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Chapter-12: Exponents and Powers

Exercise 12.1 (Page 197 of NCERT Grade 8)

Q1. Evaluate

(i) 3^{-2}

(ii) $(-4)^{-2}$

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

(i) Evaluate $(3)^{-2}$

Difficulty Level: Easy

What is known:

Exponential form

What is unknown:

Value in the number

Reasoning

We know $a^{-m} = \frac{1}{a^m}$ for any non-zero integer

Solution:

$$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$$

Related Problems:

$(-2)^{-4}$ & $(4)^{-3}$

(ii) Evaluate $(-4)^{-2}$

Difficulty Level: Easy

What is known:

Exponential form

What is unknown:

Value in the number

Reasoning:

We know $a^{-m} = \frac{1}{a^m}$ for any non-zero integer

Solution:

$$(-4)^{-2} = \frac{1}{(-4)^2} = \frac{1}{(-4) \times (-4)} = \frac{1}{16}$$

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

Difficulty Level: Easy

What is known:

Exponential form

What is unknown:

Value in the number

Reasoning:

As per the fact used in previous question

Solution:

$$\left(\frac{1}{2}\right)^{-5} = (2)^5 = 2 \times 2 \times 2 \times 2 \times 2 = 32$$

Q2. 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) $2^{-3} \times (-7)^{-3}$

(i) Evaluate $(-4)^5 \div (-4)^8$

Difficulty Level: Easy

What is known:

Expression in exponential form

What is unknown:

Result in power notation with positive exponent

Reasoning:

As we know $\frac{a^m}{a^n} = a^{m-n}$ where m & n are integers.

Solution:

$$(-4)^5 \div (-4)^8 = \frac{(-4)^5}{(-4)^8} = (-4)^{5-8}$$

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

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

Difficulty Level: Easy

What is known:

Expression in exponential form

What is unknown:

Result in power notation with positive exponent

Reasoning:

As we know for any non-zero integer a , $(a^m)^n = a^{mn}$

Solution:

$$\left(\frac{1}{2^3}\right)^2 = \frac{1}{2^6}$$

(iii) Evaluate $(-3)^4 \times \left(\frac{5}{3}\right)^4$

Difficulty Level: Medium

What is known:

Expression in exponential form

What is unknown:

Result in power notation with positive exponent

Reasoning:

we know that $a^m \times b^m = (ab)^m$ where a & b are non-zero integers and m is any integer

Solution:

$$\begin{aligned} & (-3)^4 \times \left(\frac{5}{3}\right)^4 \\ & (-1 \times 3)^4 \times \frac{5^4}{3^4} \\ & (-1)^4 \times \cancel{3^4} \times \frac{5^4}{\cancel{3^4}} \\ & (-1)^4 \times 5^4 = 5^4 \quad [\because (-1)^4 = 1] \end{aligned}$$

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

Difficulty Level: Medium

What is known:

Expression in exponential form

What is unknown:

Result in power notation with positive exponent

Reasoning:

We know $\frac{a^m}{a^n} = a^{m-n}$ & $a^m \times a^n = a^{m+n}$

Solution:

$$\begin{aligned} (3^{-7} \div 3^{-10}) \times 3^5 &= (3^{-7-(-10)}) \times 3^5 \\ &= (3^{-7+10}) \times 3^5 \\ &= 3^3 \times (3^5) \\ &= 3^{3+(5)} \\ &= 3^8 \\ &= \frac{1}{3^2} \end{aligned}$$

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

Difficulty Level: Medium

What is known:

Expression in exponential form

What is unknown:

Result in power notation with positive exponent

Reasoning:

As we know $a^m \times b^m = (ab)^m$

Solution:

$$\begin{aligned} 2^{-3} \times (-7)^{-3} &= [2 \times (-7)]^{-3} \\ &= [-14]^{-3} \quad \left[a^{-m} = \frac{1}{a^m} \right] \\ &= \left(\frac{-1}{14} \right)^3 \end{aligned}$$

Q3. Find the value of

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

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

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

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

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

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

Difficulty Level: Easy**What is known:**

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

$$a^0 = 1 \text{ and } a^{-m} = \frac{1}{a^m}$$

Solution:

$$\begin{aligned}(3^0 + 4^{-1}) \times 2^2 &= \left(1 + \frac{1}{4}\right) \times 2^2 \\ &= \left(\frac{4+1}{4}\right) \times 2^2 \\ &= \left(\frac{5}{4}\right) \times 2^2 \\ &= \frac{5}{2^2} \times 2^2 \quad [4 = 2 \times 2 = 2^2] \\ &= 5\end{aligned}$$

