Frequently Asked Questions

What are these handouts?

After graduating college, I tutored a few high school students per year as a side job. Over the first two years, I developed a set of handouts to assign for homework. Then I spent a few more years polishing them up, and writing detailed solutions with the help of two members of the US IPhO team, Gopal Goel and Sean Chen, who both won gold medals after going through the handouts.

These handouts are the most comprehensive resource for Olympiad physics that I know of. They total over 1,000 pages in length, containing over 250 worked examples and 1,000 challenging problems, along with 7 practice USAPhOs. Most USAPhO, IPhO, APhO, and EuPhO problems are included, though I've also taken problems from more obscure competitions, recent research, the Victorian-era Cambridge Tripos, graduate qualifying exams, and more. I've also written some problems myself, to illustrate ideas that common textbooks don't explain well, added subparts to classic problems to bring out subtle points, corrected competition questions when needed, and included in-depth discussions of the context for problems that originate from history or more advanced physics.

The core USAPhO material is covered in 24 handouts. There are also 3 review handouts, and 6 more advanced handouts. Since Olympiad physics ultimately is just real physics with trickier problems and elementary math, you could probably also use the handouts to learn university physics; they cover approximately the first two years of an undergraduate degree.

Who has used the handouts?

Excluding 2020, when almost all competitions were cancelled, I've tutored 11 students using these handouts. Of these, 10 have won USAPhO gold medals or equivalent, 6 have qualified for USAPhO camp, and 3 have won IPhO gold medals. In 2021, I managed the training of the US IPhO team, basing it primarily on these handouts. That year, they achieved a perfect 5 gold medal finish for the first time in history.

What's the catch?

There is no catch. All of the materials are completely free.

Why are you giving everything away for free?

When I was in high school, I heard about the Physics Olympiad from my physics teacher, spent an afternoon searching online for a book recommendation, and bugged my parents to buy Halliday, Resnick, and Krane. They got me a $20 used copy with the spine falling off, and I spent an enjoyable year puzzling over it by myself, reading it on the weekends and during chemistry class. When I went to the IPhO, I still only had that one book, held together with layers of tape.

This shows that Olympiads are one of the most accessible high school activities in the world. There's just about no other activity out there where you can make it that far with no adult help, and almost zero budget.[1] On the other hand, while there was a path, it wasn't well-paved. I spent hours at a time stuck on little things, because of missing steps in solutions, ambiguous statements, or outright errors. I didn't know much beyond the textbook, which meant I had almost no knowledge

[1] Of course, the same goes for the SAT, for which the best prep resource is still the $20 Blue Book. Tests are always cheap; it's the inspirational, classy stuff made for college essays that costs money.

of subjects like fluid dynamics and circuits, and online explanations were of dubious quality. I didn't have a broad range of sources for training problems, or any idea of how to compare their difficulty, so I was blindsided by IPhO questions that were different from what I'd seen before. Worst of all, I didn't get the big picture, the deep links between all the fields of physics I was learning. I managed to piece some of it together myself, but the process was unreliable and slow.

My goal with these handouts is to shorten the way for future students, both within the United States and around the world. In the original spirit of the Olympiads, I hope they spark interest in the subject for years to come.

Do you offer tutoring?

No, unfortunately I'm too busy to tutor individual students. However, the problems and solutions are designed so that students can follow them on their own, or with friends.

What is the schedule for releasing the handouts?

I've already released all of the main handouts, but because polishing solutions takes a great deal of time, I'll release the remaining solutions in the late summer of 2022.

How can I make similar looking documents?

You can download a TeX template for the handouts here.

How do I know if I'm ready to start using the handouts?

Before starting, you should have completed most of a standard calculus-based introductory physics book, such as Halliday, Resnick, and Krane. (For more guidance, see my advice on learning introductory physics.) You should also have some problem solving experience from entry-level competitions. To judge this, spend a few days on the basic problems in the preliminary problem set. For the handouts to be most useful, you should be able to solve over 75% of them.

How long should it take to go through them?

It varies a lot. On average, students took about 10 months to go through the core 24 problem sets. The amount of time they worked varied widely, from 8 to 15 hours per week. It also varied between problem sets: sometimes a student would blaze through an early problem set in 2 days, but then take 2 weeks on a later one because more background reading was required, or because they wanted to stop and think about the material more deeply. I wouldn't worry about how much time things are taking you, as long as you're learning new things and enjoying yourself.

How did you choose the problems?

I've tried to choose each problem to teach a distinct physical lesson, which means:

- Few "cookie-cutter" questions. I try to give one or two problems or examples for each new technique you should know, but that's enough. If you want more routine practice problems, you can easily find them in standard books.

- No "hidden math" questions, i.e. questions where the physics is just used as a thin shell for a math problem. For example, ideal gas heat engine problems are pretty routine, so some exam writers try to spice them up by adding a mathematical twist. They might give you a standard PV diagram where "the axes have been lost", and you somehow have to construct them with ruler and compass given some contrived partial information. Or, pulley problems are pretty easy, so why not make them harder by having infinitely many pulleys stacked on top of each other, so that students have to sum infinite series? But none of these things resemble anything a physicist would ever encounter. There actually are plenty of interesting questions involving ideal gases and pulleys, but you can't get to them by starting with trivial questions and stacking on mathematical complications.

- Few "one weird trick" questions. A lot of easier Olympiad problems are just cookie cutter problems that also require a single key idea. As a very simple example, in many problems that involve objects initially arranged at the vertices of a regular polygon, you can use symmetry to conclude that this always remains true. These ideas can be quite beautiful, and they're often important in more advanced physics. But I think it's sufficient to see each one just once or twice, in the simplest possible context.

- No "two weird trick" questions. Sometimes people construct tough problems by pasting together simpler ones, but I don't think that's a lot of fun, because the whole doesn't end up greater than the sum of the parts. A great tough problem should contain an *irreducible* nugget of insight: a completely new idea that is already as simple as it can possibly be, yet still difficult to find.

You might be wondering: if you can't make great problems by tweaking existing setups, adding tricks to them, or combining existing tricks, then how are they created at all? Usually, they are produced by subtraction, not addition. A physicist spots something interesting, such as a setup commonly used in their research area, an insight from an advanced course, a recent paper, a piece of technology, or even a children's toy. Then they think hard about how to present it in the simplest possible way, so that it can be solved using high school knowledge alone. The benefit of this kind of question is that when you solve them, you're learning something real, whether it's a preview of advanced material, some practical know-how, or an insight into the physics of everyday life.

Can I ask you about the problems?

I don't give hints for problems, since there are already detailed solutions. If you're stuck on a tough problem, I recommend reading a line of the solution and trying to continue from there. If you're confused about a basic problem, I recommend reviewing the background reading. I'm happy to give occasional feedback if you have deeper conceptual questions, but please first make sure your question is not already answered in the solutions.

What if I find an error in the solutions?

For IPhO and APhO problems, the official solutions often do have errors. For those with major errors, I usually either avoid assigning the problem entirely, or add a warning in the problem set. However, I can't do much about minor errors, such as factors of 2 or minus signs. Please tell me about IPhO or APhO errors only if they're major.

For USAPhO problems, the situation is different. When I was in high school, the official solutions were in pretty bad shape: about half of the solutions had some error in them, and many of the explanations were incomplete. A few years ago, I rewrote all of the official solutions from 2008 to 2019, and I believe they're currently almost error-free and much easier to understand. If you've spotted a error I missed, I would be very interested in hearing about it! The same goes for any error in the handout solutions, even if it's just a minor typo. Learning new things is hard enough without typos, and you'll be helping clear the road for future students.