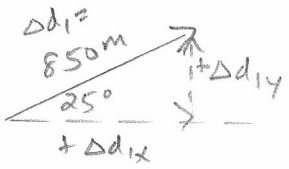
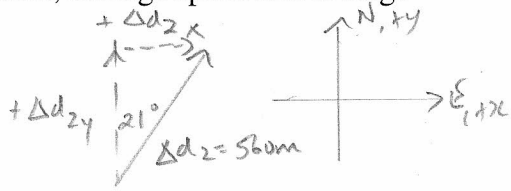
Practice: Finding Resultant Displacements

1. A skater travels in a straight line 8.5 x 10^2 m [25° N of E] and then 5.6 x 10^2 m in a straight line [21° E of N]. The entire motion takes 4.2 minutes. Find the skater's displacement, average speed and average velocity.





$\Delta\vec{d}_1 = 8.5 \times 10^2$ m [25° N of E]

$\Delta\vec{d}_2 = 5.6 \times 10^2$ m [21° E of N]

$\Delta t = ?$

$\Delta\vec{d}_R = ?$ $\vec{v}_{av} = ?$

$\Delta d_x = \Delta d_{1x} + \Delta d_{2x}$

$= (850)\cos 25 + (560)(\sin 21)$

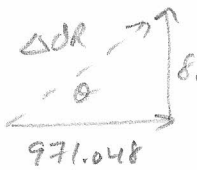
$= 971.048$

$\Delta d_y = \Delta d_{1y} + \Delta d_{2y}$

$= (850)(\sin 25) + (560)(\cos 21)$

$= 882.031$ m

Combining components:



$\Delta d_R = \sqrt{971.048^2 + 882.031^2}$

$= 1311.835$

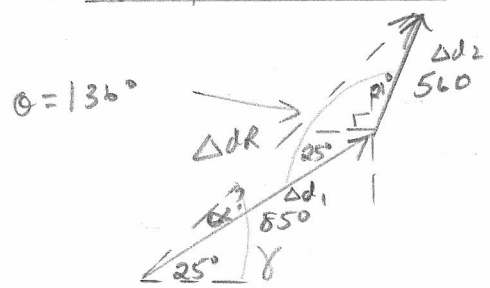
$\theta = \tan^{-1}\left(\frac{882.031}{971.048}\right) = 42.2°$

$\therefore \Delta\vec{d}_R = 1.3 \times 10^3$ m [42° N of E]

$\vec{v}_{av} = \frac{\Delta\vec{d}_R}{\Delta t} = \frac{1331.835}{(4.2\text{min})(60\text{s/min})} = 5.3$ m/s [42° N of E]

$v_{av} = \frac{\Delta d_T}{\Delta t} = \frac{850\text{ m} + 560\text{ m}}{(4.2\text{min})(60\text{s/min})} = 5.6$ m/s

Alternatively use Cosine/Sine law Soln:



$\Delta d_R = \sqrt{850^2 + 560^2 - 2(850)(560)\cos 136°}$

$= 1311.835$ m

$\frac{\sin\alpha}{560} = \frac{\sin 136}{1311.835}$

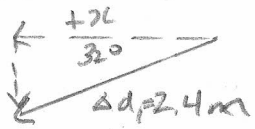
$\alpha = \sin^{-1}\left(\frac{560(\sin 136)}{1311.835}\right) = 17.249°$

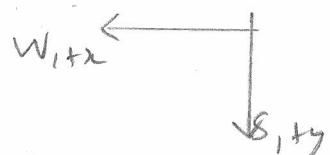
$\gamma = 25° + 17.249° = 42.2°$

$\therefore \Delta\vec{d}_R = 1.3 \times 10^3$ m [42° N of E]

2. A bird searching for worms, undergoes the following displacements as it travels over a lawn: 2.4 m [32 ° S of W], 1.6 m [S] and finally 4.9 m [27 ° S of E]. Find the bird's resultant displacement.

$\Delta\vec{d}_1 = 2.4$m [32° S of W]

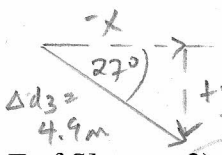




$\Delta\vec{d}_2 = 1.6$m [S] $\Delta d_2, +y$

$\Delta\vec{d}_3 = 4.9$m [27° S of E]

$\Delta\vec{d}_R = ?$

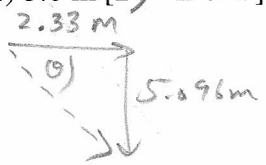


$\Delta d_x = 2.4\cos 32 + 0 - 4.9\cos 27$

$= -2.3306$ m

$\Delta d_y = 2.4\sin 32 + 1.6 + 4.9\sin 27$

$= 5.096$ m



$\Delta d_R = \sqrt{2.3306^2 + 5.096^2}$

$= 5.604$ m

$\theta = \tan^{-1}\left(\frac{5.096}{2.33}\right) = 65.42°$

$\therefore \Delta\vec{d}_R = 5.6$m [65° S of E] OR 5.6m [25° E of S]

Answers: 1) 5.6 m [25° E of S] 2) 1.3 x 10 3 m [42° N of E], 5.6 m/s , 5.2 m/s [42° N of E]