MATHEMATICS GRADES 10–12

INTRODUCTION

The Mathematics Grades 10–12 Program of Studies has been derived from *The Common Curriculum Framework for Grades 10–12 Mathematics: Western and Northern Canadian Protocol*, January 2008 (the Common Curriculum Framework). The program of studies incorporates the conceptual framework for Grades 10–12 Mathematics and most of the general outcomes and specific outcomes that were established in the Common Curriculum Framework. (Note: Some of the outcomes for Mathematics 20-2 and 30-2 in this program of studies are different from the outcomes for Foundations of Mathematics in the Common Curriculum Framework.)

BACKGROUND

The Common Curriculum Framework was developed by seven ministries of education (Alberta, British Columbia, Manitoba, Northwest Territories, Nunavut, Saskatchewan and Yukon Territory) in collaboration with teachers, administrators, parents, business representatives, post-secondary educators and others. The framework identifies beliefs about mathematics, general and specific student outcomes, and achievement indicators agreed upon by the seven jurisdictions.

BELIEFS ABOUT STUDENTS AND MATHEMATICS LEARNING

Students are curious, active learners with individual interests, abilities, needs and career goals. They come to school with varying knowledge, life experiences, expectations and backgrounds. A key component in developing mathematical literacy in students is making connections to these backgrounds, experiences, goals and aspirations.

Students construct their understanding of mathematics by developing meaning based on a variety of learning experiences. This meaning is best developed when learners encounter mathematical experiences that proceed from simple to complex and from the concrete to the abstract. The use of manipulatives, visuals and a variety of pedagogical approaches can address the diversity of learning styles and developmental stages of students. At all levels of understanding, students benefit from working with a variety of materials, tools and contexts when constructing meaning about new mathematical ideas. Meaningful student discussions also provide essential links among concrete, pictorial and symbolic representations of mathematics.

The learning environment should value, respect and address all students' experiences and ways of thinking, so that students are comfortable taking intellectual risks, asking questions and posing conjectures. Students need to explore mathematics through solving problems in order to continue developing personal strategies and mathematical literacy. It is important to realize that it is acceptable to solve problems in different ways and that solutions may vary depending upon how the problem is understood.

FIRST NATIONS, MÉTIS AND INUIT PERSPECTIVES

First Nations, Métis and Inuit students in northern and western Canada come from diverse geographic areas with varied cultural and linguistic backgrounds. Students attend schools in a variety of settings, including urban, rural and isolated communities. Teachers need to understand the diversity of students' cultures and experiences.

First Nations, Métis and Inuit students often have a holistic view of the environment—they look for connections in learning and learn best when mathematics is contextualized. They may come from cultures where learning takes place through active participation. Traditionally, little emphasis was placed upon the written word, so oral communication and practical applications and experiences are important to student learning and understanding. By understanding and responding to nonverbal cues, teachers can optimize student learning and mathematical understanding.

A variety of teaching and assessment strategies help build upon the diverse knowledge, cultures, communication styles, skills, attitudes, experiences and learning styles of students.

Research indicates that when strategies go beyond the incidental inclusion of topics and objects unique to a culture or region, greater levels of understanding can be achieved (Banks and Banks, 1993).

AFFECTIVE DOMAIN

A positive attitude is an important aspect of the affective domain and has a profound effect on learning. Environments that create a sense of belonging, support risk taking and provide opportunities for success help students to develop and maintain positive attitudes and self-confidence. Students with positive attitudes toward learning mathematics are likely to be motivated and prepared to learn, to participate willingly in classroom activities, to persist in challenging situations and to engage in reflective practices.

Teachers, students and parents need to recognize the relationship between the affective and cognitive domains and to nurture those aspects of the affective domain that contribute to positive attitudes. To experience success, students must be taught to set achievable goals and to assess themselves as they work toward these goals.

Striving toward success and becoming autonomous and responsible learners are ongoing, reflective processes that involve revisiting the setting and assessing of personal goals.

GOALS FOR STUDENTS

The main goals of mathematics education are to prepare students to:

- solve problems
- communicate and reason mathematically
- make connections between mathematics and its applications
- become mathematically literate
- appreciate and value mathematics
- make informed decisions as contributors to society.

Students who have met these goals:

- gain an understanding and appreciation of the role of mathematics in society
- exhibit a positive attitude toward mathematics
- engage and persevere in mathematical problem solving

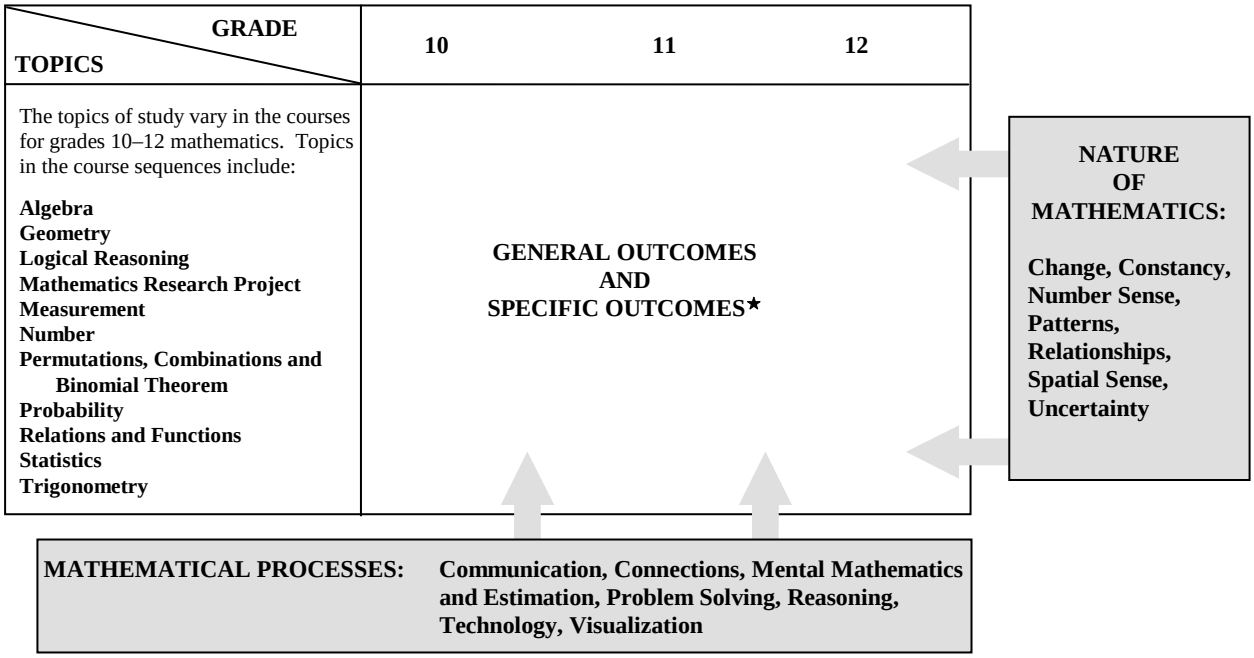
- contribute to mathematical discussions
- take risks in performing mathematical tasks
- exhibit curiosity about mathematics and situations involving mathematics.