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

Difficulty Level: Medium**What is known:**

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

$$(a^m)^n = a^{mn}, \quad a^m \times a^n = a^{m+n}, \quad a^{-m} = \frac{1}{a^m}$$

Solution:

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

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

Difficulty Level: Easy

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

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

Solution:

$$\begin{aligned}\left(\frac{1}{2}\right)^{-2} + \left(\frac{1}{3}\right)^{-2} + \left(\frac{1}{4}\right)^{-2} &= \left(\frac{2}{1}\right)^2 + \left(\frac{3}{1}\right)^2 + \left(\frac{4}{1}\right)^2 \\ &= (2)^2 + (3)^2 + (4)^2 \\ &= 4 + 9 + 16 \\ &= 29\end{aligned}$$

(iv) Evaluate $(3^{-1} + 4^{-1} + 5^{-1})^0$

Difficulty Level: Easy

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

$$a^0 = 1 \text{ and } a^{-m} = \frac{1}{a^m}$$

Solution:

$$\begin{aligned}(3^{-1} + 4^{-1} + 5^{-1})^0 &= \left[\frac{1}{3} + \frac{1}{4} + \frac{1}{5}\right]^0 && \left[a^{-m} = \frac{1}{a^m}\right] \\ &= 1 && \left[a^0 = 1\right]\end{aligned}$$

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

Difficulty Level: Easy

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

$$a^{-m} = \frac{1}{a^m} \text{ and } \left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$$

Solution:

$$\begin{aligned} \left\{\left(\frac{-2}{3}\right)^{-2}\right\}^2 &= \left\{\left(\frac{3}{-2}\right)^2\right\}^2 && \left[a^{-m} = \frac{1}{a^m}\right] \\ &= \left\{\frac{3^2}{(-2)^2}\right\}^2 && \left[\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}\right] \\ &= \left(\frac{9}{4}\right)^2 \\ &= \frac{81}{16} \end{aligned}$$

Q4. Evaluate

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

(ii) $(5^{-1} \times 2^{-1}) \times 6^{-1}$

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

Difficulty Level: Medium

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

$$a^{-m} = \frac{1}{a^m}$$

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

Solution:

$$\begin{aligned} \frac{8^{-1} \times 5^3}{2^{-4}} &= \frac{2^4 \times 5^3}{8^1} && \left[a^{-m} = \frac{1}{a^m} \right] \\ &= \frac{2^4 \times 5^3}{2^3} \\ &= 2^{4-3} \times 5^3 && \left[a^m \div a^n = a^{m-n} \right] \\ &= 2 \times 125 \\ &= 250 \end{aligned}$$

(ii) Evaluate $(5^{-1} \times 2^{-1}) \times 6^{-1}$

Difficulty Level: Easy

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

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

Solution:

$$\begin{aligned} (5^{-1} \times 2^{-1}) \times 6^{-1} &= (5 \times 2)^{-1} \times 6^{-1} \\ &= 10^{-1} \times 6^{-1} \\ &= (10 \times 6)^{-1} && \left[\because a^m \times b^m = (ab)^m \right] \\ &= (60)^{-1} \\ &= \frac{1}{60} \end{aligned}$$

Related problems:

(i) $(7^{-2} \times 14^{-2}) \times 3^{-1}$

(ii) $\frac{2^{-2} \times 5^2}{8^{-3}}$

Q5. Find the value of m for which $(5^m \div 5^{-3}) = 5^5$

Difficulty Level: Easy

What is known:

Expression in exponential form

What is unknown:

Value of m

Reasoning:

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

Solution:

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

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

$$5^{m+3} = 5^5$$

On both the side powers have the same base, so their exponents must be equal.

$$\therefore m+3=5 \rightarrow m=5-3 \rightarrow m=2$$

Q6. Evaluate

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

(ii) $\left(\frac{5}{8} \right)^{-7} - \left(\frac{8}{5} \right)^{-4}$

(i) Evaluate $\left\{ \left(\frac{1}{3} \right)^{-1} - \left(\frac{1}{4} \right)^{-1} \right\}^{-1}$

