Key CONCEPTS

1 To find the length of a line segment joining (x_1, y_1) and (x_2, y_2), use the formula $l = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$.

2 An equation of the circle with centre O(0, 0) and radius r is $x^2 + y^2 = r^2$.

Communicate Your Understanding

1. Describe how you would find the length of the line segment joining the points P(1, 2) and Q(4, 7). Explain and justify your steps.

2. Explain why the value under the radical sign in the length formula is never negative.

3. When you use the length formula to find the length of a line segment joining two points, does it matter which point is represented by (x_1, y_1) and which point is represented by (x_2, y_2)? Explain your reasoning using an example. Compare your example with a classmate's.

4. Describe how you would find the radius of the circle whose equation is $x^2 + y^2 = 81$.

5. Describe how you would write an equation for the circle with centre (0, 0) and radius 2.

Practice

A

1. Determine the length of the line segment joining each pair of points. Express each length as an exact solution and as an approximate solution, to the nearest tenth.

a) (2, 1) and (3, 5)
b) (3, –5) and (–6, 7)
c) (3, 0) and (4, –1)
d) (–1, 2) and (–6, –3)
e) (2, 1) and (2, 9)
f) (4, –7) and (11, –7)
g) (8.1, 3.7) and (3.2, –5.4)
h) (0.1, 0.2) and (–0.1, –0.2)

2. Write an equation for the circle with centre (0, 0) and the given radius.

a) radius 3
b) radius 6
c) radius 10
d) radius 11

3. The following are equations of circles with centre (0, 0). Determine the radius of each circle. Round to the nearest tenth, if necessary.

a) $x^2 + y^2 = 64$
b) $x^2 + y^2 = 4$
c) $x^2 + y^2 = 144$
d) $x^2 + y^2 = 1$
e) $x^2 + y^2 = 30$
f) $x^2 + y^2 = 1.21$

4. Determine the radius of each circle, given its centre and a point on its circumference. Round each radius to the nearest tenth, if necessary.

a) centre (0, 0), point (3, 4)
b) centre (0, 0), point (2, 7)
c) centre (0, 0), point (–4, –6)
d) centre (0, 0), point (–11, 3)

5. Measurement Given the coordinates of the vertices, classify each triangle as equilateral, isosceles, or scalene. Then, find each perimeter, to the nearest tenth.

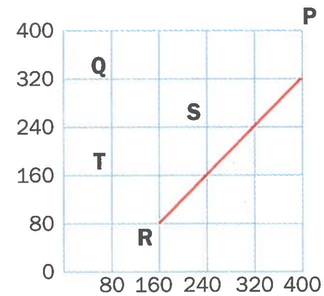
a) A(2, 5), B(−2, −1), C(6, −1) **b)** D(−2, −5), E(−3, 2), F(1, 3)

c) P(2, 1), Q(5, 3), R(0, 4) **d)** G(3, 0), H(0, $3\sqrt{3}$), I(−3, 0)

Applications and Problem Solving

6. Street grid The grid models the streets in a neighbourhood. The distances are in metres. Assume that the walking speed is 1.2 m/s, and ignore the time it takes to cross streets. If a diagonal street were constructed as shown, determine the shortest time needed for each of the following walks, to the nearest second.

a) P to Q **b)** P to R **c)** R to S **d)** T to P



B

7. Measurement A quadrilateral has vertices P(3, 5), Q(−4, 3), R(−3, −2), and S(5, −4). Find the lengths of the diagonals, to the nearest tenth.

8. Measurement The vertices of a right triangle are S(−2, −2), T(10, −2), and R(4, 4). Find the area of the triangle.

9. Coast guard A coast guard patrol boat is located 5 km east and 8 km north of the entrance to St. John's harbour. A tanker is 9 km east and 6 km south of the entrance. Find the distance between the two ships, to the nearest tenth of a kilometre.

10. Measurement Verify that A(4, 2), B(−2, −2), and C(2, −8) are the vertices of an isosceles triangle.

11. Measurement Verify that C(−5, −1) is the midpoint of the line segment joining A(−2, 5) and B(−8, −7).

12. Measurement Determine the perimeter of the quadrilateral with vertices A(3, 2), B(−2, 4), C(−4, −2), and D(4, −1)

a) as an exact solution **b)** as an approximate solution, to the nearest tenth

13. Measurement The coordinates of the endpoints of the diameter of a circle are (6, 4) and (−2, 0). Find the exact length of the radius of the circle.

14. Measurement Show that the quadrilateral with vertices K(3, 4), L(2, 0), M(−3, −2), and N(−1, 3) is a kite. Then, determine the perimeter, to the nearest tenth.

15. Measurement Show that the parallelogram with vertices W(1, 3), X(4, 1), Y(1, −1), and Z(−2, 1) is a rhombus. Then, determine the perimeter, to the nearest tenth.

