Notes
Chapter – 12
Exponents and Powers

- **Numbers with exponents obey the following laws of exponents.**
  (a) $a^m \times a^n = a^{m+n}$
  (b) $a^m \div a^n = a^{m-n}$
  (c) $\left(a^m\right)^n = a^{mn}$
  (d) $a^m \times b^m = (ab)^m$
  (e) $a^0 = 1$
  (f) $\frac{a^m}{b^m} = \left(\frac{a}{b}\right)^m$
- Very small numbers can be expressed in standard form using negative exponents.
- Use of Exponents to Express Small Number in Standard form:
  (i) Very large and very small numbers can be expressed in standard form.
  (ii) Standard form is also called scientific notation form.
  (iii) A number written as $m \times 10^n$ is said to be in standard form if m is a decimal number such that $1 \le m < 10$ and n is either a positive or a negative integer.
- Examples: 150,000,000,000 = 1.5 x 10^{11}.
- Exponential notation is a powerful way to express repeated multiplication of the same number. For any non-zero rational number 'a' and a natural number n, the product a x a x a x ..... x a(n times) = a^n.
  It is known as the nth power of 'a' and is read as '**a' raised to the power n'**. The rational number a is called the base and n is called exponent.

CLASS-8 **SUB-MATHS**

CHAPTER - 12

Exponents and Powers

Ex. 12.1

1. Evaluate:

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

Ans. (i) $3^{-2} = \frac{1}{3^2}$

$\left[\because \ a^{-m} = \frac{1}{a^m}\right]$

$= \frac{1}{9}$

(ii) $(-4)^{-2} = \frac{1}{(-4)^2}$

$\left[\because \ a^{-m} = \frac{1}{a^m}\right]$

$= \frac{1}{16}$

(iii) $\left(\frac{1}{2}\right)^{-5} = \left(\frac{2}{1}\right)^{5}$

$\left[\because \ \left(\frac{a}{b}\right)^{m} = \frac{1}{a^m}\right]$

$= \quad = 32$

2. 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) $\left(3^{-7} \div 3^{-10}\right) \times 3^{-5}$

(v) $2^{-3} \times (-7)^{-3}$

Ans. (i) $(-4)^5 \div (-4)^8 = (-4)^{5-8} \quad \left[\because \ a^m \div a^n = a^{m-n}\right]$

$= (-4)^{-3} = \frac{1}{(-4)^3} \quad \left[\because \ a^{-m} = \frac{1}{a^m}\right]$

(ii) $\left(\frac{1}{2^3}\right)^2 = \frac{1^2}{\left(2^3\right)^2}$

$\left[\because \ \left(\frac{a}{b}\right)^m = \frac{a^m}{a^n}\right]$

$= \quad \left[\because \ \left(a^m\right)^n = a^{m \times n}\right]$

(iii) $(-3)^4 \times \left(\frac{5}{3}\right)^4 = (-3)^4 \times \frac{5^4}{3^4} \quad \left[\because \ \left(\frac{a}{b}\right)^m = \frac{a^m}{a^n}\right]$

$= (-1)^4 \times 3^4 \times \frac{5^4}{3^4}$

$\left[\because \ (ab)^m = a^m b^m\right]$

$= 3^{4-4} \times 5^4 \quad \left[\because \quad a^m \div a^n = a^{m-n}\right]$

$= 3^0 \times 5^4 = 5^4 \left[\because \quad a^0 = 1\right]$

(iv) $\left(3^{-7} \div 3^{-10}\right) \times 3^{-5} = 3^{-7-(-10)} \times 3^{-5} \quad \left[\because \quad a^m \div a^n = a^{m-n}\right]$

$= 3^{-7+10} \times 3^{-5} = 3^3 \times 3^{-5} = 3^{3+(-5)} \quad \left[\because \quad a^m \times a^n = a^{m+n}\right]$

$= 3^{-2} = \frac{1}{3^2} \quad \left[\because \quad a^{-m} = \frac{1}{a^m}\right]$

(v) $2^{-3} \times (-7)^{-3} = \frac{1}{2^3} \times \frac{1}{(-7)^3} \quad \left[\because \quad a^{-m} = \frac{1}{a^m}\right]$

$= \frac{1}{\{2 \times (-7)\}^3} = \frac{1}{(-14)^3} \quad \left[\because \quad (ab)^m = a^m b^m\right]$

3. Find the value of:

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

(ii) $\left(2^{-1} \times 4^{-1}\right) \div 2^{-2}$

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

(iv) $\left(3^{-1} + 4^{-1} + 5^{-1}\right)^0$

(v) $\left\{\left(\frac{-2}{3}\right)^{-2}\right\}^2$

Ans.

$$\left(1 + \frac{1}{4}\right) \times 2^2 \quad \left[\because \quad a^{-m} = \frac{1}{a^m}\right]$$

(i) $\left(3^0+4^{-1}\right)\times 2^2 =$

$= \left(\frac{4+1}{4}\right)\times 2^2 = \frac{5}{4}\times 2^2 = \frac{5}{2^2}\times 2^2 = 5\times 2^{2-2} \quad \left[\because\ a^m \div a^n = a^{m-n}\right]$

