

## 4.2 Linear Relations

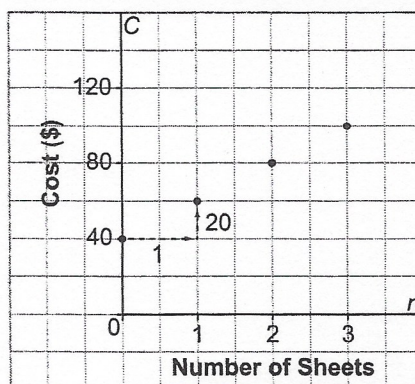
**FOCUS** Analyze the graph of a linear relation.

A photographer charges \$40 for a sitting fee, plus \$20 per sheet of prints.

The charges are shown in the table of values and in the graph.

Number of Sheets, $n$	Cost, $C$ (\$)
0	40
1	60
2	80
3	100

Cost for Number of Sheets of Photos



We cannot order part of a sheet of prints.

So, the points in the graph are not joined with a line.

We say that the data are **discrete**.

For different values of  $n$ , we get different values of  $C$ .

So the variable  $C$  *depends* on the value of the variable  $n$ .

When two variables are related in this way, they form a **relation**.

### Linear Relation

When the graph of a relation is a straight line, it is called a **linear relation**.

### Example 1 Graphing a Linear Relation from a Table of Values

A popular DVD club allows members to purchase DVDs at a reduced price according to the table of values.

- a) Graph the data.
- b) Should the points be joined?  
Why or why not?
- c) Is the relation linear? Explain.
- d) Describe the patterns in the table.  
How are these patterns shown on the graph?

Number of DVDs Purchased, $n$	Cost, $C$ (\$)
1	20
2	25
3	30
4	35



## 4.2 Skill Builder

### The Coordinate Grid

Plot  $A(-2, 3)$  on a coordinate grid.

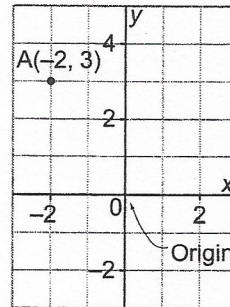
The first number in the ordered pair tells how far you move left or right on the horizontal axis.

The second number tells how far you move up or down on the vertical axis.

So, to plot  $A(-2, 3)$ :

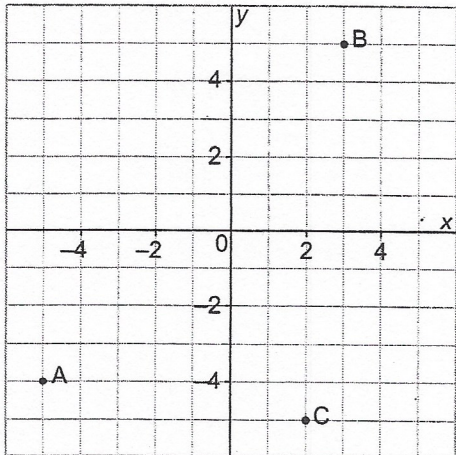
Move 2 squares left of the origin,  
then move 3 squares up.

*-2 is the  
x-coordinate.  
3 is the  
y-coordinate.*



### Check

1. What are the coordinates of points A, B, and C?



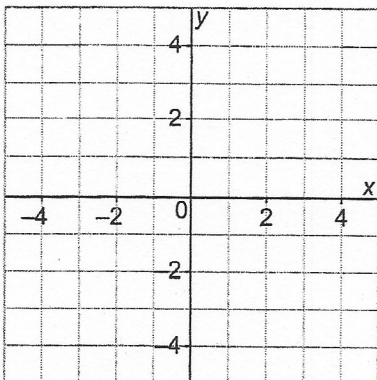
A( )

B( )

C( )

2. Graph these points on the coordinate grid.

$A(-3, 0)$      $B(2, 4)$      $C(0, -3)$





- b) Complete the table below.

Number of Shaded Tiles, $s$	Number of White Tiles, $w$
1	8
2	_____
_____	_____
_____	_____
_____	_____

- c) Write an equation for the number of white tiles,  $w$ , in terms of the number of shaded tiles,  $s$ .

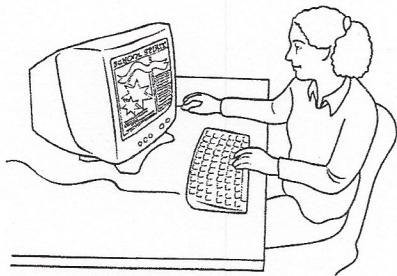
$$w = \_\_\_\_\_\_ s + \_\_\_\_\_\_$$

- d) Use your equation to find  $w$  when  $s = 25$ .

$$\begin{aligned} w &= \_\_\_\_\_\_ \\ &= \_\_\_\_\_\_ \\ &= \_\_\_\_\_\_ \end{aligned}$$

When the number of shaded tiles is 25, there are \_\_\_\_\_ white tiles.

