

Unit 3: Exponential Functions (5 Weeks)

Content Area: **Template**
Course(s):
Time Period: **Full Year**
Length: **9 Weeks**
Status: **Published**

Unit Rationale

A unit on exponential functions in Algebra 1 is crucial for developing students' understanding of growth patterns, mathematical modeling, and preparing them for advanced mathematical topics. Here's a rationale for including a unit on exponential functions in Algebra 1:

1. Understanding Growth and Decay

- **Modeling Real-World Phenomena:** Exponential functions are used to model many real-world situations, such as population growth, radioactive decay, and interest in finance. Understanding these functions helps students make sense of phenomena that involve rapid growth or decay, making mathematics more relevant and applicable to their lives.
- **Contrasting Linear and Exponential Growth:** By studying exponential functions, students learn to differentiate between linear and exponential growth. This distinction is vital for understanding how different processes change over time, which is a key concept in both science and economics.

2. Building Algebraic Skills

- **Introduction to New Function Types:** Exponential functions introduce students to a new type of function, expanding their understanding beyond linear and quadratic functions. This broadens their mathematical toolkit and prepares them for more complex types of functions they will encounter in future courses.
- **Operations with Exponents:** Working with exponential functions reinforces and extends students' knowledge of exponents, helping them to master operations involving powers and roots, which are foundational skills in algebra.

3. Preparation for Higher-Level Math

- **Foundation for Advanced Topics:** Mastery of exponential functions is essential for success in more advanced math courses such as Algebra 2, Pre-Calculus, and Calculus. Topics like logarithms, exponential growth and decay, and compound interest all build directly on the concepts learned in this unit.
- **Introduction to Logarithms:** The study of exponential functions naturally leads to the concept of logarithms, which are inverse functions of exponentials. Understanding this relationship is crucial for higher-level math and for solving more complex equations.

4. Enhancing Mathematical Reasoning

- **Developing Abstract Thinking:** Exponential functions help students develop abstract thinking by requiring them to understand how changes in the exponent affect the function's behavior. This prepares them for more advanced mathematical concepts that involve abstract reasoning.
- **Connecting Algebra and Real Life:** Exponential functions bridge the gap between abstract algebraic concepts and real-world applications. This connection helps students see the value of mathematical

reasoning in understanding and solving practical problems.

5. Real-World Applications

- **Financial Literacy:** Understanding exponential growth is crucial for financial literacy. Concepts such as compound interest, investments, and loans are all based on exponential functions. By learning these functions, students gain the tools they need to make informed financial decisions.
- **Science and Technology:** Exponential functions are widely used in various fields of science and technology, including biology, chemistry, physics, and computer science. Understanding these functions is essential for students who plan to pursue careers in STEM fields.

6. Engaging and Accessible Content

- **Exploring Growth Patterns:** Exponential functions offer a compelling way to explore growth patterns that are both rapid and surprising. This can engage students and spark curiosity about mathematical concepts, particularly when they see how exponential growth differs from other types of growth.
- **Visual Learning Opportunities:** The graphs of exponential functions provide clear visual representations of growth and decay, making the concept more accessible to students who are visual learners. This helps to deepen their understanding of how these functions behave.

7. Critical Problem-Solving Skills

- **Solving Exponential Equations:** Students learn to solve exponential equations, which enhances their problem-solving abilities and introduces them to new methods of algebraic manipulation. These skills are transferable to many other areas of mathematics and science.
- **Analyzing Data:** Exponential functions are often used to model data. Students learn to fit exponential models to data sets, which develops their ability to analyze and interpret data, a critical skill in many academic disciplines and careers.

8. Preparation for Standardized Testing

- **Commonly Tested Concept:** Exponential functions are a common topic on standardized tests like the SAT, ACT, and other high school assessments. Mastery of this topic is essential for students to perform well in these exams, particularly in questions related to growth patterns and real-world applications.

By including a unit on exponential functions in Algebra 1, educators equip students with essential mathematical tools that are crucial for understanding growth and decay, solving real-world problems, and succeeding in advanced mathematics. This unit helps students develop a deeper appreciation for the power and relevance of mathematics in both academic and everyday contexts.

