What is the transformation matrix for the rotation by 90° anticlockwise?

- $\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix}$

  Correct

  Well done!

- $\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$
- $\begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$
- $\begin{bmatrix} -1 & 0 \\ 0 & 1 \end{bmatrix}$

✓ Congratulations! You passed!

Keep

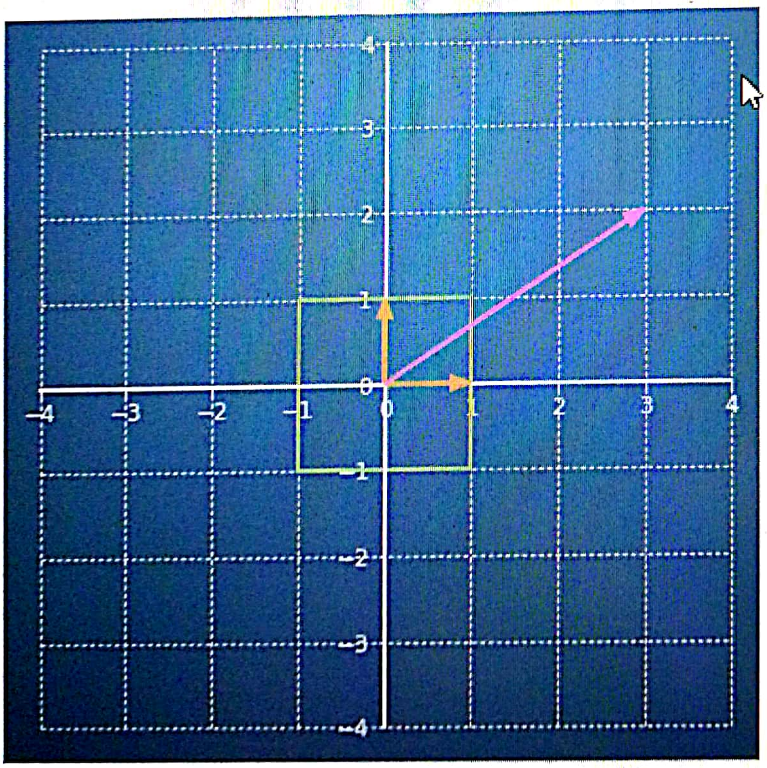
TO PASS 80% or higher

Using matrices to make transformations

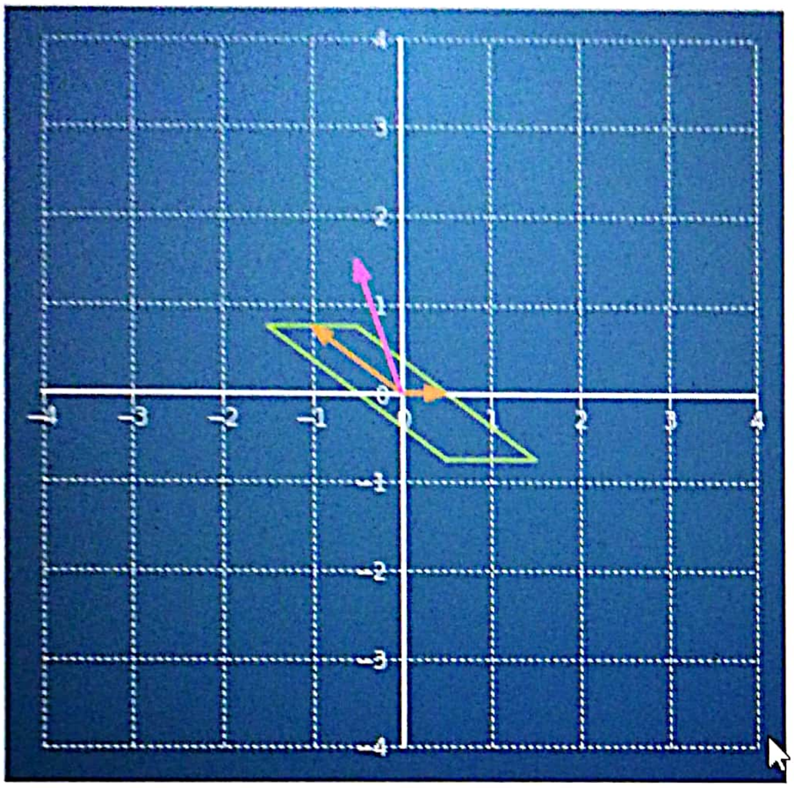
TOTAL POINTS 6

1. Matrices make transformations on vectors, potentially changing their magnitude and direction.

   If we have two unit vectors (in orange) and another vector, $\mathbf{r} = \begin{bmatrix} 3 \\ 2 \end{bmatrix}$ (in pink), before any transformations - these look like this:



   Take the matrix, $A = \begin{bmatrix} 1/2 & -1 \\ 0 & 3/4 \end{bmatrix}$, see how it transforms the unit vectors and the vector, $\mathbf{r}$, Take the matrix, $A = \begin{bmatrix} 1/2 & -1 \\ 0 & 3/4 \end{bmatrix}$, see how it transforms the unit vectors and the vector, $\mathbf{r}$.



What new vector, $\mathbf{r}'$, does A transform $\mathbf{r}$ to? Specifically, what does the following equal?

$$A\mathbf{r} = \begin{bmatrix} 1/2 & -1 \\ 0 & 3/4 \end{bmatrix} \begin{bmatrix} 3 \\ 2 \end{bmatrix} =$$

- ○ $\begin{bmatrix} 3/2 \\ -3/4 \end{bmatrix}$
- ◉ $\begin{bmatrix} -1/2 \\ 3/2 \end{bmatrix}$
- ○ $\begin{bmatrix} 3/2 \\ -1/2 \end{bmatrix}$
- ○ $\begin{bmatrix} -3/2 \\ 3/2 \end{bmatrix}$

$\begin{bmatrix} -3/2 \\ 3/2 \end{bmatrix}$

Correct

You could either calculate this or read it off the graph.

2\. Let's use the same matrix, $A = \begin{bmatrix} 1/2 & -1 \\ 0 & 3/4 \end{bmatrix}$, from the previous question.

1/1 point

Type an expression for the vector, $\mathbf{s} = A \begin{bmatrix} -2 \\ 4 \end{bmatrix}$.

```
# Replace a and b with the correct values below:
s = [-5, 3]
```

