Introduction

Ohana B. Rodrigues, on behalf of Professor Freeman

January 15, 2019

First of all… WELCOME to physics 211!!!

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Course webpage:

http://walterfreeman.github.io/phy211/

Today we will talk about…

- Course organization
- How to succeed in this course
- What is physics?
- Describing the physical world: Dimensions and Units
- How to solve a general problem using common sense and basic physics knowledge (Fermi problems)

Class organization - Basic schedule

- Lecture (TTH) - Professor Walter Freeman
  - You will be introduced to new concepts and ideas

- Recitation (WF) - your TA
  - You will be part of discussions led by your TA and
  - You will practice the knowledge you acquired during lecture by solving problems in groups (designated by your TA)
  - Homework is submitted and returned in recitation
  - Group exams

- Physics clinic (Monday to Thursday, from 8h to 20h; Friday, from 8h to 18h at **room 112**)
  - There is always a physicist there to help you with
    - Homework
    - General concepts
    - Any physics problem

Class organization - Resources and material

- All notes, etc., will be posted on the course website (**not Blackboard**).
- Professor Freeman will also post course announcements there
- The syllabus is posted there (please please, **read it!!!!**)
  - Philosophy
  - Grading
  - The components of the course
  - Academic integrity
  - Students with disabilities, religious observance policy, and my attitude about these
- Basically, want to know anything about the course, go to **the course website**
- If you can not find the information you want there, go to the slack channel

Class organization - What is Slack ???

- Slack is a collaboration hub that we will use in this class to connect you to…
  - …Professor Freeman
  - …TAs
  - …Coachs

- We will use it …
  - …for announcements
  - … to address grade problems
  - … to answer questions about physics
  - …to answer questions about class policies

- It has a web version and a phone app for it

- It's logo looks like this…

- Please **DOWNLOAD IT NOW**! I am gonna give you 3 minutes to do it.
- After downloading it, go to the following link, it will give you access to our channel

  - https://join.slack.com/t/phy211-spring2019/shared_invite/enQtNTIyNTYzMTc4NTMyLTVhOTA4MGQzZDg5M2U5ZGE0NDVlZTZlNmU0ZWVhYTAyMzcyNTMwZDY3YzZjYmQ2OTZkYTkzMzBjMDFjMDFlZWQ

How to do well in this class (important!!!)

What do are the necessary skills of a successful physics student ?

Maybe memorizing equations?

Or/and remember facts?

Noup! Being a successful physics student **is not about learning facts or memorizing equations!**

How to do well in this class (important!!!)

In this class, we hope you will…

... learn to look at moving things around you in a new, rigorous way

... learn to solve problems by taking them apart, understanding the parts, and putting them back together again

... learn to translate between and combine verbal, visual, and mathematical descriptions of things, while still being precise

These things are skills, and they all require practice
... but they also require you to ask questions and ask for guidance!

How to do well in this class: ask for guidance!

Some students might come to class, write down everything, go home and review, and then spend hours alone working on the homework. They're diligent, good, hardworking students, right?

... but this is not the best way to learn skills! Instead, I hope you will:

- Interrupt me/Professor Freeman in class and ask questions
  - Ask questions by email to wafreema@syr.edu
  - I am often by a computer and you will often get a quick reply
- You can take cellphone pictures of work and email them to me, too
- Ask questions on the Slack channels
- Come work with me and with your peers in my office hours
- Do your homework in the Physics Clinic when you can

Now that we got the bureaucratic stuff out of the way…

Physics

How would you define physics?