4. Anabelle is part of the yearbook committee. This year, the set-up cost to print yearbooks is \$400, plus \$3 for each yearbook printed.



- a) Write an equation for the total cost in terms of the number of yearbooks printed.  
Let  $C$  represent the total cost, and let  $n$  represent the number of yearbooks.

$$C = \_\_\_\_\_\_ + \_\_\_\_\_\_$$

- b) Anabelle takes 200 orders for yearbooks this year.  
What is the total cost to the yearbook committee?

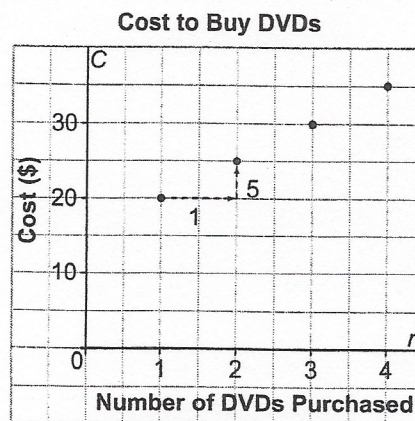
$$\begin{aligned} C &= \_\_\_\_\_\_ \\ &= \_\_\_\_\_\_ \\ &= \_\_\_\_\_\_ \end{aligned}$$

The total cost is \$ \_\_\_\_\_.



## Solution

- Plot the points on a grid.
- The points should not be joined because you cannot buy part of a DVD.
- The points on the graph lie on a straight line, so this is a linear relation.
- The table of values shows that:  
The number of DVDs purchased increases by 1 each time.  
The cost increases by \$5 each time.

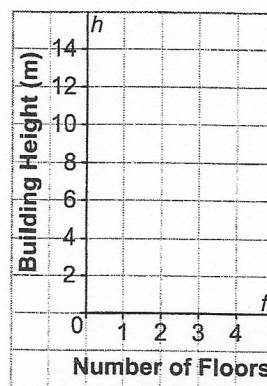


To get from one point to the next in the graph, move 1 unit right and 5 units up.

## Check

- Graph the data from the table of values.

Number of Floors, $f$	Building Height, $h$ (m)
1	5
2	8
3	11
4	14



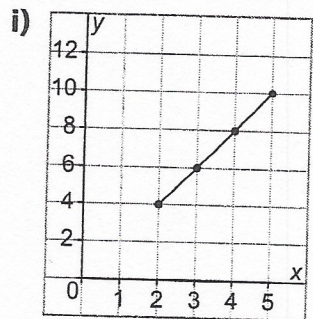
- Is the relation linear? Explain.

- Should the points on the graph be joined with a line? Explain.

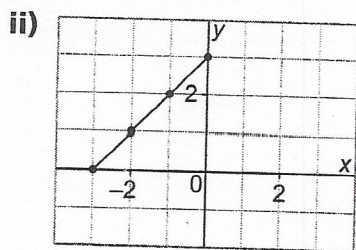


3. Each graph and table of values represents a linear relation.

a) Complete each table of values.



$x$	$y$
2	4
3	6
4	___
5	___



$x$	$y$
-3	0
-2	___
-1	2
0	___

b) Describe the patterns in the table.

i) When  $x$  increases by \_\_\_\_,  $y$  increases by \_\_\_\_.

ii) When \_\_\_\_ increases by \_\_\_\_, \_\_\_\_ increases by \_\_\_\_.

c) Describe the patterns in the graph.

i) To get from one point to the next, move 1 unit right and \_\_\_\_ up.

ii) To get from one point to the next, move \_\_\_\_ right and \_\_\_\_ up.

4. Complete the table of values for each linear relation, then graph it.

a)  $y = 4x$

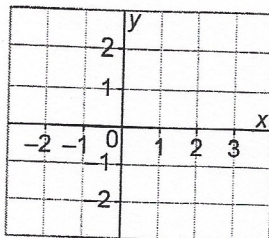
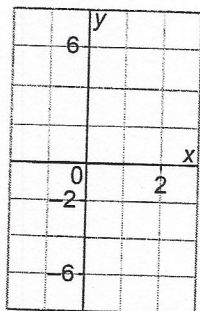
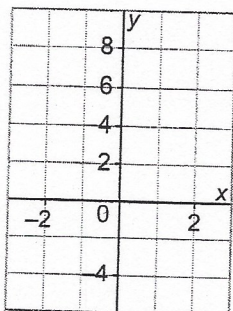
$x$	$y$
-1	___
0	___
1	___
2	___

b)  $y = -3x$

$x$	$y$
-1	___
0	___
___	___
___	___

c)  $y = 1 - x$

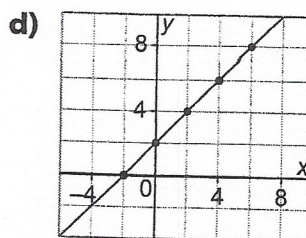
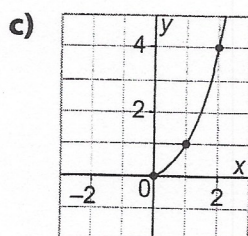
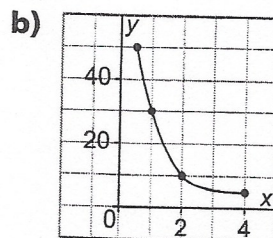
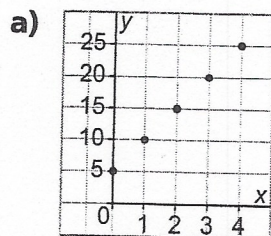
$x$	$y$
0	___
___	___
___	___
___	___





