# 1.5 Patterns and Relationships in Tables


## Quick Review

➤ You can make a table of values for a relation such as: $2n + 5$ is related to $n$
Choose values for $n$. These are Input numbers.
Substitute each value of $n$ in $2n + 5$ to get the Output numbers.

When $n = 1$, $2n + 5 = 2(1) + 5$
$= 7$
When $n = 2$, $2n + 5 = 2(2) + 5$
$= 9$
When $n = 3$, $2n + 5 = 2(3) + 5$
$= 11$
When $n = 4$, $2n + 5 = 2(4) + 5$
$= 13$

Here is the table:

| Input $n$ | Output $2n + 5$ |
|---|---|
| 1 | 7 |
| 2 | 9 |
| 3 | 11 |
| 4 | 13 |

➤ You can find a relation given its table of values.

| | Input | Output | |
|---|---|---|---|
| | 1 | 2 | |
| +1 | 2 | 6 | +4 |
| +1 | 3 | 10 | +4 |
| +1 | 4 | 14 | +4 |
| +1 | 5 | 18 | +4 |

Let $n$ represent any Input number.
When $n$ increases by 1, the Output number increases by 4.
This means that the expression for the Output numbers contains $4n$.
So, compare the Output numbers to multiples of 4: 4, 8, 12, 16, 20, . . .
Each Output number is 2 less than a multiple of 4.
So, the output is $4n - 2$.
The table shows how $4n - 2$ relates to $n$.

## Practice

**1.** **a)** Evaluate the expression $3n + 1$.

When $n = 1$, $3n + 1 = 3(1) + 1$

$= \_\_\_\_\_$

When $n = 2$, $3n + 1 = 3(2) + 1$

$= \_\_\_\_\_$

When $n = 3$, $3n + 1 = 3(3) + \_\_\_\_\_$

$= \_\_\_\_\_$

When $n = 4$, $3n + 1 = 3(\_\_\_\_\_) + \_\_\_\_\_$

$= \_\_\_\_\_$

When $n = 5$, $3n + 1 = 3(\_\_\_\_\_) + \_\_\_\_\_$

$= \_\_\_\_\_$

**b)** Complete the table. Use your results from part a.

| **Input** $n$ | **Output** $3n + 1$ |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

**2.** Complete each table.

Explain how the Output number is related to the Input number.

**a)**

| **Input** $n$ | **Output** $n + 5$ |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

_____

_____

**b)**

| **Input** $b$ | **Output** $8 - b$ |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

_____

_____

**c)**

| **Input** $a$ | **Output** $6 + a$ |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

_____

_____

**3.** Complete each table.

a)

| Input $d$ | Output $2d + 3$ |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

b)

| Input $f$ | Output $3f - 2$ |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

c)

| Input $h$ | Output $5h + 1$ |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |

**4.** Use algebra. Write a relation for each table.

a)

| Input $n$ | Output |
|---|---|
| 1 | 2 |
| 2 | 3 |
| 3 | 4 |
| 4 | 5 |
| 5 | 6 |

b)

| Input $p$ | Output |
|---|---|
| 1 | 0 |
| 2 | 1 |
| 3 | 2 |
| 4 | 3 |
| 5 | 4 |

c)

| Input $m$ | Output |
|---|---|
| 1 | 8 |
| 2 | 16 |
| 3 | 24 |
| 4 | 32 |
| 5 | 40 |

**5.** Use algebra. Write a relation for each table.
Then extend each table 3 more rows.

a)

| Input $r$ | Output |
|---|---|
| 1 | 4 |
| 2 | 6 |
| 3 | 8 |
| 4 | 10 |
| 5 | 12 |
| | |
| | |
| | |

b)

| Input $s$ | Output |
|---|---|
| 1 | 2 |
| 2 | 5 |
| 3 | 8 |
| 4 | 11 |
| 5 | 14 |
| | |
| | |
| | |

c)

| Input $n$ | Output |
|---|---|
| 1 | 9 |
| 2 | 14 |
| 3 | 19 |
| 4 | 24 |
| 5 | 29 |
| | |
| | |
| | |