16. Write an equation for the circle with centre (0, 0), if the given point lies on its circumference.

a) A(4, 3) **b)** B(5, −12) **c)** C(−6, −2)

City	Coordinates
Edmonton	(3978, 2520)
Montréal	(1015, 2104)
Ottawa	(1142, 2232)
Toronto	(1268, 2540)
Washington, D.C.	(807, 2867)

17. Telephone grid At one time, telephone companies determined the cost of a long-distance telephone call using the distance between the two stations and the length of the call. To determine the distance, a coordinate grid was superimposed over North America. The origin, (0, 0), was located off the northeast coast of Canada. Every North American city and town had a set of coordinates in the form (horizontal, vertical). The coordinates gave the distance, in kilometres, of the location from the origin. The coordinates for five cities are shown in the table.

a) Calculate the distance, to the nearest 10 kilometres, between Toronto and Ottawa; Montréal and Edmonton; Ottawa and Washington, D.C.

b) Use your research skills to find the flying distance between each pair of cities in part a). How accurate was the telephone grid system?

18. Algebra Write an expression for the length of the line segment joining each pair of points.

a) (a, b) and $(2a, 2b)$ **b)** $(x, 2y)$ and $(2x, -y)$

c) $(m + 1, n - 1)$ and $(m - 1, 2n - 1)$ **d)** $(2p, -p)$ and $(4p, 3p)$

19. Algebra The point $(x, -1)$ is 13 units from the point (3, 11). What are the possible values of x?

20. List all the points that have whole-number coordinates and are

a) 5 units from the origin **b)** 10 units from the point (2, 1)

Modelling Math — Analyzing a Design

Refer to the maple leaf design on the grid on page 63.

1. Determine the perimeter of each of the following, to the nearest tenth of a centimetre.

a) triangle M **b)** quadrilateral C **c)** quadrilateral P

2. Communication How do the perimeters of quadrilateral A and triangle K compare? Explain.

Chapter 2

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1. a) 10; 9.1 **b)** 9; 8.1 **c)** 5; 5 **d)** 7; 7 **e)** 12; 8.6 **f)** 17; 12.2 **2.** when the two points are on a horizontal or vertical line **3. a)** square with side length $\sqrt{98}$ **b)** circle with radius 7

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1. a) 9 **b)** 13 **c)** 1.2 **d)** 0.7 **2. a)** 4.8 **b)** 2.7 **c)** 20.1 **d)** 35.4 **3. a)** 3.6 **b)** 7.1 **c)** 8.1 **d)** 9.4 **4. a)** 5 **b)** 7 **c)** 6 **d)** 11 **5. a)** 7 **b)** 11 **c)** 5 **d)** 8 **6. a)** 2 **b)** 3 **c)** 1 **d)** 4 **e)** −3 **f)** 1 **7. a)** $\frac{4}{3}$ **b)** 3 **c)** 2 **d)** $\frac{3}{2}$ **e)** $-\frac{5}{3}$ **f)** −2 **g)** 0 **h)** undefined **i)** $-\frac{5}{2}$ **j)** $\frac{3}{4}$ **8. a)** 3 **b)** 3 **c)** $-\frac{1}{3}$

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Practice 1. a) $\sqrt{17}$; 4.1 **b)** 15 **c)** $\sqrt{2}$; 1.4 **d)** $\sqrt{50}$; 7.1 **e)** 8 **f)** 7 **g)** $\sqrt{106.82}$; 10.3 **h)** $\sqrt{0.2}$; 0.4 **2. a)** $x^2 + y^2 = 9$ **b)** $x^2 + y^2 = 36$ **c)** $x^2 + y^2 = 100$ **d)** $x^2 + y^2 = 121$ **3. a)** 8 **b)** 2 **c)** 12 **d)** 1 **e)** 5.5 **f)** 1.1 **4. a)** 5 **b)** 7.3 **c)** 7.2 **d)** 11.4 **5. a)** isosceles; 22.4 **b)** ~~scalene; 19.7 **c)** isosceles; 12.3~~ **d)** equilateral; 18

