Example 3

The figure shown is subjected to transformations in the following order:

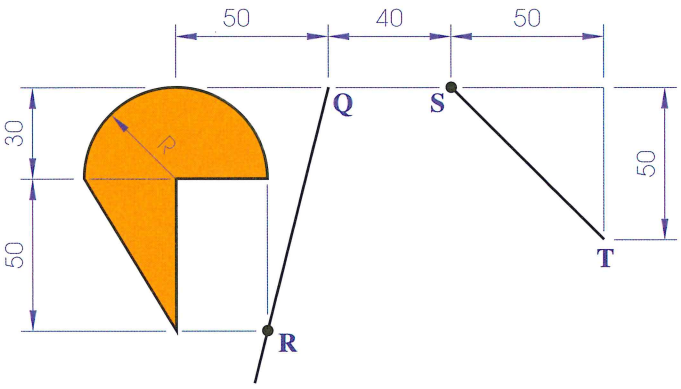
(i) **Axial symmetry** in the line QR.

(ii) **Central symmetry** in the point S.

(iii) **Translation** equal to ST.

(iv) **Rotation** clockwise about point R through an angle of 50°.

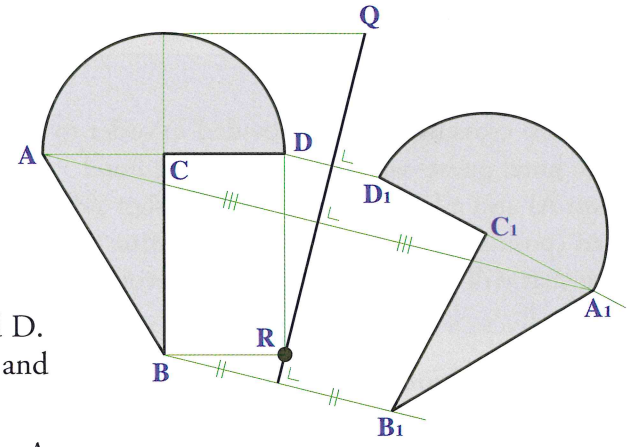
Draw the given figure and determine the image figures in each of the transformations.



1. Draw the given figure and the line QR. Index the points of the figure as shown.

Draw lines from each of the points A, B and D perpendicular to QR and extend as shown. Locate A_1 so that A_1 is the same distance from QR as A. A_1 is the image of A under **axial symmetry** in the line QR.

Repeat the procedure for each of the points B and D. Locate C_1, the midpoint of A_1D_1. Join the points and complete the image figure.

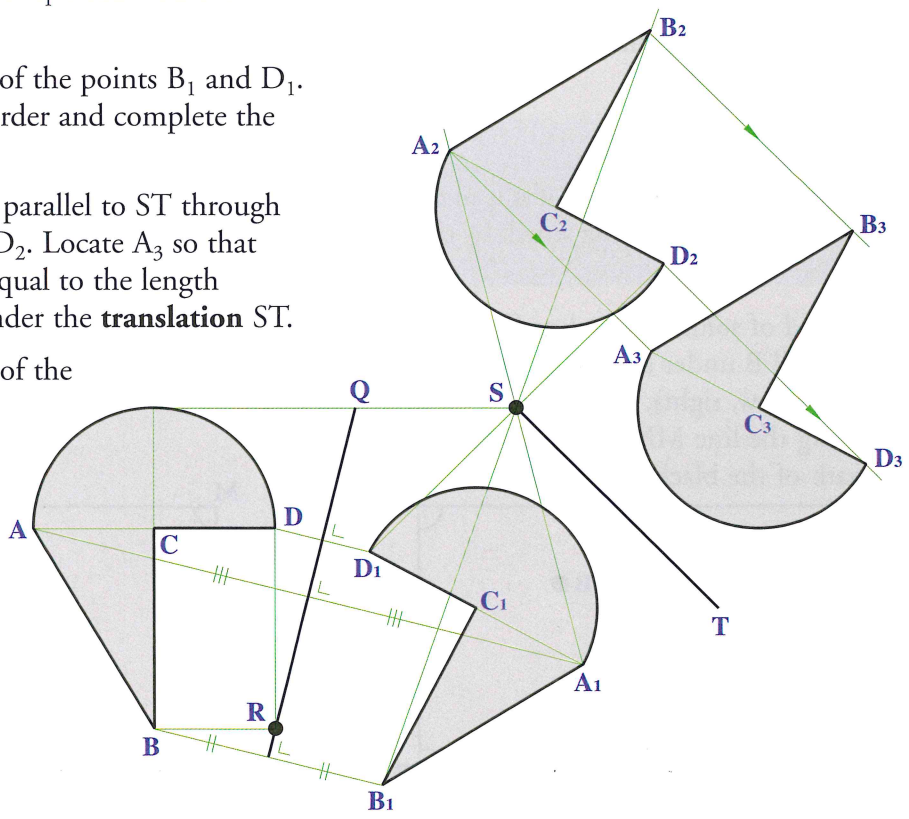


2. Locate the point S. Join A_1 to S and extend. Locate A_2 so that the distance from A_2 to S is equal to the distance from A_1 to S. A_2 is the image of A_1 under **central symmetry** in the point S.

Repeat the procedure for each of the points B_1 and D_1. Locate C_2. Join the points in order and complete the image of the figure.

