

## ALGEBRA 1 • UNIT MEGA BUNDLE

# Functions & Function Families

## Unit Mega Bundle

A comprehensive, research-based unit covering **linear**, **quadratic**, **absolute value**, **exponential**, and **piecewise** functions in a unified, comparative framework that builds deep conceptual understanding.

6 Full Lessons

Print + Digital

Answer Keys

Unit Test A &amp; B

**What's Inside:** 6 Lessons • Guided Notes • Partner Practice • Independent Practice (HW) • Exit Tickets • Mid-Lesson Checks (Google Form) • Full Answer Keys with Worked Solutions • Unit Study Guide • 30-Question Unit Test (2 Versions) • Performance Task with Rubric

*Designed for deep conceptual understanding • Aligned to Algebra 1 standards • Built for the TPT premium classroom*

# Table of Contents

|          |                                                                  |    |
|----------|------------------------------------------------------------------|----|
|          | How to Use This Mega Bundle (Teacher Guide)                      | 3  |
|          | Unit at a Glance & Pacing Guide                                  | 4  |
| LESSON 1 | Function Definition, Domain, Range & Function Notation           | 5  |
|          | • Guided Notes (Print + Google Slides)                           | 5  |
|          | • Partner Practice Activity                                      | 9  |
|          | • Independent Practice (Homework)                                | 11 |
|          | • Mid-Lesson Check for Understanding (Google Form)               | 13 |
|          | • Exit Ticket                                                    | 14 |
|          | • Answer Key with Worked Solutions                               | 15 |
| LESSON 2 | Evaluating Functions: Graphically, Numerically, Algebraically    | 18 |
|          | • Guided Notes / Partner Practice / Homework / Exit Ticket / Key | 18 |
| LESSON 3 | Key Features of Functions                                        | 27 |
|          | • Intercepts, Increasing/Decreasing, Extrema, End Behavior       | 27 |
| LESSON 4 | Parent Functions & Transformations                               | 36 |
|          | • Shifts, Reflections, Stretches & Shrinks                       | 36 |
| LESSON 5 | Comparing Functions Across Families                              | 45 |
|          | • Which Grows Fastest? When Does Exponential Exceed Linear?      | 45 |
| LESSON 6 | Modeling with Functions                                          | 54 |
|          | • Real-World Data Fit & Interpretation                           | 54 |
|          | Unit Study Guide                                                 | 63 |
|          | Unit Test — Version A (30 Questions)                             | 67 |
|          | Unit Test — Version B (30 Questions)                             | 71 |
|          | Unit Test Answer Keys (A & B)                                    | 75 |
|          | Performance Task with Rubric                                     | 78 |
|          | Review Request & Credits                                         | 82 |

## A NOTE ON PAGE NUMBERS

## Research-Based Interactive Features Embedded Throughout

TPT PREVIEW

| Feature                  | What It Does                                                                                                             |
|--------------------------|--------------------------------------------------------------------------------------------------------------------------|
| Think-Pair-Share prompts | Structures productive talk so every student rehearses reasoning before sharing publicly (Lyons, 2019).                   |
| Math Talk callouts       | Open-ended questions that target a specific mathematical practice and build academic language.                           |
| Error Analysis boxes     | Showcases common misconceptions; students diagnose and correct — a high-leverage form of retrieval (Booth et al., 2013). |
| Multiple Representations | Every key concept is shown <b>verbally, algebraically, graphically, and numerically</b> (Lesh Translation Model).        |
| Real-World Connections   | Anchors abstract ideas in authentic contexts to strengthen transfer and motivation.                                      |
| Self-Check questions     | Metacognitive prompts that build students' ability to monitor their own understanding.                                   |
| Sentence Frames          | Supports academic language for all learners, especially English Learners and students with IEPs.                         |

# LESSON 1: Function Definition, Domain, Range & Function Notation

*What is a function, and how do we communicate about it?*

## Learning Targets

- Define a **function** as a relation that assigns each input exactly one output.
- Identify functions from tables, graphs, mapping diagrams, and sets of ordered pairs.
- Determine the **domain** and **range** of a function.
- Use **function notation**  $f(x)$  to evaluate and interpret functions in context.

## Vocabulary

function, relation, input, output, domain, range, independent variable, dependent variable, function notation  $f(x)$ , vertical line test

## Materials

Guided Notes (print or Google Slides), Partner Practice, Exit Ticket, Google Form link, graph paper, calculator.

