# Outcomes with Assessment Standards
# for
# Mathematics 10-3

## 2012

This resource is intended to assist teachers with the
provincial implementation of Mathematics 10-3.

Alberta

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The primary audience for this resource is:

| | |
|---|---|
| Teachers | ✓ |
| Administrators | |
| Students | |
| Parents | |

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## INTRODUCTION

Mathematics 10-3 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 10-3* 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 10-3 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 10-3 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 10-3**

The assessment standards for Mathematics 10-3 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 10-3, published by Pacific Educational Press, are:

- MathWorks 10: Student Resource; and
- MathWorks 10: Teacher Resource.

**Acceptable Standard**

The *acceptable standard* of achievement in Mathematics 10-3 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 10-3 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 10-3 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 10-3 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 10-3 consistently perform acceptable work on routine and obvious tasks in familiar contexts. | Students who meet the *standard of excellence* in Mathematics 10-3 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 10-3 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 10-3, 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.
- Teachers should try to provide students with illustrative examples and contextual problems that are representative of the trades.
- 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 10-3, published by Pacific Educational Press, are:
  - MathWorks 10: Student Resource; and
  - MathWorks 10: Teacher Resource.
- 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.

# Topic: Measurement

**General Outcome**: Develop spatial sense through direct and indirect measurement.

**Specific Outcome**

*It is expected that students will:*

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]

**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 exposure to and experience with imperial units of measure. Some commerce in Canada, primarily involving imports from and exports to the United States, is still conducted in imperial units. Trades, such as those involved in the building industry, continue to use imperial units of measure to define standard dimensions of materials.
- This is the first time that imperial units are formally addressed in the Kindergarten to Grade 12 curriculum.
- Students may not be familiar with the units for length, area, volume, capacity, mass and temperature in the SI and imperial systems of measurement.
- Measurements in the imperial system are expressed primarily in fraction form, while measurements in the SI system are expressed in decimal form.
- Students are expected to perform the four arithmetic operations on decimals and fractions with and without the use of technology.
- Denominators for fractional measurements should be contextually appropriate; e.g., in construction, halves, quarters, eighths, sixteenths, thirty-seconds and sixty-fourths.
- Students should be encouraged to use diagrams to develop a conceptual understanding of square and cubic units of measure.
- Measurements in the SI system that use prefixes deci, centi and milli are expressed as decimals.
- Negative exponents are not an outcome for the course and have not been studied in previous grades (e.g., $\frac{1}{100}$ not $10^{-2}$).
- Proportional reasoning solves for an unknown value by comparing the unknown value to known values, using ratios and proportions. Students are expected to use 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. Conversions between systems should not be completed by entering data into a conversion program. Technology may be used, where appropriate, in solving a proportion.
- The base SI unit of thermodynamic temperature is Kelvin, but the intent of the outcome is to establish the relationship between Fahrenheit and Celsius temperature measures.
- Students are not expected to memorize long lists of conversion factors. Basic conversion factors, especially those between the SI and imperial systems of measure, shall be provided.
- When converting from SI to imperial, decimals are acceptable in the resulting imperial units. Converting the resulting decimal to the nearest practical fraction could be developed as an enrichment activity.

**Achievement Indicators**

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome. (It is intended that this outcome be limited to the base units and the prefixes milli, centi, deci, deca, hecto and kilo.)*

| Achievement Indicators | Acceptable Standard | Standard of Excellence |
|---|---|---|
| 1.1 Explain how the SI system was developed, and explain its relationship to base ten. | ✓ | |
| 1.2 Identify the base units of measurement in the SI system, and determine the relationship among the related units of each type of measurement. | ✓ | |
| 1.3 Identify contexts that involve the SI system. | ✓ | |
| 1.4 Match the prefixes used for SI units of measurement with the powers of ten. | ✓ | |
| 1.5 Explain, using examples, how and why decimals are used in the SI system. | ✓ Provide a partial explanation, with examples, as to how and why the SI system uses decimals. | ✓ Provide a complete explanation, with examples, as to how and why the SI system uses decimals. |
| 1.6 Provide an approximate measurement in SI units for a measurement given in imperial units; e.g., 1 inch is approximately 2.5 cm. | ✓ STUDENT RESOURCE : p. 111, #3 | |
| 1.7 Write a given linear measurement expressed in one SI unit in another SI unit. | ✓ STUDENT RESOURCE : p. 134, #1 | |
| 1.8 Convert a given measurement from SI to imperial units by using proportional reasoning (including formulas); e.g., Celsius to Fahrenheit, centimetres to inches. | ✓ Complete simple conversions involving units given in the conversion factor. STUDENT RESOURCE : p. 111, #2 STUDENT RESOURCE : p. 144, #4 | ✓ Perform multistep conversions where the given units do not match the units in the conversion factor. STUDENT RESOURCE : p. 111, #1 |

## Measurement (continued)

**Specific Outcome**

*It is expected that students will:*

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]

