# Classical Mechanics
# Phy 235

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1

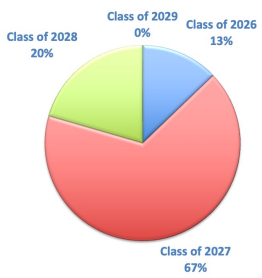
## Outline

- General introduction to the course:
  - Who are you?
  - Textbook
  - Course Components
  - Resources
  - Physics 235 webpages
- Chapter 1: Review of matrices, vectors, and vector calculus.
  - Coordinate systems and coordinate transformations.
  - Matrix operations.
  - Scalars and vectors.
  - Vector calculus.
  - Differentiation and integration.



2

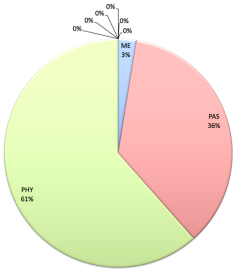
## Who are you?
## Class Distribution.






3

## Who are you?
## Major Distribution.

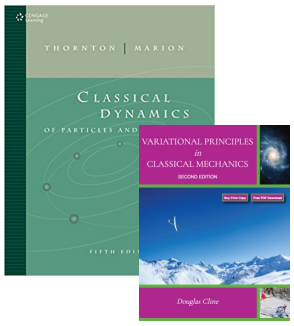





4

## Course Textbook

- *Classical Dynamics of Particles and Systems* by Thornton and Marion.
- Prof. Cline wrote a text book based on the material he used when he taught Phy 235. This is an excellent additional reference for this course and available for free online.






5

## Course Components

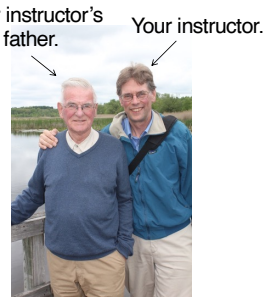
- Lectures:
  - MW: 10.25 am – 11.40 am in B&L 106.
- Recitations:
  - Start during the week of 9/1.
- Office hours:
  - Start next week.
- Homework assignments (there are 3 extra credit homework assignments during the semester):
  - Due on Fridays at noon.
- Final paper:
  - Due on Wednesday November 26 at noon.
- Midterm exams:
  - Tuesday September 23, Thursday October 23, and Tuesday November 18. Time: 8.00 am - 9.20 am (Location: B&L 109).
- Final exam:
  - Sunday December 14, 12.30 pm – 3.30 pm (location TBD)



6

## Course Components.

- I am here to help you learn this material, but it is up to you to actually master it:
  - If there is something you do not understand you need to ask for help …….. (come and talk, email, ask after class, etc.)
  - It is my job to teach you …… you are paying my salary ……
  - In lecture courses it is difficult to see who needs help. You need to ask for the help you need before you fall behind.






7

## Course Components.

So Very Dutch

**Dutch directness**

The Dutch are renowned for speaking their minds: from complete strangers reprimanding you for chatting in the train's quiet zone, to a friend not telling you a white lie about your bad haircut. Outsiders often see this as being rude or tactless, but for the Dutch it is actually a virtue of sincerity and honesty. They don't mince their words or beat around the bush, and are often not afraid to discuss hot topics such as religion, politics, immigration or money. In fact, it is even seen as a cultural faux pas to not have an opinion. Some studies trace this directness back to the country's history of Calvinism: Calvinists are concerned with the essence of things and what is really important. The good thing about this 'callous' openness? At least you know exactly where you stand with the Dutch.

**From KLM Holland Herald**



8

## Resources

- The following resources are available:
  - Recitations: ask question, discuss solutions of previous homework assignment, practice additional problems, ….
  - Office hours:
    - Wednesdays 9 am – 10 am and 12 pm – 1 pm: Frank Wolfs in B&L 203A (starting August 27).
    - TAs: TBD.
  - Course Webpage:
    - http://teacher.pas.rochester.edu/PHY235/
  - Email: details on the PHY 235 web pages.
  - Books on reserve in the POA.



9

## Other useful information.

Best and oldest airline in the world: KLM


8/20: Breakfast with a fantastic view at Schiphol

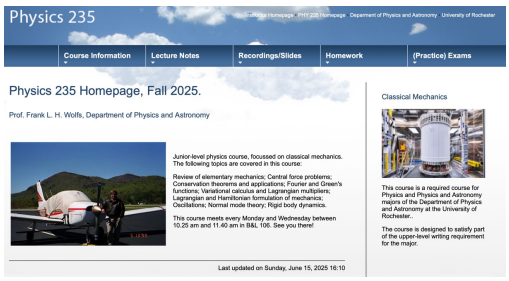
Best soccer team in the world: AJAX

Best baseball team in the world: Yankees



10

## Course homepage: http://teacher.pas.rochester.edu/PHY235/






11

## 3 Minute 1 Second Intermission.

- Since paying attention for 1 hour and 15 minutes is hard when the topic is physics, let's take a 3 minute 1 second intermission.
- You can:
  - Stretch out.
  - Talk to your neighbors.
  - Ask me a quick question.
  - Enjoy the fantastic music.




12

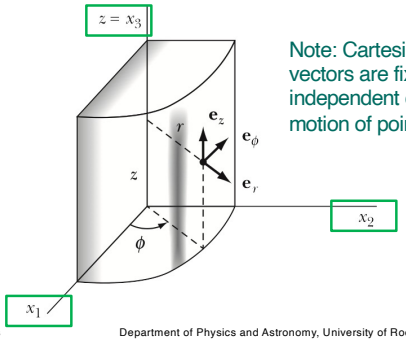
## Chapter 1: Review of matrices, vectors, and vector calculus.

