2 Expressions and functions

Objectives

- Simplify or transform linear expressions with integer coefficients; collect like terms; multiply a single term over a bracket.
- Know that algebraic operations, including brackets, follow the same order as arithmetic operations; use index notation for small positive integer powers.
- Know that letters play different roles in equations, formulae and functions; know the meanings of formula and function.
- Construct linear expressions.

What’s the point?

Basic formulas are part of your life. When you want to find out how long a journey will take you will be using an algebraic formula:

Journey time = distance ÷ speed

Before you start

You should know ...

1. How to work with negative numbers.
   
   For example:
   
   \[ 7 - (-5) = 7 + 5 = 12 \] (two minuses make a plus)
   \[ -3 + (-4) = -3 - 4 = -7 \] (mix means minus)

2. How to simplify basic algebra.
   
   For example:
   
   \[ a + a = 2a \]
   \[ 3 \times b = 3b \] for short (no need to write the multiplication symbol)
   \[ t \times 5 = 5t \] for short (write the number first, then the letter)

Check in

1. Work out:
   
   a. \(-2 - (-6)\)
   b. \(-4 + (-10)\)
   c. \(-8 - (-3)\)
   d. \(20 + (-10)\)

2. Write these expressions in a shorter way.
   
   a. \(m + m + m\)
   b. \(6 \times y\)
   c. \(r \times 10\)
   d. \(c + c + c + c + c\)
2.1 Simplifying and expanding

Algebra is really generalised arithmetic. It follows the same rules of arithmetic but uses letters or symbols instead of numbers.

In arithmetic you have:

\[ 4 + 4 + 4 + 4 + 4 = 5 \times 4 \]

while in algebra you have:

\[ x + x + x + x + x = 5 \times x = 5x \]

In the same way

\[ 3 \times 3 \times 3 \times 3 = 3^4 \]

while

\[ x \times x \times x \times x = x^4 \]

You see basic algebraic expressions in many settings. For example:

- **Area of a rectangle** = \( l w \)
  where \( l \) is length and \( w \) is width of the rectangle.

To work with algebraic expressions, you need to be able to simplify them.

The basic rule is that you can only add or subtract **like terms**.

In the expression

\[ 7 + 6x + 4y - 2x \]

6\(x\) and \(-2x\) are like terms. The number 7 and the term 6\(x\) are **unlike terms** and cannot be combined.

To simplify expressions you have to combine like terms.

**EXAMPLE 1**

Simplify:

\[
\begin{align*}
\text{a} & \quad 7 + 4x + 6y + 2x + y \\
\text{b} & \quad xy - y + 2xy + 3y \\
\end{align*}
\]

\[
\begin{align*}
\text{a} & \quad 7 + 4x + 6y + 2x + y \\
& \quad = 7 + (4x + 2x) + (6y + y) \\
& \quad = 7 + 6x + 7y \\
\text{b} & \quad xy - y + 2xy + 3y \\
& \quad = (xy + 2xy) + (3y - y) \\
& \quad = 3xy + 2y \\
\end{align*}
\]

When we simplify the expression \( b \times b \times b \times b \times b \) to get \( b^5 \), this is using **index notation**. We say “\( b \) to the power of 5.” \( b \) is the **base** and 5 is the **index**. The plural of index is **indices**. Like terms must have exactly the same indices to be combined. For example, \( x^2y \) and \( xy^2 \) are unlike terms, since \( x^2y \) means \( x \times x \times y \) and \( xy^2 \) means \( x \times y \times y \).

Remember the different notation for adding and multiplying letters. For example, \( a + a = 2a \) and \( a \times a = a^2 \). It is quite common to see these written the wrong way around.

The method for simplifying is the same even with more complex expressions.

