Polynomials

Vocabulary

variable
algebraic expression
term
polynomial
degree of a term
degree of a polynomial
like terms
distributive property

Curriculum Expectations

Mathematical Process Expectations

Throughout this course, students will:

PROBLEM SOLVING
MPS.01 develop, select, apply, and compare a variety of problem-solving strategies as they pose and solve problems and conduct investigations, to help deepen their mathematical understanding;

REASONING AND PROVING
MPS.02 develop and apply reasoning skills (e.g., recognition of relationships, generalization through inductive reasoning, use of counter-examples) to make mathematical conjectures, assess conjectures, and justify conclusions, and plan and construct organized mathematical arguments;

REFLECTING
MPS.03 demonstrate that they are reflecting on and monitoring their thinking to help clarify their understanding as they complete an investigation or solve a problem (e.g., by assessing the effectiveness of strategies and processes used, by proposing alternative approaches, by judging the reasonableness of results, by verifying solutions);

SELECTING TOOLS AND COMPUTATIONAL STRATEGIES
MPS.04 select and use a variety of concrete, visual, and electronic learning tools and appropriate computational strategies to investigate mathematical ideas and to solve problems;

CONNECTING
MPS.05 make connections among mathematical concepts and procedures, and relate mathematical ideas to situations or phenomena drawn from other contexts (e.g., other curriculum areas, daily life, current events, art and culture, sports);

REPRESENTING
MPS.06 create a variety of representations of mathematical ideas (e.g., numeric, geometric, algebraic, graphical, pictorial representations; onscreen dynamic representations), connect and compare them, and select and apply the appropriate representations to solve problems;

COMMUNICATING
MPS.07 communicate mathematical thinking orally, visually, and in writing, using mathematical vocabulary and a variety of appropriate representations, and observing mathematical conventions.

Additional information and teaching materials for this chapter are available on the McGraw-Hill Ryerson web site at http://www.mcgrawhill.ca/books/principles9. You will need your password to access this material.

Overall Expectations

By the end of this course, students will:

NAV.01 demonstrate an understanding of the exponent rules of multiplication and division, and apply them to simplify expressions;

NAV.02 manipulate numerical and polynomial expressions, and solve first-degree equations.

Specific Expectations

Operating With Exponents

By the end of this chapter, students will:

NA1.01 substitute into and evaluate algebraic expressions involving exponents (i.e., evaluate expressions involving natural-number exponents with rational-number bases [e.g., evaluate $\left(\frac{3}{2}\right)^3$ by hand and 9.8^3 by using a calculator]);

NA1.02 describe the relationship between the algebraic and geometric representations of a single-variable term up to degree three [i.e., length, which is one dimensional, can be represented by x; area, which is two dimensional, can be represented by $(x)(x)$ or x^2; volume, which is three dimensional, can be represented by $(x)(x)(x)$, $(x^2)(x)$, or x^3];

NA1.03 derive, through the investigation and examination of patterns, the exponent rules for multiplying and dividing monomials, and apply these rules in expressions involving one and two variables with positive exponents;

NA1.04 extend the multiplication rule to derive and understand the power of a power rule, and apply it to simplify expressions involving one and two variables with positive exponents.

Manipulating Expressions and Solving Equations

By the end of this chapter, students will:

NA2.03 relate their understanding of inverse operations to squaring and taking the square root, and apply inverse operations to simplify expressions and solve equations;

NA2.04 add and subtract polynomials with up to two variables [e.g., $(2x - 5) + (3x + 1)$, $(3x^2y + 2xy^2) + (4x^2y - 6xy^2)$], using a variety of tools (e.g., algebra tiles, computer algebra systems, paper and pencil);

NA2.05 multiply a polynomial by a monomial involving the same variable [e.g., $2x(x + 4)$, $2x^2(3x^2 - 2x + 1)$], using a variety of tools (e.g., algebra tiles, diagrams, computer algebra systems, paper and pencil);

NA2.06 expand and simplify polynomial expressions involving one variable [e.g., $2x(4x + 1) - 3x(x + 2)$], using a variety of tools (e.g., algebra tiles, computer algebra systems, paper and pencil).

Chapter Problem

The Chapter Problem is introduced in the Chapter Opener, in which a school logo is designed and manipulated in various ways. Have students discuss their understanding of the topic. You may wish to have students complete the Chapter Problem revisits that occur throughout the chapter. The questions draw connections between measurement problems and the algebraic skills learned throughout the chapter. These questions are designed to help students move toward the Chapter Problem Wrap-Up on page 177. Alternatively, you may wish to assign the Chapter Problem when students have completed the chapter, as part of a summative assessment.

