2 Exponents (Powers)

When a rational number x ($x \neq 0$) is repeatedly multiplied by itself n times (where n is a natural number), it is written as $x \times x \times x \times \ldots n$ times or x^n. This notation or style of writing is called **exponential notation** or **power notation**. It is also known as the nth power of x or x raised to the power n. The rational number x is called the **base** and the natural number n is called the **exponent** or the **index**.

Laws of Exponents of Rational Numbers

If x and y are two non-zero rational numbers and m, n are natural numbers, then

1. $(x)^m \times (x)^n = (x)^{m+n}$
2. $(x)^m \div (x)^n = (x)^{m-n}$ (where $m > n$)
3. $(x^m)^n = (x)^{mn} = (x^n)^m$
4. $(xy)^n = (x)^n \cdot (y)^n$
5. $\left(\frac{x}{y}\right)^n = \frac{(x)^n}{(y)^n}$
6. $(x)^1 = x$
7. $(x)^0 = 1$ (zero-exponent property)

Negative integral exponents of a rational number

You already know that, $(10)^2 = 10 \times 10 = 100$

$(10)^1 = 10$

$(10)^0 = 1$

Did you notice a pattern emerging here? The value decreases by one-tenth when the exponent decreases by one.

So, $(10)^{-1} = 10^0 \div 10 = 1 \div 10 = \frac{1}{10}$

$(10)^{-2} = (10)^{-1} \div 10 = \frac{1}{10} \div 10 = \frac{1}{10} \times \frac{1}{10} = \frac{1}{100} = \frac{1}{(10)^2}$

$(10)^{-3} = (10)^{-2} \div 10 = \frac{1}{100} \div 10 = \frac{1}{100} \times \frac{1}{10} = \frac{1}{1,000} = \frac{1}{(10)^3}$ and so on.

If $\frac{p}{q}$ is a rational number and n is any positive integer, then $\left(\frac{p}{q}\right)^{-n} = \frac{1}{\left(\frac{p}{q}\right)^n} = \left(\frac{q}{p}\right)^n$. In other words, if x ($x \neq 0$) is any rational number and n is any positive integer, then $(x)^{-n} = \frac{1}{(x)^n}$. Here, $(x)^{-n}$ is called the **reciprocal** of $(x)^n$.

Example 1: Express each of the following in the form $\frac{p}{q}$.

(a) $(4)^{-4}$ (b) $\left(\frac{-3}{5}\right)^{-4}$ (c) $\frac{1}{(2)^{-3}}$ (d) $\left(\frac{5}{8}\right)^{-7} \times \left(\frac{8}{5}\right)^{-4}$ *(NCERT)*

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Solution: (a) $(4)^{-4} = \frac{1}{(4)^4} = \frac{1}{4\times4\times4\times4} = \frac{1}{256}$ $\left(\because x^{-n} = \frac{1}{x^n}\right)$

(b) $\left(\frac{-3}{5}\right)^{-4} = \frac{1}{\left(\frac{-3}{5}\right)^4} = \frac{1}{\frac{(-3)^4}{(5)^4}}$ $\left\{\because \left(\frac{x}{y}\right)^n = \frac{x^n}{y^n}\right\}$

$= \frac{(5)^4}{(-3)^4} = \frac{5\times5\times5\times5}{(-3)\times(-3)\times(-3)\times(-3)} = \frac{625}{81}$

(c) $\frac{1}{(2)^{-3}} = \frac{1}{\frac{1}{(2)^3}} = (2)^3 = 2\times2\times2 = 8$ $\left(\because x^{-n} = \frac{1}{x^n}\right)$

(d) $\left(\frac{5}{8}\right)^{-7} = \frac{1}{\left(\frac{5}{8}\right)^7} = \frac{1}{\frac{(5)^7}{(8)^7}} = \frac{(8)^7}{(5)^7}$ and $\left(\frac{8}{5}\right)^{-4} = \frac{1}{\left(\frac{8}{5}\right)^4} = \frac{1}{\frac{(8)^4}{(5)^4}} = \frac{(5)^4}{(8)^4}$ $\left\{\because \left(\frac{x}{y}\right)^n = \frac{x^n}{y^n}\right\}$

So, $\left(\frac{5}{8}\right)^{-7} \times \left(\frac{8}{5}\right)^{-4} = \frac{(8)^7}{(5)^7} \times \frac{(5)^4}{(8)^4} = \frac{(8)^{7-4}}{(5)^{7-4}}$ $\left(\because \frac{x^m}{x^n} = x^{m-n}\right)$

$= \frac{(8)^3}{(5)^3} = \frac{8\times8\times8}{5\times5\times5} = \frac{512}{125}$

Example 2: Write each of the following as a rational number with positive exponent.

(a) $\{(3)^{-7} \div (3)^{-10}\} \times (3)^{-5}$ *(NCERT)* (b) $\left(\frac{-1}{5}\right)^{-5} \times \left(\frac{-1}{5}\right)^{-7}$

Solution: (a) $\{(3)^{-7} \div (3)^{-10}\} \times (3)^{-5}$

$= \left\{\frac{1}{(3)^7} \div \frac{1}{(3)^{10}}\right\} \times \frac{1}{(3)^5}$ $\left\{\because (x)^{-n} = \frac{1}{(x)^n}\right\}$

$= \left\{\frac{1}{(3)^7} \times \frac{(3)^{10}}{1}\right\} \times \frac{1}{(3)^5} = \left\{\frac{(3)^{10}}{(3)^7}\right\} \times \frac{1}{(3)^5}$

$= (3^{10-7}) \times \frac{1}{(3)^5} = (3)^3 \times \frac{1}{(3)^5} = (3)^{3-5} = (3)^{-2}$ $\left\{\because \frac{(x)^m}{(x)^n} = (x)^{m-n}\right\}$

$= \frac{1}{(3)^2} = \frac{(1)^2}{(3)^2} = \left(\frac{1}{3}\right)^2$ $\left\{\because \frac{(x)^n}{(y)^n} = \left(\frac{x}{y}\right)^n\right\}$

(b) $\left(\frac{-1}{5}\right)^{-5} \times \left(\frac{-1}{5}\right)^{-7} = \frac{1}{\left(\frac{-1}{5}\right)^5} \times \frac{1}{\left(\frac{-1}{5}\right)^7} = \frac{1}{\frac{(-1)^5}{(5)^5}} \times \frac{1}{\frac{(-1)^7}{(5)^7}}$

$= \frac{(5)^5}{(-1)^5} \times \frac{(5)^7}{(-1)^7} = \frac{(5)^{5+7}}{(-1)^{5+7}} = \frac{(5)^{12}}{(-1)^{12}}$

