ALGEBRA

Lesson 5: Evaluating Algebraic Expressions Using Substitution

1. Expressions with One Variable

To evaluate an algebraic expression means to calculate the value of the expression when you are given numerical values for the variables in the expression.

If $x = 3$, what is the value of $2x + 4$?
To solve, take the given value for x, in this case 3, and substitute the 3 for the x.

$2x + 4$	Start by writing the original expression.
$2(3) + 4$	Substitute 3 for x.
$6 + 4$	Now you can calculate the value of the expression.
10	So, if $x = 3$, the value of $2x + 4$ is 10.

Note that you can't get a value for the expression unless you are told the value of x. You are not trying to figure out what x is, you are calculating the value of the expression when you are told what x is.

Substitution is often called plugging in. In the above example, you would say that you plug in 3 for x.

Examples

1. If $x = 6$, what is the value of $3x - 5$?

$3x - 5$	Start by writing the original expression.
$3(6) - 5$	Substitute the 6 for x.
$18 - 5$	Calculate.
13	13 is your answer.

Notice that you are working down, not across. Always start by writing out the original expression. Then, substitute or calculate one thing at a time, and write the result on the next line down, not to the right, as you are used to. In algebra, problems are best solved working down, one line at a time.

2. When $x = 5$, what is the value of the expression $x^2 + 2x - 12$?
The variable x appears twice in this expression. Plug in 5 in both places.

$x^2 + 2x - 12$	Start by writing the original expression.
$5^2 + 2(5) - 12$	Plug in 5 for x in both places.
$25 + 2(5) - 12$	Calculate.
$25 + 10 - 12$	
23	

3. Calculate the value of $6x + 7 – x + 3x^2$ when $x = 4$.

$6x + 7 – x + 3x^2$ Start by writing the original expression.
$6(4) + 7 – 4 + 3(4)^2$ Substitute.
$6(4) + 7 – 4 + 3(16)$ Calculate.
$24 + 7 – 4 + 48$
75

NOTE – Remember to follow the order of operations rules.
To simplify $3(4)^2$, square the 4 first, and then multiply times 3, because the rules say to simplify exponents before multiplying.

Practice One *Answers – p. 6*

1. If $x = 7$, find the value of $3x + 2$.

2. If $x = 5$, then $4x – 6 = ?$

3. What is the value of the expression $x^2 – 3x$ when $x = 4$?

4. Evaluate the expression $2x^2 – 50$ when $x = 10$.

5. What is the value of $x^2 – 5x + 16$ when $x = 7$?

6. Calculate the value of $12x + 12 + 2x$ when $x = –4$.

7. Evaluate the expression $35 – x^2 + 3x$ when $x = 4$.

8. Find the value of $–4x + 12$ when $x = –2$.

2. EXPRESSIONS WITH TWO OR MORE VARIABLES

If $x = 3$ and $y = 4$, what is the value of $2x + 6y$?
To solve, take the given value for x, in this case 3, and substitute the 3 for the x in the expression. Then take the given value for y, in this case 4, and substitute the 4 for the y in the expression.

$2x + 6y$ Start by writing the original expression.
$2(3) + 6(4)$ Plug in 3 for x and 4 for y.
$6 + 24$ Calculate the value of the expression.
30 So, if $x = 3$ and $y = 4$, the value of $2x + 6y$ is 30.

Examples

1. If $x = 6$ and $y = 2$, what is the value of $x^2 + 4y – 10$?

$x^2 + 4y – 10$ Start by writing the original expression.
$6^2 + 4(2) – 10$ Substitute.
$36 + 4(2) – 10$ Calculate.
$36 + 8 – 10$
34

2. Evaluate the expression $x^2 - 2y^2 - 2x$ when $x = 9$ and $y = 5$.
If a variable appears more than once, plug the given value in each time it appears.
Be careful not to mix up the values given for the different variables.

$x^2 - 2y^2 - 2x$	Start by writing the original expression.
$9^2 - 2(5^2) - 2(9)$	Substitute 9 for x twice; substitute 5 for y.
$81 - 2(25) - 2(9)$	Calculate.
$81 - 50 - 18$	
13	

3. If $x = 5$ and $y = 4$ and $z = 7$, find the value of $4x + y^2 - z$.

$4x + y^2 - z$	Start by writing the original expression.
$4(5) + 4^2 - 7$	Substitute for three variables.
$4(5) + 16 - 7$	Calculate.
$20 + 16 - 7$	
29	

Practice Two *Answers – p. 7*

1. If $x = 3$ and $y = 5$, then the value of $3x + 9y$ is ?

2. If $x = 3$ and $y = 7$, what is the value of $x^2 + y^2 + 3y + 6$?

3. Find the value of $x^2 + y^2$ when $x = 6$ and $y = 4$.

4. Calculate the value of $2x^2 + 3y^2 - 2y + 5x$ when $x = 3$ and $y = 4$.

5. Evaluate the expression $2x^2 + 3y + x - z$ when $x = 3$ and $y = 7$ and $z = 5$.

6. What is the value of $3x^2 + 4y + 6z$ when $x = 2$ and $y = 7$ and $z = 1$?

7. Evaluate the expression $3x^2 + 4y^2 - 5x + 4y$ when $x = 2$ and $y = 1$.
a) 10 b) 28 c) 4 d) 19 e) 29

8. If $x = 5$ and $y = 3$, what is the value of $x^2 - y^2$?
a) 41 b) 16 c) 14 d) 4 e) 2

9. What is the value of $y^2 + 2x$ when $x = 2$ and $y = 11$?
a) 15 b) 26 c) 120 d) 20 e) 125

3. Expressions with Square Roots

If there is a variable inside a square root symbol, plug in the value of the variable, calculate the value of the expression, and then get the square root. Remember, to get a square root on the calculator, press the number, then shift, then the x^2 key.

