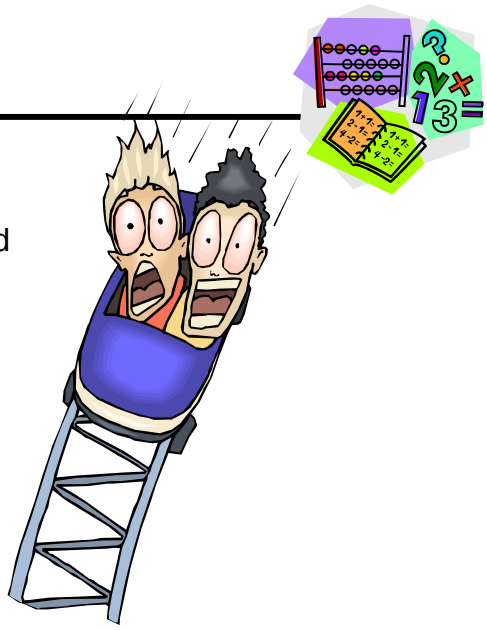
Transformations



Amusement park rides are exciting examples of objects (and people) in motion.

Of course, it is also the motion of these rides that causes motion sickness for some riders!

Transformations are movements of objects from one place to another, also called motion geometry. The shape/object created during a transformation is called an **image**.

There are three types of transformations:

Slides – Translations

Flips – Reflections

Turns – Rotations

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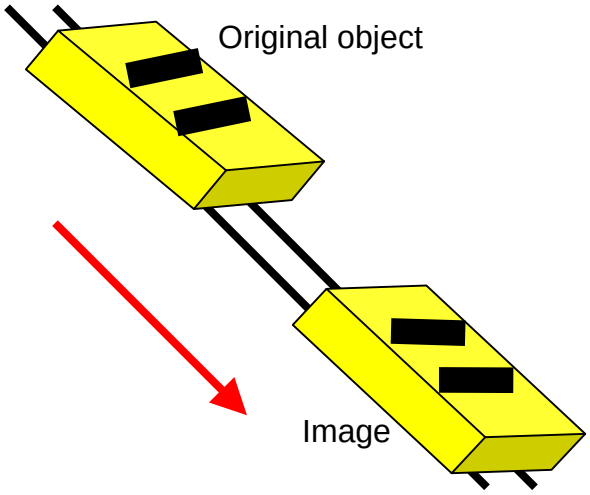
Translations (Slides)

A roller coaster is an example of a **translation** (slide). During a translation, the object has remained aligned in the same direction and has moved, or slid, to another spot.



The direction and length of a translation (or slide) can be illustrated in two ways: ordered pairs and translation arrows.

Ordered Pairs

Ordered pairs give the direction and length of a slide and in the form: **(x,y)**.

Positive x values indicate slides to the right. →
Negative x values indicate slides to the left. ←
Positive y values indicate slides up. ↑
Negative y values indicate slides down. ↓

Example: (+2,+1)

Move 2 units to the right along the x-axis.

Move 1 unit up along the y-axis.

The length and direction of the arrow also shows where to slide the object to.

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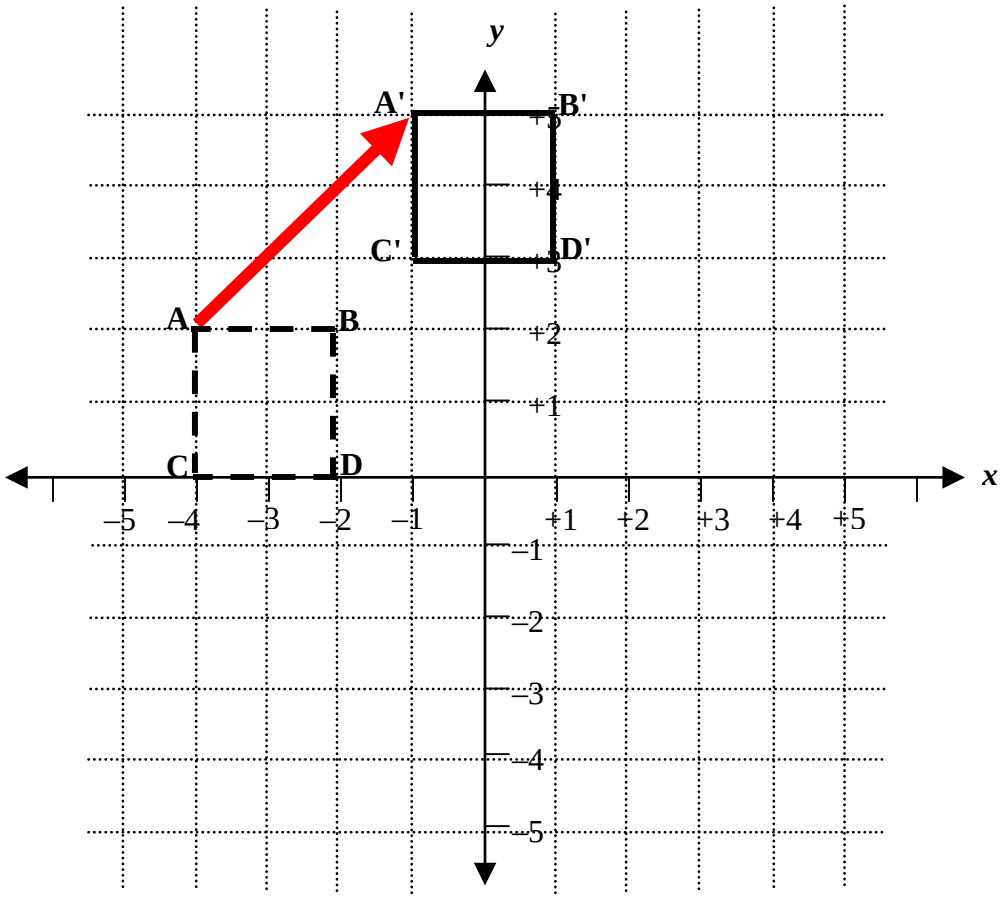
Examples

A) 3 units to the right, 2 units up



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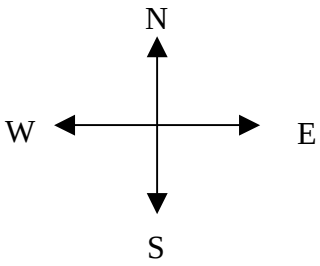
B) The park warden's patrol route has been moved to cover a new section of the park.