$= \frac{(5)^{12}}{1} = (5)^{12}$ $\{\because (\text{negative number})^{\text{even power}} = \text{positive number}\}$

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Example 3: Simplify the following:

(a) $\{(8)^{-1} \times (5)^3\} \div (2)^{-4}$ *(NCERT)*

(b) $\left\{\left(\frac{4}{5}\right)^{-1} - \left(\frac{1}{4}\right)^{-1}\right\}^{-1}$

(c) $\{(6)^{-1} - (9)^{-1}\}^{-1} + \{(2)^{-1} - (3)^{-1}\}^{-1}$

(d) $\left(\frac{1}{2}\right)^{-2} + \left(\frac{1}{3}\right)^{-2} + \left(\frac{1}{4}\right)^{-2}$ *(NCERT)*

Solution: (a) $\{(8)^{-1} \times (5)^3\} \div (2)^{-4} = \left\{\frac{1}{8} \times (5)^3\right\} \div \frac{1}{(2)^4} = \left\{\frac{(5)^3}{8}\right\} \times \frac{(2)^4}{1} = \left\{\frac{5 \times 5 \times 5}{8}\right\} \times \frac{(2)^4}{1}$

$$= \frac{125}{8} \times \frac{2 \times 2 \times 2 \times 2}{1} = \frac{125 \times 16}{8 \times 1} = \frac{125 \times 2}{1 \times 1} = \frac{250}{1} = 250$$

(b) $\left\{\left(\frac{4}{5}\right)^{-1} - \left(\frac{1}{4}\right)^{-1}\right\}^{-1} = \left\{\frac{1}{\left(\frac{4}{5}\right)} - \frac{1}{\left(\frac{1}{4}\right)}\right\}^{-1} = \left\{\frac{5}{4} - \frac{4}{1}\right\}^{-1} = \left\{\frac{5-16}{4}\right\}^{-1} = \left\{\frac{-11}{4}\right\}^{-1}$

$$= \frac{1}{\left(\frac{-11}{4}\right)} = \frac{4}{-11} = \frac{-4}{11}$$

(c) $\{(6)^{-1} - (9)^{-1}\}^{-1} + \{(2)^{-1} - (3)^{-1}\}^{-1} = \left\{\frac{1}{6} - \frac{1}{9}\right\}^{-1} + \left\{\frac{1}{2} - \frac{1}{3}\right\}^{-1}$

$$= \left\{\frac{3-2}{18}\right\}^{-1} + \left\{\frac{3-2}{6}\right\}^{-1} = \left\{\frac{1}{18}\right\}^{-1} + \left\{\frac{1}{6}\right\}^{-1}$$

$$= \frac{1}{\left(\frac{1}{18}\right)} + \frac{1}{\left(\frac{1}{6}\right)} = 18 + 6 = 24$$

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

$$= \frac{1}{\frac{(1)^2}{(2)^2}} + \frac{1}{\frac{(1)^2}{(3)^2}} + \frac{1}{\frac{(1)^2}{(4)^2}} = \frac{(2)^2}{(1)^2} + \frac{(3)^2}{(1)^2} + \frac{(4)^2}{(1)^2}$$

$$= (2)^2 + (3)^2 + (4)^2 = 4 + 9 + 16 = 29$$

Example 4: By what number should $\left(\frac{1}{3}\right)^2$ be multiplied to get the product as 15?

Solution: Let the required number be x.

$\left(\frac{1}{3}\right)^2 \times x = 15 \Rightarrow x \times \left(\frac{1}{3}\right)^2 = 15$ ($\because$ Multiplication is commutative)

$\Rightarrow x = 15 \div \left(\frac{1}{3}\right)^2$

$\Rightarrow x = 15 \times \left(\frac{3}{1}\right)^2 = 15 \times (3)^2 = 15 \times 9 = 135$

So, the required number is 135.

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EXERCISE 2.1

1. Write the following in the form $\frac{p}{q}$.

(a) $(-2)^{-3}$ (b) $\left(\frac{1}{4}\right)^{-2}$ (c) $\left(-\frac{4}{5}\right)^{-2}$ (d) $\left(\frac{3}{-7}\right)^{-3}$ (e) $\left(\frac{-3}{2}\right)^{-3}$

2. Evaluate:

(a) $\{(7)^0 + (4)^{-1}\} \times (2)^2$ (b) $\{(3)^{-2} + (4)^{-2} - (5)^{-2}\}^0$ (c) $\left(\frac{1}{3}\right)^{-1} + \left(\frac{1}{4}\right)^{-1} + \left(\frac{1}{6}\right)^{-1}$

(d) $\left\{\left(\frac{1}{3}\right)^{-3} - \left(\frac{1}{2}\right)^{-3}\right\} \div \left(\frac{1}{4}\right)^{-3}$ (e) $\{(7)^{-1} - (8)^{-1}\}^{-1} - \{(3)^{-1} - (4)^{-1}\}^{-1}$

3. Simplify:

(a) $\left(\frac{1}{3}\right)^{-3} \times (3)^{-1} \times \frac{1}{9}$ (b) $\{(5)^{-1} \times (4)^{-1}\}^2$ (c) $\{(3)^{-1} \div (4)^{-1}\}^3$

(d) $\{(5)^{-1} \div (3)^{-1}\}^{-1} \times (2)^{-1}$ (e) $\{(4)^2 - (3^2)\} \times \left(\frac{3}{4}\right)^{-3}$ (f) $\left\{\left(\frac{1}{3}\right)^{-2} \times \left(\frac{1}{2}\right)^{-2}\right\} \div \left(\frac{1}{4}\right)^{-3}$

(g) $\{(3)^2 + (2)^2 - (4)^2\} \div \left(\frac{3}{2}\right)^2$ (h) $\{(3)^{-5} \times (10)^{-5} \times 125\} \div \{(5)^{-7} \times (6)^{-5}\}$

4. By what number should $(-6)^{-1}$ be multiplied to get the product as $(15)^{-1}$?

5. By what number should $\left(\frac{-4}{5}\right)^{-3}$ be divided to get the quotient as $\left(\frac{16}{25}\right)^{-2}$?

6. Divide the sum of $\left(\frac{-1}{2}\right)^{-2}$ and $\left(\frac{-1}{3}\right)^{-2}$ by the difference of $\left(\frac{1}{5}\right)^{-1}$ and $\left(\frac{1}{4}\right)^{-1}$.

Properties of Negative Integral Exponents

In the beginning of the chapter, we have learnt about properties of exponents where x and y are rational numbers and m and n are natural numbers (positive integers).

