📘 CLASS 9 MATHEMATICS – CHAPTER 2 NOTES

➗ Introduction to Linear Polynomials

🆕 New NCERT Ganita Manjari | Grade 9 | Part I | 2026–27

These notes follow the **new 2026–27 Class 9 Mathematics syllabus and the Ganita Manjari textbook**. In the revised syllabus, this chapter is part of **Unit II – Algebra** and covers algebraic expressions, polynomials, linear polynomials, linear patterns, linear growth and decay, linear relationships, graphs, slope and y-intercept.

🌟 CHAPTER 2: INTRODUCTION TO LINEAR POLYNOMIALS

🎯 Learning Objectives

After completing this chapter, you should be able to:

✅ Understand algebraic expressions
✅ Identify variables, constants, terms and coefficients
✅ Understand the meaning of a polynomial
✅ Find the degree of a polynomial
✅ Identify linear polynomials
✅ Evaluate polynomials for given values
✅ Recognise linear patterns
✅ Understand linear growth and linear decay
✅ Model real-life situations using linear expressions
✅ Understand linear relationships
✅ Represent linear relationships graphically
✅ Understand slope and y-intercept
✅ Interpret equations of the form `y = ax + b`
✅ Connect algebra with tables, graphs and real-life situations

The new syllabus specifically expects students to identify terms, coefficients and degree, model linear growth and decay, recognise patterns, identify slope and y-intercept, and graph linear relationships.

📚 CHAPTER AT A GLANCE

1️⃣ Algebraic Expressions

2️⃣ Polynomials

3️⃣ Degree of a Polynomial

4️⃣ Linear Polynomials

5️⃣ Evaluating Polynomials

6️⃣ Exploring Linear Patterns

7️⃣ Linear Growth

8️⃣ Linear Decay

9️⃣ Linear Relationships

🔟 Visualising Linear Relationships

1️⃣1️⃣ Slope

1️⃣2️⃣ y-intercept

1️⃣3️⃣ Equation `y = ax + b`

1️⃣4️⃣ Real-Life Applications

The chapter connects algebra with patterns, real-life situations and straight-line graphs.

🔵 1. ALGEBRAIC EXPRESSIONS

An **algebraic expression** is a combination of:

🔢 Numbers
🔤 Variables
➕➖✖️➗ Mathematical operations

Examples:

$3x + 5$

$2x^2 + 3x - 7$

$4a + 5b + 9$

$7p - 2q + 6$

🧩 2. PARTS OF AN ALGEBRAIC EXPRESSION

Consider:

$$4x + 5y + 3$$

There are three terms:

$4x$, $5y$, 3

The textbook uses this type of expression to introduce variables, coefficients, terms and constants.

🔤 Variable

A **variable** is a letter whose value can change.

Examples:

`x`, `y`, `a`, `b`, `m`, `n`

In:

`4x + 5y + 3`

👉 `x` and `y` are variables.

🧩 Term

A **term** is a part of an algebraic expression separated by `+` or `−` signs.

Example:

`3x + 5y - 7`

Terms are:

`3x`

`5y`

`-7`

⚠️ Remember

The sign belongs to the term.

So in:

`4x - 3y + 5`

the terms are:

`4x`, `-3y`, `5`

🔢 3. COEFFICIENT

The **coefficient** is the numerical factor multiplying a variable.

Example:

$7x$

Coefficient of x = **7**

Example:

$-5y$

Coefficient of y = **-5**

Example:

$3x^2$

Coefficient of x^2 = **3**

Example:

x

Coefficient of x = **1**

Example:

$-x$

Coefficient of x = **-1**

⭐ 4. CONSTANT

A **constant** is a term that does not contain a variable.

Example:

$4x + 7$

Here:

$4x$ → variable term
7 → constant

Another example:

$3x^2 - 5x + 8$

Constant = **8**

🧠 QUICK SUMMARY

Term	Meaning	Example
Variable	Quantity that can vary	x
Term	Part of expression	$5x$
Coefficient	Numerical factor	5 in $5x$
Constant	Term without variable	7

🟢 5. WHAT IS A POLYNOMIAL?

