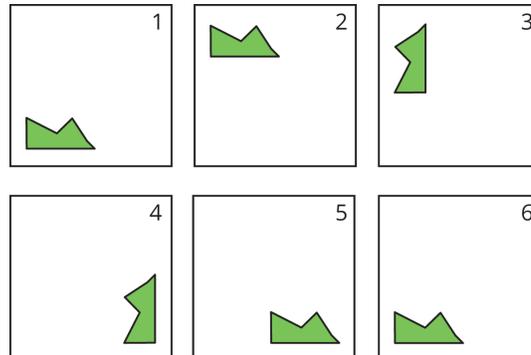


Rigid Transformations and Congruence

Lesson 1

Problem 1

The six frames show a shape's different positions.



Describe how the shape moves to get from its position in each frame to the next.

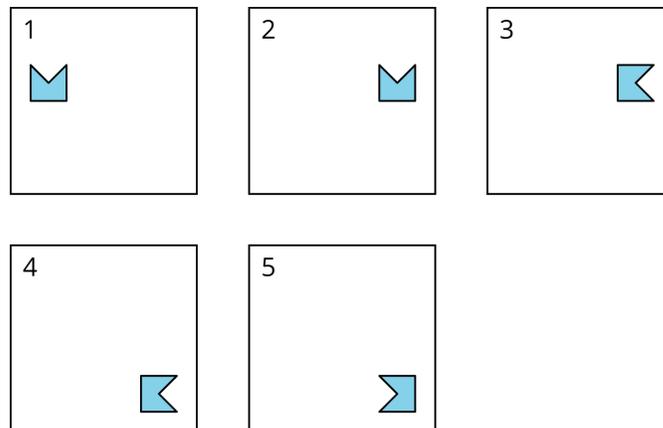
Solution

To get from Position 1 to Position 2, the shape moves up. To get from Position 2 to Position 3, the shape rotates 90 degrees counterclockwise. To get from Position 3 to Position 4, the shape moves down and to the right. To get from Position 4 to Position 5 the shape rotates 90 degrees clockwise. To get from Position 5 to Position 6, the shape moves to the left.

Note: 90 degrees counterclockwise is the same as 270 degrees clockwise, and similarly 90 degrees clockwise is the same as 270 degrees counterclockwise.

Problem 2

These five frames show a shape's different positions.



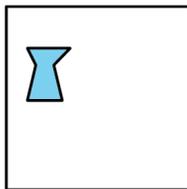
Describe how the shape moves to get from its position in each frame to the next.

Solution

To get from Position 1 to Position 2, the shape moves to the right. To get from Position 2 to Position 3, the shape rotates 90 degrees clockwise. To get from Position 3 to Position 4, the shape moves down. To get from Position 4 to Position 5, the shape rotates 180 degrees.

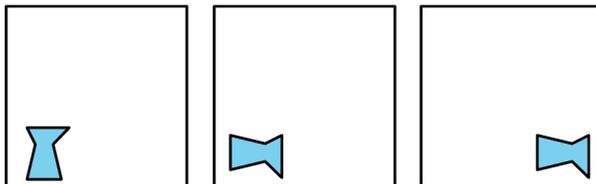
Problem 3

Diego started with this shape.



Diego moves the shape down, turns it 90 degrees clockwise, then moves the shape to the right. Draw the location of the shape after each move.

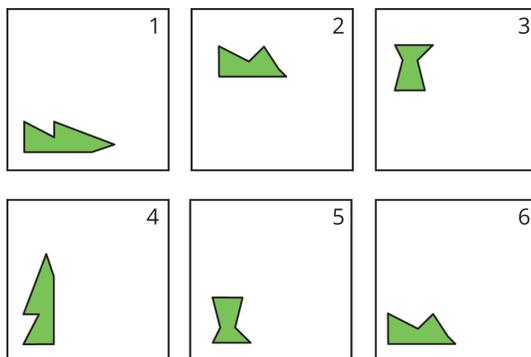
Solution



Lesson 2

Problem 1

Each of the six cards shows a shape.



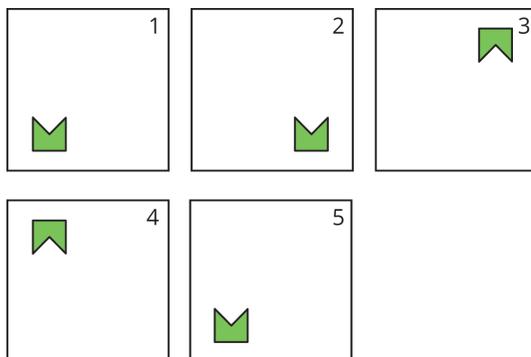
1. Which pair of cards shows a shape and its image after a rotation?
2. Which pair of cards shows a shape and its image after a reflection?

Solution

1. Cards 1 and 4
2. Cards 3 and 5

Problem 2

The five frames show a shape's different positions.



Describe how the shape moves to get from its position in each frame to the next.

Solution

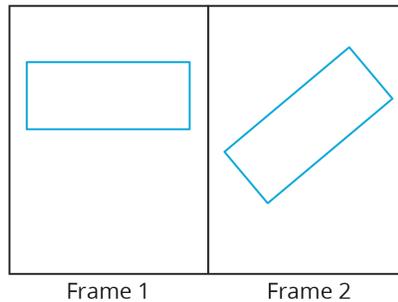
To get from Position 1 to Position 2, the shape moves to the right. To get from Position 2 to Position 3, the shape flips over a horizontal line. To get from Position 3 to Position 4, the shape moves to the left. To get from Position 4 to Position 5, the shape flips over a horizontal line again. The shape has then returned to its original position in Position 1.

Alternatively, to get from Position 1 to Position 2 or from Position 3 to Position 4, the shape may flip over a vertical line. Since the shape is symmetric, a flip looks the same as a shift here. To get from Position 2 to Position 3 or from Position 4 to Position 5, the shape may be rotated 180 degrees about a point not on the polygon.

Problem 3

(from Unit 1, Lesson 1)

The rectangle seen in Frame 1 is rotated to a new position, seen in Frame 2.



Select **all** the ways the rectangle could have been rotated to get from Frame 1 to Frame 2.

- A. 40 degrees clockwise
- B. 40 degrees counterclockwise
- C. 90 degrees clockwise
- D. 90 degrees counterclockwise
- E. 140 degrees clockwise
- F. 140 degrees counterclockwise

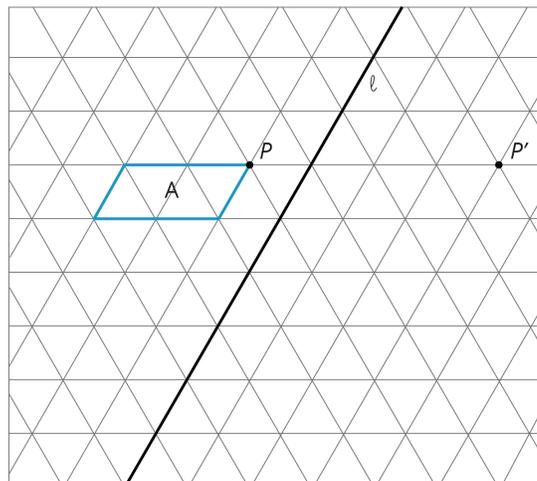
Solution

B, E

Lesson 3

Problem 1

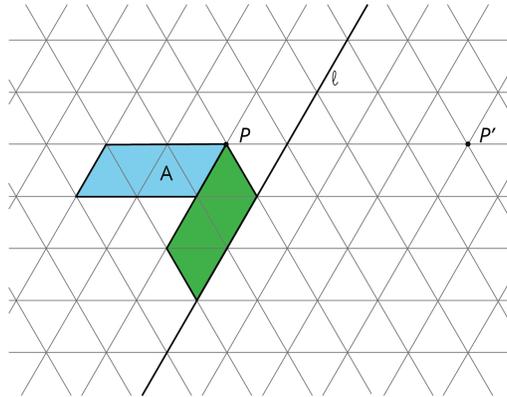
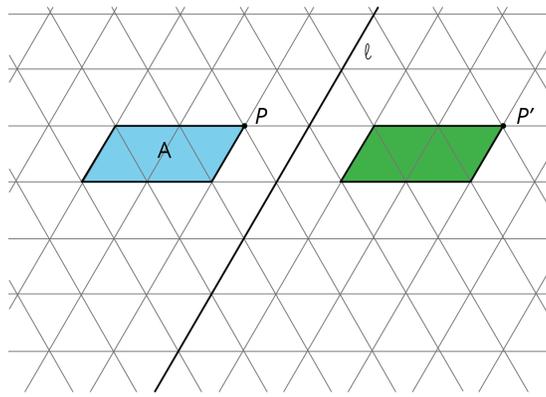
Apply each transformation described to Figure A. If you get stuck, try using tracing paper.