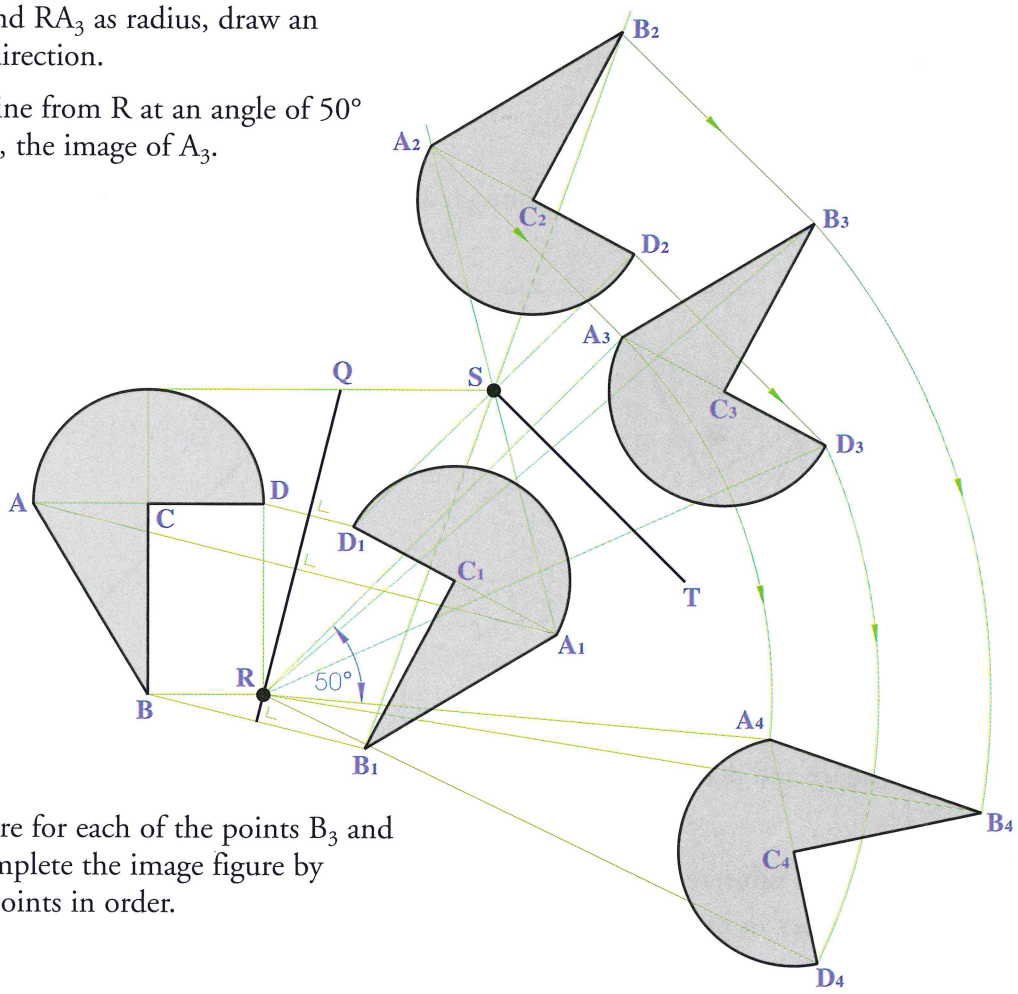
3. Locate the line ST. Draw lines parallel to ST through each of the points A_2, B_2 and D_2. Locate A_3 so that the distance from A_2 to A_3 is equal to the length of ST. A_3 is the image of A_2 under the **translation** ST.

Repeat the procedure for each of the points B_2 and D_2. Locate C_3. Join the points and draw the image figure.



4. With R as centre and RA_3 as radius, draw an arc in a clockwise direction.

Join RA_3. Draw a line from R at an angle of 50° to RA_3 to locate A_4, the image of A_3.



5. Repeat the procedure for each of the points B_3 and D_3. Locate C_4. Complete the image figure by joining the image points in order.

Exercises

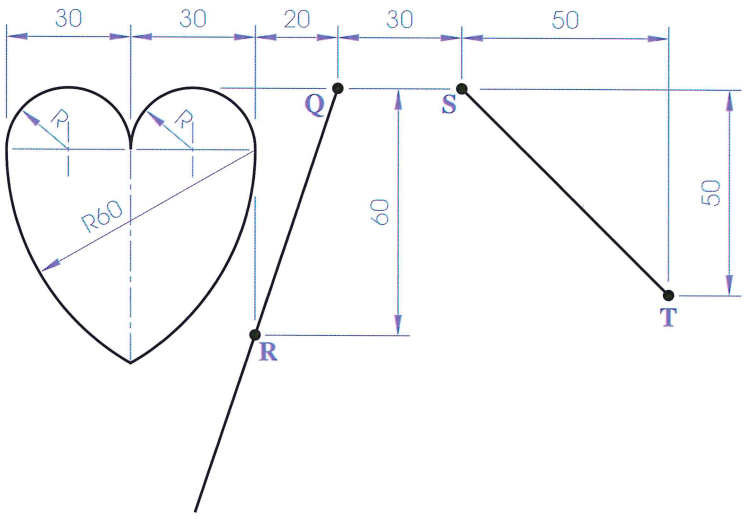
1. The figure shown is subjected to transformations in the following order:

(i) **Axial symmetry** in the line QR.

(ii) **Central symmetry** in the point S.

(iii) **Translation** equal to ST.

(iv) **Rotation** clockwise about point R through an angle of 45°.



Draw the given figure and determine the image figures in each of the transformations.

