General and Specific Learning Outcomes by Strand
Pre-Calculus Mathematics

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Number

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Develop number sense.	General Learning Outcome Develop number sense.			
Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes
8.N.1. Demonstrate an understanding of perfect squares and square roots, concretely, pictorially, and symbolically (limited to whole numbers). [C, CN, R, V] 8.N 2. Determine the approximate square root of numbers that are not perfect squares (limited to whole numbers). [C, CN, ME, R, T] 8.N 3. Demonstrate an understanding of percents greater than or equal to 0%. [CN, PS, R, V] 8.N 4. Demonstrate an understanding of ratio and rate. [C, CN, V] 8.N 5. Solve problems that involve rates, ratios, and proportional reasoning. [C, CN, PS, R]	9.N.1. Demonstrate an understanding of powers with integral bases (excluding base 0) and whole-number exponents by ■ 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, ME, PS, R] 9.N.2. Demonstrate an understanding of operations on powers with integral bases (excluding base 0) and whole-number exponents. [C, CN, ME, PS, R, T]	10I.A.1. Demonstrate an understanding of factors of whole numbers by determining ■ prime factors ■ greatest common factor ■ least common multiple ■ square root ■ cube root [CN, ME, R] 10I.A.2. Demonstrate an understanding of irrational numbers by ■ representing, identifying, and simplifying irrational numbers ■ ordering irrational numbers [CN, ME, R, V] 10I.A.3. Demonstrate an understanding of powers with integral and rational exponents. [C, CN, PS, R]	11P.A.1. Demonstrate an understanding of the absolute value of real numbers. [ME, R, V] 11P.A.2. Solve problems that involve operations on radicals and radical expressions with numerical and variable radicands. [CN, ME, PS, R, T]	12P.P.1 Apply the fundamental counting principle to solve problems. [C, CN, PS, R, V] 12P.P.2. Determine the number of permutations of n elements taken r at a time to solve problems. [C, PS, R, V] 12P.P.3. Determine the number of combinations of n different elements taken r at a time to solve problems. [C, PS, R, V]

Pre-Calculus Mathematics

Number *(continued)*

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Develop number sense.	General Learning Outcome Develop number sense.			
Specific Learning Outcomes	Specific Learning Outcomes			
8.N.6. Demonstrate an understanding of multiplying and dividing positive fractions and mixed numbers, concretely, pictorially, and symbolically. [C, CN, ME, PS] 8.N.7. Demonstrate an understanding of multiplication and division of integers, concretely, pictorially, and symbolically. [C, CN, PS, R, V] 8.N.8. Solve problems involving positive rational numbers. [C, CN, ME, PS, R, T, V]	9.N.3. Demonstrate an understanding of rational numbers by ■ comparing and ordering rational numbers ■ solving problems that involve arithmetic operations on rational numbers [C, CN, ME, PS, R, T, V] 9.N.4. Explain and apply the order of operations, including exponents, with and without technology. [ME, PS, T] 9.N.5. Determine the square root of positive rational numbers that are perfect squares. [C, CN, ME, PS, R, T] 9.N.6. Determine an approximate square root of positive rational numbers that are non-perfect squares. [C, CN, ME, PS, R, T]			

Pre-Calculus Mathematics

Patterns and Relations (Patterns)

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics	[T]	Technology
	and Estimation	[V]	Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Use patterns to describe the world and solve problems.	**General Learning Outcome** Use patterns to describe the world and solve problems.			
Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes
8.PR.1. Graph and analyze two-variable linear equations. [C, ME, PS, R, T, V]	9.PR.1. Generalize a pattern arising from a problem-solving context using linear equations, and verify by substitution. [C, CN, PS, R, V] 9.PR.2. Graph linear relations, analyze the graph, and interpolate or extrapolate to solve problems. [C, CN, ME, PS, R, T, V]	10I.R.1. Interpret and explain the relationships among data, graphs, and contexts. [C, CN, R, T, V]	11P.R.9. Analyze arithmetic sequences and series to solve problems. [C, CN, PS, R, T] 11P.R.10. Analyze geometric sequences and series to solve problems. [C, CN, PS, R, T]	12P.T.6. Prove trigonometric identities, using ■ 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) [C, R, T, V]

Pre-Calculus Mathematics

Patterns and Relations (Variables and Equations)

[C] Communication	**[PS]** Problem Solving	
[CN] Connections	**[R]** Reasoning	
[ME] Mental Mathematics and Estimation	**[T]** Technology	
	[V] Visualization	

