Chapter 1

Polynomial Functions

Curriculum Expectations

Polynomial and Rational Functions

Connecting Graphs and Equations of Polynomial Functions

C1.1 recognize a polynomial expression (i.e., a series of terms where each term is the product of a constant and a power of x with a nonnegative integral exponent, such as $x^3 - 5x^2 + 2x - 1$); recognize the equation of a polynomial function, give reasons why it is a function, and identify linear and quadratic functions as examples of polynomial functions

Technology Notes

The technology used in this chapter is primarily graphing calculators, specifically the TI-83 Plus/TI-84 Plus series, and *The Geometer's Sketchpad®*.

C1.2 compare, through investigation using graphing technology, the numeric, graphical, and algebraic representations of polynomial (i.e., linear, quadratic, cubic, quartic) functions (e.g., compare finite differences in tables of values; investigate the effect of the degree of a polynomial function on the shape of its graph and the maximum number of x-intercepts; investigate the effect of varying the sign of the leading coefficient on the end behaviour of the function for very large positive or negative x-values)

C1.3 describe key features of the graphs of polynomial functions (e.g., the domain and range, the shape of the graphs, the end behaviour of the functions for very large positive or negative x-values)

C1.4 distinguish polynomial functions from sinusoidal and exponential functions [e.g., $f(x) = \sin x$, $g(x) = 2^x$], and compare and contrast the graphs of various polynomial functions with the graphs of other types of functions

C1.5 make connections, through investigation using graphing technology (e.g., dynamic geometry software), between a polynomial function given in factored form [e.g., $f(x) = 2(x - 3)(x + 2)(x - 1)$] and the x-intercepts of its graph, and sketch the graph of a polynomial function given in factored form using its key features (e.g., by determining intercepts and end behaviour; by locating positive and negative regions using test values between and on either side of the x-intercepts)

C1.6 determine, through investigation using technology, the roles of the parameters a, k, d, and c in functions of the form $y = af(k(x - d)) + c$, and describe these roles in terms of transformations on the graphs of $f(x) = x^3$ and $f(x) = x^4$ (i.e., vertical and horizontal translations; reflections in the axes; vertical and horizontal stretches and compressions to and from the x- and y-axes)

C1.7 determine an equation of a polynomial function that satisfies a given set of conditions (e.g., degree of the polynomial, intercepts, points on the function), using methods appropriate to the situation (e.g., using the x-intercepts of the function; using a trial-and-error process with a graphing calculator or graphing software; using finite differences), and recognize that there may be more than one polynomial function that can satisfy a given set of conditions (e.g., an infinite number of polynomial functions satisfy the condition that they have three given x-intercepts)

C1.9 determine, through investigation, and compare the properties of even and odd polynomial functions [e.g., symmetry about the y-axis or the origin; the power of each term; the number of x-intercepts; $f(x) = f(-x)$ or $f(-x) = -f(x)$], and determine whether a given polynomial function is even, odd, or neither

Characteristics of Functions

Understanding Rates of Change

D1.1 gather, interpret, and describe information about real-world applications of rates of change, and recognize different ways of representing rates of change (e.g., in words, numerically, graphically, algebraically)

D1.2 recognize that the rate of change for a function is a comparison of changes in the dependent variable to changes in the independent variable, and distinguish situations in which the rate of change is zero, constant, or changing by examining applications, including those arising from real-world situations (e.g., rate of change of the area of a circle as the radius increases, inflation rates, the rising trend in graduation rates among Aboriginal youth, speed of a cruising aircraft, speed of a cyclist climbing a hill, infection rates)

D1.3 sketch a graph that represents a relationship involving rate of change, as described in words, and verify with technology (e.g., motion sensor) when possible

D1.4 calculate and interpret average rates of change of functions (e.g., linear, quadratic, exponential, sinusoidal) arising from real-world applications (e.g., in the natural, physical, and social sciences), given various representations of the functions (e.g., tables of values, graphs, equations)

D1.5 recognize examples of instantaneous rates of change arising from real-world situations, and make connections between instantaneous rates of change and average rates of change (e.g., an average rate of change can be used to approximate an instantaneous rate of change)