**EXAMPLE 2**

Simplify:

\[
\begin{align*}
\text{a} & \quad 4x^2y - 3xy^2 + xy + 2x^2y \\
\text{b} & \quad 3abc + abc^2 - 2abc - a^2bc \\
\end{align*}
\]
Exercise 2A

1 Simplify:
   a \(3x + 4x\)
   b \(5y - 2y\)
   c \(3x + 4y\)
   d \(5y - 2x + y\)
   e \(4x - 3y + 2y\)
   f \(2 + ab - 2ab + 3ab + 3\)
   g \(3x - 4y + 2x\)
   h \(4y - 2x - 2y + x\)
   i \(1 + 3xy - 2x + 4 + 2xy\)
   j \(2y - 3x + 3y - 2x\)

2 Simplify:
   a \(2x^2 - x^2 + 3x^2\)
   b \(4y - y + 6\)
   c \(3y - 2y + 4y\)
   d \(3x^2 - 2x^2 - x^2\)
   e \(4 + 3y - 2 + 4y\)
   f \(3 - 3x + 6 - 6x\)
   g \(3a^2 - 3a - a^2\)
   h \(4a^2 - 3a^2 + a^2 + a\)
   i \(3xy - y + 2xy + y\)
   j \(4a^3 - 2a^2 + 3a^2 + 2a\)

3 Sort these terms into pairs of like terms to find the odd one out:
   \(ab^2\) \(ca^2\) \(bc^2\) \(a^2c\) \(a^2b\) \(c^2b\) \(b^2a\)

4 Amy says these are all like terms:
   \(9n - 0.75n\) \(80000n\) \(2N\) \(\frac{3}{4}n\)
   Amy is wrong. Which term is the odd one out?

5 Copy the boxes below.
   Tick (✓) the pairs which are like terms.
   
   3\(x^2p\)  7\(x^2p\)  \(\frac{1}{2}y^2x\)  12\(m^2n^3\)
   0.09\(x^2p\)  0.4\(ax^2\)  5\(xy^2\)  8\(n^2m^3\)

6 Copy and complete this diagram with four more equivalent expressions for \(5t - 3m\).

7 Copy and complete
   a \(3m + \square - 2m + 4p = m + 7p\)
   b \(\square - 5t - 6v + 2t = 2v - 3t\)
   c \(3c - 4r - \square - \square = -5c - 6r\)
   d \(18p + 15y - 17p - \square p + \square y = 7p + 8y\)

8 a To complete the pyramid, the expression in each box is found by adding the two blocks below it. The second row of this pyramid has been completed for you. What goes in the top block? Simplify your answer.

   b Fill in the missing blocks in this pyramid.

TECHNOLOGY

Learn more about simplifying algebraic expressions by visiting the website
www.onlinemathlearning.com
and following the links to Algebra, Simplifying Expressions.
Make sure you watch the videos.
Expanding brackets
You can work out the multiplication
\[ 6 \times 74 \]
using the distributive law:
\[ 6 \times 74 = 6 \times (70 + 4) \]
\[ = 6 \times 70 + 6 \times 4 \]
\[ = 420 + 24 \]
\[ = 444 \]
In algebraic terms the distributive law is
\[ a \times (b + c) = a \times b + a \times c \]
That is, everything inside the brackets is multiplied by what is outside.
This is called multiplying out brackets or expanding brackets.

**EXAMPLE 3**
Expand the brackets.
\[ a \quad 3(x + 2y) \quad b \quad x(x + 1) \]
\[ a \quad 3(x + 2y) = 3 \times x + 3 \times 2y \]
\[ \Rightarrow 3x + 6y \]
\[ b \quad x(x + 1) = x \times x + x \times 1 \]
\[ \Rightarrow x^2 + x \]

In Example 3 you expanded \(3(x + 2y)\). This is like working out the area of this rectangle:

\[ x + 2y \]
which can be divided into two rectangles like this:

\[ \begin{array}{c}
 3 \\
 3x \hfill 6y \\
 3x \hfill 6y \\
\end{array} \]

\[ 3(x + 2y) = 3x + 6y \]

In Chapter 1 you learned about the order of operations, BIDMAS, and how it applies to numbers:

- **Brackets first**
- **Then Indices**
- **Then Division and Multiplication**
- **Then Addition and Subtraction**

The same rules apply to algebra. In the next example, brackets are expanded (or multiplied out) before doing the addition and subtraction, to simplify.

