1 Large Numbers Around Us

Why This Chapter Matters

Have you ever looked up at the night sky and wondered how many stars shine above? Scientists say our galaxy, the Milky Way, has over 100 billion stars! Or think about how many grains of sand cover all the beaches on Earth—too many to count! In our everyday life too, we see large numbers in population figures, space distances, or internet data. This chapter will help you read, write, and understand such big numbers. Get ready to explore the amazing world of large numbers that surround us!

Meet EeeBee.AI

Hi explorers! I'm EeeBee, your friendly guide on this exciting mathematical journey! I love numbers, especially the really, really big ones! They tell us so much about the world and the universe. I'll be here to share interesting facts, ask thought-provoking questions, and help you uncover the secrets hidden within large numbers. Whenever you see me, get ready for a fun tip or a cool challenge. Let's explore the amazing universe of large numbers together!

Learning Outcomes

By the end of this chapter, you will be able to:

- Understand and use the Indian and International systems of numeration for large numbers (lakhs, crores, millions, billions).
- Read and write large numbers accurately in both figures and words.
- Identify the place value and face value of digits in large numbers.
- Write large numbers in expanded form and convert from expanded form to standard form.
- Compare and order large numbers.
- Estimate large numbers by rounding to the nearest tens, hundreds, thousands, lakhs, millions, etc.
- Apply the four basic mathematical operations (addition, subtraction, multiplication, division) to large numbers in problem-solving contexts.
- Recognize and use patterns in multiplication (e.g., multiplying by 5, 25, 125).
- Solve real-world problems involving large numbers and make reasonable estimations.
- Appreciate the scale and magnitude of large numbers in various contexts.

From Last Year's Notebook

- Read and write 5-digit and 6-digit numbers.
- Understand the Indian system (with lakhs) and the International system (with millions).
- Compare and order large numbers.
- Understand place value up to 8 digits (lakhs and beyond).
- Use commas correctly in the Indian system (e.g., 1,00,000).
- Estimate and round off numbers to the nearest tens, hundreds, and thousands.
- Perform addition, subtraction, multiplication, and division with large numbers.

Real Math, Real Life

- **Government Planning:** Used for planning budgets in education, healthcare, and infrastructure, affecting millions.
- **Science:** Help measure huge distances in space, like the distance to stars, or count tiny cells in the human body.
- **Technology:** Used to measure data storage in gigabytes and terabytes.
- **Economics:** Track national budgets, debts, and global trade in trillions of dollars.
- **Everyday Life:** Help us understand global news, financial report[illegible] large events.

Quick Prep

Let's get our brains warmed up with a few quick questions!

1. What is the largest 5-digit number?
2. Write the number 78,405 in expanded form.
3. If one packet contains 100 biscuits, how many biscuits are there in 75 such packets?
4. Arrange the following numbers in ascending order: 67,890; 67,098; 68,001; 67,809.
5. What is the place value of the digit 3 in the number 43,567?

Introduction

Welcome to the world of large numbers! Beyond simple counting, we encounter numbers representing India's population, distances to stars, or internet data. This section will teach you to name, write, compare, and calculate with these vast quantities. We'll explore the Indian system (lakhs and crores) and the International system (millions and billions). Understanding these systems is vital for interpreting global information and appreciating the immense scale around us. Get ready to expand your numerical understanding!

Chapter Overview

- **Lakhs and Crores** in the Indian number system
- **Millions and Billions** in the International system
- **Place value, face value,** and writing numbers in expanded form
- **Comparing** and **ordering** large numbers
- Using **commas** correctly in both systems
- **Converting** numbers between Indian and International systems
- **Rounding** large numbers to the nearest ten, hundred, thousand, etc.
- **Estimating** sums, differences, products, and quotients
- Solving **real-life problems** using operations on large numbers
- Applying knowledge in **puzzles** and **real-world situations**

From History's Pages

Our modern understanding of large numbers has a rich history. Ancient methods were often unwieldy. The Indian subcontinent made monumental contributions, including the concept of zero (**shunya**) and the decimal place value system (base-10), revolutionizing mathematics from the 1st to 5th centuries CE.

Mathematicians like **Aryabhata** and **Brahmagupta** extensively developed this system, where a digit's position determines its value. This "**Hindu-Arabic numeral system**" simplified calculations immensely. Terms like '**lakh**' and '**crore**' derive from ancient Sanskrit. The International system (**millions, billions**) evolved later, driven by global trade and scientific communication, to standardize large number representation across cultures.

Lakhs and Crores (The Indian System of Numeration)

As numbers grow larger than thousands and ten thousands, we need new names to represent them conveniently. In India, and several neighboring countries, we use a system that includes units like '**Lakh**' and '**Crore**'. **Lakhs and crores** provide a more compact way to express these large quantities. This system is known as the **Indian System of Numeration**.

Here's the information presented in a table format:

Term	Value (Indian System)	Value (International System)	Calculation
1 Lakh	1,00,000	One hundred thousand	100 × 1,000
10 Lakhs	10,00,000	One million	10 × 1,00,000
1 Crore	1,00,00,000	Ten million	100 × 1,00,000
10 Crores	10,00,00,000	One hundred million	10 × 1,00,00,000

Sub-concepts to be covered

1. Place Value Chart (Indian System)
2. Comma Usage

Mathematical Explanation

Place Value Chart (Indian System)

The periods in the Indian system are **Crores, Lakhs, Thousands, and Ones.** The **Ones period** is further divided into **Hundreds, Tens, and Ones.** It continues with **Kharabs, Neels, Padmas, Shankhs**, etc., each period having two places (except the first '**Ones**' period).

The Indian system groups numbers into periods from right to left, following a 3 : 2 : 2 : 2 ... pattern for comma placement.

Here's the table representing the Indian Place Value System:

Period	Place Value	Value	Number of Zeros
Arab	Ten Arab	10,00,00,00,000	10
	Arab	1,00,00,00,000	9
Crores	Ten Crores	10,00,00,000	8
	Crores	1,00,00,000	7
Lakhs	Ten Lakhs	10,00,000	6
	Lakhs	1,00,000	5
Thousands	Ten Thousands	10,000	4
	Thousands	1,000	3
Ones	Hundreds	100	2
	Tens	10	1
	Ones	1	0

Comma Usage

Commas are used to separate the periods. In the Indian Number System, commas are used to make big numbers easy to read. The commas are placed after every two digits from the right, except the first three digits.

Rules for Placing Commas

- Start from the right-hand side.
- Put the first comma after 3 digits.
- After that, put a comma after every 2 digits

Example: 5,67,89,123 is read as "Five crore sixty-seven lakh eighty-nine thousand one hundred twenty-three."

Example 1 : Write "Seven lakh forty-five thousand two hundred sixty" in figures.

Solution: Lakhs place: 7
Thousands period: forty-five thousand = 45,000
Hundreds place: two hundred = 200
Tens place: sixty = 60
Combining these: 7,45,260

Example 2 : Write the number name for 9,23,05,781 in the Indian system.

Solution: Commas are at: 9, 23, 05, 781
Periods: Crores (9), Lakhs (23), Thousands (05), Ones (781)
Number name: Nine crore twenty-three lakh five thousand seven hundred eighty-one.

Example 3 : How many thousands make 1 lakh?

Solution: 1 Lakh = 1,00,000. 1 Thousand = 1,000.
1,00,000 ÷ 1,000 = 100.
So, 100 thousands make 1 lakh.

Example 4 : How many lakhs make 1 crore?

Solution: 1 Crore = 1,00,00,000. 1 Lakh = 1,00,000.
1,00,00,000 ÷ 1,00,000 = 100.
So, 100 lakhs make 1 crore.

Example 5 : Write 35,00,000 in words using lakhs.

Solution: The number is 35 followed by 5 zeros. This means 35 lakhs.
Number name: Thirty-five lakh.

Knowledge Checkpoint

- How many zeros are there in the number "Fifty Lakh"?
- Write "Three crore seven lakh two thousand five" in figures.
- What is the period after Lakhs (to its left) in the Indian system?

Activity

Form the Number

1. Prepare sets of cards with digits 0-9.
2. Divide students into groups.
3. Call out a number name in the Indian system (e.g., "Twenty-seven lakh five thousand sixty-two").
4. Each group arranges their digit cards to form the number and places makeshift commas (e.g., strips of paper) correctly.
5. The first group to correctly form the number wins a point.

Real Math, Real Life: This helps in quickly understanding and writing down large numbers heard in news or discussions.

Key Terms

- **Lakh:** A unit in the Indian system equal to one hundred thousand (1,00,000).
- **Crore:** A unit in the Indian system equal to one hundred lakhs (1,00,00,000).
- **Indian System of Numeration:** A system of naming numbers using periods like Ones, Thousands, Lakhs, Crores, with commas placed after 3, then 2, then 2 digits from the right.
- **Place Value:** The value of a digit based on its position in a number.
- **Period:** A group of places in a number (e.g., the thousands period includes Thousands and Ten Thousands).

