

9.1

Analysing Graphs of Linear Relations

Focus on...

After this lesson, you will be able to...

- describe patterns on the graph of a linear relation
- create a table of values using the points on a graph

Literacy Link

A *relationship* is a pattern formed by two sets of numbers.

Materials

- cardboard circle
- coloured counters



Graphs have been around for a long time. The pictorial writings of Aboriginal peoples and the drawings in the tombs of ancient Egypt are two examples. Graphs have gone through significant changes. Many graphs are now used to show relationships between sets of data.

A table of values also shows a relationship between two quantities. What is an advantage of a graph compared with a table of values?

Explore the Math

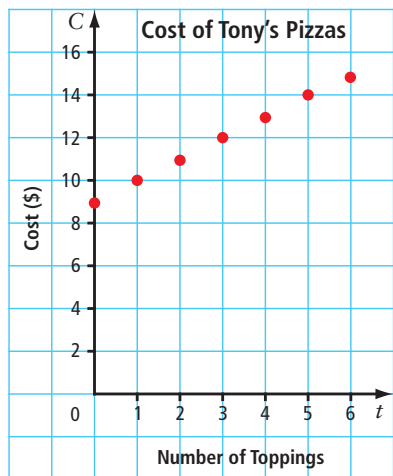
How can you represent a linear relation?

Tony's Pizzeria sells medium pizzas for \$9 each. You can order extra toppings for \$1 per topping.

TONY'S PIZZERIA

medium pizza \$9
each extra topping \$1

The graph shows the cost of Tony's medium pizzas.



On the graph, t represents the number of extra toppings and C represents the cost in dollars.

1. a) Use a cardboard circle and coloured counters to model a medium pizza with extra cheese, pineapple, and ham.
 b) Explain how your model could represent the cost of a medium pizza with three toppings. What cost does your model show?
2. Look at the graph. What is the cost of a medium pizza with three toppings? How does this compare with your answer in #1b)?
3. a) From the graph, make a table of values that shows the cost of a medium pizza with zero to six toppings.
 b) What headings did you use for your table? Why?

Strategies
Model It

Literacy Link

A *table of values* is a chart showing two sets of related numbers.

Reflect on Your Findings

4. a) What are three ways you can represent data?
 b) Which way do you prefer? Why?

You can arrange a table of values horizontally or vertically. In a horizontal table, the top row should show the x -coordinates from a graph.

x	1	2	3	4
y	5	10	15	20

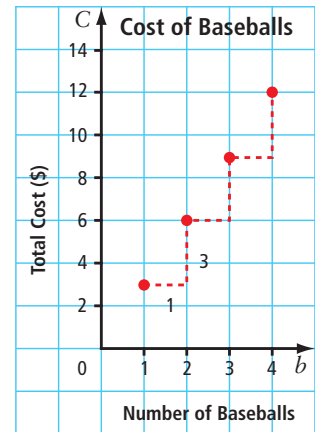
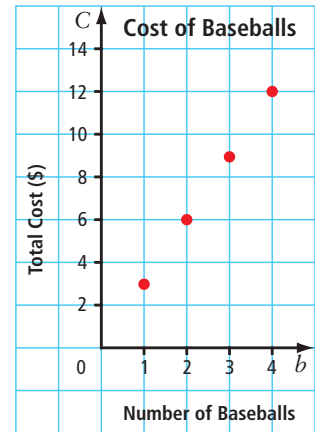
In a vertical table, the first column should show the x -coordinates from a graph.

x	y
1	5
2	10
3	15
4	20

Example 1: Make a Table of Values From a Graph

The graph shows the total cost in relation to the number of baseballs you buy.

- Describe patterns you see on the graph.
- Make a table of values from the graph.
- If the relationship continues, what is the cost of 14 baseballs?



Solution

- The patterns can be described in the following ways:
 - The graph provides data on the cost of baseballs. One ball costs \$3, two balls cost \$6, three balls cost \$9, ...
 - The points appear to lie in a straight line.
 - The graph shows that to move from one point to the next, you go one unit horizontally and three units vertically.

