6. Determine an equation for the right bisector of the line segment joining A(3, 6) and B(−1, 2).

7. Verify that the given point lies on the perpendicular bisector of the given line segment.

a) point A(3, 4); line segment BC, with endpoints B(2, 1) and C(6, 5)
b) point P(1, 3); line segment QR, with endpoints Q(−3, 1) and R(3, −1)
c) point K(−2, −4); line segment LM, with endpoints L(0, 2) and M(4, −6)

8. The equation of a circle with centre O(0, 0) is $x^2 + y^2 = 10$. The points C(3, 1) and D(1, −3) are the endpoints of chord CD. EF right bisects chord CD at G. Verify that the centre of the circle lies on the right bisector of chord CD.

9. The vertices of a quadrilateral are A(0, 0), B(2, 3), C(5, 1), and D(3, −2). Verify that the diagonals of ABCD are perpendicular to each other.

10. Verify that the quadrilateral with vertices O(0, 0), P(3, 5), Q(13, 7), and R(5, 1) is a trapezoid.

11. Verify that the quadrilateral with vertices P(−2, 2), Q(−2, −3), R(−5, −5), and S(−5, 0) is a parallelogram.

12. A triangle has vertices K(−2, 2), L(1, 5), and M(3, −3). Verify that

a) the triangle has a right angle
b) the midpoint of the hypotenuse is the same distance from each vertex

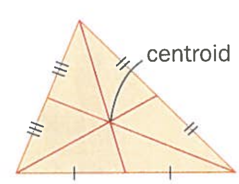
13. Quadrilateral PQRS has vertices P(0, 6), Q(−6, −2), R(2, −4), and S(4, 2). Verify that the quadrilateral formed by joining the midpoints of the sides of PQRS is a parallelogram.

14. △ABC has vertices A(3, 4), B(−5, 2), and C(1, −4). Determine an equation for

a) CD, the median from C to AB
b) AE, the altitude from A to BC
c) GH, the right bisector of AC

15. A triangle has vertices X(0, 0), Y(4, 4), and Z(8, −4).

a) Write an equation for each of the three medians.
b) Recall that the **centroid** of a triangle is the point of intersection of the medians of the triangle. Use the equations from part a) to verify that (4, 0) is the centroid of △XYZ.



16. △AOB has vertices A(4, 4), O(0, 0), and B(8, 0). EF right bisects AB at P. GH right bisects OA at Q. Determine the coordinates of the circumcentre of △DEF.

17. △POR has vertices P(0, 6), O(0, 0), and R(6, 0). Determine the coordinates of the centroid of △POR.

Applications and Problem Solving

B

18. The sides of a triangle have the equations $y = -\frac{1}{2}x + 1$, $y = 2x - 4$, and $y = -3x - 9$. Verify that the triangle is an isosceles right triangle.

19. The sides of a parallelogram have the equations $x = 0$, $y = \frac{1}{6}x + 3$, $x = 6$, and $y = \frac{1}{6}x - 2$. Verify that the diagonals intersect at the point (3, 1).

20. A triangle has vertices U(5, 5), V(1, –3), and W(–3, –1). Verify that
a) △UVW is a right triangle
b) the median from the right angle to the hypotenuse is half as long as the hypotenuse

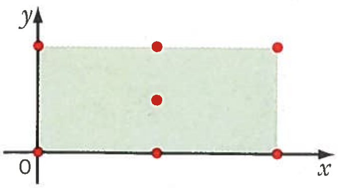
21. A quadrilateral has vertices K(–1, 4), L(2, 2), M(0, –1), and N(–3, 1). Verify that
a) the quadrilateral is a square
b) each diagonal of the quadrilateral is the perpendicular bisector of the other diagonal
c) the diagonals of the quadrilateral are equal in length

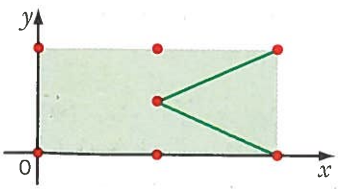
22. Given △ABC with vertices A(–7, 3), B(–2, –3), and C(4, 2),
a) classify the triangle by side length
b) verify that one median of the triangle is perpendicular to one of the sides

23. Communication Determine whether the point T(2, –1) lies on the perpendicular bisector of line segment UV, with endpoints U(3, 5) and V(–3, –1). Explain and justify your reasoning.

