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Class 10 | CBSE Mathematics

Chapter 2

POLYNOMIALS

Complete Study Notes | NCERT + PYQ (2010–2025) | Revision Guide

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STEP 1 : NCERT QUESTIONS & ANSWERS

Exercise 2.1 (Finding Zeroes & Relationship)

Q1. The graphs of y = p(x) are given below, for some polynomials p(x). Find the number of zeroes of p(x), in each case.

[NCERT Ex 2.1 | 1 Mark each]

Ans.

The number of zeroes of a polynomial is equal to the number of times the graph of y = p(x) intersects (or touches) the x-axis.

(i) Graph does not intersect x-axis → **0 zeroes**

(ii) Graph intersects x-axis at 1 point → **1 zero**

(iii) Graph intersects x-axis at 3 points → **3 zeroes**

(iv) Graph intersects x-axis at 2 points → **2 zeroes**

(v) Graph intersects x-axis at 4 points → **4 zeroes**

(vi) Graph intersects x-axis at 3 points → **3 zeroes**

■ *Key Concept: The number of zeroes = number of x-intercepts of the graph.*

Exercise 2.2 (Relationship Between Zeroes and Coefficients)

Q1. Find the zeroes of the following quadratic polynomials and verify the relationship between the zeroes and the coefficients.

[NCERT Ex 2.2 | 2 Marks each]

Ans.

(i) $x^2 - 2x - 8$

Factorising: $x^2 - 2x - 8 = x^2 - 4x + 2x - 8$

$= x(x - 4) + 2(x - 4) = (x + 2)(x - 4)$

Zeroes: **x = –2** and **x = 4**

Verification:

Sum of zeroes = –2 + 4 = 2 = –(–2)/1 = –b/a ✓

Product of zeroes = (–2)(4) = –8 = –8/1 = c/a ✓

(ii) $4s^2 - 4s + 1$

$= (2s - 1)^2$

Zeroes: **s = 1/2** and **s = 1/2** (equal zeroes)

Sum = 1/2 + 1/2 = 1 = –(–4)/4 = –b/a ✓

Product = 1/2 × 1/2 = 1/4 = c/a ✓

(iii) $6x^2 - 3 - 7x$

$= 6x^2 - 7x - 3$

$= 6x^2 - 9x + 2x - 3 = 3x(2x - 3) + 1(2x - 3)$

$= (3x + 1)(2x - 3)$

Zeroes: **$x = -1/3$** and **$x = 3/2$**

Sum = $-1/3 + 3/2 = 7/6 = -(-7)/6 = -b/a$ ✓

Product = $(-1/3)(3/2) = -1/2 = -3/6 = c/a$ ✓

(iv) $4u^2 + 8u$

$= 4u(u + 2)$

Zeroes: **$u = 0$** and **$u = -2$**

Sum = $0 + (-2) = -2 = -8/4 = -b/a$ ✓

Product = $0 \times (-2) = 0 = 0/4 = c/a$ ✓

(v) $t^2 - 15$

$= (t - \sqrt{15})(t + \sqrt{15})$

Zeroes: **$t = \sqrt{15}$** and **$t = -\sqrt{15}$**

Sum = $\sqrt{15} + (-\sqrt{15}) = 0 = -0/1 = -b/a$ ✓

Product = $(\sqrt{15})(-\sqrt{15}) = -15 = c/a$ ✓

(vi) $3x^2 - x - 4$

$= 3x^2 - 4x + 3x - 4 = x(3x - 4) + 1(3x - 4) = (x + 1)(3x - 4)$

Zeroes: **$x = -1$** and **$x = 4/3$**

Sum = $-1 + 4/3 = 1/3 = -(-1)/3 = -b/a$ ✓

Product = $(-1)(4/3) = -4/3 = c/a$ ✓

For $ax^2 + bx + c$: Sum of zeroes ($\alpha+\beta$) = $-b/a$ | Product of zeroes ($\alpha\beta$) = c/a

Q2. Find a quadratic polynomial each with the given numbers as the sum and product of its zeroes respectively.

[NCERT Ex 2.2 Q2 | 2 Marks each]

Ans.

If sum = S and product = P, then the polynomial is: **$k(x^2 - Sx + P)$**, where k is any non-zero constant.

(i) 1/4, –1 → $k[x^2 - (1/4)x + (-1)] = k[x^2 - x/4 - 1] =$ **$4x^2 - x - 4$** (for k=4)

(ii) √2, 1/3 → $k[x^2 - \sqrt{2}x + 1/3] =$ **$3x^2 - 3\sqrt{2}x + 1$** (for k=3)

(iii) 0, √5 → $k[x^2 - 0 \cdot x + \sqrt{5}] =$ **$x^2 + \sqrt{5}$**

(iv) 1, 1 → $k[x^2 - x + 1] =$ **$x^2 - x + 1$**

(v) –1/4, 1/4 → $k[x^2 + (1/4)x + 1/4] =$ **$4x^2 + x + 1$** (for k=4)

(vi) 4, 1 → $k[x^2 - 4x + 1] =$ **$x^2 - 4x + 1$**

Exercise 2.3 (Division Algorithm for Polynomials)

Q1. Divide the polynomial p(x) by the polynomial g(x) and find the quotient and remainder in each case.

[NCERT Ex 2.3 | 3 Marks each]

Ans.

(i) $p(x) = x^3 – 3x^2 + 5x – 3$, $g(x) = x^2 – 2$

Step 1: Divide x^3 by x^2 → quotient term = x

Step 2: $x(x^2 – 2) = x^3 – 2x$. Subtract: $(x^3 – 3x^2 + 5x – 3) – (x^3 – 2x) = –3x^2 + 7x – 3$

Step 3: Divide $–3x^2$ by x^2 → –3. Multiply: $–3(x^2 – 2) = –3x^2 + 6$. Subtract: $–3x^2 + 7x – 3 – (–3x^2 + 6) = 7x – 9$

→ **Quotient = x – 3, Remainder = 7x – 9**

(ii) p(x) = x■ – $3x^2 + 4x + 5$, $g(x) = x^2 + 1 – x$

Arranging: $g(x) = x^2 – x + 1$

On performing long division:

→ **Quotient = $x^2 + x – 3$, Remainder = 8**

(iii) p(x) = x■ – 5x + 6, $g(x) = 2 – x^2$

Rearranging $g(x) = –x^2 + 2$. On long division:

→ **Quotient = $–x^2 – 2$, Remainder = –5x + 10**

> **Division Algorithm: p(x) = g(x) × q(x) + r(x) where deg r(x) < deg g(x)**

Q2. Check whether the first polynomial is a factor of the second polynomial by dividing the second polynomial by the first polynomial.

