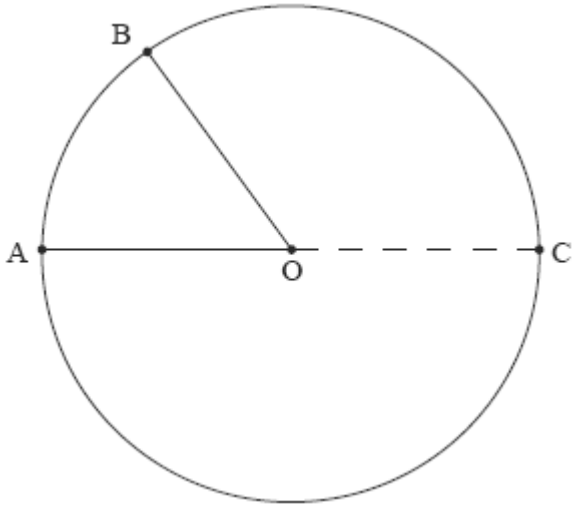
1. The diagram below shows a circle with centre O. The points A, B, C lie on the circumference of the circle and [AC] is a diameter.



Let $\overrightarrow{OA} = \boldsymbol{a}$ and $\overrightarrow{OB} = \boldsymbol{b}$.

(a) Write down expressions for $\overrightarrow{AB}$ and $\overrightarrow{CB}$ in terms of the vectors $\boldsymbol{a}$ and $\boldsymbol{b}$.

(2)

(b) Hence prove that angle $A\hat{B}C$ is a right angle.

(3)

(Total 5 marks)

2. Port A is defined to be the origin of a set of coordinate axes and port B is located at the point (70, 30), where distances are measured in kilometres. A ship S_1 sails from port A at 10:00 in a straight line such that its position t hours after 10:00 is given by $\boldsymbol{r} = t\begin{pmatrix}10\\20\end{pmatrix}$.

A speedboat S_2 is capable of three times the speed of S_1 and is to meet S_1 by travelling the shortest possible distance. What is the latest time that S_2 can leave port B?

(Total 7 marks)

3. Given that $\boldsymbol{a} = 2\sin\theta\,\boldsymbol{i} + (1 - \sin\theta)\boldsymbol{j}$, find the value of the acute angle θ, so that $\boldsymbol{a}$ is perpendicular to the line $x + y = 1$.

(Total 5 marks)