CHAPTER 11

VII-MATHEMATICS-NCERT-2024-25

11. Exponents and Powers (Notes)

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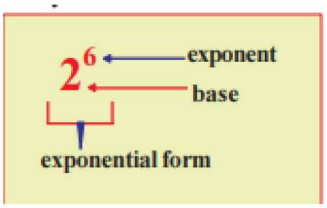
1. These very large numbers are difficult to read, understand and compare. To make these numbers easy to read, understand and compare, we use exponents.
2. $10,000 = 10 \times 10 \times 10 \times 10 = 10^4$ read as 10 raised to the power of 4
3. $100 = 10 \times 10 = 10^2$ read as '10 squared'
4. $1000 = 10 \times 10 \times 10 = 10^3$ read as '10 cubed'
5. $a \times a = a^2$ (read as 'a squared')
6. $a \times a \times a = a^3$ (*read as 'a cubed'*)
7. $a \times a \times a \times a = a^4$ (*read as a raised to the power* 4)



$2^2 = 4$	$2^{10} = 1024$	$4^4 = 256$	$7^2 = 49$
$2^3 = 8$	$3^2 = 9$	$4^5 = 1024$	$7^3 = 343$
$2^4 = 16$	$3^3 = 27$	$5^2 = 25$	$8^2 = 64$
$2^5 = 32$	$3^4 = 81$	$5^3 = 125$	$8^3 = 512$
$2^6 = 64$	$3^5 = 243$	$5^4 = 625$	$9^2 = 81$
$2^7 = 128$	$3^6 = 729$	$6^2 = 36$	$9^3 = 729$
$2^8 = 256$	$4^2 = 16$	$6^3 = 216$	$10^2 = 100$
$2^9 = 512$	$4^3 = 64$	$6^4 = 1296$	$10^3 = 1000$

TRY THESE

(i) Express 729 as a power of 3

Sol: $729 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^6$

(ii) Express 128 as a power of 2

Sol: $128 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^7$

(iii) Express 343 as a power of 7

Sol: $343 = 7 \times 7 \times 7 = 7^3$

Example 1: Express 256 as a power 2.

Sol: $256 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^8$

Example 2: Which one is greater 2^3 or 3^2 ?

Sol: $2^3 = 2 \times 2 \times 2 = 8$ and $3^2 = 3 \times 3 = 9$.

Since $9 > 8$

So, 3^2 is greater than 2^3

Example3 : Which one is greater 8^2 *or* 2^8?

Sol: $8^2 = 8 \times 8 = 64$

$2^8 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 256$

$\therefore\ 2^8 > 8^2$

Example 4: **Expand $a^3b^2, a^2b^3, b^2a^3, b^3a^2$. *Are they all same?***

Sol: $a^3b^2 = a^3 \times b^2 = a \times a \times a \times b \times b$

$a^2b^3 = a^2 \times b^3 = a \times a \times b \times b \times b$

$b^2a^3 = b^2 \times a^3 = b \times b \times a \times a \times a$

$b^3a^2 = b^3 \times a^2 = b \times b \times b \times a \times a$

$a^3b^2 = b^2a^3$ *and* $a^2b^3 = b^3a^2$

Example 5: **Express the following numbers as a product of powers of prime factors:**

(i) $\mathbf{72} = 2 \times 2 \times 2 \times 3 \times 3 = 2^3 \times 3^2$

(ii) $\mathbf{432} = 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 3 = 2^4 \times 3^3$

(iii) $\mathbf{1000} = 2 \times 2 \times 2 \times 5 \times 5 \times 5 = 2^3 \times 5^3$

(iv) $\mathbf{16,000} = 16 \times 1000 = 16 \times 10 \times 10 \times 10$

$= 2 \times 2 \times 2 \times 2 \times 2 \times 5 \times 2 \times 5 \times 2 \times 5 = 2^7 \times 5^3$

Example 6: ***Work out*** $(1)^5, (-1)^3, (-1)^4, (-10)^3, (-5)^4$.

