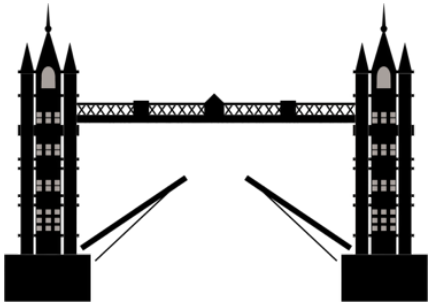
Say what you see...

What do the images below have in common?









Sarah

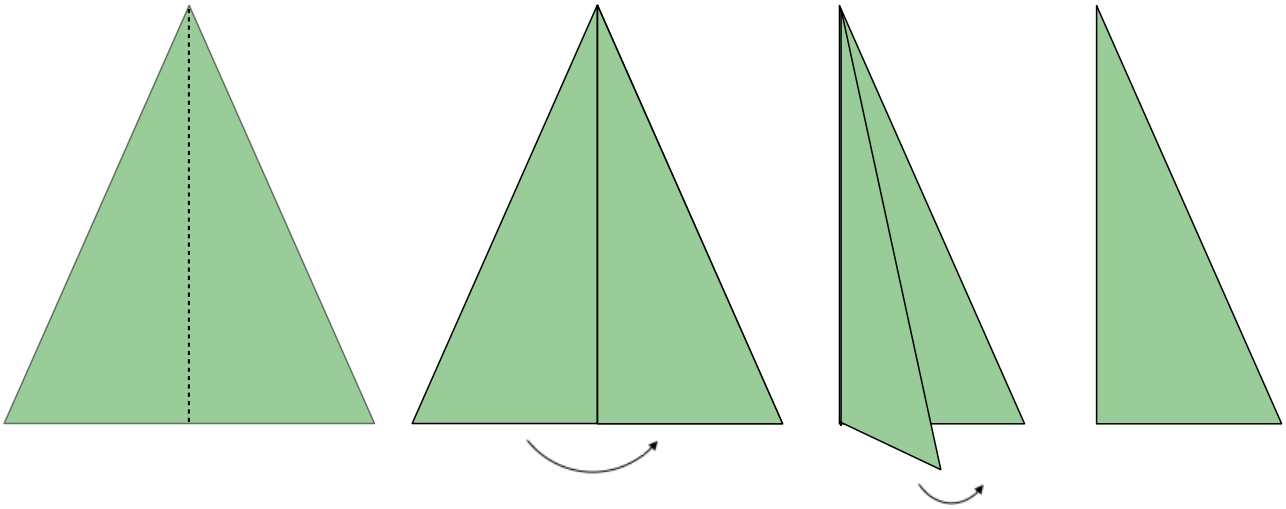
I think that if you fold them in half, they will be the same on both sides...

I think that makes them symmetrical...



Alice

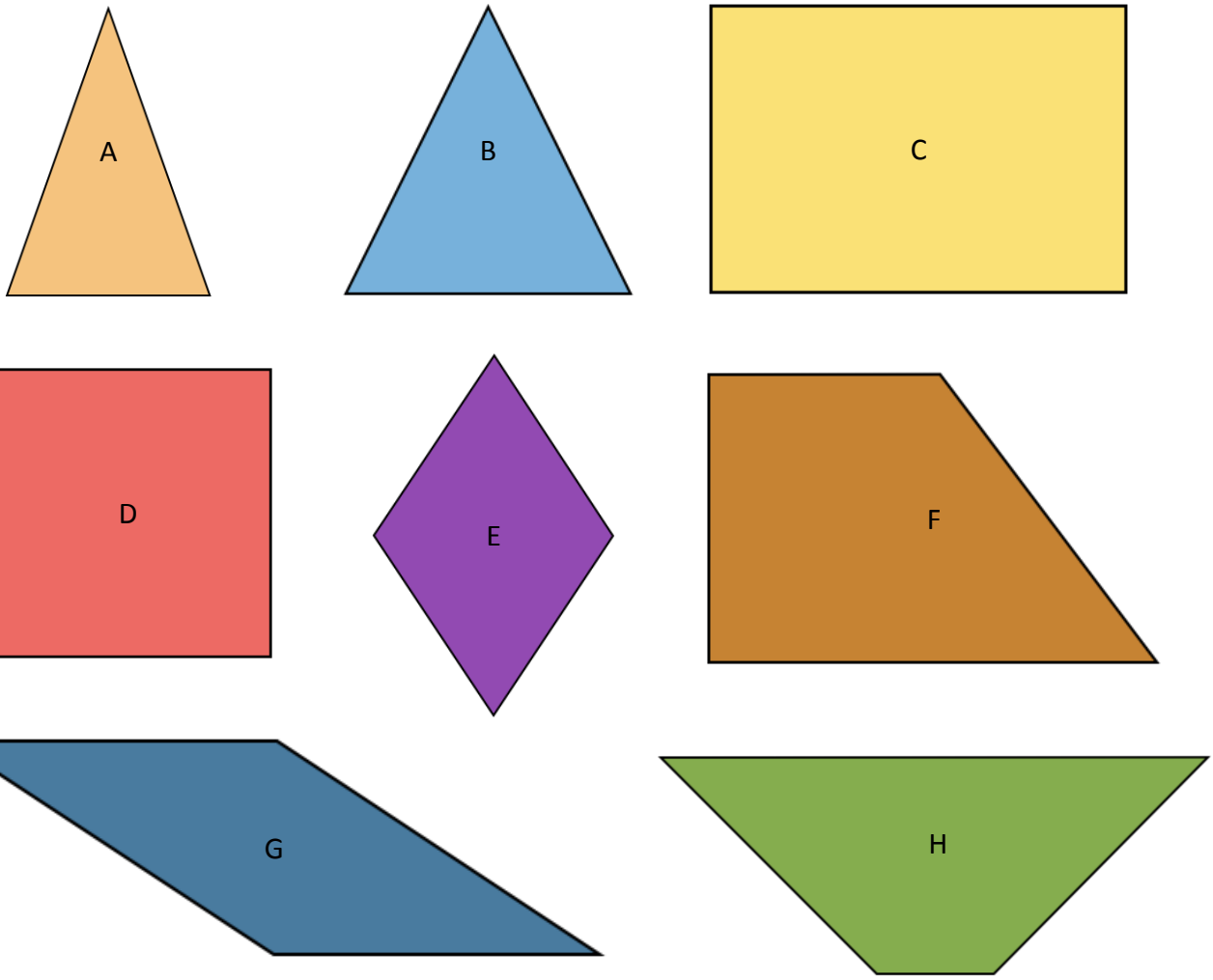
Symmetry can be used to look at different figures and shapes. Two-dimensional shapes can have two different types of symmetry; line symmetry and rotation symmetry.



A figure that has reflective symmetry has a fold 'line' so that, if folded, both sides match. The fold line is called the shape's **line of symmetry**.

Symmetry

Find the lines of symmetry on these shapes by cutting and folding



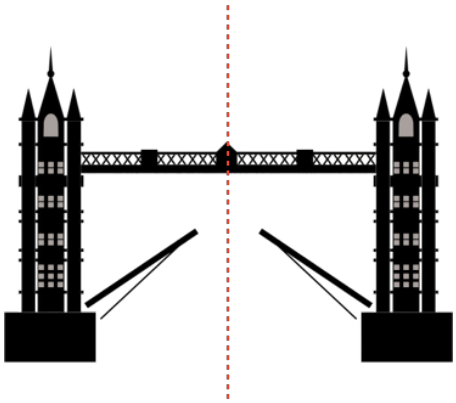


Jon

Are all of these shapes symmetrical?

1. Look at the objects and buildings around you. Are any of them symmetrical?

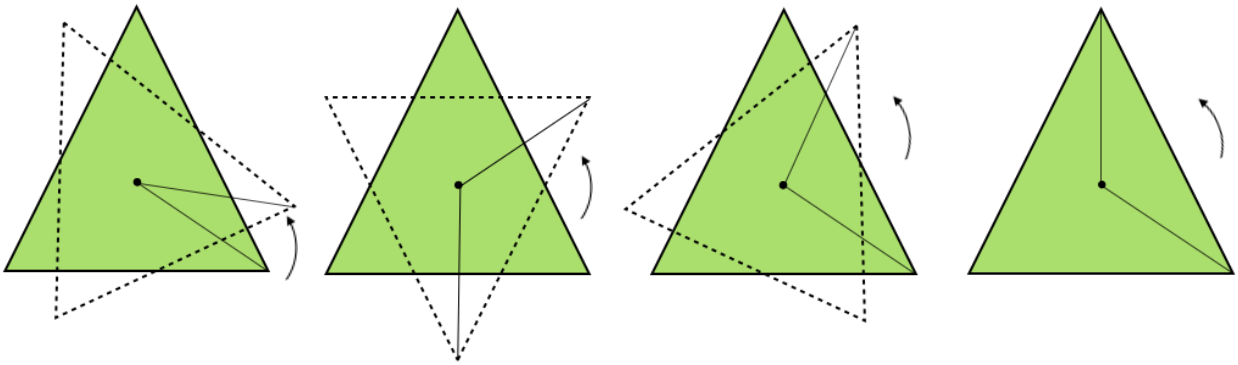




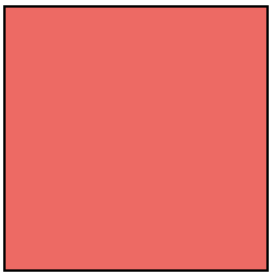
Symmetry

A figure has **rotational symmetry** if there is a central point, which the figure can be rotated from, less than a full turn, so the image matches the original perfectly.

