

Geometry and Spatial Sense

CTY Course Syllabus

	Time	WHAT/CONTENT (concepts, topics, objectives)	HOW/FORMAT (labs, readings, activities)
<p>DAY 1</p> <p>MONDAY</p> <p>Introductory, Pre-test, Honor Code, Angles and Triangles review packet Pipe Cleaner Activity</p>	<p>morning</p>	9:00 Introductions	<p>Meeting in Academic Center</p> <p>Class Roster</p> <p>Procedures</p> <p>Introduction of self and discussion of rules</p> <p>Introduction of PA and discussion of roles in the classroom</p> <p>Posting of schedule on board daily</p>
		9:30 Ice-Breaker	<p>Ice-Breaker: Students each get a card with their name on it. They are to think of three things about themselves that they want to share. Student posts a card, next student makes a connection between self and one of previous student's interests, draws a line and then puts their card, writing out three things about them, and next student connects, etc. until all students are on the poster.</p>
		10:15 Break	
		10:25 Honor Code	<p>CTY Honor Code has been retyped into sections, one for each student, and enlarged. Students read each section in order and in groups of two, act out each of the six sections.</p>
		11:15 Assessment	<p>Pass out assessment and allow students time to complete it.</p> <p>Briefly go over answers – don't explain in depth, just let them know if they were right or wrong. Explain we will be going over each of these concepts as the three weeks progresses.</p>

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	afternoon	1:00 Work Packet Geometry review; Pipe cleaner angles, triangles and quadrilaterals 2:15 Wrap up	Go over the review packet so we can review basic 3 rd & 4 th grade geometry vocabulary and exercises. In pairs, sts make a set of specific angles and triangles out of pipe cleaners, and glue to tagboard. <ul style="list-style-type: none"> 1) Create a chart demonstrating how a square is a parallelogram, a rectangle and a rhombus. 2) Demonstrate the six different ways to classify triangles (3 for angles, 3 for sides) Suggest to students that bending the pipe cleaners can be difficult and make shapes hard to form properly, so you can always cut the pipe cleaners into smaller segments and assemble the shapes that way. <p>Students get ready for afternoon activities and go over homework.</p>
	Homework (day sites)	Homework	Homework packet review Do the rest of the packet and do for homework.
DAY 2 TUESDAY Protractor Scale Archimedes Puzzle Geometry in Construction, w/ Right Angles	AM	9:00 Measuring Angles 9:45 Scale 10:15 Break	Check homework and review Teach correct use of a protractor – teach measurement of angles, how to use the top and bottom of the protractor (if the angle opens to the right, you use the bottom, if it opens to the left, you use the top) and have them practice on a worksheet (pgs 17-19) Demonstration picture of Eeyore for everyone, divided into a grid – assign each student a section and have them enlarge that section in a larger square. Color in and put together to create a poster. Teacher should label each square with a number and post a large Eeyore so that students can compare their pieces against it and against each other, so that the squares match up.
	AM	10:25 Origami	P.A. will direct: Students will make an open box and learn some of the basic folds of origami – those who have more advanced experience may do more during free time.

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	PM	10:55 Finish Scale Archimedes Puzzle	Finish and post Eeyore Introduction to the Stomachion – cut out the pieces (make sure they're copied onto cardstock) and make the large triangle. Pass out Key to help students Have students make the square Students will construct one of the other shapes BONUS ACTIVITY: Continue on Enrichment activities packet
	PM	1:00 Geometry and Construction	Students break into groups of three. Each member of the group is to make one of 3 constructions. 1) One construction must contain only right angles. 2) One construction must contain only acute angles (two acute angles together make an obtuse angle, but this won't count) 3) One construction with at least 8 or more obtuse angles. Test each structure with Geometry to Go books. The structure that holds the most books is the sturdiest. Why? Discuss.
	PM	HOMEWORK	HOMEWORK: Cartooning paper
Day 3 WEDNESDAY Building and Spatial Sense, Scale project, Geometry in Construction	AM	9:00 Ruins of Montarek; base plans using multi-link cubes.	Overview of book: <ul style="list-style-type: none"> Introduce the subject and discuss 2-D and 3-D objects and how we represent 3-D objects in a 2-D plane Read pages 2-5 and discuss possible solutions to preview problems on page 5 Investigation 1: Building Plans 1.1 Building from base plans <ul style="list-style-type: none"> Pass out a set of fifteen multi-link cubes to partners Create the building mat and explain how it's used Do problem 1.1 Answer problems on page 10, and do activity 5 1.2 Reflecting Figures <ul style="list-style-type: none"> Talk about reflections (review of 1.1) Do Problem 1.2 on page 11
	AM	10:25 Origami	PA will direct