Number of Baseballs, b	1	2	3	4
Total Cost, C (\$)	3	6	9	12

- The graph shows that the cost increases by \$3 for each baseball purchased. Let b represent the number of baseballs. The cost could be represented by $3b$.

$$\begin{aligned} \text{Cost of 14 baseballs} &= 3(14) \\ &= 42 \end{aligned}$$

The cost of 14 baseballs is \$42.

Tech Link

You can use a spreadsheet program to create a table.

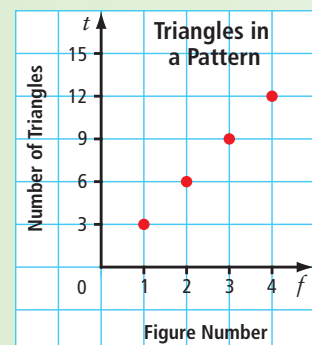
Strategies

Solve an Equation

Show You Know

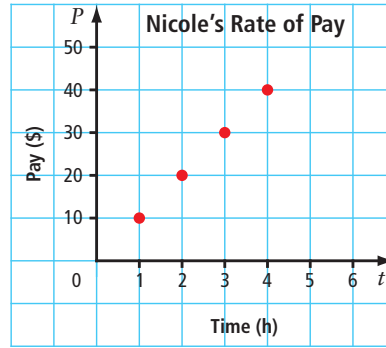
The graph shows the number of triangles in relation to the figure number in a pattern.

- Describe patterns you see on the graph.
- Draw a triangle pattern that matches the graph.
- Make a table of values from the graph.
- If the pattern continues, how many triangles are in Figure 99?



Example 2: Analyse Data on a Graph of a Linear Relation

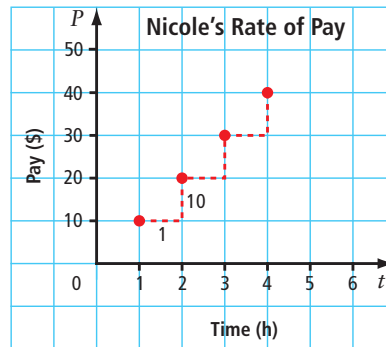
The graph shows Nicole's rate of pay based on the number of hours she has worked at her part-time job.



- Describe patterns you see on the graph.
- What is Nicole's hourly rate of pay? How do you know?
- Make a table of values from the graph.
- Is it possible to have points between the ones on the graph? Explain.

Solution

- The patterns can be described in the following ways:
 - The graph provides data on the pay Nicole receives for each hour worked. The pay for 1 h is \$10, the pay for 2 h is \$20, the pay for 3 h is \$30, ...
 - The points appear to lie in a straight line. The graph shows a linear relation.
 - The graph shows that to move from one point to the next, you go one unit horizontally and ten units vertically.



- Nicole's hourly rate of pay is \$10. The graph shows that Nicole's pay increases by \$10 for each hour that she works.

c)

Time, t (h)	0	1	2	3	4
Pay, P (\$)	0	10	20	30	40

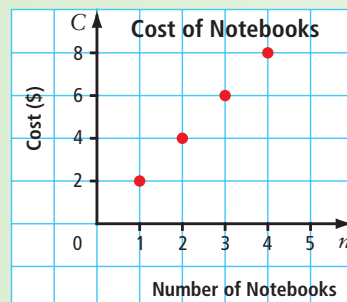
- It may be possible to have points between the ones on the graph. For example, Nicole could get paid for working for $3\frac{1}{2}$ h, and then a point could be shown between (3, 30) and (4, 40) on the graph.

Show You Know

Chad is buying notebooks at Bob's Bargain Store.

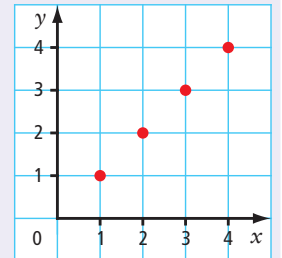
The graph shows the cost of notebooks.

- Describe patterns you see on the graph.
- What is the cost per notebook? How do you know?
- Make a table of values from the graph.
- Is it possible to have points between the ones on the graph? Explain.



Literacy Link

A linear relation is a pattern made by a set of points that lie in a straight line.