A **polynomial** is an algebraic expression in which the powers of the variables are **non-negative integers**.

Examples:

$2x + 3$

$x^2 + 5x + 6$

$3x^3 - 2x + 7$

5

The degree of a polynomial in one variable is determined by its **highest power of the variable**.

❌ 6. EXPRESSIONS THAT ARE NOT POLYNOMIALS

A polynomial cannot contain variables with:

❌ Negative powers
❌ Fractional powers

For example:

$1/x$

is not a polynomial because:

$1/x = x^{-1}$

The exponent is negative.

Similarly:

$\sqrt{x}$

is not a polynomial because:

$\sqrt{x} = x^{(1/2)}$

The exponent is not a non-negative integer.

Examples:

Expression	Polynomial?
$3x + 2$	✅ Yes
$x^2 + 5x + 1$	✅ Yes
7	✅ Yes
$x^{-1} + 2$	❌ No
$\sqrt{x} + 1$	❌ No

$1/x + 3$ ❌ No

📐 7. DEGREE OF A POLYNOMIAL

The **degree** of a polynomial is the **highest power of the variable with a non-zero coefficient**.

Example:

$2x^2 + 5x + 3$

Highest power = 2

Therefore:

Degree = 2

Example:

$3y^3 - 4y^2 + 5$

Highest power = 3

Degree = 3

Example:

$7x + 4$

Highest power = 1

Degree = 1

These examples correspond to the chapter's treatment of polynomial degree.

⭐ 8. TYPES OF POLYNOMIALS BASED ON DEGREE

🔵 Constant Polynomial

Degree = **0**

Example:

```
7
```

```
-5
```

```
12
```

🟢 Linear Polynomial

Degree = **1**

Example:

```
2x + 3
```

```
5x - 7
```

```
-3x + 4
```

🟠 Quadratic Polynomial

Degree = **2**

Example:

```
x² + 3x + 2
```

```
5x² - 7
```

🔴 Cubic Polynomial

Degree = **3**

Example:

$x^3 + 2x + 1$

$4x^3 - 5x^2 + 2$

🧠 DEGREE MEMORY TABLE

Degree	Name	Example
0	Constant	7
1	Linear	$3x + 2$
2	Quadratic	$x^2 + 4x + 1$
3	Cubic	$2x^3 - x + 5$

⭐ 9. LINEAR POLYNOMIAL

A polynomial of degree **1** is called a:

➡️ LINEAR POLYNOMIAL

Its general form is:

$$ax + b$$

where:

$a \neq 0$

and a and b are constants.

Examples:

$2x + 3$

$5x - 7$

$-4x + 9$

$x + 6$

The textbook specifically identifies degree-1 polynomials as linear polynomials.

🏠 10. LINEAR POLYNOMIALS IN REAL LIFE

Linear polynomials are useful for describing situations where a quantity changes at a **constant rate**.

Example: Perimeter of a Square

Suppose the side of a square is x.

Perimeter:

$P = 4 \times \text{side}$

Therefore:

$$P = 4x$$

This is a linear polynomial.

The textbook uses the perimeter of a square as one of its real-life examples.

♟️ 11. ANOTHER REAL-LIFE EXAMPLE

Suppose a chess club charges:

- ₹200 fixed amount
- ₹50 for every match

If m = number of matches,

Total cost:

$$C = 200 + 50m$$

This is linear because the cost increases by ₹50 for every additional match.

🧮 12. VALUE OF A POLYNOMIAL

A polynomial can be evaluated when the value of its variable is known.

Consider:

$$P(x) = 5x - 3$$

Find $P(2)$.

Substitute:

$x = 2$

$P(2) = 5(2) - 3$

$= 10 - 3$

$$= 7$$

✏️ Example

Find the value of:

$$P(x) = 5x - 3$$

for $x = -1$.

$$P(-1) = 5(-1) - 3$$

$$= -5 - 3$$

$$\mathbf{= -8}$$

This substitution approach appears in Exercise Set 2.2 of the textbook.

