CHAPTER

4

Quadratic Relations

Vocabulary

non-linear relation
curve of best fit
quadratic relation
parabola
vertex
axis of symmetry
finite differences
zero

Curriculum Expectations

Quadratic Relations of the Form $y = ax^2 + bx + c$

Investigating the Basic Properties of Quadratic Relations

By the end of this chapter, students will

QR1.01 collect data that can be represented as a quadratic relation, from experiments using appropriate equipment and technology (e.g., concrete materials, scientific probes, graphing calculators), or from secondary sources (e.g., the Internet, Statistics Canada); graph the data and draw a curve of best fit, if appropriate, with or without the use of technology;

QR1.02 determine, through investigation with and without the use of technology, that a quadratic relation of the form $y = ax^2 + bx + c$ $(a \neq 0)$ can be graphically represented as a parabola, and that the table of values yields a constant second difference;

QR1.03 identify the key features of a graph of a parabola (i.e., the equation of the axis of symmetry, the coordinates of the vertex, the y-intercept, the zeros, and the maximum or minimum value), and use the appropriate terminology to describe them;

QR1.04 compare, through investigation using technology, the features of the graph of $y = x^2$ and the graph of $y = 2^x$, and determine the meaning of a negative exponent and of zero as an exponent (e.g., by examining patterns in a table of values for $y = 2^x$; by applying the exponent rules for multiplication and division).

Relating the Graph of $y = x^2$ and Its Transformations

By the end of this chapter, students will

QR2.01 identify, through investigation using technology, the effect on the graph of $y = x^2$ of transformations (i.e., translations, reflections in the x-axis, vertical stretches or compressions) by considering separately each parameter a, h, and k [i.e., investigate the effect on the graph of $y = x^2$ of a, h, and k in $y = x^2 + k$, $y = (x - h)^2$, and $y = ax^2$];

QR2.02 explain the roles of a, h, and k in $y = a(x - h)^2 + k$, using the appropriate terminology to describe the transformations, and identify the vertex and the equation of the axis of symmetry;

QR2.03 sketch, by hand, the graph of $y = a(x - h)^2 + k$ by applying transformations to the graph of $y = x^2$;

QR2.04 determine the equation, in the form $y = a(x - h)^2 + k$, of a given graph of a parabola.

Chapter Problem

The Chapter Problem is introduced in the Chapter 4 Opener. Have students discuss their understanding of the topic, and that the increasing mass of garbage could be plotted as a scatter plot and a curve of best fit could be used to model it. Have students complete the Chapter Problem revisits that occur throughout the chapter. These questions are designed to help students move toward the Chapter 4 Problem Wrap-Up on page 203.

Alternatively, assign only the Chapter Problem when students have completed the chapter. The Chapter Problem is a summative assessment.

Chapter 4 Planning Chart

Section Suggested Timing	Student Text Page (s)	Teacher's Resource Blackline Masters	Assessment	Tools
Chapter 4 Opener • 15 min	160–161			
Get Ready • 30–45 min	162–163	• G–1 Grid Paper • G–3 Coordinate Grids • BLM 4–1 Get Ready	• BLM 4–2 Get Ready Self-Assessment Checklist	**Tools** • grid paper **Technology Tools** • graphing calculator
4.1 Investigate Non-Linear Relations • 70 min	164–167	• G–1 Grid Paper • G–3 Coordinate Grids • BLM 4–3 Section 4.1 Practice Master	• A–4 Presentation Checklist • A–11 Group Work Assessment Recording Sheet • A–12 Group Work Assessment General Scoring Rubric	**Tools** • ruler • grid paper • board at least 1.2 m in length • 2 textbooks • 1 can of soup (or other object that rolls) • metre stick or measuring tape • stopwatch
4.2 Quadratic Relations • 70 min	168–173	• G–1 Grid Paper • G–3 Coordinate Grids • BLM 4–4 Finite Difference Tables • BLM 4–5 Model the Roof of the Detroit International Airport • BLM 4–6 Section 4.2 Practice Master	• BLM 4–7 Section 4.2 Achievement Check Rubric • A–9 Communication General Scoring Rubric • A–23 News Report Checklist	**Tools** • grid paper **Technology Tools** • graphing calculator
4.3 Investigate Transformations of Quadratics • 70–140 min	174–179	• G–1 Grid Paper • G–3 Coordinate Grids • BLM 4–8 Section 4.3 Practice Master	• A–7 Thinking General Scoring Rubric • A–10 Observation General Scoring Rubric	**Tools** • grid paper **Technology Tools** • graphing calculator
4.4 Graph $y = a(x - h)^2 + k$ • 70–140 min	180–188	• G–1 Grid Paper • G–2 Placemat • G–3 Coordinate Grids • BLM 4–9 Section 4.4 Practice Master	• BLM 4–10 Section 4.4 Achievement Check Rubric	**Tools** • grid paper **Technology Tools** • graphing calculator
4.5 Quadratic Relations of the Form $y = a(x - r)(x - s)$ • 70 min	189–193	• G–1 Grid Paper • G–3 Coordinate Grids • BLM 4–11 Section 4.5 Practice Master	• A–7 Thinking General Scoring Rubric	**Tools** • grid paper
4.6 Negative and Zero Exponents • 70 min	194–201	• G–1 Grid Paper • G–3 Coordinate Grids • BLM 4–12 Section 4.6 Practice Master	• BLM 4–13 Section 4.6 Achievement Check Rubric • A–9 Communication General Scoring Rubric	**Tools** • grid paper **Technology Tools** • graphing calculator
Chapter 4 Review • 70 min	202–203	• G–1 Grid Paper • G–3 Coordinate Grids	• BLM 4–14 Chapter 4 Review	**Tools** • grid paper **Technology Tools** • graphing calculator
Chapter 4 Problem Wrap-Up • 30–70 min	203	• G–1 Grid Paper • G–3 Coordinate Grids	• BLM 4–15 Chapter 4 Problem Wrap-Up Rubric	**Tools** • grid paper **Technology Tools** • graphing calculator
Chapter 4 Practice Test • 70 min	204–205	• G–1 Grid Paper • G–3 Coordinate Grids • BLM 4–19 BLM Answers	• BLM 4–16 Chapter 4 Practice Test • BLM 4–17 Chapter 4 Test • BLM 4–18 Chapter 4 Practice Test Achievement Check Rubric	**Tools** • grid paper **Technology Tools** • graphing calculator