**Notes**

- Students may not be familiar with the units for length, area, volume, capacity, mass and temperature in the SI and imperial systems of measurement.
- British and American imperial units for capacity are not the same. The adoption of the SI system of measurement was done by many countries to establish a uniform system of measurement for commerce.
- Measurements in the imperial system are expressed primarily in fraction form, while measurements in the SI system are expressed in decimal form.
- Students are expected to perform the four arithmetic operations on decimals and fractions with and without the use of technology.
- Denominators for fractional measurements should be contextually appropriate; e.g., in construction, halves, quarters, eighths, sixteenths, thirty-seconds and sixty-fourths.
- Students should be encouraged to use diagrams to develop a conceptual understanding of square and cubic units of measure.
- Technology [T] has not been identified as one of the mathematical processes to be emphasized in completing this outcome. Conversions between systems should not be completed by entering data into a conversion program. Technology may be used, where appropriate, in solving a proportion.
- Proportional reasoning solves for an unknown value by comparing the unknown value to known values, using ratios and proportions. Students are expected to use proportional reasoning when converting units within and between the two measurement systems.
- Contexts for the imperial system should be relevant; e.g., measurements in a recipe, building materials, landscaping, travelling to countries that use the imperial system of measure.
- Students are not expected to memorize long lists of conversion factors. Basic conversion factors, especially those between the SI and imperial systems of measure, shall be provided.
- Conversions between SI and imperial units should be limited to commonly used linear units of measure; e.g., centimetres $\leftrightarrow$ inches, metres $\leftrightarrow$ yards or kilometres $\leftrightarrow$ miles. Unusual conversions, e.g., converting miles to millimetres, should be avoided.

**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 the imperial system was developed. | ✓ | |
| 2.2 | Identify commonly used units in the imperial system, and determine the relationships among the related units. | ✓ | |
| 2.3 | Identify contexts that involve the imperial system. | ✓ | |
| 2.4 | Explain, using examples, how and why fractions are used in the imperial system. | ✓ Provide a partial explanation, with examples, as to how and why the imperial system uses fractions. | ✓ Provide a complete explanation, with examples, as to how and why the imperial system uses fractions. |
| 2.5 | Compare the American and British imperial measurement systems; e.g., gallons, bushels, tons. | ✓ STUDENT RESOURCE : p. 132, #4 | |
| 2.6 | Provide an approximate measure in imperial units for a measurement given in SI units; e.g., 1 litre is approximately $\frac{1}{4}$ US gallon. | ✓ STUDENT RESOURCE : p. 111, Mental Math & Estimation | |
| 2.7 | Write a given linear measurement expressed in one imperial unit in another imperial unit. | ✓ STUDENT RESOURCE : p. 102, Mental Math & Estimation | |
| 2.8 | Convert a given measure from imperial to SI units by using proportional reasoning (including formulas); e.g., Fahrenheit to Celsius, inches to centimetres. | ✓ Complete simple conversions involving units given in the conversion factor. STUDENT RESOURCE : p. 132, #1 STUDENT RESOURCE : p. 144, #3 | ✓ Perform multistep conversions where the given units do not match the units in the conversion factor. STUDENT RESOURCE : p. 166, #5b |

## Measurement (continued)

**Specific Outcome**

*It is expected that students will:*

3. Solve and verify problems that involve SI and imperial linear measurements, including decimal and fractional measurements. [CN, ME, PS, V]

**Notes**

- Students are expected to perform the four arithmetic operations on decimals and fractions with and without the use of technology.
- Denominators for fractional measurements should be contextually appropriate; e.g., in construction, halves, quarters, eighths, sixteenths, thirty-seconds and sixty-fourths.
- A referent is something familiar that can be used to estimate a measurement. While there are some commonly used measurement referents; e.g., 1 foot is approximately the length of a person's foot, students are expected to develop their own referents for the basic units of length in each system.
- It is expected that students will use a variety of measuring instruments; e.g., ruler, yardstick, metre-stick, measuring tape, thermometer, trundle wheel, caliper, micrometer, laser, sonar.

**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 four arithmetic operations on decimals and fractions be integrated into the problems.)*

| Achievement Indicators | | Acceptable Standard | Standard of Excellence |
|---|---|---|---|
| 3.1 | Identify a referent for a given common SI or imperial unit of linear measurement. | ✓ Identify referents for millimetre, centimetre, metre, inch, foot, yard, kilometre and mile.<br>STUDENT RESOURCE : p. 96, Activity 3.1, #4 | |
| 3.2 | Estimate a linear measurement, using a referent. | ✓<br>STUDENT RESOURCE : p. 97, Activity 3.1, #5 | |
| 3.3 | Measure inside diameters, outside diameters, lengths, widths of various given objects, and distances, using various measuring instruments. | ✓ Determine measurements with reasonable accuracy. | ✓ Determine measurements with consistency and greater accuracy. |
| 3.4 | Estimate the dimensions of a given regular 3-D object or 2-D shape, using a referent; e.g., the height of the desk is about three rulers long, so the desk is approximately three feet high. | ✓<br>STUDENT RESOURCE : p. 97, Activity 3.1, #5 | |
| 3.5 | Solve a linear measurement problem including perimeter, circumference, and length + width + height (used in shipping and air travel). | ✓<br>STUDENT RESOURCE : p. 102, #3, 4 | |
| 3.6 | Determine the operation that should be used to solve a linear measurement problem. | ✓<br>STUDENT RESOURCE : p. 103, #6 | |