🔢 13. EVALUATING A QUADRATIC POLYNOMIAL

Consider:

$$P(s) = 7s^2 - 4s + 6$$

For $s = 4$:

$$P(4) = 7(4)^2 - 4(4) + 6$$

$$= 7(16) - 16 + 6$$

$$= 112 - 16 + 6$$

$$\mathbf{= 102}$$

The textbook similarly asks students to evaluate a quadratic polynomial for several values.

🟣 14. LINEAR PATTERNS

One of the important new ideas in this chapter is recognising **linear patterns**.

A sequence shows a linear pattern when the difference between consecutive terms is constant.

Example:

`1, 3, 5, 7, 9, ...`

Differences:

`3 - 1 = 2`

`5 - 3 = 2`

`7 - 5 = 2`

`9 - 7 = 2`

The difference is always:

2

Therefore, this is a **linear pattern**.

⭐ 15. CONSTANT DIFFERENCE

Rule:

If consecutive values change by the **same amount over equal intervals**, the pattern is linear.

Example:

`5, 8, 11, 14, 17`

Differences:

`+3, +3, +3, +3`

✅ Linear pattern

Example:

`20, 17, 14, 11, 8`

Differences:

`-3, -3, -3, -3`

✅ Linear pattern

Example:

`2, 4, 8, 16, 32`

Differences:

`2, 4, 8, 16`

❌ Not a linear pattern.

🧩 16. LINEAR PATTERNS FROM FIGURES

The textbook also develops patterns visually.

For example, a square-tile pattern may produce:

`1, 3, 5, 7, ...`

Each new figure adds **2 tiles**.

Therefore:

Common difference = 2

This is an example of using a visual pattern to discover an algebraic relationship.

📈 17. LINEAR GROWTH

Linear growth occurs when a quantity increases by a fixed amount over equal intervals.

Example:

A plant grows:

Month 1 → 10 cm
Month 2 → 12 cm
Month 3 → 14 cm
Month 4 → 16 cm

Increase:

$+2 \text{ cm}$ every month.

Therefore, this is **linear growth**.

📊 18. LINEAR GROWTH TABLE

Suppose a quantity starts at 5 and increases by 3 every step.

Step	Value
0	5
1	8
2	11
3	14
4	17

The increase is always:

$$+3$$

So the relationship is linear.

📉 19. LINEAR DECAY

Linear decay occurs when a quantity decreases by a fixed amount over equal intervals.

Example:

A tank contains water whose height decreases by:

`0.5 m` every month.

If the initial height is `10 m`:

Month 0 → 10 m
Month 1 → 9.5 m
Month 2 → 9 m
Month 3 → 8.5 m

The change is always:

`-0.5 m`

Therefore, this is linear decay.

📱 20. DEPRECIATION AS LINEAR DECAY

Suppose a mobile phone loses ₹2,000 of value every year.

Initial value:

`₹20,000`

After 1 year:

`₹18,000`

After 2 years:

`₹16,000`

After 3 years:

₹14,000

The value decreases by a constant amount.

📉 This is an example of **linear decay**.

The textbook uses depreciation as one of its real-life contexts.

🔗 21. LINEAR RELATIONSHIP

A relationship between two quantities is called **linear** when one quantity changes at a constant rate with respect to the other.

The chapter represents such relationships using:

⭐ $y = ax + b$

This is one of the most important forms in the chapter.

🔤 22. MEANING OF $y = ax + b$

In:

$$y = ax + b$$

x = input / independent variable

y = output / dependent variable

a = rate of change / slope

b = value of y when $x = 0$

📌 23. SLOPE

The coefficient a represents the:

Slope

Slope tells us how quickly y changes when x changes.

If $a > 0$

📈 Positive slope → growth

If $a < 0$

📉 Negative slope → decay

If $a = 0$

$y = b$

The value of y remains constant.

