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QUADRATIC EQUATIONS

Complete Study Material for CBSE Class 10 (2025-26)

🌟 FASCINATING FACTS ABOUT QUADRATIC EQUATIONS

Did You Know?

🏺 **Ancient Origins:** Babylonians (around 2000 BCE) were solving quadratic equations! They used geometric methods to find two numbers with a given sum and product.

🇮🇳 **Indian Mathematics Glory:** Brahmagupta (598-665 CE) gave explicit formulas for solving quadratic equations. Sridharacharya (1025 CE) derived the quadratic formula we use today!

📐 **Greek Geometry:** Euclid solved quadratic equations using geometric constructions, finding lengths that are solutions to these equations.

🎯 **Real-Life Applications:** Quadratic equations are everywhere - calculating projectile motion, designing bridges, optimizing business profits, computer graphics, and even in GPS technology!

🔬 **Golden Ratio:** The famous golden ratio (1.618...) is a solution to the quadratic equation $x^2 - x - 1 = 0$, found in nature, art, and architecture.

🚀 **Space Science:** NASA uses quadratic equations to calculate satellite trajectories and orbital paths!

📋 CHAPTER OVERVIEW

Chapter	Quadratic Equations (Chapter 4)
Weightage	As per latest CBSE marking scheme for 2025-26
Difficulty Level	Medium to High
Expected Questions	2 Mark, 3 Mark questions
Time Required	8-12 minutes in exam

Topics Covered:

1. **Introduction to Quadratic Equations**
2. **Standard Form: $ax^2 + bx + c = 0$**
3. **Solution by Factorization Method**
4. **Solution by Completing the Square Method**
5. **Solution by Quadratic Formula (Sridharacharya Formula)**
6. **Nature of Roots (Discriminant)**
7. **Real-Life Applications**

🎯 SECTION 1: WHAT IS A QUADRATIC EQUATION?

Definition:

A quadratic equation in variable x is an equation of the form:

$$ax^2 + bx + c = 0$$

where a, b, c are real numbers and $a \neq 0$

⚡ Key Points to Remember:

- **$a \neq 0$** is CRUCIAL. If $a = 0$, the equation becomes linear ($bx + c = 0$), not quadratic.
- The highest power of x is 2 (hence "quadratic" from Latin "quadratus" meaning square)
- Standard form: Write in descending order of powers: $ax^2 + bx + c = 0$
- Examples: $2x^2 - 5x + 3 = 0$, $x^2 - 4 = 0$, $3x^2 + 7x = 0$
- A quadratic polynomial $p(x) = 0$ gives us a quadratic equation

Identifying Quadratic Equations

Example 1: Check whether the following are quadratic equations:

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

Solution:

```
LHS = (x + 1)² = x² + 2x + 1
RHS = 2(x - 3) = 2x - 6

Equation: x² + 2x + 1 = 2x - 6
          x² + 2x - 2x + 1 + 6 = 0
          x² + 7 = 0 ✓

This is of form ax² + bx + c = 0 (where a=1, b=0, c=7)
YES, it's a quadratic equation!
```

(ii) $x(x + 1) + 8 = (x + 2)(x - 2)$

Solution:

```
LHS = x(x + 1) + 8 = x² + x + 8
RHS = (x + 2)(x - 2) = x² - 4

Equation: x² + x + 8 = x² - 4
          x² - x² + x + 8 + 4 = 0
          x + 12 = 0 ✗

This is a linear equation (degree 1, not 2)
NO, it's NOT a quadratic equation!
```

(iii) $(x - 3)(2x + 1) = x(x + 5)$

Solution:

```
LHS = (x - 3)(2x + 1) = 2x² + x - 6x - 3 = 2x² - 5x -
3
RHS = x(x + 5) = x² + 5x

Equation: 2x² - 5x - 3 = x² + 5x
          2x² - x² - 5x - 5x - 3 = 0
          x² - 10x - 3 = 0 ✓
```

YES, it's a quadratic equation!

⚠️ COMMON MISTAKES TO AVOID:

❌ **Mistake 1:** Not simplifying the equation first

- Always expand brackets and simplify before deciding if it's quadratic
- Terms may cancel out making it linear or even constant!