The same properties hold good for negative integral exponents of a rational number.

Let's learn about the properties.

I. If x and y $(x, y \neq 0)$ are rational numbers and m and n are integers, then $(x)^m \times (x)^n = x^{m+n}$.

II. If x $(x \neq 0)$ is a rational number and m and n are integers, then $(x)^m \div (x)^n = \frac{(x)^m}{(x)^n} = (x)^{m-n}$.

III. If x $(x \neq 0)$ is a rational number and m and n are integers, then $(x^m)^n = (x)^{mn} = (x^n)^m$.

IV. If x and y $(x, y \neq 0)$ are any two rational numbers and n is any integer, then $(xy)^n = (x)^n(y)^n$.

V. If x and y $(x, y \neq 0)$ are any two rational numbers and n is any integer, then $\left(\frac{x}{y}\right)^n = \frac{(x)^n}{(y)^n}$.

VI. If x and y $(x, y \neq 0)$ are any two rational numbers and n is any integer, then

$$\left(\frac{x}{y}\right)^{-n} = \frac{1}{\left(\frac{x}{y}\right)^n} = \left(\frac{y}{x}\right)^n$$

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Example 5: Simplify using the laws of exponent and write the result in exponential form:

(a) $(5)^8 \times (5)^{-3}$ (b) $(4)^{-3} \times (3)^{-3}$ (c) $(6)^{-7} \div (6)^{-3}$

(d) $(2^3)^{-2}$ (e) $\dfrac{(4)^{-6}}{(5)^{-6}}$ (f) $(2)^{-5} \div (2)^3$

Solution:

(a) $(5)^8 \times (5)^{-3} = (5)^{8+(-3)} = (5)^{8-3} = (5)^5$ $\{\because (x)^m \times (x)^n = (x)^{m+n}\}$

(b) $(4)^{-3} \times (3)^{-3} = (4 \times 3)^{-3} = (12)^{-3}$ $\{\because (x)^n \times (y)^n = (xy)^n\}$

(c) $(6)^{-7} \div (6)^{-3} = (6)^{-7-(-3)} = (6)^{-7+3} = 6^{-4}$ $\{\because (x)^m \div (x)^n = (x)^{m-n}\}$

(d) $(2^3)^{-2} = (2)^{3 \times (-2)} = (2)^{-6}$ $\{\because (x^m)^n = (x)^{mn}\}$

(e) $\dfrac{(4)^{-6}}{(5)^{-6}} = \left(\dfrac{4}{5}\right)^{-6}$ $\left\{\because \dfrac{(x)^n}{(y)^n} = \left(\dfrac{x}{y}\right)^n\right\}$

(f) $(2)^{-5} \div (2)^3 = (2)^{-5-3} = (2)^{-8}$ $\{\because (x)^m \div (x)^n = (x)^{m-n}\}$

Example 6: Simplify and write in the exponential form with positive exponent.

(a) $(2)^{-4} \times (5)^{-4}$ (b) $\left\{\left(\dfrac{-3}{2}\right)^3\right\}^{-2}$ (c) $\left\{\left(\dfrac{-2}{3}\right)^5 + \left(\dfrac{-2}{3}\right)^7\right\} \times \left(\dfrac{-2}{3}\right)^{-5}$

Solution:

(a) $(2)^{-4} \times (5)^{-4} = (2 \times 5)^{-4} = (10)^{-4}$ $\{\because (x)^n \times (y)^n = (xy)^n\}$

$= \dfrac{1}{(10)^4} = \left(\dfrac{1}{10}\right)^4$

(b) $\left\{\left(\dfrac{-3}{2}\right)^3\right\}^{-2} = \left(\dfrac{-3}{2}\right)^{3 \times (-2)}$ $\{\because (x^m)^n = x^{mn}\}$

$= \left(\dfrac{-3}{2}\right)^{-6} = \left(\dfrac{2}{-3}\right)^6 = \left(\dfrac{-2}{3}\right)^6$

(c) $\left\{\left(\dfrac{-2}{3}\right)^5 + \left(\dfrac{-2}{3}\right)^7\right\} \times \left(\dfrac{-2}{3}\right)^{-5} = \left\{\left(\dfrac{-2}{3}\right)^{5-7}\right\} \times \left(\dfrac{-2}{3}\right)^{-5}$ $\{\because (x)^m \div (x)^n = (x)^{m-n}\}$

$= \left(\dfrac{-2}{3}\right)^{-2} \times \left(\dfrac{-2}{3}\right)^{-5} = \left(\dfrac{-2}{3}\right)^{-2+(-5)}$ $\{\because (x)^m \times (x)^n = (x)^{m+n}\}$

$= \left(\dfrac{-2}{3}\right)^{-2-5} = \left(\dfrac{-2}{3}\right)^{-7}$

$= \left(\dfrac{3}{-2}\right)^7 = \left(\dfrac{-3}{2}\right)^7$ $\left\{\because \left(\dfrac{x}{y}\right)^{-n} = \left(\dfrac{y}{x}\right)^n\right\}$

Example 7: Simplify and write in exponential form:

(a) $(-8)^{-3} \times \left(\dfrac{-1}{2}\right)^{-3}$ (b) $(-2)^4 \times (3)^{-4} \times (5)^{-4}$

(c) $\left(\dfrac{32}{243}\right)^{\frac{-4}{5}}$ (d) $\{(3)^{-7} \div (3)^{-10}\} \times (3)^{-5}$ *(NCERT)*

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Solution: (a) $(-8)^{-3} \times \left(\frac{-1}{2}\right)^{-3} = \left\{-8 \times \left(\frac{-1}{2}\right)\right\}^{-3}$ $\{\because (x)^n \times (y)^n = (xy)^n\}$

$= \left\{\frac{(-8) \times (-1)}{2}\right\}^{-3} = \left\{\frac{(-4) \times (-1)}{1}\right\}^{-3} = \left\{\frac{4}{1}\right\}^{-3} = (4)^{-3}$

(b) $(-2)^4 \times (3)^{-4} \times (5)^{-4} = (-2)^4 \times (3 \times 5)^{-4}$ $\{\because (x)^n \times (y)^n = (xy)^n\}$

$= (-2)^4 \times (15)^{-4}$

$= (-2)^4 \times \frac{1}{(15)^4} = \frac{(-2)^4}{(15)^4} = \left(\frac{-2}{15}\right)^4$ $\left\{\because \frac{(x)^n}{(y)^n} = \left(\frac{x}{y}\right)^n\right\}$