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Represent algebraic expressions in multiple ways.	**General Learning Outcome** Represent algebraic expressions in multiple ways.			
Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes
8.PR.2. Model and solve problems using linear equations of the form ■ $ax = b$ ■ $\frac{x}{a} = b, a \neq 0$ ■ $ax + b = c$ ■ $\frac{x}{a} + b = c, a \neq 0$ ■ $a(x + b) = c$ concretely, pictorially, and symbolically, where a, b, and c are integers. [C, CN, PS, V]	9.PR.3. Model and solve problems using linear equations of the form ■ $ax = b$ ■ $ax + b = c$ ■ $ax = b + cx$ ■ $a(x + b) = c$ ■ $ax + b = cx + d$ ■ $a(bx + c) = d(ex + f)$ ■ $\frac{a}{x} = b, x \neq 0$ where a, b, c, d, e, and f are rational numbers. [C, CN, ME, PS, V] 9.PR.4. Explain and illustrate strategies to solve single variable linear inequalities with rational number coefficients within a problem-solving context. [C, CN, ME, PS, R, V]	10I.A.3. Demonstrate an understanding of powers with integral and rational exponents. [C, CN, PS, R] 10I.A.4. Demonstrate an understanding of the multiplication of polynomial expressions (limited to monomials, binomials, and trinomials), concretely, pictorially, and symbolically. [C, CN, R, V] 10I.A.5. Demonstrate an understanding of common factors and trinomial factoring, concretely, pictorially, and symbolically. [C, CN, R, V]	11P.A.2. Solve problems that involve operations on radicals and radical expressions with numerical and variable radicands. [CN, ME, PS, R, T] 11P.A.3. Solve problems that involve radical equations (limited to square roots). [C, CN, PS, R, T] 11P.A.4. Determine equivalent forms of rational expressions (limited to numerators and denominators that are monomials, binomials, or trinomials). [C, ME, R] 11P.A.5. Perform operations on rational expressions (limited to numerators and denominators that are monomials, binomials, or trinomials). [C, CN, ME, R]	12P.P.4. Expand powers of a binomial in a variety of ways, including using the binomial theorem (restricted to exponents that are natural numbers). [C, CN, R, V] 12P.T.5. Solve, algebraically and graphically, first and second degree trigonometric equations with the domain expressed in degrees and radians. [C, CN, PS, R, T, V]

Pre-Calculus Mathematics

Patterns and Relations (Variables and Equations) *(continued)*

	[C] Communication	[PS] Problem Solving
	[CN] Connections	[R] Reasoning
	[ME] Mental Mathematics and Estimation	[T] Technology
		[V] Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
	General Learning Outcome Represent algebraic expressions in multiple ways.			
	Specific Learning Outcomes		Specific Learning Outcomes	
	9.PR.5. Demonstrate an understanding of polynomials (limited to polynomials of degree less than or equal to 2). [C, CN, R, V] 9.PR.6. 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, ME, PS, R, V] 9.PR.7. 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]		11P.A.6. Solve problems that involve rational equations (limited to numerators and denominators that are monomials, binomials, or trinomials). [C, CN, PS, R] 11P.R.1. Factor polynomial expressions of the form ■ $ax^2 + bx + c, a \neq 0$ ■ $a^2x^2 - b^2y^2, a \neq 0, b \neq 0$ ■ $a(f(x))^2 + b(f(x)) + c, a \neq 0$ ■ $a^2(f(x))^2 - b^2(g(y))^2, a \neq 0, b \neq 0$ where a, b, and c are rational numbers. [ME, R]	

Pre-Calculus Mathematics

Patterns and Relations (Relations and Functions)

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
		Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes
		10I.R.1. Interpret and explain the relationships among data, graphs, and contexts. [C, CN, R, T, V] 10I.R.2. Demonstrate an understanding of relations and functions. [C, R, V] 10I.R.3. Demonstrate an understanding of slope with respect to ■ rise and run ■ line segments and lines ■ rate of change ■ parallel lines ■ perpendicular lines [PS, R, V]	11P.R.2. Graph and analyze absolute value functions (limited to linear and quadratic functions) to solve problems. [C, PS, R, T, V] 11P.R.3. Analyze quadratic functions of the form $y = a(x - p)^2 + q$ and determine the ■ vertex ■ domain and range ■ direction of opening ■ axis of symmetry ■ x- and y-intercepts [C, CN, R, T, V]	12P.T.2. Develop and apply the equation of the unit circle. [CN, R, V] 12P.T.3. Solve problems, using the six trigonometric ratios for angles expressed in radians and degrees. [C, ME, PS, R, T, V] 12P.T.4. Graph and analyze the trigonometric functions sine, cosine, and tangent to solve problems. [C, CN, PS, T, V]

