Outcomes with Assessment Standards
for
Mathematics 10C

2012

This resource is intended to assist teachers with the
provincial implementation of Mathematics 10C.

Alberta

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The primary audience for this resource is:

Teachers	✓
Administrators	
Students	
Parents	

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INTRODUCTION

Mathematics 10C was provincially implemented in September 2010. Teachers participating in focus groups during the development of the program of studies expressed a need for a common understanding of the curriculum and assessment standards. In response to this need, and in keeping with Alberta Education's goal of establishing and effectively communicating clear outcomes and high standards, this standards resource was developed.

This resource is designed to support the implementation of the Alberta Mathematics Grades 10–12 Program of Studies, which can be found at http://education.alberta.ca/media/655889/math10to12.pdf. Teachers are strongly encouraged to consult the program of studies for details about the philosophy of the program.

PURPOSE

Outcomes with Assessment Standards for Mathematics 10C links the achievement indicators for the specific outcomes from the program of studies with information and commentaries about standards. Its purpose is to provide teachers of Mathematics 10C with clearly stated standards to use as guidelines in their classroom instruction and assessment practices.

DEFINITIONS AND TERMINOLOGY

Standards

A *standard* is a reference point used in planning and evaluation. In evaluating educational performance, the following standards apply:

- *Curriculum* and *assessment standards* apply to the assessment of individual students.
- *Achievement standards* apply to the assessment of student populations.

In this resource, only curriculum and assessment standards are discussed.

Curriculum Standards

Curriculum standards are outcomes for a course within a program. The curriculum standards for Mathematics 10C are defined by the general and specific outcomes outlined in the program of studies. They are further clarified by the achievement indicators, which reflect the scope of each specific outcome.

Outcomes

General outcomes are concise statements identifying what it is that students are expected to know and be able to do upon completion of a course within a program.

Specific outcomes are statements identifying the component knowledge, skills and attitudes of a general outcome. Specific outcomes identify a range of contexts in which the general outcomes apply.

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.

Achievement Indicators
Achievement indicators are samples of how students may demonstrate their achievement of the goals of a specific outcome. The range of samples provided is meant to reflect the scope of the specific outcome.

The word *and* used in an achievement indicator implies that both ideas should be addressed at the same time or in the same question.

Assessment Standards

Assessment standards are the criteria used for judging individual student achievement relative to the curriculum standards.

STANDARDS FOR MATHEMATICS 10C

Mathematics 10C is designed to follow directly from Grade 9 Mathematics, so students taking Mathematics 10C are presumed to have reached the acceptable standard or better in the outcomes of Grade 9 Mathematics.

The assessment standards for Mathematics 10C include an acceptable and an excellent level of performance. Student performance should be measured on a range of tasks, some of which are routine and obvious tasks in familiar contexts, and others which are nonroutine tasks in unfamiliar contexts. In many cases, a correlated example from the authorized resources is referenced to assist in assessing student performance. The authorized resources for Mathematics 10C, published by McGraw-Hill Ryerson (MHR) and Pearson, respectively, are:

- Mathematics 10: Student Resource (MHR);
- Mathematics 10: Teacher's Resource (MHR);
- Foundations and Pre-calculus Mathematics 10: Student Resource (Pearson); and
- Foundations and Pre-calculus Mathematics 10: Teacher Resource (Pearson).

Acceptable Standard

The *acceptable standard* of achievement in Mathematics 10C is met by students who receive a course mark between and including 50 percent and 79 percent. Typically, these students have gained new skills and a basic knowledge of the concepts and procedures relative to the general and specific outcomes defined for Mathematics 10C in the program of studies. These students can apply this knowledge to a limited range of familiar problem contexts.

Standard of Excellence

The *standard of excellence* for achievement in Mathematics 10C is met by students who receive a course mark at or above 80 percent. Typically, these students have gained a breadth and depth of understanding regarding the concepts and procedures, as well as the ability to apply this knowledge to a broad range of familiar and unfamiliar problem contexts.

Description of Standards

The following statements describe what is expected of Mathematics 10C students who meet the *acceptable standard* or the *standard of excellence* on independent work. The statements represent the standards against which student achievement is measured.

Acceptable Standard	***Standard of Excellence***
Students who meet the *acceptable standard* in Mathematics 10C consistently perform acceptable work on routine and obvious tasks in familiar contexts.	Students who meet the *standard of excellence* in Mathematics 10C consistently perform excellent work on routine and obvious tasks in familiar contexts, and acceptable work on nonroutine tasks in unfamiliar contexts.
These students have a basic understanding of the concepts and procedures outlined in the program of studies. They demonstrate their understanding in concrete, pictorial and symbolic modes, and can translate from one mode to another. They perform the mathematical operations and procedures that are fundamental to Mathematics 10C and apply what they know in daily living contexts.	These students have a comprehensive understanding of the concepts and procedures outlined in the program of studies. They demonstrate their understanding in concrete, pictorial and symbolic modes, and can translate from one mode to another. They perform the mathematical operations and procedures that are fundamental to Mathematics 10C, apply what they know in daily living contexts and provide alternative solution procedures to verify results.
To meet the *acceptable standard*, students communicate about mathematical situations in an understandable way, using appropriate everyday and mathematical terms. They understand mathematical questions containing objects, diagrams or numbers in familiar contexts, and they construct mathematical models.	To meet the *standard of excellence*, students communicate about mathematical situations in a clear way, using numbers, diagrams and appropriate mathematical terms. They understand mathematical questions containing objects, diagrams or numbers in familiar and unfamiliar contexts, and they construct mathematical models by translating words into suitable numbers, diagrams, tables, equations and variables.
Students meeting the *acceptable standard* apply what they know in solving straightforward problems in familiar settings and in analyzing simple mathematical models. They describe the steps they used to solve a particular problem, and verify and defend their solution to the problem.	Students meeting the *standard of excellence* apply what they know in solving routine and nonroutine problems in a broad range of settings. They describe the steps they used to solve a particular problem, defend their solution to the problem, and, where appropriate, provide alternative solution procedures to verify results.
Students meeting the *acceptable standard* have a positive attitude toward mathematics and a sense of personal competence in using mathematics. They demonstrate confidence when using common mathematical procedures and when applying problem-solving strategies in familiar settings.	Students meeting the *standard of excellence* have a positive attitude toward mathematics and show confidence in using mathematics meaningfully. They are self-motivated risk takers who persevere when solving novel problems. They take initiative in trying new methods and are creative in their approach to problem solving.

GENERAL NOTES

- All mathematical processes should be used and integrated throughout the outcomes.
- Technology [T], including calculators and computers, has been listed as one of the mathematical processes to be emphasized for some outcomes, with the expectation that students will have access to technology when completing the outcomes. If technology has not been specifically listed for a particular outcome, teachers may, at their discretion, use it to assist students in exploring patterns and relationships when learning a concept. It is expected, however, that technology will not be considered when assessing students' understandings of such outcomes.
- Each specific outcome is accompanied by notes that address some of the questions that may arise when teaching the concepts. The assessment standards for each outcome are described in a chart that indicates, for each achievement indicator, whether the acceptable standard, the standard of excellence or, in some cases, both standards may be applicable (✓). Some check marks are accompanied by qualifying statements. Shaded regions indicate that the standard does not apply for the given achievement indicator. In many cases, a correlated example from the authorized resources is referenced in the chart to illustrate the standards. The authorized resources for Mathematics 10C, published by McGraw-Hill Ryerson (MHR) and Pearson, respectively, are:
  - Mathematics 10: Student Resource (MHR);
  - Mathematics 10: Teacher's Resource (MHR);
  - Foundations and Pre-calculus Mathematics 10: Student Resource (Pearson); and
  - Foundations and Pre-calculus Mathematics 10: Teacher Resource (Pearson).
- A *partial solution* to a problem is a solution in which a student demonstrates a basic understanding of the problem and the mathematical concepts required in solving the problem. However, the student is unable to complete the solution correctly for a variety of reasons, such as not being able to correctly connect the concepts involved or not being able to avoid procedural errors. For example, in solving a problem using right-angle trigonometry, given an angle and the measure of the side opposite that angle, a student may be able to draw a diagram to correctly represent the situation and identify the appropriate trigonometric ratio needed to solve the problem but then makes procedural errors in solving for the measure of the side adjacent. Note that assessment of student learning is the responsibility of the teacher, and what is considered a partial solution may vary according to the question or task presented.
- In Relations and Functions, note that linear regression is **not** included in the outcomes for this topic.

