Mathematics
Course of Study
2014

Wickliffe City School District
2221 Rockefeller Road
Wickliffe, Ohio 44092

February, 2014

Wickliffe City Schools

Kindergarten - Math-Pacing Guide

Quarter 1	
Unit	Standards
Counting 2 (Yearlong)	K.CC.5: Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objects.
Counting (Yearlong)	K.CC.1: Count to 100 by ones and by tens. K.CC.4a: When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object. K.CC.4b: Understand that the last number name said tells the number of objects counted. The number of objects is the same regardless of their arrangement or the order in which they were counted.
Comparing Numbers (Yearlong)	K.CC.7: Compare two numbers between 1 and 10 presented as written numerals.
Sorting (September-2 weeks)	K.MD.3: Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.
Geometry 1 (September-1 week)	K.G.2: Correctly name shapes regardless of their orientations or overall size.
Geometry 4 (September-1 week)	K.G.4: Analyze and compare two- and three- dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides equal length).
Geometry 2 (September-1 week)	K.G.1: Describe objects in the environment using names of shapes, and describe the relative positions of these objects using such as *above, below, beside, in front of, behind, and next to*.
Geometry 6	K.G.6: Compose simple shapes to form larger shapes. *For example, "Can you join these two triangles with full sides touchi*

(September- 1 week)	*a rectangle?"*
Geometry 5 (October- 1 week)	K.G.5: Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.
Counting 3 (October- 1 week)	K.CC.3: Write numbers from 0-20. Represent a number of objects with a written numeral 0-20.
Number and Operations in Base Ten (October- 1 week)	K.NBT.1: Compose and decompose numbers from 11-19 into tens and some further ones, e.g., by using objects or drawing, and record each composition or decomposition by a drawing or equation (e.g., 18=10+8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.
Measurement and Data 2 (October- 1 week)	K.MD.2: Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child has taller/shorter.*
Quarter 2	
Unit	Standards
Counting 2 (Yearlong)	K.CC.4c: Understand that each successive number name refers to a quantity that is one larger. K.CC.5: Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objects
Counting (Yearlong)	K.CC.1: Count to 100 by ones and by tens.
Counting 1 (Yearlong)	K.CC.2: Count forward beginning from a given number within the known sequence.
Counting 3 (November-	K.CC.3: Write numbers from 0-20. Represent a number of objects with a written numeral 0-20.

2 weeks) Numbers and Operations in Base Ten (November- 3 weeks) Counting 5 (December- 2 weeks)	K.NBT.1: Compose and decompose numbers from 11-19 into tens and some further ones, e.g., by using objects or drawing, and record each composition or decomposition by a drawing or equation (e.g., 18=10+8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones. K.CC.6: Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies.

Quarter 3	
Unit	Standards
Comparing Numbers (Yearlong) Counting 2 (Yearlong) Addition and Subtraction (All quarter)	K.CC.7: Compare two numbers between 1 and 10 presented as written numerals. K.CC.4c: Understand that each successive number name refers to a quantity that is one larger. K.CC.5: Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objects. K.OA.1: Represent addition and subtraction with objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations. K.OA.3: Decompose numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g., 5=2+3 and 5=4+1). K.OA.2: Solve addition and subtraction word problems, and add and subtract within e.g., by using objects or drawings to represent the problem. K.OA.5: Fluently add and subtract within 5. K.OA.4: For any number from 1 to 9, find the number that makes 10 when added to the given number, e.g., by

Number and Operations in Base Ten (All Quarter) Counting 5 (February- 2 weeks)	using objects or drawings, and record the answer with a drawing or equation. K.NBT.1: Compose and decompose numbers from 11-19 into tens and some further ones, e.g., by using objects or drawing, and record each composition or decomposition by a drawing or equation (e.g., 18=10+8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones. K.CC.6: Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies.
Quarter 4	
Unit	Standards
Counting 2 (Yearlong) Counting (Yearlong) Counting 1 (Yearlong) Addition and Subtraction (All Quarter) Number and Operations in Base Ten (All Quarter) Geometry 3	K.CC.4c: Understand that each successive number name refers to a quantity that is one larger. K.CC.5: Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1-20, count out that many objec K.CC.1: Count to 100 by ones and by tens. K.CC.2: Count forward beginning from a given number within the known sequence. K.OA.3: Decompose numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g., 5=2+3 and 5=4+1). K.OA.5: Fluently add and subtract within 5. K.OA.4: For any number from 1 to 9, find the number that makes 10 when added to the given number, e.g., by using objects or drawings, and record the answer with a drawing or equation. K.NBT.1: Compose and decompose numbers from 11-19 into tens and some further ones, e.g., by using objects or drawing, and record each composition or decomposition by a drawing or equation (e.g., 18=10+8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones. K.G.3: Identify shapes as two-dimensional (lying in a plane "flat") or three-dimensional ("solid").

(April- 2 weeks)	
Geometry 6 (April- 1 week)	K.G.6: Compose simple shapes to form larger shapes. *For example, "Can you join these two triangles with full sides touching to make a rectangle?"*
Geometry 4 (April- 2 weeks)	K.G.4: Analyze and compare two- and three- dimensional shapes, in different sizes and orientations, using informal Language to describe their similarities, differences, parts (e.g., number of sides equal length).
Geometry 5 (May- 1 week)	K.G.5: Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.
Measurement and Data 1 (May- 1 week)	K.MD.1: Describe measureable attributes of objects, such as length or weight. Describe several measureable attributes of a single object.
Measurement and Data 2 (May- 1 week)	K.MD.2: Directly compare two objects with a measurable attribute in common, to see which object has "more of"/ "less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child has taller/shorter*.

Wickliffe City Schools

Grade 1 – Mathematics - Pacing Guide

Quarter 1	
Unit	Standards
September	1.NBT-1 Count to 120, starting at any number less than 120. In this range, read and write numerals and repres number of objects with a written numeral.
October	1.MD-3 Tell and write time in hours and half-hours using analog and digital clocks. 1.MD-4 Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category and how many more or less are in one category than in another. 1.OA-5 Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).
Quarter 2	
Unit	Standards
November	1.MD-1 Order three objects by length; compare the lengths of two objects indirectly by using a third object. 1. MD-2 Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an object is the number of same-size length units that span it with no gaps of overlaps. *Limit to contexts where the object is being measured is spanned by a whole number of length units with no gaps or overlaps.* 1.MD-3 Tell and write time in hours and half-hours using analog and digital clocks.
December	1.OA-2 Solve word problems that call for addition of three whole numbers whose sum is less than or equal to 20, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem. 1.OA-7 Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. 6 = 6, 7 = 8 - 1, 5 + 2 = 2 + 5, 4 + 1 = 5 + 2
January	1.NBT-2 Understand that the two digits of a two-digit number represent amounts of tens and ones. Understand the following as special cases: a. 10 can be thought of as a bundle of ten ones- called a 'ten'. B. The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones. 20, 30, 40, 50, 60, 70, 80, 90 refer to one, two, three, four, five, six, seven, eight, or nine tens (and 0 ones). 1.NBT-3 Compare two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbol, >, <, and =.