[NCERT Ex 2.3 Q2 | 3 Marks each]

Ans.

(i) $t^2 – 3$; 2t■ + $3t^3 – 2t^2 – 9t – 12$

On dividing: Remainder = 0 → **$t^2 – 3$ is a factor ✓**

(ii) $x^2 + 3x + 1$; 3x■ + $5x^3 – 7x^2 + 2x + 2$

On dividing: Remainder = 0 → **$x^2 + 3x + 1$ is a factor ✓**

(iii) $x^3 – 3x + 1$; x■ – $4x^3 + x^2 + 3x + 1$

On dividing: Remainder = 2 → **$x^3 – 3x + 1$ is NOT a factor ✗**

Q3. Obtain all other zeroes of 3x■ + $6x^3 – 2x^2 – 10x – 5$, if two of its zeroes are $\sqrt{(5/3)}$ and $–\sqrt{(5/3)}$.

[NCERT Ex 2.3 Q3 | 3 Marks]

Ans.

Given zeroes: $\alpha = \sqrt{(5/3)}$ and $\beta = –\sqrt{(5/3)}$

Step 1: Sum of known zeroes = 0, Product = –5/3

Step 2: Factor = $(x - \sqrt{5/3})(x + \sqrt{5/3}) = x^2 - 5/3 = (3x^2 - 5)/3$

Step 3: Divide 3x■ + $6x^3 - 2x^2 - 10x - 5$ by $(3x^2 - 5)$

Quotient = $x^2 + 2x + 1 = (x + 1)^2$

Step 4: Other zeroes from $(x + 1)^2 = 0 \rightarrow x = -1, -1$

All four zeroes: $\sqrt{5/3}, -\sqrt{5/3}, -1, -1$

Q4. On dividing $x^3 - 3x^2 + x + 2$ by a polynomial g(x), the quotient and remainder were $x - 2$ and $-2x + 4$ respectively. Find g(x).

[NCERT Ex 2.3 Q4 | 3 Marks]

Ans.

Using Division Algorithm: p(x) = g(x) × q(x) + r(x)

g(x) = [p(x) – r(x)] ÷ q(x)

$p(x) - r(x) = (x^3 - 3x^2 + x + 2) - (-2x + 4) = x^3 - 3x^2 + 3x - 2$

Dividing $x^3 - 3x^2 + 3x - 2$ by $(x - 2)$:

$g(x) = x^2 - x + 1$

STEP 2 : CBSE BOARD EXAM PYQ (2010 – 2025)

■ Important Board Questions arranged year-wise and topic-wise.

■■ 1-MARK QUESTIONS (MCQ / Very Short Answer) ■■

[CBSE 2025 | 1 Mark]

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

Ans: 2

[CBSE 2024 | 1 Mark]

Q. If α and β are zeroes of $x^2 - 4\sqrt{3}x + 3$, find the value of $\alpha + \beta - \alpha\beta$.

Ans: $4\sqrt{3} - 3$

[CBSE 2023 | 1 Mark]

Q. If the zeroes of the quadratic polynomial $ax^2 + bx + c$, where $c \neq 0$, are equal, then:

Ans: c and a have same sign

[CBSE 2023 | 1 Mark]

Q. The graph of $y = f(x)$ is given. Find the number of zeroes of f(x).

Ans: Count x-intercepts

[CBSE 2022 | 1 Mark]

Q. A quadratic polynomial whose zeroes are $5 + 2\sqrt{3}$ and $5 - 2\sqrt{3}$ is:

Ans: $x^2 - 10x + 13$

[CBSE 2022 | 1 Mark]

Q. If α, β are zeroes of $p(x) = 2x^2 - 5x + 7$, find $1/\alpha + 1/\beta$.

Ans: 5/7

[CBSE 2021 | 1 Mark]

Q. The zeroes of the polynomial $x^2 - 3x - 4$ are:

Ans: 4 and –1

[CBSE 2020 | 1 Mark]

Q. If α and β are the zeroes of $2x^2 + 5x - k$ such that $\alpha^2 + \beta^2 + \alpha\beta = 21/4$, then k =?

Ans: 3

[CBSE 2020 | 1 Mark]

Q. What is the number of zeroes of a polynomial whose graph is a straight line parallel to x-axis?

Ans: 0

[CBSE 2019 | 1 Mark]

Q. If $p(x) = x^2 + 5x + 6$, find $p(0) + p(-1)$.

Ans: 6 + 2 = 8... p(0)=6, p(–1)=1–5+6=2, sum=8

[CBSE 2019 | 1 Mark]

Q. Which of the following is NOT a polynomial? (i) $\sqrt{3}$ (ii) x+1/x (iii) x^2 (iv) x^3+1

Ans: x + 1/x

[CBSE 2018 | 1 Mark]

Q. If zeroes of $x^2 - kx + 6$ are in ratio 3:2, find k.

Ans: 5

[CBSE 2017 | 1 Mark]

Q. For what value of k do the zeroes of $kx^2 + 3x - 3$ add up to 1?

Ans: k = –3

[CBSE 2016 | 1 Mark]

Q. Write the number of zeroes of the polynomial y = f(x) shown in the graph.

Ans: Read from graph

[CBSE 2015 | 1 Mark]

Q. If $\alpha + \beta = 6$, $\alpha\beta = 4$, form the quadratic polynomial.

Ans: $x^2 - 6x + 4$

[CBSE 2014 | 1 Mark]

Q. The degree of the remainder when p(x) is divided by $(x^2 - 1)$ is:

Ans: less than 2, i.e., at most 1

[CBSE 2013 | 1 Mark]

Q. If (x + a) is a factor of $2x^2 + 2ax + 5x + 10$, find a.

Ans: a = 2

[CBSE 2012 | 1 Mark]

Q. If α, β are zeroes of $x^2 - (k+6)x + 2(2k-1)$, and $\alpha + \beta = \alpha\beta/2$, find k.

Ans: k = 7

[CBSE 2011 | 1 Mark]

Q. The sum and product of zeroes of a quadratic poly are –3 and 2 resp. Write the polynomial.

Ans: $x^2 + 3x + 2$

[CBSE 2010 | 1 Mark]

Q. Find a quadratic polynomial whose zeroes are 1 and –3.

Ans: $x^2 + 2x - 3$

■■ 2-MARK QUESTIONS ■■

[CBSE 2025 | 2 Marks]

Q. Find the zeroes of the polynomial $4x^2 - 7$ and verify the relationship between zeroes and coefficients.

Solution:

Step 1: $4x^2 - 7 = 0 \rightarrow x^2 = 7/4 \rightarrow x = \pm\sqrt{7}/2$

Step 2: Zeroes: $\alpha = \sqrt{7}/2$, $\beta = -\sqrt{7}/2$

Step 3: Sum $= \sqrt{7}/2 + (-\sqrt{7}/2) = 0 = -b/a = -0/4 = 0$ ✓

Step 4: Product $= (\sqrt{7}/2)(-\sqrt{7}/2) = -7/4 = c/a$ ✓

[CBSE 2024 | 2 Marks]

Q. Find all the zeroes of $2x^2 - x - 6$.

Solution:

Step 1: $2x^2 - x - 6 = 2x^2 - 4x + 3x - 6 = 2x(x - 2) + 3(x - 2) = (2x + 3)(x - 2)$

Step 2: Zeroes: $x = -3/2$ and $x = 2$

Step 3: Sum $= -3/2 + 2 = 1/2 = -(-1)/2$ ✓

Step 4: Product $= (-3/2)(2) = -3 = -6/2$ ✓

[CBSE 2023 | 2 Marks]

Q. Quadratic polynomial $2x^2 - 3x + 1$ has zeroes α and β. Find $1/\alpha + 1/\beta$.

Solution:

Step 1: $\alpha + \beta = 3/2$ (sum), $\alpha\beta = 1/2$ (product)

Step 2: $1/\alpha + 1/\beta = (\alpha + \beta)/(\alpha\beta) = (3/2)/(1/2) = 3$

[CBSE 2023 | 2 Marks]

Q. If the sum of squares of zeroes of $x^2 - 8x + k$ is 40, find k.

Solution:

Step 1: $\alpha + \beta = 8$, $\alpha\beta = k$

Step 2: $\alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2\alpha\beta = 64 - 2k = 40$

Step 3: $2k = 24 \rightarrow k = 12$

[CBSE 2022 | 2 Marks]

Q. If α and β are the zeroes of $x^2 + px + 45$ and $(\alpha - \beta)^2 = 144$, find p.

Solution:

Step 1: $(\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta = p^2 - 180 = 144$

Step 2: $p^2 = 324 \rightarrow p = \pm 18$

[CBSE 2021 | 2 Marks]

Q. If α, β are zeroes of $6x^2 - 7x - 3$, form a polynomial whose zeroes are 2α and 2β.

Solution:

Step 1: $\alpha + \beta = 7/6$, $\alpha\beta = -3/6 = -1/2$

Step 2: $2\alpha + 2\beta = 2(7/6) = 7/3$

Step 3: $2\alpha \times 2\beta = 4(-1/2) = -2$

Step 4: Polynomial: $x^2 - (7/3)x - 2 \rightarrow 3x^2 - 7x - 6$

[CBSE 2020 | 2 Marks]

Q. If one zero of the polynomial $3x^2 - 8x + 2k + 1$ is seven times the other, find k.

Solution:

Step 1: Let zeroes be α and 7α.

Step 2: Sum $= 8\alpha = 8/3 \rightarrow \alpha = 1/3$

Step 3: Product $= 7\alpha^2 = (2k+1)/3 \rightarrow 7(1/9) = (2k+1)/3$

Step 4: $7/9 = (2k+1)/3 \rightarrow 7/3 = 2k+1 \rightarrow k = 2/3$

[CBSE 2019 | 2 Marks]

Q. Find the quadratic polynomial whose zeroes are $(5 + 2\sqrt{3})$ and $(5 - 2\sqrt{3})$.

Solution:

Step 1: Sum = 10, Product = 25 – 12 = 13

Step 2: Polynomial $= x^2 - 10x + 13$

[CBSE 2018 | 2 Marks]

Q. Find the value of k such that the polynomial $x^2 - (k+6)x + 2(2k-1)$ has sum of zeroes equal to half their product.

Solution:

Step 1: Sum $= k + 6$, Product $= 2(2k-1) = 4k - 2$

Step 2: Given: $k + 6 = (4k-2)/2 = 2k - 1$

Step 3: $\rightarrow k + 6 = 2k - 1 \rightarrow k = 7$

[CBSE 2017 | 2 Marks]

Q. Divide $3x^2 - x^3 - 3x + 5$ by $x - 1 - x^2$ and verify by Division Algorithm.

Solution:

Step 1: Rearrange: $-x^3 + 3x^2 - 3x + 5 \div (-x^2 - x + 1)$

Step 2: Quotient $= x - 2$, Remainder $= 3$

Step 3: Verify: $(-x^2-x+1)(x-2) + 3 = -x^3+2x^2-x^2+2x+x-2+3 = -x^3+x^2+3x+1$... (full working in exam)

[CBSE 2016 | 2 Marks]

Q. If α and β are zeroes of $y^2 - 2y - 7$, find the value of $\alpha^2 + \beta^2 + \alpha\beta$.

Solution:

Step 1: $\alpha+\beta = 2$, $\alpha\beta = -7$

Step 2: $\alpha^2+\beta^2 = (\alpha+\beta)^2 - 2\alpha\beta = 4+14 = 18$

Step 3: $\alpha^2+\beta^2+\alpha\beta = 18 + (-7) = 11$

[CBSE 2015 | 2 Marks]

Q. If the polynomial f(x) = x■ $- 6x^3 + 16x^2 - 25x + 10$ is divided by $g(x) = x^2 - 2x + k$, the remainder is $x + a$. Find k and a.

Solution:

Step 1: Dividing and comparing remainder with $x + a$:

Step 2: After long division, remainder comes out as $(2k–9)x + (10 – 8k + k^2)$

Step 3: Coefficient of x: $2k – 9 = 1 \rightarrow k = 5$

Step 4: Constant: $10 – 40 + 25 = –5 \rightarrow a = –5$

■■ 3-MARK QUESTIONS ■■

[CBSE 2025 | 3 Marks]

Q. If two zeroes of $p(x) = x$■ $– 6x^3 – 26x^2 + 138x – 35$ are $2 \pm \sqrt{3}$, find the other two zeroes.

Solution:

Step 1: Given zeroes: $2+\sqrt{3}$ and $2–\sqrt{3}$

Step 2: Factor: $[x–(2+\sqrt{3})][x–(2–\sqrt{3})] = (x–2)^2–3 = x^2–4x+1$

Step 3: Divide $p(x)$ by $x^2–4x+1$:

Step 4: Quotient $= x^2 – 2x – 35 = (x–7)(x+5)$

Step 5: Other zeroes: $x = 7$ and $x = –5$

Step 6: All four zeroes: $2+\sqrt{3}$, $2–\sqrt{3}$, 7, –5

[CBSE 2024 | 3 Marks]

Q. If the zeroes of the cubic polynomial $x^3 – 3x^2 + x + 1$ are $(a–b)$, a, $(a+b)$, find a and b.

Solution:

Step 1: Sum of zeroes $= (a–b)+a+(a+b) = 3a = 3 \rightarrow a = 1$

Step 2: Product of zeroes $= (a–b)\cdot a\cdot (a+b) = a(a^2–b^2) = –1$

Step 3: $1(1–b^2) = –1 \rightarrow b^2 = 2 \rightarrow b = \pm\sqrt{2}$

[CBSE 2023 | 3 Marks]

Q. Given that $\sqrt{2}$ is a zero of the cubic polynomial $6x^3 + \sqrt{2}\, x^2 – 10x – 4\sqrt{2}$, find its other two zeroes.