Difficulty Level: Medium

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

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

Solution:

$$\begin{aligned} \left\{ \left(\frac{1}{3} \right)^{-1} - \left(\frac{1}{4} \right)^{-1} \right\}^{-1} &= \{3^1 - 4^1\}^{-1} \\ &= \{3 - 4\}^{-1} \\ &= \{-1\}^{-1} \\ &= \left(\frac{1}{-1} \right)^1 \\ &= -1 \end{aligned}$$

(ii) Evaluate $\left(\frac{5}{8} \right)^{-7} \times \left(\frac{8}{5} \right)^4$

Difficulty Level: Medium

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

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

Solution:

$$\begin{aligned} \left(\frac{5}{8} \right)^{-7} \times \left(\frac{8}{5} \right)^4 &= \left(\frac{8}{5} \right)^7 \times \left(\frac{8}{5} \right)^{-4} \\ &= \left(\frac{8}{5} \right)^3 \\ &= \frac{512}{125} \end{aligned}$$

Q7. Simplify.

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

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

(i) Evaluate $\frac{25 \times t^{-4}}{5^{-3} \times 10 \times t^{-8}}$

Difficulty Level: Medium

What is known:

Expression in exponential form

What is unknown:

Value of the expression

Reasoning:

$$a^m \times a^n = a^{m+n} \quad \text{and} \quad \frac{a^m}{a^n} = a^{m-n}$$

Solution:

$$\begin{aligned} \frac{25 \times t^{-4}}{5^{-3} \times 10 \times t^{-8}} &= \frac{5^2 \times t^{-4}}{5^{-3} \times 5 \times 2 \times t^{-8}} && [a^m \times a^n = a^{m+n}] \\ &= \frac{5^2 \times t^{-4}}{5^{-3+1} \times 2 \times t^{-8}} \\ &= \frac{5^2 \times t^{-4}}{5^{-2} \times 2 \times t^{-8}} \\ &= \frac{5^{2-(-2)} \times t^{-4-(-8)}}{2} && \left[\frac{a^m}{a^n} = a^{m-n} \right] \\ &= \frac{5^4 \times t^{-4+8}}{2} \\ &= \frac{625t^4}{2} \end{aligned}$$

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

Difficulty Level: Difficult
What is known: Expression in exponential form

What is unknown: Value of the expression

Reasoning:

$$\frac{a^m}{a^n} = a^{m-n} \quad \text{and} \quad a^0 = 1$$

Solution:

$$\begin{aligned} \frac{3^{-5} \times 10^{-5} \times 125}{5^{-7} \times 6^{-5}} &= \frac{3^{-5} \times (2 \times 5)^{-5} \times 5^3}{5^{-7} \times (2 \times 3)^{-5}} \\ &= \frac{3^{-5} \times 2^{-5} \times 5^{-5} \times 5^3}{5^{-7} \times 2^{-5} \times 3^{-5}} \\ &= 3^{-5-(-5)} \times 2^{-5-(-5)} \times 5^{-5-(-7)+3} \\ &= 3^0 \times 2^0 \times 5^5 && [\because a^0 = 1] \\ &= 1 \times 1 \times 5^5 = 5^5 \end{aligned}$$

Chapter-12: Exponents and Powers

Exercise 12.2 (Page 53 of NCERT Grade 8)

Q1. Express the following numbers in standard form.

- (i) 0.0000000000085
- (ii) 0.00000000000942
- (iii) 6020000000000000
- (iv) 0.00000000837
- (v) 31860000000

(i) 0.0000000000085

Difficulty Level: Easy

What is known:

Usual form

What is unknown:

Standard form

Reasoning:

How to use $-a.b \times 10^n$

Where a is a whole number, b is a decimal number and n is an integer. Small numbers are expressed with negative exponent i.e. n is negative integer.

Solution:

To convert this small number into standard form we need to move decimal to its right by 12 steps.

		1	2	3	4	5	6	7	8	9	10	11	12	13
0		0	0	0	0	0	0	0	0	0	0	0	8	5

$$\begin{aligned}
 0.0000000000085 &= \frac{85}{10000000000000} \\
 &= \frac{85}{10000000000000} = \frac{8.5 \times 10}{10^{13}} \\
 &= 8.5 \times 10^{-13} \times 10^1 \\
 &= 8.5 \times 10^{-12}
 \end{aligned}$$

\therefore Standard form of given number is 8.5×10^{-12}

(ii) 0.00000000000942

Difficulty Level: Easy

What is known:

Usual form

What is unknown:

Standard form

Reasoning:

How to use $-a.b \times 10^n$

Where a is a whole number, b is a decimal number and n is an integer. Small numbers are expressed with negative exponent i.e. n is negative integer.