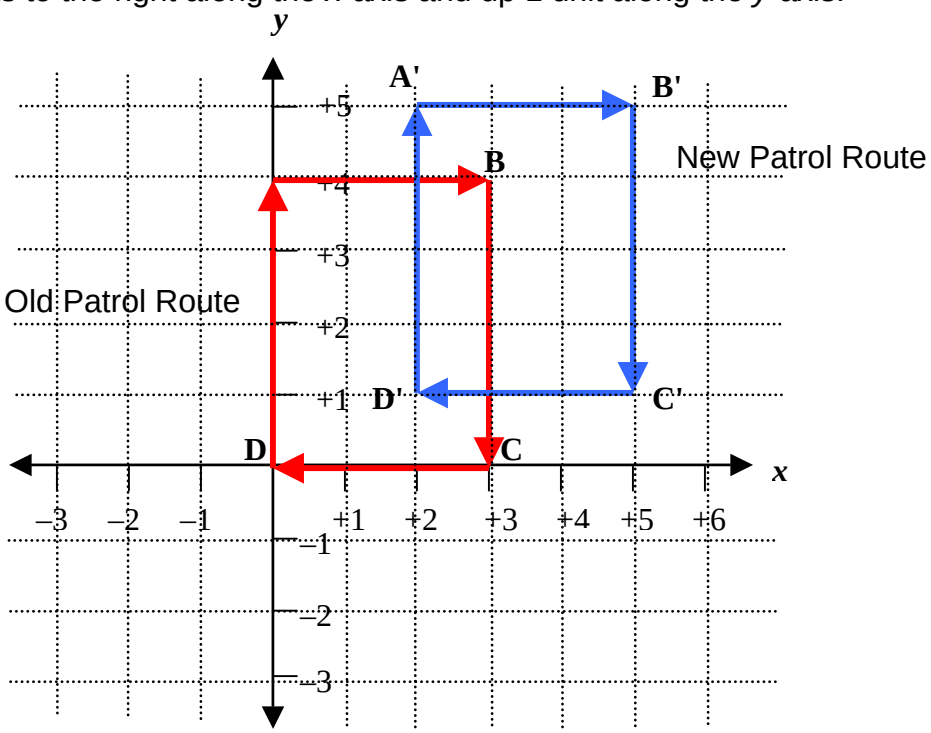
West and **East** are represented by the ***x*-axis**

North and **South** are represented by the ***y*-axis**



The former patrol route was: (0,0) (0,+4) (+3,+4) (+3,0)
The new patrol route is **2 units east** and **1 unit north** of the former route.
The new location is represented by the ordered pair **(+2,+1)**

To show movement, each of the old or original coordinates are moved **(+2,+1)**.
Move 2 units to the right along the *x*-axis and up 1 unit along the *y*-axis.



The new patrol route (A', B', C', D') is an **image** of the original patrol route.

To show that a shape or object is an image, each coordinate has a prime (**'**) symbol after the letter.

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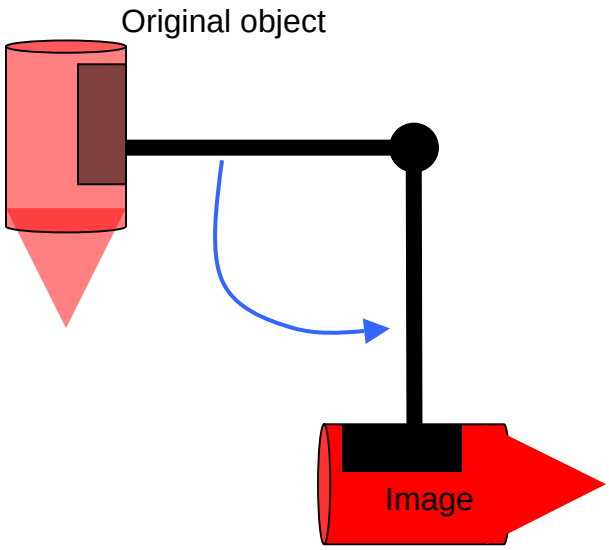
Rotations (Turns)

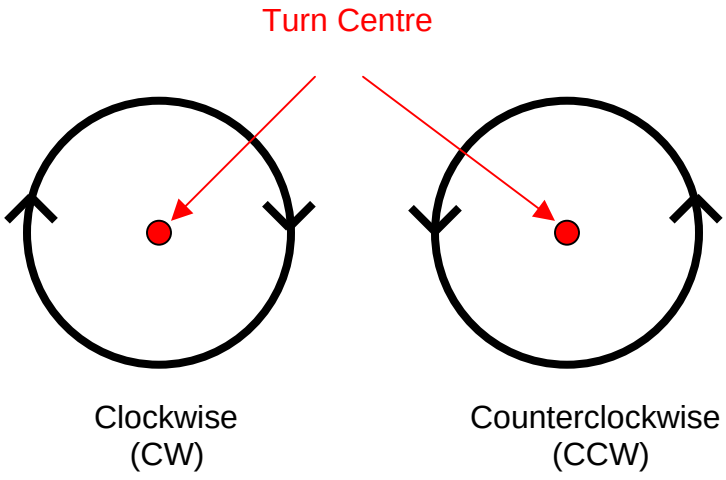
In a turn, the object has been moved around a specific point called the **turn centre**.