24. A quadrilateral has vertices D(–4, –1), E(0, –4), F(6, 0), and G(0, 4). Verify for each pair of adjacent sides that the line segment joining their midpoints is parallel to a diagonal of the quadrilateral.

25. a) Use the side lengths to classify the quadrilateral with vertices E(2, 3), F(4, –1), G(–2, –9), and H(–2, 1).
b) Verify that the midpoints of the sides of quadrilateral EFGH are the vertices of a rectangle.





26. Pocket billiards The game of pocket billiards is played on a rectangular table with dimensions 240 cm by 120 cm.
a) A coordinate grid is superimposed on the table, as shown. If one unit on each axis represents 1 cm, state the coordinates of the four corner pockets and the centre spot, which is exactly in the middle of the table.
b) If a ball is on the centre spot, there are two directions in which the ball can be hit into a pocket at the right-hand end. Verify that these directions are not perpendicular.

C

27. A quadrilateral has vertices P(–3, 1), Q(–1, –5), R(11, 1), and S(1, 3). Verify that

a) quadrilateral PQRS is a trapezoid

b) the line segment joining the midpoints of the two non-parallel sides is parallel to the bases

c) the line segment from part b) is half as long as the sum of the lengths of the bases

28. Verify that the triangle with vertices A(0, 0), B($\sqrt{3}$, –1), and C($\sqrt{3}$, 1) is equilateral.

29. A triangle has vertices A(0, 0), B(6, 4), and C(12, –4).

a) Verify that the centroid of $\triangle$ABC is at (6, 0).

b) The **orthocentre** of a triangle is the point at which the three altitudes intersect. Verify that $\left(\frac{56}{9}, \frac{14}{3}\right)$ is the orthocentre of $\triangle$ABC.

c) Verify that $\left(\frac{53}{9}, -\frac{7}{3}\right)$ is the circumcentre of $\triangle$ABC.

d) Verify that the centroid, the orthocentre, and the circumcentre of $\triangle$ABC are all collinear.

30. **Communication** Write a verification problem similar to one of the problems in this exercise. Have a classmate solve your problem.

Modelling Math — Analyzing a Design

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

1. Verify that triangle L is a right triangle.

2. Verify that quadrilateral G is a rectangle.

3. Verify that quadrilateral B is a parallelogram.

4. Verify that the line segment joining the midpoints of any two sides of triangle K is parallel to the third side and half the length of the third side.

Web Connection **www.school.mcgrawhill.ca/resources/**

To investigate other traditional Canadian quilt designs, visit the above web site. Go to **Math Resources,** then to ***MATHPOWER™ 10, Ontario Edition,*** to find out where to go next. Find three traditional designs and describe the geometric shapes on each design.

Technology Extension p. 81

1 Length of a Line Segment **1.** names the program; clears the memory; prompts user for x_1-data and reads it into variable P; prompts user for y_1-data and reads it into variable Q; prompts user for x_2-data and reads it into variable R; prompts user for y_2-data and reads it into variable S; assigns the difference R – P to the variable X; assigns the difference S – Q to the variable Y; assigns the square root of the sum of the squares of X and Y to the variable L; prints "LENGTH IS" and prints the value of L. **2. a)** 6.4 **b)** 17.1 **c)** 27.33

2 Midpoint of a Line Segment **1.** Change line 6 to (R + P)/2 → X. Change line 7 to (S + Q)/2 → Y. Delete line 8. Change the last line to DISP"MIDPOINT IS". Add lines DISP"X=",X and DISP"Y=",Y. **2. a)** (–1, 6) **b)** (2.5, –3.5) **c)** (0.3, –3.45)