Topic: Measurement

General Outcome: Develop spatial sense and proportional reasoning.

Specific Outcome

It is expected that students will:

1. Solve problems that involve linear measurement, using:
   - SI and imperial units of measure
   - estimation strategies
   - measurement strategies.

   [ME, PS, V]

Notes

- Students have been working with SI units of measure since Grade 3. While the SI system of measure is the official measurement system in Canada, students need to have some exposure to and experience with imperial units of measure. Some commerce in Canada, primarily involving imports from and exports to the U.S., is still conducted in imperial units.
- This is the first time that imperial units are formally addressed in the Kindergarten to Grade 12 Mathematics curriculum.
- In measurement, a referent is described as something common that provides students with a reference for a unit of measure. Although there are some commonly used measurement referents, e.g., 1 foot is approximately the length of an adult's foot, students are expected to develop their own referents for the basic units of length in each system.
- Measurements in imperial units should generally be expressed in fraction form. This outcome is not intended to assess operations on fractions but can be used to reinforce students' understanding of fractions.
- A student may develop his or her own personal strategy or adopt a strategy developed by another student. A personal strategy must be efficient and accurate, and the student must be able to explain it to others.
- It is expected that students will use a variety of measuring instruments.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
1.1 Provide referents for linear measurements, including millimetre, centimetre, metre, kilometre, inch, foot, yard and mile, and explain the choices.	✓ Use referents for millimetre, centimetre, metre, inch, foot and yard and explain the choices. STUDENT RESOURCE MHR: p. 11, Example 1 Pearson: pp. 5–6, Try This p. 11, #4b	✓ Use referents for kilometre and mile and explain the choices. STUDENT RESOURCE MHR: p. 21, Mini Lab Pearson: p. 15, #2
1.2 Compare SI and imperial units, using referents.	✓ STUDENT RESOURCE MHR: p. 36, #1; p. 43, #3 Pearson: p. 15, #5	
1.3 Estimate a linear measure, using a referent, and explain the process used.	✓ STUDENT RESOURCE MHR: p. 19, #14a; p. 31, #5 Pearson: p. 25, #1	
1.4 Justify the choice of units used for determining a measurement in a problem-solving context.	✓ STUDENT RESOURCE MHR: p. 17, #5 Pearson: p. 11, #3, #4a, #5a	

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Achievement Indicators		Acceptable Standard	Standard of Excellence
1.5	Solve problems that involve linear measure, using instruments such as rulers, calipers or tape measures.	✓ STUDENT RESOURCE MHR: p. 11, Example 1 Pearson: p. 17, C and D	
1.6	Describe and explain a personal strategy used to determine a linear measurement; e.g., circumference of a bottle, length of a curve, perimeter of the base of an irregular 3-D object.	✓ Describe and give a partial explanation of the personal strategy used. STUDENT RESOURCE MHR: p. 46, #13 Pearson: p. 15, #4a	✓ Describe and give a detailed explanation of the personal strategy used. STUDENT RESOURCE MHR: p. 48, #6 Pearson: p. 14, Try This p. 15, #4

Measurement (continued)

Specific Outcome

It is expected that students will:

2. Apply proportional reasoning to problems that involve conversions between SI and imperial units of measure. [C, ME, PS]

Notes

- Conversions between SI and imperial units should be limited to commonly used linear units of measure; e.g., centimetres ↔ inches or metres ↔ feet. Unusual conversions, e.g., converting miles to millimetres, should be avoided.
- Proportional reasoning solves for an unknown value by comparing it to known values, using ratios. Students are expected to use and explain proportional reasoning when converting units within and between the two measurement systems.
- Technology [T] has not been identified as one of the mathematical processes to be emphasized in completing this outcome. Technology may be used, where appropriate, in solving a proportion.
- In unit analysis, students apply the process for multiplying and simplifying fractions to verify the units in the final solution to a problem. While the analysis in Achievement Indicator 2.3 will be quite straightforward, teachers may use conversion of units within or between the two measurement systems to introduce students to unit analysis.
- Students are not expected to memorize conversion factors. Basic conversion factors, especially those between the SI and imperial systems of measure, e.g., inch ↔ centimetre, yard ↔ centimetre, Fahrenheit ↔ Celsius, should be provided.
- The use of conversion programs is not appropriate.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
2.1 Explain how proportional reasoning can be used to convert a measurement within or between SI and imperial systems.	✓ STUDENT RESOURCE MHR: p. 38, Your Turn p. 40, Example 3c Pearson: p. 20, Example 3 p. 21, Example 4	
2.2 Solve a problem that involves the conversion of units within or between SI and imperial systems.	✓ Solve problems that involve converting measures within either the SI or the imperial measurement system. STUDENT RESOURCE MHR: p. 12, Example 2 p. 32, #11 Pearson: p. 11, #10; p. 12, #16	✓ Solve problems that involve converting measures between the SI and imperial measurement systems. STUDENT RESOURCE MHR: p. 45, #10 Pearson: p. 19, Example 2 p. 23, #14
2.3 Verify, using unit analysis, a conversion within or between SI and imperial systems, and explain the conversion.	✓ STUDENT RESOURCE MHR: p. 38, Example 1c Pearson: p. 19, Example 2	
2.4 Justify, using mental mathematics, the reasonableness of a solution to a conversion problem.	✓ Justify the reasonableness of a solution to a conversion problem involving SI units. STUDENT RESOURCE MHR: p. 39, Example 2 Pearson: p. 20, CYU 3	✓ Justify the reasonableness of a solution to a conversion problem involving imperial units.

Measurement (continued)

Specific Outcome

It is expected that students will:

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]

Notes

- Prior knowledge from previous grade levels includes:
  - the surface area and volume of right rectangular prisms, right triangular prisms and right cylinders (Grade 8)
  - the surface area of composite 3-D objects (Grade 9)
  - the Pythagorean theorem (Grade 8)
  - areas of triangles, circles and parallelograms (Grade 7).
- The intent of this outcome is to extend the concepts of surface area and volume to right pyramids, right cones and spheres.
- The bases of right prisms and pyramids should be restricted to triangles, simple quadrilaterals and regular polygons.
- Teachers are expected to develop the formulae for surface area and volume with students.
- Figures can have an open side and the external surface area of the figure can still be calculated.
- In problems that involve multiple steps, rounding in calculations is to be done only after the last step.
- Students are expected to sketch and label diagrams of right prisms and cylinders, right pyramids and cones, and spheres.
- Students are expected to write complete, well-organized solutions to problems.
- Students are expected to discover the relationship between the volumes of cylinders and cones with the same base and height or prisms and pyramids with the same base and height.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
3.1 Sketch a diagram to represent a problem that involves surface area or volume.	✓ STUDENT RESOURCE MHR: p. 74, #2, #4 Pearson: p. 32, Example 3 p. 33, Example 4	
3.2 Determine the surface area of a right cone, right cylinder, right prism, right pyramid or sphere, using an object or its labelled diagram.	✓ Determine the surface area when all of the required dimensions are given. STUDENT RESOURCE MHR: p. 74, #1 Pearson: p. 34, #5, #7, #8	✓ Determine the surface area when one or more of the required dimensions have to be determined from other given information.
3.3 Determine the volume of a right cone, right cylinder, right prism, right pyramid or sphere, using an object or its labelled diagram.	✓ Determine the volume when all of the required dimensions are given. STUDENT RESOURCE MHR: p. 86, #1 Pearson: p. 42, #4, #6, #8	✓ Determine the volume when one or more of the required dimensions have to be determined from other given information.