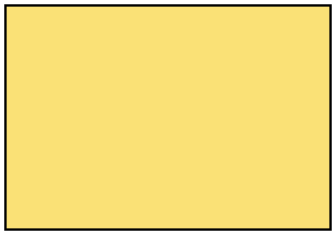
Every shape can be rotated through a full turn using any point as the centre to produce a matching image. Figures that only produce an identical image with a full turn **do not** have rotational symmetry.



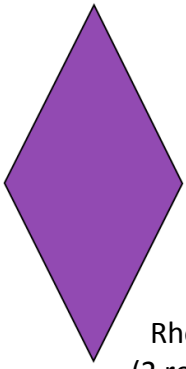
The figures below show the number of turns for each shape.
Using the resource page, can you find all the rotations?



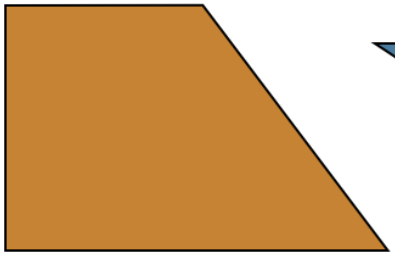
Square
(4 rotations)



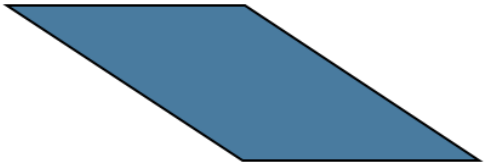
Rectangle
(2 rotations)



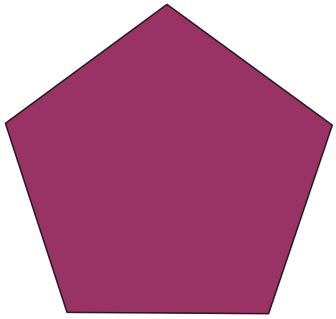
Rhombus
(2 rotations)



Trapezoid
(1 rotation)



Parallelogram
(2 rotations)

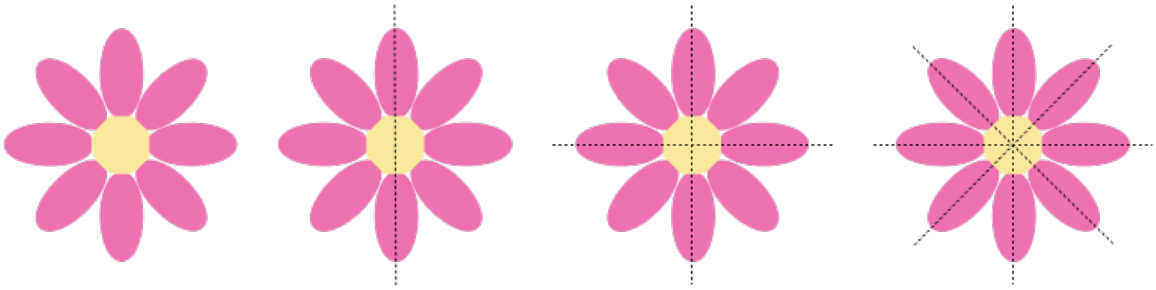


Regular Pentagon
(5 rotations)

Shapes that have reflection symmetry do not always have rotational symmetry. It is also possible to have rotational symmetry without reflection.

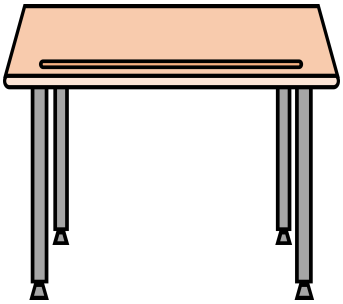
Symmetry

The flower below has both line and rotational symmetry.



1. Which of the shapes below have reflection symmetry?
2. Which of the shapes below have rotational symmetry?
3. Which of the shapes below have both?

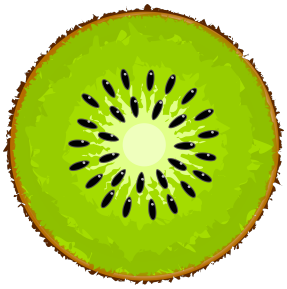
a



b



c



d



e



f



4. What is the same/different about the shapes above?
5. Write a sentence for each one, explaining the type of symmetry and how you know they are symmetrical.

Fitness check

1. How many lines of symmetry are there in the national flags on the right? Colours should be considered.



Jon

We can assume the flags are lying flat.



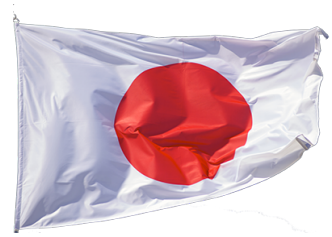


Jamaica



Argentina

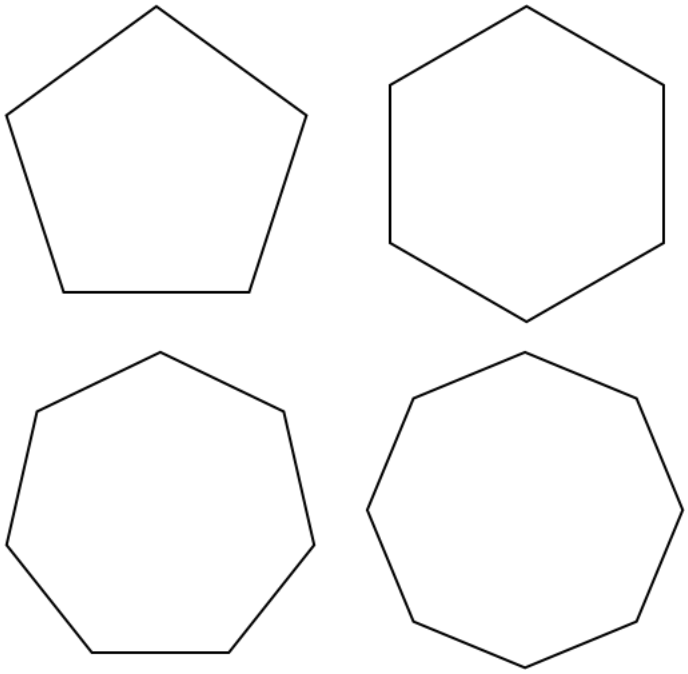
2. Which of these flags have rotational symmetry?
3. Design your own flag, which has both reflection and rotational symmetry.
4. Draw the lines of symmetry in the following regular *polygons...*



Japan



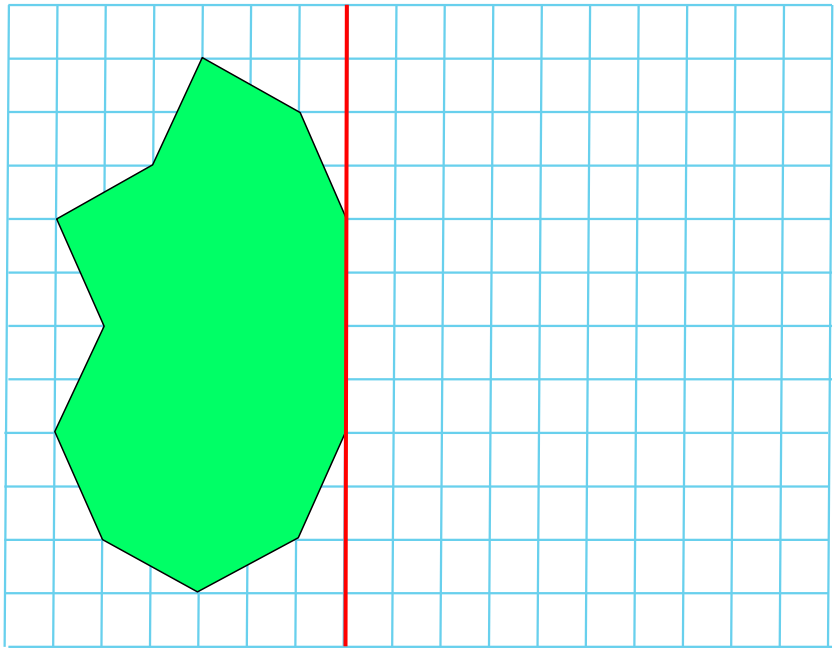
United Kingdom



5. This shows that regular *n-gons* have how many lines of symmetry?

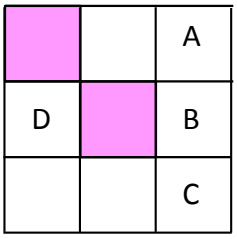
Creating symmetrical figures

1. Create a shape with one line of symmetry by reflecting this shape in the line of symmetry.



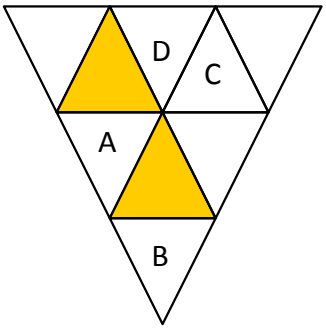
Line of symmetry

2. Look at the pattern Amber has created. She says if you shade in one of the squares A, B, C or D, the finished pattern will have two lines of symmetry and rotational symmetry of order two. Which square should you shade?