❌ **Mistake 2:** Confusing with cubic equations

- $(x + 2)^3 = x^3 - 4$ might look cubic, but after simplification could be quadratic
- Always simplify completely and check the highest power

❌ **Mistake 3:** Forgetting $a \neq 0$ condition

- If coefficient of x^2 becomes zero after simplification, it's NOT quadratic
- Example: $x^2(x - 1) = x^3 - x^2$ looks like degree 3, but $x^2 - x(x - 1) = x^2 - x^2 + x$ simplifies to $x = 0$ (linear)

Representing Real-Life Situations

Example 2: The area of a rectangular plot is 528 m². The length of the plot (in metres) is one more than twice its breadth. Find the length and breadth.

Solution:

```
Let breadth = x metres
Then length = (2x + 1) metres

Area = length × breadth
528 = (2x + 1) × x
528 = 2x² + x
2x² + x - 528 = 0

This is the required quadratic equation representing
the situation.
```

🎯 SECTION 2: SOLUTION BY FACTORIZATION METHOD

What is a Root/Solution?

A real number α is called a **root** of quadratic equation $ax^2 + bx + c = 0$ if:

$$a\alpha^2 + b\alpha + c = 0$$

In other words, the value that **satisfies** the equation is called its root/solution.

Important: A quadratic equation can have at most 2 roots

Factorization Method - Step by Step

📝 STEPS FOR FACTORIZATION METHOD:

1. Write the equation in standard form: $ax^2 + bx + c = 0$
2. Factorize the left-hand side into two linear factors (split middle term)
3. Equate each factor to zero (Zero Product Rule: if AB = 0, then A = 0 or B = 0)
4. Solve for x from each equation
5. These values are the roots of the equation
6. Verify by substituting back into original equation

Technique: Splitting the Middle Term

How to split the middle term in $ax^2 + bx + c = 0$:

1. Find the product: $a \times c$
2. Find two numbers whose:
    - **Product** = $a \times c$
    - **Sum** = b (coefficient of x)
3. Split bx using these two numbers
4. Group terms and factor out common factors

Example 3: Find the roots of $2x^2 - 5x + 3 = 0$ by factorization

Solution:

Step 1: Identify a, b, c

$a = 2, b = -5, c = 3$

Step 2: Split middle term $-5x$

Product $= a \times c = 2 \times 3 = 6$

Sum $= b = -5$

We need two numbers whose product = 6 and sum = -5

Numbers are: -2 and -3

(because $-2 \times -3 = 6$ and $-2 + (-3) = -5$)

Step 3: Rewrite and factorize

$2x^2 - 5x + 3 = 0$

$2x^2 - 2x - 3x + 3 = 0$

$2x(x - 1) - 3(x - 1) = 0$

$(2x - 3)(x - 1) = 0$

Step 4: Apply Zero Product Rule

Either $2x - 3 = 0$ or $x - 1 = 0$

Step 5: Solve for x

From $2x - 3 = 0$: $2x = 3 \rightarrow x = 3/2$

From $x - 1 = 0$: $x = 1$

Roots are: $x = 3/2$ and $x = 1$

Verification:

For $x = 3/2$: $2(3/2)^2 - 5(3/2) + 3 = 2(9/4) - 15/2 + 3$

$= 9/2 - 15/2 + 6/2 = 0$ ✓

For $x = 1$: $2(1)^2 - 5(1) + 3 = 2 - 5 + 3 = 0$ ✓

Example 4: Solve $6x^2 - x - 2 = 0$

Solution:

```
a = 6, b = -1, c = -2

Step 1: Split middle term -x
Product = 6 × (-2) = -12
Sum = -1
Numbers: -4 and +3
(because -4 × 3 = -12 and -4 + 3 = -1)

Step 2: Factorize
6x² - x - 2 = 0
6x² - 4x + 3x - 2 = 0
2x(3x - 2) + 1(3x - 2) = 0
(2x + 1)(3x - 2) = 0

Step 3: Solve
2x + 1 = 0  →  x = -1/2
3x - 2 = 0  →  x = 2/3

Roots are: x = -1/2 and x = 2/3
```

Example 5: Solve $3\sqrt{2}x^2 - 5x - \sqrt{2} = 0$

Solution:

```
a = 3√2, b = -5, c = -√2

Product = 3√2 × (-√2) = -6
Sum = -5
Numbers: -6 and +1

3√2x² - 5x - √2 = 0
3√2x² - 6x + x - √2 = 0
3√2x(x - √2) + 1(x - √2) = 0
(3√2x + 1)(x - √2) = 0

3√2x + 1 = 0  →  x = -1/(3√2) = -1/(3√2) × √2/√2 =
-√2/6
x - √2 = 0    →  x = √2

Roots are: x = √2 and x = -√2/6
```

Example 6: Find two numbers whose sum is 27 and product is 182.

