8

MATH GENIUS

Think Smart, Solve Fast

Lesson Plan

Experience the Joy of Learning Mathematical Skills

ORANGE

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PREFACE

The Teacher's Resource Manual is specially developed for teachers using **Math Genius** Coursebooks. The manual has been designed to provide the teacher with additional materials and support that they may require to effectively teach the coursebook. Each **Teacher's Resource Manual** is completely mapped with its coursebook. The method of teaching/learning suggested in the book is completely based on the Gamified Learning method which supports guidelines and aids of classroom teaching as per the New Education Policy 2020. The classroom teaching/learning activity helps to allay the fear of Mathematics from the minds of the learners and develops an inherent link for the subject.

Each **Teacher's Resource Manual** has two segments—Chapter-wise detailed **Lesson Plans** and **Practice Materials** in the form of **Worksheets**.

Features of the Teacher's Resource Manual:

Detailed Lesson Plan: It contains topics to be covered in the chapter, Suggested Allocation of Periods, Teaching Objectives, Learning Objectives and Suggested Teaching Aids.

- It enhances students' curiosity, interest, and engagement and help them access prior knowledge.
- It provides students with opportunities to construct learning experience through activities.
- It enables both teachers and students to recognise the impact of learning, reflect on what has been learned, and evaluate how it was learned.

Worksheets: This segment has worksheets for each chapter which can be used for practice and evaluation of learners' understanding of the concepts taught. At the end, answers to each worksheet have been given.

A teacher has to use his/her experience and expertise in teaching the subject. This **Teacher's Resource Manual** provides some methodology in this regard but in no way does it limit the scope of the teaching. As per the interest, experience and proficiency of the teaching, you are advised to make suitable additions and modifications to the methodology being discussed.

Suggestions for the improvement of the book by the teacher's community will be gratefully acknowledged by us.

—Publisher

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Part-1

Part-2

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PART-1

A square and A cube

Learning Objectives

After studying this chapter, students will be able to...

- identify square numbers
- recognise some interesting patterns of square numbers
- find square roots using different methods
- estimate square roots
- identify perfect cubes
- understand the properties of cube numbers
- find cube roots using different methods
- estimate cube roots
- apply the concepts of square, square root, cube and cube root in real-life situations

LESSON PLAN

Suggested number of periods: 20

Suggested Teaching Aids: Textbook Math Genius 8, blackboard or whiteboard, pens, pencils, chalk/ marker, notebook, paper, chit/number cards/flash cards, chart of square numbers from 1 to 150, etc.

Keywords: Square, Square Root, Perfect squares, Factorisation, Long Division Method, Cube, Cube root, perfect cube, etc.

Prerequisite knowledge: Students must be familiar with multiplication and division, prime numbers, powers and exponents, factorisation and number patterns.

NEP feature: This method of teaching provides experiential learning opportunities to the students and allows them to work with each other, which helps in their holistic development.

Periods: 1–3	Topics: Introduction – Square of a Fraction, Factor of Square Numbers, Perfect Squares	NEP Skills: Discussion-Based Learning, Collaborative Learning

TEACHER-PUPIL ACTIVITY

The teacher will start the topic interactively by asking questions related to the students' real-life experiences. For example,

- What happens if you multiply a number by itself? Can you think of any examples?
- If 4 students stand in each row and there are 4 rows, how many students are there?
- If a notebook page has 6 boxes in one row and there are 6 rows, how many boxes are there?
- If the side of a square garden is 7 meters, what is the area of the garden?

By asking these questions, she can introduce the concept of a square number.

The teacher will revise the learners' previous knowledge of numbers with the help of the "Get Ready "and "Let's Recall" sections given in the book.

Ask the student to prepare bingo cards with random numbers on them (some square numbers and some non-square numbers). The teacher will call out the square number (example: 1, 4, 9, 16, 25, etc.). Students need to mark the square numbers on their cards. The first student to complete a row or column of square numbers shouts "Bingo!".

Monitor Students' participation and engagement during the activities.

The teacher will introduce the term "square number" and explain that a square number is the result when a number is multiplied by itself. Next, the teacher can explain how to square a fraction.

The teacher can also demonstrate how to find the factors of square numbers by writing the factors in tree form. For example, to find the factors of 36, the teacher would use a factor tree to break it down into prime factors.

Additionally, the teacher can explain the difference between square numbers and non-square numbers. A non-square number is one that cannot be expressed as the product of an integer multiplied by itself. For example, 2, 7, and 10 are non-square numbers.

