

Mathematics 8 to 12 IRP: Prescribed Learning Outcomes Using Pre-calculus Mathematics Pathway

Mathematical Processes (Integrated)

The following mathematical processes have been integrated within the prescribed learning outcomes and achievement indicators for all grades: communication [C], connections [CN], mental mathematics and estimation [ME], problem solving [PS], reasoning [R], technology [T], and visualization [V].

K to 9 Organizers	Grade 8	Grade 9	10 to 12 Organizers	Foundations of Mathematics and Pre-calculus 10	Pre-calculus 11	Pre-calculus 12
Number	<p>A1 demonstrate an understanding of perfect squares and square roots, concretely, pictorially, and symbolically (limited to whole numbers) [C, CN, R, V]</p> <p>A2 determine the approximate square root of numbers that are not perfect squares (limited to whole numbers) [C, CN, ME, R, T]</p> <p>A3 demonstrate an understanding of percents greater than or equal to 0% [CN, PS, R, V]</p> <p>A4 demonstrate an understanding of ratio and rate [C, CN, V]</p> <p>A5 solve problems that involve rates, ratios, and proportional reasoning [C, CN, PS, R]</p> <p>A6 demonstrate an understanding of multiplying and dividing positive fractions and mixed numbers, concretely, pictorially, and symbolically [C, CN, ME, PS]</p> <p>A7 demonstrate an understanding of multiplication and division of integers, concretely, pictorially, and symbolically [C, CN, PS, R, V]</p>	<p>A1 demonstrate an understanding of powers with integral bases (excluding base 0) and whole number exponents by</p> <ul style="list-style-type: none"> representing repeated multiplication using powers using patterns to show that a power with an exponent of zero is equal to one solving problems involving powers [C, CN, PS, R] <p>A2 demonstrate an understanding of operations on powers with integral bases (excluding base 0) and whole number exponents [C, CN, PS, R, T]</p> <p>A3 demonstrate an understanding of rational numbers by</p> <ul style="list-style-type: none"> comparing and ordering rational numbers solving problems that involve arithmetic operations on rational numbers [C, CN, PS, R, T, V] <p>A4 explain and apply the order of operations, including exponents, with and without technology [PS, T]</p> <p>A5 determine the square root of positive rational numbers that are perfect squares [C, CN, PS, R, T]</p> <p>A6 determine an approximate square root of positive rational numbers that are non-perfect squares [C, CN, PS, R, T]</p>	Algebra and Number	<p>B1 Demonstrate an understanding of factors of whole numbers by determining the:</p> <ul style="list-style-type: none"> prime factors greatest common factor least common multiple square root cube root. [CN, ME, R] <p>B2 Demonstrate an understanding of irrational numbers by:</p> <ul style="list-style-type: none"> representing, identifying and simplifying irrational numbers ordering irrational numbers. [CN, ME, R, V] <p>B3 Demonstrate an understanding of powers with integral and rational exponents. [C, CN, PS, R]</p> <p>B4 Demonstrate an understanding of the multiplication of polynomial expressions (limited to monomials, binomials and trinomials), concretely, pictorially and symbolically. [CN, R, V]</p> <p>B5 Demonstrate an understanding of common factors and trinomial factoring, concretely, pictorially and symbolically. [C, CN, R, V]</p>	<p>A1 Demonstrate an understanding of the absolute value of real numbers. [R, V]</p> <p>A2 Solve problems that involve operations on radicals and radical expressions with numerical and variable radicands. [CN, ME, PS, R, T]</p> <p>A3 Solve problems that involve radical equations (limited to square roots). [C, PS, R]</p> <p>A4 Determine equivalent forms of rational expressions (limited to numerators and denominators that are monomials, binomials or trinomials). [C, ME, R]</p> <p>A5 Perform operations on rational expressions (limited to numerators and denominators that are monomials, binomials or trinomials). [CN, ME, R]</p> <p>A6 Solve problems that involve rational equations (limited to numerators and denominators that are monomials, binomials or trinomials). [C, PS, R]</p>	