3. Matthew says if you shade in a different square, you only get one line of symmetry and rotational symmetry of order one. Which square did Matthew shade?

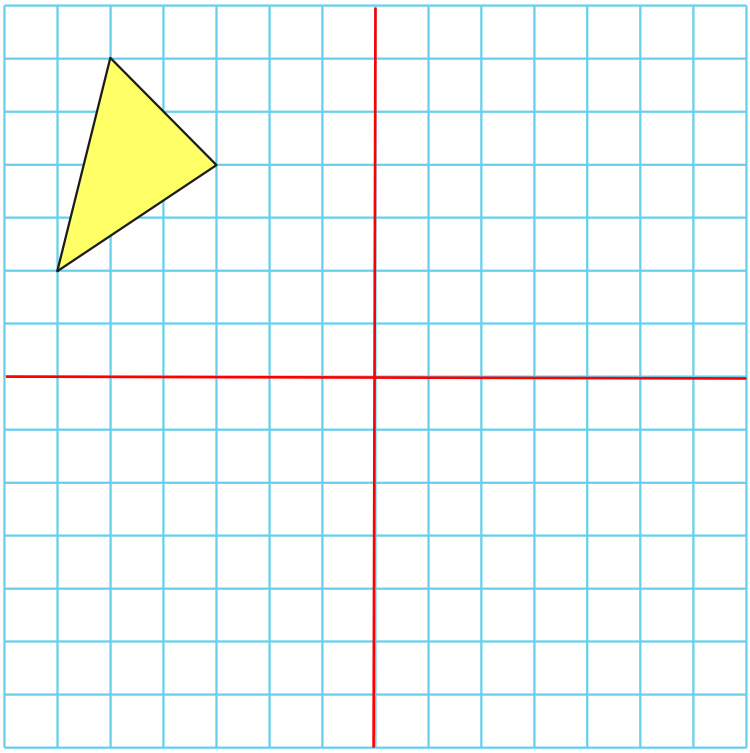
4. Look at Sarah's pattern. Which triangle should she shade in if her finished pattern has:



   a) rotational symmetry of order three and three lines of symmetry?

   b) rotational symmetry of order one and one line of symmetry?

5. Create a shape with two lines of symmetry by reflecting this shape in the two red lines of symmetry.



6. Look at this shape. Write down the coordinates of A, B, C, D and E.

   a) Now reflect the shape in the y-axis to form a new shape A'B'C'D'E'

   b) Write down the coordinates of the five new points.

   c) What do you notice about the coordinates of A and A'?

   d) Does the same apply for the other points?

   e) Explain what happens to the coordinates if we reflect a shape in the y-axis.

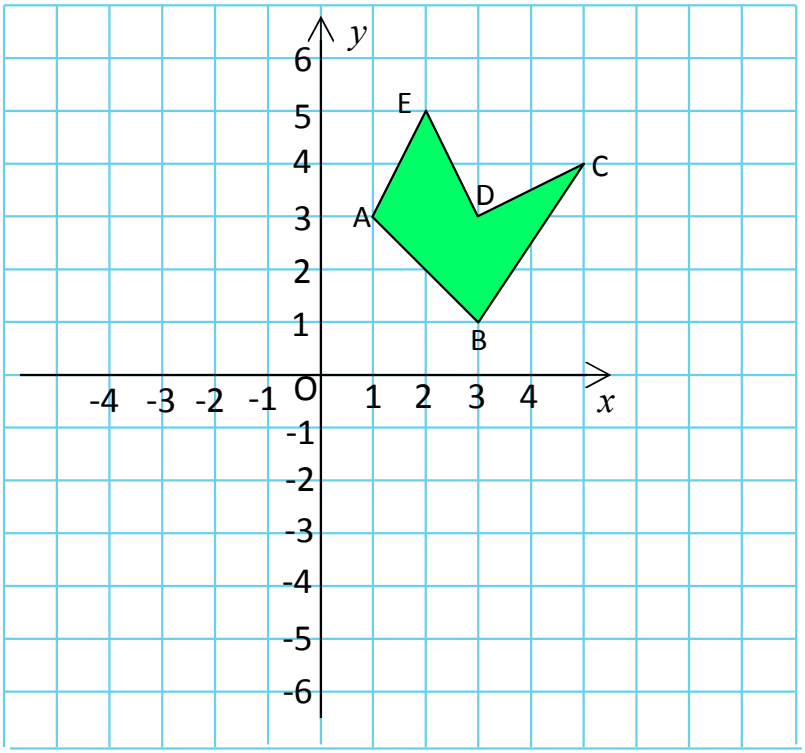


Fig. 1

7. Look at this shape. Write down the coordinates of A, B, C, D and E.

a) Now reflect the shape in the x-axis to form a new shape A'B'C'D'E'

b) Write down the coordinates of the five new points.

c) What do you notice about the coordinates of A and A'?

d) Does the same apply to the other points?

e) Explain what happens to the coordinates if we reflect a shape in the x-axis.

f) Explain what happened to coordinates of B.

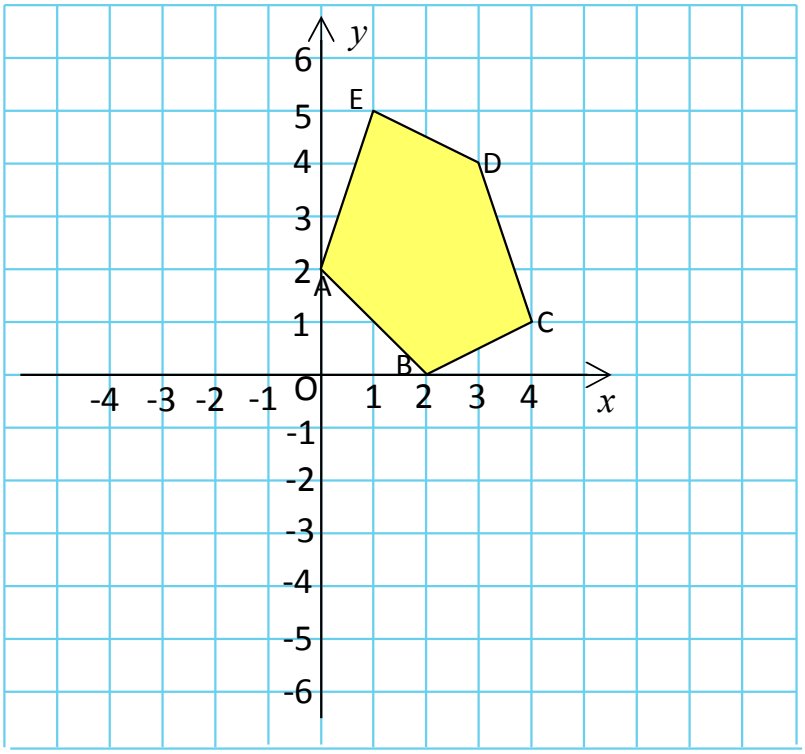


Fig. 2

Now try the questions on Worksheet Transformations_2b 1

Invariant points

Points that do not move when a shape is transformed are called **invariant points**. Their coordinates remain unchanged.

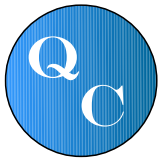
1

In a reflection, explain where the invariant points are situated.

8. Look back at *Fig.1* on the previous page. Are there any invariant points when it is reflected in the y-axis? Would there be any invariant points if it was reflected in the x-axis instead? Explain your thinking.