Next, the teacher will introduces the topic of factorisation. Factorisation is an effective method to determine whether a number is a perfect square. This method involves breaking down the number into its prime factors and then checking if all prime factors come in pairs. If they do, the number is a perfect square.

Here's a step-by-step explanation:

Step 1: Prime Factorisation

First, find the prime factors of the number. This means breaking the number down into its prime factors (numbers that are only divisible by 1 and themselves).

Let us take an example – For 36

1. Start with the smallest prime number, 2:
   $36 \div 2 = 18$
2. Now factor 18:
   $18 \div 2 = 9$
3. 9 is not divisible by 2, so move to the next smallest prime number, 3:
   $9 \div 3 = 3$
4. 3 is already a prime number, so:
   $3 \div 3 = 1$

- Prime factorisation of 36: $36 = 2 \times 2 \times 3 \times 3$.

Step 2: Check for Pairs of Prime Factors

Next, check if all prime factors appear in pairs. For a number to be a perfect square, each prime factor must appear an even number of times (since each factor is multiplied by itself).

For 36:

- Prime factorisation: $36 = 2 \times 2 \times 3 \times 3$.
- Here, the prime factors 2 and 3 appear in pairs.
  - 2 appears twice (which is an even number).
  - 3 appears twice (which is an even number).

Since all prime factors appear in pairs, 36 is a perfect square.

Step 3: Conclusion

- Perfect Square: If every prime factor appears an even number of times (in pairs), the number is a perfect square.
- Non-Perfect Square: If any prime factor appears an odd number of times, the number is not a perfect square.

EXPLANATION

Take reference of pages 8-11 of Math Genius 8 to explain about square numbers, square of a fraction, factors of a square numbers, and perfect squares.

ASSIGNMENTS

Class work: Discuss 'Be aware' of page 9, 'Fast Check' given on pages 10 and 11, 'Math Insight' given on page 10 and ask to practise Q.1, 2,3 and 4 of Practice Time 1A.

Homework: Ask to practise Q.5-6 of Practice Time 1A.

Periods: 4–6	Topics: Properties of Square Numbers, Interesting Pattern of Square Numbers	NEP Skills: Conceptual and Collaborative Learning, Discussion-Based Learning

TEACHER-PUPIL ACTIVITY

The teacher will reiterate the topic of square numbers learnt in previous classes by asking some questions.

- What happens when you multiply a number by itself?
- Can you give me some examples of square numbers?
- If I give you the number 49, how can you check if it's a square number?
- If you want to build a square-shaped garden with a side length of 6 metres, how would you calculate the area of the garden? Is the area a square number?

Tell the students to discuss the answer with their bench partners.

Hang a chart of square number up to 50 on a wall or display it on the board. The teacher will also write some non-square numbers on board.

The teacher will ask the students to observe the unit digits of each square number and non-square numbers.

The expected response from students that "A square number always ends in 0, 1, 4, 5, 6 or 9 and the number having 2, 3, 7 or 8 at the units place is never a square number".

Further, the teacher will discuss that "The number of zeros at the end of a perfect square number is always even".

Next, property the pupils will observe that "Squares of an even number is always even and squares of an odd number is always odd".

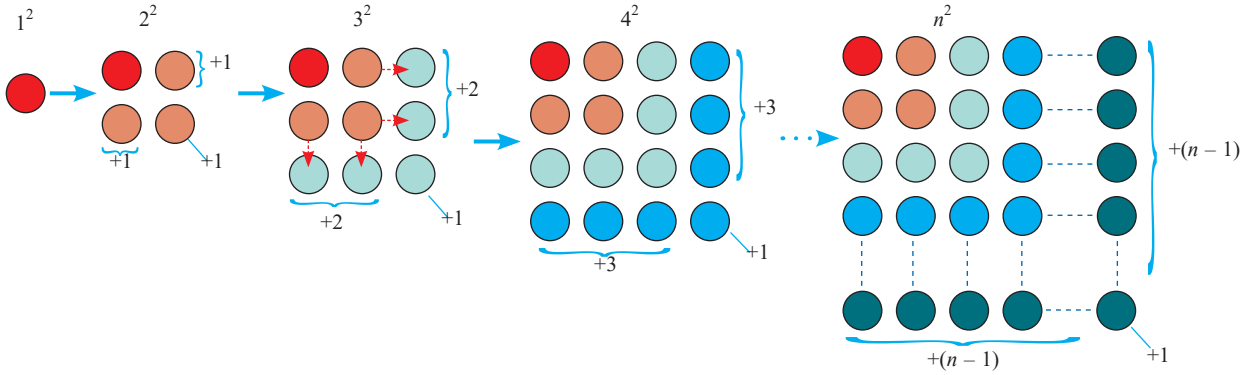
The teacher will also demonstrate that if a number ends with 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 then its square ends with 0, 1, 4, 9, 6, 5, 6, 9, 4, and 1 respectively.