## Pacing

2 class periods (55 min each)

## DIGITAL RESOURCES

**Google Slides:** Lesson 1 — Guided Notes (editable) | **Google Form:** Lesson 1 — Mid-Lesson Check (auto-graded). Access both via the bundle's master links page; see teacher guide.

## GUIDED NOTES

## Part 1: What Is a Function?

A **relation** is any set of ordered pairs (input, output). A **function** is a special kind of relation in which **each input is paired with exactly one output**. You can think of a function as a machine: drop in an input, and the machine gives you back one — and only one — output.

**A function is a rule that assigns each input exactly one output**



Figure 1.1. A function is a reliable input-output machine.

## MULTIPLE REPRESENTATIONS

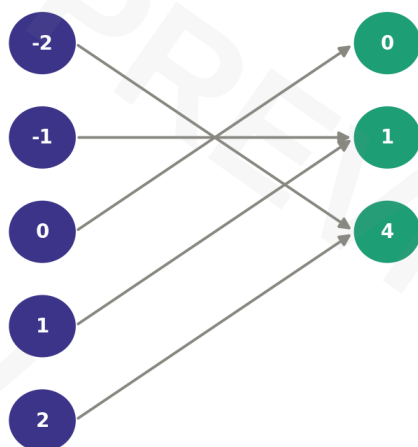
A function can be represented **four ways**: (1) a **table** of values, (2) a **graph**, (3) an **equation**, and (4) a **mapping diagram** or set of ordered pairs. The same function looks different in each form but always follows the one-input  $\rightarrow$  one-output rule.

### Example 1: Is the relation a function?

Determine whether each relation is a function. Justify your answer.

| Relation                              | Function? | Reasoning                                                                    |
|---------------------------------------|-----------|------------------------------------------------------------------------------|
| $\{(2, 5), (3, 7), (4, 9), (5, 11)\}$ | Yes       | Each input (2, 3, 4, 5) appears exactly once $\rightarrow$ one output each.  |
| $\{(1, 4), (2, 5), (1, 6), (3, 7)\}$  | No        | Input 1 is paired with both 4 and 6 $\rightarrow$ two outputs for one input. |
| $\{(-1, 0), (0, 0), (1, 0), (2, 1)\}$ | Yes       | Different inputs may share the same output (0). Each input has one output.   |

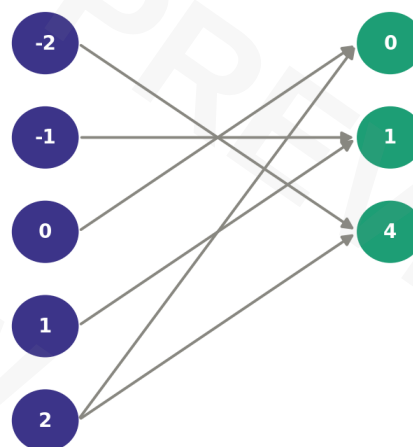
**Function (each input  $\rightarrow$  one output)**



Domain

Range

**NOT a Function (input 2  $\rightarrow$  two outputs)**



Domain

Range

Figure 1.2. Mapping diagrams make the one-input  $\rightarrow$  one-output rule visible. On the left, each domain value points to exactly one range value — a function. On the right, the input 2 points to two outputs — not a function.

### MATH TALK

Look at the right mapping diagram. The input 2 maps to *both* 4 and 0. In your own words, why does this violate the definition of a function? Can a function ever have the same output twice? Give an example or counterexample.