$= 5\times 2^0 = 5\times 1 = 5 \quad \left[\because\ a^0 = 1\right]$

(ii) $\left(2^{-1}\times 4^{-1}\right)\div 2^{-2} = \left(\frac{1}{2^1}\times\frac{1}{4^1}\right)\div 2^{-2} \left[\because\ a^{-m} = \frac{1}{a^m}\right]$

$= \left(\frac{1}{2}\times\frac{1}{2^2}\right)\div 2^{-2} = \frac{1}{2^3}\div 2^{-2} \quad \left[\because\ a^m\times a^n = a^{m+n}\right]$

$= 2^{-3}\div 2^{-2} = 2^{-3-(-2)} = 2^{-3+2} = 2^{-1} \left[\because\ a^m \div a^n = a^{m-n}\right]$

$= \frac{1}{2} \left[\because\ a^{-m} = \frac{1}{a^m}\right]$

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

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

$\left[\because\ a^{-m} = \frac{1}{a^m}\right]$

$= 2^{-1\times(-2)}+3^{-1\times(-2)}+4^{-1\times(-2)} \quad \left[\because\ \left(a^m\right)^n = a^{m\times n}\right]$

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

(iv) $\left(3^{-1}+4^{-1}+5^{-1}\right)^0 = \left(\frac{1}{3}+\frac{1}{4}+\frac{1}{5}\right)^0 \quad \left[\because\ a^{-m} = \frac{1}{a^m}\right]$

$\left(\frac{20+15+12}{60}\right)^0 = \left(\frac{47}{60}\right)^0 = 1$

=

$\left[\because \ a^0 = 1\right]$

(v) $\left\{\left(\frac{-2}{3}\right)^{-2}\right\}^2 = \left(\frac{-2}{3}\right)^{-2\times 2} \quad \left[\because \ \left(a^m\right)^n = a^{m\times n}\right]$

$= \left(\frac{-2}{3}\right)^{-4} = \left(\frac{-3}{2}\right)^4 \quad \left[\because \ a^{-m} = \frac{1}{a^m}\right]$

$= \frac{81}{16}$

4. Evaluate:

(i) $\frac{8^{-1}\times 5^3}{2^{-4}}$ **(ii)** $\left(5^{-1}\times 2^{-1}\right)\times 6^{-1}$

Ans. (i) $\frac{8^{-1}\times 5^3}{2^{-4}} = \frac{\left(2^3\right)^{-1}\times 5^3}{2^{-4}} = \frac{2^{-3}\times 5^3}{2^{-4}} \quad \left[\because \ \left(a^m\right)^n = a^{m\times n}\right]$

$= 2^{-3-(-4)}\times 5^3 = 2^{-3+4}\times 5^3 \quad \left[\because \ a^m \div a^n = a^{m-n}\right]$

$= 2\times 125 = 250$

(ii) $\left(5^{-1}\times 2^{-1}\right)\times 6^{-1} = \left(\frac{1}{5}\times\frac{1}{2}\right)\times\frac{1}{6} \quad \left[\because \ a^{-m} = \frac{1}{a^m}\right]$

$= \frac{1}{10}\times\frac{1}{6} = \frac{1}{60}$

5. Find the value of m for which $5^m \div 5^{-3} = 5^5$. Ans.

$5^m \div 5^{-3} = 5^5$

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

$\left[\because \quad a^m \div a^n = a^{m-n}\right]$

$\Rightarrow \quad 5^{m+3} = 5^5$

Comparing exponents both sides, we get

$\Rightarrow \quad m+3=5$

$\rightarrow \quad m=5-3$

$\Rightarrow \quad m=2$

1. Evaluate:

(i) $\left\{\left(\frac{1}{3}\right)^{-1} - \left(\frac{1}{4}\right)^{-1}\right\}^{-1}$ **(ii)** $\left(\frac{5}{8}\right)^{-7} \times \left(\frac{8}{5}\right)^{-4}$

Ans.

(i) $\left\{\left(\frac{1}{3}\right)^{-1} - \left(\frac{1}{4}\right)^{-1}\right\} = \left\{\left(\frac{3}{1}\right)^{1} - \left(\frac{4}{1}\right)^{1}\right\} \quad \left[\because \quad a^{-m} = \frac{1}{a^m}\right]$

$= \{3-4\} = -1$

(ii) $\left(\frac{5}{8}\right)^{-7} \times \left(\frac{8}{5}\right)^{-4} = \frac{5^{-7}}{8^{-7}} \times \frac{8^{-4}}{5^{-4}} \quad \left[\because \quad \left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}\right]$

$= 5^{-7-(-4)} \times 8^{-4-(-7)} \quad \left[\because \quad a^m \div a^n = a^{m-n}\right]$

$= 5^{-7+4} \times 8^{-4+7} = 5^{-3} \times 8^3 = \frac{8^3}{5^3} \quad \left[\because \quad a^{-m} = \frac{1}{a^m}\right]$

