4
Chapter

Exponents (Powers)

We'll cover the following key points:

→ Laws of exponents
→ Applications of exponents

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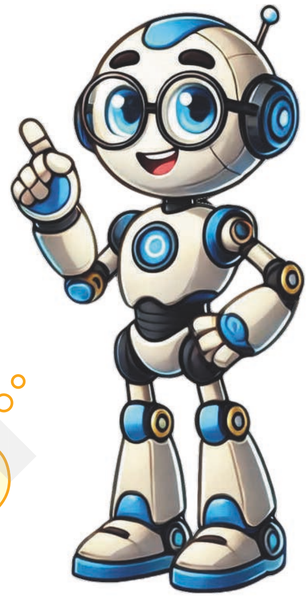


Hi, I'm EeeBee

Learning Outcomes

By the end of this chapter, students will be able to:

- Define exponents and powers and explain their significance in mathematical notation.
- Identify and interpret the base and exponent in a given power, and understand the meaning of raised powers.
- Simplify expressions involving powers of integers, using the rules of exponents.
- Understand and apply the laws of exponents, including the product of powers, quotient of powers, and power of a power.
- Evaluate expressions with exponents by following the order of operations (PEMDAS/BODMAS).
- Convert large numbers to scientific notation using exponents, and express numbers in standard form.
- Perform operations (multiplication, division) involving powers of the same base, applying the appropriate exponent rules.
- Simplify expressions involving negative exponents and understand their relation to fractions.
- Understand the concept of zero as an exponent, including the rule that any non-zero number raised to the power of zero equals one.
- Apply exponents and powers in real-life contexts, such as calculating areas, volumes, and compound growth in finance.

Mind Map

EXPONENTS AND POWERS

Exponents

- **$10000 = 10 \times 10 \times 10 \times 10 = 10^4$**

  10 is called the base and '4' the exponent. The 10^4 is read as 10 raised to the power of 4.

  $a \times a \times a \times a \times a = a^5$

Laws of exponents

i. Multiplying power with the same base ? Add Powers

e.g.,

- $2^3 \times 2^5 = 2^{3+5} = 2^8$
- $a^2 \times a^7 = a^{2+7} = a^9$

ii. Dividing powers with the same base ? subtract powers

e.g.,

- $\frac{2^5}{2^3} = 2^{5-3} = 2^2$
- $\frac{a^8}{a^3} = a^{8-3} = a^5$

iii. Taking power of a power ? Multiplying powers

e.g.,

- $(2^3)^2 = 2^{3 \times 2} = 2^6$
- $(10^5)^3 = 10^{5 \times 3} = 10^{15}$

iv. Multiplying power with the same exponents.

e.g.,

- $a^m \times b^m = (a \times b)^m$
- $2^3 \times 4^3 = (2 \times 4)^3 = 8^3$

v. Dividing power with the same exponents

e.g.,

- $\frac{a^m}{b^m} = \left(\frac{a}{b}\right)^m$
- $\frac{6^3}{2^3} = \left(\frac{6}{2}\right)^3 = 3^3$

