Chapter 9

9.1 Analysing Graphs of Linear Relations, pages 337–341

4. a) The points appear to lie in a straight line. The total height increases by 20 cm for each additional step.

b)

Number of Steps	Total Height of Steps
1	20
2	40
3	60
4	80
5	100

c) total height on step 10: 200 cm

5. a) The points appear to lie in a straight line. The number of students increases by six for each additional teacher. The pattern starts with one teacher and increases to four teachers.

b)

Number of Teachers	Maximum Number of Students
1	6
2	12
3	18
4	24

c) maximum number of students: 48

6. a) The quantities of banana chips range from 0 g to 400 g. The graph is linear because the points appear to lie in a straight line.

b)

Quantity (g)	Cost (¢)
0	0
100	60
200	120
300	180
400	240

c) Yes, it is possible to buy amounts of banana chips that are not exactly multiples of 100 g.

7. a) Yes, the points appear to lie in a straight line, so the graph shows a linear relation. The number of cubes varies from one to three. For every increase of one cube, the height increases by 2 cm.

b)

Number of Cubes	Height (cm)
1	2
2	4
3	6

c) No, it is not possible to include a point for $c = 2.5$. The number of cubes must be whole numbers.

8. a)

x	y
1	2
2	4
3	6

b)

x	y
1	2
2	4
3	6
4	8
5	10
6	12

c) The points appear to lie in a straight line. For every increase of one in the x-value, there is an increase of two in the y-value. **d)** value of y when $x = 9$: 18

9. a)

Hours Worked	Gross Pay ($)
1	15
2	30
3	45
4	60
5	75

b) hourly rate of pay: \$15 **c)** Yes, it is reasonable to include a point for $h = 3.5$. An employee could work for three and a half hours.

10. a) Yes, it should be possible to purchase two flowers. **b)** There should be one point between the two points.

11. a) coordinates of point W: (40, 2) **b)** The number 40 represents the amount of money invested in dollars. The number 2 represents the amount of interest earned by the \$40 investment after two years, in dollars. **c)** The points lie in a straight line. For every increase in \$20 invested there is an increase in \$1 in the interest earned. **d)** simple interest earned on \$180 after one year: \$9

12. a)

Side Length, s (cm)	0	1	2	3	4	5	8	28	31
Perimeter, P (cm)	0	4	8	12	16	20	32	112	124

b) The points lie on a line. For every increase of 1 cm in the side length of the square, there is an increase of 4 cm in its perimeter. **c)** Yes, it is possible to have other points between those shown on the graph. It is possible to have squares with side lengths that are not whole numbers. Example: A square might have a side length of 1.7 cm. **d)** Yes, the graph represents a linear relationship because the points lie in a straight line.

13. a)

Quantity (g)	Cost (¢)
100	75
200	150
300	225
400	300

b) The points appear to lie in a straight line. The cost ranges from 75¢ to 300¢. **c)** estimated cost of 350 g of dried apricots: 260¢. **d)** actual cost of 350 g of dried apricots: 263¢. **e)** The difference in values was 263¢ − 260¢ = 3¢.

14. a)

Boxes of Almonds	Profit ($)
0	0
2	1
4	2
6	3
8	4

b) The points appear to lie in a straight line. There is an increase of profit of \$1 for every two boxes of almonds sold. The profits range from \$1 to \$4.

c) profit on the sale of two boxes of almonds: \$1
d) value of P when the value b is 2: \$1
This is the same value as in part c), since both questions refer to the same point on the graph.

15. a) The number 2 refers to the number of minutes that Tom typed; 80 refers to the number of words that he typed in the two minutes. **b)** The typing speed for point A is 40 words per minute. **c)** Yes, it is a linear relation because the points appear to lie in a straight line. **d)** Answer may vary. Example: No. Fatigue, error correcting, or distractions can affect typing speed.