Pre-Assessment

- HMH- Math Language Routines Library

- "Are you ready"- at the beginning of all modules.
- Before you begin- interactive lessons

Module 11: Exponential Functions and Models

Instructional Plan

Lesson 1: Exponential Growth Functions

Lesson 2: Exponential Decay Functions

Lesson 3: Rewrite Exponential Models

*All resources are listed in HMH.

https://www.hmhco.com/ui/#/discover/IM_NL20_A1

Module 12: Relationships Among Exponential Functions

Instructional Plan

Lesson 1: Transform Exponential Functions

Lesson 2: Compare Exponential Functions

*All resources are listed in HMH.

https://www.hmhco.com/ui/#/discover/IM_NL20_A1

Module 13: Fit Exponential Functions to Data

Instructional Plan

Lesson 1: Scatter Plots and Fitted Exponential Curves

Lesson 2: Choose Between Linear and Exponential Models

*All resources are listed in HMH.

https://www.hmhco.com/ui/#/discover/IM_NL20_A1

Module 14: Discrete Exponential Functions

Instructional Plan

Lesson 1: Geometric Sequences Defined Recursively

Lesson 2: Geometric Sequences Defined Explicitly

*All resources are listed in HMH.

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Standards

New Jersey Student Learning Standards: Content Area

MATH.K-12.1	Make sense of problems and persevere in solving them
MATH.K-12.2	Reason abstractly and quantitatively
MATH.K-12.3	Construct viable arguments and critique the reasoning of others
MATH.K-12.4	Model with mathematics
MATH.K-12.5	Use appropriate tools strategically
MATH.K-12.6	Attend to precision
MATH.K-12.7	Look for and make use of structure

MATH.K-12.8	Look for and express regularity in repeated reasoning
MATH.9-12.A.CED.A.1	Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
MATH.9-12.A.REI.B.3	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
MATH.9-12.A.REI.C.6	Solve systems of linear equations algebraically (include using the elimination method) and graphically, focusing on pairs of linear equations in two variables.
MATH.9-12.A.REI.C.8	Represent a system of linear equations as a single matrix equation in a vector variable.
MATH.9-12.A.REI.D	Represent and solve equations and inequalities graphically
MATH.9-12.A.REI.D.12	Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

Integration of Computer Science and Design Thinking

CS.9-10.3A-AP-14	Use lists to simplify solutions, generalizing computational problems instead of repeatedly using simple variables.
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Interdisciplinary Connections: NJSLs for ELA, Social Studies, Science and/or Math

SOC.K-12.1	Developing Questions and Planning Inquiry
ELA.K-12.R.MF	Diverse Media and Formats: By the end of grade 12, synthesize content presented in diverse media and formats, including visually and quantitatively, as well as in words.
MATH.9-12.S.IC	Making Inferences and Justifying Conclusions

Integration of Career Readiness. Life Literacies and Key Skills

TECH.9.4.2.CI	Creativity and Innovation
TECH.9.4.2.CT	Critical Thinking and Problem-solving
	A variety of diverse sources, contexts, disciplines, and cultures provide valuable and necessary information that can be used for different purposes.
	Digital tools can be used to display data in various ways.

21st Century Life and Career

CRP.K-12.CRP9.1	Career-ready individuals consistently act in ways that align personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the directions and actions of a team or organization, and they apply insights into human behavior to change others' action, attitudes and/or beliefs. They recognize the near-term and long-term effects that management's actions and attitudes can have on productivity, morals and organizational culture.
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Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

Integration of Diversity, Equity and Inclusion; Climate Change; Informational and Media Literacy

Diversity, Equity, and Inclusion

[NCTM: Access and Equity in Mathematics Education](#)

[A Pathway to Equitable Math Instruction](#)

Provide students with opportunities to give feedback to teachers about the classroom and instruction.

- Verbal Example: Fist to five, How well do you understand what we talked about today? Fist to five, How well did I teach this today?
- Classroom Activity: Exit tickets or surveys that ask students to identify how well teachers taught, what helped them learn, what got in the way of their learning, etc.

Treat mathematics as a language that everyone is learning while authentically centering students home languages.

- Classroom Strategies: Color-coding ideas, learning vocabulary in student languages, visual and kinesthetic learning, representations of learning without words.
- Classroom Activity: Multilingual Frayer Models for definitions or concepts

Incorporate true culturally relevant pedagogy, practice, and curriculum.

- Verbal Example: What are some of your family traditions that you are proud of? Would you be okay if we brought some of those into the classroom?
- Classroom Activity: Use Ankara fabric to teach mathematical concepts such as tessellations, fractions, area, percentages, etc.

Incorporate the history of mathematics into lessons.

- Verbal Example: Why do you think we call it Pythagorean's theorem, when it was used before he was even born? What should we call it instead?
- Classroom Activity: Learn about different bases and numerical ideas: Base 2, binary and connections to computer programming, how the Yoruba of Nigeria used base 20, and how the Mayans conceptualized the number 0 before the first recording of it

Solicit student ways of thinking and processing.

- Verbal Example: How might you all go about this? What do you notice?
- Classroom Activity: Incorporate explorations, where students interact with mathematics in a way that allows them to “discover” or experience mathematics.