3 Collinear Points **2. a)** collinear **b)** not collinear **3.** Answers may vary. **a)** (7, 6) **b)** (–7, 6)

Review: Equations of Lines pp. 85–87

1 Using the Point-Slope Form

1. a) $2x - y - 1 = 0$ **b)** $5x - y - 18 = 0$ **c)** $3x + y + 12 = 0$ **d)** $4x + y + 9 = 0$ **e)** $x - 2y - 18 = 0$ **f)** $x + 2y + 5 = 0$ **g)** $2x - 2y - 9 = 0$ **h)** $3x - 2y + 7 = 0$ **i)** $3x + 2y + 5 = 0$ **2. a)** $2x + y - 13 = 0$ **b)** $3x + y - 3 = 0$ **c)** $x - 2y - 9 = 0$ **d)** $2x - 5y - 11 = 0$ **e)** $5x - 4y + 22 = 0$ **f)** $4x - 3y + 12 = 0$ **3. a)** $y - 5 = 0$; $x - 4 = 0$ **b)** $y - 2 = 0$; $x + 3 = 0$ **c)** $y + 6 = 0$; $x + 5 = 0$ **d)** $y - 8 = 0$; $2x - 1 = 0$ **e)** $3y + 1 = 0$; $x - 9 = 0$ **f)** $y + 9 = 0$; $x = 0$ **g)** $y = 0$; $x + 1 = 0$ **h)** $y = 0$; $x = 0$

2 Using the Slope and *y*-Intercept Form

1. a) 3, 4 **b)** –4, 6 **c)** 1, 5 **d)** $\frac{1}{2}$, –4 **e)** $-\frac{1}{2}, \frac{4}{3}$ **f)** $\frac{1}{4}$, –1 **g)** $\frac{5}{2}$, –3 **h)** $-\frac{2}{3}$, 0 **i)** –20, 6 **2. a)** 1, 2 **b)** –1, 3 **c)** 2, 5 **d)** –3, 10 **e)** $\frac{1}{2}$, –1 **f)** $-\frac{1}{2}$, 1 **g)** 4, 7 **h)** $-\frac{1}{5}, \frac{13}{5}$ **i)** $\frac{1}{3}, \frac{5}{3}$

3 Parallel and Perpendicular Lines

1. a) $3x - y - 5 = 0$ **b)** $2x - y + 8 = 0$ **c)** $x + 2y + 1 = 0$ **d)** $x - 3y + 24 = 0$ **2. a)** $x - 2y + 8 = 0$ **b)** $3x + y - 2 = 0$ **c)** $2x - y + 2 = 0$ **d)** $x + 2y - 5 = 0$

Section 2.4 pp. 95–99

Practice **1.** PQ and OR have slope $\frac{1}{5}$; OP and RQ have slope $\frac{5}{3}$ **2.** XY has slope $\frac{2}{3}$; XZ has slope $-\frac{3}{2}$; the slopes are negative reciprocals, so XY is perpendicular to XZ **3. a)** Both segments have slope $-\frac{4}{3}$ and so are parallel. **b)** PQ = 5, KM = 10; PQ = $\frac{1}{2}$KM **4.** Opposite sides are parallel (two have slope 0 and two have slope $-\frac{4}{3}$) and all sides have length 5; so PQRS is a rhombus. **5. a)** KL and NM have slope –1; KN and LM have slope 1. Thus, opposite sides are parallel and adjacent sides are perpendicular. KLMN is a rectangle. **b)** KM and LN both have length $\sqrt{26}$ **6.** $x + y - 5 = 0$ **7. a)** The midpoint of BC is (4, 3). The line containing (4, 3) and A(3, 4) has slope –1. BC has slope 1. Thus, A(3, 4) is on the perpendicular bisector of BC.