Solution:

```
Let first number = x
Then second number = 27 - x

Their product = 182
x(27 - x) = 182
27x - x² = 182
-x² + 27x - 182 = 0
x² - 27x + 182 = 0

Splitting middle term:
Product = 1 × 182 = 182
Sum = -27
Numbers: -13 and -14

x² - 13x - 14x + 182 = 0
x(x - 13) - 14(x - 13) = 0
(x - 14)(x - 13) = 0

x = 14 or x = 13

The two numbers are 13 and 14.

Verification: Sum = 13 + 14 = 27 ✓
             Product = 13 × 14 = 182 ✓
```

💡 TIPS FOR FACTORIZATION:

- **Split the Middle Term:** Most commonly used method for CBSE exams
- **Look for patterns:**
  - Perfect square: $(x + a)^2 = x^2 + 2ax + a^2$
  - Difference of squares: $x^2 - a^2 = (x + a)(x - a)$
- **Common Factor:** If all terms have a common factor, take it out first
- **Always Verify:** Substitute roots back to check your answer
- **Practice:** The more you practice, the faster you'll identify the correct split

⚠️ COMMON MISTAKES IN FACTORIZATION:

❌ **Mistake 1:** Wrong product or sum calculation

- For $ax^2 + bx + c$, product should be $a \times c$, NOT just c
- Example: For $2x^2 - 5x + 3$, product = $2 \times 3 = 6$ (not 3)

❌ **Mistake 2:** Sign errors

- Be very careful with negative signs
- Example: For sum = -5, both numbers should be negative: -2 and -3

❌ **Mistake 3:** Incomplete factorization

- Make sure both factors are completely simplified
- Check if factors can be factored further

❌ **Mistake 4:** Not checking both roots

- Remember: Zero Product Rule gives TWO equations
- Solve both to get both roots

🎯 SECTION 3: QUADRATIC FORMULA (SRIDHARACHARYA'S FORMULA)

THE QUADRATIC FORMULA

For quadratic equation $ax^2 + bx + c = 0$ (where $a \neq 0$):

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

This formula gives BOTH roots using + and - signs!

📌 When to Use Quadratic Formula?

- ✓ When factorization is difficult or not obvious
- ✓ When roots are irrational (involving surds)
- ✓ When you need exact decimal values
- ✓ As a universal method that **ALWAYS works**!
- ✓ To verify answers obtained by factorization

Derivation of Quadratic Formula (Completing the Square)

Starting with: $ax^2 + bx + c = 0$

Step 1: Divide entire equation by a

$$x^2 + (b/a)x + c/a = 0$$

Step 2: Move constant term to RHS

$$x^2 + (b/a)x = -c/a$$

Step 3: Add $(b/2a)^2$ to both sides to complete the square

$$x^2 + (b/a)x + (b/2a)^2 = -c/a + (b/2a)^2$$

Step 4: LHS is now a perfect square

$$(x + b/2a)^2 = -c/a + b^2/4a^2$$

$$(x + b/2a)^2 = (-4ac + b^2)/4a^2$$

$$(x + b/2a)^2 = (b^2 - 4ac)/4a^2$$

Step 5: Take square root of both sides

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

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

Step 6: Solve for x

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

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

Solved Examples Using Quadratic Formula

Example 7: Solve $2x^2 - 7x + 3 = 0$ using quadratic formula

Solution:

Given: $2x^2 - 7x + 3 = 0$

Comparing with $ax^2 + bx + c = 0$:

$a = 2$, $b = -7$, $c = 3$

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

Step 1: Calculate $b^2 - 4ac$

$b^2 - 4ac = (-7)^2 - 4(2)(3)$

$= 49 - 24$

$= 25$

Step 2: Substitute in formula

$x = [-(-7) \pm \sqrt{25}]/(2 \times 2)$

$x = [7 \pm 5]/4$

Step 3: Find both roots

$x = (7 + 5)/4 = 12/4 = 3$

$x = (7 - 5)/4 = 2/4 = 1/2$

Roots are: $x = 3$ and $x = 1/2$

Verification:

For $x = 3$: $2(3)^2 - 7(3) + 3 = 18 - 21 + 3 = 0$ ✓

For $x = 1/2$: $2(1/4) - 7(1/2) + 3 = 1/2 - 7/2 + 6/2 = 0$ ✓

Example 8: Solve $2x^2 + x - 4 = 0$ using quadratic formula

Solution:

```
a = 2, b = 1, c = -4
Step 1: Calculate discriminant
b² - 4ac = (1)² - 4(2)(-4)
= 1 + 32
= 33
Step 2: Apply formula
x = [-1 ± √33]/(2 × 2)
x = [-1 ± √33]/4
Roots are:
x = (-1 + √33)/4  and  x = (-1 - √33)/4
In decimal form (approximate):
x ≈ (-1 + 5.745)/4 ≈ 1.186
x ≈ (-1 - 5.745)/4 ≈ -1.686
```

Example 9: Solve $x^2 - 2\sqrt{2}x + 1 = 0$

Solution:

```
a = 1, b = -2√2, c = 1
x = [-(-2√2) ± √((-2√2)² - 4(1)(1))]/(2 × 1)
x = [2√2 ± √(8 - 4)]/2
x = [2√2 ± √4]/2
x = [2√2 ± 2]/2
x = [2(√2 ± 1)]/2
x = √2 ± 1
Two roots:
x = √2 + 1  and  x = √2 - 1
```

Example 10: Solve $100x^2 - 20x + 1 = 0$

Solution:

```
a = 100, b = -20, c = 1
x = [-(-20) ± √((-20)² - 4(100)(1))]/(2 × 100)
x = [20 ± √(400 - 400)]/200
x = [20 ± √0]/200
x = [20 ± 0]/200
x = 20/200 = 1/10
Both roots are equal: x = 1/10
This happens when discriminant = 0 (equal roots)
```

⚠️ COMMON MISTAKES WITH QUADRATIC FORMULA:

❌ **Mistake 1:** Sign errors with b

- Wrong: Using b instead of -b in the formula
- Correct: If $b = -7$, then $-b = -(-7) = +7$
- If $b = 5$, then $-b = -5$

❌ **Mistake 2:** Incorrect calculation of $b^2 - 4ac$

- Be extra careful with negative signs!
- Example: If $b = -5$, then $b^2 = 25$ (NOT -25)
- Example: If $c = -3$, then $-4ac = -4a(-3) = +12a$

❌ **Mistake 3:** Division error

- Wrong: $-b/2a \pm \sqrt{(b^2 - 4ac)}$ — only -b is divided
- Correct: $[-b \pm \sqrt{(b^2 - 4ac)}]/(2a)$ — ENTIRE numerator divided by 2a

❌ **Mistake 4:** Forgetting the ± sign

- The ± gives TWO roots, not one!
- Always calculate: one with + and one with -

❌ **Mistake 5:** Wrong square root

- $\sqrt{4} = 2$ (NOT ±2 in the formula, ± is already there)
- Calculate $\sqrt{(b^2 - 4ac)}$ as positive value, then apply ±

💡 PRO TIPS FOR QUADRATIC FORMULA:

- **Always simplify:** If possible, simplify the equation before applying formula
- **Check discriminant first:** Know what type of roots to expect
- **Write clearly:** Show all steps in exams for full marks
- **Verify:** Substitute roots back into original equation
- **Rationalize if needed:** Convert surds to simplest form

🎯 SECTION 4: NATURE OF ROOTS (DISCRIMINANT)

DISCRIMINANT (D or Δ)

$$D = b^2 - 4ac$$

The discriminant determines the **nature of roots** without actually solving the equation!