Run

Reset

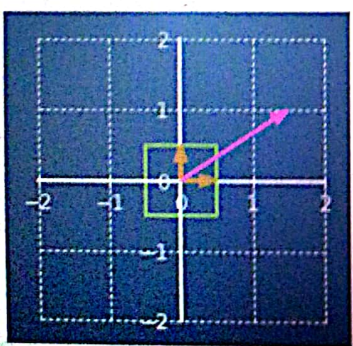
```
[-5, 3]
```

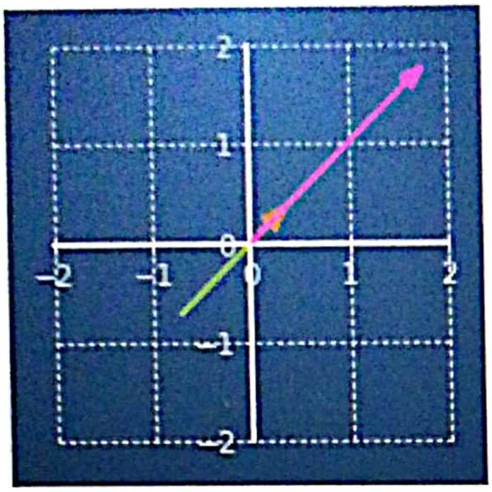
Correct

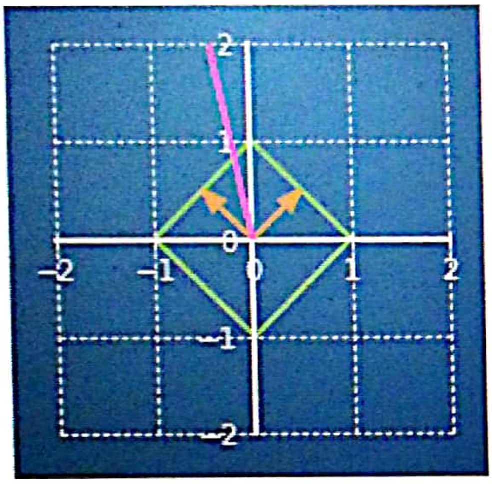
Well done.

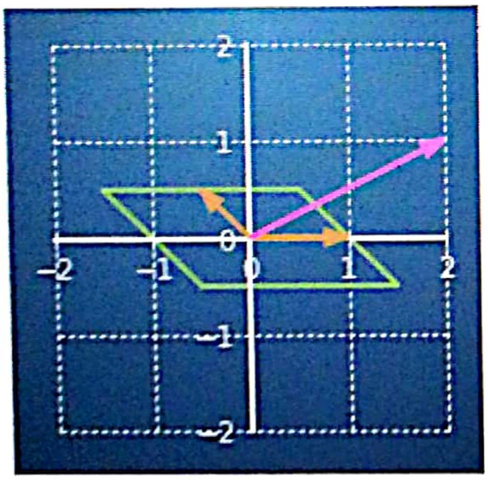
3\. Select the transformation which best corresponds to the matrix, $M = \begin{bmatrix} -1/2 & 1/2 \\ 1/2 & 1/2 \end{bmatrix}$.

1/1 point









✓ **Correct**

The axes have been rotated, and also flipped here.

4. A digital image can be stored by putting lots of coloured pixels at their particular coordinates on a grid.

If we apply a matrix transformation to the coordinates of each of the pixels in an image, we transform the image as a whole.

Given a starting image (such as this one of "The Ambassadors" [1533] by Hans Holbein the Younger),

which is made up of 400×400 pixels, if we apply the same transformation to each of those 160,000 pixels, the transformed image becomes:

Pick a matrix that could correspond to the transformation.

- [x] $\begin{bmatrix} \sqrt{3}/2 & -1/2 \\ 1/2 & \sqrt{3}/2 \end{bmatrix}$
- [ ] $\begin{bmatrix} \sqrt{3}/2 & \sqrt{3}/2 \\ 1/2 & 1/2 \end{bmatrix}$
- [ ] $\begin{bmatrix} -1/2 & 0 \\ 0 & \sqrt{3}/2 \end{bmatrix}$
- [ ] $\begin{bmatrix} 1/2 & 0 \\ -\sqrt{3}/2 & 1/2 \end{bmatrix}$

$$\begin{bmatrix} 1/2 & 0 \\ -\sqrt{3}/2 & 1/2 \end{bmatrix}$$

✓ **Correct**

This is a rotation matrix (by 30° anticlockwise).

5. At the bottom of the "The Ambassadors", in the middle of the floor, there is a skull that Holbein has already applied a matrix transformation to!

To undo the transformation, build a matrix which is firstly a shear in the y direction followed by a scaling in y direction. I.e., multiply the matrices,

$$M = \begin{bmatrix} 1 & 0 \\ 0 & 8 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ -1/2 & 1 \end{bmatrix}$$

```
# Replace a, b, c and d with the correct values below:
M = [[1, 0],
     [-4, 8]]
```