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| Achievement Indicators | | Acceptable Standard | Standard of Excellence |
|---|---|---|---|
| 3.7 | Provide an example of a situation in which a fractional linear measurement would be divided by a fraction. | ✓ Provide an example of a situation in which a fraction is divided by a whole number.<br>STUDENT RESOURCE: p. 116, Activity 3.6 | ✓ Provide an example of a situation in which a fraction is divided by a fraction.<br>STUDENT RESOURCE: pp. 101–102, Activity 3.3 |
| 3.8 | Determine, using a variety of strategies, the midpoint of a linear measurement such as length, width, height, depth, diagonal and diameter of a 3-D object, and explain the strategies. | ✓ Solve a problem, in which a diagram is given, using one strategy with a partial explanation. | ✓ Solve a problem, in which a diagram is not given, using multiple strategies and a complete explanation. |
| 3.9 | Determine if a solution to a problem that involves linear measurement is reasonable. | ✓ Identify and correct an obvious error in a solution. | ✓ Identify and correct a less obvious error in a solution. |

## Measurement (continued)

**Specific Outcome**

*It is expected that students will:*

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]

**Notes**

- Prior knowledge from previous grade levels includes the:
  - surface area of right rectangular prisms, right triangular prisms and right cylinders (Grade 8)
  - surface area of composite 3-D objects (Grade 9).
- Students are expected to perform the four arithmetic operations on decimals and fractions with or without the use of technology.
- Denominators for fractional measurements should be contextually appropriate; e.g., in construction, halves, quarters, eighths, sixteenths, thirty-seconds and sixty-fourths.
- A referent is something familiar that can be used to estimate a measurement. Students are expected to develop their own referents for the basic units of area in each system.
- Estimates using referents should be checked to allow students to adjust their referents.
- Students are expected to sketch diagrams to help them develop conceptual understanding.
- Conversion factors should be developed with visualization; e.g., a square foot measures 1 foot by 1 foot; therefore, since 1 foot is equivalent to 12 inches, a square foot can be written as 12 inches by 12 inches or 144 square inches.
- Students are expected to write area units carefully to avoid confusion; e.g., 3 square feet is not the same as a 3-foot square. A 3-foot square has an area of 9 square feet.
- Teachers are expected to develop conversion factors and formulas with students.
- In problems that involve multiple steps, rounding in calculations is to be done only after the last step.
- Contextual applications should be relevant and authentic.

**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 four arithmetic operations on decimals and fractions be integrated into the problems.)*

| Achievement Indicators | | Acceptable Standard | Standard of Excellence |
|---|---|---|---|
| 4.1 | Identify and compare referents for area measurements in SI and imperial units. | ✓ | |
| 4.2 | Estimate an area measurement, using a referent. | ✓ STUDENT RESOURCE : p. 111, Discuss the Ideas | |
| 4.3 | Identify a situation where a given SI or imperial area unit would be used. | ✓ | |
| 4.4 | Estimate the area of a given regular, composite or irregular 2-D shape, using an SI square grid and an imperial square grid. | ✓ Estimate the area of regular shapes and irregular shapes that can be broken into regular shapes. | ✓ Estimate the area of irregular or composite shapes. STUDENT RESOURCE : p. 111, Discuss the Ideas |
| 4.5 | Solve a contextual problem that involves the area of a regular, a composite or an irregular 2-D shape. | ✓ Solve problems involving no more than two shapes. STUDENT RESOURCE : p. 111, #4 | ✓ Solve problems involving more than two shapes. STUDENT RESOURCE : p. 112, #8 |
| 4.6 | Write a given area measurement expressed in one SI unit squared in another SI unit squared. | ✓ Convert area measurement in the SI system if given the conversion factor. | ✓ Convert area measurement in the SI system even if the conversion factor must be developed. |
| 4.7 | Write a given area measurement expressed in one imperial unit squared in another imperial unit squared. | ✓ Convert area measurement in the imperial system if given the conversion factor. | ✓ Convert area measurement in the imperial system even if the conversion factor must be developed. |

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| Achievement Indicators | | Acceptable Standard | Standard of Excellence |
|---|---|---|---|
| 4.8 | Solve a problem, using formulas for determining the areas of regular, composite and irregular 2-D shapes, including circles. | ✓ Solve area problems involving 2-D shapes in which a diagram is given.<br>STUDENT RESOURCE : p. 120, Activity 3.8 | ✓ Solve area problems involving 2-D shapes in which a diagram is given but a measurement is not explicit.<br>STUDENT RESOURCE : p. 113, #9 |
| 4.9 | Solve a problem that involves determining the surface area of 3-D objects, including right cylinders and cones. | ✓ Solve surface area problems involving 3-D objects in which a diagram and all related measurements are given.<br>STUDENT RESOURCE : p. 121, #3 | ✓ Solve surface area problems involving 3-D objects in which a diagram is given but a related measurement is not given.<br>STUDENT RESOURCE : p. 121, #4 |
| 4.10 | Explain, using examples, the effect of changing the measurement of one or more dimensions on area and perimeter of rectangles. | ✓ Provide a full explanation when one dimension is changed or a partial explanation when two dimensions are changed.<br>STUDENT RESOURCE : p. 111, Discuss the Ideas | ✓ Provide a full explanation when two dimensions are changed.<br>STUDENT RESOURCE : p. 111, Discuss the Ideas |
| 4.11 | Determine if a solution to a problem that involves an area measurement is reasonable. | ✓ Identify and correct an obvious error in a solution. | ✓ Identify and correct a less obvious error in a solution. |