Three Cases Based on Discriminant Value:

Discriminant	Nature of Roots	Example
$D > 0$ (Positive)	**Two distinct real roots** Roots are different and real	$x^2 - 5x + 6 = 0$ $D = 25 - 24 = 1 > 0$ Roots: $x = 2, 3$
$D = 0$ (Zero)	**Two equal real roots** (Repeated/Coincident roots)	$x^2 - 4x + 4 = 0$ $D = 16 - 16 = 0$ Roots: $x = 2, 2$
$D < 0$ (Negative)	**No real roots** (Complex/Imaginary roots)	$x^2 + 2x + 5 = 0$ $D = 4 - 20 = -16 < 0$ No real roots

🎯 Why Discriminant is Important:

- ✓ Quickly tells if equation has real solutions
- ✓ Helps decide which method to use for solving
- ✓ Useful in word problems to check if solution exists
- ✓ Important for graphing parabolas (where it crosses x-axis)

Relationship Between Discriminant and Graph

Graph of $y = ax^2 + bx + c$ is a parabola:

- **$D > 0$:** Parabola cuts x-axis at TWO distinct points
- **$D = 0$:** Parabola touches x-axis at ONE point (vertex on x-axis)
- **$D < 0$:** Parabola does NOT intersect x-axis

Solved Examples on Discriminant

Example 11: Find the discriminant and nature of roots: $2x^2 - 4x + 3 = 0$

Solution:

```
Given equation: 2x² - 4x + 3 = 0
a = 2, b = -4, c = 3
Discriminant D = b² - 4ac
D = (-4)² - 4(2)(3)
D = 16 - 24
D = -8
Since D < 0:
The equation has NO REAL ROOTS
(The roots are complex/imaginary)
```

Example 12: Find discriminant and nature of roots: $3x^2 - 4\sqrt{3}x + 4 = 0$

Solution:

```
a = 3, b = -4√3, c = 4
D = b² - 4ac
D = (-4√3)² - 4(3)(4)
D = 16 × 3 - 48
D = 48 - 48
D = 0
Since D = 0:
The equation has TWO EQUAL REAL ROOTS
Finding the roots:
x = [-b ± √D]/(2a)
x = [4√3 ± 0]/(2 × 3)
x = 4√3/6 = 2√3/3
Both roots are: x = 2√3/3
```

Example 13: Find nature of roots: $2x^2 - 6x + 3 = 0$

Solution:

```
a = 2, b = -6, c = 3
D = b² - 4ac
D = (-6)² - 4(2)(3)
D = 36 - 24
D = 12
Since D > 0:
The equation has TWO DISTINCT REAL ROOTS
Roots will be irrational (since D is not a perfect square)
x = [6 ± √12]/(2 × 2)
x = [6 ± 2√3]/4
x = [3 ± √3]/2
Roots: x = (3 + √3)/2 and x = (3 - √3)/2
```

Finding Value of k for Given Nature of Roots

Example 14: Find k if $2x^2 + kx + 3 = 0$ has two equal roots

Solution:

```
For equal roots: D = 0
Given: 2x² + kx + 3 = 0
a = 2, b = k, c = 3
D = b² - 4ac = 0
k² - 4(2)(3) = 0
k² - 24 = 0
k² = 24
k = ±√24
k = ±2√6
Therefore: k = 2√6 or k = -2√6
```

Example 15: Find k if $kx(x - 2) + 6 = 0$ has two equal roots

Solution:

First, expand the equation:

$kx(x - 2) + 6 = 0$

$kx^2 - 2kx + 6 = 0$

Comparing with $ax^2 + bx + c = 0$:

$a = k$, $b = -2k$, $c = 6$

For equal roots: $D = 0$

$b^2 - 4ac = 0$

$(-2k)^2 - 4(k)(6) = 0$

$4k^2 - 24k = 0$

$4k(k - 6) = 0$

$k = 0$ or $k = 6$

But $k \neq 0$ (otherwise not quadratic)

Therefore: $k = 6$

⚠️ COMMON MISTAKES WITH DISCRIMINANT:

❌ **Mistake 1:** Wrong calculation of b^2

- If b = -4, then $b^2 = 16$ (NOT -16)
- Square removes the negative sign

❌ **Mistake 2:** Sign error in -4ac

- If c is negative, -4ac becomes positive
- Example: c = -3, then -4ac = -4a(-3) = +12a

