Frequently Asked Questions

What are these handouts?

From 2017 to 2020, I tutored a few high school students per year as a side job, and wrote a set of common homework assignments. Fron 2021 to 2024, I trained the US Physics Team, while gradually refining the assignments into a comprehensive set of handouts. They total over 1,000 pages in length, with over 250 worked examples and 1,000 varied and challenging problems. Many USAPhO, IPhO, APhO, and EuPhO problems are included, but 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 half of an undergraduate degree.

These handouts were greatly improved with the help of many sharp readers. In particular, I thank Gopal Goel and Sean Chen for helping me write the original solutions, Alex Huang, Agastya Goel, Stefan Ivanov, Miles Zhang, and Kai Wen Teo for spotting many errors and oversights, and William Guan, Brian Zhang, and Jerry Liu for suggesting interesting followup questions.

Who has used the handouts?

From 2017 to 2020, I 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 and 2024, I trained the US traveling team primarily using these handouts, and both years the team achieved a perfect 5 gold medal finish.

Currently, the handouts are used by students in countries around the world to prepare for the IPhO. Since they're quite long and challenging, only perhaps a dozen people comprehensively solve them per year. My impression is that the majority of these people win IPhO medals.

Do you offer tutoring now?

No, I've been far too busy to tutor for years. However, the handouts are designed so that students can follow them on their own, and many have done just that. You can meet other students working through them on this Discord server.

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 that summer, 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. If you want to be a chess prodigy, a musician, or an elite athlete, you need expensive coaches, and parents who will drive you to practice and fly you to competitions around the world. If you want to do robotics, you need to go to a high school whose club has a five-figure budget, and if you want to do research, you'll almost always be doing it in a university lab with a multimillion dollar budget. But to learn physics, you only need one book and your own mind.[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 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.

How can I make similar looking documents?

You can download a TeX template for the handouts here. I use Sublime Text with LaTeXTools, though any common LaTeX editor will work well.

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.

What if I can only do the mechanics preliminary problems?

I recommend learning at least introductory mechanics and electromagnetism before starting the handouts. The reason is that a good calculus-based introductory textbook gradually increases the depth of its mathematics and the sophistication of its physical arguments. In the early mechanics chapters, it'll explain in great detail what it means to take an integral or a cross product, or to consider a system or a differential element, but by the late electromagnetism chapters these operations are used freely, and expected to be second nature. My handouts also gradually increase in level, but they start where a typical introductory textbook ends. So if you go straight from textbook mechanics to the mechanics handouts, you might face a tough difficulty jump.

[1] Of course, the same is true for the SAT, for which the best prep resource is still the $20 Blue Book. Tests are cheap and accessible, which is why they're used for college admissions in every developed country besides America.

What if I've aced both the AP Physics C exams?

The average AP Physics problem requires recalling basic formulas, plugging numbers into them, or at most combining 2-3 standard formulas and solving for a variable. By contrast, in Olympiad problems you are often expected to come up with formulas you haven't seen before, by thinking carefully about the physical principles governing the situation, and to fluently apply them. The AP exams can only contain about 100 distinct problems, with superficial variations, while the diversity of Olympiad questions is at least 10 times greater.

So the answer depends on how well you've personally learned physics. Again, the best way to check is to try some old exams, or the preliminary problem set. If you find them too challenging, you can review a good introductory physics textbook, focusing on its harder questions.

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 handouts. The amount of time they worked varied widely, from 8 to 15 hours per week. It also varied between handouts: sometimes a student would blaze through an early one 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. (The handouts contain lots of references to textbooks and papers, in case you want to take the scenic route.) I wouldn't worry about how much time things are taking you, as long as you're learning new things and enjoying yourself.

By the way, my metric for completing a handout is solving about 2/3 of the problems, weighted by points. For most purposes, doing all of every handout is overkill, and you can pick and choose what looks most interesting to you. Also, there's no need to spend a long time trying to solve the examples on your own – they are intended to introduce new ideas, and sometimes they're extremely tricky. The example solutions are designed to be read as you go.

On the other hand, you should absolutely *not* just read all the problem solutions, one after the other. I've tried to make them clear, so they'll "make sense" as you read them, but if you haven't actually tried a problem, you won't understand how to come up with its solution independently, or how to distinguish the right solution from similar-sounding wrong solutions, or how the solution relates to deeper principles. When students blast through all the handouts in a week this way, they generally end up very confused. If they retain any information at all, it's generally shallow stuff like "remember to use trick X for problem Y in handout Z", which misses the point, makes the problem useless for practice later, and doesn't generalize to unseen problems.

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. But it really doesn't make sense to demand, say, a dozen identical problems about massless pulleys. You might be trained to expect this from years of homework, but in physics competitions, success comes from deep understanding gleaned from a few tough problems, not just mindlessly exercising your fingers on many easy ones. Each problem should be different. Each one should require an idea not present in any other.
- Few "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. Maybe you'll have to calculate the efficiency of an elephant-shaped cycle, or maybe they'll erase the axes in a PV diagram and have you reconstruct them with ruler and compass. Or, pulley problems are pretty easy, so why not make them harder by having six pulleys, so students have to solve a giant system of equations, or infinitely many pulleys, so that students have to sum infinite series? Resistor networks are straightforward, so why not build fractals out of them?

But these contrived questions all have trivial *physical* content: it's always completely obvious what physics equations should be used, and the difficulty comes only from solving those equations. Worse, none of these things resemble anything a real physicist would ever encounter. There actually are plenty of interesting questions involving ideal gases, pulleys, and resistors, 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. You don't need twenty examples to see the pattern.
- 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. In other words, I constructed the handouts to be comprehensive, but also as easy as possible!

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.

Are these handouts enough for to get USAPhO or IPhO gold medals?

Not only are they more than enough, they're *exhaustive*, in the sense that I believe people should just move on to undergraduate physics after finishing them!

What if I just want USAPhO qualification/HM/bronze?

If that's your main goal, then the handouts are not an efficient tool, since they go too deeply on each subject. It would be better to understand introductory physics more deeply, and to practice on simpler questions. Again, see my advice on learning introductory physics for some options.

Are these handouts enough to qualify for the IPhO?

Paradoxically, the answer is probably yes if you live in a country with a strong IPhO team, and *no* if you don't. In the former case, your country's system is tuned to select strong IPhO competitors, and thus will have a style that overlaps with the handouts. In the latter case, your country's competitions will be idiosyncratic. They might have a lot of contrived questions with really complicated pulley or circuit setups, or qualitative questions without definite answers, or conceptually simple problems with extremely complicated algebra. They might even rely on memorization or reuse of previous questions. In these cases, you should focus your training on past exams from your own country.

Where can I find pre-2007 USAPhO and Quarterfinal exams and solutions?

See the links in the Syllabus.

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 solutions in the handouts themselves, I always welcome error reports. Learning new things is hard enough without typos, and if you point one out, you'll help clear the way for many future students. Before reporting an error, make sure you're using the latest version of the handout, available on this website, as they're updated frequently.

I would also be very interested if you spot an error in a USAPhO solution after 2007, since I've been working with AAPT to improve those solutions for the past few years. Before reporting an error, please make sure you're looking at the latest versions, available here.

I don't have any power to fix the official solutions of other Olympiads, such as the IPhO or APhO. If you find that my handouts refer to a flawed question, without a suitable warning, I would appreciate knowing! In addition, you should get in touch with Stefan Ivanov, who maintains a combined errata list here.