Patterns and Relations	B1 graph and analyse two-variable linear relations [C, ME, PS, R, T, V]	<p>B1 generalize a pattern arising from a problem-solving context using linear equations and verify by substitution [C, CN, PS, R, V]</p> <p>B2 graph linear relations, analyse the graph, and interpolate or extrapolate to solve problems [C, CN, PS, R, T, V]</p>	Relations and Functions	<p>C1 Interpret and explain the relationships among data, graphs and situations. [C, CN, R, T, V]</p> <p>C2 Demonstrate an understanding of relations and functions. [C, R, V]</p> <p>C3 Demonstrate an understanding of slope with respect to:</p> <ul style="list-style-type: none"> rise and run line segments and lines rate of change parallel lines perpendicular lines. [PS, R, V] <p>C4 Describe and represent linear relations, using:</p> <ul style="list-style-type: none"> words ordered pairs tables of values graphs equations. [C, CN, R, V] <p>C5 Determine the characteristics of the graphs of linear relations, including the:</p> <ul style="list-style-type: none"> intercepts slope domain range. [CN, PS, R, V] <p>C6 Relate linear relations expressed in:</p> <ul style="list-style-type: none"> slope-intercept form ($y = mx + b$) general form ($Ax + By + C = 0$) slope-point form ($y - y_1 = m(x - x_1)$) to their graphs. [CN, R, T, V] <p>C7 Determine the equation of a linear relation, given:</p> <ul style="list-style-type: none"> a graph a point and the slope two points a point and the equation of a parallel or perpendicular line to solve problems. [CN, PS, R, V] <p>C8 Represent a linear function, using function notation. [CN, ME, V]</p> <p>C9 Solve problems that involve systems of linear equations in two variables, graphically and algebraically. [CN, PS, R, T, V]</p>	<p>C1 Factor polynomial expressions of the form:</p> <ul style="list-style-type: none"> $ax^2 + bx + c, a \neq 0$ $a^2x^2 - b^2y^2, a \neq 0, b \neq 0$ $a(f(x))^2 + b(f(x)) + c, a \neq 0$ $a^2(f(x))^2 - b^2(g(y))^2, a \neq 0, b \neq 0$ <p>where a, b and c are rational numbers. [CN, ME, R]</p> <p>C2 Graph and analyze absolute value functions (limited to linear and quadratic functions) to solve problems. [C, PS, R, T, V]</p> <p>C3 Analyze quadratic functions of the form $y = a(x-p)^2 + q$ and determine the:</p> <ul style="list-style-type: none"> vertex domain and range direction of opening axis of symmetry x- and y-intercepts. [CN, R, T, V] <p>C4 Analyze quadratic functions of the form $y = ax^2 + bx + c$ to identify characteristics of the corresponding graph, including:</p> <ul style="list-style-type: none"> vertex domain and range direction of opening axis of symmetry x- and y-intercepts and to solve problems. [CN, PS, R, T, V] <p>C5 Solve problems that involve quadratic equations. [C, CN, PS, R, T, V]</p> <p>C6 Solve, algebraically and graphically, problems that involve systems of linear-quadratic and quadratic-quadratic equations in two variables. [CN, PS, R, T, V]</p> <p>C7 Solve problems that involve linear and quadratic inequalities in two variables. [C, PS, T, V]</p> <p>C8 Solve problems that involve quadratic inequalities in one variable. [CN, PS, V]</p> <p>C9 Analyze arithmetic sequences and series to solve problems. [CN, PS, R, T]</p> <p>C10 Analyze geometric sequences and series to solve problems. [PS, R, T]</p> <p>C11 Graph and analyze reciprocal functions (limited to the reciprocal of linear and quadratic functions). [CN, R, T, V]</p>	