Further, the teacher will discuss that "For every natural number n, the difference of the squares of two consecutive natural numbers is equal to their sum,

i.e., $(n + 1)^2 - n^2 = (n + 1) + n$.

Next, teacher will discuss some interesting patterns of square numbers, like:

Square numbers: square numbers can be represented by dots.



It can be represented as

$1^2 + (1 + 1 + 1) = 2^2$ or $1^2 + 2 \times 1 + 1 = 2^2$

…….

…….

…….

$4^2 + (4 + 4 + 1) = 5^2$ or $4^2 + 2 \times 4 + 1 = 5^2$

…….

……..

……..

$(n - 1)^2 + 2(n - 1) + 1 = n^2$

Similarly, teacher will demonstrate on the board that the sum of consecutive natural numbers make triangular numbers, like:

$1 = 1$, $1 + 2 = 3$, $1 + 2 + 3 = 6$, $1 + 2 + 3 + 4 = 10$ …and so on.

Also discuss about the following patterns:

- The sum of the first n odd natural numbers is n^2.
- The product of two consecutive even/odd numbers is equal to the square of the number that lies between them minus 1.
- The square of any odd natural number other than 1, can be expressed as the sum of two consecutive natural numbers.

In this way, the teacher will explain all the patterns in detail.

The teacher can emphasise the fact that the square of any odd natural number always results in a perfect square. The square of even numbers follows a similar pattern but results in different square numbers. Encourage students to explore other patterns on their own, and ask them to look for square numbers ending in other digits (e.g., 4, 5, 6, etc.).

EXPLANATION

Take the reference of pages 12-18 of 'Math Genius 8' to explain about the properties of square numbers, and interesting patterns of square numbers in detail.

ASSIGNMENTS

Classwork: Discuss 'Fast Check' given on page 14, 'Think Tank' given on page 18 and ask to practise Q. 1, 3, 4, 5 and 6 of Practice Time 1B.

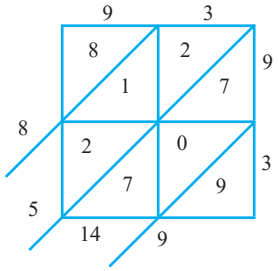
Homework: Ask to practise the remaining questions of Practice Time 1B.

Periods: 7–9	Topics: Finding the square of a number	NEP Skills: Conceptual Learning, Discussion-Based Learning

TEACHER-PUPIL ACTIVITY

Teacher will demonstrate on board, the different methods of finding the square of a number, like:

- Using the distributive property
  For example: $45^2 = (40 + 5)^2 = (40 + 5)\,(40 + 5) = 40\,(40 + 5) + 5\,(40 + 5)$
  $= 40 \times 40 + 40 \times 5 + 5 \times 40 + 5 \times 5 = 1600 + 200 + 200 + 25 = 2025$
- Square of natural numbers ending with 5.
  For example: $35^2 = 1225 = (3 \times 4)$ hundreds + 25
- Square of a number near 10, 100, 1000, …
  For example: To find the square of 97.
  Here, the nearest base = 100(two 0s)
  And, the difference = 97 – 100 = –3
  Hence $97^2 = 97 - 3 \mid 3^2 = 94 \mid 09$ (Since the base 100 has two zeros, '9' becomes '09')
  $= 9409$
- Square using Lattice/Diagonal method
  For example: To find the square of 93,



Thus, $93^2 = 8 \mid 5 \mid 14 \mid 9 = 8 \mid 5 + 1 \mid 4 \mid 9 = 8649$.

ASSIGNMENTS

Classwork: Ask to solve 'Fast Check' given on page 20 and practise Q.1, Q.2, Q.3-(*a*) to (*d*) and Q.4-(*a*) to (*d*) of Practice Time 1C.

Homework: Ask to practise the remaining questions of Practice Time 1C.

