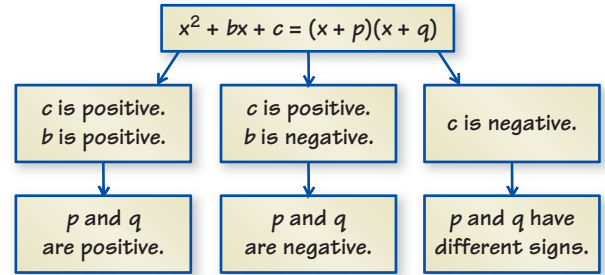


# Factoring Polynomials

Writing a polynomial as a product of factors is called *factoring*. To factor  $x^2 + bx + c$  as  $(x + p)(x + q)$ , find  $p$  and  $q$  such that  $p + q = b$  and  $pq = c$ . The diagram shows the relationships between the signs of  $b$  and  $c$  and the signs of  $p$  and  $q$ .

To factor  $ax^2 + bx + c$ , where  $a \neq 1$ , look for the GCF of the terms of the polynomial, and then factor further if possible. You can also use special product patterns to factor polynomials.



Perfect Square Trinomial Pattern	Difference of Two Squares Pattern
$a^2 + 2ab + b^2 = (a + b)^2$ $a^2 - 2ab + b^2 = (a - b)^2$	$a^2 - b^2 = (a + b)(a - b)$

## Example 1 Factor each polynomial.

- a.  $2x^2 + 6x$                       b.  $4x^2 - 25$                       c.  $x^2 + 9x + 18$                       d.  $4x^2 - 21x + 5$

a. The GCF of 2 and 6 is 2. The GCF of  $x^2$  and  $x$  is  $x$ . So, the greatest common monomial factor of the terms is  $2x$ .

▶ So,  $2x^2 + 6x = 2x(x + 3)$ .

c. Notice that  $a = 1$ ,  $b = 9$ , and  $c = 18$ . Because  $b$  and  $c$  are positive,  $p$  and  $q$  are positive. Find two positive integer factors of 18 whose sum is 9.

▶ So,  $x^2 + 9x + 18 = (x + 3)(x + 6)$ .

d. Notice that  $a = 4$ ,  $b = -21$ ,  $c = 5$ , and there is no GCF. Because  $b$  is negative and  $c$  is positive, both factors of  $c$  must be negative.

▶ So,  $4x^2 - 21x + 5 = (x - 5)(4x - 1)$ .

b. Use the difference of two squares pattern.

$$4x^2 - 25 = (2x)^2 - 5^2$$

$$= (2x + 5)(2x - 5)$$

<b>Factors of 18</b>	1, 18	2, 9	3, 6
<b>Sum of factors</b>	19	11	9

The values of  $p$  and  $q$  are 3 and 6.

Factors of 4	Factors of 5	Possible factorization	Middle term	
1, 4	-1, -5	$(x - 1)(4x - 5)$	$-9x$	✗
1, 4	-5, -1	$(x - 5)(4x - 1)$	$-21x$	✓
2, 2	-1, -5	$(2x - 1)(2x - 5)$	$-12x$	✗

## Practice

Check your answers at [BigIdeasMath.com](http://BigIdeasMath.com).

### Factor the polynomial.

- |                                       |  |   |  |
|---------------------------------------|--|---|--|
| 1. $8x - 2$<br>$2(4x - 1)$            | 2. $10x^2 + 5x$<br>$5x(2x + 1)$          | 3. $25x - 10y$<br>$5(5x - 2y)$          | 4. $x^2 - 7x + 12$<br>$(x - 4)(x - 3)$       |
| 5. $x^2 - x - 20$<br>$(x - 5)(x + 4)$ | 6. $3x^2 + 6x - 24$<br>$3(x - 2)(x + 4)$ | 7. $4x^2 + 9x + 5$<br>$(x + 1)(4x + 5)$ | 8. $-18x^2 - 6x + 4$<br>$-2(3x - 1)(3x + 2)$ |
| 9. $x^2 - 9$<br>$(x - 3)(x + 3)$      | 10. $8x^2 - 50$<br>$2(2x - 5)(2x + 5)$   | 11. $x^2 + 14x + 49$<br>$(x + 7)^2$     | 12. $3x^2 - 12x + 12$<br>$3(x - 2)^2$        |