Quarter 3	
Unit	Standard
January	1.OA-1 Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem. (Up to 20)
February	1.OA-3 Apply properties of operations as strategies to add and subtract. Examples; If 8 + 3 = 11 is known, then 3 + 8 = 11 is also known. (Commutative property of addition) To add 2 + 6 + 4, the second two numbers to make a ten, so 2 + 6 + 4 = 2 + 10 = 12. (Associative property of addition.) 1.OA-4 Use subtraction as an unknown-addend problem. For example, subtract 10-8 by finding the number that makes 10 when added to 8. 1.OA-6 Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., 8 + 6 = 8 + 2 + 4 = 10 + 4 = 14); decomposing a number leading to a ten (e.g., 13 - 4 = 13 - 3 - 1 = 10 - 1 = 9); using the relationship between addition and subtraction (e.g., knowing that 8 + 4 = 12, one knows 12 - 8 = 4); and creating equivalent but easier or known sums (e.g., adding 6 + 7 by creating the known equivalent 6 + 6 + 1 = 12 + 1 = 13).
March	1.NBT-1 Count to 120, starting at any number less than 120. In this range, **read and write numerals and r number of objects with a written numeral.** 1.OA-8 Determine the unknown whole number in an addition or subtraction equation relating three whole nu For example, determine the unknown number that makes the equation true in each of the equations: 8 + ____ 5 = ____ - 3, 6 + 6 = ____ .

Quarter 4	
Unit	Standard

April	1.G-1 Distinguish between defining attributes (e.g., color orientation, overall size); build and draw shapes to possess defining attributes. 1.G-2 Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape. 1.NBT-4 Add within 100, including a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models and drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones, and sometimes it is necessary to compose a ten. 1.NBT-5 Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used.
May/June	1.G-3 Partition circles and rectangles into two and four equal shares, describe the shares using the words halves, fourths, and quarters, and use the phrases half of, fourth of, and quarter of. Describe the whole as two of, or four of the shares. Understand for these examples that decomposing into more equal shares creates smaller shares. 1.NBT-6 Subtract multiples of 10 in the range 10-90 from multiples of 10 in the range 10-90 (positive or zero differences), using concrete models or drawings and strategies based on place value, properties of operations, the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

Wickliffe City Schools

Grade 2 - Mathematics -Pacing Guide

Quarter 1	
Unit	Standards
Unit 1 Addition and Subtraction (September)	2.OA.1 Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing with unknowns in all positions. 2OA.2 Fluently add and subtract within 20 using mental strategies. 2.OA.3 Determine whether a group of objects (up to 20) has an add or ever number of members. 2.MD.6 Represent whole numbers as lengths from 0 on a number line diagram with equally spaced points corresponding to the numbers 0,1,2,… and represent whole-number sums and differences within 100 on a number line diagram.
Unit 2 Place Value (October)	2.NBT.1 Understand that the three digits of a three-digit number represent amounts of hundreds, tens, and ones. 2.NBT.1a – 100 can be thought of as a bundle of tens called “hundred”. 2.NBT.1b – The numbers 100,…900 refer to one, two, three, four, five, six, seven, eight, or nine hundreds (and 0 tens and 0 ones) 2.NBT.3 Read and write numbers to 1000 using base-ten numerals, number names, and expanded form. 2.NBT.4 – Compare two three-digit numbers based on meanings of hundreds, tens, and ones digits using <,>,= symbols to record the results of comparisons.
Unit 3 Time (October)	2.MD.7 Tell and write time from analog and digital clocks to the nearest five minutes, using am and pm.
Quarter 2	
Unit	Standards
Unit 4 Addition to 1,000 (November)	2.NBT.5 Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. 2.NBT.6 Add up to four two-digit numbers using strategies based on place value and properties of operations. 2.NBT.7 – Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds. 2.NBT.8 Mentally add 10 or 100 to a given number 100-900, and mentally subtract 10 or 100 from a given number 100-900.

	2.NBT.9 Explain why addition and subtraction strategies work, using place value and the properties of operations.
Unit 5 Graphing (December)	2.MD.10 – Draw a picture graph and bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple up-together, take-apart, and compare problems using information presented in a bar graph.
Unit 6 Geometry (December)	2.G.1 – Recognize and draw shapes having specific attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.

Quarter 3	
Unit	Standard
Unit 7 Subtraction to 1000 (January)	2.NBT.5 Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction. 2.NBT.6 Add up to four two-digit numbers using strategies based on place value and properties of operations. 2.NBT.7 – Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds. 2.NBT.8 Mentally add 10 or 100 to a given number 100-900, and mentally subtract 10 or 100 from a given number 100-900. 2.NBT.9 Explain why addition and subtraction strategies work, using place value and the properties of operations.
Unit 8 Fractions (February)	2.G.3 – Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of, a third of, etc., and describe the whole as two havles,three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape.
Unit 9	2.MD.1 – Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Measurement (March)	2.MD.2 – Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen. 2.MD.3 – Estimate lengths using inches, feet, centimeters, and meters. 2.MD.4 – Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit. 2.MD.5 – Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem. 2.MD.9 – Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole number units.
Quarter 4	
Unit	Standard
Unit 10 Multiplication (April)	2.OA.4 Use addition to find the total number of objects arranged in rectangular array with up to 5 rows and up to 5 columns; write an equation to express the total as a sum of equal addends. 2.G.2 Partition a rectangle into rows and columns of same-size squares and count to find the total number of them. 2.NBT.2 Count within 1000, skip count by 5s, 10s, and 100s.
Unit 11 Money (May)	2.MD.8 Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies using $ and cent sign symbols appropriately.

WICKLIFFE CITY SCHOOLS
Grade 3 – Math – Pacing Guide

Quarter 1	
Unit	Standards
August, September, October Number and Operations in Base 10 (place value) Operations and Algebraic Thinking (two step word problems)	3 NBT 1- Use place value understanding to round whole numbers to the nearest 10 or 100 3 NBT 2 – Use place value understanding and properties of operations to perform multi digit athematic (number patterns) 3 OA 9 – Identify arithmetic patterns and explain using properties of operations (addition tables) 3 OA 8 – Solve two-step word problems using the four operations represent the problems using equations with a letter standing for the unknown quality (adding and subtracting) 3 NBT 2 - Use place value understanding and properties of operations to perform multi digit athematic (adding/subtracting and solving number stories) 3 OA 1 – Interpret products of whole numbers (5 x 7 as 5 groups 7 objects each)
Quarter 2	
Unit	Standards
November, December, January Operations and Algebraic Thinking (multiplication and division)	3 OA 7 – Fluently multiply within 100 3 NBT 3 – Multiply one digit whole numbers by multiples of 10 3 OA 3 – Use multiplication within 100 to solve word problems 3 OA 4 – Determine the unknown whole number in a multiplication equation 3 OA 9 - Identify multiplication patterns and explain using properties of operations (multiplication tables) 3 OA 8 – Solve two-step word problems using the four operations represent the problems using equations with a letter standing for the unknown quality (multiply) 3 OA 5 – Apply properties of operations as strategies to multiply 3 OA 2 – Interpret whole numbers quotients of whole numbers (56 divided by 8 is the number of objects shared equally) 3 OA 7 – Fluently divide within 100 3 OA 3 – Use division within 100 to solve word problems 3 OA 6 – Determine the unknown whole number in a division equation 3 OA 8 – Solve two-step word problems using the four operations represent the problems using equations with a letter standing for the unknown quality (divide)

