

How to study for USAPhO and IPhO

The United States Physics Olympiad (USAPhO) and International Physics Olympiad (IPhO) are competitions in which high school students are tested on their knowledge of physics, generally at the high school and undergraduate level, and their problem-solving skills. In the US, 6000 students sit the qualifying exam called the F=ma exam, of whom 400 sit the semi-final exam called the USAPhO exam, of whom 20 are invited to the US Physics Team Camp, of whom 5 are selected to represent the US at the International Physics Olympiad. It is a giant commitment to try to make it to IPhO and get a gold medal, and I assume this is your goal when I write the following program.

Starting from scratch

I'd suggest to start preparing for this competition before high school, if possible. Therefore, the program assumes you're starting from scratch:

1. High school math. A background of 8th grade math means you're comfortable with Algebra 1. It's super important to gain more experience with algebra so that it becomes your second language. Here are links to Khan Academy, the best resource for learning any high school subject:
 - a. [Algebra 2 - necessary](#)
 - b. [Geometry - helpful](#)
 - c. [Precalc - helpful](#)

I don't think any of these courses will take more than 40 hours to complete and master.

2. First taste of physics. The only prerequisites for high school/AP physics are the math prerequisites completed in step 1. Let's just skip non-AP physics since it's unnecessary. Khan Academy's AP Physics 2 is incomplete so I'll link AP Chemistry instead—Chemistry and Physics 2 have a bit of material overlap, and the skills gained from Chemistry are very helpful to physics. These may take ~40 hours each to complete and master.
 - a. [AP Physics 1 - necessary](#)
 - b. [AP Chemistry - recommended](#)

3. Do this step concurrently with step 2. Mathematical intuition and problem-solving skills are absolutely vital to Physics Olympiad. This is why it's so helpful to grind out hard math while preparing for Physics Olympiad. My favorite resource for this is AoPS Alcumus—an online program where you solve problems in various areas of math and gain experience points and a rating kind of like in Madden. Use the AoPS wiki when you encounter problems you don't know how to solve. The wiki will have helpful tricks and formulas for this purpose. Aim to solve 2 problems (~20 minutes) for every hour you spend on step 2. Once you've finished step 2, continue grinding Alcumus by doing a few problems a week. For reference if you want to set a goal, I've completed 1200 problems, my overall rating is 95.5, and my overall level is level 13.

- a. [Alcumus - necessary](#)
- b. [AoPS wiki - necessary](#)

4. At this point, you could score well on the $F=ma$ exam, but you may not pass it. The next step is to dial in your physics grinding. However, you will need to learn calculus first. Calc AB will suffice, no need to do Calc BC. If you want a challenge, do MIT OCW's single variable calculus instead.

- a. [AP Calc AB](#) – necessary. Probably around 50 hours to complete.
- b. [MIT single variable calculus](#) – challenging replacement for AP Calc AB. Roughly 80 hours.

5. Calc-based physics. Now we'll switch to MIT OCW as our main resource since we're at the college level. It's also nice that their courses are rigorous and challenging, prepping your brain for the feat of intelligence that is the Physics Olympiad. The first physics course is Classical Mechanics 1, which overlaps with AP Physics 1 but is more in-depth. This could easily take 80 hours to complete.

- a. [Classical Mechanics - necessary](#)

Don't be discouraged if this is hard. Just take it slowly. I rushed through it and had to redo the course twice because I struggled so much.

Steps 1-5 total time: roughly between 250-400 hours (plus weekly Alcumus), depending on the choices you make. This is overkill if you just want to pass the F=ma, but again, I'm assuming you want to go to IPhO, so you need this backbone.

Checkpoint 1: you're ready to demolish the F=ma exam and move to the next level.

The F=ma exam tests only over mechanics, so a mastery of calc-based classical mechanics is enough to pass the F=ma exam. To ensure you pass, practice the test using old F=ma exams on [this website](#). Do a full practice test emulating real exam conditions, grade the test, and make corrections. Compare your score to the cutoff score (look this up, it changes every year but is usually around 13-18). I'd suggest just one or two practice tests per week, and never cram practice tests in the 3-7 days preceding test day—that will fatigue you and make you perform worse. And don't forget to keep grinding Alcumus!

