

# CHAPTER 11

## Algebraic expressions 2

You already know that an algebraic expression is a computational procedure. It tells you what calculations you must do with the value of one variable, to produce the value of another variable. In this chapter, we extend the work you have already done to include algebraic expressions with integer constants, including negative numbers.

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$$\begin{array}{rcl}
 & 45 & -228 \\
 & 41 & -208 \\
 & 37 & -188 \\
 & 33 & -168 \\
 & 29 & -148 \\
 & 25 & -128 \\
 (-3) - 5 \times \textcolor{red}{x} = & & \\
 & 21 & -108 \\
 & 17 & -88 \\
 & 13 & -68 \\
 & 9 & -48 \\
 & 5 & -28 \\
 & 1 & -8
 \end{array}$$

# 11 Algebraic expressions 2

## 11.1 Interpret rules to calculate values of a variable

### RULES IN VERBAL AND SYMBOLIC FORM

- Do this to each of the numbers in the top row of the table, and write your answers in the bottom row: *multiply the input number by 20 and add 50 to the answer.*

$x$	1	2	3	4	5	6	7	8	9
$y$									

The sentence *multiply the input number by 20 and add 50 to the answer* is the rule that describes how the output number that corresponds to each input number in the above relationship between the variables  $x$  and  $y$  can be calculated.

The same rule can be described with the algebraic expression  $20x + 50$ . In this expression, the symbol  $x$  represents the input variable (the values of  $x$ ). The numbers 20 and 50 are constant; they remain the same for all the different values of  $x$ .

The rule *add 50 to the input number and multiply the answer by 20* can be described with the expression  $20(x + 50)$ .

If there are no brackets in an expression, multiplication is done first, even if it appears later in the expression like in  $30 + 5x$ .

If there are brackets in an algebraic expression, the operations in brackets are to be done first.

- Describe each of the following rules in words.

- $15x + 30$  .....
- $30 + 15x$  .....
- $15(x + 30)$  .....
- $15(x + 2)$  .....
- $15x - 30$  .....
- $15(x - 30)$  .....
- $15(x - 2)$  .....

- What is the difference between  $3(x + 5)$  and  $3x + 5$ ?

.....

.....

.....

4. Complete the table.

$x$	1	2	3	4	5	6	7	8	9
$15x + 30$									
$30 + 15x$									
$15(x + 30)$									
$15(x + 2)$									

5. Complete the table.

$x$	30	40	50	60	70	80	90
$15x - 30$							
$15(x - 30)$							
$15(x - 2)$							

6. (a) Investigate which of the following rules will produce the same output numbers.  
You need to check for several different input numbers.

A: Multiply the input number by 10 and then add 20.

B: Add 20 to the input number and then multiply by 10.

C: Add 2 to the input number and then multiply by 10.

D: Multiply the input number by 3, add 15, add 7 times the input number,  
and then add 5.

$x$								
A								
B								
C								
D								

.....

(b) Describe each of the above rules with an algebraic expression.

A: .....

B: .....

C: .....

D: .....

7. (a) Which of these rules do you think will produce the same output numbers?

A:  $5x + 20$

B:  $4x + 19$

C:  $5(x + 20)$

D:  $20 + 5x$

E:  $5(x + 4)$

F:  $3x + 7 + 2x + 13$

- .....  
(b) Express each of the above rules in words.

A: .....

B: .....

C: .....

D: .....

E: .....

F: .....

- .....  
(c) Complete this table for the rules given in (a).

$x$	0	5	10	15
$5x + 20$				
$4x + 19$				
$5(x + 20)$				
$20 + 5x$				
$5(x + 4)$				
$3x + 7 + 2x + 13$				

- (d) Use your completed table to check your answer in question (a).

8. (a) Which of these rules do you think will produce the same output numbers?

A:  $5x - 20$

B:  $20 - 5x$

C:  $5(x - 20)$

D:  $3x - 18$

E:  $5(x - 4)$

F:  $9x + 10 - 4x - 30$

- .....  
.....  
(b) Express each of the above rules in words.