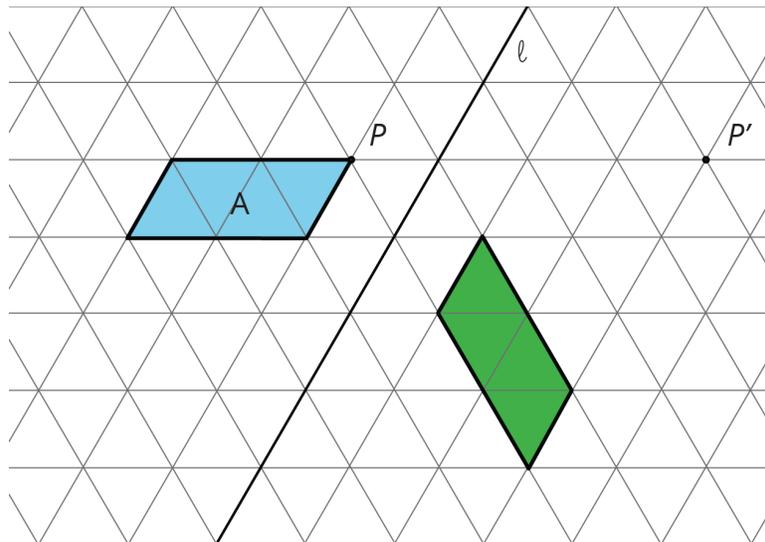
1. A translation which takes P to P'
2. A counterclockwise rotation of A , using center P , of 60 degrees
3. A reflection of A across line ℓ

Solution

- 1.

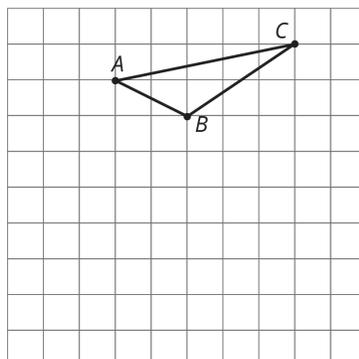


3.



Problem 2

Here is triangle ABC drawn on a grid.



On the grid, draw a rotation of triangle ABC , a translation of triangle ABC , and a reflection of triangle ABC . Describe clearly how each was done.

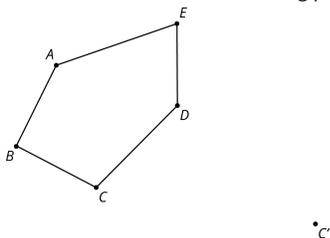
Solution

Answers vary. Sample answers: The rotation is a 90-degree counterclockwise rotation using center A . The translation is 4 units down and 3 to the left. The reflection is across a horizontal line through point B .

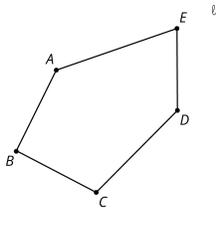
Problem 3

(from Unit 1, Lesson 2)

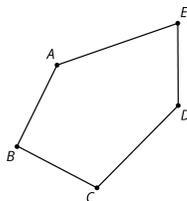
1. Draw the translated image of $ABCDE$ so that vertex C moves to C' . Tracing paper may be useful.



2. Draw the reflected image of Pentagon $ABCDE$ with line of reflection ℓ . Tracing paper may be useful.

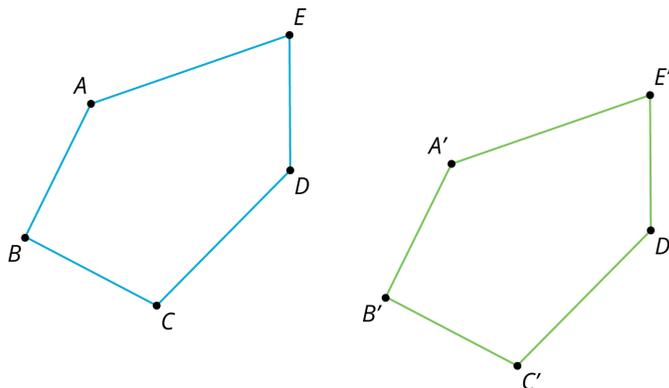


3. Draw the rotation of Pentagon $ABCDE$ around C clockwise by an angle of 150 degrees. Tracing paper and a protractor may be useful.

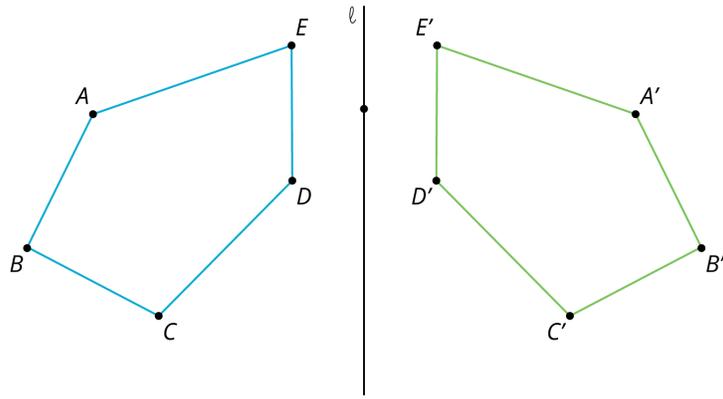


Solution

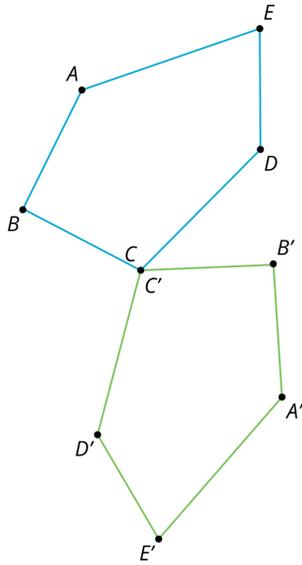
- 1.



- 2.



3.



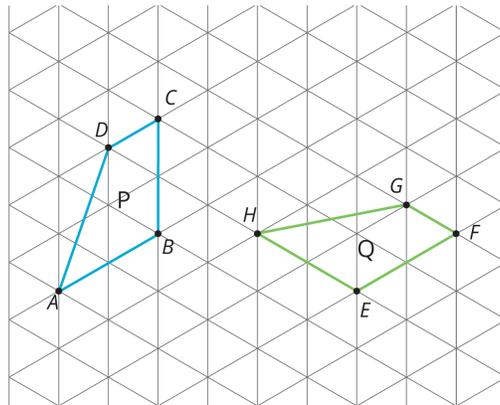
In the picture, angle DCD' measures 150 degrees.

Lesson 4

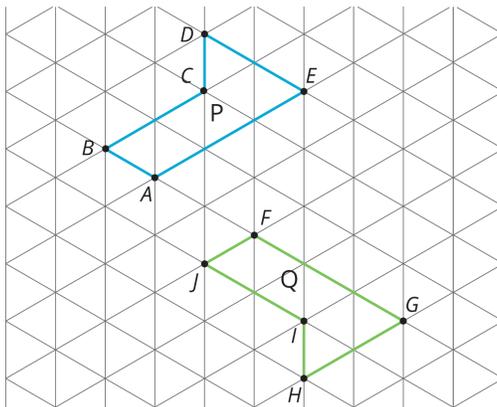
Problem 1

For each pair of polygons, describe a sequence of translations, rotations, and reflections that takes Polygon P to Polygon Q.

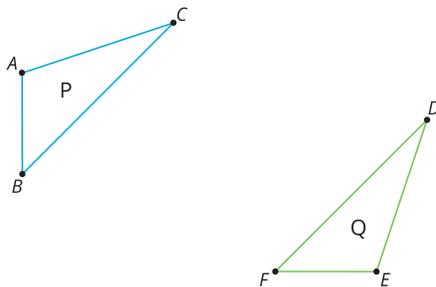
1.



2.



3.

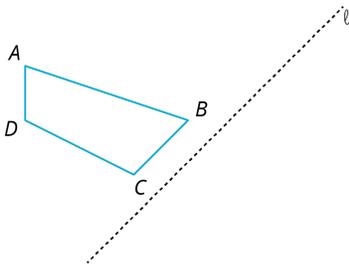


Solution

1. Sample response: A is translated to H , followed by a rotation 60 degrees clockwise with center H .
2. Sample response: Polygon $ABCDE$ is reflected over line AE . A is then translated to F and a rotation of 60 degrees clockwise with center F is applied.
3. Sample response: A is translated to E , then apply a rotation with center E so that B lands on top of F . Finally the polygon is reflected over line EF .

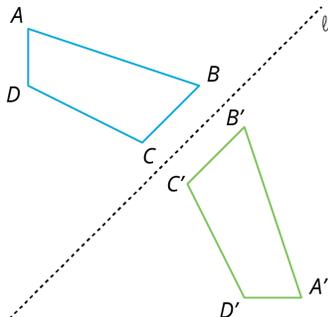
Problem 2

(from Unit 1, Lesson 2)
Here is quadrilateral $ABCD$ and line ℓ .



Draw the image of quadrilateral $ABCD$ after reflecting it across line ℓ .

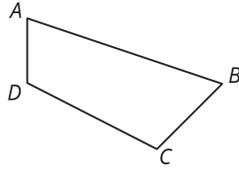
Solution



Problem 3

(from Unit 1, Lesson 2)

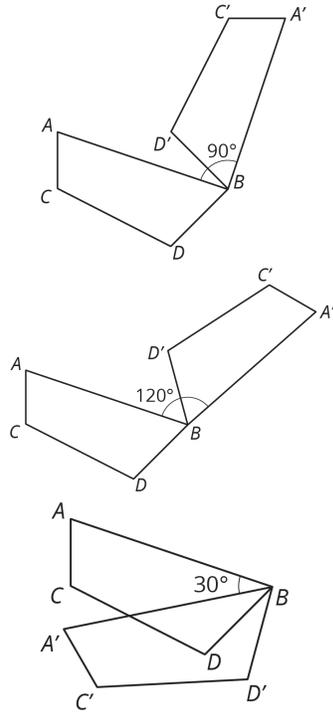
Here is quadrilateral $ABCD$.