**EXAMPLE 4**
Simplify:
\[ a \quad 3(a - 2b) + a(4 - 2b) \]
\[ b \quad 2a(3 - 2b) - a(4b - 2) \]
\[ c \quad 7m + 5(6n + 3m) - 4n \]
\[ a \quad 3(a - 2b) + a(4 - 2b) \]
\[ = 3a - 6b + 4a - 2ab \]
\[ = 3a + 4a - 6b - 2ab \]
\[ = 7a - 6b - 2ab \]
\[ b \quad 2a(3 - 2b) - a(4b - 2) \]
\[ = 6a - 4ab - 4ab + 2a \]
\[ = 6a + 2a - 4ab - 4ab \]
\[ = 8a - 8ab \]
\[ c \quad 7m + 5(6n + 3m) - 4n \]
\[ = 7m + 30n + 15m - 4n \]
\[ = 22m + 26n \]

**Exercise 2B**
1. Expand the brackets.
   - **a** \( 3(x + 2) \)
   - **b** \( 4(2x - 6) \)
   - **c** \( 5(3x - 3) \)
   - **d** \( 6(4 - 3x) \)
   - **e** \( x(x + 5) \)
   - **f** \( 3x(x + 4) \)
   - **g** \( 2m(3m + 7) \)
   - **h** \( 5p(7 - 2p) \)
2 Work out the areas of the rectangles.

\[
\begin{align*}
a & \quad x + 7y \\
b & \quad x - 3y \\
c & \quad 2x + 5y \\
d & \quad 3x + 6y
\end{align*}
\]

3 a Draw an area that shows the expression \(4(x + 3)\).
   b Write a different expression that gives the same area.

4 a Draw an area that shows the expression \((4p)^2\).
   b Write a different expression that gives the same area.

5 a Draw an area that shows the expression \((r + 4)^2\).
   b Write a different expression that gives the same area.

6 Expand the brackets and simplify.

\[
\begin{align*}
a & \quad 2(x + 1) + 3(x + 2) \\
b & \quad 4(y - 1) + 2(y - 2) \\
c & \quad 3(2x + 1) + 4(3x - 4) \\
d & \quad 4(1 - 2x) + 3(2 - 3x) \\
e & \quad 5(x - 3) - 2(x + 2) \\
f & \quad 3(4x - 2y) + 3(2x - 3y) \\
g & \quad 2(x - 4y) - 2(x + y)
\end{align*}
\]

7 Work out the areas of the two shaded regions below. Simplify your expressions.

\[
\begin{align*}
a & \quad 2x + 5 \\
b & \quad 3x + 6y
\end{align*}
\]

8 Pair up equivalent expressions to find the odd one out.

\[
\begin{align*}
a & \quad -6x - 5 \\
b & \quad 6x - 11 \\
c & \quad 5 - 2(3x + 5) \\
d & \quad 6 + 15x \\
e & \quad 5(3x + 2) - 9x - 7 \\
f & \quad 4(2x - 1) - (2x - 7) \\
g & \quad 5 - 3(4 - 5x) + 13
\end{align*}
\]

9 Simplify:

\[
\begin{align*}
a & \quad 5y^2 - y(1 + 2y) \\
b & \quad x(3 + 2x) + x^2(1 + 2x) \\
c & \quad 3x(1 - 2x) + x(x - 1) \\
d & \quad 5y(1 - y) - y(y + 3) \\
e & \quad 3y(1 + y - y^2) - y^2(2 - 3y) \\
f & \quad 7 - (e - 3) - 2e + 3(4 - c) \\
g & \quad 3m + 6 \times 2m - 20m \\
h & \quad f - (h - 3f) + 5 \times 4h - 8f
\end{align*}
\]
10 Work out the missing numbers:
   a  $2(x - \square) = 2x - 16$
   b  $\square(3x + 4) = 18x + 24$
   c  $\square(8g - 12) = 104g - 156$
   d  $\square(6 + 13y) = 42 + \square$

11 If the area of a rectangle is $8x + 12$ and the width is 4, what is the length of the rectangle?

12 Remove brackets and simplify:
   a  $3(x - 2y) + 2(x + y) - 3(x + 2y)$
   b  $4x(1 + y) + 3y(2 - x) - 2(xy + 3y)$
   c  $x(x^2 - 3) + x^2(1 - x) - 3x(3 + x)$

2.2 Functions

An algebraic expression is one which contains some letters instead of numbers. An equation is different from an expression. An equation contains an equals sign. The equals sign shows that the expressions either side of it equal each other. Equations can be solved to find the value of the unknown letters (you will learn more about this in Chapter 8). A formula also has an equals sign. It describes the relationship between two (or more) variables. The value of one variable depends on the value (or values) of another.

In Book 1 you learned about function machines and mappings, for example that:

If $x$ is the input, this can also be written as $x \rightarrow 2x + 3$ and if you call the output $y$, this is written as $y = 2x + 3$.