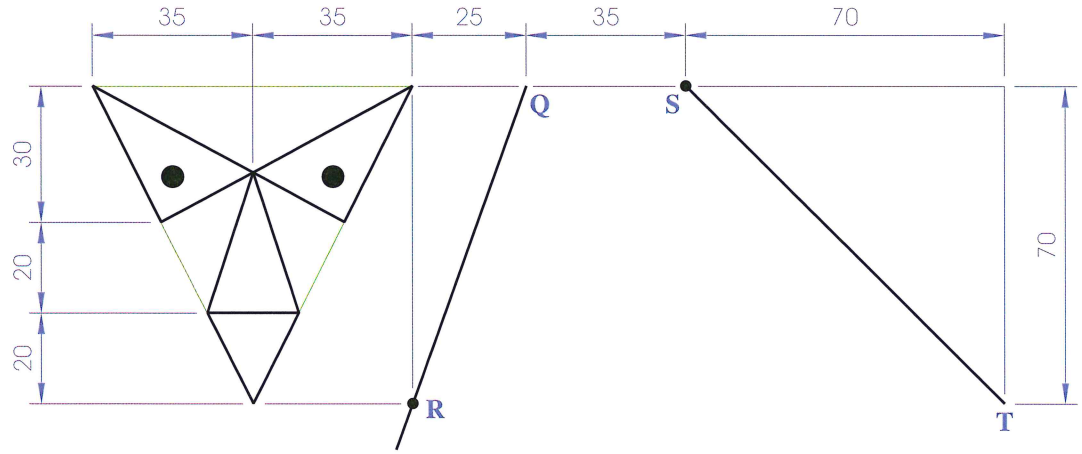
2. The figure shown is subjected to transformations in the following order:

(i) **Axial symmetry** in the line QR.

(ii) **Central symmetry** in the point S.

(iii) **Translation** equal to ST.

(iv) **Rotation** clockwise about point R through an angle of 40°.



Draw the given figure and determine the image figures in each of the transformations.

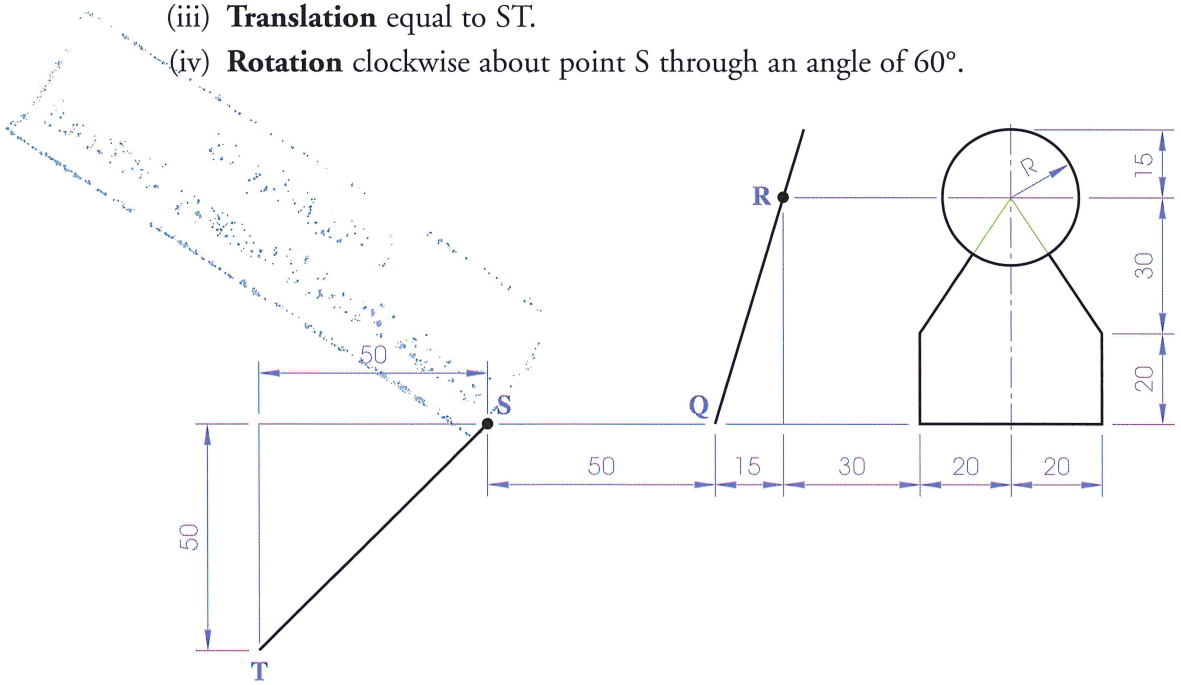
3. The figure shown is subjected to transformations in the following order:

(i) **Axial symmetry** in the line QR.

(ii) **Central symmetry** in the point S.

(iii) **Translation** equal to ST.

(iv) **Rotation** clockwise about point S through an angle of 60°.

