**Area of Learning: MATHEMATICS — Pre-calculus Grade 12**

**BIG IDEAS**

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| Using **inverses** is the foundation of solving equations and can be extended to relationships between functions. |  | Understanding the characteristics of families of **functions** allows us to model and understand relationshipsand to build connections between classes of functions. |  | **Transformations** of shapes extend to functions and relations in all of their representations. |

**Learning Standards**

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| **Curricular Competencies** | **Content** |
| *Students are expected to do the following:*  Reasoning and modelling   * Develop **thinking strategies** to solve puzzles and play games * Explore, **analyze**, and apply mathematical ideas using **reason**, **technology**, and **other tools** * **Estimate reasonably** and demonstrate **fluent, flexible, and strategic** thinking about number * **Model** with mathematics in **situational contexts** * **Think** **creatively** and with **curiosity and wonder** when exploring problems   Understanding and solving   * Develop, demonstrate, and apply conceptual understanding of mathematical ideas through play, story, **inquiry**, and problem solving * **Visualize** to explore and illustrate mathematical concepts and relationships * Apply **flexible and strategic approaches** to **solve problems** * Solve problems with **persistence and a positive disposition** * Engage in problem-solving experiences **connected** with place, story, cultural practices, and perspectives relevant to local First Peoples communities, the local community, and other cultures | *Students are expected to know the following:*   * **transformations** of functions and relations * **exponential** functions and equations * **geometric** sequences andseries * **logarithms:** operations, functions, and equations * **polynomial** functions and equations * **rational** functions * **trigonometry:** functions, equations, and identities |

**Area of Learning: MATHEMATICS — Pre-calculus Grade 12**

**Learning Standards (continued)**

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| **Curricular Competencies** | **Content** |
| Communicating and representing   * **Explain and justify** mathematical ideas and **decisions** in **many ways** * **Represent** mathematical ideas in concrete, pictorial, and symbolic forms * Use mathematical vocabulary and language to contribute to **discussions** in the classroom * Take risks when offering ideas in classroom **discourse**   Connecting and reflecting   * **Reflect** on mathematical thinking * **Connect mathematical concepts** with each other, other areas, and personal interests * Use **mistakes** as **opportunities to advance learning** * **Incorporate** First Peoples worldviews, perspectives, **knowledge**, and **practices** to makeconnections with mathematical concepts |  |

| **MATHEMATICS – Pre-calculus  Big Ideas – Elaborations Grade 12** |
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| * **inverses:**   + *undo* the operations within an expression or function to reduce the expression to an identity (e.g., *x* = )   *Sample questions to support inquiry with students:*   * + How can the inverse help to solve an equation?   + How is solving an equation related to identifying the specific input for a function, given a specific output?   + How are exponential and l­­­ogarithmic functions related?   + How are the laws of exponents connected to the laws of logarithms?   + What are some other examples of inversely related functions?   + How are inverses related graphically, and why?   + How is solving an exponential equation similar to solving a trigonometric equation?   + How are inverse operations related to solving a polynomial equation by factoring?   + What is the value of using trigonometric identities to find equivalent expressions?   + Why do some equations have extraneous roots and other equations do not? * **functions:**   *Sample questions to support inquiry with students:*   * + How do we decide which kind of function to use to model a given problem?   + What do functions and relations look like beyond the visible axes?   + A set of data looks like a parabola, but it is not. What function could be used to model this data?   + What does the number of zeros tell us about a function?   + What connections do we see within the characteristics of a particular class of function? * **Transformations:**   *Sample questions to support inquiry with students:*   * + How can we tell whether a transformation will have invariant points?   + Under what circumstances will different transformations produce the same result?   + How do graphical transformations affect the tables of values?   + How does a transformation affect a point found at the origin as compared to a point on an axis or a point in one of the four quadrants?   + How can a rational function of the form be considered as a transformation of the reciprocal function ? |

