Phys 301
Modern Physics

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Fall 2023

What is Modern Physics?

- Special Relativity
  - Unify electrodynamics and Newtonian mechanics
  - The nature of space and time
- Introduction to Quantum Mechanics
  - The theory of very small things
  - The nature of matter
- Physics before all that = Classical Physics
  - Newtonian mechanics, thermodynamics, Maxwell's Equations (electricity and magnetism)

Plan for the Day

- Introductions
- Syllabus, Requirements, Procedures, Expectations… First Day Stuff
- Break
- Review: Inertial Reference Frames

Introductions

- Name, especially preferred/nickname
- Pronouns, if you wish
- Physics major or minor? Other majors/minors?
- Something you did this summer

Break into 4 “Units” (schedule on web page)

1. Special Relativity
2. Waves
3. Development of Quantum Mechanics
4. One-Dimensional Quantum Mechanics

First Exam: Thursday, October 12th

Second Exam: Thursday, December 14th

Grade Breakdown

15% Reading Memos
25% Homework
15% Final Paper
45% Exams (two, approx. equal weight)

Attendance/Participation

Reading Memos

- Readings posted on schedule; complete before class.
- Start practicing how you will learn for the rest of your life.
- Encourage “active reading.”
- Help me see how you are doing.
- Grading:
  - Out of 3 points for good faith effort.
  - Up to 1 day late; 1 point off.
  - Three lowest grades dropped.

Reading Memos

- Send to me by e-mail: Word document or scan written work as a PDF.
- Discussion: How do you “actively” read a science textbook?

"Study actively. Don't just read the text; fight it! Ask your own questions, look for your own examples, discover your own proofs."

- Paul R. Halmos, *I Want to Be a Mathematician*

Critical Reading

"They **ask questions**; they **relate the text to other sources**; they think of examples to **corroborate** or **challenge the text**; they **play with the ideas**, extending or elaborating on them; they **relate** the text to their **own purposes or experience**. Furthermore, they "**criticize**" the text in the more traditional sense of the word; looking for **bias**, for poorly developed logic, for hidden assumptions. They locate the **author's position** through active "listening", relate this to their own ideas or experience, and **reshape their own understandings** in the light of the text."

Homework

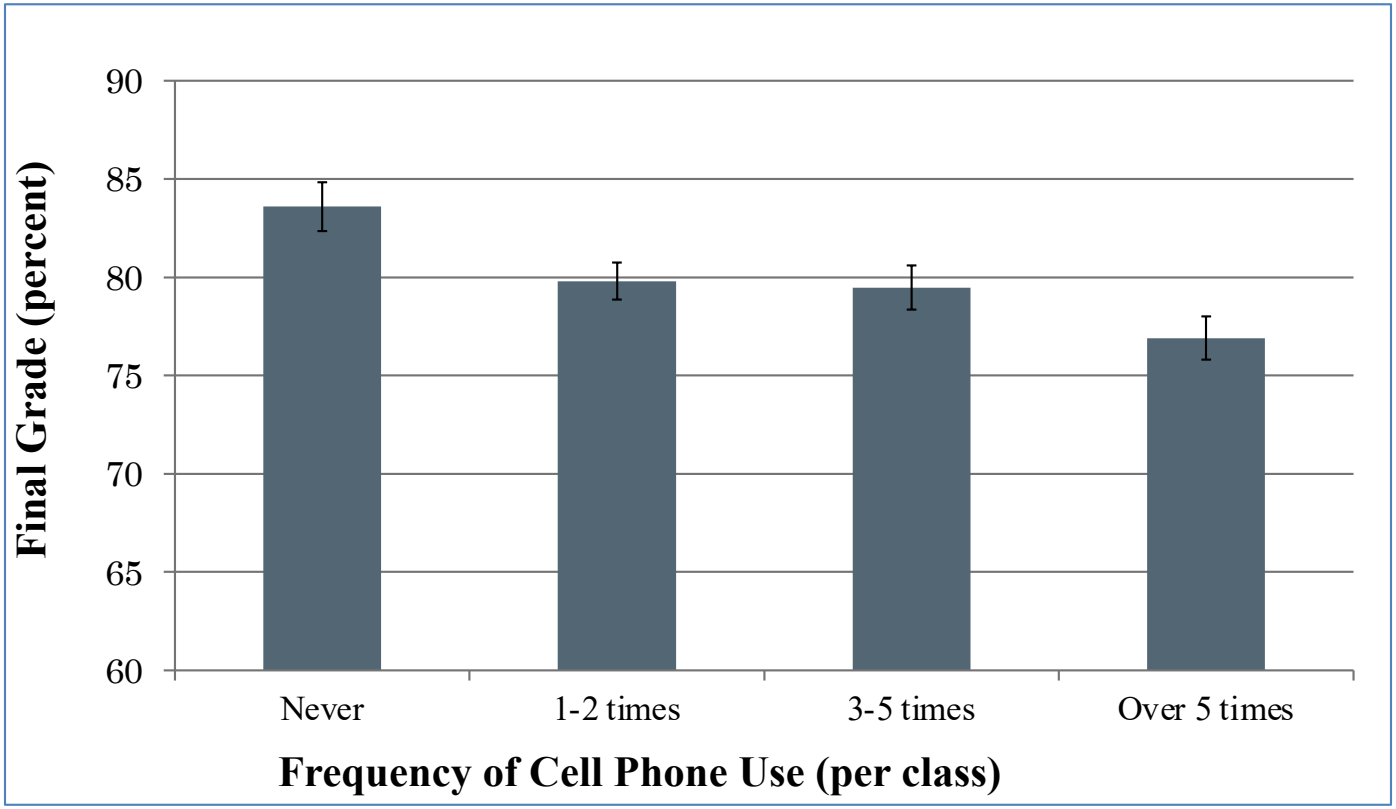
- Probably 6 assignments and 1-3 labs.
- Encourage you to review them as they become available; don’t wait until the last minute.
- *Present* your answers.
- Scoring your own homework using a rubric.
- Late work not accepted; 2 lowest scores dropped.