Quarter 3	
Unit	Standards
January, February, March Measurement and Data (area and perimeter) Fractions	3 MD 5 – Solve real world problems involving area of polygons 3 MD 6 – Measure area by counting units squares 3 MD 7 – Relate area to the operations of multiplication and addition 3 MD 8 – Solve real world problems involving perimeter of polygons 3 NF 1 – Understand a fraction 1/b as the quantity formed by one part when a whole is partitioned into b equal parts; understand a fraction a/b as the quantity formed by parts of size 1/b (limited to denominators 2, 3, 4, 6, 8) 3 NF 2 – Understand a fraction as a number on a number line; show fractions on a number line diagram 3 NF 3 – Explain equivalence of fractions and compare fractions
Quarter 4	
Unit	Standards
April, May, June Measurement and Data (time, mass, volumes) Geometry	3 MD 1 – Solve problems involving measurement and estimation of intervals of time 3 MD 2 – Add, subtract, multiply and divide to solve one step word problems using masses or volumes that are given in the same units by using drawings to represent the problem 3 MD 2 – Measure and estimate liquid volumes and masses of objects using standard units of grams, kilograms, and liters 3 MD 3 – Represent and interpret data (bar graph/problem solving) 3 MD 4 – Represent and interpret data (measurement data/line plot/whole number, half quarter units) 3 G 1 – Shapes (2 D only) have attributes that support problem solving (classifying, attributes, quadrilaterals) 3 G 2 – Shapes (2 D only) have attributes that support problem solving (divide shapes into equal areas/fractions)

Wickliffe City Schools

Grade 4 – Math - Pacing Guide

Quarter 1	
Unit	Standards
Place Value	4NBT 1: Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents the place to the right. 4NBT 2: Read and write multi-digit whole numbers using base-ten numerals, number names and expanded form Compare two multi-digit numbers based on meanings of the digits in each place. 4NBT 3: Use place value understanding to round multi-digit whole numbers. 4NBT 4: Fluently add and subtract multi-digit whole numbers using the standard algorithm.
Multiplication	4OAT 4: Find all factor pairs for a whole number in the range 1-100. Recognize that a whole number is a multiple each of its factors. Determine whether a given whole number is a multiple of each of its factors. Determine whetl a given whole number in the range 1-100 is a multiple of a given one-digit number. Determine whether a given w number in the range 1-100 is prime or composite. 4OAT 1: Interpret a multiplication equation as a comparison. Represent verbal statements of multiplicative comparisons as multiplication equations. 4OAT 2: Multiply or divide to solve word problems involving multiplicative comparison, e.g. by using drawings a equations with a symbol for the unknown whole number to represent the problem, distinguishing multiplicative c comparison. 4OAT 5: Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern were not explicit to the rule itself. 4NBT 5: Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calcul rectangular arrays and/or area models.
Quarter 2	
Unit	Standards
Division	4NBT 6: Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors,

	using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays and/or area models.
Multi-step Word Problems	OAT 3: Solve multi-step word problems posed with whole numbers and having whole number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.
Geometry	4G 1: Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. 4G 2: Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles. 4G 3: Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line symmetric figures and draw lines of symmetry.
Geometric Measurement	4MD 5: Recognize angles as geometric shapes that are formed whenever two rays share a common endpoint, and understand the concepts of angle measurement. 4MD 6: Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure. 4MD 7: Recognize angle measurement as additive.

Quarter 3	
Unit	Standard
Decimals	4NF 6: Use decimal notation for fractions with denominators 10 or 100. 4NF 7: Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the two decimals refer to the same whole. Record the results of the comparisons with the symbols >, <, or =, and justify the conclusions, e.g., by using a visual model.

Fractions Interpreting Data	4NF 1: Explain why a fraction a/b is equivalent to a fraction (nxa)/(nxb) by using visual fraction models with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions. 4NF 2: Compare two fractions with different numerators and different denominators, by creating common denominators or numerators, or by comparing to a benchmark fraction, such as ½. Recognize that comparisons are only valid when two fractions refer to the same whole. Record the results of comparisons with >, <, or = , and justify the conclusions, e.g., by using a visual fraction model. (Limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12 and 100.) 4NF 3: Understand a fraction a/b with a >1 as a sum of fractions 1/b. 4NF 4: Apply and extend previous understandings of multiplication to multiply a fraction by a whole number. 4NF 5: Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions. 4MD 4: Make a line plot to display a set of measurements in fractions of a unit (1/2, ¼, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots.
Quarter 4	
Unit	Standard
(April, May, June) Area/Perimeter Measurement	4MD 3: Apply the area and perimeter formula for rectangles in real world and mathematical problems. 4MD 1: Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz; l, ml; hr, min, sec. Within a single system of measurement, express measurement in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. 4MD 2: Use the four operations to solve word problems involving distance, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

Wickliffe City Schools

Grade 5 Mathematics -Pacing Guide

Quarter 1	
Unit	Standards
Unit 1-August-Mid September	5.NBT.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. 5.NBT.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use wh denote powers of 10. 5.NBT.3 Read, write, and compare decimals to thousandths. 5.NBT.4 Use place value understanding to round decimals to any place.
Unit 2-Mid September-Mid of October	5.NBT.5 Fluently multiply multi-digit whole numbers using the standard algorithm. 5.NBT.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models. 5.NBT.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.
Unit 4-Mid October-Mid November	5.MD.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. 5.MD.2 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. *For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.*
Quarter 2	
Unit	Standards
Unit 5-Mid November to Mid December	5.MD.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement. 5.MD.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft., and improvised units 5.MD. 5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.
Unit 6- Mid-December-End of January	5.G.1 Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate,

	y-axis and *y*-coordinate). 5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation. 5.G.3 Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles. 5.G.4 Classify two-dimensional figures in a hierarchy based on properties.