Fact Flash

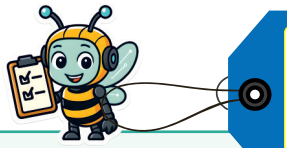
- The words "**Lakh**" (from Sanskrit laksa) and "**Crore**" (from Sanskrit koti) have been used in the Indian subcontinent for thousands of years to denote large numbers.
- Ancient Indian texts like the **Vedas** and **Puranas** mention even larger numerical denominations beyond Crore, such as **Arab, Kharab, Neel, Padma, Shankh**.

Do It Yourself

If you started saving ₹1000 every month, how many years would it take you to save one lakh rupees? What about one crore rupees?

Mental Mathematics

- Quickly add/subtract multiples of lakhs:
  i) 5 Lakhs + 3 Lakhs = ii) 25 Lakhs – 10 Lakhs =
- How many lakhs in 1 Crore 50 Lakhs?



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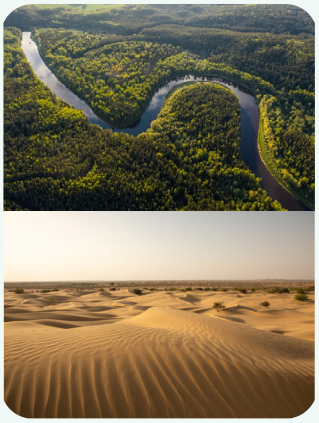
Exercise 1.1

1. **Fill-in-the-blanks questions:**
   a) The number 1 followed by 7 zeros is called _____.
   b) The period immediately to the left of the Thousands period in the Indian system is the _____ period.
   c) One hundred million in the International System is equal to _____ Crores in the Indian System.
   d) In the number 74,526 the digit '4' is in the _____ place.
   e) In the Indian system, the first comma from the right is placed after the _____ period.
2. **Converting Words to Figures:**
   a) Nine crore fifty-two lakh thirty thousand one hundred eight.
   b) Forty-six lakh seven thousand two hundred five.
   c) Two crore eight lakh ninety-four.
   d) Seventeen lakh fifty thousand six hundred fifty.
   e) One crore six lakh twenty-one thousand three hundred.
3. **Write the number name in the Indian system:**
   a) 7,04,12,345 b) 56,18,00,902 c) 1,00,75,400 d) 89,01,23,067
4. **Consider the number 9,02,65,184.**
   (a) Write the number name for this numeral according to the Indian System of Numeration.
   (b) Write the place value and face value of the digit '2'.
   (c) Write the number in its expanded form.

5. A digital marketing campaign reached 10 Lakh unique users in its first month. If it aims to reach 1 Crore unique users by the end of the year, how many more users (in Lakhs) does it need to reach?
6. A social welfare fund collected ₹8,50,000 in donations. If the goal was to collect 1 Crore, how much more money is needed? Express your answer in Lakhs.
7. **Here are some noteworthy facts you may have come across.**

   The **Amazon Rainforest** is often called the "**lungs of the Earth**." It covers an area of about 55,00,000 square kilometres.

   The Thar Desert in India covers about 2,00,000 square kilometres. The total surface area of Earth is about 51,00,00,000 square kilometres.



Questions

i. By how much is the Amazon Rainforest larger than the Thar Desert?
ii. Express the area of the Amazon Rainforest in both the Indian Number System and the International Number System.
iii. What fraction of Earth's total surface area is covered by the Amazon Rainforest? (Write in simplest form.)
iv. If 1 square kilometre can hold about 1,000 trees, estimate how many trees the Amazon Rainforest might have.
v. Round off the areas of the Amazon Rainforest and Thar Desert to the nearest lakh square kilometres and compare again.

The International Number System and Comparison with the Indian System

While the Indian system is widely used in India and neighboring regions, much of the world uses a different system for reading and writing large numbers, known as the International System of Numeration. This system uses units like '**Millions**', '**Billions**', and '**Trillions**'. Understanding this system is essential for interpreting global data, international news, scientific publications, and financial information from around the world.

Here's the information about millions and billions in a table format:

Term	Value (International System)	Calculation
1 Million	1,000,000	1,000 × 1,000
10 Millions	10,000,000	10 × 1,000,000
100 Millions	100,000,000	100 × 1,000,000
1 Billion	1,000,000,000	1,000 × 1,000,000

Sub-concepts to be covered

1. Place Value Chart (International System)
2. Comma Usage

Mathematical Explanation

In the International System of Numeration, digits are grouped into periods of three, starting from the right.

Place Value Chart (International System)

The periods are Billions, Millions, Thousands, and Ones. Each period is divided into Hundreds, Tens, and Ones of that unit.

The International Place Value System organizes large numbers into periods, with each period containing three place values.

Here's the International Place Value Chart with periods:

Period	Place Value	Value	Number of Zeros
Billion	Hundred Billion	100,000,000,000	11
	Ten Billion	10,000,000,000	10
	Billion	1,000,000,000	9
Million	Hundred Million	100,000,000	8
	Ten Million	10,000,000	7
	Million	1,000,000	6
Thousands	Hundred Thousands	100,000	5
	Ten Thousands	10,000	4
	Thousands	1,000	3
Ones	Hundreds	100	2
	Tens	10	1
	Ones	1	0

Comma Usage

Commas are used to separate the periods, placed after every three digits from the right.

Example: 567,891,234 is read as "Five hundred sixty-seven million, eight hundred ninety-one thousand, two hundred thirty-four."

Comparison with Indian System:

- 1 Million = 10 Lakhs
- 10 Millions = 1 Crore
- 100 Millions = 10 Crores
- 1 Billion = 100 Crores (or 1 Arab in the traditional Indian system beyond crore)

Comparing the Indian and International System:

The primary differences between the Indian and International Place Value Systems lie in the naming of larger numbers and the comma placement.

Features	Indian Place Value System	International Place Value System
Comma Placement	3, 2, 2, 2... (from right)	3, 3, 3, 3... (from right)
Periods	Ones, Thousands, Lakhs, Crores, Arab	Ones, Thousands, Millions, Billions
Key Equivalences	1 Lakh = 100,000	1 Million = 1,000,000
	1 Crore = 10,000,000	10 Million = 10,000,000
	1 Arab = 1,000,000,000	1 Billion = 1,000,000,000

Example 6 : Write "Twelve million, three hundred forty-five thousand, six hundred seventy-eight" in figures.

Solution: Millions period: 12
Thousands period: three hundred forty-five = 345
Ones period: six hundred seventy-eight = 678
Combining these: 12,345,678

Example 7 : Write the number name for 723,056,901 in the International system.

Solution: Commas are at: 723, 056, 901
Periods: Millions (723), Thousands (056), Ones (901)
Number name: Seven hundred twenty-three million, fifty-six thousand, nine hundred one.

Example 8 : Convert 7 Crores to millions.

Solution: We know 1 Crore = 10 Millions.
So, 7 Crores = 7 × 10 Millions = 70 Millions.

Example 9 : Convert 250 Million to crores.

Solution: We know 10 Millions = 1 Crore,
So 1 Million = 1/10 Crore.
250 Millions = 250 × (1/10) Crores = 25 Crores.
Alternatively, 100 Million = 10 Crores.
So 200 Million = 20 Crores, and 50 Million = 5 Crores. Total 25 Crores.

Example 10 : Compare: 45 Million and 4 Crore.

Solution: Convert one to the other's system.
45 Million = 45 × 10 Lakhs = 450 Lakhs.
4 Crore = 4 × 100 Lakhs = 400 Lakhs.
Since 450 Lakhs > 400 Lakhs,
45 Million > 4 Crore.

Example 11 : Write the number 37,84,62,105 in both the Indian and International number systems. Also, write the number names in both systems.

Solution: **Indian Number System**

We place commas like this: 37,84,62,105

Now group and read it:

• 37 = Crore • 84 = Lakh • 62 = Thousand • 105 = Ones

Number name (Indian system): Thirty-seven crore eighty-four lakh sixty-two thousand one hundred five

International Number System

We place commas like this: 378,462,105

Now group and read it:

- 378 = Million
- 462 = Thousand
- 105 = Ones

Number name (International system): Three hundred seventy-eight million four hundred sixty-two thousand one hundred five

Knowledge Checkpoint

- How many zeros are there in "Two Hundred Million"?
- How many lakhs are there in 3 Million?
- Which is larger: 5 Billion or 50 Crore?

Activity

1. Prepare chits with large numbers written in figures (e.g., 250000000).
2. Divide the class into two teams: “Team India” and “Team International.”
3. One member from each team picks a chit.
4. “Team India” member writes the number name in the Indian system on the board.
5. “Team International” member writes the number name in the International system.
6. The other team members verify. Correct answers get points.

