Unit 05: Exponents and Roots

Content Area: **Template**
Course(s):
Time Period: **Full Year**
Length: **10 weeks**
Status: **Published**

Standards Alignment

New Jersey Student Learning Standards

MATH.8.NS	The Number System
MATH.8.NS.A	Know that there are numbers that are not rational and approximate them by rational numbers
MATH.8.NS.A.1	Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually and convert a decimal expansion which repeats eventually into a rational number.
MATH.8.NS.A.2	Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π^2).
	For example, by truncating the decimal expansion of √2, show that √2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.
MATH.8.NS.A.3	Understand that the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.
MATH.8.EE	Expressions and Equations
MATH.8.EE.A	Work with radicals and integer exponents
MATH.8.EE.A.1	Know and apply the properties of integer exponents to generate equivalent numerical expressions.
	For example, $3^2 \times (3^{-5}) = (3^{-3}) = 1/(3^3) = 1/27$.
MATH.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.
MATH.8.EE.A.2.a	Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.
MATH.8.EE.A.2.b	Simplify numerical radicals, limiting to square roots (i.e., nonperfect squares).
	For example, simplify √8 to 2√2.
MATH.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.
	For example, estimate the population of the United States as 3×10^8 and the population of the world as 7×10^9, and determine that the world population is more than 20 times larger.
MATH.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.
MATH.8.EE.B	Understand the connections between proportional relationships, lines, and linear equations
MATH.8.EE.B.5	Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.
	For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.
MATH.8.EE.B.6	Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b.
MATH.8.EE.C	Analyze and solve linear equations and pairs of simultaneous linear equations
MATH.8.EE.C.7.a	Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
MATH.8.EE.C.7.b	Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.
MATH.8.EE.C.8	Analyze and solve pairs of simultaneous linear equations.
MATH.8.EE.C.8.a	Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.
MATH.8.EE.C.8.b	Solve systems of two linear equations in two variables using the substitution method and estimate solutions by graphing the equations. Solve simple cases by inspection.
	For example: by inspection, conclude that $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6. Solve $3x + y = 30$ and $y = 2x$ using the substitution method; Solve $y = 3x + 1$ and $y = -2x + 7$ using the substitution method.
MATH.8.EE.C.8.c	Solve real-world and mathematical problems leading to two linear equations in two variables.
	For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.
MATH.8.G.B.6	Explain a proof of the Pythagorean Theorem and its converse.
MATH.8.G.B.7	Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
MATH.8.G.B.8	Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.
MATH.8.G.C	Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres
MATH.8.G.C.9	Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.
MATH.8.SP	Statistics and Probability
MATH.8.SP.A	Investigate patterns of association in bivariate data
MATH.8.SP.A.1	Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.
MATH.8.SP.A.2	Know that straight lines are widely used to model relationships between two quantitative

variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit (e.g., line of best fit) by judging the closeness of the data points to the line.

MATH.8.SP.A.3	Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept.
	For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.
MATH.8.SP.A.4	Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables.

Integration of Career Readiness, Life Literacies and Key Skills

CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP3	Attend to personal health and financial well-being.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP5	Consider the environmental, social and economic impacts of decisions.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CRP.K-12.CRP9	Model integrity, ethical leadership and effective management.
CRP.K-12.CRP10	Plan education and career paths aligned to personal goals.
CRP.K-12.CRP11	Use technology to enhance productivity.
CRP.K-12.CRP12	Work productively in teams while using cultural global competence.

Technology / Integration of Computer Science and Design Thinking

| CS.6-8.8.1.8.AP.2 | Create clearly named variables that represent different data types and perform operations on their values. |

Interdisciplinary Connections: NJSLS for ELA, Social Studies, Science and/or Math Section

ELA.SL.PE.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
ELA.SL.PE.8.1.A	Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.
ELA.SL.PE.8.1.B	Follow rules for collegial discussions and decision-making, track progress toward specific

	goals and deadlines, and define individual roles as needed.
ELA.SL.PE.8.1.C	Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.
ELA.SL.PE.8.1.D	Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.