Solution:

		1	2	3	4	5	6	7	8	9	10	11	12	13	14
0		0	0	0	0	0	0	0	0	0	0	0	9	4	2

$$\begin{aligned}
 0.00000000000942 &= \frac{942}{100000000000000} \\
 &= \frac{942}{100000000000000} = \frac{9.42 \times 10^2}{10^{14}} \\
 &= 9.42 \times 10^{-14} \times 10^2 \\
 &= 9.42 \times 10^{-12}
 \end{aligned}$$

\therefore Standard form of given number is 9.42×10^{-12}

(iii) 6020000000000000

Difficulty Level: Easy

What is known:

Usual form

What is unknown:

Standard form

Reasoning:

In this question a big number has to be converted to its standard form. In this case n is positive to represent this number as $a \cdot b \times 10^n$ and the decimal will be moved to its left to represent this number in its standard form as below.

Solution:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0

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

Decimal has moved by 15 steps so standard form of given number is 6.2×10^{15}

(iv) 0.00000000837

Difficulty Level: Easy
What is known:

Usual form

What is unknown:

Standard form

Reasoning:

How to use $-a.b \times 10^n$

Where a is a whole number, b is a decimal number and n is an integer. Small numbers are expressed with negative exponent i.e. n is negative integer.

Solution:

		1	2	3	4	5	6	7	8	9	10	11
0		0	0	0	0	0	0	0	0	8	3	7

$$0.00000000837 = \frac{837}{100000000000}$$

$$\frac{837}{100000000000} = \frac{8.37 \times 10^2}{10^{11}}$$

$$= 8.37 \times 10^{-11} \times 10^2$$

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

\therefore Standard form of given number is 8.37×10^{-9}

(v) 31860000000

Difficulty Level: Easy
What is known:

Usual form

What is unknown:

Standard form

Reasoning:

In this question a big number has to be converted to its standard form. In this case n is positive to represent this number as $a \cdot b \times 10^n$ and the decimal will be moved to its left to represent this number in its standard form as below.

Solution:

1	2	3	4	5	6	7	8	9	10	11
3	1	8	6	0	0	0	0	0	0	0

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

So, decimal has moved by 10 steps to its left

\therefore Standard form of given number is 3.186×10^{10}

Q2. 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

(i) Evaluate 3.02×10^{-6}

Difficulty Level: Easy**What is known:**

Standard form

What is unknown:

Usual form

Reasoning:

As we know standard form of any small or larger number is $a.b \times 10^n$, Where a is a whole number, b is a decimal number and n is an integer

For small number n is negative and for large number n is positive. So, to convert a small number to its usual form we need to move decimal to its left by number of steps given as exponent values.

Solution:

(i) 3.02×10^{-6}

∴ Its usual form is

$$\begin{aligned} 3.02 \times 10^{-6} &= \frac{3.02}{1000000} \\ &= 0.00000302 \end{aligned}$$

(ii) 4.5×10^4

Now to convert a big number to its usual form we need to move decimal to its right by number of steps given as its exponent.

$$\begin{aligned} 4.5 \times 10^4 &= 45000 \\ \therefore \text{Answer is } &45000 \end{aligned}$$

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

(iv) $1.0001 \times 10^9 = 1000100000$

(v) $5.8 \times 10^{12} = 5800000000000$

(vi) $3.61492 \times 10^6 = 3614920$

Q3. Express the number appearing in the following statements in standard form.

(i) 1 micron is equal to $\frac{1}{100000}$ 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

Difficulty Level: Easy

What is known:

Usual form

What is unknown:

Standard form

Reasoning:

How to use $-a.b \times 10^n$

Where a is a whole number, b is a decimal number and n is an integer. Small numbers are expressed with negative exponent i.e. n is negative integer.

Solution:

(i) 1 micron is equal to

$$\frac{1}{1000000} \text{ m}$$

$$\frac{1}{1000000} = 0.000001 = 1 \times 10^{-6}$$

(ii) 0.0000000000000000000016

$$0.0000000000000000000016 = \frac{16}{100000000000000000000}$$

$$= \frac{1.6 \times 10}{10^{20}}$$

$$= 1.6 \times 10^{-19} \text{ coulomb}$$

(iii) 0.0000005m

$$0.0000005 \text{ m} = \frac{5}{10000000}$$

$$= \frac{5}{10^7}$$

$$= 5 \times 10^{-7} \text{ m}$$

(iv)

$$0.00001275 \text{ m} = \frac{1275}{100000000}$$

$$= \frac{1.275 \times 10^3}{10^8}$$

$$= 1.275 \times 10^{-5} \text{ m}$$

(v) 0.07mm

$$0.07 \text{ mm} = \frac{7}{100}$$

$$= \frac{7}{10^2}$$

$$7 \times 10^{-2} \text{ mm}$$

Q4. In a stack there are 5 books each of thickness 20mm and 5 paper sheets each of thickness 0.016 mm. What is the total thickness of the stack?