In order to assist students in attaining these goals, teachers are encouraged to develop a classroom atmosphere that fosters conceptual understanding through:

- taking risks
- thinking and reflecting independently
- sharing and communicating mathematical understanding
- solving problems in individual and group projects
- pursuing greater understanding of mathematics
- appreciating the value of mathematics throughout history.

CONCEPTUAL FRAMEWORK FOR GRADES 10–12 MATHEMATICS

The chart below provides an overview of how mathematical processes and the nature of mathematics influence learning outcomes.



★ Achievement indicators for the prescribed program of studies outcomes are provided in the companion document *The Alberta 10–12 Mathematics Program of Studies with Achievement Indicators*, 2008.

Mathematical Processes

The seven mathematical processes are critical aspects of learning, doing and understanding mathematics. Students must encounter these processes regularly in a mathematics program in order to achieve the goals of mathematics education.

This program of studies incorporates the following interrelated mathematical processes. They are to permeate the teaching and learning of mathematics.

Students are expected to:

Communication [C]	• use *communication* in order to learn and express their understanding
Connections [CN]	• make *connections* among mathematical ideas, other concepts in mathematics, everyday experiences and other disciplines
Mental Mathematics and Estimation [ME]	• demonstrate fluency with *mental mathematics and estimation*
Problem Solving [PS]	• develop and apply new mathematical knowledge through *problem solving*
Reasoning [R]	• develop mathematical *reasoning*
Technology [T]	• select and use *technology* as a tool for learning and for solving problems
Visualization [V]	• develop *visualization* skills to assist in processing information, making connections and solving problems.

All seven processes should be used in the teaching and learning of mathematics. Each specific outcome includes a list of relevant mathematical processes. The identified processes are to be used as a primary focus of instruction and assessment.

COMMUNICATION [C]

Students need opportunities to read about, represent, view, write about, listen to and discuss mathematical ideas. These opportunities allow students to create links among their own language and ideas, the language and ideas of others, and the formal language and symbols of mathematics.

Communication is important in clarifying, reinforcing and modifying ideas, attitudes and beliefs about mathematics. Students should be encouraged to use a variety of forms of communication while learning mathematics. Students also need to communicate their learning by using mathematical terminology.

Communication can play a significant role in helping students make connections among concrete, pictorial, symbolic, verbal, written and mental representations of mathematical ideas.

Emerging technologies enable students to engage in communication beyond the traditional classroom to gather data and share mathematical ideas.

CONNECTIONS [CN]

Contextualization and making connections to the experiences of learners are powerful processes in developing mathematical understanding. When mathematical ideas are connected to each other or to real-world phenomena, students begin to view mathematics as useful, relevant and integrated.

Learning mathematics within contexts and making connections relevant to learners can validate past experiences and increase student willingness to participate and be actively engaged.

The brain is constantly looking for and making connections. "Because the learner is constantly searching for connections on many levels, educators need to *orchestrate the experiences* from which learners extract understanding.… Brain research establishes and confirms that multiple complex and concrete experiences are essential for meaningful learning and teaching" (Caine and Caine, 1991, p. 5).

MENTAL MATHEMATICS AND ESTIMATION [ME]

Mental mathematics is a combination of cognitive strategies that enhance flexible thinking and number sense. It involves using strategies to perform mental calculations.

Mental mathematics enables students to determine answers without paper and pencil. It improves computational fluency by developing efficiency, accuracy and flexibility in reasoning and calculating.

"Even more important than performing computational procedures or using calculators is the greater facility that students need—more than ever before—with estimation and mental math" (National Council of Teachers of Mathematics, May 2005).

Students proficient with mental mathematics "become liberated from calculator dependence, build confidence in doing mathematics, become more flexible thinkers and are more able to use multiple approaches to problem solving" (Rubenstein, 2001, p. 442).

Mental mathematics "provides a cornerstone for all estimation processes, offering a variety of alternative algorithms and nonstandard techniques for finding answers" (Hope, 1988, p. v).

Estimation is used for determining approximate values or quantities, usually by referring to benchmarks or referents, or for determining the reasonableness of calculated values. Estimation is also used to make mathematical judgements and to develop useful, efficient strategies for dealing with situations in daily life. When estimating, students need to learn which strategy to use and how to use it.

PROBLEM SOLVING [PS]

Problem solving is one of the key processes and foundations within the field of mathematics. Learning through problem solving should be the focus of mathematics at all grade levels. Students develop a true understanding of mathematical concepts and procedures when they solve problems in meaningful contexts. Problem solving is to be employed throughout all of mathematics and should be embedded throughout all the topics.

When students encounter new situations and respond to questions of the type, *How would you ...?* or *How could you …?,* the problem-solving approach is being modelled. Students develop their own problem-solving strategies by listening to, discussing and trying different strategies.

In order for an activity to be problem-solving based, it must ask students to determine a way to get from what is known to what is sought. If students have already been given ways to solve the problem, it is not a problem, but practice. Students should not know the answer immediately. A true problem requires students to use prior learnings in new ways and contexts. Problem solving requires and builds depth of conceptual understanding and student engagement. Students will be engaged if the problems relate to their lives, cultures, interests, families or current events.

Both conceptual understanding and student engagement are fundamental in moulding students' willingness to persevere in future problem-solving tasks.

Problems are not just simple computations embedded in a story, nor are they contrived. They are tasks that are rich and open-ended, so there may be more than one way of arriving at a solution or there may be multiple answers. Good problems should allow for every student in the class to demonstrate his or her knowledge, skill or understanding. Problem solving can vary from being an individual activity to a class (or beyond) undertaking.

In a mathematics class, there are two distinct types of problem solving: solving contextual problems outside of mathematics and solving mathematical problems. Finding the maximum profit given manufacturing constraints is an example of a contextual problem, while seeking and developing a general formula to solve a quadratic equation is an example of a mathematical problem.

Problem solving can also be considered in terms of engaging students in both inductive and deductive reasoning strategies. As students make sense of the problem, they will be creating conjectures and looking for patterns that they may be able to generalize. This part of the problem-solving process often involves inductive reasoning. As students use approaches to solving the problem, they often move into mathematical reasoning that is deductive in nature. It is crucial that students be encouraged to engage in both types of reasoning and be given the opportunity to consider the approaches and strategies used by others in solving similar problems.

Problem solving is a powerful teaching tool that fosters multiple, creative and innovative solutions. Creating an environment where students openly look for, and engage in, finding a variety of strategies for solving problems empowers students to explore alternatives and develops confident, cognitive mathematical risk-takers.