16. a)

Time (h)	Test Score (%)
1	60
2	70
3	80
4	90
5	100

b) Yes, the graph is a linear relation. The points appear to lie in a straight line. **c)** No, the rate cannot continue to increase at this same rate with more and more studying. Alana's test scores will reach 100% after five hours of studying. It is not possible for her success rate to improve beyond 100%.

17. a) Susie's wages: red points

b)

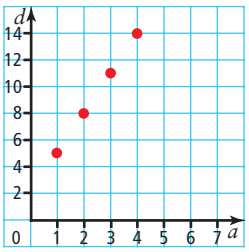
Time (h)	Total Pay for Mario ($)	Total Pay for Susie ($)
1	10	38
2	20	46
3	30	54
4	40	62
5	50	70

c) The two sets of points will meet at the point (15, 150).

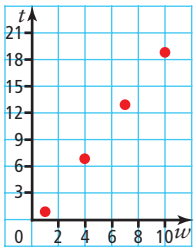
18. a) Mark: red points **b)** Kendal will run out of money in 21 days. **c)** 6 days

9.2 Patterns in a Table of Values, pages 348–351

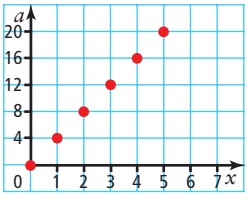
4.



5.

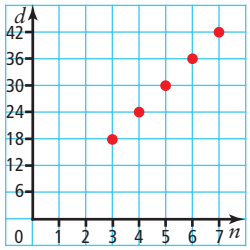


6. a)



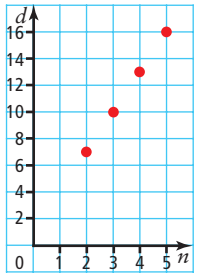
b) difference in value for consecutive x-values: 1; difference in value for consecutive a-values: 4 **c)** The value of a is equal to four times the value of x. **d)** $a = 4x$

7. a)

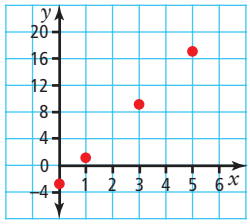


b) difference in value for consecutive n-values: 1; difference in value for consecutive d-values: 6
c) The value of d is six times the value of n.
d) $d = 6n$

8. a) The relationship is linear because the difference between consecutive values of each variable is constant. The graph confirms that the relationship is linear.



b) The relationship may be linear because the difference between three of the consecutive values of each variable is constant. The graph confirms that the relationship is linear.



9. a) The relationship is not linear. The difference between successive q-values is the same but the difference between successive p-values is not the same. **b)** The relationship is linear. The difference between successive x-values is the same and the difference between successive y-values is the same.

10. a)

Time, t (min)	1	2	3	4	5	6
Number of Words, w	90	180	270	360	450	540

b) Yes, the relation is linear because the consecutive values for each variable have the same difference.
c) $w = 90t$ where w is the number of words and t is the time in minutes. **d)** 1080 words.

11. a)

Increase in Mass Over 10 kg, m (kg)	Dosage, d (mg)
1	60
2	70
3	80
4	90
5	100
6	110
7	120
8	130
9	140
10	150

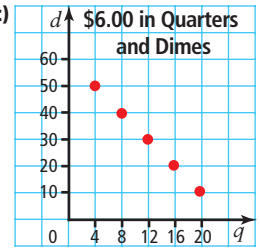
b) Yes. Consecutive values of m increase each time by 1, and consecutive values of d increase each time by 10.
c) $10m + 50$
d) $10(17) + 50 = 220$. The dosage is 220 mg.
e) Yes. The value of 0 kg represents a child with a mass of 10 kg.

