SUNY Cortland
Physics Department

Hello Eric,

Thank you for inviting me to attend your Classical Mechanics class on Nov. 1, 2019. Here are my observations and some feedback.

This is the second time that I have observed your Mechanics class for substantially the same topic (i.e., a perturbation analysis of motion in a gravity well). There were clear signs of improvement from last year's course as well as areas for future growth.

You started the course by taking care of some administrative logistics:

- Making ungraded homeworks available for students to use while studying for an upcoming exam.
- Answering questions about the content of the exam and providing suggestions for how students could effectively study for it.
- Discussing an assignment for the writing intensive aspect of the course where you encouraged students to improve their writing (CVs and cover letters) both using your comments and by making use of the Writing Center on campus.

These things completed you started the content of the course with a review of the results from last class. This was done using both equations and sketches of the relevant functions (potential and effective potential). The sketches were clear and you were careful to define all relevant items and to present a physical interpretation of a key quantity (i.e., r_{min}) both in terms of the motion of the object in the gravity well and in terms of the derivation that you were about to perform.

Next you shared your plan, to use perturbation analysis to approximate the effective potential as a parabola centered on r_{min}, and asked the class; Why they should look for a solution of this sort? This question was met with silence. You then pushed further and asked; Why approximate at all? With a back and forth session between you and the students you as a group reach a conclusion that it was useful when a closed form solution is unavailable and because of the ability to make an analogy to the mass-on-a-spring system where the students should have a well-developed understanding of the behavior both quantitatively and qualitatively.

Carrying out your plan you started from equations for the total energy and conservation of angular momentum and through much effort derived equations for $\dot{r}$ and $\dot{\theta}$. Using Taylor series (which you took the time to review) you integrated these to find $r(t)$ and $\theta(t)$ which you sketched to show the important aspects of the behavior. Additionally you ran numerical demonstrations of the orbit and pointed out where approximations started to give important differences with the minimum energy orbit as well as examples of when the approximation was pushed too hard and started to breakdown. You ended the class by going back to the question of why one would perform this analysis in a situation where you already know the shape of the orbit analytically, here you made an appeal to

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using the method in a situation that is already understood so that one is prepared to use it in more complex situations.

During your derivation you seemed to make a sincere effort to involve the students. You fielded a student question about kinetic energy, potential energy, and total energy that revealed that there was erroneous implicit assumption in an equation you had written on the board ($E_{tot}=0$). This you handled with grace and used it as an opportunity to discuss the difference between potential and effective potential and to note that task you were undertaking with them was not a simple one. As another example of class involvement you started to use of conservation of momentum only after extracting that as a voluntary suggestion from the class. Some participation was compulsory where you called on a student to make a contribution by performing the integration of $\theta(t)$ from $\dot{\theta}(t)$. It was clear from the student's body language that she was extremely uncomfortable with this. I talked with you about this afterward where you made it clear that you were trying to foster more participation with this approach and to build greater accountability from the students. I sympathize both with your intentions and with the student's discomfort. In situations where greater participation is the main thrust of calling on students I would encourage you to consider having the students discuss their ideas in small groups before calling on a student in-front of the whole class so that they can try out their ideas where it is easier to save-face if they are wrong and can build confidence if they are right. Finally there was a question toward the end of the derivation that you dismissed as getting off into the weeds. With such an intricate derivation it can be hard for a novice to tell just where the important part of the derivation stops and the weeds start. It is a difficult juggling act to decide how much detail to include, how much math review to give, how many student questions to answer, how much student input to seek and how important it is to make it through to your punchline. I would encourage you to continue your tack toward giving student question greater weight. Either by directly answering them or addressing them (e.g., this takes us into the weeds because …).

The class I saw this year was both more polished than last year's and more inclusive. I look forward to seeing more in the future.

Sincerely,

Douglas Armstead
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