9. Now look at *Fig. 2* above. Would there be any invariant points If the shape was reflected in the y-axis instead?

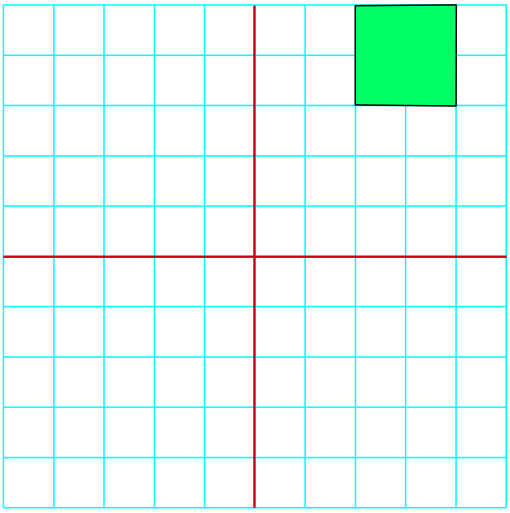
Question Creation

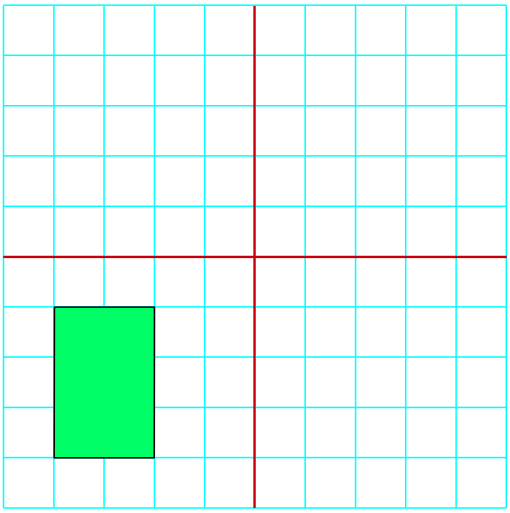


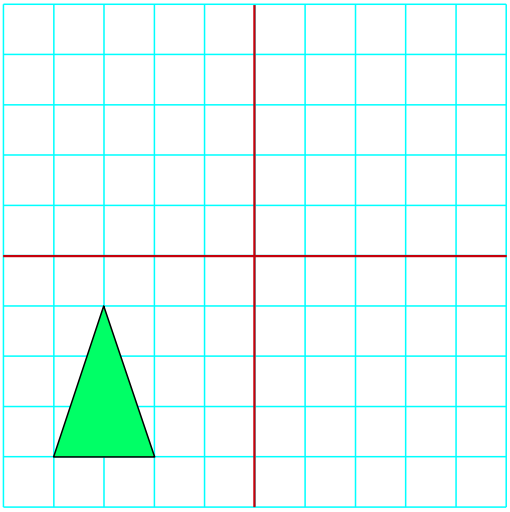
Have fun creating problems for your friends to solve. Make up a shape that, when you reflect it in both the x and y-axes has 3 invariant points. Describe it to your friends in words and see if they can draw it.

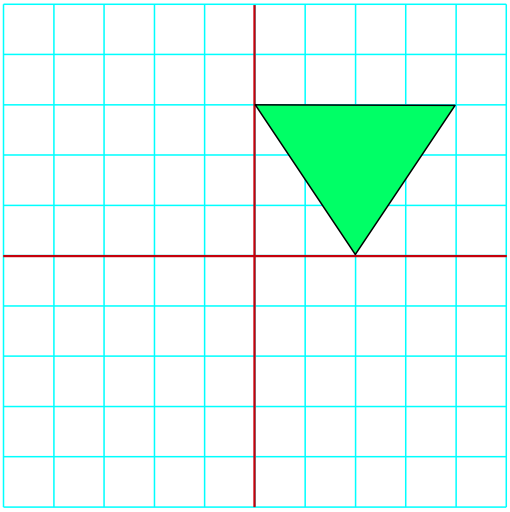
Worksheet Transformations_2b_ 1

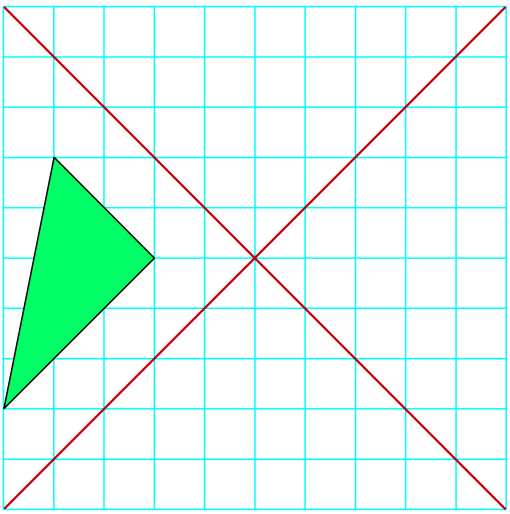
Create a shape with two lines of symmetry by reflecting these shapes in the two red lines of symmetry.

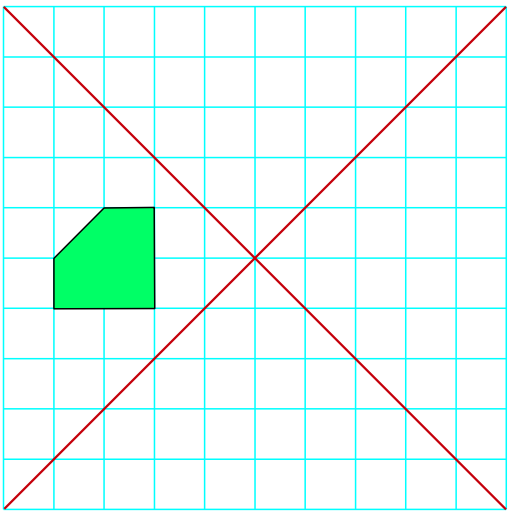












Where's the point?

1. Look at Fig. 1. If ABCD is a square, what are the coordinates of D?

2. If ABCD is trapezium but not a square, what might the coordinates of D be?

3. How many different answers can you find for the coordinates of D if ABCD is a trapezium?

4. Could (5,-11) be an answer for the coordinates of D if ABCD is a trapezium?

5. Look at your answers. Do you notice anything interesting?

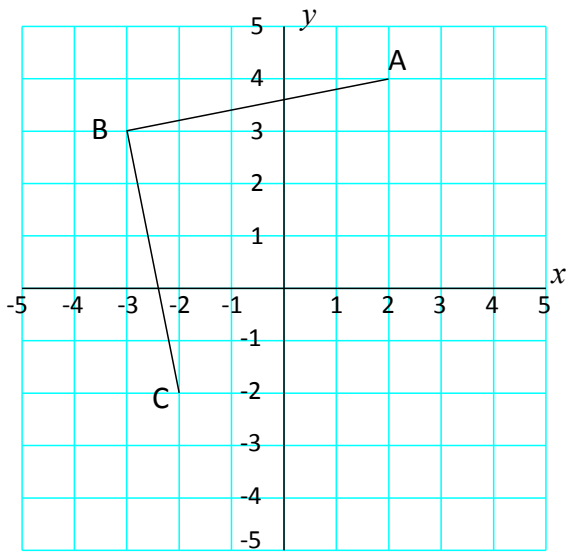


Fig. 1

6. Look at Fig. 2. If ABCD is a rectangle, what are the coordinates of D?

7. If ABCD is trapezium but not a rectangle, with CD parallel to AB, what might the coordinates of D be?

8. How many different answers can you find for the coordinates of D if ABCD is a trapezium?

9. Could (0,9) be an answer for the coordinates of D if ABCD is a trapezium?

10. Look at your answers. Do you notice anything interesting?

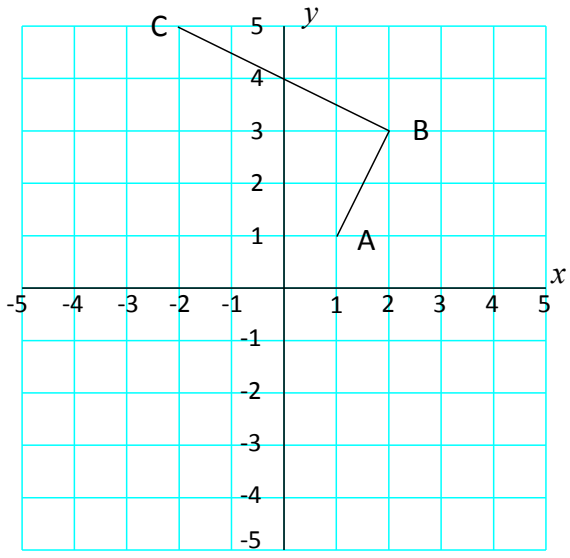


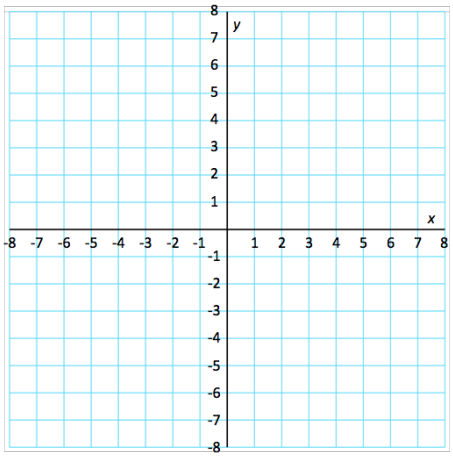
Fig. 2

Now the questions on Worksheet Translations_2b 2

Worksheet Transformations_1b_ 2 What's the point?

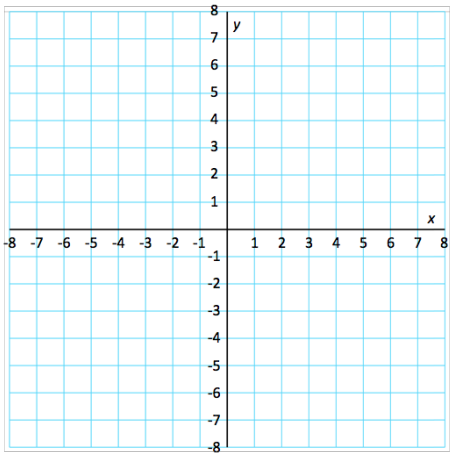
For each of these questions, you need to find the missing corner of the shape. Plot the coordinates in your book and then join the edges together to form the given shape.

a.



