Lesson 1: Introductions; Mathematics, Units, and Graphs (Sections 1.1-1.9)

Welcome to PHY2053, physics 1 without calculus. To set the mood
http://www.youtube.com/watch?v=T24DPU-hkJM

We will start with some questions about your physics background. Please stand.

- How many have taken International Baccalaureate (IB) physics?
- How many have taken Advanced Placement (AP) physics?
- How many have taken any kind of physics?
- How many have never taken physics before?

This course is about at the level of an AP physics course.

Is there anyone here who is taking their first classes at UF? Welcome to UF.

The website for the class is
http://www.phys.ufl.edu/courses/phy2053/sum16

Here is the syllabus for the semester:
http://www.phys.ufl.edu/courses/phy2053/sum16/syllabus.pdf

Here is the schedule for the semester:
http://www.phys.ufl.edu/courses/phy2053/sum16/schedule.pdf

I am designing the class so that you will have to do some physics everyday.

- There will be quizzes in discussion.
- There will be HITT quizzes in lectures as well.
- We will remain on schedule. There might be topics that I cannot explain thoroughly in lecture. You are still responsible for that information.
- Homework will be collected and graded through the Physics Connect system.
- There will be Canvas questions on the text and lectures.

Why emphasize the textbook?

- The text has been carefully constructed to teach you physics. Read the Preface and you will see what I mean.
- I can make mistakes while lecturing. If I make a mistake please point it out. However, there is one question that I will not answer.
- You can make mistakes while taking notes. It can be distracting to sit in this large room. Please leave your laptops and cell phones off.
- There will come a time when you will have to figure something out for yourself by reading an instruction manual or a book. Not everything will be on youtube or google.

Some information about H-ITT clickers.

Let’s get started.

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Chapter 1 Introduction

Project gorilla:
http://www.youtube.com/watch?v=0QGmERpNoNc

Okay, how many of you are interested in becoming a doctor? A dentist? A veterinarian? Why are they making you take physics?

I am not a doctor (and I don't play one on TV) but when you go to the doctor how much chemistry do they do on you?

- Take your weight.
- Take your blood pressure.
- Check your reflexes.
- Examine your eyes, ears, nose, and throat.
- Maybe take an x-ray.

Of course you need to know chemistry and biology, but it seems that a lot of physics occurs in the examining room.

As we go through this semester, we will be learning a lot of vocabulary. Many of the words we use will be familiar: work, energy, momentum, *et al*. For us, those words will have very specific definitions. You will need to consider these definitions carefully.

Physics will use a lot of mathematics. This course is physics without calculus. How many of you have had at least one semester of calculus? I will use calculus very sparingly, but I will use it so you can see how it helps with physics. There won't be any calculus problems on any quizzes or exams.

If you look in your physics text, you'll see a number of word problems. In my experience, most people hate word problems. You will be taught how to solve physics word problems, but you will need to practice to master them.

Let us see how physics problems will differ from math problems.

In previous math courses, you had a few formulas that were handy: the equation of a line, equations of conic sections (parabola, hyperbola, ellipse, circle), the quadratic formula, etc. Much of the time you had to make up your equation. For example, let us solve this problem:

The sum of 3 consecutive integers is 57. What are the numbers?

Strategy: If x is the first number, $x + 1$ and $x + 2$ are the next two.

Solution:

$$\begin{aligned} x+(x+1)+(x+2) &= 57 \\ 3x+3 &= 57 \\ 3x &= 54 \end{aligned}$$

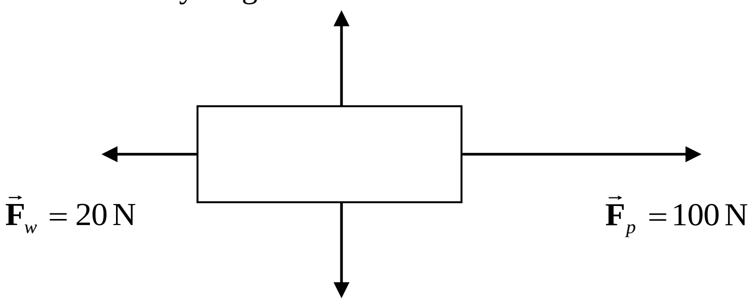
$$x = 18$$

The numbers are 18, 19, and 20.