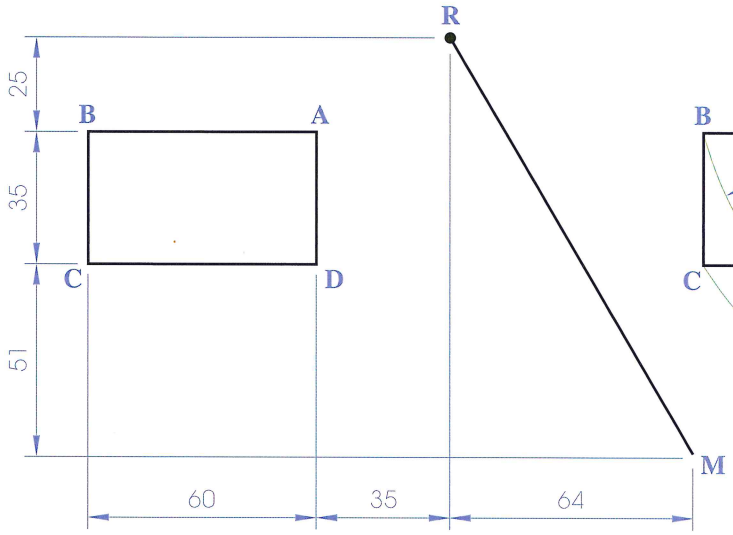


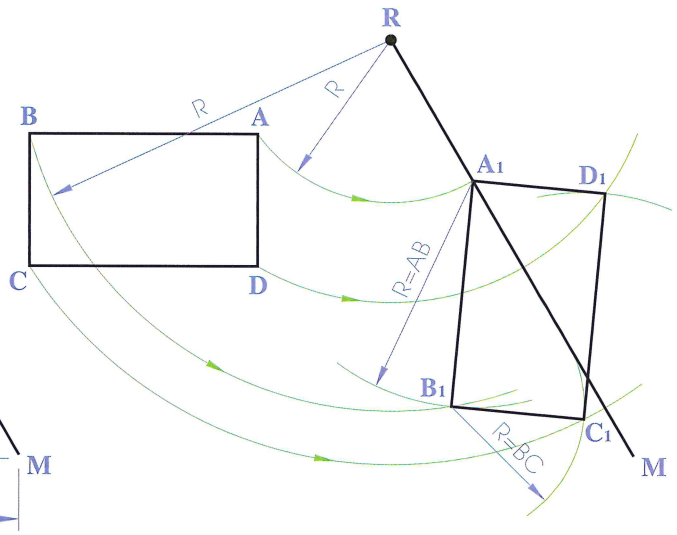
Draw the given figure and determine the image figures in each of the transformations.

Answer Worksheet 26B

Example

The figure (below, left) shows a rectangle ABCD and a line RM. The rectangle ABCD is rotated anti-clockwise about the point R until the vertex A reaches the line RM. Draw the given figure and determine the image figure under the transformation.

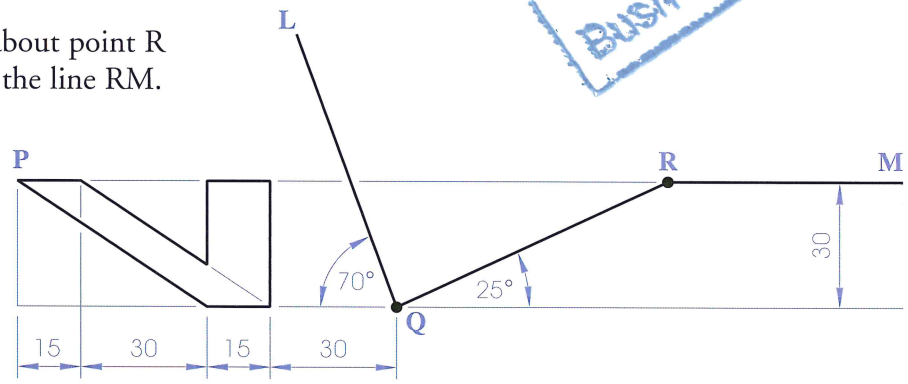




1. With R as centre and RA as radius, draw an arc in an anti-clockwise direction to locate A_1 on the line RM.
2. With R as centre and RB as radius, draw an arc in an anti-clockwise direction. With A_1 as centre and AB as radius, draw an arc to locate B_1 on the arc drawn from B.
3. With R as centre and RC as radius, draw an arc in an anti-clockwise direction. With B_1 as centre and BC as radius, draw an arc to locate C_1 on the arc drawn from C.
4. Repeat the procedure for point D. Join the points in order to obtain the required image $A_1B_1C_1D_1$.

Exercises

1. The figure shown is subjected to transformations in the following order:
   (i) **Axial symmetry** in the line LQ.
   (ii) **Central symmetry** in the point Q.
   (iii) **Translation** equal to QR.
   (iv) **Rotation** anti-clockwise about point R until the vertex P reaches the line RM.



Draw the given figure and determine the image figures in each of the transformations.

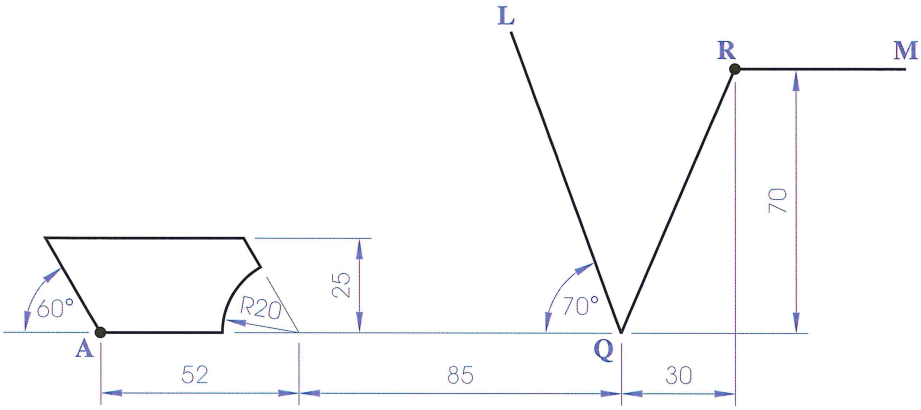
2. The figure shown is subjected to transformations in the following order:

(i) **Translation** equal to QR.