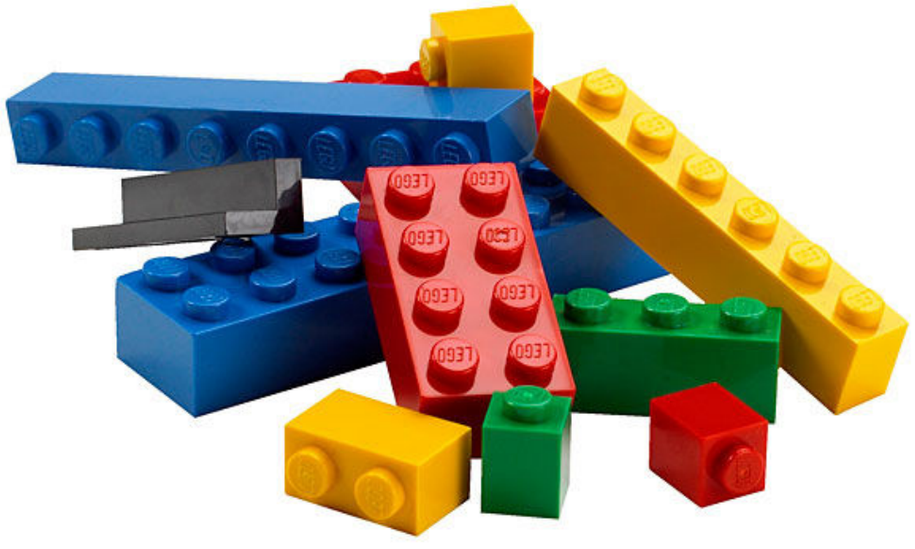
In my personal view…

…Physics is the science that explains complicated natural phenomena from simple basic ideas.

Physicists are professional general problem solvers.

It is kind of like lego…

This may be complicated but…



It is actually made of pieces like these!

Physics

These phenomena are all governed by the same few principles!

Mechanics

The most fundamental question physics asks:

"Why do things move in the ways that they do?"

The answer is given by Isaac Newton's second law of motion:

"Objects accelerate when pushed by forces; they accelerate in the direction of the force, proportional to the size of the force divided by their mass."

That's it. We will spend much of our class talking about the meaning and consequences of this one statement.

The physicist's eye

Coming back to the idea of understanding complicated things in terms of simple pieces, like Newton's law.

The perspective of physics is one that looks at a situation and asks:

"What phenomena are involved in this thing?"
"How do they interact to determine its behavior?"

In this class, you'll learn about some of those simple pieces, but that's not the important thing.

You'll also learn the skill of asking those two questions, and develop a physicist's perspective for solving problems.

This will serve you well in whatever field you pursue, since the ability to quickly look at a problem and understand the crucial elements is universally helpful.

Dimensions

Ok, this all sounds exciting and promising but, how do we start to learn how to become professional problem solvers?

If we are going to model something, we need to ask ourselves with what we are going to model it. What are the basic tools we need in order to model something?

Dimensions!!

Dimensions versus Units

Things in nature aren't just described by numbers; they have an associated dimension, and we measure them using a system of units.

We have three different kinds of dimension:

- Length: usually measured in meters; also inches, miles, light-years...
- Mass: usually measured in kilograms; also grams, tonnes…
- Time: usually measured in seconds; also hours, days...

Dimension is the abstract idea	versus	Unit is the way you take the dimension and bring it from the abstract world to concrete

Let's practice a little bit…

Dimensions and units

"How far away is Syracuse from Adirondack State Park ?"

"How far" implies which dimension?

Length or distance

Can I answer that with…

…129 miles?

What about…
…207 km?

What about…
…2 hours?

Doing math with dimensions

"How far away is Syracuse from Adirondack State Park ?"

What about…
…2 hours?

Is “hours" the right unit for length?
No!

Thus, the mistake we are making is…
Distance = Time

How do we fix it?
Distance = Distance x Time/Time

Doing math with dimensions

"How far away is Syracuse from Adirondack State Park ?"

Distance = Time x Distance / Time = Velocity

Thus, “2 hours” is not an answer to our question. But if you also have the velocity, we can find our way there!

Notice, we **did not use units** at all!!

Dimensions and units

Combinations of those basic dimensions are also dimensions.

Can you guess a few?

