Unit 05 Exponents and Exponential Functions

Content Area: **Mathematics**
Course(s): **Algebra I**
Time Period: **November**
Length: **17 days**
Status: **Published**

Enduring Understandings

- Properties of exponents make it easier to simplify products or quotients of powers with the same base or powers raised to a power or products raised to a power.
- The idea of exponents can be extended to include zero and negative exponents.
- The parent of a family of exponential functions is y = ab^x. The independent variable is an exponent. This family of functions can model growth or decay of an initial amount.
- You can use rational exponents to represent radicals.

Essential Questions

- How are exponential functions similar to and different from linear functions?
- How can you represent numbers less than 1 using exponents?
- How can you simplify expressions involving exponents?
- How do the domain and range effect the graph of a function?
- What are the characteristics of exponential functions?
- What variable is interchangeable with f(x) in a graph?

Lesson Titles

- Division Properties of Exponents
- Exponential Functions
- Exponential Growth and Decay
- More Multiplication Properties of Exponents
- Multiplying Powers with the Same Base
- Rational Exponents and Radicals
- Zero and Negative Exponents

Standards/Indicators

CCSS.Math.Practice.MP1	Make sense of problems and persevere in solving them. Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original

	problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
CCSS.Math.Content.HSN-RN.A.1	Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.
CCSS.Math.Practice.MP2	Reason abstractly and quantitatively.
CCSS.Math.Content.HSF-IF.A.1	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.
CCSS.Math.Content.HSA-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
	Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize-to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents-and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
CCSS.Math.Content.HSA-SSE.A.1.a	Interpret parts of an expression, such as terms, factors, and coefficients.
CCSS.Math.Practice.MP3	Construct viable arguments and critique the reasoning of others.
CCSS.Math.Content.HSN-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.
CCSS.Math.Content.HSA-SSE.A.1.b	Interpret complicated expressions by viewing one or more of their parts as a single entity.
	Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and-if there is a flaw in an argument-explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.
CCSS.Math.Practice.MP4	Model with mathematics.
CCSS.Math.Content.HSF-IF.B.4	For a function that models a relationship between two quantities, interpret key features of

	graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
CCSS.Math.Content.HSF-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
CCSS.Math.Practice.MP6	Attend to precision. Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.
CCSS.Math.Content.HSA-SSE.B.3.c	Use the properties of exponents to transform expressions for exponential functions.
CCSS.Math.Practice.MP7	Look for and make use of structure.
CCSS.Math.Content.HSF-IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7 × 8 equals the well remembered 7 × 5 + 7 × 3, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2 × 7 and the 9 as 2 + 7. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 – 3(x – y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.
CCSS.Math.Practice.MP8	Look for and express regularity in repeated reasoning. Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y – 2)/(x – 1) = 3$. Noticing the regularity in the way terms cancel when expanding $(x – 1)(x + 1)$, $(x – 1)(x^2 + x + 1)$, and $(x – 1)(x^3 + x^2 + x + 1)$ might lead them to the general formula for the sum of a geometric series. As they

	work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.
CCSS.Math.Content.HSF-IF.C.7.e	Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.
CCSS.Math.Content.HSF-IF.C.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
CCSS.Math.Content.HSF-IF.C.8.b	Use the properties of exponents to interpret expressions for exponential functions.
CCSS.Math.Content.HSF-IF.C.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
CCSS.Math.Content.HSA-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
CCSS.Math.Content.HSF-BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\ f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.
CCSS.Math.Content.HSF-LE.A.1	Distinguish between situations that can be modeled with linear functions and with exponential functions.
CCSS.Math.Content.HSF-LE.A.1.c	Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
CCSS.Math.Content.HSF-LE.A.2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

Inter-Disciplinary Connections

- Business
- Chemistry
- Computers
- Engineering
- English
- Geography
- History
- Physics

Warm-Up

- PARCC type of question
- SAT question of the day
- Skill needed to do lesson
- Use What You Know - type of question

Anticipatory Set

- 5 Minute Activity Based
- connecting previous lessons
- connecting vocabulary with roots words
- Discussion including vocab review/recall
- Video Clip

Instructional Strategies, Learning Activities, and Levels of Blooms/DOK

- Introduction, notes, and examples on raising a power to a power
- students will work as a team and explain their work
- #1- Blooms Knowledge - Remember previously learned information
- #2 - Blooms Comprehension - Demonstrate an understanding of facts
- #3 - Blooms Application - Apply Knowledge to actual situations
- #4 - Blooms Analysis - Break down objects or ideas into simpler parts and find evidence to support generalizations
- #5 - Blooms Synthesis - Compile component ideas into a new whole or propose alternative solutions
- #6 - Blooms Evaluation - Make and defend judgments based on internal evidence or external criteria
- Discussion on vocabulary including functions, domain, and range, exponential growth and decay
- Introduction, notes, and examples of exponential growth and decay tables and graphs
- Introduction, notes, and examples of multiplying monomials
- Introduction, notes, and examples on calculating the domain and range
- Introduction, notes, and examples on dividing monomials
- Introduction, notes, and examples on function notation relating equations, graphs, and data in a table
- Introduction, notes, and examples on graphing functions by hand and with a calculator
- Introduction, notes, and examples on simplifying negative and fractional exponents
- Introduction, notes, and examples on word problems involving functions
- review homework if need - answers posted on Edmodo
- review warm up
- students will work individually

Closure

- evaluate your understanding of the lesson
- Pass out of class
- turn to your partner and discuss

Formative Assessment

- Edmodo assignments

- Guided Review
- homework/classwork
- Mathxlforschool
- Partner Board Presentation
- Pass Out of Class
- Socrative
- teacher observation
- think-pair-share
- Warm up Review
- White Boards

Summative Assessment

- quiz
- unit test
- warm up quiz

Resources & Technology

- Algebra 1 Book
- class dojo.com
- color pencils
- desmos.com
- Edmodo
- edpuzzle.com
- Google Forms
- graphing calculator
- Learn Zillion
- mathway.com
- mathxlforschool.com
- quizlet.com
- Remind
- smartboard
- socrative
- student whiteboards
- Teacher Generated Worksheets
- video clips