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
		Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes
		10I.R.4. Describe and represent linear relations, using ■ words ■ ordered pairs ■ tables of values ■ graphs ■ equations [C, CN, R, V] 10I.R.5. Determine the characteristics of the graphs of linear relations, including the ■ intercepts ■ slope ■ domain ■ range [CN, PS, R, T, V]	11P.R.4. Analyze quadratic functions of the form $y = ax^2 + bx + c$ to identify characteristics of the corresponding graph, including ■ vertex ■ domain and range ■ direction of opening ■ axis of symmetry ■ x- and y-intercepts [C, CN, PS, R, T, V] 11P.R.5. Solve problems that involve quadratic equations. [C, CN, PS, R, T, V] 11P.R.6. Solve, algebraically and graphically, problems that involve systems of linear-quadratic and quadratic-quadratic equations in two variables. [C, CN, PS, R, T, V]	12P.R.1. Demonstrate an understanding of operations on, and compositions of, functions. [CN, R, T, V] 12P.R.2. Demonstrate an understanding of the effects of horizontal and vertical translations on the graphs of functions and their related equations. [C, CN, R, V] 12P.R.3. Demonstrate an understanding of the effects of horizontal and vertical compressions and stretches on the graphs of functions and their related equations. [C, CN, R, V] 12P.R.4. Apply translations, compressions, and stretches to the graphs and equations of functions. [C, CN, R, V]

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
		Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes
		10I.R.6. Relate linear relations expressed in ■ 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. [C, CN, R, T, V] 10I.R.7. Determine the equation of a linear relation, given ■ a graph ■ a point and the slope ■ two points ■ a point and the equation of a parallel or perpendicular line ■ a scatterplot [C, CN, PS, R, T, V]	11P.R.7. Solve problems that involve linear and quadratic inequalities in two variables. [C, PS, T, V] 11P.R.8. Solve problems that involve quadratic inequalities in one variable. [CN, PS, V] 11P.R.11. Graph and analyze reciprocal functions (limited to the reciprocal of linear and quadratic functions). [CN, R, T, V]	12P.R.5. Demonstrate an understanding of the effects of reflections on the graphs of functions and their related equations, including reflections through the ■ x-axis ■ y-axis ■ line $y = x$ [C, CN, R, V] 12P.R.6. Demonstrate an understanding of inverses of relations. [C, CN, R, V] 12P.R.7. Demonstrate an understanding of logarithms. [C, CN, ME, R]

Pre-Calculus Mathematics

Patterns and Relations (Relations and Functions) *(continued)*

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
		Specific Learning Outcomes		Specific Learning Outcomes
		10I.R.8. Represent a linear function, using function notation. [CN, ME, V]		12P.R.8. Demonstrate an understanding of the product, quotient, and power laws of logarithms. [C, CN, R, T]
		10I.R.9. Solve problems that involve systems of linear equations in two variables, graphically and algebraically. [CN, PS, R, T, V]		12P.R.9. Graph and analyze exponential and logarithmic functions. [C, CN, T, V]
		10I.R.10. Solve problems that involve the distance between two points and the midpoint of a line segment. [C, CN, PS, V]		12P.R.10. Solve problems that involve exponential and logarithmic equations. [C, CN, PS, R]
				12P.R.11. Demonstrate an understanding of factoring polynomials of degree greater than 2 (limited to polynomials of degree ≤ 5 with integral coefficients). [C, CN, ME]

Pre-Calculus Mathematics

Patterns and Relations (Relations and Functions) *(continued)*

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12

Specific Learning Outcomes

12P.R.12. Graph and analyze polynomial functions (limited to polynomial functions of degree ≤ 5).
[C, CN, PS, T, V]

12P.R.13. Graph and analyze radical functions (limited to functions involving one radical).
[C, CN, R, T, V]

12P.R.14. Graph and analyze rational functions (limited to numerators and denominators that are monomials, binomials, or trinomials).
[C, CN, R, T, V]

Pre-Calculus Mathematics

Shape and Space (Measurement)

[C] Communication	**[PS]** Problem Solving	
[CN] Connections	**[R]** Reasoning	
[ME] Mental Mathematics and Estimation	**[T]** Technology	
	[V] Visualization	

