The expression $2x^2 + 11x + 12$ can be expressed in the form $mnx^2 + (mq + np)x + pq$, and then factored as shown in the previous example. The table below shows a colour-coded step-by-step procedure relating the two expressions.

$mnx^2 + (mq + np)x + pq$	$2x^2 + 11x + 12$
$mnx^2 + (mq + np)x + pq$	$2x^2 + (8 + 3)x + 12$
$mnx^2 + mqx + npx + pq$	$2x^2 + 8x + 3x + 12$
$(mnx^2 + mqx) + (npx + pq)$	$(2x^2 + 8x) + (3x + 12)$
$mx(nx + q) + p(nx + q)$	$2x(x + 4) + 3(x + 4)$
$(nx + q)(mx + p)$	$(x + 4)(2x + 3)$

Check Up

1. The integers –6 and 5 have a sum of –1 and a product of –30. As such, they can be used to factor $2x^2 - x - 15$. Decompose the x-term into two terms, using the given integers.

2. Factor each of the following trinomials.

   a. $2x^2 + 3x + 1$

   b. $8x^2 + 2x - 15$

   c. $10x^2 - 17x + 3$

3. Verify your work in part 2.

Compare your answers.

1. The integers –6 and 5 have a sum of –1 and a product of –30. As such, they can be used to factor $2x^2 - x - 15$. Decompose the x-term into two terms, using the given integers.

$$\begin{aligned} 2x^2 - x - 15 &= 2x^2 + (-6 + 5)x - 15 \\ &= 2x^2 - 6x + 5x - 15 \end{aligned}$$

2. Factor each of the following trinomials.

   a. $2x^2 + 3x + 1$

   $ac = 2$ and $b = 3$

   The integers 2 and 1 have a product of 2 and a sum of 3.

$$\begin{aligned} 2x^2 + 3x + 1 &= 2x^2 + (2 + 1)x + 1 \\ &= 2x^2 + 2x + x + 1 \\ &= (2x^2 + 2x) + (x + 1) \\ &= 2x(x + 1) + (x + 1) \\ &= (x + 1)(2x + 1) \end{aligned}$$

The expression $2x(x + 1) + (x + 1)$ can also be rewritten as $2x(x + 1) + 1(x + 1)$. Be sure to remember this 1 when removing the common factor $x + 1$.

   b. $8x^2 + 2x - 15$

   $ac = -120$ and $b = 2$

   The integers –10 and 12 have a product of –120 and a sum of 2.

$$\begin{aligned} 8x^2 + 2x - 15 &= 8x^2 + (12 - 10)x - 15 \\ &= 8x^2 + 12x - 10x - 15 \\ &= (8x^2 + 12x) + (-10x - 15) \\ &= 4x(2x + 3) - 5(2x + 3) \\ &= (2x + 3)(4x - 5) \end{aligned}$$

c. $10x^2 - 17x + 3$

$ac = 30$ and $b = -17$

The integers –15 and –2 have a product of 30 and sum of –17.

$$\begin{aligned} 10x^2 - 17x + 3 &= 10x + (-15 - 2)x + 3 \\ &= 10x^2 - 15x - 2x + 3 \\ &= (10x^2 - 15x) + (-2x + 3) \\ &= 5x(2x - 3) - (2x - 3) \\ &= (2x - 3)(5x - 1) \end{aligned}$$

3. Verify your work in part 2.

$$\begin{aligned} (x + 1)(2x + 1) &= (x)(2x) + (x)(1) + (1)(2x) + (1)(1) \\ &= 2x^2 + x + 2x + 1 \\ &= 2x^2 + 3x + 1 \end{aligned}$$

$$\begin{aligned} (2x + 3)(4x - 5) &= (2x)(4x) + (2x)(-5) + (3)(4x) + (3)(-5) \\ &= 8x^2 - 10x + 12x - 15 \\ &= 8x^2 + 2x - 15 \end{aligned}$$

$$\begin{aligned} (2x - 3)(5x - 1) &= (2x)(5x) + (2x)(-1) + (-3)(5x) + (-3)(-1) \\ &= 10x^2 - 2x - 15x + 3 \\ &= 10x^2 - 17x + 3 \end{aligned}$$