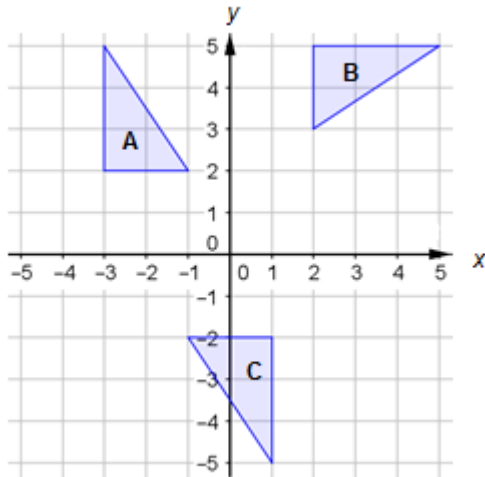


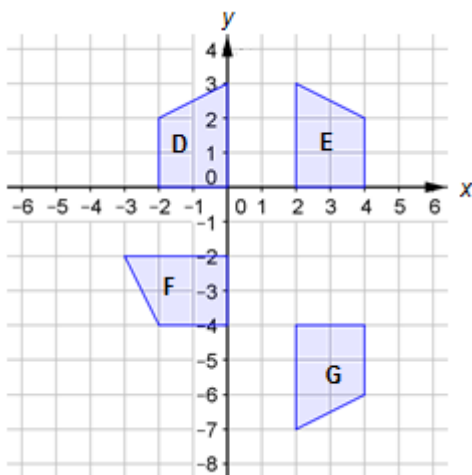
## Foundation Check In - 9.01 Plane isometric transformations

For questions 1-2, use the diagram below.



1. Shape A is rotated onto shape B. What are the coordinates of the centre of rotation?
2. Shape A is rotated onto shape C. What are the coordinates of the centre of rotation?

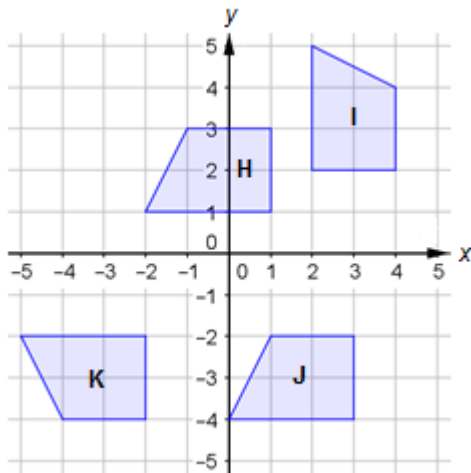
For questions 3-5, use the diagram below.



3. Shape D is reflected onto shape E. What is the equation of the mirror line?
4. Shape E is reflected onto shape G. What is the equation of the mirror line?
5. Shape E is reflected onto shape F. What is the equation of the mirror line?

# GCSE (9–1) MATHEMATICS

For questions 6-8, use the diagram below.



6. Use a column vector to describe the translation that maps shape H onto shape J.
7. Fully describe the transformation that maps shape I onto shape K.
8. Fully describe the transformation that maps shape H onto shape I.
9. Kara draws a triangle with vertices at (3, 1), (6, 2) and (3, 3). She reflects this triangle in the line  $y = x$ . What are the coordinates of the vertices of the reflected triangle?
10. A triangle with vertices at (1, 2), (5, 2) and (5, 4) is reflected in the line  $y = 2$ . The original triangle and its reflection combine to form a new triangle which is isosceles. Work out the area of the isosceles triangle.

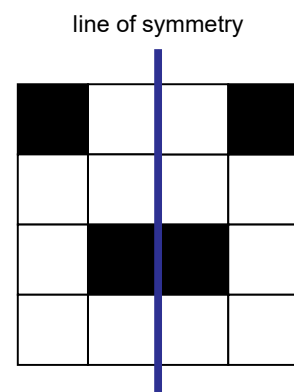
## Extension

Nigel has 20 white tiles and 4 black tiles. Each of his tiles are square and the same size as each other.