REASONING [R]

Mathematical reasoning helps students think logically and make sense of mathematics. Students need to develop confidence in their abilities to reason and to justify their mathematical thinking. Questions that challenge students to think, analyze and synthesize help them develop an understanding of mathematics. All students need to be challenged to answer questions such as, *Why do you believe that's true/correct?* or *What would happen if ….*

Mathematical experiences provide opportunities for students to engage in inductive and deductive reasoning. Students use inductive reasoning when they explore and record results, analyze observations, make generalizations from patterns

and test these generalizations. Students use deductive reasoning when they reach new conclusions based upon the application of what is already known or assumed to be true. The thinking skills developed by focusing on reasoning can be used in daily life in a wide variety of contexts and disciplines.

TECHNOLOGY [T]

Technology can be used effectively to contribute to and support the learning of a wide range of mathematical outcomes. Technology enables students to explore and create patterns, examine relationships, test conjectures and solve problems.

Calculators and computers can be used to:

- explore and demonstrate mathematical relationships and patterns
- organize and display data
- generate and test inductive conjectures
- extrapolate and interpolate
- assist with calculation procedures as part of solving problems
- increase the focus on conceptual understanding by decreasing the time spent on repetitive procedures
- reinforce the learning of basic facts
- develop personal procedures for mathematical operations
- model situations
- develop number and spatial sense.

Technology contributes to a learning environment in which the curiosity of students can lead to rich mathematical discoveries at all grade levels. The use of technology should not replace mathematical understanding. Instead, technology should be used as one of a variety of approaches and tools for creating mathematical understanding.

VISUALIZATION [V]

Visualization "involves thinking in pictures and images, and the ability to perceive, transform and recreate different aspects of the visual-spatial world" (Armstrong, 1993, p. 10). The use of visualization in the study of mathematics provides students with opportunities to understand mathematical concepts and make connections among them.

Visual images and visual reasoning are important components of number, spatial and measurement sense. Number visualization occurs when students create mental representations of numbers.

Being able to create, interpret and describe a visual representation is part of spatial sense and spatial reasoning. Spatial visualization and spatial reasoning enable students to describe the relationships among and between 3-D objects and 2-D shapes.

Measurement visualization goes beyond the acquisition of specific measurement skills. Measurement sense includes the ability to determine when to measure and when to estimate and involves knowledge of several estimation strategies (Shaw and Cliatt, 1989, p. 150).

Visualization is fostered through the use of concrete materials, technology and a variety of visual representations. It is through visualization that abstract concepts can be understood concretely by the student. Visualization is a foundation to the development of abstract understanding, confidence and fluency.

Nature of Mathematics

Mathematics is one way of understanding, interpreting and describing our world. There are a number of characteristics that define the nature of mathematics, including change, constancy, number sense, patterns, relationships, spatial sense and uncertainty.

CHANGE

It is important for students to understand that mathematics is dynamic and not static. As a result, recognizing change is a key component in understanding and developing mathematics.

Within mathematics, students encounter conditions of change and are required to search for explanations of that change. To make

predictions, students need to describe and quantify their observations, look for patterns, and describe those quantities that remain fixed and those that change. For example, the sequence 4, 6, 8, 10, 12, … can be described as:

- skip counting by 2s, starting from 4
- an arithmetic sequence, with first term 4 and a common difference of 2
- a linear function with a discrete domain

(Steen, 1990, p. 184).

Students need to learn that new concepts of mathematics as well as changes to already learned concepts arise from a need to describe and understand something new. Integers, decimals, fractions, irrational numbers and complex numbers emerge as students engage in exploring new situations that cannot be effectively described or analyzed using whole numbers.

Students best experience change to their understanding of mathematical concepts as a result of mathematical play.

CONSTANCY

Many important properties in mathematics do not change when conditions change. Examples of constancy include:

- the conservation of equality in solving equations
- the sum of the interior angles of any triangle
- the theoretical probability of an event.

Some problems in mathematics require students to focus on properties that remain constant. The recognition of constancy enables students to solve problems such as those involving constant rates of change, lines with constant slope, or direct variation situations.

NUMBER SENSE

Number sense, which can be thought of as deep understanding and flexibility with numbers, is the most important foundation of numeracy (British Columbia Ministry of Education, 2000, p. 146). Continuing to foster number sense is fundamental to growth of mathematical understanding.

A true sense of number goes well beyond the skills of simply counting, memorizing facts and the situational rote use of algorithms. Students with strong number sense are able to judge the reasonableness of a solution, describe relationships between different types of numbers, compare quantities and work with different representations of the same number to develop a deeper conceptual understanding of mathematics.

Number sense develops when students connect numbers to real-life experiences and when students use benchmarks and referents. This results in students who are computationally fluent and flexible with numbers and who have intuition about numbers. Evolving number sense typically comes as a by-product of learning rather than through direct instruction. However, number sense can be developed by providing mathematically rich tasks that allow students to make connections.

PATTERNS

Mathematics is about recognizing, describing and working with numerical and non-numerical patterns. Patterns exist in all of the mathematical topics, and it is through the study of patterns that students can make strong connections between concepts in the same and different topics. Working with patterns also enables students to make connections beyond mathematics. The ability to analyze patterns contributes to how students understand their environment.

Patterns may be represented in concrete, visual, auditory or symbolic form. Students should develop fluency in moving from one representation to another.

Students need to learn to recognize, extend, create and apply mathematical patterns. This understanding of patterns allows students to make predictions and justify their reasoning when solving problems.

Learning to work with patterns helps develop students' algebraic thinking, which is foundational for working with more abstract mathematics.

RELATIONSHIPS

Mathematics is used to describe and explain relationships. Within the study of mathematics, students look for relationships among numbers, sets, shapes, objects, variables and concepts. The search for possible relationships involves collecting and analyzing data, analyzing patterns and describing possible relationships visually, symbolically, orally or in written form.

SPATIAL SENSE

Spatial sense involves the representation and manipulation of 3-D objects and 2-D shapes. It enables students to reason and interpret among 3-D and 2-D representations.

Spatial sense is developed through a variety of experiences with visual and concrete models. It offers a way to interpret and reflect on the physical environment and its 3-D or 2-D representations.

Some problems involve attaching numerals and appropriate units (measurement) to dimensions of objects. Spatial sense allows students to make predictions about the results of changing these dimensions.

Spatial sense is also critical in students' understanding of the relationship between the equations and graphs of functions and, ultimately, in understanding how both equations and graphs can be used to represent physical situations.

