Geometry: Transformations – AP Book 6.2: Unit 11

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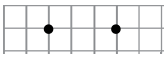
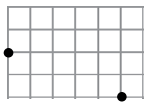
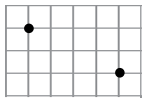
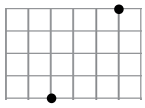
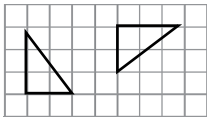
1. a) 4
   b) 3 units right
   c) 2 units right
2. a) 3
   b) 4 units left
   c) 2 units left
3. a) 
   b) 
   c) 
4. a) 4
   2
   b) 2
   3
   c) 3
   1
5. a) 
   b) 
   c) 
6. a) i) 29, 90°
      17, 30°
      34, 60°
      ii) 29, 28°
      17, 100°
      36, 52°
   b) Teacher to check.
   c) i) 29, 90°
      17, 30°
      34, 60°
      ii) 29, 28°
      17, 100°
      36, 52°
   d) They are equal.
7. a) True. A triangle and its image under translation have equal angles and side lengths and so are congruent.

   BONUS

   False.

   Teacher to check counterexample.

   Sample answer:

   
8. a) Teacher to check.
   b) Teacher to check arrows.

   The arrows are parallel.
   c) They are equal.
   d) yes
      i) 3, up
      2, right
      ii) 1, left
      1, down
9. a) Quadrilaterals will vary. Teacher to check.
   b) Predictions may vary. Teacher to check.

   Sample answer:

   2, right

   7, down
   c) Teacher to check translation.

   Sample answer: yes
10. Jax is correct.

    Sample explanation: Moving up 3, and then down 3 brings the shape back to its original position, as does moving 4 left and then 4 right.

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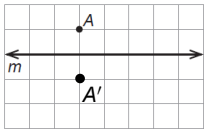
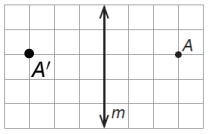
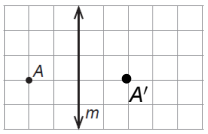
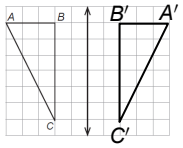
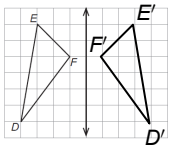
1. a) 

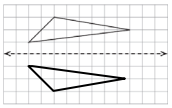
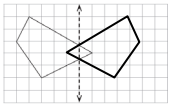
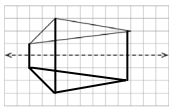
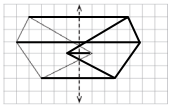
   b) 

   c) 

2. a) i) 17, 63°
      38, 90°
      34, 27°
      ii) 35, 28°
      16, 54°
      28, 98°
   b) i) 

      ii) 

   c) i) 17, 63°
      38, 90°
      34, 27°
      ii) 35, 28°
      16, 54°
      28, 98°
   d) they are equal

   yes
3. a) i) 
      ii) 
   b) i) 
      ii) 

   The line segments are parallel.
   c) Teacher to check drawings.

   The midpoints are all on the mirror line.
4. a) Teacher to check.
   b) Teacher to check drawings.
      i) yes
      ii) no

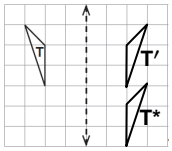
   BONUS

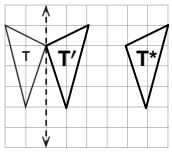
   yes
   c) The shapes in part i) and the Bonus are reflections of each other because the line segments between corresponding vertices are parallel and the midpoints of those line segments are all on the same line. The shapes in part ii) are not reflections of each other because the midpoints are not all on the same line.

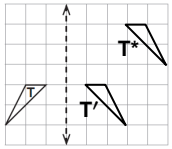
   BONUS

   For part ii), translate the top shape 3 units down to get to the bottom shape.
5.

same	same	changed
same	same	same

6. a–b) i) 

   ii) 

   iii) 

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(continued)

c) Teacher to check drawings.

i) no

ii) yes

iii) no

d) i) no

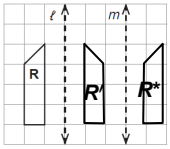
ii) no

iii) no

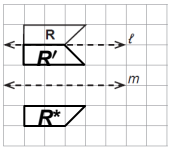
e) Teacher to check mirror line in part a) ii).

f) Triangles T and T* are congruent because reflections and translations preserve lengths of sides and sizes of angles. So a combination of a reflection and a translation will also preserve congruency.