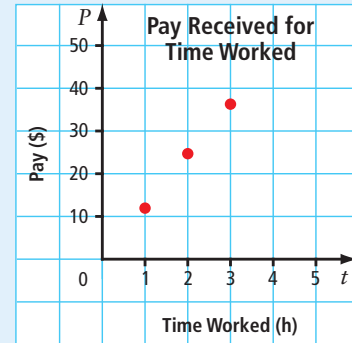


Key Ideas

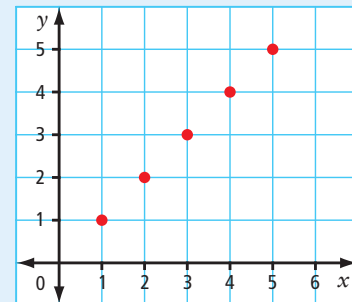
- You can use the coordinates of the points on a graph to make a table of values.
- The top row or left column in a table of values has the same label as the horizontal axis. The second row or right column has the same label as the vertical axis.

Time Worked, t (h)	1	2	3
Pay, P (\$)	12	24	36

Time Worked, t (h)	Pay, P (\$)
1	12
2	24
3	36

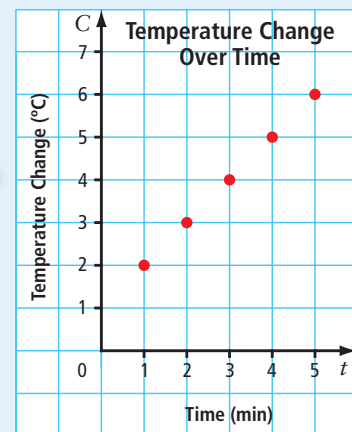


- When you describe a pattern, tell what it relates to, where it starts, and how it changes.
- A linear relation is a pattern made by a set of points that lie in a straight line.



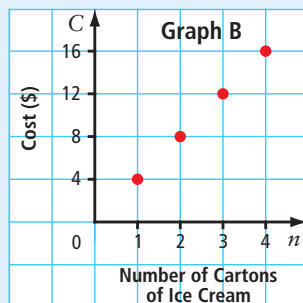
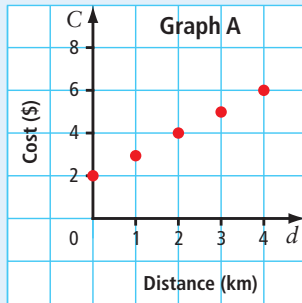
- Sometimes, it is possible to have points between the ones on a graph. Ask yourself, “Does it make sense to have other values between those on the graph?”

Could there be points between the ones on the graph? For example, is it possible to determine the temperature at $2\frac{1}{2}$ min? Is it possible to read a temperature as part of a degree, such as 3.5°C ?



Communicate the Ideas

1. Tell whether you think it is reasonable to have points between the ones on each graph. Explain your answer.



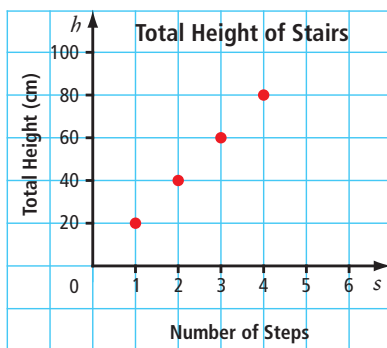
2. Draw a graph of a linear relation. Use integer values only. Label your graph. Write a brief description that matches the information on your graph.
3. Use an example to show one way that a graph and a table of values are different and one way that they are similar.

Check Your Understanding

Practise

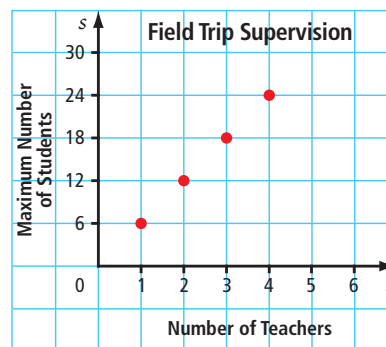
For help with #4 and #5, refer to Example 1 on page 334.

4. The graph shows the increase in total height for each step of a staircase.



- a) Describe patterns you see on the graph.
- b) Make a table of values from the graph.
- c) If the pattern continues, what is the total height on step 10?

