

POLYNOMIALS

DESIGNED BY TINKU SIR

Complete Theory • Geometrical Graphs • Formulas • Tinku Sir Tricks • OnePath Hacks • 2023-2026 PYQs • Mindmap

1. Chapter Overview

What is this Chapter?

A fundamental unit in Algebra dealing with expressions having non-negative integer exponents, zeroes of linear/quadratic polynomials, their geometrical graphs (parabolas), and relationships between zeroes & coefficients.

Why is it Important?

Carries direct weightage of **4 to 6 Marks** in CBSE Class 10 Board Exams and forms the bedrock for Class 10 *Quadratic Equations* and Class 11-12 *Calculus & Functions*.

Major CBSE Focus Areas:

- Geometrical interpretation (number of zeroes from graph).
- Relationship between zeroes (α, β) and coefficients (a, b, c).
- Forming quadratic polynomial when zeroes or sum/product given.
- Evaluating symmetric expressions: $\alpha^2 + \beta^2$, $1/\alpha + 1/\beta$, $\alpha/\beta + \beta/\alpha$.
- Case-study / Competency questions on parabolic trajectories.

Difficulty Level: Moderate • **Target Board Score:** 100% Accuracy • **Estimated Time:** 2.5 Hours

2. Chapter Roadmap



3. Complete Concepts

CONCEPT 1 Definition & Classification of Polynomials

 **What is it?** An algebraic expression consisting of variables and coefficients, involving only addition, subtraction, multiplication, and non-negative integer exponents.

Standard Form of a Polynomial in Variable x

$$p(x) = a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x + a_0 \quad (a_n \neq 0)$$

Where $a_n, a_{n-1}, \dots, a_0$ are real numbers (coefficients) and n is a non-negative integer (0, 1, 2, ...).

What IS a Polynomial:

- $p(x) = 3x^2 - 5x + 7$ (Degree 2)
- $g(x) = \sqrt{2}x + 5$ (Coefficient can be irrational!)
- $h(x) = -9$ (Constant polynomial, Degree 0)

What is NOT a Polynomial:

- $f(x) = 2/x + 3 = 2x^{-1} + 3$ (Negative exponent)
- $g(x) = 4\sqrt{x} + 1 = 4x^{1/2} + 1$ (Fractional exponent)
- $h(x) = 1/(x^2 - 2)$ (Variable in denominator)

Types of Polynomials (By Degree)

Type	Degree (n)	Standard Form	Example	Max Zeroes
Zero Polynomial	Not Defined	$p(x) = 0$	0	Infinite
Constant	0	$p(x) = c \quad (c \neq 0)$	$7, -12$	0
Linear	1	$p(x) = ax + b \quad (a \neq 0)$	$3x - 4$	1
Quadratic	2	$p(x) = ax^2 + bx + c \quad (a \neq 0)$	$2x^2 - 5x + 3$	2
Cubic	3	$p(x) = ax^3 + bx^2 + cx + d$	$x^3 - 3x^2 + 2$	3

CONCEPT 2 Zeroes of a Polynomial & Geometrical Meaning

What is a Zero? A real number k is called a zero of a polynomial $p(x)$ if $p(k) = 0$.

🎯 CBSE Geometrical Rule (Golden Principle)

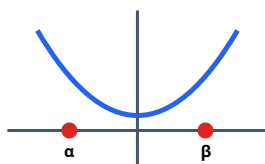
The zeroes of a polynomial $p(x)$ are precisely the **x-coordinates** of the points where the graph of $y = p(x)$ intersects or touches the X-axis.

Number of Zeroes = Number of points where graph meets X-axis.

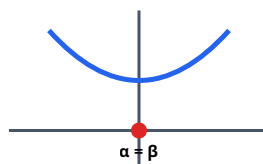
Geometrical Representation of Quadratic Polynomial $y = ax^2 + bx + c$

The graph of a quadratic polynomial is a smooth curve called a **PARABOLA**.

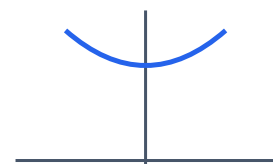
- If $a > 0$, the parabola opens **UPWARDS** (U-shape: U).
- If $a < 0$, the parabola opens **DOWNWARDS** (inverted U-shape: ∩).