UNCERTAINTY

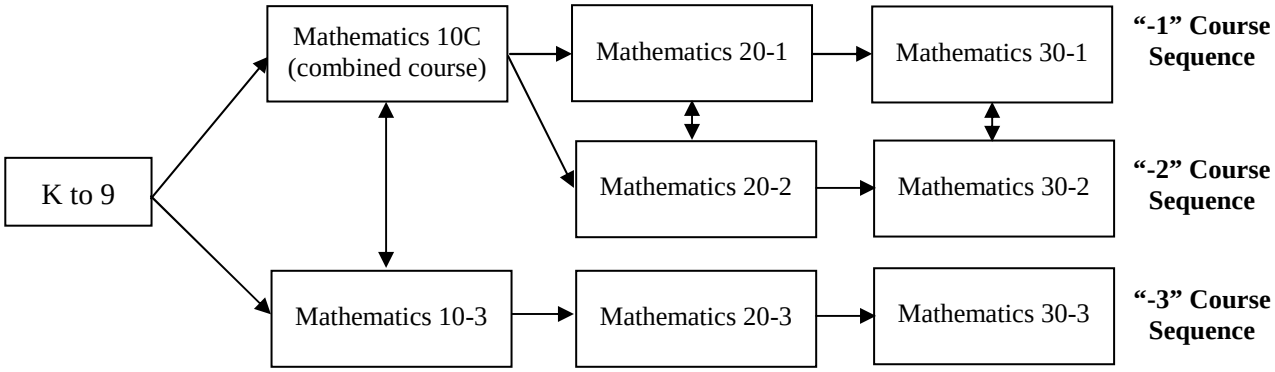
In mathematics, interpretations of data and the predictions made from data inherently lack certainty.

Events and experiments generate statistical data that can be used to make predictions. It is important that students recognize that these predictions (interpolations and extrapolations) are based upon patterns that have a degree of uncertainty. The quality of an interpretation or conclusion is directly related to the quality of the data it is based upon. An awareness of uncertainty provides students with an understanding of why and how to assess the reliability of data and data interpretation.

Chance addresses the predictability of the occurrence of an outcome. As students develop their understanding of probability, the language of mathematics becomes more specific and describes the degree of uncertainty more accurately. This language must be used effectively and correctly to convey valuable messages.

Course Sequences and Topics

The Mathematics Grades 10–12 Program of Studies includes course sequences and topics rather than strands as in the Mathematics Kindergarten to Grade 9 Program of Studies. Three course sequences are available: "-1," "-2" and "-3." A combined course (Mathematics 10C) is the starting point for the "-1" course sequence and the "-2" course sequence. Each topic area requires that students develop a conceptual knowledge base and skill set that will be useful to whatever course sequence they have chosen. The topics covered within a course sequence are meant to build upon previous knowledge and to progress from simple to more complex conceptual understandings.



GOALS OF COURSE SEQUENCES

The goals of all three course sequences are to provide prerequisite attitudes, knowledge, skills and understandings for specific post-secondary programs or direct entry into the work force. All three course sequences provide students with mathematical understandings and critical-thinking skills. It is the choice of topics through which those understandings and skills are developed that varies among course sequences. When choosing a course sequence, students should consider their interests, both current and future. Students, parents and educators are encouraged to research the admission requirements for post-secondary programs of study as they vary by institution and by year.

DESIGN OF COURSE SEQUENCES

Each course sequence is designed to provide students with the mathematical understandings, rigour and critical-thinking skills that have been identified for specific post-secondary programs of study and for direct entry into the work force.

The content of each course sequence has been based on consultations with mathematics teachers and on the *Western and Northern Canadian Protocol (WNCP) Consultation with Post-Secondary Institutions, Business and Industry Regarding Their Requirements for High School Mathematics: Final Report on Findings*.

"-1" Course Sequence

This course sequence is designed to provide students with the mathematical understandings and critical-thinking skills identified for entry into post-secondary programs that require the study of calculus. Topics include algebra and number; measurement; relations and functions; trigonometry; and permutations, combinations and binomial theorem.

"-2" Course Sequence

This course sequence is designed to provide students with the mathematical understandings and critical-thinking skills identified for post-secondary studies in programs that do not require the study of calculus. Topics include geometry, measurement, number and logic, logical reasoning, relations and functions, statistics, and probability.

"-3" Course Sequence

This course sequence is designed to provide students with the mathematical understandings and critical-thinking skills identified for entry into the majority of trades and for direct entry into the work force. Topics include algebra, geometry, measurement, number, statistics and probability.

Outcomes

The program of studies is stated in terms of general outcomes and specific outcomes.

General outcomes are overarching statements about what students are expected to learn in each course.

Specific outcomes are statements that identify the specific knowledge, skills and understandings that students are required to attain by the end of a given course.

In the specific outcomes, the word *including* indicates that any ensuing items must be addressed to fully meet the learning outcome. The phrase *such as* indicates that the ensuing items are provided for clarification and are not requirements that must be addressed to fully meet the learning outcome.

The word *and* used in an outcome indicates that both ideas must be addressed to fully meet the learning outcome, although not necessarily at the same time or in the same question.

Links to Information and Communication Technology (ICT) Outcomes

Some curriculum outcomes from Alberta Education's Information and Communication Technology (ICT) Program of Studies can be linked to outcomes in the mathematics program so that students will develop a broad perspective on the nature of technology, learn how to use and apply a variety of technologies, and consider the impact of ICT on individuals and society. The connection to ICT outcomes supports and reinforces the understandings and abilities that students are expected to develop through the general and specific outcomes of the mathematics program. Effective, efficient and ethical application of ICT outcomes contributes to the mathematics program vision.

Links to the ICT outcomes have been identified for some specific outcomes. These links appear in square brackets below the process codes for an outcome, where appropriate. The complete wording of the relevant outcomes for ICT is provided in the Appendix.

Summary

The Conceptual Framework for Grades 10–12 Mathematics describes the nature of mathematics, the mathematical processes, the course sequences and topics, and the role of outcomes in grades 10–12 mathematics. Activities that take place in the mathematics classroom should be based on a problem-solving approach that incorporates the mathematical processes and leads students to an understanding of the nature of mathematics.

INSTRUCTIONAL FOCUS

Each course sequence in the Mathematics Grades 10–12 Program of Studies is arranged by topics. Students should be engaged in making connections among concepts both within and across topics to make mathematical learning experiences meaningful.

Teachers should consider the following points when planning for instruction and assessment.

- The mathematical processes that are identified with the outcome are intended to help teachers select effective pedagogical approaches for the teaching and learning of the outcome.
- All seven mathematical processes must be integrated throughout teaching and learning approaches, and should support the intent of the outcomes.
- Wherever possible, meaningful contexts should be used in examples, problems and projects.
- Instruction should flow from simple to complex and from concrete to abstract.

- The assessment plan for the course should be a balance of assessment for learning, assessment as learning and assessment of learning.

The focus of student learning should be on developing a conceptual and procedural understanding of mathematics. Students' conceptual understanding and procedural understanding must be directly related.