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Use direct or indirect measurement to solve problems.	**General Learning Outcome** Use direct or indirect measurement to solve problems.			
Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes
8.SS.1. Develop and apply the Pythagorean theorem to solve problems. [CN, PS, R, T, V] 8.SS.2. Draw and construct nets for 3-D objects. [C, CN, PS, V] 8.SS.3. Determine the surface area of ■ right rectangular prisms ■ right triangular prisms ■ right cylinders to solve problems. [C, CN, PS, R, V] 8.SS.4. Develop and apply formulas for determining the volume of right prisms and right cylinders. [C, CN, PS, R, V]	9.SS.1. Solve problems and justify the solution strategy using circle properties, including ■ 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]	10I.M.1. Solve problems that involve linear measurement, using ■ SI and imperial units of measure ■ estimation strategies ■ measurement strategies [ME, PS, V] 10I.M.2. Apply proportional reasoning to problems that involve conversions between SI and imperial units of measure. [C, ME, PS, T]	11P.T.1. Demonstrate an understanding of angles in standard position [0° to 360°]. [C, R, V] 11P.T.2. Solve problems, using the three primary trigonometric ratios (sine, cosine, and tangent) for angles from 0° to 360° in standard position. [C, ME, PS, R, T, V] 11P.T.3. Solve problems, using the cosine law and sine law, including the ambiguous case. [C, CN, PS, R, T]	12P.T.1. Demonstrate an understanding of angles in standard position, expressed in degrees and radians. [CN, ME, R, V]

Pre-Calculus Mathematics

Shape and Space (3-D Objects and 2-D Shapes)

[C]	Communication	**[PS]** Problem Solving
[CN]	Connections	**[R]** Reasoning
[ME]	Mental Mathematics and Estimation	**[T]** Technology
		[V] Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationships among them.	**General Learning Outcome** Describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationships among them.			
Specific Learning Outcomes	Specific Learning Outcomes	Specific Learning Outcomes		
8.SS.5. Draw and interpret top, front, and side views of 3-D objects composed of right rectangular prisms. [C, CN, R, T, V]	9.SS.2. Determine the surface area of composite 3-D objects to solve problems. [C, CN, ME, PS, R, V] 9.SS.3. Demonstrate an understanding of similarity of polygons. [C, CN, PS, R, T, V]	10I.M.3. Solve problems, using SI and imperial units, that involve the surface area and volume of 3-D objects, including ■ right cones ■ right cylinders ■ right prisms ■ right pyramids ■ spheres [CN, PS, R, T, V] 10I.M.4. Develop and apply the primary trigonometric ratios (sine, cosine, tangent) to solve problems that involve right triangles. [C, CN, PS, R, T, V]		

Pre-Calculus Mathematics

Shape and Space (Transformations)

[C] Communication	**[PS]** Problem Solving	
[CN] Connections	**[R]** Reasoning	
[ME] Mental Mathematics and Estimation	**[T]** Technology	
	[V] Visualization	

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Describe and analyze position and motion of objects and shapes.	General Learning Outcome Describe and analyze position and motion of objects and shapes.			
Specific Learning Outcomes	Specific Learning Outcomes			
8.SS.6. Demonstrate an understanding of tessellation by ■ explaining the properties of shapes that make tessellating possible ■ creating tessellations ■ identifying tessellations in the environment [C, CN, PS, T, V]	9.SS.4. Draw and interpret scale diagrams of 2-D shapes. [CN, R, T, V] 9.SS.5. Demonstrate an understanding of line and rotation symmetry. [C, CN, PS, V]			

Pre-Calculus Mathematics

Statistics and Probability (Data Analysis)

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Collect, display, and analyze data to solve problems.	**General Learning Outcome** Collect, display, and analyze data to solve problems.			
Specific Learning Outcomes	Specific Learning Outcomes			
8.SP.1. Critique ways in which data are presented. [C, R, T, V]	9.SP.1. Describe the effect of • bias • use of language • ethics • cost • time and timing • privacy • cultural sensitivity on the collection of data. [C, CN, R, T] 9.SP.2. Select and defend the choice of using either a population or a sample of a population to answer a question. [C, CN, PS, R]			

Pre-Calculus Mathematics

Statistics and Probability (Data Analysis) *(continued)*

[C]	Communication	[PS]	Problem Solving
[CN]	Connections	[R]	Reasoning
[ME]	Mental Mathematics and Estimation	[T]	Technology
		[V]	Visualization

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
	General Learning Outcome Collect, display, and analyze data to solve problems.			
	Specific Learning Outcomes			
	9.SP. 3. Develop and implement a project plan for the collection, display, and analysis of data by ■ 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]			

Pre-Calculus Mathematics

Statistics and Probability (Chance and Uncertainty)

Grade 8	Grade 9	Grade 10	Grade 11	Grade 12
General Learning Outcome Use experimental or theoretical probabilities to represent and solve problems involving uncertainty.	**General Learning Outcome** Use experimental or theoretical probabilities to represent and solve problems involving uncertainty.			
Specific Learning Outcomes	Specific Learning Outcomes			
8.SP.2. Solve problems involving the probability of independent events. [C, CN, PS, T]	9.SP.4. Demonstrate an understanding of the role of probability in society. [C, CN, R, T]			