Physics 114 **Doing Seminar Problems** **Spring, 2021**

Rationale: In any physics seminar, the heart of your learning is doing problems. This is how you activate your reading knowledge, and how you grow your skills and understanding. This year, some of us are remote, and all of us are working in small groups, with a brief amount of time to gather to ask questions and present our work. It is particularly good to strategize about how to get the most out of our time apart, time together, and ways to share our insights.

Guidelines:

1. **Collaborating** is warmly encouraged. On the other hand, to get the most from collaboration, best practices say that you should work alone for a while, before you turn to friends in your study circle.
2. During our 90 minute seminar meetings, we'll consolidate our understanding by **discussing problems**. We'll take turns leading the discussion. We'll mention the strategies we used, the answers, their physical interpretation, and how that problem fits into the big picture of statistical physics.
3. **We must be able to rely on each other**, during our meetings and outside of them, to be **respectful and supportive**. Please have high expectations combined with patience for the struggle toward understanding. Asking questions of each other, pointing out possible mistakes and different routes through a problem should happen in a forthright and upbeat manner.
4. In terms of your **workload**, let's try the **5-Step Strategy** described below.

   a. For warmup problems: Aim to do **Steps 1-5** for every problem.

   b. To present problems during our meetings**:** Aim to present **Steps 1-5** for ***most* problems***.* Aim to share and discuss **Steps 1-3** for ***all* problems**. Regardless, if you have answers, let's share and discuss them!

   c. **Please reach out to Amy before Tuesday** (email, office hours) to achieve a. and b. You are welcome to bring friends to work together in office hours :-)

   d. For hand-in problems due a day after seminar: Aim to do in **Steps 1-5** for **every problem.**
5. In our meetings, we will also be talking about **conceptual issues from the reading**, **running simulations**, and showing the **results of simulations** we have found on the Web or authored ourselves. It would be wonderfully helpful if you come to your Tuesday meeting with, insofar as you can, neatly written documents to share:

   • conceptual issues/reading questions

   • numerical and graphical results of codes

   • (if you have authored a code) a short "meta" description of the algorithm, and guidance to where people can find it on deepnotes.com

5-Step Strategy:

Step 1: State the **goal** of doing this problem... what **answer(s)** do we seek? What **laws** or **ideas** of **thermo/stat mech** feed into it?

Step 2: Visualize by drawing sketches of the setup which models the situation. **Define variables**, saying which are known and which are unknown. (One key unknown is always the answer :-)

Step 3: Describe a **method to solve** this problem. Try to summarize it by giving a **logical series of steps**. Include **equations you'll solve** (and maybe mention where in the reading we'd find them?) Describe the kind of **math** you'd employ to get between steps. Mention **approximations** and **other assumptions** needed for your model and method

Step 4: Using the visuals and variables of Step 2, **do the calculations** of Step 3. Get to the answer(s).

Step 5: Reality-check your answer(s): (Correct units? Reasonable order of magnitude?) Talk about their implications and importance ... imagining yourself justifying these to a friend who hasn't looked at the problem. **Does answering this question make you want to ask other questions?** If so, what are they?

What the strategy is *not*:

*It is **not linear.*** No one can read a problem and know (Step 1) all the ideas it involves, then symbolize (Step 2) every needed variable, then successfully outline the steps to solve it (Step 3). Steps 1-3 have to be tested by implementing them in Step 4, and fixed-up as needed. The answer might fail the Step 5 reality check, motivating you to go back and recalculate.

So, it's expected you will will dip your toe into trying to find the answer as you weave back and forth between the steps. However, writing up a beautiful Step 4 takes time which might be better spent making progress on reading or other problems. This is why I suggest **you can stop at documenting Steps 1-3 for many of the problems assigned.** Steps 4 and 5 will show up in discussion, when you hand in problems, and in solutions posted on our Moodle page.

What the strategy *does:*

a. Makes the most of our **synchronous time together** by having a document with an informative start to each problem. With this foundation, we can spend as much time as possible focussing on parts of Steps 4 and 5 that are difficult and/or interesting.

b. Gives people the tools to **finish their "hand-in" problems** by setting them up in seminar.

c. Takes a problem apart and **gets at what challenges us.** This creates transferrable problem-solving skills to let us do similar problems in the future. It reveals issues we might be having with the big concepts, the small techniques, model assumptions, math methods, putting answers in perspective, ...

Example of using the 5-Step Strategy:

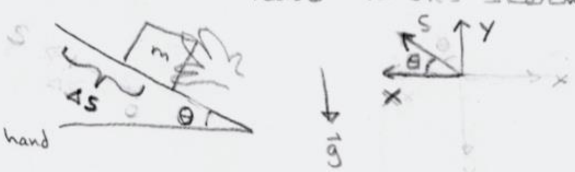
G&T ***Problem*** 2.7 Work

To refresh your understanding of work in the context of mechanics, look at Figure 2.3 and explain whether the following quantities are positive, negative, or zero:
(a) The work done on the block by the hand.
(b) The work done on the block by the Earth.
(c) The work done on the hand by the block. (If there is no such work, state so explicitly.)

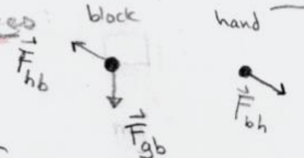
Step 1 Goal: Find the sign of work done on object given situation. This preps us to talk about 1st law of thermo:

$$E_{gained} = W_{on} + Q_{added}$$

Step 2 Fig 2.3 of G&T leads to this sketch:



Forces



Say block moves from $s = 0$ to $s = \Delta s$
Say it has mass $m \Rightarrow \vec{F}_{gb} = mg(-\hat{j})$ is force from earth on block

We seek signs of
(a) W_{hb} (b) W_{gb} (c) W_{bh}

Step 3
- Both G&T (Ch 2) and B&B (Ch. 11) jump to pressure-volume work ... so they assume we know about good old work by a force on a solid object. Looking back at Phys 7:

def $$W_{\substack{by\\ force\\ \vec{F}}} = \int_0^{\Delta s} F_s(s)\,ds \equiv W$$

- We apply this to constant forces so
$$W = F_s \Delta s$$

- We need Newton's 3rd law for part (c)
$$\vec{F}_{hb} = -\vec{F}_{bh}$$

- Ready to solve ... just need to remember how to take a component: $F_s = \vec{F} \cdot \hat{s}$

Step 4 (a) $F_{hb,s} = \vec{F}_{hb} \cdot \hat{s} = F_{hb} > 0$

$\Rightarrow$ $W_{hb} = F_{hb} \Delta s > 0$

(b) $F_{gb} = \vec{F}_{gb} \cdot \hat{s} = mg(-\hat{j}) \cdot \hat{s} = -mg\sin\theta$

$\Rightarrow$ $W_{gb} = -mg\sin\theta \Delta s < 0$

Note: We don't actually need θ to answer their question. But see step 5

(c) $F_{bh} = -F_{hb}$ (By Newton's 3rd)

$\Rightarrow$ $W_{bh} = -W_{hb} < 0$

Step 5 This makes sense. Forces do {positive / negative} work if their projection along a path is {positive / negative}.

It makes me want to ask the further question: What's the net work on block? This would tell me if it speeds up or slows down, for example. To answer it, we'd have to know the ramp angle θ, as well as size of F_{hb} and mg.