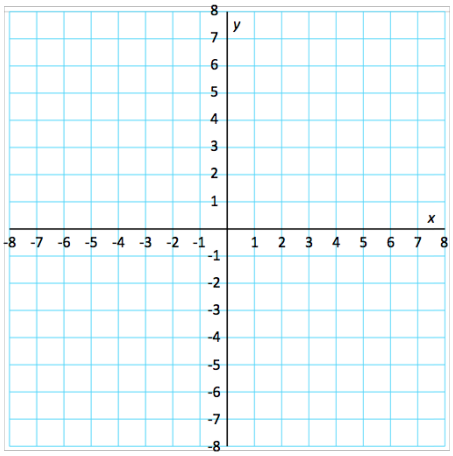
Square (-1, -1), (2, 3), (6, 0), (,)

b.



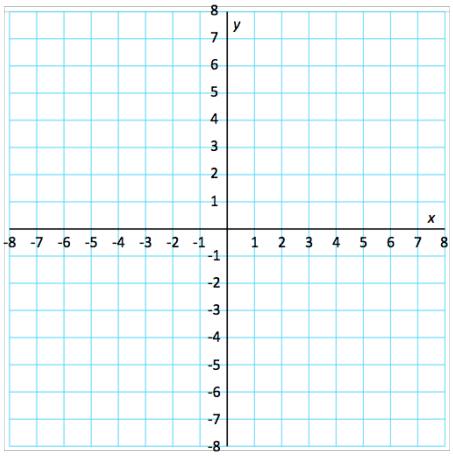
Rectangle (-2, 3), (4, 3), (4, -2), (,)

c.



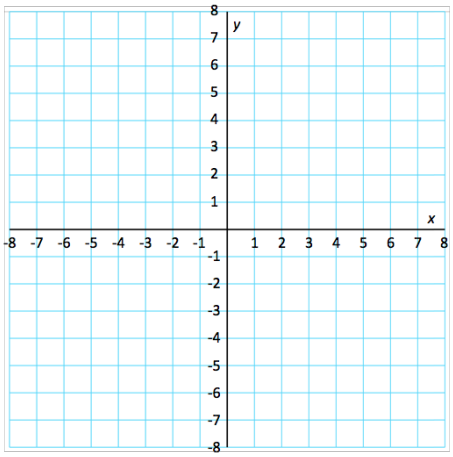
Square (3, -1), (5, 1), (3, 3), (,)

d.



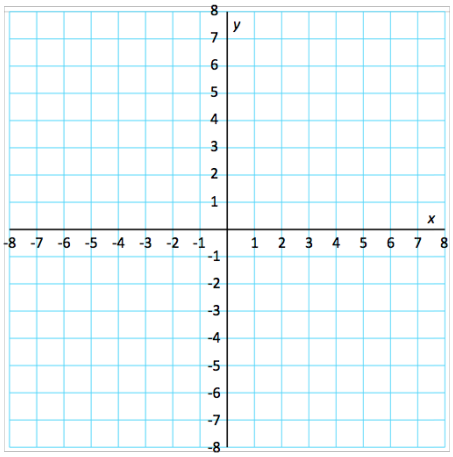
Rectangle (1, -6), (7, 1), (-6, -6), (,)

e.



Parallelogram (-6, 2), (-3, 5), (1, 5), (,)

f.



Symmetrical Hexagon (-6, 0), (-2, 4), (2, 4), (6, 0), (2, -4), (,)

Let's learn about piloting a robot.

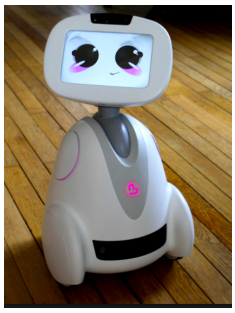
Robots are changing our lives. Some are used in dangerous situations, such as bomb disposal. Others help us to investigate far off planets whilst others are simply just good fun.



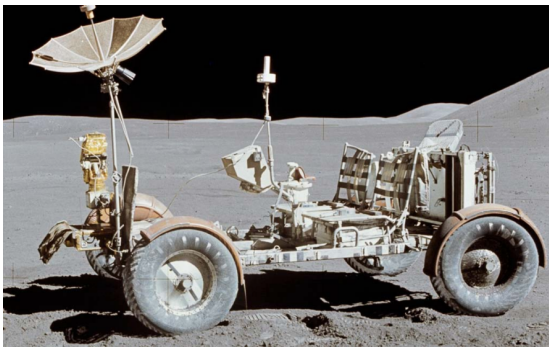
Bomb disposal robot



Pet dog



Buddy



Mars dune buggy

In this section, we will be investigating how a very simple robot can be given instructions to move around an obstacle course. If our robot is on the green square (A) and we want him to move to the pink square (C), our instructions would be right 3, up 4. We always move horizontally before we move vertically. This is called a **translation** or slide.

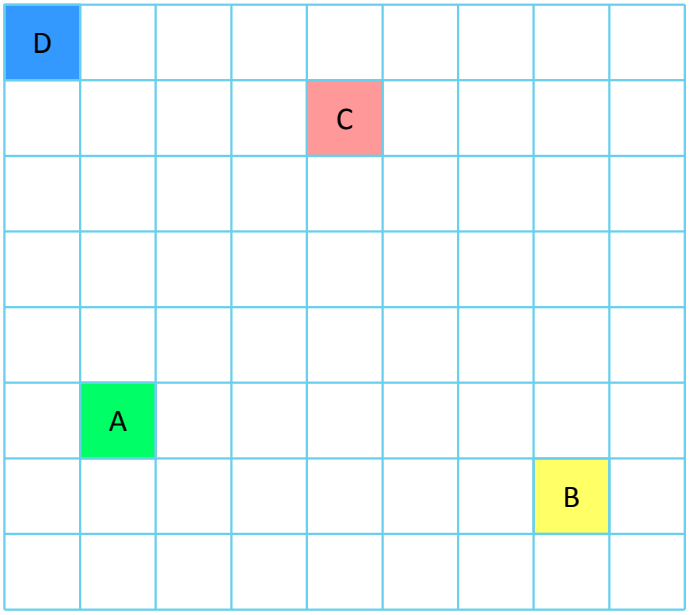
To enter this into our robot's control system, we use vector notation, as shown below.

$$\begin{pmatrix} 3 \\ 4 \end{pmatrix}$$

This tells the robot to move 3 squares right and then 4 up.

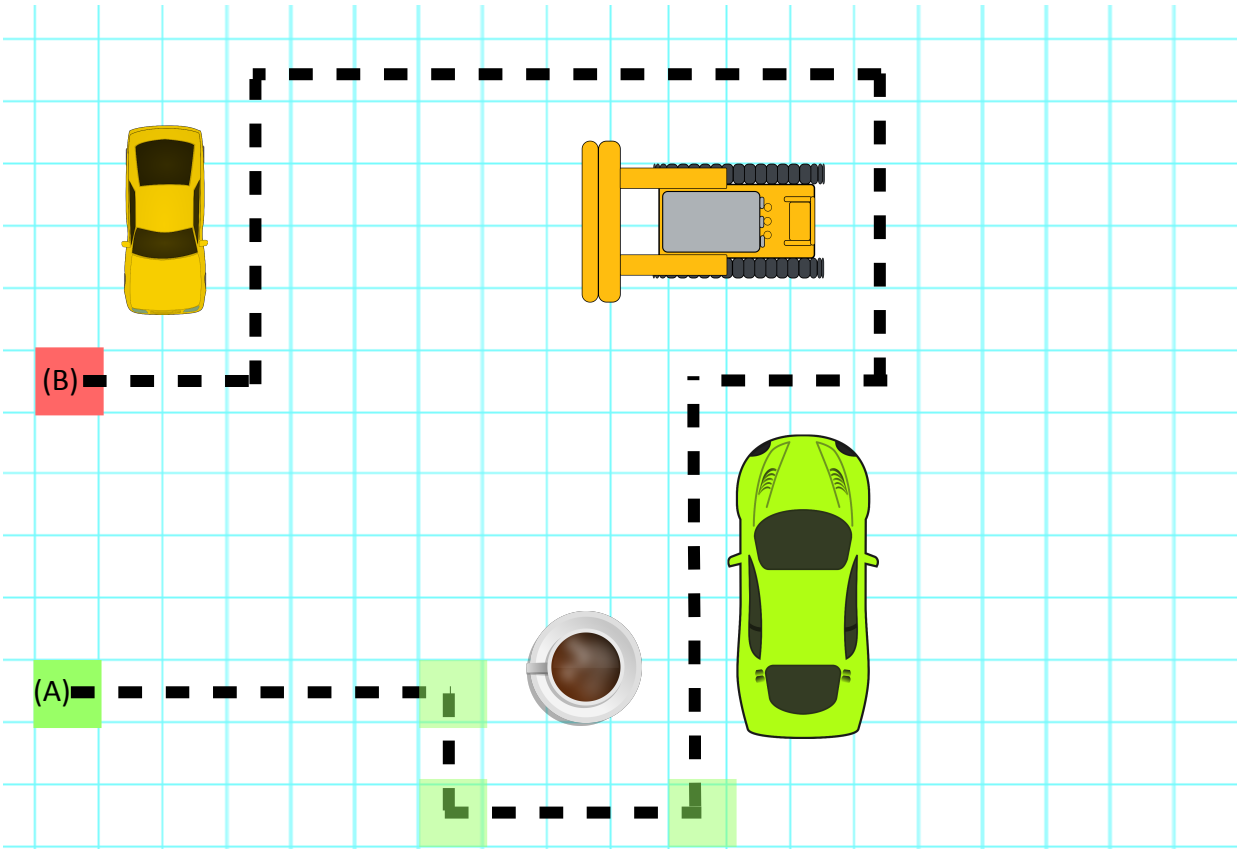
Write the instructions in vector form to move the robot from