Run

Reset

```
[[1, 0], [-4, 8]]
```

✓ **Correct**

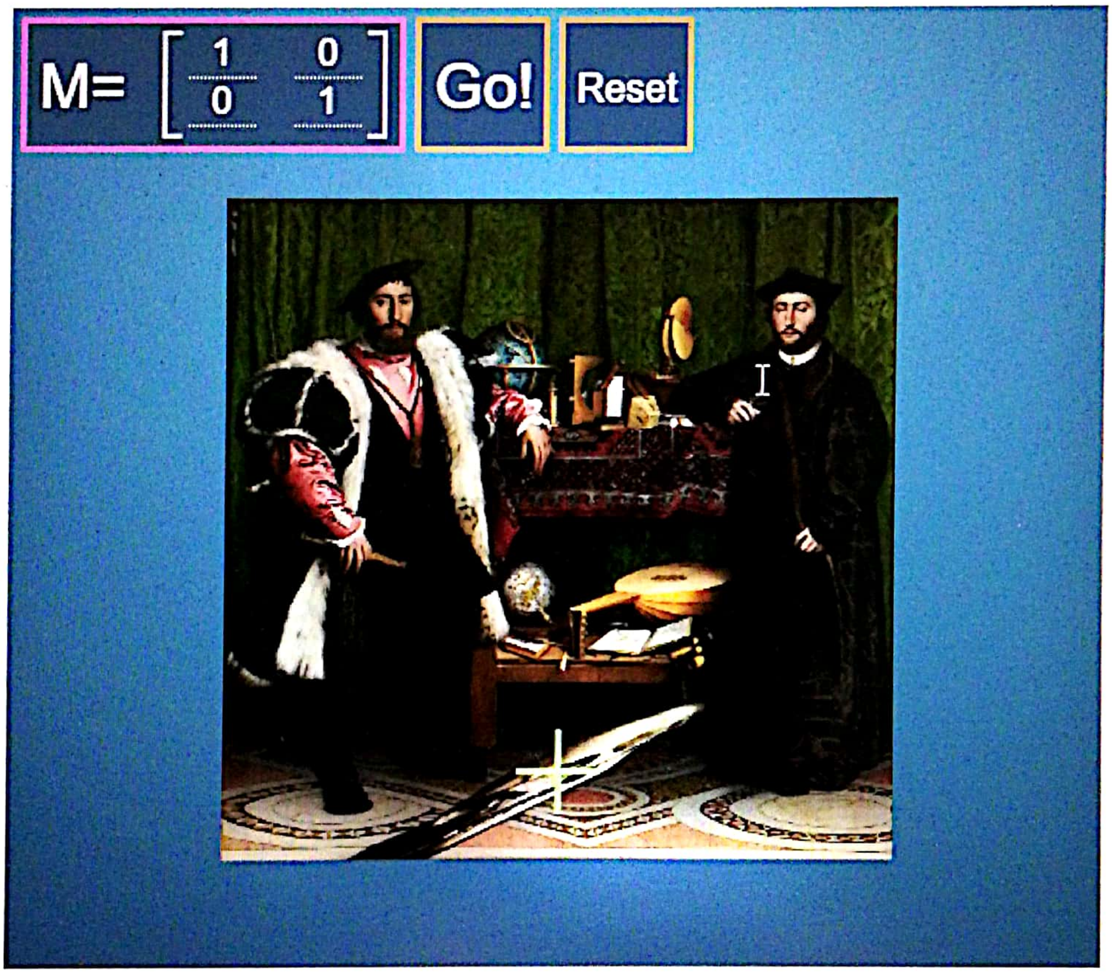
Well done.
Use your answer in the next question to transform the skull back.

6. Use your answer from the previous question to transform the skull back to normal. Change the values of the matrix and press *Go!* to score on this question.

You can also use this example to experiment with other matrix transformations. Try some of the ones in this quiz. Have a play!

6. Use your answer from the previous question to transform the skull back to normal. Change the values of the matrix and press *Go!* to score on this question.

You can also use this example to experiment with other matrix transformations. Try some of the ones in this quiz. Have a play!



✓ **Correct**

Feel free to use the tool to try out different matrices too.