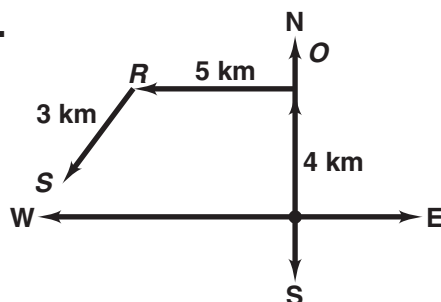# Answers for Lesson 9-1, pp. 473–476 Exercises

1. Yes; the trans. is a slide.

2. Yes; the trans. is a flip.

3. No; the figures are not $\cong$.

4. **a.** Answers may vary. Sample: $\angle Q \rightarrow \angle Q'$

   b. $\overline{QR}$ and $\overline{Q'R'}$; $\overline{RS}$ and $\overline{R'S'}$; $\overline{SP}$ and $\overline{S'P'}$; $\overline{QP}$ and $\overline{Q'P'}$

5. **a.** Answers may vary. Sample: $\angle R \rightarrow \angle R'$

   b. $\overline{RI}$ and $\overline{R'I'}$; $\overline{IT}$ and $\overline{I'T'}$; $\overline{RT}$ and $\overline{R'T'}$

6. **a.** Answers may vary. Sample: $G \rightarrow M$

   b. $\overline{GW}$ and $\overline{MR}$; $\overline{WP}$ and $\overline{RT}$; $\overline{PN}$ and $\overline{TX}$; $\overline{NB}$ and $\overline{XS}$; $\overline{BG}$ and $\overline{SM}$

7. $(-6, 5), (-3, 1), (2, 4)$

8. $(1, -2), (4, 1), (10, -2), (7, -5)$

9. $(-7, 5), (-7, 8), (-4, 8), (-1, 2)$

10. $(-4, -0.5), (-2, -3), (-1, 4), (5, 0)$

11. $(x, y) \rightarrow (x + 1, y - 3)$ 12. $(x, y) \rightarrow (x + 1, y - 1)$

13. $(x, y) \rightarrow (x - 5, y - 2)$ 14. $(x, y) \rightarrow (x + 4, y - 2)$

15. **a.**

   b. about 7.1 km west, 1.9 km north

16.
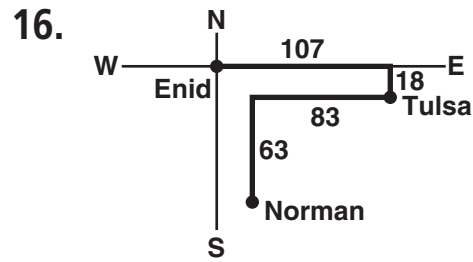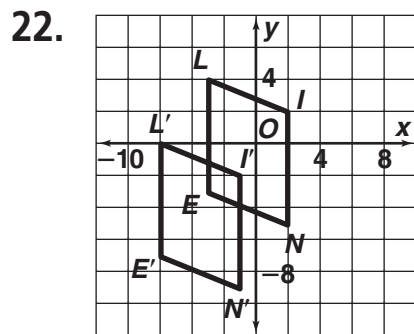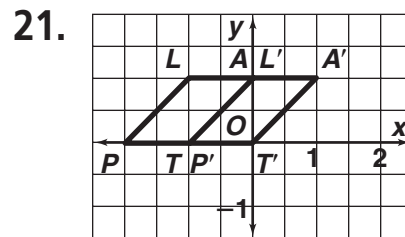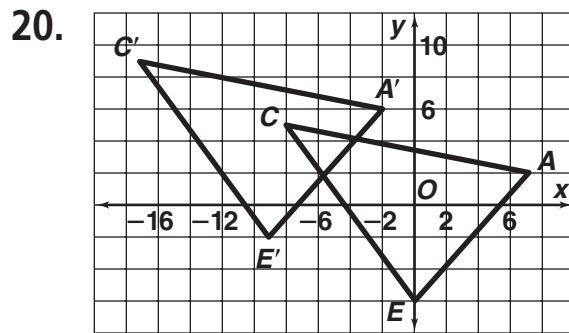

Norman is 24 mi east and 81 mi south of Enid.

17. $(x, y) \rightarrow (x + 2, y + 2)$

18. $(x, y) \rightarrow (x - 3, y + 1)$

19. D

20.

21.

22.

23. a. At least 5 ft east, 10 ft north

b. Sample: $(x, y) \rightarrow (x + 5, y + 10)$

24. Check students' work.

25. $U'(1, 16), G'(2, 12)$

26. a. $\langle -4, -2 \rangle$

b.
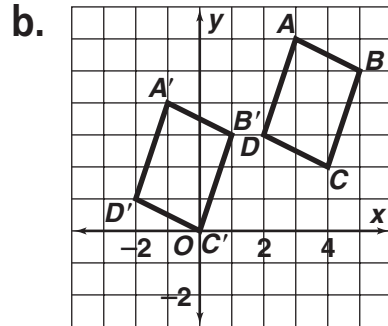
27. No; $\triangle HYP \rightarrow \triangle Y'H'P'$ is the translation

28. $(x, y) \rightarrow (x - 2, y + 14)$

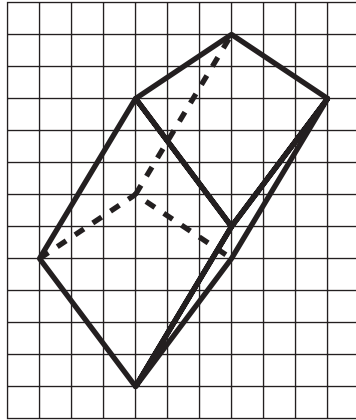**29.** $(x, y) \rightarrow (x + 13, y - 2.5)$

30. a. A slant involves one translation straight downfield and then another diagonally towards the middle of the field; the composition is one translation.

b. The ball drops straight back with the QB and is then thrown to the receiver downfield; the composition is one translation.

c. a completion

31.

32.