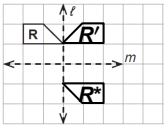
7. a–b) i)



ii)



BONUS



c) i) Yes, translate R 6 units right.

ii) Yes, translate R 4 units down.

iii) no

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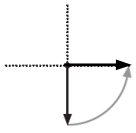
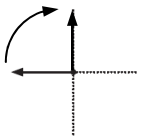
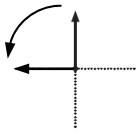
1. b)



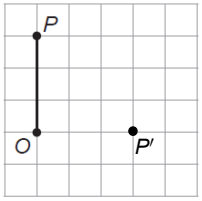
c)



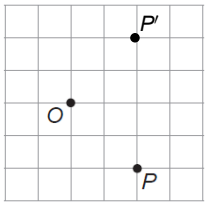
d)



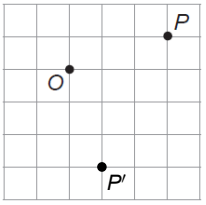
2. a)



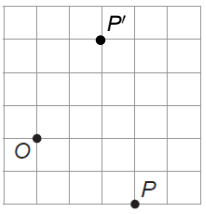
b)



c)



d)

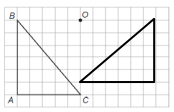


3. yes

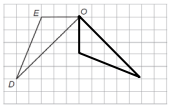
4. a) i) 34 mm, 90°
29 mm, 40°
45 mm, 50°

ii) 30 mm, 24°
17 mm, 112°
40 mm, 44°

b) i)



ii)



c) i) 34 mm, 90°
29 mm, 40°
45 mm, 50°

ii) 30 mm, 24°
17 mm, 112°
40 mm, 44°

d) equal

yes

5. a) True. A rotation does not change lengths of sides or sizes of angles.

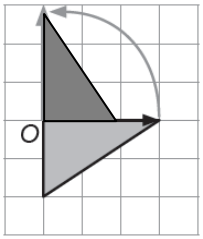
b) False.

Teacher to check counterexample.

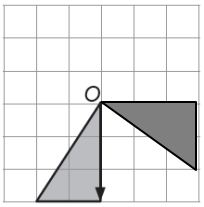
6.

same	same	changed
same	same	same
same	same	changed

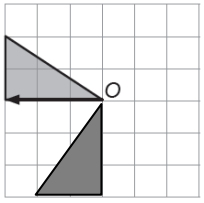
7. a)



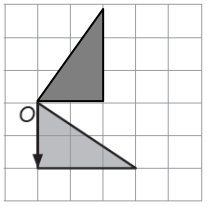
b)



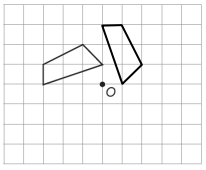
c)



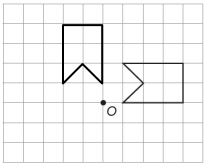
d)



8. a)



b)



BONUS

Teacher to check drawings.

The two triangles make a parallelogram.

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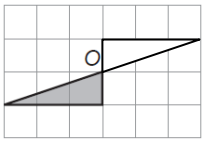
1. a) 3
2
3
2

b) horizontal, vertical

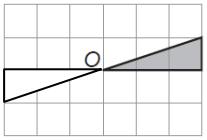
BONUS

A full rotation is 360°, so a rotation of 180° CW is the same as the rotation of 360° − 180° = 180° CCW.

