Model Quadratic Relations

Specific Expectations
Identifying Characteristics of Quadratic Relations
In this section, students will
QR2.01 collect data that can be represented as a quadratic relation, from experiments using appropriate equipment and technology (e.g., concrete materials, scientific probes, 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

Link to Get Ready
Have students complete questions 2 and 3 from the Get Ready before proceeding with Section 6.2.

Warm-Up
• Enter these data into lists L1 and L2 on a graphing calculator.

0	0
20	7.2
40	12.8
60	16.8
80	19.2
100	20
120	19.2
140	16.8
160	12.8

• Change the Window settings so Xmin = 0, Xmax = 160, Xscl = 10, Ymin = 0, Ymax = 20, and Yscl = 0.2.
• Turn on Plot 1 and set it to graph the data in L1 and L2.
• Graph the scatter plot.

Does the relationship between corresponding values appear to be linear?

Warm-Up Answers

If possible, take the question up using the overhead calculator screen so students may follow along.

•Press ⟨STAT⟩ ⟨ENTER⟩. Enter the data into L1 and L2.

•Press ⟨WINDOW⟩ to change the settings.

•Press ⟨2nd⟩ [STATPLOT] ⟨ENTER⟩ to turn on Plot 1. For Xlist, enter L1. For Ylist, enter L2.

•Press ⟨GRAPH⟩ to see the scatter plot.

No, the data do not appear to be linear, so the graph is not well represented by a straight line.

Teaching Suggestions

Warm-Up

- Write the Warm-Up questions on the board or on an overhead. Have students complete the questions independently. Then, discuss the solutions as a class. (5–10 min)

Section Opener

- The Section Opener introduces the idea of modelling the path of the shadow created by a sundial. Take some time to show students how they could do this for themselves.

Investigate

- You may wish to complete Investigate A as a demonstration for the class.
- Alternatively, have half the class work on Investigate A while the other half works on Investigate B, then switch.
- If you do not complete this activity as a class demonstration, ensure students compare their results with those of other students.
- You may wish to have students work with a partner for Investigate B.
- You may wish to use a transparency of the graph on an overhead to demonstrate to students how to read ordered pairs from the graph.
- Have students press MODE and select 2 under Float.
- Once students have completed the Investigate, ask them how the regression equation compares to a linear equation.
- Use **BLM 6.2.1 Practice: Model Quadratic Relations** for extra practice or remediation.

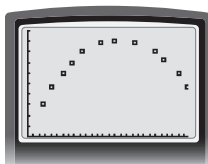**Investigate Answers (page 247)**

Investigate A

1. Answers will vary.
2. Answers will vary.
3. The equation has an x^2 term, an x term, and a constant. The equation of a linear relation never has an x^2 term.

Investigate B

1. Answers may vary.

| Width (mm)	Depth (mm)
0	0
5	28
10	37
15	42
20	45
25	46
30	46
35	45
40	44
45	40
50	35
55	27

2.

3.
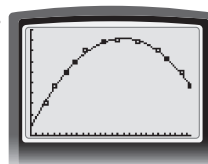
4. A quadratic relation fits these data reasonably well.

Examples
- In the Example, the graph showing the path of a basketball appears to be quadratic. You may wish to discuss if quadratic models may occur in other sports.
- Some students may benefit from plotting the points and drawing the line to represent the ceiling as shown below. This provides an alternative way of showing how they know the ball will not hit the ceiling.
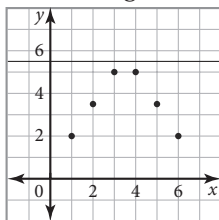
Key Concepts
Discuss why $a \neq 0$. Students should understand that if $a = 0$, the equation is linear.

Discuss the Concepts
- Ask students to explain why it is possible for b to be 0 in a quadratic relation of the form $y = ax^2 + bx + c$.
- Encourage students to use a graphing calculator to enter an equation with a squared term but no x term.

Discuss the Concepts Suggested Answers (page 249)

D1. The equation representing a linear relation never has a term that is squared; a quadratic relation always does.

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Practise the Concepts (A)
- Encourage students to refer back to the Examples before asking for assistance.
- You may wish to use **BLM G1 Grid Paper**.

Apply the Concepts (B)
- For questions 4 to 6, have students use a graphing calculator to find the equations of the curves of best fit. You may wish to have students draw the scatter plots without technology.
- Question 7 is an Achievement Check. It can be used as a form of diagnostic or formative assessment, or assigned as a small summative assessment piece. This provides an opportunity for formative or self-assessment, using **BLM 6.2.2 Achievement Check Rubric**.
- Question 8 deals with stopping distances of cars. Some students may find this very interesting and can be encouraged to investigate further.
- Question 9 links to the Chapter Problem. Remind students to keep the solution to this question handy as it may help them with the Chapter Problem Wrap-Up.
- Question 10 is a Literacy Connect. Literacy Connect questions offer the opportunity to explore literacy issues in the mathematics classroom and within the context of mathematics. This supports general Think Literacy strategies. For more information, visit http://www.edu.gov.on.ca/eng/studentsuccess/thinkliteracy.

7. a)
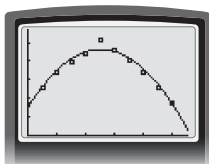
b) The formation is approximately parabolic in shape.

c) No, since the depth measures increase, then decrease again, the formation is a trough (the depth is greater in the middle than at the beginning and end of the data). The graph looks like a hill.

d) The graph is a reflection of the actual formation. As the trough gets deeper, the graph increases. As the trough gets less deep, the graph decreases. To better interpret the data, you can reflect the graph in the x-axis or turn the graph upside down so that it becomes a trough like the actual formation.

Extend the Concepts (C)

• Assign the Extend the Concepts question to students who are not being challenged by questions in Apply the Concepts.

• Extend the Concepts questions can be used as a diagnostic assessment for those students considering a university-level course in grade 11.

• You may wish to use **BLM G1 Grid Paper** for this activity.