Final Paper

- Choose one topic related to special relativity or quantum mechanics.
- 2-5 pages, single spaced.
- Include at least one figure, and two outside sources.
- List of possible topics and other info in the syllabus.


FORESTER
AWD

3 Astronomy Classes (N = 328)
Spring 2012
University of Colorado, Boulder

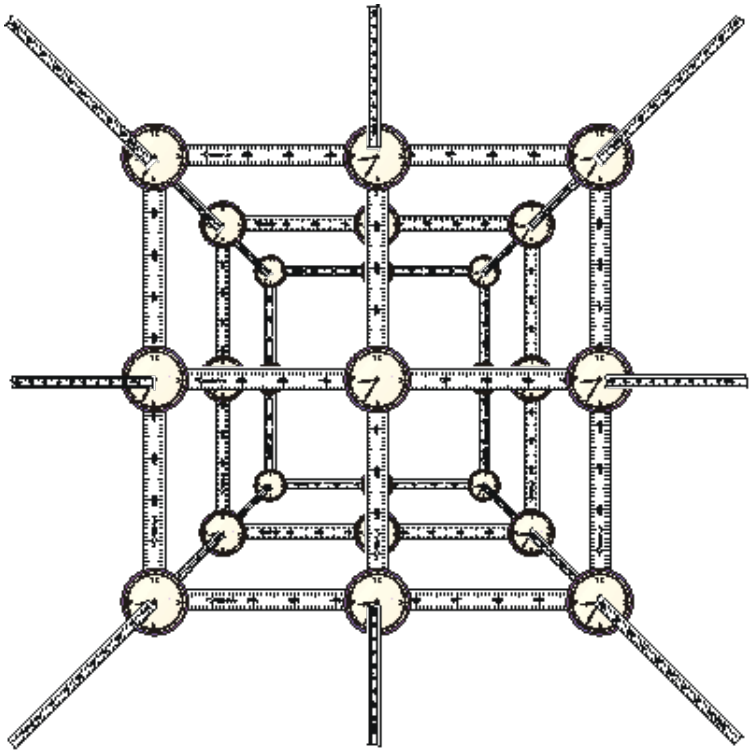


Please do read the syllabus for more information.

Let’s take a break!