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		10:55 Finish Pipe Cleaners and work on Stomachion	Finish pipe cleaner activity and post. Students may work in pairs to see how many of the alternate shapes they can make from the pieces of the Stomachion. Once they make the shape, place a checkmark on it.
	PM	1:00 Scale	Create a map of the classroom using CM grid paper. Students work in groups of 3 – 2 do the measuring and the third writes down the measurements. Write your scale on the bottom – 1 ft = 1 cm (have students decide exact scale) After you have the room's shell, start adding desks in their proper arrangement.
	PM	2:15 Wrap-up	Students clean up and prepare for activities – Homework: Scale a room in your house (or where you are staying)
DAY 4 THURSDAY Building and Spatial Sense, Enrichment activities, Compass practice, Polyominoes, pentominoes and hexominoes	AM	9:00 Ruins of Montarek	Investigation 1 Cont'd: Check problems on page 12 1.3: Making drawings of cube models <ul style="list-style-type: none"> • distribute isometric dot paper and grid paper • Do problem 1.3; construct building on your building mat and do A, B and C. • Follow up – Did you know? 1.4: Unraveling mysteries <ul style="list-style-type: none"> • Problem 1.4, drawing building views: Students will construct a model using only the front and right views of a building. 1.5: Matching a Building to its plans Do problem 1.5, set 1, 2 and 3; which ones don't match?
	AM	10:25 Origami	PA will direct

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	AM	10:55 Compass Practice; Activity Packets (2) Circles and circumference; Angles (vertical, adjacent, complimentary and supplementary)	Demonstrate how to hold a compass and how to make a circle – RECOMMEND that students purchase compass with the center wheel, NOT the kind that you need to put a pencil in (these get loose) Teach diameter, radius, circumference, and pi. Students are to do worksheets to practice finding diameter of circles. Students will practice alphabetic notation of angles using activity packet pages. Teach complimentary and supplementary angles, vertical and adjacent angles. Do packet pages 25-33.
		1:00 Polyominoes (Dominoes, triominoes, tetrominoes, pentominoes, Using triangles and squares	Introduce the concept – explain that they are squares that share at least one side. Show overheads of dominoes and tri-ominoes. Have students construct as many tetrominoes as they can using the directions with teacher direction. Then students individually will see how many combinations they can come up with to create pentominoes. After they've had some time, show them the answers and explain that these figures are named after the shape they take. BONUS ACTIVITY: Can you make hexominoes? How many combinations are there without repeating? (35) Draw as many as you can.
	PM	2:15 Wrap-up	Homework and close-up for day
		HOMEWORK	Worksheet from Circumference packet Worksheet from finding unknown angles packet