$= \frac{512}{125}$

6. Simplify:

(i) $\dfrac{25\times t^{-4}}{5^{-3}\times 10\times t^{-8}} \quad (t\neq 0)$

(ii) $\dfrac{3^{-5}\times 10^{-5}\times 125}{5^{-7}\times 6^{-5}}$

Ans. (i) $\dfrac{25\times t^{-4}}{5^{-3}\times 10\times t^{-8}}$

$$=\frac{5^2\times t^{-4}}{5^{-3}\times 5\times 2\times t^{-8}}$$

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

$=$ $=$

$\left[\because a^m\div a^n=a^{m-n}\right]$ $\dfrac{5^4\times t^4}{2}$ $\dfrac{625}{2}t^4$

(ii) $\dfrac{3^{-5}\times 10^{-5}\times 125}{5^{-7}\times 6^{-5}}$

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

$$=\frac{3^{-5}\times 2^{-5}\times 5^{-5}\times 5^3}{5^{-7}\times 2^{-5}\times 3^{-5}}$$

$=$

$\dfrac{3^{-5}\times 2^{-5}\times 5^{-5+3}}{5^{-7}\times 2^{-5}\times 3^{-5}}$ $\left[\because (ab)^m=a^m b^m\right]$ $\dfrac{3^{-5}\times 2^{-5}\times 5^{-2}}{5^{-7}\times 2^{-5}\times 3^{-5}}$ $\left[\because a^m\times a^n=a^{m+n}\right]$

$= 3^{-5-(-5)} \times 2^{-5-(-5)} \times 5^{-2-(-7)} \quad \left[\because \ a^m \div a^n = a^{m-n}\right]$

$= 3^{-5+5} \times 2^{-5+5} \times 5^{-2+7} \quad = 3^0 \times 2^0 \times 5^5$

$= 1 \times 1 \times 3125 \left[\because \ a^0 = 1\right]$

$= 3125$

Exponents and Powers

Ex. 12.2

1. Express the following numbers in standard form:

(i) 0.0000000000085

(ii) 0.00000000000942

(iii) 6020000000000000

(iv) 0.00000000837

(v) 31860000000

Ans. (i) 0.0000000000085

$= 0.0000000000085 \quad \times \frac{10^{12}}{10^{12}} = 8.5 \times 10^{-12}$

(ii) 0.00000000000942

=0.00000000000942 $\times \frac{10^{12}}{10^{12}} = 9.42 \times 10^{-12}$

(iii) 6020000000000000

=6020000000000000 $\times \frac{10^{15}}{10^{15}} = 6.02 \times 10^{15}$

(iv) 0.00000000837

=0.00000000837 $\times \frac{10^{9}}{10^{9}} = 8.37 \times 10^{-9}$

(v) 31860000000

=31860000000 $\times \frac{10^{10}}{10^{10}} = 3.186 \times 10^{10}$

2. Express the following numbers in usual form:

(i) 3.02×10^{-6}

(ii) 4.5×10^{4}

(iii) 3×10^{-8}

(iv) 1.0001×10^{9}

(v) 5.8×10^{12}

(vi) 3.61492×10^{6}

Ans. (i) 3.02 X1/10^5 = 302/100 X 1 / 100000 = 302/10000000 = 0.0000302.

(ii) $4.5 \times 10^{4} =$ **4.5 ×10000 = 45000**

(iii) $3 \times 10^{-8} = \frac{3}{10^{8}}$ **= 0.00000003**

(iv) 1.0001×10^{9} **= 1000100000**

(v) 5.8×10^{12} **= 5.8 x 1000000000000**

= 5800000000000

(vi) 3.61492×10^{6} **= 3.61492 X 1000000**

= 3614920

3. 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 if a thick paper is 0.07 mm.

Ans. (i) 1micron

= $\frac{1}{1000000}=\frac{1}{10^{6}}=1\times10^{-6}$ **m**

(ii) Charge of an electron is 0.0000000000000000016 coulombs.

$=0.0000000000000000016\times\frac{10^{19}}{10^{19}}$

= 1.6×10^{-19} **coulomb**

(iii) Size of bacteria = 0.0000005

$\frac{5}{10000000}=\frac{5}{10^{7}}=\quad\times10^{-7}$ m

(iv) Size of a plant cell is 0.00001275 m

= 0.00001275 $\times\frac{10^{5}}{10^{5}}$ = 1.275×10^{-5} **m**

(v) Thickness of a thick paper = 0.07 mm

$\frac{7}{100}\qquad\frac{7}{10^{2}}=7\times10^{-2}$

= mm = mm

4. In a stack there are 5 books each of thickness 20 mm and 5 paper sheets each of thickness 0.016 mm. What is the total thickness of the stack?

Ans. Thickness of one book = 20 mm Thickness

of 5 books = 20 × 5 = 100 mm Thickness of one

paper = 0.016 mm Thickness of 5 papers = 0.016

× 5

= 0.08 mm

Total thickness of a stack = 100 + 0.08

=100.08 mm

= 100.08 $\times \frac{10^2}{10^2}$

$= 1.0008 \times 10^2$ **mm**

----------THE END ----------