a) A to D
b) D to C
c) B to A

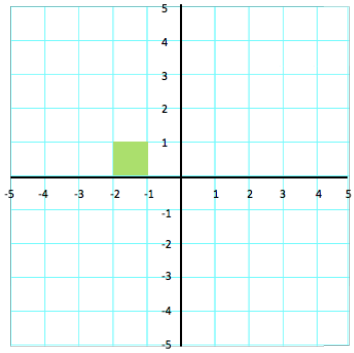


Translation

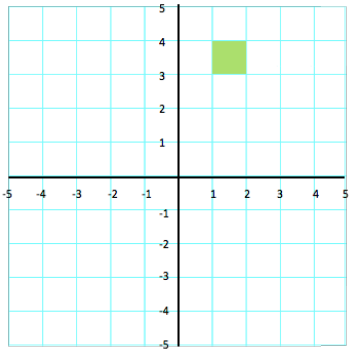
1. Answer the questions on Worksheet Transformations_2b 3
2. Answer the questions on Worksheet Transformations_2b 4
3. Now look at the diagram below. Write down the vector commands to describe the robot's route around the objects on the classroom floor, from the green square (A) to the red square (B). The first turning positions of the robot are shown.



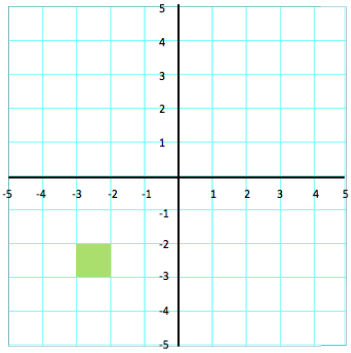
Worksheet Transformations_2b_3



Translate 4 squares right and 3 squares down

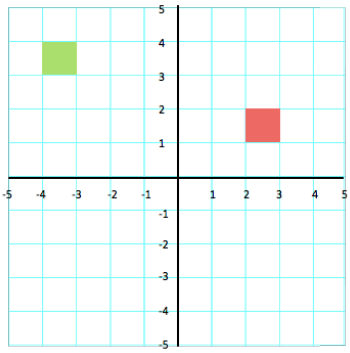


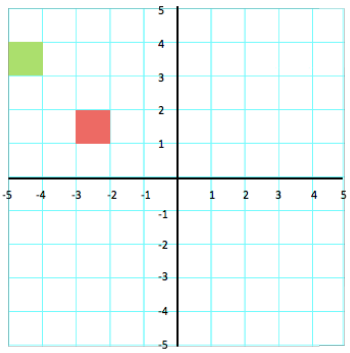
Translate 6 squares left and 1 square down

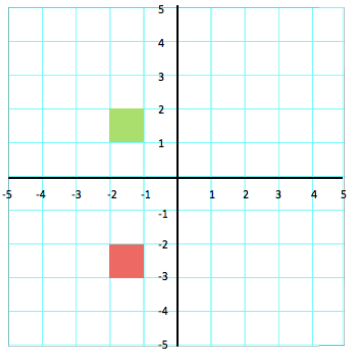


Translate 1 square left and 4 squares up

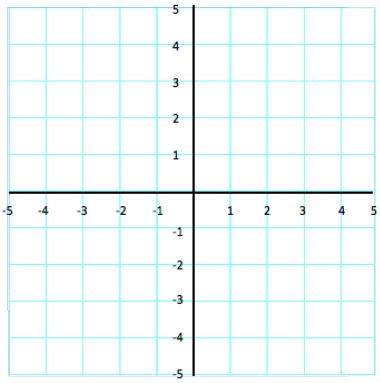
Write the translation from the green square to the red square for the questions below.

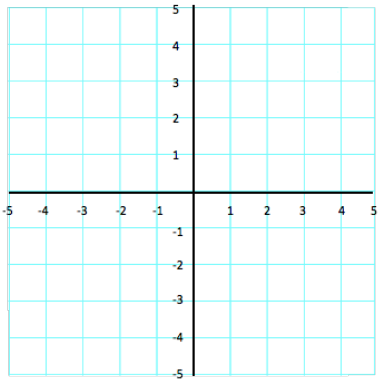


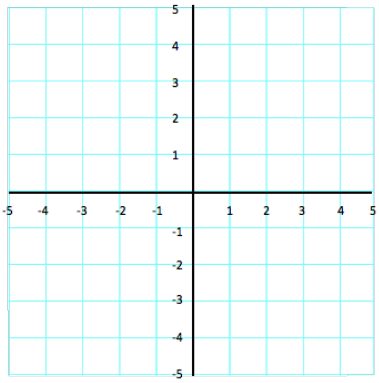




Create your own translation questions!

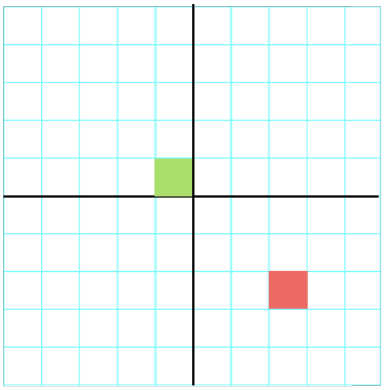


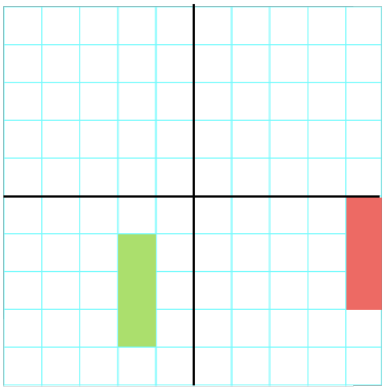


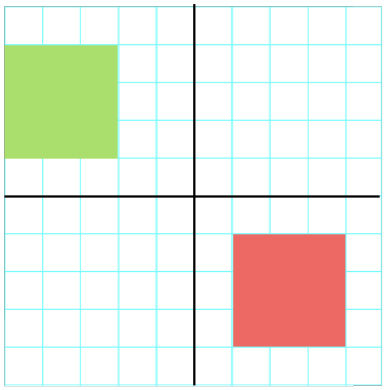


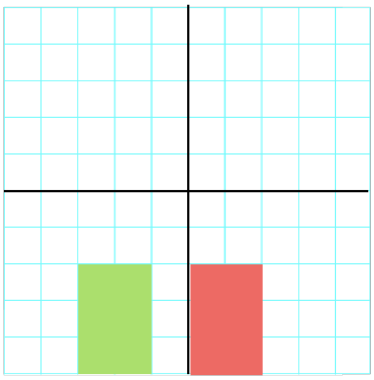
Worksheet Transformations_2b_4

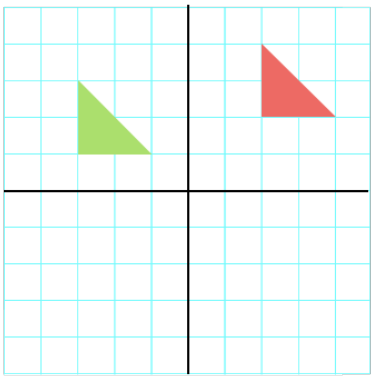
Write the translation of the green shape onto the red shape using vector notation.