Answers for Lesson 9-1, pp. 473–476 Exercises (cont.)
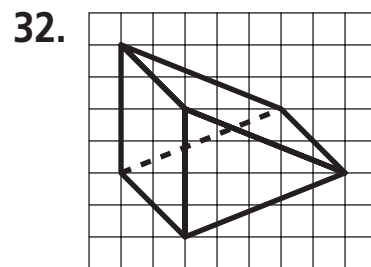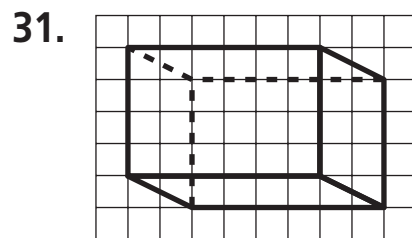
33.

34. Check students' work.

35. **a.** $A'(2, 7), B'(0, 1), C'(6, -1)$

   b. midpoint of $\overline{AB} = (-3, 2)$; midpoint of $\overline{BC} = (-1, -2)$; midpoint of $\overline{AC} = (0, 1)$; midpoint of $\overline{A'B'} = (1, 4)$; midpoint of $\overline{B'C'} = (3, 0)$; midpoint of $\overline{A'C'} = (4, 3)$; image of $(-3, 2) = (1, 4) =$ midpoint of $\overline{A'B'}$; image of $(-1, -2) = (3, 0) =$ midpoint $\overline{B'C'}$; image of $(0, 1) = (4, 3) =$ midpoint of $\overline{A'C'}$

36. Translate a line segment in a direction different than along the segment. Then connect the endpoints of the line segment and its image to form a ▱.

Answers for Lesson 9-2, pp. 480–482 Exercises

1. $(-1, 2)$

2. $(-1, -4)$

3. $(-3, 2)$

4. $(-3, 2)$

5. $(-5, -3)$

6.

7.

8.

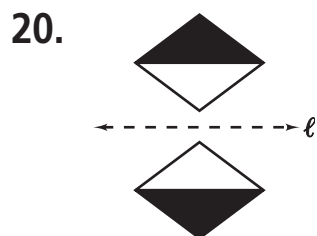
9.

10.

11.

12.

13.
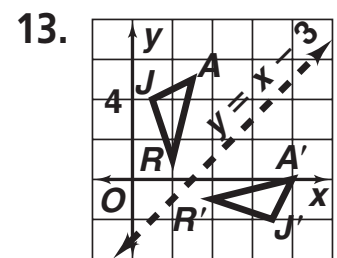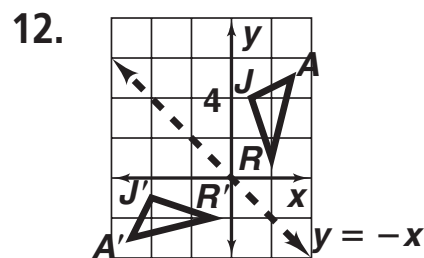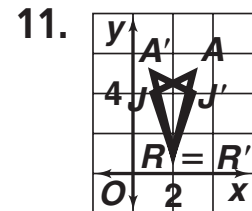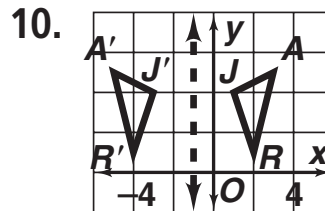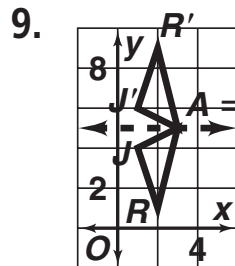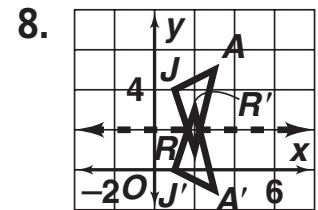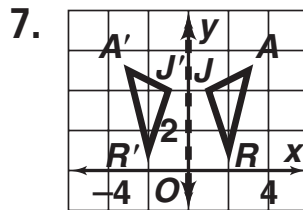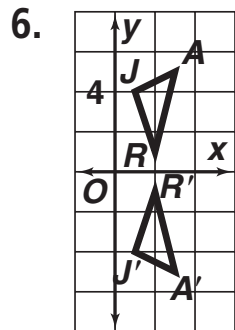
14. Reflect the point for Balance Rock over the line for Summit Trail. Connect this point and Overlook. The trails will connect at the intersection of the segment and Summit Trail.

15. Reflect point D over the mirrored wall. Connect this point and C. The intersection of the segment and the wall is the point to focus the camera.

16.

17.

18.

19. A

20.

21.
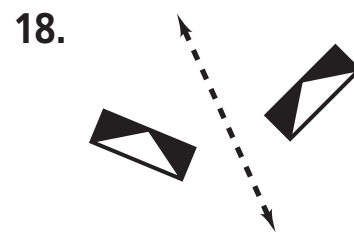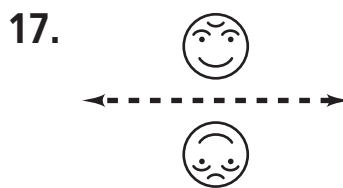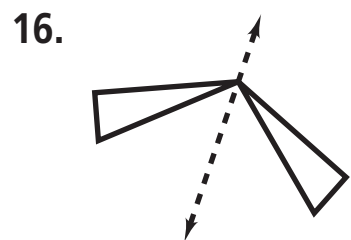
22. S-Isomer

23. Answers may vary. Sample: scissors, a baseball glove, a guitar

24. (x, y) has image $(x, -y)$.

25. (x, y) has image $(-x, y)$.

26. (x, y) has image (y, x).

27. a. Leonardo da Vinci was left-handed.

b. Answers may vary. Sample: His writing hand would not cover what was written so far.