Sol: $(1)^5 = 1 \times 1 \times 1 \times 1 \times 1 = 1$

$(-1)^3 = \underline{(-1) \times (-1)} \times (-1) = 1 \times (-1) = -1$

$(-1)^4 = \underline{(-1) \times (-1)} \times \underline{(-1) \times (-1)} = 1 \times 1 = 1$

$(-10)^3 = \underline{(-10) \times (-10)} \times (-10) = 100 \times (-10) = -1000$

$(-5)^4 = \underline{(-5) \times (-5)} \times \underline{(-5) \times (-5)} = 25 \times 25 = 625$

(i) $1^{any\ number} = 1$

(ii) $(-1)^{\text{even number}} = 1$

(iii) $(-1)^{\text{odd number}} = -1$

EXERCISE 11.1

1. Find the value of:

(i) $\mathbf{2^6} = \underline{2 \times 2 \times 2} \times \underline{2 \times 2 \times 2} = 8 \times 8 = 64$

(ii) $\mathbf{9^3} = \underline{9 \times 9} \times 9 = 81 \times 9 = 729$

(iii) $\mathbf{11^2} = 11 \times 11 = 121$

(iv) $\mathbf{5^4} = 5 \times 5 \times 5 \times 5 = 25 \times 25 = 625$

2. Express the following in exponential form:

(i) $\mathbf{6 \times 6 \times 6 \times 6} = 6^4$

(ii) $\mathbf{t \times t} = t^2$

(iii) $b \times b \times b \times b = b^4$

(iv) $5 \times 5 \times 7 \times 7 \times 7 = 5^2 \times 7^3$

(v) $2 \times 2 \times a \times a = 2^2 \times a^2$

(vi) $a \times a \times a \times c \times c \times c \times c \times d = a^3 \times c^4 \times d$

2	512
2	256
2	128
2	64
2	32
2	16
2	8
2	4
2	2
	1

7	343
7	49
7	7
	1

3	729
3	243
3	81
3	27
3	9
3	3
	1

5	3125
5	625
5	125
5	25
5	5
	1

3. Express each of the following numbers using exponential notation:

(i) $512 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 2^9$

(ii) $343 = 7 \times 7 \times 7 = 7^3$

(iii) $729 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^6$

(iv) $3125 = 5 \times 5 \times 5 \times 5 \times 5 = 5^5$

4. Identify the greater number, wherever possible, in each of the following?

(i) 4^3 *or* 3^4

Sol: $4^3 = 4 \times 4 \times 4 = 16 \times 4 = 64$

$3^4 = 3 \times 3 \times 3 \times 3 = 9 \times 9 = 81$

$\therefore 3^4$ *is greater than* 4^3 $(3^4 > 4^3)$

(ii) 5^3 *or* 3^5

Sol: $5^3 = 5 \times 5 \times 5 = 25 \times 5 = 125$

$3^5 = 3 \times 3 \times 3 \times 3 \times 3 = 9 \times 9 \times 3 = 81 \times 3 = 243$

$\therefore 3^5$ *is greater than* 5^3 $(3^5 > 5^3)$

(iii) 2^8 *or* 8^2

Sol: $2^8 = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 16 \times 16 = 256$

$8^2 = 8 \times 8 = 64$

$\therefore 2^8$ *is greater than* 8^2 $(2^8 > 8^2)$

(iv) 100^2 *or* 2^{100}

Sol: $100^2 = 100 \times 100 = 10{,}000$

$2^{100} = 2 \times 2 \times 2 \times 2 \ldots . \times 2(100\ times)$

$= 2 \times 2 \times 2 \times 2 \ldots . \times 2(14\ times) \times 2 \times 2 \times 2 \times 2 \ldots . \times 2(86\ times)$

$= 16384 \times 2 \times 2 \times 2 \times 2 \ldots . \times 2(86\ times)$

$\therefore 2^{100}$ *is greater than* 100^2

(v) 2^{10} or 10^2

Sol: $2^{10} = 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 32 \times 32 = 1024$

$10^2 = 10 \times 10 = 100$

$\therefore 2^{10}$ *is greater than* 10^2

5. Express each of the following as product of powers of their prime factors:

2	648
2	324
2	162
3	81
3	27
3	9
3	3
	1

3	405
3	135
3	45
3	15
5	5
	1

2	540
2	270
3	135
3	45
3	15
5	5
	1

2	3600
2	1800
2	900
2	450
3	225
3	75
5	25
5	5
	1

(i) $648 = 2 \times 2 \times 2 \times 3 \times 3 \times 3 \times 3 = 2^3 \times 3^4$

