01. Introduction

Model building in physics

Physicists do not study the real world. Physicists build models of the physical world, and then study these models in the hopes of gaining insight into how the world operates. This is the same thing that engineers do – they make assumptions to help simplify a complex problem.

What you will do throughout this course is build models, of increasing complexity, of the real world and by closely examining these models you may gain insight into how the world operates. Some of the early models you will examine will be obviously limited, but keep in mind that even the most advanced physicists are merely model-builders, and the models they study are as obviously superficial to them as the models we will study are to us.

Model building is necessary because of the overwhelming complexity of the real world. To attempt to study a real phenomenon, with all of its many details intact, is extremely difficult. Moreover, models often allow you to focus on the important aspects of a phenomenon, without the distracting details.

For example, a model of reality that everyone is familiar with is the road map. Imagine trying to drive to a strange address across town using a road map that included every driveway and alleyway! Although these details do exist, a model that tried to encompass all of these details would be less useful than one in which everyone's driveway was omitted. Thus, it is possible to omit detail, to be a poorer reflection of reality, yet to be a better, more effective, and more useful model. A useful model for driving across town would ignore driveways but probably include most, if not all, streets. However, if your task was to drive across the state, not only should the driveways be omitted, but so should the vast majority of side streets; probably state and federal highways should be the only roads on the map. Thus, a good model is closely tied to the task at hand. What can be a very useful model for one task can be useless for another.

Thus, when we build models where the effects of friction are neglected, or the shape of an object is ignored, it is not the case that this is a deficient model of the situation. It may well be the case that if these details were included, some important features of the scenario would be masked by the complexity. Simplifications made in constructing models of reality are not always limitations to the usefulness of the model, often they are the key to building a useful and productive model.

Units

In this course we will exclusively use the *International System of Units (SI Units).* These are also more commonly referred to as the metric system. In this system, all times are measured in seconds (s), all positions in meters (m), and all masses in kilograms (kg). For the sake of clarity, I will not include units during every step of a calculation, but it can safely be assumed that these standard units are in use throughout all calculations.

As many of you are engineering majors, we will specify all answers in engineering notation. Engineering notation is a version of scientific notation in which the power of ten is always a multiple of three (e.g, 10,000 N is written as 10 x 10^3 N or 10 kN). Whenever possible it is preferable to use the SI prefexes in lieu of writing the powers of 10. Common SI prefexes are shown below:

10^{12}	tera	T	Trillion	1,000,000,000,000
10^{9}	giga	G	Billion	1,000,000,000
10^{6}	mega	M	Million	1,000,000
10^{3}	kilo	k	Thousand	1,000
10^{0}	--	--	One	1
10^{-3}	milli	m	Thousandth	0.001
10^{-6}	micro	μ	Millionth	0.000001

10^{-9}	nano	n	Billionth	0.000000001
10^{-12}	pico	p	Trillionth	0.000000000001

Active reading

If you do not currently have a pen or pencil in your hand, pick one up.

As you read this text, you should be writing down explanatory notes to yourself, questions to be asked in class, and any flashes of insight you may have. Don't be afraid to write in the text. I promise that actively wrestling with the ideas on the page rather than passively reading the words on the page will make a huge difference in your understanding. If you find yourself reading page after page of the text without spontaneously thinking of questions, either you are not really digesting the material or you should be in a more advanced class.

In addition, the concepts and principles of physics are complex, even the ones that appear to be simple. (If the principles really were simple, it would not have taken humankind thousands of years to understand the motion of a simple falling object!) They will become clear to you only after careful study. With this in mind, the text is not meant to be read (and written in) once. It should be re-read (and re-written in!) as you work through the various activities included. Hopefully, as you complete the activities, the concepts will come into better focus.