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<p>DAY FIVE FRIDAY</p> <p>Supermag constructions, Constructions in architecture and nature, bee hives use hexagons, assessment over week 1</p>		9:00 Supermag constructions; magnet genius	<p>Using rods and balls, students will use magnets to make constructions and test their strength –</p> <ol style="list-style-type: none"> 1) Make four constructions – a) square, b) rectangle, c) hexagon and d) pentagon What are the strengths and weaknesses of each construction? 2) How can the shape be strengthened? Can you add other shapes to make the first shape stronger? 3) Shapes in architecture – pass out pictures of houses and buildings and compare sturdiness – why do bridges use triangles and buildings use squares or rectangles? 4) The bee hive – why do bees build hexagons? See article and discuss that the ratio of lateral surface area to storage space is less in a hexagon than to either a square or triangle. 5) Can you build the three dimensional objects on the back board? (polyhedra)
	AM	10:25 Origami	PA will direct
Building and Spatial Sense		11:00 Assessment over basic terms, using a protractor etc.	<p>Pass out assessment and have students complete. Check together, collect.</p> <p>See Week 1, Assessment one:</p> <ol style="list-style-type: none"> 1) naming angles by points 2) naming triangles by both angles and length of sides 3) rules of vertical and supplementary angles 4) pentominoes 5) measuring a protractor 6) finding the circumference of a given circle. 7) Front view of a building from a base plan.
Cube Nets	PM	1:00 Building a Box Activity	<p>Have students check the hexominoes they made the other day and turn in paper</p> <p>Students will investigate cube nets – see Illuminations Lesson, worksheet and packet</p> <p>Students will take the hexominoes they made yesterday and see how many of them can fold into cubes – these will be called cube nets.</p>

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DAY SIX MONDAY	AM	9:00 Ruins of Montarek	Investigation 1: 1.6; which building is which? Do independently, also pages 19-24 Investigation 2: Making Buildings 2.1 Reconstructing Ruins 2.2 Constructing Buildings from Plans 2.3 Building from Incomplete Plans Applications – Connections – Extensions –
	AM	10:25 Origami	PA will direct
Building and Spatial Sense, Polygons, Polyhedrons		10:55 Polygons review, Polygon Capture Game, intro to Polyhedrals	Introduce various Polygons – Polygon sheet with all possible names Penrose and the Mathematical Stars, page 8 Pass out paper containing polygons and have students create the stars. The Polyhedra connect with Penrose, page 28 Complete the data chart and have students find the common property ($f + v = e - 2$)
Building a tetrahedral and other polyhedrons		1:00 Geometry in Construction; build a tetrahedral kite	Illuminations Lesson: Tetrahedral Kite Students will follow directions and make a tetrahedral out of string, tissue paper and straws. --Divide students into 4 groups of 3 – figure out how to make a larger tetrahedral using your small tetrahedrals – or can you make other shapes? What other kinds of polyhedron can we make with these tetrahedrals? Students are to construct four tetrahedral and put them together to form a larger tetrahedral, then choose if they wish to combine with three other groups to make the largest tetrahedron

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		2:10 Homework project assignment Catch-up and Wrap up	Talk about homework project: Students will create a "Geometry Storybook." Like Penrose, the Ruins of Montarek, and other upcoming stories, we are going to write fiction and use geometric concepts in the fiction writing. Pass out handout that explains the guidelines. Students are to bring in their work every day so that we can share at the end of the day and compare notes, take suggestions, etc. ALSO: Ruins of Montarek, pages 33-38
DAY SEVEN TUESDAY Building and Spatial Sense, Cubes, Tangrams, writing project Polyhedrons		9:00 Ruins of Montarek	Mathematical Reflections Investigation 3: Describing Unique Buildings 3.1 Finding All the Possibilities * Students are to pair up and work together to find all the possible combinations of building plans for the given problem. Teach that the building with the most cubes is called the maximal building and that the building with the least cubes is called the minimal building. Maximal buildings are unique, minimal buildings are not. Figure out all possible combinations, count up the cubes (there are 17 different combinations) and discover the minimal and maximal buildings. 3.2 Finding Maximal and Minimal Buildings * With a partner figure out the minimal and maximal buildings for problem 3.2. It should take much less time because you find out which structure uses the most, and then try to use as few as possible for the least. EMPHASIS that the base OUTLINE and the base PLAN are not the same, and that front and right views WILL NOT CHANGE! 3.3 Unraveling an Ancient Mystery
	AM	10:25 Origami	PA will direct
	AM	10:55 Catch-up	Finish putting together the tetrahedral kites Check the cube building activity and collect.