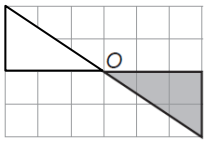
2. a)



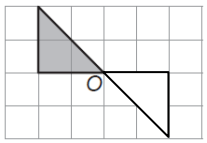
b)



c)



d)



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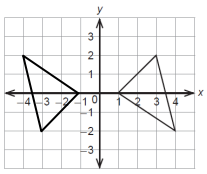
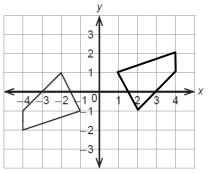
(continued)

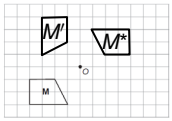
3. a)



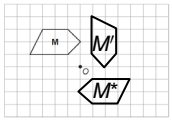
b)



4. a–b) i)

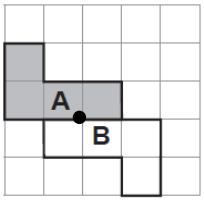


ii)



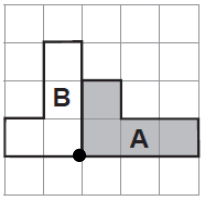
c) 180° CW or 180° CCW

5. b) 90°
   c) 180°
   d) 90°
6. b) 270° CW
   c) 90° CW
   d) 270° CCW
7. a) 90° CW
   b) 180° CW or 180° CCW
   c) 90° CCW
   d) 90° CW
8. b)



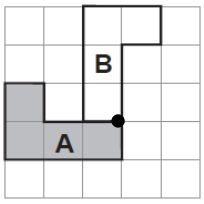
180° CW or 180° CCW

c)



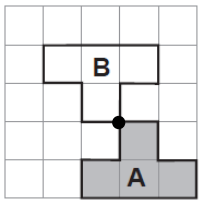
90° CCW

d)



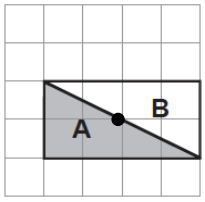
90° CW

e)



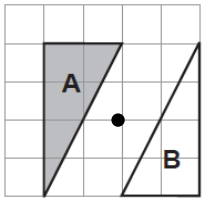
180° CW or 180° CCW

f)



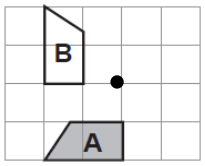
180° CW or 180° CCW

g)



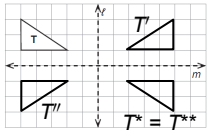
180° CW or 180° CCW

BONUS



90° CW

9. a) S
   b) W
   c) N
   d) W
   e) N
10. a–d)



e) They are the same.

f) 180° CW or CCW rotation around the intersection of lines ℓ and m.

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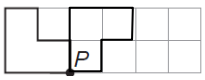
1. b)

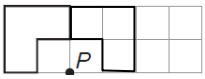
c)

d)

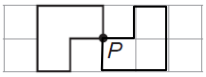
2. a)



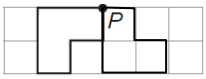
b)



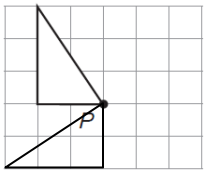
c)



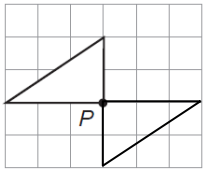
d)



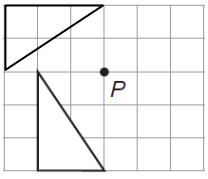
e)



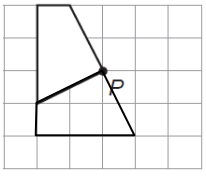
f)



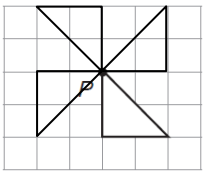
g)



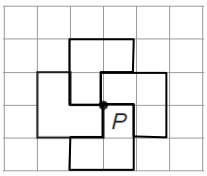
BONUS



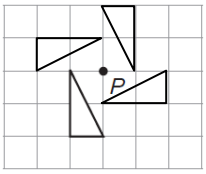
3. a)



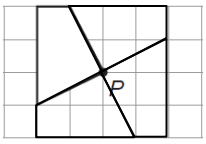
b)



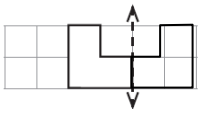
c)



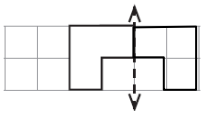
BONUS



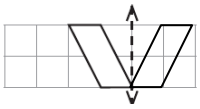
4. a)