(ii) $405 = 3 \times 3 \times 3 \times 3 \times 5 = 3^4 \times 5$

(iii) $540 = 2 \times 2 \times 3 \times 3 \times 3 \times 5 = 2^2 \times 3^3 \times 5$

(iv) $3{,}600 = 36 \times 100 = 6 \times 6 \times 10 \times 10$

$= 2 \times 3 \times 2 \times 3 \times 2 \times 5 \times 2 \times 5$

$= 2 \times 2 \times 2 \times 2 \times 3 \times 3 \times 5 \times 5 = 2^4 \times 3^2 \times 5^2$

6. Simplify:

(i) $2 \times 10^3 = 2 \times 10 \times 10 \times 10 = 2 \times 1000 = 2000$

(ii) $7^2 \times 2^2 = 7 \times 7 \times 2 \times 2 = 49 \times 4 = 196$

(iii) $2^3 \times 5 = 2 \times 2 \times 2 \times 5 = 8 \times 5 = 40$

(iv) $3 \times 4^4 = 3 \times 4 \times 4 \times 4 \times 4 = 3 \times 256 = 768$

(v) $0 \times 10^2 = 0 \times 100 = 0$

(vi) $5^2 \times 3^3 = 5 \times 5 \times 3 \times 3 \times 3 = 25 \times 27 = 675$

(vii) $2^4 \times 3^2 = 2 \times 2 \times 2 \times 2 \times 3 \times 3 = 16 \times 9 = 144$

$(viii)$ $3^2 \times 10^4 = 9 \times 10000 = 90000$

7. Simplify:

(i) $(-4)^3 = \underline{(-4) \times (-4)} \times (-4) = 16 \times (-4) = -64$

(ii) $(-3) \times (-2)^3 = (-3) \times \underline{(-2) \times (-2) \times (-2)} = (-3) \times (-8) = 24$

(iii) $(-3)^2 \times (-5)^2 = \underline{(-3) \times (-3)} \times \underline{(-5) \times (-5)} = 9 \times 25 = 225$

(iv) $(-2)^3 \times (-10)^3 = (-8) \times (-1000) = 8000$

8. Compare the following numbers:

(i) 2.7×10^{12} ; 1.5×10^8

Sol: $2.7 \times 10^{12} = 2.7 \times 10^4 \times 10^8 = 2.7 \times 10000 \times 10^8 = 27000 \times 10^8$

$27000 \times 10^8 > 1.5 \times 10^8$

$\therefore 2.7 \times 10^{12} > 1.5 \times 10^8$

(ii) 4×10^{14} ; 3×10^{17}

Sol: $3 \times 10^{17} = 3 \times 10^3 \times 10^{14} = 3000 \times 10^{14}$

$3000 \times 10^{14} > 4 \times 10^{14}$

$\therefore 3 \times 10^{17} > 4 \times 10^{14}$

LAWS OF EXPONENTS

Multiplying Powers with the Same Base

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

$(ii) (-3)^4 \times (-3)^3 = (-3) \times (-3) \times (-3) \times (-3) \times (-3) \times (-3) \times (-3) = (-3)^7 = (-3)^{4+3}$

For any non-zero integer$a$, where m *and* n are whole numbers

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

TRY THESE

Simplify and write in exponential form

(i) $2^5 \times 2^3 = 2^{5+3} = 2^8$

(ii) $p^3 \times p^2 = p^{3+2} = p^5$

(iii) $4^3 \times 4^2 = 4^{3+2} = 4^5$

(iv) $a^3 \times a^2 \times a^7 = a^{3+2+7} = a^{12}$

(iv) $5^3 \times 5^7 \times 5^{12} = 5^{3+7+12} = 5^{22}$

(v) $(-4)^{100} \times (-4)^{20} = (-4)^{100+20} = (-4)^{120}$

Dividing Powers with the Same Base

$(i) 3^7 \div 3^4 = \frac{3^7}{3^4} = \frac{3 \times 3 \times 3 \times \cancel{3 \times 3 \times 3 \times 3}}{\cancel{3 \times 3 \times 3 \times 3}} = 3^3 = 3^{7-4}$