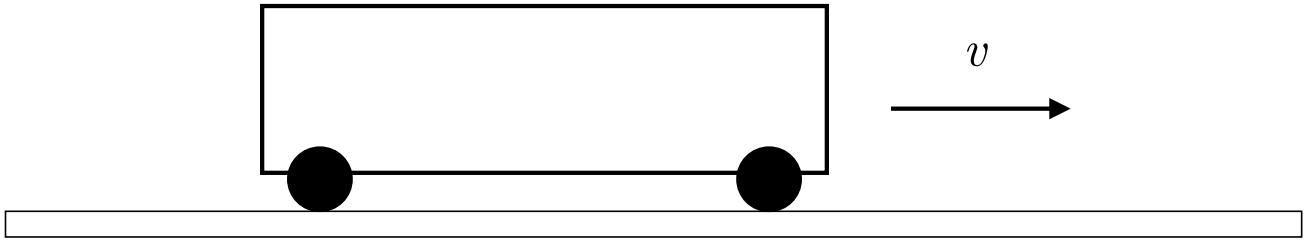
Review: Reference Frames

- "A coordinate system in which experimenters are equipped with meter sticks, stopwatches, and any other equipment needed to make position and time measurements on moving objects."
- Examples: walking in the classroom, bowling ball in Phys 211.



Reference Frames: 3 Ideas

- Extends infinitely far in all directions.
- Experimenters are at rest in the reference frame.
- The number of experimenters and the quality of their equipment are sufficient to measure positions and time intervals to any level of accuracy needed.



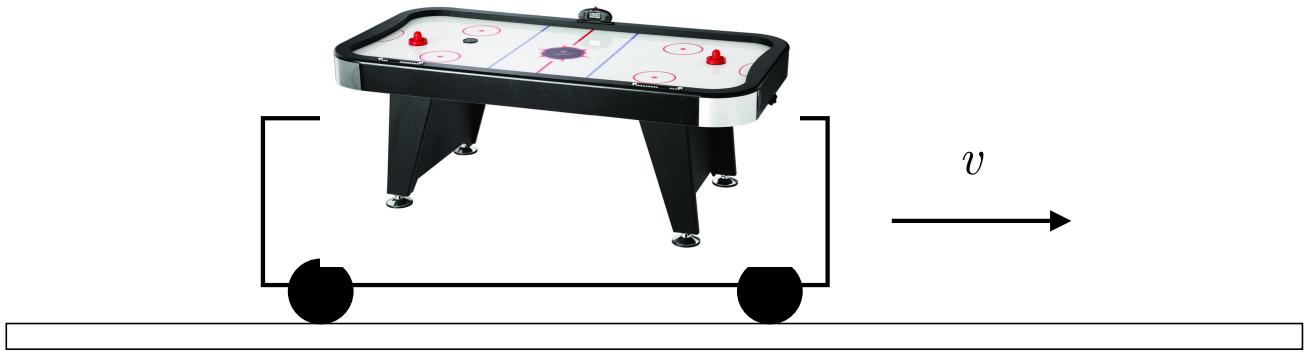
Imagine a train car (it's always a train!) moving on a straight track with constant velocity with respect to the ground. The train runs smoothly, so that you can't tell it's moving by feeling the bumps on the track. There are no windows.

Would you expect the laws of Physics to be different inside this train compared to the labs here at Westminster? What laws? What does that mean?

Now, you're playing air hockey on the train. Can you tell which way you are moving?

a) Yes

b) No



The puck is stationary, and I am about to take my opening shot, when the train slows and approaches the station. I have not touched the puck. What does it do?

a) Slides to the front of the train
b) Slides to the back of the train
c) Remains motionless

Why is that weird?

Draw the following free-body diagrams. Assume friction between train and track but NOT between puck and table.

1. The train while it is moving at constant velocity.
2. The hockey puck while the train is moving at constant velocity.
3. The hockey puck while the train is slowing down.
4. The train while the train is slowing down.

Which one seems to violate a law of physics?

Inertial Reference Frames

- One in which the laws of physics, especially Newton's First Law, applies.
- Other ways to put it:
  - A reference frame that is not accelerating.
  - A reference frame in which an isolated object is always and everywhere observed to move at a constant velocity (N1L)

Inertial Reference Frames

- Train moving at constant velocity: Inertial
- Train slowing down or speeding up: Non-Inertial

Inertial Ref. Frame? Yes or No?

1. A nonrotating frame floating in deep space.
2. A rotating frame floating in deep space.
3. A frame attached to a roller-coaster car.

Since the laws of physics are the same in every inertial reference frame, an object must have the same kinetic energy in all inertial reference frames.

A) True

B) False

Next Time:

- Mathematical transformations between inertial reference frames.
- Prove the laws of physics still work.
- Introduce the postulates of special relativity.