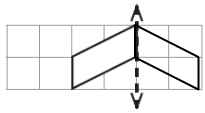
b)



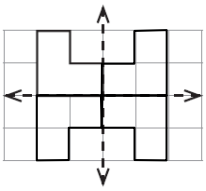
c)



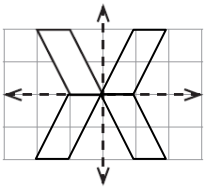
d)

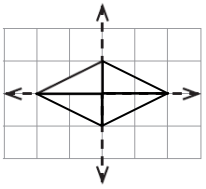


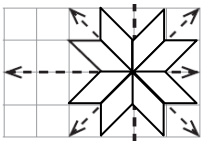
5. a)

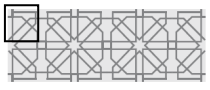
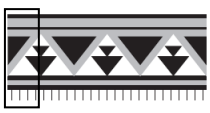


b)



c) 

d) 

6. Teacher to check continuation of patterns and mirror lines, translation arrows, and centres of rotation.
   b) translation
   c) rotation
   d) rotation
7. Teacher to check patterns.
   b) translation 2 units right
      reflection in the right side
   c) reflection in the right side
      rotation around top right corner
   d) Teacher to check.
   e) Teacher to check.
8. a) parts a), b), and d)
      Teacher to check explanation.
   b) parts a), b), and d)
   c) they are the same
9. Teacher to check.
10. Answers will vary. Teacher to check.
11. Answers will vary. Teacher to check.
12. a) 
    b) 
    c) 

BONUS

Teacher to check.

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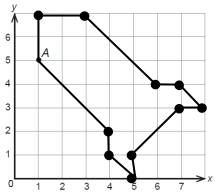
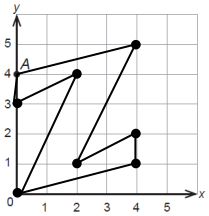
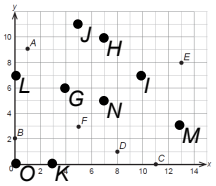
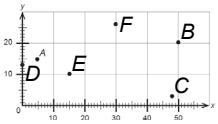
1. a–b) 
   c) rocket ship
2. a) *B* (3, 5), *C* (6, 4), *D* (0, 2), *E* (7, 3), *F* (2, 2), *G* (4, 2), *H* (3, 1), *I* (5, 0), *J* (6, 1), *K* (0, 0), *L* (2, 0)
   b) *K*, *L*, *I*
   c) *D*, *K*
   d) *K*
3. a–b) 
   c) Z
4. a) *B* (0, 2), *C* (11, 0), *D* (8, 1), *E* (13, 8), *F* (5, 3)
   b) 
5. a) Teacher to check.
   b) 

BONUS

Teacher to check.

6. Teacher to check.
   a) Teacher to check.
   b) Teacher to check coordinate grids.
      i) parallelogram
      ii) rectangle

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1. Teacher to check coordinate grids.
   a) *B* (2, 5), *B*′ (6, 6)
      C (4, 1), *C*′ (8, 2)
   b) *D* (10, 4), *D*′ (5, 1)
      E (9, 6), *E*′ (4, 3)
      F (6, 5), *F*′ (1, 2)
      G (7, 3), *G*′ (2, 0)
2. a) *B* (8, 1), *B*′ (4, 3)
      C (11, 2), *C*′ (7, 4)
      4
      increases, 2
      4, left
      2, up
   b) *P* (1, 4), *P*′ (6, 1)
      Q (3, 6), *Q*′ (8, 3)
      R (5, 5), *R*′ (10, 2)
      increases, 5
      decreases, 3
      5, right
      3, down
3. Teacher to check coordinate grids.
   a) *B* (2, 6), *B*′ (2, 0)
      C (7, 1), *C*′ (7, 5)
   b) *D* (9, 6), *D*′ (1, 6)
      E (5, 4), *E*′ (5, 4)
      F (8, 1), *F*′ (2, 1)
   c) *G* (3, 1), *G*′ (3, 7)
      H (4, 3), *H*′ (4, 5)
      K (6, 4), *K*′ (6, 4)
      M (8, 1), *M*′ (8, 7)
      N (5, 2), *N*′ (5, 6)
   d) *W* (9, 4), *W*′ (3, 4)
      X (7, 6), *X*′ (5, 6)
      Y (9, 0), *Y*′ (3, 0)
      Z (10, 1), *Z*′ (2, 1)
4. a) *x*-coordinate
      y-coordinate
   b) *E*, *K*
      E and *K* were on the mirror lines.