vi. Numbers with exponent zero

e.g.,

- $a^0 = 1$
- $8^0 = 1$

Decimal Number System

- **47561**

  $= 4 \times 10000 + 7 \times 1000 + 5 \times 100 + 6 \times 10 + 1$

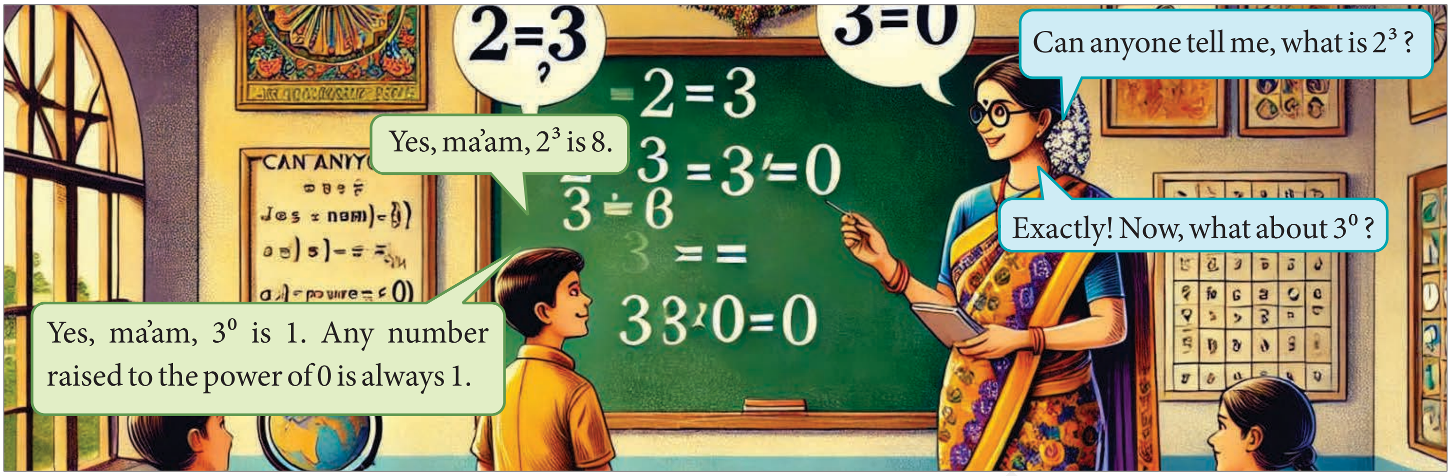
  $= 4 \times 10^4 + 7 \times 10^3 + 5 \times 10^2 + 6 \times 10^1 + 1 \times 10^0$

Expressing large numbers in the standard form

- $59 = 5.9 \times 10^1$
- $590 = 5.9 \times 10^2$
- $5900 = 5.9 \times 10^3$
- $59000 = 5.9 \times 10^4$

Based on NCERT*

Introduction



In this chapter, we learn about exponents. You know that $8 + 8 = 16$. $8 + 8$ can also be written as 2×8, read as two times, eight . Similarly, eight times can be written as $8 \times 8 = 64$.

There is another way to express $8 \times 8 = 64$, i.e., it can be written as $8^2 = 64$. Here, 8^2 is read as 8 raised to the power of two or 8 squared. Similarly, $8 \times 8 \times 8 = 512$ can be written as $8^3 = 512$ in which 8^3 is read as 8 raised to the power of three or 8 cubed.

What is this 8^2 or 8^3 ? This is nothing but the exponential form of a number. Exponents are shortcuts for multiplication. The word '**exponent**' indicates how many times a number is being multiplied.

In 8^3, 8 is the **base** and 3 is the **power** or **exponent**. To illustrate this more clearly, let us look at the following table:

Repeated multiplication of a number	Exponential form of the product	Base of the product	Power or exponent of the product
$2 \times 2 \times 2 \times 2$	2^4	2	4
7×7	7^2	7	2
$a \times a \times \ldots m$ times	a^m	a	m

Take a Task

Watch Remedial

From the table, we conclude that, if a is a rational number and m is a positive integer, then

$a \times a \times a \times \ldots.. m$ times $= a^m$ (m^{th} power of a).

Here 'a' is called the base and 'm' is called the exponent or power or index.

In the exponential form, the number which is repeatedly multiplied is called the **base** and the number of times it is repeated is called the **exponent** or **power** or index. This notation of writing the product of a rational number by itself several times is called the **exponential notation**.

If the base is a negative integer, then the product will be either negative or positive, depending upon whether the exponent is an odd number or an even number.

Examples: $(-7)^3 = -343$ (Power is odd, so the product is negative.)

$(-2)^6 = 64$ (Power is even, so the product is positive.)

$(-5)^3 = -125$ (Power is odd, so the product is negative.)

