v_1=30.0 km/hr W   *v_2 = 40.0 km NW*

Δt_1 = 4 hrs   *Δt_2 = 2 hrs*

make Grand Bahama Island the origin of our coordinate system with East being the + x direction and North being the + y direction (see diagram below). Use constant velocity motion and addition of vectors

Problem 5 (20 points)

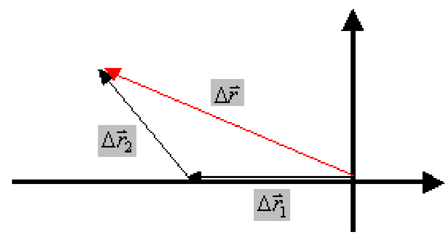
Several years ago, at 8 AM the eye of hurricane Floyd passed over Grand Bahama Island heading due west at a speed of 30.0 km/h. Four hours later, the course of hurricane Floyd shifted to Northwest towards the Florida coast and its speed increased to 40.0 km/h. Floyd continued on this course at this speed for two hours before turning due north again.

A. How far from Grand Bahama was hurricane Floyd 6 hours after it passes over the island?

The hurricane makes two constant velocity motions:

$\Delta\vec{r}_1$ from going West at 30.0 km/hr for 4 hrs &

$\Delta\vec{r}_2$ from going NW at 40.0 km/hr for 2 hrs



The hurricane's displacement $\Delta\vec{r} = \Delta\vec{r}_1 + \Delta\vec{r}_2$

$\Delta\vec{r} = |\Delta\vec{r}_1|(-\cos\phi\,\hat{i} + \sin\phi\,\hat{j}) + |\Delta\vec{r}_2|(-\cos\alpha\,\hat{i} + \sin\alpha\,\hat{j})$ where

$\phi = 0°$ *is the angle between* $\Delta\vec{r}_1$ *& the –x axis,* $\alpha = 45°$ *is the angle between* $\Delta\vec{r}_2$ *and the –x axis,*

$|\Delta\vec{r}_1| = v_1\,\Delta t_1 =$ *(30.0 km/hr) (4 hrs) = 120 km* $|\Delta\vec{r}_2| = v_2\Delta t_2 =$ *(40.0 km/hr) (2h) = 80 km*

$$\Delta\vec{r} = \left(-|\Delta\vec{r}_1|\cos\phi\,\hat{i} + 0\hat{j}\right) + (-|\Delta\vec{r}_2|\cos\alpha\,\hat{i} + |\Delta\vec{r}_2|\sin\alpha\,\hat{j}) = (-|\Delta\vec{r}_1|\cos\phi - |\Delta\vec{r}_2|\cos\alpha)\hat{i} + |\Delta\vec{r}_2|\sin\alpha\,\hat{j}$$

$$\Delta\vec{r} = [-(120\,km)\ \cos 0° - 80\,km\ \cos 45°]\,\hat{i} + 80\,km\sin 45°\,\hat{j} = -176.6\,km\,\hat{i} + 56.57\,km\,\hat{j}$$

$$|\Delta\vec{r}| = \sqrt{(-176.6\,km)^2 + (56.57km)^2} = 185\ km\ (185.4\ km)$$

B. What was Floyd's average speed during this time?

Average Speed = distance / time = (d1 + d2) / (Dt1 + Dt2) = (120 km + 80 km) / (4 hrs + 2 hrs)

Average Speed = 200 km / 6 hrs = 33.3 km / hr

C. What was Floyd's average velocity during this time?

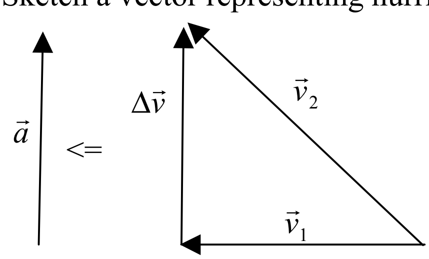
Average velocity $<\vec{v}> =$ *displacement/time =* $\Delta\vec{r}\,/\,\Delta t$

$|\langle\vec{v}\rangle| = |\Delta\vec{r}\,/\,\Delta t| = |\Delta\vec{r}|/(\Delta t_1 + \Delta t_2) =$ *(185.4 km) / (4 hrs + 2 hrs) = 30.9 km / hr*

direction: $\vartheta = \arctan\dfrac{|\Delta\vec{r}_y|}{|\Delta\vec{r}_x|} = \arctan\left(\dfrac{56.56\,km}{176.6\,km}\right) = 17.8°$

alternatively, $<\vec{v}> = \Delta\vec{r}\,/\,\Delta t = (-176.6\,km\,\hat{i} + 56.57\,km\,\hat{j})/(4\,hrs + 2\,hrs) = -29.4\,km\,\hat{i} + 9.43\,km\,\hat{j}$

D. Sketch a vector representing hurricane Floyd's average acceleration during this time.



Since Delta v is proportional to the average acceleration, Delta v vector points in the direction of the acceleration. Recall that $\vec{a} = \Delta\vec{v}\,/\,\Delta t = (\vec{v}_f - \vec{v}_i)\,/\,\Delta t$