## Domain & Range of $f(x) = -(x-1)^2 + 4$

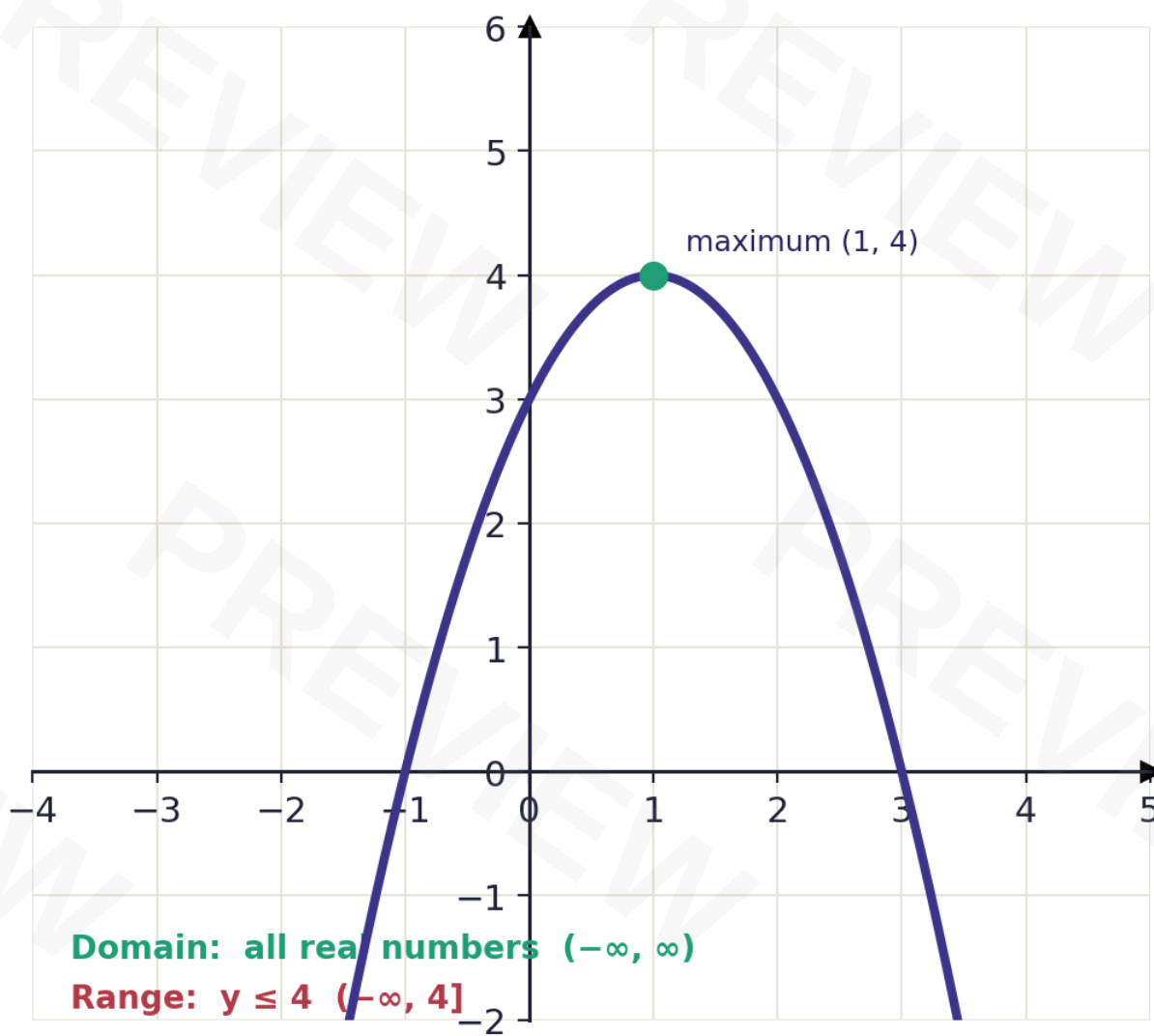


Figure 1.4. For  $f(x) = -(x-1)^2 + 4$ , the domain is all real numbers  $(-\infty, \infty)$  but the range is limited to  $y \leq 4$  because 4 is the maximum.

### Example 2: Finding domain and range

| Function         | Domain              | Range               |
|------------------|---------------------|---------------------|
| $f(x) = 3x - 7$  | $(-\infty, \infty)$ | $(-\infty, \infty)$ |
| $f(x) = x^2 + 2$ | $(-\infty, \infty)$ | $[2, \infty)$       |
| $f(x) =  x  - 4$ | $(-\infty, \infty)$ | $[-4, \infty)$      |
| $f(x) = 2^x$     | $(-\infty, \infty)$ | $(0, \infty)$       |

**STRATEGY:** Reading Range from an Equation

## Partner Practice: Function Detectives

**Directions:** With your partner, analyze each "mystery relation." Decide whether it is a function, state the domain and range, and write the answer in function notation where possible. Partner A explains the reasoning; Partner B writes. Switch roles after Question 4.