Now a physics problem. A 100 kg rowboat is being paddled upstream. The paddles push the boat forward with a 100 newton (N) force while the current impedes the motion with a 20 N force. What is the acceleration of the boat?

We will cover this type of problem in Chapter 4. But since Newton's laws are the cornerstone of this semester we will talk about this problem now.

Strategy: Draw a free-body diagram for the boat.



The net force accelerates the boat.

Solution: Use Newton's second law

$$\sum F_x = ma_x$$
$$F_p - F_w = ma_x$$

Solving for the acceleration (a_x)

$$a_x = \frac{F_p - F_w}{m} = \frac{100\,\text{N} - 20\,\text{N}}{100\,\text{kg}} = 0.80\,\text{m/s}^2$$

This time we did not "make up" the formula. But I hope that you find the formula makes sense.

What do the arrows represent? What about the arrows pointing up and down?

Units
In the problem above we used the metric system. As is common in science classes, we will use the *Systeme International d'Unites* (SI) units.

Table 1.1 SI Base Units

Quantity	Unit Name	Symbol	Definition
Length	meter	m	The distance traveled by light in vacuum during a time interval of 1/299 792 458 s.

Mass	kilogram	kg	The mass of the international prototype of the kilogram.
Time	second	s	The duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the cesium-133 atom.
Electric current	ampere	A	The constant current in two long, thin, straight, parallel conductors placed 1 m apart in vacuum that would produce a force on the conductors of 2×10^{-7} N per meter of length.
Temperature	kelvin	K	The fraction 1/273.16 of the thermodynamic temperature of the triple point of water.
Amount of substance	mole	mol	The amount of substance that contains as many elementary entities as there are atoms in 0.012 kg of carbon-12.
Luminous intensity	candela*	cd	The luminous intensity, in a given direction, of a source that emits radiation of frequency 540×10^{12} Hz and that has a radiant intensity in that direction of 1/683 watts per steradian.