(ii) **Axial symmetry** in the line LQ.

(iii) **Central symmetry** in the point R.

(iv) **Rotation** anti-clockwise about point R until the vertex A reaches the line RM.

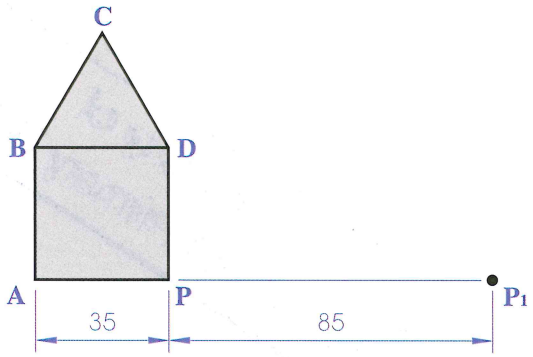


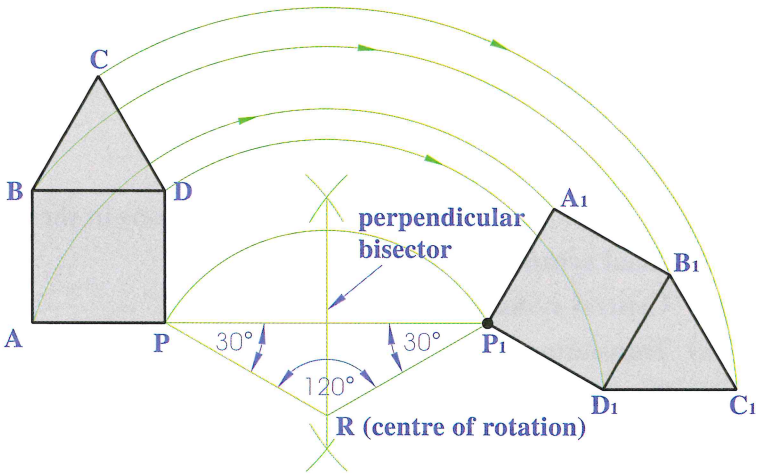
Draw the given figure and determine the image figures in each of the transformations.

Example

The figure PABCD (below, left) is based on a square and an equilateral triangle. It is subjected to a **rotation** clockwise through an angle of 120°. P_1 shows the position of the vertex P under this transformation.

Draw the given figure and determine the image figure under the rotation.





1. Join P to P_1 and construct the perpendicular bisector of this line. The **centre of rotation** lies on the perpendicular bisector as every point on the bisector is equidistant from P and P_1.

2. The centre of rotation will lie on the lower side of the line PP_1 in order to allow for a clockwise rotation. If the centre of rotation were on the upper side of the line, this would allow for an anti-clockwise rotation. Draw lines at 30° to PP_1 to locate R, the centre of rotation. Complete the rotation as shown, and draw the image figure $P_1A_1B_1C_1D_1$.

$\triangle PRP_1$ is isosceles. As $\angle PRP_1$ is 120°, then $\angle RPP_1 = \angle RP_1P = 30°$ (180° – 120° = 60° ÷ 2 = 30°).

Exercises

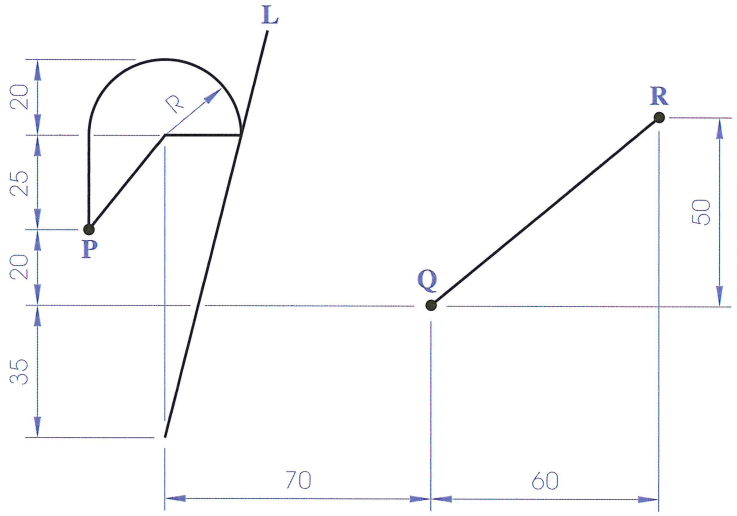
1. The figure shown is subjected to transformations in the following order:

(i) **Axial symmetry** in the line L.

(ii) **Translation** equal to QR.

(iii) **Central symmetry** in the point Q.

(iv) **Rotation** anti-clockwise through an angle of 110° so that R will be the image of vertex P.



Draw the given figure and determine the image figures in each of the transformations.