A **rotation** (turn) of an object involves turning an original object around a turn centre to make a congruent (or identical) image of the original object in another location and facing another direction.

Rotations can be either **clockwise** (CW) or **counterclockwise** (CCW) around a **turn centre**.

Rotations are described in angles or degrees, or in fractions such as one quarter, one half, three quarters and one whole.



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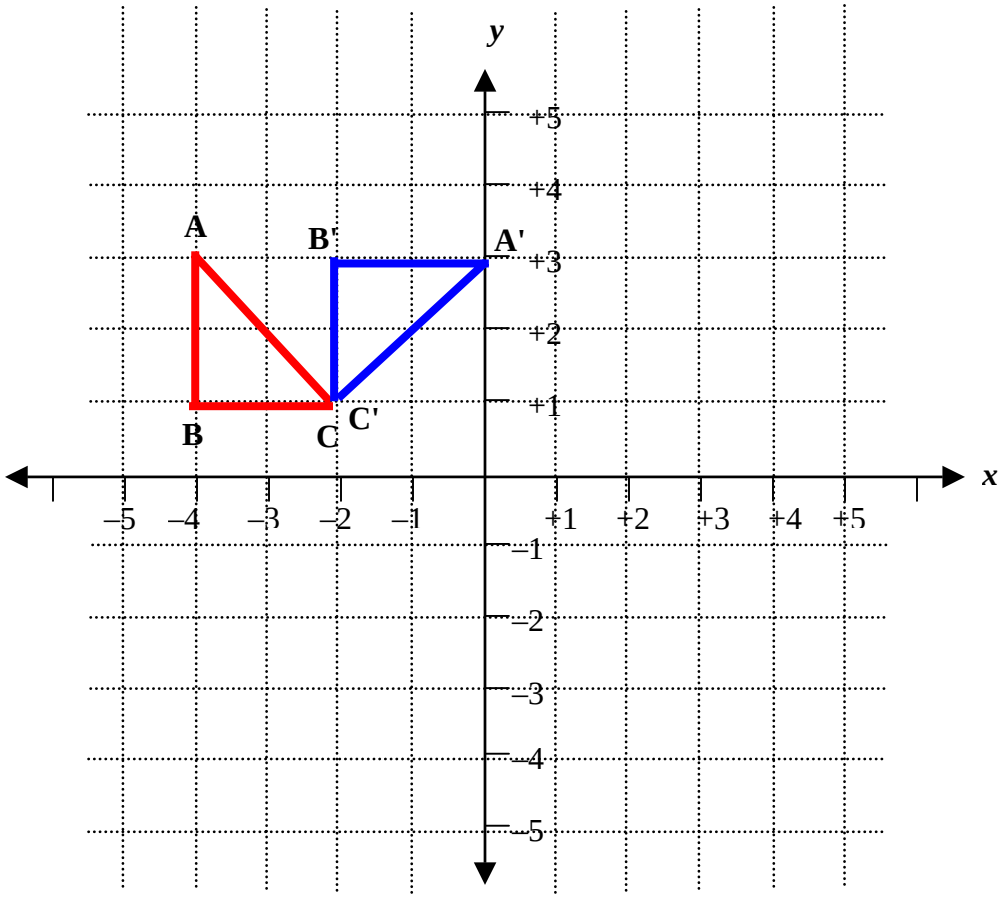
Example Rotate the triangle 90° CW.



Turns can be illustrated using graph paper and dot paper, and a protractor.

Turns can be illustrated using tracing paper.

- Trace the original object, including the turn centre.
- Rotate/turn the tracing paper the approximate angle and direction while keeping your pencil on the turn centre.
- Label the new points with the same letters but with a ' mark (e.g., A').

A computer and drawing software may be used to illustrate turns.

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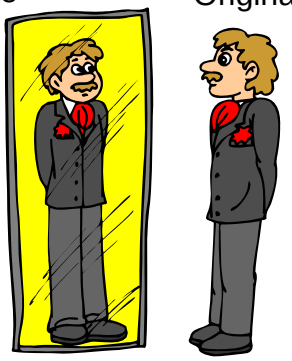
Reflections (Flips)

Image

Original object



The mirror shows a reflection (flip).