Example 1: Write the base and exponent of the following:

(*i*) a^7 (*ii*) t^{-8}

Solution: (*i*) a^7 Base = a and Exponent = 7

(*ii*) t^{-8} Base = t and Exponent = –8

Example 2: Express into power notation:

(*i*) $\frac{3}{4}\times\frac{3}{4}\times\frac{3}{4}\times\frac{3}{4}$ (*ii*) $\frac{-64}{125}$ (*iii*) $\frac{1}{1000}$

Solution: (*i*) $\frac{3}{4}\times\frac{3}{4}\times\frac{3}{4}\times\frac{3}{4}=\left(\frac{3}{4}\right)^4$ (*ii*) $\frac{(-64)}{125}=\frac{(-4)\times(-4)\times(-4)}{5\times5\times5}=\left(\frac{-4}{5}\right)^3$

(*iii*) $\frac{1}{1000}=\frac{1\times1\times1}{10\times10\times10}=\left(\frac{1}{10}\right)^3$

Example 3: Find the value of the following:

(*i*) $\left(\frac{2}{3}\right)^3$ (*ii*) $\left(-\frac{2}{3}\right)^5$

Solution: (*i*) $\left(\frac{2}{3}\right)^3=\frac{2}{3}\times\frac{2}{3}\times\frac{2}{3}=\frac{2\times2\times2}{3\times3\times3}=\frac{8}{27}$

(*ii*) $\left(-\frac{2}{3}\right)^5=\left(-\frac{2}{3}\right)\times\left(-\frac{2}{3}\right)\times\left(-\frac{2}{3}\right)\times\left(-\frac{2}{3}\right)\times\left(-\frac{2}{3}\right)$

$$=-\frac{2\times2\times2\times2\times2}{3\times3\times3\times3\times3}=-\frac{32}{243}$$

Laws of Exponents

The laws of exponents are very useful in numbers involving exponents to do the operations of multiplication and division.

Law 1 : If x is a non-zero rational number, then $x^1 = x$

Examples : $9^1 = 9$, $(999)^1 = 999$ $\quad (234)^1 = 234$

Law 2 : Any non-zero rational number having zero exponent is equal to one. If x is a non-zero rational number, then $x^0 = 1$.

Examples : (*i*) $8^3 \div 8^3 = 8^{3-3} = 8^0 = 1$ or $8^3 \div 8^3 = \dfrac{8 \times 8 \times 8}{8 \times 8 \times 8} = 1$

(*ii*) $(12)^2 \div (12)^2 = (12)^{2-2} = (12)^0 = 1$

or $(12)^2 \div (12)^2 = \dfrac{12 \times 12}{12 \times 12} = 1$

Law 3 : If x is a non-zero rational number and a and b are positive integers, then

$$x^a \times x^b = x^{a+b}$$

Here, if bases are the same, then the powers are added in the multiplication of numbers.

Examples : (*i*) $5^3 \times 5^4 = (5)^{3+4} = 5^7$ $\quad$ (*ii*) $\left(\dfrac{2}{3}\right)^3 \times \left(\dfrac{2}{3}\right)^5 = \left(\dfrac{2}{3}\right)^{3+5} = \left(\dfrac{2}{3}\right)^8$

Law 4 : If x is a non-zero rational number and a and b are positive integers, then

$$x^a \div x^b = x^{a-b}$$

Examples : (*i*) $3^8 \div 3^5 = 3^{8-5} = 3^3$

(*ii*) $\left(\dfrac{2}{7}\right)^3 \div \left(\dfrac{2}{7}\right)^7 = \left(\dfrac{2}{7}\right)^{3-7} = \left(\dfrac{2}{7}\right)^{-4}$

Law 5 : If x is a non-zero rational number and a is a negative integer, then $x^{-a} = \dfrac{1}{x^a}$

Examples : (*i*) $2^{-5} = \dfrac{1}{2^5}$ $\quad$ (*ii*) $2^{-1} = \dfrac{1}{2^1} = \dfrac{1}{2}$

(*iii*) $\left(\dfrac{2}{7}\right)^{-4} = \dfrac{1}{\left(\dfrac{2}{7}\right)^4} = \left(\dfrac{7}{2}\right)^4$

Take a Task

Watch Remedial

Law 6 : If x is a non-zero rational number and a and b are positive integers, then $(x^a)^b = x^{ab}$