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

see Crosswalks

21st Century Life and Careers

| CAEP.9.2.12.C.1 | Review career goals and determine steps necessary for attainment. |
| CAEP.9.2.12.C.2 | Modify Personalized Student Learning Plans to support declared career goals. |

Stage I: Desired Results

Transfer/Overview/Rationale

Transfer / Overview / Rationale
Unit Rationale
The purpose of this unit…
Correctly applying the properties of exponents and square and cube roots helps us to solve problems found in the world around us. The knowledge and skills taught in this unit will prepare students for such situations.

Meaning

Essential Questions

Essential Questions

-Why is it important to understand and apply irrational numbers?

-Why is estimation an important skill to have in life?

-How can we use our understanding of radical numbers to solve for missing sides/distances in right triangles?

-How can we use properties of exponents to understand and define scientific phenomena?

Enduring Understanding/Indicators of Understanding

Enduring Understanding/Indicators of Understanding

-Understand that within the number system exists decimals that never terminate or repeat called irrational numbers

-Apply reasoning and knowledge of radical expressions in order to estimate values

-Derive, understand, and apply the Pythagorean theorem to find missing lengths in right triangles

-Understand properties of exponents in order to solve a variety of problems including reading, writing, and understanding scientific notation

Acquisition (Student Learning Objectives)

Knowledge

Knowledge
Students will know…

-How to identify irrational numbers

-Square and cube roots

-How to find missing side lengths of right triangles using the Pythagorean theorem

-Properties of exponents including product, quotient, zero, and power of a power

-How to simplify negative exponents

-How to read, write, and perform operations using scientific notation

Skills

Skills

Student will be skilled at …

-Classify numbers as rational or irrational

-Calculate rational square and cube roots

-Estimate irrational square and cube roots

-Locate rational and irrational square and cube roots on a number line

-Simplify expressions with exponents

-Read, write, and perform operations with values written in scientific notation

-Apply the Pythagorean theorem to right triangles to find missing measures

-Classify triangles as right or not by applying the Pythagorean theorem

Stage 3: Learning Plan

Resource and Mentor Texts

Resources and Mentor Texts

Formative Assessment Strategies

Formative Assessment Strategies

- ixl.com scores
- tenmarks.com scores
- teacher center observation
- STEM projects

Learning Activities/Unit of Study

Learning Activities/Unit of Study

Exponents and Roots: Approximately 4 Cycles

Cycle 1: Topics Covered

- Square roots
- Cube Roots
- Pythagorean Theorem

- Activities/Centers
  - IXL.com centers
    - F.14 Square roots of perfect squares

- F.15 Positive and negative square roots
- F.16 Estimate positive and negative square roots
- F.17 Relationship between squares and square roots
- F.18 Solve equations involving squares and square roots
- F.19 Cube roots of perfect cubes
- F.20 Solve equations involving cubes and cube roots
- F.21 Estimate cube roots
- O.1 Pythagorean theorem: find the length of the hypotenuse
- O.2 Pythagorean theorem: find the missing leg length
- O.3 Pythagorean theorem: find the perimeter
- O.4 Pythagorean theorem: word problems
- O.5 Converse of the Pythagorean theorem: is it a right triangle?
        - Tenmarks centers
            - 8.NS.2 Approximating Irrational Numbers
            - 8.EE.2 Evaluating Square Roots
        - Hands-On/Creative Centers
            - Pythagorean theorem game in groups
              http://www.glencoe.com/sec/math/t_resources/gamezone/pdfs/mac3_04/class_ch03.pdf
        - Online games
            - http://www.math-play.com/square-root-game.html
            - https://campus.mangahigh.com/en-us/px/122/0/0
        - Xtramath: review flashcards
        - Teacher Directed Stations
            - Bellringers: Week 24—page 47-48
            - Bellringers: Week 24—page 45-46
            - Teacher created problems on white boards: Do the numbers make a Pythagorean Triple?
    - STEM activity: Pythagorean art activity http://britton.disted.camosun.bc.ca/geometry/spiral.pdf