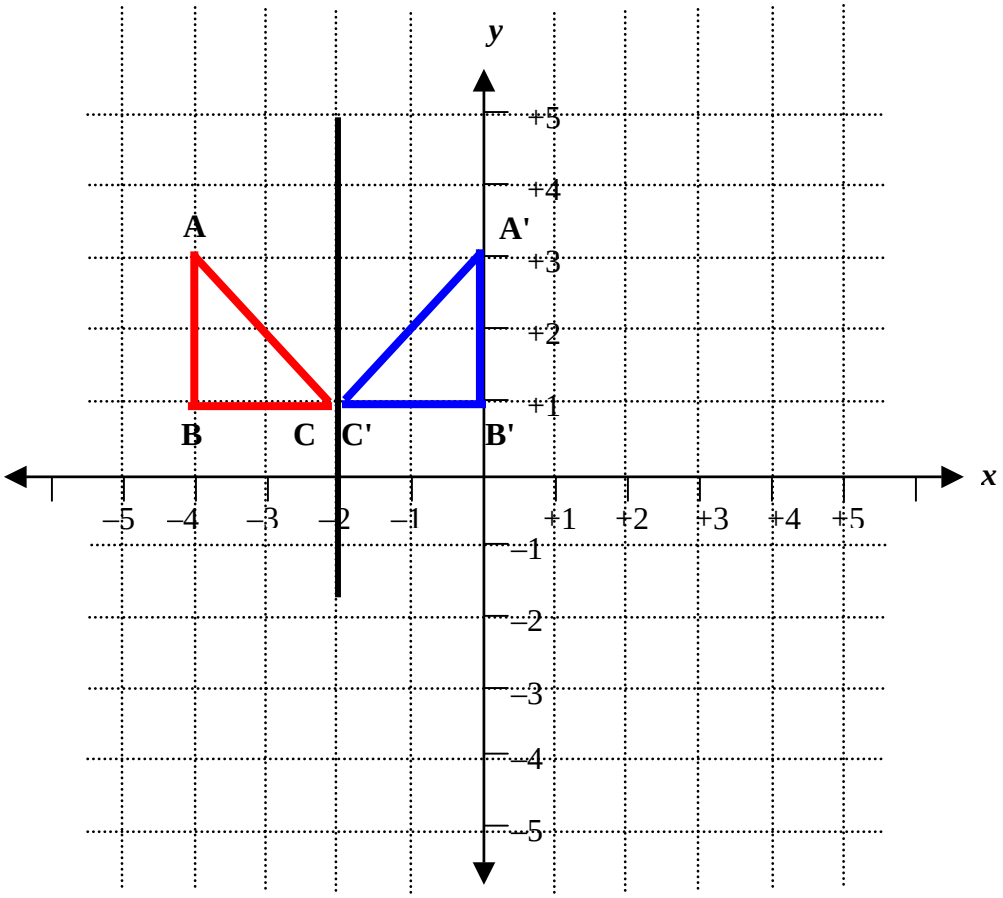
In a reflection, the object is flipped or reversed in comparison to the original object.

For example, if the man lifts his right arm, the image appears to lift his left arm.

A reflection (flip) occurs along a **reflection line**.

A reflection line is a line over which the original object will be flipped to create a congruent, mirror image of an object.

Each point of the original object is flipped or reflected an equal distance on the opposite side of the reflection line.



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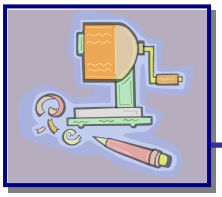

Practice: Slides, Turns and Flips

1. Plot the following points on grid paper and connect the points in order from first to last, connecting the last point to the first point to form a shape.

   (3,4) (5,4) (5,6) (3,6)

   Move the shape created above as described by the following ordered pairs and draw the new locations. Label each move using the number. Begin each move with the original location.

   a) (2,3)

   b) (–5,1)

   c) (4,–4)

   d) (–1,–2)

2. Plot the following order pairs in order onto a coordinate grid, and then connect the points.

   A (–1,+4) B (–1,–2) C (+2,–2) D (+2,+4)

   Use the shape above and perform the following transformations.

   a) Slide the shape (+2,+4) and label the image.

   b) Slide the shape (+1,–5) and label the image.

   c) Draw a reflection line that runs straight up and down, passing through the *x*-axis at (–3,0). Flip the original shape along this reflection line and label the image.

   d) Identify a turn centre and turn the shape 90° counterclockwise (CCW).

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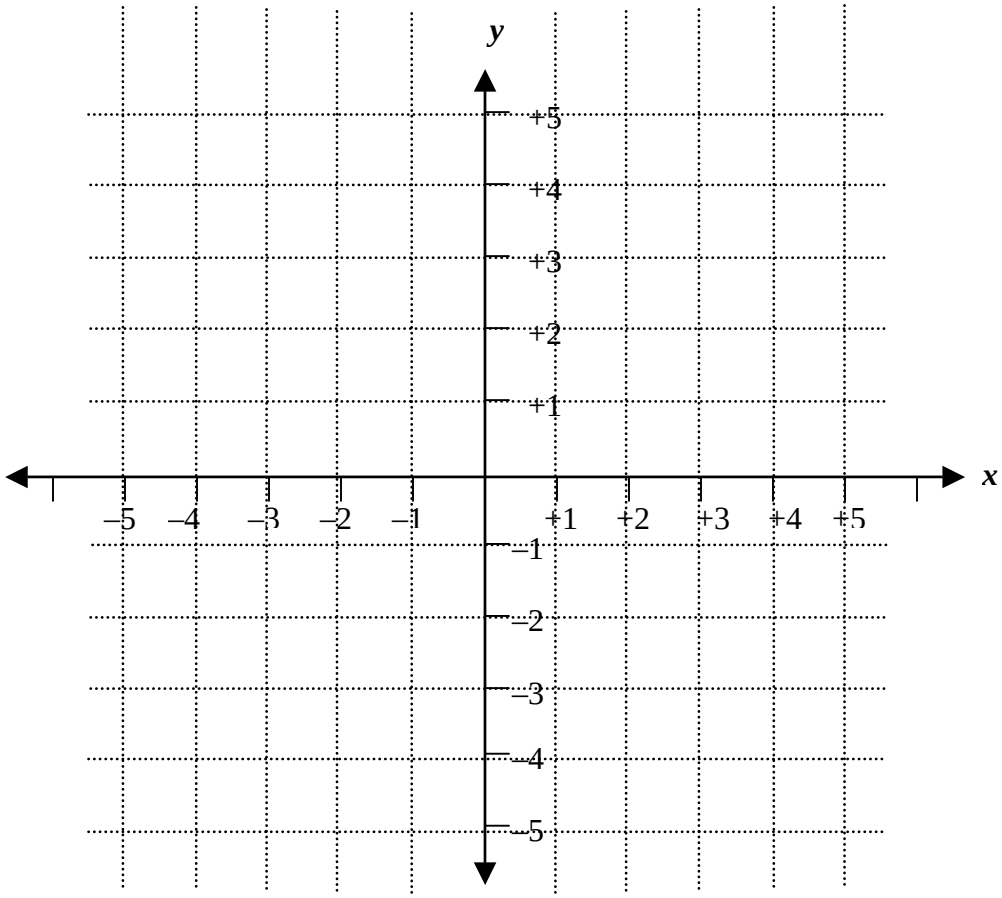