Examples : (*i*) $(3^3)^4 = 3^{3\times4} = 3^{12}$ (*ii*) $\left[\left(\frac{-2}{3}\right)^4\right]^5 = \left(\frac{-2}{3}\right)^{4\times5} = \left(\frac{-2}{3}\right)^{20}$

Law 7 : If x and y are non-zero rational numbers and a is a positive integer, then

$x^a \times y^a = (xy)^a$ and $x^a \div y^a = \left(\frac{x}{y}\right)^a$

Examples : (*i*) $3^3 \times 4^3 = 3\times3\times3\times4\times4\times4$

$= (3\times4)\times(3\times4)\times(3\times4)$

$= 12\times12\times12 = (12)^3$

(*ii*) $3^{-4}\times4^{-4} = \frac{1}{3^4} = \frac{1}{3\times3\times3\times3}$

$4^{-4} = \frac{1}{4^4} = \frac{1}{4\times4\times4\times4}$

$\therefore \quad 3^{-4}\times4^{-4} = \frac{1}{3\times3\times3\times3\times4\times4\times4\times4}$

$= \frac{1}{(3\times4)\times(3\times4)\times(3\times4)\times(3\times4)} = \frac{1}{(3\times4)^4}$

$= \frac{1}{(12)^4} = 12^{-4}$

Example 4 : If $\frac{a}{b} = \left(\frac{5}{2}\right)^3 \div \left(\frac{5}{2}\right)^{-2}$, find the value of $\left(\frac{a}{b}\right)^2$

Solution : $\frac{a}{b} = \frac{\left(\frac{5}{2}\right)^3}{\left(\frac{5}{2}\right)^{-2}}$

$= \left(\frac{5}{2}\right)^3 \times \left(\frac{5}{2}\right)^2$ [Using $x^{-a} = \left(\frac{1}{x^a}\right)$]

$= \left(\frac{5}{2}\right)^{3+2} = \left(\frac{5}{2}\right)^5$ [Using $x^a \times x^b = x^{a+b}$]

Now $\left(\frac{a}{b}\right)^2 = \left[\left(\frac{5}{2}\right)^5\right]^2 = \left(\frac{5}{2}\right)^{5\times2} = \left(\frac{5}{2}\right)^{10}$ [Using $(x^a)^b = x^{ab}$]

Example 5 : Find the value of m if $64 \times 2^{(m+2)} = \frac{1}{128}$

Solution :

$$64 \times 2^{(m+2)} = \frac{1}{128}$$

$$\left[\begin{array}{l}\text{Factoring} \\ 64 = 2\times2\times2\times2\times2\times2=2^6 \\ 128 = 2\times2\times2\times2\times2\times2\times2=2^7\end{array}\right]$$

or $2^6 \times 2^{(m+2)} = \frac{1}{2^7}$

$$\left[\begin{array}{l}\text{Using} \\ x^a \times x^b = x^{a+b} \\ \text{and } \frac{1}{x^a} = x^{-a}\end{array}\right]$$

or $2^{6+(m+2)} = 2^{-7}$

or $2^{8+m} = 2^{-7}$

As bases are same, so on comparing the powers we get

$$8 + m = -7$$

$$\Rightarrow \quad m = -7-8 = -15$$

Example 6 : Express 108×144 into exponents.

Solution :

$$108 \times 144 = (2\times2\times3\times3\times3) \times (2\times2\times2\times2\times3\times3)$$

$$= (2^2 \times 3^3) \times (2^4 \times 3^2)$$

$$= 2^{2+4} \times 3^{3+2} = 2^6 \times 3^5 \qquad [\text{Using } x^a \times x^b = x^{a+b}]$$

Example 7 : Which is greater 3^4 or 4^3?