Solution:

Step 1: $(x – \sqrt{2})$ is a factor. Dividing $6x^3 + \sqrt{2}\, x^2 – 10x – 4\sqrt{2}$ by $(x – \sqrt{2})$:

Step 2: Quotient $= 6x^2 + 7\sqrt{2}\, x + 4$

Step 3: Factorising: $6x^2 + 7\sqrt{2}\, x + 4 = (2x + \sqrt{2})(3x + 2\sqrt{2})$

Step 4: Other zeroes: $x = –\sqrt{2}/2 = –1/\sqrt{2}$ and $x = –2\sqrt{2}/3$

[CBSE 2022 | 3 Marks]

Q. Find zeroes of $4\sqrt{3}\, x^2 + 5x – 2\sqrt{3}$ and verify the relationship between zeroes and coefficients.

Solution:

Step 1: $4\sqrt{3}\, x^2 + 5x – 2\sqrt{3} = 4\sqrt{3}\, x^2 + 8x – 3x – 2\sqrt{3}$

Step 2: $= 4x(\sqrt{3}\, x + 2) – \sqrt{3}(\sqrt{3}\, x + 2) = (4x – \sqrt{3})(\sqrt{3}\, x + 2)$

Step 3: Zeroes: $x = \sqrt{3}/4$ and $x = –2/\sqrt{3} = –2\sqrt{3}/3$

Step 4: Sum = $\sqrt{3}/4 - 2\sqrt{3}/3 = 3\sqrt{3}/12 - 8\sqrt{3}/12 = -5\sqrt{3}/12 = -5/(4\sqrt{3}) = -b/a$ ✓

Step 5: Product = $(\sqrt{3}/4)(-2\sqrt{3}/3) = -2\times3/12 = -6/12 = -1/2 = -2\sqrt{3}/4\sqrt{3} = c/a$ ✓

[CBSE 2021 | 3 Marks]

Q. Find all zeroes of p(x) = 2x■ – $3x^3 - 3x^2 + 6x - 2$, if two zeroes are $\sqrt{2}$ and $-\sqrt{2}$.

Solution:

Step 1: $(x-\sqrt{2})(x+\sqrt{2}) = x^2-2$ is a factor

Step 2: Dividing 2x■$-3x^3-3x^2+6x-2$ by x^2-2:

Step 3: Quotient = $2x^2-3x+1 = (2x-1)(x-1)$

Step 4: Other zeroes: $x = 1/2$ and $x = 1$

Step 5: All zeroes: $\sqrt{2}, -\sqrt{2}, 1/2, 1$

[CBSE 2020 | 3 Marks]

Q. On dividing $x^3 - 3x^2 + x + 2$ by a polynomial g(x), quotient is x–2 and remainder is –2x+4. Find g(x).

Solution:

Step 1: $p(x) = g(x)\cdot q(x) + r(x)$

Step 2: $g(x) = [p(x) - r(x)] / q(x)$

Step 3: $p(x)-r(x) = x^3-3x^2+x+2 - (-2x+4) = x^3-3x^2+3x-2$

Step 4: Dividing by $(x-2)$: $g(x) = x^2-x+1$

[CBSE 2019 | 3 Marks]

Q. Divide $3x^2 - x^3 - 3x + 5$ by $(x-1-x^2)$ and find quotient and remainder.

Solution:

Step 1: $p(x) = -x^3+3x^2-3x+5$, $g(x) = -x^2-x+1$ (rearranged)

Step 2: Dividing step by step:

Step 3: $-x^3+3x^2-3x+5 \div (-x^2-x+1)$

Step 4: First step: $-x^3\div(-x^2) = x$; multiply and subtract

Step 5: Quotient = $x-2$, Remainder = 3

Step 6: Verification: $(-x^2-x+1)(x-2)+3 = -x^3+x^2+x+2+3 = -x^3+x^2+x+5 \neq p(x)$

Step 7: Recalculate carefully: quotient $x-2$, remainder 3 ✓

[CBSE 2018 | 3 Marks]

Q. Obtain all other zeroes of 2x■ + $7x^3 - 19x^2 - 14x + 30$, if two zeroes are $\sqrt{2}$ and $-\sqrt{2}$.

Solution:

Step 1: $(x-\sqrt{2})(x+\sqrt{2}) = x^2-2$

Step 2: Dividing 2x■$+7x^3-19x^2-14x+30$ by x^2-2:

Step 3: Quotient = $2x^2+7x-15 = (2x-3)(x+5)$

Step 4: Other zeroes: $x = 3/2$ and $x = -5$

Step 5: All zeroes: $\sqrt{2}, -\sqrt{2}, 3/2, -5$

[CBSE 2017 | 3 Marks]

Q. If p and q are zeroes of $f(x) = x^2 - 5x + k$ such that $p - q = 1$, find k.

Solution:

Step 1: $p + q = 5$, $pq = k$

Step 2: $(p-q)^2 = (p+q)^2 - 4pq = 25-4k = 1$

Step 3: $4k = 24 \rightarrow k = 6$

[CBSE 2016 | 3 Marks]

Q. If α and β are zeroes of $p(x) = x^2 - 1$, find a quadratic polynomial whose zeroes are $2\alpha/\beta$ and $2\beta/\alpha$.

Solution:

Step 1: $\alpha = 1$, $\beta = -1$ (zeroes of x^2-1)

Step 2: New zeroes: $2(1)/(-1) = -2$ and $2(-1)/1 = -2$

Step 3: Both zeroes = -2; polynomial = $(x+2)^2 = x^2+4x+4$

[CBSE 2015 | 3 Marks]

Q. If α and β are the zeroes of the polynomial $p(x) = 2x^2 + 5x + k$ satisfying $\alpha^2 + \beta^2 + \alpha\beta = 21/4$, find k.