Case I: $D > 0$ (2 Zeroes)



Case II: $D = 0$ (1 Zero)



Case III: $D < 0$ (0 Zeroes)

✗ COMMON BOARD MISTAKE ALERT!

Students often count the intersection point on the **Y-axis**! Remember: **ONLY COUNT X-AXIS INTERSECTIONS/ TOUCHES**. The Y-intercept gives $p(0) = c$, NOT a zero!

CONCEPT 3 Relationship Between Zeroes & Coefficients

For Quadratic Polynomial: $p(x) = ax^2 + bx + c$ where $a \neq 0$. Let α (alpha) and β (beta) be the zeroes.

🔑 Quadratic Relationship Formulas (MUST MEMORIZE)

Sum of Zeroes ($\alpha + \beta$)

$$\alpha + \beta = -b/a = -(\text{Coeff. of } x) / (\text{Coeff. of } x^2)$$

Product of Zeroes ($\alpha \cdot \beta$)

$$\alpha \cdot \beta = c/a = (\text{Constant Term}) / (\text{Coeff. of } x^2)$$

Forming a Quadratic Polynomial when Zeroes are Given

If α and β are zeroes, or if Sum $S = \alpha + \beta$ and Product $P = \alpha \cdot \beta$ are known:

$$p(x) = k [x^2 - (\alpha + \beta)x + \alpha\beta] = k [x^2 - Sx + P]$$

Where k is any non-zero real constant (used to eliminate fractional denominators).

Cubic Polynomial Relationships (Enrichment / Optional CBSE)

For $p(x) = ax^3 + bx^2 + cx + d$ ($a \neq 0$) with zeroes α, β, γ (alpha, beta, gamma):

- Sum of zeroes: $\alpha + \beta + \gamma = -b/a$
- Product of zeroes: $\alpha\beta\gamma = -d/a$
- Sum of products taken two at a time: $\alpha\beta + \beta\gamma + \gamma\alpha = c/a$
- Forming Cubic: $k[x^3 - (\alpha + \beta + \gamma)x^2 + (\alpha\beta + \beta\gamma + \gamma\alpha)x - \alpha\beta\gamma]$

CONCEPT 4 Transformed Symmetric Expressions of Zeroes (α & β)

CBSE frequently asks values of non-linear expressions of α and β . **Do NOT find individual zeroes!** Always convert the expression into $(\alpha + \beta)$ and $(\alpha\beta)$.

Expression to Find	Identity Formula in terms of $(\alpha + \beta)$ and $(\alpha\beta)$	Tinku Sir Secret Tip
$\alpha^2 + \beta^2$	$(\alpha + \beta)^2 - 2\alpha\beta$	Square sum, subtract 2×product
$(\alpha - \beta)^2$	$(\alpha + \beta)^2 - 4\alpha\beta$	Equal to D / a^2
$\alpha - \beta$	$\pm \sqrt{[(\alpha + \beta)^2 - 4\alpha\beta]} = \pm \sqrt{D} / a $	Difference of zeroes formula!
$\alpha^2 - \beta^2$	$(\alpha + \beta)(\alpha - \beta) = (\alpha + \beta)\sqrt{[(\alpha + \beta)^2 - 4\alpha\beta]}$	Factorize into sum × diff
$1/\alpha + 1/\beta$	$(\alpha + \beta) / (\alpha\beta)$	Simply $(-b/a) / (c/a) = -b/c$
$\alpha/\beta + \beta/\alpha$	$(\alpha^2 + \beta^2) / (\alpha\beta) = [(\alpha + \beta)^2 - 2\alpha\beta] / (\alpha\beta)$	Take LCM first!
$\alpha^3 + \beta^3$	$(\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$	Use binomial identity
$1/\alpha^2 + 1/\beta^2$	$(\alpha^2 + \beta^2) / (\alpha\beta)^2 = [(\alpha + \beta)^2 - 2\alpha\beta] / (\alpha\beta)^2$	Numerator is $\alpha^2 + \beta^2$