Cycle 2: Topics Covered

- Exponent rules

- Activities/Centers
        - IXL.com centers
            - F.1 Understanding exponents
            - F.2 Evaluate exponents
            - F.3 Solve equations with variable exponents
            - F.4 Exponents with negative bases
            - F.6 Understanding negative exponents
            - F.7 Evaluate negative exponents
            - F.8 Multiplication with exponents
            - F.9 Division with exponents
            - F.10 Multiplication and division with exponents
            - F.11 Power rule
            - F.12 Evaluate expressions involving exponents
            - F.13 Identify equivalent expressions involving exponents
        - Tenmarks centers
            - 8.EE.1 Identifying Exponential Expressions
        - Hands-On/Creative Centers
            - Simplify exponent expressions scavenger hunt*
        - Online games
            - http://www.math-play.com/Exponents-Jeopardy/Exponents-Jeopardy.html
        - Xtramath: review flashcards
        - Teacher Directed Stations
            - Bellringers: Week 24—page 43-44

- ▪ Bellringers: Week 24—page 41-42
- ▪ Teacher created problems on white boards: simplify the exponential expressions

Cycle 3: Topics Covered

- Scientific Notation

- Activities/Centers
  - ○ IXL.com centers
    - ▪ G.1 Convert between standard and scientific notation
    - ▪ G.2 Compare numbers written in scientific notation
  - ○ Tenmarks centers
    - ▪ 8.EE.3 Expressing Numbers in Scientific Notation
  - ○ Hands-On/Creative Centers
    - ▪ Scientific notation real world page
      http://www.beaconlearningcenter.com/documents/1669_4927.pdf
  - ○ Online games
    - ▪ https://janus.astro.umd.edu/cgi-bin/astro/scinote.pl
  - ○ Xtramath: review flashcards
  - ○ Teacher Directed Stations
    - ▪ Bellringers: Week 23—page 39-40
    - ▪ Bellringers: Week 23—page 37-38
    - ▪ Teacher created problems on white boards: convert between scientific notation and standard notation
- STEM activity: measurement with scientific notation
  http://map.mathshell.org/lessons.php?unit=8100&collection=8&redir=1

Cycle 4: Topics Covered

- Operations with scientific notation

- Activities/Centers
  - ○ IXL.com centers
    - ▪ G.3 Multiply numbers written in scientific notation
    - ▪ G.4 Divide numbers written in scientific notation
  - ○ Tenmarks centers
    - ▪ 8.EE.4 Operations with Scientific Notation
  - ○ Hands-On/Creative Centers
    - ▪ Scavenger hunt*
  - ○ Online games
    - ▪ http://www.aaamath.com/g71n_mx1.htm
  - ○ Xtramath: review flashcards
  - ○ Teacher Directed Stations
    - ▪ Bellringers: Week 23—page 35-36
    - ▪ Bellringers: Week 23—page 33-34
    - ▪ PARCC center*

Modifications and/or Accommodations
Suggested Modifications (ELL, Sp. Ed, GIfted, At-risk of Failure)

English Language Learners

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing the students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

Special Education Students

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

Students with 504 Plans

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Gifted & Talented Strategies

Extensions/Enrichments: Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

Modify/Change Activities: Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

Students at Risk of School Failure

Directions or Instructions: Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

Peer Support: Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for clarification before going to you.

Alternate or Modified Assignments: Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

Increase One to One Time: When other students are working, always touch base with your students

at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

Contracts: It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

Hands On: As much as possible, think in concrete terms and provide hands-on tasks. This means a child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.