Great Discoveries in Mathematics  
CTY Course Syllabus

Week 1

<table>
<thead>
<tr>
<th>Day</th>
<th>Topics</th>
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| 1   | • Introductions and Getting Started  
     • Origin of Numbers  
     • The origin of the ZERO and Positional Number Systems  
     • Base conversions: 10, 2, and others.  
     • Introduction to exponents  
     • Babylonian culture and number system |
|     | Structure and Methods  
     • Warm-up Puzzle  
     • Start up: Read Syllabus, and make the classroom rules  
     • First day of Class: Pre-assessment of skills  
     • 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.)  
     • Worksheet: Bases and conversion (Inductive reasoning: Base10, 2, 5, and Switching back and forth between bases)  
     • Worksheet: Babylonian Number System  
     • Puzzle-of-the-day  
     • Collaboration Project (pairs): Create your own number system. |
| 2   | • Finish Number Systems Project  
     • Introduction to Ancient Chinese, Magic Squares, Chinese Rod Numerals.  
     • Roman Number System. |
|     | Structure and Methods  
     • Warm-up Puzzle  
     • Presentations: Number Systems  
     • Discussion Topic: students take turns answering two questions: (a) "Why are positional number systems important? And (b) "What are the challenges with the ancient number system?."  
     • Worksheet: 2400B.C. Chinese System of Numerals  
     • Worksheet: Roman System of Numerals  
     • Worksheets: Magic Squares  
     • Academic Curiosity: Exchanging magic square rows and columns.  
     • Puzzle-of-the-day  
     • Partner Project: Create your own magic square(s). |
| 3   | • Finish Magic Squares Project.  
     • Introduction to the Greek Culture and Thales.  
     • Egyptian Number Systems  
     • Egyptian Culture  
     • Egyptian Multiplication and Addition.  
     • Overview: congruent triangles and similar triangles. |
|     | Structure and Methods  
     • Warm-up Puzzle  
     • Group Activity where students take turns answering the question: "Why are fractional numbers important?"  
     • Write fractions using Eye of Horus fractions.  
     • Presentation of Magic Square Projects.  
     • Math Reasoning Worksheet (deductive reasoning)  
     • Worksheets: Egyptian Hieroglyphics. (inductive reasoning)  
     • Worksheet: Learning to write a proof (deductive reasoning)  
     • Collaboration Project: Invention of an ancient culture, number system. |
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| 4   | • Similar triangles and proportions. (Thales)  
• Introduction to proof writing (direct and indirect)  
• More Greek Culture with Pythagoras. Who was Pythagoras?  
• Introduction to the Pythagorean Theorem proof, Geometry Book, Structure and Method page 290.  
• Introduction to number shapes, square numbers, oblong numbers, triangular numbers.  
• Fun with Figurate Numbers. | • Warm-up Puzzle  
• Similar Triangles and proportions.  
• Reading Assignment: Pythagoras and/or Pythagorean Theorem Video  
• Practice using figurate numbers.  
• Puzzle-of-the-Day: The Spider and The Fly and etc. (Historical Connections in Mathematics, Volume I, page 8 - 10.)  
• Pythagorean Theorem construction activity.  
• **Review of material covered** for Test tomorrow (Days 1 – 4). |
| 5   | • **Week 1 Test** on information covered.  
• Platonic Solids – building them.  
• Who is Euclid?  
• Euclidean algorithms for basic construction.  
• Basic construction. | • Warm-up puzzle.  
• Discover the heights of objects around campus using Thales’ method. (Suggested 9:00 – 10:30 am)  
• Individual Project: Construction of Platonic solids using gum drops (candy) and toothpicks (See next two pages for diagrams).  
• Academic Curiosity: Unsolved Problems.  
• Puzzle-of-the-Day! |