A function is similar to an equation and a formula. Another way of writing the same thing is $f(x) = 2x + 3$. This means the function applied to $x$ is multiply by 2 then add 3. The function tells us about the way in which the output depends on the input.

If you want to find the value of the output when the input is 5, you would do:

To write this in a shorter way, when $f(x) = 2x + 3$, $f(5) = 2 \times 5 + 3$
   $= 10 + 3$
   $= 13$

EXAMPLE 5

<table>
<thead>
<tr>
<th>INPUT</th>
<th>\times 5</th>
<th>-1</th>
<th>OUTPUT</th>
</tr>
</thead>
</table>

a Write down the function in the form $f(x) = \ldots$
   for the function machine.

b Find $f(3)$.
   $\ldots$
   $f(3) = 5 \times 3 - 1$
   $= 15 - 1$
   $= 14$

Exercise 2C

1 i INPUT | \times 3 | -10 | OUTPUT

ii INPUT | \times 4 | +3 | OUTPUT

iii INPUT | \times -2 | +5 | OUTPUT

iv INPUT | \times 3 | \times 5 | OUTPUT

a Write down each function in the form $f(x) = \ldots$

b For each of these functions find $f(3)$.

c For each of these functions find $f(6)$.

d For each of these functions find $f(0)$.

2 For the function $f(x) = 7x - 3$, find:
   a $f(0)$
   b $f(1)$
   c $f(-1)$
3 For the function \( f(x) = 2 - 4x \), find:
   a \( f(4) \)
   b \( f(2) \)
   c \( f(-5) \)

4 For the function \( f(x) = 5(x + 2) \), find:
   a \( f(2) \)
   b \( f(6) \)
   c \( f(-3) \)

5 Match one card from the first column with one from the second column. The first is done for you.

   | 3b and 12b | expression |
   | 2x + 9 = 19 | function   |
   | 4x + 5      | term       |
   | 5x          | equation   |
   | \( f(x) = 3x - 1 \) | like terms |

6 For the function \( f(x) = 8x - 3 \), the output was 37. What was the input?

7 What do you think \( f(x) = 2 \) means?

8 If \( f(x) = 2(3x - 5) \) when \( f(x) = 74 \), what is the value of \( x \)?

---

2.3 Constructing expressions

We can write algebraic expressions to help us derive formulae (you will learn more about formulae in Chapter 8). Algebraic expressions are a shorter way of writing something.

In Book 1 you learned how to construct simple expressions like this:

If I have 3 pens costing $4 each the cost of these 3 pens is \( 3 \times 4 = 12 \)

If I have 5 pens costing $4 each the cost of these 5 pens is \( 5 \times 4 = 15 \)

If I have \( x \) pens costing $4 each the cost of these \( x \) pens is \( x \times 4 = 4x \)

4\( x \) is an expression that tells us the cost of an unknown number of pens each costing $4.

If you are not sure how to construct the expression, think what sum you would need to do if numbers were involved instead of letters. For instance, in Example 6 you could estimate the number of paper clips in the pot, think what sum to do using that number, then replace that number with a letter.

**EXAMPLE 6**

Write an expression for the number of paper clips if there are:

- a 2 paper clips taken out of the pot
- b 5 more paper clips in the pot
- c 3 pots of paper clips exactly the same as this one
- d 4 people sharing the pot of paper clips equally between them.

There is an unknown number of paper clips in this pot, let’s say \( n \) paper clips.

- a \( n - 2 \)
- b \( n + 5 \)
- c \( 3n \)
- d \( n \div 4 \) or \( \frac{n}{4} \)

**EXAMPLE 7**

Write an expression for the total time needed to roast a turkey with a mass of \( k \) kilograms, if it takes 20 minutes plus 35 minutes for each kilogram.

Time, in minutes, is \( 20 + 35k \)
Exercise 2D

1. There are $S$ sugar cubes in a bowl.

Write an expression for the number of sugar cubes left in the bowl if I
   a. take out 6 sugar cubes
   b. put in 10 sugar cubes
   c. have 5 bowls exactly the same
   d. take out half of the sugar cubes.

