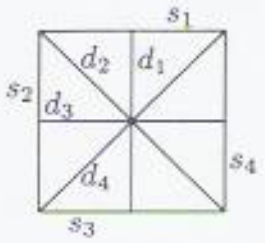
**Question 9**

The figure below shows a square and its four axes of reflectional symmetry.




The set $X$ consists of the four sides of the square and the four axes of reflectional symmetry as shown: that is

$$X = \{s_1, s_2, s_3, s_4, d_1, d_2, d_3, d_4\}$$

The group $S(\square)$ (the group of symmetries of the square) acts on $X$ in the natural way: if $f \in S(\square)$ and $x \in X$ then $f \wedge x = f(x)$, the image of the line segment $x$ under the symmetry $f$. You are NOT asked to prove that this is a group action.

(a) Write down the orbits of this action within $X$.

(b) Describe geometrically the elements of

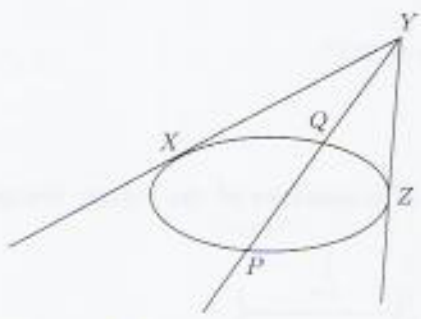
(i) $\mathrm{Stab}(s_1)$

(ii) $\mathrm{Stab}(d_2)$

(iii) $\mathrm{Fix}(t)$ where $t$ is reflection in the horizontal axis of symmetry, $d_3$. [5]

**Question 10**

The figure below shows a conic in standard form in $\mathbb{RP}^2$, where the Points $X[1,0,0]$, $Z[0,0,1]$ and $P[1,1,1]$ lie on the conic and the tangents at $X$ and $Z$ meet at $Y[0,1,0]$. The Point $Q$ is where the Line $PY$ cuts the conic again.




(a) What is the equation of the conic?

(b) Find the equation of the Line $PY$.

(c) Find the Point $Q$ where the Line $PY$ cuts the conic again. [5]

**Question 11**

Sketch each of the following Circles together with its image under inversion in the unit circle. If the image is a Euclidean circle, state its centre and radius.

(a) $C_1$: the line $y = 3$;

(b) $C_2$: the circle centre $(\frac{1}{3}, 0)$, radius $\frac{2}{3}$.

You should draw separate diagrams for parts (a) and (b) and, on each diagram, distinguish clearly between the Circle and its image. [5]