D1.6 determine, through investigation using various representations of relationships (e.g., tables of values, graphs, equations), approximate instantaneous rates of change arising from real-world applications (e.g., in the natural, physical, and social sciences) by using average rates of change and reducing the interval over which the average rate of change is determined

D1.7 make connections, through investigation, between the slope of a secant on the graph of a function (e.g., quadratic, exponential, sinusoidal) and the average rate of change of the function over an interval, and between the slope of the tangent to a point on the graph of a function and the instantaneous rate of change of the function at that point

D1.9 solve problems involving average and instantaneous rates of change, including problems arising from real-world applications, by using numerical and graphical methods (e.g., by using graphing technology to graph a tangent and measure its slope)

Chapter 1 Planning Chart

Section Suggested Timing	Student Text Page(s)	Teacher's Resource Blackline Masters	Assessment	Tools
Chapter 1 Opener • 10 min	1			
Prerequisite Skills • 45–60 min	2–3	• G–1 Grid Paper • BLM 1–1 Prerequisite Skills		• grid paper
1.1 Power Functions • 45–65 min	4–14	• G–1 Grid Paper • G–2 Placemat • BLM 1–2 Section 1.1 Summary • BLM 1–3 Section 1.1 Practice		• grid paper • graphing calculator
1.2 Characteristics of Polynomial Functions • 45–90 min	15–29	• G–1 Grid Paper • G–3 Four Quadrant Grids • T–2 *The Geometer's Sketchpad®* 4 • BLM 1–4 Investigate 1 Part A • BLM 1–5 Investigate 1 Part B • BLM 1–6 Investigate 2 Finite Differences Table • BLM 1–7 Section 1.2 Summary • BLM 1–8 Section 1.2 Practice	• BLM 1–9 Section 1.2 Achievement Check Rubric	• graphing calculator • computer with *The Geometer's Sketchpad®* (optional) • grid paper
1.3 Equations and Graphs of Polynomial Functions • 45–90 min	30–41	• G–1 Grid Paper • G–3 Four Quadrant Grids • T–2 *The Geometer's Sketchpad®* 4 • BLM 1–10 Function Analysis Tables • BLM 1–11 Section 1.3 Practice		• graphing calculator • computer with *The Geometer's Sketchpad®* (optional) • grid paper
1.4 Transformations • 40–70 min	42–52	• G–1 Grid Paper • T–2 *The Geometer's Sketchpad®* 4 • BLM 1–12 Section 1.4 Investigate • BLM 1–13 Section 1.4 Summary • BLM 1–14 Section 1.4 Practice		• graphing calculator • computer with *The Geometer's Sketchpad®* (optional) • grid paper
1.5 Slopes of Secants and Average Rate of Change • 40–65 min	53–64	• G–1 Grid Paper • BLM 1–15 Section 1.5 Practice		• grid paper • graphing calculator
1.6 Slopes of Tangents and Instantaneous Rate of Change • 45–60 min	65–73	• G–1 Grid Paper • BLM 1–16 Average Rate of Change Tables • BLM 1–17 Section 1.6 Practice		• grid paper • graphing calculator
Chapter 1 Review • 45–60 min	74–77	• G–1 Grid Paper • BLM 1–18 Chapter 1 Review		• grid paper • graphing calculator
Chapter 1 Problem Wrap-Up • 30–50 min	77	• G–1 Grid Paper • T–2 *The Geometer's Sketchpad®* 4	• BLM 1–19 Chapter 1 Problem Wrap-Up Rubric	• grid paper • computer with *The Geometer's Sketchpad®*
Chapter 1 Practice Test • 45–60 min	78–79	• G–1 Grid Paper	• BLM 1–20 Chapter 1 Test	• grid paper • graphing calculator
Chapter 1 Task: Create Your Own Water Park • 60–75 min	80	• G–1 Grid Paper • T–2 *The Geometer's Sketchpad®* 4 • T–3 *Fathom™* • BLM 1–22 BLM Answers	• BLM 1–21 Task: Create Your Own Water Park Rubric	• grid paper • computer • The *The Geometer's Sketchpad®* • *Fathom™* • graphing calculator (optional)