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1. Teacher to check coordinate grids.
   a) i) *A* (3, 2), *A*′ (5, 4)
         B (1, 3), *B*′ (6, 6)
         C (5, 5), *C*′ (8, 2)
      ii) *D* (8, 1), *D*′ (3, 6)
         E (7, 2), *E*′ (2, 5)
         Q (3, 1), *Q*′ (3, 1)
      iii) *F* (2, 4), *F*′ (3, 5)
         G (7, 4), *G*′ (3, 0)
         H (6, 6), *H*′ (5, 1)
         I (2, 6), *I*′ (5, 5)
      iv) *J* (4, 5), *J*′ (2, 3)
         K (6, 5), *K*′ (2, 5)
         L (8, 1), *L*′ (6, 7)
         M (3, 1), *M*′ (6, 2)
   b) *Q*
      It is the centre of rotation.
   c) no
      no
2. a) i) *N* (5, 1), *N*′ (5, 5)
         P (4, 0), *P*′ (6, 6)
         Q (2, 3), *Q*′ (8, 3)
         R (4, 3), *R*′ (6, 3)
      ii) *S* (6, 1), *S*′ (6, 5)
         T (4, 3), *T*′ (8, 3)
         U (7, 6), *U*′ (5, 0)
         V (9, 4), *V*′ (3, 2)
   b)

	Hor.	Vert.
i)	*Q*, *R*	*N*
	Q′, *R*′	*N*′
ii)	*T*	*S*
	T′	*S*′

   c) *N*, *S*
      Q, *R*, *T*

d) The x-coordinate of a point on the same vertical line as the centre of rotation doesn't change in a 180° CW or CCW rotation, and the y-coordinate of a point on the same horizontal line as the centre of rotation doesn't change in a 180° CW or CCW rotation, because any line through the centre of rotation is the same as its image under this rotation.

3. Teacher to check coordinate grid.

   $S'T'U'V'$ and $S^*T^*U^*V^*$ are on the same place on the grid, but the images of individual vertices are different. $S' = U^*$, $T' = V^*$, $U' = S^*$, $V' = T^*$

4. a) Simon is correct. The coordinates of the image are (5, 6). Rotation of 180° around a point on the same vertical line will result in an image with the same x-coordinate.

   b) Kathy is correct. The image coordinates are (2, 3). A 90° rotation will change the x-coordinate.

5. a) Teacher to check.

   b) D (6, 1)

   c) A^* (2, 5), B^* (6, 5), C^* (6, 1), D^* (2, 1)

   d) $ABCD$ and $A^*B^*C^*D^*$ take up the same place on the grid because the centre of rotation was the centre of the shape.

   $B = A^*$, $C = B^*$, $D = C^*$, $A = D^*$

BONUS

a) Teacher to check.

b) H (6, 6)

c) The smallest clockwise rotation is 180° because parallelograms have rotational symmetry of order 2, meaning there are 2 positions that the shape will look exactly the same when rotated around the centre.

6. Answers may vary. Teacher to check.

   Sample answer:

   Translate P down 2 units, then reflect P in the line $x = 4$.

7. a) Translate M 6 units right.

   Reflect M in the line $x = 5$.

   Rotate M 180° CCW around (5, 3).

   b) Translation:
   (2, 1) ➔ (8, 1)
   (1, 3) ➔ (7, 3)
   (2, 5) ➔ (8, 5)
   (3, 3) ➔ (9, 3)

   Reflection:
   (2, 1) ➔ (8, 1)
   (1, 3) ➔ (9, 3)
   (2, 5) ➔ (8, 5)
   (3, 3) ➔ (7, 3)

   Rotation:
   (2, 1) ➔ (8, 5)
   (1, 3) ➔ (9, 3)
   (2, 5) ➔ (8, 1)
   (3, 3) ➔ (7, 3)

   c) i) top and bottom
   ii) none
   iii) left and right

8. Answers will vary. Teacher to check.