

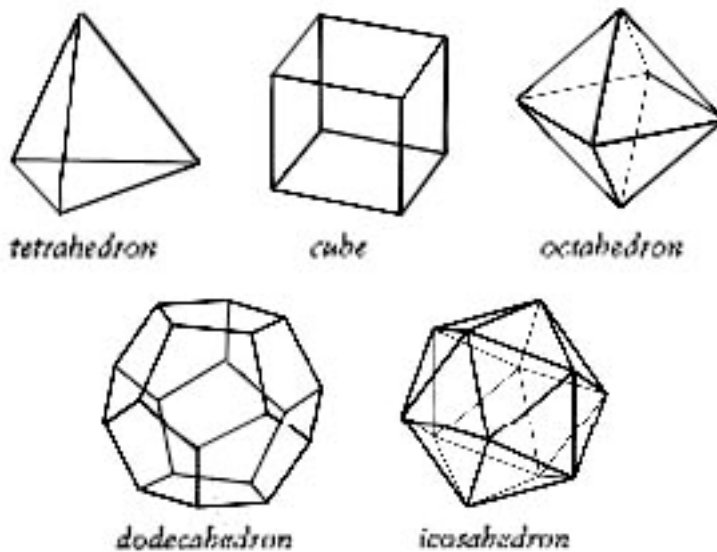
## Great Discoveries in Mathematics

### CTY Course Syllabus

#### Week 1

Day	Topics	Structure and Methods
1	<ul style="list-style-type: none"> <li>• Introductions and Getting Started</li> <li>• Origin of Numbers</li> <li>• The origin of the <i>ZERO</i> and Positional Number Systems</li> <li>• Base conversions: 10, 2, and others.</li> <li>• Introduction to exponents</li> <li>• Babylonian culture and number system</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up Puzzle</li> <li>• Start up: Read Syllabus, and make the classroom rules</li> <li>• First day of Class: Pre-assessment of skills</li> <li>• Lecture/discussion: Origin of Numbers and Positional Number Systems (Our own number system is a positional system with 9 special symbols and a zero symbol to denote an empty place.)</li> <li>• Worksheet: Bases and conversion (Inductive reasoning: Base 10, 2, 5, and Switching back and forth between bases)</li> <li>• Worksheet: Babylonian Number System</li> <li>• Puzzle-of-the-day</li> <li>• Collaboration Project (pairs): Create your own number system.</li> </ul>
2	<ul style="list-style-type: none"> <li>• Finish Number Systems Project</li> <li>• Introduction to Ancient Chinese, Magic Squares, Chinese Rod Numerals.</li> <li>• Roman Number System.</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up Puzzle</li> <li>• Presentations: Number Systems</li> <li>• Discussion Topic: students take turns answering two questions: (a) <i>“Why are positional number systems important? And (b) “What are the challenges with the ancient number system?”</i></li> <li>• Worksheet: 2400B.C. Chinese System of Numerals</li> <li>• Worksheet: Roman System of Numerals</li> <li>• Worksheets: Magic Squares</li> <li>• Academic Curiosity: Exchanging magic square rows and columns.</li> <li>• Puzzle-of-the Day</li> <li>• Partner Project: Create your own magic square(s).</li> </ul>
3	<ul style="list-style-type: none"> <li>• Finish Magic Squares Project.</li> <li>• Introduction to the Greek Culture and Thales.</li> <li>• Egyptian Number Systems</li> <li>• Egyptian Culture</li> <li>• Egyptian Multiplication and Addition.</li> <li>• Overview: congruent triangles and similar triangles.</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up Puzzle</li> <li>• Group Activity where students take turns answering the question: <i>“Why are fractional numbers important?”</i></li> <li>• Write fractions using <i>Eye of Horus</i> fractions.</li> <li>• Presentation of Magic Square Projects.</li> <li>• Math Reasoning Worksheet (deductive reasoning)</li> <li>• Worksheets: Egyptian Hieroglyphics. (inductive reasoning)</li> <li>• Worksheet: Learning to write a proof (deductive reasoning)</li> <li>• Collaboration Project: Invention of an ancient culture, number system.</li> </ul>