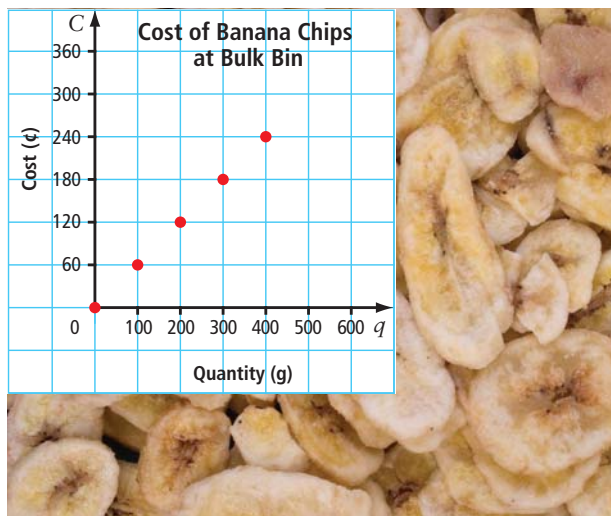
5. The graph shows the maximum number of students allowed on a field trip based on the number of teachers available to supervise.



- a) Describe three patterns on the graph.
- b) Make a table of values from the graph.
- c) If there are eight teachers available for a field trip, what is the maximum number of students who can go?

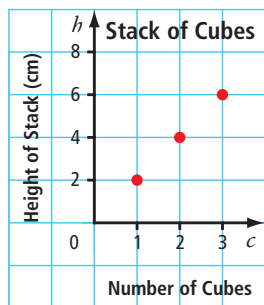
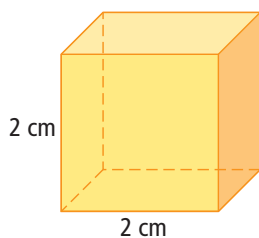
For help with #6 and #7, refer to Example 2 on page 335.

6. Tessa and Vince go shopping at Bulk Bin. The graph shows the cost of banana chips.



- Describe patterns shown on this graph. Does the graph show a linear relation? Explain.
- Make a table of values from the graph.
- Is it reasonable to include a point on the graph that shows the cost of 250 g of banana chips? Explain.

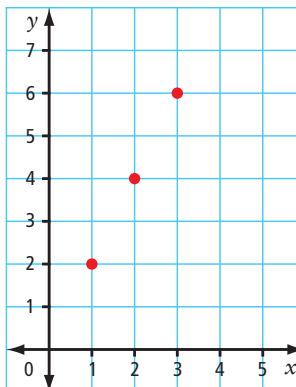
7. The graph shows the height of a stack of cubes in relation to the number of cubes.



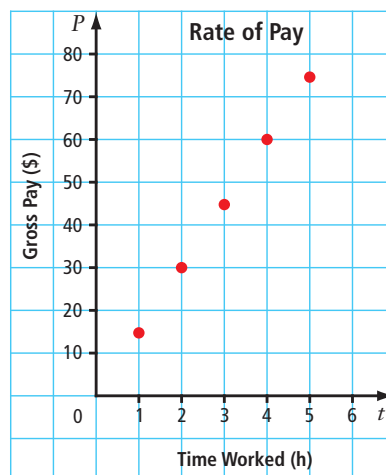
- Describe patterns on the graph. Does the graph show a linear relation? Explain.
- Make a table of values from the graph.
- Is it reasonable to include a point for $c = 2.5$? Explain.

Apply

8. a) Make a table of values for the ordered pairs on the graph.

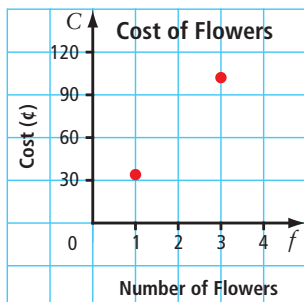


- Assume the pattern continues. Extend your table, using the next three whole number values for x .
 - Describe the patterns on the graph.
 - What is the value of y when the value of x is 9?
9. The graph shows the rate of pay based on the number of hours worked.