(c) $\left(\frac{32}{243}\right)^{\frac{-4}{5}} = \left(\frac{(2)^5}{(3)^5}\right)^{\frac{-4}{5}} = \left\{\left(\frac{2}{3}\right)^5\right\}^{\frac{-4}{5}}$ $\left\{\because \frac{(x)^n}{(y)^n} = \left(\frac{x}{y}\right)^n\right\}$

$= \left\{\frac{2}{3}\right\}^{5 \times \left(\frac{-4}{5}\right)} = \left(\frac{2}{3}\right)^{-4}$ $\{\because (x^m)^n = (x)^{mn}\}$

(d) $\{(3)^{-7} \div (3)^{-10}\} \times (3)^{-5} = \{(3)^{-7-(-10)}\} \times (3)^{-5}$ $\{\because (x)^m \div (x)^n = (x)^{m-n}\}$

$= \{3^{-7+10}\} \times (3)^{-5}$

$= (3)^3 \times (3)^{-5} = (3)^{3+(-5)}$ $\{\because (x)^m \times (x)^n = (x)^{m+n}\}$

$= (3)^{-2}$

Example 8: Simplify:

(a) $\left(\frac{2}{3}\right)^3 \times \left(\frac{2}{3}\right)^{-2} \times \left\{\left(\frac{1}{2}\right)^2\right\}^{-2} \times \frac{1}{24}$ (b) $\left[\left\{\left(\frac{-1}{6}\right)^2\right\}^{-2}\right]^{-1}$

(c) $\left\{\left(\frac{1}{4}\right)^{-3} - \left(\frac{1}{3}\right)^{-3}\right\} \div \left(\frac{1}{5}\right)^{-3}$

Solution: (a) $\left(\frac{2}{3}\right)^3 \times \left(\frac{2}{3}\right)^{-2} \times \left\{\left(\frac{1}{2}\right)^2\right\}^{-2} \times \frac{1}{24} = \left(\frac{2}{3}\right)^{3+(-2)} \times \left(\frac{1}{2}\right)^{2 \times (-2)} \times \frac{1}{24}$

$\{\because (x)^m \times (x)^n = (x)^{m+n}; (x^m)^n = (x)^{mn}\}$

$= \left(\frac{2}{3}\right)^1 \times \left(\frac{1}{2}\right)^{-4} \times \frac{1}{24} = \frac{2}{3} \times (2)^4 \times \frac{1}{24} = \frac{2 \times (2)^4 \times 1}{3 \times 24} = \frac{(2)^5 \times 1}{3 \times 24}$

$= \frac{2 \times 2 \times 2 \times 2 \times 2}{3 \times 24} = \frac{32}{3 \times 24} = \frac{4}{3 \times 3} = \frac{4}{9}$

(b) $\left[\left\{\left(\frac{-1}{6}\right)^2\right\}^{-2}\right]^{-1} = \left\{\left(\frac{-1}{6}\right)^2\right\}^{(-2) \times (-1)}$ $\{\because (x^m)^n = (x)^{mn}\}$

$= \left\{\left(\frac{-1}{6}\right)^2\right\}^2 = \left(\frac{-1}{6}\right)^{2 \times 2}$ $\{\because (x^m)^n = (x)^{mn}\}$

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$$= \left(\frac{-1}{6}\right)^4 = \frac{(-1)^4}{(6)^4} \qquad \left\{\because \left(\frac{x}{y}\right)^n = \frac{(x)^n}{(y)^n}\right\}$$

$$= \frac{1}{1296}$$

(c) $$\left\{\left(\frac{1}{4}\right)^{-3} - \left(\frac{1}{3}\right)^{-3}\right\} \div \left(\frac{1}{5}\right)^{-3} = \left\{\left(\frac{4}{1}\right)^3 - \left(\frac{3}{1}\right)^3\right\} \div \left(\frac{5}{1}\right)^3 \qquad \left\{\because \left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^n\right\}$$

$$= \{(4)^3 - (3)^3\} \div \left(\frac{5}{1}\right)^3$$

$$= \{64 - 27\} \times \left(\frac{1}{5}\right)^3$$

$$= 37 \times \frac{(1)^3}{(5)^3} = \frac{37 \times 1}{125} \qquad \left\{\because \left(\frac{x}{y}\right)^n = \frac{(x)^n}{(y)^n}\right\}$$

$$= \frac{37}{125}$$

(NCERT)

Example 9: Simplify:

(a) $\dfrac{25 \times (p)^{-4}}{(5)^{-3} \times 10 \times (p)^{-8}}, (p \neq 0)$ (b) $\dfrac{(3)^{-5} \times (10)^{-5} \times 125}{(5)^{-7} \times (6)^{-5}}$

Solution: (a) $$\frac{25 \times (p)^{-4}}{(5)^{-3} \times 10 \times (p)^{-8}} = \frac{(5)^2}{(5)^{-3}} \times \frac{1}{10} \times \frac{(p)^{-4}}{(p)^{-8}}$$

$$= (5)^{2-(-3)} \times \frac{1}{10} \times (p)^{-4-(-8)} \qquad \{\because (x)^m \div (x)^n = (x)^{m-n}\}$$

$$= (5)^{2+3} \times \frac{1}{10} \times (p)^{-4+8} = (5)^5 \times \frac{1}{5 \times 2} \times (p)^4$$

$$= (5)^{5-1} \times \frac{1}{2} \times (p)^4 = \frac{(5)^4 \times (p)^4}{2} = \frac{625}{2} p^4$$

(b) $$\frac{(3)^{-5} \times (10)^{-5} \times 125}{(5)^{-7} \times (6)^{-5}} = \frac{(3)^{-5} \times (5 \times 2)^{-5} \times (5)^3}{(5)^{-7} \times (3 \times 2)^{-5}} = \frac{(3)^{-5} \times (5)^{-5} \times (2)^{-5} \times (5)^3}{(5)^{-7} \times (3)^{-5} \times (2)^{-5}}$$

$$= (3)^{-5-(-5)} \times (5)^{-5+3-(-7)} \times (2)^{-5-(-5)}$$

$$\{\because (x)^m \times (x)^n = (x)^{m+n} \text{ and } (x)^m \div (x)^n = (x)^{m-n}\}$$

$$= (3)^{-5+5} \times (5)^{-2+7} \times (2)^{-5+5}$$

$$= (3)^0 \times (5)^5 \times (2)^0 = 1 \times (5)^5 \times 1 \qquad \{\because (x)^0 = 1\}$$

$$= (5)^5 = 3{,}125$$

Example 10: By what number should $(-16)^{-1}$ be divided to give the quotient as $(-4)^{-1}$?