$(ii) 5^6 \div 5^2 = \frac{5^6}{5^2} = \frac{5 \times 5 \times 5 \times 5 \times \cancel{5 \times 5}}{\cancel{5 \times 5}} = 5^4 = 5^{6-2}$

For any non-zero integer a, where m and n are whole numbers

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

TRY THESE

Simplify and write in exponential form:

(i) $2^9 \div 2^3 = 2^{9-3} = 2^6$

(ii) $10^8 \div 10^4 = 10^{8-4} = 10^4$

(iii) $9^{11} \div 9^7 = 9^{11-7} = 9^4$

(iv) $20^{15} \div 20^{13} = 20^{15-13} = 20^2$

(v) $7^{13} \div 7^{10} = 7^{13-10} = 7^3$

Taking Power of a Power

(i) $(2^3)^2 = 2^3 \times 2^3 = 2^{3+3} = 2^6 = 2^{3\times2}$

(ii) $(3^2)^4 = 3^2 \times 3^2 \times 3^2 \times 3^2 = 3^{2+2+2+2} = 3^8 = 3^{2\times4}$

For any non-zero integer 'a', where 'm' and 'n' are whole numbers

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

TRY THESE

Simplify and write the answer in exponential form:

(i) $(6^2)^4 = 6^{2\times4} = 6^8$

(i) $(2^2)^{100} = 2^{2\times100} = 2^{200}$

(i) $(7^{50})^2 = 7^{50\times2} = 7^{100}$

(i) $(5^3)^7 = 5^{3\times7} = 5^{21}$

Example 7: Can you tell which one is greater $(5^2) \times 3$ *or* $(5^2)^3$?

Sol: $(5^2) \times 3 = 5 \times 5 \times 3 = 25 \times 3 = 75$

$(5^2)^3 = 5^{2\times3} = 5^6 = 5 \times 5 \times 5 \times 5 \times 5 \times 5 = 25 \times 25 \times 25 = 625 \times 25 = 15625$

$\therefore (5^2)^3 > (5^2) \times 3$

Multiplying Powers with the Same Exponents

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

$= (2 \times 3)^3 = 6^3$

(ii) $a^4 \times b^4 = (a \times a \times a \times a) \times (b \times b \times b \times b)$

$= (a \times b) \times (a \times b) \times (a \times b) \times (a \times b)$

$= (a \times b)^4 = (ab)^4$

For any non-zero integer 'a', where 'm' is any whole number

$$a^m \times b^m = (a \times b)^m$$

TRY THESE

Put into another form using $a^m \times b^m = (ab)^m$

(i) $4^3 \times 2^3 = (4 \times 2)^3 = 8^3$

(ii) $2^5 \times b^5 = (2 \times b)^5 = (2b)^5$

(iii) $a^2 \times t^2 = (a \times t)^2 = (at)^2$

(iv) $5^6 \times (-2)^6 = (5 \times -2)^6 = (-10)^6$

(v) $(-2)^4 \times (-3)^4 = (-2 \times -3)^4 = 6^4$

Example 8: Express the following terms in the exponential form:

$(i)(2 \times 3)^5 = 2^5 \times 3^5$

$(ii)(2a)^4 = (2 \times a)^4 = 2^4 \times a^4$

$(iii)(-4m)^3 = (-4 \times m)^3 = (-4)^3 \times m^3$

Dividing Powers with the Same Exponents

$(i)\frac{2^4}{3^4} = \frac{2 \times 2 \times 2 \times 2}{3 \times 3 \times 3 \times 3} = \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} = \left(\frac{2}{3}\right)^4$

$(ii)\frac{a^3}{b^3} = \frac{a \times a \times a}{b \times b \times b} = \frac{a}{b} \times \frac{a}{b} \times \frac{a}{b} = \left(\frac{a}{b}\right)^3$