12. a) The following five combinations of quarters and dimes each equal \$6.00: 4 quarters and 50 dimes, 8 quarters and 40 dimes, 12 quarters and 30 dimes, 16 quarters and 20 dimes, and 20 quarters and 10 dimes.

b)

Number of Quarters, q	Number of Dimes, d
4	50
8	40
12	30
16	20
20	10

c)

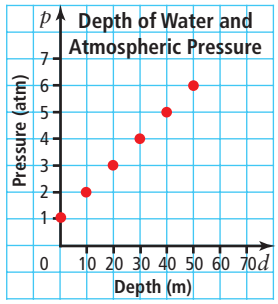


Yes, the relation is linear because the points appear to lie in a straight line. **d)** largest possible number of dimes: 55 (2 quarters); largest possible number of quarters: 22 (5 dimes)

13. a)

Depth (m)	Pressure (atm)
0	1
10	2
20	3
30	4
40	5
50	6

b)



Label the horizontal axis d for the depth and label the vertical axis p for pressure.
c) Divers tend to become dizzy at depths greater than 40 m.

14. a)

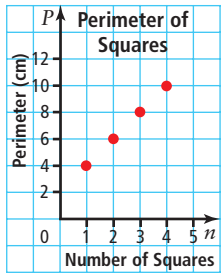
Figure Number	Number of Small Squares
1	4
2	7
3	10
4	13
5	16
6	19

b) $s = 3n + 1$ where n is the figure number and s is the number of squares. **c)** Figure 20: 61 squares **d)** 30 squares

15. a)

Number of Squares, n	1	2	3	4
Perimeter, P (cm)	4	6	8	10

b)

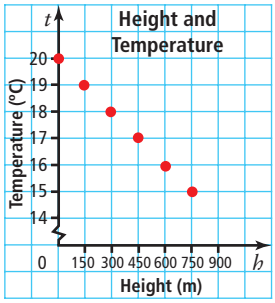


c) The perimeter increases by 2 cm for each additional small square that is added to the pattern.
d) $P = 2n + 2$ **e)** Perimeter of 50 squares: 102 cm

16. a)

Height (m)	0	150	300	450	600	750
Temperature (°C)	20	19	18	17	16	15

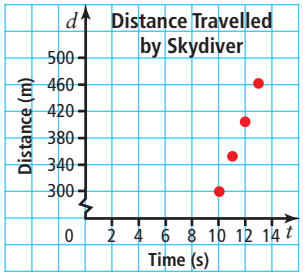
b)



c) Yes, the relationship is linear. There is a common difference between the consecutive values for both variables.
d) Height climbed if the temperature is 13 °C: 1050 m

17. a) There is a common difference between the consecutive values for both variables. The prediction is that the graph will be linear.

b)

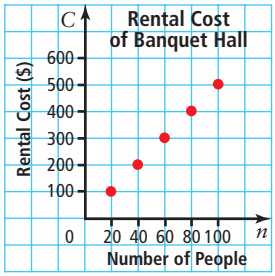


Yes, the prediction was correct.
c) The parachutist descends about 54 m per second after the parachute opens.

18. a)

Number of People, n	20	40	60	80	100
Rental Cost, C ($)	100	200	300	400	500

b)

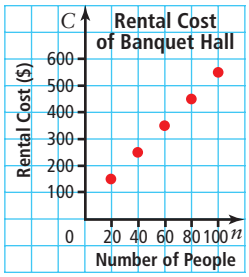


c) $C = 5n$

19. a)

Number of People, n	20	40	60	80	100
Rental Cost, C ($)	150	250	350	450	550

b)



The points on the graph are moved up an equal distance from each of the points on the graph in #18. **c)** $C = 5n + 50$; The variable n represents the number of people and the variable C represents the cost of renting the banquet hall.

20. a)

Number of Additional Days	0	1	2	3	4	5
Rental Cost ($)	40	75	110	145	180	215

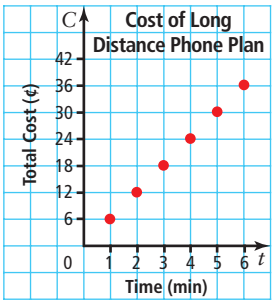
b) $C = 35n + 40$ **c)** $390; A better option would be to buy the snowboard equipment for $350.