Chapter 3 Planning Chart

Section Suggested Timing	Student Text Page (s)	Teacher's Resource Blackline Masters	Assessment	Tools
Chapter 3 Opener • 15 min	100–101			
Get Ready • 80–240 min	102–103	• BLM 3.GR.1 Practice: Get Ready • BLM G1 Integer Number Lines	• BLM A6 Knowledge/ Understanding General Scoring Rubric • 3.GR.2 Get Ready Self-Assessment Checklist	
3.1 Build Algebraic Models Using Concrete Materials • 80 min	104–109	• BLM 3.1.1 Practice: Build Algebraic Models Using Concrete Materials • BLM T4 *The Geometer's Sketchpad®* 3 • BLM T5 *The Geometer's Sketchpad®* 4	• BLM A7 Thinking/General Scoring Rubric	**Tools** • algebra tiles • linking cubes **Technology Tools** • *The Geometer's Sketchpad®* • computers
3.2 Work With Exponents • 80 min	110–118	• BLM 3.2.1 Practice: Work With Exponents • BLM G15 Placemat • BLM G10 Grid Paper	• BLM A1 Assessment Recording Sheet: Work With Exponents	**Tools** • calculators • grid paper
3.3 Discover the Exponent Laws • 160 min	119–129	• BLM 3.3.1 Practice: Discover the Exponent Laws • BLM 3.3.3 Student Success: Exponent Law for Multiplication of Powers • BLM 3.3.4 Student Success: Exponent Law for Division of Powers • BLM 3.3.5 Student Success: Exponent Law for Powers of Powers	• BLM A8 Application General Scoring Rubric • BLM 3.3.2 Achievement Check Rubric	**Tools** • calculators
3.4 Communicate With Algebra • 80 min	130–139	• BLM T4 *The Geometer's Sketchpad®* 3 • BLM T5 *The Geometer's Sketchpad®* 4 • BLM 3.4.1 Practice: Communicate With Algebra	• BLM A5 Problem Solving Checklist • BLM A18 My Progress as a Problem Solver • BLM A9 Communication General Scoring Rubric • BLM A7 Thinking/General Scoring Rubric • BLM 3.4.2 Achievement Check Rubric	**Tools** • algebra tiles **Technology Tools** • *The Geometer's Sketchpad®* • computers • graphing calculators
Use Technology: Virtual Algebra Tiles With *The Geometer's Sketchpad®* • 40–80 min	140–143	• BLM T4 *The Geometer's Sketchpad®* 3 • BLM T5 *The Geometer's Sketchpad®* 4	• BLM A10 Observation General Scoring Rubric	**Technology Tools** • *The Geometer's Sketchpad®* • Algebra Tiles.gsp • computers
3.5 Collect Like Terms • 80 min	144–153	• BLM 3.5.1 Practice: Collect Like Terms	• BLM A8 Application General Scoring Rubric • BLM A9 Communication General Scoring Rubric	**Tools** • algebra tiles
3.6 Add and Subtract Polynomials • 80 min	154–159	• BLM 3.6.1 Practice: Add and Subtract Polynomials • BLM T4 *The Geometer's Sketchpad®* 3 • BLM T5 *The Geometer's Sketchpad®* 4	• BLM A8 Application General Scoring Rubric • BLM A9 Communication General Scoring Rubric	**Tools** • algebra tiles **Technology Tools** • *The Geometer's Sketchpad®* • computers
3.7 The Distributive Property • 80–160 min	160–169	• BLM 3.7.1 Investigate Table • BLM 3.7.2 Practice: The Distributive Property	• BLM 3.7.3 Achievement Check Rubric	**Tools** • algebra tiles
Use Technology: Computer Algebra Systems • 80 min	170–173	• BLM T7 The Computer Algebra System (CAS) on the TI-89 Calculator		**Technology Tools** • TI-89 calculators

