# (Olympiad Comprehensive Notes)

# NOTES

# Numbers

Numbers are mathematical symbol by which we express date, time, distance, position, quantity etc. We use ten symbols (0, 1, 2, 3, 4, 5, 6, 7, 8, 9) to write any number. Like 346562232, 34654521155, 4003444656 etc.

# Number System

Number system deals with the study of different types of numbers. In this chapter, we will study about the categorization of different types of numbers.

# **Natural Numbers**

Counting starts with 1 and continue till infinite. Counting numbers are called natural numbers.

For example, 1, 2, 3, 4, 5, 6, 7 ..... etc.

# Whole Numbers

When 0 is included with natural numbers, they are called whole number. In other words "Natural numbers together with zero are called whole numbers."

For example, 0, 1, 2, 3, 4, 5, 6, 7 ..... etc.

# Integers

Integers are the collection of whole numbers and negative of natural numbers.

For example, -5, -4, -3, -2, -1, 0, +1, +2, +3, +4, +5, +6, +7 ..... Etc.

# System of Numeration

Mathematical notation of numbers is called numeration. Let us know about two types of numeration.

- (a) Indian system of numeration
- (b) International system of numeration

# **Indian System of Numeration**

It is a positional decimal number system. Look at the following place value chart

| Period | Kharab            |             | Arab           |            | Crores           |            | Lakhs           |           | Thousands            |                | Ones        |          |          |
|--------|-------------------|-------------|----------------|------------|------------------|------------|-----------------|-----------|----------------------|----------------|-------------|----------|----------|
| Places | Ten Kharab (T-kh) | Kharab (kh) | Ten Arab (T-A) | Arab (A)   | Ten Crores (T-C) | Crores (C) | Ten Lakhs (T-L) | Lakhs (L) | Ten thousands (T-TH) | Thousands (TH) | Hundred (H) | Tens (T) | Ones (0) |
|        | 100000000000      | 10000000000 | 1000000000     | 1000000000 | 10000000         | 10000000   | 1000000         | 100000    | 10000                | 1000           | 100         | 10       | 0        |

# > Example

# Name the number, indicated in the place value chart:

| Period | Kharab                            |                            | Arab                          |                       | Crores                        |                        | Lakhs                      |                     | Thousands                         |                        | Ones               |                |               |
|--------|-----------------------------------|----------------------------|-------------------------------|-----------------------|-------------------------------|------------------------|----------------------------|---------------------|-----------------------------------|------------------------|--------------------|----------------|---------------|
| Places | Ten Kharab (T-kh)<br>100000000000 | Kharab (kh)<br>10000000000 | Ten Arab (T-A)<br>10000000000 | Arab (A)<br>100000000 | Ten Crores (T-C)<br>100000000 | Crores (C)<br>10000000 | Ten Lakhs (T-L)<br>1000000 | Lakhs (L)<br>100000 | Ten thousands (T-<br>TH)<br>10000 | Thousands (TH)<br>1000 | Hundred (H)<br>100 | Tens (T)<br>10 | Ones (0)<br>0 |
|        | 1                                 | 4                          | 0                             | 2                     | 6                             | 5                      | 2                          | 1                   | 0                                 | 3                      | 2                  | 5              | 3             |

# Solution:

Fourteen kharab two arab sixty five crore twenty one lakh three thousand two hundred fifty three.

#### **International System of Numeration**

This system is applied in whole world. The following place value chart shows the international system of numeration.

| Period | Trillions        |                        |                | Billion          |              |             | Million          |              |           | Thousands         |               |           | Ones    |      |      |
|--------|------------------|------------------------|----------------|------------------|--------------|-------------|------------------|--------------|-----------|-------------------|---------------|-----------|---------|------|------|
| Places | Hundred Trillion | T <i>e</i> n Trillions | Trillions      | Hundred billions | Ten billions | Billions    | Hundred millions | Ten millions | Millions  | Hundred thousands | Ten thousands | Thousands | Hundred | Tens | Ones |
|        | (1000000000000)  | (100000000000)         | (100000000000) | (10000000000)    | (1000000000) | (100000000) | (100000000)      | (10000000)   | (1000000) | (100000)          | (10000)       | (1000)    | (100)   | (10) | (0)  |

# > Example:

# Name the number indicated in the place value chart.

| Period | Trillion                              |                                 |                             | Billions                          |                              |                         | Million                        |                          |                       | Thousands                     |                          |                     | Ones             |              |             |
|--------|---------------------------------------|---------------------------------|-----------------------------|-----------------------------------|------------------------------|-------------------------|--------------------------------|--------------------------|-----------------------|-------------------------------|--------------------------|---------------------|------------------|--------------|-------------|
| Places | Hundred Trillions<br>(10000000000000) | Ten Trillions<br>(100000000000) | Trillions<br>(100000000000) | Hundred billions<br>(10000000000) | Ten billions<br>(1000000000) | Billions<br>(100000000) | Hundred millions<br>(10000000) | Ten million<br>(1000000) | Millions<br>(1000000) | Hundred thousands<br>(100000) | Ten thousands<br>(10000) | Thousands<br>(1000) | Hundred<br>(100) | Tens<br>(10) | Ones<br>(0) |
|        | 5                                     | 4                               | 6                           | 5                                 | 6                            | 8                       | 0                              | 2                        | 2                     | 0                             | 6                        | 5                   | 2                | 1            | 5           |

# Solution:

Five hundred forty six trillion five hundred sixty eight billion twenty two million sixty five thousands two hundred fifteen.