## Topic: Geometry

**General Outcome**: Develop spatial sense.

**Specific Outcome**

*It is expected that students will:*

1. Analyze puzzles and games that involve spatial reasoning, using problem-solving strategies.
   [C, CN, PS, R]

**Notes**

- Puzzles and games used should involve spatial reasoning. Numerical reasoning and logical reasoning are addressed in grades 11 and 12, respectively.
- Problem-solving strategies are crucial and will vary in the analysis of puzzles and games.
- Students can use familiar puzzles and games or discover new ones.
- A variety of puzzles and games should be used; e.g.,
  - board games
  - online puzzles and games
  - appropriate selections for gaming systems
  - pencil and paper games.
- One source of online puzzles and games is the National Library of Virtual Manipulatives.
- Puzzles and games involving spatial reasoning could include Lights Out, Fifteen Puzzles, Pattern Blocks, Peg Puzzle, Pentominoes, Polyominoes, Towers of Hanoi, Magic Squares, Tic-Tac-Toe, Pythagorean Puzzles, Connect Four, Nim, Checkers, Sequence, Jenga, KerPlunk, Tangrams, Othello, Dots and Boxes (Capture), Pipelayer, Sprouts, Tower Defense Games, Battleship, Tetris and Rush Hour Traffic.

**Achievement Indicators**

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome. (It is intended that this outcome be integrated throughout the course by using sliding, rotation, construction, deconstruction and similar puzzles and games.)*

| Achievement Indicators | Acceptable Standard | Standard of Excellence |
|---|---|---|
| 1.1 Determine, explain and verify a strategy to solve a puzzle or to win a game; e.g.,<br>• guess and check<br>• look for a pattern<br>• make a systematic list<br>• draw or model<br>• eliminate possibilities<br>• simplify the original problem<br>• work backward<br>• develop alternative approaches. | ✓ Determine and verify a strategy.<br>STUDENT RESOURCE : p. 22, Puzzle it Out | ✓ Provide a complete explanation of the strategy and communicate the strategy to others.<br>STUDENT RESOURCE : p. 218, Puzzle it Out |
| 1.2 Identify and correct errors in a solution to a puzzle or in a strategy for winning a game. | ✓ Identify and correct an obvious error in a simple puzzle or game.<br>STUDENT RESOURCE : p. 314, Puzzle it Out | ✓ Identify and correct a less obvious error in a complex puzzle or game.<br>STUDENT RESOURCE : p. 131, Puzzle it Out |
| 1.3 Create a variation on a puzzle or a game, and describe a strategy for solving the puzzle or winning the game. | ✓ Modify a puzzle or game with a simple variation and provide revised rules and strategies.<br>STUDENT RESOURCE : p. 71, Puzzle it Out | ✓ Modify a puzzle or game with a complex variation and provide revised rules and strategies.<br>STUDENT RESOURCE : p. 255, Puzzle it Out |

## Geometry (continued)

**Specific Outcome**

*It is expected that students will:*

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]

**Notes**

- Prior knowledge from previous grade levels includes:
  - the Pythagorean theorem (Grade 8)
  - square roots (Grade 8)
  - similar polygons (Grade 9).
- Right angles can be described in context using terminology; e.g., perpendicular, plumb or square.
- Algebra skills may be reinforced by having students manipulate the Pythagorean theorem formula to find the length of a leg rather than the hypotenuse (see Topic: Algebra, Specific Outcome 1).
- Students are expected to create sketches to illustrate situations described in problems.
- In problems that involve multiple steps, rounding in calculations is to be done only after the last step.
- Right triangles should be given in various orientations.

**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 illustrations, why the Pythagorean theorem only applies to right triangles. | ✓ STUDENT RESOURCE : p. 278, Activity 7.2 | |
| 2.2 Verify the Pythagorean theorem, using examples and counterexamples, including drawings, concrete materials and technology. | ✓ STUDENT RESOURCE : p. 278, Activity 7.2 | |
| 2.3 Describe historical and contemporary applications of the Pythagorean theorem. | ✓ STUDENT RESOURCE : p. 272, Math on the Job<br>STUDENT RESOURCE : p. 275, Discuss the Ideas | |
| 2.4 Determine if a given triangle is a right triangle, using the Pythagorean theorem. | ✓ STUDENT RESOURCE : p. 316, #1 | |
| 2.5 Explain why a triangle with the side length ratio of 3:4:5 is a right triangle. | ✓ STUDENT RESOURCE : p. 275, Discuss the Ideas, #1, 2 | ✓ Identify other Pythagorean triplets. STUDENT RESOURCE : p. 275, Discuss the Ideas, #3, 4 |
| 2.6 Explain how the ratio of 3:4:5 can be used to determine if a corner of a given 3-D object is square (90°) or if a given parallelogram is a rectangle. | | ✓ Develop and use alternative strategies to test for a square corner. |