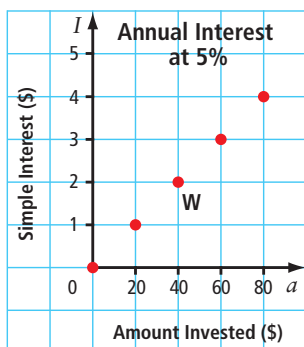


- Make a table of values from the graph.
- What is the hourly rate of pay shown on this graph?
- Do you think it is reasonable to include a point for $t = 3.5$ h?

10. The graph shows part of a linear relation that represents the cost to purchase sugar flowers for a cake.

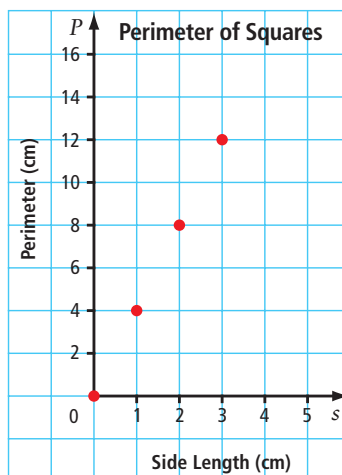


- a) Is it reasonable to have points between the ones on the graph? Explain your answer.
- b) How many points could there be between the two shown on the graph? Explain your answer.
11. The graph shows the simple interest for one year at 5% for different dollar amounts invested.



- a) What are the coordinates for point W?
- b) What does each coordinate for point W represent?
- c) Describe patterns on the graph.
- d) If the pattern continues, what is the simple interest earned on \$180 after one year?

12. The graph shows the perimeter of a square in relation to the length of its side.



- a) Copy the table and fill in the missing values for s and P .

Side Length, s (cm)	Perimeter, P (cm)
0	0
1	4
2	
	12
4	
5	
	32
28	
	124

- b) Describe the patterns on the graph.
- c) Are any other points possible between those shown on the graph? Explain.
- d) Does the graph represent a linear relation? Explain.

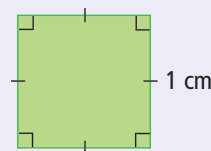
Literacy Link

Perimeter of a Square

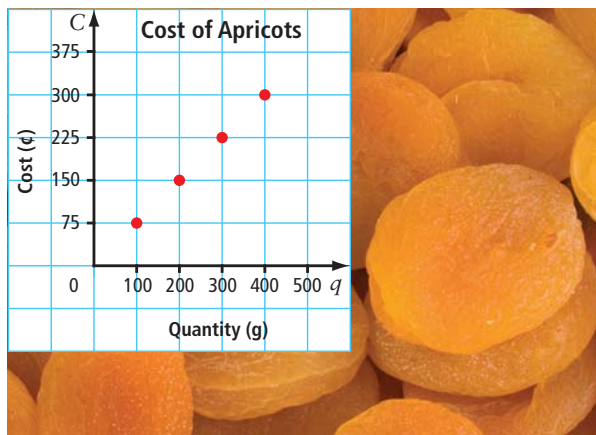
$$P = 1 + 1 + 1 + 1$$

$$P = 4$$

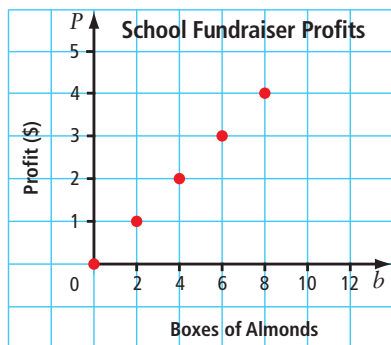
The perimeter is 4 cm.



13. The graph shows the cost of dried apricots at Bulk N Save.

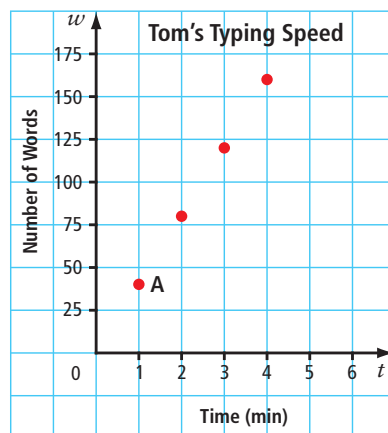


- Make a table of values from the graph.
 - Describe patterns on the graph.
 - Use the graph to estimate the cost of 350 g of dried apricots.
 - What is the actual cost of 350 g of dried apricots? Round your answer to the nearest cent.
 - Compare your answers in parts c) and d).
14. The graph below represents the relationship between the number of boxes of almonds a student sells for a school fundraiser and the profit in dollars for the school.