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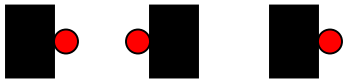
3. Identify the following transformations as a SLIDE, a TURN or a FLIP. Beside each term, place the appropriate word: translation, rotation or reflection.

a)

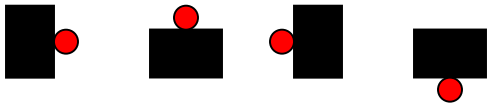
This is an example of a:

_____

b) 

This is an example of a:

_____

c) 

This is an example of a:

_____

d)

This is an example of a:

_____

e)

This is an example of a:

_____

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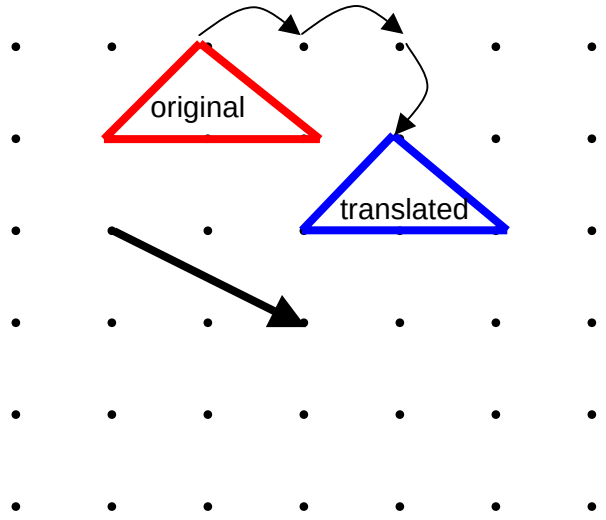
4. Complete the following translations. The first one has been done for you.

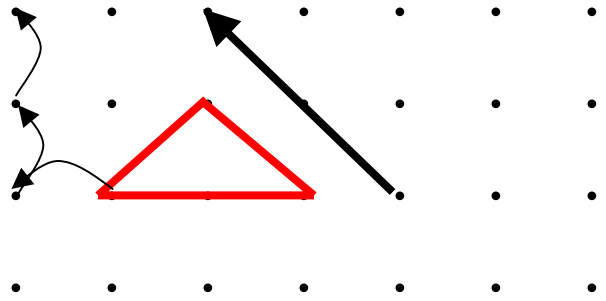
a)



The translation arrow represents a movement of the triangle three units to the right and one unit down.

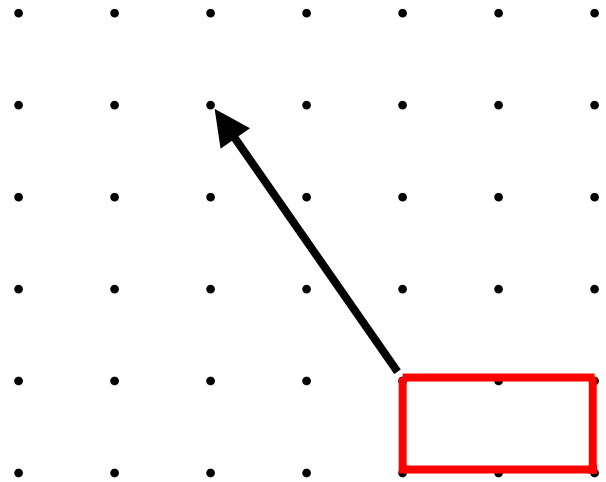
(2,–1)

b)



(–1,2)

c)



(–2,3)

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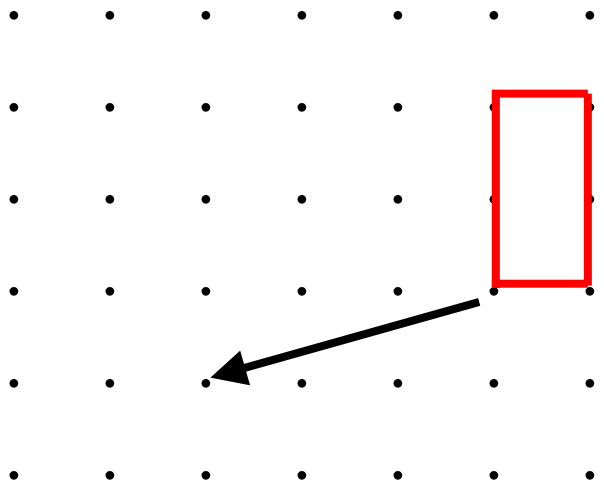
d)



(–3,–1)

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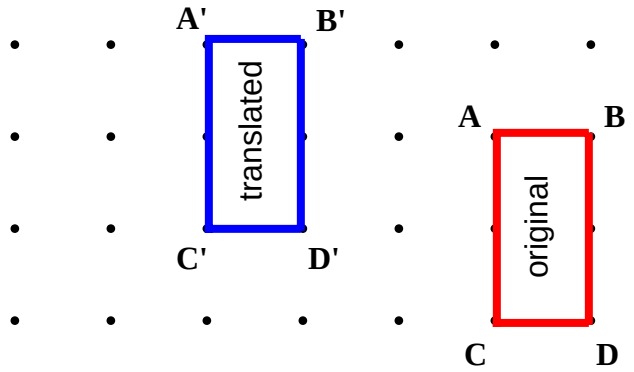
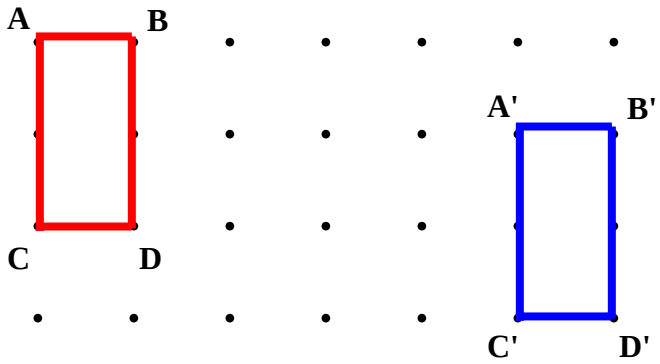
5. Identify the ordered pairs that describe the translations below. Remember how to identify the original and translated shapes.