6. More math prerequisites. Concepts of multivariable calculus, linear algebra, and differential equations will be incredibly helpful. Each course will take around 80 hours to complete, so be patient.
 - a. [Multivariable Calculus - recommended](#)
 - b. [Linear Algebra - recommended](#)
 - c. [Differential Equations - recommended](#)
7. The fun stuff. Let's first expand our horizons before we re-relearn mechanics. E&M will use your math prerequisites, but the others won't really need it yet. Also, we are running out of OCW resources, so we will resort to textbooks.
 - a. [Electricity & Magnetism - necessary](#). This is also available on edX for free. Probably 80 hours.
 - b. Thermodynamics – chapters 18-20 of Resnick, Halliday, and Walker (RHW) – necessary. Maybe 20 hours.
 - c. Waves and optics – chapters 16, 17, 34-36 of RHW – necessary. Maybe 30 hours.

8. On top of your weekly Alcumus grinding, we can now add a physics version of this, though it's from a textbook, not a fancy website. The following books have nice problems to challenge your problem-solving skill in physics. Do a few each week.
 - a. I.E. Irodov – problems in general physics
 - b. 200 puzzling physics problems
9. The hardcore stuff. Now, we'll have to pull out our math prerequisites to tackle these courses. David Morin is important because his problems are incredible. If you can do 3- and 4-star problems consistently, then you're practically guaranteed a spot at training camp. Do at least 20 problems from each chapter (if there are 20 problems) before moving on to the next. Each book will likely take 120+ hours to complete thoroughly.
 - a. Mechanics and Relativity – Introduction to Classical Mechanics by David Morin (MM), all chapters – necessary. At least do chapter 11 (relativistic kinematics) early on so that you don't get lost in the relativistic chapters of the following book.
 - b. E&M – Electricity and Magnetism by Edward Purcell and David Morin (P&M), all chapters except the last 2 – necessary

Steps 6-9 total time: ~600 hours (plus weekly Alcumus and Irodov/200PPP), including all the math prerequisites. You could shave a hundred hours off this time if you rush the math prerequisites since they aren't absolutely essential. Be ready to spend your summers locked in, grinding out physics—in addition to an hour or two every day during the school year.

Checkpoint 2 – you can finesse the USAPhO exam and move on to training camp and beyond.

At this point, you will probably be able to reach the USAPhO exam and perform well enough to make it to the training camp. In the months leading up to the USAPhO, practice with old exams from [this website](#). Do a full practice test emulating real exam conditions, grade the test, and make corrections. I'm pretty sure a good goal is to get a 70%, though they never release cutoff scores to be invited to the training camp. I'd suggest just one or two practice tests per week, and never cram practice tests in the 3-7 days preceding test day—that will fatigue you and

make you perform worse. Beyond this point, I can only speculate how to move on since I have yet to make it past training camp.

10. Stop doing I.E. Irodov's problems or the 200 puzzling physics problems, and start doing old IPhO problems instead. You'll find they're actually easier than the USAPhO. Do a couple each week, grade them, and make corrections. Aim for the moon and set a goal to hit 8+ points per question (out of 10 total).

- a. [Old IPhO problems and solutions](#). This website also has the experimental portions if you want to look at them. 100 minutes per problem time limit, but I find they usually take less time.

11. Kevin Zhou's Physics Olympiad handouts. This guy is an absolute hero for the work he has done with these handouts. You could do them in order, but they take a long time, so I'd suggest starting with your weak points.

- a. [Kevin Zhou](#). Scroll down to his Physics Olympiad handouts. He says they take about a year to complete in entirety.

12. Lab skills. Look at old experimental portions of the IPhO. Email a professor at a local university and ask if you can borrow the physics lab to try doing these experiments with him.