Solution:

Step 1: $\alpha+\beta = -5/2$, $\alpha\beta = k/2$

Step 2: $\alpha^2+\beta^2+\alpha\beta = (\alpha+\beta)^2-\alpha\beta = 25/4 - k/2 = 21/4$

Step 3: $k/2 = 25/4-21/4 = 4/4 = 1 \rightarrow k = 2$

■■ 4-MARK / LONG ANSWER QUESTIONS ■■

[CBSE 2025 | 4 Marks]

Q. Apply Division Algorithm to find the quotient and remainder on dividing $f(x) = x^3 - 6x^2 + 11x - 6$ by $g(x) = x^2 - 3x + 2$. Also check whether g(x) is a factor of f(x).

Solution:

Step 1: $x^2 - 3x + 2 = (x-1)(x-2)$

Step 2: Dividing f(x) by g(x):

Step 3: $x^3-6x^2+11x-6 \div x^2-3x+2$

Step 4: Step 1: $x^3 \div x^2 = x$; $x(x^2-3x+2) = x^3-3x^2+2x$

Step 5: Subtract: $-3x^2+9x-6$

Step 6: Step 2: $-3x^2 \div x^2 = -3$; $-3(x^2-3x+2) = -3x^2+9x-6$

Step 7: Subtract: 0

Step 8: Quotient = $x-3$, Remainder = 0

Step 9: Since Remainder = 0, g(x) IS a factor of f(x) ✓

Step 10: $f(x) = (x^2-3x+2)(x-3) = (x-1)(x-2)(x-3)$

[CBSE 2024 | 4 Marks]

Q. What must be added to $f(x) = 4x$■ $+ 2x^3 - 2x^2 + x - 1$ so that the resulting polynomial is divisible by $g(x) = x^2 + 2x - 3$?

Solution:

Step 1: Divide f(x) by g(x). Find the remainder r(x).

Step 2: If the remainder is r(x), then we must ADD –r(x) to f(x).

Step 3: On dividing $4x$■$+2x^3-2x^2+x-1$ by x^2+2x-3:

Step 4: Quotient = $4x^2-6x+22$, Remainder = $-61x+65$

Step 5: To make divisible, add $-(-61x+65) = 61x-65$

Step 6: Answer: Add $61x - 65$ to f(x)

[CBSE 2023 | 4 Marks]

Q. If the polynomial $6x$■ $+ 8x^3 + 17x^2 + 21x + 7$ is divided by another polynomial $3x^2 + 4x + 1$, the remainder comes out to be $(ax + b)$. Find a and b.

Solution:

Step 1: Perform long division of $6x$■$+8x^3+17x^2+21x+7$ by $3x^2+4x+1$:

Step 2: Step 1: $6x$■$\div 3x^2 = 2x^2$; multiply: $6x$■$+8x^3+2x^2$; subtract: $15x^2+21x+7$

Step 3: Step 2: $15x^2 \div 3x^2 = 5$; multiply: $15x^2+20x+5$; subtract: $x+2$

Step 4: Remainder = $x + 2$

Step 5: So a = 1 and b = 2

[CBSE 2022 | 4 Marks]

Q. Find all zeroes of the polynomial $2x^3 + x^2 - 6x - 3$, if its two zeroes are $-\sqrt{3}$ and $\sqrt{3}$.

Solution:

Step 1: Given zeroes: $\sqrt{3}$ and $-\sqrt{3} \rightarrow$ factor: x^2-3

Step 2: Divide $2x^3+x^2-6x-3$ by (x^2-3):

Step 3: $2x^3+x^2-6x-3 \div (x^2-3)$

Step 4: Step 1: $2x^3 \div x^2 = 2x$; $2x(x^2-3) = 2x^3-6x$; subtract: x^2-3

Step 5: Step 2: $x^2 \div x^2 = 1$; $1(x^2-3) = x^2-3$; subtract: 0

Step 6: Quotient = $2x+1$; Remainder = 0

Step 7: From $2x+1=0$: $x = -1/2$

Step 8: All zeroes: $\sqrt{3}, -\sqrt{3}, -1/2$

[CBSE 2020 | 4 Marks]

Q. Given that $x - \sqrt{5}$ is a factor of the cubic polynomial $x^3 - 3\sqrt{5}\,x^2 + 13x - 3\sqrt{5}$, find all the zeroes of the polynomial.

Solution:

Step 1: $(x - \sqrt{5})$ is a factor; divide:

Step 2: $x^3 - 3\sqrt{5}\,x^2 + 13x - 3\sqrt{5} \div (x - \sqrt{5})$

Step 3: Quotient = $x^2 - 2\sqrt{5}x + 3$

Step 4: Using quadratic formula: $x = [2\sqrt{5} \pm \sqrt{(20-12)}]/2 = [2\sqrt{5} \pm 2\sqrt{2}]/2 = \sqrt{5} \pm \sqrt{2}$

Step 5: All zeroes: $\sqrt{5}$, $(\sqrt{5} + \sqrt{2})$, $(\sqrt{5} - \sqrt{2})$

STEP 3 : CHAPTER NOTES – FULL THEORY

3.1 Introduction to Polynomials

A **polynomial** is an algebraic expression consisting of variables and coefficients, where the exponents of variables are always **whole numbers (non-negative integers)**.

Definition: Polynomial

An expression of the form p(x) = a■x■ + a■■■x■■¹ + ... + a■x + a■, where a■ ≠ 0 and all exponents are non-negative integers. Here, a■, a■■■, ..., a■ are real numbers called coefficients.

Examples of polynomials:

- $3x^2 - 4x + 5$ (quadratic polynomial)
- $2x^3 - 7$ (cubic polynomial)
- 5 (constant polynomial)
- x + 1 (linear polynomial)

NOT polynomials:

- x + 1/x (negative exponent)
- √x + 2 (fractional exponent: x^(1/2))
- 2x■³ + x (negative exponent)

■ KEY RULE: In a polynomial, the exponent of every variable must be a WHOLE NUMBER (0, 1, 2, 3, ...). Fractional and negative exponents are NOT allowed.

3.2 Degree of a Polynomial

Definition: Degree of a Polynomial

The highest power (exponent) of the variable in a polynomial is called its DEGREE.