Section Suggested Timing	Student Text Page (s)	Teacher's Resource Blackline Masters	Assessment	Tools
Chapter 3 Review • 80 min	174–175	• BLM 3.CR.1 Chapter 3 Review • BLM G10 Grid Paper	• BLM A14 Self-Assessment Recording Sheet • BLM A15 Self-Assessment Checklist	**Tools** • grid paper
Chapter 3 Practice Test • 60–80 min	176–177		• BLM 3.PT.1 Chapter 3 Practice Test • BLM 3.CT.1 Chapter 3 Test	
Chapter 3 Problem Wrap-Up • 30 min	177	• BLM T4 *The Geometer's Sketchpad®* 3 • BLM T5 *The Geometer's Sketchpad®* 4 • BLM G10 Grid Paper	• BLM 3.CP.1 Chapter 3 Problem Wrap-Up Rubric	**Tools** • algebra tiles • grid paper **Technology Tools** • *The Geometer's Sketchpad®* • computers
Chapters 1 to 3 Review • 80 min	178–179	• BLM G10 Grid Paper	• BLM A14 Self-Assessment Recording Sheet • BLM A15 Self-Assessment Checklist	
Task: Electricity and Gas Costs • 20 min	180	• BLM G10 Grid Paper • BLM T4 *The Geometer's Sketchpad®* 3 • BLM T5 *The Geometer's Sketchpad®* 4	• BLM 3.T1.1 Task: Electricity and Gas Costs Rubric	**Tools** • grid paper **Technology Tools** • graphing calculators • *The Geometer's Sketchpad®* • computers
Task: Perimeters and Areas • 20 min	181	• BLM G10 Grid Paper • BLM G7 Square Dot Paper • BLM G8 Isometric Dot Paper	• BLM 3.T2.1 Task: Perimeters and Areas Rubric	**Tools** • grid paper • square dot paper • isometric dot paper
Task: Mind Reader • 20 min	181		• BLM 3.T3.1 Task: Mind Reader Rubric	

Chapter 3 Blackline Masters Checklist

	BLM	Title	Purpose
Get Ready			
	BLM 3.GR.1	Practice: Get Ready	Practice
	BLM A6	Knowledge/Understanding General Scoring Rubric	Assessment
	BLM G1 **BLM 3.GR.2 Get Ready Self-Assessment Checklist**	Integer Number Lines	Student Support
3.1: Build Algebraic Models Using Concrete Materials			
	BLM 3.1.1	Practice: Build Models Using Concrete Materials	Practice
	BLM T4	*The Geometer's Sketchpad*® 3	Technology
	BLM T5	*The Geometer's Sketchpad*® 4	Technology
	BLM A7	Thinking General Scoring Rubric	Assessment
3.2: Work With Exponents			
	BLM A1	Assessment Recording Sheet	Assessment
	BLM 3.2.1	Practice: Work With Exponents	Practice
	BLM G15	Grid Paper	Student Success
	BLM G10	Placemat	Student Support
3.3: Discover the Exponent Laws			
	BLM 3.3.1	Practice: Discover the Exponent Laws	Practice
	BLM 3.3.2	Achievement Check Rubric	Assessment
	BLM 3.3.3	Student Success: Exponent Law for Multiplication of Powers	Student Success
	BLM 3.3.4	Student Success: Exponent Law for Division of Powers	Student Success
	BLM 3.3.5	Student Success: Exponent Law for Powers of Powers	Student Success
	BLM A8	Application General Scoring Rubric	Assessment

	BLM	Title	Purpose
3.4: Communicate with Algebra			
	BLM A5	Problem Solving Checklist	Assessment
	BLM A18	My Progress as a Problem Solver	Student Self-Assessment
	BLM 3.4.1	Practice: Communicate With Algebra	Practice
	BLM A9	Communication General Scoring Rubric	Assessment
	BLM A7	Thinking General Scoring Rubric	Assessment
	BLM T4	*The Geometer's Sketchpad*® 3	Technology
	BLM T5	*The Geometer's Sketchpad*® 4	Technology
	BLM 3.4.2	Achievement Check Rubric	Assessment
Use Technology: Virtual Algebra Tiles with *The Geometer's Sketchpad*®			
	BLM T4	*The Geometer's Sketchpad*® 3	Technology
	BLM T5	*The Geometer's Sketchpad*® 4	Technology
	BLM A10	Observation General Scoring Rubric	Assessment
3.5: Collect Like Terms			
	BLM 3.5.1	Practice: Collect Like Terms	Practice
	BLM A8	Application General Scoring Rubric	Assessment
	BLM A9	Communication General Scoring Rubric	Assessment
3.6: Add and Subtract Polynomials			
	BLM 3.6.1	Practice: Add and Subtract Polynomials	Practice
	BLM A8	Application General Scoring Rubric	Assessment
	BLM A9	Communication General Scoring Rubric	Assessment
	BLM T4	*The Geometer's Sketchpad*® 3	Technology
	BLM T5	*The Geometer's Sketchpad*® 4	Technology
3.7: The Distributive Property			
	BLM 3.7.1	Investigate Table	Student Support
	BLM 3.7.2	Practice: The Distributive Property	Practice
	BLM 3.7.3	Achievement Check Rubric	Assessment
Use Technology: Computer Algebra Systems			
	BLM T7	The Computer Algebra System (CAS) on the TI-89 Calculator	Technology