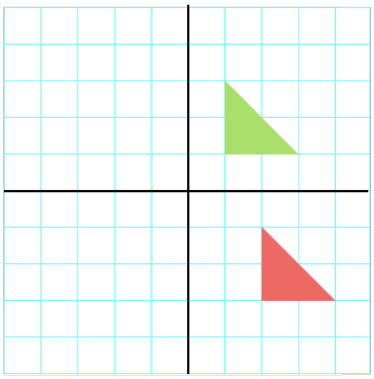


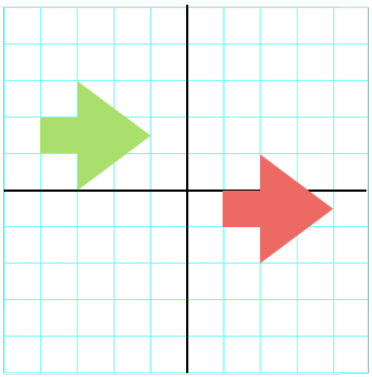


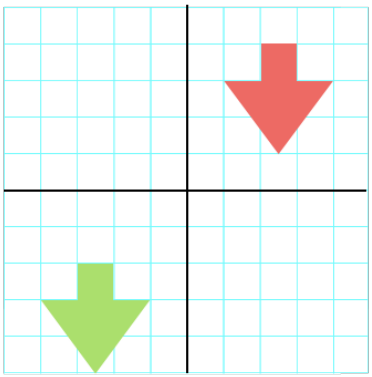


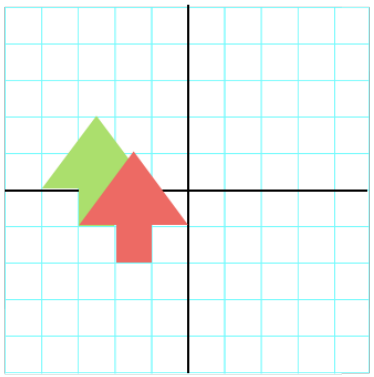






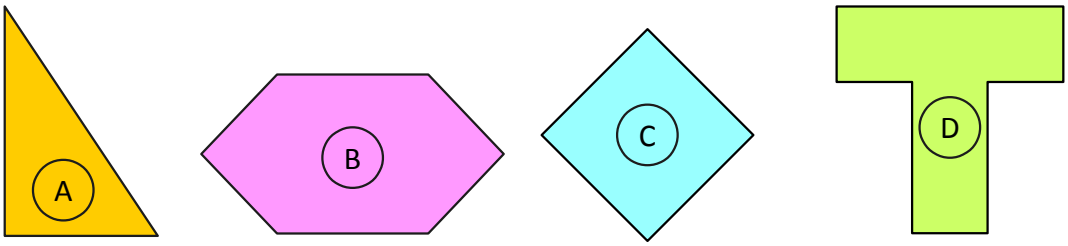






Geometry 2b: Mastery questions

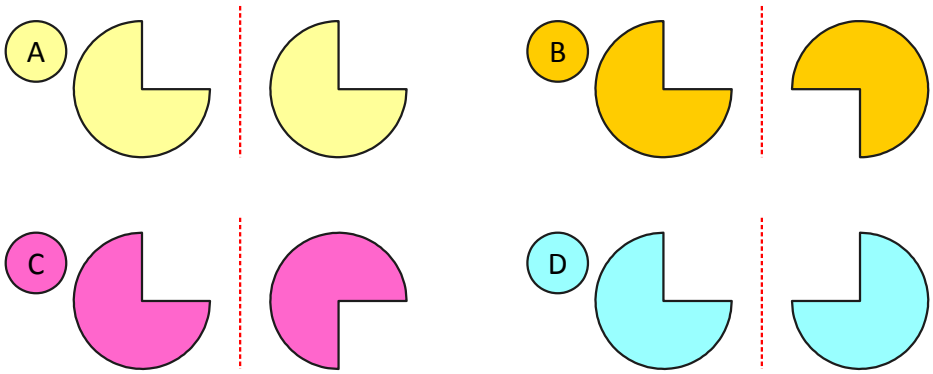
1. Which shape has exactly one line of symmetry?



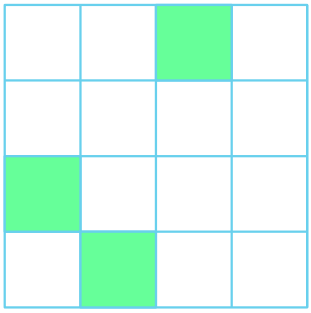
2. How many lines of symmetry does this shape have?



3. Which of these shapes have been reflected correctly?



4. What is the smallest number of additional squares that need to be shaded so that this shape has 1 line of symmetry?



A	B	C	D
1	2	3	4

5. Which is the correct point for E when the triangle in Fig. 1 is reflected in the x-axis?

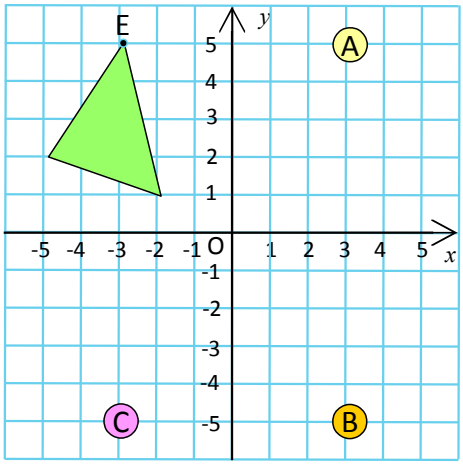


Fig. 1

6. Which is the correct point for E when the triangle in Fig. 1 is reflected in the y-axis?

7. What are the coordinates of the point F when the quadrilateral in Fig. 2 is reflected in the x-axis?

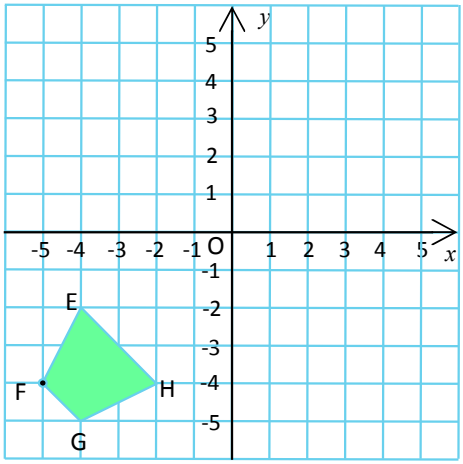


Fig. 2

A	B	C	D
(-5, 4)	(4, -5)	(4, 5)	(-4, 5)

8. What are the coordinates of the point G when the quadrilateral in Fig. 2 is reflected in the y-axis?

A	B	C	D
(-5, 4)	(4, -5)	(4, 5)	(-4, 5)

9. What are the coordinates of the point H when the quadrilateral in Fig. 2 is translated 3 units to the right and 4 up?

A	B	C	D
(2, 0)	(2, -1)	(1, 1)	(1, 0)

10. Which is the correct point for E when the triangle in Fig. 3 is translated by the vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$?

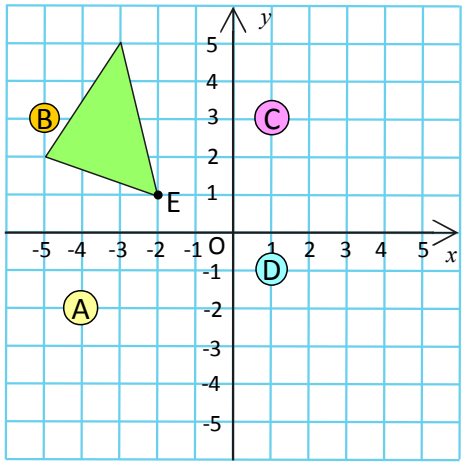


Fig. 3

11. Which is the correct point for E when the triangle in Fig. 3 is translated by the vector $\begin{pmatrix} -3 \\ 2 \end{pmatrix}$?

12. What are the coordinates of the point F when the quadrilateral in Fig. 4 is translated by the vector $\begin{pmatrix} -4 \\ -5 \end{pmatrix}$?

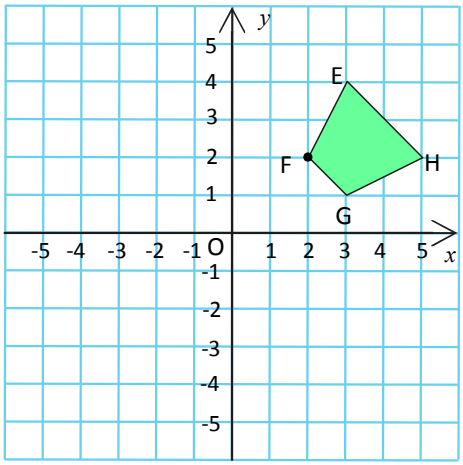


Fig. 4

A	B	C	D
(-3, -2)	(-2, -2)	(-3, -3)	(-2, -3)

13. What are the coordinates of the point G when the quadrilateral in Fig. 4 is translated by the vector $\begin{pmatrix} -2 \\ 3 \end{pmatrix}$?

A	B	C	D
(1, -2)	(1, 4)	(0, -1)	(-1, -1)

14. Which vector correctly describes the single translation that moves triangle (1) to triangle (2) in Fig. 5 ?

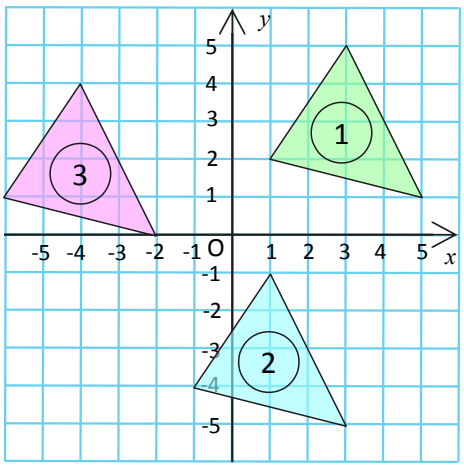


Fig. 5

A	B	C	D
$\begin{pmatrix}2\\5\end{pmatrix}$	$\begin{pmatrix}2\\6\end{pmatrix}$	$\begin{pmatrix}-2\\-5\end{pmatrix}$	$\begin{pmatrix}-2\\-6\end{pmatrix}$