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Achievement Indicators	Acceptable Standard	Standard of Excellence
3.4 Determine an unknown dimension of a right cone, right cylinder, right prism, right pyramid or sphere, given the object's surface area or volume and the remaining dimensions.	✓ Solve a given problem in which the unknown dimension can be found directly from the formula. STUDENT RESOURCE MHR: p. 84, Example 3 p. 87, #5 Pearson: p. 41, Example 4 p. 41, CYU 4	✓ Solve a given problem in which the unknown dimension cannot be found directly from the formula. STUDENT RESOURCE MHR: p. 89, #12 Pearson: p. 33, CYU 4
3.5 Solve a problem that involves surface area or volume, given a diagram of a composite 3-D object.	✓ Provide a partial solution to the problem. STUDENT RESOURCE MHR: p. 75, #5 p. 84, Example 4 Pearson: p. 56, Example 1 p. 56, CYU 1	✓ Provide a complete solution to the problem. STUDENT RESOURCE MHR: p. 75, #5 p. 84, Example 4 Pearson: p. 57, Example 2 p. 57, CYU 2
3.6 Describe the relationship between the volumes of: • right cones and right cylinders with the same base and height • right pyramids and right prisms with the same base and height.	✓ STUDENT RESOURCE MHR: p. 82, Example 1 p. 90, #17 Pearson: pp. 36–37, Construct Understanding	

Measurement (continued)

Specific Outcome

It is expected that students will:

4. Develop and apply the primary trigonometric ratios (sine, cosine, tangent) to solve problems that involve right triangles.
   [C, CN, PS, R, T, V]

Notes

- Prior knowledge from previous grade levels includes:
  - the Pythagorean theorem (Grade 8)
  - similar polygons (Grade 9).
- This outcome is the students' introduction to trigonometry; the primary trigonometric ratios are no longer developed in Grade 9.
- It is expected that students will develop the trigonometric ratios through hands-on activities that involve measurement and investigation.
- The relationship between corresponding angles formed by two parallel lines and a transversal is not an outcome addressed in previous grades. As a result, teachers may need to explain the relationship between an angle of elevation and the corresponding angle of depression.
- In problems that involve multiple steps, rounding in calculations is to be done only after the last step.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
4.1 Explain the relationships between similar right triangles and the definitions of the primary trigonometric ratios.	✓ Provide a partial explanation of the relationships. STUDENT RESOURCE MHR: pp. 114–115, Investigate Trigonometric Ratios Pearson: p. 71, Try This	✓ Provide a complete and detailed explanation of the relationships. STUDENT RESOURCE MHR: pp. 114–115, Investigate Trigonometric Ratios Pearson: p. 71, Try This
4.2 Identify the hypotenuse of a right triangle and the opposite and adjacent sides for a given acute angle in the triangle.	✓ STUDENT RESOURCE MHR: p. 107, #1 Pearson: p. 95, #4a	
4.3 Solve right triangles.	✓ STUDENT RESOURCE MHR: p. 129, Example 3 p. 131, #1 Pearson: p. 106, Example 1 p. 106, CYU 1	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
4.4 Solve a problem that involves one or more right triangles by applying the primary trigonometric ratios or the Pythagorean theorem.	✓ Provide a full solution for problems involving one right triangle or a partial solution for problems involving more than one right triangle. STUDENT RESOURCE MHR: p. 132, #6 Pearson: p. 83, #10; p. 111, #7	✓ Provide a full solution for problems involving more than one right triangle. STUDENT RESOURCE MHR: p. 131, #2 Pearson: p. 115, Example 2 p. 115, CYU 2 p. 119, #9
4.5 Solve a problem that involves indirect and direct measurement, using the trigonometric ratios, the Pythagorean theorem and measurement instruments such as a clinometer or metre stick.	✓ Provide a partial explanation of the solution. STUDENT RESOURCE MHR: pp. 125–126, Investigate Estimation of Distance Pearson: p. 86, #1	✓ Provide a detailed explanation of the solution. STUDENT RESOURCE MHR: pp. 125–126, Investigate Estimation of Distance Pearson: p. 86, #2

Topic: Algebra and Number

General Outcome: Develop algebraic reasoning and number sense.

Specific Outcome

It is expected that students will:

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]

Notes

- Prior knowledge from previous grade levels includes:
  - factors of numbers (Grade 7)
  - perfect squares and square roots (Grade 8)
  - equivalent fractions (Grade 7).
- Students are expected to develop a conceptual understanding of factors, multiples, square roots and cube roots, without the use of technology.
- Students may not be familiar with the terms least common multiple and greatest common factor as these terms are not formally introduced in previous grade levels.
- Students will be familiar with the use of a common denominator in adding or subtracting fractions but may not necessarily be familiar with the lowest common denominator.
- A prime number is defined as a positive integer with two distinct divisors—1 and the number itself; thus, 1 is **not** a prime number.
- In addition to listing the prime factors of a whole number, students are expected to determine the prime factorization of a composite number.
- There is a subtle distinction between the following statements.
  - Determine a number whose square is 16; i.e., solve the equation $x^2 = 16$.
  - Determine the square root of 16; i.e., determine $\sqrt{16}$.

  The correct response to the first question is ± 4, whereas the correct response to the second question is 4 (or + 4). The convention for the use of the square root symbol is that the symbol by itself, e.g., the square root of 16 ($\sqrt{16}$), refers specifically to the principal (positive) square root of the number. The symbol for the negative square root includes a minus sign before the symbol; e.g., the negative square root of 16 is $-\sqrt{16}$.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
1.1 Determine the prime factors of a whole number.	✓ STUDENT RESOURCE MHR: p. 155, Example 1b Pearson: p. 135, Example 1 p. 135, CYU 1	
1.2 Explain why the numbers 0 and 1 have no prime factors.	✓ STUDENT RESOURCE MHR: p. 215, Investigate Common Factors: 1b, c Pearson: p. 140, #7	
1.3 Determine, using a variety of strategies, the greatest common factor or least common multiple of a set of whole numbers, and explain the process.	✓ STUDENT RESOURCE MHR: p. 216, Example 1 p. 215, #3, #4 Pearson: p. 136, Example 2 p. 138, Example 4 p. 138, CYU 4	
1.4 Determine, concretely, whether a given whole number is a perfect square, a perfect cube or neither.	✓ STUDENT RESOURCE MHR: p. 154, Example 1 p. 158, #6 Pearson: pp. 143–144, Construct Understanding	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
1.5 Determine, using a variety of strategies, the square root of a perfect square, and explain the process.	✓ STUDENT RESOURCE MHR: p. 158, #5 Pearson: p. 144, Example 1 p. 144, CYU 1 p. 146, #4	
1.6 Determine, using a variety of strategies, the cube root of a perfect cube, and explain the process.	✓ STUDENT RESOURCE MHR: p. 156, Example 2 p. 158, #5 Pearson: p. 145, Example 2 p. 145, CYU 2 p. 146, #5	
1.7 Solve problems that involve prime factors, greatest common factors, least common multiples, square roots or cube roots.	✓ STUDENT RESOURCE MHR: p. 159, #10, #11 p. 222, #13 Pearson: p. 141, #20 p. 149, #10	