Draw the image of quadrilateral $ABCD$ after each rotation using B as center.

1. 90 degrees clockwise
2. 120 degrees clockwise
3. 30 degrees counterclockwise

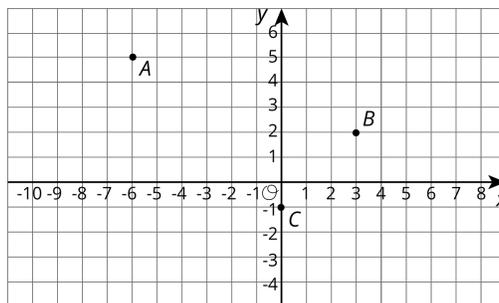
Solution



Lesson 5

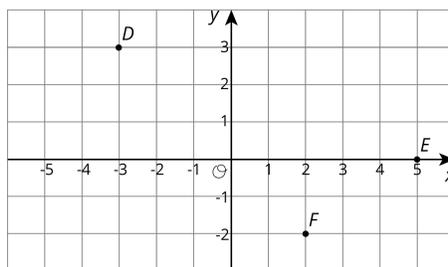
Problem 1

1. Here are some points.



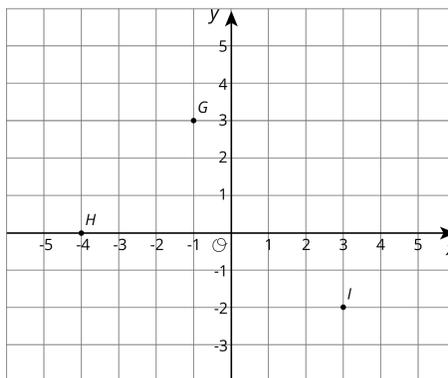
What are the coordinates of A , B , and C after a translation to the right by 4 units and up 1 unit? Plot these points on the grid, and label them A' , B' and C' .

2. Here are some points.



What are the coordinates of D , E , and F after a reflection over the y axis? Plot these points on the grid, and label them D' , E' and F' .

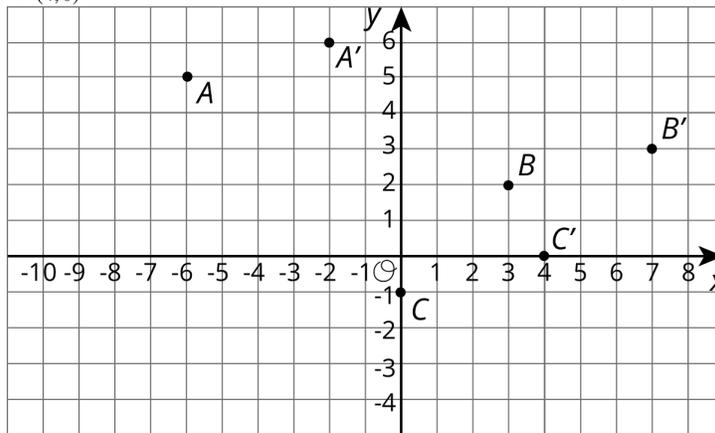
3. Here are some points.



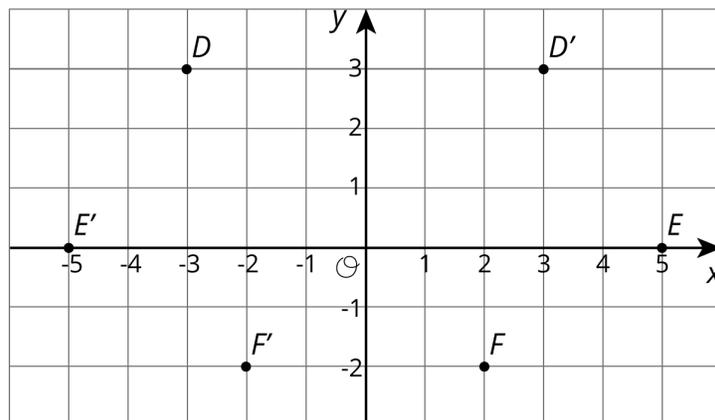
What are the coordinates of G , H , and I after a rotation about $(0,0)$ by 90 degrees clockwise? Plot these points on the grid, and label them G' , H' and I' .

Solution

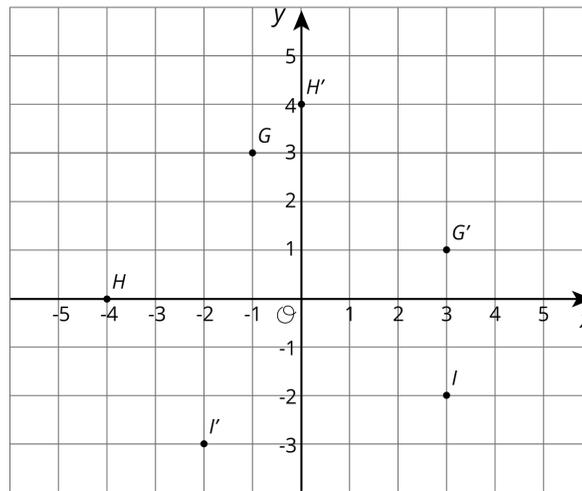
1. $A' = (-2,6), B' = (7,3), C' = (4,0)$



2. $D' = (3,3), E' = (-5,0), F' = (-2,-2)$



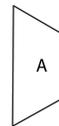
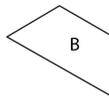
3. $G' = (3,1), H' = (0,4), I' = (-2,-3)$



Problem 2

(from Unit 1, Lesson 4)

Describe a sequence of transformations that takes trapezoid A to trapezoid B.



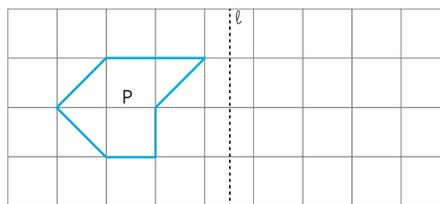
Solution

Answers vary. Sample response: Translate A up, then rotate it 60 degrees counter-clockwise (with center of rotation the bottom vertex), and then translate it left.

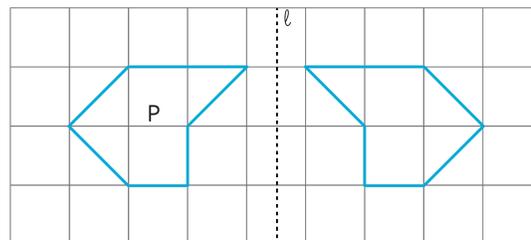
Problem 3

(from Unit 1, Lesson 3)

Reflect polygon *P* using line *ℓ*.



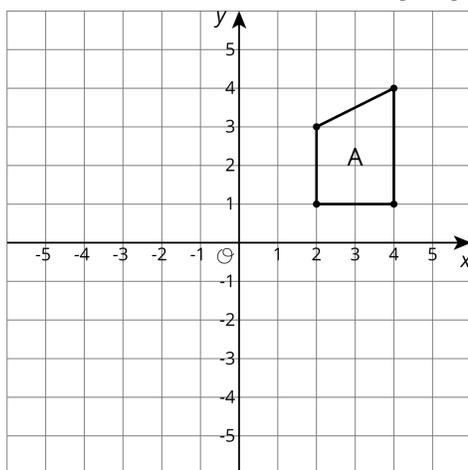
Solution



Lesson 6

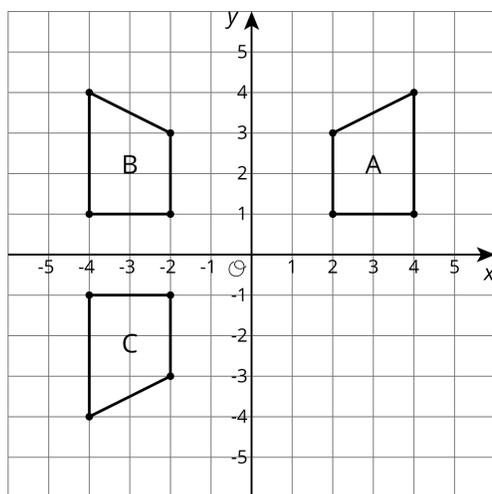
Problem 1

Here is Trapezoid A in the coordinate plane:



1. Draw Polygon B, the image of A, using the y -axis as the line of reflection.
2. Draw Polygon C, the image of B, using the x -axis as the line of reflection.
3. Draw Polygon D, the image of C, using the x -axis as the line of reflection.

Solution



Polygon D is the same as B: reflecting a polygon twice over the x -axis returns it to its original position.

Problem 2

The point $(-4, 1)$ is rotated 180 degrees counterclockwise using center $(-3, 0)$. What are the coordinates of the image?

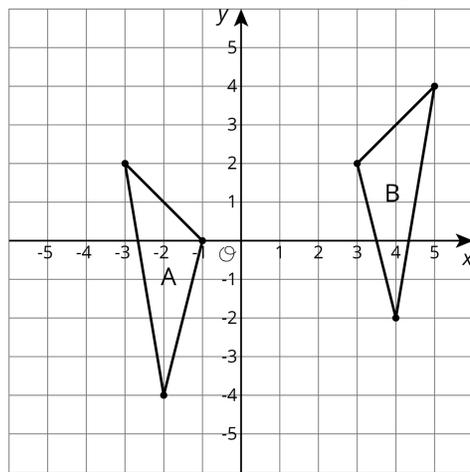
- a. $(-5, -2)$
- b. $(-4, -1)$
- c. $(-2, -1)$
- d. $(4, -1)$

Solution

C

Problem 3

Describe a sequence of transformations for which Triangle B is the image of Triangle A.