A: .....

B: .....

C: .....

D: .....

E: .....

F: .....

(c) Complete this table for the rules given in (a).

$x$	20	30	40	50	60	70	80	90
$5x - 20$								
$20 - 5x$								
$5(x - 20)$								
$3x - 18$								
$5(x - 4)$								
$9x + 10 - 4x - 30$								

(d) Use your completed table to check your answer to question (a).

## 11.2 Slightly different kinds of rules

### SUBTRACT POSITIVE AND NEGATIVE QUANTITIES

1. Complete the table.

$x$	1	10	5	20	25
$10x$					
$50 - 10x$					
$20 - 10x$					
$0 - 10x$					

2. (a) Complete the table.

$x$	0	5	10	15	20	25	30
$10x - 5$							
$5x - 10$							
$100 - 5x$							
$-100 + 5x$							
$5x - 100$							
$5 - 10x$							

(b) The values of  $10x - 5$  *increase* as the values of  $x$  increase from 0 to 30.

For which expressions in (a) do the values *decrease* when  $x$  is increased?

.....

(c) Do the values of  $-100 + 5x$  *increase* or *decrease* when  $x$  is increased from 0 to 30?

.....

3. (a) The values of the expression  $5x - 10$  increase when  $x$  is increased from 0 to 30. Do you think the values will increase further when  $x$  is increased beyond 30, or will they start to decrease at some stage? .....
- (b) Do you think the values of the expression  $100 - 3x$  will increase when  $x$  is increased from 0 to 30? Explain why you think they will or will not.
- .....
- .....

The additive inverse of a number may be indicated by writing a negative sign before the number. For example, the additive inverse of 8 can be written as  $-8$ .

4. Write the additive inverse of each of the following numbers:

20      30       $-25$        $-20$       40

.....

When a number is added to the number called its additive inverse, the answer is 0. For example,  $45 + (-45) = 0$  and  $(-12) + 12 = 0$ .

5. Different values for  $x$  are given in the first row of the table below. Write the additive inverses of the  $x$  values in the second row, and then complete the table.

$x$	5	10	15	20	25	30
the additive inverse of $x$						
$20 +$ (the additive inverse of $x$ )						
$20 -$ (the additive inverse of $x$ )						
$20 + x$						
$20 - x$						

6. Complete the table.

$x$	$-5$	$-10$	$-15$	$-20$	$-25$	$-30$
the additive inverse of $x$						
$20 +$ (the additive inverse of $x$ )						
$20 -$ (the additive inverse of $x$ )						
$20 + x$						
$20 - x$						

7. Complete the table.

$x$	3	2	1	0	$-1$	$-2$	$-3$
$-x$							
$5 + (-x)$							
$5 - (-x)$							
$5 - x$							
$5 + x$							

## EXPRESSIONS WITH ADDITIVE INVERSES

1. Complete the table.

$x$	1	5	10	20	25
$5x$					
the additive inverse of $5x$					
$20 + (\text{the additive inverse of } 5x)$					
$20 - (\text{the additive inverse of } 5x)$					
$3x$					
$-3x$					
$10 + (-3x)$					
$10 - 3x$					
$10 - (-3x)$					

2. Complete the table below.

Note that  $(-10x)$  indicates the additive inverse of  $10x$ .

$x$	1	2	3	4	-4	-3	-2
$10x - 1\ 000$							
$1\ 000 - (-10x)$							
$1\ 000 - 10x$							
$(-10x) + 1\ 000$							
$10x + 1\ 000$							
$10x + (-1\ 000)$							
$(-10x) - 1\ 000$							
$1\ 000 + (-10x)$							
$1\ 000 + 10x$							
$10x - (+1\ 000)$							

Instead of  $(-10x) - 1\ 000$  we may write  $-10x - 1\ 000$ , in other words the brackets around the additive inverse may be left out.

Similarly,  $(-10x) + 1\ 000$  may be written as  $-10x + 1\ 000$ .

3. Complete the table.

$x$	1	5	10	20	25	30
$-5x + 20$						
$-5x + (-20)$						