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Fully Revised

Shraddha Singh

MATHS OLYMPIAD

International Mathematics Olympiad

4

Number
System

Strictly according
to the latest
syllabus of Maths
Olympiad

Factors and
Multiples

Money

Measurement

Mirror
Images

Geometry

Number
Ranking

Time

Series and
Pattern

The
Gen X
Series

A SUCCESS PACKAGE FOR ASPIRANTS OF MATHS OLYMPIAD

IMO

INTERNATIONAL
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Shraddha Singh



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Published by:



V&S PUBLISHERS

F-2/16, Ansari road, Daryaganj, New Delhi-110002

☎ 23240026, 23240027 • Fax: 011-23240028

Email: info@vspublishers.com • Website: www.vspublishers.com

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ISBN 978-93-505795-5-8

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PUBLISHER'S NOTE

V&S Publishers, after the grand success of a number of Academic and General books, is pleased to bring out a series of *Mathematics Olympiad books* under *The Gen X series – generating Xcellence in generation X* – which has been designed to focus the problems faced by students. In all books the concepts have been explained clearly through examples, illustrations and diagrams wherever required. The contents have been developed to meet specific needs of students who aspire to get distinctions in the field of mathematics and want to become Olympiad champs at national and international levels.

To go through Maths Olympiad, the students need to do thorough study of topics covered in the *Olympiad syllabus and those covered in the school syllabus as well*. The Olympiads not only tests subjective knowledge but Reasoning skills of students also. So students are required to comprehend the depth of concepts and problems and gain experience through practice. The Olympiad check efficiency of candidates in problem solving. These exams are conducted in different stages at regional, national, and international levels. At each stage of the test, the candidate should be fully prepared to go through the exam. Therefore, this test requires careful attention towards comprehension of concepts, thorough practice, and application of rules.

While other books in market focus selectively on questions or theory; V&S Maths Olympiad books are rather comprehensive. Each book of this series has been divided into four sections namely *Mathematics, Logical Reasoning, Achievers section, Model Papers*. The theory has been explained through solved examples. To enhance the problem solving skills of candidates, *Multiple Choice Questions (MCQs)* with detailed solutions are given at the end of each chapter. Two *Mock Test Papers* have been included to understand the pattern of exam. A CD containing Study Chart for systematic preparation, Tips & Tricks to crack Maths Olympiad, Pattern of exam, and links of Previous Years Papers is accompanied with this book. The books are also useful for various other competitive exams such as NTSE, NSTSE, and SLTSE as well.

We wish you all success in the examination and a very bright future in the field of mathematics.

All the best

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SECTION 1
MATHEMATICAL
REASONING

Unit-1 : Number System



Learning Objectives : In this unit, we will learn about:

- Numbers (Numerals)
- Number Names
- 5 Digit Numbers
- Place Value
- Comparison of Numbers
- Successor and Predecessor
- Ascending and Descending Order
- Even and Odd Number

Numbers (Numerals)

We are surrounded by numbers in each and every sphere of our life. Large numbers are often used in monetary transactions in businesses, banks, etc. Total numbers of schools in a city, total numbers of students in a university are all examples of large numbers.

Number Names

Let us have a look at the table given below :

Number	Number Name
1	One
10	Ten
100	One hundred
1000	One thousand
10000	Ten thousand
100000	One lakh
1000000	Ten lakh
10000000	Crore
100000000	Ten crore

Numbers given above in the table are based on Indian System of Numeration. As the number increases, it becomes larger and larger.

As we know there are ten digits: 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9. Numbers are written using these digits. These digits are called ones. The numerals formed by the digits 0, 1, 2, 3, 4, ... are known as Hindu-Arabic numbers. This system is popular world-wide.

Numeral system is a way of counting and naming number. Number is an idea whereas the symbols used to represent the numbers are called numerals.

5 Digit Numbers

We know that 99,999 is the greatest 5 digit number. If we add 1 to it, it will give us the smallest 6 digit number.

Place Value

Place value of a digit depends on its position in the number. As the digit moves to the left, its value increases.

The place value of a 6 digit number is Lakhs in the place value chart. Here is the relative chart :

Lakhs Period		Thousands Period		Ones Period		
Ten Lakhs	Lakhs	Ten Thousands	Thousands	Hundreds	Tens	Ones
0	4	5	7	2	8	3

The place value chart has been separated into three groups : The ones period has three places – Hundreds, tens and ones. The thousands period has two places – Ten thousands and thousands.

Next period is the lakhs period which includes – Ten lakhs and lakhs.

Comparison of Numbers

Symbol	Meaning	Example in Symbols	Example in Words
>	Greater than More than Bigger than Larger than	$7 > 4$	7 is greater than 4 7 is more than 4 7 is bigger than 4 7 is larger than 4

<	Less than Fewer than Smaller than	$4 < 7$	4 is less than 7 4 has fewer than 7 4 is smaller than 7
=	Equal to Same as	$7 = 7$	7 is equal to 7 7 is the same as 7

Use of Commas

If we write the number without using the place values chart, we use comma to separate the periods.