**Platonic Solids**
## Week 2

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<tr>
<th>Day</th>
<th>Topics</th>
<th>Structure and Methods</th>
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<tr>
<td>6</td>
<td>Platonic Solids complete.</td>
<td>Warm-up puzzle.</td>
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<tr>
<td></td>
<td>Average of Heights using Thales, another similar Triangles Activity.</td>
<td>Finish platonic solids.</td>
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<td>Great Mathematicians and their work involving number systems and number theory: Euclid.</td>
<td>Activity: Students examine Euclid’s propositions.</td>
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<td>Reading Assignment: Who is Euclid? Taken from the book, Historical Connections Vol. II, pages 9 – 16</td>
<td>Introduction/review of Radicals</td>
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<td>Introduction to construction.</td>
<td>Construction examples.</td>
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<td>Basic axioms (postulates) of Geometry from Geometry Book pages 12-23.</td>
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<td>Fundamentals of Geometry – Euclid’s first 28 propositions put into current language.</td>
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<td>7</td>
<td>Return and review Week 1 Test</td>
<td>Warm-up puzzle.</td>
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<td>Algebra lesson: radicals</td>
<td>Worksheet: radicals.</td>
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<td></td>
<td>Introduction to construction. (learning the fundamentals)</td>
<td>Worksheet : Zeno paradoxes</td>
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<td>Zeno and his paradoxes (Greek Philosopher and Mathematician)</td>
<td>Construction of bisecting a line segment, angles and sides of a triangle.</td>
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<td>Archimedes and the Eureka Boat Project.</td>
<td>Worksheet: Word Problems</td>
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<td>Heron of Alexandria and area of triangles using his formula and square root approximation method.</td>
<td>Puzzle Challenge.</td>
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<td>Research Project: Introduce requirements for individual research projects due the morning of the last day of class.</td>
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<td>Algebra: Fun with Word Problems!</td>
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<tr>
<td>9</td>
<td>More on geometry: Conic Sections and equations for conics.</td>
<td>Warm-up puzzle</td>
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<td>Techniques for solving Sudoku puzzles</td>
<td>Worksheet: Construction</td>
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<td>Worksheet: Heron’s Formula for the area of triangles and method for finding square roots.</td>
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<td>Worksheet: word problems</td>
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<td>Challenging puzzle.</td>
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<td>10</td>
<td><strong>Week 2 Test</strong> on information covered this week.</td>
<td>Warm-up puzzle</td>
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<td>Crazy Numbers Day (Golden ration, perfect numbers, etc.)</td>
<td>More on the Golden Ratio</td>
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<td>History of pi through the ages including important figures from all cultures</td>
<td>Game: Pi trivia</td>
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<td>Video: Story of pi</td>
<td>Afternoon Guest: Becca Roberson</td>
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<td>Pneumatic game for digits of pi.</td>
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Syllabus: Great Discoveries in Mathematics
# Week 3

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<tr>
<th>Day</th>
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| 11  | • Great Women in Mathematics  
     • Hypatia, Maria Agnesi  
     • Sophie Germain  
     • Sonya Kovalevsky  
     • Emmy Noether (contributions to abstract algebra)  
     • Math related to Sophie Germain, Sonya Kovalevsky, and Emmy Noether.  
|     | • Morning Warm-up puzzles (1 hour)  
     • Compile survey results for birthday data.  
     • A Birthday Surprise! Historical Connections in Mathematics, Volume I, page 55  
     • 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.  
     • Worksheets: Women in mathematics  
     • Afternoon puzzles.  
     • Research Paper 3:00 – 4:20 pm.  |
| 12  | • Complete Women in Mathematics.  
     • Introduction to arithmetic and geometric sequences  
     • Fibonacci and his sequence  
     • Mayans and their number  
     • Algebra: binomial expansion  
     • Pascal and his triangle  
     • Reading Assignment: Blaise Pascal, Historical Connections in Mathematics, Volume I, pages 47 – 49.  
|     | • Morning warm-up puzzles (1 hour)  
     • Worksheet: recognizing number patterns (including Fibonacci sequence)  
     • Worksheet: Arithmetic and Geometric Sequences  
     • Worksheet: binomial expansion, difference of squares  
     • **Research Paper** 9:00 – 10:20 am  
     • Worksheet: Mayan Numbers  
     • Project: Pascal’s Perimeter, page 54, Historical Connections in Mathematics, Volume I.  
     • Afternoon hard puzzle (30 -45 minutes)  
     • Selection of mathematicians for research papers.  |
| 13  | • Introduction to binomial expansion,  
     • \((a+b)^2 = a^2 + 2ab + b^2\).  
     • More on Pascal, binomial expansion.  
     • Conic Sections (parabola, circle, ellipse, hyperbola)  
     • Techniques for solving Sudoku, Magic Squares, and other puzzles.  
|     | • Morning warm-up puzzles (1 hour)  
     • Academic Curiosity: Using Pascal’s Triangle to solve, \((a+b)^n\), when \(n \geq 2\).  
     • Worksheet: conic section equations, puzzle cut-out to make conic sections  
     • Afternoon hard puzzle (30-45 minutes)  
     • Research Paper Today! (3:00 – 4:20 pm)  |
| 14  | • Finish up Research Papers (9:00 – 10:00 am)  
     • Puzzles  
     • Post-Assessment Skills Test  
     • Great Mathematicians Presentations: half of the class (afternoon)  
|     | • Morning warm-up puzzles (1 hour)  
     • Post-skills test (1:00 – 2:00 pm)  
     • Worksheet: Review of the week’s topics.  
     • Evaluations of instructor and TA.  |
| 15  | • Great Mathematicians Presentations: half of the class  
     • Introducing the difference between sequence and series.  
     • Gauss and summing up arithmetic series  
|     | • Presentation of Research Papers  
     • Puzzles  |

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