Real-life connection: This helps in becoming fluent with both systems, essential for understanding diverse sources of information.

Key Terms

- **Million:** A unit in the International system equal to one thousand thousand (1,000,000).
- **Billion:** A unit in the International system equal to one thousand million (1,000,000,000).
- **International System of Numeration:** A system of naming numbers using periods like Ones, Thousands, Millions, Billions, with commas placed after every three digits from the right.
- **Trillion:** A unit in the International system equal to one thousand billion (1,000,000,000,000).

Fact Flash

- The term "**billion**" historically had different meanings. In American English (and now mostly standard), it's a thousand million. In traditional British English, a billion was a million million (what Americans call a trillion). This is why clarity in systems is important!
- A "**googol**" is a very large number: 1 followed by 100 zeros. The search engine "**Google**" was named as a play on this word, reflecting the vast amount of information they aimed to organize.

Do It Yourself

Why do you think the International system groups digits in threes (hundreds, tens, ones of each period – thousands, millions), while the Indian system uses groups of two for lakhs and crores after the initial three for ones? Is there an advantage to either system in terms of readability or pronunciation?

Mental Mathematics

- Quickly convert: 7 Million = ? Lakhs
- If a number has 8 digits and is written in the International system, it’s in the _____ millions.
- Which is greater: 3 crore or 30 million?
- Convert the number 56 million into the Indian number system with commas.
- How many lakhs are there in 1 crore?

Exercise 1.2

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1. Expressing Numbers in Words: International Format

a) 581,002,345 b) 90,760,103 c) 1,234,567,890 d) 400,000,004
e) 67,032,009 f) 150,755,230 g) 7,850,650,000 h) 950,740,080

2. Solve the following questions:

a) How many zeros are there in one hundred million?
b) What is the smallest 7-digit number?
c) If you add 1 to the largest 5-digit number, what number do you get?
d) What is the difference between the smallest 3-digit number and the largest 2-digit number?

3. Rewrite the following number by inserting commas according to both the Indian and International systems of numeration:

a) 7354829 b) 900004800 c) 123456789 d) 5000900451
e) 204891005 f) 678905246 g) 1000000000 h) 3456789012

4. Compare the following numbers:

a) Compare: 7.5 Crore and 75 Million
b) Compare: 90 Lakh and 0.9 Million
c) Compare: 400 Million and 40 Crore
d) Compare: 5 Billion and 500 Crore

5. A company's annual profit was reported as fifty-two crore, seventy-eight lakh, five thousand rupees in the Indian system. Express this amount in figures using the International system of numeration and write its name in the International system.

6. A news report stated that a project requires two hundred fifty million dollars. Another report mentioned the same project requires twenty-five crore rupees. If 1 dollar is approximately equal to 80 rupees, which reported amount is greater and by approximately how much in rupees according to the Indian system?

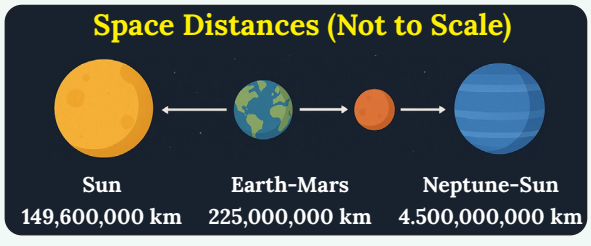
7. "Global Corp" announced its quarterly profit as $750 Million USD. Its Indian subsidiary, "Bharat Innovations," reported a profit of ₹60 Crore. Assuming 1 USD = ₹80, compare the profits of Global Corp and Bharat Innovations. Which company had a higher profit in terms of value?

8. Here are some noteworthy facts you may have come across.

The distance from Earth to the Sun is about 149,600,000 kilometres, while the distance from Earth to Mars is about 225,000,000 kilometres. The farthest planet, Neptune, is around 4,500,000,000 kilometres from the Sun. These very large numbers are written differently in the Indian Number System and the International Number System.

Questions

i. Write 149,600,000 (Earth–Sun distance) in both systems.
ii. Write 225,000,000 (Earth–Mars distance) and 4,500,000,000 (Sun–Neptune distance) in both systems.
iii. Compare the distances to Mars and Neptune. By how much is Neptune farther from the Sun?
iv. Round off 225,000,000 to the nearest crore (Indian) and nearest million (International).



Working with Large Numbers

We've learned to name large numbers, but what gives each digit its specific meaning within that number? The position of a digit is key! In this section, we'll delve into place value (the value a digit holds due to its position) and face value (the intrinsic value of the digit itself). We'll also learn to break down large numbers into their expanded form to better understand their composition and use this understanding to compare and order even the largest numbers.

Sub-concepts to be covered

1. Face Value
2. Place Value
3. Expanded Form
4. Comparing Large Numbers
5. Ordering Large Numbers

Mathematical Explanation

Face Value

The face value of a digit in a numeral is the value of the digit itself, regardless of its position in the number.

For example, in the number 3,45,678, the face value of '5' is 5, the face value of '3' is 3.

Place Value

The place value of a digit in a numeral depends on the position or place it occupies in the number. It is calculated as:

Place Value = Face Value × Value of the place

For example, in 3,45,678:

- Place value of 8 is 8 × 1 = 8 (Ones place)
- Place value of 7 is 7 × 10 = 70 (Tens place)
- Place value of 6 is 6 × 100 = 600 (Hundreds place)
- Place value of 5 is 5 × 1,000 = 5,000 (Thousands place)
- Place value of 4 is 4 × 10,000 = 40,000 (Ten Thousands place)
- Place value of 3 is 3 × 1,00,000 = 3,00,000 (Lakhs place)

Expanded Form

Writing a number as the sum of the place values of its digits is called its expanded form.

Example: 7,45,62,891 (Indian System)

= 7 × 1,00,00,000 + 4 × 10,00,000 + 5 × 1,00,000 + 6 × 10,000 + 2 × 1,000 + 8 × 100 + 9 × 10 + 1 × 1

= 7,00,00,000 + 40,00,000 + 5,00,000 + 60,000 + 2,000 + 800 + 90 + 1

Example: 12,345,678 (International System)

= 1 × 10,000,000 + 2 × 1,000,000 + 3 × 100,000 + 4 × 10,000 + 5 × 1,000 + 6 × 100 + 7 × 10 + 8 × 1

= 10,000,000 + 2,000,000 + 300,000 + 40,000 + 5,000 + 600 + 70 + 8

Comparing Large Numbers

1. The number with more digits is greater. (e.g., 1,00,00,000 is greater than 99,99,999)
2. If the numbers have the same number of digits, start comparing the digits from the leftmost place. The number with the greater digit at the first point of difference is greater.

Example: Compare 5,67,89,123 and 5,67,79,123.

Both have 8 digits.

Crores place: 5 = 5

Ten Lakhs place: 6 = 6

Lakhs place: 7 = 7

Ten Thousands place: 8 > 7.

So, 5,67,89,123 > 5,67,79,123.

Ordering Large Numbers:

Arranging numbers from smallest to largest (ascending order) or largest to smallest (descending order) using the comparison rules.

Example: Arrange the following numbers in ascending order: 34,000,000; 3,500,000; 345,000,000; 3,000,000,000.

Solution: Convert to a common understanding of magnitude:

345,000,000 (345 Million)

34,000,000 (34 Million)

3,500,000 (3.5 Million)

3,000,000,000 (3 Billion or 3000 Million)

Smallest is 3.5 Million, then 34 Million, then 345 Million, then 3 Billion.

Ascending order: 3,500,000; 34,000,000; 345,000,000; 3,000,000,000.

Example 12 : Find the place value and face value of the digit 7 in the number 3,75,40,680.

Solution: The digit is 7.

Face Value of 7 is 7.

The digit 7 is in the Ten Lakhs place.

Place Value of 7 = 7 × 10,00,000 = 70,00,000 (Seventy Lakh).

Example 13 : Write 5,02,67,809 in expanded form.

Solution: 5,02,67,809 = 5 × 1,00,00,000 + 0 × 10,00,000 + 2 × 1,00,000 + 6 × 10,000 + 7 × 1,000 + 8 × 100 + 0 × 10 + 9 × 1

= 5,00,00,000 + 2,00,000 + 60,000 + 7,000 + 800 + 9

Example 14 : Compare 45,678,901 and 45,687,901 (International System).

Solution: Both numbers have 8 digits.

Ten Millions place: 4 = 4

Millions place: 5 = 5

Hundred Thousands place: 6 = 6

Ten Thousands place: 7 < 8.

So, 45,678,901 < 45,687,901.

Example 15 : Form the largest and smallest 8-digit number using the digits 1, 0, 3, 5, 7, 9, 2, 4 without repetition.

Solution: For the largest number, arrange digits in descending order: 9,75,43,210.