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	PM	1:00 Penrose the Cat; Tangram applet in computer lab; 1:30 Isometric view	Read: "Penrose meets the Tangramians." See if it's possible to get the computer lab for the tangram applet that day. Explore the different shapes made with trigrams Isometric applet to explain the isometric view
		2:00 Writing homework, Geometry Storybook	Time to start making up those geometry stories! Demonstrate by reading aloud the sample (from session 1, 2009)
DAY EIGHT	AM	9:00 Ruins of Montarek	Applications – Connections – Extensions— Mathematical Reflections Investigation 4: Isometric Dot Paper Representations 4.1 Drawing a Cube 4.2 Drawing a Cube Model 4.3 Drawing more Complex Buildings * On an overhead, model how to draw an isometric drawing of a four cube structure, making the fourth cube come out of the bottom third one. Explain that they are to show six views
Wednesday	AM	10:25 Origami	PA will direct
Building and Spatial Sense Finding pi	AM	10:55 Read Aloud, working with Pi Circles	What is pi? Read Sir Cumference and the Dragon of Pi. Discuss and talk about Pi. How can we prove that pi exists? Finding the circumference of circles. If we couldn't use pi, if we weren't sure if it existed, how else could we find circumference? Pass out various cylindrical objects to students and have them measure with string and rulers. What is the circumference according to what you've found? Now how do you find the radius? (take the diameter and divide by 2). Now use the circumference and diameter to prove that pi exists.
	PM	1:00 Polyhedral nets	Students will receive a packet of various nets. Step by step instructions to put together the dodecahedron and the octahedron. Pass out pipe cleaners and have them twist them on their fingers, sticking one end into a Styrofoam disk and the other into one of the faces of the polyhedron.

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		2:00 Writing homework, "Geometry Storybook" 2:15 Wrap-up	Have students volunteer to read segments of their written work and show illustrations (if any). Students will discuss each other's work and make suggestions for improvements. Model "Praise, Problem, Solution" approach.
DAY NINE Thursday Building and Spatial Sense, Tessellations, Assessment	AM	9:00 Ruins of Montarek	4.4 Creating Your Own Building * Add three more cubes. Create a building and place it on their building mat. They are to draw their building from the four different corners on their isometric dot paper. * Exchange the paper with a partner and have them construct your building. Investigation 5: Ziggurats 5.1 Building Ziggurats 5.2 Representing Ziggurats Applications – Connections – Extensions – Mathematical Reflections
	AM	10:25 Origami	PA will direct
	AM	10:55 Polyhedra Garden	Cut out and put together more polyhedral nets. Finish assembly of the garden. (Note: Cube = hexahedron) Print paper modes of polyhedra and have the students use tape to put them together. http://www.korthalsaltes.com/paper_polyhedra_collections.htm (for collections) http://www.korthalsaltes.com/index.html (for examples)
		1:00 Tessellations 1:45 Penrose	COMPUTER LAB: Do the Tessellations.org activity and have the kids investigate how they can make their own tessellations. Then have the students try to create a tessellation out of the first letter of their name. Pass out paper with circles on front and a semi-regular tessellation on back (hexagons, heptagons, octagons, pentagons and squares) and have the students use the same color for each polygon to distinguish the tessellation. When we return to the classroom, begin tessellation of a rectangle by reading Penrose: Martius teaches Penrose a tessellation trick.

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	PM	2:15 Writing homework, "Geometry Storybook"	Have students volunteer to read segments of their written work and show illustrations (if any). Students will discuss each other's work and make suggestions for improvements.
DAY 10 Friday		9:00 Ruins of Montarek	Investigation 6: Seeing the Isometric View 6.1 Viewing a Building * Students are divided into three groups and given a stack of linking cubes. * Students are to construct the three models and match them to their representations from all four corners on page 73 * Check with class when done to make sure everyone has matched the right view to the right corner. 6.2 Removing Cubes * Students are to visualize page 74 and draw on isometric drawing paper what the new building will look like with the orange cubes removed.
		10:25 Origami	P.A. Will direct
		11:00 Weekly Assessment	Teach students how to create an equilateral triangle using a compass and a straight edge. Sum of the angles of a triangle; Pi; Sum of the angles of a quadrilateral; Create a cube net; Diameter, radius, chord; Minimal and Maximal buildings; creating an equilateral triangle with a compass and straight edge; what polygons can and cannot tessellate
		1:00 Equilateral triangles; Tessellations	Demonstrate to students how to create an equilateral triangle using a compass and a straight edge. Read "Penrose: Mauritus Teaches Penrose a Tessellation Trick." Students are to use a regular shape (triangle) to create a tessellation using the directions in Penrose. They are to fill a page of their tessellation and color them in 2-3 colors to make the pattern stand out. At 1:45 demonstrate how to make a tessellation out of a hexagon.
DAY 11 Monday	AM	9:00 The Ruins of Montarek	6.3 Adding Cubes 6.4 Putting the Pieces Together Applications – Connections – Extensions – Mathematical Reflections TBD