Solution: Let the required number be x.

$$(-16)^{-1} \div x = (-4)^{-1}$$

$$\frac{1}{-16} \times \frac{1}{x} = \frac{1}{-4}$$

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$$\Rightarrow \frac{1}{x} = \frac{(-1)}{4} \div \left(\frac{-1}{16}\right) = \frac{(-1)}{4} \times \frac{16}{(-1)} = \frac{16}{4} = 4$$

$$\Rightarrow \frac{1}{x} = 4 \Rightarrow x = \frac{1}{4}$$

Example 11: Find the reciprocal of $\left(\frac{9}{2}\right)^{-5} \div \left(\frac{2}{9}\right)^{-3}$.

Solution:

$$\left(\frac{9}{2}\right)^{-5} \div \left(\frac{2}{9}\right)^{-3} = \left(\frac{2}{9}\right)^{5} \div \left(\frac{9}{2}\right)^{3} \qquad \left\{\because \left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^{n}\right\}$$

$$= \left(\frac{2}{9}\right)^{5} \times \left(\frac{2}{9}\right)^{3}$$

$$= \left(\frac{2}{9}\right)^{5+3} = \left(\frac{2}{9}\right)^{8} \qquad \{\because (x)^m \times (x)^n = (x)^{m+n}\}$$

So, reciprocal of $\left(\frac{2}{9}\right)^{8} = \frac{1}{\left(\frac{2}{9}\right)^{8}} = \left(\frac{2}{9}\right)^{-8} = \left(\frac{9}{2}\right)^{8}$

Try It Out!

Solve the given expression mentally.

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

Example 12: Find the value of x if $\left(\frac{-2}{5}\right)^{-3} \times \left(\frac{-2}{5}\right)^{11} = \left(\frac{-2}{5}\right)^{3x+2}$.

Solution:

$$\left(\frac{-2}{5}\right)^{-3} \times \left(\frac{-2}{5}\right)^{11} = \left(\frac{-2}{5}\right)^{3x+2}$$

$$\Rightarrow \left(\frac{-2}{5}\right)^{-3+11} = \left(\frac{-2}{5}\right)^{3x+2} \qquad \{\because (x)^m \times (x)^n = (x)^{m+n}\}$$

$$\Rightarrow \left(\frac{-2}{5}\right)^{8} = \left(\frac{-2}{5}\right)^{3x+2}$$

$$\Rightarrow 3x + 2 = 8 \qquad \{\because \text{If } (x)^m = (x)^n \Rightarrow m = n\}$$

$$\Rightarrow 3x = 8 - 2 = 6$$

$$\Rightarrow x = \frac{6}{3} = 2$$

So, $x = 2$

Example 13: If $\frac{p}{q} = \left(\frac{2}{3}\right)^{-2} \div \left(\frac{2}{5}\right)^{-1}, (q \neq 0)$, find the value of $\left(\frac{p}{q}\right)^{-3}$.

Solution:

$$\frac{p}{q} = \left(\frac{2}{3}\right)^{-2} \div \left(\frac{2}{5}\right)^{-1} = \left(\frac{3}{2}\right)^{2} \div \left(\frac{5}{2}\right)^{1} \qquad \left\{\because \left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^{n}\right\}$$

$$= \left(\frac{3}{2}\right)^{2} \times \frac{2}{5} = \frac{(3)^2}{(2)^2} \times \frac{2}{5} = \frac{9 \times 2}{4 \times 5} = \frac{9 \times 1}{2 \times 5} = \frac{9}{10} \Rightarrow \frac{p}{q} = \frac{9}{10}$$

So, $\left(\frac{p}{q}\right)^{-3} = \left(\frac{9}{10}\right)^{-3} = \left(\frac{10}{9}\right)^{3} = \frac{1{,}000}{729}$ $\qquad \left\{\because \left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^{n}\right\}$

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(NCERT)

Example 14: Find the value of m for which $(5)^m \div (5)^{-3} = (5)^5$.

Solution: $(5)^m \div (5)^{-3} = (5)^5$ $\{\because (x)^m \div (x)^n = (x)^{m-n}\}$

$\Rightarrow (5)^{m-(-3)} = (5)^5$

$\Rightarrow (5)^{m+3} = (5)^5$ $\{\because \text{If } (x)^m = (x)^n \Rightarrow m = n\}$

$\Rightarrow m + 3 = 5$

$\Rightarrow m = 5 - 3 = 2$

So, $m = 2$

EXERCISE 2.2

1. Evaluate:

   (a) $(3)^{-2}$ (b) $(-5)^{-4}$ (c) $\left(\frac{-1}{4}\right)^{-2}$ (d) $\left(\frac{2}{5}\right)^{-3}$

2. Write the following in the form $\frac{p}{q}$:

   (a) $\left(\frac{3}{5}\right)^{-1}$ (b) $(-6)^{-1} \times \left(\frac{2}{3}\right)^{-1}$ (c) $\left(\frac{3}{5}\right)^{-1} \times \left(\frac{5}{2}\right)^{-1}$

3. Simplify:

   (a) $\{(5)^{-1} \times (4)^{-1}\}^2$ (b) $\{(5)^{-1} \div (6)^{-1}\}^{-1}$ (c) $\{(2)^{-1} \times (3)^{-1}\}^{-1} \times (4)^{-1}$ (d) $\{(4)^{-1} - (5)^{-1}\} \div (3)^{-1}$

4. Find the reciprocal of the following:

   (a) $\left\{\left(\frac{1}{4}\right)^{-1}\right\}^3$ (b) $\left(\frac{2}{3}\right)^{-2} \div \left(\frac{3}{2}\right)^{-4}$ (c) $\left(\frac{-4}{7}\right)^{-2} \times \left(\frac{-4}{7}\right)^{-3} \div \left(\frac{-4}{7}\right)^{5}$

5. Write each of the following as a rational number with negative exponent:

   (a) $(7)^4$ (b) $\left(\frac{4}{9}\right)^6$ (c) $\left\{\left(\frac{2}{3}\right)^3\right\}^{-2}$ (d) $\left[\left\{\left(\frac{3}{4}\right)^2\right\}^{-1}\right]^3$

6. Write each of the following as rational number with positive exponent:

   (a) $\left(\frac{4}{3}\right)^{-3}$ (b) $\left[\left(\frac{1}{5}\right)^{-2}\right]^3$ (c) $\left[\left(\frac{3}{7}\right)^{-3}\right]^{-4}$ (d) $(8)^{-5} \times (8)^3 \times (8)^{-4}$