Periods: 10–13	Topic: Square Roots of Numbers	NEP Skills: Conceptual Learning, Discussion-Based Learning and Experiential Learning

TEACHER-PUPIL ACTIVITY

The teacher will start the class by introducing that the square root of a number is the value that, when multiplied by itself, gives the original number. In other words, the square root is the inverse operation of squaring a number.

For example: $4^2 = 16$, so $\sqrt{16} = 4$, i.e., the square root of 16 is 4, because $4 \times 4 = 16$

The square root of a number is written using the radical symbol $\left(\sqrt{\ }\right)$.

Use a visual area model to introduce square roots. Draw squares of varying sizes—such as 16 and 25 square units—on the grid or board. Ask students to identify the side length of each square by counting the units. This activity concretely illustrates that the square root of a number is the length of the side of a square with that specific area.

Further, the teacher will introduce different methods for finding the square roots by the following methods:

- **Repeated subtraction method**

  For example: Find the square root of 36.

  Step 1: 36 – 1 = 35 **Step 2:** 35 – 3 = 32 **Step 3:** 32 – 5 = 27

  Step 4: 27 – 7 = 20 **Step 5:** 20 – 9 = 11 **Step 6:** 11 – 11 = 0

  Students will count, that it took 6 steps to reach zero.

  So, $\sqrt{36} = 6$.

- **Prime factorisation method**

  For example: Let us find its square root of 144 using the prime factorisation method.

  Students will factorise $144 = 2 \times 2 \times 2 \times 2 \times 3 \times 3$

  So, $\sqrt{144} = 2 \times 2 \times 3 = 12$

2	144
2	72
2	36
2	18
3	9
3	3
	1

- **Long division method**

  When the numbers given are large even the prime factorisation method is tedious and time consuming. So, we use the long division method.

  For example: Find the square root of 390625 using the long division method.

  The teacher will demonstrate on board that,

  We have,

	6 2 5
6	$\overline{39}\ \overline{06}\ \overline{25}$
	–36
122	306
	–244
1245	6225
	–6225
	0

  So, $\sqrt{390625} = 625$

  Further, the teacher will discuss that for non-perfect squares, the square root is not an integer but can still be approximated.

EXPLANATION

Take the reference of pages 23-28 of 'Math Genius 8' to explain in detail the different methods of finding squares roots of numbers on board.

ASSIGNMENTS

Classwork: Discuss 'Math Insight' given on pages 25 and 27 and 'Fast Check' given on page 27 and ask student to practise Q. 1, 2, 4, 5 and 6 of Practice Time 1D.

Homework: Ask to practise the remaining questions of Practice Time 1D.

Periods: 14–16	Topics: Cube, Perfect Cube, Properties of Perfect Cube, Some interesting patterns of cube numbers	NEP Skills: Logical Thinking, Experiential Learning, Discussion-Based Learning

TEACHER-PUPIL ACTIVITY

The teacher can start the topic in the classroom in an interactive way. For this, she can ask some questions related to the students' real life. For example,

- If I give you the length of a side of a cube, how do you think we could find how much space is inside?
- What happens if you try to find the volume of a cube? How would you calculate that?
- Have you ever heard of a cube in maths? Can anyone guess what a cube could mean?
- What happens when we multiply a number by itself three times?

After accepting students' answers to the initial questions, the teacher can proceed with introducing the definition and explaining the concept of the cube, the cube of a number is found by multiplying that number by itself three times. For example, the cube of 2 is written as $(2)^3 = 2 \times 2 \times 2 = 8$.

The cube of a negative number is negative. This is because when a negative number is multiplied by itself three times, the result is negative. For example: $(-3)^3 = (-3) \times (-3) \times (-3) = -27$

The teacher can emphasise the fact that multiplying three negative numbers results the negative product.

Decimal numbers and fractions can also be cubed using the same process — multiplying the number by itself three times.

For example: $(0.5)^3 = 0.5 \times 0.5 \times 0.5 = 0.125$

$$\left(\frac{2}{3}\right)^3 = \frac{2^3}{3^3} = \frac{8}{27}$$

Next, the teacher will divide the class into small groups. Assign each group a set of numbers (both negative and positive integers, decimals, and fractions). The students will calculate the cubes of these numbers and also identify if any of them is perfect cube. The teacher encourage the students to discuss the results and compare the differences between the cubes of different types of numbers.

Next, teacher will demonstrate the following one-by-one:

- Checking whether a number is a perfect cube or not.