- Coordinate systems and coordinate transformations.
- Matrix operations.
- Scalars and vectors.
- Vector calculus.
- Differentiation and integration.



13

## Coordinate Systems: Cartesian Coordinates: $(x_1, x_2, x_3)$ or $(x, y, z)$.

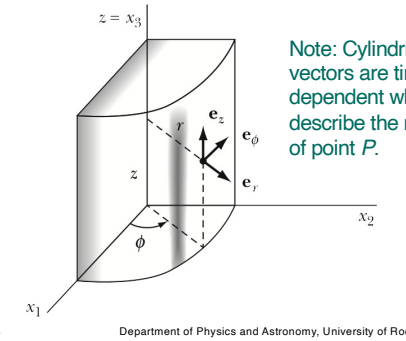



Note: Cartesian unit vectors are fixed, independent of the motion of point *P*.



14

## Coordinate Systems: Cylindrical Coordinates: $(r, \phi, z)$.



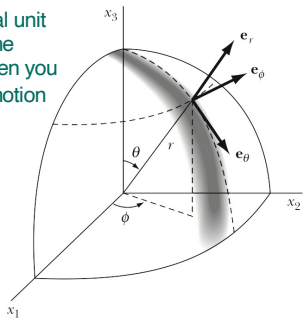

Note: Cylindrical unit vectors are time dependent when you describe the motion of point *P*.



15

## Coordinate Systems: Spherical Coordinates: $(r, \phi, \theta)$.

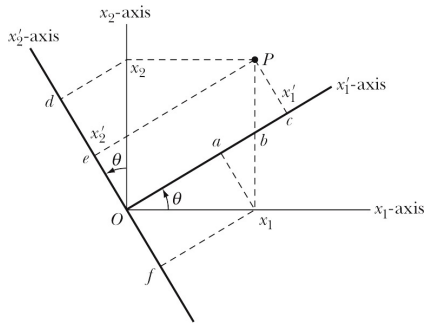
Note: Spherical unit vectors are time dependent when you describe the motion of point *P*.






16

## Coordinate systems are not uniquely defined. P = $(x_1, x_2) = (x_1', x_2')$.






17

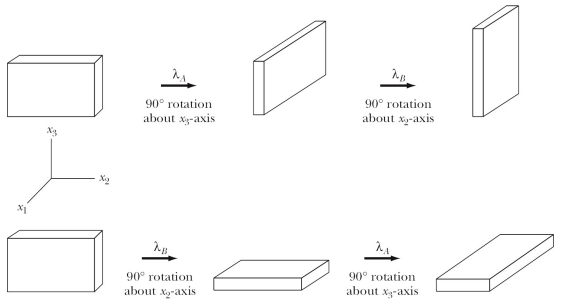
## Coordinate transformations connect two coordinate systems.

- Rotation matrices are used to convert coordinates in one coordinate system to coordinates in another coordinate system.
- Properties of the rotation matrix:
  - Each rotation matrix has 3 truly independent parameters (two to define the rotation axis and one to define the rotation angle).
  - Rotation matrices preserve the length of a vector.
  - Rotation matrices preserve the angle between two vectors.
  - If we apply multiple rotation matrices, we need to realize that the order matters.



18

## Rotation matrices: the order of multiplication matters.






19

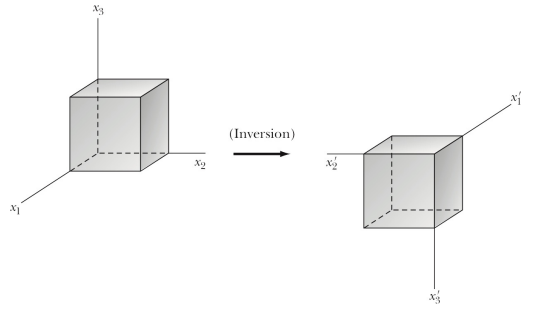
## Vectors and Scalars.

- Scalars are unaffected by a coordinate transformation:
  - Examples of scalars are:
    - The length of a vector.
    - The angle between two vectors.
- Vectors are sets of three quantities that transform in the same manner as the coordinates of a point *P*:
  - Having a magnitude and direction is not sufficient to define a vector.
  - Some transformations cannot be written in terms of a series of rotations. An example is an **inversion**. These are called **improper rotations.**
  - Transformations that can be written in terms of a series of rotations are called **proper rotations**.



20

## Inversion: **cannot** be expressed in terms of a series of rotations. **Improper rotation.**






21

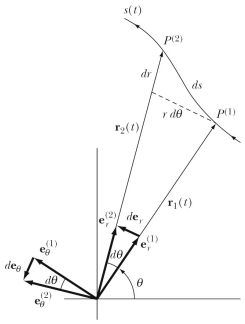
## Differentiation and Integration.

- Differentiating a scalar with respect to a scalar variable will produce another scalar.
- Differentiating a vector with respect to a scalar variable will produce another vector.
- Note: an important scalar variable in this course is time *t*.
  - Differentiating the position with respect to time provides the velocity.
  - Differentiating the velocity with respect to time provides the acceleration.



22

## Motion described in spherical coordinates.






23

## More Differentiation and Integration.

- The gradient:
  - The gradient of a scalar function at *P* is directed normal to the lines or surface for which the scalar function is constant.
  - The gradient of a scalar function at *P* is directed in the direction of maximum change in the scalar function.
- Integration:
  - Volume integration of a vector.
  - Surface integration of a vector.
  - Line integration of a vector.
  - Gauss' theorem for volume integrals.
  - Stoke's theorem for line integrals.



24

## ENOUGH FOR TODAY?



25