MATHEMATICS 10C

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

Measurement	
General Outcome	**Specific Outcomes**
	It is expected that students will:
Develop spatial sense and proportional reasoning.	1. Solve problems that involve linear measurement, using: • SI and imperial units of measure • estimation strategies • measurement strategies. [ME, PS, V]
	2. Apply proportional reasoning to problems that involve conversions between SI and imperial units of measure. [C, ME, PS]
	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, V]
	4. Develop and apply the primary trigonometric ratios (sine, cosine, tangent) to solve problems that involve right triangles. [C, CN, PS, R, T, V]

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

Algebra and Number

General Outcome	Specific Outcomes
	It is expected that students will:
Develop algebraic reasoning and number sense.	1. Demonstrate an understanding of factors of whole numbers by determining the: • prime factors • greatest common factor • least common multiple • square root • cube root. [CN, ME, R]
	2. Demonstrate an understanding of irrational numbers by: • representing, identifying and simplifying irrational numbers • ordering irrational numbers. [CN, ME, R, V] [ICT: C6–2.3]
	3. Demonstrate an understanding of powers with integral and rational exponents. [C, CN, PS, R]
	4. Demonstrate an understanding of the multiplication of polynomial expressions (limited to monomials, binomials and trinomials), concretely, pictorially and symbolically. [CN, R, V]
	5. Demonstrate an understanding of common factors and trinomial factoring, concretely, pictorially and symbolically. [C, CN, R, V]

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

Relations and Functions

General Outcome	Specific Outcomes
Develop algebraic and graphical reasoning through the study of relations.	*It is expected that students will:* 1. Interpret and explain the relationships among data, graphs and situations. [C, CN, R, T, V] [ICT: C6–4.3, C7–4.2] 2. Demonstrate an understanding of relations and functions. [C, R, V] 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] 4. Describe and represent linear relations, using: • words • ordered pairs • tables of values • graphs • equations. [C, CN, R, V] 5. Determine the characteristics of the graphs of linear relations, including the: • intercepts • slope • domain • range. [CN, PS, R, V] 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. [CN, R, T, V] [ICT: C6–4.3]

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

Relations and Functions (continued)	
General Outcome	**Specific Outcomes**
	It is expected that students will:
Develop algebraic and graphical reasoning through the study of relations.	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 to solve problems. [CN, PS, R, V]
	8. Represent a linear function, using function notation. [CN, ME, V]
	9. Solve problems that involve systems of linear equations in two variables, graphically and algebraically. [CN, PS, R, T, V] [ICT: C6–4.1]

MATHEMATICS 20-1

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

Algebra and Number

General Outcome	Specific Outcomes
	It is expected that students will:
Develop algebraic reasoning and number sense.	1. Demonstrate an understanding of the absolute value of real numbers. [R, V]
	2. Solve problems that involve operations on radicals and radical expressions with numerical and variable radicands. [CN, ME, PS, R]
	3. Solve problems that involve radical equations (limited to square roots). [C, PS, R]
	4. Determine equivalent forms of rational expressions (limited to numerators and denominators that are monomials, binomials or trinomials). [C, ME, R]
	5. Perform operations on rational expressions (limited to numerators and denominators that are monomials, binomials or trinomials). [CN, ME, R]
	6. Solve problems that involve rational equations (limited to numerators and denominators that are monomials, binomials or trinomials). [C, PS, R]

Trigonometry

General Outcome	Specific Outcomes
	It is expected that students will:
Develop trigonometric reasoning.	1. Demonstrate an understanding of angles in standard position [0° to 360°]. [R, V]
	2. Solve problems, using the three primary trigonometric ratios for angles from 0° to 360° in standard position. [C, ME, PS, R, T, V] [ICT: C6–4.1]
	3. Solve problems, using the cosine law and sine law, including the ambiguous case. [C, CN, PS, R, T] [ICT: C6–4.1]

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

Relations and Functions

General Outcome	Specific Outcomes
Develop algebraic and graphical reasoning through the study of relations.	*It is expected that students will:* 1. Factor polynomial expressions of the form: • $ax^2+bx+c,\ a\neq 0$ • $a^2x^2-b^2y^2,\ a\neq 0,\ b\neq 0$ • $a\left(f\left(x\right)\right)^2+b\left(f\left(x\right)\right)+c,\ a\neq 0$ • $a^2\left(f\left(x\right)\right)^2-b^2\left(g\left(y\right)\right)^2,\ a\neq 0,\ b\neq 0$ where a, b and c are rational numbers. [CN, ME, R] 2. Graph and analyze absolute value functions (limited to linear and quadratic functions) to solve problems. [C, PS, R, T, V] [ICT: C6–4.1, C6–4.3] 3. Analyze quadratic functions of the form $y=a\left(x-p\right)^2+q$ and determine the: • vertex • domain and range • direction of opening • axis of symmetry • x- and y-intercepts. [CN, R, T, V] [ICT: C6–4.3, C7–4.2] 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 and to solve problems. [CN, PS, R, T, V] [ICT: C6–4.1, C6–4.3] 5. Solve problems that involve quadratic equations. [C, CN, PS, R, T, V] [ICT: C6–4.1] 6. Solve, algebraically and graphically, problems that involve systems of linear-quadratic and quadratic-quadratic equations in two variables. [CN, PS, R, T, V] [ICT: C6–4.1, C6–4.4]

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

Relations and Functions (continued)	
General Outcome	**Specific Outcomes**
	It is expected that students will:
Develop algebraic and graphical reasoning through the study of relations.	7. Solve problems that involve linear and quadratic inequalities in two variables. [C, PS, T, V] [ICT: C6–4.1, C6–4.3]
	8. Solve problems that involve quadratic inequalities in one variable. [CN, PS, V]
	9. Analyze arithmetic sequences and series to solve problems. [CN, PS, R]
	10. Analyze geometric sequences and series to solve problems. [PS, R]
	11. Graph and analyze reciprocal functions (limited to the reciprocal of linear and quadratic functions). [CN, R, T, V] [ICT: C6–4.1, C6–4.3]

MATHEMATICS 30-1

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

Trigonometry

General Outcome	Specific Outcomes
	It is expected that students will:
Develop trigonometric reasoning.	1. Demonstrate an understanding of angles in standard position, expressed in degrees and radians. [CN, ME, R, V]
	2. Develop and apply the equation of the unit circle. [CN, R, V]
	3. Solve problems, using the six trigonometric ratios for angles expressed in radians and degrees. [ME, PS, R, T, V] [ICT: C6–4.1]
	4. Graph and analyze the trigonometric functions sine, cosine and tangent to solve problems. [CN, PS, T, V] [ICT: C6–4.1, C6–4.3]
	5. Solve, algebraically and graphically, first and second degree trigonometric equations with the domain expressed in degrees and radians. [CN, PS, R, T, V] [ICT: C6–4.1, C6–4.4]
	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). [R, T, V] [ICT: C6–4.1, C6–4.4]