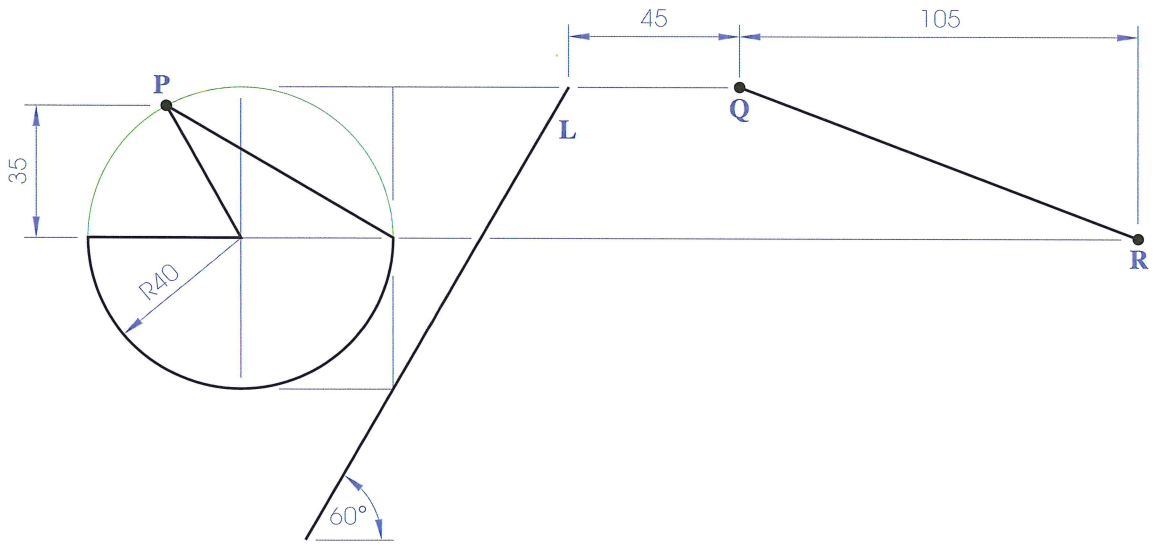
2. The figure shown is subjected to transformations in the following order:

(i) **Axial symmetry** in the line L.

(ii) **Translation** equal to QR.

(iii) **Central symmetry** in the point R.

(iv) **Rotation** anti-clockwise through an angle of 100° so that Q will be the image of vertex P.



Draw the given figure and determine the image figures in each of the transformations.

Example

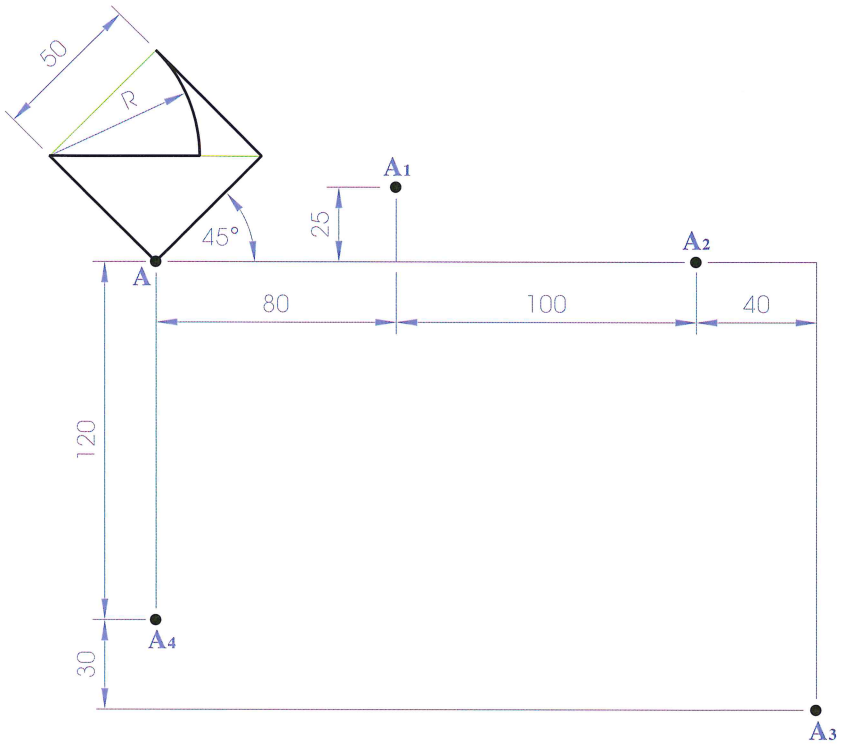
The figure shown is subjected to transformations in the following order:

(i) **Central symmetry** in a point.

(ii) **Axial symmetry**.

(iii) **Rotation** clockwise through 120°.

(iv) **Translation**.

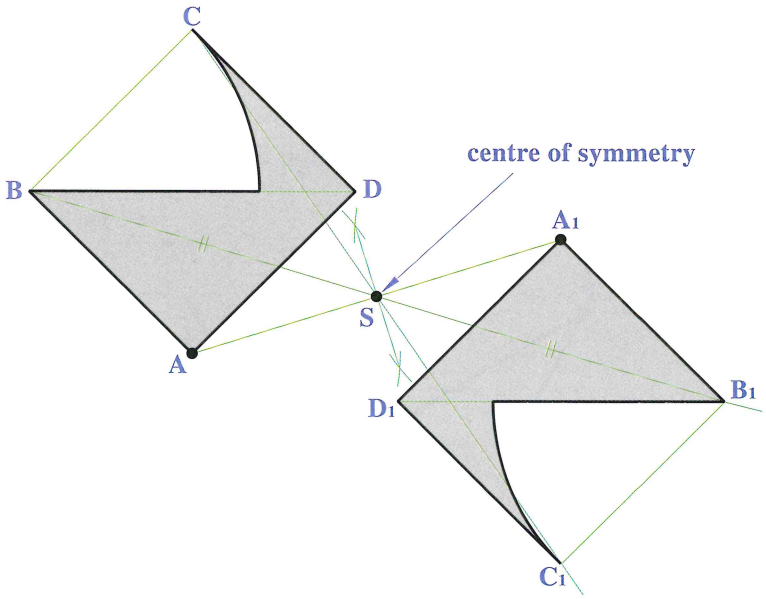


A1, A2, A3 and A4 show the positions of the vertex A under these transformations. Draw the given figure and determine the image figures in each of the transformations.