*Not used in this book

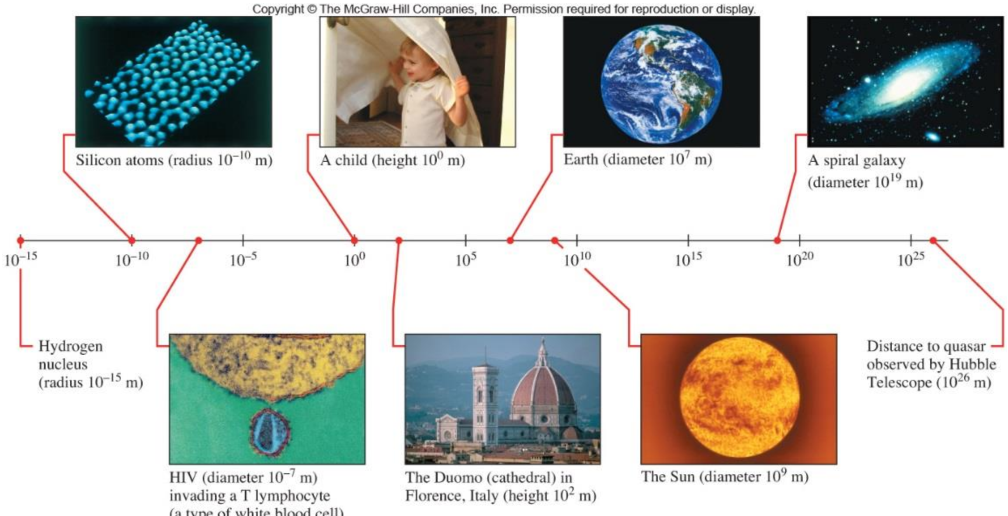


Table 1.2 SI Prefixes

Prefix (abbreviation)	Power of Ten
peta- (P)	10^{15}
tera- (T)	10^{12}
giga- (G)	10^{9}
mega- (M)	10^{6}
kilo- (k)	10^{3}
deci- (d)	10^{-1}
centi- (c)	10^{-2}
milli- (m)	10^{-3}
micro- (μ)	10^{-6}
nano- (n)	10^{-9}
pico- (p)	10^{-12}
femto- (f)	10^{-15}

Let's practice.

- 10^{-6} wave
- 10^{-3} pede
- 10^{-2} pede
- 10^{6} bucks
- 10^{-12} choo

Converting units. How many square inches are there in one square meter? There are 2.54 cm in one inch.

$$1\text{m}^2 = 1\text{m}^2 \times \left(\frac{1\text{cm}}{10^{-2}\ \text{m}}\right)^2 \times \left(\frac{1\text{in}}{2.54\,\text{cm}}\right)^2 = 1550\,\text{in}^2$$

Significant figures? We will not worry about significant figures. As a rule of thumb, keep your answers to 3 sig figs. Significant figures will be more important in lab.

It is assumed that you know about scientific notation.

Can you make an approximation for the conversion problem? A meter stick is about 39 inches long.

General Guidelines for Problem Solving (page 13)

1. Read the problem *carefully* and *all the way through*. Identify the goal of the problem. What are you trying to find?
2. Reread the problem and draw a sketch or diagram to help you visualize what is happening. If the problem involves motion or change, sketch it at different times (especially the initial and final situations).
3. Write down and organize the given information. Some of the information can be written in labels on the diagram. Be sure that the labels are unambiguous. Identify in the diagram the object, the position, the instant of time, or the time interval to which the quantity applies. Sometimes information might be usefully written in a table beside the diagram. Look at the wording of the problem again for information that is implied or stated indirectly. Decide on algebraic symbols to stand for each quantity and make sure your notation is clear and unambiguous.
4. Identify the units appropriate for the answer. If possible, make an estimate to determine the order of magnitude of the answer. This estimate is useful as a check on the final result to see if it is reasonable.
5. Think about how to get from the given information to the final desired information. Do not rush this step. Which principles of physics can be applied to the problem? Which will help get to the solution? How are the known and unknown quantities related? Are all of the known quantities relevant, or might some of them not affect the answer? Which equations are *relevant* and may lead to the solution to the problem

6. Frequently, the solution involves more than one step. Intermediate quantities might have to be found first and then used to find the final answer. Try to map out a path from the given information to the solution. Whenever possible, a good strategy is to divide a complex problem into several simpler subproblems.
7. Perform algebraic manipulations with algebraic symbols (letters) as far as possible. Substituting the numbers in too early has a way of hiding mistakes.
8. Finally, if the problem requires a numerical answer, substitute the known numerical quantities, *with their units*, into the appropriate equation. Leaving out the units is a common source of error. Writing the units shows when a unit conversion needs to be done – and also may help identify an algebra mistake.
9. Once the solution is found, don't be in a hurry to move on. Check the answer – is it reasonable? Test your solution in special cases or with limiting values of quantities to see if the solution makes sense. (For example, what happens if the mass is very large? What happens as it approaches zero?) Try to think of other ways to solve the same problem. Many problems can be solved in several different ways. Besides proving a check on the answer, finding more than one method of solution deepens our understanding of the principles of physics and develops problem-solving skills that will help solve other problems.

Graphs

We will use graphs throughout the semester. In physics, points on graphs may have units associated with them. Accordingly, the slope of a line and its intercept may have units and not be pure numbers. This will be very important in lab.

How about a demo?