Examples

1. If $x = 6$, what is the value of $\sqrt{6x + 64}$?

$\sqrt{6x + 64}$	Start by writing the original expression.
$\sqrt{6(6) + 64}$	Substitute 6 for x, then multiply.
$\sqrt{36 + 64}$	Add 36 + 64, and then get the square root.
$\sqrt{100}$	*(Do not get the square root of 36*
10	*and add it to the square root of 64.)*

2. Calculate the value of $\sqrt{4x + 8}$ when $x = 7$.

$\sqrt{4x + 8}$	Start by writing the original expression.
$\sqrt{4(7) + 8}$	Substitute, then multiply.
$\sqrt{28 + 8}$	Add 28 + 8, then get the square root.
$\sqrt{36}$	
6	

3. When $x = 33$, find the value of $\sqrt{5x + 60}$.

$\sqrt{5x + 60}$	Start by writing the original expression.
$\sqrt{5(33) + 60}$	Substitute, then multiply.
$\sqrt{165 + 60}$	Add 165 + 60, then get the square root.
$\sqrt{225}$	
15	

4. What is the value of $\sqrt{5x - 2y}$ when $x = 19$ and $y = 7$?

$\sqrt{5x - 2y}$	Start by writing the original expression.
$\sqrt{5(19) - 2(7)}$	Plug in 19 for x, plug in 7 for y, and then multiply.
$\sqrt{95 - 14}$	Subtract 95 – 14, then get the square root.
$\sqrt{81}$	
9	

Practice Three *Answers – p. 9*

1. If $x = 121$, what is the value of $\sqrt{x}$?

a) 10 b) 11 c) 12 d) 13 e) 14

2. Evaluate $\sqrt{3x + 37}$ when $x = 9$.

a) 64 b) 7 c) 8 d) 18 e) 4

3. Calculate the value of $\sqrt{10x - 6}$ when $x = 15$.

a) 144 b) 12 c) 10 d) 18 e) 4

4. When $x = 8$, what is the value of $\sqrt{2x + 9}$?

a) 7 b) 25 c) 5 d) 16 e) 37

5. What is the value of $\sqrt{10x + 5y}$ when $x = 20$ and $y = 5$?

a) 225 b) 32 c) 200 d) 28 e) 15

6. Evaluate $\sqrt{4x - 3y}$ when $x = 4$ and $y = 5$.

a) 1 b) 0 c) 31 d) 8 e) 9

7. If $x = 9$, find the value of $\sqrt{5x + 4}$.

a) 49 b) 63 c) 6 d) 7 e) 8

8. When $x = 5$, what is the value of $\sqrt{6x - 14}$?

a) 4 b) 16 c) 44 d) 51 e) 8

ANSWER KEY Lesson 5 Evaluating Algebraic Expressions

Practice One

1. If $x = 7$, find the value of $3x + 2$. **Answer = 23**

$3x + 2$
$3(7) + 2$
$21 + 2$
23

2. If $x = 5$, then $4x – 6 = ?$ **Answer = 14**

$4x – 6$
$4(5) – 6$
$20 – 6$
14

3. What is the value of the expression $x^2 – 3x$ when $x = 4$? **Answer = 4**

$x^2 – 3x$
$4^2 – 3(4)$
$16 – 3(4)$
$16 – 12$
4

4. Evaluate the expression $2x^2 – 50$ when $x = 10$. **Answer = 150**

$2x^2 – 50$
$2(10^2) – 50$
$2(100) – 50$
$200 – 50$
150

5. What is the value of $x^2 – 5x + 16$ when $x = 7$? **Answer = 30**

$x^2 – 5x + 16$
$7^2 – 5(7) + 16$
$49 – 5(7) + 16$
$49 – 35 + 16$
30

6. Calculate the value of $12x + 12 + 2x$ when $x = –4$. **Answer = –44**

$12x + 12 + 2x$
$12(–4) + 12 + 2(–4)$
$–48 + 12 + (–8)$
–44

7. Evaluate the expression $35 - x^2 + 3x$ when $x = 4$. **Answer = 31**

$35 - x^2 + 3x$
$35 - 4^2 + 3(4)$
$35 - 16 + 3(4)$
$35 - 16 + 12$
31

8. Find the value of $-4x + 12$ when $x = -2$. **Answer = 20**

$-4x + 12$
$-4(-2) + 12$
$8 + 12$
20

Practice Two

1. If $x = 3$ and $y = 5$, then the value of $3x + 9y$ is ? **Answer = 54**

$3x + 9y$
$3(3) + 9(5)$
$9 + 45$
54

2. If $x = 3$ and $y = 7$, what is the value of $x^2 + y^2 + 3y + 6$? **Answer = 85**

$x^2 + y^2 + 3y + 6$
$3^2 + 7^2 + 3(7) + 6$
$9 + 49 + 3(7) + 6$
$9 + 49 + 21 + 6$
85