b) The midpoint of QR is (0, 0). The line containing (0, 0) and P(1, 3) has slope 3. QR has slope $-\frac{1}{3}$. Thus, P(1, 3) is on the perpendicular bisector of QR. **c)** The midpoint of LM is (2, –2). The line containing (2, –2) and K(–2, –4) has slope $\frac{1}{2}$. LM has slope –2. Thus, K(–2, –4) is on the perpendicular bisector of LM. **8.** The midpoint of CD is (2, –1). The line containing (2, –1) and O(0, 0) has slope $-\frac{1}{2}$. CD has slope 2. Thus, O(0, 0) is on the right bisector of CD. **9.** Slope AC is $\frac{1}{5}$ and slope BD is –5. The slopes are negative reciprocals, so the diagonals AC and BD are perpendicular.

10. The opposite sides PQ and OR both have slope $\frac{1}{5}$ and so are parallel; the other two sides have different slopes, so are not parallel. OPRQ is a trapezoid.

11. PS and QR both have slope $\frac{2}{3}$; RS and QP are both vertical. Thus, opposite sides are parallel and PQRS is a parallelogram. **12. a)** KL has slope 1, KM has slope –1. KL and KM are perpendicular. **b)** The midpoint of LM is a distance of $\sqrt{17}$ from each vertex. **13.** Opposite sides of the quadrilateral are parallel (two sides have slope $\frac{2}{5}$ and two have slope –5) and so the quadrilateral is a parallelogram. **14. a)** $7x + 2y + 1 = 0$ **b)** $x - y + 1 = 0$ **c)** $x + 4y - 2 = 0$ **15. a)** $y = 0$, $x - 4 = 0$, $x + y - 4 = 0$ **b)** All three medians intersect at (4, 0). **16.** (4, 0) **17.** (2, 2)

Applications and Problem Solving **18.** The vertices of the triangle are A(2, 0), B(–4, 3), and C(–1, –6). AB = AC = $\sqrt{45}$; AC has slope 2 and AB has slope $-\frac{1}{2}$

and so they are perpendicular. The triangle is right isosceles. **19.** The equations of the diagonals are $x - y - 2 = 0$ and $2x + 3y - 9 = 0$. These lines intersect at (3, 1). **20. a)** UV has slope 2; WV has slope $-\frac{1}{2}$; UV and WV are perpendicular. **b)** The median has length 5; the hypotenuse UW has length 10; the median is half the length of the hypotenuse. **21. a)** Opposite sides are parallel (two sides have slope $\frac{3}{2}$ and two sides have slope $-\frac{2}{3}$). Adjacent sides are perpendicular and all sides have length $\sqrt{13}$. KLMN is a square. **b)** The midpoints of the diagonals coincide at $(-\frac{1}{2}, \frac{3}{2})$, so the diagonals bisect each other. One diagonal has slope $\frac{1}{5}$ and the other has slope −5. The diagonals are perpendicular. **c)** The diagonals both have length $\sqrt{26}$. **22. a)** isosceles **b)** AC has slope $-\frac{1}{11}$ and the median from B to AC has slope 11; thus, they are perpendicular **23.** No, the perpendicular bisector of UV has equation $x + y - 2 = 0$, which does not contain the point T(2, −1). **24.** One diagonal is vertical, and two segments joining midpoints of adjacent sides are also vertical; the other diagonal has slope $\frac{1}{10}$, and two segments joining midpoints of adjacent sides also have slope $\frac{1}{10}$. **25. a)** kite **b)** Opposite sides are parallel (two sides have slope $-\frac{1}{3}$ and two have slope 3) and adjacent sides are perpendicular. Thus, it is a rectangle. **26. a)** (0, 0), (240, 0), (240, 120), (0, 120), (120, 60) **b)** One direction may be described by a line segment with slope $\frac{1}{2}$ and the other by a line segment with slope $-\frac{1}{2}$. These are not negative reciprocals, so the directions are not perpendicular. **27. a)** $m\text{PS} = m\text{QR} = \frac{1}{2}$, $m\text{PQ} = -3$, $m\text{SR} = -\frac{1}{5}$ **b)** midpoint of PQ is A (−2, −2), midpoint of SR is B(6, 2); $m\text{AB} = \frac{1}{2}$ **c)** $\text{PS} = 2\sqrt{5}$, $\text{QR} = 6\sqrt{5}$, $\text{AB} = 4\sqrt{5}$; PS + QR = 2AB **28.** All sides have length 2. **29. a)** The equations of the medians are $x = 6$, $y = 0$, and $2x + 3y - 12 = 0$; these lines intersect at (6, 0). **b)** The equations of the altitudes are $3x - y - 14 = 0$, $3x - 4y = 0$, and $3x + 2y - 28 = 0$. These lines intersect at $\left(\frac{56}{9}, \frac{14}{3}\right)$. **c)** The equations of the perpendicular bisectors are $3x - y - 20 = 0$, $3x - 4y - 27 = 0$, and $3x + 2y - 13 = 0$. These lines intersect at $\left(\frac{53}{9}, -\frac{7}{3}\right)$. **d)** The slope of the line segment connecting the centroid and the orthocentre is 21. The slope of the line segment connecting the orthocentre and the circumcentre is 21. The three points are collinear.