Variables and Equations	B2 model and solve problems using linear equations of the form: <ul style="list-style-type: none"> $ax = b$ $\frac{x}{a} = b, a \neq 0$ $ax + b = c$ $a(x + b) = c$ <p>concretely, pictorially, and symbolically, where $a, b,$ and c are integers [C, CN, PS, V]</p>	<p>B3 model and solve problems using linear equations of the form</p> <ul style="list-style-type: none"> $ax = b$ $\frac{x}{a} = b, a \leq 0$ $ax + b = c$ $\frac{x}{a} + b = c, a \leq 0$ $ax = b + cx$ $a(x + b) = c$ $ax + b = cx + d$ $a(bx + c) = d(ex + f)$ $\frac{x}{a} = b, x \leq 0$ <p>where $a, b, c, d, e,$ and f are rational numbers [C, CN, PS, V]</p> <p>B4 explain and illustrate strategies to solve single variable linear inequalities with rational coefficients within a problem-solving context [C, CN, PS, R, V]</p> <p>B5 demonstrate an understanding of polynomials (limited to polynomials of degree less than or equal to 2) [C, CN, R, V]</p> <p>B6 model, record, and explain the operations of addition and subtraction of polynomial expressions, concretely, pictorially, and symbolically (limited to polynomials of degree less than or equal to 2) [C, CN, PS, R, V]</p> <p>B7 model, record, and explain the operations of multiplication and division of polynomial expressions (limited to polynomials of degree less than or equal to 2) by monomials, concretely, pictorially, and symbolically [C, CN, R, V]</p>	<p>B1 Demonstrate an understanding of operations on, and compositions of, functions. [CN, R, T, V]</p> <p>B2 Demonstrate an understanding of the effects of horizontal and vertical translations on the graphs of functions and their related equations. [C, CN, R, V]</p> <p>B3 Demonstrate an understanding of the effects of horizontal and vertical stretches on the graphs of functions and their related equations. [C, CN, R, V]</p> <p>B4 Apply translations and stretches to the graphs and equations of functions. [C, CN, R, V]</p> <p>B5 Demonstrate an understanding of the effects of reflections on the graphs of functions and their related equations, including reflections through the:</p> <ul style="list-style-type: none"> x-axis y-axis line $y = x$. [C, CN, R, V] <p>B6 Demonstrate an understanding of inverses of relations. [C, CN, R, V]</p> <p>B7 Demonstrate an understanding of logarithms. [CN, ME, R]</p> <p>B8 Demonstrate an understanding of the product, quotient and power laws of logarithms. [C, CN, R, T]</p> <p>B9 Graph and analyze exponential and logarithmic functions. [C, CN, T, V]</p> <p>B10 Solve problems that involve exponential and logarithmic equations. [C, CN, PS, R]</p> <p>B11 Demonstrate an understanding of factoring polynomials of degree greater than 2 (limited to polynomials of degree ≤ 5 with integral coefficients). [C, CN, ME]</p> <p>B12 Graph and analyze polynomial functions (limited to polynomial functions of degree ≤ 5). [C, CN, T, V]</p> <p>B13 Graph and analyze radical functions (limited to functions involving one radical). [CN, R, T, V]</p> <p>B14 Graph and analyze rational functions (limited to numerators and denominators that are monomials, binomials or trinomials). [CN, R, T, V]</p>			



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K to 9 Organizers	Grade 8	Grade 9	10 to 12 Organizers	Foundations of Mathematics and Pre-calculus 10	Pre-calculus 11	Pre-calculus 12
Shape and Space Measurement	C1 develop and apply the Pythagorean theorem to solve problems [CN, PS, R, V, T] C2 draw and construct nets for 3-D objects [C, CN, PS, V] C3 determine the surface area of <ul style="list-style-type: none"> right rectangular prisms right triangular prisms right cylinders to solve problems [C, CN, PS, R, V] C4 develop and apply formulas for determining the volume of right prisms and right cylinders [C, CN, PS, R, V]	C1 solve problems and justify the solution strategy using circle properties, including <ul style="list-style-type: none"> the perpendicular from the centre of a circle to a chord bisects the chord the measure of the central angle is equal to twice the measure of the inscribed angle subtended by the same arc the inscribed angles subtended by the same arc are congruent a tangent to a circle is perpendicular to the radius at the point of tangency [C, CN, PS, R, T, V] 	Measurement	A1 Solve problems that involve linear measurement, using: <ul style="list-style-type: none"> SI and imperial units of measure estimation strategies measurement strategies. [ME, PS, V] A2 Apply proportional reasoning to problems that involve conversions between SI and imperial units of measure. [C, ME, PS] A3 Solve problems, using SI and imperial units, that involve the surface area and volume of 3-D objects, including: <ul style="list-style-type: none"> right cones right cylinders right prisms right pyramids spheres. [CN, PS, R, V] A4 Develop and apply the primary trigonometric ratios (sine, cosine, tangent) to solve problems that involve right triangles. [C, CN, PS, R, T, V]		
