

Solutionbank M1

Heinemann Modular Maths for Edexcel AS and A-level

Exam style practice papers

Exercise MM1A, Question 7

Question:

A speed boat moves with a constant acceleration of $(-i + j) \text{ m s}^{-2}$. Initially the boat is at the origin and has velocity $4i \text{ m s}^{-1}$. The unit vectors i and j are directed east and north, respectively. The velocity of the boat at time t seconds is $v \text{ m s}^{-1}$.

(a) Find v in terms of t . (2 marks)

(b) At time T seconds, where $T > 0$, the speed of the boat is 20 m s^{-1} .

(i) Write down an equation that T must satisfy. (3 marks)

(ii) Hence, find T . (2 marks)

(iii) Find the distance of the boat from the origin at this time. (4 marks)

Solution:

Using $v = u + at$,

$$\begin{aligned} \text{(a) } v &= 4i + (-i + j)t \\ &= (4 - t)i + tj \end{aligned}$$

(b) (i) If the speed is 20 m s^{-1} , and $t = T$;

$$\begin{aligned} 20 &= \sqrt{(4 - T)^2 + T^2} \\ 400 &= 16 - 8T + T^2 + T^2 \\ 2T^2 - 8T - 384 &= 0 \\ T^2 - 4T - 192 &= 0 \end{aligned}$$

$$\begin{aligned} \text{(ii) } (T - 16)(T + 12) &= 0 \\ \therefore T &= 16 \quad (-12, \text{ not required}) \end{aligned}$$

Using $s = ut + \frac{1}{2}at^2$,

$$\begin{aligned} s &= 4iT + \frac{1}{2}(-i + j)T^2 \\ \text{(iii) } s &= 64i + 128(-i + j) \quad (\text{using } T = 16) \\ s &= -64i + 128j \\ \text{Distance is } &\sqrt{64^2 + 128^2} \\ &= 143.1 \\ \text{Distance is } &143 \text{ m.} \end{aligned}$$