 4. Complete Formula Sheet

S.N.	Concept / Title	Formula / Relation	Condition / Symbol Meaning
1	Linear Zero	$x = -b / a$	For $ax + b = 0$, $a \neq 0$
2	Sum of Zeroes	$\alpha + \beta = -b / a$	For $ax^2 + bx + c = 0$
3	Product of Zeroes	$\alpha \cdot \beta = c / a$	For $ax^2 + bx + c = 0$
4	Polynomial Formation	$p(x) = k[x^2 - Sx + P]$	$S = \alpha + \beta$, $P = \alpha\beta$, $k \neq 0$
5	Difference of Zeroes	$ \alpha - \beta = \sqrt{D} / a $	$D = b^2 - 4ac$
6	Reciprocal Zeroes	$c = a$	When $\beta = 1/\alpha \Rightarrow \alpha\beta = 1 \Rightarrow c/a = 1$
7	Equal & Opposite Zeroes	$b = 0$	When $\beta = -\alpha \Rightarrow \alpha + \beta = 0 \Rightarrow -b/a = 0$
8	Sum of Reciprocals	$1/\alpha + 1/\beta = -b / c$	Direct ratio without finding zeroes

 5. Tinku Sir Tricks **TRICK #1: Reciprocal Zeroes Shortcut**

Problem Type: Find unknown k in $ax^2 + bx + c$ if one zero is reciprocal of the other.

Normal Method: Assume zeroes α and $1/\alpha$, write product $\alpha \cdot (1/\alpha) = c/a$, solve $1 = c/a$.

 **TINKU SIR TRICK:** Directly equate **Constant Term = Coefficient of x^2** ($c = a$)! Answer in 2 seconds!

Example: In $3x^2 + 11x + (k - 2)$, zeroes are reciprocals. $\Rightarrow k - 2 = 3 \Rightarrow k = 5$. Done!

⚡ TRICK #2: Zeroes Equal in Magnitude, Opposite in Sign

Problem Type: Find unknown k if zeroes are equal in magnitude but opposite in sign.

⚡ TINKU SIR TRICK: Directly set **Coefficient of $x = 0$** ($b = 0$)!

Example: If zeroes of $2x^2 + (k - 4)x + 7$ are equal and opposite $\implies k - 4 = 0 \implies k = 4$.

⚡ TRICK #3: Instant Sum of Reciprocals $1/\alpha + 1/\beta$

⚡ TINKU SIR TRICK: $1/\alpha + 1/\beta = -b/c = -(\text{Coeff of } x) / (\text{Constant Term})$. You don't even need a !

Example: For $5x^2 - 7x + 3 \implies 1/\alpha + 1/\beta = -(-7)/3 = 7/3$.

🚀 6. OnePath Hacks (Exam Winning Strategies)

🚀 HACK #1: Fractional Polynomial Denominator Removal Hack

When zeroes are fractions like $2/3$ and $-1/4$:

Sum $S = 2/3 - 1/4 = 5/12$, Product $P = (2/3)(-1/4) = -2/12 = -1/6$.

Formula gives $p(x) = k[x^2 - (5/12)x - 1/6]$. Take $k = 12$ (LCM of denominators).

Polynomial becomes $12x^2 - 5x - 2$. (Clean, no fraction, full marks guaranteed!)

🚀 HACK #2: Answer Verification Hack

After finding zeroes $x = \alpha$ and $x = \beta$ by splitting the middle term, quickly check:

- 1) $\alpha + \beta$ must equal $-b/a$.
- 2) Substitute $x = \alpha$ into $p(x)$; output MUST be 0 . Takes 10 seconds to ensure 100% correctness!

🚀 HACK #3: Board Exam Presentation Hack

In 3-mark & 5-mark board questions, ALWAYS write:

"Let α and β be the zeroes of the quadratic polynomial $p(x) = ax^2 + bx + c...$ "

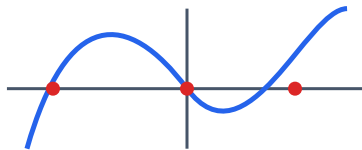
Explicitly write values of a, b, c before plugging into formulas. CBSE evaluators look for explicit step parameters!



7. Solved Examples (Graded Levels)

LEVEL 1 — BASIC Graphical Zero Identification

Q1: The graph of $y = p(x)$ is given below. Find the number of zeroes of $p(x)$.



Solution:

Given: Graph of $y = p(x)$.

Concept: The number of zeroes is equal to the number of points where the curve intersects the X-axis.

Step: Observing the graph, the curve cuts the X-axis at exactly 3 distinct points.

