Guide to U. S. Physics Olympiad Competitions

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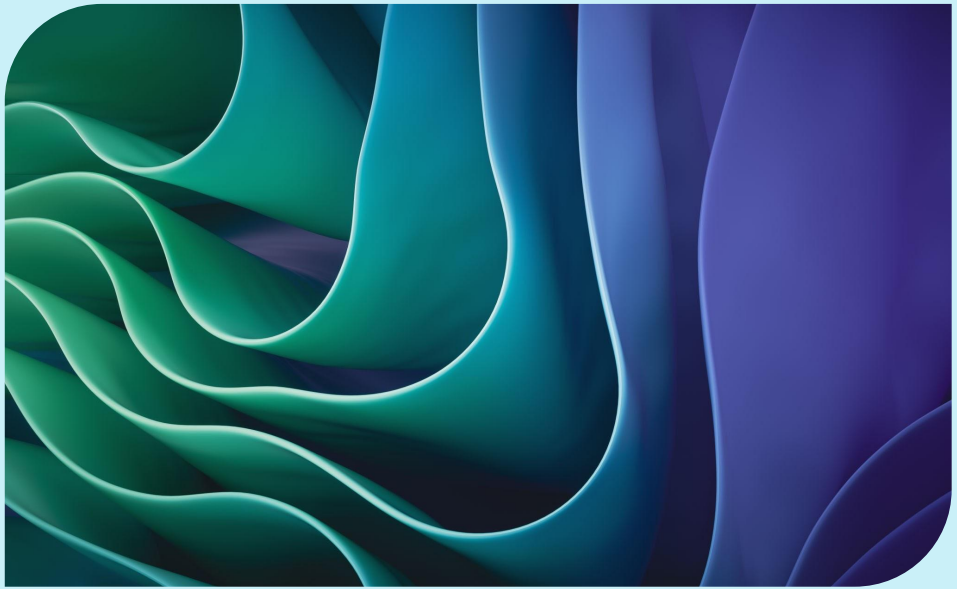
03/30/2025



Self Introduction

Ryan Wang

- Sophomore (10th grade) at Granada High School in Livermore
- Participation in math / physics competitions
  - Qualified for USAMO / USAPhO - 2025
  - USAJMO honors - 2024
  - USAPhO Honorable Mention - 2024
- Officer at Cowconuts (student run non-profit organization promoting math and STEM)

Overview

Topics We'll Be Covering

- Physics competition pathway for US (middle) high school students
  - F = ma
  - USAPhO
- Benefits of participating in physics competitions
- How to study / prepare for Physics competitions
  - School classes
  - Self study materials
  - Other resources
- How the competition topics correlate with school curriculum

Background

AAPT, or the **American Association of Physics Teachers**, is responsible for recruiting, selecting, and training teams that compete in the International Physics Olympiad each year.

- AAPT and the American Institute of Physics (AIP) organize a series of exams / events to select the U. S. Physics Team to represent the US competing in the International Physics Olympiad (IPhO)
- Mission of U.S. Physics Team Program is to promote and demonstrate academic excellence through preparation for and participation in the International Physics Olympiad
- Many students participate in these competitions to show their talent and determination to succeed

The United States has won **85 Gold Medals, 54 Silver Medals, 29 Bronze Medals, and 11 Honorable Mentions** at the International Physics Olympiad (from 1986 to 2024)

- China has been the most successful country at the IPhO, securing the highest number of gold medals (151 gold medals) and frequently topping the overall rankings. Russia, Taiwan, and South Korea also consistently excel in the competition.

Physics competitions

F = ma

- Open to all US students
- ~ 6000 students
- Exam in January/February of each year

USAPhO

- ~400-500 students qualified through F=ma exam
- Exam in April each year
- Gold / Silver / Bronze / HM awards

U. S. Physics Camp

- 20 selected for camp
- 10-days training in June
- 5 selected for U. S. Physics Team

AAPT PHYSICS EDUCATION®

U.S. Physics Team

F = ma: basics

- 75-minute exam
- 25 multiple-choice questions
- Handheld calculator may be used (no graphical calculators/ memory cleared)
- Problems can be solved without the use of calculus (some may have shorter calculus-based solutions)
- Each correct answer earns points, while incorrect answers typically do not incur penalties.
- Top 400 to 500 students nationwide advance to the USAPhO semifinals
- Qualifying score: 14-18 (2025: 15) / Average score: 8