Day	Topics	Structure and Methods
4	<ul style="list-style-type: none"> <li>• Similar triangles and proportions. (Thales)</li> <li>• Introduction to proof writing (direct and indirect)</li> <li>• More Greek Culture with Pythagoras. Who was Pythagoras?</li> <li>• Introduction to the Pythagorean Theorem proof, Geometry Book, Structure and Method page 290.</li> <li>• Introduction to number shapes, square numbers, oblong numbers, triangular numbers.</li> <li>• Fun with Figurate Numbers.</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up Puzzle</li> <li>• Similar Triangles and proportions.</li> <li>• Reading Assignment: Pythagoras and/or Pythagorean Theorem Video</li> <li>• Practice using figurate numbers.</li> <li>• Puzzle-of-the-Day: The Spider and The Fly and etc. (Historical Connections in Mathematics, Volume I, page 8 - 10.)</li> <li>• Pythagorean Theorem construction activity.</li> <li>• <b>Review of material covered</b> for Test tomorrow (Days 1 – 4).</li> </ul>
5	<ul style="list-style-type: none"> <li>• <b>Week 1 Test</b> on information covered.</li> <li>• Platonic Solids – building them.</li> <li>• Who is Euclid?</li> <li>• Euclidean algorithms for basic construction.</li> <li>• Basic construction.</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up puzzle.</li> <li>• Discover the heights of objects around campus using Thales’ method. (Suggested 9:00 – 10:30 am)</li> <li>• Individual Project: Construction of Platonic solids using gum drops (candy) and toothpicks (See next two pages for diagrams).</li> <li>• Reading Assignment: “An Amateur Becomes a Prince,” from <i>Mathematicians Are People, Too</i>, pages 44 – 51. Authors: Luetta Reimer and Wilbert Reimer.</li> <li>• Academic Curiosity: Unsolved Problems.</li> <li>• Puzzle-of-the-Day!</li> </ul>



### Platonic Solids

Week 2

Day	Topics	Structure and Methods
6	<ul style="list-style-type: none"> <li>• Platonic Solids complete.</li> <li>• Average of Heights using Thales, another similar Triangles Activity.</li> <li>• Great Mathematicians and their work involving number systems and number theory: Euclid.</li> <li>• Reading Assignment: Who is Euclid? Taken from the book, Historical Connections Vol. II, pages 9 – 16</li> <li>• Introduction to construction.</li> <li>• Basic axioms (postulates) of Geometry from Geometry Book pages 12-23.</li> <li>• Fundamentals of Geometry – Euclid’s first 28 propositions put into current language.</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up puzzle.</li> <li>• Finish platonic solids.</li> <li>• Activity: Students examine Euclid’s propositions.</li> <li>• Introduction/review of Radicals</li> <li>• Construction examples.</li> </ul>
7	<ul style="list-style-type: none"> <li>• Return and review Week 1 Test</li> <li>• Algebra lesson: radicals</li> <li>• Introduction to construction. (learning the fundamentals)</li> <li>• Zeno and his paradoxes (Greek Philosopher and Mathematician)</li> <li>• Archimedes and the Eureka Boat Project.</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up puzzle.</li> <li>• Worksheet: radicals.</li> <li>• Worksheet : Zeno paradoxes</li> <li>• Construction of bisecting a line segment, angles and sides of a triangle.</li> <li>• Worksheet: Word Problems</li> <li>• Archimedes and the Eureka Boat Project (Materials supplied: pennies, aluminum foil 12”x12” squares).</li> <li>• Puzzle Challenge.</li> </ul>
8	<ul style="list-style-type: none"> <li>• More on construction (circumcenter, incenter, orthocenter, and center of gravity/mass).</li> <li>• Heron of Alexandria and area of triangles using his formula and square root approximation method.</li> <li>• Research Project: Introduce requirements for individual research projects due the morning of the last day of class.</li> <li>• Algebra: Fun with Word Problems!</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up puzzle.</li> <li>• Worksheet: Construction</li> <li>• Worksheet: Heron’s Formula for the area of triangles and method for finding square roots.</li> <li>• Worksheet: word problems</li> <li>• Challenging puzzle.</li> </ul>
9	<ul style="list-style-type: none"> <li>• More on geometry: Conic Sections and equations for conics.</li> <li>• Techniques for solving Sudoku puzzles</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up puzzle</li> <li>• Survey Project: student are to ask 35 other students and/or faculty the question, “When is your Birthday?” (Activity continues during Break Times)</li> <li>• Worksheet: conic Sections</li> <li>• Review of material covered this week</li> </ul>
10	<ul style="list-style-type: none"> <li>• <b>Week 2 Test</b> on information covered this week.</li> <li>• Crazy Numbers Day (Golden ration, perfect numbers, etc.)</li> <li>• History of pi through the ages including important figures from all cultures</li> <li>• Video: Story of pi</li> <li>• Pneumatic game for digits of pi.</li> </ul>	<ul style="list-style-type: none"> <li>• Warm-up Puzzle</li> <li>• More on the Golden Ratio</li> <li>• Game: Pi trivia</li> <li>• Afternoon Guest: Becca Roberson</li> </ul>