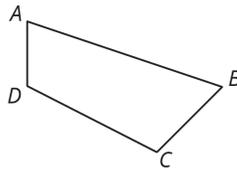
Solution

Answers vary. Sample response: B is the image of A under a reflection over the y -axis, then a translation 2 units to the right and 2 units up.

Problem 4

(from Unit 1, Lesson 2)

Here is quadrilateral $ABCD$.



Draw the image of quadrilateral $ABCD$ after each transformation.

1. The translation that takes B to D .
2. The reflection over segment BC .
3. The rotation about point A by angle DAB , counterclockwise.

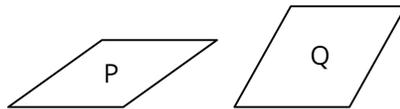
Solution

1. Image of trapezoid moved to the left so that B lines up with D
2. Image of trapezoid sharing segment BC with $ABCD$
3. Image of trapezoid rotated so that the side corresponding to AD is now part of segment AB

Lesson 7

Problem 1

Is there a rigid transformation taking Rhombus P to Rhombus Q? Explain how you know.

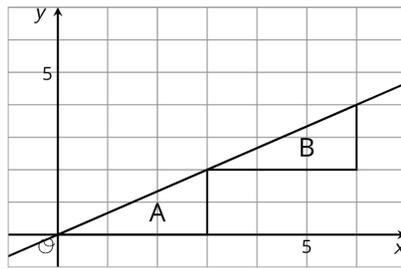


Solution

No, because the angle measures of the two polygons are different, and a rigid transformation must preserve all lengths and angle measures.

Problem 2

Describe a rigid transformation that takes Triangle A to Triangle B.

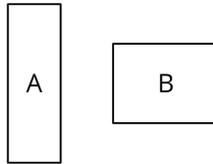


Solution

Translate three units right and two units up.

Problem 3

Is there a rigid transformation taking Rectangle A to Rectangle B? Explain how you know.



Solution

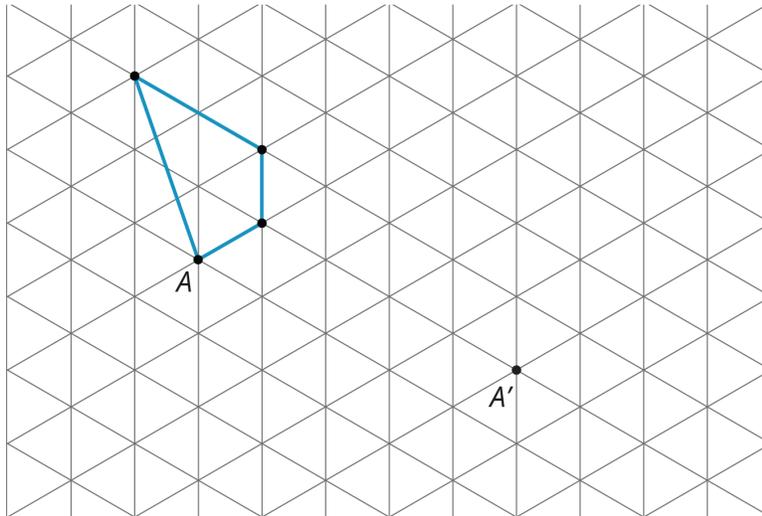
No, because the side lengths of the two rectangles are different, and a rigid transformation must preserve all lengths and angle measures.

Problem 4

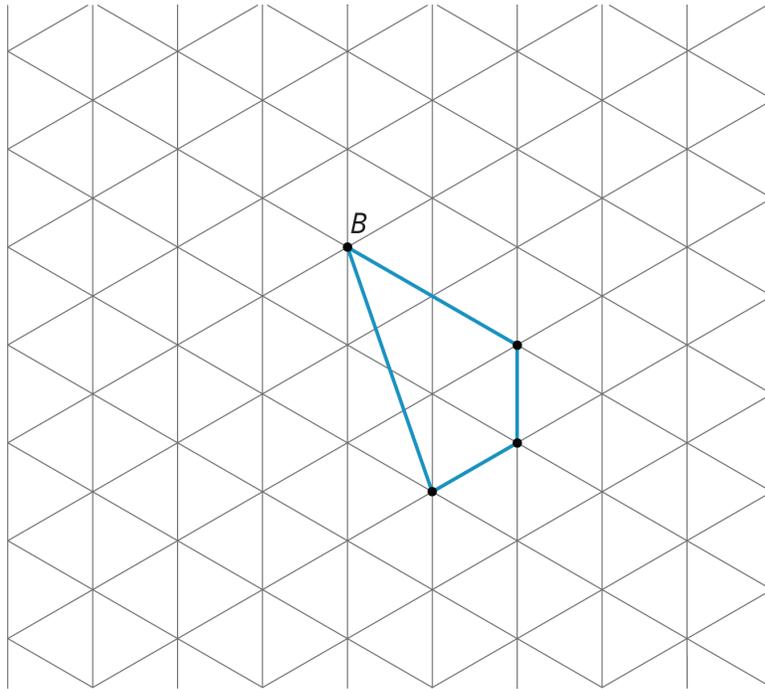
(from Unit 1, Lesson 4)

For each shape, draw its image after performing the transformation. If you get stuck, consider using tracing paper.

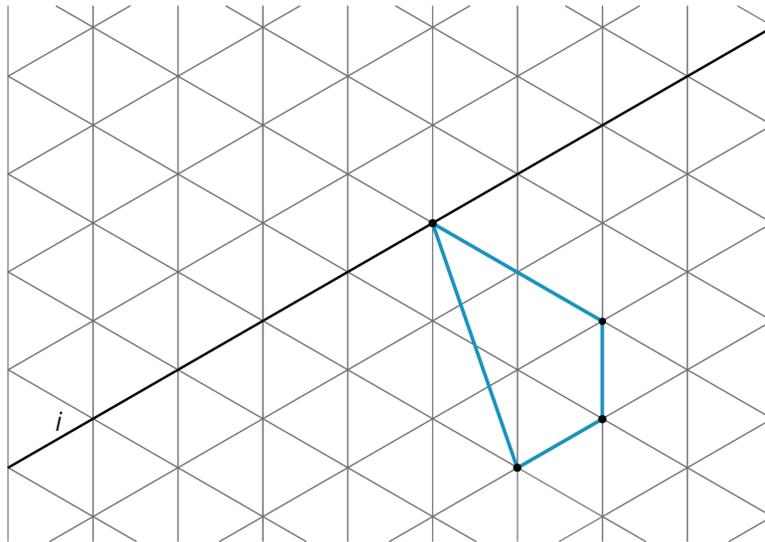
1. Translate the shape so that A goes to A' .



2. Rotate the shape 180 degrees counterclockwise around B .

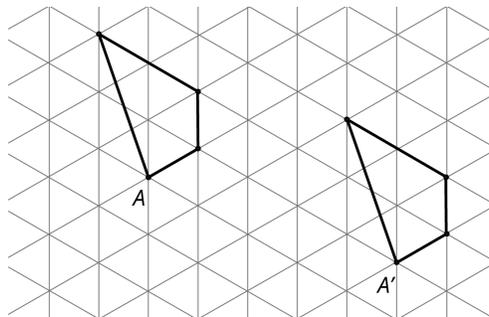


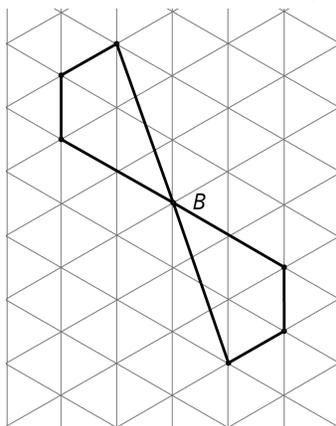
3. Reflect the shape over the line shown.



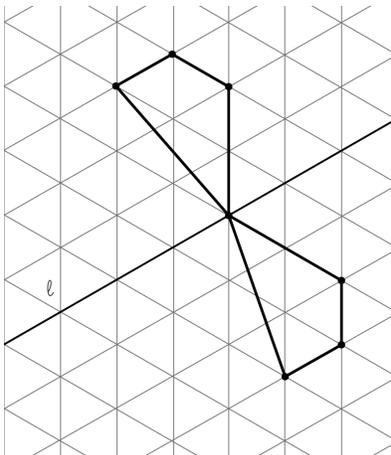
Solution

1.





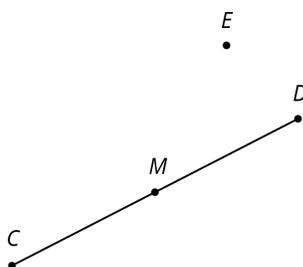
3.



Lesson 8

Problem 1

For the figure shown here,



1. Rotate segment CD 180° around point D .
2. Rotate segment CD 180° around point E .
3. Rotate segment CD 180° around point M .