F = ma: topics

- Focuses on mechanics
  - Kinematics
  - Newton's Laws of Motion
  - Work, Energy, and Power
  - Momentum and Impulse
  - Rotational Motion
  - Gravitation
  - Simple Harmonic Motion (SHM)
  - Statics
  - Fluid mechanics
- Topics generally covered by AP Physics 1 / AP Physics C - Mechanics classes, but in much higher level of difficulty and depth

F = ma: how to participate

Eligibility: Middle or high school students who are either U.S. Citizens, U.S. Permanent Residents (Green Card holders), or currently attending a U.S. school

- **New for 2025**, students must also be located within the U.S. to take the F=ma exam

When: currently one time each year: typically in January or February. (it was offered 2 times in some past years).

Cost: The registration fee to participate is $75 ($37.5 for AAPT Members) per school plus $15 per student.

Where: The exam is usually proctored by student's school or non-profit local organizations

- **New for 2025**, due to security concerns, for-profit test prep centers, and for-profit educational services will no longer be allowed to proctor the F=ma or USAPhO exams

USAPhO: basics

- 3-hour exam
- Part A and Part B: each for 90 minutes
- Free response questions: detailed justifications for the answers
- Handheld calculator may be used (no graphical calculators/ memory cleared)
- Knowledge of calculus can be very helpful in solving some problems
- Awards (similar to IPHO):
    - Gold: top 10-12% scorers in USAPhO: ~top 40
    - Silver: next 14-16% scorers in USAPhO: ~top 100
    - Bronze: next 20-22% scorers in USAPhO: ~top 180
    - Honorable mentions: 24%-26% scorers in USAPhO: ~top 250
- Top **20** students selected for U. S. Physics Camp

USAPhO: additional topics

Electromagnetism

- Electrostatics
- Electric Circuits
- Magnetism

Optics

- Geometrical Optics
- Wave Optics

Thermodynamics

- Laws of Thermodynamics
- Kinetic Theory of Gases

Modern Physics

- Quantum Mechanics
- Atomic Physics
- Nuclear Physics
- Relativity

➢ Topics generally covered by AP Physics 2 / AP Physics C - E&M classes, but in much higher level of difficulty and depth

USAPhO: how to participate

Eligibility: Middle or high school students who are either U.S. Citizens, or U.S. Permanent Residents (Green Card holders)

- **New for 2025**, students must also be located within the U.S. to take the USAPhO exam

When: currently one time each year: typically in April

Cost: No additional cost

Where: The exam is usually proctored by student's school or non-profit local organizations.

- **New for 2025**, due to security concerns, for-profit test prep centers, and for-profit educational services will no longer be allowed to proctor the F=ma or USAPhO exams

Benefits

- **Great Preparation** (might be overkill) for AP Physics exams
- **Promote Self-motivation:** students need to learn many new things / self study skills
- **Build Confidence**: excelling in a challenging environment can significantly enhance student confidence in their abilities
- **Develop Problem-Solving Skills**: the preparation and competition require advanced problem-solving and critical thinking, which are invaluable in any academic or professional setting
- **Boost Your College Applications**: success in prestigious competitions like the USAPhO can strengthen your college applications, highlighting your dedication and expertise in physics

Physics vs. Math

Similarities

- Challenging / Demanding
- Focus on problem solving skills
- Prestigious for college admission
- Great foundation for future study/career

Differences

- Much fewer participants: 6000 vs. 50,000
- Learn many concepts in 1-2 years vs. over 10+ years
- Contest materials similar to college courses vs. niche topics for math

Is it for you ?