For the smallest number, arrange digits in ascending order, but '0' cannot be the first digit.

So, start with the next smallest digit (1), then place '0', then the rest in ascending order:

1,02,34,579.

Knowledge Checkpoint

- What is the place value of 0 in the number 1,05,67,892?
- Write the number 40,000,000 + 500,000 + 2,000 + 50 in standard form.
- Which is greater: 9,87,65,000 or 10,00,00,000?

Activity

Largest and Smallest Number Challenge

1. Provide each group of students with a set of 7-8 unique digit cards (e.g., 0, 2, 3, 5, 7, 8, 9).
2. Challenge them to form:
   a) The largest possible number using all digits.
   b) The smallest possible number using all digits (remind them '0' cannot be the leading digit unless it's a single-digit number, which is not the case here).
   c) The largest 5-digit number using any 5 of the given digits.
   d) The smallest 6-digit number ending with a specific digit (e.g., ending with 8).
3. Groups write down their numbers and then compare with other groups.

Real-life connection: Understanding how to arrange digits is fundamental in various coding and data sorting applications, or even setting high scores in games.

Key Terms

- **Place Value:** The value represented by a digit in a number on the basis of its position in the number.
- **Face Value:** The intrinsic value of a digit, irrespective of its position.
- **Expanded Form:** A way of writing numbers to see the mathematical value of individual digits (sum of place values).
- **Standard Form (Numeral):** The usual way of writing numbers using digits.
- **Ascending Order:** Arranging numbers from the smallest to the largest.
- **Descending Order:** Arranging numbers from the largest to the smallest.

Do It Yourself

Does the face value of a digit ever change within a number? Why or why not? Can the place value of the same digit be different in two different numbers? Give examples.

Fact Flash

- The Great Wall of China is about 21,000 km long, more than half the Earth's circumference.
- A human body has over 37 trillion cells.

Mental Mathematics

- Quickly identify the larger of two numbers by comparing the leftmost differing digit.
- What is the sum of the place values of all digits in 2,345?
- If you add 1 to 4,99,999, which place values will change?

Exercise 1.3

Gap Analyzer™ Homework | Watch Remedial

1. Find the place value and face value of the underlined digit:

a) 90176557 b) 73450052 c) 18942572 d) 65307142
e) 2900000 f) 4765123 g) 81235679 h) 69005420

2. Write the Numbers in Expanded Form:

a) 87,654 b) 3,09,128 c) 56,70,049 d) 1,23,45,678
e) 9,00,00,000 f) 25,08,10,300 g) 7,00,00,00,000 h) 4,12,34,56,789

3. Arrange the following numbers in ascending order:

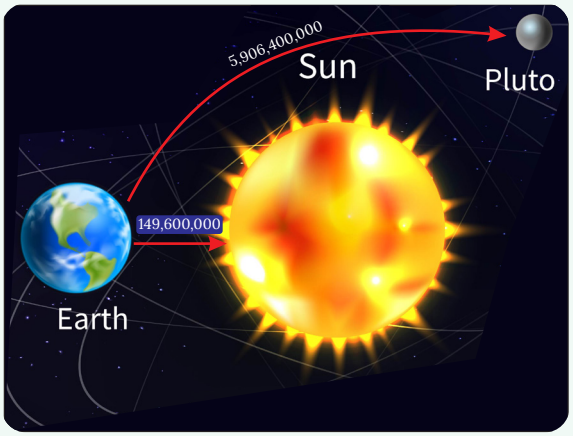
a) 56,000,000; 5,800,000; 565,000,000; 5,000,000,000.
b) 12,500,000; 1,300,000; 125,000,000; 1,000,000,000.
c) 78,000,000; 7,900,000; 789,000,000; 7,050,050,000.
d) 21,000,000; 2,300,000; 215,000,000; 2,000,830,000.

4. Arrange the following numbers in descending order

a) 87,000,000; 8,900,000; 875,000,123; 8,000,060,000.
b) 4,500,000; 45,000,000; 4,000,090,000; 456,080,000.
c) 67,000,000; 6,800,530; 678,000,000; 6,000,000,000.
d) 1,900,000,000; 19,000,000; 198,041,000; 1,900,000.

5. Consider the number 7,345,901,268.

a) What is the face value of the digit '5'?
b) What is the place value of the digit '3'?
c) In which place is the digit '0'?



6. The approximate distance from Earth to the Sun is 149,600,000 kilometers. The approximate distance to Pluto is 5,906,400,000 kilometers.

a) Which celestial body is further from Earth, the Sun or Pluto?
b) Arrange these distances in ascending order.
c) What is the difference between the distance to Pluto and the distance to the Sun? Write this difference in expanded form.

7. Here are some noteworthy facts you may have come across.

- The length of the Great Wall of China is about 21,196 kilometres.
- The area of Rajasthan, the largest state in India, is about 342,239 square kilometres.
- The population of Delhi is about 32,941,000, while the population of Mumbai is about 20,961,000.

Questions

i. In the number 342,239, find the place value and face value of the digit 4.
ii. Write the numbers 32,941,000 and 20,961,000 in their expanded forms according to the Indian System and the International System.
iii. Arrange the following numbers in ascending order:
- 21,196
- 342,239
- 32,941,000
- 20,961,000

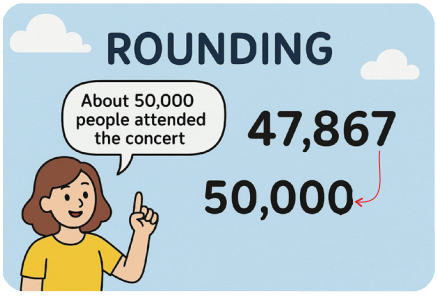
8. A large city consumed approximately 1,234,500,000 liters of water in a month. In the previous month, it consumed 1,230,000,000 liters.
   a) By how much did the water consumption increase in the current month compared to the previous month?
   b) What is the face value of the digit '5' in the current month's consumption?
   c) If we were to write the previous month's consumption in expanded form, which terms would be missing (have a coefficient of zero)?

Estimation and Rounding Large Numbers

In real life, we often use approximate numbers instead of exact ones. For example, saying "about 50,000 people attended the concert" is quicker than giving the exact count. This process, called **rounding**, means simplifying a number to the nearest ten, hundred, thousand, lakh, or million.

Sub-concepts to be covered

1. Rounding Rules
2. Rounding Up vs. Rounding Down in Context



Mathematical Explanation

Rounding Rules

1. Identify the rounding digit:

This is the digit in the place value you are rounding to (e.g., if rounding to the nearest thousand, the thousands digit is the rounding digit).

Example: Round 2,34,102 to the nearest thousand.

Solution: Rounding digit (thousands place) is 4. Digit to its right is 1 (which is < 5). Round down.
2,34,102 ≈ 2,34,000.

2. Look at the digit to its right:

- If this digit is 5 or greater (5, 6, 7, 8, 9), you round up. Increase the rounding digit by 1, and change all digits to its right to zero.
- If this digit is less than 5 (0, 1, 2, 3, 4), you round down. Keep the rounding digit as it is, and change all digits to its right to zero.

Example 16 : Rounding to the nearest Thousand. Round 4,56,789 to the nearest thousand.

Solution: Rounding digit (thousands place) is 6. Digit to its right is 7 (which is ≥ 5). Round up.
4,56,789 ≈ 4,57,000.

Example 17 : Rounding to the nearest Ten. Round 3,75,482 to the nearest ten.

Solution: Rounding digit (tens place) is 8. Digit to its right is 2 (which is ≤ 5). Round down.
3,75,482 ≈ 3,75,480.

Example 18 : Rounding to the nearest Hundred. Round 2,87,653 to the nearest hundred.

Solution: Rounding digit (hundreds place) is 6. Digit to its right is 5 (which is ≥ 5). Round up.
2,87,653 ≈ 2,87,700.

Example 19 : Rounding to the nearest Lakh. Round 7,89,54,321 to the nearest lakh.

Solution: Rounding digit (lakhs place) is 9. Digit to its right is 5 (which is ≥ 5). Round up.
The 9 (lakhs) becomes 10 lakhs, so it carries over.
7,89,54,321 ≈ 7,90,00,000 (Seven crore ninety lakh).

Example 20 : Rounding to the nearest Million (International System). Round 45,678,123 to the nearest million.

Solution: Rounding digit (millions place) is 5. Digit to its right is 6 (which is ≥ 5). Round up.
45,678,123 ≈ 46,000,000 (Forty-six million).

Rounding Up vs. Rounding Down in Context

Sometimes, the situation dictates whether it's better to round up or round down, even if the standard rule suggests otherwise (though for mathematical exercises, follow the rule).

Round Up Example

If you need at least 732 invitation cards, and they are sold in packs of 50, you'd round up your need to order enough. You'd calculate 732/50 ≈ 14.64, so you'd order 15 packs (750 cards).