Solution

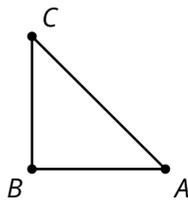
1. The segment is attached at point D and is an extension of segment CD .
2. The segment is above point E and is parallel to segment CD .
3. The segment is identical to segment CD .

Problem 2

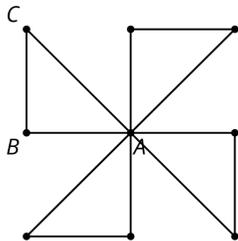
Here is an isosceles right triangle:

Draw these three rotations of triangle ABC together.

1. Rotate triangle ABC 90 degrees clockwise around A .
2. Rotate triangle ABC 180 degrees around A .
3. Rotate triangle ABC 270 degrees clockwise around A .



Solution

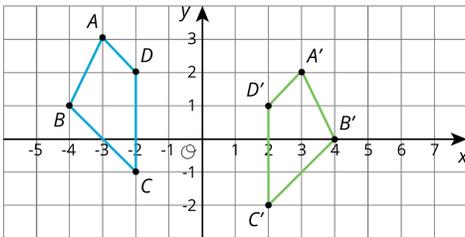


Problem 3

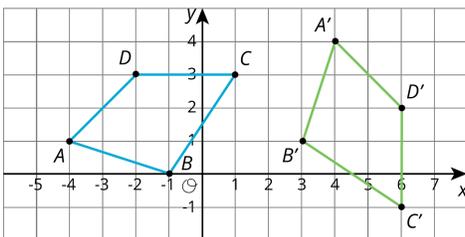
(from Unit 1, Lesson 5)

Each graph shows two polygons $ABCD$ and $A'B'C'D'$. In each case, describe a sequence of transformations that takes $ABCD$ to $A'B'C'D'$.

1.



2.



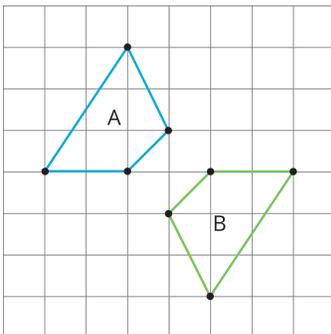
Solution

1. Reflect $ABCD$ over the y -axis, and then translate down 1.
2. Rotate $ABCD$ 90 degrees clockwise with center $B = (-1, 0)$, and then translate $(-1, 0)$ to $(3, 1)$.

Problem 4

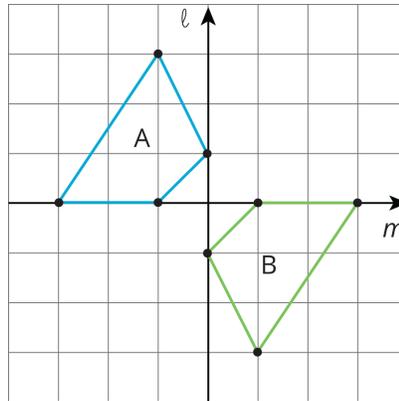
(from Unit 1, Lesson 4)

Lin says that she can map Polygon A to Polygon B using *only* reflections. Do you agree with Lin? Explain your reasoning.



Solution

I agree with Lin. If Polygon A is reflected first over the vertical line ℓ and then over the horizontal line m , this takes Polygon A to Polygon B.

**Lesson 9****Problem 1**

1. Draw parallel lines AB and CD .
2. Pick any point E . Rotate AB 90 degrees clockwise around E .
3. Rotate CD 90 degrees clockwise around E .
4. What do you notice?

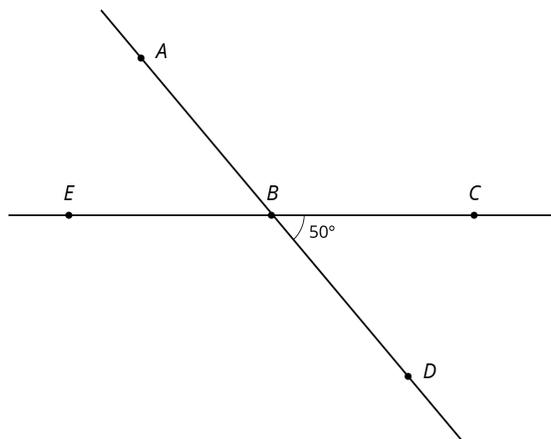
Solution

1. Answers vary.
2. Answers vary. The new line should be perpendicular to AB .
3. Answers vary. The new line should be perpendicular to CD and parallel to AB .
4. Answers vary. Sample response: the two new rotated lines are parallel.

Problem 2

Use the diagram to find the measures of each angle. Explain your reasoning.

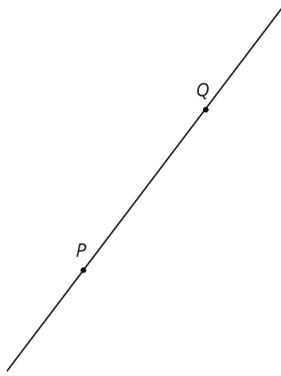
1. $m\angle ABC$
2. $m\angle EBD$
3. $m\angle ABE$

**Solution**

1. 130 degrees. $\angle ABC$ and $\angle CBD$ make a line, so they add up to 180 degrees.
2. 130 degrees. $\angle EBD$ and $\angle CBD$ make a line, so they add up to 180 degrees.
3. 50 degrees. $\angle ABE$ and $\angle ABC$ make a line, so they add up to 180 degrees.

Problem 3

Points P and Q are plotted on a line.



1. Find a point R so that a 180-degree rotation with center R sends P to Q and Q to P .
2. Is there more than one point R that works for part a?

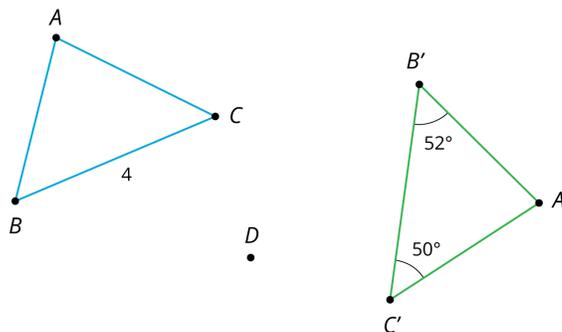
Solution

1. If R is the midpoint of segment PQ , then a rotation of 180 degrees with center R sends P to Q and Q to P .
2. No (The midpoint of PQ is the only point that works. 180 rotations with any other center do not send P to Q or Q to P .)

Problem 4

(from Unit 1, Lesson 7)

In the picture triangle $A'B'C'$ is an image of triangle ABC after a rotation. The center of rotation is D .



1. What is the length of side $B'C'$? Explain how you know.
2. What is the measure of angle B' ? Explain how you know.
3. What is the measure of angle C' ? Explain how you know.

Solution

1. 4 units. Rotations preserve side lengths, and side $B'C'$ corresponds to side BC under this rotation.
2. 52 degrees. Rotations preserve angle measures, and angles B and B' correspond to each other under this rotation.
3. 50 degrees. Rotations preserve angle measures, and angles C and C' correspond to each other under this rotation.

Problem 5

(from Unit 1, Lesson 6)

The point $(-4, 1)$ is rotated 180 degrees counterclockwise using center $(0, 0)$. What are the coordinates of the image?

- a. $(-1, -4)$
- b. $(-1, 4)$
- c. $(4, 1)$
- d. $(4, -1)$

Solution

D

Lesson 10

Problem 1

Here is the design for the flag of Trinidad and Tobago.



Describe a sequence of translations, rotations, and reflections that take the lower left triangle to the upper right triangle.

Solution

Answers vary. Sample response: 180 degree rotation around the center point of the flag. Another sample response: The lower left triangle is first translated to the right so that it shares an edge with the upper right triangle. Then it's rotated 180 degrees around the midpoint of the common side.

Problem 2

Here is a picture of an older version of the flag of Great Britain. There is a rigid transformation that takes Triangle 1 to Triangle 2, another that takes Triangle 1 to Triangle 3, and another that takes Triangle 1 to Triangle 4.



1. Measure the lengths of the sides in Triangles 1 and 2. What do you notice?
2. What are the side lengths of Triangle 3? Explain how you know.
3. Do all eight triangles in the flag have the same area? Explain how you know.

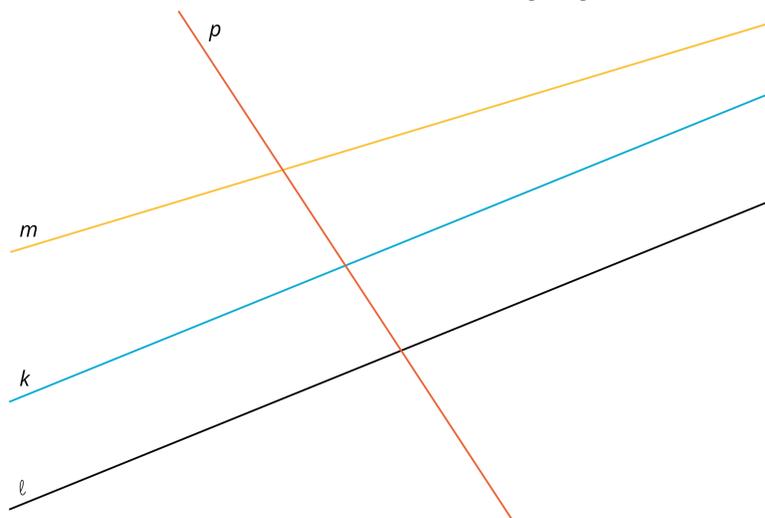
Solution

1. Answers vary. The side lengths of the two triangles are the same.
2. The side lengths will be the same as Triangle 1, because there is a rigid transformation taking Triangle 1 to Triangle 3.
3. No. The four triangles without number labels are larger, so they will not have the same area as the smaller labeled triangles.

