



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: The open exam round will broadly cover two 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.

- 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, Kinetic Theory of Gases, and Entropy

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 1-17 and 37 for mechanics, chapters 21-36 for electromagnetism, and chapters 18-20 for thermodynamics. 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. What is the speed of light through a transparent substance with a refractive index of 3.0?
 - a. 9.0×10^8 m/s
 - b. 3.0×10^8 m/s
 - c. 1.0×10^8 m/s
 - d. 9.0×10^7 m/s
 - e. 1.0×10^7 m/s

They will then progress in difficulty to a level where it will take more time.

3. 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. $f_R = \frac{1}{2\pi\sqrt{LC}}$

4. 7 moles of an ideal gas undergoes an expansion from 16 L to 20 L at a constant temperature of 65°C . How much work is done by the gas during this expansion?

- a. 200 J
- b. 440 J
- c. 4,400 J
- d. 11,000 J
- e. 25,000 J