  For example: Checking if 27 is a Perfect Cube:

  Step 1: Prime factorisation of 27 is $3 \times 3 \times 3$

  Step 2: Group the factors into triplets: $(3 \times 3 \times 3)$

  Step 3: Since the factors are grouped into a triplet, so, 27 is a perfect cube *i.e.*, $(3)^3 = 27$

The teacher will explain that a number is a perfect cube, if in its prime factorisation, every prime factor appears in a multiple of three. In other words, the exponent of each prime factor must be a multiple of 3.

Next, the teacher will present some natural numbers and their cubes on board and ask students to observe the cubes of the given numbers, such that,

- The cubes of all odd numbers are odd, and the cubes of all even numbers are even.
- The number of zeros at the end of a perfect cube is always a multiple of 3.
- Cubes of numbers having the digits 0, 1, 4, 5, 6 and 9 at the ones place end in the same digits respectively.
- Cubes of numbers ending with the digit 2 end with the digit 8 at the ones place and vice versa.
- Cubes of numbers ending with the digit 3 end with the digit 7 at the ones place and vice versa.

Students will check these properties by taking some examples from the textbook in their notebook.

EXPLANATION

Further, the teacher will explain some interesting patterns of cube numbers and other previously mentioned topics in detail by taking the reference of pages 29-33 of Math Genius 8.

ASSIGNMENTS

Classwork: Discuss 'Think Tank' given on pages 29 and 32, 'Fast Check' given on pages 30-31 and 'Be aware' given on page 30. Ask to practise Q. 1, 2, 4, 6 and 7 of Practice Time 1E.

Homework: Ask to practise the remaining questions of Practice Time 1E.

Periods: 17–18	Topics: Cube roots	NEP Skills: Logical Thinking, Experiential Learning, Discussion-Based Learning

TEACHER-PUPIL ACTIVITY

The teacher presents a scenario: "Imagine you are lead engineers. You must build a cube-shaped swimming pool with a total volume of 512 m^3. To order the tiles for the floor and walls, you must find the exact length of one side."

The teacher asks, "If Volume = L × L × L, how can we work backward to find L?"

Students brainstorm in pairs to guess the number which, when multiplied by itself three times, equals 512. They recognize that this "backward" calculation is called finding the Cube Root. Further, the teacher provides unit blocks to groups. "Create a solid cube using 27 blocks."

Students will arrange the blocks into a 3 × 3 × 3 formation. They count the blocks along one edge and conclude that the cube root of 27 is 3.

To help students to grasp the concept of cube roots further, the teacher can introduce the following method to find the cube root of any number.

- **Successive Subtraction Method**

  For example: Find the cube root of 512.

  512 – 1 = 511, 511 – 7 = 504, 504 – 19 = 485, 485 – 37 = 448, 448 – 61 = 387, 387 – 91 = 296, 296 – 127 = 169, 169 – 169 = 0

  Since we have subtracted eight times to get 0, so $\sqrt[3]{512} = 8$.

- **Prime Factorisation Method**

  For example: The cube root of 2744,

  $$2744 = \underbrace{2\times2\times2}\times\underbrace{7\times7\times7}$$

  $$\therefore \quad \sqrt[3]{2744} = 2 \times 7 = 14$$

- **Estimation Method or Using Units and Tens Digit**

  For example: Find the cube root of 110592 by the method of estimation.

  Given number = 110592

  $$= \underbrace{110}_{\text{Second group}}\ \underbrace{592}_{\text{First group}}$$

  The units digit of the first group of the given number is 2.

  So, the units digit of the cube root of the given number is 8.

  The number formed by the leftover digits is 110.

  $$43 = 64 < 110 < 53 = 125$$

So, the tens digit of the cube root of the given number = 4

Hence, the cube root of 110592 is 48 i.e., $\sqrt[3]{110592} = 48$.

This method involves finding the closest perfect cubes below and above a given number and estimating the cube root. This practical technique is especially useful for numbers that don't have an exact cube root.

ASSIGNMENTS

Classwork: Discuss 'Be Aware' given on page 35 and 'A Pinch of History' given on page 36 and ask to practise Q. 1, 3, 4 and 8 of Practice Time 1F.

Homework: Ask to practise the remaining questions of Practice Time 1F.