3. Find the value of $x^2 + y^2$ when $x = 6$ and $y = 4$. **Answer = 52**

$x^2 + y^2$
$6^2 + 4^2$
$36 + 16$
52

4. Calculate the value of $2x^2 + 3y^2 - 2y + 5x$ when $x = 3$ and $y = 4$. **Answer = 73**

$2x^2 + 3y^2 - 2y + 5x$
$2(3^2) + 3(4^2) - 2(4) + 5(3)$
$2(9) + 3(16) - 2(4) + 5(3)$
$18 + 48 - 8 + 15$
73

5. Evaluate the expression $2x^2 + 3y + x - z$ when $x = 3$ and $y = 7$ and $z = 5$.

$2x^2 + 3y + x - z$ **Answer = 37**

$2(3^2) + 3(7) + 3 - 5$

$2(9) + 3(7) + 3 - 5$

$18 + 21 + 3 - 5$

37

6. What is the value of $3x^2 + 4y + 6z$ when $x = 2$ and $y = 7$ and $z = 1$? **Answer = 46**

$3x^2 + 4y + 6z$

$3(2^2) + 4(7) + 6(1)$

$3(4) + 4(7) + 6(1)$

$12 + 28 + 6$

46

7. Evaluate the expression $3x^2 + 4y^2 - 5x + 4y$ when $x = 2$ and $y = 1$. **Answer = 10**

a) 10 b) 28 c) 4 d) 19 e) 29

$3x^2 + 4y^2 - 5x + 4y$

$3(2^2) + 4(1^2) - 5(2) + 4(1)$

$3(4) + 4(1) - 5(2) + 4(1)$

$12 + 4 - 10 + 4$

10

8. If $x = 5$ and $y = 3$, what is the value of $x^2 - y^2$? **Answer = 16**

a) 41 **b) 16** c) 14 d) 4 e) 2

$x^2 - y^2$

$5^2 - 3^2$

$25 - 9$

16

9. What is the value of $y^2 + 2x$ when $x = 2$ and $y = 11$? **Answer = 125**

a) 15 b) 26 c) 120 d) 20 **e) 125**

$y^2 + 2x$

$11^2 + 2(2)$

$121 + 2(2)$

$121 + 4$

125

Practice Three

1. If $x = 121$, what is the value of $\sqrt{x}$? **Answer = 11**

a) 10 **b) 11** c) 12 d) 13 e) 14

$\sqrt{x}$

$\sqrt{121}$

11

2. Evaluate $\sqrt{3x + 37}$ when $x = 9$. **Answer = 8**

a) 64 b) 7 **c) 8** d) 18 e) 4

$\sqrt{3x + 37}$

$\sqrt{3(9) + 37}$

$\sqrt{27 + 37}$

$\sqrt{64}$

8

3. Calculate the value of $\sqrt{10x - 6}$ when $x = 15$. **Answer = 12**

a) 144 **b) 12** c) 10 d) 18 e) 4

$\sqrt{10x - 6}$

$\sqrt{10(15) - 6}$

$\sqrt{150 - 6}$

$\sqrt{144}$

12

4. When $x = 8$, what is the value of $\sqrt{2x + 9}$? **Answer = 5**

a) 7 b) 25 **c) 5** d) 16 e) 37

$\sqrt{2x + 9}$

$\sqrt{2(8) + 9}$

$\sqrt{16 + 9}$

$\sqrt{25}$

5

5. What is the value of $\sqrt{10x + 5y}$ when $x = 20$ and $y = 5$? **Answer = 15**

a) 225 b) 32 c) 200 d) 28 **e) 15**

$\sqrt{10x + 5y}$

$\sqrt{10(20) + 5(5)}$

$\sqrt{200 + 25}$

$\sqrt{225}$

15

6. Evaluate $\sqrt{4x-3y}$ when $x = 4$ and $y = 5$. **Answer = 1**

a) 1 b) 0 c) 31 d) 8 e) 9

$\sqrt{4x-3y}$

$\sqrt{4(4)-3(5)}$

$\sqrt{16-15}$

$\sqrt{1}$

1

7. If $x = 9$, find the value of $\sqrt{5x+4}$. **Answer = 7**

a) 49 b) 63 c) 6 **d) 7** e) 8

$\sqrt{5x+4}$

$\sqrt{5(9)+4}$

$\sqrt{45+4}$

$\sqrt{49}$

7

8. When $x = 5$, what is the value of $\sqrt{6x-14}$? **Answer = 4**

a) 4 b) 16 c) 44 d) 51 e) 8

$\sqrt{6x-14}$

$\sqrt{6(5)-14}$

$\sqrt{30-14}$

$\sqrt{16}$

4