Unit 5 Applications of Real Numbers and Exponents
Advanced 2

Last Update: August 1, 2025

Archdiocesan Curriculum > Advanced 2> Math > Length of unit 21 to 24 days

Stage 1: Desired Results

General Information

In this unit, students will deepen their understanding of the real number system by distinguishing between rational and irrational numbers, evaluating square and cube roots, and ordering real numbers. They will prove and apply the Pythagorean Theorem and its converse, using the theorem to solve real-world problems and to determine distances in the coordinate plane. Students will also explore the properties of integer exponents and apply them to simplify expressions. Additionally, they will learn to express very large and very small numbers using scientific notation and compute with numbers in scientific notation to solve problems efficiently.

Mathematical Practices

- MP2 – Reason abstractly and quantitatively
- MP6 – Attend to precision
- MP7 – Look for and make use of structure
- MP8 – Look for and express regularity in repeated reasoning

Essential Question(s)

- What makes a number rational or irrational, and how can we classify and compare them on the number line?
- How do square roots and cube roots help us describe relationships between numbers and solve real-world problems?
- What does the Pythagorean Theorem reveal about the relationship between the sides of a right triangle, and how can we apply it to real-world and coordinate plane problems?
- How can we use properties of integer exponents to simplify expressions and represent very large or very small numbers?
- In what ways does scientific notation help us efficiently represent and operate with extremely large or small quantities?

Enduring Understanding/Knowledge

Students will:

- Determine if a number is rational.
- Evaluate square and cube roots.
- Order a list of real numbers consisting of both rational and irrational numbers.

Review/Assess

- Prove and apply the Pythagorean Theorem and its converse.
- Use the Pythagorean Theorem to solve real-world problems involving right triangles.
- Use the Pythagorean Theorem to determine distance between any two points in the coordinate plane.

Review/Assess

- Develop and use the properties of integer exponents.
- Express numbers using scientific notation.
- Compute with numbers written in scientific notation.

Review/Assess

Vocabulary

New	Review
irrational number	rational number
cube root	repeating decimal
perfect cube	terminating decimal
perfect square	cube
principal square root	cone
radical symbol	base
square root	exponent
Pythagorean Theorem	power
Pythagorean triple	
properties of exponents	
scientific notation	
standard form of a number	

Connections to Catholic Identity / Other Subjects

Religion/Catholic Identity:

- According to the Biblical Archaeology Society, God gave Moses the value of pi on Mount Sinai in 1440 BC to use in constructing the Wilderness

Differentiation

Enrichment

- **Explore Non-Terminating Decimals** – Have students investigate famous irrational numbers (e.g., π, √2) and analyze their decimal

Tabernacle **Other Subject Here:** ● **Euler's number (e):** Used in exponential growth calculations, like compound interest	representations and uses in geometry or science. ● **Apply the Pythagorean Theorem in 3D** – Extend problem-solving to include three-dimensional contexts such as the diagonal of a rectangular prism or the space between two points in 3D space. ● **Scientific Notation in Astronomy** – Provide data from astronomy (e.g., distances between planets or sizes of stars) to deepen fluency with scientific notation in real-world scenarios. ● **Investigate Patterns in Powers and Roots** – Challenge students to develop generalizations about the properties of powers and their relationships to roots using number tables or algebraic reasoning. ● **Develop Proofs for the Converse** – Engage students in developing their own visual or algebraic proof of the Pythagorean Theorem and its converse using coordinate geometry or dynamic software. **Support** ● **Use a Real Number Line as Anchor** – Build understanding by locating and classifying rational and irrational numbers on a number line with guided questioning. ● **Simplify Square and Cube Root Concepts** – Use manipulatives (e.g., square tiles or cubes) or digital models to visualize square and cube roots and perfect squares/cubes. ● **Provide Structured Pythagorean Problem Solving** – Break down word problems using the Pythagorean Theorem into concrete steps, with sentence starters and diagramming scaffolds. ● **Exponent Rule Sorting Activities** – Create matching tasks where students connect exponent expressions with the correct property name (e.g., product of powers, quotient of powers). ● **Scientific Notation Conversion Templates** – Use guided templates that walk students through moving decimal places and identifying powers of 10 when switching between standard and scientific form.

Standards & Benchmarks

Real Numbers:

8.NS.1

Give examples of rational and irrational numbers, and explain the difference between them. State decimal equivalents for any number. For rational numbers, show that the decimal equivalent terminates or repeats, and convert a repeating decimal into a rational number.

8.NS.2

Use rational approximations of irrational numbers to compare the size of irrational numbers, plot them approximately on a number line, and estimate the value of expressions involving irrational numbers.

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. Students evaluate square roots of small perfect squares and cube roots of small perfect cubes. Use bases 1 through 5 and 10 for cubes.

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. For example, estimate the value of $\sqrt{2}$. By truncating the decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5, and explain how to continue-on to get better approximations.

8.EE.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 $\sqrt{2}$ is irrational.

8.NS.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).
8.NS.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.
8.NS.1.b
Students will demonstrate the following Knowledge and Skills: Use rational approximations (to the nearest hundredth) of irrational numbers to compare, order, and locate values on a number line. Radicals may include both positive and negative square roots of values from 0 to 400 yielding an irrational number.
8.N.1.d
Approximate, compare, and order real numbers, both rational and irrational, and locate them on the number line.

The Pythagorean Theorem:

G.GF.7
Develop the distance formula using the Pythagorean Theorem. Find the lengths and midpoints of line segments in the two-dimensional coordinate system. (E)
8.G.B.6
Explain a proof of the Pythagorean Theorem and a proof of its converse.
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.
8.G.B.8
Apply the Pythagorean Theorem to find the distance between two points in a coordinate system..
8.G.6
Explain a proof of the Pythagorean Theorem and its converse.
8.G.7
Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.
8.MG.4
The student will apply the Pythagorean Theorem to solve problems involving right triangles, including those in context.

Exponents and Scientific Notation:

8.NS.3
Given a numeric expression with common rational number bases and integer exponents, apply the properties of exponents to generate equivalent expressions. (E)
8.EE.A.3
Use numbers expressed in the form of a single digit times an integer power of 10 to estimate exceptionally large or small quantities and to express how many times as much one is than another. For example, estimate the population of the United States as 3 times 10^8 and the population of the world as 7 times 10^9, and determine that the world population is more than 20 times larger.
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 convenient size for quantities. For example, use millimeters per year for seafloor spreading. Interpret scientific notation that has been generated by technology.
8.EE.A.1
Apply the properties of integer exponents to generate equivalent numerical expressions. For example, $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.
8.EE.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.
8.EE.1
Know and apply the properties of integer exponents to generate equivalent numerical expressions.
8.EE.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.
8.N.2.b

Simplify numerical expressions involving integer exponents, square roots, and cube roots (e.g., 4^{-2} is the same as 1/16).
Teaching Ideas/Resources ***<u>Websites/Resources:</u>*** ● **Laws of Exponents- Math Antics** ● **Desmos activity builder on radicals, exponents, and rations numbers:** Radicals- Exponent Rules- Number Exponent Practice ● **Irrational Numbers Explained: Math with Mr J https://www.youtube.com/watch?v=GupzujexBFA** ● **https://docs.google.com/document/d/1euoySr1o4FmNbSMYBVTijDXhf5obICMVuDhyLzbgE-4/edit?usp=sharing** ● **https://ispeakmath.org/2012/05/03/square-roots-with-cheez-its-and-a-graphic-organizer/ Irrational Numbers -Math Antics Extras…https://www.youtube.com/watch?v=wg4YXMe5ccs**