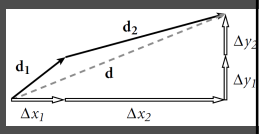
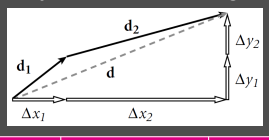
Adding Vectors That Are Not Perpendicular

- Objects in the physical world can move in one direction and then turn before continuing to move.
- If the displacement vectors of an object do not form a right triangle, you can not apply the tangent function or the Pythagorean theorem to add them.
- Determining the magnitude and the direction of the resultant can be done by resolving each of the object's displacement vectors into its x and y components.



Adding Vectors That Are Not Perpendicular

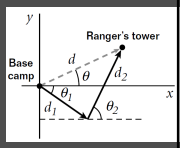
- Once we've resolved the vectors into their x and y components, they can be added together.



Vector	X-Component	Y-Component
d_1	Δx_1	Δy_1
d_2	Δx_2	Δy_2
d (resultant)	$\Delta x_1 + \Delta x_2$	$\Delta y_1 + \Delta y_2$

Adding Vectors Example

- A hiker walks 27.0 km from her base camp at 35° south of east.
- The next day, she walks 41.0 km in a direction 65° north of east to get to a Ranger Station.
- How far and in what direction could she have walked to get from her base camp directly to the Ranger Station?

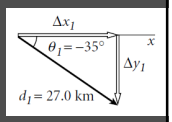


Vector	Distance	Direction	X-Comp	Y-Comp
Day 1	$d_1 = 27.0km$	$\theta_1 = -35°$		
Day 2	$d_2 = 41.0km$	$\theta_2 = 65°$		
Total	$d_{total} = ?$	$\theta_{total} = ?$		

Adding Vectors Example

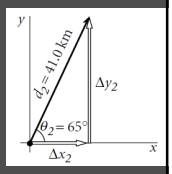
- Find the x and y components of all vectors

Day 1



- $\Delta x_1 = d_1 \cos(\theta_1) = (27.0km)[\cos(-35°)] = 22\text{km}$
- $\Delta y_1 = d_1 \sin(\theta_1) = (27.0km)[\sin(-35°)] = -15\text{km}$

Day 2



- $\Delta x_2 = d_2 \cos(\theta_2) = (41.0km)[\cos(65°)] = 17\text{km}$
- $\Delta y_2 = d_2 \sin(\theta_2) = (41.0km)[\sin(-65°)] = 37\text{km}$

Adding Vectors Example

- Find the x and y components of the total displacement
  - $\Delta x_{total} = \Delta x_1 + \Delta x_2 = 22\text{km} + 17\text{km} = 39\text{km}$
  - $\Delta y_{total} = \Delta y_1 + \Delta y_2 = -15\text{km} + 37\text{km} = 22\text{km}$
- Use the Pythagorean theorem to find the magnitude of the resultant vector
  - $d^2 = (\Delta x_{total})^2 + (\Delta y_{total})^2$
  - $d = \sqrt{(\Delta x_{total})^2 + (\Delta y_{total})^2} = \sqrt{(39km)^2 + (22km)^2} = 45km$
- Use trig to find the angle
  - $\theta = \tan^{-1}\left(\frac{\Delta y_{total}}{\Delta x_{total}}\right) = \tan^{-1}\left(\frac{22km}{39km}\right) = 29°\ north\ of\ east$