### SENTENCE FRAMES

**Is it a function?** "This relation *is* / *is not* a function because \_\_\_\_."

**Domain:** "The domain is \_\_\_\_, which means the input can be \_\_\_\_."

**Range:** "The range is \_\_\_\_, which means the output is between \_\_\_\_."

| # | Mystery Relation                                                                  | Function? | Domain | Range |
|---|-----------------------------------------------------------------------------------|-----------|--------|-------|
| 1 | $\{(-2, 5), (-1, 3), (0, 1), (1, 3), (2, 5)\}$                                    |           |        |       |
| 2 | Table: $x = \{1, 2, 3, 4\}$ , $y = \{5, 5, 5, 5\}$                                |           |        |       |
| 3 | Graph: a sideways parabola $x = y^2$                                              |           |        |       |
| 4 | Equation: $y = 2 x  - 3$                                                          |           |        |       |
| 5 | Mapping: $\{1 \rightarrow 3, 2 \rightarrow 5, 3 \rightarrow 3, 4 \rightarrow 7\}$ |           |        |       |
| 6 | Equation: $y^2 = x + 4$                                                           |           |        |       |

### Partner Practice — Function Notation

Let  $f(x) = x^2 - 4x + 7$ . With your partner, evaluate each and explain in words what the result means.

7.  $f(0)$

.....

8.  $f(2)$

.....

9.  $f(-1)$

.....

10.  $f(3) - f(1)$

.....