1. Draw the given figure and locate the point A_1. Index the points of the given figure as shown. Join A to A_1 and bisect this line at S. S is the **centre of symmetry** for the transformation.

Join B to S and extend. Locate B_1 so that the distance from B_1 to S is equal to the distance from B to S. B_1 is the image of B under **central symmetry** in the point S.

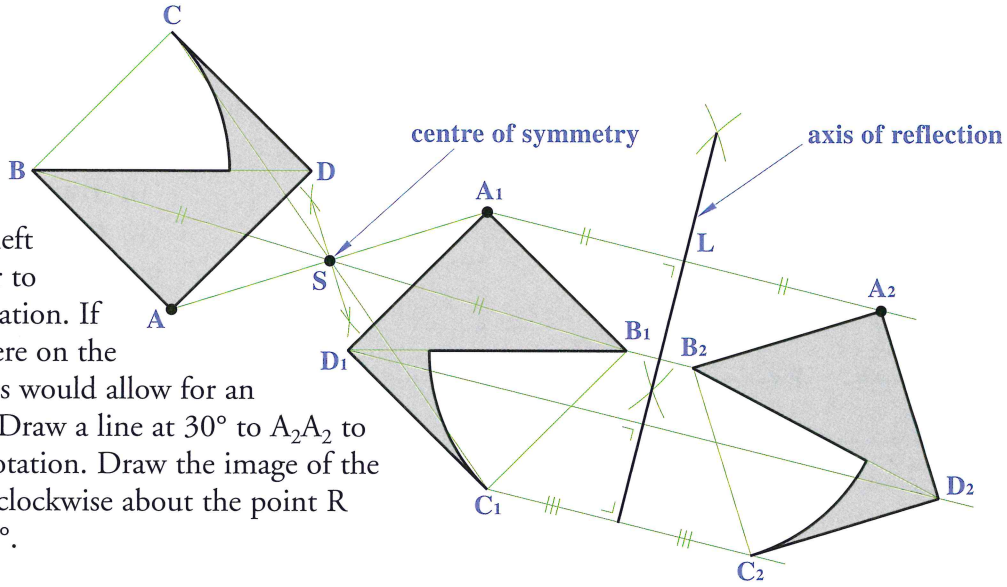
Repeat the procedure for each of the points C and D. Join the points in order and complete the image of the figure.



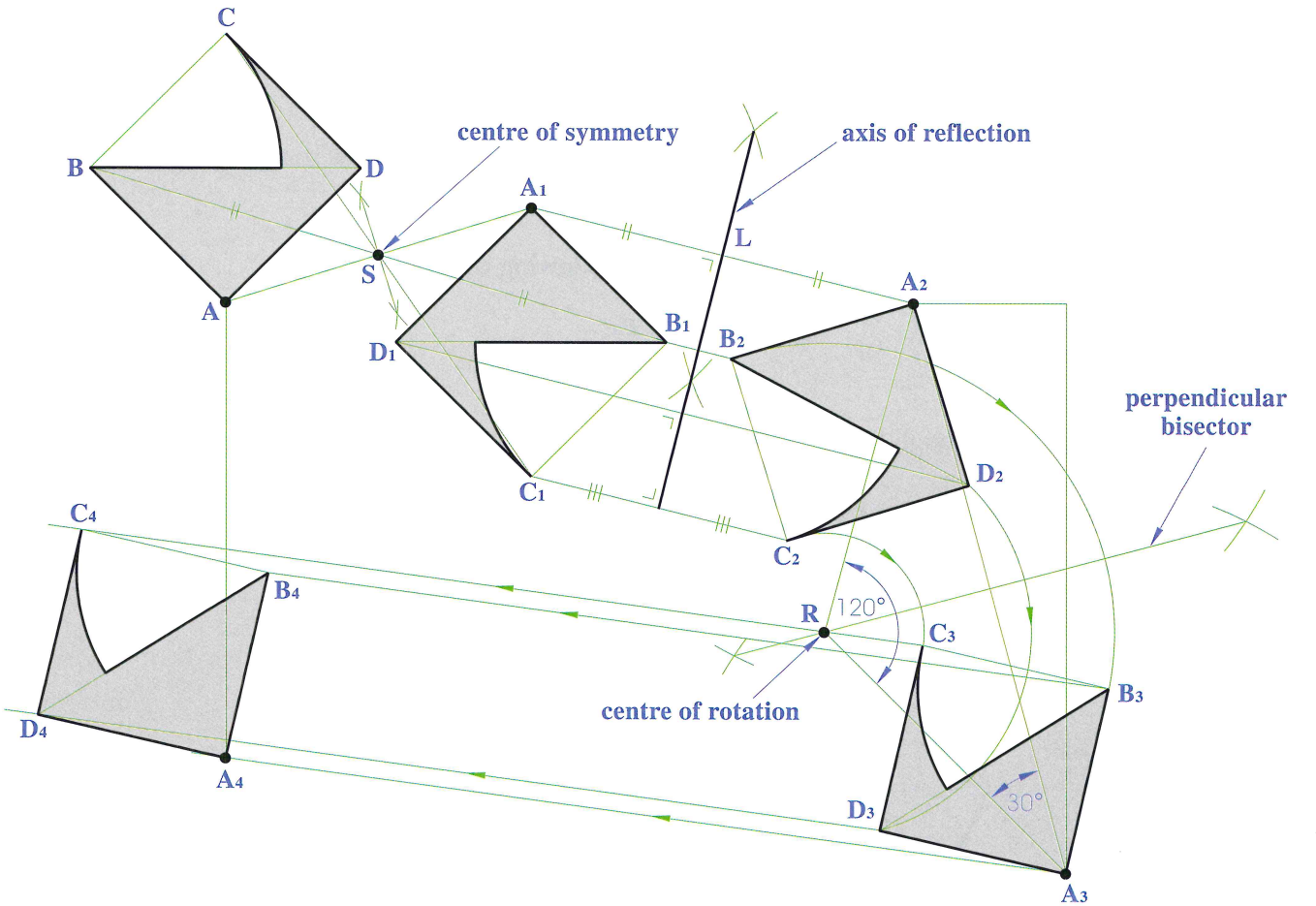
2. Locate the point A_2 (page 275, top). Join A_1 to A_2 and construct the perpendicular bisector L of this line. L is the **axis of reflection** for the transformation.