28. $(0, -6)$

29. $(4, 0)$

30. $(0, 0)$

31. $(-4, 6)$

32. $(-4, 6)$

33. $(0, -4)$

34. $(2a, 2b)$

35. $(0, 2a)$

36. $(2b, 0)$

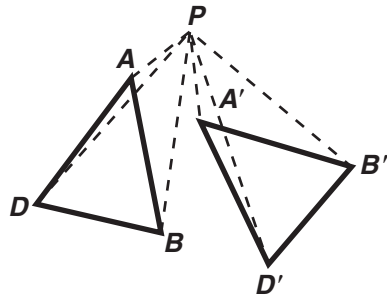**37.** $\overline{AB} \cong \overline{A'B'}; \overline{BC} \cong \overline{B'C'}; \overline{AC} \cong \overline{A'C'}; A \rightarrow A'; B \rightarrow B';$ $C \rightarrow C'; \angle A \cong \angle A'; \angle B \cong \angle B'; \angle C \cong \angle C'$

38–45. Answers may vary. Samples are given.
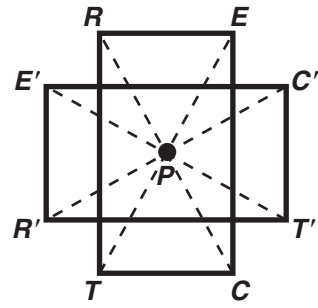
38. yes; reflect a △ across any side and then reflect the image across the ⊥ bisector of that side.

39. yes; follow Exercise 38 steps, first using one side of the triangle and again using a second side.

40. yes; reflect a scalene △ across any side, a non-rt. isosc. △ across either leg, or a non-isosc. rt. △ across its hyp.

41. yes; reflect an isosc. △ across its base.

42. yes; follow Exercise 38 using a rt. △ and the hyp. as the first reflection line.

43. yes; reflect an isosc. rt. △ across its hyp.

44. The slope of $\overleftrightarrow{AB}$ is $\frac{a - b}{b - a} = \frac{a - b}{-1(a - b)} = -1$.

The slope of $y = x$ is 1. Since $(1)(-1) = -1$, the lines are ⊥.

The midpoint of $\overline{AB} = \left(\frac{b + a}{2}, \frac{a + b}{2}\right)$, which is a pt. on $y = x$.

45. for $b \neq d$, $y = \left(\frac{a - c}{d - b}\right)x - \frac{a^2 + b^2 - c^2 - d^2}{2(d - b)}$; for $b = d$,

$x = \frac{a + c}{2}$

46. a. $(4, 2)$

b. $(-2, -4)$

c. $(-4, -2)$

d. $(2, 4)$

e. They are the same point.

1.

2.

3.

4.

5.

6.

7.

8.

Answers for Lesson 9-3, pp. 485–487 Exercises (cont.)

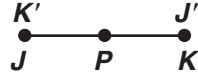**9.**
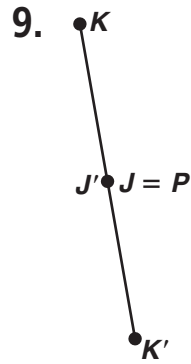
10. H

11. M

12. C

13. $\overline{BC}$

14. A

15. $\overline{LM}$

16. I

17. K

18. $90°; 270$

19. $108°; 252$

20.

21.

22.

23.

24.

25.

$Y = Y'$

$X = X'$ $Z = Z'$
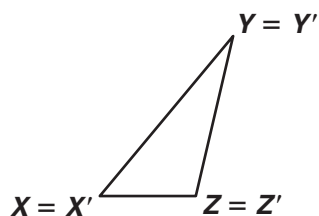
26. $\overline{MN} \cong \overline{M'N'}$; $\overline{EN} \cong \overline{EN'}$; $\overline{ME} \cong \overline{M'E}$; $\angle M \cong \angle M'$; $\angle N \cong \angle N'$; $\angle MEN \cong$ $\angle M'EN'$; $\angle MEM' \cong$ $\angle NEN'$

27. 180° rotation about its center

28. 180

29. 110

30. 290

31. a–c.
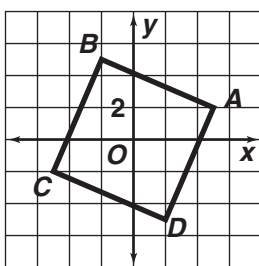
d. Square; all sides are $\cong$ and all $\angle$s are 90°.

32. Draw two segments connecting preimage pts. A and B to image pts. A' and B'. Construct the $\perp$ bis. of $\overline{AA'}$ and $\overline{BB'}$ to find C, the center of rotation. $m\angle ACA'$ is the $\angle$ of rotation.

33. Answers may vary. Sample: a 90° and a 270° rotation

34. Check students' graphs.
Rotation about origin: $L'(1, 2)$, $M'(2, 6)$, $N'(-2, 4)$
Rotation about L: $L'(2, -1)$, $M'(3, 3)$, $N'(-1, 1)$
Rotation about M: $L'(5, -6)$, $M'(6, -2)$, $N'(2, -4)$
Rotation about N: $L'(7, 0)$, $M'(8, 4)$, $N'(4, 2)$

Answers for Lesson 9-4, pp. 494–496 Exercises

1. line; rotational: 180°
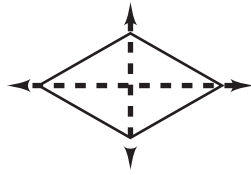
2. line
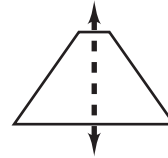
3. rotational: 90°

4. line, rotational: 60°

5. rotational: 180°   **6.** no symmetry   **7.** no symmetry

8. rotational: any angle; line: any line passing through the center

9. rotational: 60°

10. line

11. line, rotational: 180°

12. line, rotational: 90°

13.

14.

15.

16.

17. rotational and reflectional   **18.** reflectional

19–20. Answers may vary. Samples are given.

19. CODE, HOOD, DOCK

20. TOMATO, HOAX, WAXY

21. a.

