

## Chapter 13 Vector Applications

1. In this question, all position vectors are given relative to an origin,  $O$ . Distances are measured in meters, and time,  $t$ , is measured in seconds.

An antelope runs across flat ground, and his path is given by the vector equation  $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} -9 \\ 11 \end{pmatrix} + t \begin{pmatrix} 4 \\ 3 \end{pmatrix}, t \geq 0$

- a. Find the speed of the antelope.
  
  
  
  
  
  
  
  
  
  
- b. Find the coordinates of the point where the antelope starts.
  
  
  
  
  
  
  
  
  
  
- c. Find the coordinates of the antelope's position after four seconds.

A cheetah chases after the antelope, starting at  $t = 0$ , from a point with coordinates  $(0, -25)$  and runs in a straight line with constant velocity. The cheetah catches the antelope after 11 seconds.

- d. Find the coordinates of the point where the cheetah catches the antelope.
  
  
  
  
  
  
  
  
  
  
- e. Find the speed of the cheetah.
  
  
  
  
  
  
  
  
  
  
- f. Explain why this question offers an inadequate model of a realistic chase.

2. In this question, units of distance are in meters and units of velocity are in meters per second. The path of a skier traveling down a slope is modeled by a straight line whose vector equation is  $\vec{r} = \vec{a} + t\vec{v}$ .  $\vec{a} = \begin{pmatrix} 5.83 \\ 2.11 \\ 3.74 \end{pmatrix}$  is the position vector of his path at time  $t = 0$ , and  $\vec{v} = \begin{pmatrix} 0.711 \\ -0.283 \\ 1.782 \end{pmatrix}$  is the skier's velocity for  $t \geq 0$ . The components of both  $\vec{a}$  and  $\vec{v}$  are relative to a fixed set of axes.
- Find the skier's speed.
  - Find the skier's position vector after 10 seconds.
  - Find the time taken for the skier to reach the point whose coordinates are  $(43.51, -12.89, 98.19)$
3. Juan lost his watch which is lying at the bottom of a swimming pool. The watch is located at point  $P$  whose coordinates are  $(21, -8, 8)$ . Juan is standing on the edge of the pool at point  $Q$  with coordinates  $(4, 0, 15)$  relative to the origin,  $O$ .
- Find  $\overrightarrow{QP}$ .
  - Juan dives into the pool at  $Q$  and swims in a straight line to  $P$ . Swimming at a speed of  $1\text{ms}^{-1}$ , show that his velocity is  $0.848\vec{i} - 0.399\vec{j} - 0.349\vec{k}$ .
  - If Juan can maintain this speed while picking up the watch and then rise vertically to the surface, how long will he need to hold his breath?