MODULE 4 OVERVIEW

TEKS* Addressed:
A.3B, **A.3C**, A.9A, A.9B, **A.9C**, **A.9D**, A.9E, A.11A, **A.11B** A.12B, A.12C, A.12D

*Bold TEKS = Readiness Standard

Investigating Growth and Decay

Sessions: **25**

Why is this module named *Investigating Growth and Decay*?

Students are familiar with constant differences—where the ratio of output values to input values is the same across the function's domain.

In this module, however, the functions model constant growth or decay, meaning that the amount that the output changes within each interval increases or decreases by a constant multiplier.

All of the functions in this module, from geometric sequences through data regressions, share this key characteristic of exponential functions.

The Research Shows . . .

"When students compare and contrast different characteristics of functions, they develop a more complex, connected understanding of the structure of functions in general and structures that make families of functions unique, thus helping them connect features of the graph with different real-world contexts."

—*Catalyzing Change in High School Mathematics Initiating Critical Conversations*, *NCTM*, | Page 54

Functions:
- compare & contrast characteristics
- structure of functions

What is the mathematics of *Investigating Growth and Decay*?

Investigating Growth and Decay contains two topics: *Introduction to Exponential Functions* and *Using Exponential Equations*. Students explore and write exponential functions. They apply the properties of radicals to simplify square roots and the properties of exponents to rewrite numeric expressions involving rational exponents. Students use the structure of exponential functions to solve for unknown values.

2 topics
- Intro to Expon functions
- Using Expon functions

1 DAY PACING = 45-MINUTE SESSION

15 SESSIONS
14 LEARNING • 1 ASSESSMENT

TOPIC 1 *Introduction to Exponential Functions*

Learning Together: 11 Sessions

TEKS: A.9A, A.9B, **A.9C**, **A.9D**, A.11A, **A.11B**, A.12B, A.12C, A.12D

Students learn that exponential functions have a constant ratio.

- Students rewrite algebraic expressions containing integer exponents.
- Students learn to write exponential functions from graphs, written descriptions, and tables.
- Students use the properties of radicals to simplify square roots.
- Students rewrite expressions with rational exponents in radical form and vice versa.

Learning Individually: 3 Sessions

Targeted Skills Practice for *Introduction to Exponential Functions*

- Students rewrite algebraic expressions containing integer exponents.
- Students write exponential functions to represent sequences, tables, and graphs.
- Students complete tables of values to graph exponential functions and describe the characteristics of the graph.
- Students use the properties of radicals to simplify square roots.
- Students rewrite radical expressions and powers with rational exponents.

10 SESSIONS
9 LEARNING • 1 ASSESSMENT

TOPIC 2 *Using Exponential Equations*

Learning Together: 6 Sessions

TEKS: **A.3B**, **A.3C**, A.9A, A.9B, **A.9C**, **A.9D**, A.9E, **A.11B**, A.12B

Students build on their current tools for using exponential equations.

- Students solve exponential equations using a graph.
- Students generate equivalent algebraic expressions using the properties of exponents.
- Students use technology to calculate regression functions and use them to make predictions.

Learning Individually: 3 Sessions

Targeted Skills for *Using Exponential Equations*

- Students identify scenarios of exponential growth or decay.
- Students analyze and write exponential functions.
- Students determine exponential regression functions and use them to make predictions.
- Students identify the domain and range of exponential functions.

How is *Investigating Growth and Decay* connected to prior learning?

Previously, students wrote explicit formulas for sequences with a common ratio.

They know the rules of integer exponents and are familiar with function notation.

Math Representation

The exponential expression $(4^2)^3$ is a power of a power. You can write it as two repeated multiplication expresstions using the definition of a power.

$$(4^2)^3 = (4^2)(4^2)(4^2)$$
$$= (4 \cdot 4)(4 \cdot 4)(4 \cdot 4)$$

There are 6 factors of 4.

Students understand that the x-coordinates of the points where the graphs of $y = f(x)$ and $y = g(x)$ intersect are solutions of the equation $f(x) = g(x)$. They have used such intersections to solve linear functions with a horizontal line and to solve systems of linear functions.

Students have transformed linear functions. In this module, activities reinforce what students already know about function transformations and apply that understanding to exponential functions.

When will students use knowledge from *Investigating Growth and Decay* in future learning?

Exponential functions are the first nonlinear functions that students have studied in depth. Throughout this module, students recognize the characteristics that exponential functions and linear functions share. However, they also start to differentiate functions by recognizing that an exponential function grows or decays at a rate much faster than a linear function, that the average rate of change between two points in an exponential function is not constant, and that the range of an exponential function is a subset of the real numbers. Being able to compare functions is important as students prepare to encounter more complicated function types. In future courses, students will solve exponential equations.

Math Representation

You can write any exponential equation as a logarithmic equation and vice versa.

Exponential Form	⇔	Logarithmic Form
$y = b^x$	⇔	$\log_b y = x$
$16 = 4^2$	⇔	$\log_4 16 = 2$
$1000 = 10^3$	⇔	$\log_{10} 1000 = 3$
$32 = 16^{1.25}$	⇔	$\log_{16} 32 = 1.25$
$a = b^c$	⇔	$\log_b a = c$

4 Investigating Growth and Decay

MODULE 4: Assessment Summary

Topic	Topic Title	Name	Administered	TEKS*
1	Introduction to Exponential Functions	End of Topic Assessment	After Topic 1	A.9A A.9B **A.9C** **A.9D** A.11A **A.11B** A.12B A.12C A.12D
2	Using Exponential Functions	End of Topic Assessment	After Topic 2	**A.3B** A.9A A.9B **A.9C** **A.9D** A.9E **A.11B** A.12B

READINESS TEKS

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