Problem 3

(from Unit 1, Lesson 9)

1. Which of the lines in the picture is parallel to line l ? Explain how you know.

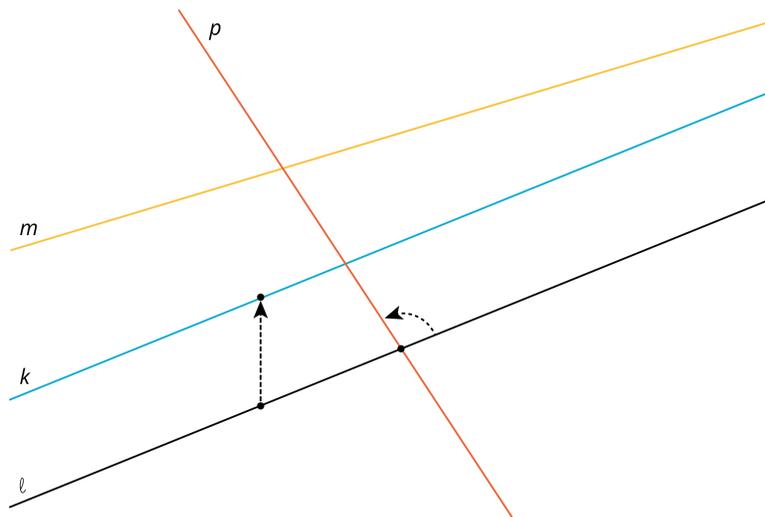


2. Explain how to translate, rotate or reflect line ℓ to obtain line k .
3. Explain how to translate, rotate or reflect line ℓ to obtain line p .

Solution

1. k . These two lines do not intersect no matter how far out they extend.
2. Line k can be obtained by translating line ℓ .
3. Line p can be obtained by rotating line ℓ .

The picture below shows how to translate ℓ to get k and how to rotate ℓ to get p .



Problem 4

(from Unit 1, Lesson 6)

Point A has coordinates $(3, 4)$. After a translation 4 units left, a reflection across the x -axis, and a translation 2 units down, what are the coordinates of the image?

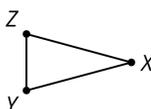
Solution

$(-1, -6)$

Problem 5

(from Unit 1, Lesson 8)

Here is triangle XYZ :



Draw these three rotations of triangle XYZ together.

1. Rotate triangle XYZ 90 degrees clockwise around Z .
2. Rotate triangle XYZ 180 degrees around Z .
3. Rotate triangle XYZ 270 degrees clockwise around Z .

Solution

Each rotation shares vertex Z with triangle XYZ . The four triangles together look like a pinwheel.

Lesson 11

Problem 1

If two rectangles have the same perimeter, do they have to be congruent? Explain how you know.

Solution

No. Two non-congruent rectangles can have the same perimeter. For example, a rectangle with side lengths 3 inches and 4 inches is not congruent to a rectangle with side lengths 2 inches and 5 inches. Even though the angles of all rectangles have the same measure, when two figures are congruent all side lengths and angle measures are the same.

Problem 2

Draw two rectangles that have the same area, but are *not* congruent.

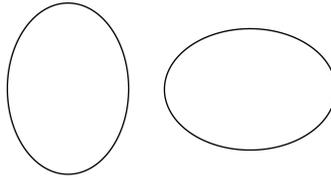
Solution

Answers vary. Sample response: a 2-by-6 rectangle and a 3-by-4 rectangle.

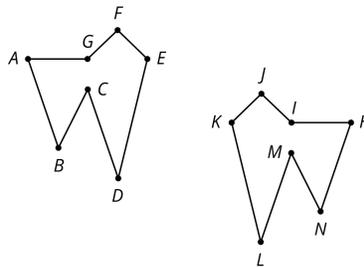
Problem 3

For each pair of shapes, decide whether or not it appears that the two shapes are congruent. Explain your reasoning.

1.



2.

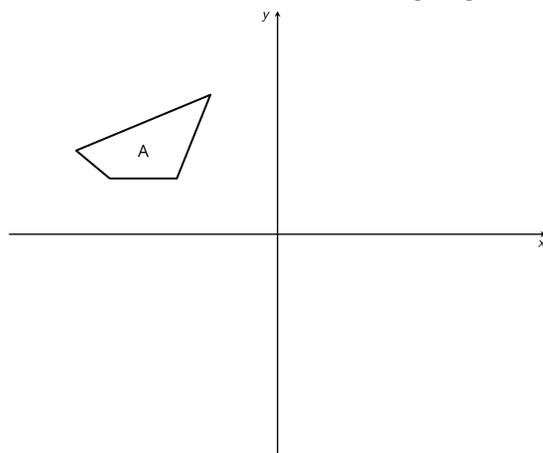


Solution

1. These appear to be congruent. If the shape on the right is traced, it can be moved over and it appears to match up perfectly with the shape on the left. This can be done with a rotation (90 degrees clockwise) and then a translation.
2. These appear to be congruent. If $ABCDEFG$ is reflected about a vertical line and then translated, it appears to land on top of $HNMLKJI$.

Problem 4

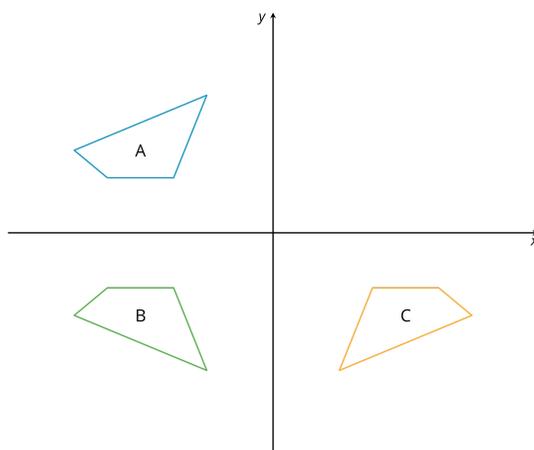
1. Reflect Quadrilateral A over the x -axis. Label the image quadrilateral B. Reflect Quadrilateral B over the y -axis. Label the image C.



2. Are Quadrilaterals A and C congruent? Explain how you know.

Solution

1.



2. Yes, because there is a rigid transformation taking A to C, the two shapes are congruent.

Problem 5

(from Unit 1, Lesson 6)

The point $(-2, -3)$ is rotated 90 degrees counterclockwise using center $(0, 0)$. What are the coordinates of the image?

- a. $(-3, -2)$
- b. $(-3, 2)$
- c. $(3, -2)$
- d. $(3, 2)$

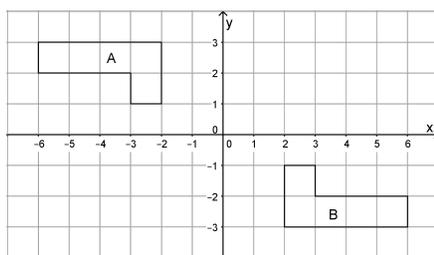
Solution

C

Problem 6

(from Unit 1, Lesson 7)

Describe a rigid transformation that takes Polygon A to Polygon B.



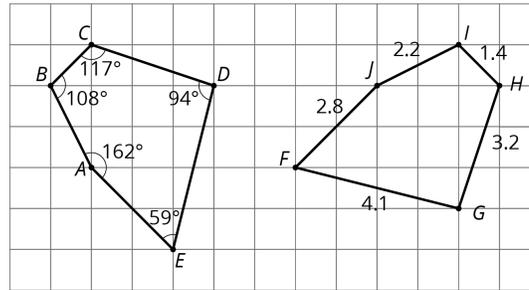
Solution

Answers vary. Sample response: Rotate Polygon A 180 degrees around $(0, 0)$.

Lesson 12

Problem 1

1. Show that the two pentagons are congruent.
2. Find the side lengths of $ABCDE$ and the angle measures of $FGHIJ$.



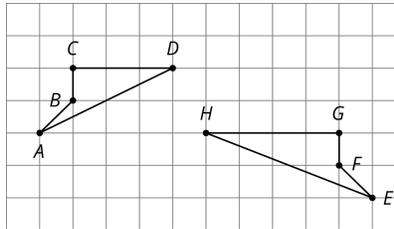
Solution

1. After performing a 90-degree clockwise rotation with center D , then translating 3 units down and 6 units to the right, $ABCDE$ matches up perfectly with $JIHGF$. The rotation and translation do not change side lengths or angle measures.
2. $AB = 2.2$, $BC = 1.4$, $CD = 3.2$, $DE = 4.1$, and $EA = 2.8$. $m\angle F = 59^\circ$, $m\angle G = 94^\circ$, $m\angle H = 117^\circ$, $m\angle I = 108^\circ$, and $m\angle J = 162^\circ$.

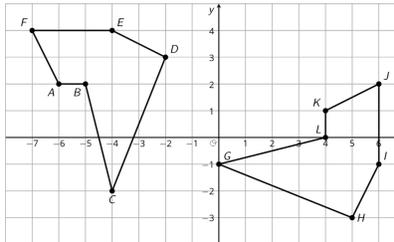
Problem 2

For each pair of shapes, decide whether or not the two shapes are congruent. Explain your reasoning.