Final Answer: The number of zeroes of $p(x)$ is 3.

LEVEL 2 — NCERT STANDARD Find Zeroes & Verify Relationship

Q2: Find the zeroes of the quadratic polynomial $p(x) = x^2 - 2x - 8$, and verify the relationship between the zeroes and the coefficients.

Solution:

Step 1: Find Zeroes by Splitting Middle Term

$$\text{Set } p(x) = 0 \implies x^2 - 2x - 8 = 0$$

We need factors of -8 whose sum is -2 : $(-4) + 2 = -2$.

$$x^2 - 4x + 2x - 8 = 0 \implies x(x - 4) + 2(x - 4) = 0$$

$$(x - 4)(x + 2) = 0 \implies x = 4 \text{ or } x = -2.$$

So, zeroes are $\alpha = 4$ and $\beta = -2$.

Step 2: Verification with Coefficients

Comparing $x^2 - 2x - 8$ with $ax^2 + bx + c$: $a = 1$, $b = -2$, $c = -8$.

• **Sum of Zeroes:** L.H.S. = $\alpha + \beta = 4 + (-2) = 2$.

R.H.S. = $-b/a = -(-2)/1 = 2$. (Verified ✓)

• **Product of Zeroes:** L.H.S. = $\alpha \cdot \beta = 4 \times (-2) = -8$.

R.H.S. = $c/a = -8/1 = -8$. (Verified ✓)

LEVEL 3 — CBSE BOARD EXAM Transformed Symmetric Expressions

Q3: If α and β are zeroes of $2x^2 - 5x + 3$, find the value of $\alpha/\beta + \beta/\alpha$ without finding zeroes.

Solution:

Given: Polynomial $p(x) = 2x^2 - 5x + 3$. Here $a = 2$, $b = -5$, $c = 3$.

Formula Values:

$$\text{Sum } \alpha + \beta = -b/a = -(-5)/2 = 5/2$$

$$\text{Product } \alpha\beta = c/a = 3/2$$

Evaluation:

$$\alpha/\beta + \beta/\alpha = (\alpha^2 + \beta^2) / (\alpha\beta) = [(\alpha + \beta)^2 - 2\alpha\beta] / (\alpha\beta)$$

$$\text{Numerator} = (5/2)^2 - 2(3/2) = 25/4 - 3 = (25 - 12)/4 = 13/4$$

$$\text{Expression} = (13/4) / (3/2) = (13/4) \times (2/3) = 13/6.$$

Final Answer: 13/6

LEVEL 4 — COMPETENCY BASED / REAL LIFE
Parabolic Trajectory Problem

Q4: A football is kicked into the air. Its height h (in meters) at time t (in seconds) is given by $h(t) = -5t^2 + 20t + 25$.

- 1) Find the time when the ball hits the ground.
- 2) What is the maximum height achieved by the ball?

Solution:

Part 1: The ball hits the ground when height $h(t) = 0$.

$$-5t^2 + 20t + 25 = 0$$

Divide entire equation by -5 : $t^2 - 4t - 5 = 0$

Factorize: $(t - 5)(t + 1) = 0 \Rightarrow t = 5$ or $t = -1$.

Since time cannot be negative, $t = 5$ seconds.

The ball hits the ground after 5 seconds.

Part 2: Max height occurs at the vertex of parabola $t = -b / (2a)$.

Here $a = -5$, $b = 20 \Rightarrow t = -20 / (2 \times -5) = -20 / -10 = 2$ seconds.

Substitute $t = 2$ into $h(t)$:

$$h(2) = -5(2)^2 + 20(2) + 25 = -20 + 40 + 25 = 45 \text{ meters.}$$

Maximum height reached = 45 meters.

LEVEL 5 — CHALLENGE / HOTS
Advanced Parameter Problem

Q5: If α, β are zeroes of $x^2 - p(x + 1) - c$, show that $(\alpha + 1)(\beta + 1) = 1 - c$.

Solution:

Step 1: Simplify Polynomial into Standard Form

$$p(x) = x^2 - px - p - c = x^2 - px - (p + c)$$

Comparing with $ax^2 + bx + c$: $a = 1$, $b = -p$, $c = -(p + c)$.