Solution :

$$3^4 = 3 \times 3 \times 3 \times 3 = 81$$

$$4^3 = 4 \times 4 \times 4 = 64$$

So, $3^4 > 4^3$

Example 8 : Simplify : $\left[\frac{1}{3^{-3}} + \frac{1}{4^{-3}} + \frac{1}{5^{-3}}\right]^{-2} \div \frac{1}{(1296)^2}$

$$\left[\begin{array}{l}\text{Factoring} \\ 1296 = 6\times6\times6\times6\end{array}\right]$$

Solution :

$$\left[\frac{1}{3^{-3}} + \frac{1}{4^{-3}} + \frac{1}{5^{-3}}\right]^{-2} \div \frac{1}{(1296)^2} = \left[3^3 + 4^3 + 5^3\right]^{-2} \div \frac{1}{(6^4)^2}$$

$$= [27 + 64 + 125]^{-2} \div \frac{1}{6^8} \qquad [\text{Using } (x^a)^b = x^{a \times b}]$$

$$= [216]^{-2} \div [6]^{-8} \qquad [\text{Using } \frac{1}{x^a} = x^{-a}]$$

$$= [6^3]^{(-2)} \div 6^{-8} \qquad [\text{Factoring } 216 = 6\times6\times6]$$

$$= 6^{-6} \div 6^{-8} \qquad [\text{Using } (x^a)^b = x^{a\times b}]$$

$$= 6^{-6-(-8)} \qquad [\text{Using } x^a \div x^b = x^{a-b}]$$

$$= 6^{-6+8}$$

$$= 6^2 = 36$$

Exercise 4.1

1. Find the base and power of the following :

(i) $(-3)^8$ (ii) $(-27)^3$ (iii) $(-11)^{-4}$ (iv) $(25)^{-8}$

2. Find the value of the following :

(i) $(-7)^3$ (ii) $(-8)^3$ (iii) $(-6)^3$ (iv) $10\times10\times10$

(v) 3^4 (vi) 4^5 (vii) $(-7)^4$ (viii) $(-2)^5$

3. Find the value of the following :

(i) $\left(\frac{11}{15}\right)^2$ (ii) $\left(-\frac{2}{2}\right)^3$ (iii) $\left(\frac{2}{3}\right)^4$ (iv) $\left(\frac{-3}{-8}\right)^4$ (v) $\left(\frac{6}{7}\right)^4$

4. Convert the following into power notation :

(i) $-\frac{16}{81}$ (ii) $-\frac{343}{729}$ (iii) $\frac{1}{625}$ (iv) $\frac{81}{625}$

(v) $\frac{25}{100}$ (vi) $\frac{49}{144}$ (vii) $-\frac{512}{343}$ (viii) $\frac{625}{2401}$

5. Simplify :

(i) $p^5\times p^3$ (ii) $r^5\times r^3\times r^{-5}$ (iii) $(-8)^7\div(-8)^3$ (iv) $(-7)^2\div(7)^3$

(v) $\left(\frac{2}{3}\right)^4\div\left(\frac{2}{3}\right)^5$ (vi) $\left(-\frac{2}{3}\right)^3\times\left(-\frac{2}{3}\right)^4$ (vii) $(20^3)^2$ (viii) $\left[\left(\frac{-2}{5}\right)^5\right]^{-2}$

6. Express into power notation :

(i) $7^5\times(1)^5$ (ii) $4^4\times3^4$ (iii) $a^3\times l^3$ (iv) $a^x\times b^x$

(v) $8^7\times8^5$ (vi) $\left(\frac{6}{11}\right)^3\times\left(\frac{6}{11}\right)^5$

7. Simplify :

(i) $\left(\frac{3}{5}\right)^0\div\left(\frac{2}{3}\right)^0$ (ii) $[(-3)^0+2^0]\div7^0$ (iii) $[2398^0+102^0]^{-2}$

(iv) $(1^0+2^0+3^0)\div(10)^0$ (v) $\frac{5^0(3^0-4^0)}{3^0}$

8. Express the following with a negative integer as exponent :

(i) $\frac{x^3\times y^2}{x^4}$ (ii) $\frac{5}{x}$ (iii) $\frac{1}{x}$ (iv) $\frac{2^5}{2^7}$

(v) $\frac{1}{5^3}$ (vi) $\frac{a^{-2}}{a^5}$

Mental Maths

Experiential Learning

1. Evaluate :

(i) $\left(\frac{1}{3}\right)^3 \times \left(\frac{1}{3}\right)^5$ (ii) $\left(\frac{11}{13}\right)^2 \div \left(\frac{11}{13}\right)^5$ (iii) $\left[\left(\frac{2}{3}\right)^3\right]^4$