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Building and Spatial Sense,	AM	10:25 Origami	PA will direct; discuss how we are going to be making an origami diorama.
Diagonals, ratios, Pythagorean Theorem		10:55 Squares, Diagonals and Square roots	<p>Illuminations Activity: Corner to Corner, Lesson 1; squares, diagonals and square roots.</p> <ul style="list-style-type: none"> • Use baseball diamond overhead to demonstrate the problem about knowing the length of diagonals. Have the students guess the length. • Demonstrate the ratio of side to diagonal using the square worksheet. The students will measure the length of each side and chart it, then go back and measure the length of the diagonal and chart it. Using the ratio, students will divide to find 1.4, which will appear every time. • Explain that a ratio shows a relationship. Numbers have relationships and the relationship between the length of a side and the length of the diagonal is that the diagonal is always 1.4 times longer than the length.
		1:00 Tessellations Regular vs. irregular	<p>All other polygons semi-regular tessellate because they need to be combined together. Pass out semi-regular tessellation and point out all the various polygons (triangle, quadrilateral, pentagon, hexagon, heptagon, octagon) and have them color each polygon one color.</p> <p>Using pattern blocks, students will create a semi-regular tessellation and color it. Draw tessellations before coloring!</p>
	PM	1:45 Writer's Workshop HOMEWORK	<p>Bring in completed stories and start sharing them with the class.</p> <p>Finish Geometry Storybook – Due Monday</p>
DAY 12 Tuesday Building and Spatial Sense, Tessellations, Fibonacci	AM	9:00 Ruins of Montarek	<p>FINAL PROJECT – create your own building for the city of Montarek.</p> <p>Students will have the opportunity to put together their building for their final project. Whatever doesn't get done here at school has to be done at home.</p>
		10:25 Origami	PA will direct

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		10:55 Squares, diagonals and square roots	<p>Illuminations Activity: Corner to Corner, Lesson 2; exploring diagonals and the Pythagorean theorem.</p> <ul style="list-style-type: none"> • Review ratios – pi, diagonals, etc. • Students review the previous lesson about the length of the diagonal in a square (isosceles right triangle), which is $d=1.4s$, or about the square root of 2. • Using this information, students are to make a prediction about the relationship when it comes to a rectangle (scalene right triangle). Write down guesses on the worksheet • Motivational problem – write down guesses on the worksheet • Students are to measure the length and width of the rectangles and fill in the chart, and then measure the diagonal. • Do a few rectangles in the classroom and measure the 2 sides and diagonal, and have everyone record on their chart. • Students are to do the math to find the relationship between the three lengths. – what kind of math do you do? What is the relationship between the numbers? Point out that the diagonal is the square root of some number, every time. <p>Read aloud <i>Pythagoras, What's Your Angle?</i> and discuss. How did he solve the problem?</p>
		1:00 Fibonacci numbers and Geometry	<p>Penrose the Cat: Penrose/Fibonacci rabbit</p> <ul style="list-style-type: none"> • Set up the pattern 1, 1, 2, 3, 5, 8, 13, 21...and tell the students that there is a pattern. Can they figure it out? • Explain that this is the Fibonacci pattern, and that each successive number is the addition of the two numbers before it. <p>Go outside and look around – can we find any Fibonacci numbers in nature?</p>
		1:45 Writer's Workshop	Bring in completed stories and start sharing them with the class.
DAY 13 Wednesday	AM	9:00 The Ruins of Montarek	Students will present their buildings to the class and share their various ideas to a mock panel of the Council of Montarek (Beth, Me, Michelle)