7. Simplify:

   (a) $\left(\frac{3}{2}\right)^2 \times \frac{1}{4^{-4}} \times (3)^{-4} \times \left(\frac{7}{3}\right)^{-1}$ (b) $\left(\frac{3}{4}\right)^{-2} + \left(\frac{2}{3}\right)^{-2} + \left(\frac{1}{2}\right)^{-2}$ (c) $\left[\left\{\left(\frac{-1}{3}\right)^2\right\}^{-2}\right]^{-1}$

   (d) $(5^2 - 3^2) \times \left(\frac{4}{3}\right)^{-3}$ (e) $\left[\left(\frac{1}{5}\right)^{-1} \times (-25)^{-1}\right]^{-1}$ (f) $\left\{\left(\frac{1}{3}\right)^3\right\} \times \left(\frac{3}{2}\right)^2 \div \left\{\left(\frac{2}{3}\right)^{-1}\right\}^3$

8. By what number should $(3)^{-1}$ be multiplied to get the product as $(-6)^{-1}$?

9. By what number should $\left(\frac{2}{3}\right)^{-2}$ be multiplied to get the product as $\left(\frac{-9}{4}\right)^{-1}$?

10. By what number should $\left(\frac{-3}{2}\right)^{-4}$ be divided to give the quotient as $\left(\frac{4}{27}\right)^3$?

11. By what numbe
12. Find x, if:

    (a) $\left(\frac{1}{5}\right)^{-8} \times \left(\right.$

13. If $x = \left(\frac{2}{3}\right)^{-4} \times$

14. If $\frac{p}{q} = \left(\frac{5}{6}\right)^{-2}$

15. Find the valu

Use of Exponents

You already know

For example: Spe

Sol

Similarly, we can

by following the

1. For numbers
2. For numbers
   (i) multipl shifted
   (ii) shift th
   (iii) write t

Example 15:

Solution:

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11. By what number should $\left(\frac{7}{3}\right)^{-1}$ be divided to give the quotient as $\frac{25}{21}$?

12. Find x, if:

(a) $\left(\frac{1}{5}\right)^{-8} \times \left(\frac{1}{5}\right)^{-4} = \left(\frac{1}{5}\right)^{-4x}$ (b) $\left(\frac{-1}{3}\right)^{-18} \div \left(\frac{-1}{3}\right)^{7} = \left(\frac{-1}{3}\right)^{-2x+1}$ (c) $\left(\frac{-3}{5}\right)^{14} \times \left(\frac{-3}{5}\right)^{-3} = \left(\frac{-3}{5}\right)^{3x+2}$

13. If $x = \left(\frac{2}{3}\right)^{-4} \times \left(\frac{3}{2}\right)^{2}$, find the value of (a) $(x)^{-2}$ (b) $(x)^{-1}$

14. If $\frac{p}{q} = \left(\frac{5}{6}\right)^{-2} \div \left(\frac{1}{5}\right)^{2}$, find the value of $\left(\frac{p}{q}\right)^{-3}$.

15. Find the value of m, if: (a) $(6)^{2m} \div (6)^{-3} = (6)^{5}$ (b) $(9)^{-3m} \div (9)^{-4} = (9)^{7}$ (c) $(-5)^{m-1} \div (-5)^{2} = (-5)^{-6}$

Use of Exponents to Express Small Numbers in Standard Form

You already know how to write large numbers in standard form using exponential notations.

For example: Speed of light is 300,000,000 m/s = 3×10^8 m/s

Solar radius is 69,57,00,000 m (approx.) = 6.957×10^8 m

Similarly, we can write very small numbers in standard form using exponential notations. This can be done by following the given method:

1. For numbers greater than 1 and less than 10, write it as a product of the number and 10^0. ($\because 10^0 = 1$)
2. For numbers less than 1,
   (i) multiply and divide the number by 10^n, where n is the number of places the decimal point is to be shifted to the right, till there is only one non-zero digit to the left of the decimal point.
   (ii) shift the decimal point to the right and keep 10^n as the denominator.
   (iii) write the resulting number as the product of the number and 10^{-n}.

Example 15: Write in standard form:

(a) 0.5368 (b) 0.00000000000942 (*NCERT*) (c) 365100000

(d) 16.00007 (e) 0.0035×10^{-6} (f) 0.002×0.006

Solution: (a) To write 0.5368 in standard form:

(i) we have to shift the decimal one place to the right, so that there is only one non-zero digit to the left of the decimal point.

(ii) multiply and divide by 10 to keep the given number same.

i.e., $\frac{0.5368 \times 10}{10} = \frac{5.368}{10^1} = 5.368 \times (10)^{-1}$

So, the standard form of 0.5368 = $5.368 \times (10)^{-1}$

(b) $0.00000000000942 = \frac{0.00000000000942 \times (10)^{12}}{(10)^{12}}$ (Shift decimal 12 places to the right)

$= \frac{9.42}{(10)^{12}} = 9.42 \times (10)^{-12}$

(c) $365100000 = \frac{365100000}{(10)^{8}} \times (10)^{8} = 3.651 \times (10)^{8}$ (Shift decimal 8 places to the left)

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(d) $16.00007 = \frac{16.00007}{(10)^1} \times (10)^1$ (Shift decimal 1 place to the left)

$= 1.600007 \times (10)^1$

(e) $0.0035 \times 10^{-6} = \frac{0.0035 \times (10)^3}{(10)^3} \times (10)^{-6}$ (Shift decimal 3 places to the right)

$= \frac{3.5}{(10)^3} \times (10)^{-6}$

$= 3.5 \times 10^{-3} \times 10^{-6}$ $\{\because (x)^m \times (x)^n = (x)^{m+n}\}$

$= 3.5 \times (10)^{[(-3)+(-6)]}$

$= 3.5 \times 10^{-9}$

(f) $0.002 \times 0.006 = \frac{0.002 \times (10)^3}{(10)^3} \times \frac{0.006 \times (10)^3}{(10)^3}$ (Shift decimal 3 places to the right)

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

$= 12 \times (10)^{-6}$

$= \frac{12}{(10)^1} \times (10)^1 \times (10)^{-6}$ (Shift decimal 1 place to the left)

$= 1.2 \times (10)^1 \times (10)^{-6} = 1.2 \times (10)^{-5}$

Example 16: Write in usual form:

(a) $1.0001 \times (10)^9$ *(NCERT)* (b) $3.61492 \times (10)^6$ *(NCERT)* (c) $2.67004 \times (10)^{-3}$

Solution: (a) $1.0001 \times (10)^9 = \frac{10001}{10^4} \times (10)^9 = 10001 \times (10)^{9-4}$

$= 10001 \times (10)^5 = 10001 \times 100000 = 1000100000$

(b) $3.61492 \times (10)^6 = \frac{361492}{100000} \times (10)^6 = \frac{361492}{10^5} \times (10)^6$

$= 361492 \times (10)^{6-5} = 361492 \times (10)^1 = 3614920$

(c) $2.67004 \times (10)^{-3} = \frac{267004}{100000} \times (10)^{-3}$

$= \frac{267004}{(10)^5} \times (10)^{-3} = 267004 \times (10)^{-3-5} = 267004 \times (10)^{-8}$

$= \frac{267004}{(10)^8} = \frac{267004}{100000000} = 0.00267004$

Example 17: Convert the numbers appearing in the following statements in their standard form. *(NCERT)*

(a) The average diameter of a red blood cell is 0.000007 mm.