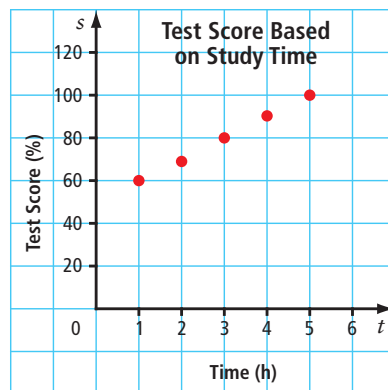


- Make a table of values from the graph.
- Describe three patterns on the graph.
- How much profit does the school make on two boxes of almonds?
- What is the value of P when the value of b is 2? How does this answer relate to your answer in part c)?

15. The following graph represents the number of words Tom can type in relation to the time in minutes.



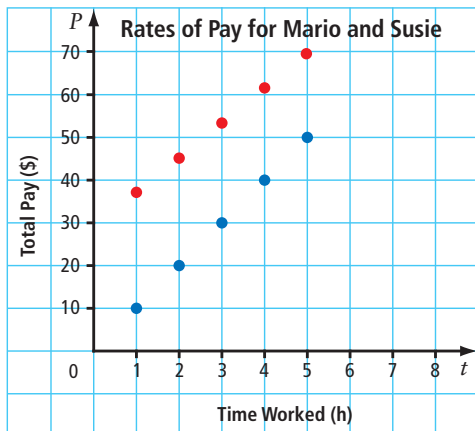
- For the ordered pair $(2, 80)$ tell what each coordinate represents.
 - What is the typing speed in words per minute for point A?
 - Does this graph represent a linear relation? Explain.
 - Would most people's typing speed result in a linear graph? Explain.
16. Alena gathered data comparing the amount of time she spent studying for her tests and the marks she received.



- Make a table of values from this graph.
- Does the graph appear to be a linear relation? Why?
- Will Alena's scores continue increasing at this same rate with more and more time spent studying? Why?

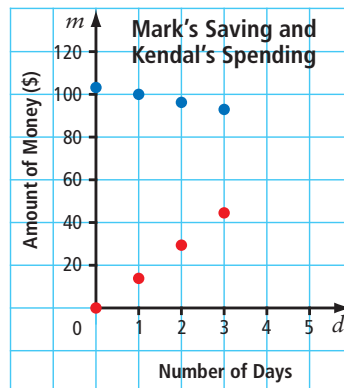
Extend

17. At Ciao Restaurant, Mario works in the kitchen for \$10 an hour. Susie works as a server. She gets \$30 monthly clothing allowance plus \$8 an hour.



- Which colour of points provides information about Susie's wages?
- Make a table of values with three columns showing Time Worked (h) and Total Pay (\$) for Susie and Mario.
- If the pattern continues, at what point will the two sets of points meet?

18. Mark begins saving \$15 a day to buy a three-month gym membership for \$90. Kendal has \$105 in the bank and spends \$5 a day to go to the gym. The graph shows how much money they have over the first three days.



- Which colour of points provides information about Mark?
- When will Kendal run out of money?
- When will Mark have saved enough money to buy the membership?

MATH LINK

Whatever adventure you are looking for, it can be found in Western and Northern Canada. Adventures include polar bear tours in Churchill, Manitoba, aurora borealis adventures in the Northwest Territories, and white-water rafting in Yukon Territory.

You are going on a polar bear adventure tour. The graph shows the cost of the trip.

- Describe any patterns on the graph.
- Make a table of values from the graph.
- Assume the pattern continues. Extend your table of values to include the cost of a tour for eight days.
- Suppose it is possible to upgrade to better accommodations for a one-time fee of \$300 plus the regular \$400 per day. Make a new table of values for deluxe tours that last from one to eight days.
- Compare the data in the two tables of values. How are they similar? How are they different?

