Harvard Undergraduate Science Olympiad India 2024
Open 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!

The open exam round will broadly cover two main subjects, Mechanics and Electromagnetism. 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.

- Mechanics
    - Kinematics, Dynamics, Conservation Laws (Energy, Momentum), Circular Motion, and Gravity
- Electromagnetism
    - Electrostatics and Circuits

Advanced Topics:

- Mechanics
    - Angular Momentum, Rotation, and Simple Harmonic Motion
- Electromagnetism
    - Electric Fields, Electric Potential, and Magnetic Fields

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. Students will be expected to have read chapters 1-11, 13, and 15 for mechanics, and chapters 21, 22, and 24-29. There are plenty of good example questions that will help make confusing concepts much easier to understand.

Sample Questions: More questions of a comparable difficulty can be found on the website for the United States Physics Bowl (https://www.aapt.org/Programs/PhysicsBowl/printexams.cfm)

The questions in the beginning of the exam will be rather simple, and can be solved in a matter of seconds.

Examples.

1. What is the equation for the moment of inertia of a thin stick with total length L and mass M about its end?
    a. ML^2
    b. $\frac{ML^2}{2}$
    c. $\frac{ML^2}{3}$
    d. $\frac{ML^2}{4}$

e. $\frac{ML^2}{6}$

2. How much charge is stored on a 6.0 μF capacitor with a potential difference of 2.5V across its plates?
   a. 3.0 μC
   b. 8.5 μC
   c. 12.0 μC
   d. 15.0 μC
   e. 22.5 μC

They will then progress in difficulty to a level where it will take more time. INSERT NOTE ABOUT TIEBREAKERS

1. Consider a circuit that consists of a resistor of resistance R, a capacitor of capacitance C, and an inductor of inductance L connected to an oscillating voltage source in series. What is the expression for the resonant frequency of this circuit?
   a. $f_R = \frac{R}{LC}$
   b. $f_R = \sqrt{\frac{R}{LC^2}}$
   c. $f_R = \frac{1}{2\pi\sqrt{RLC}}$
   d. $f_R = \frac{1}{2\pi RLC}$
   e. $f_R = \frac{1}{2\pi\sqrt{LC}}$

2. What is the moment of inertia of a triangular prism about an axis located at one of the points of the triangle perpendicular to the face of the triangle? The triangular prism has a density of ρ, a triangular side length of L, and a depth of d.
   a. $\frac{\sqrt{3}\rho d^2 L^3}{48}$
   b. $\frac{5\sqrt{3}\rho d^3 L^2}{16}$
   c. $\frac{3\rho d L^4}{25}$
   d. $\frac{\rho d^2 L^3}{16}$
   e. $\frac{5\sqrt{3}\rho d L^4}{48}$