AIMs (**A**stronomy **I**nstructional **M**odules) for Physics: FAQ

Why teach physics using astronomy?

The topic of astrophysics is highly engaging and at times awe-inspiring. More adults retain a life-long passion for astronomy, as gauged by amateur involvement, than for any other science. The AIMs curriculum makes use of the natural curiosity that students already have to engage them in the study of physics. This curriculum will bring into your classroom topics that students already have some interest in. Whether they have seen the latest end-of-the-world asteroid movie or read a headline about a new planet being discovered, the topic of astrophysics is present in today's popular culture. Not only is it engaging for many students, it also offers students a chance to apply their basic physics content knowledge in a new, rigorous way.

What astronomy background do I need?

As a teacher new to the content, you will be able to apply your prior physics content knowledge and skills to learning the astrophysics content. Each module includes the lesson objectives, questions and activities, answers for selected questions, and other ancillary materials. While we recommend attending an AIMs workshop, teachers with a strong physics background should be able to figure out most of the content in the curriculum. Teachers new to astrophysics may wish to browse the web on topics like dark matter and black holes to enrich their ability to go beyond the lessons in discussions with students.

How much class time will this take?

Each of the classroom modules (excluding the Moon Project which will span several weeks outside of class) varies in length between 20 minutes and 80 minutes, with several possible multiple-module combinations (see Sequence Options page). However, this does not mean that you will be giving up class time to include these lessons into your curriculum. Because they are meant to be taught alongside content that the standard physics course will cover, they enrich students' ability to master the standard physics skills they are already practicing. Students may retain content that is enriched by the astrophysics curriculum better because they practiced using it at a more advanced level.

In the Sequence Options document, several different unit length options are provided: everything from teaching one enrichment lesson to covering the complete set of nine modules. If you are not sure how much of the curriculum you would like to include in your class, but you would like to introduce at least one major astrophysics topic, we recommend the medium unit. The medium unit will introduce your students to the topic of Dark Matter, one of the most intriguing and timely mysteries in astrophysics. If you are interested in using the entire curriculum, please see the section below ("Where do the modules fit in my curriculum?") for suggestions on when to include each module in your course.

What costs or resources are involved?

The AIMs curriculum requires no telescopes or other specialized equipment. If you are already working in a typical school, then most of the materials are probably already in hand. Some of the not so common materials, such as a bed sheet, should be easy to find in a home. If you choose to do the Moon Project, you will need a dark room (very dark) to perform the introductory activity.

What kind of student population will benefit?

This curriculum has been designed to improve certain skills that physics students already commonly need to master. For example, we have made a point to include graphical analysis as a skill in the AIMs curriculum because of the rigorous thinking it pushes students to use. This is present in modules 2, 4, 6, and 8. In addition, certain lessons include derivations, which show students the logic underlying equations. Therefore students should have a strong algebra background to find the lessons meaningful and not frustrating. However, the modules are otherwise appropriate for beginning physics students (e.g., *not* necessarily Advanced Placement), and the use of interactive learning techniques should aid learning in a class with diverse backgrounds. We note that without a teacher aide, these interactive methods may put a limit on ideal classroom size at around 30 students.

What does each module provide?

As an example, take a look at Module 2, Far Away Is Long Ago. On the first page, you will find the lesson Objectives/Key Points (here involving understanding lookback time), suggested Unit Home (in this case 1D kinematics), Prerequisites for the lesson (Module 1, d=vt, and the concept of a constant speed of light c), and the Time needed in class (here, 30 min). The Materials are also listed here and may include physical resources as well as helpful websites and videos. Sticking Points are listed at the beginning, including common misconceptions and easy mistakes to make. Some lessons, such as this one, include Warm-Ups that access prior knowledge and suggest interesting initial questions (hooks) to get students thinking. The Pre-Lesson, while not directly connected to the objectives of the lesson, frames the learning that is about to take place by asking relevant questions. The Main Lesson section lays out how the students are going to master the objectives for the class: scenarios to be discussed, definitions to be given, questions to be asked, and problems to be solved. Selected questions and problems include answers to help the teacher with the content. The Summarizer at the end of the lesson helps students wrap up the big ideas from the lesson. Finally, an optional Enrichment section addresses additional questions that are fun to consider if there is time (in this case, thinking about looking at dinosaurs in other galaxies!). Because this lesson makes use of graphs, we have provided blank grids at the end of the document that can be used for class work. Some other lessons provide in-class worksheets or preparatory handouts, and some suggest post-lesson options such as homework or assessment questions.

What should I do when I see this symbol [the interactive learning symbol]? 

Students will be asked to engage with each other many times throughout the curriculum. A large body of research demonstrates that student-student interaction can increase student achievement, for example erasing the physics achievement gap between boys and girls. The interactive learning symbol indicates that students should be asked to interact with each other in a purposeful way. The most common type of interactive learning in the AIMs curriculum is Think-Pair-Share. During a Think-Pair-Share, students have a chance to consider a question individually, commit to an answer (by writing it down or voting), then pair up with a partner and discuss responses (often arguing for their own answer). Research indicates that the initial individual step is crucial – the teacher must ***insist*** that each student attempt to answer before discussing. From a classroom management point of view, teachers should be sure that they have established an effective procedure for having students work in pairs.

Where will the modules fit into my curriculum?

Various unit lengths are possible (see the Sequence Options page). Independent of the number of modules you use, we find that the modules are most effective when used to enrich the standard physics curriculum. The modules are mostly chronological.

Here's an overview of what it would be like to use the entire AIMs curriculum in your physics class: Module 1, *You Are Here*, addresses our place in the Universe. This is a great excitement building topic for a physics class and ideally should occur early in the year. It can be used to reinforce the concepts of scientific notation and powers of ten. Module 2, *Far Away Is Long Ago*, applies the equations of one-dimensional motion at a constant velocity and would be appropriate after students have just learned to analyze 1D motion graphs. In Module 3, *Angular Measurements and Motion*, students are given a quick introduction to angular motion. If the course is at the AP level, this content will be covered in the rotational kinematics unit and Module 3 may be skipped (it includes no astrophysics). Module 4, *Motions Find Mass*, is an application of Newton's Laws and circular motion. This module is a great enrichment lesson on astronomical applications of these two concepts. Module 5, *Red Recedes, Blue Approaches*, can replace the standard lesson on Doppler shifts and should follow after the students' introduction to waves (or can be omitted if the physics content is duplicated in the course, as this module contains minor astrophysics content). Module 6, *Rotation Curves and Dark Matter*, is a fun application of the skills acquired in Modules 4 and 5. Modules 7 and 8, *Black Holes* and *The Cosmos in Motion*, can come at any point thereafter.

The Moon Project can be started any time after Module 3, but its completion roughly 1-2 months later will require the material covered in Module 4 as well. In North Carolina, starting the Moon Project at the beginning of the second semester is ideal because students will have a chance to observe in the winter months when skies tend to be clear and beautiful.

There is also the option of teaching all of the modules consecutively at the end of the year. However, this approach deprives students of regular fun breaks from the standard material, and also it has been our experience that school schedules at the end of the year are unpredictable, so that the "cool" topics in Modules 7 and 8 are often squeezed out if everything is left to the end.