Harvard Undergraduate Science Olympiad 2026
Open Round
Mathematics Syllabus: 9th-10th Grade

Potential Topics Covered on the Exam:
This syllabus contains topics which will be covered both in the open and the in person round. 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 high school math curriculum (see Khan academy). It will be a difficult exam, but remember you don't need, nor do we expect you, to get a 100%! Just do your best and show us all that you've learned!

This syllabus contains topics which might be covered both in the open and the in person round. The exam will have questions testing a subset and not all of these bullet points in this extensive list of topics in the syllabus. Good luck and happy studying!

Algebra:

- Polynomials:
    - Divisibility and Factorization of Polynomials;
    - Vieta's Formulas;
    - Binomial Theorem;
    - Rational Root Theorem;
- Sequences and Series:
    - Arithmetic, Geometric, and Other Telescoping Series;
- Inequalities:
    - Trivial Inequality
    - AM-GM-HM Inequalities;
    - Triangle inequality;
- Functions:

    - Injectivity, Surjectivity, and Bijectivity;
    - Functional Equations;
    - Odd and Even Functions;
    - Floor and Ceiling Functions with their properties;
    - Logarithmic and Trigonometric Functions with their properties;

Number Theory:

- Modular Arithmetic - Introduction:
    - Congruences;
    - Prime factorization;
- Miscellaneous:
    - Pythagorean Triples;
    - Diophantine Equations;
    - Number Bases;

Geometry:

- Triangles:
    - Centers of Triangles:
        - Centroid (medians);
        - Circumcenter (perpendicular bisectors);
        - Orthocenter (altitudes);
        - Incenter (angle bisectors);
    - Area Formulas:
        - Heron's formula;
        - Inradius formula;
        - Circumradius formula;
        - Sine formula;
    - Ratios and Side Lengths:
        - Similar Triangles;
        - Congruent Triangles;
        - Angle Bisector Theorem;
    - Special Triangles:
        - 30-60-90 (angles);
        - 45-45-90 (angles);
- Circles:
    - Tangent Circles;
    - Power of a Point;
    - Cyclic Quadrilaterals;
    - Inscribed Angles;
- Transformations of the plane:
    - Rotation;
    - Reflection;

    - Translation;
    - Dilation;
- Miscellaneous:
    - Coordinate Geometry;
        - Equations of Lines;
        - Intersections of Lines;
        - Equations of Circles;
        - Shoelace Formula;
        - Distance Formula;
    - 3D Geometry:
        - Volumes of prisms, pyramids, cones, cylinders, and spheres;
        - Surface Areas of prisms, pyramids, cones, cylinders, and spheres;

Combinatorics:

- Counting Principles:
    - Rule of Product + Rule of Sum;
    - Principle of Inclusion-Exclusion;
    - Pigeonhole Principle;
    - Invariance Principle;
    - Extremal Principle;
    - Coloring Principle;
- Enumerative Combinatorics:
    - Permutations, Combinations, and Partitions;
    - Pascal's Triangle;
    - Stars and Bars;
- Probability:
    - Unconditional and Conditional Probability;
- Strategies:
    - Casework;
    - Constructive Counting;
    - Complementary Counting;
    - Finding Bijections;
    - Symmetry;

Preparation for Exam: The AOPS community website provides examples of textbooks as well as problems with their solutions which can be used to study for mathematics olympiads. Also, the following books which can be found online cover good fundamentals.

- Art of Problem Solving, Volume 1, 7th ed. By Sandor Lehoczky and Richard Rusczyk;
- Problem-Solving Strategies by Arthur Engel;

A student with a thorough understanding of these books will be well suited to do well on the exam. However, please note there are a variety of topics on the syllabus that are not covered in these books, which we think are best learned through practice problems (and google!).

Note that these books and websites are not required to prepare for the exam, nor are they the only way possible to prepare. We expect the difficulty and style of the questions in this exam to resemble those of the questions in competitions like the AMC10 (US Contest). Therefore, check out the questions and their solutions from these exams on the AOPS website or wiki (recommended).