9.3 Linear Relationships, pages 357–359

5. a)

Time, t (min)	1	2	3	4	5	6
Cost, C (¢)	6	12	18	24	30	36

b)

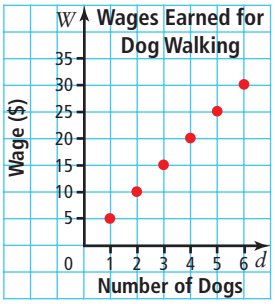


c) No. Any part minutes will be rounded up to the nearest minute.

6. a)

Number of Dogs, d	1	2	3	4	5	6
Wage, W ($)	5	10	15	20	25	30

b)

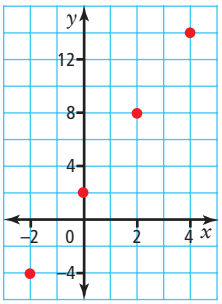


c) No, it is not reasonable to have points between the ones on the graph. The number of dogs walked will be a whole number.

7. a) $y = 27$ **b)** $y = -3$ **c)** $y = 10$ **d)** $x = 25$
8. a) $y = 10$ **b)** $y = -25$ **c)** $y = 3$ **d)** $x = 2$

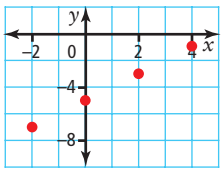
9. a)

x	y
−2	−4
0	2
2	8
4	14



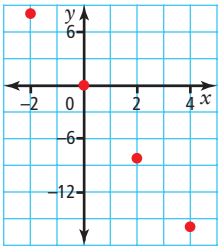
b)

x	y
−2	−7
0	−5
2	−3
4	−1



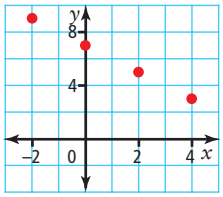
c)

x	y
−2	8
0	0
2	−8
4	−16



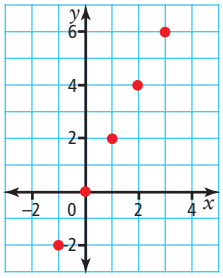
d)

x	y
−2	9
0	7
2	5
4	3



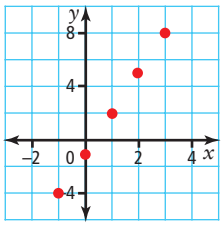
10. a) Answers may vary. Example:

x	y
−1	−2
0	0
1	2
2	4
3	6



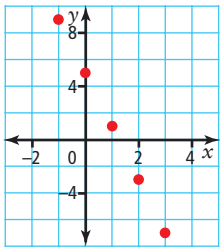
b)

x	y
−1	−4
0	−1
1	2
2	5
3	8



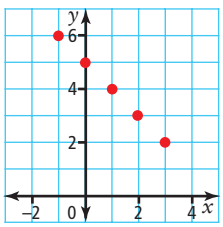
c)

x	y
−1	9
0	5
1	3
2	−3
3	−7



d)

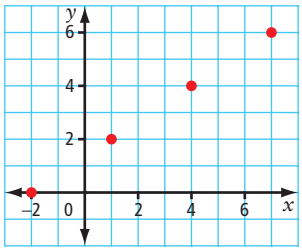
x	y
−1	6
0	5
1	4
2	3
3	2



11. a) $y = 2$ **b)** $y = 8$

12. a) (0, 0) **b)** $y = -1$ **c)** $y = -3$

13. a)



b) Yes, it is reasonable to assume that there are points between the values given. Without any restrictions in the question, numbers with decimal values can be evaluated in linear relations.

