Laws of exponents for Grade 9

Visual learning guide - Maths · Grade 9

Build each law from factors, track brackets and restrictions, then practise zero, negative and rational powers with checks.

Start with the key idea

For positive integer powers, a^n represents n factors of a. Multiplying powers with the same base adds exponents; dividing subtracts exponents when the denominator is nonzero; raising a power to a power multiplies exponents. Zero and negative powers extend these patterns for nonzero bases. Read the base and operation before choosing a law.

1. Identify the base and what the exponent counts

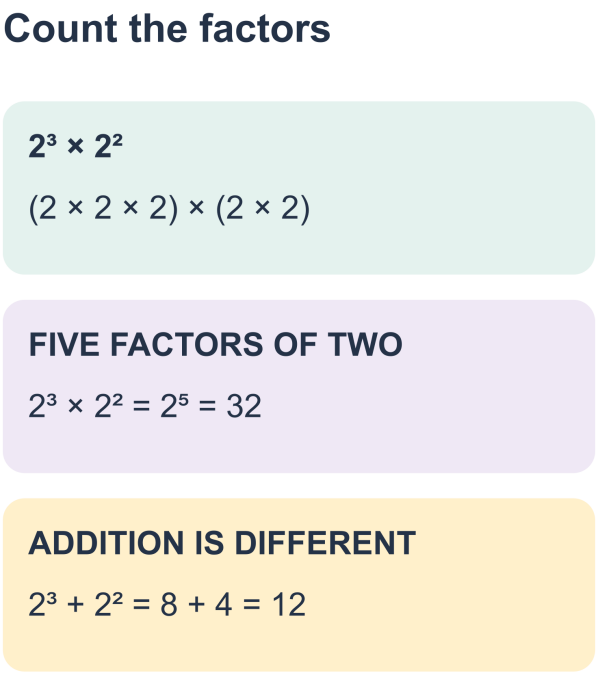
In 5^3, the base is 5 and the positive integer exponent 3 counts three factors: $5 \times 5 \times 5 = 125$. It does not mean 5×3. This expanded form is the simplest way to check a new rule.

The base can itself be an expression. In $(x + 1)^2$, the base is the whole bracket $x + 1$, so the expansion is $(x + 1)(x + 1)$. Do not remove brackets before identifying the object being raised to a power.

A power describes an operation, not a size guarantee. For example, $(1/2)^3 = 1/8$, which is smaller than $1/2$. A larger exponent need not produce a larger value when the base is between zero and one.

2. Same-base products join factors

For positive integer m and n, $a^m \times a^n = a^{m+n}$ because the first power contributes m factors of a and the second contributes n more. Thus $2^3 \times 2^2 = 2^5$. The bases must match for this particular rule.



Two cubed times two squared contains five factors of two; the sum of those powers is instead 12.

In $2^3 \times 3^2$, the bases differ and the exponents differ, so neither a same-base rule nor a common-exponent rule directly combines the expression into one of these simple powers. Calculate $8 \times 9 = 72$ or retain a useful factorised form.

Addition does not join factors. $2^3 + 2^2 = 8 + 4 = 12$. You may factor out 2^2 to write $2^2(2 + 1)$, but adding the exponents would change the value. Look at the operation sign before reaching for a law.

3. Division cancels matching factors

For a nonzero base, $a^m \div a^n = a^{m-n}$ when the powers are defined. With positive integers and m greater than n, expand and cancel: $7^5 \div 7^2$ leaves three factors of 7, so the result is 7^3.

The nonzero condition matters because division by zero is undefined. Do not apply a cancellation rule to a fraction with a zero denominator. For a symbolic fraction, record restrictions before simplifying; a shortened expression can hide them.

If m equals n and a is nonzero, the quotient equals 1. This motivates $a^0 = 1$. In this school treatment, 0^0 is not assigned a value by that rule: the reasoning used a nonzero denominator.

