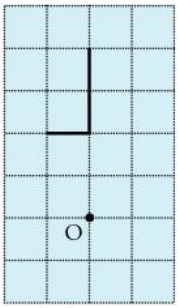
Exercise 15

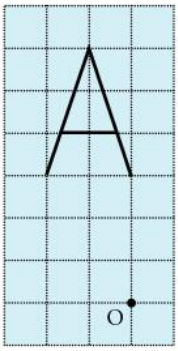
In questions **1** to **4** draw the object and its image under the rotation given.
Take O as the centre of rotation in each case.

1.



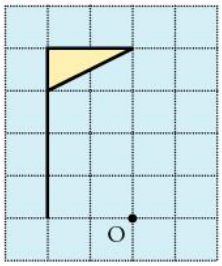
90° clockwise

2.



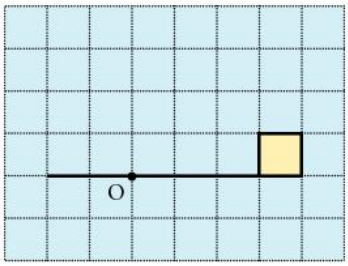
90° anticlockwise

3.



180°

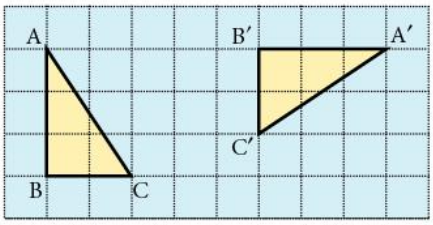
4.



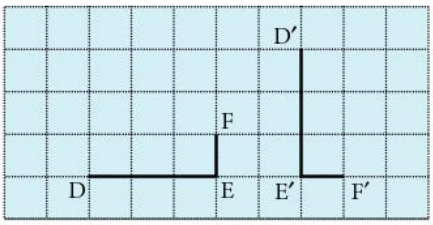
90° clockwise

In questions **5** to **8**, copy the diagram on squared paper and find the angle, the direction, and the centre of the rotation.

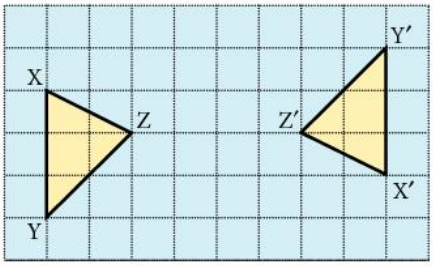
5.



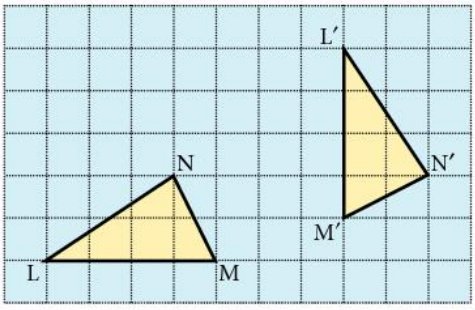
6.



7.



8.



Exercise 16

For all questions draw x- and y-axes for values from -8 to $+8$.

1. a) Draw the object triangle ABC at A(1, 3), B(1, 6), C(3, 6), rotate ABC through 90° clockwise about (0, 0), mark A′B′C′.

b) Draw the object triangle DEF at D(3, 3), E(6, 3), F(6, 1), rotate DEF through 90° clockwise about (0, 0), mark D′E′F′.

c) Draw the object triangle PQR at P(−4, 7), Q(−4, 5), R(− 1, 5), rotate PQR through 90° anticlockwise about (0, 0), mark P′Q′R′.

2. a) Draw Δ1 at (1, 4), (1, 7), (3, 7).

b) Draw the images of Δ1 under the following rotations:

i) 90° clockwise, centre (0, 0). Label it Δ2.

ii) 180°, centre (0, 0). Label it Δ3.

iii) 90° anticlockwise, centre (0, 0). Label it Δ4.

3. a) Draw triangle PQR at P(1, 2), Q(3, 5), R(6, 2).

b) Find the image of PQR under the following rotations:

i) 90° anticlockwise, centre (0, 0); label the image P′Q′R′

ii) 90° clockwise, centre (−2, 2); label the image P″Q″R″

iii) 180°, centre (1, 0); label the image P*Q*R*.

c) Write down the coordinates of P′, P″, P*.

4. a) Draw Δ1 at (1, 2), (1, 6), (3, 5).

b) Rotate Δ1 90° clockwise, centre (1, 2) onto Δ2.

c) Rotate Δ2 180°, centre (2, −1) onto Δ3.

d) Rotate Δ3 90° clockwise, centre (2, 3) onto Δ4.

e) Write down the coordinates of Δ4.

5. a) Draw and label the following triangles:

Δ1: (3, 1), (6, 1), (6, 3)

Δ2: (−1, 3), (−1, 6), (−3, 6)

Δ3: (1, 1), (−2, 1), (−2, −1)

Δ4: (3, −1), (3, −4), (5, −4)

Δ5: (4, 4), (1, 4), (1, 2)

b) Describe fully the following rotations:

i) Δ1 onto Δ2

ii) Δ1 onto Δ3

iii) Δ1 onto Δ4

iv) Δ1 onto Δ5

v) Δ5 onto Δ4

vi) Δ3 onto Δ2

6. a) Draw Δ1 at (4, 7), (8, 5), (8, 7).

b) Rotate Δ1 90° clockwise, centre (4, 3) onto Δ2.

c) Rotate Δ2 180°, centre (5, −1) onto Δ3.

d) Rotate Δ3 90° anticlockwise, centre (0, −8) onto Δ4.

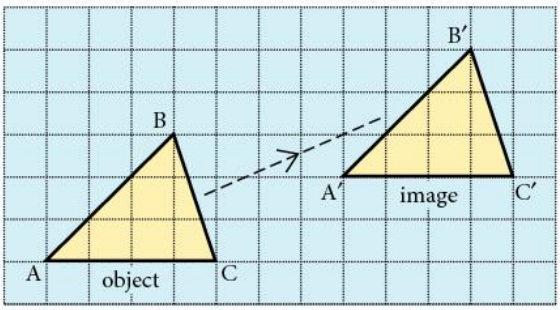
e) Describe fully the following rotations:

i) Δ4 onto Δ1

ii) Δ4 onto Δ2

Translation

The triangle ΔABC below has been transformed onto the triangle A′B′C′ by a *translation*.



Here the translation is 7 squares to the right and 2 squares up the page. The translation can be described by a column vector.

In this case the translation is $\begin{pmatrix} 7 \\ 2 \end{pmatrix}$.

Exercise 17

1. Make a copy of the diagram below and write down the column vector for each of the following translations:

a) D onto A

b) B onto F

c) E onto A

d) A onto C

e) E onto C

f) C onto B

g) F onto E

h) B onto C.