Quarter 3	
Unit	Standard
Unit 7-End of January-End of February	5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, 2/3 + 5/4 = 8/12 + 15/12 = 23/12. (In general, a/b + c/d = (ad + bc)/bd.)* 5.NF,2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. *For example, recognize an incorrect result 2/5 + 1/2 = 3/7, by observing that 3/7 < 1/2.*
Unit 8 End of February-end of March	5.NF.3 Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret 3/4 as the result of dividing 3 by 4, noting that 3/4 multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size 3/4. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?* 5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.
Quarter 4	
Unit	Standard
End of March-Beginning of May	5.NF.5 Interpret multiplication as scaling (resizing), by: 5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem. 5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.[1]

Wickliffe City Schools

Grade 6 Mathematics - Pacing Guide

Quarter 1	
Unit	Standards
Unit 1: Number Systems	6.NS.1 Interpret and compute quotient of fractions, and solve word problems involving division of fractions. 6. NS.2 Fluently divide multi-digit numbers using the standard algorithm. 6. NS.3 Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation. 6.NS.4 Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiples of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1-100 with a common factor as a multiple of a sum of two whole numbers with no comm factor. 6.NS.5 Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. 6.NS.6 Understand a rational number as a point on the number line. Extend number line diagrams and coordi familiar from previous grades to represent points on the line and in the plane with negative number coordinates a. Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; Recognize that the opposite of the opposite of a number is the number itself. b. Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate pl recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflection across one or both axes. c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram and position pairs of integers and other rational numbers on a coordinate plane. 6.NS.8 Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate Include use of coordinates and absolute value to find distances between points with the first coordinate or the s Second coordinate. 6.NS.7 Understand ordering and absolute value of rational numbers. a. Interpret statements of inequality as statements about relative position of two numbers on a number l diagram. b. Write, interpret, and explain statements of order for rational numbers in real-world contexts. c. Understand the absolute value of a rational number as its distance from 0 on the number line; interpre value as magnitude for a positive or negative quantity in a real-world situation. d. Distinguish comparisons of absolute value from statements about order. 6.NS.8 Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate

	Include use of coordinates and absolute value to find distances between points with the first coordinate or the same second coordinate.
Quarter 2	
Unit	Standards
Unit 2: Ratios	6.RP.1 Understand the concepts of a ratio and use ration language to describe a ratio relationship between two quantities. 6. RP. 2. Understand the concept of a unit rated/b associated with a ration a:b with b not equal to 0, and use rate language in the context of a ration relationship. 6.RP.3. Use a ratio and rate reasoning to solve real-world and mathematical problems. a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratio b. Solve unit rate problems including those involving unit pricing and constant speed. c. Find a percent of a quantity as a rate per 100; solve problems involving finding the whole, given a part and the percent. d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. 6.EE.2.c Order of Operations. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations).
Unit 3: Data Analysis	6.SP.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. 6.SP.2 Understand that a set of data collected to answer a statistical question has a distribution, which can be described by its center, spread and overall shape. 6.SP.3 Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. 6.SP.4 Display numerical data in plots on a number line, including dot plots, histograms and box plots. 6.SP.5 Summarize numerical data sets in relation to their context, such as by: a. Reporting the number of observations b. Describing the nature of the attribute under investigation c. Giving quantitative measure of center (median and / or mean) and variability d. Relating the choice of measure of center and variability to the shape of the data distribution

Quarter 3	
Unit	Standard
Unit 4: Expression & Equations	6.EE.1 Write and evaluate numerical expressions involving whole-number exponents

	6.EE.2 Write, read, and evaluates expressions in which letters stand for numbers. a. Write expressions that record operations with numbers and with letters standing for numbers. b. Identify parts of an expression using mathematical terms as a product of two factors; view as both a single entity and a sum of two terms. c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). 6.EE.3 Apply the properties of operations to generate equivalent expressions. 6.EE.4 Identify when two expressions are equivalent. 6.EE.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use a substitution to determine whether a given number in a specified set makes an equation or inequality true.
Quarter 4	
Unit	Standards
Unit 5: Geometry	6.G.1 Find the area of right triangles, other triangles, special quadrilaterals and polygons by composing into rectangles or other shapes. 6.G.2 Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. 6.G.3 Draw polygons in the coordinate plane given the coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. 6.G.4 Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures.

Wickliffe City Schools

Grade 7 Mathematics -Pacing Guide

Quarter 1	Standards
Unit	Standards
Unit 1 Proportional reasoning August-September	7.RP.1 Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. 7.NS.2 Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers. d. Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats. 7.NS.3 Solve real-world and mathematical problems involving the four operations with rational numbers. 7.G.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths from a scale drawing.
Unit 2 Proportional relationships September	7.RP.2 Recognize and represent proportional relationships between quantities. a. Decide whether two quantities are in proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin. b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. c. Represent proportional relationships by equations. d. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate.
Unit 3 Proportional reasoning with percent September-October	7.RP.3 Use proportional relationships to solve multistep ratio and percent problems. 7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.
Unit 4 Rational number operations-addition and subtraction October	7.NS.1 Apply and extend previous understands of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram. **a.** Describe situations in which opposite quantities combine to make 0. **b.** Understand p + q as the number located a distance |q| from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts. **c.** Understand subtraction of rational numbers as adding the additive inverse, p – q = p + (-q). Show

	that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts. **d.** Apply properties of operations as strategies to add and subtract rational numbers. 7.NS.3 Solve real-world and mathematical problems involving the four operations with rational numbers. 7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.
Quarter 2	
Unit	Standards
Unit 5 Rational number operations-multiplication and division November	7.NS.2 Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers. a. Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as (-1)(-1) = 1 and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts. b. Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then $-(p/q) = (-p)/q = p/(-q)$. Interpret quotients of rational numbers by describing real-world contexts. c. Apply properties of operations as strategies to multiply and divide rational numbers. 7.NS.3 Solve real-world and mathematical problems involving the four operations with rational numbers.

Wickliffe City Schools

Grade 8 Pre-Algebra - Pacing Guide

Quarter 1	
Unit	Standards
Working with Rational & Irrational Numbers	(8.NS.1) Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion, which repeats eventually into a rational number. (8.NS.2) Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions.
Working with Exponents & Scientific Notation	(8.EE.1) Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $32 \times 3^{-5} = 3^{-3} = 1/33 = 1/27$. (8.EE.2) Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. (8.EE.3) Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as 7×10^9, and determine that the world population is more than 20 times larger. (8.EE.4) Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.
Pythagorean Theorem	(8.G.6) Explain a proof of the Pythagorean Theorem and its converse. (8.G.7) Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. (8.G.8) Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

Quarter 2	
Unit	Standard
Variable Equations & Function Rule	(8.EE.7) Solve linear equations in one variable: (a) Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, using an equivalent equation of the form x = a, a =a, or a=b results (where a and b are different numbers) (b) Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms. (8.F.1) Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.
Understanding Slope	(8.EE.6) Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane. ; derive the equation y = mx for a line through the origin and the equation y = mx + b for a line intercepting the vertical axis at b. (8.EE.5) Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.
Linear Functions	(8.F.3) Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are non-linear. For example, the function A = s2 giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line. (8.F.2) Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change. (8.F.4) Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. (8.F.5) Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Quarter 3	
Unit	Standard

Linear Functions (Continued from Quarter 2)	(8.F.3) Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are non-linear. For example, the function A = s2 giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line. (8.F.2) Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change. (8.F.4)Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. (8.F.5) Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.
Patterns in Bivariate Data	(8.SP.1) Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. (SP2) Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line. (8.SP.3) Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.
Systems of Equations	(8.EE.8) A. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously. B. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example 3x + 2y = 5 and 3x + 2y = 6 have no solutions because 3x + 2y cannot simultaneously be 5 and 6. C. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

