

Algebra 1 - Exponent Rules and Radicals - Lesson

Common Core N-RN.A.1, N-RN.A.2, N-RN.B.3 · maths-pdf.fr/en/

Exponent rules let you simplify powers: add exponents when multiplying like bases, subtract when dividing, and multiply when raising a power to a power. A zero exponent gives 1, and a negative exponent means a reciprocal. A rational exponent m/n means the n -th root raised to the m power. Irrational numbers cannot be written as fractions.

Algebra 1 · Common Core State Standards: **N-RN.A.1, N-RN.A.2, N-RN.B.3**

Key facts

- Product rule: $a^m \cdot a^n = a^{m+n}$; quotient rule: $a^m / a^n = a^{m-n}$.
- Power rule: $(a^m)^n = a^{mn}$.
- $a^0 = 1$ and $a^{-n} = 1/a^n$ for $a \neq 0$.
- $a^{(1/2)} = \sqrt{a}$, and $a^{(m/n)}$ is the n -th root of a raised to the m .
- A rational plus an irrational number is irrational.

What do exponents mean?

An exponent says how many times to multiply the base: $a^n = a \cdot a \cdot a$. A **power** has a base and an exponent. These four rules work for any nonzero base.

Rule	Words	Example
$a^m \cdot a^n = a^{(m+n)}$	add exponents	$x^3 \cdot x^4 = x^7$
$a^m / a^n = a^{(m-n)}$	subtract exponents	$x^7 / x^3 = x^4$
$(a^m)^n = a^{(mn)}$	multiply exponents	$(x^2)^3 = x^6$
$(ab)^n = a^n b^n$	power of a product	$(2x)^3 = 8x^3$

The four basic exponent rules.

What are zero and negative exponents?

Continue the pattern of powers of 2: each step to the right divides by 2.

Power	2^3	2^2	2^1	2^0	2^{-1}	2^{-2}
Value	8	4	2	1	1/2	1/4

Each step down divides by 2, so $2^0 = 1$ and $2^{-1} = \frac{1}{2}$.

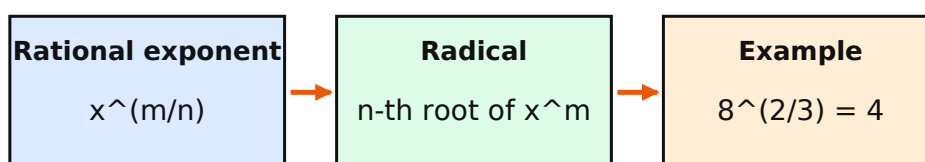
Zero and negative exponents

For a not equal to 0, $a^0 = 1$ and $a^{-n} = \frac{1}{a^n}$. A negative exponent means a reciprocal, not a negative number.

Example: Simplify $(x^{-2})^3 \cdot x^8$. Use the power rule and the negative exponent: $x^{-6} \cdot x^8 = x^2$, and $2^{-3} = \frac{1}{8}$.

What are rational exponents and radicals?

A square root $\sqrt{a}$ asks which number squared gives a . A cube root $\sqrt[3]{a}$ asks which number cubed gives a . The exponent $a^{1/2}$ means the same as the square root.

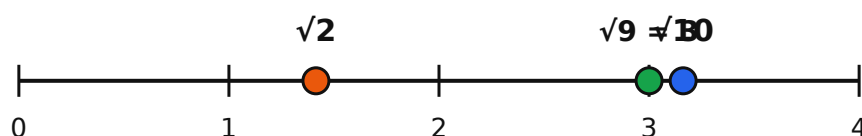


The denominator is the root; the numerator is the power.

To simplify a square root, factor out the greatest perfect square: $\sqrt{48} = \sqrt{16 \cdot 3} = 4\sqrt{3}$.

What are rational and irrational numbers?

A **rational number** can be written as a fraction of integers, such as $\frac{3}{4}$, 0.5, or $\sqrt{9}$. An **irrational number** cannot, and its decimal never ends or repeats. Examples are $\sqrt{2}$ and π .



Square roots of non-perfect squares, such as $\sqrt{2}$ and $\sqrt{10}$, lie between whole numbers and are irrational.

Square roots of perfect squares, such as 9 or 49, are rational. Square roots of other whole numbers, such as 2 or 10, are irrational. Estimate them by finding the two perfect squares on either side: $\sqrt{10}$ lies between 3 and 4 because $9 < 10 < 16$.

The sum of two rational numbers is rational. The sum of a rational number and an irrational number is irrational, and so is the product of a nonzero rational number and an irrational number.

Common mistake: $(2x)^3$ equals $8x^3$, not $2x^3$, and 2^{-3} equals $\frac{1}{8}$, not -8 . Test any rule with small numbers first: $2^2 \cdot 2^3 = 4 \cdot 8 = 32 = 2^5$.

Questions about exponent rules and radicals

What does a zero exponent mean?

Any nonzero number to the power 0 equals 1. For example $7^0 = 1$ and $(5x)^0 = 1$. This keeps the pattern of dividing by the base.

What does a negative exponent mean?

A negative exponent means the reciprocal of the positive power. So $2^{-3} = 1/2^3 = 1/8$. The result is a fraction, not a negative number.

How do you simplify a square root?

Factor the number so that one factor is the greatest perfect square, then take its root. For $\sqrt{48} = \sqrt{(16 \cdot 3)} = 4\sqrt{3}$.

What is $8^{(2/3)}$?

The denominator 3 is a cube root and the numerator 2 is a power. The cube root of 8 is 2, and $2^2 = 4$.

Is the sum of a rational and an irrational number irrational?

Yes. If $1/2 + \sqrt{2}$ were rational, then subtracting $1/2$ would make $\sqrt{2}$ rational, which is false.