Classical Mechanics
Phy 235, Lecture 09.

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Results Exam # 1

- Question 1:
  - Average = 17.4 out of 25.
  - Example problem in book.
- Question 2:
  - Average =11.5 out of 25.
  - Discussed during class.
- Question 3:
  - Average = 17.3 out of 25.
  - Homework problem.
- Question 4:
  - Average = 20.9 out of 25.
  - NAP = Normaal Amsterdams Peil!

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Observations

- We noticed a fairly alarming number of mistakes with basic trigonometry and geometry in question 1.
- In question 2, a lot of students introduced their own variables that were not given in the problem and left those variables in their final answer.
- About half of the students don't seem to understand that the spring force is proportional to the displacement from the rest length and instead assumed it was proportional to the absolute position.
- In question 3, many students assumed that the potential energy is a vector and calculated U_x, U_y, and Uz.

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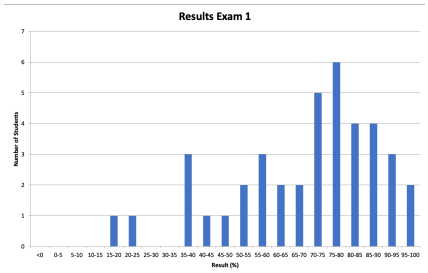
Exam 1



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Exam # 1
General Comments

- Exam # 1 was/will be returned in recitations this week.
- General comments:
  - Many students do not look carefully at their graded homework. You learn most from your mistakes and comparing your solutions with the posted solutions is an important part of mastering the material.
  - Pick up your exam and compare your solutions with the posted solutions.
  - Look and understand the example problems described in the textbook.
  - Look at the end-of-chapter problems. Do you see what approach to use to solve those problems?
  - Look at the equation sheet (and the equations that apply to the exam): do you understand how to use these equations?
- A D or a C on this exam does not prevent you from earning an A in this course!

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Exam # 1
General Comments

- If you feel your exam was not graded properly, you need to tell me. Do not complain to your TAs.
- Any requests for regrades for specific problems should be made by Monday October 6 (end of lecture). I need the following:
  - Your blue book(s).
  - A written explanation why you feel you deserve more points.

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PHY 235 Term Paper

- Details about the requirements can be found here:
  - http://teacher.pas.rochester.edu/PHY235/CourseInformation/TermPaper.htm
- Deadlines:
  - Friday October 24, 2025: proposals for the term paper are due (I encourage you to submit these much earlier)!
  - Wednesday November 26, 2025: Term paper due.
- Warnings:
  - You need to meet with a Writing Fellow of College Writing Center to discuss your first draft of the term paper. You will need to schedule an appointment for such meeting.
  - Waiting too long to make an appointment is not a valid reason to extend the deadline for your submission.
- Check the grading matrix for the paper:
  - http://teacher.pas.rochester.edu/PHY235/DownloadFolder/GradingMatrixFinalPaper.pdf

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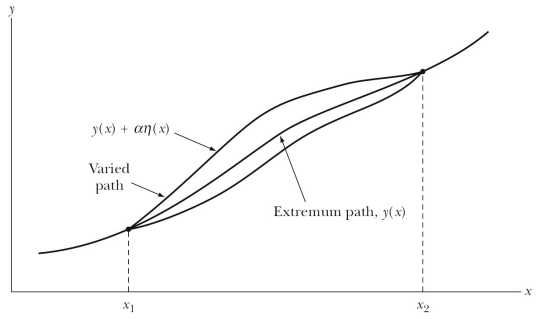
Calculus of Variations. The rest of the story.



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Euler's Equations.

- The first version of Euler's equation is:

$$\frac{\partial f}{\partial y} - \frac{d}{dx}\left(\frac{\partial f}{\partial y'}\right) = 0$$

- The second version of Euler's equation is useful when f does not explicitly depend on x.
- The second version of Euler's equation is:

$$\frac{\partial f}{\partial x} - \frac{d}{dx}\left(f - y'\frac{\partial f}{\partial y'}\right) = 0$$

- When f does not explicitly depend on x, this equation becomes:

$$f - y'\frac{\partial f}{\partial y'} = \text{constant}$$

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Euler's Equations with Boundary Conditions.

- The boundary conditions can be specified using one or more boundary equations: $g\{y_i; x\} = 0$.
- Euler's equation with this boundary condition becomes:

$$\left(\frac{\partial f}{\partial y} - \frac{d}{dx}\left(\frac{\partial f}{\partial y'}\right)\right) + \lambda(x)\left(\frac{\partial g}{\partial y}\right) = 0$$

- The parameter λ is called the Lagrange undetermined multiplier. We will see in Chapter 7 that these multiplier(s) are related to the forces of constraint.

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The great circle distance. Problem 6.12.

- Find the shortest distance between any two points on a sphere.
- Use the Euler method with an auxiliary condition imposed.
- Note:
  - In 2021, it took the KLM 10h40m to fly from Amsterdam to Tokyo.
  - In 2025, it takes the KLM 13h20m to fly from Amsterdam to Tokyo.

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2 Minute 44 Second Intermission.

- Since paying attention for 1 hour and 15 minutes is hard when the topic is physics, let's take a 2 minute 44 second intermission.
- You can:
  - Stretch out.
  - Talk to your neighbors.
  - Ask me a quick question.
  - Enjoy the fantastic music.

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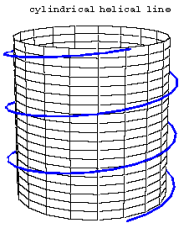
Problem 6.4 – Part III

- Show that the geodesic on the surface of a right circular cylinder is a segment of a helix.
- Now use Euler's equation with constraints.
- **This is by far the most complicated way to solve this problem.**



https://www.encyclopediaofmath.org/index.php/Helical_line

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The δ notation.

- δy tells us how much y changes when we change α.

$$\delta y = \frac{\partial y}{\partial \alpha} d\alpha$$

- Note: do not confuse δy with dy.

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ENOUGH FOR TODAY?

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