Let us take an example : 4,57,283

First comma is used when the ones period is complete. Second comma is used when thousands period is complete. Next comma is used to separate thousands and lakhs period.

Comparison of two numbers

If a number has more digits than the other, then it is greater of the two.

For example 8552 is greater than 285.

(i) If two numbers have the same number of digits and the extreme left digits are also the same then compare the next digits to the right and so on.

For example 342 is greater than 332.

(ii) If two numbers have the same number of digits then the number with bigger digit on the extreme left is greater. For example, 5732 is greater than 3584.

Note : Count the digits first, then check 'H' then 'T' then 'O'.

Successor and Predecessor

Successor

The number that comes just after a given number is called its Successor.

Example :	Number	Successor
	578	579
	284	285
	999	1000

The successor of a number is obtained by adding 1 to that number.

Predecessor

The number that comes just before a particular number is called its predecessor.

Example :	Number	Predecessor
	178	177
	195	194
	285	284

Clearly the predecessor of a number is obtained by subtracting 1 from the given number.

Note : Zero has no predecessor.

Ascending and Descending Order

Ascending order

Arranging the given numbers from the smallest to the greatest is called ascending order or increasing order.

Example : Arrange these numbers in ascending order

4572, 5132, 4698, 8455

Sol. In 4572, 5132, 4698, 8455

As $4572 < 4698 < 5132 < 8455$

\therefore Ascending order is 4572, 4698, 5132, 8455

Descending order

Arranging the given number from the greatest to the smallest is called descending order or decreasing order.

Example : Arrange these numbers in descending order.

5431, 3451, 5231, 4531

Sol. In 5431, 3451, 5231, 4531

As $5431 > 5231 > 4531 > 3451$

\therefore Decreasing order is 5431, 5231, 4531, 3451.

Even and Odd Number

Even numbers

In an even number the digits in the ones place is 0, 2, 4, 6 or 8.

Odd numbers

In an odd number the digits in the ones place is 1, 3, 5, 7 or 9.

Expanded form of 9999

$$\begin{aligned} 9999 &= 9 \text{ thousands} + 9 \text{ hundreds} + 9 \text{ tens} + 9 \text{ ones} \\ &= 9 \times 1000 + 9 \times 100 + 9 \times 10 + 9 \times 1 \\ &= 9000 + 900 + 90 + 9 \end{aligned}$$

Multiple Choice Questions

- 99,999 is the greatest _____ digit number.
A. 5 B. 4
C. 3 D. 2
- Place value of 5 in 5,43,621 is _____.
A. Lakh B. Thousand
C. Ones D. Tens
- Smallest 6 digit number = _____.
A. 0,00,000 B. 1,00,000
C. 9,99,999 D. 99,999
- $300000 + 20000 + 4000 + 200 + 2 =$ _____.
A. 3,24,202 B. 3,42,222
C. 2,34,222 D. 3,22,432
- Ones period includes:
A. Hundreds B. Thousands
C. Ten thousands D. Lakhs
- Lakhs period includes:
A. Thousand B. Lakh
C. Tens D. Ones
- Thousands period includes:
A. Ten thousands B. Tens
C. Ones D. Hundreds
- Pick the odd one out :
A. Hundreds B. Tens
C. Ones D. Urans
- We use _____ to separate the periods.
A. Comma B. Full stop
C. Brackets D. Hyphen
- 4,37,283 is a _____ number.
A. 4 digit B. 5 digit
- 6 digit C. 7 digit
- Instead of putting comma, we can _____ to separate the periods.
A. Put hyphen B. Leave space
C. Put full stop D. Put brackets
- Ten lakhs comes in _____ period.
A. Thousands B. Lakhs
C. Ones D. Hundreds
- Pick odd one out:
A. 6, 34, 231 B. 1,34,345
C. 1,34,655 D. 1,23,456
- Pick the odd one out:
A. 6,44,245 B. 4,65,345
C. 2,55,666 D. 2,566,55
- Pick the odd one out:
A. 1,00,000 B. 10,000
C. 1,00,001 D. 10,00,00
- 3,44,567 has _____ lakhs.
A. 3 B. 4
C. 5 D. 6
- 3,44,567 has _____ thousands
A. 3 B. 4
C. 5 D. 6
- 3,44,567 has _____ ones
A. 3 B. 4
C. 7 D. 5
- 3,44,567 has _____ tens
A. 3 B. 4
C. 5 D. 6
- 3,44,567 has _____ hundreds
A. 3 B. 4
C. 5 D. 6