a)



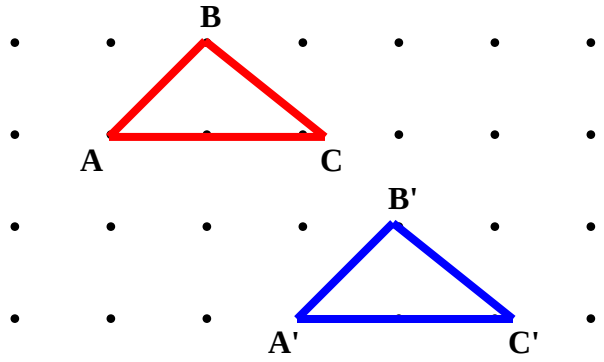
The ordered pair is: _____

b)



The ordered pair is: _____

c)



The ordered pair is: _____

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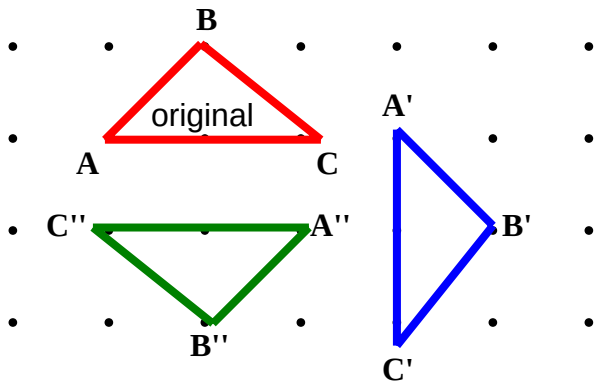
6. Complete the following turns. Be sure to label the points of your image. The first one has been done for you.

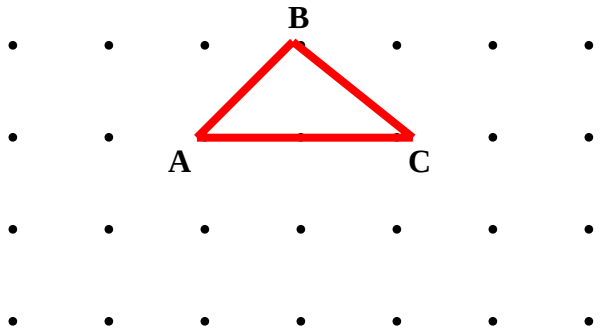
a)



Rotate:

a) 90° CW
b) 180° CCW

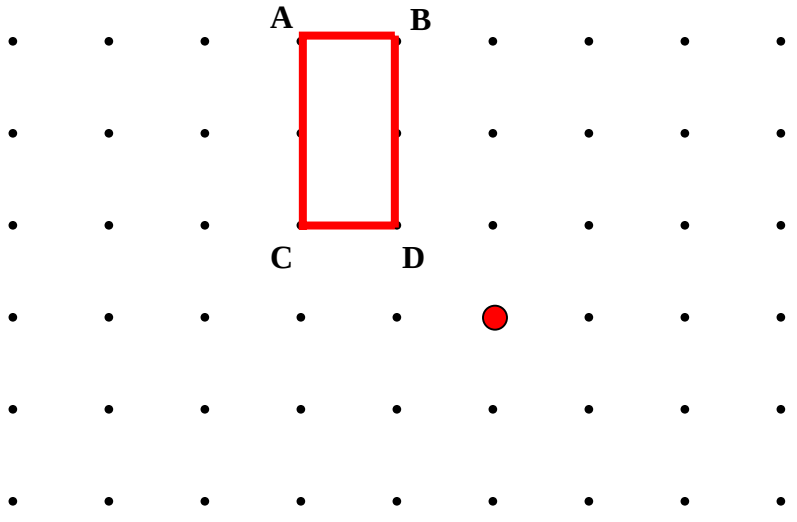
b)



Rotate:

a) 90° CCW
b) 180° CW

c)



Rotate using turn centre:

