

## STEP II, 2001, Q7

- 7 In an Argand diagram,  $O$  is the origin and  $P$  is the point  $2 + 0i$ . The points  $Q$ ,  $R$  and  $S$  are such that the lengths  $OP$ ,  $PQ$ ,  $QR$  and  $RS$  are all equal, and the angles  $OPQ$ ,  $PQR$  and  $QRS$  are all equal to  $5\pi/6$ , so that the points  $O$ ,  $P$ ,  $Q$ ,  $R$  and  $S$  are five vertices of a regular 12-sided polygon lying in the upper half of the Argand diagram. Show that  $Q$  is the point  $2 + \sqrt{3} + i$  and find  $S$ .

The point  $C$  is the centre of the circle that passes through the points  $O$ ,  $P$  and  $Q$ . Show that, if the polygon is rotated anticlockwise about  $O$  until  $C$  first lies on the real axis, the new position of  $S$  is

$$-\frac{1}{2}(3\sqrt{2} + \sqrt{6})(\sqrt{3} - i).$$



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