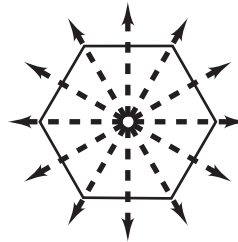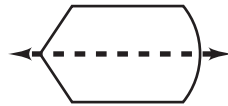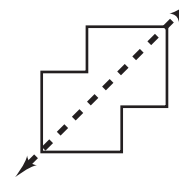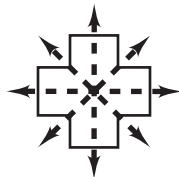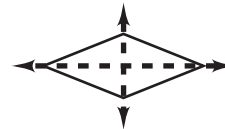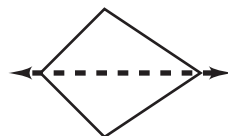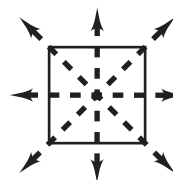| Language	Horz. line	Vert. line	Point
English	B, C, D, E, H, I, K, O, X	A, H, I, M, O, T, U, V, W, X, Y	H, I, N, O S, X, Z
Greek	B, E, H, Θ, I, K, Ξ, O, Σ, Φ, X	A, Δ, H, Θ, I, Λ, M, Ξ, O, Π, Τ, Υ, Φ, X, Ψ, Ω	Z, H, Θ, I, N, Ξ, O, Φ, X

b. Answers may vary. Sample: Greek; Greek alphabet has more letters with at least one kind of symmetry and more letters with multiple symmetries.

22–23. Sketches may vary.

22. reflectional

23. rotational: 90°; reflectional

24. Answers may vary. Sample: $30 \div 10 = 3$; $|8 - 1| = |1 - 8|$, $80 + 3 < 88$; $\frac{80}{80} = \frac{33}{33}$

25. reflectional; rotational   **26.** reflectional

27. point   **28.** none

29. reflectional; rotational   **30.** reflectional

31. reflectional, rotational   **32.** reflectional

33. Yes; the bisector divides the ∠ into 2 ≅ ⩙ with one side of the ∠ being the reflection of the other.

34. Not necessarily; the △ would need the two other ⩙ to be ≅.

35. Not necessarily; the bisector divides the segment into 2 ≅ parts but one part cannot be the reflection of the other unless the bisector is the ⊥ bisector.

36. D

37. $(-3, 4)$ **38.** $(3, -4)$

39. $(-3, -4)$ **40.** $(4, 3)$

41.
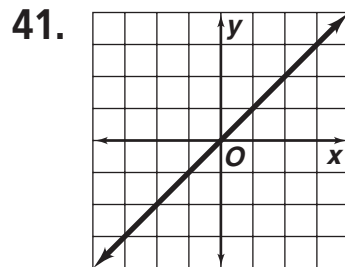
point symmetry about any pt. on the line; reflectional in any member of the family of lines $y = -x + b$

42.

reflectional in y-axis

43.

reflectional in x-axis

44.
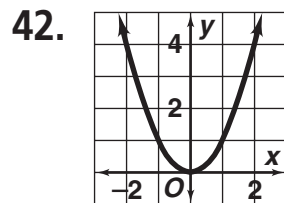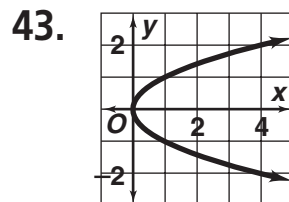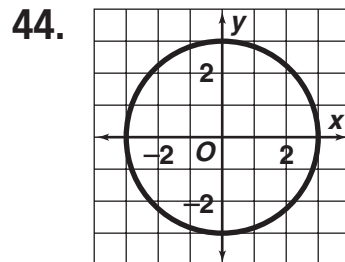
rotational symmetry of any ∠ about the origin; reflectional in any line through the origin

45.
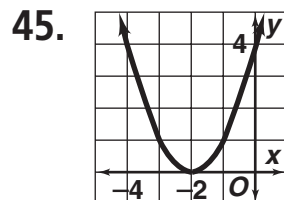
reflectional in $x = -2$

Answers for Lesson 9-4, pp. 494–496 Exercises (cont.)

46.

point symmetry about origin

47.

reflectional in *y*-axis

48.

reflectional in *x*-axis
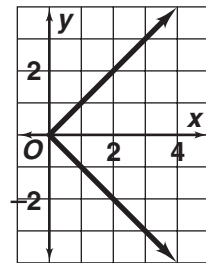
49–50. Answers may vary. Samples are given.

49.

50.
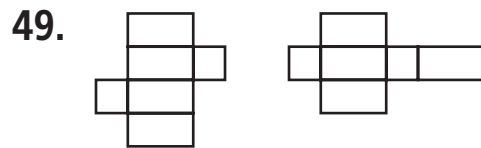
Answers for Lesson 9-5, pp. 500–503 Exercises

1. enlargement; center A, scale factor $\frac{3}{2}$

2. enlargement; center C, scale factor 3

3. enlargement; center R, scale factor $\frac{3}{2}$

4. reduction; center K, scale factor $\frac{1}{3}$

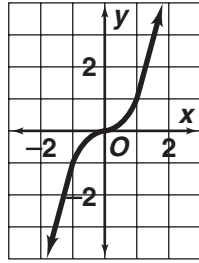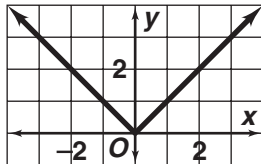5. reduction; center L, scale factor $\frac{1}{3}$

6. enlargement; center M, scale factor 2

7. reduction; center $(0, 0)$, scale factor $\frac{1}{2}$

8. enlargement; center $(0, 0)$, scale factor 2

9. enlargement; center $(0, 0)$, scale factor $\frac{3}{2}$

10. 121.94 in.   11. 512 in.

12. 67.5 in.   13. 1.25 ft

14. about 0.35 in.