3-D Objects and 2-D Shapes	C5 draw and interpret top, front, and side views of 3-D objects composed of right rectangular prisms [C, CN, R, T, V]	C2 determine the surface area of composite 3-D objects to solve problems [C, CN, PS, R, V] C3 demonstrate an understanding of similarity of polygons [C, CN, PS, R, V]	Trigonometry		B1 Demonstrate an understanding of angles in standard position $[0^\circ$ to $360^\circ]$. [R, V] B2 Solve problems, using the three primary trigonometric ratios for angles from 0° to 360° in standard position. [C, ME, PS, R, T, V] B3 Solve problems, using the cosine law and sine law, including the ambiguous case. [C, CN, PS, R, T]	A1 Demonstrate an understanding of angles in standard position, expressed in degrees and radians. [CN, ME, R, V] A2 Develop and apply the equation of the unit circle. [CN, R, V] A3 Solve problems, using the six trigonometric ratios for angles expressed in radians and degrees. [ME, PS, R, T, V] A4 Graph and analyze the trigonometric functions sine, cosine and tangent to solve problems. [CN, PS, T, V] A5 Solve, algebraically and graphically, first and second degree trigonometric equations with the domain expressed in degrees and radians. [CN, PS, R, T, V] A6 Prove trigonometric identities, using: <ul style="list-style-type: none"> reciprocal identities quotient identities Pythagorean identities sum or difference identities (restricted to sine, cosine and tangent) double-angle identities (restricted to sine, cosine and tangent). [R, T, V]
Transformations	C6 demonstrate an understanding of tessellation by <ul style="list-style-type: none"> explaining the properties of shapes that make tessellating possible creating tessellations identifying tessellations in the environment [C, CN, PS, T, V] 	C4 draw and interpret scale diagrams of 2-D shapes [CN, R, T, V] C5 demonstrate an understanding of line and rotation symmetry [C, CN, PS, V]				
Statistics and Probability Data Analysis	D1 critique ways in which data is presented [C, R, T, V]	D1 describe the effect of <ul style="list-style-type: none"> bias use of language ethics cost time and timing privacy cultural sensitivity on the collection of data [C, CN, R, T] D2 select and defend the choice of using either a population or a sample of a population to answer a question [C, CN, PS, R] D3 develop and implement a project plan for the collection, display, and analysis of data by <ul style="list-style-type: none"> formulating a question for investigation choosing a data collection method that includes social considerations selecting a population or a sample collecting the data displaying the collected data in an appropriate manner drawing conclusions to answer the question [C, PS, R, T, V] 	Permutations, Combinations and Binomial Theorem			C1 Apply the fundamental counting principle to solve problems. [C, PS, R, V] C2 Determine the number of permutations of n elements taken r at a time to solve problems. [C, PS, R, V] C3 Determine the number of combinations of n different elements taken r at a time to solve problems. [C, PS, R, V] C4 Expand powers of a binomial in a variety of ways, including using the binomial theorem (restricted to exponents that are natural numbers). [CN, R, V]
Chance and Uncertainty	D2 solve problems involving the probability of independent events [C, CN, PS, T]	D4 demonstrate an understanding of the role of probability in society [C, CN, R, T]				