⭐ 24. y-INTERCEPT

In:

$$y = ax + b$$

b is the **y-intercept**.

It tells us where the graph crosses the y-axis.

When:

$x = 0$

we get:

$y = a(0) + b$

$y = b$

Therefore, the graph crosses the y-axis at:

$$(0, b)$$

The textbook defines b as the value when $x = 0$ and the y-intercept.

🧠 25. EXAMPLE OF $y = ax + b$

Consider:

$$y = 20x + 150$$

Here:

$a = 20$

$b = 150$

Therefore:

📌 Slope = 20

📌 y-intercept = 150

This can represent a bill with:

₹150 fixed charge

-

₹20 per unit of usage

The textbook uses this type of fixed-charge-plus-usage example.

📊 26. MAKE A TABLE

For:

y = 2x + 1

Let's find values.

x	y = 2x + 1	Point
0	1	(0,1)
1	3	(1,3)
2	5	(2,5)
3	7	(3,7)

Notice:

1, 3, 5, 7

has a constant difference of:

+2

So the relationship is linear.

The textbook demonstrates $y = 2x + 1$ using points (0,1) and (1,3).

📈 27. VISUALISING A LINEAR RELATIONSHIP

A linear relationship of the form:

y = ax + b

is represented graphically by a:

⭐ STRAIGHT LINE

To draw the graph:

Step 1️⃣

Choose values of x.

Step 2️⃣

Calculate corresponding values of y.

Step 3️⃣

Write the ordered pairs.

Step 4️⃣

Plot the points.

Step 5️⃣

Join the points with a straight line.

The textbook recommends identifying at least two points and joining them to visualise the line.

✏️ 28. GRAPH EXAMPLE

Given:

$$y = 2x + 1$$

For $x = 0$:

$$y = 2(0) + 1 = 1$$

Point:

$(0,1)$

For $x = 1$:

$y = 2(1) + 1 = 3$

Point:

$(1,3)$

Plot:

$(0,1)$

and

$(1,3)$

Join them.

📈 You get a straight line.

📐 29. UNDERSTANDING SLOPE THROUGH PATTERNS

Suppose:

$y = 2x + 1$

Every time x increases by 1:

y increases by 2.

So:

Change in y = 2

for

Change in x = 1

Therefore the rate of change is:

`2/1 = 2`

So the slope is:

2

🟢 30. POSITIVE SLOPE

Example:

y = 3x + 2

Here:

`a = 3`

Since:

`3 > 0`

the slope is positive.

📈 The line rises from left to right.

This represents **linear growth**.

🔴 31. NEGATIVE SLOPE

Example:

y = -2x + 5

Here:

`a = -2`

Since:

`-2 < 0`

the slope is negative.

📉 The line falls from left to right.

This represents **linear decay**.

⚪ 32. ZERO SLOPE

Example:

`y = 5`

This can be written as:

`y = 0x + 5`

So:

`a = 0`

The graph is a horizontal line.

🪜 33. EFFECT OF CHANGING `a`

Consider:

`y = ax + b`

If we change `a` but keep `b` fixed:

📈 The steepness of the line changes.

For example:

`y = x + 2`

$y = 2x + 2$

$y = 4x + 2$

All have:

$b = 2$

so they cross the y-axis at the same point.

But their slopes are different.

The textbook specifically notes that changing a changes the slope while keeping the y-intercept fixed.

↔ 34. EFFECT OF CHANGING b

Consider:

$y = 2x + 1$

and

$y = 2x + 5$

Both have:

$a = 2$

Therefore:

Same slope

But their y-intercepts are different.

So the lines are:

Parallel

The textbook highlights that equal slopes with different y-intercepts produce parallel lines.

⭐ 35. SPECIAL CASE: `y = ax`

When:

`b = 0`

the equation becomes:

`y = ax`

The graph passes through the origin `(0,0)`.