Area

Volume

Velocity

Side note: Scientific notation

- It is a easier way to write too small or too big numbers
- To write in scientific notation, you will represent the number as a number from 1 to 9 times some power of 10
- Ex.:

$$0.1 = 10^{-1}$$

$$100 = 1 \times 10^{2}$$

$$8{,}000{,}000 = 8 \times 10^{6}$$

$$000000003 = 3 \times 10^{-9}$$

Order of magnitude

Fermi problems

With dimensions we can solve general estimation problems called **Fermi problems**

Lets try a few of them…

"How many steps you need to take to go from here Syracuse to NYC?"

What is the dimension we care about?
Length

Choose a unit…
Let's use meters

A step is ~ 0.5 m
The distance from Syracuse to NYC is ~ 400 km = 400,000 m

$$\textbf{\# of steps necessary to walk from Syracuse to NYC} = \frac{\textbf{distance from Syracuse to NYC}}{\textbf{size of a step}}$$

$$= \frac{\textbf{400,000 m}}{\textbf{0.5 m}} = \textbf{800,000 steps}$$

Fermi problems

Important notes…

- Yes, that number can vary depending on your modeling and the numbers you assume at first. This is not a problem as long as your assumptions are reasonable.
- We will always have an acceptable range for an answer. The goal is for your estimation to fall within given range.
- Always make sure you are **using the same unit for a given dimension** in the problem! Be careful to not mix up in the same problem cm, m, in, mile, for example.

Fermi problems

"What is the sum of the mass of all this class' students?"

What dimension we need to use?
Mass

sum of the mass of all the students = mass of one student × # of students

Choose a unit…
kg

Mass of one student in kg?
70 kg

# of students?
200

Mass (in kg)

Dimensionless number (it has no units)

sum of the mass of all the students $= 70\,kg \times 200 =$ **14,000 kg**

Fermi problems

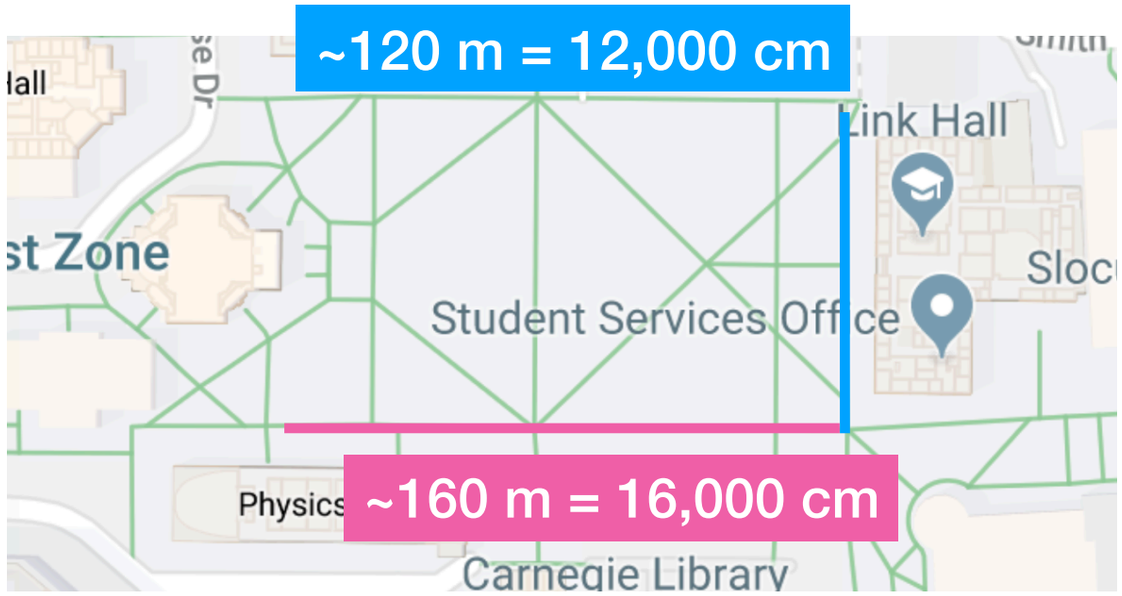
“How many post-its we need to cover the quad?”

What dimension we need to use?
Area

$$\text{\# of post-its} = \frac{\text{area of the quad}}{\text{area of one post-it}}$$

Fermi problems

"How many post-its we need to cover the quad?"