Step 2: Write Relations

$$\alpha + \beta = -(-p)/1 = p$$

$$\alpha\beta = -(p + c)/1 = -(p + c)$$

Step 3: Expand Required Expression

$$\text{L.H.S.} = (\alpha + 1)(\beta + 1) = \alpha\beta + \alpha + \beta + 1$$

Substitute values of $\alpha\beta$ and $(\alpha + \beta)$:

$$\text{L.H.S.} = -(p + c) + p + 1 = -p - c + p + 1 = 1 - c = \text{R.H.S.}$$

Hence Proved! 🎉

8. Question Type Master Guide

If Question Wording Says...	Think of Concept...	Formula / Approach to Use
"Find zeroes and verify relation"	Middle term splitting + Coefficients	Find α, β . Verify $\alpha + \beta = -b/a$ & $\alpha\beta = c/a$
"One zero is reciprocal of other"	Product of zeroes = 1	Set $c = a$ directly
"Zeroes are equal in magnitude, opposite in sign"	Sum of zeroes = 0	Set $b = 0$ directly
"Find value of $\alpha^2 + \beta^2$ or $1/\alpha + 1/\beta$ "	Symmetric Identities	Convert to $(\alpha + \beta)$ & $(\alpha\beta)$ without finding individual zeroes
	Polynomial Formation	

If Question Wording Says...	Think of Concept...	Formula / Approach to Use
"Form quadratic polynomial whose zeroes are..."		Calculate new sum S and product P , then $k[x^2 - Sx + P]$
"Find number of zeroes from graph"	Geometrical Meaning	Count X-axis intersection / touching points only



9. CBSE PYQ Master Section (2023 - 2026)

CBSE 2023 BOARD [2 MARKS]

Q (PYQ 2023): If one zero of the polynomial $p(x) = (k + 4)x^2 + 13x + 4k$ is reciprocal of the other, find the value of k .

Solution:

Here $a = k + 4$, $b = 13$, $c = 4k$.

Since zeroes are reciprocal $\Rightarrow \alpha\beta = 1 \Rightarrow c/a = 1$.

$4k/(k + 4) = 1 \Rightarrow 4k = k + 4 \Rightarrow 3k = 4 \Rightarrow k = 4/3$.

Final Answer: $k = 4/3$. (Difficulty: Easy)

CBSE 2024 BOARD [3 MARKS]

Q (PYQ 2024): If α and β are the zeroes of polynomial $f(x) = x^2 - px + q$, form a quadratic polynomial whose zeroes are $1/\alpha$ and $1/\beta$.

Solution:

For $f(x) = x^2 - px + q$: Sum $\alpha + \beta = p$, Product $\alpha\beta = q$.

For new polynomial, new zeroes are $\alpha' = 1/\alpha$, $\beta' = 1/\beta$.

New Sum $S = 1/\alpha + 1/\beta = (\alpha + \beta) / (\alpha\beta) = p/q$.

New Product $P = (1/\alpha)(1/\beta) = 1 / (\alpha\beta) = 1/q$.

New Polynomial $= k[x^2 - Sx + P] = k[x^2 - (p/q)x + 1/q]$.

Taking $k = q \Rightarrow qx^2 - px + 1$. (Difficulty: Medium)

CBSE 2025 OFFICIAL SAMPLE / BOARD [3 MARKS]

Q (PYQ 2025): If α, β are zeroes of $x^2 - 6x + k$ such that $3\alpha + 2\beta = 20$, find the value of k .

Solution:

From polynomial $x^2 - 6x + k$: $\alpha + \beta = 6$ --- (Eq 1), and $\alpha\beta = k$.

Given: $3\alpha + 2\beta = 20$ --- (Eq 2).

Multiply (Eq 1) by 2: $2\alpha + 2\beta = 12$ --- (Eq 3).

Subtract (Eq 3) from (Eq 2): $(3\alpha + 2\beta) - (2\alpha + 2\beta) = 20 - 12 \Rightarrow \alpha = 8$.

Substitute $\alpha = 8$ in Eq 1: $8 + \beta = 6 \Rightarrow \beta = -2$.

Now, $k = \alpha\beta = 8 \times (-2) = -16$.

Final Answer: $k = -16$. (Difficulty: Medium-High)

Q (PYQ-STYLE 2026): An arch of a bridge is parabolic in shape given by $p(x) = -x^2 + 6x - 5$.