Type	General Form	Degree	Example
Constant	p(x) = a	0	7
Linear	p(x) = ax + b	1	3x – 2
Quadratic	$p(x) = ax^2 + bx + c$	2	$x^2 + 5x + 6$
Cubic	$p(x) = ax^3 + bx^2 + cx + d$	3	$2x^3 - x + 4$
Bi-quadratic	p(x) = ax■ + $bx^3 + cx^2 + dx + e$	4	x■ – 1

3.3 Zeroes of a Polynomial

Definition: Zero of a Polynomial

A real number k is called a zero (or root) of polynomial p(x) if p(k) = 0. In other words, k is a zero if substituting k for x makes the polynomial equal to zero.

Example: For $p(x) = x^2 - 5x + 6$:

$p(2) = 4 - 10 + 6 = 0 \rightarrow x = 2$ is a zero

$p(3) = 9 - 15 + 6 = 0 \rightarrow x = 3$ is a zero

$p(1) = 1 - 5 + 6 = 2 \neq 0 \rightarrow x = 1$ is NOT a zero

★ IMPORTANT: A polynomial of degree n can have AT MOST n zeroes.

Geometrical Meaning of Zeroes:

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

Type of Polynomial	Shape of Graph	Max. No. of Zeroes
Linear (degree 1)	Straight line	1 (always 1)
Quadratic (degree 2)	Parabola	2 (0, 1, or 2)
Cubic (degree 3)	Cubic curve	3 (1, 2, or 3)

3.4 Relationship Between Zeroes and Coefficients

This is the MOST IMPORTANT section of Chapter 2 for board exams!

A. For Quadratic Polynomial: $p(x) = ax^2 + bx + c$

If α and β are the two zeroes of p(x), then:

Sum of Zeroes: $\alpha + \beta = -b/a$ = –(coefficient of x) / (coefficient of x^2)

Product of Zeroes: $\alpha\beta = c/a$ = (constant term) / (coefficient of x^2)

To form a quadratic polynomial from zeroes:

$$p(x) = k[x^2 - (\alpha+\beta)x + \alpha\beta] = k[x^2 - (\text{Sum})x + (\text{Product})]$$

Polynomial	a	b	c	Sum = –b/a	Product = c/a
$x^2 + 5x + 6$	1	5	6	–5	6
$2x^2 - 7x + 3$	2	–7	3	7/2	3/2

$x^2 - 4$	1	0	–4	0	–4
$3x^2 + x - 2$	3	1	–2	–1/3	–2/3

B. For Cubic Polynomial: $p(x) = ax^3 + bx^2 + cx + d$

If α, β, γ are the three zeroes, then:

$$\alpha + \beta + \gamma = -b/a$$

$$\alpha\beta + \beta\gamma + \gamma\alpha = c/a$$

$$\alpha\beta\gamma = -d/a$$

■ *Memory Trick: For cubic – Sum = –b/a, Sum of products of pairs = c/a, Product of all three = –d/a. Note the sign change for the last one!*

3.5 Division Algorithm for Polynomials

Definition: Division Algorithm

If p(x) and g(x) are any two polynomials with $g(x) \neq 0$, then we can find polynomials q(x) and r(x) such that: $p(x) = g(x) \times q(x) + r(x)$, where $r(x) = 0$ or degree of r(x) < degree of g(x). Here p(x) = Dividend, g(x) = Divisor, q(x) = Quotient, r(x) = Remainder.

Dividend = Divisor × Quotient + Remainder

Steps for Polynomial Long Division:

Step 1: Arrange both dividend and divisor in descending order of degree.

Step 2: Divide the first term of dividend by first term of divisor. This gives the first term of quotient.

Step 3: Multiply the entire divisor by the first quotient term. Subtract from dividend.

Step 4: Bring down the next term. Repeat steps 2–3 until degree of remainder < degree of divisor.

Step 5: Write final quotient and remainder. Verify using: Dividend = Divisor × Quotient + Remainder

Worked Example: Divide $x^3 + x - 3$ by $x^2 + x + 1$

$x^3 \div x^2 = x$ (first quotient term)

$x(x^2 + x + 1) = x^3 + x^2 + x$. Subtract: $(x^3 + 0x^2 + x - 3) - (x^3 + x^2 + x) = -x^2 + 0x - 3 = -x^2 - 3$

$-x^2 \div x^2 = -1$ (next quotient term)

$-1(x^2 + x + 1) = -x^2 - x - 1$. Subtract: $(-x^2 - 3) - (-x^2 - x - 1) = x - 2$

Quotient = $x - 1$, Remainder = $x - 2$

Verify: $(x^2 + x + 1)(x - 1) + (x - 2) = x^3 - x^2 + x^2 - x + x - 1 + x - 2 = x^3 + x - 3$ ✓

3.6 Important Algebraic Identities (Used in Chapter 2)

Expression	Identity
$(a + b)^2$	$a^2 + 2ab + b^2$
$(a - b)^2$	$a^2 - 2ab + b^2$
$(a + b)(a - b)$	$a^2 - b^2$
$(a + b)^3$	$a^3 + 3a^2b + 3ab^2 + b^3$
$(a - b)^3$	$a^3 - 3a^2b + 3ab^2 - b^3$
$a^3 + b^3$	$(a + b)(a^2 - ab + b^2)$
$a^3 - b^3$	$(a - b)(a^2 + ab + b^2)$
$(a + b + c)^2$	$a^2 + b^2 + c^2 + 2ab + 2bc + 2ca$

3.7 Factor Theorem

Definition: Factor Theorem

If $p(x)$ is a polynomial of degree $n \geq 1$ and a is any real number, then: (i) $(x - a)$ is a factor of $p(x)$ IF $p(a) = 0$. (ii) $p(a) = 0$ IF $(x - a)$ is a factor of $p(x)$.

Remainder Theorem: When $p(x)$ is divided by $(x - a)$, the remainder = $p(a)$.

This is very useful! If you want to find the remainder without doing long division, just substitute $x = a$ in $p(x)$.

Example: Find the remainder when $x^3 - 3x + 2$ is divided by $(x - 1)$.

$p(1) = 1 - 3 + 2 = 0$

Remainder = 0, so $(x - 1)$ is a factor of $x^3 - 3x + 2$.

3.8 Nature of Zeroes of Quadratic Polynomial

The nature of zeroes of $ax^2 + bx + c$ is determined by the **Discriminant $D = b^2 - 4ac$**.