Periods: 19–20	Topic: Revision	NEP Skills: Creative Thinking, Critical Thinking, Discussion-Based Learning

TEACHER-PUPIL ACTIVITY

- Make students comfortable, so that they can ask any question on any previously taught topics. Clarify their doubts or queries and start the revision of the exercise.
- Divide the students into small groups and guide them to do the activity given in the 'Gamified Learning' section on page 43.
- Start the revision of the exercise by using 'Mind Map', 'Mental Maths' and 'Chapter Assessment'.
- Discuss questions A, B and C of the 'Chapter Assessment' and accept students' answers. If they have any confusion or make any errors, then explain and correct them. Motivate students to solve 'Mental Maths'.

ASSIGNMENTS

Classwork: Discuss and motivate to solve 'Maths Fun', 'Challenge Question' and 'Create and Solve' sections of the chapter.

Homework: Ask to solve the remaining questions of 'Chapter Assessment' given on pages 41-42.

2 Power play

Learning Objectives

After studying this chapter, students will be able to...

- apply the concept of doubling
- introduce exponential notation
- understand exponential growth
- understand how to express large numbers or values using powers and exponents
- define exponential growth and recognise how it differs from linear growth
- explore real-world examples of exponential growth
- use exponential growth to compare large quantities
- explore how scientific notation can simplify representing and comparing very large numbers

LESSON PLAN

Suggested number of periods: 12

Suggested Teaching Aids: Textbook Math Genius 8, blackboard or whiteboard, pens, pencils, chalk/ marker, notebook, paper, chit/number cards/flash cards, etc.

Keywords: Base, exponent, power, power of a power, scientific notation, standard form, multiplying exponents, dividing exponents, negative exponents.

Prerequisite knowledge: Students must be familiar with a strong foundation in multiplication, division, addition, and subtraction of integers and rational numbers.

NEP feature: This method of teaching provides experiential learning opportunities to the students and allows them to work with each other, which helps in their holistic development.

Periods: 1–3	Topic: Introduction(Exponential Notation and Operation)	NEP Skills: Discusion-Based Learning, Holistic Skills

TEACHER-PUPIL ACTIVITY

The teacher will start the topic interactively by asking questions related to the students' real-life experiences. For example,

- If you could double your money every day, how much would you have after 10 days? What about after 20 days?
- What happens when you keep multiplying a number by itself over and over again? For example, if you have 2 and multiply it by 2, how big will it be if you do that several times?
- What would happen if you started with one follower on social media and doubled the followers every day? How many followers will you have after a month?

The teacher will revise the learners' previous knowledge of numbers with the help of the "Get Ready" and "Let's Recall" sections given on pages 44 and 45 in the book.

To help the students' to memorise the exponent rules and values in a fun and engaging way, the teacher can organise a memory-building activity. Begin by preparing two sets of cards: one set with exponent problems (for example: 2^3, 3^2, 4^4) and another set with their corresponding results (e.g., 8, 9, 256). Shuffle the cards and place them face down on the table. Students will then take turns flipping two cards at a time, trying to match each exponent problem with the correct result. The student who successfully matches the most pairs wins. This activity encourages students to familiarise themselves with exponent values and reinforces their understanding of exponent properties in a fun, interactive manner. It provides an opportunity for students to actively engage with the material while promoting friendly competition.

Further, the teacher can explain the concept of exponents and their importance in representing large numbers and simplifying complex calculations.

By explaining that an exponent shows how many times the base number is multiplied by itself. For example, 2^3 means $2 \times 2 \times 2 = 8$. The base is 2, and the exponent is 3. The teacher can emphasise how this helps in handling large numbers more easily. Use examples from the textbook, such as folding a piece of paper (which doubles in thickness each time) to demonstrate exponential growth.

The teacher will discuss the relationship between large numbers and exponents, showing that exponential growth helps us to deal with extremely large quantities, like the mass of the Earth or the distance between planets.

To introduce the concept of exponents, first reiterate the prime factorisation of a number. Once the prime factorisation is complete, explain how exponents are used to represent repeated factors more efficiently. For example, $432 = 2^4 \times 3^3$. This means that 2 is used four times and 3 is used three times. Once students understand this, explain that exponents allow us to express repeated multiplication of the same factor in a compact form, such as 2^4 for four 2's, making it easier to express large numbers. This helps simplify calculations, especially when dealing with large numbers.

EXPLANATION

Refer to "Math Genius 8" on pages 45-48 for more examples and explanations on prime factorisation and exponents. The teacher can also discuss the 'Be Aware' on page 46 and the "Knowledge Desk" on page 48 as additional resources for students.