Draw lines from each of the points B_1, C_1, and D_1 perpendicular to L and extend as shown. Locate B_2 so that B_2 is the same distance from L as B_1. B_2 is the image of B_1 under **axial symmetry** in the line L. Repeat the procedure for each of the points C_1 and D_1. Join the points and draw the image figure.

3. Locate the point A_3 (below). Join A_2 to A_3 and construct the perpendicular of this line. The **centre of rotation** will lie on the left of the line A_2A_3 in order to allow for a clockwise rotation. If the centre of rotation were on the right side of the line, this would allow for an anti-clockwise rotation. Draw a line at 30° to A_2A_2 to locate R, the centre of rotation. Draw the image of the figure under a **rotation** clockwise about the point R through an angle of 120°.



$\triangle A_2RA_3$ is isosceles. $\angle A_2RA_3$ is 120°. Thus, $\angle RA_2A_3 = \angle RA_3A_2 = 30°$ (180° − 120° = 60° ÷ 2 = 30°).



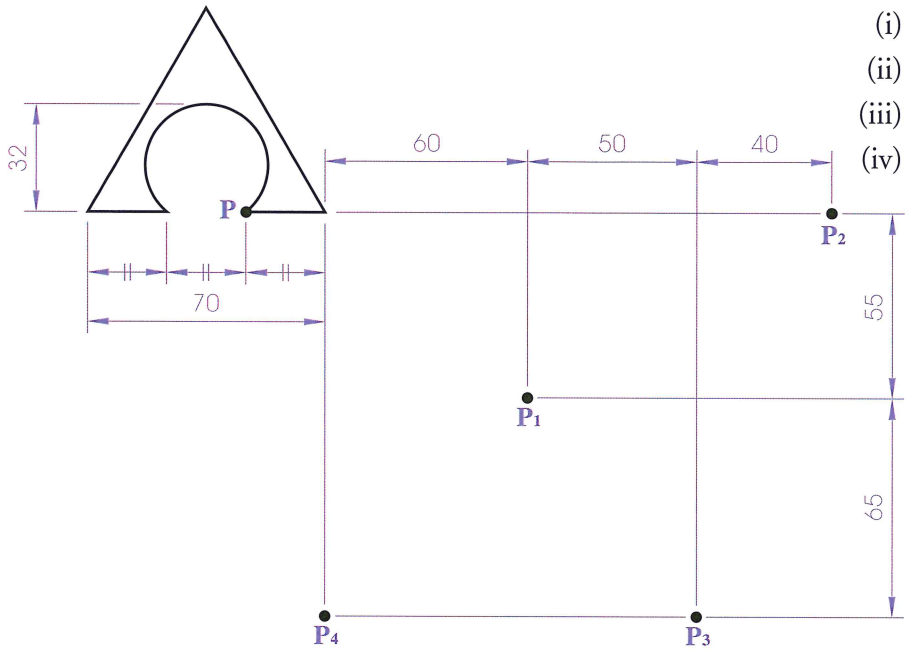
4. Locate the point A_4. Join A_3 to A_4. Draw lines parallel to A_3A_4 through each of the points B_3, C_3 and D_3. Locate B_4 so that the distance from B_3 to B_4 is equal to the length of A_3A_4. B_4 is the image of B_3 under the **translation**.

Repeat the procedure for each of the points C_3 and D_3. Join the points and draw the image figure.

Exercises

1. The figure shown is based on an **equilateral triangle**. It is subjected to transformations in the following order:

(i) **Translation**
(ii) **Central symmetry**
(iii) **Axial symmetry**
(iv) **Rotation** clockwise through an angle of 120°.



P_1, P_2, P_3 and P_4 show the positions of point P under these transformations. Draw the given figure and determine the image figures in each of the transformations.

The figure shown is subjected to transformations in the following order:

(i) **Translation**
(ii) **Axial symmetry**
(iii) **Central symmetry**
(iv) **Rotation** clockwise through 90°.

P_1, P_2, P_3 and P_4 show the positions of the vertex P under these transformations. Draw the given figure and determine the image figure in each the transformations.