Algebra and Number (continued)

Specific Outcome

It is expected that students will:

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]

Notes

- Prior knowledge from previous grade levels includes:
  - rational numbers (Grade 9)
  - operations on rational numbers, including order of operations (Grade 9)
  - square roots of positive rational numbers that are perfect squares (Grade 9)
  - approximations of square roots of positive rational numbers that are not perfect squares (Grade 9).
- Operations on radicals, other than those required for simplifying radicals, are **not** part of this outcome and will be introduced in Mathematics 20-1 and Mathematics 20-2.
- Students are expected to estimate, within reason, the value of a radical, using perfect square numbers, e.g., 1, 4, 9, 16, 25 …, as benchmarks.
- A benchmark is a standard against which something can be measured or assessed.
- In Achievement Indicator 2.8, students should be encouraged to develop their own graphic organizer to show the relationship among the subsets of the real numbers.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
2.1 Sort a set of numbers into rational and irrational numbers.	✓ STUDENT RESOURCE MHR: p. 193, #8; p. 198, #22 Pearson: p. 211, #3 pp. 207–208, Construct Understanding	
2.2 Determine an approximate value of a given irrational number.	✓ Express to the nearest whole number. STUDENT RESOURCE MHR: p. 191, Example 6 p. 192, #3 Pearson: p. 206, #3	✓ Express to the nearest tenth. STUDENT RESOURCE MHR: p. 191, Example 6 p. 192, #3 Pearson: p. 206, #3
2.3 Approximate the locations of irrational numbers on a number line, using a variety of strategies, and explain the reasoning.	✓ STUDENT RESOURCE MHR: p. 190, Example 5 p. 193, #9 Pearson: pp. 207–208, Construct Understanding	
2.4 Order a set of irrational numbers on a number line.	✓ STUDENT RESOURCE MHR: p. 190, Example 5 Pearson: p. 209, Example 2 p. 210, CYU 2	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
2.5 Express a radical as a mixed radical in simplest form (limited to numerical radicands).	✓ STUDENT RESOURCE MHR: p. 189, Example 4 Pearson: p. 215, Example 1 p. 215, CYU 1	
2.6 Express a mixed radical as an entire radical (limited to numerical radicands).	✓ STUDENT RESOURCE MHR: p. 188, Example 3 Pearson: p. 217, Example 3 p. 217, CYU 3	
2.7 Explain, using examples, the meaning of the index of a radical.	✓ STUDENT RESOURCE MHR: pp. 191–192, Key Ideas Pearson: p. 206, #6	
2.8 Represent, using a graphic organizer, the relationship among the subsets of the real numbers (natural, whole, integer, rational, irrational).	✓ STUDENT RESOURCE MHR: p. 186, Link the Ideas Pearson: p. 209, Example 1	

Algebra and Number (continued)

Specific Outcome

It is expected that students will:

3. Demonstrate an understanding of powers with integral and rational exponents.
   [C, CN, PS, R]

Notes

- Prior knowledge from previous grade levels includes:
  - powers with integral bases, excluding base 0, and whole number exponents (Grade 9)
  - exponent laws for whole number exponents (Grade 9).
- Technology [T] has not been identified as one of the mathematical processes to be emphasized in completing this outcome. Students are expected to apply the exponent laws without relying on the use of technology.
- It is important that students are able to provide explanations for the restrictions on the variables in the definitions and exponent laws in Achievement Indicators 3.1, 3.2 and 3.3. In particular, in Achievement Indicator 3.2, students are expected to explain when $a \geq 0$:
  - If n is even, then $a \geq 0$.
  - If n is odd, then there is no restriction on the variable a.
- Students are expected to perform simple operations with rational numbers. This outcome is not intended to assess operations with rational numbers but may be used to reinforce students' understanding of rational numbers.
- Exponents should be restricted to simple rational numbers.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
3.1 Explain, using patterns, why $a^{-n} = \frac{1}{a^n}, a \neq 0$.	✓ STUDENT RESOURCE MHR: p. 163, Investigate Negative Exponents Pearson: p. 230, Try This	
3.2 Explain, using patterns, why $a^{\frac{1}{n}} = \sqrt[n]{a},\ n > 0$.	✓ STUDENT RESOURCE MHR: pp. 174–175, Investigate Rational Exponents p. 186, Link the Ideas Pearson: pp. 222–223, Try This	
3.3 Apply the exponent laws: • $(a^m)(a^n) = a^{m+n}$ • $a^m \div a^n = a^{m-n}$, $a \neq 0$ • $(a^m)^n = a^{mn}$ • $(ab)^m = a^m b^m$ • $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$, $b \neq 0$ to expressions with rational and variable bases and integral and rational exponents, and explain the reasoning.	✓ STUDENT RESOURCE MHR: p. 180, #1, #2 Pearson: p. 242, #9, #10	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
3.4 Express powers with rational exponents as radicals and vice versa.	✓ Use exponents such as $\frac{1}{n}$. STUDENT RESOURCE MHR: p. 187, Example 1a, c p. 192, #1b, c, d, e Pearson: p. 224, Example 1	✓ Use exponents such as $\frac{m}{n}$ where $m \neq 1$. STUDENT RESOURCE MHR: p. 187 Example 1b p. 192, #1a, f Pearson: p. 225, Example 2
3.5 Solve a problem that involves exponent laws or radicals.	✓ Solve simple problems. STUDENT RESOURCE MHR: p. 193, #11, #12 Pearson: p. 247, #20	✓ Solve complex problems that involve applying more than one exponent law. STUDENT RESOURCE MHR: p. 194, #14 Pearson: p. 247, #26
3.6 Identify and correct errors in a simplification of an expression that involves powers.	✓ STUDENT RESOURCE MHR: p. 181, #7; p. 200, #11 Pearson: p. 242, #19	

Algebra and Number (continued)

Specific Outcome

It is expected that students will:

4. Demonstrate an understanding of the multiplication of polynomial expressions (limited to monomials, binomials and trinomials), concretely, pictorially and symbolically. [CN, R, V]

Notes

- Prior knowledge from previous grade levels includes:
  - an introduction to polynomials of degree less than or equal to 2 (Grade 9)
  - the addition and subtraction of polynomials of degree less than or equal to 2 (Grade 9)
  - the multiplication and division of polynomials of degree less than or equal to 2 by a monomial (Grade 9).
- Students are expected to:
  - multiply two binomials of degree 1 concretely; e.g., using algebra tiles
  - multiply two binomials of degree 1 pictorially; e.g., using drawings to represent algebra tiles
  - find the product symbolically.
- Students are not required to represent the product of two trinomials concretely or pictorially.
- Students are expected to perform operations on polynomials involving one or two variables.
- Students, from Kindergarten to Grade 9, have been encouraged to develop personal strategies for performing operations with numbers. In Achievement Indicator 4.3, students are therefore expected to explain the strategy they used for multiplying two-digit numbers; e.g., $15 \times 23 = (10 + 5)(20 + 3)$.
- Division of a polynomial by a binomial is not part of this outcome and will be introduced in Mathematics 30-1.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome. (It is intended that the emphasis of this outcome be on binomial by binomial multiplication, with extension to polynomial by polynomial to establish a general pattern for multiplication.)*