2. Write an expression for the perimeter of these shapes (the distance around the edge). Simplify your expression where possible.
   a. \[ \text{Perimeter} = 3x + 4x \]
   b. \[ \text{Perimeter} = 3m + m + m + m \]
   c. \[ \text{Perimeter} = 2p + 4 + 3 \]
   d. \[ \text{Perimeter} = a + a + b + b + c \]

3. a. Write an expression for the total cost of $k$ pens at $3$ per pen and $p$ pencils at $1$ per pencil.
   b. Write an expression for the total cost of $k$ pens at $m$ per pen and $p$ pencils at $t$ per pencil.

4. Write an expression for the cost of hiring a taxi to travel $K$ kilometres if there is a fixed cost of $2$ plus $0.50$ per kilometre.

5. To change a temperature in degrees Celsius to degrees Fahrenheit, multiply by 1.8 and then add 32. Write an expression to show the temperature in degrees Fahrenheit of something with a temperature of $C$ degrees Celsius.

6. An exchange rate shows that you get 2 New Zealand dollars for every UK pound. Write an expression to show the number of New Zealand dollars you would get for $P$ UK pounds.

7. a. A book costs $V$ dollars. A CD costs $W$ dollars. Match each description with the correct expression. The first one is done for you.

   - The total cost of 3 books: $30 - 3W$
   - The total cost of 3 books and 3 CDs: $3V$
   - How much more 3 CDs cost than 3 books: $3W$
   - The change from $30$ after buying 3 CDs: $3V - 3W$

   b. Choose any two expressions from a that are not paired with a description and write the meaning of those expressions in words.
8. To change kilometres to miles you divide by 8 then multiply by 5. Write an expression for the number of miles in $H$ kilometres.

9. Write using algebra:
   a. I think of a number $w$, multiply it by 3 and add 7
   b. I think of a number $x$, add 4 then multiply it by 2
   c. I think of a number $y$, divide it by 5 and then subtract 9
   d. I think of a number $z$, and multiply it by itself

10. The monthly cost of local calls on a mobile phone is $8 plus 9 cents per call. Write an expression for the total cost, in dollars, of $r$ local calls in $x$ months.

11. Write an expression for the number of sugar cubes left in the bowl in Question 1 if I take out 10% of the sugar cubes.

INVESTIGATION

Think of a number, call it $A$. Think of a different number, call it $B$. Which of the expressions below are always the same as each other no matter what values you choose for $A$ and $B$?

- $AB$
- $A + B$
- $\frac{B}{A}$
- $2(A + B)$
- $\frac{A}{B}$
- $BA$
- $A^2 + B^2$
- $B - A$
- $B + A$
- $(A + B)^2$
- $A - B$
- $2A + 2B$
### Consolidation

#### Example 1
Simplify:

- **a** \(2s + 8 + 3t - 5s + 4t - 2\)
  
  \[= 2s - 5s + 3t + 4t + 8 - 2\]
  
  \[= -3s + 7t + 6\]

- **b** \(4(3x + 5) - 3(6 - 2x)\)
  
  \[= 12x + 20 - 18 + 6x\]
  
  \[= 18x + 2\]

#### Example 2
For the function \(f(x) = 10 - 2x\), find:

- **a** \(f(4)\)
  
  \[= 10 - 2 \times 4\]
  
  \[= 10 - 8\]
  
  \[= 2\]

- **b** \(f(-2)\)
  
  \[= 10 - 2 \times (-2)\]
  
  \[= 10 + 4\]
  
  \[= 14\]

#### Example 3
Write an expression for the distance travelled by a man walking at \(U\) kilometres per hour for \(t\) hours.

Distance = speed \(\times\) time, so distance is \(U \times t\) or \(Ut\).

#### Exercise 2
1. Simplify:
   - **a** \(5x - 4y + 2x\)
   - **b** \(2y - 4x - 3y - 8x\)
   - **c** \(-4d + 3a + 6d - a\)
   - **d** \(5R - 2r + 3R + 4 + 8r\)

2. Fill in the blanks in the expression
   
   \(3t + \Box h - 5t + \Box t + 4h\)
   
   if it simplifies to give \(t + 6h\).

3. Expand the brackets:
   - **a** \(5(x - 3)\)
   - **b** \(9(2x + 8)\)

4. Write down four expressions equivalent to \(5m - 3t + m - 3t\) without using the numbers 5, 3 or 1. You may use brackets if you want.