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

Relations and Functions

General Outcome	Specific Outcomes
Develop algebraic and graphical reasoning through the study of relations.	*It is expected that students will:* 1. Demonstrate an understanding of operations on, and compositions of, functions. [CN, R, T, V] [ICT: C6–4.1] 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] 3. Demonstrate an understanding of the effects of horizontal and vertical stretches on the graphs of functions and their related equations. [C, CN, R, V] 4. Apply translations and stretches to the graphs and equations of functions. [C, CN, R, V] 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] 6. Demonstrate an understanding of inverses of relations. [C, CN, R, V] 7. Demonstrate an understanding of logarithms. [CN, ME, R] 8. Demonstrate an understanding of the product, quotient and power laws of logarithms. [C, CN, ME, R, T] [ICT: C6–4.1] 9. Graph and analyze exponential and logarithmic functions. [C, CN, T, V] [ICT: C6–4.3, C6–4.4, F1–4.2]

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

Relations and Functions (continued)	
General Outcome	**Specific Outcomes**
	It is expected that students will:
Develop algebraic and graphical reasoning through the study of relations.	10. Solve problems that involve exponential and logarithmic equations. [C, CN, PS, 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]
	12. Graph and analyze polynomial functions (limited to polynomial functions of degree ≤ 5). [C, CN, T, V] [ICT: C6–4.3, C6–4.4]
	13. Graph and analyze radical functions (limited to functions involving one radical). [CN, R, T, V] [ICT: C6–4.1, C6–4.3]
	14. Graph and analyze rational functions (limited to numerators and denominators that are monomials, binomials or trinomials). [CN, R, T, V] [ICT: C6–4.1, C6–4.3, C6–4.4]

Permutations, Combinations and Binomial Theorem	
General Outcome	**Specific Outcomes**
	It is expected that students will:
Develop algebraic and numeric reasoning that involves combinatorics.	1. Apply the fundamental counting principle to solve problems. [C, PS, R, V] [ICT: C6–2.3]
	2. Determine the number of permutations of n elements taken r at a time to solve problems. [C, PS, R, V]
	3. Determine the number of combinations of n different elements taken r at a time to solve problems. [C, PS, R, V]
	4. 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]

MATHEMATICS 20-2

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

Measurement	
General Outcome	**Specific Outcomes**
	It is expected that students will:
Develop spatial sense and proportional reasoning.	1. Solve problems that involve the application of rates. [CN, PS, R]
	2. Solve problems that involve scale diagrams, using proportional reasoning. [CN, PS, R, V]
	3. Demonstrate an understanding of the relationships among scale factors, areas, surface areas and volumes of similar 2-D shapes and 3-D objects. [C, CN, PS, R, V]

Geometry	
General Outcome	**Specific Outcomes**
	It is expected that students will:
Develop spatial sense.	1. Derive proofs that involve the properties of angles and triangles. [CN, R, V]
	2. Solve problems that involve properties of angles and triangles. [CN, PS, V]
	3. Solve problems that involve the cosine law and the sine law, excluding the ambiguous case. [CN, PS, R]

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

Number and Logic

General Outcome	Specific Outcomes
	It is expected that students will:
Develop number sense and logical reasoning.	1. Analyze and prove conjectures, using inductive and deductive reasoning, to solve problems. [C, CN, PS, R]
	2. Analyze puzzles and games that involve spatial reasoning, using problem-solving strategies. [CN, PS, R, V]
	3. Solve problems that involve operations on radicals and radical expressions with numerical and variable radicands (limited to square roots). [CN, ME, PS, R]
	4. Solve problems that involve radical equations (limited to square roots or cube roots). [C, PS, R]

Statistics

General Outcome	Specific Outcomes
	It is expected that students will:
Develop statistical reasoning.	1. Demonstrate an understanding of normal distribution, including: • standard deviation • z-scores. [CN, PS, T, V] [ICT: C6–4.1, C7–4.2]
	2. Interpret statistical data, using: • confidence intervals • confidence levels • margin of error. [C, CN, R] [ICT: C1–4.2, C2–4.2, C7–4.2]

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

Relations and Functions	
General Outcome	**Specific Outcomes** *It is expected that students will:*
Develop algebraic and graphical reasoning through the study of relations.	1. Demonstrate an understanding of the characteristics of quadratic functions, including: • vertex • intercepts • domain and range • axis of symmetry. [CN, PS, T, V] [ICT: C6–4.1, C6–4.3] 2. Solve problems that involve quadratic equations. [C, CN, PS, R, T, V] [ICT: C6–4.1, C6–4.3]

Mathematics Research Project	
General Outcome	**Specific Outcomes** *It is expected that students will:*
Develop an appreciation of the role of mathematics in society.	1. Research and give a presentation on a historical event or an area of interest that involves mathematics. [C, CN, ME, PS, R, T, V] [ICT: C1–4.2, C1–4.4, C2–4.1, C3–4.1, C3–4.2, C7–4.2, F2–4.7]

MATHEMATICS 30-2

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

Logical Reasoning

General Outcome	Specific Outcomes
	It is expected that students will:
Develop logical reasoning.	1. Analyze puzzles and games that involve numerical and logical reasoning, using problem-solving strategies. [CN, ME, PS, R]
	2. Solve problems that involve the application of set theory. [CN, PS, R, V] [ICT: C6–2.3]

Probability

General Outcome	Specific Outcomes
	It is expected that students will:
Develop critical thinking skills related to uncertainty.	1. Interpret and assess the validity of odds and probability statements. [C, CN, ME]
	2. Solve problems that involve the probability of mutually exclusive and non–mutually exclusive events. [CN, PS, R, V] [ICT: C6–2.3]
	3. Solve problems that involve the probability of two events. [CN, PS, R]
	4. Solve problems that involve the fundamental counting principle. [PS, R, V] [ICT: C6–2.3]
	5. Solve problems that involve permutations. [ME, PS, R, T, V]
	6. Solve problems that involve combinations. [ME, PS, R, T, V]

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

Relations and Functions

General Outcome	Specific Outcomes
	It is expected that students will:
Develop algebraic and graphical reasoning through the study of relations.	1. Determine equivalent forms of rational expressions (limited to numerators and denominators that are monomials and binomials). [C, ME, R]
	2. Perform operations on rational expressions (limited to numerators and denominators that are monomials and binomials). [CN, ME, R]
	3. Solve problems that involve rational equations (limited to numerators and denominators that are monomials and binomials). [C, CN, PS, R]
	4. Demonstrate an understanding of logarithms and the laws of logarithms. [C, CN, ME, R] [ICT: C6–4.1]
	5. Solve problems that involve exponential equations. [C, CN, PS, R, T] [ICT: C6–4.1, C6–4.3]
	6. Represent data, using exponential and logarithmic functions, to solve problems. [C, CN, PS, T, V] [ICT: C6–4.1, C6–4.3, C6–4.4]
	7. Represent data, using polynomial functions (of degree ≤ 3), to solve problems. [C, CN, PS, T, V] [ICT: C6–4.1, C6–4.3, C6–4.4]
	8. Represent data, using sinusoidal functions, to solve problems. [C, CN, PS, T, V] [ICT: C6–4.1, C6–4.3, C6–4.4]