### SELF-CHECK

## Key Features of a Function

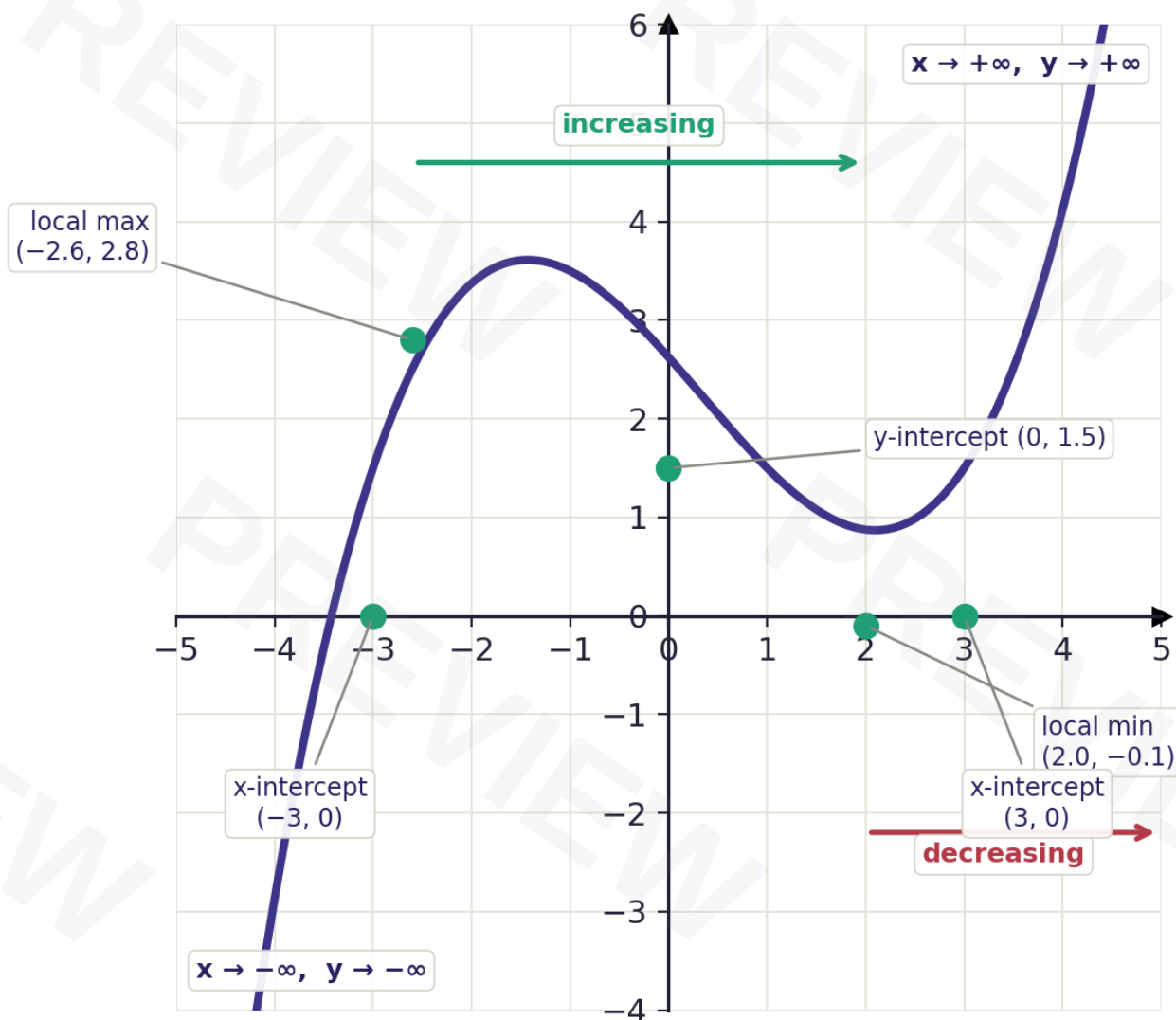


Figure 3.1. The key features of a function, all visible on one graph.

### Feature 1: Intercepts

An **x-intercept** is a point where the graph crosses the x-axis — that is, where  $f(x) = 0$ . The x-values are called **zeros** or **roots**. A **y-intercept** is where the graph crosses the y-axis — that is, where  $x = 0$ , so the y-intercept is  $f(0)$ .

**Example 1: Find the intercepts of  $f(x) = x^2 - 5x + 6$ .**

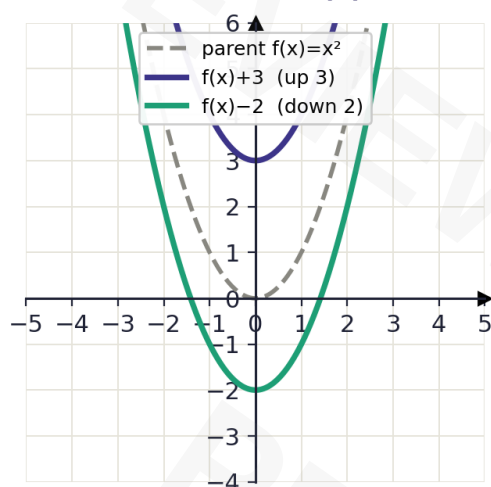
y-intercept: set  $x = 0$ :  $f(0) = 0 - 0 + 6 = 6$ . So y-int =  $(0, 6)$ .

x-intercepts: set  $f(x) = 0$ :  $x^2 - 5x + 6 = 0 \rightarrow (x - 2)(x - 3) = 0 \rightarrow x = 2$  or  $x = 3$ . So x-ints =  $(2, 0)$  and  $(3, 0)$ .

