

# What Goes Up, Days 1–3

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GRADE LEVEL High School

IN THE STANDARDS F-IF.B.4, F-IF.B.6, F-BF.B.3, A-CED.A.2, MP.4

## WHAT WE LIKE ABOUT THIS LESSON

Mathematically:

- Connects a quadratic function with its graph, table, and matching verbal description
- Develops students' understanding of key features of a quadratic function in a real-world context (F-IF.B.4)
- Includes several stages of the basic modeling cycle (computing, interpreting, and validating) (MP.4)
- Provides opportunities for students to make use of the structure of a quadratic function (MP.7)
- Requires students to use precision in describing the path of an object, both qualitatively and quantitatively (MP.6)

In the classroom:

- Allows for student collaboration and discussion
- Uses technology to help make the mathematics explicit
- Gives formal and informal opportunities for teachers to check for understanding
- Provides extensive time for students to engage deeply with the mathematics

## MAKING THE SHIFTS<sup>1</sup>

	Focus	Belongs to the Widely Applicable Prerequisites for College and Careers <sup>2</sup>
	Coherence	Builds on many key understandings of functions from grade 8 and Algebra 1, expanding from linear to quadratic functions; lays foundations for potential future work with average rate of change in Calculus
	Rigor <sup>3</sup>	Conceptual Understanding: primary in this lesson Procedural Skill and Fluency: not addressed in this lesson Application: primary in this lesson

<sup>1</sup>For more information read [Shifts for Mathematics](#).

<sup>2</sup>For more information, see [Widely Applicable Prerequisites for College and Careers](#).

<sup>3</sup>Lessons may target one or more aspect(s) of rigor.

## ADDITIONAL THOUGHTS

It is worth noting that this lesson is part of a multi-lesson unit on “Modeling with Algebra.” It is not intended for students to meet the full expectations of the course-level standards in these lessons through only this selected lesson. This particular lesson, intended to be taught over 3 days, focuses on projectile motion as a context for average rates of change in the context of velocity and acceleration. Other lessons in this unit focus on systems of inequalities, linear systems, and constant area models.

Within this lesson, students apply key understandings of functions and equations from previous grades or courses. Students graph the function  $h(t) = -16t^2 + 50t + 5$ , showing how the height,  $h(t)$ , of a stone changes with relation to time,  $t$ . To create the graph, students evaluate the function for several input values of  $t$ . To find the specific time at which the stone will return to launch height (or similarly when it will hit the ground), students will need to find the input that correspond to a specific output. For example, requiring that  $h(t) = 5$  gives an equation in one variable,  $-16t^2 + 50t + 5 = 5$ , solvable by factoring. The distinction between function and equation is an important one as the two terms are often conflated by students and teachers. Equations answer a question: “For what values of the variable(s) is the equation true?” Functions, on the other hand, describe a rule for turning an input number into an output number and are neither true nor false. Confusion may arise when graphing: the graph of the solutions to an equation in two variables (an infinitude of  $(u, v)$  pairs that satisfy the equation) can often look the same as the graph of a function (a picture of the output changes as the input changes). For more information, read pages 2 and 3 of the progression document, [High School, Algebra](#).

The format of this lesson has some interesting aspects to highlight. There is continuous movement from individual work to group work and back to allow students time to think and work independently as well as share their ideas with classmates. There are also built-in checkpoints for the teacher to ensure students have correct understanding before moving forward in the lesson. Included with the lesson resources are example class conversations, student materials, video introductions and reflections, potential student misconceptions, and examples of student work. This lesson assumes a classroom culture where students are ready to grapple with problems and persevere in solving them. Teachers who are still establishing this culture could benefit from more guiding questions, additional information about necessary prior knowledge, and additional strategies to facilitate discussion.

This lesson begins with a focus on the interpretation of functions and moves to building new functions from existing ones. For more insight on the course-level concepts around interpreting functions addressed in this lesson, read pages 7–9 of the progression document, [Grade 8, High School, Functions](#). For more insight on the course-level concepts around building functions addressed in this lesson, read pages 11–12 of the same progression document.