Round Down Example

If you have a budget of ₹500 and an item costs ₹470, you might say you have "around ₹450 left" if you want to be cautious about spending, even though ₹470 rounds to ₹500 (nearest hundred).

Example 21 : Round 2,87,65,900 to the nearest lakh.

Solution: The lakhs digit is 7. The digit to its right is 6 (which is ≥ 5). So, we round up.
2,87,65,900 ≈ 2,88,00,000 (Two crore eighty-eight lakh).

Example 22 : Estimate the sum of 4,56,789 and 2,34,102 by rounding each number to the nearest ten thousand.

Solution: 4,56,789 rounded to the nearest ten thousand:
Ten thousands digit is 5. Digit to its right is 6 (≥ 5). Round up.
4,56,789 ≈ 4,60,000.
2,34,102 rounded to the nearest ten thousand:
Ten thousands digit is 3. Digit to its right is 4 (< 5). Round down.
2,34,102 ≈ 2,30,000.
Estimated sum = 4,60,000 + 2,30,000 = 6,90,000.

Example 23 : A city's population is 7,84,560. Round this to the nearest thousand and nearest lakh.

Solution: Nearest thousand: Thousands digit is 4. Digit to its right is 5 (≥ 5). Round up.
7,84,560 ≈ 7,85,000.
Nearest lakh: Lakhs digit is 7. Digit to its right is 8 (≥ 5). Round up.
7,84,560 ≈ 8,00,000.

Example 24 : Round 12,875,340 (International System) to the nearest million.

Solution: Millions digit is 2. Digit to its right is 8 (≥ 5). Round up.
12,875,340 ≈ 13,000,000 (Thirteen million).

Knowledge Checkpoint

- Round the numbers 47,832 and 21,395 to the nearest thousand and find their estimated sum.
- Estimate the product of 8,125 and 39 by rounding the numbers to their greatest place value.
- A concert hall has 295 rows, and each row has 98 seats. Estimate the total number of seats in the hall to determine if it can hold an audience of 30,000 people.

Activity

Estimation Shopping Spree

1. Create a mock shopping catalogue with items and their prices (use large, slightly irregular numbers, e.g., ₹1,285; ₹7,950; ₹23,499).
2. Give students a budget (e.g., ₹50,000).
3. In groups, students must "buy" items without exceeding the budget. They should first estimate the cost of each item by rounding (e.g., to nearest hundred or thousand) and keep a running estimated total.
4. After making their selections based on estimates, they calculate the exact total.
5. Discuss how close their estimates were and the importance of estimation in budgeting.

Real-life connection: This directly mimics real-world budgeting and shopping.

Key Terms

- **Estimation:** The process of finding an approximate value or quantity.
- **Rounding:** A method of estimation where a number is simplified to its nearest specified place value (e.g., nearest ten, hundred, thousand).
- **Approximate Value:** A value that is close to the exact value but not necessarily precise.
- **Rounding Digit:** The digit in the place value to which you are rounding.

Fact Flash

- The symbol "≈" is used to denote "**approximately equal to**." It was introduced by mathematician **Alfred George Greenhill in 1892**.
- Sometimes, for very large numbers, like populations of countries, estimates are given as a range (e.g., "population is between 1.3 and 1.4 billion") because exact counts are difficult and constantly changing.

Do It Yourself

Can rounding ever lead to significant errors? When might this happen? Consider a situation where you are multiplying two large numbers. If you round both numbers before multiplying, how might that affect the accuracy of your estimated product compared to multiplying first and then rounding?

Mental Mathematics

- Estimate the sum of 58,920 and 31,150 by rounding to the nearest ten thousand.
- What is the approximate difference between 8,145 and 2,958?
- Estimate the product of 697 and 41.
- A car travels 489 kilometers on a full tank of petrol. Estimate how many kilometers it can travel on 19 such tanks.
- Estimate the value of 35,890 divided by 9.
- Estimate the difference between 90,500 and 19,800 by rounding each number to the nearest thousand.

Exercise 1.4

Gap Analyzer™ Homework | Watch Remedial

1. **Rounding to the Nearest Place Value:**
   a) Round the number 4,58,367 to the nearest ten.
   b) What is 7,29,538 rounded to the nearest hundred?
   c) Round the number 6,03,812 to the nearest thousand.
   d) Round 18,72,450 to the nearest ten thousand.
   e) What is the number 53,67,890 when rounded to the nearest lakh?
   f) Round the number 3,78,45,120 to the nearest million.
   g) Round 24,65,78,900 to the nearest crore.
2. A total budget of ₹24,65,000 is allocated for a rural development project to be completed in 12 months. Estimate the approximate budget allocated per month by rounding the total budget to the nearest lakh and the number of months to the nearest ten.
3. The number of visitors to a national park in a year, when rounded to the nearest thousand, was reported as 1,45,000. What is the smallest possible actual number of visitors that year? What is the largest possible actual number?

4. **The annual revenue of Company X is ₹4,67,89,120 and Company Y is ₹8,21,34,560.**
   a) Round the revenue of Company X to the nearest lakh.
   b) Round the revenue of Company Y to the nearest ten lakh.
   c) Estimate the combined revenue of both companies by first rounding each company's revenue to the nearest ten lakh, and then adding the rounded figures.
5. **Study the table carefully and answer the questions that follow.**

Fact/Data	Number
Population of India (2024)	1,430,000,000
Length of the Great Wall of China	21,196 km
Annual Visitors to the Taj Mahal	6,497,000
Area of the Sahara Desert	9,200,000 sq. km

Questions

i. Round the population of India (1,430,000,000) to the nearest hundred million.If each person planted 1 tree, estimate how many trees would be planted using your rounded figure.
ii. Round the annual visitors to the Taj Mahal (6,497,000) to the nearest lakh (Indian System).
iii. Round the length of the Great Wall of China (21,196 km) to the nearest thousand. If a tourist walks 30 km each day, estimate how many days it would take to cover the rounded length.
iv. Round the area of the Sahara Desert (9,200,000 sq. km) to the nearest million.

6. A state government plans to build a new highway. The estimated costs for three sections are:
   a) ₹2,78,50,000,
   b) ₹25,20,75,000, and
   c) ₹9,65,00,000.
   Estimate the total cost of the highway project by rounding the cost of each section to the nearest crore.

Operations with Large Numbers

Now that we can read, write, and estimate large numbers, let's explore how to perform basic mathematical operations – addition, subtraction, multiplication, and division – with them. While the fundamental principles remain the same as with smaller numbers, working with large numbers requires careful organization and often involves estimation to check the reasonableness of our answers.

Sub-concepts to be covered

1. Addition and Subtraction
2. Multiplication
3. Division
4. Estimating Outcomes of Operations

Mathematical Explanation

The standard algorithms (step-by-step methods) for addition, subtraction, multiplication, and division that you learned for smaller numbers apply to large numbers as well.

Addition and Subtraction

Align the numbers vertically according to their place values (ones under ones, tens under tens, and so on). Add or subtract column by column, starting from the rightmost (ones) place, regrouping (carrying over or borrowing) as necessary.

Example: 3,45,67,890 + 1,02,34,567

Solution:

```
   3,45,67,890
+  1,02,34,567
-------------
   4,48,02,457
-------------
```

Example: 2,34,56,789 - 78,90,123

Solution:

```
   2,34,56,789
-     78,90,123
-------------
   1,55,66,666
-------------
```

Multiplication: Multiplying by powers of 10 (10, 100, 1000, etc.): To multiply a number by 10, 100, 1000, etc., simply add as many zeros to the right of the number as there are zeros in the power of 10.

Example: 4,56,000 × 100 = 4,56,00,000 (add 2 zeros).

Multiplying by other large numbers: This follows the standard long multiplication algorithm. It can be lengthy, so estimation is useful.

Example: 1,23,000 × 45. You can multiply 123 by 45 and then add three zeros.

Or, estimate: 1,20,000 × 50 = 60,00,000.

Division: Dividing by powers of 10 (10, 100, 1000, etc.): To divide a number by 10, 100, 1000, etc., remove as many zeros from the right of the number as there are zeros in the power of 10 (if the number ends in sufficient zeros). If not, the decimal point shifts to the left.

Example: 7,89,00,000 ÷ 1000 = 78,900 (remove 3 zeros).

Example: 4567 ÷ 100 = 45.67 (decimal shifts 2 places left).

Dividing by other large numbers: This uses the long division algorithm. Estimation of the quotient is very helpful.

Estimating Outcomes of Operations

Before performing exact calculations, especially with multiplication and division, it's good practice to estimate the result by rounding the numbers involved. This helps check if your final answer is reasonable.

Example 25 : Estimate 4,87,650 × 19.

