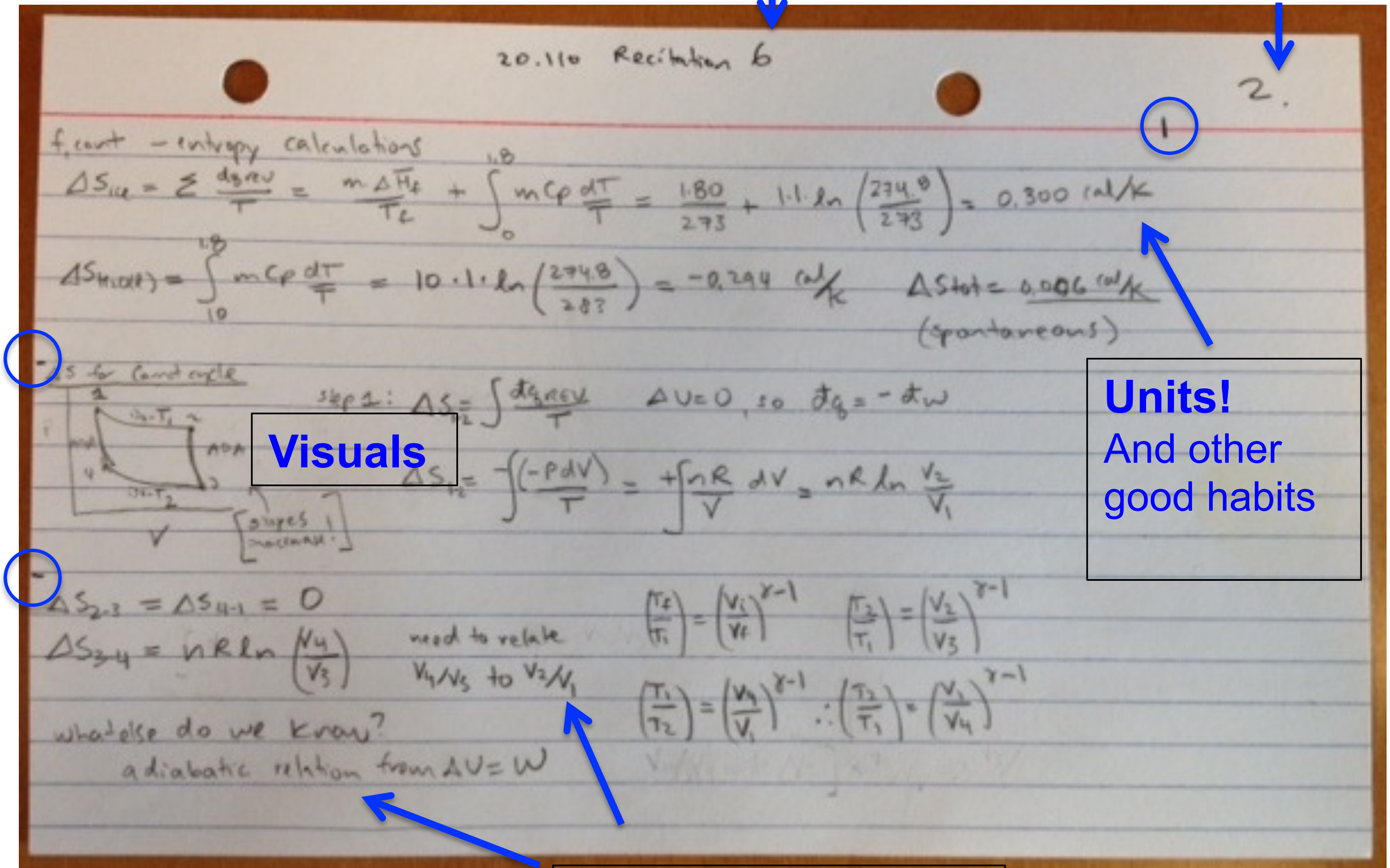
Board height markings

Board width marking

Lecture review: synthesize, systematize

Recitation # on each card

Page # on each card



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2.

f, cont – entropy calculations

$\Delta S_{ice} = \Sigma \frac{dq_{rev}}{T} = \frac{m \Delta H_f}{T_f} + \int_0^{1.8} m C_p \frac{dT}{T} = \frac{1.80}{273} + 1 \cdot 1 \cdot \ln\left(\frac{274.8}{273}\right) = 0.300$ cal/K

$\Delta S_{H_2O(l)} = \int_{10}^{1.8} m C_p \frac{dT}{T} = 10 \cdot 1 \cdot \ln\left(\frac{274.8}{283}\right) = -0.294$ cal/K

$\Delta S_{tot} = 0.006$ cal/K (spontaneous)

ΔS for Carnot cycle

step 1: $\Delta S_{12} = \int \frac{dq_{rev}}{T}$ $\quad \Delta U = 0$, so $đq = -đw$

$\Delta S_{12} = -\int \frac{(-PdV)}{T} = +\int \frac{nR}{V} dV = nR \ln \frac{V_2}{V_1}$

[slopes ...]