❌ **Mistake 3:** Confusing conditions

- D > 0 means distinct (NOT equal)
- D = 0 means equal (NOT distinct)
- D < 0 means no real roots (NOT complex is asked in Class 10)

❌ **Mistake 4:** Forgetting $k \neq 0$

- When finding k, check if it makes 'a' coefficient zero
- If yes, reject that value

🎯 SECTION 5: REAL-LIFE APPLICATIONS (WORD PROBLEMS)

📝 Steps to Solve Word Problems:

1. **Read carefully:** Understand what is given and what is to be found
2. **Assume variable:** Let the unknown be x
3. **Form equation:** Translate words into mathematical equation
4. **Solve:** Use factorization or quadratic formula
5. **Check validity:** Reject negative/impractical solutions
6. **Write answer:** State the final answer clearly

Example 16: The altitude of a right triangle is 7 cm less than its base. If the hypotenuse is 13 cm, find the other two sides.

Solution:

Let base = x cm
Then altitude = $(x - 7)$ cm
Hypotenuse = 13 cm
By Pythagoras theorem:
$(\text{base})^2 + (\text{altitude})^2 = (\text{hypotenuse})^2$
$x^2 + (x - 7)^2 = 13^2$
$x^2 + x^2 - 14x + 49 = 169$
$2x^2 - 14x + 49 - 169 = 0$
$2x^2 - 14x - 120 = 0$
$x^2 - 7x - 60 = 0$ (dividing by 2)
Factorizing:
$x^2 - 12x + 5x - 60 = 0$
$x(x - 12) + 5(x - 12) = 0$
$(x + 5)(x - 12) = 0$
$x = -5$ or $x = 12$
Since side cannot be negative: **$x = 12$**
Base = 12 cm
Altitude = 12 - 7 = 5 cm
Verification: $12^2 + 5^2 = 144 + 25 = 169 = 13^2$ ✓
Answer: Base = 12 cm, Altitude = 5 cm

Example 17: A train travels 480 km at uniform speed. If the speed had been 8 km/h less, it would have taken 3 hours more. Find the speed of the train.

Solution:

```
Let original speed = x km/h
Distance = 480 km
Original time = 480/x hours
If speed is reduced by 8 km/h:
New speed = (x - 8) km/h
New time = 480/(x - 8) hours
According to problem:
New time - Original time = 3 hours
480/(x - 8) - 480/x = 3
480x - 480(x - 8) = 3x(x - 8)
480x - 480x + 3840 = 3x² - 24x
3840 = 3x² - 24x
3x² - 24x - 3840 = 0
x² - 8x - 1280 = 0  (dividing by 3)
Using quadratic formula:
x = [8 ± √(64 + 5120)]/2
x = [8 ± √5184]/2
x = [8 ± 72]/2
x = 80/2 = 40  or  x = -64/2 = -32
Speed cannot be negative: x = 40
Answer: Speed of train = 40 km/h
Verification:
Original time = 480/40 = 12 hours
New time = 480/32 = 15 hours
Difference = 15 - 12 = 3 hours ✓
```

Example 18: Two consecutive positive integers have product 306. Find the integers.

Solution:

```
Let first integer = x
Then next consecutive integer = x + 1
Their product = 306
x(x + 1) = 306
x² + x = 306
x² + x - 306 = 0
Factorizing:
Product = 1 × (-306) = -306
Sum = 1
Numbers: 18 and -17
x² + 18x - 17x - 306 = 0
x(x + 18) - 17(x + 18) = 0
(x - 17)(x + 18) = 0
x = 17 or x = -18
Since we need positive integers: x = 17
First integer = 17
Second integer = 18
Answer: The integers are 17 and 18
Verification: 17 × 18 = 306 ✓
```

Example 19: Is it possible to design a rectangular park with perimeter 80 m and area 400 m²? If yes, find length and breadth.