15. $P'(6, -3)$, $Q'(6, 12)$, $R'(12, -3)$
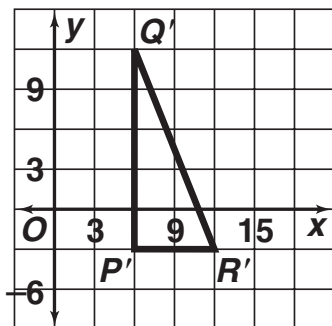
16. $P'(-50, 10)$, $Q'(-30, 30)$, $R'(10, -30)$
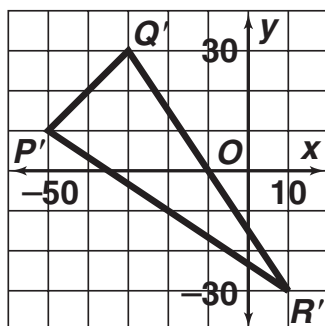
17. $P'\left(-\frac{9}{4}, 0\right)$, $Q'\left(0, \frac{9}{4}\right)$, $R'\left(\frac{3}{4}, -\frac{9}{4}\right)$

18. $D'(2, -10)$

19. $L'(-15, 0)$

20. $A'(-9, 3)$

21. $T'(0, 18)$

22. $M'(0, 0)$

23. $N'(-0.4, -0.7)$

24. $F'\left(-1, -\frac{2}{3}\right)$

25. $B'\left(\frac{1}{8}, -\frac{1}{15}\right)$

26. $Q'\left(6\sqrt{6}, \frac{3\sqrt{2}}{2}\right)$
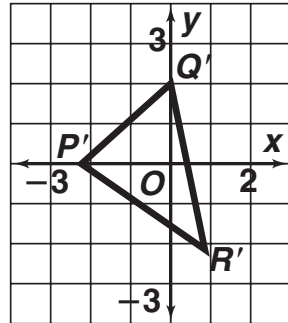
27. $Q'(-9, 12)$, $W'(9, 15)$, $T'(9, 3)$, $R'(-6, -3)$

28. $Q'(-6, 8)$, $W'(6, 10)$, $T'(6, 2)$, $R'(-4, -2)$

29. $Q'\left(-\frac{3}{2}, 2\right)$, $W'\left(\frac{3}{2}, \frac{5}{2}\right)$, $T'\left(\frac{3}{2}, \frac{1}{2}\right)$, $R'\left(-1, -\frac{1}{2}\right)$

30. $Q'\left(-\frac{3}{4}, 1\right)$, $W'\left(\frac{3}{4}, \frac{5}{4}\right)$, $T'\left(\frac{3}{4}, \frac{1}{4}\right)$, $R'\left(-\frac{1}{2}, -\frac{1}{4}\right)$

31. $Q'(-1.8, 2.4)$, $W'(1.8, 3)$, $T'(1.8, 0.6)$, $R'(-1.2, -0.6)$

32. $Q'(-2.7, 3.6)$, $W'(2.7, 4.5)$, $T'(2.7, 0.9)$, $R'(-1.8, -0.9)$
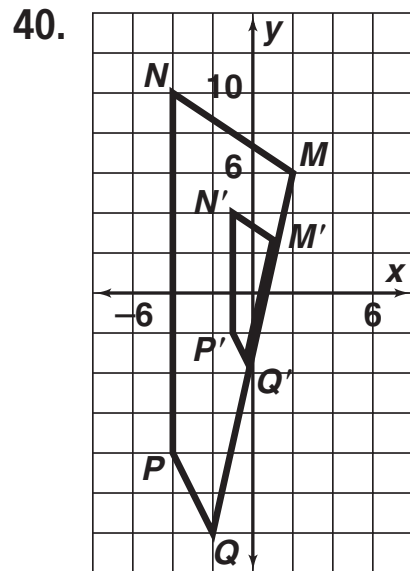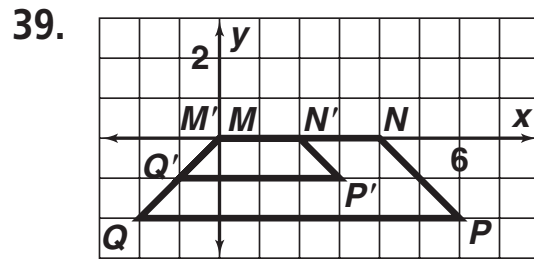
33. $Q'(-30, 40)$, $W'(30, 50)$, $T'(30, 10)$, $R'(-20, -10)$

34. $Q'(-300, 400)$, $W'(300, 500)$, $T'(300, 100)$, $R'(-200, -100)$

35. The image has side lengths 10 in. and $\angle$ measures 60.

36. B

Answers for Lesson 9-5, pp. 500–503 Exercises (cont.)

37.

38.

39.

40.
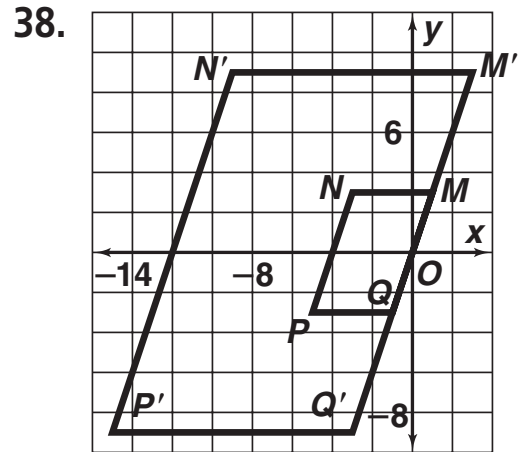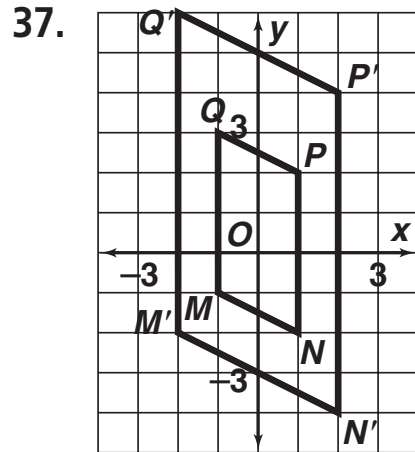
41. Check students' work.

