



Harvard Undergraduate Science Olympiad India 2024 Final Round Physics Syllabus: 7th-8th 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 7th-8th 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 most high school level topics in mechanics and electromagnetism, as well as some in 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. Some basic trigonometry will be included in the more advanced questions on the exam.

Basic Topics:

- Mechanics
 - Kinematics, Dynamics, Conservation Laws (Energy, Momentum), Circular Motion, Gravity, Angular Momentum, Rotation, and Simple Harmonic Motion
- Electromagnetism
 - Electrostatics, Circuits, Electric, Magnetic Fields, and Optics

Advanced Topics:

- Mechanics
 - Special Relativity, Waves, Fluids, and Orbital Mechanics
- Thermodynamics
 - The Three Laws of Thermodynamics

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. Let's consider a planet with constant mass density ρ and radius R . A civilization living on the planet has reached the space age, and are now planning their first space mission. The planet has one moon of mass M that orbits with a circular orbit. Answer the following questions to help them with their blossoming space program
 - a. What is the gravitational potential energy associated with the planet-moon system?

- b. The civilization's first attempt is a rocket that can produce a thrust of T . Assuming that the rocket doesn't travel too far before reaching escape velocity, how long should the rocket's thruster fire?

- c. The planet has a very strong magnetic field at the launch pad that points to the East. If the rocket has a very large surplus positive charge, what direction will the magnetic force point?