Modelling Math p. 98

1. Two sides of the triangle have slopes −1 and 1, respectively. Thus they are perpendicular. **2.** Opposite sides are parallel and adjacent sides are perpendicular (two sides have slope 1 and two have slope −1). **3.** Opposite sides are parallel (two have slope 0 and two have slope 1). **4.** For example, the line joining the midpoints (15, 35) and (25, 35) has length 10 and slope 0. The corresponding side of the triangle has length 20 and slope 0.

Career Connection p. 99

1. a) (0, 0), (5, 0), (5, 3), (0, 3) **b)** $\sqrt{34}$ **c)** No, since $\sqrt{34}$ is an irrational number. A builder would probably round to the nearest millimetre.

Section 2.5 pp. 103–104

Practice **1. a)** $\sqrt{8}$ **b)** $\sqrt{18}$ **c)** $\sqrt{10}$ **d)** $\sqrt{5}$ **e)** 2 **f)** 3 **g)** $\sqrt{117}$ **h)** $\sqrt{20}$ **2. a)** 2.1 **b)** 1.4 **c)** 1.8 **d)** 1.2 **e)** 0.5 **f)** 1.8 **g)** 2.5 **h)** 2.2 **3. a)** 0.7 **b)** 6.7 **c)** 4.2 **d)** 4.9 **e)** 4.5 **f)** 1.9 **g)** 0.2 **h)** 0.9 **4.** 6.01 **5.** 0; the point is on the line. **6.** $\sqrt{32}$ **7. a)** $\sqrt{45}$ **b)** 6.7
Applications and Problem Solving **8.** 5 **9.** 5 **10.** 6.7 **11. a)** isosceles **b)** C lies on the perpendicular bisector of AB. **c)** 24 **12. a)** 5.58, 3.78, 3.94 **b)** 11.5 **13.** $\sqrt{2}$ **14.** 2.9 **15. a)** 0.38 **b)** 0.14 **16.** 60 **17. a)** $y = \frac{1}{2}x + \frac{\sqrt{65}}{2}$, $y = \frac{1}{2}x - \frac{\sqrt{65x}}{2}$
b) $y = -3x + \sqrt{50}$, $y = -3x - \sqrt{50}$

Modelling Math p. 105

1. $x + y - 40 = 0$ **2. a)** $\sqrt{450}$ **b)** $\sqrt{450}$ **3.** The points are the same distance from, and on opposite sides of, the diagonal. **4.** (0, 10) and (30, 40); (10, 10) and (30, 30); (10, 20) and (20, 30) The points in each pair are the same distance from, and on opposite sides of, the diagonal.