Example:

`y = 2x`

At `x = 0`:

`y = 0`

Therefore:

`(0,0)`

lies on the line.

📈 36. STEEPNESS OF A LINE

For:

`y = ax`

if:

`a > 1`

the line is steeper than `y = x`.

If:

$0 < a < 1$

the line is less steep than $y = x$.

The textbook uses this comparison to build an intuitive understanding of slope.

🧮 37. REAL-LIFE WORD PROBLEM

Example: Mother's and Salil's Ages

Suppose Salil's present age is x years.

His mother's age is three times his age.

Therefore:

Mother's age = $3x$

After 5 years:

Salil = $x + 5$

Mother = $3x + 5$

Their ages then add to 70:

$(x + 5) + (3x + 5) = 70$

Simplify:

$x + 5 + 3x + 5 = 70$

$4x + 10 = 70$

$4x = 60$

$x = 15$

Therefore:

Salil's present age = 15 years

Mother's age:

`3 × 15 = 45 years`

The textbook uses this kind of linear modelling problem in Exercise Set 2.2.

🏠 38. LINEAR POLYNOMIALS IN GEOMETRY

Suppose the width of a rectangle is `x cm`.

If its length is three more than twice its width:

Length = `2x + 3`

Perimeter:

`P = 2(length + width)`

Therefore:

`P = 2[(2x + 3) + x]`

`P = 2(3x + 3)`

`P = 6x + 6`

This is a linear polynomial in `x`.

The textbook uses a rectangle problem of this type.

🧠 39. IMPORTANT DIFFERENCE: POLYNOMIAL VS LINEAR POLYNOMIAL

Polynomial

Can have different degrees.

Examples:

$x^2 + 2x + 1$

$x^3 + x + 5$

$4x + 7$

Linear Polynomial

Must have degree exactly **1**.

Examples:

$2x + 3$

$5x - 8$

$-x + 4$

❌ Not linear:

$x^2 + 3$

because degree = 2.

🔍 40. HOW TO FIND DEGREE

Step 1️⃣

Look at the powers of the variable.

Step 2️⃣

Find the highest power.

Step 3️⃣

That highest power is the degree.

Example:

$7x^4 + 3x^2 - 5x + 2$

Highest power = 4

Degree = 4

🧮 41. FINDING COEFFICIENTS

Consider:

$$x^4 - 3x^3 + 6x^2 - 2x + 7$$

Coefficient of x^3:

-3

Coefficient of x^2:

6

Coefficient of x:

-2

Constant:

7

This is directly aligned with the textbook's Exercise Set 2.1 focus on identifying coefficients.

📊 42. LINEAR PATTERN VS NON-LINEAR PATTERN

Pattern	Differences	Linear?
`2,4,6,8`	`+2,+2,+2`	✅
`5,10,15,20`	`+5,+5,+5`	✅
`20,17,14,11`	`-3,-3,-3`	✅
`1,4,9,16`	`+3,+5,+7`	❌
`2,4,8,16`	`+2,+4,+8`	❌

⭐ Key Rule

Constant difference = Linear pattern

📝 43. QUICK FORMULA SHEET

🔹 General linear polynomial

```
ax + b
```

where:

```
a ≠ 0
```

🔹 Linear relationship

```
y = ax + b
```

🔹 Slope

```
a
```

🔹 y-intercept

```
b
```

🔹 y-coordinate when x = 0

```
y = b
```

🔹 y-intercept point

```
(0,b)
```

🔹 Linear growth

Constant positive change.

🔹 Linear decay

Constant negative change.

⭐ 44. MOST IMPORTANT CONCEPTS FOR EXAM

- 🔹 Algebraic expression = combination of numbers, variables and operations.
- 🔹 A **term** is a part of an expression separated by `+` or `−`.
- 🔹 A **coefficient** is the numerical factor of a variable term.
- 🔹 A **constant** contains no variable.