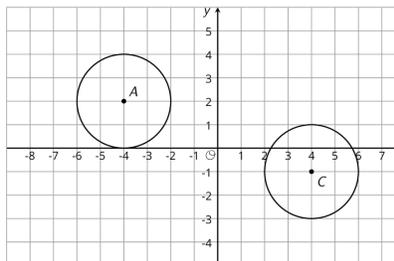
1.



2.



3.



Solution

1. Not congruent. Segment EH in polygon $EFGH$ is longer than any of the sides in polygon $ABCD$. A , B , and C can be matched up with vertices E , F , and G , but H does not match up with D .
2. Congruent. If $ABCDE$ is rotated 90 degrees clockwise about C and then moved 4 units to the right and 1 unit up, it matches up perfectly with $GHIJKL$.
3. Congruent. If the circle on the top left is translated to the right by 8 units and down 3 units, it lands on top of the other circle.

Problem 3

(from Unit 1, Lesson 8)

1. Draw segment PQ .

2. When PQ is rotated 180° around point R , the resulting segment is the same as PQ . Where could point R be located?

Solution

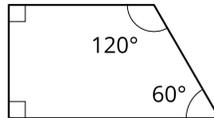
1. Answers vary.

2. R must be the midpoint of PQ .

Problem 4

(from Unit 1, Lesson 10)

Here is trapezoid $ABCD$.



Using rigid transformations on the trapezoid, build a pattern. Describe some of the rigid transformations you used.

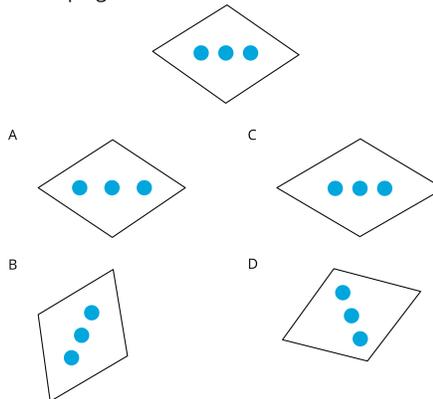
Solution

Answers vary. Sample response: clockwise rotations, centered at the vertex of the 60° angle, of 60° , 120° , 180° , 240° , and 300° make a "windmill" type figure with copies of the trapezoid.

Lesson 13

Problem 1

Which of these four figures are congruent to the top figure?

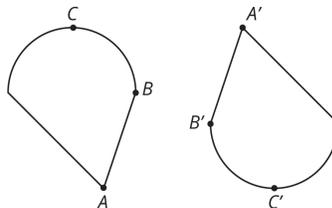


Solution

B

Problem 2

These two figures are congruent, with corresponding points marked.



1. Are angles ABC and $A'B'C'$ congruent? Explain your reasoning.

2. Measure angles ABC and $A'B'C'$ to check your answer.

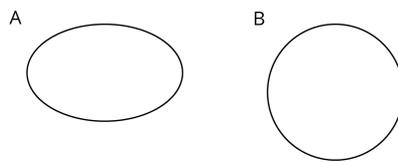
Solution

1. Yes they are angles made by corresponding points on congruent figures so they are congruent.

2. Both angles measure about 110 degrees.

Problem 3

Here are two figures.



Show, using measurement, that these two figures are *not* congruent.

Solution

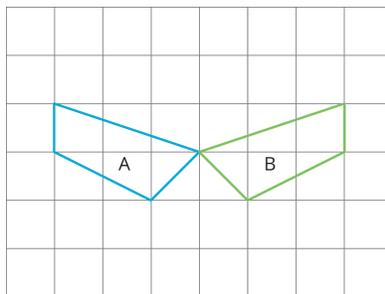
Answers vary. Sample response: The rightmost and leftmost points on Figure A are further apart than any pair of points on Figure B. So these two points can not correspond to any pair of points on Figure B and the two figures are not congruent.

Problem 4

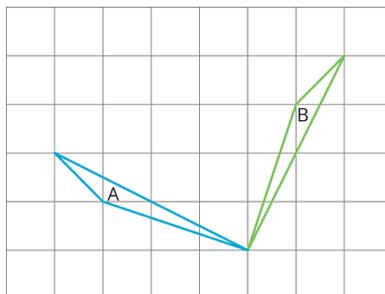
(from Unit 1, Lesson 3)

Each picture shows two polygons, one labeled Polygon A and one labeled Polygon B. Describe how to move Polygon A into the position of Polygon B using a transformation.

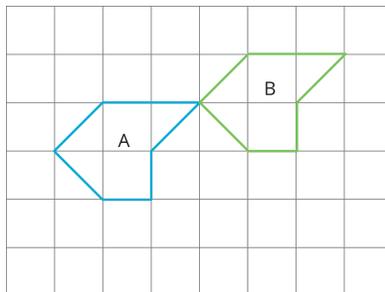
1.



2.



3.



Solution

1. Flip A over the vertical line through the vertex shared by A and B.
2. Rotate A in a clockwise direction around the vertex shared by the two polygons.
3. Translate A up and to the right. It needs to go up one unit and right 3 units.

Lesson 14

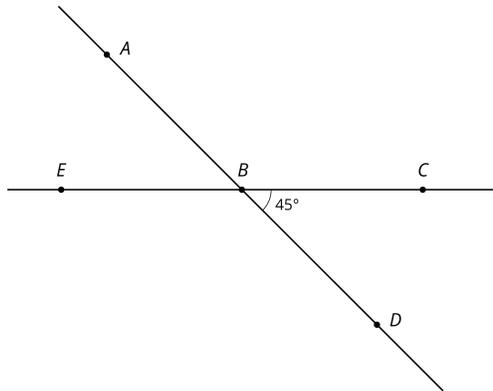
Problem 1

Use the diagram to find the measure of each angle. Explain your reasoning.

1. $m\angle ABC$

2. $m\angle EBD$

3. $m\angle ABE$

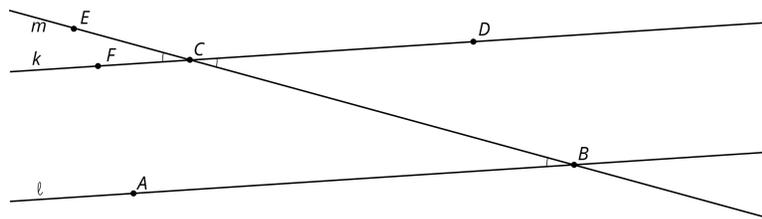


Solution

- 135 degrees. $\angle ABC$ and $\angle CBD$ make a line, so they add up to 180 degrees.
- 135 degrees. $\angle EBD$ and $\angle ABC$ are vertical angles made by intersecting lines, so they are congruent.
- 45 degrees. $\angle ABE$ and $\angle CBD$ are vertical angles made by intersecting lines, so they are congruent.

Problem 2

Lines k and ℓ are parallel, and the measure of angle ABC is 19 degrees.



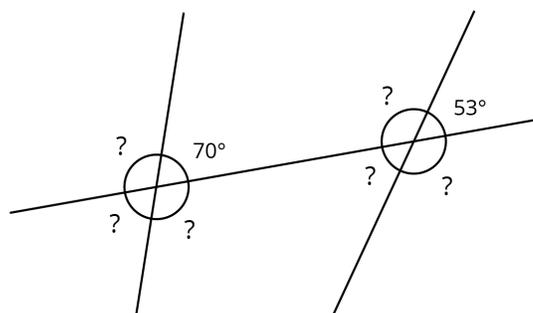
- Explain why the measure of angle ECF is 19 degrees. If you get stuck, consider translating line ℓ by moving B to C .
- What is the measure of angle BCD ? Explain.

Solution

- If ℓ is translated so that B goes to C , then l goes to k because k is parallel to ℓ . Angle ABC matches up with angle FCE after this translation, so FCE (and ECF) is also a 19 degree angle.
- Angles ECF and BCD are congruent because they are vertical angles. Since angle ECF is a 19 degree angle, so is angle BCD .

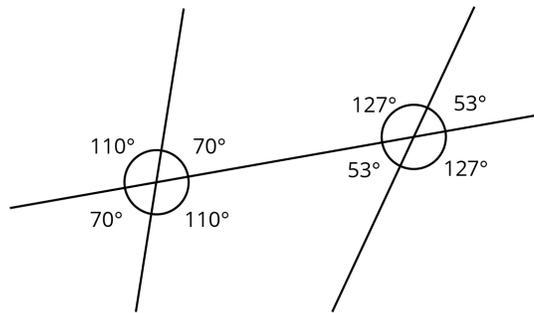
Problem 3

The diagram shows three lines with some marked angle measures.



Find the missing angle measures marked with question marks.

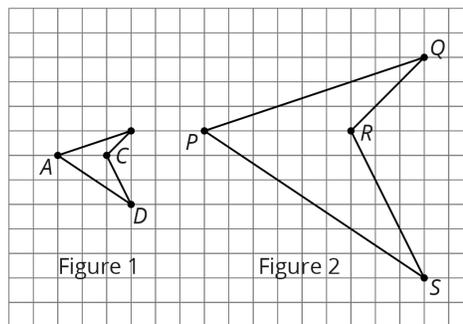
Solution



Problem 4

The two figures are scaled copies of each other.