Achievement Indicators	Acceptable Standard	Standard of Excellence
4.1 Model the multiplication of two given binomials, concretely or pictorially, and record the process symbolically.	✓ STUDENT RESOURCE MHR: p. 206, Example 1 p. 209, #1 Pearson: p. 169, Example 1	
4.2 Relate the multiplication of two binomial expressions to an area model.	✓ STUDENT RESOURCE MHR: p. 206, Example 1 p. 209, #1 Pearson: p. 169, Example 1	
4.3 Explain, using examples, the relationship between the multiplication of binomials and the multiplication of two-digit numbers.	✓ STUDENT RESOURCE MHR: pp. 204–205, Investigate Multiplying Polynomials Pearson: p. 157, Make Connections	
4.4 Verify a polynomial product by substituting numbers for the variables.	✓ STUDENT RESOURCE MHR: p. 211, #12b p. 212, #13c Pearson: p. 200, #27	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
4.5 Multiply two polynomials symbolically, and combine like terms in the product.	✓ STUDENT RESOURCE MHR: p. 207, Example 2 p. 209, #4 Pearson: p. 201, #6a	
4.6 Generalize and explain a strategy for multiplication of polynomials.		✓
4.7 Identify and explain errors in a solution for a polynomial multiplication.	✓ Identify errors in a solution. STUDENT RESOURCE MHR: p. 211, #12 Pearson: p. 186, #14	✓ Identify and explain errors in a solution.

Algebra and Number (continued)

Specific Outcome

It is expected that students will:

5. Demonstrate an understanding of common factors and trinomial factoring, concretely, pictorially and symbolically.
   [C, CN, R, V]

Notes

- Topic: Algebra and Number, Specific Outcome 1 should be completed prior to this outcome.
- Students are expected to demonstrate their understanding of factoring concretely, pictorially and symbolically. Concrete and pictorial representations should be limited to trinomials of the form $ax^2 + bx + c$, where $a \in I$.
- Students are expected to factor expressions such as $ax^2 + bx + c$, where $a \neq 1$, $a \in I$.
- In Achievement Indicator 5.1, if the common factor is a monomial, students are expected to factor the remaining polynomial factor.
- Polynomials involving two variables, e.g., $ax^2 + bxy + cy^2$, are included in this outcome.
- Students should not spend a lot of time factoring quadratics in which the product ac has many factors.
- Students are not expected to factor such expressions as $af^2 + bf + c$, where f is itself a monomial or a binomial.
- Students are expected to have a good understanding of, and mastery of the processes involved in, factoring polynomials since factoring is essential for topics in both Mathematics 20-1 and 20-2.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
5.1 Determine the common factors in the terms of a polynomial, and express the polynomial in factored form.	✓ STUDENT RESOURCE MHR: p. 217, Example 2 p. 221, #5, #6 Pearson: p. 152, Example 1	
5.2 Model the factoring of a trinomial, concretely or pictorially, and record the process symbolically.	✓ STUDENT RESOURCE MHR: p. 227, Example 1 p. 234, #2 Pearson: p. 199, #15	
5.3 Factor a polynomial that is a difference of squares, and explain why it is a special case of trinomial factoring where $b = 0$.	✓ Factor without explanation. STUDENT RESOURCE MHR: p. 242, Example 1 p. 247, #5 Pearson: p. 193, Example 3	✓ Factor with a complete explanation. STUDENT RESOURCE MHR: pp. 242–243, Example 1 p. 240, #7 Pearson: p. 195, Reflect
5.4 Identify and explain errors in a polynomial factorization.	✓ Identify errors without explanation. STUDENT RESOURCE MHR: p. 255, #12 Pearson: p. 199, #14, #21	✓ Identify and explain errors. STUDENT RESOURCE MHR: p. 250, #20 Pearson: p. 200, #26

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Achievement Indicators	Acceptable Standard	Standard of Excellence
5.5 Factor a polynomial, and verify by multiplying the factors.	✓ STUDENT RESOURCE MHR: pp. 227–228, Example 1 pp. 229–231, Example 2 Pearson: p. 199, #13	
5.6 Explain, using examples, the relationship between multiplication and factoring of polynomials.	✓ STUDENT RESOURCE MHR: p. 237, #21 Pearson: p. 196, Concept Summary	
5.7 Generalize and explain strategies used to factor a trinomial.	✓ STUDENT RESOURCE MHR: pp. 224–225, Investigate Factoring Trinomials Pearson: p. 178, Reflect	
5.8 Express a polynomial as a product of its factors.	✓ STUDENT RESOURCE MHR: p. 235, #7 Pearson: p. 177, #13	

Topic: Relations and Functions

General Outcome: Develop algebraic and graphical reasoning through the study of relations.

Specific Outcome

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]

Notes

- It is important that teachers view the nine specific outcomes in this topic as a package and not as individual outcomes. Teachers may choose to develop lessons and activities that include parts of several outcomes.
- Prior knowledge from previous grade levels includes:
  - an introduction to linear relations, including tables of values and graphs (Grade 7)
  - graphing and analyzing two-variable linear relations (Grade 8)
  - using linear relations to solve problems, including graphing, interpolation and extrapolation (Grade 9).
- Technology [T] has been identified as one of the mathematical processes to be emphasized in completing this outcome. It is expected, however, that students will be able to graph both linear and nonlinear data with and without the use of technology.
- Students are expected to draw graphs that include a title, properly labelled axes and appropriate scales.
- For a given context, students are expected to identify key points on a graph, such as intercepts or points where the graph changes direction.
- While students may have previously discussed restrictions on the variables in a linear relation, this is the first time that the terms domain and range are addressed. Some ways students may describe the domain and range for a linear relation include:
  - written or verbal descriptions
  - lists
  - set builder notation; e.g., $\{ x \mid -2 \leq x < 3, x \in R\}$
  - interval notation; e.g., [–2, 3).
- It is essential that students understand and are able to use set builder notation and interval notation effectively since these will be the primary ways of describing sets of numbers in future courses including Mathematics 20-1 and 20-2.
- Students are expected to distinguish between continuous and discrete data and understand their implications for a graph.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
1.1 Graph, with or without technology, a set of data, and determine the restrictions on the domain and range.	✓ STUDENT RESOURCE MHR: p. 303, #5 Pearson: p. 297, #20	
1.2 Explain why data points should or should not be connected on the graph for a situation.	✓ STUDENT RESOURCE MHR: p. 290, #10b, c Pearson: p. 295, #11c	
1.3 Describe a possible situation for a given graph.	✓ STUDENT RESOURCE MHR: p. 271, Example 1 p. 274, #4 Pearson: p. 299, #1	
1.4 Sketch a possible graph for a given situation.	✓ STUDENT RESOURCE MHR: p. 273, Example 3 p. 276, #10 Pearson: p. 283, #16a	
1.5 Determine, and express in a variety of ways, the domain and range of a graph, a set of ordered pairs or a table of values.	✓ Use written or verbal descriptions and lists. STUDENT RESOURCE MHR: p. 302, #3; p. 332, #7 Pearson: p. 329, #3	✓ State domain and range correctly in set builder or interval notation. STUDENT RESOURCE MHR: p. 301, #1; p. 332, #8 Pearson: p. 329, #3