## Practice

1. Which graphs represent a linear relation?



2. Describe the patterns in each table of values.

Does each table of values represent a linear relation?

a)

x	y
-3	6
-2	5
-1	4
0	3

x increases by \_\_\_\_\_ each time.  
 y decreases by \_\_\_\_\_ each time.  
 The relation is \_\_\_\_\_, because a constant change  
 in x produces a constant change in y.

b)

x	y
0	1
2	4
4	7
6	10

x increases by \_\_\_\_\_ each time.  
 y increases by \_\_\_\_\_ each time.  
 The relation is \_\_\_\_\_, because a constant change  
 in x produces a constant change in y.

c)

x	y
1	1
2	3
3	7
4	13

x increases by \_\_\_\_\_ each time.

y \_\_\_\_\_

The relation \_\_\_\_\_



## Example 2 Graphing a Linear Relation from an Equation

- a) Complete the table of values.
- b) Graph the relation represented by the data in the table of values.
- c) Describe the patterns in the graph and in the table.
- d) Is the relation linear? Explain.

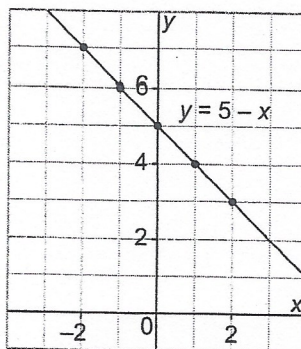
$x$	$y = 5 - x$
-2	
-1	
0	
1	
2	

### Solution

a)

$x$	$y = 5 - x$
-2	$5 - (-2) = 7$
-1	$5 - (-1) = 6$
0	$5 - 0 = 5$
1	$5 - 1 = 4$
2	$5 - 2 = 3$

b)



Since we can substitute any value for  $x$ , the points can be joined with a line.

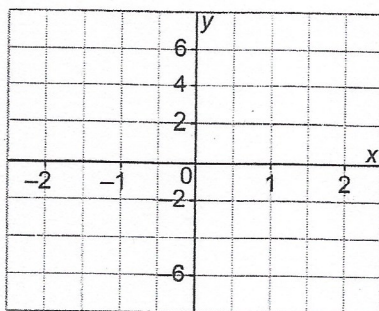
- c) Each point on the graph is 1 unit right and 1 unit down from the previous point. In the table, when  $x$  increases by 1,  $y$  decreases by 1.
- d) This is a linear relation because its graph is a straight line.

### Check

1. Complete the table of values.

Then, graph the relation.

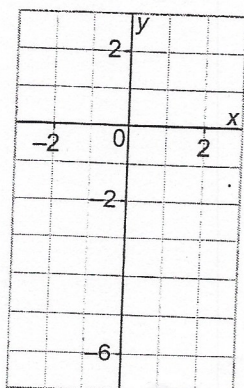
$x$	$y = 4x - 2$
-1	-6
0	-2
1	
2	





5. Complete the table of values.

Graph the data.



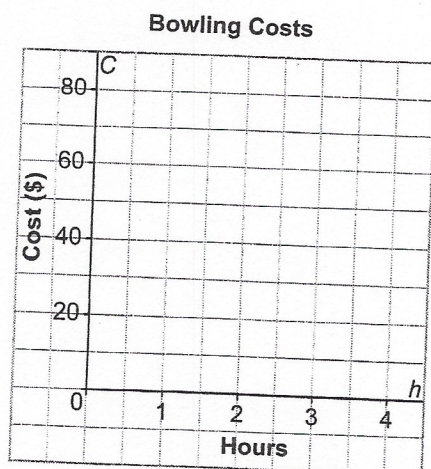
$x$	$y = 2x - 4$
-1	-6
0	-4
1	_____
2	_____

6. For special events, a bowling alley charges a set fee plus a fee for each hour bowled.

a) Graph the data.

**Bowling Costs**

Hours, $h$	Cost, $C$ (\$)
1	40
2	50
3	60
4	70



Does it make sense to join the points on the graph? Explain.

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b) Is this a linear relation? Why?

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c) Describe the pattern in words and using an equation.

When  $h$  increases by \_\_\_\_\_,  $C$  increases by \_\_\_\_\_.

$C = \underline{\hspace{2cm}} h + 30$