Chapter 4 Blackline Masters Checklist

	BLM	Title	Purpose
Get Ready			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–1	Get Ready	Practice
	BLM 4–2	Get Ready Self-Assessment Checklist	Self-Assessment
4.1: Investigate Non-Linear Relations			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–3	Section 4.1 Practice Master	Practice
	A–4	Presentation Checklist	Assessment
	A–11	Group Work Assessment Recording Sheet	Assessment
	A–12	Group Work Assessment General Scoring Rubric	Assessment
4.2: Quadratic Relations			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–4	Finite Difference Tables	Student Support
	BLM 4–5	Model the Roof of the Detroit International Airport	Student Support
	BLM 4–6	Section 4.2 Practice Master	Practice
	BLM 4–7	Section 4.2 Achievement Check Rubric	Assessment
	A–9	Communication General Scoring Rubric	Assessment
	A–23	News Report Checklist	Assessement Literacy
4.3: Investigate Transformations of Quadratics			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–8	Section 4.3 Practice Master	Practice
	A–7	Thinking General Scoring Rubric	Assessment
	A–10	Observation General Scoring Rubric	Assessment
4.4: Graph $y = a(x - h)^2 + k$			
	G–1	Grid Paper	Student Support
	G–2	Placemat	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–9	Section 4.4 Practice Master	Practice
	BLM 4–10	Section 4.4 Achievement Check Rubric	Assessment

	BLM	Title	Purpose
4.5: Quadratic Relations of the Form $y = a(x - r)(x - s)$			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–11	Section 4.5 Practice Master	Practice
	A–7	Thinking General Scoring Rubric	Assessment
4.6: Negative and Zero Exponents			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–12	Section 4.6 Practice Master	Practice
	BLM 4–13	Section 4.6 Achievement Check Rubric	Assessment
	A–9	Communication General Scoring Rubric	Assessment
Chapter 4 Review			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–14	Chapter 4 Review	Review
Chapter 4 Problem Wrap-Up			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–15	Chapter 4 Problem Wrap-Up Rubric	Review
Chapter 4 Practice Test			
	G–1	Grid Paper	Student Support
	G–3	Coordinate Grids	Student Support
	BLM 4–16	Chapter 4 Practice Test	Diagnostic Assessment
	BLM 4–17	Chapter 4 Test	Summative Assessment
	BLM 4–18	Chapter 4 Practice Test Achievement Check Rubric	Assessment
	BLM 4–19	BLM Answers	Answers

Get Ready

Student Text Pages
160–161

Suggested Timing
30–45 min

Tools
- grid paper

Technology Tools
- graphing calculator

Related Resources
- G–1 Grid Paper
- G–3 Coordinate Grids
- BLM 4–1 Get Ready
- BLM 4–2 Get Ready Self-Assessment Checklist

TI-Navigator™

Go to **www.mcgrawhill.ca/books/principles10** and follow the links to the files for this section.

Common Errors

- Some students may scale the axes of a scatter plot by labelling them with the values in the chart.

R_x Remind students that the scale is simply that—a set of numbers to scale, as they are on a ruler. The numbers in the chart are plotted based on the horizontal and vertical scales.

- When working with exponents, some students may make errors with negative bases.

R_x Have students expand the power and count the number of negative signs. Remind them that an even number of negative signs results in a positive product.

Accommodations

Visual—Let students work in groups when creating scatter plots using technology.

Perceptual—Encourage students to colour-code the independent variable and the dependent variable when graphing using pencil and paper.

Motor—Give students extra time to complete the questions in this section and let them work with a partner when creating graphs using technology.

Teaching Suggestions

- Discuss the use of scatter plots to illustrate trends and relationships between an independent variable (controlled by you) and a dependent variable (measured in the experiment).
- Ensure students understand the language of transformations. This is important for Sections 4.2, 4.3, and 4.4.
- Exponent laws are not needed until Section 4.6. You may wish to wait until that section is covered.
- Use **BLM 4–1 Get Ready** for remediation or extra practice.

Assessment

Assess student readiness to proceed by informal observation as students are working on the exercises. A formal test would be inappropriate since this material is not part of the grade 10 curriculum for this chapter. Student self-assessment is also an effective technique; students can place a check mark beside topics in the Get Ready with which they feel confident of having the necessary skills. Use **BLM 4–2 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.