15. Which vector correctly describes the single translation that moves triangle (3) to triangle (1) in Fig. 5 ?

A	B	C	D
$\begin{pmatrix}1\\7\end{pmatrix}$	$\begin{pmatrix}2\\6\end{pmatrix}$	$\begin{pmatrix}-6\\-1\end{pmatrix}$	$\begin{pmatrix}7\\1\end{pmatrix}$

16. A reflection in which line would give exactly 2 invariant points in Fig 6?

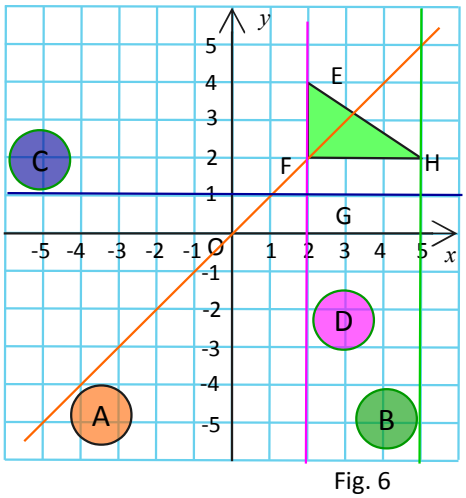
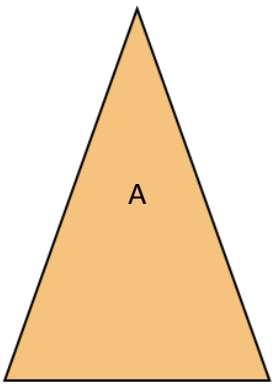


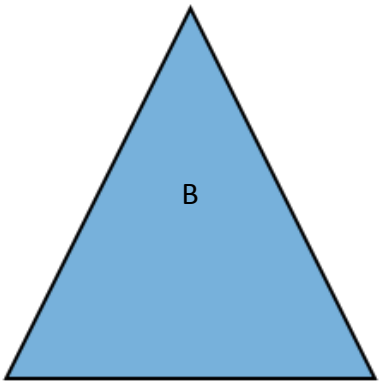
Fig. 6

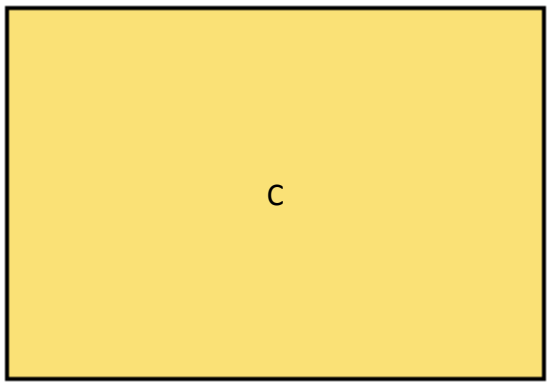
17. A reflection in which line would give more than 2 invariant points in Fig 6?

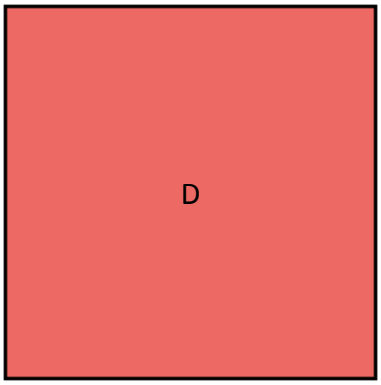
Resource sheet Geometry 2b_R1

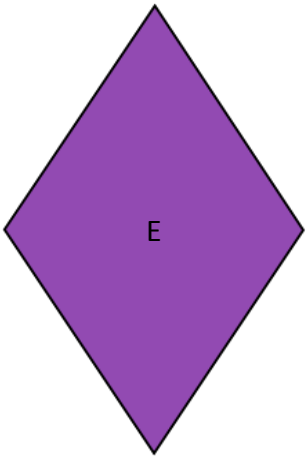
Find the lines of symmetry on these shapes by cutting .. and folding

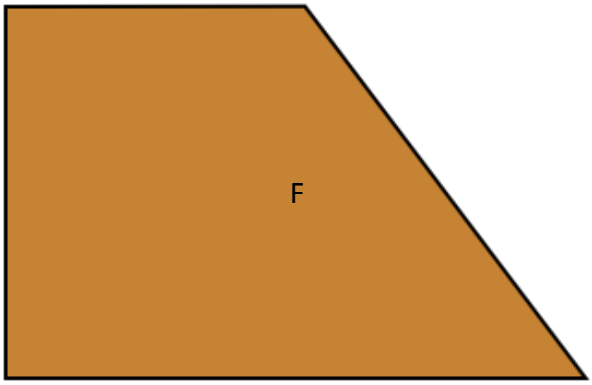


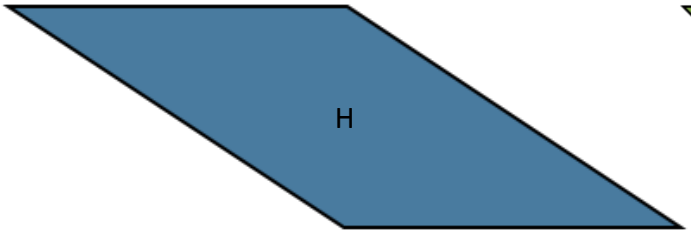


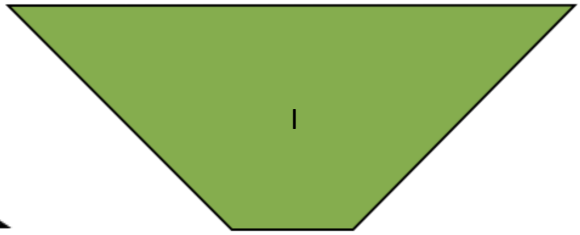






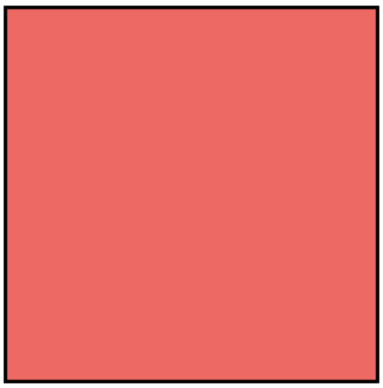




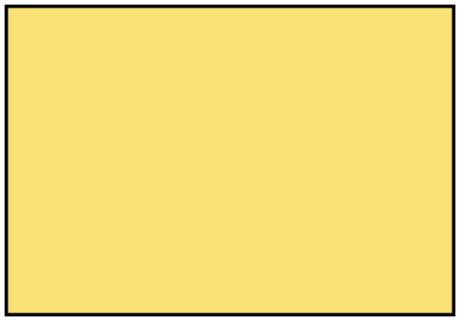


Resource sheet Geometry 2b_R2

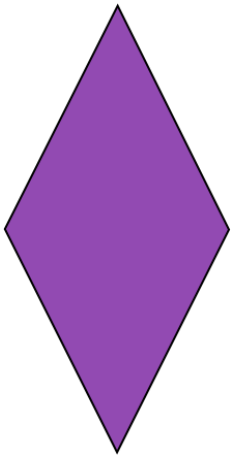
The figures below show the number of turns for each shape.
Cut each figure out. Can you now find all the rotations?



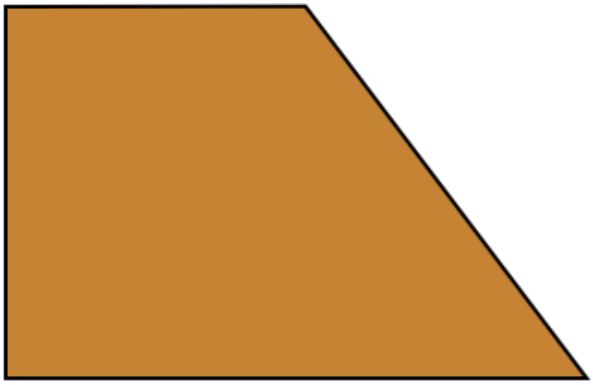
Square
(4 rotations)



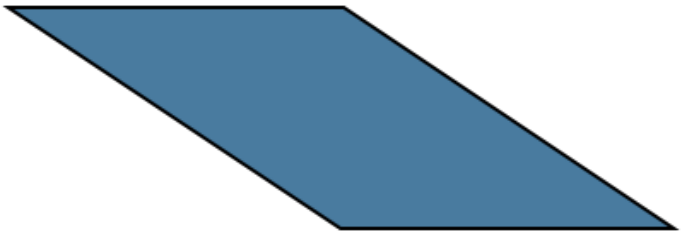
Rectangle
(2 rotations)



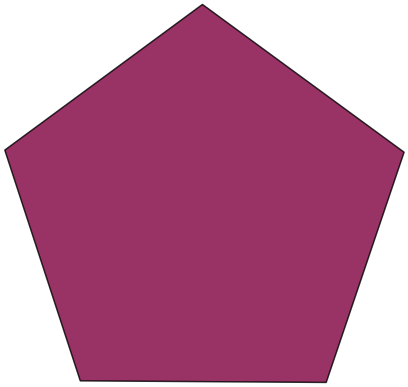
Rhombus
(2 rotations)



Trapezoid
(1 rotation)



Parallelogram
(2 rotations)



Regular Pentagon
(5 rotations)