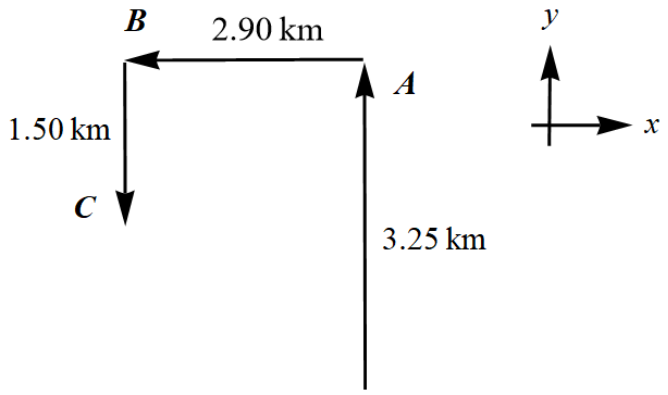
Exercise 1.37

A disoriented physics professor drives 3.25 km north, then 2.90 km west, and then 1.50 km south. Find the magnitude and direction of the resultant displacement, using the method of components. In a vector-addition diagram (roughly to scale), show that the resultant displacement found from your diagram is in qualitative agreement with the result you obtained using the method of components.

Solution

Draw the professor's path with displacement vectors and label each of them.



These vectors are written as

$$\begin{aligned}\mathbf{A} &= \langle A_x, A_y\rangle = \langle 0, 3.25\rangle \text{ km}\\ \mathbf{B} &= \langle B_x, B_y\rangle = \langle -2.90, 0\rangle \text{ km}\\ \mathbf{C} &= \langle C_x, C_y\rangle = \langle 0, -1.50\rangle \text{ km}.\end{aligned}$$

The resultant displacement is obtained by taking the vector sum of all three.

$$\begin{aligned}\mathbf{R} &= \mathbf{A} + \mathbf{B} + \mathbf{C}\\ &= \langle 0, 3.25\rangle \text{ km} + \langle -2.90, 0\rangle \text{ km} + \langle 0, -1.50\rangle \text{ km}\\ &= \langle 0 - 2.90 + 0, 3.25 + 0 - 1.50\rangle \text{ km}\\ &= \langle -2.90, 1.75\rangle \text{ km}\end{aligned}$$

The magnitude of the resultant displacement is

$$\begin{aligned}|\mathbf{R}| &= \sqrt{(-2.90 \text{ km})^2 + (1.75 \text{ km})^2}\\ &\approx 3.39 \text{ km},\end{aligned}$$

and its direction is

$$\begin{aligned}\theta &= \tan^{-1}\left(\frac{1.75}{-2.90}\right)\\ &= \pi - \tan^{-1}\left(\frac{1.75}{2.90}\right)\\ &\approx 149^\circ\end{aligned}$$

measured counterclockwise from the positive x-axis.

The resultant is the vector from the tail of the first vector to the head of the last vector.