5. Expand the brackets and simplify:
   - **a** \(3(x + 2) + 4x\)
   - **b** \((2 + 4y) + 3(2y + 6)\)
   - **c** \(2 + 4(5x - 7)\)
   - **d** \(3(2t - 1) - 5(4t - 3)\)

6. Write down an expression for the areas of these rectangles:
   - **a** \(x + 8\)
   - **b** \(11\)

7. Work out the missing numbers:
   - **a** \(3(h - \Box) = 3h - 15\)
   - **b** \(\Box(4x + 3) = 16x + 12\)
   - **c** \(\Box(4x - 3) = 40x - 30\)
   - **d** \(\Box(3 + 12m) = 15 + \Box\)

8. If the area of a rectangle is \(4x + 6\) and the width is 2, what is the length?

9. Write down an expression for the shaded area in this shape:
10 Write down the functions for these function machines in the form $f(x) = \ldots$.

<table>
<thead>
<tr>
<th>a</th>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>$\times 4$</td>
<td>$+ 9$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>b</th>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$-2$</td>
<td>$\times 3$</td>
<td></td>
</tr>
</tbody>
</table>

11 Copy and complete this diagram for the function $f(x) = \frac{2x}{5}$.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>x</strong></td>
<td>$\frac{2x}{5}$</td>
</tr>
</tbody>
</table>

12 For the function $f(x) = 7(x - 8)$, find

<table>
<thead>
<tr>
<th>a</th>
<th>$f(10)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>$f(5)$</td>
</tr>
</tbody>
</table>

13 Rewrite using algebra:

<table>
<thead>
<tr>
<th>a</th>
<th>I think of a number $x$, multiply it by 4 and add 2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>I think of a number $y$, add 15 then multiply it by 9.</td>
</tr>
</tbody>
</table>

14 Write down an expression for the perimeter of each shape.

| a | \[
\text{Perimeter} = 2k + h \]

15 The monthly cost of local calls on a mobile phone is $7 plus 10 cents per call. Write an expression for the total cost, in dollars, of $m$ local calls in a month.

16 Write an expression for the cost of hiring a plumber for $t$ hours if he has a fixed call out fee of $40 and charges an hourly rate of $30.

17 Simplify:

<table>
<thead>
<tr>
<th>a</th>
<th>$3 - (2p - 5) + 3p - 5(7 - p)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>$6y + 2 \times 3y - 10y$</td>
</tr>
<tr>
<td>c</td>
<td>$2f + h + 5 \times 3h - 8f$</td>
</tr>
</tbody>
</table>
### Summary

**You should know ...**

1. Like terms of an algebraic expression contain the same letters and can be simplified.  
   For example: \(5x + 2y - x - 3y = 4x - y\)

2. You can expand brackets and use the order of operations with algebra.  
   For example:  
   \[2 - 2(3x - 4) + 7x = 2 - 6x + 8 + 7x = 10 + x\]

3. The difference between a term, an expression, an equation, a function and a formula.  
   For example:  
   - \(3x\) is a term (and also a simple expression)  
   - \(f(x) = 4x\) is a function  
   - \(5x + 2\) is an expression  
   - \(3x + 1 = 13\) is an equation

4. You can construct expressions.  
   For example:  
   \[\text{area} = 3x + 2\]  
   The area is \(\text{width} \times \text{length} = 4 \times (3x + 2) = 4(3x + 2) = 12x + 8\)  
   The perimeter is the distance around the outside \[= 4 + 3x + 2 + 4 + 3x + 2 = 6x + 12\]

### Check out

1. Simplify:  
   a. \(5m + 3t - 4m - t\)  
   b. \(3x + 4y + 2x - 9y\)  
   c. \(3p + 4 - 5p + 7 + 4y\)  
   d. \(6f - 3g - 10f - 8 + 2f - g\)

2. a. Expand the brackets:  
   i. \(3(5p - 2)\)  
   ii. \(6(4 - 3x)\)  
   iii. \(x(x + 5)\)  
   iv. \(3(p(5p - 4))\)

   b. Expand the brackets and simplify:  
   i. \(7(6p - 8m) + 5(2p + 4m)\)  
   ii. \(50 + 80T - 10(5T + 2)\)

3. Which of the following are expressions?  
   a. \(3t - 4 = 11\)  
   b. \(7x + 4y\)  
   c. \(2t\)  
   d. \(f(x) = 3x\)

4. Construct expressions for:  
   i. the area and  
   ii. the perimeter of these rectangles.  
   a. \(7x + 2\)  
   b. \(11p - 12\)