$\Delta S_{2\text{-}3} = \Delta S_{4\text{-}1} = 0$

$\Delta S_{3\text{-}4} = nR \ln \left(\frac{V_4}{V_3}\right)$

need to relate V_4/V_3 to V_2/V_1

$\left(\frac{T_4}{T_1}\right) = \left(\frac{V_1}{V_4}\right)^{\gamma-1} \quad \left(\frac{T_3}{T_1}\right) = \left(\frac{V_2}{V_3}\right)^{\gamma-1}$

$\left(\frac{T_1}{T_2}\right) = \left(\frac{V_4}{V_1}\right)^{\gamma-1} \therefore \left(\frac{T_2}{T_1}\right) = \left(\frac{V_3}{V_4}\right)^{\gamma-1}$

what else do we know?

adiabatic relation from $\Delta U = W$

Units!
And other good habits

Visuals

Make logic and steps transparent

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2.

Short lecture segment followed by immediate application

may repeat 2-3x per recitation

Intro to stat mech: multiplicities

$$W = \frac{N!}{n_1! n_{i+1}! \ldots n_t!}$$

N = total objects

t = distinguishable categories of objects

n_i = # of (indistinguishable) objects in i^{th} category

probability = $\frac{\text{part}}{\text{whole}}$

Note where problems come from

D&B = textbook

D&B # 1-2

a.) AAATCGA...

whole = 4^9, part = 1 $\}$ $p_a = 3.8 \cdot 10^{-6}$

b.) AAAAAAAAA $p_b = p_a$

c.) 4 A's, 1 T's, 2 G's, 1 C

$N = 9$ $n_A = 4$ $n_T = 2$ $n_G = 2$ $n_C = 1$

$$\text{part} = W = \frac{9!}{4!\,2!\,2!\,1!} = 3780$$

$p_c = 3780/4^9 = \underline{0.014}$

D&B # 2-1

lattice model of gas

15 particles on 20 or 16, or 15 sites — W's?

• are indistinguishable

a.) $N = 20$ sites categories: + or — •

$$W = \frac{N!}{n_\bullet!\, n_\square!} = \frac{20!}{15!\,5!} = 15{,}504$$

b.) $N = 16$, $n_\bullet = 15$, $n_\square = 1$ → 16

c.) $N = 15$, $n_\bullet = 15$, $n_\square = 0$ → 15

Problems for Recitation 14 (11.02.09, 9 am session)

1. Features of cooperative transitions.

We talked about two features of cooperative transitions that you can see graphically.

(a) Out loud, explain/discuss how a sigmoidal curve indicates cooperativity.

(b) What are x and y for the 2-state helix-coil model? Be careful and specific with your definition of y.

(c) Out loud, explain/discuss how the change in steepness of said sigmoidal curve with system size is in the expected direction. You might use the 2-state model as an example for your discussion.

2. Arbitrary partition functions for helix-coil models.

In class, we discussed examples of non-cooperative and fully cooperative helix-coil systems with independent residues. Using a similar type of partition function as in those cases, answer the following:

a) Only partial helix-coil states can exist. The molecule may never be fully coiled or fully helical. What is q(s) for a 4-mer? Does this model seem physically likely?

b) Unlike a protein with a defined N an C terminus, this molecule looks the same going forwards or backwards through its chemical structure. What is q(s) for a 4-mer? Does this model seem physically likely? What is θ (s, N)?

Recitation number and date

Conceptual/discussion problem

Algorithmic problem(s)

Hand out at the beginning so students can work at own pace, during lecture part if they want to.

Summary and related topics

- Recitations
  - a mix of lecture and problems
  - emphasis on problem-solving approaches
  - broader than just homework content
- Review sessions
  - like a super-recitation
  - both lecture *and* problems are still valuable
- Office hours
  - usually for addressing homework questions