Who should consider

- Genuine interest in STEM topics
- Solid foundation in math (Algebra & Trigonometry)
- Enjoy problem-solving and competition

When to start

- 8th / 9th /10th grade
- Completing Algebra II / Pre-calculus
- It is never “too late”

How to prepare

Taking classes

Learn the materials for the topics

Develop good understanding of concepts

Understand how the concepts can be applied

Self study

College textbooks

- David Morin
- HRW: Fundamentals of Physics
- HRK: Physics (I & II)

Online courses: Yale / MIT / Khan academy

Youtube channels: “Physics Galaxy” and “Flipping Physics”

Handouts: Kevin Zhou

Practice problems

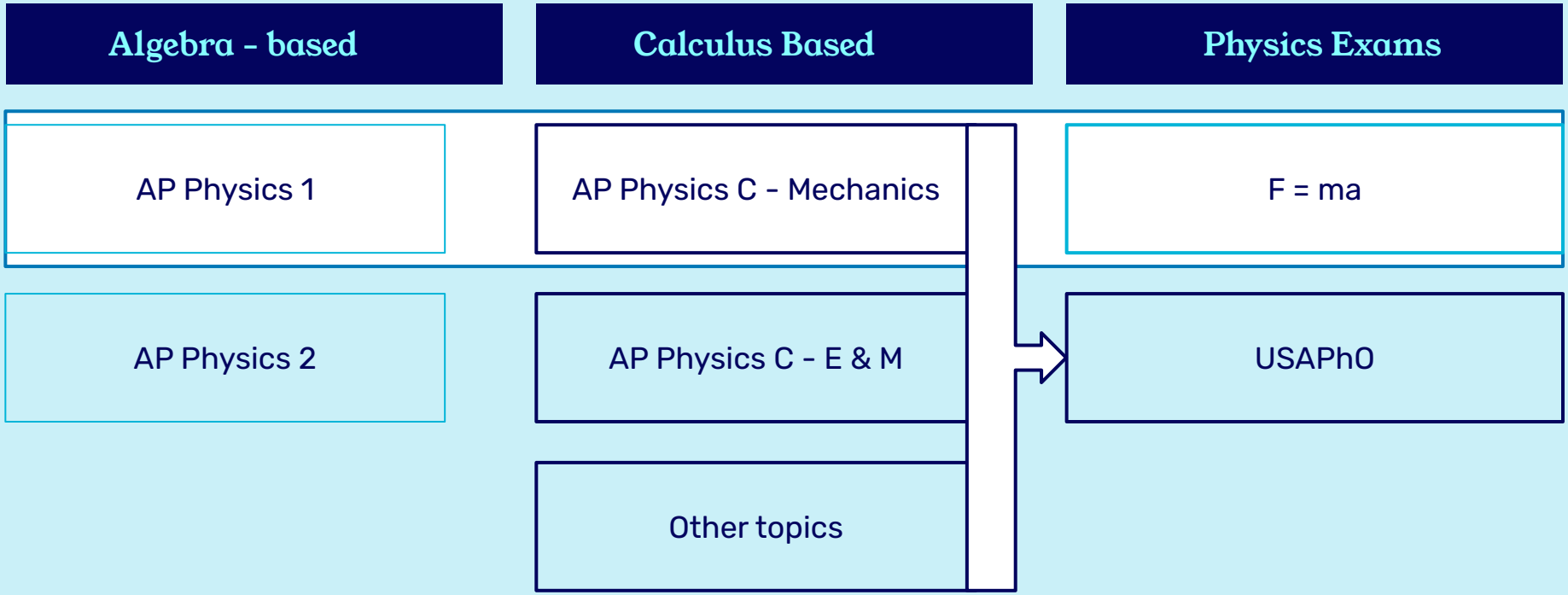
Past Exam problems & Solutions

- AAPT
- Kevin Huang Website
- AOPS

Handouts: Kevin Zhou

Mock exams

Correlating with high school physics classes



Resources

- Mechanics lectures series from MIT Open Courseware (This series is conducted by Walter Lewin who is an incredible professor at MIT)
- MIT OCW: Classical Mechanics - This course introduces the topic of classical mechanics. It is modified from the materials presented in the fall 2016 course taught at MIT.
- Open Yale Course: Fundamental of Physics - A great course to introduce the principles and methods of physics for students who have good preparation in physics and mathematics.
- khan Academy - excellent topic-focused tutorials.
- Flipping Physics - for all your F=ma or AP Physics needs!

- Kevin Huang: past problems (more for F=ma)
- Kevin Zhou: advice and handouts (more for USAPhO)

Any Questions?