42. Use a scale factor of $\frac{2}{5}$.

43. $I'J' = 10; H'J' = 12$

44. $HJ = 12; I'J' = 5.25$

45. $HI = 32; I'J' = 7.5$

46. The perimeter is doubled but the area is multiplied by 4.

47. $x = 3; y = 60$

48. 60, 60; the two triangles are similar, so corresponding angles are congruent.

49.

50.

51.

52.

53.
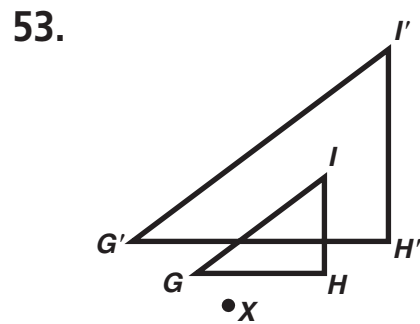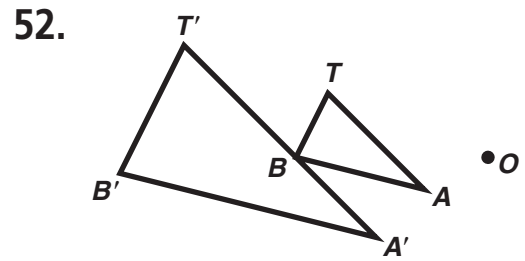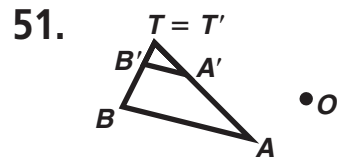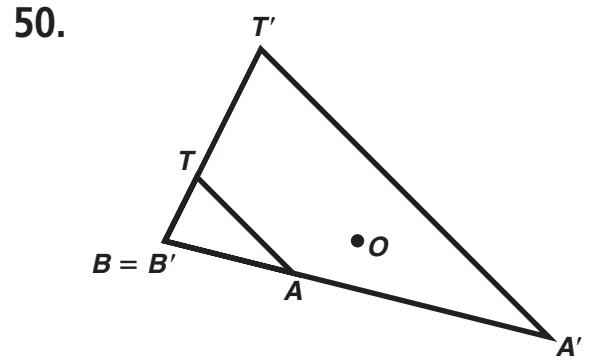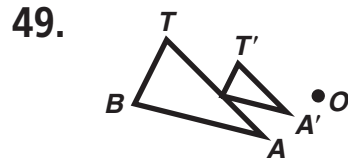
54. 12

55. 60 cm

56. $\frac{9}{256}$ ft^2

57. False; a dilation doesn't map a segment to a $\cong$ segment unless the scale factor is 1.

58. False; a dilation does not change orientation.

59. False; a dilation with a scale factor greater than 1 is an enlargement.

60. True; the image and preimage are similar, so the corresponding $\angle$s are $\cong$.

61. False; if the center of dilation is on the preimage, it is also on the image.

62. Each vertex is 1 ft from the light.

63. Connect corresponding points A and A' and B and B'. Extend $\overline{AA'}$ and $\overline{BB'}$ until they intersect at the center of dilation. The scale factor is the length of $\overline{A'B'}$ divided by the length of $\overline{AB}$.

64. a., c.
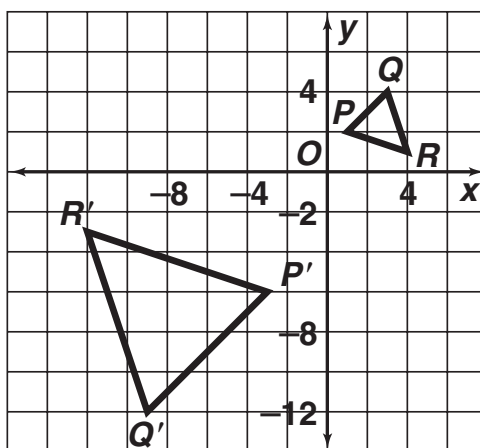
b. $P'(-3, -6)$, $Q'(-9, -12)$, $R'(-12, -3)$

65. a. $P'(-1, -2), Q'(-3, -4), R'(-4, -1)$

b. Each point of the $\triangle$ is reflected in the origin, which is the point of reflection. Two figures are symmetrical with respect to a pt. P if P is the midpoint of each segment that connects two corr. points of the figures.

66. Construct small square $D'E'F'G'$ so that $\overline{D'G'}$ is on $\overline{AC}$ (with D' between A and G'), E' is on $\overline{AB}$, and F' is inside $\triangle ABC$. Draw $\overrightarrow{AF'}$ to meet $\overline{BC}$ at F. Through F construct the line $\parallel$ to $\overline{AC}$. Label its point of intersection with $\overline{AB}$ as E. Through E and F construct the lines $\perp$ to $\overline{AC}$. Label their points of intersection with $\overline{AC}$ as D and G respectively. $DEFG$ is the desired square.
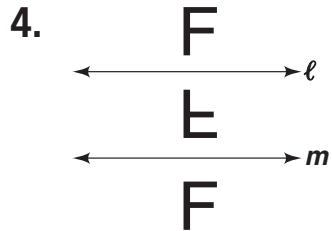
Answers for Lesson 9-6, pp. 509–511 Exercises

1. rotation

2. translation

3. Neither; the figures do not have the same orientation.

4.

F is translated down twice the distance between ℓ and *m*.

5.
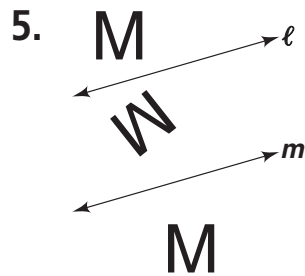
M is translated across line *m* twice the distance between ℓ and *m*.

6.

T is translated across line *m* twice the distance between ℓ and *m*.