(iv) $\left(\frac{-7}{11}\right)^3 \div \left(\frac{-7}{11}\right)^5$ (v) $\left(\frac{6}{17}\right)^{2+3} \div \left(\frac{6}{17}\right)^5$ (vi) $\left[\left(\frac{6}{11}\right)^3\right]^2 \div \left[\left(\frac{6}{11}\right)^2\right]^3$

2. Find the value of the following :

(i) $(-1)^{17}$ (ii) $(-1)^{100}$ (iii) $(-1)^{35}$

(iv) $(-1)^3 \times (-1)^2$ (v) $(-1)^{10} \div (-1)^{200}$ (vi) $[(-1)^9]^{1000}$

HOTS (Higher Order Thinking Skills)

Experiential Learning

1. Find x, if:

(i) $4 \times 2^{x+2} = 32$ (ii) $\left(\frac{9}{4}\right)^{-3} \times \left(\frac{9}{4}\right)^6 = \left(\frac{9}{4}\right)^{2x+1}$

2. If $\frac{p}{q} = \left(\frac{12}{5}\right)^2 \div \left(\frac{12}{5}\right)^0$, find the value of $\left(\frac{p}{q}\right)^2$.

3. By what number should 3^{-1} be multiplied so that the product is equal to $(2)^2$?

Applications of Exponents

1. Exponents can be used to write the expanded form of a number whether it is an integer or it is in decimal form. For example,

45672 can be expressed as follows:

$$45672 = 40000 + 5000 + 600 + 70 + 2$$
$$= 4\times10^4 + 5\times10^3 + 6\times10^2 + 7\times10^1 + 2\times10^0$$

Similarly 45672.32 can be expressed as follows :

$$45672.32 = 40000+5000+600+70+2+0.3+0.02$$
$$= 40000+5000+600+70+2+\frac{3}{10}+\frac{2}{100}$$
$$= 4\times10^4 + 5\times10^3 + 6\times10^2 + 7\times10^1 + 2\times10^0 + 3\times10^{-1} + 2\times10^{-2}$$

Take a Task

Watch Remedial

REMEMBER

$10^0 = 1$, so it will not affect any number if 10^0 is multiplied in it.

Notice that the exponent of 10 decreasing by 1 in each step. So trick is simple, just multiply maximum exponents of 10 and keep it decreasing by one with each digit while moving from left to right.

2. Exponents can be used to represent very small and large numbers.

For example, one of the moon of Jupiter has

30000000000000000000000 tons of water on it.

This large number can be expressed as 3×10^{22} tons of water.

Similarly the diameter of smallest particle is 0.000000000000315 m. It can be expressed as 3.15×10^{-13} m using exponents.

The exponential form of the numbers 3×10^{22} and 3.15×10^{-13} are called standard or scientific form of a number.

Notice a point that while representing 30000000000000000000000 as 3×10^{22} the decimal which is not present considered at the end is shifted to the left until one digit remains in its left and the number of places it shifts to left becomes the exponent.

Similarly in case of 0.000000000000315, the decimal shift to right 13 place, ahead. Again we keep the thing in mind that we shift the decimal to right until, we have a digit other than zero to the left of decimal and the number of places we shift the decimal becomes the exponent of 10 but this time with negative sign.

The number when expressed in 0.000000000000315, this form is called usual or normal form.

Example 9 : Find the standard form of 12800000.

