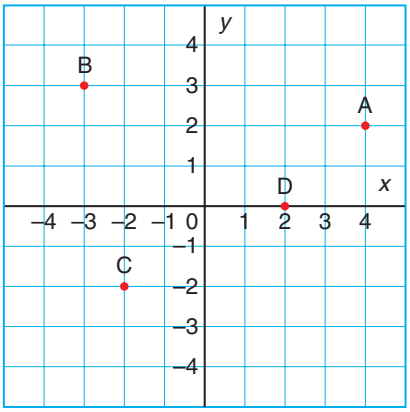
6.7 Graphing Linear Relations

Focus Construct a graph from the equation of a linear relation and describe the graph.

Look at the coordinate grid.
Point A has coordinates (4, 2).
What are the coordinates of Point B? Point C? Point D?



Investigate

Work with a partner.

Benny is designing banners for a school event.
On a banner, the school motto is 50 cm long and the school logo is 20 cm long.

In each design, the banner has the school logo at each end, and the school motto in the middle. The motto can be repeated any number of times.

An equation that relates the length of the banner to the number of mottos is $\ell = 40 + 50n$, where ℓ is the length of the banner in centimetres with n mottos.

- Explain each term in the equation of the relation.
  What does each term represent?
- Use the equation to make a table of values for the relation.
- Graph the relation.
- What can you find out from the table of values? From the graph?

Reflect & Share

Compare your table of values and graph with those of another pair of classmates.
Should you draw a line through the points? Justify your decision.
Is the relation linear? How can you tell?

Connect

Sylvia works at a garden nursery. She is paid \$6 for every tray of tomatoes she plants. Let n represent the number of trays Sylvia plants. Let p represent her pay in dollars. An equation that relates Sylvia's pay to the number of trays she plants is: $p = 6n$

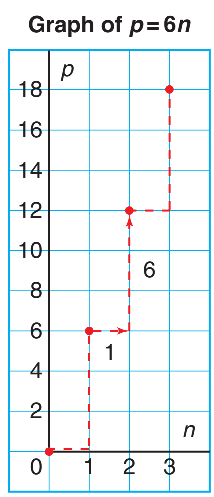
Substitute values for n to find corresponding values of p.

When $n = 0$, $p = 6(0)$
$= 0$

When $n = 1$, $p = 6(1)$
$= 6$

Here is a table of values.

n	p
0	0
1	6
2	12
3	18



To graph the relation, plot n along the horizontal axis and p along the vertical axis.
Label the axes and write the equation of the relation on the graph.
The points lie on a straight line, so the relation is linear.
Since Sylvia only gets paid for whole numbers of trays planted, we do not join the points. For example, Sylvia is *not* paid for 1.5 trays planted.
These data are **discrete**. When data are discrete, there are numbers between those given that are not meaningful in the context of the problem.

The graph shows that for every tray Sylvia plants, her pay increases by \$6.
As the number of trays increases, so does her pay.

Example 1

A Grade 8 class is going on a field trip. The bus seats 24 students.
An equation that relates the number of boys on the bus to the number of girls is $b = 24 - g$, where g represents the number of girls and b represents the number of boys.

a) Create a table of values for the relation.

b) Graph the relation.

c) Describe the relationship between the variables in the graph.

A Solution

a) Substitute values for g to find corresponding values of b.

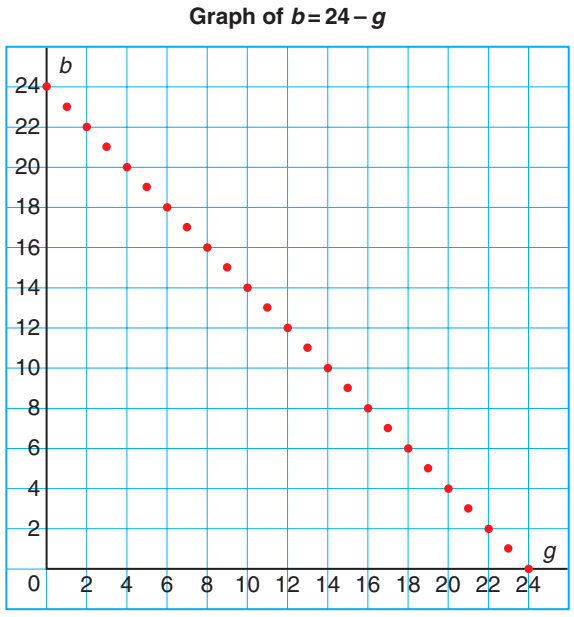
When $g = 0, b = 24 - 0$
$= 24$

When $g = 1, b = 24 - 1$
$= 23$

A table of values is:

	g	b	
	0	24	
+1	1	23	−1
+1	2	22	−1
+1	3	21	−1
+1	4	20	−1
	...	...	
	24	0	

b)



c) The variables represent the number of boys and the number of girls.
As the number of girls increases by 1, the number of boys decreases by 1.
The graph begins and ends at 24 on each axis. It is not possible to have more than either 24 boys or 24 girls on the bus.