- 🔹 A polynomial has non-negative integer powers of variables.
- 🔹 Degree = highest power of the variable.
- 🔹 Degree 1 → **linear polynomial**.
- 🔹 A linear pattern has a **constant difference**.
- 🔹 Linear growth = fixed increase.
- 🔹 Linear decay = fixed decrease.
- 🔹 Linear relationship can be represented as:

```
y = ax + b
```

- 🔹 `a` = slope/rate of change.
- 🔹 `b` = y-intercept.
- 🔹 Positive slope → increasing relationship.
- 🔹 Negative slope → decreasing relationship.
- 🔹 Graph of a linear relationship is a **straight line**.
- 🔹 Same slope + different y-intercepts → **parallel lines**.

⚠️ 45. COMMON MISTAKES

❌ Mistake 1

Calling every polynomial a linear polynomial.

✅ Remember:

Only degree **1** polynomials are linear.

❌ Mistake 2

Forgetting the negative sign of a coefficient.

In:

`5x - 7`

coefficient of the constant term is not the coefficient of `x`.

Coefficient of `x` = **5**

❌ Mistake 3

Confusing `a` and `b`.

In:

`y = ax + b`

`a = slope`

`b = y-intercept`

❌ Mistake 4

Thinking every increasing pattern is linear.

Example:

`1, 4, 9, 16`

is increasing but **not linear** because the differences are not constant.

❌ Mistake 5

Thinking a negative slope means the graph is always below the x-axis.

❌ Wrong.

A negative slope means the graph **decreases as x increases**.

For example:

$y = -2x + 5$

starts above the x-axis but slopes downward.

🧠 46. COMPETENCY-BASED QUESTIONS TO EXPECT

The revised curriculum focuses on applying mathematical ideas rather than simply memorising definitions.

You should be able to answer questions such as:

🔎 Identify

What is the degree of:

$4x^3 - 2x + 7$?

🧠 Reason

Why is:

$1/x$

not a polynomial?

📊 Analyse

Is:

3, 7, 11, 15

a linear pattern? Explain.

🏠 Apply

A taxi charges a fixed amount plus a charge per kilometre. Represent the cost using $y = ax + b$.

📈 Interpret

What does the slope represent in a real-life situation?

📉 Compare

How are the graphs of:

`y = 2x + 3`

and

`y = 2x - 5`

related?

📐 Model

Use an algebraic expression to represent the perimeter or cost of a real-life situation.

🚀 47. ONE-PAGE REVISION

➗ ALGEBRAIC EXPRESSIONS

Expression → numbers + variables + operations

Example:

`4x + 5y + 3`

🔤 TERMS

`4x`, `5y`, `3`

🔢 COEFFICIENT

Numerical factor of a variable.

⚪ CONSTANT

Term without a variable.

📐 POLYNOMIAL

Expression with non-negative integer powers.

⭐ DEGREE

Highest power of the variable.

➡️ LINEAR POLYNOMIAL

Degree = 1

Example:

```
3x + 5
```

📊 LINEAR PATTERN

Constant difference.

```
2, 5, 8, 11
```

Difference = +3

📈 LINEAR GROWTH

Fixed increase.

📉 LINEAR DECAY

Fixed decrease.

📈 LINEAR RELATIONSHIP

`y = ax + b`

🪜 SLOPE

`a`

📍 y-INTERCEPT

`b`

Point:

`(0,b)`

📏 GRAPH

`y = ax + b` → **straight line**

🌟 CHAPTER TAKEAWAY

Chapter 2 is much more than simply learning the definition of a polynomial. The **new Ganita Manjari approach connects algebra with patterns, real-life situations and graphs**.

The central idea is:

🔢 Algebra → 📊 Patterns → 📈 Relationships → 📉 Growth/Decay → 📐 Graphs

A linear polynomial such as:

$$ax + b$$

can describe a real-life situation in which a quantity changes at a **constant rate**.

The same relationship can then be represented through:

Expression → Table → Graph → Interpretation 🧠📊📈

That connection between algebraic thinking, modelling and graphical representation is a key emphasis of the new 2026–27 syllabus.