Example 3 Factor Trinomials of the Form $ax^2 + bx + c, a \neq 1$

Factor, if possible.
$3x^2 + 8x + 4$

1) GCF → see if you can factor out a GCF.

2) top of cross → a value mult. by the c value.

$a = 3$ $c = 4$
$b = 8$

$3 \cdot 4 = 12$

3) bottom of cross → b value.

4) Sides of the cross → are two numbers that multiply to give top + add to give you the bottom.

→ what two numbers multiply to give 12 & add to give 8 → 6 & 2

$3x^2 + 8x + 4$ 5) Find two numbers that multiply to give you ax^2 $(3x^2)$

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

6) Look at the two numbers in the brackets & see if they each divide into one of the numbers on the sides of the cross.

7) Divide the side numbers by the numbers in brackets & put answers into opposite brackets

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Example 3 Factor Trinomials of the Form $ax^2 + bx + c, a \neq 1$
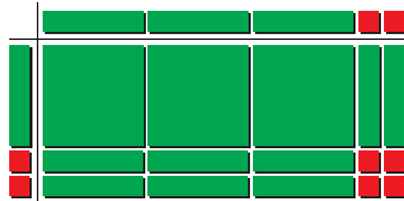
Factor, if possible.
$3x^2 + 8x + 4$

Solution
First, check for a GCF. The GCF of the polynomial $3x^2 + 8x + 4$ is 1.

Method 1: Use Algebra Tiles
Arrange three x^2-tiles, eight x-tiles, and four 1-tiles into a rectangle.
Then, add tiles to show the dimensions.

The dimensions of the resulting rectangle are $3x + 2$ and $x + 2$.

Check:
Multiply.
$(3x + 2)(x + 2) = 3x(x + 2) + 2(x + 2)$
$= 3x^2 + 6x + 2x + 4$
$= 3x^2 + 8x + 4$

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Method 2: The Cross or Diamond Method

Recall: $(3x + 2)(x + 5)$
              $= 3x^2 + 15x + 2x + 10$
              $= 3x^2 + 17x + 10$

**Note that the sum of $15x + 2x$ is the middle term, $17x$.**

The product of these two numbers is $30x^2$.

**This is the same as the product of the first and last terms of the trinomial.
($3x^2$ x $10 = 30x^2$)**

Therefore, to factor $3x^2 + 17x + 10$, look for two numbers that have a product of 30 and a sum of 17.
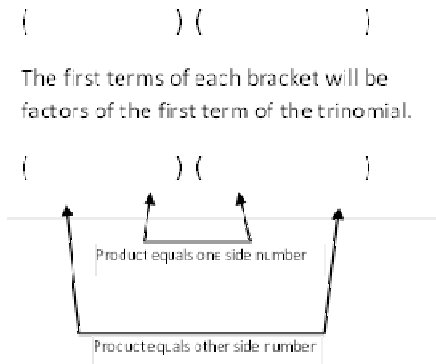
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A cross can be used to help organize these numbers when factoring.

First times Last

Side   Side

Middle
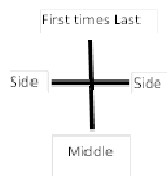
_____ x _____ = Top
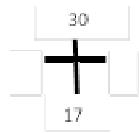_____ + _____ = Bottom
These numbers become the side numbers on the cross.

Once all numbers are filled in on the cross, step away from the cross and use the brackets to finish factoring.
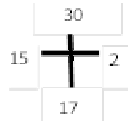
(   ) (   )

The first terms of each bracket will be factors of the first term of the trinomial.

(   ) (   )

Product equals one side number

Product equals other side number

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Example 3 continued

Factor $3x^2 + 17x + 10$

```
   30
  _|_
 __|__
   |
   17
```

$$\_15\_ \text{ x } \_2\_ = 30$$
$$\_15\_ + \_2\_ = 17$$

These numbers become the side numbers on the cross.

```
      30
  15 _|_ 2
  ___|___
      |
      17
```

($3x$) (x)

The first terms of each bracket will be factors of the first term of the trinomial.

($3x$ + 2) (x + 5)

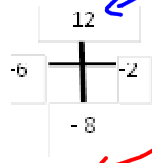Product equals one side number

Product equals other side number

The factors of $3x^2 + 17x + 10$ are $(3x + 2)(x + 5)$

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Example 4
Factor, if possible $3x^2 - 8x + 4$

Solution

multiply

```
       12
  -6 _|_ -2
  ___|___
       |
      - 8
```

$(3x$ $)(x$ $)(3x - 2)(x - 2)$

$$(3x - 2)(x - 2)$$

Example 5
Factor, if possible $12y^2 - 5y - 3$

Solution

There are 3 possible pairs of factors for the first terms in the brackets. 1 x 12, 2 x 6, and 3 x 4. Use the side numbers to help you decide which pair to use. Since 3 and 4 divide evenly into -9 and 4, the chosen pair will be 3 and 4.

$(12y \quad)(y \quad)$
$(6y \quad)(2y \quad)$
$(4y - 3)(3y + 1)$

$(3x \quad)(4x \quad)(3x - 1)(4x - 3)$

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Example 6
Factor, if possible $6x^2 - 5xy + y^2$

$(3x \quad y)(2x \quad y)(3x - y)(2x - y)$

$(6x \quad)(1x \quad)$
$(3x - 1y)(2x - 1y)$

$(x \quad y)(x \quad y)$

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