Question:

A car travels 3km due north, then 5km northeast.
Determine the resultant displacement.

Solution:
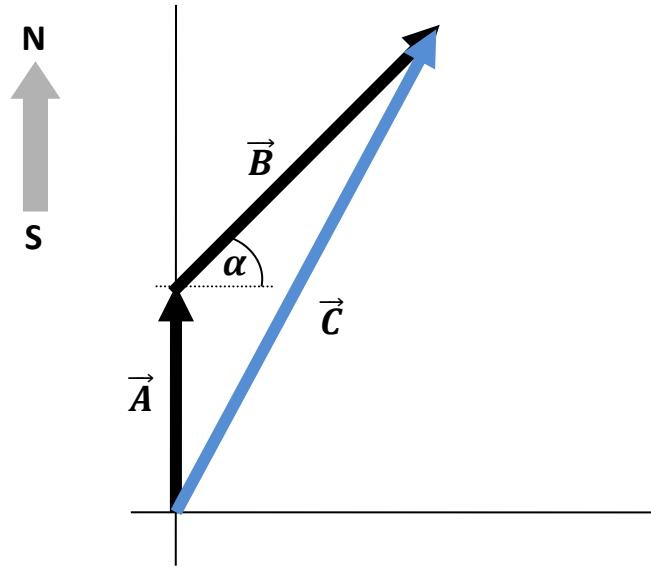
In Cartesian coordinates the first part of car's travel is vector $\vec{A} = (0; 3)$, and the second part is vector $\vec{B} = (5 \cdot \cos\alpha \, ; 5 \cdot \sin\alpha) = \left(\frac{5}{\sqrt{2}} ; \frac{5}{\sqrt{2}}\right)$.

The resultant displacement vector $\vec{C} = \vec{A} + \vec{B} = (0; 3) + \left(\frac{5}{\sqrt{2}} ; \frac{5}{\sqrt{2}}\right) = \left(\frac{5}{\sqrt{2}} ; 3 + \frac{5}{\sqrt{2}}\right)$.

Its length $\left|\vec{C}\right| = \sqrt{\left(\frac{5}{\sqrt{2}}\right)^2 + \left(3 + \frac{5}{\sqrt{2}}\right)^2} = \sqrt{\frac{25}{2} + 9 + \frac{30}{\sqrt{2}} + \frac{25}{2}} = \sqrt{34 + 15\sqrt{2}} \cong 7.43$

Answer:

7.43km