- 1) Find the zeroes of $p(x)$ and explain what they represent physically.
- 2) Find the width of the arch at ground level.

Solution:

$$1) \text{ Set } -x^2 + 6x - 5 = 0 \implies x^2 - 6x + 5 = 0 \implies (x - 1)(x - 5) = 0.$$

Zeroes are $x = 1$ and $x = 5$.

Physical meaning: These represent the positions of the two ends of the bridge arch at ground level.

$$2) \text{ Width at ground level} = |\beta - \alpha| = |5 - 1| = 4 \text{ units.}$$

Final Answer: Zeroes = 1, 5; Width = 4 units. (Difficulty: Application)

10. Most Repeated Concepts & PYQ Patterns

1. Finding Unknown k given a relation between zeroes (e.g., $\alpha - \beta = 1$ or $2\alpha + 5\beta = 21$) → Appeared 6 times in last 4 years!
2. Forming a new polynomial with modified zeroes (e.g., zeroes α/β , β/α or $\alpha+2$, $\beta+2$) → High probability 3-marker.
3. Graph based zero counting MCQs → Guaranteed 1 Mark MCQ in Section A.
4. Evaluating $\alpha^2 + \beta^2$ and $1/\alpha + 1/\beta$ → Standard 2-marker.

11. Top Mistakes Students Make

#	Common Mistake	Why Students Make It	Correct Approach
1	Counting Y-intercept as a zero from graph	Confusion between X and Y axes	Zeroes are ONLY x-coordinates where graph touches/cuts X-axis.
2	Writing $\alpha + \beta = b/a$ (forgetting negative sign)	Carelessness in formula	Sum of zeroes is strictly $-b/a$.
3	Writing $\alpha^2 + \beta^2 = (\alpha + \beta)^2$	Algebraic misconception	Correct identity: $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$.
4	Forgetting constant k when forming polynomial	Copying incomplete formula	Always write $p(x) = k[x^2 - Sx + P]$ to clear fractional denominators.
5	Finding individual zeroes when evaluating $1/\alpha + 1/\beta$	Wasting time on tough roots	Directly use $1/\alpha + 1/\beta = -b/c$.
6	Incorrect sign when splitting middle term	Speed/Calculation error	Re-check product of factors equals $a \times c$ including sign.
7	Assuming degree 2 polynomial ALWAYS has 2 distinct zeroes	Ignoring $D = 0$ and $D < 0$ cases	Can have 2 distinct, 2 equal (1 real), or 0 real zeroes. Maximum is 2.
8	Confusing Zero of Polynomial with Root of Equation	Terminology mix-up	Zero is for expression $p(x)$; Root is for equation $p(x) = 0$.
9	Not writing units in competency word problems	Ignoring contextual questions	Always specify seconds, meters, units in real-world application questions.
10	Dividing polynomial by variable factor without checking non-zero	Algebraic cancellation rush	Never cancel variable terms across equations without considering zero case.

12. Concept Connection Map

POLYNOMIAL STRUCTURE & FLOW

Degree n Expression: $p(x) = a_n x^n + \dots + a_0$

→ Geometrical Representation ($y = p(x)$) → X-axis Intercepts = Zeroes

→ Quadratic Polynomial ($ax^2 + bx + c$)

→ Zeroes α, β

→ Sum $\alpha + \beta = -b/a$ & Product $\alpha\beta = c/a$

→ Formation: $p(x) = k[x^2 - Sx + P]$

→ Transformed Algebraic Identities

→ $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$

→ $1/\alpha + 1/\beta = -b/c$

13. CBSE Exam Strategy — Polynomials

- **MCQ Strategy (Section A):** Use Tinku Sir Tricks for reciprocal zeroes ($c = a$) and equal-opposite zeroes ($b = 0$) to answer in under 30 seconds!
- **Presentation in Section B & C:** Always state "Let α and β be the zeroes of..." and explicitly list a, b, c values.
- **Verification:** Spend 10 seconds plugging zeroes back into $p(x)$ to confirm $p(\alpha) = 0$.
- **Case Study Strategy:** Parabola vertex formula $t = -b/(2a)$ gives the time of peak height; distance between ground intercepts gives width.