Mathematics Research Project

General Outcome	Specific Outcomes
	It is expected that students will:
Develop an appreciation of the role of mathematics in society.	1. Research and give a presentation on a current event or an area of interest that involves mathematics. [C, CN, ME, PS, R, T, V] [ICT: C1–4.2, C1–4.4, C2–4.1, C3–4.1, C3–4.2, C7–4.2, F2–4.7, P2–4.1]

MATHEMATICS 10-3

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

Measurement	
General Outcome	**Specific Outcomes** *It is expected that students will:*
Develop spatial sense through direct and indirect measurement.	1. Demonstrate an understanding of the Système International (SI) by: • describing the relationships of the units for length, area, volume, capacity, mass and temperature • applying strategies to convert SI units to imperial units. [C, CN, ME, V] 2. Demonstrate an understanding of the imperial system by: • describing the relationships of the units for length, area, volume, capacity, mass and temperature • comparing the American and British imperial units for capacity • applying strategies to convert imperial units to SI units. [C, CN, ME, V] 3. Solve and verify problems that involve SI and imperial linear measurements, including decimal and fractional measurements. [CN, ME, PS, V] 4. Solve problems that involve SI and imperial area measurements of regular, composite and irregular 2-D shapes and 3-D objects, including decimal and fractional measurements, and verify the solutions. [ME, PS, R, V]

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

Geometry

General Outcome	Specific Outcomes
	It is expected that students will:
Develop spatial sense.	1. Analyze puzzles and games that involve spatial reasoning, using problem-solving strategies. [C, CN, PS, R]
	2. Demonstrate an understanding of the Pythagorean theorem by: • identifying situations that involve right triangles • verifying the formula • applying the formula • solving problems. [C, CN, PS, V]
	3. Demonstrate an understanding of similarity of convex polygons, including regular and irregular polygons. [C, CN, PS, V]
	4. Demonstrate an understanding of primary trigonometric ratios (sine, cosine, tangent) by: • applying similarity to right triangles • generalizing patterns from similar right triangles • applying the primary trigonometric ratios • solving problems. [CN, PS, R, T, V] [ICT: C6–4.1]
	5. Solve problems that involve parallel, perpendicular and transversal lines, and pairs of angles formed between them. [C, CN, PS, V]
	6. Demonstrate an understanding of angles, including acute, right, obtuse, straight and reflex, by: • drawing • replicating and constructing • bisecting • solving problems. [C, ME, PS, T, V] [ICT: C6–4.1]

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

Number

General Outcome	Specific Outcomes
	It is expected that students will:
Develop number sense and critical thinking skills.	1. Solve problems that involve unit pricing and currency exchange, using proportional reasoning. [CN, ME, PS, R] [ICT: F2–4.7]
	2. Demonstrate an understanding of income, including: • wages • salary • contracts • commissions • piecework to calculate gross pay and net pay. [C, CN, R, T] [ICT: C6–4.1, C6–4.2, C7–4.2, F2–4.7]

Algebra

General Outcome	Specific Outcomes
	It is expected that students will:
Develop algebraic reasoning.	1. Solve problems that require the manipulation and application of formulas related to: • perimeter • area • the Pythagorean theorem • primary trigonometric ratios • income. [C, CN, ME, PS, R]

MATHEMATICS 20-3

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

Measurement	
General Outcome	**Specific Outcomes** *It is expected that students will:*
Develop spatial sense through direct and indirect measurement.	1. Solve problems that involve SI and imperial units in surface area measurements and verify the solutions. [C, CN, ME, PS, V] 2. Solve problems that involve SI and imperial units in volume and capacity measurements. [C, CN, ME, PS, V]

Geometry	
General Outcome	**Specific Outcomes** *It is expected that students will:*
Develop spatial sense.	1. Solve problems that involve two and three right triangles. [CN, PS, T, V] [ICT: C6–4.1] 2. Solve problems that involve scale. [PS, R, V] 3. Model and draw 3-D objects and their views. [CN, R, V] 4. Draw and describe exploded views, component parts and scale diagrams of simple 3-D objects. [CN, V]

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

Number

General Outcome	Specific Outcomes
Develop number sense and critical thinking skills.	*It is expected that students will:* 1. Analyze puzzles and games that involve numerical reasoning, using problem-solving strategies. [C, CN, PS, R] 2. Solve problems that involve personal budgets. [CN, PS, R, T] [ICT: C6–4.2, C6–4.4] 3. Demonstrate an understanding of compound interest. [CN, ME, PS, T] [ICT: C6–4.1] 4. Demonstrate an understanding of financial institution services used to access and manage finances. [C, CN, R, T] [ICT: F2–4.6] 5. Demonstrate an understanding of credit options, including: • credit cards • loans. [CN, ME, PS, R] [ICT: F2–4.7]

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

Algebra

General Outcome	Specific Outcomes
	It is expected that students will:
Develop algebraic reasoning.	1. Solve problems that require the manipulation and application of formulas related to: • volume and capacity • surface area • slope and rate of change • simple interest • finance charges. [CN, PS, R]
	2. Demonstrate an understanding of slope: • as rise over run • as rate of change • by solving problems. [C, CN, PS, V]
	3. Solve problems by applying proportional reasoning and unit analysis. [C, CN, PS, R]

Statistics

General Outcome	Specific Outcomes
	It is expected that students will:
Develop statistical reasoning.	1. Solve problems that involve creating and interpreting graphs, including: • bar graphs • histograms • line graphs • circle graphs. [C, CN, PS, R, T, V] [ICT: C6–4.1, C6–4.2, C6–4.3, P2–4.1]

MATHEMATICS 30-3

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

Measurement

General Outcome	Specific Outcomes
	It is expected that students will:
Develop spatial sense through direct and indirect measurement.	1. Demonstrate an understanding of the limitations of measuring instruments, including: • precision • accuracy • uncertainty • tolerance and solve problems. [C, PS, R, T, V] [ICT: C6–4.4, C6–4.5]

Geometry

General Outcome	Specific Outcomes
	It is expected that students will:
Develop spatial sense.	1. Solve problems by using the sine law and cosine law, excluding the ambiguous case. [CN, PS, V]
	2. Solve problems that involve: • triangles • quadrilaterals • regular polygons. [C, CN, PS, V]
	3. Demonstrate an understanding of transformations on a 2-D shape or a 3-D object, including: • translations • rotations • reflections • dilations. [C, CN, R, T, V] [ICT: C6–3.4]

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

Number

General Outcome	Specific Outcomes
	It is expected that students will:
Develop number sense and critical thinking skills.	1. Analyze puzzles and games that involve logical reasoning, using problem-solving strategies. [C, CN, PS, R]
	2. Solve problems that involve the acquisition of a vehicle by: • buying • leasing • leasing to buy. [C, CN, PS, R, T]
	3. Critique the viability of small business options by considering: • expenses • sales • profit or loss. [C, CN, R] [ICT: F2–4.7]