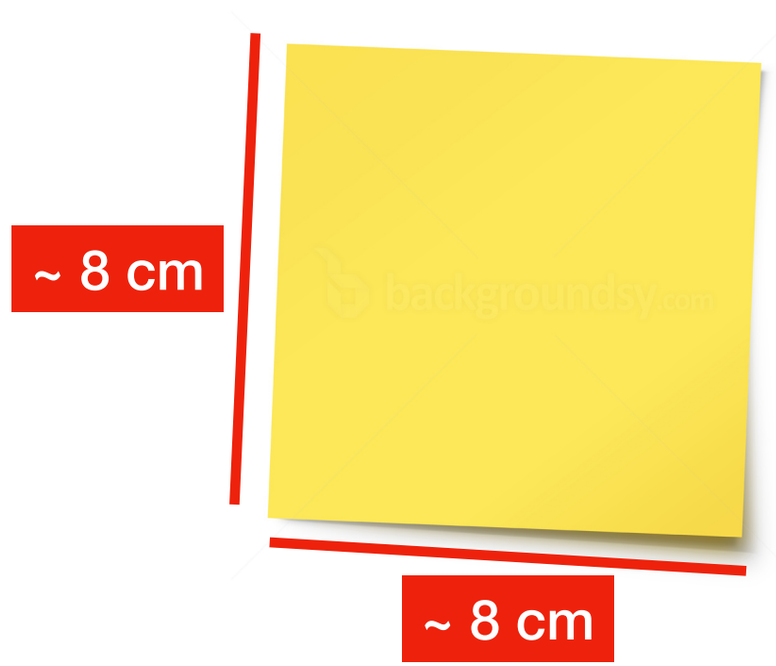


area of the quad $= 12{,}000\,cm \times 16{,}000\,cm = 192{,}000{,}000\,cm^2$

Fermi problems

"How many post-its we need to cover the quad?"

$$\textbf{\# of post-its} = \frac{\textbf{area of the quad}}{\textbf{area of one post-it}}$$



$$\textbf{area of a post-it} = 8\,cm \times 8\,cm = 64 \quad cm^2$$

Fermi problems

"How many post-its we need to cover the quad?"

$$\textbf{\# of post-its} = \frac{\textbf{area of the quad}}{\textbf{area of one post-it}}$$

$$\textbf{\# of post-its} = \frac{192{,}000{,}000\,cm^2}{64\,cm^2} = 3{,}000{,}000$$

Fermi problems

"How many basketball balls we need in order to fill an olympic swimming pool?"

What dimension we need to use?
Volume

$$\text{\# of basketball balls} = \frac{\text{volume of the swimming pool}}{\text{volume of one basketball ball}}$$

