



Syllabus of F=ma and USAPhO Mechanics Part (Calculus-based) ¹

PROFESSOR CHEN EDUCATION PALACE

OBJECTIVES

We prepare students to achieve the following objectives after taking this course:

1. Qualify for USAPhO through F=ma.
2. Be ready for solving USAPhO mechanics problems and the mechanics components of USAPhO non-mechanics problems.
3. Be able to solve mechanics problems in USA Astronomy and Astrophysics Olympiad (USAAAO), another STEM Olympiad competition recognized by MIT.

PREREQUISITES

1. Prerequisites in physics: AP Physics 1. We presume students have finished studying AP Physics 1 before taking our training course.
2. Prerequisites in math: Fundamentals of single-variable calculus, such as calculating **basic**

derivatives $\frac{d \sin\left(3x + \frac{\pi}{4}\right)}{dx}$, $\frac{d}{dx} \frac{1}{\sqrt{1+x^2}}$ and calculating **basic integrals** $\int \cos\left(2x + \frac{\pi}{5}\right) dx$,
 $\int (x + 3)^n dx$.

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WHY THIS COURSE IS CALCULUS-BASED

The F=ma contest syllabus says that the F=ma contest problems can all be solved without using calculus. However, a main lesson that many students who took past F=ma contests have learned is that this is **NOT** true.

1. The calculus tool helps students establish correct physics pictures and clearly understand physics processes.
2. The infinitesimal analysis (such as establishing continuity equations in hydrodynamics, doing higher-order approximations, small oscillations near equilibrium points) is tested in F=ma. The ideas and techniques are rooted in calculus.
3. USAPhO requires calculus. There are only 2 months between F=ma and USAPhO. If a student qualified for USAPhO without knowing how to use calculus to analyze physics problems, then this student would be very likely to receive a very low score in USAPhO.

WHY THIS COURSE REACHES THE USAPhO DIFFICULTY LEVEL

1. If you prepare for a contest in a hard way, you are more likely to do better than your expectation if the actual contest problems are easier.
2. Some F=ma problems are simplified versions or parts of USAPhO level problems.
3. F=ma and USAPhO problems are written by almost the same group of people.

DURATION

This is a 30-hour course.

TEXTBOOKS

We use our own course packet developed by Professor Chen Education Palace.

TEACHING PLATFORM



We use Zoom for teaching. We provide recordings to our students.

COURSE CONTENTS

1. Dimensional analysis
2. Uncertainty calculation and analysis
3. Kinematics
4. Translational dynamics
5. Rotational dynamics
6. Energy and momentum
7. Statics
8. Orbital mechanics
9. Oscillations
10. Non-inertial frames
11. Lagrangian mechanics
12. Fluids

