

Laws of Indices

Laws of indices provide us with rules for simplifying calculations or expressions involving powers of the same base.

$$a^m \times a^n = a^{m+n}$$

$$a^m \div a^n = a^{m-n}$$

$$a^0 = 1$$

$$(a^m)^n = a^{m \times n} = a^{mn}$$

$$a^{-m} = \frac{1}{a^m}$$

$$a^{\frac{m}{n}} = \sqrt[n]{a^m}$$

GCSE Higher only

Multiplying Indices

When **multiplying indices** with the **same base**, add the powers.

$$a^m \times a^n = a^{m+n}$$

 Example

Simplify $a^3 \times a^4$

$$a^3 \times a^4 = a^{3+4} = a^7$$

 Example

Simplify $a^{-2} \times a^6$

$$a^{-2} \times a^6 = a^{-2+6} = a^4$$

Dividing Indices

When **dividing indices** with the **same base**, **subtract the powers**.

$$a^m \div a^n = a^{m-n}$$

 Example

Simplify $a^5 \div a^3$

$$a^5 \div a^3 = a^{5-3} = a^2$$

 Example

Simplify $a^3 \div a^5$

$$a^3 \div a^5 = a^{3-5} = a^{-2}$$

Power of 0

Anything raised to the **power of 0** is 1

$$x^2 \div x^2 = x^0 \quad \text{but also} \quad x^2 \div x^2 = 1 \quad \text{so} \quad x^0 = 1$$

Using the division
law of indices:
 $2 - 2 = 0$

Anything divided
by itself is 1

 Examples

$$x^0 = 1 \quad 3^0 = 1 \quad (2x + 4)^0 = 1$$


Negative Indices


Negative indices are powers with a minus sign in front of them.

If a number or expression is raised to a negative power, we find its **reciprocal**.

$$a^{-m} = \frac{1}{a^m}$$

Reciprocal means
multiplicative inverse.

 **Example** The reciprocal of 4
is $\frac{1}{4}$ because $4 \times \frac{1}{4} = 1$

 **Example**

Simplify x^{-2}

This means 'the reciprocal of x^2 ', which is $\frac{1}{x^2}$

Fractional Indices

When using **fractional indices**:

- The **denominator** is the **root** of the number or letter
- Then raise the answer **to the power of** the **numerator**

$$a^{\frac{m}{n}} = \sqrt[n]{a^m}$$

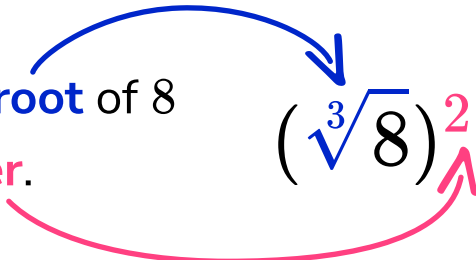
 Example

Evaluate $8^{\frac{2}{3}}$

The denominator **3** means we are finding the **cube root** of 8

The numerator **2** means we then **square our answer**.

$$8^{\frac{2}{3}} = (\sqrt[3]{8})^2 = 2^2 = 4$$


$$(\sqrt[3]{8})^2$$

Brackets with Indices

Brackets with indices are where we have a term inside a bracket with an index (or power) outside of the bracket.

When there is a power outside the bracket, **multiply the powers**.

$$(a^m)^n = a^{m \times n} = a^{mn}$$

 Example

$$(a^4)^2 = a^{4 \times 2} = a^8$$

 Example

$$(a^{-2})^3 = a^{-2 \times 3} = a^{-6}$$