Quarter 4	
Unit	Standard

Systems of Equations (Continued from Quarter 3)	(8.EE.8) A. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously. B. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example $3x + 2y = 5$ and $3x + 2y = 6$ have no solutions because $3x + 2y$ cannot simultaneously be 5 and 6. C. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.
Transformations in the Coordinate Plane	(8.G.1) Verify experimentally the properties of rotations, reflections, and translations: A. Lines are taken to lines, and line segments to line segments of the same length. B. Angles are taken to angles of the same measure. C. Parallel lines are taken to parallel lines. (8.G.2) Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them. (8.G.3) Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. (8.G.4) Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.
Angles	(8.G.5) Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.
Volume	(8.G.9) Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
Construct & Interpret Two-Way Tables	(8.SP.4) Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

Wickliffe City Schools

Algebra 1-Mathematics Pacing Guide

Quarter 1	
Unit	Standards
Properties of Rational and Irrational Numbers Interpret the structure of expressions Solving Linear Equations and Inequalities Building Functions that model relationships between 2 quantities	N-RN.3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational. (SSE.1): Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients. Interpret complicated expressions by viewing one or more of their parts as a single entity. (REI.1): Explain each step in solving a simple equation as following the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. (REI.3) Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (CED.1): Create equations and inequalities in one variable and use them to solve problems. F-BF.1. Write a function that describes a relationship between two quantities.★ a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model. F-BF.2. Write arithmetic and geometric sequences both recursively and with an explicit formula, uses them to model situations, and translates between the two forms.★ F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x3 or f(x) = (x+1)/(x–1) for x ≠ 1.
Quarter 2	
Unit	Standards
Unit Analysis/Reasoning to Solve Problems	N-Q.1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. N-Q.2. Define appropriate quantities for the purpose of descriptive modeling. N-Q.3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

Functions/Function Notation/Interpreting Functions	F-IF.1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x). F-IF.2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. F-IF.3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1. F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.★ F-IF.5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.★ F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★ b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay.
Interpreting Categorical and Quantitative Data	S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots). S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. S-ID.3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). S-ID.5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data. S-ID.6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. b. Informally assess the fit of a function by plotting and analyzing residuals. c. Fit a linear function for a scatter plot that suggests a linear association. S-ID.7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. S-ID.8. Compute (using technology) and interpret the correlation coefficient of a linear fit. S-ID.9. Distinguish between correlation and causation.
Creating and Solving Systems of Equations and Inequalities	A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost

	constraints on combinations of different foods. A-REI.5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions. A-REI.6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. A-REI.7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line y = –3x and the circle x2 + y2 = 3. A-REI.10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). A-REI.12. Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes. A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★

Quarter 3	
Unit	Standard
Properties of Exponents	c. Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as (1.151/12)12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%. N-RN.1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want (51/3)3 = 5(1/3)3 to hold, so (51/3)3 must equal 5. N-RN.2. Rewrite expressions
Solving Quadratic Equations	involving radicals and rational exponents using the properties of exponents. A-REI.4. Solve quadratic equations in one variable. a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x – p)2 = q that has the same solutions. Derive the quadratic formula from this form. b. Solve quadratic equations by inspection (e.g., for x2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as
Graphing Quadratic Functions	appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as a ± bi for real numbers a and b. (IF.7) Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology in more complicated cases. Graph quadratic functions and interpret x and y
Analyzing and Graphing Functions	intercepts, maxima, minima, zeros, the vertex, and the axis of symmetry. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. e. Graph exponential and logarithmic functions, showing intercepts and end behavior,

	and trigonometric functions, showing period, midline, and amplitude. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.
Quarter 4	
Unit	Standard
Construct and compare linear, quadratic, exponential models and solve problems	F-LE.1. Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. F-LE.2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). F-LE.3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. F-LE.5. Interpret the parameters in a linear or exponential function in terms of a context.
Factoring Polynomials	A-SSE.2. Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y4 as (x2)2 – (y2)2, thus recognizing it as a difference of squares that can be factored as (x2 – y2)(x2 + y2) .A-SSE.3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
Perform Arithmetic Operations on Polynomials	A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

Wickliffe City Schools

Geometry Mathematics-Pacing Guide

Quarter 1	
Unit	Standards
Definitions and Transformation Introduction	G.CO.1 Know precise definitions of an angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc. G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
Experiment with Transformations in the Plane	G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself. G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel line, and line segments. G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
Understand Congruence in terms of Rigid Motion	G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent. G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
Prove Geometric Theorems about Lines and Angles	G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions. G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.
Prove Theorems about Triangles and Parallelograms	G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

	G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.
Quarter 2	
Unit	Standards
Geometric Constructions	G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line. G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.
Similarity Transformations	G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor: a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged. b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor. G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides. G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.
Prove Theorems About Triangles and Pythagorean Theorem	G-SRT.4 Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity. G-SRT.5 Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.
Trigonometric Ratios and Solving Right Triangles	G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles. G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles. G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.★
Modeling with Geometric Concepts	G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).★ G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).★ **G-MG.3** Apply geometric methods to solve design problems (e.g.,

	designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).★

Quarter 3	
Unit	Standard
Trigonometry with General Triangles	G-SRT.9 (+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. G-SRT.10 (+) Prove the Laws of Sines and Cosines and use them to solve problems. G-SRT.11 (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).
Volume, Two-Dimensional, and Three-Dimensional	G-MD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments. G-MD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. G-MD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
Use Coordinates to Prove Simple Geometric Theorems Algebraically	G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2). G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point). G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
Derive Equations of Circles and Parabolas	G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.★
Understand and apply theorems about circles	G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. G-GPE.2 Derive the equation of a parabola given a focus and directrix. G.C.1 Prove that all circles are similar. G.C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

Quarter 4 Unit	Standard
Understand and Apply Theorems about Circles	G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle. G-C.4 (+) Construct a tangent line from a point outside a given circle to the circle.
Find Arc Length and Areas of Sectors of Circles	G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.
Interpreting Data Using Probability	S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent. S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B. S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results. S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.
Probability of Compound Events	S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model. S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model. S-CP.8 (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model. S-CP.9 (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Wickliffe City Schools

Honors Geometry Mathematics-Pacing Guide

Quarter 1	
Unit	Standards
Definitions and Transformation Introduction	G.CO.1 Know precise definitions of an angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc. G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).
Experiment with Transformations in the Plane	G-CO.3 Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself. G-CO.4 Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel line, and line segments. G-CO.5 Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.
Understand Congruence in terms of Rigid Motion	G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent. G-CO.7 Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
Prove Geometric Theorems about Lines and Angles	G-CO.8 Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions. G-CO.9 Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.
Prove Theorems about Triangles and Parallelograms	G-CO.10 Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.