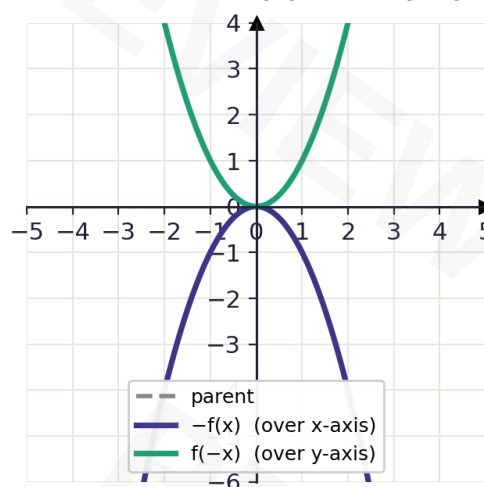
### REAL WORLD

## Transformations of Parent Functions

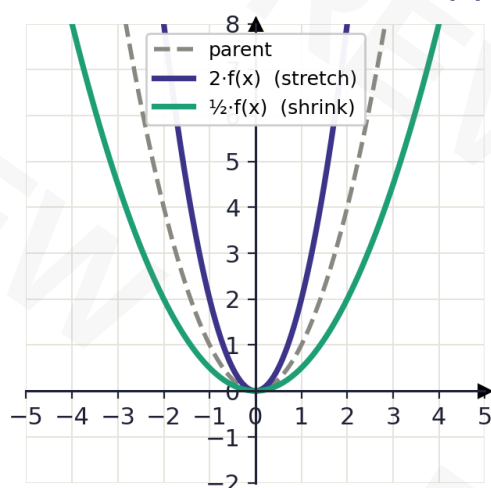
### Vertical Shift: $f(x) + k$



### Reflection: $-f(x)$ and $f(-x)$



### Vertical Stretch / Shrink: $a \cdot f(x)$



### Horizontal Shift: $f(x - h)$

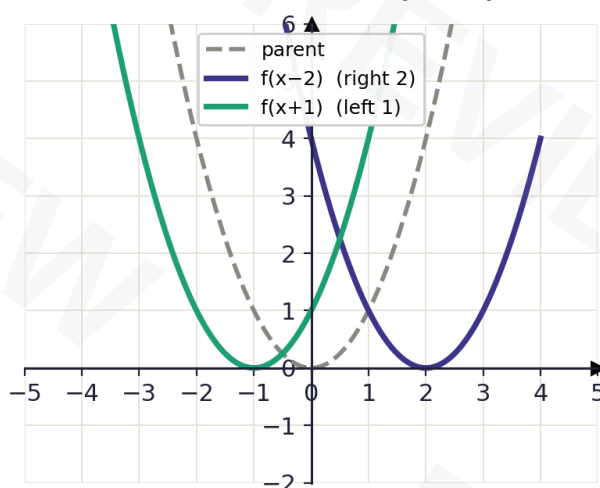


Figure 4.2. Each type of transformation applied to  $f(x) = x^2$ . Notice how the parent (dashed gray) becomes the colored curve.

### Example 1: Describe the transformation

Let  $g(x) = -2(x + 3)^2 + 5$ . The parent is  $f(x) = x^2$ . Compare to  $y = a \cdot f(x - h) + k$ :

$a = -2$  (reflection over x-axis + vertical stretch by 2) |  $h = -3$  (shift LEFT 3) |  $k = 5$  (shift UP 5)

**Transformation:** Reflect  $f(x) = x^2$  over the x-axis, stretch vertically by a factor of 2, shift left 3, and shift up 5. The vertex moves from (0, 0) to (-3, 5).

**STRATEGY:** Map the Vertex First

## Which grows fastest? Exponential overtakes all

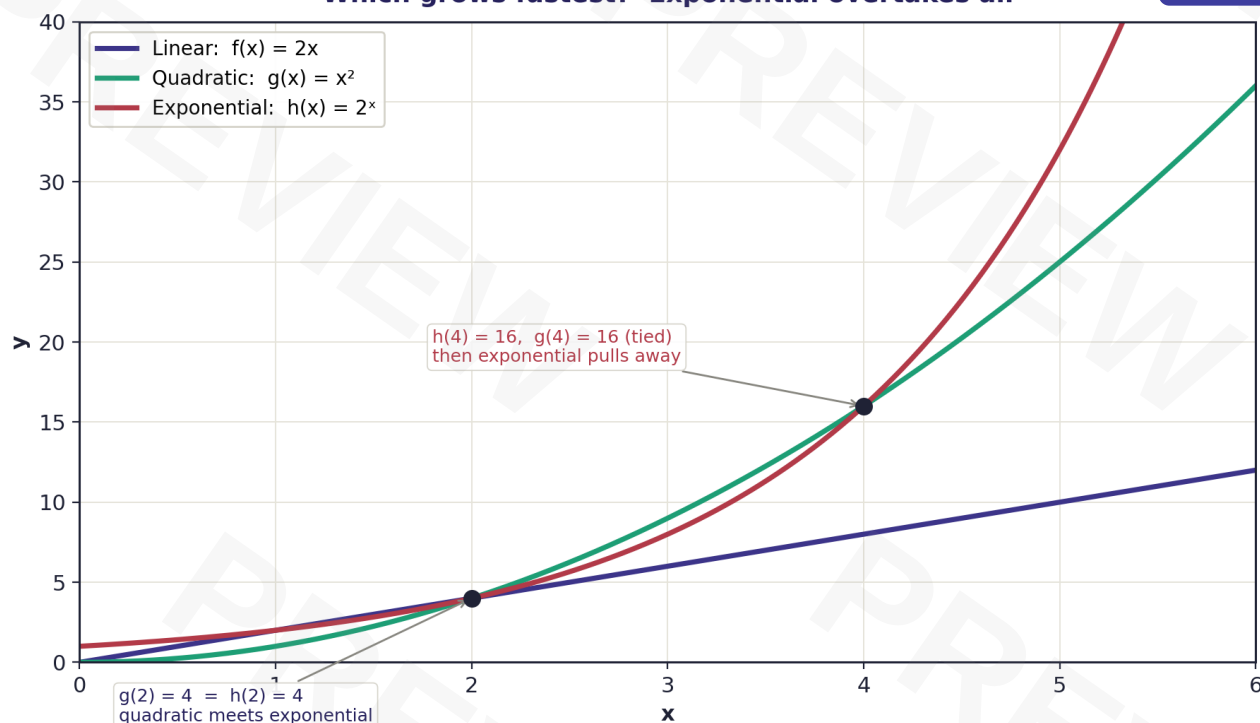


Figure 5.1. Linear ( $y=2x$ ), quadratic ( $y=x^2$ ), and exponential ( $y=2^x$ ) all start near the origin. The exponential eventually overtakes both.