(continued)

(continued)

| Achievement Indicators | Acceptable Standard | Standard of Excellence |
|---|---|---|
| 2.7 Solve a problem, using the Pythagorean theorem. | ✓ Solve for the length of any side in a right triangle, with or without a diagram given in the question.<br>STUDENT RESOURCE: p. 278, Build Your Skills, #1a | ✓ Solve a multiple-step problem where more than one right triangle is required to solve for the length of an unknown side.<br>STUDENT RESOURCE: p. 278, Build Your Skills, #1b |

## Geometry (continued)

**Specific Outcome**

*It is expected that students will:*

3. Demonstrate an understanding of similarity of convex polygons, including regular and irregular polygons.
   [C, CN, PS, V]

**Notes**

- Prior knowledge from previous grade levels includes:
  - geometric constructions; i.e., bisecting angles, bisecting segments and perpendicular bisectors (Grade 7)
  - the sum of interior angles in triangles (Grade 7)
  - the similarity of polygons and drawing scale diagrams (Grade 9).
- Students require a compass, ruler and protractor to complete Achievement Indicator 3.5.
- Interior angles and sums of interior angles of convex polygons are studied. Concave polygons are not explored.
- Students are expected to develop strategies to reproduce angles from a sketch.
- Achievement Indicator 3.6 refers to "nested" right triangles and provides a foundation for the development of trigonometry in Specific Outcome 4 (Topic: Geometry).
- Contextual problems that are relevant and authentic should be taken from the trades or the workplace.
- Examples and nonexamples should be used to identify regular polygons, irregular polygons and convex polygons.

**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, using angle measurements, if two or more regular or irregular polygons are similar. | ✓ STUDENT RESOURCE : p. 233, #3 | |
| 3.2 Determine, using ratios of side lengths, if two or more regular or irregular polygons are similar. | ✓ STUDENT RESOURCE : p. 234, #5 | |
| 3.3 Explain why two given polygons are not similar. | ✓ STUDENT RESOURCE : pp. 244–245, #7 | |
| 3.4 Explain the relationships between the corresponding sides of two polygons that have corresponding angles of equal measure. | ✓ STUDENT RESOURCE : p. 233, #4 | |
| 3.5 Draw a polygon that is similar to a given polygon. | ✓ STUDENT RESOURCE : p. 253, #2 | |
| 3.6 Explain why two or more right triangles with a shared acute angle are similar. | ✓ Provide a partial explanation. STUDENT RESOURCE : p. 261, #1 | ✓ Provide a complete explanation. STUDENT RESOURCE : p. 259, Example 1 |
| 3.7 Solve a contextual problem that involves similarity of polygons. | ✓ Solve simple problems involving similar polygons. STUDENT RESOURCE : p. 234, #6 | ✓ Solve complex problems involving similar polygons. STUDENT RESOURCE : p. 254, #5 |

## Geometry (continued)

**Specific Outcome**

*It is expected that students will:*

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]

**Notes**

- Prior knowledge from previous grade levels includes:
  – the Pythagorean theorem (Grade 8)
  – similar polygons (Grade 9).
- This is the first time trigonometry is developed in the Kindergarten to Grade 12 curriculum.
- Conceptual understanding of the trigonometric ratios should be developed through an understanding of similar triangles.
- In problems that involve multiple steps, rounding in calculations is to be done only after the last step.
- Algebra skills may be reinforced by having students manipulate a trigonometric equation to isolate the unknown value (Topic: Algebra, Specific Outcome 1).
- Proportions are used to calculate an indirect measurement when direct measurement is not possible or feasible; e.g., height of a tree.
- Estimation should be encouraged to check if answers are "reasonable."
- Students are expected to visualize and model to assist in problem solving.

**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 Show, for a specified acute angle in a set of similar right triangles, that the ratios of the length of the side opposite to the length of the side adjacent are equal, and generalize a formula for the tangent ratio. | ✓ | |
| 4.2 Show, for a specified acute angle in a set of similar right triangles, that the ratios of the length of the side opposite to the length of the hypotenuse are equal, and generalize a formula for the sine ratio. | ✓<br>STUDENT RESOURCE : pp. 283–284, Explore the Math | |
| 4.3 Show, for a specified acute angle in a set of similar right triangles, that the ratios of the length of the side adjacent to the length of the hypotenuse are equal, and generalize a formula for the cosine ratio. | ✓<br>STUDENT RESOURCE : pp. 293–294, Explore the Math | |
| 4.4 Identify situations where the trigonometric ratios are used for indirect measurement of angles and lengths. | ✓<br>STUDENT RESOURCE : p. 305, #1 | |
| 4.5 Solve a contextual problem that involves right triangles, using the primary trigonometric ratios. | ✓ Solve problems involving one triangle where a diagram is given.<br>STUDENT RESOURCE : p. 311, #1 | ✓ Solve problems involving one triangle where a diagram is not given or involving more than one triangle where a diagram is given.<br>STUDENT RESOURCE : p. 312, #2<br>STUDENT RESOURCE : p. 316, #5 |
| 4.6 Determine if a solution to a problem that involves primary trigonometric ratios is reasonable. | ✓ Provide case-specific justification. | ✓ Develop personal strategies for checking if solutions are reasonable. |

