

3. In this question, distance is in metres, time is in minutes.

Two model airplanes are each flying in a straight line.

At 13:00 the first model airplane is at the point $(3, 2, 7)$. Its position vector after t minutes is given by

$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 3 \\ 2 \\ 7 \end{pmatrix} + t \begin{pmatrix} 3 \\ 4 \\ 10 \end{pmatrix}.$$

- (a) Find the speed of the model airplane.

(2)

At 13:00 the second model airplane is at the point $(-5, 10, 23)$. After two minutes, it is at the point $(3, 16, 39)$.

- (b) Show that its position vector after t minutes is given by $\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} -5 \\ 10 \\ 23 \end{pmatrix} + t \begin{pmatrix} 4 \\ 3 \\ 8 \end{pmatrix}$.

(3)

- (c) The airplanes meet at point Q.

- (i) At what time do the airplanes meet?
(ii) Find the position of Q.

(6)

- (d) Find the angle θ between the paths of the two airplanes.

(6)

(Total 17 marks)