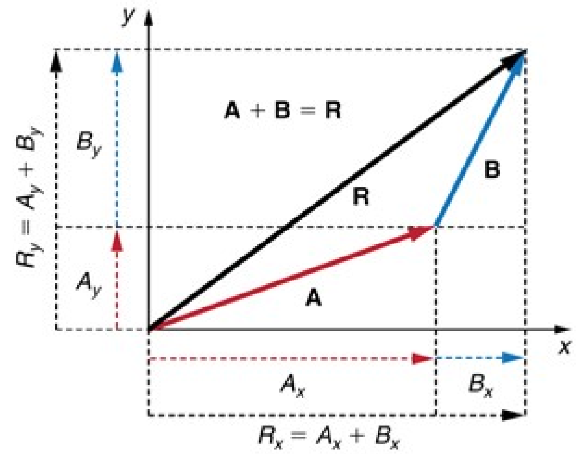
Adding Vectors Mathematically

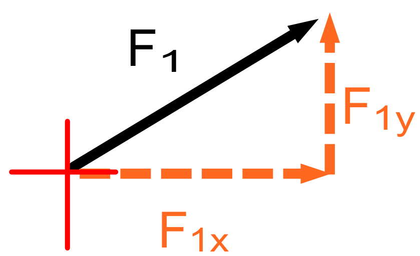
- Resolve the vectors into their components
- The components of the resultant vector are the sum of the respective components of the individual vectors
- Components are perpendicular

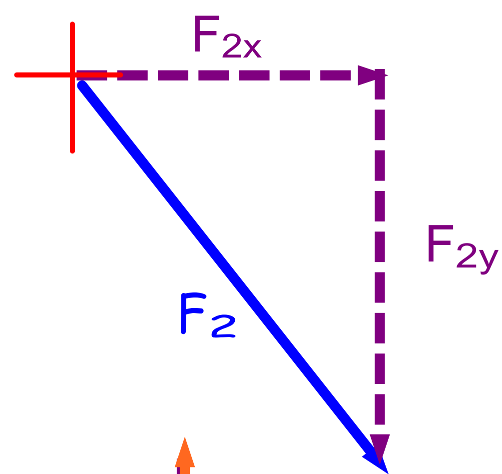


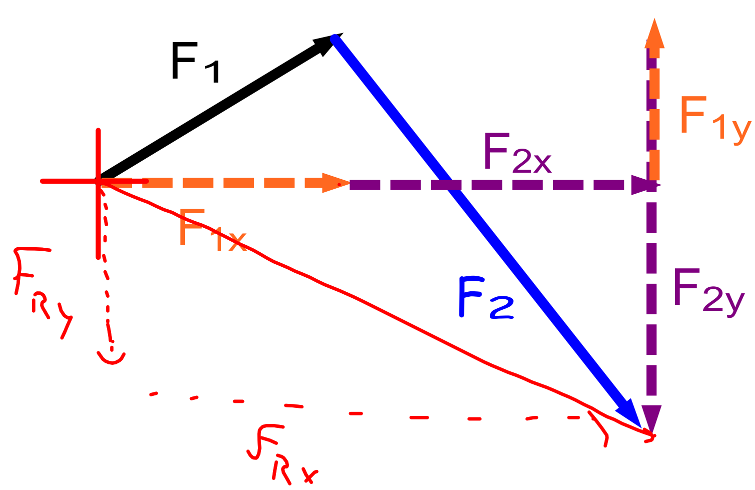
$$R_x = A_x + B_x + \ldots$$

$$R_y = A_y + B_y + \ldots$$

$$tan(\theta) = \frac{R_y}{R_x}$$







Adding Non-perpendicular Vectors

Ex. 1 Emily pulls a trolley with a force of 40 N [E 30^o N]. At the same time, Kristen pulls the trolley with 80 N [E 40^0 S]. What is the resultant force the girls are applying on the trolley?

Ex. 2 A car drives 56.8 km [E 49.3^o S] and then 83.9 km [W 16.4^o N]. What is the resultant displacement of the car?

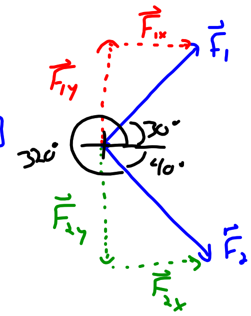
Ex. 3 A plane is flying with a speed of 180 km/h, relative to the air. The wind is blowing 52 km/h [E 33.6^o N] relative to the ground. What heading does the plane need to fly in order to reach a destination that is directly east from the starting location.

