Berkeley Physics Tournament - Berkeley
Rules, Outline, & Syllabus

1 General Resources

Textbooks

- Daniel Kleppner and Robert Kolenkow–An Introduction to Mechanics, 2nd Edition [ISBN-13: 978-0521198110]
- Edward Murcell, David Morin–Electricity and Magnetism, 3rd Edition [ISBN-13: 978-1107014022]
- Douglas Giancoli–Physics: Principles with Applications (7th Edition) [ISBN-13: 978-0321625922]
- Richard Feynman–The Feynman Lectures on Physics [ISBN-13: 978-0201021165]

Practice Questions

- USAPhO and F=ma past exams
- Physics Brawl
- Chinese Physics Olympiad

2 Rules

This competition is *team based.* Teams consist of either three or four students. Whole teams register simultaneously. There is no inherent score disadvantage for not having four members.

3 Competitions Format

- Part 1 - **Team Lab**
  - 1 lab, 60 minutes
  - Groups will receive sets of materials and a formula sheet, and will be tasked with something such as finding a constant or property of a material.
- Part 2 - **Team FRQ**
  - 9 Questions, each containing a few (3-4) subsections, totaling 90 minutes
  - Will cover a wide variety of topics that stray from standard high school physics content to encourage teams to split up the questions according to their personal preferences.
- Part 3 - **GUTS**
  - 7 sets of questions, each containing 3 parts, totaling 60 minutes.
  - Each correct part is worth an increasing number of points as the set number increases.
  - (e.g. Set 1: 10 points total; Set 2: 12 points; Set 3: 15 points . . .)
  - Each team will choose one "runner" to retrieve the next set of problems after submitting the first set. No more than one set per team is allowed to be solved at a time.
  - We will compile a total of 9 sets in order of increasing difficulty. The easiest 7 will be used for the Pion division (junior) and the hardest 7 will be used for the Kaon division (senior).

4 Scoring

4.1 Grading

FRQ style questions will be marked by a rubric by hand.

The rubric for the free response focuses on partial credit, so correct/final answers are not required to still score points. Questions are valued at a max of **between 1 and 4 points** based on certain thresholds and quantities of correct work.

The lab will be graded based on the procedure and the result, with a safe/accurate procedure scoring points and a well-justified result scoring better.

GUTS will consist of **5 sets of questions** scored with x1 points, x1.1, x1.3, x1.6, and x2 point multipliers.

4.2 Point Allocation

The competition will be weighted as follows:

Team

- 40% from FRQ
- 40% from GUTS
- 20% from Lab

5 Syllabus

- Math
  - Interpret, create, and analyze graphs of motion and forces.
  - Perform dimensional analysis.
  - Understanding of geometry, angles, and trigonometric functions.
- Kinematics/Mechanics
  - Draw and interpret free-body diagrams for objects in various contexts.
  - Projectile motion and range equation. Find the distance and height of a projectile in uniform gravity.
  - Apply Newton's laws of motion to solve dynamics problems.
  - Solve problems involving uniform and accelerated motion in one and two dimensions.
  - Basic application of Hooke's law. Sinusoidal motion of simple oscillators.
  - Analyze energy transformations and apply conservation of energy.
  - Use impulse-momentum theorem and conservation of momentum in elastic and inelastic collisions.
  - Apply simple rotational kinematics in 2 dimensions.
  - Basic understanding of torque, angular momentum, and rotational energy in 2 dimensions.
  - Relate linear and angular variables.
  - Solve equilibrium problems involving torques and forces.
  - Basic understanding of work and work-energy theorem.
- Fluid Dynamics
  - Pressure, flow of incompressible fluids.
  - Continuity of fluid motion.
  - Bernoulli's equation
- Electricity and Magnetism
  - Apply Coulomb's law and the principle of superposition for electric forces.

  - Use electric field and potential relationships, including equipotential diagrams.
  - Apply Ohm's law and Kirchhoff's rules to solve DC circuit problems.
  - Understand magnetic fields from currents and forces on charges in fields.
  - Analyze electromagnetic induction.
  - Apply ray diagrams, lens/mirror equations, and magnification.
  - Energy of systems of multiple charges.

- Calculus-Based Mechanics
  - Understand the calculus definitions of physical quantities.
  - Differentiate the position, velocity, and acceleration functions with respect to time.
  - Integrate acceleration or velocity functions to find velocity or position.
  - Solve motion problems with non-constant acceleration using differential equations.
  - Apply calculus to rotational motion (e.g. torque from distributed forces, moment of inertia via integration).

- Calculus-Based Electricity & Magnetism
  - Analyze capacitors, dielectrics, and RC circuits.
  - Calculate electric field and potential from continuous charge distributions using integrals.
  - Solve problems using Gauss's law with symmetry arguments and calculus.
  - Use Ampere's law to find magnetic fields from current distributions.
  - Apply Faraday's law in integral form to calculate induced emf.
  - Solve differential equations in RC, RL, and LC circuits for charge, current, or voltage as functions of time.
  - Understand and apply Maxwell's equations.