## BIG IDEA

**For large  $x$ , exponential growth always wins.** No matter how steep the line or how wide the parabola, an exponential function with base  $> 1$  will eventually exceed it. This is the mathematical heart of compound interest, population growth, and pandemics.

## Average Rate of Change

The **average rate of change** (ARC) of a function  $f$  over the interval  $[a, b]$  measures how fast the function changes on average across that interval. It is the slope of the **secant line** connecting  $(a, f(a))$  and  $(b, f(b))$ :

$$\text{ARC} = [f(b) - f(a)] / (b - a)$$

## Example 1: Compare ARCs

| Function                  | ARC on $[0,1]$ | ARC on $[1,2]$ | ARC on $[2,3]$ |
|---------------------------|----------------|----------------|----------------|
| Linear: $f(x) = 2x$       | 2              | 2              | 2              |
| Quadratic: $g(x) = x^2$   | 1              | 3              | 5              |
| Exponential: $h(x) = 2^x$ | 1              | 2              | 4              |

**Linear** ARCs are constant (always 2). **Quadratic** ARCs grow linearly (1, 3, 5 — each increases by 2). **Exponential** ARCs grow exponentially (1, 2, 4 — each doubles). This pattern reveals why exponential eventually wins: its rate of change grows geometrically, not arithmetically.

# Unit Test — Version A

30 Questions • 60 minutes • No calculator on Part 1

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

Score: \_\_\_\_\_ / 100

## DIRECTIONS

**Part 1 (Q1–Q15): Multiple choice, 2 points each, no calculator.** Circle the best answer. **Part 2 (Q16–Q25): Short answer, 3 points each, calculator OK.** Show work for full credit. **Part 3 (Q26–Q30): Constructed response, 6 points each, calculator OK.** Show all work and explain your reasoning. Total = 100 points.

## Part 1: Multiple Choice (2 pts each)

- Which relation is NOT a function?
  - $\{(1,2), (2,4), (3,6)\}$
  - $\{(0,1), (1,1), (0,2)\}$
  - $\{(-1, 0), (0, 0), (1, 0)\}$
  - $\{(2,5), (3,5), (4,5)\}$
- The graph of  $y^2 = x$  is:
  - A function
  - Not a function
  - A linear function
  - Cannot tell
- What is the range of  $f(x) = -x^2 + 7$ ?
  - $(-\infty, \infty)$
  - $(-\infty, 7]$
  - $[7, \infty)$
  - $(0, \infty)$
- If  $f(x) = 3x - 4$ , what is  $f(-2)$ ?
  - 10
  - 2
  - 2
  - 10

# Performance Task with Rubric

Real-world modeling • Summative • 50 points

## The Drip Drop Investigation

**Scenario:** A science class is studying water loss from a leaky faucet. They collect the following data, measuring the volume of water (in mL) remaining in a 1000 mL beaker after  $t$  minutes of dripping:

| $t$ (min) | 0    | 2   | 4   | 6   | 8   | 10  |
|-----------|------|-----|-----|-----|-----|-----|
| $V$ (mL)  | 1000 | 800 | 640 | 512 | 410 | 328 |

## Your Task

As the class statistician, write a complete report that includes each of the five parts below. Show all work. Use function notation throughout. Your report should be neat, well-organized, and use correct mathematical vocabulary.

**Part A. Analyze the data.** Compute the ratios of consecutive  $V$ -values. What do you notice? Which function family best models this data, and why?

---

---

---

---

---

**Part B. Write the model.** Find the exponential model  $V(t) = a \cdot r^t$  that fits the data. State the values of  $a$  and  $r$  and interpret each in the context of the dripping faucet.

---

---

---

---

---

**Part C. Predict.** Use your model to find: (1) the volume after 15 minutes, (2) the time when the volume reaches 200 mL. Round to 2 decimal places. Label each as interpolation or extrapolation.