a) 90° CW
b) 180° CCW
c) 270° CW

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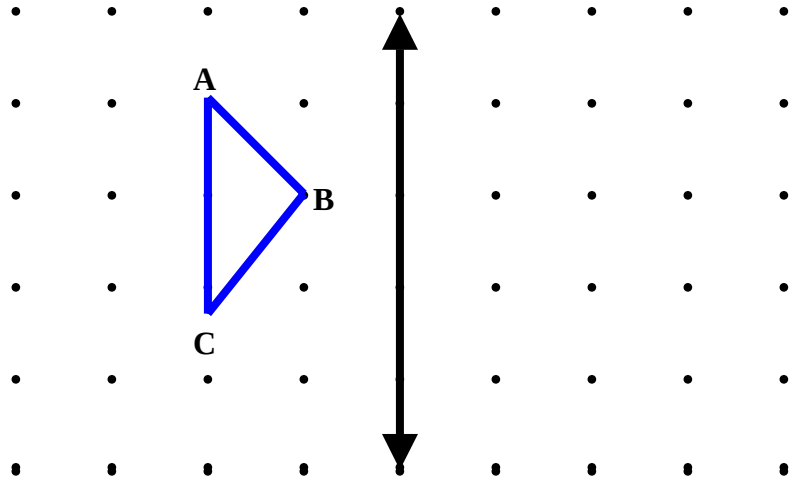
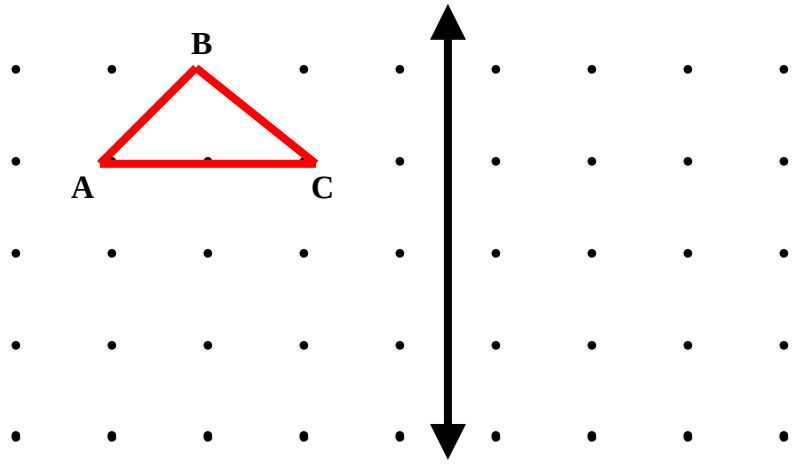
7. Complete the following flips. Label the points of your image.

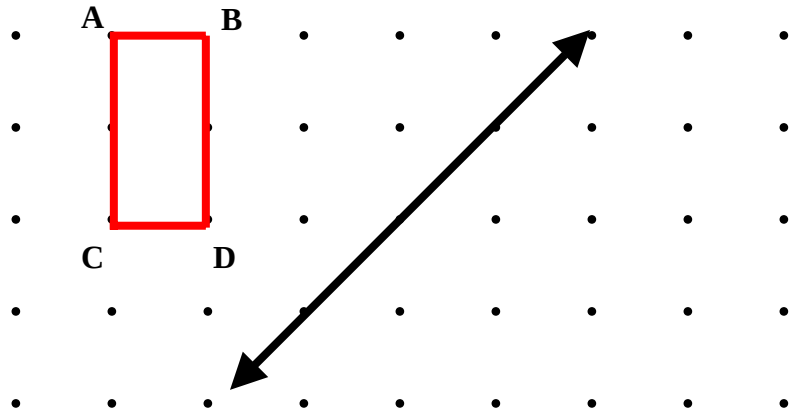
a)



b)



c)



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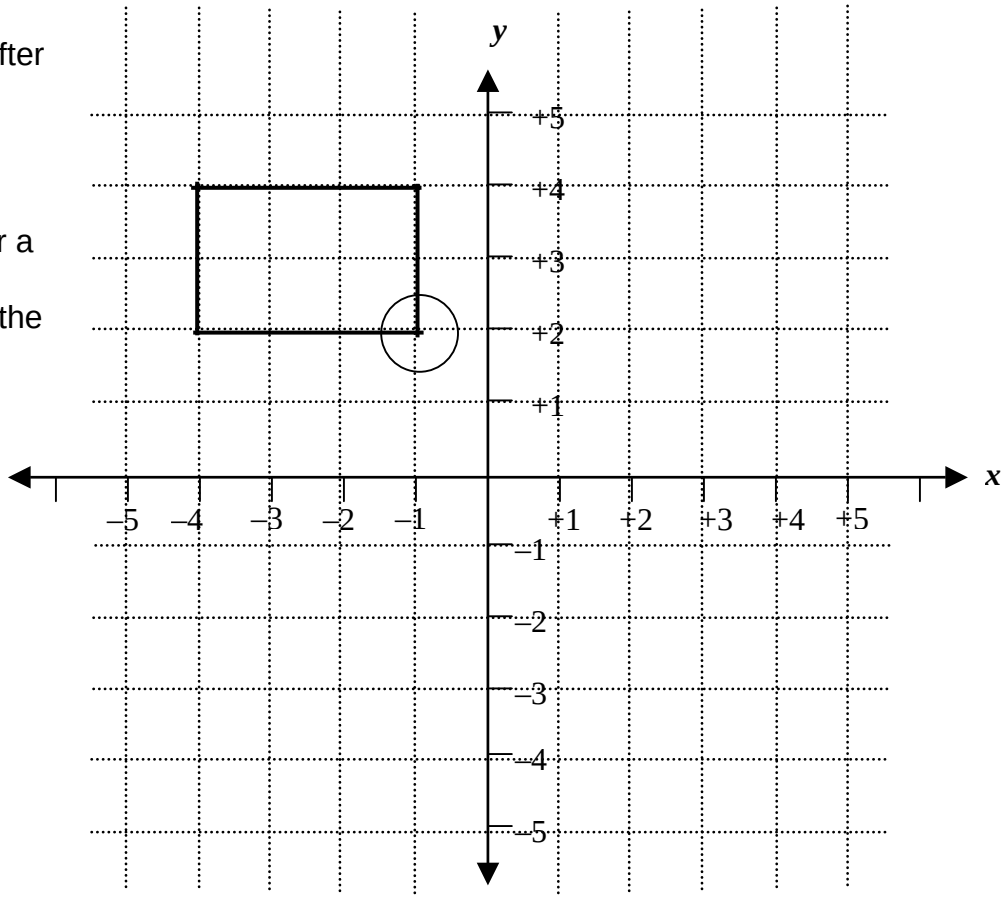
8. a) Draw the shape after a rotation of 90° clockwise at the turn centre (circled).

b) Draw the shape after a rotation of 180° counterclockwise at the turn centre (circled).