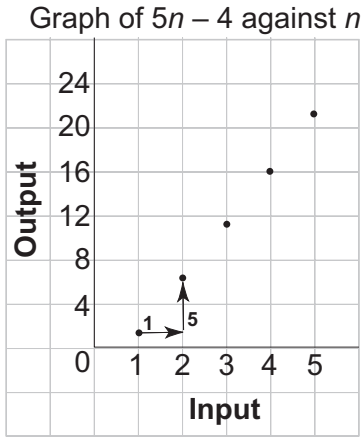
# 1.6 Graphing Relations

## Quick Review

➤ You can use a graph to show a relation.
This table and graph show how $5n - 4$ relates to $n$.

| Input $n$ | Output $5n - 4$ |
|---|---|
| 1 | 1 |
| 2 | 6 |
| 3 | 11 |
| 4 | 16 |
| 5 | 21 |

+1, +1, +1, +1 (between rows 1–2, 2–3, 3–4, 4–5)
+5, +5, +5, +5 (between rows 1–2, 2–3, 3–4, 4–5)




The scale on the *Output* axis is 1 square to 4 units.
The points lie on a straight line, so the relation is linear.
Both the table and the graph show that when the input increases by 1, the output increases by 5.

## Practice

**1.** Complete each table.

a)

| Input $n$ | Output $2n + 8$ |
|---|---|
| 1 | 10 |
| 2 | 12 |
| 3 | 14 |
| 4 | 16 |
| 5 | |
| 6 | |
| 7 | |

b)

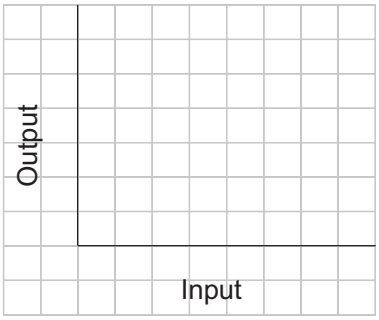
| Input $n$ | Output $5n + 1$ |
|---|---|
| 1 | 6 |
| 2 | 11 |
| 3 | 16 |
| 4 | 21 |
| 5 | |
| 6 | |
| 7 | |

c)

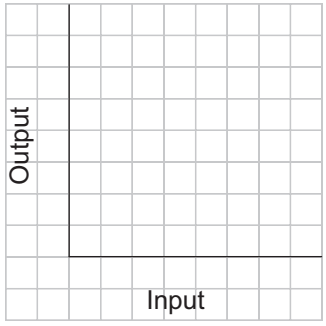
| Input $n$ | Output $9 - n$ |
|---|---|
| 1 | 8 |
| 2 | 7 |
| 3 | 6 |
| 4 | 5 |
| 5 | |
| 6 | |
| 7 | |

**2.** Choose a suitable scale.
Graph each relation in question 1.

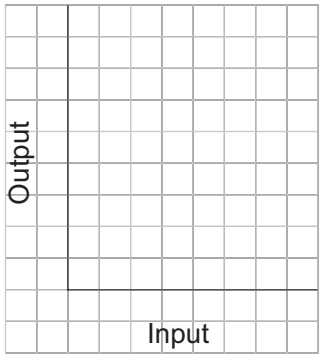
**a)**




**b)**




**c)**




**3.** Look at the graph at the right.

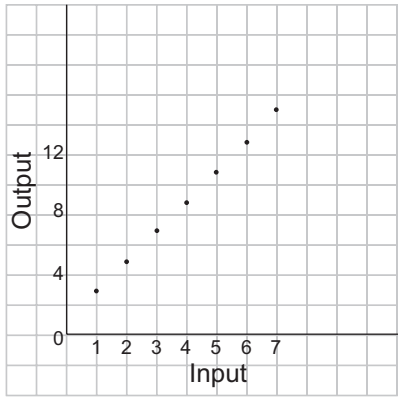
**a)** What is the output when the input is 1? _____

**b)** Which input gives an output of 13? _____

**c)** Extend the graph.

**i)** What is the output when the input is 8? _____

**ii)** What is the input when the output is 21? _____




**4.** **a)** Complete this table.

| **Input** $a$ | **Output** $5a + 3$ |
|---|---|
| 2 | |
| 4 | |
| 6 | |
| 8 | |
| 10 | |