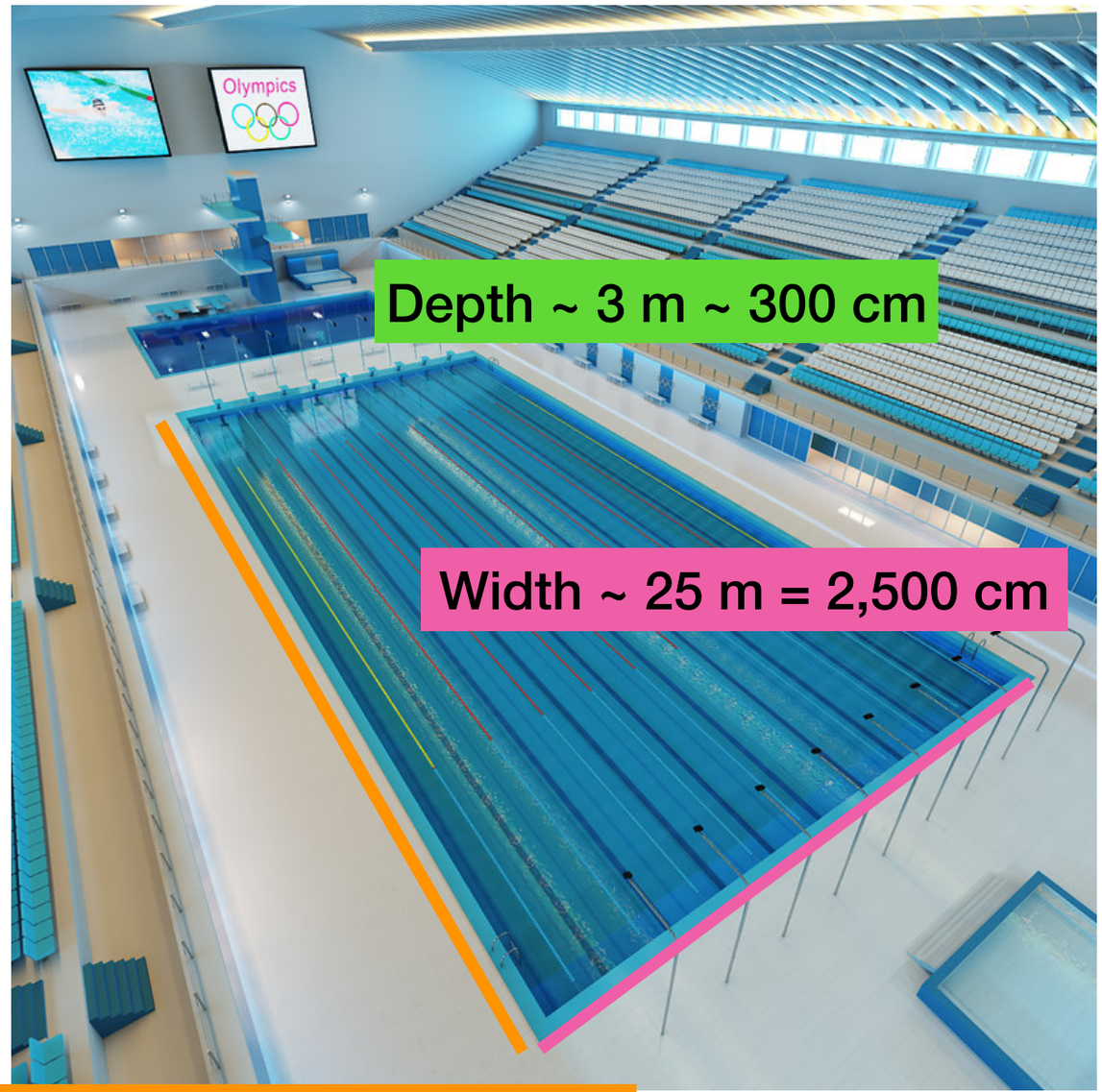
Fermi problems

"How many basketball balls we need to fill an olympic swimming pool?"

$$\textbf{volume of a sphere} = \frac{4\pi r^3}{3} = \frac{4\pi \times 10^3\, cm^3}{3} \approx 4189\, cm^3$$

Fermi problems

"How many basketball balls we need to fill an olympic swimming pool?"



volume of an olympic swimming pool =

$$= \textbf{depth} \times \textbf{width} \times \textbf{lenght} =$$

$$= 3000\,cm \times 2{,}500\,cm \times 5{,}000\,cm =$$

$$= 3.8 \times 10^9\,cm^3$$

Fermi problems

"How many basketball balls we need to fill an olympic swimming pool?"

$$\textbf{\# of basketball balls} = \frac{\textbf{volume of the swimming pool}}{\textbf{volume of one basketball ball}}$$

$$\textbf{\# of basketball balls} = \frac{3.8 \times 10^9\, cm^3}{4.2 \times 10^3\, cm^3} \approx 9 \times 10^5$$

Fermi problems

- Fermi problems are extremely useful and all you need is a bit of math and creativity on how to approach the problems.
- They can help you calculate…

…the total number of hairs on your head.
…the number of square inches of pizza consumed by all the students at SU during one semester.
…the total amount of time 19 year olds in the US spent during this past semester studying for exams in college.
… the number drops of waters in all of the Great Lakes.

Tomorrow we will solve some interesting ones in recitation.

Thank you!