## Geometry (continued)

**Specific Outcome**

*It is expected that students will:*

5. Solve problems that involve parallel, perpendicular and transversal lines, and pairs of angles formed between them. [C, CN, PS, V]

**Notes**

- Prior knowledge from previous grade levels includes parallel and perpendicular line construction (Grade 7).
- Protractors should be used to develop some of the angle relationships.
- Teaching Specific Outcome 6 (Topic: Geometry) first may assist in the successful completion of this outcome.
- Technology [T] has not been identified as one of the mathematical processes to be emphasized in completing this outcome. Technology may be used to develop understanding of the relationships of angles formed by parallel lines and a transversal.
- Achievement Indicator 5.7 connects to Topic: Geometry, Specific Outcome 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 Sort a set of lines as perpendicular, parallel or neither, and justify this sorting. | ✓ | |
| 5.2 Illustrate and describe complementary and supplementary angles. | ✓ STUDENT RESOURCE : p. 191, Activity 5.5 | |
| 5.3 Identify, in a set of angles, adjacent angles that are not complementary or supplementary. | ✓ | |
| 5.4 Identify and name pairs of angles formed by parallel lines and a transversal, including corresponding angles, vertically opposite angles, alternate interior angles, alternate exterior angles, interior angles on same side of transversal and exterior angles on same side of transversal. | ✓ STUDENT RESOURCE : pp. 209–210, Explore the Math | |
| 5.5 Explain and illustrate the relationships of angles formed by parallel lines and a transversal. | ✓ STUDENT RESOURCE : p. 213, Example 2 | |
| 5.6 Explain, using examples, why the angle relationships do not apply when the lines are not parallel. | ✓ STUDENT RESOURCE : pp. 206–207, #4 | |
| 5.7 Determine if lines or planes are perpendicular or parallel, e.g., wall perpendicular to floor, and describe the strategy used. | ✓ Provide a solution without a description of the strategies used. STUDENT RESOURCE : p. 214, #2 | ✓ Provide a solution with a description of the strategies used. STUDENT RESOURCE : pp. 214–215, #3 |
| 5.8 Determine the measures of angles involving parallel lines and a transversal, using angle relationships. | ✓ STUDENT RESOURCE : p. 215, #4 | |
| 5.9 Solve a contextual problem that involves angles formed by parallel lines and a transversal (including perpendicular transversals). | ✓ Solve simple problems. STUDENT RESOURCE : p. 216, #7 | ✓ Solve complex problems. STUDENT RESOURCE : p. 223, #8 |

## Geometry (continued)

**Specific Outcome**

*It is expected that students will:*

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]

**Notes**

- Prior knowledge from previous grade levels includes:
  - geometric constructions; e.g., bisecting angles, bisecting segments and perpendicular bisectors (Grade 7)
  - the sum of interior angles in triangles (Grade 7)
  - the similarity of polygons and drawing scale diagrams (Grade 9).
- A referent is something familiar that can be used to estimate a value; e.g., the face on an analog clock can be used to estimate the measure of an angle.
- A Mira is an I-beam piece of red translucent acrylic plastic used for geometric constructions and investigations.

**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 | Draw and describe angles with various measures, including acute, right, straight, obtuse and reflex angles. | ✓ STUDENT RESOURCE : p. 179, Activity 5.1 | |
| 6.2 | Identify referents for angles. | ✓ STUDENT RESOURCE : p. 181, Activity 5.2 | |
| 6.3 | Sketch a given angle. | ✓ STUDENT RESOURCE : p. 185, #5 | |
| 6.4 | Estimate the measure of a given angle, using $22.5^o$, $30^o$, $45^o$, $60^o$, $90^o$ and $180^o$ as referent angles. | ✓ STUDENT RESOURCE : p. 184, #4 | |
| 6.5 | Measure, using a protractor, angles in various orientations. | ✓ STUDENT RESOURCE : p. 184, #2 | |
| 6.6 | Explain and illustrate how angles can be replicated in a variety of ways; e.g., Mira, protractor, compass and straightedge, carpenter's square, dynamic geometry software. | ✓ STUDENT RESOURCE : pp. 175–178, Example 1 | |
| 6.7 | Replicate angles in a variety of ways, with and without technology. | ✓ Replicate acute and obtuse angles. | ✓ Replicate a reflex angle. |
| 6.8 | Bisect an angle, using a variety of methods. | ✓ STUDENT RESOURCE : pp. 188–190, Example 1 | |
| 6.9 | Solve a contextual problem that involves angles. | ✓ Solve simple problems. STUDENT RESOURCE : p. 194, #5 | ✓ Solve complex problems. STUDENT RESOURCE : pp. 190–191, Activity 5.4 |