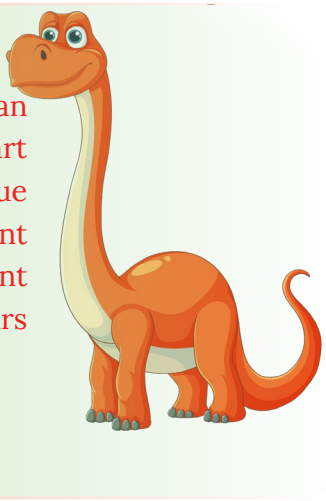
Solution: Round 4,87,650 to 5,00,000. Round 19 to 20.

Estimated product = 5,00,000 × 20 = 1,00,00,000 (1 Crore).

(Exact product: 4,87,650 × 19 = 92,65,350, which is close to 1 Crore).

1,50,000 ÷ 6000

A blue whale can weigh up to 1,50,000 kilograms. The heart of a blue whale can weigh nearly 700 kg, and its tongue weighs as much as an elephant. Its heart pumps nearly 2,20,000 liters of blood through its body. In a lifetime, a blue whale may eat nearly 36,00,00,000 kilograms of krill. An adult African elephant can weigh up to 6,000 kg, making it the largest land animal alive today. A giant sequoia tree can weigh over 2,000,000 kg, far heavier than the largest dinosaurs



Example 26 : A state has 2,34,500 primary schools. If, on average, each school needs 15 additional books for its library, estimate the total number of additional books needed for all schools. Then find the exact number.

Solution: Estimation: Round 2,34,500 to 2,30,000.

Estimated books = 2,30,000 × 15

= 23 × 15 × 10,000

= 345 × 10,000

= 34,50,000 books.

(Or round 2,34,500 to 2,00,000.

Estimated books = 2,00,000 × 15

= 30,00,000 books.)

Exact Calculation: 2,34,500 × 15

$$\begin{array}{r} 234500 \\ \times \quad 15 \\ \hline 1172500 \\ 2345000 \\ \hline 3517500 \\ \hline \end{array}$$

Exact number of books = 35,17,500 (Thirty-five lakh seventeen thousand five hundred).

Our first estimate (34,50,000) was closer.

Example 27 : A company produces 1,25,00,000 units of a product annually. If these are packed equally into boxes, and each box holds 100 units, how many boxes are needed?

Solution: Number of boxes = Total units ÷ Units per box
= 1,25,00,000 ÷ 100
= 1,25,000 (Remove two zeros from 1,25,00,000)
1,25,000 boxes are needed.

Example 28 : Estimate the quotient: 78,50,00,000 ÷ 390.

Solution: Round 78,50,00,000 to 80,00,00,000 (80 Crores).

Round 390 to 400.

Estimated quotient = 80,00,00,000 ÷ 400
= 80,00,000 ÷ 4 (Remove two zeros from both)
= 20,00,000 (Twenty Lakh).

Knowledge Checkpoint

- Estimate the sum of 5,12,340 and 2,89,700 by rounding each to the nearest lakh.
- What is 75,00,000 × 100?
- If you subtract 1,00,00,000 from 3,50,00,000, what is the result?

Activity

The Billion Dollar Project Plan

1. Divide students into groups. Each group is given a fictional budget of ₹100 Crore (or $1 Billion) to plan a large-scale community project (e.g., building a new park with multiple facilities, organizing a city-wide sports event, a tech innovation lab).
2. They must research or estimate costs for different components (land, construction, equipment, personnel, marketing etc.), ensuring their total estimated cost stays within the budget.
3. They need to list at least 5-7 major expense categories, assign estimated large number values to them, and then sum them up.
4. Groups present their project plans and budget allocations.

Real-life connection: This simulates real-world project planning, budgeting, and resource allocation which heavily involves operations with large numbers and estimation.

Key Terms

- **Sum:** The result of addition.
- **Difference:** The result of subtraction.
- **Product:** The result of multiplication.
- **Quotient:** The result of division.
- **Algorithm:** A step-by-step procedure for calculations.
- **Regrouping:** Carrying over (in addition/multiplication) or borrowing (in subtraction).

Fact Flash

- The word "**calculate**" comes from the Latin word "**calculus**," which means a small stone or pebble. In ancient times, pebbles were used on counting boards (**abacuses**) to perform calculations.
- Multiplication was once considered so difficult that in the 16th century, only university students were typically taught how to do it!

Do It Yourself

When performing multiple operations (e.g., adding several large numbers and then multiplying the sum by another number), does the order in which you round (if you are estimating) matter for the final estimated result? Try an example.

Mental Mathematics

- What is the sum of 4,50,000 and 200,000?
- Calculate 10,00,000 minus 999.
- What is 7,000 multiplied by 60?
- How many times does 500 go into 2,50,000?
- If a company earns a profit of ₹25,00,000 each quarter, what is its total profit in a year? (Hint: There are 4 quarters in a year.)

Gap Analyzer™ Homework | Watch Remedial

Exercise 1.5

1. **Estimate the following questions:**
   a) 3,98,760 × 42 b) 1,05,200 × 67 c) 8,51,999 × 12 d) 4,12,34,500 ÷ 78
2. A country has a population of approximately 138,00,00,000. If the land area is roughly 32,87,000 sq km, estimate the population density
3. A factory produces 38 toy cars per day. If they produce for 5 days and then have 120 cars already in stock, approximately how many cars do they have in total? (Round daily production to the nearest ten before multiplying.)

4. As of 2022, India had about 830,000,000 internet users, second only to China. Globally, the number of internet users reached 5,300,000,000. Every day, more than 300,000,000 hours of video are watched online worldwide.

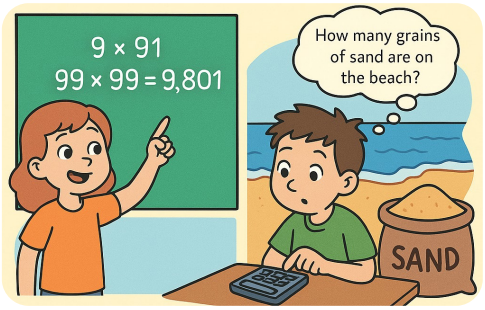
   Questions

   i. Write 830,000,000 in words using the Indian system.
   ii. How many more internet users are there in the world compared to India?
   iii. Express 300,000,000 hours in crores of hours.
   iv. If each user in India spends on average ₹50 per month on internet services, calculate the total monthly revenue.

5. A factory produced 5,678,000 units in the first quarter and 6,123,000 units in the second quarter. If they aim to produce 25,000,000 units annually, how many more units do they need to produce in the remaining two quarters?
6. An investor started with ₹5,000,000. In the first year, their investment grew by ₹1,250,000. In the second year, they withdrew ₹750,000. What is the current value of their investment?

Patterns in Products and Real-World Applications of Large Numbers

Mathematics is full of beautiful patterns! Discovering these patterns can often lead to shortcuts for calculations, making complex problems simpler. In this section, we'll explore some interesting patterns in multiplication. Furthermore, we'll see how our understanding of large numbers, estimation, and operations can be applied to solve intriguing real-world problems and answer "**Did you ever wonder...?**" type questions that involve vast quantities.



Sub-concepts to be covered

1. Multiplication Shortcuts/Patterns
2. Product of numbers consisting only of 1s
3. Multiplying by numbers consisting only of 9s (e.g., 9, 99, 999)
4. Real-World Applications (Estimation and Large Number Sense)

Mathematical Explanation

Multiplication Shortcuts/Patterns

1. Multiplying by 5

To multiply a number by 5, you can multiply it by 10 and then divide by 2.

Since $5 = \frac{10}{2}$

Example:
$$846 \times 5 = 846 \times \frac{10}{2} = \frac{(846 \times 10)}{2} = \frac{8460}{2} = 4230$$

2. Multiplying by 50

Multiply by 100, then divide by 2.

Since $50 = \frac{100}{2}$

Example:
$$324 \times 50 = 324 \times \frac{100}{2} = \frac{(324 \times 100)}{2} = \frac{32400}{2} = 16200$$

3. Multiplying by 25

To multiply a number by 25, you can multiply it by 100 and then divide by 4.

Since $25 = \frac{100}{4}$

Example:
$$488 \times 25 = 488 \times \frac{100}{4} = \frac{(488 \times 100)}{4} = \frac{48800}{4} = 12200$$

4. Multiplying by 125

To multiply a number by 125, you can multiply it by 1000 and then divide by 8.

Since $125 = \frac{1000}{8}$

Example:
$$64 \times 125 = 64 \times \left(\frac{1000}{8}\right) = \frac{64 \times 1000}{8} = \frac{64000}{8} = 8000$$

Product of numbers consisting only of 1s

$1 \times 1 = 1$
$11 \times 11 = 121$
$111 \times 111 = 12321$
$1111 \times 1111 = 1234321$
$11111 \times 11111 = 123454321$

The digits ascend to the number of 1s and then descend. This pattern holds up to nine 1s.