Solution :

$$12800000 = 128 \times (10)^5 = 1.28\,(10)^2 \times (10)^5$$
$$= 1.28 \times (10)^{2+5} = 1.28 \times (10)^7$$

Example 10 : Express the following numbers in scientific notation:

(*i*) 0.23 (*ii*) 0.0000072

Solution :

$$(i)\ 0.23 = \frac{23}{100} = \frac{23}{10} \times \frac{1}{10} = 2.3 \times \frac{1}{10^1} = 2.3 \times (10)^{-1}$$

$$(ii)\ 0.0000072 = \frac{72}{10000000} = \frac{72}{(10)^7} = \frac{72}{10 \times (10)^6}$$
$$= \frac{72}{10} \times (10)^{-6} = 7.2 \times (10)^{-6}$$

Check Your Progress

Experiential Learning

1. **Convert the following into scientific or standard form:**

   (*i*) 0.00405 *m* (*ii*) 0.000038 kg (*iii*) 1380000000 *m* (*iv*) 281000 *g*

2. **Convert the following into usual form :**

   (*i*) 2.38×10^{-8} kg (*ii*) 7.2×10^{-9} kg (*iii*) $8 \times 10^{18}\, m$ (*iv*) $2.96 \times 10^{12}\, m$.

Exercise 4.2

1. **Write the following numbers in the expanded form :**

   (*i*) 862790 (*ii*) 4916003 (*iii*) 6916082

   (*iv*) 917021 (*v*) 86002

2. **Find the number from each of the following expanded forms :**

   (*i*) $8 \times 10^4 + 7 \times 10^3 + 4 \times 10^2 + 5 \times 10^0$ (*ii*) $2 \times 10^5 + 3 \times 10^3 + 5 \times 10^2 + 4 \times 10^0$

   (*iii*) $7 \times 10^4 + 7 \times 10^3 + 5 \times 10^1 + 3 \times 10^0$ (*iv*) $3 \times 10^5 + 9 \times 10^3 + 8 \times 10^2 + 1 \times 10^1 + 9 \times 10^0$

3. **Express the following numbers in standard form:**

   (*i*) 7, 00, 00, 000 (*ii*) 9, 22, 55, 00, 000 (*iii*) 50, 00, 000

   (*iv*) 6, 70, 383 (*v*) 29018.7 (*vi*) 5106.89

4. **Express the number appearing in the following statements in standard form:**

   (*i*) In a galaxy there are on an average 750, 000, 000, 000 stars.

   (*ii*) The population of India was about 1,39, 00, 00, 000 in March, 2001.

   (*iii*) Speed of light in vacuum is 300, 000, 000 m/s.

   (*iv*) Diameter of the Earth is 1, 27, 56, 000 *m*.

   (*v*) Diameter of the Sun is 1, 400, 000, 000, *m*.

Chapter-end Exercise

Gap Analyzer™

A. Tick (✓) the correct option:

1. $\left(\frac{1}{2}\right)^{-2} + \left(\frac{1}{3}\right)^{-2} + \left(\frac{1}{4}\right)^{-2} = \_\_\_\_\_\_\_\_\_\_$.

   (*a*) $\frac{16}{144}$ ☐ (*b*) 29 ☐ (*c*) $\frac{144}{61}$ ☐ (*d*) none ☐

2. $(3^x) \times (3^y) \times (3^z)$ is equal to ________ .

(a) $(3)^{x \times y \times z}$ ☐ (b) $(3)^{x(y+z)}$ ☐ (c) $(3)^{y(x+z)}$ ☐ (d) $(3)^{x+y+z}$ ☐

3. $(216)^8 \div (6^2)^3$ is equal to ________ .

(a) $(6)^8$ ☐ (b) $(216)^2$ ☐ (c) $(6)^{18}$ ☐ (d) none ☐

B. Fill in the blanks:

1. The reciprocal of $\left(\frac{1}{6}\right)^4$ is __________ .

2. Express $\frac{3}{2} \times \frac{3}{2} \times \frac{3}{2} \times \frac{3}{2} \times \frac{3}{2} \times \frac{3}{2}$ in power notation _________ .

3. The value of $\left[\left\{\left(\frac{1}{2}\right)^3\right\}^{-2}\right]^{-1}$ is ________ .

4. The value of m, if $\left(\frac{4}{5}\right)^3 \div \left(\frac{-4}{5}\right)^3 = (-1)^{3m}$ is _______ .

C.