Answer Key

1. A	2. A	3. B	4. A	5. A	6. B	7. A	8. D
9. A	10. C	11. B	12. B	13. D	14. D	15. D	16. A
17. B	18. C	19. D	20. C				

Hints and Solutions

- | | |
|---|--|
| <p>1. Greatest 5 digit number = 99999</p> <p>2. Place value of 5 in 5,43,621
= $5 \times 100,000 = 500000$</p> <p>3. Smallest 6 digit number = 1,00,000</p> <p>4. We have $300000 + 20000 + 4000 + 200 + 2$</p> | <p>9. We use comma to separate the periods.</p> <p>11. Instead of putting comma, we can leave space to separate the periods.</p> <p>13. 1,23,456 is an even number.</p> <p>16. 3,44,567 has 3 lakhs.</p> |
|---|--|

=	L	TTh	T	H	T	O
	3	0	0	0	0	0
	0	2	0	0	0	0
	0	0	4	0	0	0
	0	0	0	2	0	0
+	0	0	0	0	0	2
	3	2	4	2	0	2

Since	L	TTh	T	H	T	O
	3	4	4	5	6	7

Unit-2 : Roman Numerals



Learning Objectives : In this unit, we will learn about:

- Roman Symbols
- Uses of Roman Symbols

Roman numbers are used widely in our daily life. The most important and common example is watches and clocks with Roman numbers on it. Roman numerals are used to number different volumes of a book classroom in a school. Questions in a question paper or exercise.



Roman Symbols

There are seven symbols used in this system which are as follows :

I, V, X, L, C, D & M

Value of the symbol

Each symbol has a corresponding value:

Roman Symbols		
I	stands for	1
V	stands for	5
X	stands for	10
L	stands for	50
C	stands for	100
D	stands for	500
M	stands for	1000

Note : There is no symbol for zero in the roman numeral system.

Uses of Roman Numerals

1. When certain roman numerals are repeated, the value of the resulting numeral is equal to their sum.

$$\text{III} = 1 + 1 + 1 = 3$$

$$\text{XX} = 10 + 10 = 20$$

2. Roman numerals read from left to right, larger values to the left and work to the smaller values on the right.
3. If a lesser symbol is before a greater symbol, the lesser is subtracted from the greater. For example, $\text{IV} = 5 - 1 = 4$
4. If a lesser symbol is after a greater symbol, the two values are added. For example, $\text{VI} = 5 + 1 = 6$
5. I and V can only modify up to an X. For example, 49 is not written IL, rather you first resolve 40 as XL and then resolve 9 as IX. Put them together and $49 = 10 + 40 + 9 = \text{XLIX}$.
6. X and L can only modify up to a C. For example, 490 are not written XD. First you resolve 400 as CD and then you resolve 90 as XC. Put them together and $490 = \text{CDXC}$.
7. C and D can only modify up to an M. For example, 950 is not written LM, rather you first resolve 900 as CM and then add L for 50. So $950 = \text{CML}$.

Note : (a) V, L, D are not repeated (b) No roman numeral can come together more than three times. It is wrong to write $\text{IIII} = 4$. (c) The symbol V can never be written on the left of any greater value symbol.

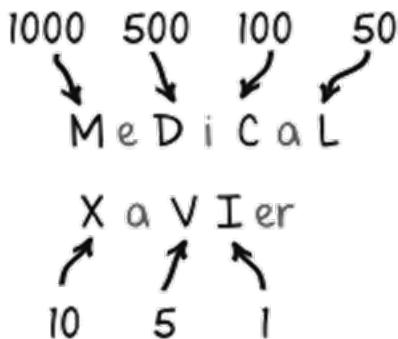
Shortcuts to Problem Solving

1. An accurate way to write the roman numbers is to first take the thousands, hundreds, tens and ones.

Example : 1999, One thousand is M, nine hundred is CM, ninety is XC, nine is IX. Combine all these : MCMXCIX

2. Develop a mnemonic device to remember the order of Roman numerals.

Think "MeDiCaLXaVler". It has the roman numerals in order from 1000 to 1.



Another common mnemonic like “I Value Xylo-phones Like Cows Dig Milk” puts the Roman numerals I, V, X, L, C, D and M in order from smallest to largest. If you have problem only in remembering larger numbers, it may help you to remember that “C” is equivalent to “century” and “M” is equivalent to “millennium”: 100 and 1000, respectively.

3. Write the six pairs of subtractive Roman numeral on a notecard along with their equivalents in Roman numerals, “IV” is equal to 4, “IX” is equal to 9, “XL” is equal to 40, “XC” is equal to 90, “CD” is equal to 400 and “CM” is equal to 900. These are called “subtractive” because the first letter is “subtracted” from the second. Keep the notecard visible at all times so you know to recognize these pairs when they appear.

Example : Shraddha wants to convert her friend’s year of birth(1989) into roman numbers. Can you help her to do so?

Sol. Break 1989 into 1000, 900, 80 and 9, then do each conversion.

$$1000 = M \qquad 900 = CM$$

$$80 = LXXX \qquad 9 = IX$$

$$\text{So, } 1989 = 1000 + 900 + 80 + 9 = MCMLXXXIX$$