

Physics 314

Classical and Computational Mechanics

Final Project

1 Overview

For your final project, you and your group will build a trebuchet. You can modify your existing catapult or you can start from scratch. With your trebuchet, you will analyze and model the motion of the trebuchet *and* the motion of the projectile once it is launched.

For your trebuchet, try to focus on adding just one new level con complexity. Consider adding:

- A sling
- A swinging basket
- A sling *and* a swinging basket
- Wheels
- Vertical drop trebuchet design
- Wheels and a swinging baskets
- Etc.

You probably want to add just one of these, not many of them.

Then try test-firing it a few times. As you fire it, observe the motion and decide how you plan to model your trebuchet. There are big things you'll definitely want to include, the counter-weight. But you will also have a lot of little things to decide whether to model or not, like flexing in your projectile arm and friction. It's up to you what to model, but justify why you model what you do.

Your first job, then, is to come up with a research plan: what do you want to model and explain and how do you plan to do it? Your ultimate goal is the siege engine effectiveness, so make sure you fold in the aiming/range/damage into your goals. (It should also appear as part of your final talk and paper as a theme.)

Build up a computational model in MATLAB (or other platform, but that's probably your best bet) of the trebuchet using what we've learned this term.

2 Presentation and Paper

During the final exam period, we'll convene you and your group will give a 15-minute presentation. I plan to invite other faculty (and, perhaps, some peers) as an audience, so remember that you're not only speaking to me.

For your presentation, explain what you studied and how you attacked the problem. Consider carefully how much math to show and whether each equation will be helpful for your classmates' understanding. Go

into enough depth so that they understand what you did, but keep it fun and interesting, too. Feel free to come in costume or use some other technique to liven up your presentation.

Also during the final period, we will again hold a contest to see who build the mightiest of trebuchets. As there is only the one group, I think I know who will win. Still, the scoring will be tougher this time than with the earlier problem set version, so work on your range and accuracy. Losing would be embarrassing.

At the end of the presentations, there will be cake. The cake is not a lie.

Your group should submit a final paper at the time of the final exam explaining your findings. It will probably be similar to the talk, but with more details on the math. Papers will be 5 pages in length, plus appendices and figures.

3 Deadlines

3.1 Check-in 1

Before 6 PM on Monday, 14 April, your group needs to email me a report on your progress. Your report should include:

- Group name (Yes, I know there is just one of you; still, have fun with it!)
- What feature you'll study in your trebuchet and your goals
- Anticipated meeting times
- Group member responsibilities
- How the group work is going

3.2 Check-In 2

By 5 PM on Tuesday, 22 April, send another progress report to me with

- Accomplishments
- Contributions of each group member so far
- Anticipate meeting times
- Deadlines
- Upcoming responsibilities, including who is responsible and how long you think it should take
- How you're working as a group

3.3 Consultations

You'll also need to arrange at least one whole-group, technical consultations with John. For each consultation, please email him with any problems or questions you have so far 24 hours in advance of the consultation if possible. At the consultation, we'll discuss challenges you're facing and strategies for tackling them.

To prove your mettle, be sure to present the Lagrangian or Hamiltonian for your system of interest at your first consultation.

3.4 Five-Minute Talk

In tenth week, you'll present a 5-minute talk to John about a *Scientific American*-level article of your group's choice. The talk will be short and is meant as a short preparation for the final talks later. The goal is to practice speaking and presenting technical material. John will offer feedback to the group to help make your final presentation Saturday the best it can be.

3.5 Final Exam Period

Your presentation and test of your trebuchet will happen during this time-slot. Also, your paper is due to John. Everyone must attend.

4 Resources

We have many resources you can use to get help.

4.1 John

John's here and ready to help. Stop by his office or email and he'll do what he can.

4.2 High-Speed Camera and Motion Analysis Software

There is free motion analysis software called called Motion Tracker. (Try the tutorials to get the hang of it.) You can use this to track the parts of your trebuchet and the projectile. The software is at <http://www.cabrillo.edu/~dbrown/tracker/>

How do you get a movie, you might ask? We also have a high-speed camera. Ask if you want to use it.

5 Notes

1. It'll help John if you designate one team-member to email him.
2. Start meeting as early as possible. Arrange tasks and a meeting schedule ASAP.

3. You may use 112 freely for your projects, as well as 113. (But remember that that room is also used by other classes.) But be aware: straighten up after yourself. This rule will be enforced with a penalty of having to debug a long, poorly documented MATLAB program as punishment.
4. This is meant to be an experiment and an experience, not a test. You needn't model everything or do a perfect job. Don't stress out! Have fun with this.

6 Grading

Grading will be roughly 1/3 individual effort and 2/3 group effort.

Here are rough estimates for how the 100 points on the project will be assigned:

Category	Points	Explanation
Trebuchet Contest	20	8 points in the range competition, 12 in the accuracy
Presentation	25	Most points go for clarity and content, with a few for style/fun factors
Paper	15	Clarity and content
5-minute Talk	5	Mostly, did you do it and put in a reasonable effort
Deadlines	5	Group met all deadlines
Individual	30	Starts of proportional to group score (the above scores), but may be adjusted based on individual effort or contribution

Note that these are rough estimates. John reserves the right to adjust points based on extraordinary performances (either good or bad) in some of these areas. For example, if your team scores more than 20 points in the Trebuchet Contest, you may be allowed to use those to make up for lost points elsewhere.