7.
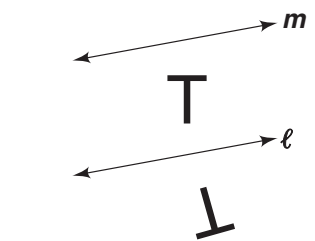
L is rotated clockwise about 180°.
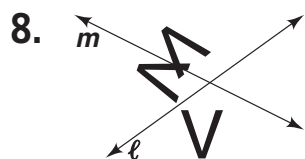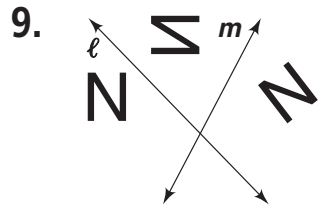
8.

V is rotated clockwise about 145°.

9.

N is rotated clockwise about 160°.

10.

11.

12.

13.

14.

15.
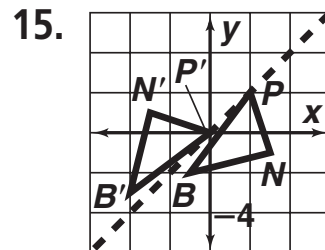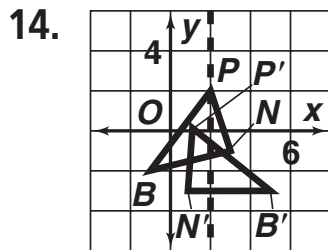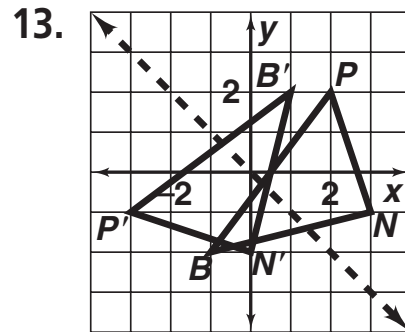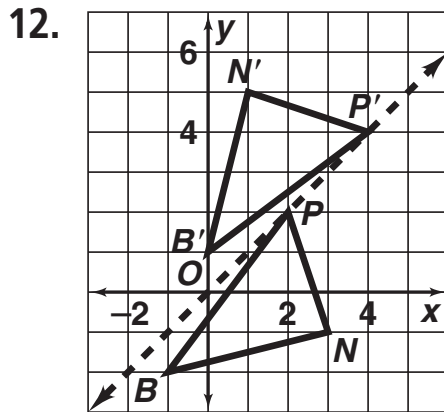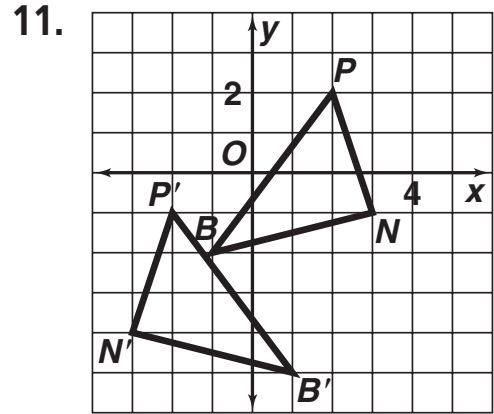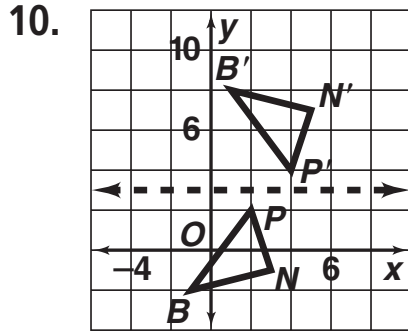
16. opp.; reflection

17. opp.; glide reflection

18. same; translation

19. same; rotation

20. same; rotation

21. same; translation

22. opp.; reflection

23. opp.; glide reflection

24. glide reflection; $(x, y) \rightarrow (x - 2, y - 2)$ followed by refl. in $y = x - 1$

25. rotation; $180°$ about the pt. $\left(\frac{1}{2}, 0\right)$

26. C

27. Odd isometries can be expressed as the composition of an odd number of reflections. Even isometries are the composition of an even number of reflections.

28. Check students' work.

29. Yes; a rotation of $x°$ followed by a rotation of $y°$ is equivalent to a rotation of $(x + y)°$.

30. No; explanations may vary.

31. $60°$ **32.** $60°$ **33.** $51\frac{3}{7}°$ **34.** $30°$

35. rotation; center C, $\angle$ of rotation $180°$

36. glide reflection; $(x, y) \rightarrow (x + 11, y)$, $y = 0$

37. translation; $(x, y) \rightarrow (x - 9, y)$

38. reflection; $y = 0$ **39.** reflection; $x = 4$

40. reflection; $x = -\frac{1}{2}$

41. rotation; center $(3, 0)$, $\angle$ of rotation $180°$

42. glide reflection; $(x, y) \rightarrow (x, y + 4)$, $x = 4$

43. translation; $(x, y) \rightarrow (x - 11, y - 4)$

44. rotation; center $(0, 2)$, $\angle$ of rotation $180°$

45. Sample: Translate the red R so that one point moves to its corresponding point on the blue R. Then reflect across a line passing through that point.
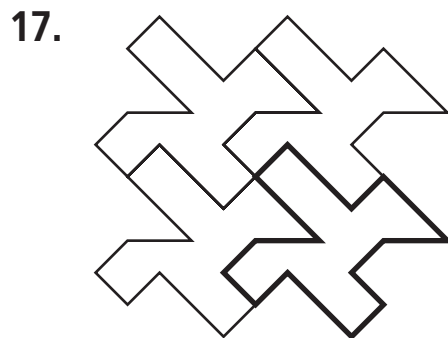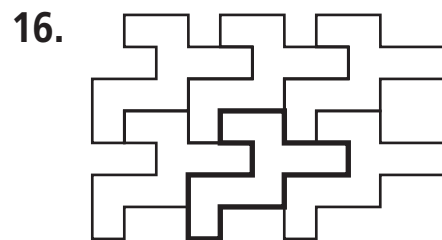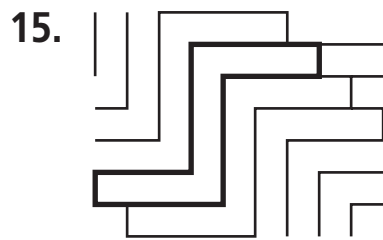
Answers for Lesson 9-6, pp. 509–511 Exercises (cont.)