Multiplying by numbers consisting only of 9s (e.g., 9, 99, 999)

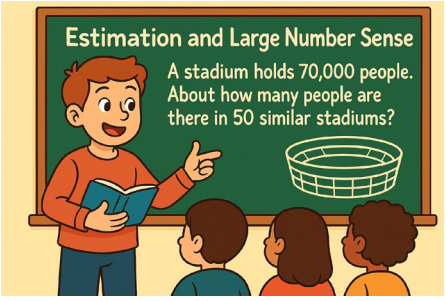
A number × 9 = (A number × 10) − A number

Example: $78 \times 9 = (78 \times 10) - 78 = 780 - 78 = 702$.

A number × 99 = (A number × 100) − A number

Example: $45 \times 99 = (45 \times 100) - 45 = 4500 - 45 = 4455$.

Real-World Applications (Estimation and Large Number Sense)



Many real-world questions involve estimating large quantities where exact calculation is difficult or unnecessary. This often involves:

- Making reasonable assumptions.
- Breaking the problem down into smaller, manageable parts.
- Using rounding and basic operations with large numbers.

Example 29 : How many buses would be needed to transport 1,50,000 people if each bus can hold 60 people?

Solution: Calculation: 1,50,000 ÷ 60 = 15,000 ÷ 6 = 2,500 buses.

Example 30 : Calculate 588 × 25 quickly using the shortcut.

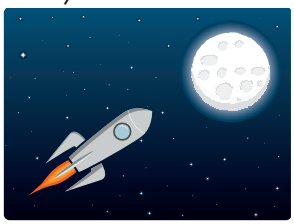
Solution:

$$588 \times 25 = \frac{(588 \times 100)}{4}$$
$$= \frac{58800}{4}$$
$$= 14700$$

36,00,00,00,000 ÷ 12

In 2021, global carbon dioxide emissions were about 36 billion tons. If this were spread evenly over 12 months, how many tons would that be per month?

Example 31 : The distance to the Moon is approximately 3,84,000 km. If a spacecraft travels at an average speed of 8,000 km per hour, estimate how many hours it would take to reach the Moon.



Solution: Time = Distance ÷ Speed

Estimate: Round 3,84,000 km to 4,00,000 km for easier division by 8,000 km/hr.

Time ≈ 4,00,000 km ÷ 8,000 km/hr

Time ≈ 400 ÷ 8 (removing three zeros from both)

Time ≈ 50 hours.

(Exact: 3,84,000 ÷ 8,000 = 384 ÷ 8 = 48 hours. The estimate is close.)

Example 32 : A factory aims to produce 1,00,00,000 screws. If one machine produces 250 screws per minute, how many minutes will it take? Convert this to hours (approx).

Solution: Total screw 1,00,00,000 (Minutes = Total screws ÷ Screws per minute)

Minutes = 1,00,00,000 ÷ 250

$$\text{To Simplify, } 1,00,00,000 \div 250 = 1,00,00,000 \div \left(\frac{1000}{4}\right)$$

$$= \frac{1,00,00,000 \times 4}{1000}$$

$$= 10,000 \times 4$$

$$= 40,000 \text{ minutes.}$$

$$\text{Alternatively, } \frac{1,00,00,000}{250} = \frac{10,00,000}{25}$$

$$= \frac{10,00,000 \times 4}{100}$$

$$= \frac{40,00,000}{100}$$

$$= 40,000 \text{ minutes.}$$

Hours = Minutes ÷ 60

Hours = 40,000 ÷ 60 = 4000 ÷ 6 ≈ 666.67 hours.

Approximately 667 hours.

Knowledge Checkpoint

- How would you quickly calculate 320 × 50?
- If 111 × 111 = 12321, what is a likely product for 1111 × 1111 based on the pattern?
- To estimate the number of people in 300 cars, if each car typically holds 3 people, what is your quick estimate?

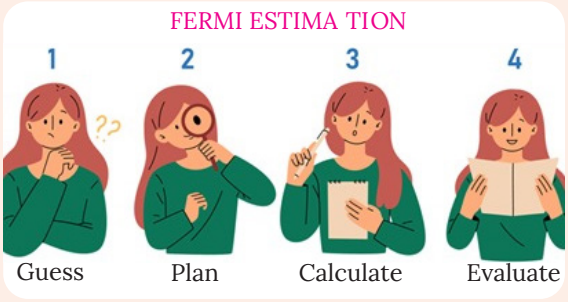
Key Terms

- **Pattern:** A regularly repeated arrangement or sequence in numbers or shapes.
- **Shortcut:** A quicker method to achieve a result, often based on a pattern or property.
- **Estimation:** The process of finding an approximate value.
- **Application:** The use of mathematical concepts in real-world situations.
- **Fermi Problem:** An estimation problem designed to teach dimensional analysis, approximation, and the importance of clearly identifying assumptions.

Activity

Fermi Problems - Estimation Challenge

1. **Introduce Fermi Problems:** These are estimation problems named after physicist Enrico Fermi, famous for his ability to make good approximate calculations with little or no actual data.
2. **Pose questions like:**
   a) "How many piano tuners are there in our city?"
   b) "How many grains of rice would fill a 1-liter bottle?"
   c) "How many times does a person blink in a lifetime?"
3. **In groups, students must:**
   a) Identify necessary assumptions (e.g., population of city, hours a tuner works, size of a rice grain, aver age lifespan).
   b) Break down the problem.
   c) Make estimations for each part using large numbers where appropriate.
   d) Calculate a final estimate.
4. Groups present their estimation process and reasoning.



Real-life connection: This develops critical thinking, problem-solving, and the ability to make reasoned judgments with incomplete information, a valuable skill in many fields.

Fact Flash

A "**googolplex**" is 1 followed by a googol (10^{100}) zeros. It's so large that it cannot be written down in standard decimal notation, as it would require more digits than there are atoms in the observable universe.

Do It Yourself

How do scientists estimate quantities like the number of stars in a galaxy or the number of atoms in the Earth? What kind of assumptions and calculations might they use?

Mental Mathematics

- Practice multiplication shortcuts:

  $$32 \times 125 = \left(\frac{32000}{8}\right)$$

- Estimate products quickly: 48 × 19?
- Using patterns: What is 67 × 9?
- The government of a city with a population of 4 million decides to plant 50 trees for every resident over the next decade. How many trees will be planted in total?
- A popular creator's new video gets 25,000 views every hour. How many views will it have after 8 hours?
- Your school library is ordering 102 copies of a new graphic novel for different sections. If each copy costs ₹200, what is the total cost of the order?

Exercise 1.6

Gap Analyzer™ Homework | Watch Remedial

1. **Let P = 2,500,000 and Q = 0.005.**
   a) Calculate P × Q. b) Calculate P ÷ 500. c) Calculate Q × 2000.
2. **A city library has 4,200 shelves, and each shelf can hold an average of 115 books.**
   a) Calculate the total number of books the library can currently hold.
   b) If the library plans to add 800 more shelves with the same capacity, how many books will the expanded library be able to hold in total?

3. If one standard sheet of A4 paper is approximately 0.1 millimeters thick, estimate the height (in centimeters and meters) of a stack of 1,00,000 (one lakh) sheets of paper.

4. A country has approximately 7,500 kilometers of coastline. If lighthouses are to be placed roughly every 25 kilometers, estimate how many lighthouses would be needed.
5. In cricket, if a batsman scores 100 runs in 50 balls, his strike rate is 200. If he scores 200 runs in 100 balls, his strike rate is also 200. This shows a pattern: doubling both runs and balls keeps the strike rate constant.

   Questions
   i. If a batsman scores 300 runs in 150 balls, what is his strike rate?
   ii. Write the common pattern in all three cases.
   iii. A batsman scores 75 runs in 25 balls. Is his strike rate more or less than 200?
   iv. Why is strike rate an example of a real-life ratio with large numbers?

Common Misconceptions

Misconception: More digits always mean a larger number.
Example Error: Thinking that 99,000 is greater than 1,00,000 because it looks longer.
Correction: Place value matters more than length — 1,00,000 > 99,000 even if the latter looks bigger.

