Special Factoring

Perfect Trinomial Squares

Difference of Squares

Difference of Cubes

Sum of Cubes

Once recognized, these special polynomials are very easily factored.

Perfect Trinomial Squares - Three terms with perfect squares on each end and a positive sign in the middle will always have two *exact* factors.

There is a perfect square on this end: $x \cdot x = x^2$ → $\mathbf{X^2 + 6x + 9}$ ← There is a perfect square on this end: $3 \cdot 3 = 9$

Place an x and a 3 in each set of parentheses. In this case, both signs are positive:

$$= (x + 3)(x + 3) \text{ or } (x + 3)^2$$

Difference of Squares - Two terms with perfect squares on each end and a minus sign in the middle will always have two *opposite* factors.

There is a perfect square on this end: $x \cdot x = x^2$ → $\mathbf{x^2 - 4}$ ← There is a perfect square on this end: $2 \cdot 2 = 4$

There is a minus sign in the middle

Place an x and a 2 in each set of parentheses. One will be negative and the other positive:

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

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Difference of Cubes

Two terms with perfect cubes on each end and a minus sign in the middle:
$(x^3 - 125)$

and

Sum of Cubes

Two terms with perfect cubes on each end and a plus sign in the middle:
$(x^3 + 64)$

Both ***difference* and *sum*** of *cubes* can be factored using the same steps. The following example will demonstrate how this is done.

Difference	Steps	Sum
$(x^3 - 125)$ / \ $x \cdot x \cdot x$ $5 \cdot 5 \cdot 5$	1. Factor each term in the polynomial separately.	$(x^3 + 64)$ / \ $x \cdot x \cdot x$ $4 \cdot 4 \cdot 4$
( )( )	2. Put down two sets of parentheses - one small, and one large.	( )( )
$(x - 5)($ $)$	3. Small parentheses: Place one of the x·x·x in the small set of parentheses, then bring down the sign, and put one of the numbers (as in: 5·5·5 or 4·4·4) on the other side of the sign.	$(x + 4)($ $)$
$(x - 5)(\, x \cdot x \quad + 5 \cdot 5)$	4. Large parentheses: Place the remainder of (x . x) on left side of parentheses, then put the remainder of numbers (as in 5 . 5) on right side of the parentheses. It will always take a + sign.	$(x + 4)(\, x \cdot x \quad + 4 \cdot 4)$
$(x - 5)(X^2 + 5x + 25)$	5. To get the middle term, multiply the two terms in the small parentheses, and then <u>change the sign:</u> $x \cdot (-5) = -5x \Rightarrow +5x$ $x \cdot (+4) = +4x \Rightarrow -4x$	$(x+ 4)(X^2 - 4x + 16)$