Exponents and Powers

Class 8 Mathematics

Complete Study Notes

Learning Objectives

Understand the meaning of exponents and powers. Learn how repeated multiplication is represented using exponential notation, apply the laws of exponents to simplify expressions, work with negative and zero exponents, and express very large and very small numbers using scientific notation with confidence.

Introduction to Exponents and Powers

Exponents and powers are one of the most important concepts in mathematics because they provide a short and efficient way to represent repeated multiplication. Instead of writing the same number several times, exponents allow us to express the multiplication in a compact form. These concepts are widely used in algebra, geometry, physics, engineering, computer science, finance, and scientific calculations.

Understanding exponents helps students simplify complicated mathematical expressions, solve equations efficiently, and work comfortably with extremely large or extremely small numbers. Mastering the laws of exponents also forms the foundation for higher mathematics studied in later classes.

Meaning of Exponents and Powers

When a number is multiplied by itself repeatedly, the expression can be written using exponents. In the expression $\mathbf{a^n}$, the number *a* is called the base, while *n* is called the exponent or power. The exponent tells us how many times the base is multiplied by itself.

For example,
$5^3 = 5 \times 5 \times 5 = 125$
Here, 5 is the base and 3 is the exponent. Similarly,
$10^4 = 10 \times 10 \times 10 \times 10 = 10000$.

Exponential notation makes lengthy calculations much shorter and easier to understand. Instead of writing repeated multiplication every time, a simple exponential expression clearly represents the same value.

> **Negative Exponents:** Students should also understand the concept of negative exponents. A negative exponent does not make the answer negative. Instead, it represents the reciprocal of the corresponding positive power. For every non-zero number: $\mathbf{a^{-m} = 1 / a^m}$.
> For example: $2^{-3} = 1 / 2^3 = 1/8$.

Laws of Exponents

The laws of exponents simplify calculations involving powers and make mathematical expressions much easier to solve. These rules are applicable whenever the bases or exponents satisfy the required conditions.

- **Multiplication Rule:** When multiplying powers having the same base, the exponents are added.
  $a^m \times a^n = a^{m+n}$
  Example: $2^3 \times 2^4 = 2^7 = 128$.
- **Division Rule:** When dividing powers with the same base, the exponents are subtracted.
  $a^m \div a^n = a^{m-n}$
  Example: $5^6 \div 5^2 = 5^4 = 625$.
- **Power of a Power Rule:** If a power itself is raised to another power, the exponents are multiplied.
  $(a^m)^n = a^{mn}$
  Example: $(3^2)^4 = 3^8 = 6561$.
- **Power of a Product:** When different bases have the same exponent, the bases may be multiplied first while keeping the exponent unchanged.
  $a^m \times b^m = (ab)^m$
- **Zero Exponent Rule:** Every non-zero number raised to the power zero is equal to one.
  $a^0 = 1$
  Example: $15^0 = 1$ *and* $200^0 = 1$.

These laws allow students to simplify complex exponential expressions quickly without performing repeated multiplication.

Scientific Notation (Standard Form)

Scientific notation, also called Standard Form, is used to express very large and very small numbers in a simple and convenient way. Scientists, engineers, astronomers, and mathematicians use this notation because writing long strings of zeros becomes difficult and time-consuming.

A number written in scientific notation has the form:
$k \times 10^n$
where $1 \leq k < 10$ and n is an integer.

For large numbers, the decimal point moves to the left, producing a positive exponent.
For example: 150,000,000 = 1.5×10^8 and 7,200,000 = 7.2×10^6

For very small numbers, the decimal point moves to the right, producing a negative exponent.
For example: 0.000007 = 7×10^{-6} and 0.00045 = 4.5×10^{-4}

Applications of Exponents and Scientific Notation

Exponents are used extensively in daily life and advanced mathematics. Computer memory is measured using powers of two. Population growth, compound interest, radioactive decay, and exponential growth models all depend upon exponents.

Scientific notation is used in astronomy to measure distances between planets and galaxies, in biology to represent the size of cells and microorganisms, and in physics and chemistry to express very small atomic measurements. Learning exponents prepares students for future topics such as algebraic identities, logarithms, and polynomials.

Practice Questions

1. Identify the base and exponent in 7^5.
2. Simplify $3^4 \times 3^2$.
3. Simplify $5^7 \div 5^3$.
4. Write 0.00009 in scientific notation.
5. Express 48,000,000 in standard form.

Answer Key

- **ANSWER 1:** In 7^5, the base is 7 and the exponent is 5.
- **ANSWER 2:** $3^4 \times 3^2 = 3^6 = 729$.
- **ANSWER 3:** $5^7 \div 5^3 = 5^4 = 625$.
- **ANSWER 4:** $0.00009 = 9 \times 10^{-5}$.
- **ANSWER 5:** $48{,}000{,}000 = 4.8 \times 10^7$.