ASSIGNMENTS

Classwork: Discuss 'Think Tank' given on page 47 and ask students to practise Q.1, 2, 3, 4, 8 and 10 of Practice Time 2A.

Homework: Ask students to practise the remaining questions of Practice Time 2A.

Periods: 4–6	Topic: Laws of Exponents	NEP Skills: Critical Thinking, Experiential Learning

TEACHER-PUPIL ACTIVITY

The teacher can begin the lesson by asking some questions from previous learning.

- What does 5^3 mean?
- In 4^2, which number is the base and which is the exponent?
- What does the exponent tell us?
- How would you expand 3^4?
- If I write $2 \times 2 \times 2 \times 2$, how can we write this in short form?

The teacher will start the teaching the concept of exponents as repeated multiplication. Students already know that, $2 \times 2 \times 2 = 8$. This can be written as 2^3.

The teacher will then explain that when numbers with exponents are multiplied or divided, certain rules make calculations easier. These rules are called the Laws of Exponents. The teacher will demonstrate each law using simple numerical examples and gradually move towards application-based questions.

The main laws to be discussed:

- **Law 1:** Multiplication with the same base: $n^a \times n^b = n^{(a+b)}$
- **Law 2:** Power of a power: $(n^a)^b = (n^b)^a = n^{ab} = n^{a \times b}$
- **Law 3:** Multiplying bases with the same exponents: $m^a \times n^a = (mn)^a$
- **Law 4:** Dividing bases with the same exponents: $m^a \div n^a = \left(\frac{m}{n}\right)^a$
- **Law 5:** Division with the same base: $n^a \div n^b = n^{(a-b)}$
- **Law 6:** Any non-zero base raised to the power 0 is 1, *i.e.*, $n^0 = 1$.
- **Law 7:** For any non-zero integer n, $n^{-a} = \frac{1}{n^a}$, where a is a positive integer.

The teacher will connect each rule with logical reasoning rather than only memorising formulas.

Why Do We Need the Law of Exponents in Real Life?

The teacher can explain that exponents help us work with very large or very small numbers easily. In real life, many quantities grow or shrink very quickly. Writing repeated multiplication every time is not practical. Exponents help simplify such calculations.

Without exponent rules, calculations involving growth, decay or repeated multiplication would become long and confusing.

The teacher will use the following examples to reinforce the concept of law of exponents:

1. The Magic Chocolate Factory

   A chocolate machine multiplies chocolates by 3 every minute.

   Minute 1 → 3 chocolates Minute 2 → $3 \times 3 = 3^2$ Minute 3 → $3 \times 3 \times 3 = 3^3$

   After 6 minutes, how many chocolates are there? Guide students to write: 3^6

   Now ask: If the machine runs for 6 minutes in the morning and 2 more minutes in the evening, how can we write it? $3^6 \times 3^2 = 3^8$

   Here students discover $a^m \times a^n = a^{m+n}$

2. The Super Bacteria Lab

   A bacterium doubles every hour. After 5 hours → 2^5

   If scientists observe it for 3 more hours: $2^5 \times 2^3 = 2^8$

   Ask students: Why did we add the powers?

   Then ask: If the bacteria reduce in number by half every hour, how can we represent it?

   2^{-1}. This helps introduce negative exponents naturally.

3. The Tower Building Game.

   Students build cube towers. Each layer has 4 times more cubes than the previous layer.

   Layer 1 → 4 Layer 2 → 4^2 Layer 3 → 4^3

   If two such towers are joined, how can we write it? $4^3 \times 4^3 = 4^6$

   Then show: $(4^3)^2 = 4^6$

   Now students understand $(a^m)^n = a^{mn}$

4. The Digital Password Puzzle

   A password system allows 5 choices for each position.

   If the password has 4 positions: Total combinations = 5^4

   If the system upgrades to 6 positions: $5^4 \times 5^2 = 5^6$

   This connects to combinations and growth.

The teacher can summarise that exponent laws are not just algebra rules. They help simplify complex calculations in banking, science, technology and daily life situations involving growth and repeated multiplication.

EXPLANATION

Discuss 'How many combination' by taking reference of pages 52-53 of the textbook. Refer Math Genius 8, pages 49-56, for more explanations and examples.