For any non-zero integers 'a'and 'b' where 'm' is any whole number

$$a^m \div b^m = \frac{a^m}{b^m} = \left(\frac{a}{b}\right)^m$$

TRY THESE

Put into another form using $a^m \div b^m = \left(\frac{a}{b}\right)^m$

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

(ii) $2^5 \div b^5 = \left(\frac{2}{b}\right)^5$

(iii) $(-2)^3 \div b^3 = \left(\frac{-2}{b}\right)^3$

(iv) $p^4 \div q^4 = \left(\frac{p}{q}\right)^4$

(v) $5^6 \div (-2)^6 = \left(\frac{5}{-2}\right)^6$

***Example 9*: *Expand*:**

(i) $\left(\frac{3}{5}\right)^4 = \frac{3^4}{5^4} = \frac{3 \times 3 \times 3 \times 3}{5 \times 5 \times 5 \times 5}$

$(ii)\left(\frac{-4}{7}\right)^5 = \frac{(-4)^5}{7^5} = \frac{(-4) \times (-4) \times (-4) \times (-4) \times (-4)}{7 \times 7 \times 7 \times 7 \times 7}$

Numbers with exponent zero

$\frac{3^5}{3^5} = \frac{\cancel{3 \times 3 \times 3 \times 3 \times 3}}{\cancel{3 \times 3 \times 3 \times 3 \times 3}}$

$3^{5-5} = 1$

$3^0 = 1$

For any non − zero integer a, $a^0 = 1$

Example 10: Write exponential form for 8 × 8 × 8 × 8 taking base as 2.

Sol: $8 \times 8 \times 8 \times 8 = 8^4$

$= (2^3)^4 = 2^{3\times4} = 2^{12}$

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

Example 11:Simplify and write the answer in the exponential form.

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

$= 3^5 \times 3^5 = 3^{5+5} = 3^{10}$

$\frac{a^m}{a^n} = a^{m-n}$; $a^m \times a^n = a^{m+n}$

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

$= 2^5 \times 5^5 = (2 \times 5)^5 = 10^5$

$a^m \times b^m = (a \times b)^m$

(iii) $(6^2 \times 6^4) \div 6^3 = 6^{2+4} \div 6^3$

$= 6^6 \div 6^3$

$= 6^{6-3} = 6^3$

(iv) $\left[(2^2)^3 \times 3^6\right] \times 5^6 = [2^{2\times3} \times 3^6] \times 5^6$

$= [2^6 \times 3^6] \times 5^6$

$= (2 \times 3)^6 \times 5^6$

$= 6^6 \times 5^6$

$= (6 \times 5)^6 = 30^6$

(v) $8 = 2 \times 2 \times 2 = 2^3$

$8^3 \div 2^3 = (2^3)^3 \div 2^3$

$= 2^9 \div 2^3 = 2^{9-3} = 2^6$

Example 12:Simplify:

(i) $\frac{12^4 \times 9^3 \times 4}{6^3 \times 8^2 \times 27} = \frac{(2^2 \times 3)^4 \times (3^2)^3 \times 2^2}{(2 \times 3)^3 \times (2^3)^2 \times 3^3}$

$= \frac{(2^2)^4 \times 3^4 \times 3^{2\times3} \times 2^2}{2^3 \times 3^3 \times 2^{3\times2} \times 3^3}$

$= \frac{2^8 \times 3^4 \times 3^6 \times 2^2}{2^3 \times 3^3 \times 2^6 \times 3^3}$

$= \frac{2^{8+2} \times 3^{4+6}}{2^{3+6} \times 3^{3+3}} = \frac{2^{10} \times 3^{10}}{2^9 \times 3^6}$

$= 2^{10-9} \times 3^{10-6} = 2^1 \times 3^4$

$= 2 \times 81 = 162$

(ii) $2^3 \times a^3 \times 5a^4 = 2^3 \times 5 \times a^3 \times a^4 = 8 \times 5 \times a^{3+4} = 40a^7$

$(iii)\ \dfrac{2\times 3^4\times 2^5}{9\times 4^2}=\dfrac{2\times 3^4\times 2^5}{3^2\times (2^2)^2}$

$=\dfrac{2^{1+5}\times 3^4}{3^2\times 2^4}=\dfrac{2^6\times 3^4}{2^4\times 3^2}$

$=2^{6-4}\times 3^{4-2}=2^2\times 3^2=4\times 9=36$

EXERCISE 11.2

1. **Using laws of exponents, simplify and write the answer in exponential form:**