| **MATHEMATICS – Pre-calculus  Curricular Competencies – Elaborations Grade 12** |
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| * **thinking strategies:**   + using reason to determine winning strategies   + generalizing and extending * **analyze:**   + examine the structure of and connections between mathematical ideas (e.g., exponential functions to geometric sequences) * **reason:**   + inductive and deductivereasoning   + predictions, generalizations, conclusions drawn from experiences (e.g., with puzzles, games, and coding) * **technology:**   + graphing technology, dynamic geometry, calculators, virtual manipulatives, concept-based apps   + can be used to for a wide variety of purposes, including:     - exploring and demonstrating mathematical relationships     - organizing and displaying data     - generating and testing inductive conjectures     - mathematical modelling * **other tools:**   + manipulatives such as algebra tiles and other concrete materials * **Estimate reasonably:**   + be able to defend the reasonableness of an estimated value or a solution to a problem or equation (e.g., the zeros of a graphed polynomial function) * **fluent, flexible and strategic thinking:**   + includes:     - using known facts and benchmarks, partitioning, applying whole number strategies to rational numbers and algebraic expressions     - choosing from different ways to think of a number or operation (e.g., Which will be the most strategic or efficient?) * **Model:**   + use mathematical concepts and tools to solve problems and make decisions (e.g., in real-life and/or abstract scenarios)   + take a complex, essentially non-mathematical scenario and figure out what mathematical concepts and tools are needed to make sense of it * **situational contexts:**   + including real-life scenarios and open-ended challenges that connect mathematics with everyday life * **Think creatively:**   + by being open to trying different strategies   + refers to creative and innovative mathematical thinking rather than to representing math in a creative way, such as through art or music * **curiosity and wonder:**   + asking questions to further understanding or to open other avenues of investigation * **inquiry:**   + includes structured, guided, and open inquiry   + noticing and wondering   + determining what is needed to make sense of and solve problems * **Visualize:**   + create and use mental images to support understanding   + Visualization can be supported using dynamic materials (e.g., graphical relationships and simulations), concrete materials, drawings,  and diagrams. * **flexible and strategic approaches:**   + deciding which mathematical tools to use to solve a problem   + choosing an effective strategy to solve a problem (e.g., guess and check, model, solve a simpler problem, use a chart, use diagrams,  role-play) * **solve problems:**   + interpret a situation to identify a problem   + apply mathematics to solve the problem   + analyze and evaluate the solution in terms of the initial context   + repeat this cycle until a solution makes sense * **persistence and a positive disposition:**   + not giving up when facing a challenge   + problem solving with vigour and determination * **connected:**   + through daily activities, local and traditional practices, popular media and news events, cross-curricular integration   + by posing and solving problems or asking questions about place, stories, and cultural practices * **Explain and justify:**   + use mathematical arguments to convince   + includes anticipating consequences * **decisions:**   + Have students explore which of two scenarios they would choose and then defend their choice. * **many ways:**   + including oral, written, visual, use of technology * **Represent:**   + using models, tables, graphs, words, numbers, symbols   + connecting meanings among various representations * **discussions:**   + partner talks, small-group discussions, teacher-student conferences * **discourse:**   + is valuable for deepening understanding of concepts   + can help clarify students’ thinking, even if they are not sure about an idea or have misconceptions * **Reflect:**   + share the mathematical thinking of self and others, including evaluating strategies and solutions, extending, posing new problems and questions * **Connect mathematical concepts:**   + to develop a sense of how mathematics helps us understand ourselves and the world around us (e.g., daily activities, local and traditional practices, popular media and news events, social justice, cross-curricular integration) * **mistakes:**   + range from calculation errors to misconceptions * **opportunities to advance learning:**   + by:     - analyzing errors to discover misunderstandings     - making adjustments in further attempts     - identifying not only mistakes but also parts of a solution that are correct * **Incorporate:**   + by:     - collaborating with Elders and knowledge keepers among local First Peoples     - exploring the [First Peoples Principles of Learning](http://www.fnesc.ca/wp/wp-content/uploads/2015/09/PUB-LFP-POSTER-Principles-of-Learning-First-Peoples-poster-11x17.pdf) (e.g., Learning is holistic, reflexive, reflective, experiential, and relational [focused on connectedness, on reciprocal relationships, and a sense of place]; Learning involves patience and time)     - making explicit connections with learning mathematics     - exploring cultural practices and knowledge of local First Peoples and identifying mathematical connections * **knowledge:**   + local knowledge and cultural practices that are appropriate to share and that are non-appropriated * **practices:**   + [Bishop’s cultural practices](http://www.csus.edu/indiv/o/oreyd/ACP.htm_files/abishop.htm): counting, measuring, locating, designing, playing, explaining   + [Aboriginal Education Resources](http://www.aboriginaleducation.ca/)   + [*Teaching Mathematics in a First Nations Context*,](http://www.fnesc.ca/resources/math-first-peoples/) FNESC |

| **MATHEMATICS – Pre-calculus  Content – Elaborations Grade 12** |
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| * **transformations:**   + of graphs and equations of parent functions and relations (e.g., absolute value, radical, reciprocal, conics, exponential, logarithmic, trigonometric)   + vertical and horizontal translations, stretches, and reflections   + inverses: graphs and equations   + extension:     - recognizing composed functions (e.g., )     - operations on functions * **exponential:**    + graphing, including transformations   + solving equations with same base and with different bases, including base *e*   + solving problems in situational contexts * **geometric:**   + common ratio, first term, general term   + geometric sequences connecting to exponential functions   + infinite geometric series   + sigma notation * **logarithms:**   + applying laws of logarithms   + evaluating with different bases   + using common and natural logarithms   + exploring inverse of exponential   + graphing, including transformations   + solving equations with same base and with different bases   + solving problems in situational contexts * **polynomial:**   + factoring, including the factor theorem and the remainder theorem   + graphing and the characteristics of a graph (e.g., degree, extrema, zeros, end-behaviour)   + solving equations algebraically and graphically * **rational:**   + characteristics of graphs, including asymptotes, intercepts, point discontinuities, domain, end-behaviour * **trigonometry:**    + examining angles in standard position in both radians and degrees   + exploring unit circle, reference and coterminal angles, special angles   + graphing primary trigonometric functions, including transformations and characteristics   + solving first- and second-degree equations (over restricted domains and all real numbers)   + solving problems in situational contexts   + using identities to reduce complexity in expressions and solve equations (e.g., Pythagorean, quotient, double angle, reciprocal,  sum and difference) |