---

---

---

---

---

## Scoring Rubric (50 points total)

| Part              | Exemplary (full)                                                                                                                             | Proficient (partial)                                              | Emerging (minimal)                    | Pts |
|-------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|---------------------------------------|-----|
| <b>A: Analyze</b> | Correctly computes all 5 ratios (0.8 each), identifies as exponential, justifies with constant ratio.                                        | Computes most ratios, identifies exponential, weak justification. | Incorrect family or no justification. | 10  |
| <b>B: Model</b>   | $V(t) = 1000(0.8)^{t/2}$ ; interprets $a=1000$ (initial) and $r=0.8$ (80% remains each 2 min; 20% lost).                                     | Correct model but incomplete interpretation.                      | Wrong model or no interpretation.     | 10  |
| <b>C: Predict</b> | $V(15) \approx 174$ mL (extrap.); $t \approx 13.95$ min for 200 mL (interpolation within range, near boundary). Both labeled.                | One prediction correct; labels missing.                           | Both wrong or not attempted.          | 10  |
| <b>D: Compare</b> | $L(2)=800$ , $L(4)=600$ , $L(10)=0$ . Notes L matches at $t=2$ but diverges ( $L(10)=0$ vs actual 328). Exponential better; cites residuals. | Computes L values, picks exponential, weak evidence.              | Wrong L values or wrong conclusion.   | 10  |
| <b>E: Reflect</b> | Notes beaker empties in reality (finite water); exponential model approaches 0 but never reaches — unrealistic for very small volumes.       | Identifies one limitation.                                        | No meaningful reflection.             | 10  |

## Sample Exemplary Responses (Teacher Reference)

**A. Ratios:  $800/1000 = 0.8$ ,  $640/800 = 0.8$ ,  $512/640 = 0.8$ ,  $410/512 \approx 0.80$ ,  $328/410 \approx 0.80$ .**

The ratio is constant at 0.8, so the data follow an **exponential decay** pattern. Each 2-minute interval, 80% of the water remains (20% drips out).

**B.  $V(t) = 1000 \cdot (0.8)^{t/2}$ .**

$a = 1000$  (initial volume at  $t = 0$ ).  $r = 0.8$  per 2-minute interval, so per minute the factor is  $0.8^{1/2}$ . Equivalently, using  $t$  in 2-minute units:  $V(t) = 1000 \cdot (0.8)^{t/2}$ . Interpretation: the beaker starts with 1000 mL; every 2 minutes it keeps 80% of its current volume (loses 20%).

**C.  $V(15) \approx 174$  mL (extrapolation);  $t \approx 14.4$  min for 200 mL (extrapolation).**

$V(15) = 1000 \cdot (0.8)^{7.5} \approx 1000 \cdot 0.174 \approx 174$  mL. Since  $t = 15$  is beyond the data range (0–10), this is extrapolation. Solve  $1000(0.8)^{t/2} = 200$ :  $(0.8)^{t/2} = 0.2 \rightarrow (t/2) \cdot \log(0.8) = \log(0.2) \rightarrow t/2 = \log(0.2)/\log(0.8) \approx (-0.699)/(-0.097) \approx 7.21 \rightarrow t \approx 14.4$  min. Since 14.4 is beyond the data range (max 10), this is also extrapolation. **Both are extrapolation.**

## ALGEBRA 1 • MEGA BUNDLE

# WHAT'S INSIDE THE FULL BUNDLE

A comprehensive, research-based unit on Functions & Function Families — 109 pages of guided notes, practice, assessments, and complete answer keys.

6

FULL LESSONS

109

TOTAL PAGES

36

PRACTICE SETS

2

UNIT TESTS

100%

ANSWER KEYS

## THE 6 LESSONS

## LESSON 1

Function Definition, Domain, Range & Notation

## LESSON 2

Evaluating Functions: Graphically, Numerically, Algebraically

## LESSON 3

Key Features: Intercepts, Extrema, End Behavior

## LESSON 4

Parent Functions & Transformations

## LESSON 5

Comparing Functions Across Families

## LESSON 6

Modeling with Functions: Real-World Data Fit

## EVERY LESSON INCLUDES

Guided Notes (Print + Google Slides)

Partner Practice Activity

Independent Practice (HW)

Mid-Lesson Check (Google Form)

Exit Ticket

Full Answer Key with Worked Solutions



Unit Study Guide

3-pass review framework



Unit Test A &amp; B

30 questions each + keys



Performance Task + Rubric

50-point analytic rubric

*This is a preview — the full resource contains 109 pages. Watermarked pages are samples only.*