Week 3

Day	Topics	Structure and Methods
11	<ul style="list-style-type: none"> <li>• Great Women in Mathematics</li> <li>• Hypatia, Maria Agnesi</li> <li>• Sophie Germain</li> <li>• Sonya Kovalevsky</li> <li>• Emmy Noether (contributions to abstract algebra)</li> <li>• Math related to Sophie Germain, Sonya Kovalevsky, and Emmy Noether.</li> </ul>	<ul style="list-style-type: none"> <li>• Morning Warm-up puzzles (1 hour)</li> <li>• Compile survey results for birthday data.</li> <li>• A Birthday Surprise! Historical Connections in Mathematics, Volume I, page 55</li> <li>• Group Project: Skits. Students will be asked to work either independently or in groups to prepare a skit on one famous mathematician covered to this point.</li> <li>• Worksheets: Women in mathematics</li> <li>• Afternoon puzzles.</li> <li>• Research Paper 3:00 – 4:20 pm.</li> </ul>
12	<ul style="list-style-type: none"> <li>• Complete Women in Mathematics.</li> <li>• Introduction to arithmetic and geometric sequences</li> <li>• Fibonacci and his sequence</li> <li>• Mayans and their number</li> <li>• Algebra: binomial expansion</li> <li>• Pascal and his triangle</li> <li>• Reading Assignment: Blaise Pascal, Historical Connections in Mathematics, Volume I, pages 47 – 49.</li> <li>• Academic Curiosity: Patterns using Pascal’s Triangle, Examples from the book: Historical Connections In Mathematics, Volume I, pages 51 - 53.</li> </ul>	<ul style="list-style-type: none"> <li>• Morning warm-up puzzles (1 hour)</li> <li>• Worksheet: recognizing number patterns (including Fibonacci sequence)</li> <li>• Worksheet: Arithmetic and Geometric Sequences</li> <li>• Worksheet: binomial expansion, difference of squares</li> <li>• <b>Research Paper</b> 9:00 – 10:20 am</li> <li>• Worksheet: Mayan Numbers</li> <li>• Project: Pascal’s Perimeter, page 54, Historical Connections in Mathematics, Volume I.</li> <li>• Afternoon hard puzzle (30 -45 minutes)</li> <li>• Selection of mathematicians for research papers.</li> </ul>
13	<ul style="list-style-type: none"> <li>• Introduction to binomial expansion,</li> <li>• <math>(a+b)^2 = a^2 + 2ab + b^2</math>.</li> <li>• More on Pascal, binomial expansion.</li> <li>• Conic Sections (parabola, circle, ellipse, hyperbola)</li> <li>• Techniques for solving Sudoku, Magic Squares, and other puzzles.</li> </ul>	<ul style="list-style-type: none"> <li>• Morning warm-up puzzles (1 hour)</li> <li>• Academic Curiosity: Using Pascal’s Triangle to solve, <math>(a+b)^n</math>, when <math>n \geq 2</math>.</li> <li>• Worksheet: conic section equations, puzzle cut-out to make conic sections</li> <li>• Afternoon hard puzzle (30-45 minutes)</li> <li>• Research Paper Today! (3:00 – 4:20 pm)</li> </ul>
14	<ul style="list-style-type: none"> <li>• Finish up Research Papers (9:00 – 10:00 am)</li> <li>• Puzzles</li> <li>• Post-Assessment Skills Test</li> <li>• Great Mathematicians Presentations: half of the class (afternoon)</li> </ul>	<ul style="list-style-type: none"> <li>• Morning warm-up puzzles (1 hour)</li> <li>• Post-skills test (1:00 – 2:00 pm)</li> <li>• Worksheet: Review of the week’s topics.</li> <li>• Evaluations of instructor and TA.</li> </ul>
15	<ul style="list-style-type: none"> <li>• Great Mathematicians Presentations: half of the class</li> <li>• Introducing the difference between sequence and series.</li> <li>• Gauss and summing up arithmetic series</li> </ul>	<ul style="list-style-type: none"> <li>• Presentation of Research Papers</li> <li>• Puzzles</li> </ul>