Applications and Problem Solving 6. a) 5 min 33 s **b)** 5 min 50 s **c)** 2 min 41 s **d)** 6 min 29 s **7.** PR = 9.2, QS = 11.4 **8.** 36 **9.** 14.6 km **10.** AB = $\sqrt{52}$, BC = $\sqrt{52}$, AC = $\sqrt{104}$; $AB^2 + BC^2 = 52 + 52 = 104 = AC^2$ **11.** AC = $\sqrt{45}$, BC = $\sqrt{45}$, AC = BC; slope AB = 2, slope AC = 2; so A, B, and C are collinear. Thus, C is the midpoint of AB. **12. a)** $\sqrt{29} + \sqrt{40} + \sqrt{65} + \sqrt{10}$ **b)** 22.9 **13.** $\frac{\sqrt{80}}{2}$ **14.** KL = $\sqrt{17}$, LM = $\sqrt{29}$, MN = $\sqrt{29}$, NK = $\sqrt{17}$; $P = 19.0$ **15.** WX = $\sqrt{13}$, XY = $\sqrt{13}$, YZ = $\sqrt{13}$, ZW = $\sqrt{13}$; $P = 14.4$ **16. a)** $x^2 + y^2 = 25$ **b)** $x^2 + y^2 = 169$ **c)** $x^2 + y^2 = 40$ **17. a)** 330 km; 2990 km; 720 km **18. a)** $\sqrt{a^2 + b^2}$ **b)** $\sqrt{x^2 + 9y^2}$ **c)** $\sqrt{4 + n^2}$ **d)** $\sqrt{20p^2}$ **19.** −2, 8 **20. a)** (0, 5), (3, 4), (4, 3), (5, 0), (0, −5), (3, −4), (4, −3), (−3, 4), (−4, 3), (−5, 0), (−3, −4), (−4, −3) **b)** (2, 11), (8, 9), (10, 7), (12, 1), (−4, 9), (−6, 7), (−8, 1), (8, −7), (10, −5), (2, −9), (−4, −7), (−6, −5)

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1. a) 17.1 cm **b)** 48.3 cm **c)** 65.4 cm

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1 Midpoints of Horizontal Line Segments 1. a) (5, 4) **b)** (2, 2) **c)** (3, −3) **d)** (−4, −2) **e)** (4, 0) **2.** The y-coordinates are the same. The x-coordinate of the midpoint is half the sum of the x-coordinates of the endpoints. **3. a)** (4, 3) **b)** (2, 1) **c)** (−5, 5) **d)** (4, −5) **4.** (4, 3), (6, 3), (8, 3)

2 Midpoints of Vertical Line Segments 1. a) (2, 5) **b)** (5, 2) **c)** (−3, −3) **d)** (−2, −2) **e)** (0, 3) **2.** The x-coordinates are the same. The y-coordinate of the midpoint is half the sum of the y-coordinates of the endpoints. **3. a)** (4, 4) **b)** (1, −1) **c)** (−2, 0) **d)** (0, 5) **4.** (3, 5), (3, 2), (3, −1)

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Practice 1. a) (4, 8) **b)** (5, 5) **c)** (0, −3) **d)** (−2, 2) **e)** (−2, −5) **f)** (1, 4) **g)** (1.9, 0.9) **h)** $\left(1, -\frac{1}{2}\right)$ **i)** (301.5, 149.5) **j)** $\left(\frac{a+c}{2}, \frac{b+d}{2}\right)$

Applications and Problem Solving 2. (−4, 3) **3.** Their midpoints coincide. **4.** (6, 9), (2, 2), (−2, −5) **5.** (2, −1) **6.** (8, 8) **7.** (−6, 8) **8.** (3, −2) **9.** 20.2 **10.** Their midpoints coincide. **11.** Their midpoints coincide. **12. a)** E(5, 2), F(3, 7), G(−1, 6), H(1, 1) **b)** EF = $\sqrt{29}$, GH = $\sqrt{29}$ **c)** FG = $\sqrt{17}$, EH = $\sqrt{17}$ **13.** T(0, −2), M(3, 0) **14.** $\sqrt{45}$, $\sqrt{18}$, 9 **15.** AM = $\sqrt{20}$, MB = $\sqrt{20}$ **16.** Let S be the midpoint of the hypotenuse QR. RS = QS = PS = $\sqrt{40}$. **17. a)** (9, 12.2) **b)** 5.81 km **c)** \$4 589 900 **d)** Find the length of the road and divide by 2. Then, multiply by the cost per kilometre. **18. a)** Try for the refuelling depot. **b)** Continue to the end. **19. a)** $\left(\frac{3x}{2}, \frac{3y}{2}\right)$ **b)** $(6a, b)$ **c)** $\left(m, \frac{2n+1}{2}\right)$ **d)** $(-t, t+1)$ **20.** $c = 10$, $d = 7$ **21.** $(2c - p, 2d - q)$ **22.** $\left(\frac{3x_1 + x_2}{4}, \frac{3y_1 + y_2}{4}\right)$, $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$, $\left(\frac{x_1 + 3x_2}{4}, \frac{y_1 + 3y_2}{4}\right)$ **23.** (−4, 0), (4, 0), (0, 6) **24. a)** (0, 5), (0, −3), (8, 1) **b)** (0, 1), (8, −3), (8, 5) **25. a)** sometimes true **b)** sometimes true **c)** always true **d)** sometimes true

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1. Their midpoints coincide at (30, 25). Thus, they bisect each other. **2.** No, the diagonals of quadrilaterals P and Q do not bisect each other.