14. a) Since the x-values are consecutive integers, consecutive y-values will have the same difference in the linear relation. The difference for this linear relation is two.

b)

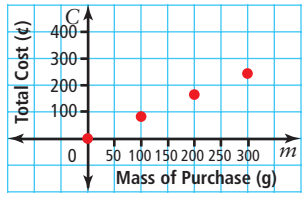
x	−3	−2	−1	0	1	2
y	0	2	4	6	8	10

15. a)

Mass of Purchase (g)	Cost (¢)
0	0
100	80
200	160
300	240
400	320

b) Answers may vary. Example: The most logical value is 400 g because the common difference between consecutive values of mass is 100 g.

c)

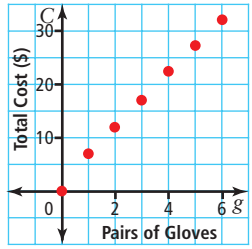


16. a) $1200 **b)** $1400 **c)** $6000

17. a)

Number of Pairs of Gloves, g	1	2	3	4	5	6
Total Cost, C ($)	7	12	17	22	27	32

b)



c) Yes, the points appear to lie in a straight line on the graph.
d) No. The values for g must be whole numbers because they represent the number of pairs of gloves.
e) This number could represent the cost of shipping or administrative charges.

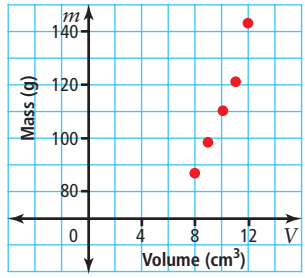
18.

Amount Spent ($)	Points Received
1	40
2	80
3	120
4	160
5	200

b) 4000 **c)** $2500

19. a) The difference between consecutive masses is 11 g except for the metal with a volume of 12 cm^3, which has a mass of 144 g in the given table. The correct mass is 132 g.

b)



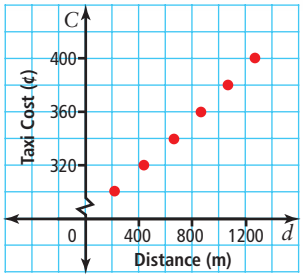
c) A straight line could be drawn through the first four points and extended to show that the correct mass associated with a volume of 12 cm^3 is 132 g.

20. a) $4.80; $7.00

b)

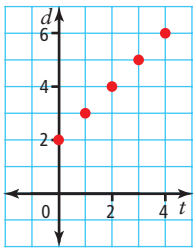
Distance Travelled, d (m)	210	420	630	840	1050	1260
Taxi Cost, C (¢)	300	320	340	360	380	400

c)

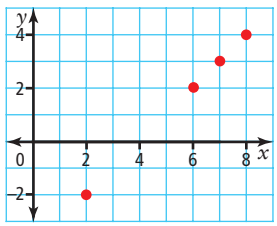


d) Yes, the relation is linear. The increase in cost for each 210 m travelled after the first segment is constant.

21. a) The value of d is 2 more than the value of t.



b) The y-value is four less than the x-value.



22. a)

x	−2	−1	0	1	2	3	11
y	−1	1	3	5	7	9	25

b) Yes, the relation is linear. The difference between consecutive x-values and the consecutive y-values is constant.

Chapter Review, pages 360–361

1. expression
2. linear relation
3. formula
4. equation
5. variable
6. table of values

7. a)

Time (h)	Pay ($)
0	0
1	9
2	18
3	27
4	36

b) Yes, the graph represents a linear relation. The points on the graph lie in a straight line and rate of pay is $9 for each hour worked. **c)** Yes, it is possible that Klaus works for part of an hour and is paid a portion of his hourly salary.

8. a) The graph shows the amount of money earned at a grade 8 car wash based on the number of cars washed. **b)** For every car that is washed $10 is collected. The points appear to lie in a straight line. **c)** cost of one car wash: $10

d)

Number of Cars	Income ($)
1	10
2	20
3	30
4	40

e) $150

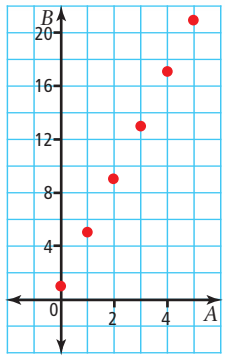
9. a) The points lie in a straight line. The x-values range between 0 and 6. The y-values range between 2 and 20.

