Harvard Undergraduate Science Olympiad 2026
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. For students, 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. No calculus will be needed to solve the problems. Formulas and constants that will be provided in the exam are in the reference sheet at the back of this syllabus.

- Mechanics
    - Kinematics, Dynamics, Vector and Scalar Quantities, Conservation Laws (Energy, Momentum), Circular Motion, and Gravity
- Electromagnetism
    - Electrostatics and DC Circuits (Batteries, Resistors)

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. You can ignore the parts involving calculus for the purpose of 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 2 through 9, 13, 18, 26, and 34. 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.

1. Which of the following forces is most directly responsible for the turning of a car on the road?

    a. Gravity
    b. Normal
    c. Friction
    d. Magnetic
    e. Drag

2. How much heat must be added to a 5 kg object to raise its temperature by 20˚C if it is made of a material with a specific heat capacity of 0.385 J/g˚C?

    a. 38.5 J
    b. 259.7 J
    c. 649.4 J
    d. 38500 J

e. 259740.3 J

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

1. Suppose a circuit has five resistors, each with a value of 30Ω. What is the difference between the equivalent resistance if all the resistors are connected in series and the equivalent resistance if all the resistors are connected in parallel?

    a. 15 Ω
    b. 60 Ω
    c. 120 Ω
    d. 144 Ω
    e. 294 Ω

2. Suppose the gravitational acceleration on the surface of a planet is g. Suppose the planet keeps the same density, but the radius increases by a factor of 2. What is the new value of gravitational on the planet's surface?

    a. $\frac{g}{4}$
    b. $\frac{g}{2}$
    c. g
    d. $2g$
    e. $4g$

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Physics Reference Sheet

Important Constant Values

Name	Symbol	Value	Units
Universal Gravity Constant	G	6.674×10^{-11}	$\frac{m^3}{kg\, s^2}$
Speed of Light	c	2.998×10^{8}	$\frac{m}{s}$
Mass of Proton	m_p	1.673×10^{-27}	kg
Mass of Neutron	m_n	1.675×10^{-27}	kg
Mass of Electron	m_e	9.109×10^{-31}	kg
Universal Gas Constant	R	8.315	$\frac{J}{mol\, K}$
Permittivity of Free Space	ϵ_0	8.854×10^{-12}	$\frac{A^2 s^4}{m^3 kg}$
Permeability of Free Space	μ_0	$4\pi \times 10^{-7}$	$\frac{m\, kg}{A^2 s^2}$
Avogadro's Number	N_A	6.022×10^{23}	$\frac{1}{mol}$
Elementary Charge	e	1.602×10^{-19}	C

Speed of Sound in Dry Air (STP)	v_s	343	$\frac{m}{s}$
Planck's Constant	h	6.626×10^{-34}	$J\,s$

Important Formulas

$v_f = v_i + at$	$x_f = x_i + v_i t + \frac{at^2}{2}$	$v_f^{\,2} = v_i^{\,2} + 2a(x_f - x_i)$
$F = ma$	$a = \frac{v^2}{r}$	$p = mv$
$F_f = \mu N$	$F_k = -kx$	$W = Fd$
$KE = \frac{mv^2}{2}$	$U_g = mgh$	$U_k = \frac{kx^2}{2}$
$P = \frac{W}{t}$	$p_f = p_i + Ft$	$\tau = I\alpha$
$I_{ring} = mr^2$	$I_{disk} = \frac{mr^2}{2}$	$I_{stick,\,center} = \frac{ml^2}{12}$
$I_d = I_0 + md^2$	$T = 2\pi\sqrt{\frac{L}{g}}$	$T = 2\pi\sqrt{\frac{m}{k}}$
$f = \frac{\omega}{2\pi} = \frac{1}{T}$	$L = I\omega$	$L_f = L_i + \tau t$
$F = \frac{q_2 q_2}{4\pi\varepsilon_0 r^2}$	$F = qE$	$V = -Ed$
$R = \frac{\rho L}{A}$	$R_{eq,\,series} = \Sigma R$	$\frac{1}{R_{eq,\,parallel}} = \Sigma\frac{1}{R}$
$V = IR$	$I = \frac{q}{t}$	$E = hf$
$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$	$f = \frac{r}{2}$	$v = \lambda f$