He plans to create a tile design in the shape of a square made up of 16 tiles. He wants the design to have a vertical line of symmetry.

One example design, using 12 white tiles and all 4 black tiles, is shown to the right.

How many different tile designs can Nigel make?



# GCSE (9–1)

# MATHEMATICS

## Answers

1. (1, 1)
2. (-1, 0)
3.  $x = 1$
4.  $y = -2$
5.  $y = -x$
6. Translation  $\begin{pmatrix} 2 \\ -5 \end{pmatrix}$
7. Reflection in  $y = -x$ .
8. Rotation about (2, 1) by  $90^\circ$  clockwise (or  $270^\circ$  anticlockwise).
9. A diagram could be used, however reflection in  $y = x$  implies the  $y$ -coordinate of each vertex becomes the  $x$ -coordinate (and vice-versa). The coordinates are (1, 3), (2, 6) and (3, 3) with the final vertex being unchanged by the reflection.
10. The original triangle has a horizontal base length of 4 units and a vertical height of 2 units, so its area is  $\frac{4 \times 2}{2} = 4$  units<sup>2</sup>. Since the isosceles triangle is formed from the original triangle and its reflection, the area of the isosceles triangle will be double that of the original triangle. Therefore the area is 8 units<sup>2</sup>.

# GCSE (9–1)

# MATHEMATICS

## Extension

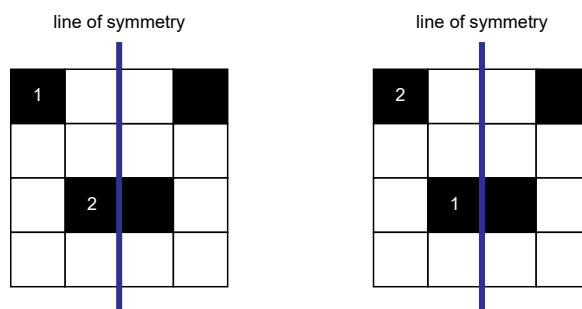
Since the design needs to have a line of symmetry, whatever Nigel does on the left of the “mirror line” will need to be reflected in the right. He is limited by having 4 black tiles and so at most 2 of these can be on the left of the mirror line (since 2 would then need to be on the right, using up all 4 black tiles).

We therefore consider how many ways he can use up to 2 black tiles on the  $2 \times 4$  grid to the left of the mirror line.

Firstly, with no black tiles (and 8 white) there is only one design he can make.

With 1 black tile (and 7 white), there are 8 positions it could go in, so 8 possible designs with 1 black tile.

With 2 black tiles (and 6 white), there are 8 positions the first tile could go in. For each of these, there are only 7 remaining choices for where the second tile could go. But half of these would be duplicates: for example in the diagram below, the 1 and 2 indicate which tile is placed first and second.



But these lead to the same design (we don't care about which one is placed first), so we only need to consider half of the  $7 \times 6 = 56$  ways of placing the two black tiles, i.e. 28 designs are possible with 2 black tiles.

Altogether there are  $1 + 8 + 28 = 37$  different designs that Nigel could make.

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# GCSE (9-1)

# MATHEMATICS

Assessment Objective	Qu.	Topic	R	A	G
AO1	1	Identify the centre of rotation of a triangle under rotation			
AO1	2	Identify the centre of rotation of a triangle under rotation			
AO1	3	Identify vertical mirror line and state its equation			
AO1	4	Identify horizontal mirror line and state its equation			
AO1	5	Identify mirror line and state its equation			
AO2	6	Use a column vector to describe a translation of a simple shape			
AO2	7	Fully describe reflection, identifying a mirror line and state its equation			
AO2	8	Fully describe rotation, identifying the centre, angle and direction			
AO3	9	Solve a problem involving reflection			
AO3	10	Solve a problem involving reflection and area			

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