Harvard Undergraduate Science Olympiad India 2024
Open Round
Physics Syllabus: 9th-10th Grade

Reference Material: You will be provided with a list of fundamental constants that may be useful during the exam. Any formulas that you are not expected to know will be given in relevant questions.

Potential Topics Covered on the Exam:
Please note that not necessarily every topic on this list will be on the exam, don't get overwhelmed! The syllabus is meant to be exhaustive of all *potential* topics that could be on the exam. A great place to start is with making sure you're comfortable with the ICSE curriculum for 9th-10th grade. It will be a difficult exam, but remember you don't need to (nor do we expect you) get a 100%! Just do your best and show us all that you've learned! Good luck and happy studying! There may be questions concerning more advanced topics, but no prior knowledge will be expected for these, just physical reasoning skills.

The open exam round will broadly cover three main subjects, Mechanics, Electromagnetism, and Thermodynamics. More specific topics will be listed below. It is expected that fundamental knowledge (such as concepts and formulas) from these topics will be known, and will not be provided in the exam.

Basic Topics:
- Mechanics

- Kinematics, Dynamics, Conservation Laws (Energy, Momentum, Angular Momentum), Circular Motion, Rotation, Simple Harmonic Motion, Gravity, Special Relativity, Waves, and Fluids
  - Electromagnetism
    - Electrostatics, Electric Fields, Electric Potential, Magnetic Fields, Circuits, Maxwell's Equations, Electromagnetic Waves, and Optics
  - Thermodynamics
    - The Three Laws of Thermodynamics

Advanced Topics
- Mechanics
  - Orbital Mechanics, Lagrangian Mechanics and Hamiltonian Mechanics
- Electromagnetism
  - Inductance and Capacitance
- Thermodynamics
  - Kinetic Theory of Gases, Entropy, and Heat Transfer

Preparation for Exam: The following textbooks are often considered gold standards for physics education. All of the knowledge expected of students will be found in these textbooks.

1.
Problems and Solutions in Introductory Mechanics by David Morin

This book focuses on Newtonian mechanics, which will only make up a part of the exam. Despite this, this book is very good for students who want to develop their physical intuition. A wide variety of carefully crafted problems and solutions will challenge students to think deeper about the physics of certain scenarios. This will help students with their problem solving skills that will be essential for this exam.

2.
Fundamentals of Physics 10e by David Halliday, Robert Resnick, and Jearl Walker

This book covers all of the topics that will potentially be covered in the exam. Content from the entire book may be tested, but certain sections that aren't included above will not be expected as prior knowledge. There are plenty of good example questions that will help make confusing concepts much easier to understand.

Sample Question:

The following question is an example of something that could appear on the exam. The format for all of the questions will be similar.

1. You have purchased a metal ring with radius R. As you walk past a lab, you drop the ring, and it rolls into a region with a magnetic field B. Consider what happens to the ring below.

   a. Assume that the ring starts off fully in the region with the magnetic field, with the field pointing in the direction normal to the ring. As the ring tips over, it falls over with an angular speed of $\omega(\theta)$. Using this, what is the emf generated in the ring?

   b. If the ring has a cross-sectional radius of r, and a resistivity of ρ, what is the current in the ring?

   c. Find an expression for B if a heat of Q is generated.