Solution:

```
Let length = x m
Perimeter = 80 m
2(length + breadth) = 80
length + breadth = 40
breadth = (40 - x) m
Area = length × breadth
400 = x(40 - x)
400 = 40x - x²
x² - 40x + 400 = 0
Check discriminant to see if solution exists:
D = b² - 4ac
D = (-40)² - 4(1)(400)
D = 1600 - 1600
D = 0
Since D = 0, solution exists (equal roots)
x = -b/(2a) = 40/2 = 20
Length = 20 m
Breadth = 40 - 20 = 20 m
Answer: YES, it's possible. The park will be a SQUARE
with side = 20 m
```

Example 20: Rohan's mother is 26 years older than him. The product of their ages 3 years from now will be 360. Find Rohan's present age.

Solution:

Let Rohan's present age = x years

Mother's present age = $(x + 26)$ years

After 3 years:

Rohan's age = $(x + 3)$ years

Mother's age = $(x + 26 + 3) = (x + 29)$ years

Product of their ages = 360

$(x + 3)(x + 29) = 360$

$x^2 + 29x + 3x + 87 = 360$

$x^2 + 32x + 87 - 360 = 0$

$x^2 + 32x - 273 = 0$

Using quadratic formula:

$x = [-32 \pm \sqrt{(1024 + 1092)}]/2$

$x = [-32 \pm \sqrt{2116}]/2$

$x = [-32 \pm 46]/2$

$x = 14/2 = 7$ or $x = -78/2 = -39$

Age cannot be negative: **$x = 7$**

Answer: Rohan's present age = 7 years

Verification:

Present: Rohan = 7, Mother = 33

After 3 years: Rohan = 10, Mother = 36

Product = $10 \times 36 = 360$ ✓

📝 PREVIOUS YEARS' BOARD QUESTIONS

2 MARK QUESTIONS

Q1. Solve: $x^2 - 3x - 10 = 0$ by factorization (2022)

Solution:

```
x² - 3x - 10 = 0
Product = 1 × (-10) = -10
Sum = -3
Numbers: -5 and +2
x² - 5x + 2x - 10 = 0
x(x - 5) + 2(x - 5) = 0
(x + 2)(x - 5) = 0
x = -2 or x = 5
Roots: x = -2, 5
```

Q2. Solve $2x^2 + x - 6 = 0$ (2023)

Solution:

```
2x² + x - 6 = 0
Product = 2 × (-6) = -12
Sum = 1
Numbers: 4 and -3
2x² + 4x - 3x - 6 = 0
2x(x + 2) - 3(x + 2) = 0
(2x - 3)(x + 2) = 0
x = 3/2 or x = -2
Roots: x = 3/2, -2
```

3 MARK QUESTIONS

Q3. Find the discriminant and nature of roots of $3x^2 - 4\sqrt{3}x + 4 = 0$. Also find the roots. (2024)

Solution:

$a = 3,\ b = -4\sqrt{3},\ c = 4$

Step 1: Find discriminant

$D = b^2 - 4ac$

$D = (-4\sqrt{3})^2 - 4(3)(4)$

$D = 48 - 48$

$D = 0$

Nature: Two equal real roots ($\because D = 0$)

Step 2: Find roots

$x = -b/(2a)$ [when $D = 0$]

$x = -(-4\sqrt{3})/(2 \times 3)$

$x = 4\sqrt{3}/6$

$x = 2\sqrt{3}/3$

Both roots are: $x = 2\sqrt{3}/3$

Q4. Solve using quadratic formula: $2x^2 - 7x + 5\sqrt{2} = 0$ (2023)

Solution:

$a = 2,\ b = -7,\ c = 5\sqrt{2}$

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

Step 1: Calculate discriminant

$D = (-7)^2 - 4(2)(5\sqrt{2})$

$D = 49 - 40\sqrt{2}$

Step 2: Apply formula

$x = [7 \pm \sqrt{(49 - 40\sqrt{2})}]/4$

Roots: $x = [7 \pm \sqrt{(49 - 40\sqrt{2})}]/4$

(Leave in this form unless asked to simplify)

Q5. Find the consecutive positive integers whose sum of squares is 365. (2024)

Solution:

Let first integer = x

Next consecutive integer = $x + 1$

Sum of squares = 365

$$x^2 + (x + 1)^2 = 365$$

$$x^2 + x^2 + 2x + 1 = 365$$

$$2x^2 + 2x + 1 - 365 = 0$$

$$2x^2 + 2x - 364 = 0$$

$$x^2 + x - 182 = 0$$

Factorizing:

$$x^2 + 14x - 13x - 182 = 0$$

$$x(x + 14) - 13(x + 14) = 0$$

$$(x - 13)(x + 14) = 0$$

$x = 13$ or $x = -14$

Since positive integers: $x = 13$

The integers are: 13 and 14

Verification: $13^2 + 14^2 = 169 + 196 = 365$ ✓

💯 EXAM STRATEGY & TIME MANAGEMENT

Question Type	Time	Strategy	
Factorization	2	2-3 min	Show split of middle term clearly, Write both factors, Solve each equation
Quadratic Formula	2-3	3-4 min	Write formula, Calculate discriminant, Substitute values, Simplify carefully
Nature of Roots	2-3	2-3 min	Find discriminant, State nature based on $D > 0$, $= 0$, or < 0
Word Problems	3-5	5-7 min	Read carefully, Form equation, Solve, Check validity, State answer

⏰ Time Allocation Tips:

- **Read question twice:** Understand what's asked (30 seconds)
- **Choose method wisely:** Factorization if obvious, else formula
- **Show all steps:** Don't skip steps even if obvious to you
- **Verify if time permits:** Substitute answer back
- **Leave space:** For corrections if needed

⚠️ COMMON MISTAKES TO AVOID (CONSOLIDATED)

Top 10 Mistakes Students Make:

1. **Not checking $a \neq 0$:** Always verify it's actually quadratic
2. **Wrong splitting:** Product should be $a \times c$, not just c
3. **Sign errors in formula:** Be careful with $-b$ and negative c
4. **Division error:** Divide ENTIRE numerator by 2a
5. **Forgetting $\pm$ sign:** This gives TWO roots
6. **Wrong discriminant calculation:** Careful with b^2 (always positive)
7. **Not rejecting invalid solutions:** Check context (age, length can't be negative)
8. **Incomplete factorization:** Ensure factors can't be factored further
9. **Not simplifying final answer:** Rationalize surds, simplify fractions
10. **Skipping verification:** Always check your answer if time permits

📚 IMPORTANT FORMULAS - QUICK REFERENCE

1. Standard Form: $ax^2 + bx + c = 0$ (where $a \neq 0$)

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

3. Discriminant: $D = b^2 - 4ac$

4. Nature of Roots:

- $D > 0 \rightarrow$ Two distinct real roots
- $D = 0 \rightarrow$ Two equal real roots
- $D < 0 \rightarrow$ No real roots

5. Sum of Roots: $\alpha + \beta = -b/a$

6. Product of Roots: $\alpha\beta = c/a$

7. If roots given, equation: $x^2 - (\alpha + \beta)x + \alpha\beta = 0$

🚀 LAST MINUTE REVISION CHECKLIST

☐ Theory to Remember:

- ☐ Definition: $ax^2 + bx + c = 0, a \neq 0$
- ☐ Quadratic formula (write it 5 times!)
- ☐ Three conditions of discriminant
- ☐ Zero Product Rule: If AB = 0, then A = 0 or B = 0

☐ Methods to Practice:

- ☐ Factorization by splitting middle term (most common)
- ☐ Applying quadratic formula correctly
- ☐ Finding discriminant and nature of roots
- ☐ Solving word problems step-by-step

☐ Common Question Types:

- ☐ Solve by factorization
- ☐ Solve using quadratic formula
- ☐ Find discriminant and nature of roots
- ☐ Find k for given nature of roots
- ☐ Word problems: age, consecutive numbers, geometry

☐ Before Exam:

- ☐ Practice at least 20 questions
- ☐ Solve previous 3 years' board questions
- ☐ Time yourself while solving
- ☐ Revise formulas and common mistakes

💡 EXPERT TIPS FOR SCORING FULL MARKS

How to Score 100% in Quadratic Equations:

- **1. Write Clean:** Clear handwriting, proper alignment
- **2. Show Steps:** Even if you can do mentally, show work
- **3. Use Formulas:** Write formulas before applying them
- **4. Box Final Answer:** Makes it easy for examiner to find
- **5. Units Matter:** Don't forget units in word problems
- **6. Verify:** If time permits, substitute back
- **7. Double Check:** Signs, calculations, simplifications
- **8. Practice:** Solve at least 50 questions before exam

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