14. 5-Minute Revision Sheet

- **Polynomial definition:** Non-negative integer exponents only.
- **Degree 2 (Quadratic):** $ax^2 + bx + c$ ($a \neq 0$). Graph is a Parabola.
- **Parabola orientation:** Opens UP if $a > 0$; DOWN if $a < 0$.
- **Zeroes count:** Equal to number of X-axis intersection points.
- **Sum of zeroes:** $\alpha + \beta = -b/a$
- **Product of zeroes:** $\alpha\beta = c/a$
- **Polynomial formula:** $p(x) = k[x^2 - (\alpha + \beta)x + \alpha\beta]$
- **Reciprocal zeroes:** $c = a$
- **Equal & opposite zeroes:** $b = 0$
- **Sum of reciprocals:** $1/\alpha + 1/\beta = -b/c$

15. One-Page Chapter Revision Box

POLYNOMIALS — ALL-IN-ONE CHEAT SHEET

KEY FORMULAS

- $\alpha + \beta = -b/a$ • $\alpha\beta = c/a$
- $p(x) = k[x^2 - Sx + P]$
- $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$
- $1/\alpha + 1/\beta = (\alpha + \beta)/\alpha\beta = -b/c$
- $(\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta = D/a^2$
- $\alpha/\beta + \beta/\alpha = [(\alpha + \beta)^2 - 2\alpha\beta] / \alpha\beta$
- $\alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$

QUICK TRICKS & GRAPH RULES

- Reciprocal Zeroes $\implies c = a$
- Equal-Opposite Zeroes $\implies b = 0$
- Number of zeroes = X-axis cuts/touches only!
- $a > 0 \implies$ Parabola opens U
- $a < 0 \implies$ Parabola opens n
- $D > 0$: 2 zeroes | $D = 0$: 1 zero | $D < 0$: 0 zeroes

16. Complete Chapter Mindmap

[POLYNOMIALS]

- 1. BASICS & TYPES
 - | — Degree (highest power of x)
 - | — Linear (deg 1) $\longrightarrow ax + b \longrightarrow$ 1 zero ($-b/a$)
 - | — Quadratic (deg 2) $\longrightarrow ax^2 + bx + c \longrightarrow$ Max 2 zeroes
 - | — Cubic (deg 3) $\longrightarrow ax^3 + bx^2 + cx + d \longrightarrow$ Max 3 zeroes
- 2. GEOMETRICAL MEANING
 - | — Graph of Quadratic = Parabola ($\cup$ if $a > 0$, $\cap$ if $a < 0$)
 - | — Zeroes = X-coordinates where graph meets X-axis
- 3. ZEROES & COEFFICIENTS RELATION
 - | — Sum $\alpha + \beta = -b/a$
 - | — Product $\alpha\beta = c/a$
 - | — Polynomial Formation = $k[x^2 - Sx + P]$
- 4. TINKU SIR TRICKS
 - | — Reciprocal zeroes $\longrightarrow c = a$
 - | — Equal & opposite zeroes $\longrightarrow b = 0$
 - | — $1/\alpha + 1/\beta = -b/c$
- 5. BOARD PYQ PATTERNS
 - | — Finding k given zero relations
 - | — Evaluating $\alpha^2 + \beta^2$, $1/\alpha + 1/\beta$
 - | — Real-world parabolic trajectory problems

17. Final Chapter Master Checklist

- ☐ Definition of polynomial & non-polynomial expressions clear
- ☐ Degree and types of polynomials revised
- ☐ Geometrical graphs and X-axis zero counting rule understood
- ☐ Formulas for $\alpha + \beta = -b/a$ and $\alpha\beta = c/a$ memorized
- ☐ Polynomial formation formula $p(x) = k[x^2 - Sx + P]$ practiced
- ☐ Transformed identities ($\alpha^2 + \beta^2$, $1/\alpha + 1/\beta$, $\alpha/\beta + \beta/\alpha$) revised
- ☐ Tinku Sir Tricks for reciprocal & opposite zeroes mastered
- ☐ OnePath Hacks for denominator elimination practiced
- ☐ Solved examples Level 1 to Level 5 completed
- ☐ CBSE Board PYQs (2023, 2024, 2025, 2026) solved
- ☐ Top 10 Common Mistakes reviewed & avoided
- ☐ Mindmap & 5-minute revision completed