	G-CO.11 Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.
Quarter 2	
Unit	Standards
Geometric Constructions	G-CO.12 Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line. G-CO.13 Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.
Similarity Transformations	G-SRT.1 Verify experimentally the properties of dilations given by a center and a scale factor: a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged. b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor. G-SRT.2 Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides. G-SRT.3 Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.
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Trigonometric Ratios and Solving Right Triangles	G-SRT.6 Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles. G-SRT.7 Explain and use the relationship between the sine and cosine of complementary angles. G-SRT.8 Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.★
Modeling with Geometric Concepts	G-MG.1 Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).★ G-MG.2 Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).★ **G-MG.3** Apply geometric methods to solve design problems (e.g.,

	designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).★

Quarter 3	
Unit	Standard
Trigonometry with General Triangles	G-SRT.9 (+) Derive the formula A = 1/2 ab sin(C) for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. G-SRT.10 (+) Prove the Laws of Sines and Cosines and use them to solve problems. G-SRT.11 (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).
Volume, Two-Dimensional, and Three-Dimensional	G-MD.1 Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments. G-MD.3 Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems. G-MD.4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.
Use Coordinates to Prove Simple Geometric Theorems Algebraically	G-GPE.4 Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2). G-GPE.5 Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point). G-GPE.6 Find the point on a directed line segment between two given points that partitions the segment in a given ratio.
Derive Equations of Circles and Parabolas	G-GPE.7 Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.★
Understand and apply theorems about circles	G-GPE.1 Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. G-GPE.2 Derive the equation of a parabola given a focus and directrix. G.C.1 Prove that all circles are similar. G.C.2 Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.

Quarter 4 Unit	Standard
Understand and Apply Theorems about Circles	G-C.3 Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle. G-C.4 (+) Construct a tangent line from a point outside a given circle to the circle.
Find Arc Length and Areas of Sectors of Circles	G-C.5 Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.
Interpreting Data Using Probability	S-CP.1 Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). S-CP.2 Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent. S-CP.3 Understand the conditional probability of A given B as P(A and B)/P(B), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B. S-CP.4 Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results. S-CP.5 Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.
Probability of Compound Events	S-CP.6 Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model. S-CP.7 Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model. S-CP.8 (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model. S-CP.9 (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Wickliffe City Schools

Algebra 2 Mathematics-Pacing Guide

Quarter 1	
Unit	Standards
Complex Numbers	N.CN.1 Know there is a complex number i such that i=√(-1), and every complex number has the form a+bi with N.CN. 2 Use the relation i^2=-1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
Quadratics with Complex Solutions	N.CN.7 Solve quadratic equations with real coefficients that have complex solutions. N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite x2 + 4 as (x + 2i)(x – 2i). F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
Polynomials	A-SSE.1. Interpret expressions that represent a quantity in terms of its context.★ a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret parts of an expression, such as terms, factors, and coefficients. A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. A-SSE.2. Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y4 as (x2)2 – (y2)2, thus recognizing it as a difference of squares that can be factored as (x2 – y2)(x2 + y2). A-APR.4. Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2)2 = (x2 – y2)2 + (2xy)2 can be used to generate Pythagorean triples.

Quarter 2	
Unit	Standards
Polynomials	A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system. A-APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x). A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

	F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.★ F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★ c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.F.IF.7d: Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
Rational Expressions	A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system. A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions. A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Quarter 3	
Unit	Standards
Modeling Functions	A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods. A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance. A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.
Interpreting Functions	F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function. F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★

	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. F-BF.4. Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x3 or f(x) = (x+1)/(x–1) for x ≠ 1.

Interpreting Functions	F-BF.1. Write a function that describes a relationship between two quantities.★ b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model. A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic function★
Exponential and Logarithmic Functions	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior. F.IF.8 Write a function defined by an expression in different in different but equivalent forms to reveal and explain different properties of the function. F.IF.9 Compare properties of two functions each represented in different way (algebraically, graphically, numerically in tables, or by verbal descriptions). F.LE.4 For exponential models, express as a logarithm the solution to a b^ct=d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

Quarter 4	
Unit	Standards

Trigonometric Functions	F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.★ F-TF.8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.
Statistics	S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model? S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. S-IC.6. Evaluate reports based on data. S-MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Wickliffe City Schools

Honors Algebra 2 Mathematics-Pacing Guide

Quarter 1	
Unit	Standards
Complex Numbers	N.CN.1 Know there is a complex number i such that i=√(-1), and every complex number has the form a+bi with N.CN. 2 Use the relation i^2=-1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
Quadratics with Complex Solutions	N.CN.7 Solve quadratic equations with real coefficients that have complex solutions. N-CN.8. (+) Extend polynomial identities to the complex numbers. For example, rewrite x2 + 4 as (x + 2i)(x – 2i). F-IF.8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
Polynomials	A-SSE.1. Interpret expressions that represent a quantity in terms of its context.★ a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret parts of an expression, such as terms, factors, and coefficients. A-APR.1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. A-SSE.2. Use the structure of an expression to identify ways to rewrite it. For example, see x4 – y4 as (x2)2 – (y2)2, thus recognizing it as a difference of squares that can be factored as (x2 – y2)(x2 + y2). A-APR.4. Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x2 + y2)2 = (x2 – y2)2 + (2xy)2 can be used to generate Pythagorean triples.

Quarter 2	
Unit	Standards
Polynomials	A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system. A-APR.2. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x). A-APR.3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. F-IF.4. For a function that models a relationship between two quantities, interpret key features of graphs and

	tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.★ F-IF.7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★ c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. N-CN.9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.F.IF.7d: Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
Rational Expressions	A-APR.6. Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system. A-APR.7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions. A-REI.2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

Quarter 3	
Unit	Standards
Modeling Functions	A-CED.1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions. A-CED.2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. A-CED.3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods. A-CED.4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance. A-SSE.4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.
Interpreting Functions	F.IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function. F-IF.6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★ F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases

	and using technology for more complicated cases. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. F-IF.9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum. F-BF.3. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. F-BF.4. Find inverse functions. a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2 x3 or f(x) = (x+1)/(x–1) for x ≠ 1.

Interpreting Functions	F-BF.1. Write a function that describes a relationship between two quantities.★ b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model. A-REI.11. Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are the solutions of the equation f(x) = g(x); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where f(x) and/or g(x) are linear, polynomial, rational, absolute value, exponential, and logarithmic function★
Exponential and Logarithmic Functions	F.IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior. F.IF.8 Write a function defined by an expression in different in different but equivalent forms to reveal and explain different properties of the function. F.IF.9 Compare properties of two functions each represented in different way (algebraically, graphically, numerically in tables, or by verbal descriptions). F.LE.4 For exponential models, express as a logarithm the solution to a b^ct=d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.