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

2. Demonstrate an understanding of relations and functions.
   [C, R, V]

Notes

- This is the first time the concept of a function is introduced in the Kindergarten to Grade 12 Mathematics curriculum. Students are expected to develop a good understanding of the concept at this level as the study of functions is a recurring topic in grades 11 and 12.
- Students are expected to discover, through investigation, the rules for distinguishing between relations and functions.
- Students are expected to identify functions expressed in multiple formats; e.g., graphs, tables of values, lists of ordered pairs and mapping diagrams.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
2.1 Explain, using examples, why some relations are not functions but all functions are relations.	✓ STUDENT RESOURCE MHR: pp. 305–306, Investigate Functions p. 311, #1 Pearson: p. 290, Example 1 p. 290, CYU 1	
2.2 Determine if a set of ordered pairs represents a function.	✓ STUDENT RESOURCE MHR: p. 306, Example 1c Pearson: p. 271, #5	
2.3 Sort a set of graphs as functions or non-functions.	✓ STUDENT RESOURCE MHR: pp. 305–306, Investigate Functions p. 311, #1f, g Pearson: p. 294, #8	
2.4 Generalize and explain rules for determining whether graphs and sets of ordered pairs represent functions.	✓ Determine without explanation. STUDENT RESOURCE MHR: pp. 306–307, Example 1 Pearson: p. 297, Reflect	✓ Determine with explanation. STUDENT RESOURCE MHR: pp. 306–307, Example 1 p. 333, #11b, d Pearson: p. 297, Reflect

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

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]

Notes

- While students have sketched the graphs of linear relations in previous grades, this outcome is their introduction to the concept of slope.
- In Achievement Indicators 3.2 and 3.3, students are expected to draw conclusions, through investigation, about lines with a:
  - positive or negative slope
  - slope of zero
  - slope that is undefined.
- In Achievement Indicator 3.8, students are expected to develop, through investigation, the rules for determining whether two lines are parallel or perpendicular.
- Slope can be referred to as a rate of change, specifically the rate of change of the variable *y* with respect to the change in the variable *x*. If slope is discussed in context, the units for each variable should be included with the slope; e.g., if the context provides a relationship between distance in metres and time in seconds, then the rate of change of distance with respect to time should be expressed in *m/s* and related to the slope of the graph.
- The focus of this outcome is to develop a visual understanding of slope and then, when solving problems, to connect slope to the concept of rate of change.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
3.1 Determine the slope of a line segment by measuring or calculating the rise and run.	✓ STUDENT RESOURCE MHR: pp. 320–321, Example 3 p. 325, #2 Pearson: pp. 334–335, Example 1 p. 334, CYU 1	
3.2 Classify lines in a given set as having positive or negative slopes.	✓ STUDENT RESOURCE MHR: p. 319, Example 1 Pearson: p. 339, #5	
3.3 Explain the meaning of the slope of a horizontal or vertical line.	✓ STUDENT RESOURCE MHR: p. 321, Example 3b, c Pearson: p. 341, #19	
3.4 Explain why the slope of a line can be determined by using any two points on that line.	✓ STUDENT RESOURCE MHR: p. 328, #17 Pearson: p. 353, #3	
3.5 Explain, using examples, slope as a rate of change.	✓ STUDENT RESOURCE MHR: p. 323, Example 5 p. 326, #5 Pearson: pp. 338–339, Example 4 p. 338, CYU 4	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
3.6 Draw a line, given its slope and a point on the line.	✓ STUDENT RESOURCE MHR: p. 325, #4; p. 349, #3 Pearson: p. 340, #9	
3.7 Determine another point on a line, given the slope and a point on the line.	✓ STUDENT RESOURCE MHR: p. 322, Example 4 p. 336, #6 Pearson: p. 341, #23	
3.8 Generalize and apply a rule for determining whether two lines are parallel or perpendicular.	✓ Develop a rule with an explanation for parallel lines; apply a rule for perpendicular lines. STUDENT RESOURCE MHR: pp. 383–384 Investigate Slopes of Parallel and Perpendicular Lines p. 384, #4 Pearson: p. 348, #1 p. 349, #3, #4	✓ Develop a rule with an explanation for perpendicular lines. STUDENT RESOURCE MHR: pp. 383–384, Investigate Slopes of Parallel and Perpendicular Lines p. 384, #6 Pearson: p. 348, #2
3.9 Solve a contextual problem involving slope.	✓ Solve simple contextual problems. STUDENT RESOURCE MHR: p. 320, Example 2 p. 335, #2 Pearson: p. 353, #4	✓ Solve complex contextual problems. STUDENT RESOURCE MHR: p. 336, #7 Pearson: p. 343, #29

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

4. Describe and represent linear relations, using:
   - words
   - ordered pairs
   - tables of values
   - graphs
   - equations.

   [C, CN, R, V]

Notes

- Students are expected to investigate relations represented in a variety of ways and explain why a given relation is or is not a linear relation.
- With the exception of Achievement Indicator 4.3, in determining whether a given relation is or is not a linear relation, the explanation should be more detailed than stating whether or not the graph is a straight line. For example, if the relation is given as a set of ordered pairs or a table of values (Achievement Indicator 4.4), the explanation should make reference to the constant rate of change (slope) between any two points.
- Students may be familiar with some of the vocabulary used in representing relations and functions; the terms *input* and *output values* are sometimes used in previous grade levels. In science courses, students may encounter the terms *manipulated* and *responding variables*; however, students are expected to use the formal terminology generally used in mathematics courses; i.e., *independent variable* and *dependent variable*.
- In Achievement Indicator 4.6, students are expected to investigate different equations and develop a rule for determining which equations represent linear relations.
- In Achievement Indicator 4.7, students are expected to recognize different representations of the same linear relation; i.e., students are expected to select from a list those representations (words, ordered pairs, tables of values, graphs, equations) that represent the same linear relation.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
4.1 Identify independent and dependent variables in a given context.	✓ STUDENT RESOURCE MHR: pp. 282–283, Example 1 p. 288, #3 Pearson: p. 306, CYU 4a	
4.2 Determine whether a situation represents a linear relation, and explain why or why not.	✓ STUDENT RESOURCE MHR: p. 288, #5a; p. 289, #7a Pearson: p. 309, #10	
4.3 Determine whether a graph represents a linear relation, and explain why or why not.	✓ STUDENT RESOURCE MHR: p. 291, #12a Pearson: p. 308, #5	
4.4 Determine whether a table of values or a set of ordered pairs represents a linear relation, and explain why or why not.	✓ STUDENT RESOURCE MHR: p. 287, #2d, e p. 291, #11a Pearson: p. 308, #3	
4.5 Draw a graph from a set of ordered pairs within a given situation, and determine whether the relationship between the variables is linear.	✓ STUDENT RESOURCE MHR: p. 289, #8b, d, e Pearson: p. 309, #8	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
4.6 Determine whether an equation represents a linear relation, and explain why or why not.	✓ STUDENT RESOURCE MHR: p. 287, #2a, b, c Pearson: p. 308, #6	
4.7 Match corresponding representations of linear relations.	✓ STUDENT RESOURCE MHR: pp. 285–286, Example 3 p. 331, #5 Pearson: p. 310, #16	

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

5. Determine the characteristics of the graphs of linear relations, including the:
   - intercepts
   - slope
   - domain
   - range.