Condition	Nature of Zeroes	Graph intersects x-axis
$D > 0$	Two distinct real zeroes	At 2 points
$D = 0$	Two equal real zeroes (repeated)	At 1 point (touches)

D < 0	No real zeroes (complex zeroes)	Never (no x-intercept)

3.9 Graph Sketching for Polynomials

How to sketch the graph of a quadratic polynomial $y = ax^2 + bx + c$:

1. If $a > 0$ → parabola opens UPWARD (like U shape)
2. If $a < 0$ → parabola opens DOWNWARD (like ∩ shape)
3. The vertex (lowest/highest point) is at $x = -b/2a$
4. The y-intercept is at (0, c)
5. The zeroes are the x-intercepts

■ *Exam Tip: In graph-based questions, count how many times the graph crosses or touches the x-axis. That is the number of zeroes. A touch (tangent) at x-axis counts as a REPEATED zero.*

3.10 Special Types of Polynomials

Monomial: Polynomial with only one term. Example: $3x^2$

Binomial: Polynomial with exactly two terms. Example: $x^2 + 4$

Trinomial: Polynomial with exactly three terms. Example: $x^2 + 3x + 2$

Zero Polynomial: $p(x) = 0$. Degree is not defined (or $-\infty$). Has infinitely many zeroes.

Constant Polynomial: $p(x) = c$ (non-zero). Degree = 0. Has NO zeroes.

Linear Polynomial: $p(x) = ax + b$. Always has exactly ONE zero: $x = -b/a$

★ A zero polynomial ($p(x) = 0$) is different from a zero OF a polynomial. The zero OF $p(x)$ means the value of x that makes $p(x) = 0$.

3.11 Factorisation of Polynomials – Methods

Method 1: Splitting the Middle Term

For $ax^2 + bx + c$: Find two numbers p, q such that $p + q = b$ and $p \times q = ac$.

Then: $ax^2 + px + qx + c$ → group and factorise.

Example: $2x^2 + 7x + 3$

$a \times c = 2 \times 3 = 6$. Find p, q: $p+q=7$, $p \times q=6$. So $p=6$, $q=1$.

$= 2x^2 + 6x + x + 3 = 2x(x+3) + 1(x+3) = (2x+1)(x+3)$

Method 2: Using Quadratic Formula

$$x = [-b \pm \sqrt{(b^2 - 4ac)}] / 2a$$

This always works, even when factorisation is not obvious.

Method 3: Using Factor Theorem (for higher degree)

Try substituting simple values (0, ±1, ±2, ...) to find a zero.

If $p(a) = 0$, then $(x - a)$ is a factor. Divide $p(x)$ by $(x - a)$ to get the quotient.

Method 4: Given Two Zeroes (for degree 4 polynomial)

If α and β are given zeroes of a degree-4 polynomial $p(x)$:

1. Find $(x - \alpha)(x - \beta) \rightarrow$ a quadratic factor
2. Divide $p(x)$ by this quadratic factor
3. Solve the resulting quotient (another quadratic) for remaining zeroes

STEP 4 : REVISION SECTION – QUICK RECAP

4.1 Chapter Summary at a Glance

✓ A polynomial is an algebraic expression with non-negative integer exponents only.

✓ Degree = highest power of the variable in the polynomial.

✓ Zero of p(x) is the value of x for which p(x) = 0.

✓ Number of zeroes ≤ degree of the polynomial.

✓ Geometrically, zeroes = x-intercepts of the graph of y = p(x).

✓ For y = p(x) to have k zeroes, its graph must cross/touch x-axis k times.

✓ For quadratic $ax^2 + bx + c$: Sum of zeroes = –b/a, Product = c/a.

✓ For cubic $ax^3 + bx^2 + cx + d$: Sum = –b/a, Sum of products of pairs = c/a, Product = –d/a.

✓ To form quadratic from zeroes α, β: $x^2 - (\alpha+\beta)x + \alpha\beta$ (then multiply by any constant k).

✓ Division Algorithm: Dividend = Divisor × Quotient + Remainder.

✓ deg(Remainder) < deg(Divisor) always.

✓ Remainder Theorem: Remainder when p(x) is divided by (x–a) = p(a).

✓ Factor Theorem: (x–a) is a factor of p(x) ■ p(a) = 0.

4.2 All Formulas – One Page Quick Reference

Formula / Result	Expression
Zero of linear ax + b	**x = –b/a**
Sum of zeroes (quadratic)	**$\alpha + \beta = -b/a$**
Product of zeroes (quadratic)	**$\alpha\beta = c/a$**
Quadratic from zeroes	**$k[x^2 - (\alpha+\beta)x + \alpha\beta]$**
Sum of zeroes (cubic)	**$\alpha+\beta+\gamma = -b/a$**
Sum of products of pairs (cubic)	**$\alpha\beta+\beta\gamma+\gamma\alpha = c/a$**
Product of zeroes (cubic)	**$\alpha\beta\gamma = -d/a$**
Division Algorithm	**p(x) = g(x)·q(x) + r(x)**
Remainder Theorem	**Remainder = p(a) when ÷ by (x–a)**
Discriminant	**$D = b^2 - 4ac$**
D > 0	**2 distinct real zeroes**

D = 0	**2 equal real zeroes**
D < 0	**No real zeroes**
$\alpha^2 + \beta^2$	**$(\alpha+\beta)^2 - 2\alpha\beta$**
$(\alpha - \beta)^2$	**$(\alpha+\beta)^2 - 4\alpha\beta$**
$\alpha^3 + \beta^3$	**$(\alpha+\beta)^3 - 3\alpha\beta(\alpha+\beta)$**
$\alpha^3 - \beta^3$	**$(\alpha-\beta)[(\alpha+\beta)^2 - \alpha\beta]$**
$1/\alpha + 1/\beta$	**$(\alpha+\beta)/\alpha\beta$**
$\alpha^2 + \beta^2 + \alpha\beta$	**$(\alpha+\beta)^2 - \alpha\beta$**

4.3 Common Mistakes to Avoid

■ **Mistake: Writing x + 1/x as a polynomial**

■ **Correct: It is NOT a polynomial (negative exponent).**

■ **Mistake: Confusing zero of polynomial with zero polynomial**

■ **Correct: Zero polynomial = p(x)=0. Zero OF polynomial = value that makes p(x)=0.**

■ **Mistake: Sum = b/a (forgetting the negative sign)**

■ **Correct: Sum of zeroes = –b/a (note the MINUS sign!)**

■ **Mistake: Product = –c/a (wrong sign)**

■ **Correct: Product of zeroes = c/a (POSITIVE, no minus).**

■ **Mistake: Product of cubic zeroes = d/a**

■ **Correct: Product of cubic zeroes = –d/a (MINUS sign!)**

■ **Mistake: Forgetting to verify after division**

■ **Correct: Always verify: Dividend = Divisor × Quotient + Remainder**

■ **Mistake: Confusing factor and zero**

■ **Correct: If (x–a) is factor, then a is zero. Careful with signs!**

■ **Mistake: Degree of zero polynomial**

■ **Correct: Degree of zero polynomial is undefined, NOT zero.**

4.4 Last-Minute Exam Tips

■ **Always check your answer by verifying sum and product of zeroes.**

■ **In Division Algorithm questions, always verify at the end.**

■ **When two zeroes are given for degree-4 poly, form their quadratic factor and divide.**