(b) Average radius of the sun is 695,000 km.

(c) 1 micron is equal to $\frac{1}{1000000}$ m.

(d) Size of a plant cell is 0.00001275 m.

Solution: (a) $0.000007 = \frac{0.000007 \times (10)^6}{(10)^6} = \frac{7}{(10)^6} = 7 \times (10)^{-6}$ mm

(b) $695000 = \frac{695000}{100000} \times 100000 = 6.95 \times (10)^5$ km

(c) $\frac{1}{1000000} = \frac{1}{(10)^6} = 1 \times (10)^{-6}$ m

(d) $0.00001275 = \frac{0.00001275 \times (10)^5}{(10)^5} = \frac{1.275}{(10)^5} = 1.275 \times (10)^{-5}$ m

Example 18: Compare the diameter of a wire on a computer chip which is 0.000003 m to that of a plant cell which is 0.00001275 m.

Solution: Diameter of a wire on computer chip = 0.000003 m

Size of plant cell = 0.00001275 m

Now, 0.000003 mm = $3 \times (10)^{-6}$ m

and 0.00001275 m = $1.275 \times (10)^{-5}$ m

So, $\frac{\text{Diameter of wire}}{\text{Size of plant cell}} = \frac{3 \times (10)^{-6}}{1.275 \times (10)^{-5}} = \frac{3 \times (10)^{-6-(-5)}}{1.275}$

$= \frac{3 \times (10)^{-6+5}}{1.275} = \frac{3 \times (10)^{-1}}{1.275}$

$\frac{3}{1.275 \times 10} = \frac{3}{12.75} \approx \frac{3}{12} \approx \frac{1}{4}$

So, the diameter of wire is approximately one-fourth of the size of the plant cell.

Try It Out!

1. What is the value of $\{2 - 3(2-3)^{-1}\}$?
2. What is the value of the expression $(x+y)^{-1}(x^{-1}+y^{-1})$ when it is simplified and expressed with negative exponents?

'≈' sign denotes the approximate value, e.g., 1.1 ≈ 1

EXERCISE 2.3

1. Write in standard form:

   (a) 0.000000375 (b) 506.289 (c) 9280000000000 (d) $\frac{3}{100000000}$

   (e) $4603 \times (10)^{-5}$ (f) $0.0000478 \times (10)^4$

2. Write in usual form:

   (a) $3.25 \times (10)^{-8}$ (b) $4.083 \times (10)^4$ (c) $9.17 \times (10)^{-5}$ (d) $2.0001 \times (10)^9$

   (e) $8 \times (10)^{-9}$ (f) $7.9 \times (10)^3$

3. Compare the diameter of the sun $1.4 \times (10)^9$ m to the diameter of the earth $1.2756 \times (10)^7$ m.

AT A GLANCE

1. If x is a non-zero rational number and n is any positive integer, then

   (a) $(x)^n = x \times x \times x \times x \times \ldots n$ times (b) $(x)^{-n} = \frac{1}{(x)^n}$ (c) $(x)^0 = 1$

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2. If x and y are two non-zero rational numbers and m and n are any two integers, then

(a) $(x)^m \times (x)^n = (x)^{m+n}$ (b) $\frac{(x)^m}{(x)^n} = (x)^m \div (x)^n = (x)^{m-n}$

(c) $(x^m)^n = (x)^{mn}$ (d) $\left(\frac{x}{y}\right)^n = \frac{(x)^n}{(y)^n}$ (e) $(x)^n \times (y)^n = (xy)^n$

3. If $\frac{x}{y}$ is any non-zero rational number and n is a positive integer, then $\left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^n = \frac{(y)^n}{(x)^n}$.

4. Standard form of any number = (A number between 1 and 10) × $(10)^n$; where n is any integer

REVIEW EXERCISES

MULTIPLE CHOICE QUESTIONS

1. The value of $(2)^{-5} \times (64)^{\frac{2}{3}}$ is:

(a) 512 (b) $\frac{1}{512}$ (c) 16 (d) $\frac{1}{2}$

2. $\left\{\left(\frac{-2}{3}\right)^{-3}\right\}^2$ is equal to:

(a) $\frac{3}{2}$ (b) $\frac{64}{729}$ (c) $\frac{81}{32}$ (d) $\frac{729}{64}$

3. Which of the following is not equal to $\left(\frac{-2}{5}\right)^4$?

(a) $\frac{2^4}{(-5)^4}$ (b) $\left(\frac{-2}{5}\right)\times\left(\frac{-2}{5}\right)\times\left(\frac{-2}{5}\right)\times\left(\frac{-2}{5}\right)$ (c) $\frac{(-2)^4}{(5)^4}$ (d) $-\frac{(2)^4}{(5)^4}$

4. $\left(\frac{-2}{7}\right)^{-6} \div \left(\frac{-2}{7}\right)^4$ is equal to:

(a) $\left(\frac{-2}{7}\right)^2$ (b) $\left(\frac{-2}{7}\right)^{-10}$ (c) $\left(\frac{-7}{2}\right)^{-10}$ (d) $\left(\frac{-7}{2}\right)^2$

5. $\{(4)^{-1} - (2)^{-1}\} \times (3)^{-1}$ is equal to:

(a) $\frac{-1}{12}$ (b) $\frac{1}{12}$ (c) $\frac{3}{8}$ (d) $\frac{-3}{8}$

SOLVE MENTALLY

True or False

1. The standard form of 0.0000000000942 is $9.42 \times (10)^{-11}$.
2. The value of m for which $\left(\frac{6}{13}\right)^{-4} \times \left(\frac{6}{13}\right)^{3m} = \left(\frac{6}{13}\right)^5$ is –3.
3. If $\{(2)^{3m-1} + 10\} \div 7 = 6$, then m is 2.
4. The usual form of $6.8 \times (10)^4$ is 6,80,000.
5. The value of $(2)^{55} \times (2)^{60} - (2)^{97} \times (2)^{18}$ is 0.