1. Write the following in expanded form :

(i) $\left(\frac{-5}{11}\right)^3$ (ii) $\left(\frac{2}{3}\right)^4$ (iii) $(-5)^3$

2. Express the following in power notation form :

(i) $\frac{25}{81}$ (ii) $\frac{16}{625}$ (iii) $\frac{-16}{2401}$

3. Simplify :

(i) $\left(\frac{3}{2}\right)^7 \times \left(\frac{3}{2}\right)^8$ (ii) $\left(-\frac{5}{9}\right)^2 \times \left(-\frac{5}{9}\right)^6$ (iii) $\left(\frac{3}{11}\right)^3 \times \left(\frac{3}{11}\right)^3 \times \left(\frac{3}{11}\right)^{-4}$

4. Express the result with a positive integers as an exponent:

(i) 3^{-8} (ii) $\frac{5^7 \times 5^3}{5^5}$ (iii) $\left(-\frac{4}{5}\right)^{10} \div \left(-\frac{4}{5}\right)^6$

5. Evaluate :

(i) $(8^3)^2$ (ii) $\left(\frac{1}{8^3}\right)^2$ (iii) $\left[\left(-\frac{2}{7}\right)^0\right]^{17}$ (iv) $\left[\left(-\frac{2}{3}\right)^2\right]^3$

HOTS (Higher Order Thinking Skills)

Critical Thinking

1. Find the value of each of the following:

   (*i*) $(3^0 - 4^0) \times 7^0$ (*ii*) $(6^0 + 7^0) \times (6^0 - 7^0$ (*iii*) $\left(\dfrac{3^0 \times 4^0 \times 5^0}{6^0 + 7^0}\right)$

2. Simplify:

   (*i*) $(4^{-1} \times 3^{-1})^2$ (*ii*) $[5^{-1} \div 6^{-1}]$ (*iii*) $(1^2 \times 2^2 + 3^2) \times \left(\dfrac{2}{3}\right)^3 \div \left(\dfrac{4}{3}\right)^2$

Assertion and Reason

Experiential Learning

In each of the following questions, an Assertion (A) and a corresponding Reason (R) supporting it is given.

Study both the statements and state which of the following is correct:

(*a*) Both A and R are true and R is the correct explanation of A.

(*b*) Both A and R are true but R is not the correct explanation of A.

(*c*) A is true but R is false.

(*d*) A is false but R is true.

1. **Assertion (A) :** If n is a natural number, then 0^n is always zero.

   Reason (R) : The exponential form of $x \times x \times x \times y \times y$ is $x^3 y^2$.

2. **Assertion (A) :** For any non-zero national number x, we get $(x)^1 = x$.

   Reason (R) : The value of $\left(\dfrac{2}{7}\right)^{-5} \times \left(\dfrac{3}{4}\right)^{-5}$ is $\left(\dfrac{3}{14}\right)^5$

3. **Assertion (A) :** The value of $5^0 \times 5^0 \times 5^0 \times (5^0 - 5^0)$ is 1.

   Reason (R) : The value of $\dfrac{3^0 \times 4^0 + 2^0 \times 3^3}{16^0}$ is 2.

4. **Assertion (A) :** $(-3)^{57}$ will be a negative integer.

   Reason (R) : The value of $(3^0 - 2^1) \times 6^2$ is 36.

5. **Assertion (A) :** The value of $4^3 \times 3^2 \times 2^1 \times 1^0 \times 0^2$ is 1.

   Reason (R) : The value of x in $5^x = 625$, is 4.

Project

Find out the distance between these planetary bodies in km and write them in scientific notations.

Distance between	Distance in Kilometers	Scientific Notation
Sun and Earth		
Earth and Mars		
Jupiter and Neptune		
Earth and Mercury		

Activity

Law of Exponents

Teacher will make a chart given below and fix on the notice board of the class.

Laws of Exponents		
$a^m \times a^n$	=	
$a^m \div a^n$	=	
$(a^m)^n$	=	
a^0	=	
a^1	=	
$a^m \times b^m$	=	
$a^m \div b^m$	=	

Now make these slips of remaining parts of Laws of exponents

a^{m+n}	a^{m-n}	a^{mn}	1	a	$(ab)^m$	$(a/b)^m$

Put all the slips in a bowl. Now ask students to come one by one and take a slip from the bowl and place it to the correct place on the chart.