Difficulty Level: Easy

What is known:

5 books of 20mm thickness each.

5 paper sheets of 0.016mm thickness each.

What is unknown:

Total thickness of the stack

Reasoning:

First find the total thickness of 5 books then find out total thickness of 5 paper sheets. Now find total thickness of stack by adding these two.

Solution:

Thickness of each book = 20mm

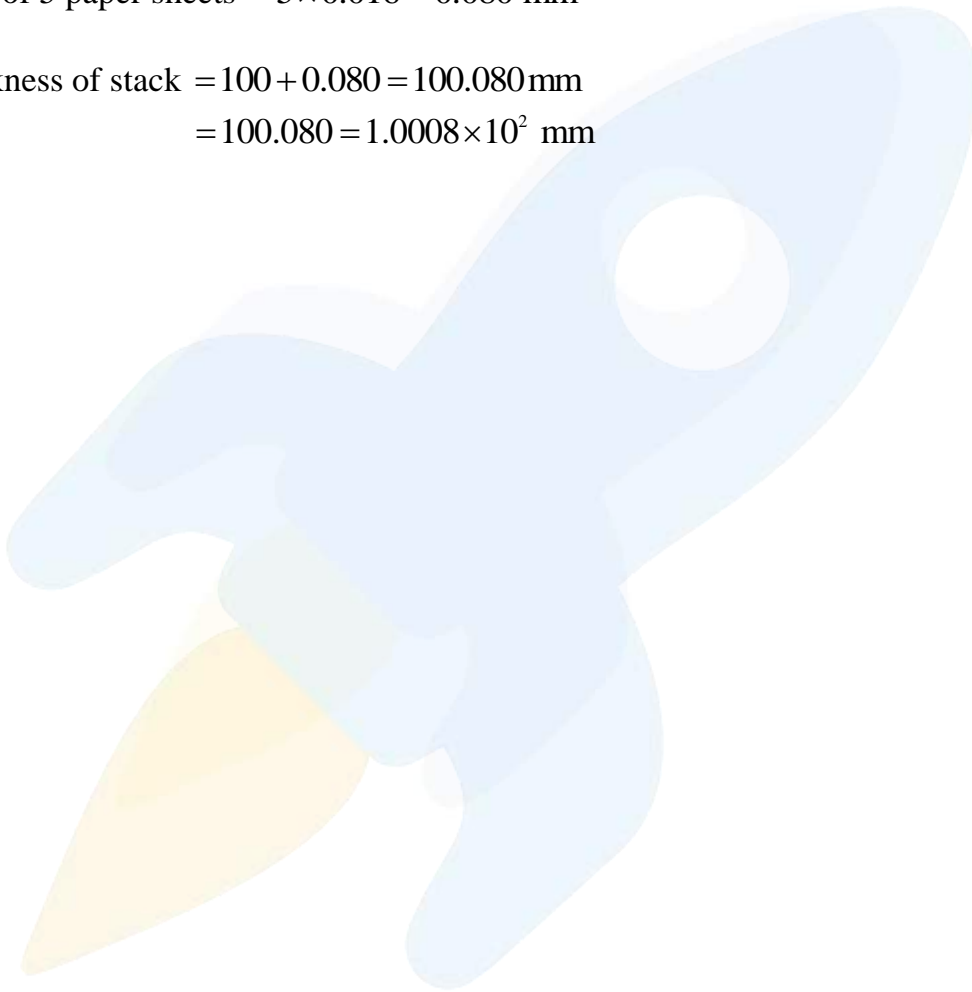
Number of books per stack = 5

Thickness of 5 books = $5 \times 20 = 100$ mm

Thickness of each sheet = 0.016 mm

Thickness of 5 paper sheets = $5 \times 0.016 = 0.080$ mm

Total thickness of stack = $100 + 0.080 = 100.080$ mm
= $100.080 = 1.0008 \times 10^2$ mm



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