## Topic: Number

**General Outcome**: Develop number sense and critical thinking skills.

**Specific Outcome**

*It is expected that students will:*

1. Solve problems that involve unit pricing and currency exchange, using proportional reasoning.
   [CN, ME, PS, R]
   [ICT: F2–4.7]

**Notes**

- Students have studied percentages and their applications in grades 6 to 8.
- Proportional reasoning solves for an unknown value by comparing the unknown value to known values, using ratios and proportions.
- Cross multiplication should not be used as an isolated strategy for developing conceptual understanding.
- Unit rates can be used as a strategy to solve exchange rate, ratio and proportion problems.
- Consumer awareness should be developed through discussing, explaining and comparing the factors that can influence the decision to purchase an item or a service.
- Currency exchange rates quoted in the media do not reflect the actual rate that will be charged to exchange a currency.
- The price to buy or sell currencies is different and is set by the individual institution.
- Exchange rates fluctuate so the rates quoted in the resource will differ from the current exchange rates.
- Rounding of exchange rates could be one strategy to estimate costs in Achievement Indicator 1.7.

**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 | Compare the unit price of two or more given items. | ✓<br>STUDENT RESOURCE: pp. 25–26, Activity 1.3 | |
| 1.2 | Solve problems that involve determining the best buy, and explain the choice in terms of the cost as well as other factors, such as quality and quantity. | ✓ Provide an explanation that includes cost.<br>STUDENT RESOURCE: p. 27, #4 | ✓ Provide an explanation that includes cost and the influence of one or more other factors.<br>STUDENT RESOURCE: p. 26, Build Your Skills, #3 |
| 1.3 | Compare, using examples, different sales promotion techniques; e.g., deli meat at $2 per 100 g seems less expensive than $20 per kilogram. | ✓<br>STUDENT RESOURCE: p. 37, Build Your Skills, #3 | |
| 1.4 | Determine the percent increase or decrease for a given original and new price. | ✓<br>STUDENT RESOURCE: p. 38, #6 | |
| 1.5 | Solve, using proportional reasoning, a contextual problem that involves currency exchange. | ✓<br>STUDENT RESOURCE: p. 48, #6 | |
| 1.6 | Explain the difference between the selling rate and purchasing rate for currency exchange. | | ✓<br>STUDENT RESOURCE: p. 47, #5 |
| 1.7 | Explain how to estimate the cost of items in Canadian currency while in a foreign country, and explain why this may be important. | ✓<br>STUDENT RESOURCE: p. 48, #6 | |
| 1.8 | Convert between Canadian currency and foreign currencies, using formulas, charts or tables. | ✓<br>STUDENT RESOURCE: p. 48, #6 | |

## Number (continued)

**Specific Outcome**

*It is expected that students will:*

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]

**Notes**

- Some methods of calculating a person's gross pay will be known to students. Students are expected to share and compare the way they are paid.
- Some deductions will not be familiar to students and will need to be clarified and given in contexts.
- Technology [T] should be used to develop an understanding of how changes in the parameters used to determine a person's pay will influence his or her income. The technology used could include spreadsheets.
- This is the first time that the Canada Pension Plan (CPP) and Employment Insurance (EI) are seen in the Kindergarten to Grade 12 curriculum. Providing **current** information regarding rules, ages at which contributions begin and rates of contribution may be beneficial.
- Canada Pension Plan (CPP), Employment Insurance (EI) and taxation rates are set by the federal government. Federal legislation can change the rates used to calculate CPP and EI. Maximum contribution values are also legislated for CPP and EI deductions.
- Students are expected to calculate the dollar amounts for CPP, EI and income tax when the gross pay and the rates for each deduction are given.
- It is not the intent of this outcome to have students complete a personal income tax form.
- Employee and employer perspectives should be considered in the analysis of methods of earning income.

**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 Describe, using examples, various methods of earning income. | ✓ STUDENT RESOURCE: p. 55, Discuss the Ideas, #1 | |
| 2.2 Identify and list jobs that commonly use different methods of earning income; e.g., hourly wage, wage and tips, salary, commission, contract, bonus, shift premiums. | ✓ STUDENT RESOURCE: p. 55, Discuss the Ideas, #2 | |
| 2.3 Determine in decimal form, from a time schedule, the total time worked in hours and minutes, including time and a half and/or double time. | ✓ STUDENT RESOURCE: p. 61, #8 | |
| 2.4 Determine gross pay from given or calculated hours worked when given:<br>• the base hourly wage, with and without tips<br>• the base hourly wage, plus overtime (time and a half, double time). | ✓ STUDENT RESOURCE: p. 60, Build Your Skills, #1<br>STUDENT RESOURCE: p. 76, #3<br>STUDENT RESOURCE: p. 89, #3 | |
| 2.5 Determine gross pay for earnings acquired by:<br>• base wage, plus commission<br>• single commission rate. | ✓ STUDENT RESOURCE: p. 90, #5 | |
| 2.6 Explain why gross pay and net pay are not the same. | ✓ STUDENT RESOURCE: pp. 79–80, Explore the Math | |
| 2.7 Determine the Canadian Pension Plan (CPP), Employment Insurance (EI) and income tax deductions for a given gross pay. | ✓ STUDENT RESOURCE: p. 91, #8 | |
| 2.8 Determine net pay when given deductions; e.g., health plans, uniforms, union dues, charitable donations, payroll tax. | ✓ STUDENT RESOURCE: pp. 87–88, #7 | |

