8 In this question all distances are in km.

A ship P sails from a point A, which has position vector $\begin{pmatrix}0\\0\end{pmatrix}$, with a speed of $52\,\text{kmh}^{-1}$ in the direction of $\begin{pmatrix}-5\\12\end{pmatrix}$.

(a) Find the velocity vector of the ship. [1]

(b) Write down the position vector of P at a time t hours after leaving A. [1]

At the same time that ship P sails from A, a ship Q sails from a point B, which has position vector $\begin{pmatrix}12\\8\end{pmatrix}$, with velocity vector $\begin{pmatrix}-25\\45\end{pmatrix}\text{kmh}^{-1}$.

(c) Write down the position vector of Q at a time t hours after leaving B. [1]

(d) Using your answers to **parts (b)** and **(c)**, find the displacement vector $\overrightarrow{PQ}$ at time t hours. [1]

© UCLES 2020

(e) Hence show that $PQ = \sqrt{34t^2 - 168t + 208}$. [2]

(f) Find the value of t when P and Q are first 2 km apart. [2]