	BLM	Title	Purpose
Chapter 3 Review			
	BLM 3.CR.1	Chapter 3 Review	Review
	BLM G10	Grid Paper	Student Support
	BLM A14	Self-Assessment Recording Sheet	Student Self-Assessment
	BLM A15	Self-Assessment Checklist	Student Self-Assessment
Chapter 3 Practice Test			
	BLM 3.PT.1	Chapter 3 Practice Test	Diagnostic Assessment
	BLM 3.CT.1	Chapter 3 Test	Summative Assessment
Chapter 3 Problem Wrap-Up			
	BLM T4	*The Geometer's Sketchpad*® 3	Technology
	BLM T5	*The Geometer's Sketchpad*® 4	Technology
	BLM G10	Grid Paper	Student Support
	BLM 3.CP.1	Chapter 3 Problem Wrap-Up Rubric	Assessment
Chapters 1 to 3 Review			
	BLM G10	Grid Paper	Student Support
	BLM A14	Self-Assessment Recording Sheet	Student Self-Assessment
	BLM A15	Self-Assessment Checklist	Student Self-Assessment
Task: Electricity and Gas Costs			
	BLM G10	Grid Paper	Student Support
	BLM T4	*The Geometer's Sketchpad*® 3	Technology
	BLM T5	*The Geometer's Sketchpad*® 4	Technology
	BLM 3.T1.1	Task: Electricity and Gas Costs Rubric	Assessment
Task: Perimeters and Areas			
	BLM G10	Grid Paper	Student Support
	BLM G7	Square Dot Paper	Student Support
	BLM G8	Isometric Dot Paper	Student Support
	BLM 3.T2.1	Task: Perimeters and Areas Rubric	Assessment
Task: Mind Reader			
	BLM 3.T3.1	Task: Mind Reader Rubric	Assessment

Get Ready

Common Errors

- Some students may misapply rules for adding, multiplying, or dividing integers.

R_x Have students work with manipulatives (e.g., integer tiles) to correct fundamental understanding of operations. Then, follow up with practice exercises in the form of worksheets. You may wish to use **BLM G1 Integer Number Lines**. Use **BLM 3.GR.1 Practice: Get Ready** for remediation.

- Some students may struggle with signs when multiplying rational numbers.

R_x Consolidate their understanding of multiplication of integers and multiplication of positive fractions first, before mixing the two concepts. Then, have students consider the sign of the result independently of the fraction work when multiplying positive and negative rational numbers.

Accommodations

Gifted and Enrichment—Encourage students to research formulas used in other disciplines, such as science, and to rearrange each formula in as many different ways as they can.

Perceptual—Encourage students to used calculators to check their answers for the questions in this section.

ESL—Let students work with partners when using a graphing calculator in this section.

Teaching Suggestions

- Students' needs may vary significantly for these topics from class to class and from student to student.
- A solid grounding in operations, involving integers and rational numbers in particular, is critical for students' success in this chapter.
- Use the Get Ready as a diagnostic assessment, with additional remediation provided as needed. You may wish to use **BLM 3.GR.1 Practice: Get Ready** as remediation or extra practice.
- Refer to the Link to Get Ready in the chapters sections of the Teacher's Resource
- You may wish to use **BLM A6 Knowledge/Understanding General Scoring Rubric** to assist you in assessing your students.
- All **BLMs** referred to throughout this chapter can be found on the *Principles of Mathematics 9* Teacher's Resource CD-ROM.

Assessment

Assess student readiness to proceed by informal observation as students are working on the questions. A formal test would be inappropriate since this material is not part of the grade 9 curriculum for this chapter. Student self-assessment is also an effective technique; students can place a checkmark beside topics in the Get Ready in which they feel confident with the necessary skills. You may wish to use **BLM 3.GR.2 Get Ready Self-Assessment Checklist** as a self-assessment for students. Remedial action can be taken in small groups or with a whole class skill review.