**b)** Graph the relation in part a.



**c)** How does the graph illustrate the relation?

_____

_____

**5.** The members of the student council wash cars to raise money for charity.
The students charge $3.00 per car.

**a)** Let $c$ represent the number of cars washed.
Write a relation to show how the money collected, in dollars, is related to the number of cars washed. _____

**b)** Complete this table to show the relation.

| Number of cars | Money collected ($) |
|---|---|
| 10 | |
| 20 | |
| 30 | |
| 40 | |
| 50 | |

**c)** Graph the data.



**d)** Describe the graph.

_____

_____

**e)** Use the relation, the graph, or the table to answer these questions.
Explain your choice.

**i)** Suppose the students wash 33 cars.
How much money will they collect? _____

I used the: _____

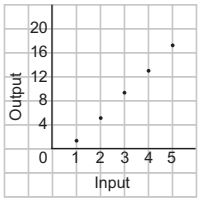
**ii)** Suppose the students wash 60 cars.
How much money will they collect? _____

I used the: _____

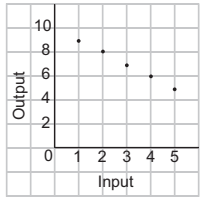
_____

**6.** Match each graph to its relation.

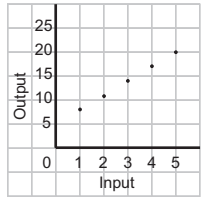
**a)**




**b)**




**c)**




**A.** $10 - n$ relates to $n$

_____

**B.** $3n + 5$ relates to $n$

_____

**C.** $4n - 3$ relates to $n$

_____

# 1.7 Reading and Writing Equations

## Quick Review

➤ An equation is a statement that two expressions are equal.

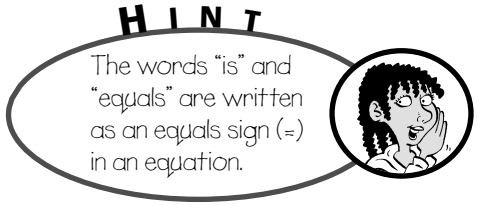
$2x + 1$ is an algebraic expression.
7 is an expression.
$2x + 1 = 7$ is an equation.

This equation can be expressed in words as:
*One more than double a number is seven.*

➤ Here's how to write an equation from a statement.

1. Choose a letter for the variable.
2. Write an algebraic expression to represent the relationship described.
3. Write an equals sign between the expression and the constant term.

*Five more than a number is 20.*
Let $p$ represent the number.
Five more than $p$: $p + 5$
The equation is: $p + 5 = 20$




*A number subtracted from ten is 4.*
Let $x$ represent the number.
$x$ subtracted from ten: $10 - x$
The equation is: $10 - x = 4$

*A number divided by two is 8.*
Let $n$ represent the number.
$n$ divided by two: $\frac{n}{2}$
The equation is: $\frac{n}{2} = 8$

## Practice

**1.** Match each sentence with an equation. The first one is done for you.

| | |
|---|---|
| A number divided by three is 4. | $20 - n = 6$ |
| Twenty subtract a number equals 6. | $2n + 3 = 11$ |
| Nine subtract one-half a number is 6. | $\frac{n}{3} = 4$ |
| Three added to double a number is 11. | $9 - \frac{n}{2} = 6$ |

**2.** Write an equation for each sentence.
Let $n$ represent the number.

**a)** Eight less than a number is 2. $n -$ _____ $=$ _____

**b)** One-half a number equals 5. _____

**c)** Four more than double a number is 20. _____

**d)** Six plus three times a number is 9. _____

**3.** Write a sentence for each equation.

**a)** $n - 6 = 12$

_____

**b)** $\frac{x}{2} = 10$

_____

**c)** $2p + 10 = 14$

_____

**4.** Write an equation for each sentence.
Let $x$ represent the number.

**a)** Three more than a number is 12. _____

**b)** Three less than a number is 12. _____

**c)** Three times a number equals 12. _____

**d)** Three more than three times a number is 12. _____

**e)** Three subtracted from three times a number equals 12. _____

**5.** Write an equation for each sentence.

**a)** The cost of 2 adult tickets at \$5 each and $n$ child tickets at \$3 each is \$25.

_____

**b)** William's age 4 years ago was 12. Let $a$ years represent William's age now.

_____

**c)** The perimeter of a square with side length $s$ is 28.

_____

# 1.8 Solving Equations Using Algebra Tiles

## Quick Review

At Home At School

➤ You can use tiles to represent an expression.
This **unit tile** represents +1.