46–48. Answers may vary. Samples are given.

46. If $\overline{XY}$ is reflected in line ℓ, then ℓ is the $\perp$ bis. of $\overline{XX'}$ and $\overline{YY'}$, so $\overline{XX'} \parallel \overline{YY'}$ and $XX'YY'$ is an isosc. trap. Therefore $\overline{XY} \cong \overline{X'Y'}$.

47. $\overline{XX'} \parallel \overline{YY'}$ and $\overline{XX'} \cong \overline{YY'}$, so $XX'Y'Y$ is a $\square$. Therefore, $\overline{XY} \cong \overline{X'Y'}$.

48. If $\overline{XY}$ is rotated $x°$ about pt. R, then $\overline{RX} \cong \overline{RX'}$ and $\overline{RY} \cong \overline{RY'}$. Also, $m\angle XRY + m\angle YRX' = m\angle YRX' + m\angle X'RY' = x$, so $\angle XRY \cong \angle X'RY'$. So $\triangle XRY \cong \triangle X'RY'$ by SAS and $\overline{XY} \cong \overline{X'Y'}$ by CPCTC.

49. Answers may vary. Sample: Since a reflection moves a pt. in the direction $\perp$ to the translation, the order does not matter.

50. No; explanations may vary. Sample: If $(1, 1)$ is reflected over the line $y = x$ and then the x-axis, the image is $(1, -1)$. If the reflections are reversed, the image is $(-1, 1)$.

51. $(6, 5)$ **52.** $(3, 8)$ **53.** $(2, 6)$ **54.** $(-3, 1)$

Answers for Lesson 9-7, pp. 518–520 Exercises

**1–4. Answers may vary. Samples are given.**

1. yes; translation; two ⊥ rectangles

2. yes; translation; two ⑤ and a rhombus with a flower in it

3. yes; translation; four rectangles in a square shape

4. yes; translation; from upper left corner, 5 rectangles down and full width

5. yes

6. yes

7. no

8. no

9. no

10. no

11. rotational, reflectional, glide reflectional, and translational

12. rotational, point, reflectional, glide reflectional, and translational

13. rotational, reflectional, glide reflectional, and translational

14. rotational and reflectional

15.

16.

17.

18. C

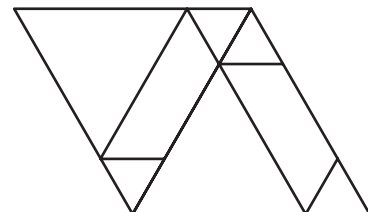**19–21. Answers may vary. Samples are given.**

19.

20.

21.
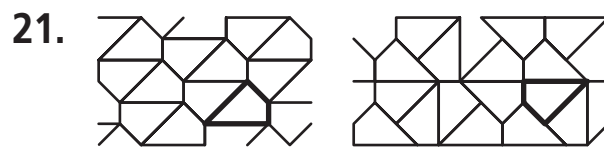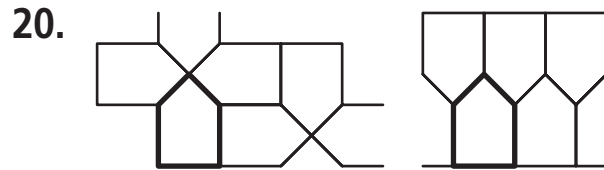
22. A regular polygon with more than 6 sides must have ∠ measures greater than 120, and at least 3 polygons must meet at each vertex. The sum of 3 or more ⧍ with measures greater than 120 > 360. So the 3 regular polygons are 3-, 4-, and 6-sided, since their int. ∠ measures divide 360.

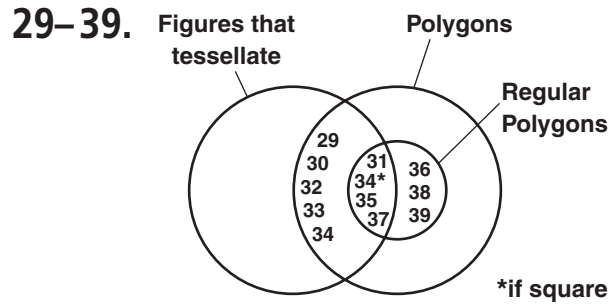**23.** no

24. yes;
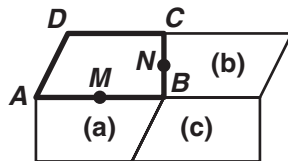

25. yes;
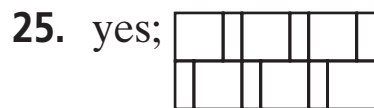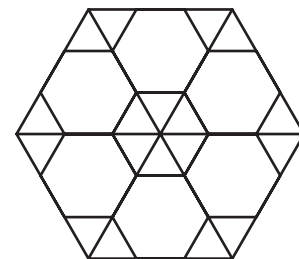
26. yes;

27. reflectional, glide reflectional, rotational, and translational

28. rotational, point, reflectional, glide reflectional, and translational

29–39.

40. a–c. Drawings may vary. Sample:

   d. Yes, *ABCD* tessellates; the sum of the measures of the ⓥ of a quad. is 360. Copies of the quad. can be arranged so that the four ⓥ share a vertex. The quad. fills the plane.

41. Answers may vary. Sample: Draw △*ABC*. Locate *M*, the mdpt. of $\overline{AB}$, and *N*, the mdpt. of $\overline{BC}$. Draw the images of △*ABC* under 180° rotations about *M* and *N*. Draw the image of △*ABC* under the translation that maps *A* to *C*. 2nd way: Draw △*ABC*. Draw the reflection image of pt. *C* over $\overline{AB}$, *C*′. Now use the steps from Ex. 38 for quad. *ACBC*′.