4. A power of a power repeats groups

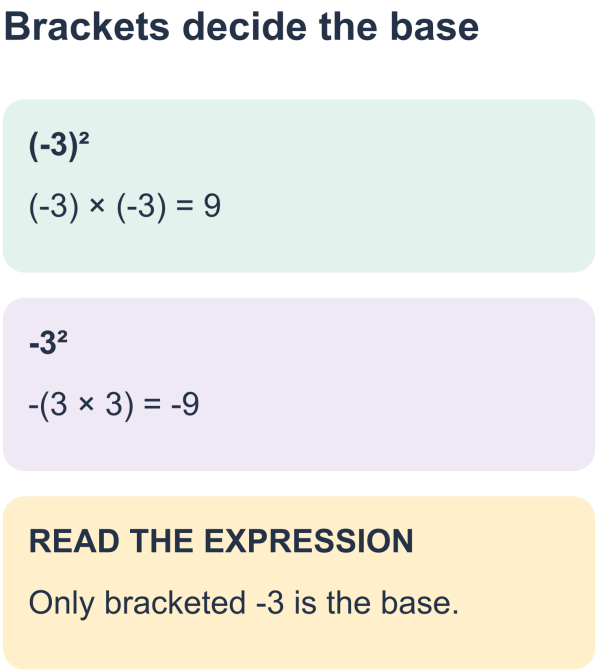
For integer powers where the expressions are defined, $(a^m)^n = a^{mn}$. For example, $(3^2)^3 = 3^2 \times 3^2 \times 3^2$, which contains six factors of 3. The exponents multiply because three groups each contain two factors.

A product raised to a positive integer power distributes over its factors: $(ab)^n = a^n b^n$. For example, $(2 \times 5)^3 = 2^3 \times 5^3$. A quotient behaves similarly when its denominator is nonzero: $(a/b)^n = a^n/b^n$.

A power does not generally distribute over addition. $(2 + 3)^2 = 25$, while $2^2 + 3^2 = 13$. Expand $(x + 1)(x + 1)$ to see the cross terms. Confusing addition with multiplication is a common source of wrong simplifications.

5. A negative exponent means a reciprocal

For a nonzero base and positive integer n, $a^{-n} = 1/a^n$. It does not mean a negative answer. For example, $2^{-3} = 1/8$. The exponent records how the multiplication pattern extends backwards.



Negative three inside brackets squared equals positive nine; a leading minus outside three squared gives negative nine.

A fractional base reverses when taking a reciprocal: $(2/3)^{-2} = (3/2)^2 = 9/4$. Keep the whole fraction inside brackets so the exponent applies to numerator and denominator together.

Compare $(-3)^2$ and -3^2. The first has base -3 and equals 9. In the second, the exponent applies to 3 before the leading minus, giving -9. With an odd integer exponent, $(-3)^3 = -27$. The sign comes from multiplication and brackets, not from guessing that every power is positive.

6. Connect rational powers with roots

For a positive base a and positive integer n, a^(1/n) means the positive nth root of a. For example, 16^(1/2) = 4 and 27^(1/3) = 3. More generally, for a positive base, a^(m/n) = (the nth root of a)^m.

Therefore 27^(2/3) = 3^2 = 9 and 16^(-1/2) = 1/4. In these examples, taking the root first keeps the arithmetic simple. State the positive-base condition when using the rational-power rules in this introductory treatment.

Negative bases with fractional exponents require more care in real-number mathematics. This guide does not extend every rational-power identity blindly to them. Stay with the stated positive-base examples unless the task explicitly defines a valid odd-root interpretation.

7. Use a short checking routine

First mark the complete base and the operation between powers. Then state any nonzero or positive-base condition. Apply one matching law at a time, and write a result with positive exponents when requested.

For a numerical problem, compare with direct arithmetic on a small example. For a symbolic expression, testing a permitted number can reveal an error but does not prove an identity for every value. The algebraic reasoning supplies the general justification.

Keep excluded values even if a factor cancels. For x^5/x^2, write x^3 with $x \neq 0$. The simplified expression x^3 exists at zero, but the original quotient does not. Correct simplification preserves the original domain.

6 worked examples with reasoning

1. Simplify $3^4 \times 3^{-2}$.

1. The bases match and are nonzero.

2. Add the exponents: 4 + (-2) = 2.

3. The result is 3^2 = 9.

2. Simplify $(2^3)^2 \div 2^4$.

1. Multiply exponents inside the power of a power: $(2^3)^2 = 2^6$.

2. Subtract exponents in the quotient: $2^6 \div 2^4 = 2^2$.

3. The value is 4; directly, 64 ÷ 16 = 4.

3. Write $(3/5)^{-2}$ with positive exponents and evaluate.

1. Take the reciprocal of the whole nonzero fraction.

2. $(3/5)^{-2} = (5/3)^2$.

