# Quadratic Equations: Unit Overview

**MPM2D, Grade 10 Principles of Mathematics (Academic), Unit 5.** 13 classes of 75 minutes, plus one class for the unit test (about three weeks).

### The big question

How many ways can we solve a quadratic equation, and what do the answers mean in real situations?

Students solve quadratic equations by factoring and by graphing, and see that an equation can have two, one or no real roots. They complete the square with algebra tiles and diagrams, rewrite $y = ax^2 + bx + c$ in vertex form, and sketch quadratics using intercepts, completing the square, partial factoring and technology. A history lesson follows quadratic problem solving from Babylonian tablets and al-Khwarizmi's completed squares to the quadratic formula, connecting each step of its development to a numerical example. Students use the formula, interpret the discriminant, and solve maximum and minimum, projectile, area and revenue problems. An optional coding lesson reads and alters a Python program that applies the formula. The summative, Launch It, models a water-bottle rocket launch and finds its maximum height, landing time and time above 8 m in more than one way.

## Lessons

| # | Lesson | Classes | Question | Expectations | What's inside |
|---|---|---|---|---|---|
| 1 | **Solving by Factoring** | 1 | How can factors solve an equation? | QR3.8 | Zero product property; roots in context |
| 2 | **Solving by Graphing** | 1 | What if it won't factor? | QR3.8, QR3.4 | Roots as x-intercepts; two, one or none |
| 3 | **Completing the Square** | 1 | How do we build a perfect square? | QR3.5 | Algebra tiles; $(x - h)^2 + k$ |
| 4 | **From Standard Form to Vertex Form** | 1 | Where is the vertex? | QR3.5, QR3.6, QR4.1 | Completing the square with $a \neq 1$; profit |
| 5 | **Sketching $y = ax^2 + bx + c$** | 1 | Which sketching method fits? | QR3.6 | Intercepts, completing the square, partial factoring, technology |
| 6 | **The Story of the Quadratic Formula** | 1 | Where did the formula come from? | QR3.7 | Babylon, Brahmagupta, al-Khwarizmi; following the development |
| 7 | **Using the Quadratic Formula** | 1 | Can one formula solve them all? | QR3.8 | Exact and approximate roots; verifying |
| 8 | **Real and Non-Real Roots** | 1 | How many roots? | QR3.4 | The discriminant and the graph |
| 9 | **Maximum and Minimum Problems** | 1 | What is the best value? | QR4.1 | Zeros, vertex and optimization |

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| # | Lesson | Classes | Question | Expectations | What's inside |
|---|---|---|---|---|---|
| 10 | **Projectile Problems** | 1 | How high, how long, and when? | QR4.2 | A baseball, a rocket and a diver |
| 11 | **Area and Revenue Problems** | 1 | What is the best design or price? | QR4.2 | Fences, borders and ticket prices |
| 12 | **Coding Quadratics** | 1 | Can code use the formula? | QR3.8, QR4.1 | A Python roots function (optional) |
| 13 | **Quadratics Review** | 1 | Which method is best? | QR3.4–QR4.2 | Choosing methods; mixed review |

## Assessment

| Type | In this unit |
|---|---|
| Assessment for learning | Factor and Solve, Graph and Read, Complete It, Convert the Form, Sketch It Three Ways, Al-Khwarizmi's Square, Formula Practice, Count the Roots, Zeros and Optimal Values, A Baseball's Flight, Area Problems, Read the Code, Choose Your Method, quick checks and exit tickets |
| Assessment as learning | Self-checks, Roots in Context, Graphs at Work, Squares at Work, Following the Development, Formula at Work, Discriminant at Work, Optimization, Rockets and Divers, Revenue Problems, Alter the Code, Unit Review |
| Assessment of learning | Summative task (Launch It) with a rubric, and a unit test with full solutions |

## Materials

Included:

- **Original problems and data:** every problem, data set and diagram was written for this unit (launch data is fictional)
- **History:** a lesson on how the quadratic formula developed, from Babylon to Baghdad
- **Code:** one short Python program (any free Python editor, or trace on paper)
- **Start Here:** unit overview, summative task and rubric, unit test, and teacher solutions for both

Free tools only: algebra tiles (paper or free online), graph paper, calculators, Desmos (free) and any board-approved Python editor. The coding lesson extends MTH1W coding and is optional.

## What's in each lesson

- Teacher lesson plan with expectations, timed sequence, differentiation, look-fors and answer guides
- Slides with speaker notes
- Student handouts and organizers
- Editable Word and PowerPoint files, plus PDFs

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