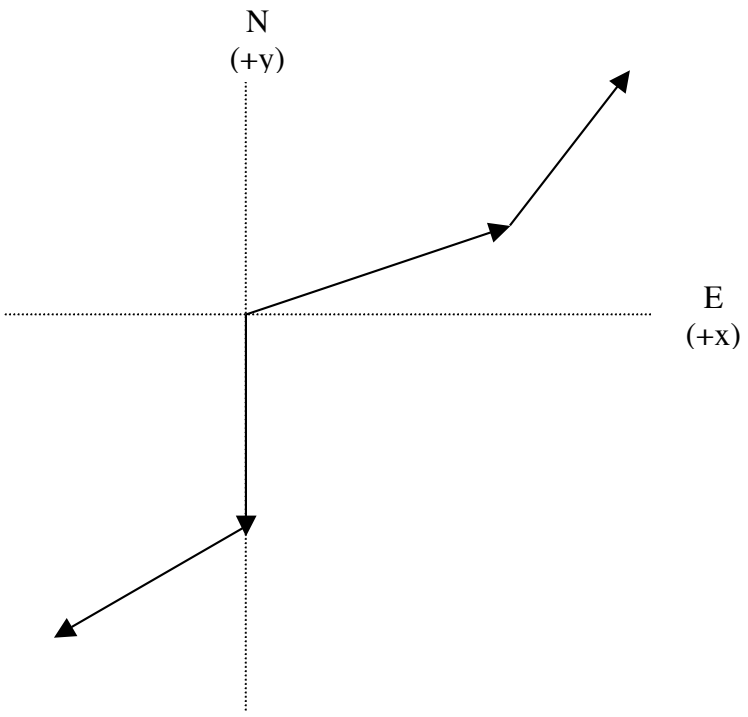
Question:
Two hikers leave from the ranger station and head off in different directions for 2 hours. Hiker A covers these distances at a rate of 1m/s: 1 hour at 30 degrees north of east, then 1 hour at 60 degrees north of east. Hiker B moves at 1.5m/s for 1 hour due south, 1 hour at 60 degrees west of south

a) Find the magnitude and direction of the average velocity of each hiker.
b) What is the distance that separates the two hikers at the end of 6 hours?

Numerical Answer:

a) v_A ~0.97m/s @ 45 degrees wrt East, v_B ~1.3m/s @ 30 degrees South of East
b) ~16.2km



Reasoning:
Start with a sketch: So, hiker A has two displacements in the +x direction, and two in the +y direction. Hiker B has 2 displacements in the (-y) direction and 1 in the (-x) direction.

To find the final position of hiker A – find the net x & y displacements:

$$x_{fA} = v\cos 30t_1 + v\cos 60t_2$$
$$x_{fA} = 1m/s \times 3600s(\cos 30 + \cos 60)$$
$$x_{fA} = 3600m(.866 + .5) = 4.92 \bullet 10^3 m(+x)$$
$$y_{fA} = v\sin 30t_1 + v\sin 60t_2$$
$$y_{fA} = 1m/s \times 3600s(\sin 30 + \sin 60)$$
$$y_{fA} = 3600m(.5 + .866) = 4.92 \bullet 10^3 m(+y)$$
$$R_A = \sqrt{x_{fA}{}^2 + y_{fA}{}^2} = 6.96 \bullet 10^3 m$$
$$\tan\theta_{RA} = \frac{4.92 \bullet 10^3 m}{4.92 \bullet 10^3 m}$$
$$\theta_{RA} = 45 wrt + x$$

Since average speed is total displacement over total time, then

$$\overline{v}_A = \frac{6.96 \bullet 10^3 m}{2 \times 3600 s} = 9.67 \bullet 10^{-1} m/s, \theta = 45 wrt + x$$

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Follow exactly the same steps for hiker B and

$$x_{fB} = v\cos 270t + v\cos 210t$$
$$x_{fB} = 1.5m/s \times 3600s(0 - .866)$$
$$x_{fB} = 4.68 \bullet 10^3 m(-x)$$
$$y_{fB} = v\sin 270t + v\sin 210t$$
$$y_{fB} = 1.5m/s \times 3600s(-1 - .5)$$
$$y_{fB} = 8.10 \bullet 10^3 m(-y)$$
$$R_B = \sqrt{x_{fB}{}^2 + y_{fB}{}^2} = 9.36 \bullet 10^3 m$$
$$\tan\theta_{RB} = \frac{-8.10 \bullet 10^3}{-4.68 \bullet 10^3}$$
$$\theta_{RB} = 240 wrt + x$$

Again, average speed is displacement over time

$$\bar{v}_B = \frac{9.36 \bullet 10^3 m}{7200 s} = 1.3 m/s, \theta = 240 wrt + x$$

b) Distance is the absolute value of the displacement between the hikers after the trip.

Since displacement is defined as final position – initial position, we can proceed…

$$x_{fA} - x_{fB} = \Delta x_{AB}$$

$$\Delta x_{AB} = 4.92 \bullet 10^3 m(+x) - 4.68 \bullet 10^3 m(-x)$$

$$\Delta x_{AB} = 9.60 \bullet 10^3 m(+x)$$

$$y_{fA} - y_{fB} = \Delta y_{AB}$$

$$\Delta y_{AB} = 4.92 \bullet 10^3 m(+y) - 8.10 \bullet 10^3 m(-y)$$

$$\Delta y_{AB} = 1.30 \bullet 10^4 m(+y)$$

$$R_{AB} = \sqrt{\Delta x_{AB}{}^2 + \Delta y_{AB}{}^2} = 1.62 \bullet 10^4 m$$