# **Factorization When an Expression is a Perfect Square**

## **Understanding of Factorization When an Expression is a Perfect Square**

- An expression is a perfect square if it can be written as  $(a + b)^2$  or  $(a b)^2$ .
- The general forms are:  $a^2 + 2ab + b^2 = (a + b)^2$  and  $a^2 2ab + b^2 = (a b)^2$ .
- Recognizing perfect square expressions helps in quick and easy factorization.

#### **Important Points**

- Check if the first and last terms are perfect squares.
- Check if the middle term is twice the product of the square roots of the first and last terms.
- If yes, the expression is a perfect square trinomial.
- Use  $(a + b)^2$  when the middle term is positive.
- Use  $(a b)^2$  when the middle term is negative.

### **Examples with Solutions**

#### **Example: Simple Perfect Square**

> Factorize  $x^2 + 6x + 9$ .

**Solution:**  $x^2 + 6x + 9 = (x + 3)^2$ 

#### **Example: Perfect Square with Variables**

Factorize 4a<sup>2</sup> + 12ab + 9b<sup>2</sup>.

**Solution:**  $4a^2 + 12ab + 9b^2 = (2a + 3b)^2$ 

#### **Example: Negative Middle Term**

- Factorize  $p^2 8p + 16$ .
- **Solution:**  $p^2 8p + 16 = (p 4)^2$

#### **Example: Higher Degree Powers**

> Factorize  $9x^4 + 12x^2 + 4$ .

**Solution:**  $9x^4 + 12x^2 + 4 = (3x^2 + 2)^2$ 

# **Example: With Fractional Coefficients**

 $\succ \text{Factorize } \frac{1}{4}x^2 + \frac{1}{2}x + \frac{1}{4}.$ 

Solution: 
$$\frac{1}{4}x^2 + \frac{1}{2}x + \frac{1}{4} = \left(\frac{1}{2x} + \frac{1}{2}\right)^2$$

## **Summary Points**

- A perfect square trinomial follows the pattern of  $a^2 \pm 2ab + b^2$ .
- Identify perfect squares at first and last terms.
- Check if the middle term matches 2ab.
- Use  $(a + b)^2$  for positive middle terms and  $(a b)^2$  for negative.
- Always verify by expanding the factors.