Quarter 4	
Unit	Standards
Trigonometric Functions	F-TF.1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the

	angle. F-TF.5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.★ F-TF.8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ and the quadrant of the angle.
Statistics	S-ID.4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve. S-IC.1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population. S-IC.2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model? S-IC.3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. S-IC.4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. S-IC.5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. S-IC.6. Evaluate reports based on data. S-MD.6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). S-MD.7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

Wickliffe City Schools

Functions, Statistics and Trigonometry Mathematics -Pacing Guide

Quarter 1 Unit	Standards
Complex Numbers	N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex n N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real ar numbers), and explain why the rectangular and polar forms of a given complex number represent the same nun N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometricall plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}\, i)3 = 8$ because $(-1 + \sqrt{3}\, i)$ h argument 120°. N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and segment as the average of the numbers at its endpoints.
Vectors	N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities b segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordin point. N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors. N-VM.4. (+) Add and subtract vectors. a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a is typically not the sum of the magnitudes. b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. c. Understand vector subtraction $v - w$ as $v + (-w)$, where $-w$ is the additive inverse of w, with the same magni pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appro perform vector subtraction component-wise. N-VM.5. (+) Multiply a vector by a scalar. a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform component-wise, e.g., as $c(vx, vy) = (cvx, cvy)$. b. Compute the magnitude of a scalar multiple cv using $\|\|cv\|\| = \|c\|v$. Compute the direction of cv knowing that when $\|c\|v \neq 0$, the direction of cv is either along v (for $c > 0$) or against v (for $c < 0$).
Quarter 2	
Unit	Standards
Matrices	A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable. A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3×3 or greater). N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

	N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors. N-VM.12. (+) Work with 2 × 2 matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area.
Graphing Rational Functions	F.IF.7d: Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
Inverse Functions	F.BF.1c: Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time. F.BF.4b: Verify by composition that one function is the inverse of another. F.BF.4c: Read values of an inverse function from a graph or a table, given that the function has an inverse. F.BF.4d: Produce an invertible function from a non – invertible function by restricting the domain. F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents

Quarter 3	
Unit	Standard
Trigonometric Functions and The Unit Circle	F.TN.2 - Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. F.TN.3 - Use special triangles to determine geometrically the values of sine, cosine, and tangent for $\pi/3$, $\pi/4$, and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for x, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number. F.TN.4 - Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.
Trigonometric Functions	F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.
Conic Sections	

	G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
Quarter 4	
Unit	Standard
Cavalieri's Principle Random Variables and Expected Values	G - GMD.2. Give an informal argument using Cavalieri's Principle for the formulas for the volume of a sphere and other solid figures. S-MD.1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions. S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution. S-MD.3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes. S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households? S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant. b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

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Grade 11/12 Pre-Calculus Mathematics-Pacing Guide

Quarter 1	
Unit	Standards
Complex Numbers	N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number. N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}\, i)3 = 8$ because $(-1 + \sqrt{3}\, i)$ has modulus 2 and argument 120°. N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.
Vectors	N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors. N-VM.4. (+) Add and subtract vectors. a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnit of a sum of two vectors is typically not the sum of the magnitudes. b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. c. Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the perform vector subtraction component-wise. N-VM.5. (+) Multiply a vector by a scalar. a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy). b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowir direction of cv is either along v (for c > 0) or against v (for c < 0).
Quarter 2	
Unit	Standards
Matrices	A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable. A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using

	technology for matrices of dimension 3 × 3 or greater). N-VM.6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network. N-VM.7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled. N-VM.8. (+) Add, subtract, and multiply matrices of appropriate dimensions. N-VM.9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties. N-VM.10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. N-VM.11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.
Graphing Rational Functions	N-VM.12. (+) Work with 2 × 2 matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area. F.IF.7d: Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
Inverse Functions	F.BF.1c: Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time. F.BF.4b: Verify by composition that one function is the inverse of another. F.BF.4c: Read values of an inverse function from a graph or a table, given that the function has an inverse. F.BF.4d: Produce an invertible function from a non – invertible function by restricting the domain. F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Quarter 3	
Unit	Standard
Trigonometric Functions and The Unit Circle	F.TN.2 - Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. F.TN.3 - Use special triangles to determine geometrically the values of sine, cosine, and tangent for π/3, π /4, and π /6, and use the unit circle to express the values of sine, cosine, and tangent for x, π + x, and 2 π - x in terms of their values for x, where x is any real number.
Trigonometric Functions	F.TN.4 - Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

Conic Sections	F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems. G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
Quarter 4	
Unit	Standard
Cavalieri's Principle Random Variables and Expected Values	G - GMD.2. Give an informal argument using Cavalieri's Principle for the formulas for the volume of a sphere and other solid figures. S-MD.1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions. S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution. S-MD.3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes. S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households? S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant. b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

Wickliffe City Schools

Grade 11/12 Honors Pre-Calculus Mathematics-Pacing Guide

Quarter 1	
Unit	Standards
Complex Numbers	N-CN.3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers. N-CN.4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number. N-CN.5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. For example, $(-1 + \sqrt{3}\, i)3 = 8$ because $(-1 + \sqrt{3}\, i)$ has modulus 2 and argument 120°. N-CN.6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.
Vectors	N-VM.1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., v, |v|, ||v||, v). N-VM.2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. N-VM.3. (+) Solve problems involving velocity and other quantities that can be represented by vectors. N-VM.4. (+) Add and subtract vectors. b. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnit of a sum of two vectors is typically not the sum of the magnitudes. b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum. c. Understand vector subtraction v – w as v + (–w), where –w is the additive inverse of w, with the same pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the perform vector subtraction component-wise. N-VM.5. (+) Multiply a vector by a scalar. b. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as c(vx, vy) = (cvx, cvy). b. Compute the magnitude of a scalar multiple cv using ||cv|| = |c|v. Compute the direction of cv knowing that when |c|v ≠ 0, the direction of cv is either along v (for c > 0) or against v (for c < 0).
Quarter 2	
Unit	Standards
Matrices	A-REI.8. (+) Represent a system of linear equations as a single matrix equation in a vector variable. A-REI.9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using

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Inverse Functions	F.BF.1c: Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time. F.BF.4b: Verify by composition that one function is the inverse of another. F.BF.4c: Read values of an inverse function from a graph or a table, given that the function has an inverse. F.BF.4d: Produce an invertible function from a non – invertible function by restricting the domain. F-BF.5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

Quarter 3	
Unit	Standard
Trigonometric Functions and The Unit Circle	F.TN.2 - Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. F.TN.3 - Use special triangles to determine geometrically the values of sine, cosine, and tangent for $\pi/3$, $\pi/4$, and $\pi/6$, and use the unit circle to express the values of sine, cosine, and tangent for x, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.
Trigonometric Functions	F.TN.4 - Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. F-TF.6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.

Conic Sections	F-TF.7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. F-TF.9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems. G-GPE.3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.
Quarter 4	
Unit	Standard
Cavalieri's Principle Random Variables and Expected Values	G - GMD.2. Give an informal argument using Cavalieri's Principle for the formulas for the volume of a sphere and other solid figures. S-MD.1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions. S-MD.2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution. S-MD.3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes. S-MD.4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households? S-MD.5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values. a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant. b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.

AP Calculus AB/Honors Calculus
Syllabus

Course Overview
The goal of this course is to provide the students with the tools necessary to succeed in future mathematics courses. Students understand that they will work extremely hard in this class in order to succeed. We believe that students succeed in Calculus when they understand the reasons and meanings behind the concepts being taught. We stress the importance of understanding the concepts behind each topic and applying the concepts to each particular problem. If the students can understand the concept, they can apply it to a specific problem. We use a variety of instructional techniques and our hope is that these students will enjoy calculus and take the foundation that has been provided to them into their future mathematics courses.