   [CN, PS, R, V]

Notes

- Slope, domain and range are introduced in other outcomes. In this outcome, students are expected to relate, through investigation, these characteristics to the graphs of linear relations.
- Students are expected to indicate the significance of intercepts, slope, domain and range, within the context of a problem.
- Students are expected to state any restrictions on the domain and range of a linear relation, within the context of a problem.
- In Achievement Indicator 5.4, students are expected to determine, through investigation, how they would draw a line that has one, two or an infinite number of intercepts.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
5.1 Determine the intercepts of the graph of a linear relation, and state the intercepts as values or ordered pairs.	✓ STUDENT RESOURCE MHR: p. 360, Example 2 Pearson: p. 311, Make Connections	
5.2 Determine the slope of the graph of a linear relation.	✓ STUDENT RESOURCE MHR: p. 325, #2 Pearson: p. 340, #6	
5.3 Determine the domain and range of the graph of a linear relation.	✓ Use written or verbal descriptions, including tables or lists. STUDENT RESOURCE MHR: p. 302, #2a, b, f Pearson: p. 314, Example 1b	✓ State domain and range correctly in set builder or interval notation. STUDENT RESOURCE MHR: p. 302, #2a Pearson: p. 314, Example 1b
5.4 Sketch a linear relation that has one intercept, two intercepts or an infinite number of intercepts.	✓ STUDENT RESOURCE MHR: p. 364, Key Ideas Pearson: p. 341, #21	
5.5 Identify the graph that corresponds to a given slope and *y*-intercept.	✓ STUDENT RESOURCE MHR: p. 352, #12 Pearson: p. 364, #20	

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Achievement Indicators	Acceptable Standard	Standard of Excellence
5.6 Identify the slope and *y*-intercept that correspond to a given graph.	✓ STUDENT RESOURCE MHR: p. 344, Your Turn p. 351, #8 Pearson: pp. 362–363, #12	
5.7 Solve a contextual problem that involves intercepts, slope, domain or range of a linear relation.	✓ Solve simple contextual problems. STUDENT RESOURCE MHR: p. 367, #10 Pearson: p. 363, #13	✓ Solve complex contextual problems. STUDENT RESOURCE MHR: p. 381, #18 p. 401, #14 Pearson: p. 363, #14

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

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]

Notes

- Students may have some prior exposure to equations having more than one variable. In this outcome, students make the connection between linear equations in two variables and the graph of a line.
- When writing a linear equation in general form, e.g., $Ax + By + C = 0$, the coefficients A, B and C must be integers and, by convention, $A > 0$. In the case where $A = 0$, the equation is written as $By + C = 0$, with $B, C \in I$ and $B > 0$.
- Technology [T] has been identified as one of the mathematical processes to be emphasized in completing this outcome. It is expected, however, that students will be able to graph linear relations with and without the use of technology.
- In Achievement Indicator 6.3, students are expected to discover, through investigation, and generalize the strategies for graphing linear relations.
- The equations and graphs of vertical, e.g., ($B = 0$), and horizontal, e.g., ($A = 0$), lines are part of this outcome.
- On completion of this outcome, students are expected to relate the equation of a linear relation to a graph by comparing the characteristics as determined from the equation to the characteristics of the graph and vice versa.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
6.1 Express a linear relation in different forms, and compare the graphs.	✓ STUDENT RESOURCE MHR: p. 400, #10 Pearson: p. 385, #18, #19	
6.2 Rewrite a linear relation in either slope–intercept or general form.	✓ STUDENT RESOURCE MHR: p. 359, Example 1 p. 399, #4, #6 Pearson: p. 384, #12 p. 385, #18	
6.3 Generalize and explain strategies for graphing a linear relation in slope–intercept, general or slope–point form.	✓ Generalize and explain strategies for graphing a linear relation in slope–intercept or slope–point form. STUDENT RESOURCE MHR: p. 349, #2b; p. 369, #18 Pearson: p. 386, Reflect on the Chapter	✓ Generalize and explain strategies for graphing a linear relation in general form.

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Achievement Indicators	Acceptable Standard	Standard of Excellence
6.4 Graph, with and without technology, a linear relation given in slope–intercept, general or slope–point form, and explain the strategy used to create the graph.	✓ Graph and explain the strategy used. STUDENT RESOURCE MHR: p. 349, #2; p. 377, #4 Pearson: p. 362, #7	✓ Graph and explain more than one strategy that could be used. STUDENT RESOURCE MHR: p. 401, #13 Pearson: p. 383 Discuss the Ideas #1, #2
6.5 Identify equivalent linear relations from a set of linear relations.	✓ STUDENT RESOURCE MHR: p. 400, #10 Pearson: p. 385, #24	
6.6 Match a set of linear relations to their graphs.	✓ STUDENT RESOURCE MHR: p. 366, #6 Pearson: p. 390, #26	

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

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]

Notes

- Students are expected to determine the equation of a linear relation algebraically.
- Technology [T] has not been identified as one of the mathematical processes to be emphasized in completing this outcome. There may be some opportunities for students to use technology to investigate the equations of linear relations, given two or more points on the graph, but students are expected to meet this outcome without the use of technology.
- Linear regression is not part of this outcome.
- In Achievement Indicators 7.2, 7.3 and 7.4, students are expected to apply and explain multiple strategies to write the equation of a linear relation in each situation; e.g., given the slope and a point, students could substitute the coordinates of the point and the slope:
  - directly into the slope–point form to determine the equation of the linear relation
  - into the slope–intercept form of the equation to determine the *y*-intercept.
- In Achievement Indicators 7.2, 7.3 and 7.4, students are expected to explain the reasoning used in determining their equations.
- In Achievement Indicators 7.5 and 7.6, students are expected to identify any restrictions on the domain and range of the linear relation.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
7.1 Determine the slope and *y*-intercept of a given linear relation from its graph, and write the equation in the form $y = mx + b$.	✓ STUDENT RESOURCE MHR: p. 351, #8 Pearson: p. 360, Example 3 p. 360, CYU 3	
7.2 Write the equation of a linear relation, given its slope and the coordinates of a point on the line, and explain the reasoning.	✓ Write an equation with a partial explanation. STUDENT RESOURCE MHR: p. 377, #3 Pearson: p. 362, #5	✓ Write an equation with a complete explanation. STUDENT RESOURCE MHR: p. 397, #8 Pearson: p. 372, #8
7.3 Write the equation of a linear relation, given the coordinates of two points on the line, and explain the reasoning.	✓ Write an equation with a partial explanation. STUDENT RESOURCE MHR: p. 397, #9 Pearson: p. 372, #11	✓ Write an equation with a complete explanation. STUDENT RESOURCE MHR: p. 397, #9 Pearson: p. 390, #19
7.4 Write the equation of a linear relation, given the coordinates of a point on the line and the equation of a parallel or perpendicular line, and explain the reasoning.	✓ Write an equation with a partial explanation.	✓ Write an equation with a complete explanation. STUDENT RESOURCE MHR: p. 398, #14, #15 Pearson: pp. 370–371, Example 4 p. 370, CYU 4

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Achievement Indicators	Acceptable Standard	Standard of Excellence
7.5 Graph linear data generated from a context, and write the equation of the resulting line.	✓ Give a complete solution. STUDENT RESOURCE MHR: p. 396, #3 Pearson: p. 373, #16	✓ Give a complete solution, including restrictions on the domain and range. STUDENT RESOURCE MHR: p. 397, #7 Pearson: p. 373, #16
7.6 Solve a problem, using the equation of a linear relation.	✓ Give a complete solution. STUDENT RESOURCE MHR: p. 400, #11 Pearson: p. 384, #15	✓ Give a complete solution, including restrictions on the domain and range. STUDENT RESOURCE MHR: p. 300, Example 4 Pearson: p. 384, #15