Chapter 1 Blackline Masters Checklist

	BLM	Title	Purpose
Prerequisite Skills			
	G–1	Grid Paper	Student Support
	BLM 1–1	Prerequisite Skills	Practice
1.1 Power Functions			
	G–1	Grid Paper	Student Support
	G–2	Placemat	Student Support
	BLM 1–2	Section 1.1 Summary	Student Support
	BLM 1–3	Section 1.1 Practice	Practice
1.2 Characteristics of Polynomial Functions			
	G–1	Grid Paper	Student Support
	G–3	Four Quadrant Grids	Student Support
	T–2	*The Geometer's Sketchpad*® 4	Technology
	BLM 1–4	Investigate 1 Part A	Student Support
	BLM 1–5	Investigate 1 Part B	Student Support
	BLM 1–6	Investigate 2 Finite Differences Table	Student Support
	BLM 1–7	Section 1.2 Summary	Student Support
	BLM 1–8	Section 2.2 Practice	Practice
	BLM 1–9	Section 1.2 Achievement Check Rubric	Assessment
1.3 Equations and Graphs of Polynomial Functions			
	G–1	Grid Paper	Student Support
	G–3	Four Quadrant Grids	Student Support
	T–2	*The Geometer's Sketchpad*® 4	Technology
	BLM 1–10	Function Analysis Tables	Student Support
	BLM 1–11	Section 1.3 Practice	Practice
1.4 Transformations			
	G–1	Grid Paper	Student Support
	T–2	*The Geometer's Sketchpad*® 4	Technology
	BLM 1–12	Section 1.4 Investigate	Student Support
	BLM 1–13	Section 1.4 Summary	Student Support
	BLM 1–14	Section 1.4 Practice	Practice
1.5 Slopes of Secants and Average Rate of Change			
	G–1	Grid Paper	Student Support
	BLM 1–15	Section 1.5 Practice	Practice
1.6 Slopes of Tangents and Instantaneous Rate of Change			
	G–1	Grid Paper	Student Support
	BLM 1–16	Average Rate of Change Tables	Student Support
	BLM 1–17	Section 1.6 Practice	Practice
Chapter 1 Review			
	G–1	Grid Paper	Student Support
	BLM 1–18	Chapter 1 Review	Practice
Chapter 1 Problem Wrap-Up			
	G–1	Grid Paper	Student Support
	T–2	*The Geometer's Sketchpad*® 4	Technology
	BLM 1–19	Chapter 1 Problem Wrap-Up Rubric	Assessment
Chapter 1 Practice Test			
	G–1	Grid Paper	Student Support
	BLM 1–20	Chapter 1 Test	Summative Assessment
Chapter 1 Task: Create Your Own Water Park			
	G–1	Grid Paper	Student Support
	T–2	*The Geometer's Sketchpad*® 4	Technology
	T–3	*Fathom*™	Technology
	BLM 1–21	Task: Create Your Own Water Park Rubric	Assessment
	BLM 1–22	BLM Answers	Answers

Prerequisite Skills

Student Text Pages
2 to 3

Suggested Timing
45–60 min

Tools
- grid paper

Related Resources
- G–1 Grid Paper
- BLM 1–1 Prerequisite Skills

Assessment
You may wish to use **BLM 1–1 Prerequisite Skills** as a diagnostic assessment. Refer students to the Skills Appendix for examples and further practice of topics.

Since this is the first chapter of the course, you may wish to either

- work out some of the prerequisite skills exercises as examples or
- have students work on them in pairs or small groups as you monitor their progress, assess student strengths and weakness, and address areas of difficulty.

Chapter Problem

- The Chapter Problem is introduced on page 3. Have students discuss their understanding of the problem, and how mathematical shapes are found in man-made objects and in nature. Draw from students their knowledge of careers involving design and math. The Chapter Problem is revisited in Sections 1.1 (question 13), 1.3 (question 10), 1.4 (question 11), and 1.5 (question 9). These questions are designed to help students move toward the Chapter Problem Wrap-Up on page 77. The Chapter Problem questions may be assigned in each section where they appear. Alternatively, you may wish to assign them all with the Chapter Problem Wrap-Up when students have completed the chapter, as part of a summative assessment.