Unit 03 - Exponential Functions

Content Area: **Math**
Course(s):
Time Period: **Full Year**
Length: **22 days**
Status: **Published**

General Overview, Course Description or Course Philosophy

In Grade 8, instructional time should focus on three critical areas: (1) formulating and reasoning about expressions and equations, including modeling an association in bivariate data with a linear equation, and solving linear equations and systems of linear equations; (2) grasping the concept of a function and using functions to describe quantitative relationships; (3) analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem.

In this unit students will continue their discussion of functions by examining exponential functions and models for exponential growth/decay. Students will also develop rules for operating with exponents including operations with scientific notation.

OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Essential Questions:

- Why does one need to express a number in a form with integer exponents?
- Why does one need to write numbers in scientific notation?
- What is the advantage of performing operations on numbers expressed in scientific notation rather than numbers in standard form?
- Why does one need to define a function?
- When should functions be evaluated and compared?
- How does knowing the algebraic properties of a function help to graph that function?
- What applications could be represented by variables that are not related by a linear function?
- Why would one use functions to model relationships between quantities?
- What are the distinguishing characteristics of a graph of a function?
- What situations can be modeled with an exponential function?
- What is the pattern of change (growth/decay factor) between two variables that identifies an exponential function in a situation, table, graph, or equation?
- How is an exponential function represented with a table, graph, or equation?
- How is the growth/decay factor and initial value in problem situations, tables, graphs, and equations identified when representing exponential functions?
- How are exponential functions represented as a growth (increasing) or decay (decreasing) patterns, in an equation, table, or graph that represents the exponential function?
- How are the values of the independent and dependent variables determined from a table, graph, or equation of an exponential function?
- How is the y-intercept of an exponential function found from an equation, graph, or table that represents the function?
- How do exponential and linear functions compare?

- What are the rules for operating with rational exponents and why do they work?
- How can numerical expressions in scientific notation be written, interpreted and used in operations?
- How can equivalent expressions be written and interpreted using the rules for exponents and operations?
- How are problems solved that involve exponents, including scientific notation?

Enduring Understandings:

- A number raised to a power *m* means that number is multiplied by itself *m* times.
- Numbers can be written in many equivalent forms.
- Perfect square numbers are the whole numbers each raised to the second power.
- Perfect cube numbers are the whole numbers each raised to the third power.
- Very large or very small quantities can be estimated using numbers expressed in scientific notation.
- How many times as much one number is than another is determined by the relationship between both the single digit parts and their respective powers of ten. For example, 12×10^5 compared to 3×10^3 requires comparing 12 to 3 (4 times larger) and 10^5 to 10^3 (100 times larger), so 12×10^5 is 400 times bigger than 3×10^3.
- Operations can be performed with numbers expressed in scientific notation.
- To find a measurement, the appropriate unit should be used.
- A function is a rule that assigns to each input exactly one output.
- The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.
- Functions can be represented in 4 different ways:
    - algebraically
    - graphically
    - numerically in tables
    - by verbal descriptions
- There are many different functional relationships that are not linear.
- Situations that can be modeled by an exponential function show a multiplicative pattern in the table of data; the rate of change grows or decays by a constant factor.
- Tables and graphs can provide more information about a function and help solve problems.
- There is often more than one way to write an equation. The ability to rewrite an equation as an equivalent relationship can be helpful when solving problems involving exponential functions and relationships.
- There are rules for working with exponential expressions. These properties of exponents are useful in writing equivalent expressions and particularly when working with values written in scientific notation.

CONTENT AREA STANDARDS

MA.8.F.A.1	Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.
MA.8.F.A.2	Compare properties (e.g. rate of change, intercepts, domain and range) of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
MA.8.F.A.3	Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight

	line; give examples of functions that are not linear.
MA.8.F.B.4	Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.
MA.8.F.B.5	Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.
MA.8.EE.A.1	Know and apply the properties of integer exponents to generate equivalent numerical expressions.
MA.8.EE.A.2	Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.
MA.8.EE.A.3	Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other.
MA.8.EE.A.4	Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.K-12.8	Look for and express regularity in repeated reasoning.

RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

CS.K-12.3	Recognizing and Defining Computational Problems
CS.K-12.5	Creating Computational Artifacts
CS.K-12.6	Testing and Refining Computational Artifacts
LA.K-12.NJSLSA.R1	Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.
LA.K-12.NJSLSA.SL1	Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
LA.K-12.NJSLSA.SL4	Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

WRK.K-12.P.4	Demonstrate creativity and innovation.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.

STUDENT LEARNING TARGETS

Declarative Knowledge

Students will understand that:

- a function is a rule that assigns to each input exactly one output.
- the graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

Procedural Knowledge

Students will be able to:

- compare properties of two functions each represented in a different way.
- describe qualitatively the functional relationship between two quantities by analyzing a graph.
- sketch a graph that exhibits the qualitative features of a function that has been described verbally.
- give examples of functions that are not linear.
- interpret scientific notation that has been generated by technology.
- know and apply the properties of integer exponents to generate equivalent numerical expressions.
- perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used.
- use numbers expressed in the form of a single digit times an integer power of 10 to express how many times as much one number is than the other.
- evaluate square roots of small perfect squares and cube roots of small perfect cubes.
- know that the square root of 2 is irrational.
- use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities.
- use the square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number.

EVIDENCE OF LEARNING

Formative Assessments

Mathematical Reflections

Check Up

Self Assessment Take-Home Questions

Delta Math Assignments

Summative Assessments

Partner Quiz

Teacher created assessments (both test generator and teacher generated questions)

OnCourse generated assessments

Delta Math - teacher generated assessments

Unit Project - (optional) - Half Life, Celebrity Net Worth, Space-cation Projects

RESOURCES (Instructional, Supplemental, Intervention Materials)

Instructional Materials

- CMP3 Unit - Growing, Growing, Growing (briefly explore investigations 1, 2, 3 and 4), majority of time spent in investigation 5.
- https://www.savvasrealize.com/ (teacher and student recourses)
- Delta Math

Supplemental/Intervention Materials

- https://www.khanacademy.org/
  - Exponents and scientific notation
- https://illuminations.nctm.org/
  - Too big or too small
- https://www.illustrativemathematics.org/
  - 8.7 Exponents and Scientific Notation - all lessons

INTERDISCIPLINARY CONNECTIONS

Science and space exploration

Financial/Economic/Business/Entrepenerial Literacy

ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.