This **variable tile** or ***x*-tile** represents $x$.



➤ You can use tiles to solve an equation. For example, to solve: $x + 3 = 14$:
Draw a vertical line in the centre of the page.
It represents the equals sign in the equation.
Arrange the tiles on each side of the line to represent the expression or number on each side of the equation.
On the left side, place tiles to represent $x + 3$.
On the right side, place tiles to represent 14.

To isolate the $x$-tile, remove 3 unit tiles from each side.

The tiles show the solution is $x = 11$.

To *verify* the solution, replace $x$ with 11 tiles.

Left side:  +  → 14 unit tiles

Right side:  → 14 unit tiles

Since both sides have equal numbers of tiles, the solution $x = 11$ is correct.

## Practice

**1.** Complete each algebraic expression.

**a)** A number increased by 3: $x +$ _____

**b)** Two times a number: _____ $x$

**c)** Three more than 4 times a number: $4x +$ _____

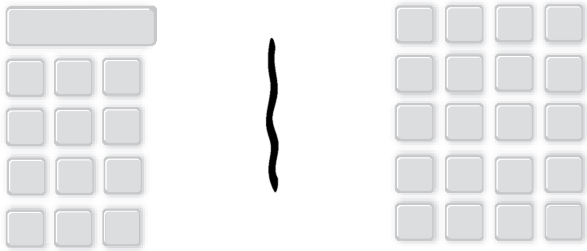
**d)** Twelve less than a number: _____ $- 12$

**2.** Match each picture to its equation.

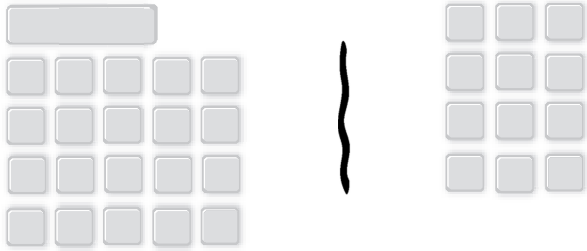
**a)** $x + 1 = 3$

**b)** $x + 2 = 4$

**c)** $x + 20 = 12$



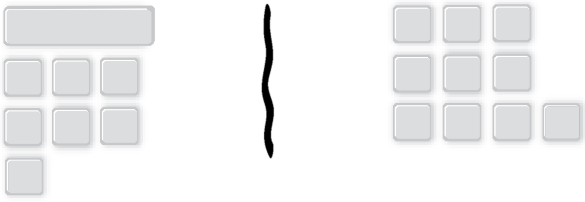
**d)** $x + 12 = 20$



**3.** Zephyr had songs in his music player folder.
He bought 7 more. Zephyr then had 10 songs.
How many did he start with?
Complete the solution for the equation: $x + 7 = 10$

Step 1

Step 2



Step 3

The solution is: _____

**4.** An online book costs $15.00 to upload to a computer.
How many online books can be purchased for $75.00?

**a)** Write an equation to represent this problem.

_____

**b)** Solve the equation to find how many online books can be purchased.

_____

**5.** Erica is thinking of a number. She multiplies it by 2, then adds 5.
The result is 19. Which number did Erica begin with?

**a)** Write an equation to represent this problem.

_____

**b)** Solve the equation to find the number.

_____

# In Your Words

Here are some of the important mathematical words of this unit.
Build your own glossary by recording definitions and examples here. The first one is done for you.

**divisibility rules** *rules I can use to find out multiples of numbers and factors of numbers. For example, to find out if a certain number is a multiple of 3, I add the digits of the number; if the sum is a multiple of 3, then the number is also a multiple of 3.*

**algebraic expression**

**variable**

**evaluate**

**equation**

**solve an equation**

List other mathematical words you need to know.