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

2) $a^m\div b^m=\dfrac{a^m}{a^n}=a^{m-n}$

3) $(a^m)^n=a^{mn}$

4) $a^m\times b^m=(a\times b)^m$

5) $\dfrac{a^m}{b^m}=\left(\dfrac{a}{b}\right)^m$

6) $a^0=1\ (a\neq 0)$

7) $1^{any\ number}=1$

8) $(-1)^{\text{even number}}=1,$ $(-1)^{\text{odd number}}=-1$

$(i)\ 3^2\times 3^4\times 3^8=3^{2+4+8}=3^{14}$

$(ii)\ 6^{15}\div 6^{10}=6^{15-10}=6^5$

$(iii)\ a^3\times a^2=a^{3+2}=a^5$

$(iv)\ 7^x\times 7^2=7^{x+2}$

$(v)\ (5^2)^3\div 5^3=5^{2\times 3}\div 5^3=5^6\div 5^3=5^{6-3}=5^3$

$(vi)\ 2^5\times 5^5=(2\times 5)^5=10^5$

$(vii)\ a^4\times b^4=(a\times b)^4=(ab)^4$

$(viii)\ (3^4)^3=3^{4\times 3}=3^{12}$

$(ix)\ \left(2^{20}\div 2^{15}\right)\times 2^3=2^{20-15}\times 2^3=2^5\times 2^3=2^{5+3}=2^8$

$(x)\ 8^t\div 8^2=8^{t-2}$

2. **Simplify and express each of the following in exponential form:**

$(i)\ \dfrac{2^3\times 3^4\times 4}{3\times 32}=\dfrac{2^3\times 3^4\times 2^2}{3^1\times 2^5}=\dfrac{2^{3+2}\times 3^4}{3^1\times 2^5}$

$=\dfrac{2^5\times 3^4}{3^1\times 2^5}=3^{4-1}=3^3$

$(ii)\ [(5^2)^3\times 5^4]\div 5^7=[5^{2\times 3}\times 5^4]\div 5^7$

$=[5^6\times 5^4]\div 5^7=5^{6+4}\div 5^7$

$=5^{10}\div 5^7=5^{10-7}=5^3$

$(iii)\ 25^4 \div 5^3 = (5^2)^4 \div 5^3 = 5^{2\times4} \div 5^3$

$= 5^8 \div 5^3 = 5^{8-3} = 5^5$

$(iv)\ \dfrac{3\times7^2\times11^8}{21\times11^3} = \dfrac{3^1\times7^2\times11^8}{3^1\times7^1\times11^3}$

$= 7^{2-1}\times11^{8-3}$

$= 7^1\times11^5 = 7\times11^5$

$(v)\ \dfrac{3^7}{3^4\times3^3} = \dfrac{3^7}{3^{4+3}} = \dfrac{3^7}{3^7} = 1$

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

$(vii)\ 2^0\times3^0\times4^0 = 1\times1\times1 = 1$

$(viii)\ (3^0+2^0)\times5^0 = (1+1)\times1 = 2\times1 = 2$

$(ix)\ \dfrac{2^8\times a^5}{4^3\times a^3} = \dfrac{2^8\times a^5}{(2^2)^3\times a^3} = \dfrac{2^8\times a^5}{2^6\times a^3}$

$= 2^{8-6}\times a^{5-3} = 2^2\times a^2$

$(x)\ \left(\dfrac{a^5}{a^3}\right)\times a^8 = a^{5-3}\times a^8$

$= a^2\times a^8 = a^{2+8} = a^{10}$

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

$(xii)\ (2^3\times2)^2 = (2^{3+1})^2 = (2^4)^2 = 2^{4\times2} = 2^8$

3. *Say true or false and justify your answer*:

$(i)\ 10\times10^{11} = 100^{11}$ → False

LHS $= 10^1\times10^{11} = 10^{1+11} = 10^{12}$

RHS $= 100^{11}$

LHS $\neq$ RHS

$(ii)\ 2^3 > 5^2$ → *False*

LHS $= 2^3 = 8$

RHS $= 5^2 = 25$

LHS $\not>$ RHS

$(iii)\ 2^3\times3^2 = 6^5$ → *False*

LHS $= 2^3 \times 3^2 = 8 \times 9 = 72$

RHS $= 6^5 = \underline{6 \times 6} \times \underline{6 \times 6} \times 6 = 36 \times 36 \times 6 = 1296 \times 6 = 7776$