Reorganize your classroom teaching around concepts, and teach them more like a web rather than discrete sets of knowledge.

- Verbal Example: How does this connect to what you’ve learned in the past? How can you use that knowledge today?
- Classroom Activity: Learning webs that connect content

Start with more complex math problems and scaffold as necessary.

- Verbal Example: If we wanted to build a rocket, what are all the things we might need to know before we get started? Along the way, we decided that we want the rocket to reach the moon. What do we need to consider now?
- Classroom Activity: When solving equations, start with the most complex problem, generate ideas for how to solve it, and use the simpler equations as examples to support those ideas.

Offer a variety of ways to demonstrate thinking and knowledge.

- Verbal Example: Show your thinking with words, pictures, symbols.

Ask other questions that will demonstrate learning when it is not clear to you how students know the answer.

- Verbal Example: If you were working with a fellow mathematician who was absent this day, what might you tell them to help them learn it?

Learn about, engage with, and incorporate ethnomathematics.

- Verbal Example: Reflect on your day so far. What math have you already used today?
- Classroom Activity: Community walks to engage with slope.

Co-construct knowledge in the classroom.

- Verbal Example: Let’s get into partners and do a think pair-share. We will incorporate everyone’s ideas and try to synthesize them.
- Classroom Activity: Have students create mathematical definitions in their own words in groups, and bring the groups together to co-construct mathematical definitions as a class

Choose problems that have complex, competing, or multiple answers.

- Verbal Example: Come up with at least two answers that might solve this problem.

- Classroom Activity: Challenge standardized test questions by getting the “right” answer, but justify other answers by unpacking the assumptions that are made in the problem.
- Classroom Activity: Deconstructed Multiple Choice
 - given a set of multiple choice answers, students discuss why these answers may have been included (can also be used to highlight common mistakes).

Identify what is right about the thinking, and highlight the mistake in what is factually or procedurally accepted.

- Verbal Example: You recognized that you had to combine the constants 27 and 9, could you explain your thinking?
- Classroom Activity: Error Analysis worksheets that highlight what is the right idea behind the mistake.

Using thoughtful questioning to solicit mathematical thoughts rather than telling.

- Verbal Example: What would a mathematician who is confused ask about this question?
- Classroom Activity: After students demonstrate knowledge of a topic, have them play a game where they have to explain their topic to a fellow mathematician and a skeptic. Develop their own reflective questioning/explaining in all three roles.

Create multiple ways of participating that honor myriad ways of thinking and being.

- Verbal Example: For this section, feel free to work alone, in pairs, trios, or quads (let them choose).
- Classroom Activity: Community circles or storytelling circles, incorporating dance, music, song, call and response, and other cultural ways of communicating.

Climate Change

[Math Climate Change Companion Guide](#)

- S.ID.B.6a Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.

Climate Change Example: Students may use linear or exponential functions fitted to geoscience data to solve problems and analyze the results from global climate models to make an evidence-based forecast of the current rate of global climate change.

- F.IF.A.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

Climate Change Example: Students may use function notation to determine the amount of carbon dioxide produced by burning a given number of molecules of ethane (gasoline), m , where $c(m)$ is the number of molecules of carbon dioxide.

- F.IF.B.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

Climate Change Example: Students may relate the domain of a function $c(m)$ representing the amount of

carbon dioxide produced by burning m molecules of ethane (gasoline), to its graph in order to determine the appropriate domain for $c(m)$.

- F.IF.B.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

Climate Change Example: Students may calculate the average rate of change of a function $c(m)$ presented symbolically or as a table, where $c(m)$ represents the amount of carbon dioxide produced by burning a given number of molecules of ethane (gasoline).

- A.CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

Climate Change Example: Students may create equations and/or inequalities to represent the economic impact of climate change.

- A.CED.A.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

Climate Change Example: Students may represent constraints describing the economic impact of climate change by equations, inequalities, and/or by systems of inequalities, and interpret solutions as viable or nonviable options.

- A.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law to highlight resistance R .

Climate Change Example: Students may rearrange formulas related to the economic impact of climate change to highlight a quantity of interest, using the same reasoning as in solving equations.

- N.Q.A.1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

Climate Change Example: Students may use units to guide the solution of multi-step problems about how variations in the flow of energy into and out of the Earth's systems result in climate change. Note: Changes in climate are limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.

- N.Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

Climate Change Example: Students may define appropriate quantities for a descriptive model of how variations in the flow of energy into and out of Earth's systems result in climate change. Note: changes in climate are limited to changes in surface temperatures, precipitation patterns, glacial ice volumes, sea levels, and biosphere distribution.