Example 2

The equation of a linear relation is: $y = -4x + 1$

a) Create a table of values for the relation for integer values of x from -4 to 4.

b) Graph the relation.

c) Describe the relationship between the variables in the graph.

A Solution

a) When $x = -4$,

$$\begin{aligned} y &= -4x + 1 \\ &= -4(-4) + 1 \\ &= 16 + 1 \\ &= 17 \end{aligned}$$

When $x = -3$,

$$\begin{aligned} y &= -4x + 1 \\ &= -4(-3) + 1 \\ &= 12 + 1 \\ &= 13 \end{aligned}$$

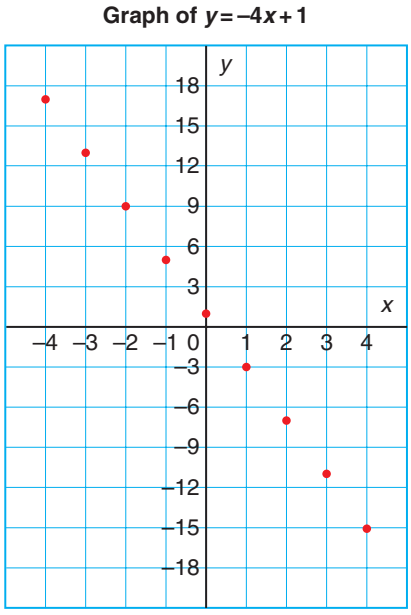
When $x = -2$,

$$\begin{aligned} y &= -4x + 1 \\ &= -4(-2) + 1 \\ &= 8 + 1 \\ &= 9 \end{aligned}$$

A table of values is:

	x	y	
	–4	17	
+1	–3	13	–4
+1	–2	9	–4
+1	–1	5	–4
+1	0	1	–4
+1	1	–3	–4
+1	2	–7	–4
+1	3	–11	–4
+1	4	–15	–4

b)



c) The variables are x and y.
When x increases by 1, y decreases by 4.
The points lie on a line that goes down to the right.

Discuss the ideas

1. In *Example 1*, is it possible to have negative values for b and g? Justify your answer.
2. In *Example 1*, the relation is linear and the points lie on a line. Why did we not draw a line through the points?
3. In *Example 1*, the equation for the relation could have been written as $g = 24 - b$.
   How would the table of values change?
   How would the graph change?

Practice

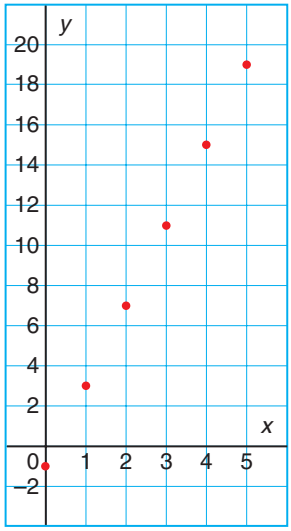
Check

You will need grid paper.

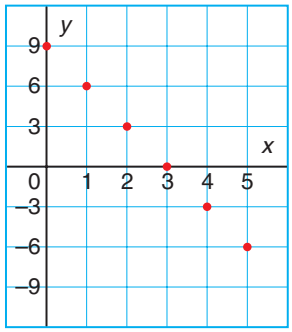
4. Each graph below is a graph of a linear relation. Describe the relationship between the variables in each graph.

a) $y = 4x - 1$ **b)** $y = -3x + 9$

Graph of $y = 4x - 1$



Graph of $y = -3x + 9$



5. Graph each relation for integer values of x from 0 to 5.

a) $y = 2x$ **b)** $y = 3x$
c) $y = 4x$ **d)** $y = 5x$
e) $y = -2x$ **f)** $y = -3x$
g) $y = -4x$ **h)** $y = -5x$

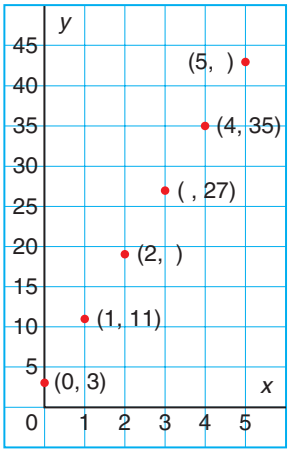
6. Graph each relation for integer values of x from 0 to 5.