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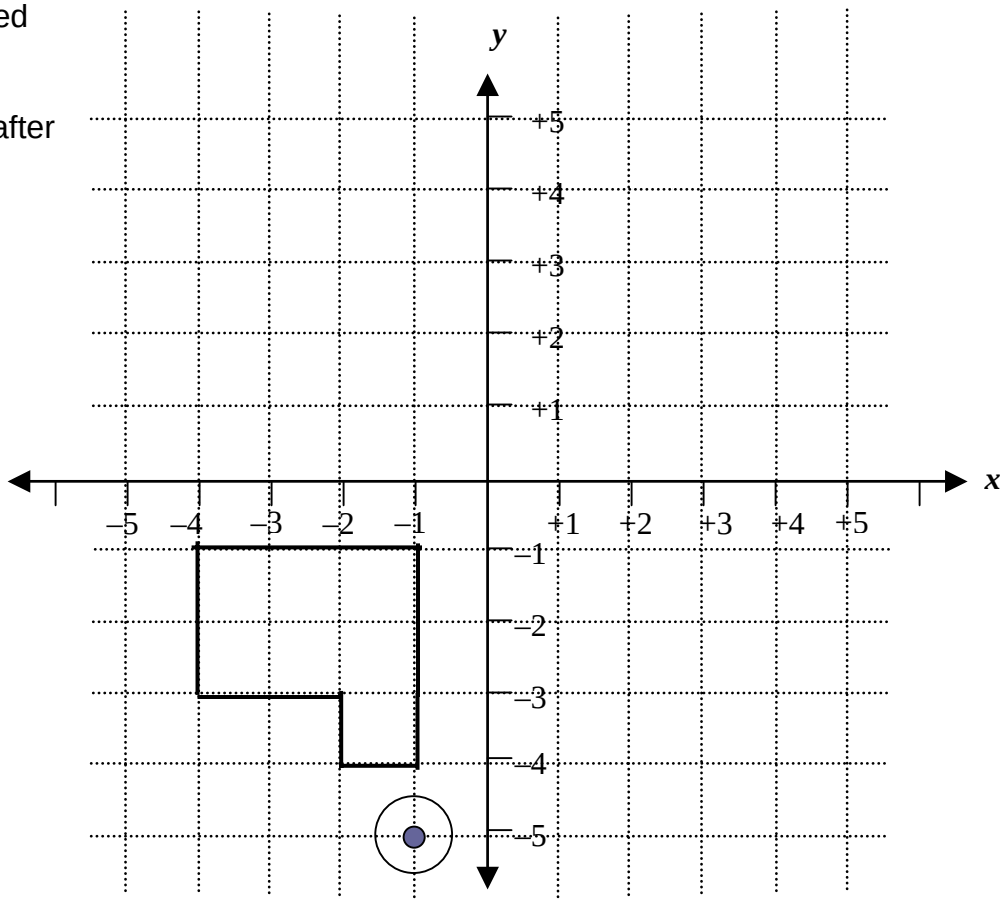
9. a) Draw the shape after a rotation of 90° clockwise at the turn centre (circled below).

   b) Draw the shape after a slide of 5 units up.



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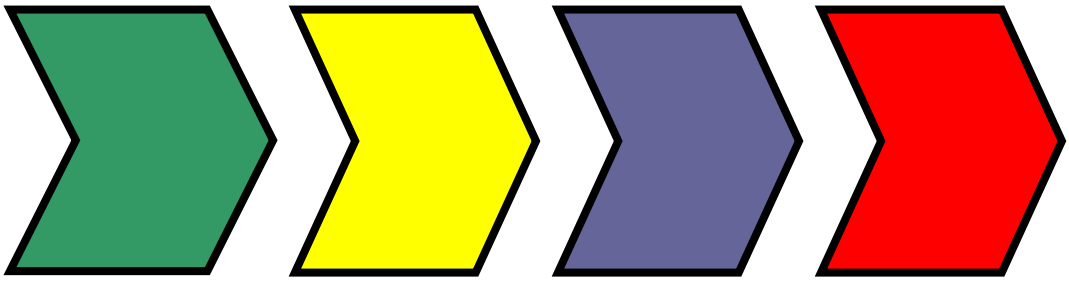
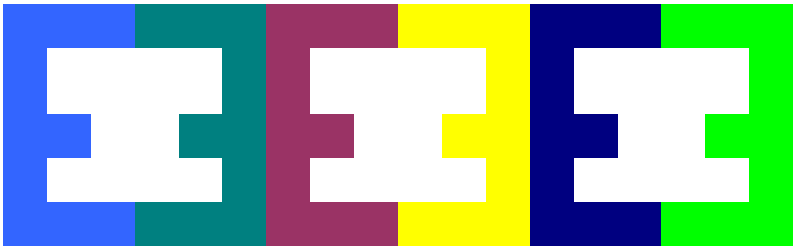
Creating Designs with Transformation

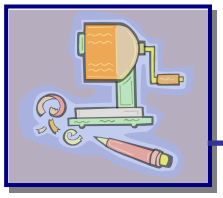
Transformations can be used to create interesting patterns and designs with basic shapes.

The pattern below was created from the original shape (far left) that has been **translated** to the right three times.



The original shape (far left) has been **reflected** or **flipped** five times to create the pattern below.





Practice: Creating Designs with Transformations

1. Make a shape. Use pencil and paper, a computer drawing program or another strategy to reproduce the shape.

   Fill the entire page with translations and reflections of your shape.

   Colour/shade your design with the aid of the computer or by hand when finished to create a dazzling piece of artwork ready to display on a wall.

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