3. The value is 25/9.

4. Compare $(-2)^4$ and -2^4.

1. In $(-2)^4$, the base is -2 and four negative factors give 16.

2. In -2^4, calculate 2^4 first, then apply the minus.

3. The second value is -16.

5. Evaluate 64^(2/3).

1. Use the positive cube root of 64, which is 4.

2. Square the root: $4^2 = 16$.

3. Check with $(64^{(1/3)})^2$; the positive base satisfies the stated rule.

6. Simplify x^7/x^3 and state the restriction.

1. The original denominator x^3 must not be zero, so $x \neq 0$.

2. Subtract exponents: $7 - 3 = 4$.

3. The result is x^4, retaining $x \neq 0$.

Use the ideas without looking at the notes

For each law, write one valid example, its condition and a tempting invalid example. Include addition versus multiplication, a negative exponent versus a negative base, and a cancelled denominator that still excludes zero.

Common questions

Do exponents always add?

Only in the relevant same-base multiplication rule. Quotients subtract exponents; powers of powers multiply them.

Does a negative exponent make the answer negative?

No. It indicates a reciprocal for a nonzero base. The sign depends on the base and exponent.

Is every number to the power zero equal to one?

Every nonzero base has zeroth power one. The rule used here does not assign a value to 0^0.

Why do brackets change a negative-base answer?

They show whether the minus sign belongs to the base being raised to the power.

Can I ignore a denominator restriction after cancellation?

No. The simplified expression must retain the original excluded values.

Connect your learning

- Review earlier exponent examples
- Use formulas with their conditions
- Read brackets and operations in the right order

Ask about guided Maths learning if your child needs help explaining these ideas.

About this guide

Original explanations, examples, diagrams and practice by BananaLearn. The grade label indicates the intended learning level; this is not an official textbook extract or exam paper.

Laws of exponents for Grade 9

Practice worksheet - Maths · Grade 9

Name: _____ Date: _____

Show your working. Answers and explanations follow on a separate page.

Try each task before opening its answer. Give an example or reason, not only a label.

Write an answer and your reason before opening the explanation. Check the reasoning as well as the final answer.

1. Expand 4^3 and evaluate.

2. Simplify $5^2 \times 5^3$.

3. Simplify $2^7 \div 2^4$.

4. Simplify $(3^2)^2$.

5. Find 11^0.

6. Find 4^{-2}.

7. Find $(2/5)^{-2}$.

8. Find $(-5)^2$ and -5^2.

9. Find $(-2)^3$.

10. Does $3^2 + 3^2$ equal 3^4?

11. Find 81^(1/2).

12. Find 8^(2/3).

13. Find 25^(-1/2).

14. Simplify y^6/y^2 and state the excluded value.

15. Evaluate $2^2 \times 3^2$ using a common exponent.

16. Is $(1/2)^4$ greater than $(1/2)^2$?

Answers and explanations

Answer key - Maths · Grade 9

Laws of exponents for Grade 9

1. $4 \times 4 \times 4 = 64$.

The exponent counts factors, not a multiplier of the base.

2. $5^5 = 3{,}125$.

Same-base multiplication adds exponents.

3. $2^3 = 8$.

Cancel four of the seven factors of two.

4. $3^4 = 81$.

Two groups of two factors make four factors.

5. 1.

The base is nonzero.

6. 1/16.

Take the reciprocal of 4^2.

7. 25/4.

Invert the fraction and square: $(5/2)^2$.

8. 25 and -25 respectively.

The brackets change whether the minus is part of the base.

9. -8.

Three negative factors give a negative product.

10. No. It equals 18, while $3^4 = 81$.

The product rule does not apply to addition.

11. 9.

This denotes the positive square root.

12. 4.

The cube root is 2, and $2^2 = 4$.

13. 1/5.

Take the reciprocal of the positive square root of 25.

14. y^4, with $y \neq 0$.

The original denominator is zero at $y = 0$.

15. $(2 \times 3)^2 = 36$.

A product raised to the same integer power can be combined this way.

16. No: 1/16 is less than 1/4.

For a base between zero and one, larger positive integer powers are smaller.