a) $y = 2x + 1$ **b)** $y = 2x - 1$
c) $y = -2x + 1$ **d)** $y = -2x - 1$
e) $y = 3x + 1$ **f)** $y = 3x - 1$
g) $y = -3x + 1$ **h)** $y = -3x - 1$

Apply

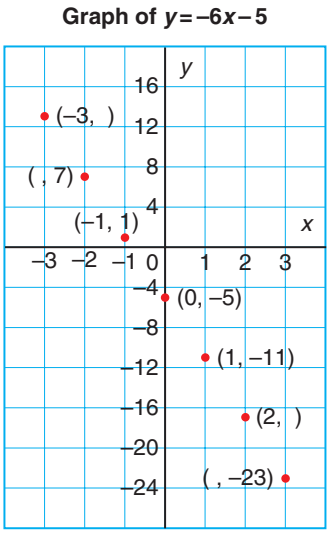
7. Here is a graph of the linear relation $y = 8x + 3$.

Graph of $y = 8x + 3$



Each point on the graph is labelled with an ordered pair.
Some numbers in the ordered pairs are missing. Find the missing numbers.
Explain how you did this.

8. Here is a graph of the linear relation $y = -6x - 5$.



Each point on the graph is labelled with an ordered pair.
Some numbers in the ordered pairs are missing. Find the missing numbers.
Explain how you did this.

9. Use the data from *Example 1*, page 361.
An equation for the linear relation is:
$c = 11 + 2n$,
where n is the number of toppings on the pizza, and c is the total cost of the pizza in dollars. Here is a table of values.

n	0	1	2	3	4	5	6	7	8
c	11	13	15	17	19	21	23	25	27

a) Construct a graph for the data.
b) Describe the relationship between the variables in the graph.
c) Find the ordered pair on the graph that shows the cost of a pizza with 6 toppings.

10. Use the data from Lesson 6.6 *Practice* question 12, page 357.
An equation for the linear relation is:
$m = 100 - 2n$,
where n is the number of months that Herbie trains and m is his mass at any time in kilograms.
Here is a table of values.

n	0	2	4	6	8	10
m	100	96	92	88	84	80

a) Construct a graph for the data.
b) Describe the relationship between the variables in the graph.
c) Find the ordered pair on the graph that indicates Herbie's mass after 7 months. Explain how you did this.

11. **Assessment Focus** Regina plans a marshmallow roast. She will buy 8 marshmallows for each person who attends, and 12 extra marshmallows in case someone shows up unexpectedly.
Let n represent the number of people who attend. Let m represent the number of marshmallows Regina must buy. An equation that relates the number of marshmallows to the number of people is: $m = 8n + 12$

a) Create a table of values for the relation.
b) Graph the relation.
c) Describe the relationship between the variables in the graph.
d) Is the relation linear?
How do you know?

12. Graph each relation for integer values of x from -4 to 4.

a) $y = 8x + 2$ **b)** $y = -8x - 2$

c) $y = -7x + 4$ **d)** $y = 5x - 4$

13. Peter's Promoting is organizing a concert. The cost of the venue and the rock band is \$15 000. Each concert ticket sells for \$300. Peter's profit is the money he makes from selling tickets minus the cost. Let n represent the number of tickets sold. Let p represent Peter's profit. An equation that relates the profit to the number of tickets sold is:

$p = 300n - 15\,000$

a) Create a table of values for the relation. Use these values of n: 10, 20, 30, 40, 50, 60, 70, 80

b) Graph the relation. What do negative values of p represent?

c) Describe the relationship between the variables in the graph.

d) How can you use the graph to find the profit when 75 tickets are sold?

14. Take It Further A computer repair company charges \$60 to make a house call, plus an additional \$40 for each hour spent repairing the computer. An equation that relates the total cost to the time in hours for a house call is $C = 60 + 40n$, where n represents the time in hours, and C represents the total cost of the house call in dollars.

a) Graph the relation.

b) Describe the relationship between the variables in the graph.

c) Does the point $(-1, 20)$ lie on the graph? What does this point represent? Does this point make sense in the context of the problem? Explain.

15. Take It Further

a) Graph each relation. Describe the relationship between the variables in the graph.

i) $y = -9x + 4$ **ii)** $y = 6x - 3$

iii) $y = -7x - 2$ **iv)** $y = 4x + 11$

v) $y = 7x + 5$ **vi)** $y = 3x - 8$

vii) $y = -9x - 6$ **viii)** $y = -8x + 7$

b) Which graphs go up to the right? Which graphs go down to the right?

c) How can you use the equation of a linear relation to tell if its graph goes up to the right or down to the right?

Reflect

You now know these ways to represent a relation:

- table of values
- equation
- graph

Which way do you think tells you the most about the relation?