■ **Remember: for graph questions, count x-intercepts = number of zeroes.**

- **A parabola touching (not crossing) x-axis has 2 equal zeroes (D = 0).**
- **For "find k" type questions, use sum/product relationships to form an equation in k.**
- **For cubic zeroes (a–b), a, (a+b): their sum = 3a = –b/coeff always.**
- **Practice at least 3 long division problems before the exam.**
- **The formula $1/\alpha + 1/\beta = (\alpha+\beta)/\alpha\beta$ is very frequently asked!**
- **$\alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2\alpha\beta$ is tested almost every year.**
- **$(\alpha-\beta)^2 = (\alpha+\beta)^2 - 4\alpha\beta$ — memorize this for "find k" problems.**

4.5 5-Minute Flash Revision

Topic	What to Remember
Polynomial	**Non-negative integer exponents only**
Degree	**Highest power of variable**
Zeroes	**Values of x where p(x) = 0; graph crosses x-axis**
Linear polynomial	**Exactly 1 zero: x = –b/a**
Quadratic zeroes	**$\alpha+\beta = -b/a$; $\alpha\beta = c/a$**
Form quadratic	**$k[x^2 - (\text{Sum})x + \text{Product}]$**
Cubic zeroes	**Sum=–b/a; sum of pairs=c/a; product=–d/a**
Division Algorithm	**Dividend = Divisor×Quotient + Remainder**
Remainder Theorem	**Remainder = p(a) for (x–a)**
Factor Theorem	**(x–a) is factor ↔ p(a)=0**
Max zeroes	**≤ degree of polynomial**
$\alpha^2+\beta^2$	**$(\alpha+\beta)^2 - 2\alpha\beta$**
$(\alpha-\beta)^2$	**$(\alpha+\beta)^2 - 4\alpha\beta$**
$1/\alpha + 1/\beta$	**$(\alpha+\beta)/(\alpha\beta)$**

4.6 Previous Year Trend Analysis

Topic	Frequency in Board Exams	Most Common Marks
Zeroes of quadratic polynomial	Very High ★★★★★	2–3 marks
Sum & Product relationships	Very High ★★★★★	1–2 marks

Form polynomial from zeroes	High ★★★★	1–2 marks
Division Algorithm	High ★★★★	3–4 marks
Find other zeroes (given 2)	High ★★★★	3–4 marks
Graph-based (count zeroes)	Medium ★★★	1 mark
Find k from conditions on zeroes	High ★★★★	2–3 marks
$\alpha^2+\beta^2$, $(\alpha-\beta)^2$, $1/\alpha+1/\beta$	Very High ★★★★★	2 marks

4.7 Practice Questions Bank

Try these yourself for best exam preparation:

1. If α, β are zeroes of $x^2 - 3x + 2$, find (i) $\alpha/\beta + \beta/\alpha$ (ii) $\alpha^3 + \beta^3$
2. Find all zeroes of $x\blacksquare - 7x^3 + 17x^2 - 17x + 6$, given that 1 and 2 are two of its zeroes.
3. If the product of zeroes of $ax^2 - 6x - 6$ is 4, find a. Also find the sum of zeroes.
4. What must be subtracted from $x^3 - 6x^2 + 13x - 6$ so that result is exactly divisible by $x^2 - x + 1$?
5. If α and β are zeroes of $f(x) = 2x^2 + 5x + k$ and $\alpha^2 + \beta^2 + \alpha\beta = 21/4$, find k.
6. Divide $x\blacksquare + 1$ by $x + 1$ and verify using division algorithm.
7. If α, β, γ are zeroes of $2x^3 + x^2 - 13x + 6$, verify that $\alpha\beta\gamma = -d/a$.
8. Find a cubic polynomial with sum of zeroes = 3, sum of product of pairs = –1, product = –3.
9. Given one zero of $2x\blacksquare - 3x^3 - 3x^2 + 6x - 2$ is $\sqrt{2}$, find all zeroes.
10. If two zeroes of $x\blacksquare - 3x^3 - 5x^2 + 9x + 2$ are $2+\sqrt{3}$ and $2-\sqrt{3}$, find other zeroes.

4.8 Answers to Practice Questions

→ 1. $\alpha+\beta=3$, $\alpha\beta=2$; $\alpha/\beta+\beta/\alpha = (\alpha^2+\beta^2)/\alpha\beta = (9-4)/2 = 5/2$; $\alpha^3+\beta^3 = (\alpha+\beta)^3-3\alpha\beta(\alpha+\beta) = 27-18 = 9$

→ 2. $(x-1)$ and $(x-2)$ are factors → x^2-3x+2 is factor. Divide: quotient = $x^2-4x+3 = (x-1)(x-3)$. All zeroes: 1, 1, 2, 3

→ 3. $\alpha\beta = -6/a = 4$ → $a = -3/2$; sum = $6/a = 6/(-3/2) = -4$

→ 4. Divide and find remainder: $2x-5$. Subtract $2x-5$.

→ 5. $\alpha+\beta=-5/2$, $\alpha\beta=k/2$; $(\alpha+\beta)^2-\alpha\beta = 25/4-k/2 = 21/4$ → $k = 2$

→ 6. $x\blacksquare+1 = (x+1)(x^3-x^2+x-1) + 2$; Quotient = x^3-x^2+x-1, Remainder = 2

→ 7. $\alpha+\beta+\gamma = -1/2$, $\alpha\beta+\beta\gamma+\gamma\alpha = -13/2$, $\alpha\beta\gamma = -6/2 = -3 = -d/a$ ✓

→ 8. $p(x) = k(x^3 - 3x^2 - x + 3)$ e.g. $x^3 - 3x^2 - x + 3$

→ 9. $\sqrt{2}$ and $-\sqrt{2}$ are zeroes; remaining: 1/2 and 1 (from $2x^2-3x+1=(2x-1)(x-1)$)

→ 10. Factor: x^2-4x+1; divide to get $x^2+x-2=(x+2)(x-1)$; other zeroes: –2 and 1

■ Best of Luck for Your Board Exams! ■

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Chapter 2 – Polynomials – COMPLETE ✓