Course Planner
Below is the sequence of our AP Calculus AB and Honors Calculus course.

Preparation for Calculus (Chapter P)
(2 weeks)
This is a review of pre-calculus material.

1. Graphs and Models
2. Linear Models and Rates of Change
3. Functions and their Graphs
4. Fitting Models to Data

Limits and Their Properties (Chapter 1)
(4 weeks)

1. What is Calculus?
2. Finding Limits Graphically and Numerically
3. Evaluating Limits Analytically
4. Continuity and One-Sided Limits
5. Infinite Limits

Differentiation (Chapter 2)
(3 Weeks)

1. The Derivative
2. Basic Differentiation Rules and Rates of Change
3. The Product and Quotient Rules and Higher Order Derivatives
4. The Chain Rule
5. Implicit Differentiation
6. Related Rates

Activity: World Population Activity

Applications of Differentiation (Chapter 3)
(4 Weeks)

1. Extrema on an Interval
2. Rolle's Theorem and the Mean Value Theorem
3. Increasing and Decreasing Functions and the Derivative
4. Concavity and the Second Derivative Test
5. Limits at Infinity
6. A Summary of Curve Sketching
7. Optimization Problems
8. Newton's Method
9. Differentials
10. Business and Economics Application

Integration (Chapter 4)
(3 Weeks)

1. Antiderivatives and Indefinite Integration
2. Area
3. Riemann Sums and Definite Integrals
4. The Fundamental Theorem of Calculus
5. Integration by Substitution
6. Numerical Integration

Activity: Area under a Curve Activity

Midterm Exam

February, 2014

Logarithmic, Exponential, and Other Transcendental Functions (Chapter 5)
(4 Weeks)

1. The Natural Logarithmic Function and Differentiation
2. The Natural Logarithmic Function and Integration
3. Inverse Functions
4. Exponential Functions: Differentiation and Integration
5. Bases Other than e and Applications
6. Differential Equations: Growth and Decay
7. Differential Equations: Separation of Variables
8. Inverse Trigonometric Functions and Differentiation
9. Inverse Trigonometric Functions and Integration
10. Hyperbolic Functions

Applications of Integration (Chapter 6)
(3 Weeks)

1. Area of a Region Between Two Curves
2. Volume: The Disc Method
3. Volume: The Shell Method
4. Arc Length and Surfaces of Revolution
5. Work
6. Moments, Centers of Mass, and Centroids
7. Fluid Pressure and Fluid Force

Integration Techniques, L'Hopital's Rule, and Improper Integrals (Chapter 7)
(4 Weeks)

1. Basic Integration Rules
2. Integration by Parts
3. Trigonometric Integrals
4. Trigonometric Substitution
5. Partial Fractions
6. Integration By Tables and Other Integration Techniques
7. Indeterminate Forms and L'Hopital's Rule
8. Improper Integrals

Infinite Series (Chapter 8)
(4 Weeks)

1. Sequences
2. Series and Convergence
3. The Integral Test and p-Series
4. Comparisons of Series
5. Alternating Series
6. Power Series
7. Taylor and Maclaurin Series

Conics, Parametric Equations, and Polar Coordinates (Chapter 9)
(3 Weeks)

1. Conics and Calculus
2. Plane Curves and Parametric Equations
3. Parametric Equations and Calculus
4. Polar Coordinates and Polar Graphs
5. Area and Arc Length in Polar Coordinates
6. Polar Equations of Conics and Kepler's Laws

Teaching Strategies

For most of these students, this class is taken during their senior year. They have taken honors classes throughout their high school years. This class is designed to prepare the students for the AP test at the end of the year and provide them with the necessary tools to be successful on this test as well as in future mathematics courses. As a teacher, I feel that it is important to work along side the students in this class. The students learn many of the concepts through the explorations and activities that are provided. Students are required to make good arguments in order to prove a mathematical concept and I feel that through cooperative learning with a teacher-assisted atmosphere, the students are given the most opportunity to be successful. I also set the standards high for this class. We feel that these students have stood out in mathematics and that the expectations should mimic the expectations of a college level class. Students are also aware of the availability in my schedule. I feel that as a teacher I need to be available for the students and that this is an essential part of this class.

Student Evaluation

Quarter grades in AP Calculus are computed by using homework, quizzes, tests, and other activities, such as projects, presentations, and writing assignments. Each quarter is worth 40 percent of the grade and the remaining 20 percent is assigned to the Exam at the end of each semester. I also supplement the class with multiple-choice questions and free-response questions from earlier AP exams as well as the additional text book (see below). Many times as a class we will review the questions on a daily basis to make sure that all students have an understanding of the concepts. The class is also supplemented with mock AP tests from previous tests and the additional resource from Amsco (see below).

Technology

The students are assigned a TI-82 graphing calculator to use throughout the year. Some of the students own their own calculators as well. Some students own TI-83 calculators and some students own TI-89 calculators. PowerPoint is also used as a technology supplement for several concepts throughout the year.

Primary Textbook

Larson, Roland, and Robert Hostetler. *Calculus of a Single Variable*. 6th ed. Boston, New York: Houghton Mifflin Company, 1998.

Additional Resources

Lifshitz, Maxine, and Martha Green. *Amsco's AP Calculus AB/BC. Preparing for the Advanced Placement Examinations*. New York: Amsco School Publications, Inc, 2004.

Student Activities

These are two of the activities that we do in AP Calculus. Both of these activities are cooperative group activities and both require a graphing calculator. These help the students understand these two topics as well as improving their calculator skills. They also require the

students to be able to use written and oral explanations of concepts. They draw connections to previous topics and understand how these concepts relate to real-life.

World Population Activity

This activity is used after discussing derivatives. The goal of this activity is to use a real-life example to determine estimates of the population and when it increased most rapidly. This activity allows the students to develop a scatter plot. This model is a logistic function and the students look at the end behavior. This activity also requires the use of the TI-82 or TI-83.

The students work in groups of four, with each member having a specific role. After they develop their ideas and conclusions from the population, they present their conclusions to the class. The students can use the overhead calculator to present and many use PowerPoint in their presentations. There is also a teacher-made rubric to assess the performance. Along with the rubric is a peer assessment form that the students complete to assess the members in their group for future activities.

Area under a Curve Activity

This activity is used when we start Riemann sums. The students go through finding the area of a curve using both right and left endpoints. They should determine that these are approximations of the area. This allows the students to make the connections between Riemann sums and integrals.

The students will work in groups of four to determine the solutions to these problems. Each group will have a different problem that they will explore and solve. After completion of the sums by going through the steps that I have developed for them, the groups will present their problem to the class as if they were teaching the lesson.

Following the presentations, my goal is to have the students write programs for their calculators. I will guide the students through programming for the Riemann sums. Following this, the students will develop their own programs for Midpoint Rule, Trapezoid Rule, and Simpson's Rule.