Do Practice Problems 4 + 6 on page 463

Ex 1 $\vec{F_1} = 40N\ [E\ 30°\ N]$

$\vec{F_2} = 80N\ [E\ 40°\ S]$

$\vec{F_R} = ? = \vec{F_1} + \vec{F_2}$



x-dir

$F_{1x} = F_1 \cos(\theta) = (40N)\cos(30°) = 34.6410\ N$

$F_{2x} = F_2 \cos(\theta) = (80N)\cos(320°) = 61.28356\ N$

$F_{Rx} = F_{1x} + F_{2x} = 95.9246\ N$

y-dir

$F_{1y} = F_1 \sin(\theta) = (40N)\sin(30°) = 20\ N$

$F_{2y} = F_2 \sin(\theta) = (80N)\sin(320°) = -51.423N$

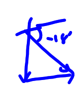
$F_{Ry} = F_{1y} + F_{2y} = -31.423\ N$

$$F_R = \sqrt{F_{Rx}^2 + F_{Ry}^2}$$

$$= \sqrt{(95.9246N)^2 + (-31.423N)^2}$$

$$= 100.94N = 100\ N$$

Q4



$$\theta = \tan^{-1}\left(\frac{F_{Ry}}{F_{Rx}}\right) = \tan^{-1}\left(\frac{-31.423N}{95.9246N}\right) = -18.13778°$$

$$= -20°$$

$\vec{F_R} = 100N\ [-20°]$

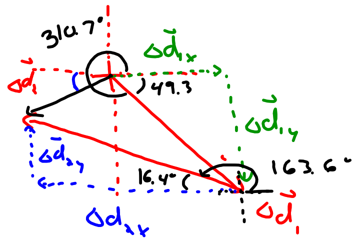
$[E\ 20°\ S]$

$[340°]$

Ex 2 $\Delta\vec{d}_1 = 56.8\text{ km}\ [E\ 49.3^\circ S]$

$\Delta\vec{d}_2 = 83.9\text{ km}\ [W\ 16.4^\circ N]$

$\Delta\vec{d} = ? = \Delta\vec{d}_1 + \Delta\vec{d}_2$



x-dir

$\Delta d_{1x} = \Delta d_1 \cos(\theta) = (56.8\text{ km})\cos(310.7^\circ)$
$= 37.039\text{ km}$

$\Delta d_{2x} = \Delta d_2 \cos(\theta) = (83.9\text{ km})\cos(163.6^\circ)$
$= -80.486\text{ km}$

y-dir

$\Delta d_{1y} = \Delta d_1 \sin(\theta) = (56.8\text{ km})\sin(310.7^\circ)$
$= -43.062\text{ km}$

$\Delta d_{2y} = \Delta d_2 \sin\theta = (83.9\text{ km})\sin(163.6^\circ)$
$= 23.688\text{ k}$

$\Delta d_{Rx} = 37.039\text{ km} - 80.486\text{ km} = -43.447\text{ km}$

$\Delta d_{Ry} = -43.062\text{ km} + 23.688\text{ km} = -19.374\text{ km}$

$\Delta d_R = \sqrt{\Delta d_{rx}^2 + \Delta d_{ry}^2}$
$= \sqrt{(-43.447\text{ km})^2 + (-19.374\text{ km})^2}$
$= 47.571\text{ km}$
$= 47.6\text{ km}$

$\Theta = \tan^{-1}\left(\frac{-19.374\text{ km}}{-43.447\text{ km}}\right) = 24.03^\circ$
$= 24.0^\circ$

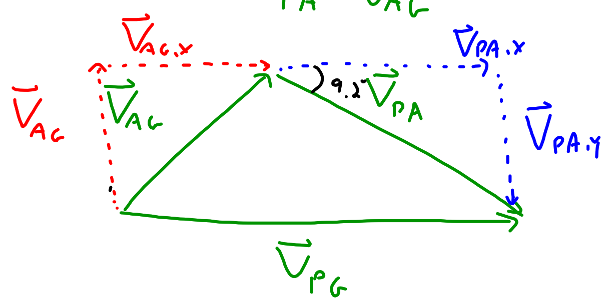
$\boxed{\Delta\vec{d}_R = 47.6\text{ km}\ [W\ 24.0^\circ S]}$

Ex 3 $V_{PA} = 180\ km/h$

$\vec{V}_{AG} = 52\ km/h\ [E\ 33.6^\circ\ N]$

$\Theta_{PA} = ?$

$$\vec{V}_{PG} = \vec{V}_{PA} + \vec{V}_{AG}$$



$$V_{AG,y} = V_{PA,y}$$

$$V_{AG}\sin(\Theta_{AG}) = V_{PA}\sin(\Theta_{PA})$$

$$\sin(\Theta_{PA}) = \frac{V_{AG}}{V_{PA}}\sin(\Theta_{AG})$$

$$\Theta_{PA} = \sin^{-1}\left(\frac{V_{AG}}{V_{PA}}\sin(\Theta_{AG})\right)$$

$$= \sin^{-1}\left(\frac{52\ km/h}{180\ km/h}\sin(33.6^\circ)\right)$$

$$= 9.19^\circ = 9.2^\circ$$

$$\Theta_{PA} = [E\ 9.2^\circ\ S] \text{ or } [350.8^\circ]$$