1. What are some ways that you can tell they are scaled copies?
2. What is the scale factor that takes Figure 1 to Figure 2?
3. What is the scale factor that takes Figure 2 to Figure 1?



Solution

1. Answers vary.
2. 3
3. $\frac{1}{3}$

Lesson 15

Problem 1

In triangle ABC , the measure of angle A is 40° .

1. Give possible measures for angles B and C if triangle ABC is isosceles.
2. Give possible measures for angles B and C if triangle ABC is right.

Solution

1. There are two possibilities: Angles B and C each measure 70° , or one of angles B and C measures 40° and the other measures 50° .
2. One of angles B and C measures 50° , and the other angle measures 90° .

Problem 2

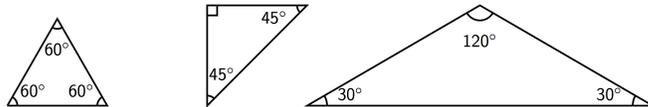
For each set of angles, decide if there is a triangle whose angles have these measures in degrees:

1. 60, 60, 60
2. 90, 90, 45
3. 30, 40, 50
4. 90, 45, 45
5. 120, 30, 30

If you get stuck, consider making a line segment. Then use a protractor to measure angles with the first two angle measures.

Solution

Triangles can be made with the sets of angles in a, d, and e but not with b, and c.



Problem 3

Angle A in triangle ABC is obtuse. Can angle B or angle C be obtuse? Explain your reasoning.

Solution

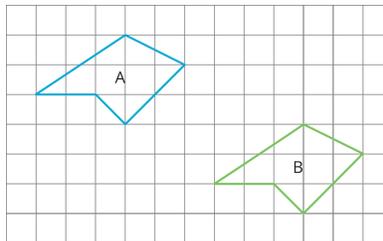
No, a triangle can not have two obtuse angles. If the obtuse angles were at vertices A and B , for example, then those angles do not meet at any point C .

Problem 4

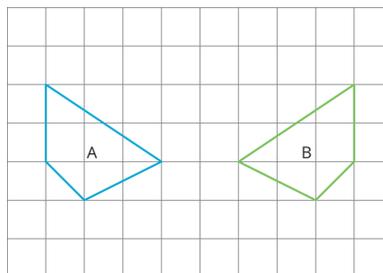
(from Unit 1, Lesson 3)

For each pair of polygons, describe the transformation that could be applied to Polygon A to get Polygon B.

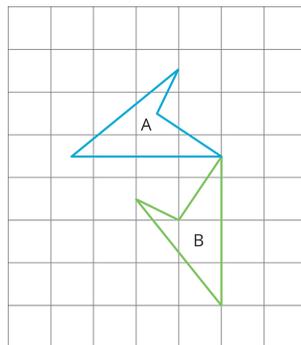
1.



2.



3.



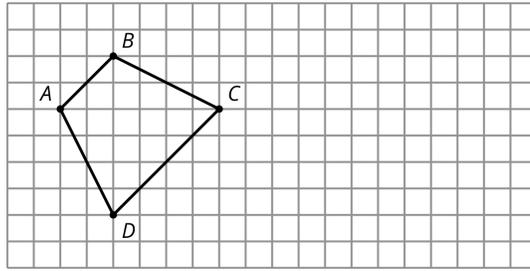
Solution

1. Translation down 3 units and right 6 units
2. Reflection with a vertical line of reflection halfway between the two polygons
3. Rotation by 90 degrees counterclockwise with the vertex shared by the two polygons as the center of rotation

Problem 5

(from Unit 1, Lesson 14)

On the grid, draw a scaled copy of quadrilateral $ABCD$ using a scale factor of $\frac{1}{2}$.



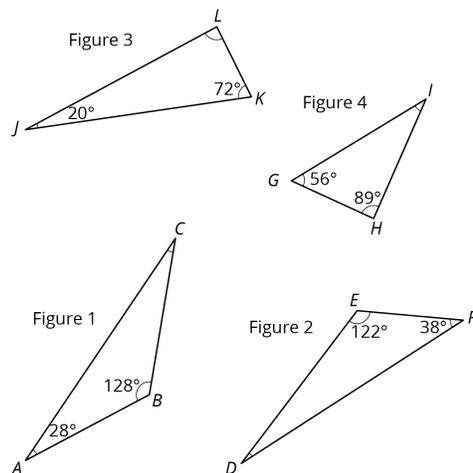
Solution

Answers vary. Each side is $\frac{1}{2}$ the length of the corresponding side on $ABCD$. For example, if $B'C'$ on the scaled copy corresponds to BC , then C' should be down 1 grid square and right 2 grid squares from B' . The same should be true for all other sides: this guarantees that corresponding angles will have the same measure.

Lesson 16

Problem 1

For each triangle, find the measure of the missing angle.



Solution

- 24 degrees ($24 + 28 + 128 = 180$)
- 20 degrees ($20 + 38 + 122 = 180$)
- 88 degrees ($88 + 20 + 72 = 180$)
- 35 degrees ($35 + 56 + 89 = 180$)

Problem 2

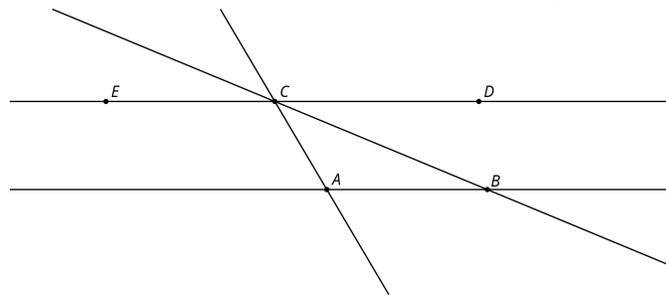
Is there a triangle with *two* right angles? Explain your reasoning.

Solution

No, the three angles in a triangle add up to 180 degrees. Two right angles would already make 180 degrees, and so the third angle of the triangle would have to be 0 degrees—this is not possible.

Problem 3

In this diagram, lines AB and CD are parallel.



Angle ABC measures 35° and angle BAC measures 115° .

1. What is $m\angle ACE$?
2. What is $m\angle DCB$?
3. What is $m\angle ACB$?

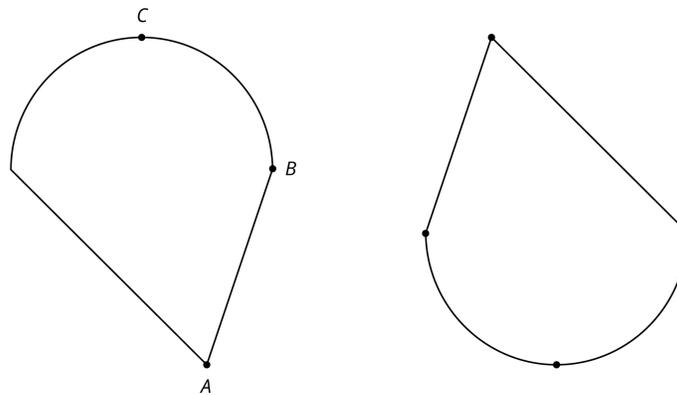
Solution

1. 115°
2. 35°
3. 30°

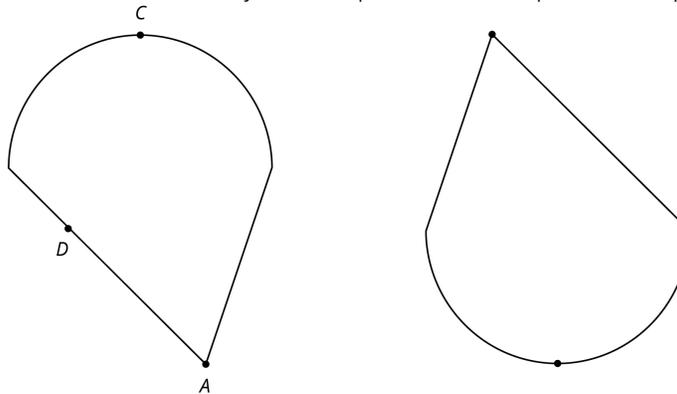
Problem 4

(from Unit 1, Lesson 13)
The two figures are congruent.

1. Label the points A' , B' and C' that correspond to A , B , and C in the figure on the right.

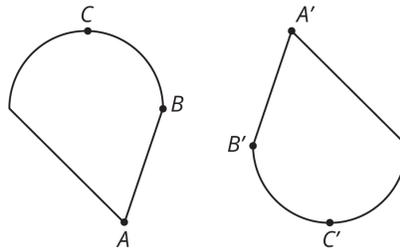


2. If segment AB measures 2 cm, how long is segment $A'B'$? Explain.
3. The point D is shown in addition to A and C . How can you find the point D' that corresponds to D ? Explain your reasoning.



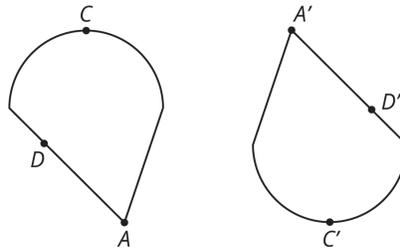
Solution

- 1.



2. 2 cm. The shapes are congruent, and the corresponding segments of congruent shapes are congruent.

3. Because the figures are congruent, the point D' will be on the corresponding side and will be the same distance from C' that D is from C . D can be found by looking for the point on the segment going down and to the right from A' that is the appropriate distance from C' .



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