b)

x	1	2	3	4	5	6
y	5	8	11	14	17	20

c) $y = 8$ when $x = 2$ **d)** $y = 17$ when $x = 5$

10. a)



b) The difference in consecutive A-values is one. The difference in consecutive B-values is four. **c)** In words: For every increase of one unit in the A-value there is a corresponding increase of four units in the B-value. As an expression: $B = 4A + 1$

11. a) Table 1: the m-variable increases by one unit; Table 2: the p-variable increases by two units; Table 3: the d-variable increases by one unit **b)** Table 1: the n-variable increases by two units; Table 2: the q-variable decreases by four units; Table 3: the C-variable increases alternately—by 3 units then by 2 units.

c) Table 1

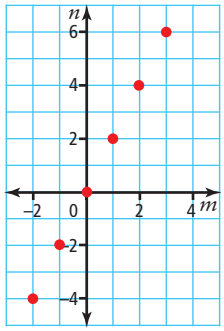


Table 2

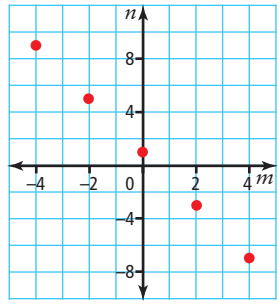
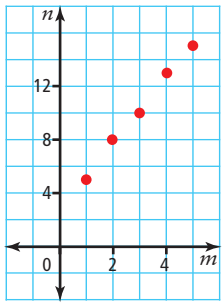


Table 3



12. a)

Number of Copies, n	0	1	2	3	4	5
Total Cost, C ($)	0	2	3	4	5	6

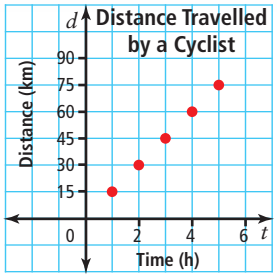
b) Yes, this is a linear relation for one or more copies. The consecutive values for both variables for one or more copies have a common difference. **c)** For one or more copies: $C = n + 1$ where C is the cost in dollars and n is the number of colour copies. **d)** $13

13. a) The variable t represents the time the cyclist travels in hours. The variable d represents the distance the cyclist travels in kilometres. **b)** 15 represents the constant speed of 15 km/h travelled by the cyclist.

c)

Time (h)	Distance (km)
1	15
2	30
3	45
4	60
5	75

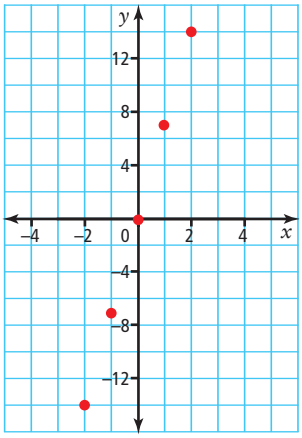
d)



e) Yes, it is reasonable to have points between the ones in the graph. The cyclist can travel for times that are not whole numbers of hours. **f)** 120 km

14. Equation A: $y = 7x$

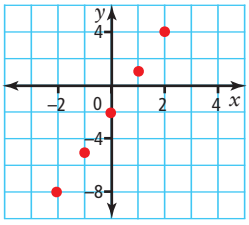
x	y
−2	−14
−1	−7
0	0
1	7
2	14



$y = -49$ when $x = -7$

Equation B: $y = 3x - 2$

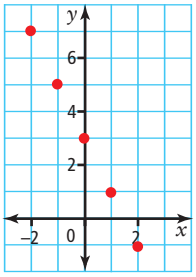
x	y
−2	−8
−1	−5
0	−2
1	1
2	4



$y = -23$ when $x = -7$

Equation C: $y = -2x + 3$

x	y
−2	7
−1	5
0	3
1	1
2	−1



$y = 17$, when $x = -7$

15. a) Both graphs are linear relations and both graphs cross the y-axis at (0, 1). **b)** The points on the graph lie on straight lines that slant in different directions. The graph of $y = 2x + 1$ increases from left to right and the graph of $y = -2x + 1$ decreases from left to right.