Misconception: Confusing Indian and International place value systems.
Example Error: Reading 1,00,000 as "one million" instead of "one lakh".
Correction:

In the Indian system: 1,00,000 = One Lakh

In the International system: 100,000 = One Hundred Thousand

Misconception: Misreading commas and number names.
Example Error: Reading 10,00,000 as “ten thousand” instead of “ten lakh.”
Correction: Understand the comma placement:
Indian: 10,00,000 = Ten Lakh
International: 1,000,000 = One Million

Real-Life Large Numbers: Mathematical Applications

1. **Population Comparison:** To understand how populations differ between states.
   Expression: 14,10,00,000 (UP) − 6,80,000 (Sikkim)
2. **Budget Planning:** Governments manage huge amounts through budgeting.
   Expression: Total Budget ₹1,00,00,00,00,000 − Health Allocation ₹7,50,00,00,000
3. **Cricket Match Analysis:** Total score made by three players in a match.
   Expression: Virat (134) + Rohit (98) + Rahul (76)
4. **Space Travel Estimation:** To calculate the round-trip distance from Earth to the Moon.
   Expression: 3,84,400 km × 2
5. **School Expenses Calculation:** Finding total annual expense for all students.
   Expression: 950 students × ₹12,000 per student

Gap Analyzer™
Complete Chapter Test

EXERCISE

A. Choose the correct answer.

1. **The number 5,07,83,204 is read in the Indian system as:**
   a) Five crore seventy-eight lakh thirty-two thousand four ☐
   b) Five crore seven lakh eighty-three thousand two hundred four ☐
   c) Fifty lakh seventy-eight thousand three hundred twenty-four ☐
   d) Five crore seven lakh eighty-three thousand twenty-four ☐
2. **How many millions are there in 3 Crores?**
   a) 3 million ☐ b) 30 million ☐ c) 300 million ☐ d) 0.3 million ☐
3. **The place value of 6 in the number 26,78,90,123 is:**
   a) 6 Lakhs ☐ b) 60 Lakhs ☐ c) 6 Crores ☐ d) 60 Crores ☐
4. **78,542 rounded to the nearest thousand is:**
   a) 78,000 ☐ b) 79,000 ☐ c) 78,500 ☐ d) 80,000 ☐
5. **Which of the following is the largest number?**
   a) 9,87,65,432 ☐ b) 10,00,00,001 ☐
   c) 99,99,99,999 ☐ d) 1,00,00,00,000 ☐

Assertion & Reason

In each of the following questions, an Assertion (A) and a corresponding Reason (R) supporting it is given. Study both the statements and state which of the following is correct:

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) A is false but R is true.

1. **Assertion (A):** 100 million is equal to 10 crore.
   Reason (R): 1 million = 10 lakhs and 1 crore = 100 lakhs.
2. **Assertion (A):** When 7,48,500 is rounded to the nearest lakh, the result is 7,00,000.
   Reason (R): To round to the nearest lakh, we look at the ten thousands digit. If it is 5 or more, we round up the lakhs digit.
3. **Assertion (A):** The expanded form of 3,05,007 is 3,00,000 + 5,000 + 7.
   Reason (R): Expanded form is the sum of the place values of each digit.

Case Study

Space Mission Budget: NASA's Artemis program aims to return humans to the Moon. Suppose the estimated cost for one phase of the program is $28,000,000,000 (28 billion USD).

a) Write this cost in words using the International system.

b) If 1 USD is approximately ₹80, convert this estimated cost into Indian Rupees (in crores).

c) If this amount was to be spent over 5 years, what would be the approximate annual spending in rupees (crores)?

Project

"My Dream City Budget"

Imagine you are the mayor of a new city with a planned population of 10,00,000 (10 lakh or 1 million) people. You have been allocated an initial development budget of ₹5,000 Crores.

1. **Research & Plan:** Identify at least 5 key sectors essential for your city (e.g., Housing, Schools, Hospitals, Roads & Transport, Parks & Recreation, Water & Sanitation, Safety).
2. **Allocate Funds:** Decide how much of your ₹5,000 Crore budget you will allocate to each sector. Express these amounts in crores and lakhs. Make sure your total allocation does not exceed the budget.
3. **Justify:** For each sector, briefly explain why you allocated that amount and what kind of development you envision (e.g., "₹800 Crores for 200 new schools and upgrading existing ones").
4. **Presentation:** Create a simple budget report or a visual presentation (poster/slides) showing your city's name, your sector allocations, and justifications. Use large numbers clearly.

Source-Based Question

India's Progress Against Poverty

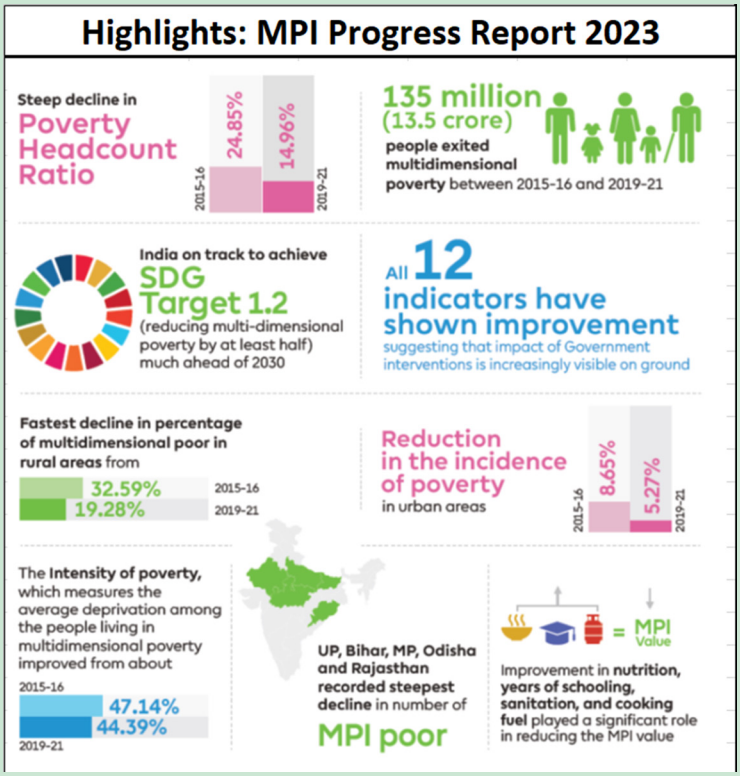
Directions: Read the following text and analyze the infographic about India's progress in reducing multidimensional poverty. Then, answer the questions that follow.

Source Text

According to a report by NITI Aayog, the Government of India's public policy think tank, India has made remarkable progress in its fight against poverty. The report, titled "National Multidimensional Poverty Index: A Progress Review 2023," found that a total of 13.5 crore people moved out of multidimensional poverty between the years 2015-16 and 2019-21.

The decline was particularly notable in rural areas. The fastest reductions were seen in some of India's most populous states. For instance, Uttar Pradesh saw the largest decline with 3.43 crore people exiting poverty, followed by Bihar with 2.25 crore and Madhya Pradesh with 1.36 crore. This achievement is a significant step towards the nation's development goals.

(Source: Adapted from NITI Aayog & PIB reports, 2023)



Questions

a) The source states that 13.5 crore people moved out of poverty. Write this number in figures, using commas correctly as per the Indian System of Numeration.

b) According to the data, which state saw a larger reduction in the number of poor people: Bihar or Madhya Pradesh? By how much did the reduction in one state exceed the other?

c) What is the combined number of people who moved out of poverty in the three states mentioned in the infographic (Uttar Pradesh, Bihar, and Madhya Pradesh)?

d) The total number of people who exited poverty in India was 13.5 crore over a 5-year period. First, convert this number to the International System (in millions). Then, estimate the average number of people who exited poverty per year by rounding the total to the nearest crore before dividing.

Large Numbers Around Us

Lakhs and Crores: The Indian System of Numeration

- **Periods:** Crores, Lakhs, Thousands, Ones
- **Comma Pattern:** 3,2,2,2
- **Key Values:**
  - ✓ 1 Lakh = 100 thousands
  - ✓ 1 Crore = 100 lakhs

Working with Large Numbers

- **Face Value:** Actual digit
- **Place Value:** Digit × its position
- **Expanded Form:** Sum of place values
- **Comparing Numbers:**
  - ✓ More digits → Greater
  - ✓ Equal digits → Compare left to right
- **Ordering:** Ascending / Descending

Operations with Large Numbers

- **Addition/Subtraction:** Align digits, carry/borrow
- **Multiplication:** Long method; powers of 10 → add zeros
- **Division:** Long division; powers of 10 → remove zeros/shift decimal).

The International System & Comparison

- **Periods:** Billions, Millions, Thousands, Ones
- **Comma Pattern:** 3,3,3,3...
- **Key Values:**
  - ✓ 1 Million = 10 Lakhs
  - ✓ 10 Million = 1 Crore

Estimation and Rounding

- **Rules:**
  - ✓ Identify rounding digit
  - ✓ Check right digit → 0–4 round down; 5–9 round up
- **Example: 4,56,789 → 4,57,000 (nearest thousand)**

Patterns & Real-World Applications

- **Multiplication Shortcuts:**
  - ✓ ×5 → ×10 ÷2
  - ✓ ×25 → ×100 ÷4
  - ✓ ×125 → ×1000 ÷8
  - ✓ ×9, 99, 999 → ×(10−1), (100−1), (1000−1)
- **Real-Life Use:** Population, distances, money, statistics