## **Place Value**

Place value of a digit in a number is the position it occupies according to the place value chart.

#### > Example:

Find the place value of 5 in the number 646568232.

**Solution:** 500000

# **Face Value**

Face value of a number is the number itself.

#### > Example:

Find the face value of 3 in the number 451453282.

Solution: 3

#### Successor

The number which comes just after a number is called successor of that number.

#### > Example:

#### Find the successor of 5456446.

**Solution:** 54564446 + 1 = 54564447

#### Predecessor

Predecessor of a number just comes before the number.

#### > Example:

#### Find the predecessor of 4665655416.

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Solution: 4665655416 – 1 = 4665655415
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#### **Roman Numeral**

Roman numerals the number using alphabetical symbols.

The seven alphabetical symbols, which are used in Roman system of numeration, and their values are as follows:

| Symbols | Value |
|---------|-------|
| Ι       | 1     |
| V       | 5     |
| Х       | 10    |
| L       | 50    |
| С       | 100   |
| D       | 500   |
| М       | 1000  |

#### **Rules for Using Symbols**

Rule1: When a symbol is repeated, its value is multiplied as many times as the symbol is repeated.

#### > Example:

 $II=2\!\times\!1=2$ 

# $XXX = 3 \times 10 = 30$

Rule 2: The symbols I, X, C, M can be repeated in a roman numeral.

> Example:

 $CCC = 3 \times 100 = 300$ 

#### $MM = 2 \times 1000 = 2000$

Rule 3: The symbols V, L, and D can not be repeated.

> Example:

#### $DD = 2 \times 500 = 1000$

But 1000 is represented by symbol M.

#### Therefore, the above expression is not correct.

Rule 4: If a symbol of smaller value is right to the symbol to greater value, their values are added.

Example:
LV = 50 × 5 = 55
DC = 500 × 100 = 600

Rule 5: If a symbol of smaller value is left to the symbol of greater value, their difference is the resulting value.

Example
VL = 50 - 5 = 45

#### CD = 500 - 100 = 400

**Rule 6:** If a symbol of smaller value comes between two symbols of larger value, its value is subtracted from the value of the symbol, which is right to it.

# > Example XIV = 10 + 5 - 1 = 14DXC = 500 + 100 - 10 = 590

Look at the following table:

| Ι     | 1  | XXVI    | 26 | LI     | 51 | LXXVI    | 76   |
|-------|----|---------|----|--------|----|----------|------|
| II    | 2  | XXVII   | 27 | LII    | 52 | LXXVII   | 77   |
| III   | 3  | XXVIII  | 28 | LIII   | 53 | LXXVIII  | 78   |
| IV    | 4  | XXIX    | 29 | LIV    | 54 | LXXIX    | 79   |
| V     | 5  | XXX     | 30 | LV     | 55 | LXXX     | 80   |
| VI    | 6  | XXXI    | 31 | LVI    | 56 | LXXXI    | 81   |
| VII   | 7  | XXXII   | 32 | LVII   | 57 | LXXXII   | 82   |
| VIII  | 8  | XXXIII  | 33 | LVIII  | 58 | LXXXIII  | 83   |
| IX    | 9  | XXXIV   | 34 | LIX    | 59 | LXXXIV   | 84   |
| Х     | 10 | XXXV    | 35 | LX     | 60 | LXXXV    | 85   |
| XI    | 11 | XXXVI   | 36 | LXI    | 61 | LXXXVI   | 86   |
| XII   | 12 | XXXVII  | 37 | LXII   | 62 | LXXXVII  | 87   |
| XIII  | 13 | XXXVIII | 38 | LXIII  | 63 | LXXXVIII | 88   |
| XIV   | 14 | XXXIX   | 39 | LXIV   | 64 | LXXXIX   | 89   |
| XV    | 15 | XL      | 40 | LXV    | 65 | XC       | 90   |
| XVI   | 16 | XLI     | 41 | LXVI   | 66 | XCI      | 91   |
| XVII  | 17 | XLII    | 42 | LXVII  | 67 | XCII     | 92   |
| XVIII | 18 | XLIII   | 43 | LXVIII | 68 | XCIII    | 93   |
| XIX   | 19 | XLIV    | 44 | LXIX   | 69 | XCIV     | 94   |
| XX    | 20 | XLV     | 45 | LXX    | 70 | XCV      | 95   |
| XXI   | 21 | XLVI    | 46 | LXXI   | 71 | XCVI     | 96   |
| XXII  | 22 | XLVII   | 47 | LXXII  | 72 | XCVII    | 97   |
| XXIII | 23 | XLVIII  | 48 | LXXIII | 73 | XCVIII   | 98   |
| XXIV  | 24 | XLIX    | 49 | LXXIV  | 74 | XCIX     | 99   |
| XXV   | 25 | L       | 50 | LXXV   | 75 | С        | 100  |
|       |    |         |    |        |    | D        | 500  |
|       |    |         |    |        |    | М        | 1000 |

Note: A symbol can not be repeated more than 3 times.