LHS $\neq$ RHS

(iv) $\mathbf{3^0 = 1000^0}$ → True

$3^0 = 1$ *and* $1000^0 = 1$

4. Express each of the following as a product of prime factors only in exponential form:

$(i)\mathbf{108 \times 192} = 2^2 \times 3^3 \times 2^6 \times 3^1 = 2^{2+6} \times 3^{3+1} = 2^8 \times 3^4$

2	108
2	54
3	27
3	9
	3

2	192
2	96
2	48
2	24
2	12
2	6
	3

(ii) $\mathbf{270} = 27 \times 10 = 3 \times 3 \times 3 \times 2 \times 5 = 2 \times 3^3 \times 5$

3	729
3	243
3	81
3	27
3	9
	3

$(iii)\mathbf{729 \times 64} = 3^6 \times 2^6$

2	64
2	32
2	16
2	8
2	4
	2

5. Simplify:

(i) $\dfrac{\mathbf{(2^5)^2 \times 7^3}}{\mathbf{8^3 \times 7}} = \dfrac{(2^5)^2 \times 7^3}{(2^3)^3 \times 7}$

$= \dfrac{2^{5\times2} \times 7^3}{2^{3\times3} \times 7^1} = \dfrac{2^{10} \times 7^3}{2^9 \times 7^1}$

$= 2^{10-9} \times 7^{3-1}$

$= 2^1 \times 7^2$

$= 2 \times 49 = 98$

(ii) $\dfrac{\mathbf{25 \times 5^2 \times t^8}}{\mathbf{10^3 \times t^4}} = \dfrac{5^2 \times 5^2 \times t^8}{(2 \times 5)^3 \times t^4}$

$= \dfrac{5^{2+2} \times t^8}{2^3 \times 5^3 \times t^4}$

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

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

$= \dfrac{5^1 \times t^4}{2^3} = \dfrac{5t^4}{8}$

(iii) $\dfrac{\mathbf{3^5 \times 10^5 \times 25}}{\mathbf{5^7 \times 6^5}} = \dfrac{3^5 \times (2 \times 5)^5 \times 5^2}{5^7 \times (2 \times 3)^5}$

$= \dfrac{3^5 \times 2^5 \times 5^5 \times 5^2}{5^7 \times 2^5 \times 3^5}$

$$= \frac{3^5 \times 2^5 \times 5^7}{5^7 \times 2^5 \times 3^5} = 1$$

DECIMAL NUMBER SYSTEM

(i) **47561** = 4 × 10000 + 7 × 1000 + 5 × 100 + 6 × 10 + 1

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

(ii) **104278** = 1 × 100,000 + 0 × 10,000 + 4 × 1000 + 2 × 100 + 7 × 10 + 8 × 1

$= 1 \times 10^5 + 0 \times 10^4 + 4 \times 10^3 + 2 \times 10^2 + 7 \times 10^1 + 8 \times 10^0$

TRY THESE

Expand by expressing powers of 10 in the exponential form:

(i) **172**=1×100+7×10+2×1

$= 1 \times 10^2 + 7 \times 10^1 + 2 \times 10^0$

(ii) **5,643**=5×1000+6×100+4×10+3×1

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

(iii) **56,439**=5 × 10,000 + 6 × 1000 + 4 × 100 + 3 × 10 + 9 × 1

$= 5 \times 10^4 + 6 \times 10^3 + 4 \times 10^2 + 3 \times 10^1 + 9 \times 10^0$

(iv) **1,76,428**=1×1,00,000+7 × 100,000 + 6 × 10,000 + 4 × 1000 + 2 × 100 + 8 × 10 + 8 × 1

$= 1 \times 10^5 + 7 \times 10^4 + 6 \times 10^3 + 4 \times 10^2 + 2 \times 10^1 + 8 \times 10^0$

EXPRESSING LARGE NUMBERS IN THE STANDARD FORM

Any number can be expressed as a decimal number between 1.0 and 10.0 including 1.0 multiplied by a power of 10. Such a form of a number is called its standard form.