ASSIGNMENTS

Classwork: Discuss 'Think Tank' given on pages 51 and 53, 'Maths Talk' given on page 53, 'Math Insight' given on page 54, 'Fast Check' on page 55 and 'Get it Right' on page 56. Also, guide the students to do the 'Activity' given on page 56. Ask students to practise Q.1, 2, 3, 7 and 8 of Practice Time 2B.

Homework: Ask students to practise the remaining questions of Practice Time 2B.

Periods: 7–10	Topic: Power Lines, Powers of 10	NEP Skills: Conceptual Learning, Discussion-based Learning and Experiential Learning

TEACHER-PUPIL ACTIVITY

Teacher will draw a vertical line on the board. Marks the centre as $3^0 = 1$. And ask to the class that, if we multiply by 3, we move up. If we divide by 3, we move down. Teacher will demonstrates moving from $3^2(9)$ to $3^1(3)$ and $3^0(1)$, and ask students to predict the position of 3^{-1} and 3^{-2}. Further, students will take turns placing the values of 3^2, 3^3, 3^4, …, 3^8 on the number line. Students calculate $38 \div 35$ using the line to see that it results in $33 = 27$.

Further, teacher will move on to writing numbers in expanded form using powers of 10.

For example: $4536 = 4 \times 10^3 + 5 \times 10^2 + 3 \times 10^1 + 6 \times 10^0$

And the decimal numbers like 124.56

$$124.56 = 1 \times 10^2 + 2 \times 10^1 + 4 \times 10^0 + 5 \times 10^{-1} + 6 \times 10^{-2}$$

Now, before starting 'Expressing Large Numbers in Standard Form', the teacher should activate prior knowledge and create curiosity. The aim is to make students feel the need for scientific notation before formally introducing it.

- Write a large number on the board: 4,500,000,000

  Ask:

  1. Is this number easy to read?
  2. Can you quickly count how many zeroes there are?
  3. Is there a shorter way to write it?
  4. How would you compare this number with 45,000,000?

The teacher will explain that very large and very small numbers are difficult to read, compare and calculate in their usual form. Scientific notation helps us write such numbers in a compact and meaningful way.

The teacher will emphasise that a number in standard form is written as: $m \times 10^n$, where $1 \leq m < 10$ and n is an integer.

If we move the decimal to the left → power is positive.

If we move the decimal to the right → power is negative.

For example: $4500000 = 4.5 \times 10^{6}$

$0.00045 = 4.5 \times 10^{-4}$

Demonstrate counting decimal places carefully.

Further, the teacher will demonstrate the exponential growth by taking the following example:

1. If one domino knocks down 2 dominoes, and each of those knocks down 2 more, what happens?
   Level 1 → 1
   Level 2 → 2
   Level 3 → 4
   Level 4 → 8
   Level 10 → 2^{10}
   How many dominoes fall after 20 levels? This helps them visualise doubling and powers of 2.
2. Suppose you send a message to 3 friends. Each friend forwards it to 3 more friends.
   After 1 round → 3
   After 2 rounds → 3^{2}
   After 5 rounds → 3^{5}
   Is this growth linear or exponential? Why?
   This connects directly to the textbook's linear vs exponential growth section given on page 60.

EXPLANATION

The teacher should explain that the standard form is not just about shifting decimals. It shows the magnitude of a number clearly. It helps compare sizes quickly. Also explain the number of large Indian numerals by taking reference of Math Genius 8, pages 58-64, for more explanations of other topics and examples.

EVALUATE

Classwork: Ask students to practise Q.1, 2, 3, 4, 5, 7 and 8 of Practice Time 2C.

Homework: Ask students to practise the remaining questions of Practice Time 2C.

Periods: 11–12	Topic: Revision	NEP Skills: Creative Thinking, Experiential Learning, Cross-Curricular Learning

TEACHER-PUPIL ACTIVITY

- Make students comfortable so that they can ask any questions on any previously taught topics. Clarify their doubts or queries and start the revision of the exercise.
- Divide the students into small groups and guide them to do the activity given in the 'Gamified Learning' section on page 69.
- Start the revision of the exercise by using 'Mind Map', 'Mental Maths' and 'Chapter Assessment'.
- Discuss questions A, B and C of the 'Chapter Assessment' and accept students' answers. If they have any confusion or make any errors, then explain and correct them. Motivate students to solve 'Mental Maths'.

ASSIGMENTS

Classwork: Discuss questions A, B and C of the 'Chapter Assessment' in the classroom.

Homework: Ask students to solve the remaining questions of 'Chapter Assessment' given on pages 67-68.