

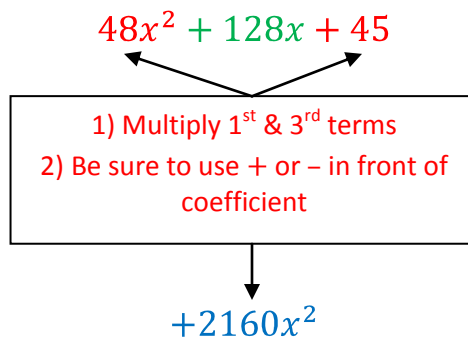
We often use guess-and-check when factoring trinomials, which is not a problem with small numbers or big prime numbers (there's only one pair of factors that equal 73 → 1 & 73!). Sometimes we run into large numbers or numbers with lots of pairs of factors (72 can be made by 1 & 72, 2 & 36, 3 & 24, 6 & 12, and 8 & 9).

We can get frustrated with all the incorrect guesses, worn-out erasers, and papers with holes erased through them. Is there another way?

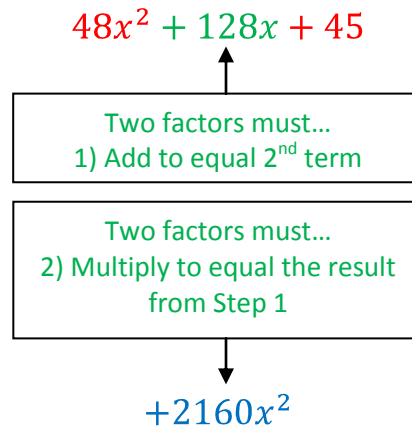
### Example 1

Factor  $48x^2 + 128x + 45$

**Step 1-** Multiply the 1<sup>st</sup> term and 3<sup>rd</sup> term and write down the result. Be sure to pay attention to whether the result is positive or negative.



**Step 2-** Find two factors that will multiply to equal our new coefficient. These two factors must add to equal the 2<sup>nd</sup> term coefficient.



We need two factors with a product of  $+2160x^2$  that also have a sum of  $+128x$ . We will do some guessing here as well, but we can guess with our brains (or calculators) and save a lot of erasing.

We already know two factors that multiply to equal  $+2160x^2 \rightarrow +48x$  &  $+45x$ . But these factors have a sum of  $+93x$ , which isn't what we want. What are some more combinations (that you can try in a calculator, if necessary) of two numbers that multiply to equal  $+2160x^2$ ? Do you notice that it ends in 0 and all the digits add up to 9?

$$\begin{array}{ll} (+48x) \cdot (+45x) = +2160x^2 & \text{and} \quad (+48x) + (+45x) = +93x \\ (+10x) \cdot (+216x) = +2160x^2 & \text{and} \quad (+10x) + (+216x) = +226x \\ (+20x) \cdot (+108x) = +2160x^2 & \text{and} \quad (+20x) + (+108x) = +128x \end{array}$$

We found them!  $(+20x)$  &  $(+108x)$  are what we need!

**Step 3-** Write the two factors we found in Step 2 in the middle. On the outside, bring down the original 1<sup>st</sup> & 3<sup>rd</sup> terms.

$$\begin{array}{c}
 48x^2 + 128x + 45 \\
 \swarrow \quad \quad \searrow \\
 \quad +2160x^2 \\
 \swarrow \quad \quad \searrow \\
 48x^2 + 20x + 108x + 45
 \end{array}$$

**Step 4-** Factor by grouping to get the final answer.

$$\begin{array}{l}
 48x^2 + 20x + 108x + 45 \\
 (48x^2 + 20x) + (108x + 45) \\
 4x(12x + 5) + 9(12x + 5) \\
 (4x + 9)(12x + 5)
 \end{array}$$

**Step 5 (Optional)-** Use FOIL to check your answer.

$$(4x + 9)(12x + 5) = 48x^2 + 20x + 108x + 45 = 48x^2 + 128x + 45$$

$$(4x + 9)(12x + 5)$$