(i) $59 = 5.9 \times 10 = 5.9 \times 10^1$

(ii) $590 = 5.9 \times 100 = 5.9 \times 10^2$

(iii) $5985 = 5.985 \times 1000 = 5.985 \times 10^3$

(iv) The distance between Sun and Saturn is 1,433,500,000,000 m=1.4335×10^{12} m

(v) The distance between Saturn and Uranus is 1,439,000,000,000 m=1.439×10^{12} m

(vi) distance between Sun and Earth is 149, 600,000,000 m = 1.496×10^{11}m

EXAMPLE 13:Express the following numbers in the standard form:

(i) **5985.3** = 5.9853 × 1000 = 5.9853 × 10^3

(ii) **65,950** = 6.595 × 10,000 = 6.595 × 10^4

(iii) **3,430,000** = 3.43 × 1,000,000 = 3.43 × 10^6

(iv) **70,040,000,000** = 7.004 × 10,000,000,000 = 7.004 × 10^{10}

EXERCISE 11.3

1. Write the following numbers in the expanded forms:

(i) $279404 = 2 \times 10^5 + 7 \times 10^4 + 9 \times 10^3 + 4 \times 10^2 + 0 \times 10^1 + 4 \times 10^0$

(ii) $3006194 = 3 \times 10^6 + 0 \times 10^5 + 0 \times 10^4 + 6 \times 10^3 + 1 \times 10^2 + 9 \times 10^1 + 4 \times 10^0$

(iii) $2806196 = 2 \times 10^6 + 8 \times 10^5 + 0 \times 10^4 + 6 \times 10^3 + 1 \times 10^2 + 9 \times 10^1 + 6 \times 10^0$

(iv) $120719 == 1 \times 10^5 + 2 \times 10^4 + 0 \times 10^3 + 7 \times 10^2 + 1 \times 10^1 + 9 \times 10^0$

(v) $20068 = 2 \times 10^4 + 0 \times 10^3 + 0 \times 10^2 + 6 \times 10^1 + 8 \times 10^0$

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

(a) $8 \times 10^4 + 6 \times 10^3 + 0 \times 10^2 + 4 \times 10^1 + 5 \times 10^0 = 86045$

(b) $4 \times 10^5 + 5 \times 10^3 + 3 \times 10^2 + 2 \times 10^0 = 405302$

(c) $3 \times 10^4 + 7 \times 10^2 + 5 \times 10^0 = 30705$

(d) $9 \times 10^5 + 2 \times 10^2 + 3 \times 10^1 = 900230$

3. Express the following numbers in standard form:

(i) $5,00,00,000 = 5 \times 10^7$

(ii) $70,00,000 = 7 \times 10^6$

(iii) $3,18,65,00,000 = 3.1865 \times 10^9$

(iv) $3,90,878 = 3.90878 \times 10^5$

(v) $39087.8 = 3.90878 \times 10^4$

(vi) $3908.78 = 3.90878 \times 10^3$

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

(a) The distance between Earth and Moon is 384,000,000 m

Sol: $3.84 \times 10^8\ m$

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

Sol: $3 \times 10^8 m/s$

(c) Diameter of the Earth is 1,27,56,000 m

Sol: $1.2756 \times 10^7\ m$

(d) Diameter of the Sun is 1,400,000,000 m

Sol: $1.4 \times 10^9 m$

(e) In a galaxy there are on an average 100,000,000,000 stars.

Sol: 1×10^{11}

(f) The universe is estimated to be about 12,000,000,000 years old.

Sol: $1.2 \times 10^{10}\ years$

(g) The distance of the Sun from the centre of the Milky Way Galaxy is estimated to be 300,000,000,000,000,000,000 m.

Sol: $3 \times 10^{20} m$

(h)60,230,000,000,000,000,000,000 molecules are contained in a drop of water weighing 1.8 gm.

Sol: $6.023 \times 10^{22}\ molecules$

(i) The earth has 1,353,000,000 cubic km of sea water.

Sol: $1.353 \times 10^{9} cubik\ km\ or\ km^3$

(j) The population of India was about 1,027,000,000 in March, 2001.

Sol: 1.027×10^{9}