Applications and Problem Solving

2. A diameter of a circle joins the points C(–7, –4) and D(–1, 10). What are the coordinates of the centre of the circle?

3. A parallelogram has vertices A(–2, –2), B(3, 3), C(7, 4), and D(2, –1). Verify that the diagonals bisect each other.

B

4. The endpoints of AB are A(10, 16) and B(–6, –12). Find the coordinates of the points that divide the segment into four equal parts.

5. For a line segment DE, one endpoint is D(6, 5) and the midpoint is M(4, 2). Find the coordinates of endpoint E.

6. For a line segment AB, one endpoint is A(0, 6) and the midpoint is M(4, 7). Find the coordinates of endpoint B.

7. For a line segment PQ, one endpoint is P(–2, –6) and the midpoint is M(–4, 1). Find the coordinates of endpoint Q.

8. The centre of a circle has coordinates (0, 0). One endpoint of a diameter of the circle has coordinates (–3, 2). What are the coordinates of the other endpoint of the diameter?

9. Measurement A quadrilateral has vertices P(0, 8), Q(–4, 4), R(2, –2), and S(6, 4). Find the perimeter of the figure whose vertices are the midpoints of the sides of the quadrilateral.

10. Verify that the diagonals of the rectangle with vertices P(–1, 4), Q(–2, 1), R(4, –1), and S(5, 2) bisect each other.

11. Verify that the diagonals of the square with vertices A(–2, 1), B(2, –1), C(0, –5), and D(–4, –3) bisect each other.

12. Measurement A quadrilateral ABCD has vertices A(4, –2), B(6, 6), C(0, 8), and D(–2, 4).

a) Find the coordinates of the following points.

E, the midpoint of AB
F, the midpoint of BC
G, the midpoint of CD
H, the midpoint of AD

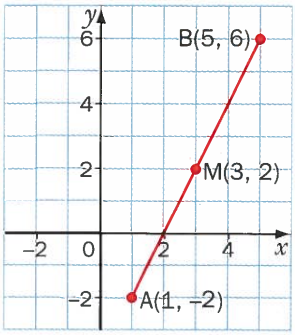
b) Verify that the length of EF equals the length of GH.

c) Verify that the length of FG equals the length of EH.

13. For the line segment ST, S has coordinates (6, 2) and T is on the y-axis. The midpoint, M, of ST is on the x-axis. Find the coordinates of T and M.

14. Measurement Triangle RST has vertices R(4, 4), S(–6, 2), and T(2, 0). Find the lengths of the three medians.

15. Verify that M is the midpoint of line segment AB by using the length formula.



16. Measurement A right triangle has vertices P(2, 3), Q(6, –5), and R(–6, –1). Verify that the midpoint of the hypotenuse is equidistant from each vertex of the triangle.

17. Building a road Historic Fort Bragg is to be rebuilt for visitors. A map of the area around the fort is drawn on a coordinate grid. The coordinates of the fort are (5.2, 16.6). A straight road is to be constructed to the fort from a point on a highway with coordinates (12.8, 7.8). The federal government has agreed to pay half the cost of the road. Construction costs are $790/m.

a) Find the coordinates of the midpoint of the road.

b) If one unit of length on the grid represents 1 km, use the midpoint to find half the length of the road.

c) Calculate the federal government's cost.

d) Communication Describe a different method of solving the problem.

18. Communication A jeep is travelling in a straight line across a flat, empty desert. On a navigational map with 1 unit representing 1 km, the starting point of the jeep is at (–140, –70) and its destination is at (280, 50). There is a refueling depot with an emergency transmitter half way along the route. During the journey, the jeep shows signs that engine trouble will soon develop. The driver must decide whether to turn back to the start, try for the refuelling depot, or continue to the end of the trip. If the jeep travels at 30 km/h, what should the driver do in each of the following situations? Explain.

a) The signs of engine trouble develop after 4 h.

b) The signs of engine trouble develop after 11 h.

C

19. Algebra Write the coordinates of the midpoint between each of the following pairs of points.

a) (x, y) and $(2x, 2y)$

b) $(4a, 3b)$ and $(8a, -b)$

c) $(m + 1, n + 3)$ and $(m - 1, n - 2)$

d) $(2t, 3t + 1)$ and $(-4t, 1 - t)$

20. Algebra The endpoints of PQ are P(3, –4) and Q(11, c). The midpoint of PQ is M(d, 3). Find the values of c and d.

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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.