

Section 1: Motion in two dimensions**Exercise level 3 (Extension)**

1. A particle moves so that its position vector in terms of the time t seconds is given

$$\text{by } \mathbf{r} = \begin{pmatrix} 1-t^2 \\ t^2-3t \end{pmatrix} \text{ metres.}$$

- Show that the particle is never at the origin.
- Find the time at which the particle is moving parallel to the y -axis.
- Show that when $t \neq 0$ the particle's velocity is never perpendicular to its position vector.
- Show that the velocity of the particle is never parallel to its position vector.
- Find the minimum distance of the particle from the origin and sketch its path for $-1 < t < 1$.

2. A particle moves so that its position vector in terms of the time t (>0) seconds is

$$\text{given by } \mathbf{r} = \begin{pmatrix} 5 \cos t \\ 5 \sin t \\ 4t \end{pmatrix} \text{ metres.}$$

- Describe its motion in words.
 - Find an expression in terms of t for the distance of the particle from O .
 - When is the position vector of the particle inclined at 45° to the horizontal?
3. In a clay pigeon shoot the target is launched vertically from ground level with speed v . At a time T later the competitor fires a rifle inclined at α to the horizontal. The competitor is also at ground level and is a distance l from the launcher. The speed of the bullet leaving the rifle is u . Show that if the competitor scores a hit then

$$l \sin \alpha - \left(vT - \frac{1}{2} gT^2 \right) \cos \alpha = \frac{v - gT}{u} l$$

[1993 STEP Mathematics q12 – part; this question appears by permission of Cambridge Assessment.]