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		10:25 Origami project	Students will create their own origami and write down instructions on how to make it.
	AM	11:00 Post Assessment	Pass out and have students complete the post assessment for the course. Go over it together – what did we learn? What are we still unsure about?
Building and Spatial Sense, The Golden Ratio, the Golden Rectangle, Fractals		1:00 The Golden Ratio/The Golden Rectangle	Penrose the Cat: The golden rectangle dazzles Penrose Students will study the golden ratio and create rectangles using it – refer to Geometry to Go, 251 – 253 to teach the ratio, but show them that Penrose has an easier way to do it. Connect to Fibonacci – any two numbers ratioed in the Fibonacci sequence equals a golden ratio.
		Creating Fractals	Penrose the Cat: Penrose meets the fractal dragon – follow up with p. 254 in Geometry to Go Have the students create a fractal and model it – then vary their ideas and exchange them with a partner – can the partner do your fractal, based on your rules?
		HOMEWORK	All tessellations, fractals, etc, must be turned in.
DAY 14 Thursday		9:00 Student Evaluations	Students will be given time to fill out evals on Instructor and PA.
		9:20 Student Presentations	STUDENTS SHARE THEIR GEOMETRY STORIES with the class
Assessment Egg Puzzles Tessellations Presentations		9:50 Egg Puzzles	Penrose the Cat: Penrose watches the puzzling egg hatch Xerox the egg and have students create the chicks from the polygons If TIME: Polygon stars from Penrose
		10:55 Finish Tessellations, Egg puzzles and cube building	Students finish making their tessellations, constructing their egg puzzles (with a brief description of what kind of bird) and work in groups to complete the cube building.

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Polyhedra in nature		1:00 Students prepare for parent presentations Friday	<p>PREPARE THE PRESENTATIONS FOR PARENTS –</p> <ol style="list-style-type: none"> 1) Ruins of Montarek – one will present his/her construction to the class 2) Story writing – one will read his/her story to the parents 3) Geometric Constructions – present the activities we did with the gumdrops and toothpicks 4) Polyominoes – explain to the parents what they are and how we discovered the combinations to the 12 different pentominoes and the 35 different hexominoes – and cube nets! 5) Scale – present Eeyore (making it bigger) and our portraits (making it smaller) 6) Origami – present an origami diorama and discuss the various objects we made during the three weeks. 7) Tetrahedral kite: present the kite and explain how we built it. 8) Fibonacci numbers: Explain the pattern and how it can be found in nature – give examples. 9) The Golden Rectangle: present the Golden Ratio and the Golden Rectangle 10) Circumference: explain how we proved the existence of Pi. 11 & 12) Tessellations: presentation on tessellations, regular vs. semi-regular (1 student explains how only certain polygons tessellate regularly, and other student explains polygons that leave gaps)
		1:40 Polyhedra in nature	Students will make ice-cream and identify the different polyhedrals found in its structure.
		HOMEWORK	FINISH PRESENTATION!
DAY 15 Friday		9:00 Labeling Polyhedra	Students will label the various polyhedra in their garden using pre-typed labels.
Tessellations, polygons, Geometry in Construction		10:25 Tetrahedra	Try to fly the Tetrahedral Kite – students take turns trying to get it into the air.

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Parent Presentations		10:55 Geometry in Construction	Students are to make any figure they like from the gumdrops and toothpicks, but they must write a paragraph stating what it is and what it could be used for as a building.
		11:40 Presentation check	Have each student go through their presentation to review each concept with the instructor.
		1:00 Catch up and wrap-up	Check through everything, label and pack up
		2:00 Presentations	PARENT DAY – PRESENTATIONS See above – give each student about 5-7 minutes for each presentation Pass out all projects to students for them to take home – this may take a while but do it at the END.