Algebra

General Outcome	Specific Outcomes
	It is expected that students will:
Develop algebraic reasoning.	1. Demonstrate an understanding of linear relations by: • recognizing patterns and trends • graphing • creating tables of values • writing equations • interpolating and extrapolating • solving problems. [CN, PS, R, T, V] [ICT: C6–4.1, C6–4.3, C7–4.2]

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

Statistics

General Outcome	Specific Outcomes
	It is expected that students will:
Develop statistical reasoning.	1. Solve problems that involve measures of central tendency, including: • mean • median • mode • weighted mean • trimmed mean. [C, CN, PS, R]
	2. Analyze and describe percentiles. [C, CN, PS, R]

Probability

General Outcome	Specific Outcomes
	It is expected that students will:
Develop critical thinking skills related to uncertainty.	1. Analyze and interpret problems that involve probability. [C, CN, PS, R]

APPENDIX: INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) OUTCOMES

The following excerpts from the Information and Communication Technology (ICT) Program of Studies provide the complete wording for outcomes that are linked to the mathematics program of studies. For the complete ICT Program of Studies, go to the Alberta Education Web site at http://education.alberta.ca/teachers/program/ict.aspx.

ICT Outcomes, Division 2

General Outcomes	Specific Outcomes
C6 – Students will use technology to investigate and/or solve problems.	2.3 use graphic organizers, such as mind mapping/webbing, flow charting and outlining, to present connections between ideas and information in a problem-solving environment

ICT Outcomes, Division 3

General Outcomes	Specific Outcomes
C6 – Students will use technology to investigate and/or solve problems.	3.4 pose and test solutions to problems by using computer applications, such as computer-assisted design or simulation/modelling software

ICT Outcomes, Division 4

General Outcomes	Specific Outcomes
C1 – Students will access, use and communicate information from a variety of technologies.	4.2 select information from appropriate sources, including primary and secondary sources 4.4 communicate in a persuasive and engaging manner, through appropriate forms, such as speeches, letters, reports and multimedia presentations, applying information technologies for context, audience and purpose that extend and communicate understanding of complex issues
C2 – Students will seek alternative viewpoints, using information technologies.	4.1 consult a wide variety of sources that reflect varied viewpoints on particular topics 4.2 evaluate the validity of gathered viewpoints against other sources
C3 – Students will critically assess information accessed through the use of a variety of technologies.	4.1 assess the authority, reliability and validity of electronically accessed information 4.2 demonstrate discriminatory selection of electronically accessed information that is relevant to a particular topic
C6 – Students will use technology to investigate and/or solve problems.	4.1 investigate and solve problems of prediction, calculation and inference 4.2 investigate and solve problems of organization and manipulation of information 4.3 manipulate data by using charting and graphing technologies in order to test inferences and probabilities 4.4 generate new understandings of problematic situations by using some form of technology to facilitate the process 4.5 evaluate the appropriateness of the technology used to investigate or solve a problem

General Outcomes	Specific Outcomes
C7 – Students will use electronic research techniques to construct personal knowledge and meaning.	4.2 analyze and synthesize information to determine patterns and links among ideas
F1 – Students will demonstrate an understanding of the nature of technology.	4.2 solve mathematical and scientific problems by selecting appropriate technology to perform calculations and experiments
F2 – Students will understand the role of technology as it applies to self, work and society.	4.6 demonstrate an understanding of the basic principles and issues of e-commerce, including such topics as security and privacy, marketing, and implications for governments, businesses and consumers alike 4.7 use current, reliable information sources from around the world
P2 – Students will organize and manipulate data.	4.1 manipulate and present data through the selection of appropriate tools, such as scientific instrumentation, calculators, databases and/or spreadsheets

REFERENCES

Alberta Education. Mathematics Kindergarten to Grade 9 Program of Studies. Edmonton, AB: Alberta Education, 2007. http://education.alberta.ca/media/645594/kto9math.pdf (Accessed February 6, 2008).

Alberta Education, System Improvement Group. *Western and Northern Canadian Protocol (WNCP) Consultation with Post-Secondary Institutions, Business and Industry Regarding Their Requirements for High School Mathematics: Final Report on Findings*. Edmonton, AB: Alberta Education, 2006. Available at http://www.wncp.ca/math/report_2006.pdf (Accessed February 6, 2008).

Alberta Education. *The Alberta 10–12 Mathematics Program of Studies with Achievement Indicators*. Edmonton, AB: Alberta Education, 2008.

Alberta Learning. Information and Communication Technology (ICT) Program of Studies. Edmonton, AB: Alberta Learning, 2000–2003. http://education.alberta.ca/media/453069/pofs.pdf (Accessed February 6, 2008).

Armstrong, Thomas. *7 Kinds of Smart: Identifying and Developing Your Many Intelligences*. New York, NY: Plume, 1993.

Banks, J. A. and C. A. M. Banks. *Multicultural Education: Issues and Perspectives*. 2nd ed. Boston, MA: Allyn and Bacon, 1993.

British Columbia Ministry of Education. *The Primary Program: A Framework for Teaching*. Victoria, BC: British Columbia Ministry of Education, 2000.

Caine, Renate Nummela and Geoffrey Caine. *Making Connections: Teaching and the Human Brain*. Alexandria, VA: Association for Supervision and Curriculum Development, 1991.

Hope, Jack A. et al. *Mental Math in the Primary Grades*. Palo Alto, CA: Dale Seymour Publications, 1988.

McAskill, B. et al. *WNCP Mathematics Research Project: Final Report*. Victoria, BC: Holdfast Consultants Inc., 2004. Available at http://www.wncp.ca/math/Final_Report.pdf (Accessed February 6, 2008).

National Council of Teachers of Mathematics. *Computation, Calculators, and Common Sense: A Position of the National Council of Teachers of Mathematics*. May 2005. http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/computation.pdf (Accessed February 6, 2008).

Rubenstein, Rheta N. "Mental Mathematics beyond the Middle School: Why? What? How?" *Mathematics Teacher* 94, 6 (September 2001), pp. 442–446.

Shaw, J. M. and M. J. P. Cliatt. "Developing Measurement Sense." In P. R. Trafton (ed.), *New Directions for Elementary School Mathematics: 1989 Yearbook* (Reston, VA: National Council of Teachers of Mathematics, 1989), pp. 149–155.

Steen, L. A. *On the Shoulders of Giants: New Approaches to Numeracy*. Washington, DC: Mathematical Sciences Education Board, National Research Council, 1990.

Western and Northern Canadian Protocol for Collaboration in Basic Education (Kindergarten to Grade 12). *The Common Curriculum Framework for Grades 10–12 Mathematics: Western and Northern Canadian Protocol*. January 2008. http://www.wncp.ca/math/math10to12.pdf (Accessed February 6, 2008).