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Fill in the Blanks

1. $(x)^m = (x)^n \Rightarrow$ _____
2. $\left(\frac{p}{q}\right)^{-m} = \left(\text{———}\right)^{m}$
3. The standard form of $21.36 \times (10)^{-5} =$ _____
4. The usual form of $4.39 \times (10)^3 =$ _____

Answer in One Word or a Line

1. What is the reciprocal of x^n?
2. What is the reciprocal of $x^m \times x^n$?
3. If $x^m = x^5$, what is the value of m?
4. What is $(2^2)^3$?
5. What is $\left(\frac{3}{4}\right)^5 \div \left(\frac{3}{4}\right)^2$?

Let's Evaluate

1. Write in the form $\frac{p}{q}$: (a) $\left(\frac{-4}{5}\right)^{-4}$ (b) $\left(\frac{2}{3}\right)^{-5}$ (c) $\frac{1}{(4)^{-2}}$
2. Find the value of:
   (a) $\{(6)^0 + (2)^{-1}\} \times 3^2$ (b) $\{(2)^{-2} + (3)^{-2} + (4)^{-2}\}^0$ (c) $\left\{\left(\frac{1}{6}\right)^{-1} - \left(\frac{1}{5}\right)^{-1}\right\}^{-1}$
3. Simplify:
   (a) $\left\{\left(\frac{1}{3}\right)^{-3} - \left(\frac{1}{2}\right)^{-3}\right\} \div \left(\frac{1}{4}\right)^{-3}$ (b) $\{(2)^{-3} + (3)^{-3}\} \times (7)^0$ (c) $\{(1)^{-1} + (2)^{-1} + (3)^{-1}\} \div (4)^{-1}$
4. By what number should $(2)^{-1}$ be multiplied to get the product as $\left(\frac{-7}{4}\right)^{-1}$?
5. Express the following as a power with base 2:
   (a) $(4)^{-3}$ (b) $(8)^{-5}$ (c) $(4)^6$ (d) $(16)^3$
6. Write as a rational number with negative exponent:
   (a) $\left(\frac{1}{6}\right)^4$ (b) $(2)^5$ (c) $\left\{\left(\frac{6}{7}\right)^3\right\}^{-2}$
7. Simplify: (a) $\{(3)^3 - (2)^3\} \times \left(\frac{2}{3}\right)^{-3}$ (b) $\left[\left\{\left(\frac{-1}{2}\right)^2\right\}^{-2}\right]^{-1}$
8. Find m if: (a) $(3)^{-7} \div (3)^{-10} = (3)^{2m-1}$ (b) $\left(\frac{-1}{4}\right)^{3m} \times \left(\frac{-1}{4}\right)^2 = \left(\frac{-1}{4}\right)^{m-6}$
9. Write in standard form:
   (a) 0.00000000156 (b) 0.009801 (c) $215.06 \times (10)^{-2}$
10. Write in usual form:
    (a) $8.03 \times (10)^{-7}$ (b) $1.426 \times (10)^5$ (c) $6 \times (10)^{-5}$

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THINKING SKILLS

1. Simplify:

(a) $(0.000125)^{\frac{-4}{3}}$ (b) $\left[\left\{\left(\left(\frac{4}{5}\right)^{-1}\right)^{-2}\right\}^{\frac{1}{5}}\right]^{-10}$ (c) $\left[\left\{\left(\left(\frac{2}{5}\right)^{-3} \div \left(\frac{15}{4}\right)^{3}\right)^{5}\right\}^{\frac{-1}{15}}\right]^{2}$

2. Evaluate:

(a) $\left(\frac{390625}{6561}\right)^{\frac{1}{8}}$ (b) $\left(\frac{117649}{1771561}\right)^{\frac{1}{6}}$ (c) $(32768)^{\frac{1}{15}}$ (d) $(279936)^{\frac{1}{7}}$

3. Find a number which when divided by $\{(3)^{-1} + (2)^{-1}\}^2$ gives the quotient as $\left\{(6)^{-1} + \left(\frac{3}{2}\right)^{-1}\right\}^{-1}$.

VALUES AND LIFE SKILLS

The distance between the sun and the earth is $1.496 \times (10)^{11}$ m and the distance between the earth and the moon is $3.84 \times (10)^{8}$ m. During a solar eclipse, the moon comes in between the earth and the sun. At that time, what is the distance between the moon and the sun? Is it safe to watch solar eclipse with naked eye?

SOME NCERT TEXTBOOK QUESTIONS

1. Simplify and express the result in power notation with positive exponent.

(i) $(-4)^5 \div (-4)^8$ (ii) $\left(\frac{1}{2^3}\right)^2$ (iii) $(-3)^4 \times \left(\frac{5}{3}\right)^4$

(iv) $(3^{-7} \div 3^{-10}) \times 3^{-5}$ (v) $2^{-3} \times (-7)^{-3}$

2. Find the value of

(i) $(3^0 + 4^{-1}) \times 2^2$ (ii) $(2^{-1} \times 4^{-1}) \div 2^{-2}$ (iii) $\left(\frac{1}{2}\right)^{-2} + \left(\frac{1}{3}\right)^{-2} + \left(\frac{1}{4}\right)^{-2}$

3. Simplify

(i) $\frac{25 \times t^{-4}}{5^{-3} \times 10 \times t^{-8}} (t \neq 0)$ (ii) $\frac{3^{-5} \times 10^{-5} \times 125}{5^{-7} \times 6^{-5}}$

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

(i) 1 micron is equal to $\frac{1}{1000000} m$.

(ii) Charge of an electron is 0.000, 000, 000, 000, 000, 000, 16 coulomb.

(iii) Size of a bacteria is 0.0000005 m

(iv) Size of a plant cell is 0.00001275 m

(v) Thickness of a thick paper is 0.07 mm

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EXEMPLAR PROBLEMS

1. The standard form of $\left(\frac{1}{100000000}\right)$ is _____.

2. The expression for 3^5 with a negative exponent is _____.

3. The exponential form for $(-2)^4 \times \left(\frac{5}{2}\right)^4$ is 5^4. (True/False)

4. By what number should $\left(\frac{-3}{2}\right)^{-3}$ be divided so that the quotient is $\left(\frac{4}{27}\right)^{-2}$?

5. Planet A is at a distance of 9.35×10^6 km from earth and planet B is 6.27×10^7 km from earth. Which planet is nearer to earth?

6. The cells of a bacteria double itself every hour. How many cells will be there after 8 hours, if initially we start with 1 cell? Express the answer in powers.

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