(continued)

(continued)

| Achievement Indicators | Acceptable Standard | Standard of Excellence |
|---|---|---|
| 2.9 Investigate, with technology, "what if …" questions related to changes in income; e.g., "What if there is a change in the rate of pay?" | ✓ STUDENT RESOURCE : p. 60, #5 | |
| 2.10 Identify and correct errors in a solution to a problem that involves gross or net pay. | ✓ Identify and correct obvious errors. STUDENT RESOURCE : p. 56, Example 1 | ✓ Identify and correct less obvious errors. STUDENT RESOURCE : pp. 61–62, #9 |
| 2.11 Describe the advantages and disadvantages for a given method of earning income; e.g., hourly wage, tips, piecework, salary, commission, contract work. | ✓ Determine the best payment method, given a scenario. STUDENT RESOURCE : p. 60, #4 | ✓ Give support to different payment methods by altering a scenario's parameters. STUDENT RESOURCE : p. 62, #10 |

# Topic: Algebra

**General Outcome**: Develop algebraic reasoning.

**Specific Outcome**

*It is expected that students will:*

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]

**Notes**

- The general outcome is integrated throughout the course. The specific outcome is integrated as follows.
  - **Perimeter** – Topic: Measurement, Specific Outcome 3
  - **Area** – Topic: Measurement, Specific Outcome 4
  - **The Pythagorean theorem** – Topic: Geometry, Specific Outcome 2
  - **Primary trigonometric ratios** – Topic: Geometry, Specific Outcome 4
  - **Income** – Topic: Number, Specific Outcome 2
- Students are expected to manipulate formulas to isolate the unknown quantity, when appropriate.
- In Grade 6, students first modelled the preservation of equality in equations. Students are expected to continue to use the preservation of equality to solve equations and to manipulate formulas.

**Achievement Indicators**

*The following set of indicators **may** be used to determine whether students have met the corresponding specific outcome. (It is intended that this outcome be integrated throughout the course.)*

| Achievement Indicators | | Acceptable Standard | Standard of Excellence |
|---|---|---|---|
| 1.1 | Solve a contextual problem that involves the application of a formula that does not require manipulation. | ✓<br>STUDENT RESOURCE : pp. 100–101, Example 3 | |
| 1.2 | Solve a contextual problem that involves the application of a formula that requires manipulation. | ✓ Solve simple problems.<br>STUDENT RESOURCE : p. 280, #6 | ✓ Solve complex problems.<br>STUDENT RESOURCE : p. 282, #12 |
| 1.3 | Explain and verify why different forms of the same formula are equivalent. | ✓ Verify with partial explanation.<br>STUDENT RESOURCE : pp. 100–101, Example 3 & p. 118 Example 1 | ✓ Verify with complete explanation.<br>STUDENT RESOURCE : pp. 100–101, Example 3 & p. 118 Example 1 |
| 1.4 | Describe, using examples, how a given formula is used in a trade or an occupation. | ✓<br>STUDENT RESOURCE : p. 288, Example 1 | |
| 1.5 | Create and solve a contextual problem that involves a formula. | ✓ Create and solve simple problems.<br>STUDENT RESOURCE : p. 278, Build Your Skills, #1a | ✓ Create and solve complex problems.<br>STUDENT RESOURCE : p. 278, Build Your Skills, #1b |
| 1.6 | Identify and correct errors in a solution to a problem that involves a formula. | ✓ Identify and correct obvious errors. | ✓ Identify and correct less obvious errors. |

## Appendix 1: 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. |

## Appendix 2: Mathematics 10-3 Formulas and Conversions

| | |
|---|---|
| 1 mile = 1760 yards | 1 inch ≈ 2.54 centimetres |
| 1 yard = 3 feet | 1 mile ≈ 1.6093 kilometres |
| 1 foot = 12 inches | 1 yard ≈ 0.9144 metres |
| | |
| 1 ton = 2000 pounds | 1 tonne = 1000 kilograms |
| 1 pound = 16 ounces | 1 kilogram ≈ 2.2046 pounds |
| | |
| 1 cup = 8 fluid ounces | 1 gallon (US) ≈ 3.7854 litres |
| 1 pint = 2 cups | 1 gallon (imp) ≈ 4.5461 litres |
| 1 quart = 2 pints | 1 fluid ounce (US) ≈ 29.5735 millilitres |
| 1 gallon = 4 quarts | 1 bushel (US) ≈ 35.2391 litres |
| 1 gallon (imp) ≈ 1.2 gallon (US) | 1 metric cup = 250 millilitres |

| | |
|---|---|
| $c^2 = a^2 + b^2$ | $°F = \frac{9}{5}°C + 32$ |
| $A_{circle} = \pi r^2$ | $C_{circle} = 2\pi r$ |
| $SA_{cone} = \pi r^2 + \pi rs$ | $SA_{cylinder} = 2\pi r^2 + 2\pi rh$ |