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

8. Represent a linear function, using function notation. [CN, ME, V]

Notes

- It is important that students understand the meaning of the symbols used in function notation. Function notation will be used extensively to represent functions in grades 11 and 12.
- In using function notation, students are expected to choose variables that are meaningful in the context being described; e.g., if a linear relation describes the height of an object as a function of time, then the variables selected should reflect these quantities, as in $h(t) = 5t + 20$.
- A function of an algebraic expression, such as $f(2x - 3)$, is not part of this outcome.
- Students are expected to connect function notation to other representations of linear relations; i.e., words, ordered pairs, tables of values, graphs.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
8.1 Express the equation of a linear function in two variables, using function notation.	✓ STUDENT RESOURCE MHR: p. 311, #2 Pearson: p. 271, #6	
8.2 Express an equation given in function notation as a linear function in two variables.	✓ STUDENT RESOURCE MHR: p. 311, #3; p. 332, #9 Pearson: p. 271, #7	
8.3 Determine the related range value, given a domain value for a linear function; e.g., if $f(x) = 3x - 2$, determine $f(-1)$.	✓ STUDENT RESOURCE MHR: p. 308, Example 2a p. 311, #4a, b; #5a, b Pearson: p. 293, Example 4a	
8.4 Determine the related domain value, given a range value for a linear function; e.g., if $g(t) = 7 + t$, determine t so that $g(t) = 15$.	✓ STUDENT RESOURCE MHR: p. 308, Example 2b p. 311, #4c; #5c Pearson: p. 293, Example 4b	
8.5 Sketch the graph of a linear function expressed in function notation.	✓ STUDENT RESOURCE MHR: p. 309, Example 3 p. 312, #7 Pearson: p. 315, Example 2 p. 315, CYU 2	

Relations and Functions (continued)

Specific Outcome

It is expected that students will:

9. Solve problems that involve systems of linear equations in two variables, graphically and algebraically.
   [CN, PS, R, T, V]
   [ICT: C6–4.1]

Notes

- Students are expected to apply multiple strategies in solving systems of equations.
- While students are expected to solve most systems of equations algebraically, it is important that they be able to connect the solution with the graphical representation of the system.
- Technology [T] has been identified as one of the mathematical processes to be addressed in completing this outcome. For some systems of equations, technology may be a more efficient way to solve the systems.
- Strategies selected should be appropriate for the system of equations being solved.
- The systems of equations may include the equations of horizontal or vertical lines.
- In Achievement Indicator 9.1, students are expected to select variables that are contextually appropriate.
- In Achievement Indicator 9.7, students are expected to explain why they chose a particular strategy to solve a system of linear equations.

Achievement Indicators

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome.*

Achievement Indicators	Acceptable Standard	Standard of Excellence
9.1 Model a situation, using a system of linear equations.	✓ Model a given simple situation. STUDENT RESOURCE MHR: p. 434, Example 1a Pearson: p. 397, Example 1 p. 397, CYU 1	✓ Solve a given complex situation in which additional information may be needed. STUDENT RESOURCE MHR: p. 436, Example 2a Pearson: p. 402, #11
9.2 Relate a system of linear equations to the context of a problem.	✓ Give a partial explanation. STUDENT RESOURCE MHR: p. 463, #5; p. 465, #12 Pearson: p. 401, #6	✓ Give a complete explanation, including any restrictions on the domain and range. STUDENT RESOURCE MHR: p. 463, #5; p. 465, #12 Pearson: p. 401, #6
9.3 Determine and verify the solution of a system of linear equations graphically, with and without technology.	✓ STUDENT RESOURCE MHR: pp. 420–422, Example 2 Pearson: p. 405, Example 1 p. 405, CYU 1	

(continued)

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Achievement Indicators	Acceptable Standard	Standard of Excellence
9.4 Explain the meaning of the point of intersection of a system of linear equations.	✓ STUDENT RESOURCE MHR: p. 424, Example 4b Pearson: p. 409, #5	
9.5 Determine and verify the solution of a system of linear equations algebraically.	✓ STUDENT RESOURCE MHR: pp. 472–473, Example 2 pp. 482–483, Example 1 Pearson: p. 436, Example 4 p. 436, CYU 4	
9.6 Explain, using examples, why a system of equations may have no solution, one solution or an infinite number of solutions.	✓ Give a partial explanation. STUDENT RESOURCE MHR: pp. 451–452, Example 2 Pearson: pp. 444–445, Example 1 p. 444, CYU 1	✓ Give a complete explanation. STUDENT RESOURCE MHR: pp. 451–452, Example 2 Pearson: p. 447, Discuss the Ideas
9.7 Explain a strategy to solve a system of linear equations.	✓ Explain a strategy. STUDENT RESOURCE MHR: p. 509, #13 Pearson: p. 450, Reflect on the Chapter	✓ Explain a strategy and justify the choice of method. STUDENT RESOURCE MHR: p. 509, #13 Pearson: p. 439, Reflect
9.8 Solve a problem that involves a system of linear equations.	✓ STUDENT RESOURCE MHR: p. 499, #6 Pearson: p. 438, #16	

Appendix: Mathematics Directing Words

Discuss	The word "discuss" **will not** be used as a directing word on mathematics examinations because it is not used consistently to mean a single activity.
	The following words are specific in meaning.
Algebraically	Use mathematical procedures that involve letters or symbols to represent numbers.
Analyze	Make a mathematical or methodical examination of parts to determine aspects of the whole; e.g., nature, proportion, function, interrelationship.
Compare	Examine the character or qualities of two things by providing characteristics of both that point out their mutual similarities and differences.
Conclude	State a logical end based on reasoning and/or evidence.
Contrast/Distinguish	Point out the differences between two things that have similar or comparable natures.
Criticize	Point out the merits and demerits of an item or issue.
Define	Provide the essential qualities or meaning of a word or concept; make distinct and clear by marking out the limits.
Describe	Give a written account or represent the characteristics of something, using a figure, model or picture.
Design/Plan	Construct a plan, i.e., a detailed sequence of actions, for a specific purpose.
Determine	Find a solution to a problem, to a specified degree of accuracy, by showing appropriate formulas, procedures and calculations.
Enumerate	Specify one-by-one or list in a concise form and according to some order.
Evaluate	Give the significance or worth of something by identifying the good and bad points or the advantages and disadvantages.
Explain	Make clear what is not immediately obvious or entirely known; give the cause of or reason for; make known in detail.
Graphically	Use a drawing that is produced electronically or by hand and that shows a relation between certain sets of numbers.

How	Show in what manner or way, with what meaning.
Hypothesize	Form a tentative proposition intended as a possible explanation for an observed phenomenon; i.e., a possible cause for a specific effect. The proposition should be testable logically and/or empirically.
Identify	Recognize and select as having the characteristics of something.
Illustrate	Make clear by providing an example. The form of the example must be specified in the question; i.e., word description, sketch or diagram.
Infer	Form a generalization from sample data; arrive at a conclusion by reasoning from evidence.
Interpret	State the meaning of something; present information in a new form that adds meaning to the original data.
Justify/Show How	Show reasons for or give facts that support a position.
Model	Find a model that does a good job of representing a situation. In mathematics, a model of a situation is a pattern that is supposed to represent or set a standard for a real situation.
Outline	Give, in an organized fashion, the essential parts of something. The form of the outline must be specified in the question; i.e., lists, flowcharts, concept maps.
Predict	State in advance on the basis of empirical evidence and/or logic.
Prove	Establish the truth or validity of a statement for the general case by providing factual evidence or a logical argument.
Relate	Show a logical or causal connection between things.
Sketch	Provide a drawing that represents the key features of an object or a graph.
Solve	Give a solution for a problem; i.e., explanation in words and/or numbers.
Summarize	Give a brief account of the main points.
Trace	Give a step-by-step description of the development.
Verify	Establish, by substitution for a particular case or by geometric comparison, the truth of a statement.
Why	Show the cause, reason or purpose.