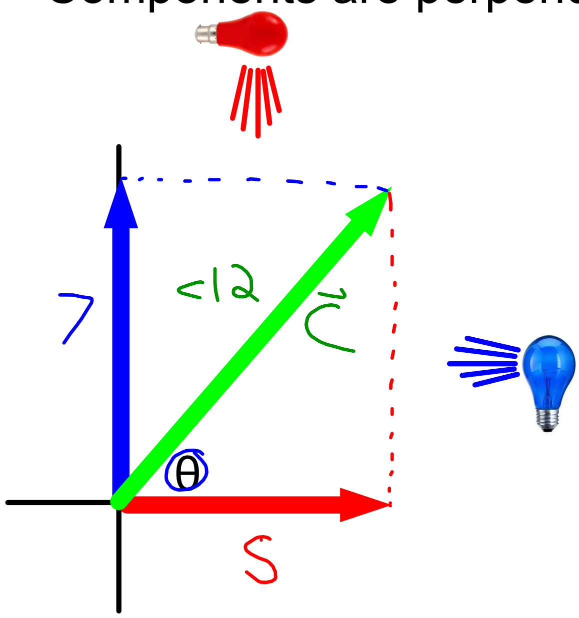
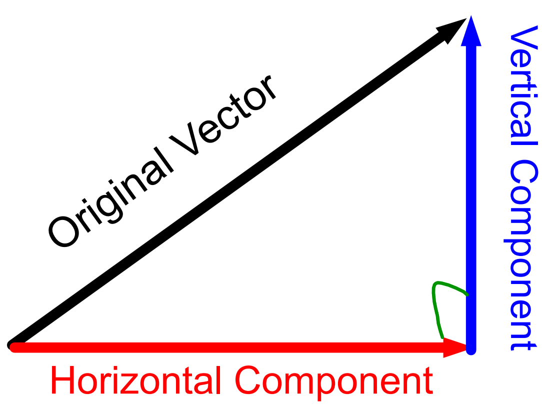
Vector Resolution

- Refers to the process of breaking vectors into **components**
- Components are perpendicular to each other

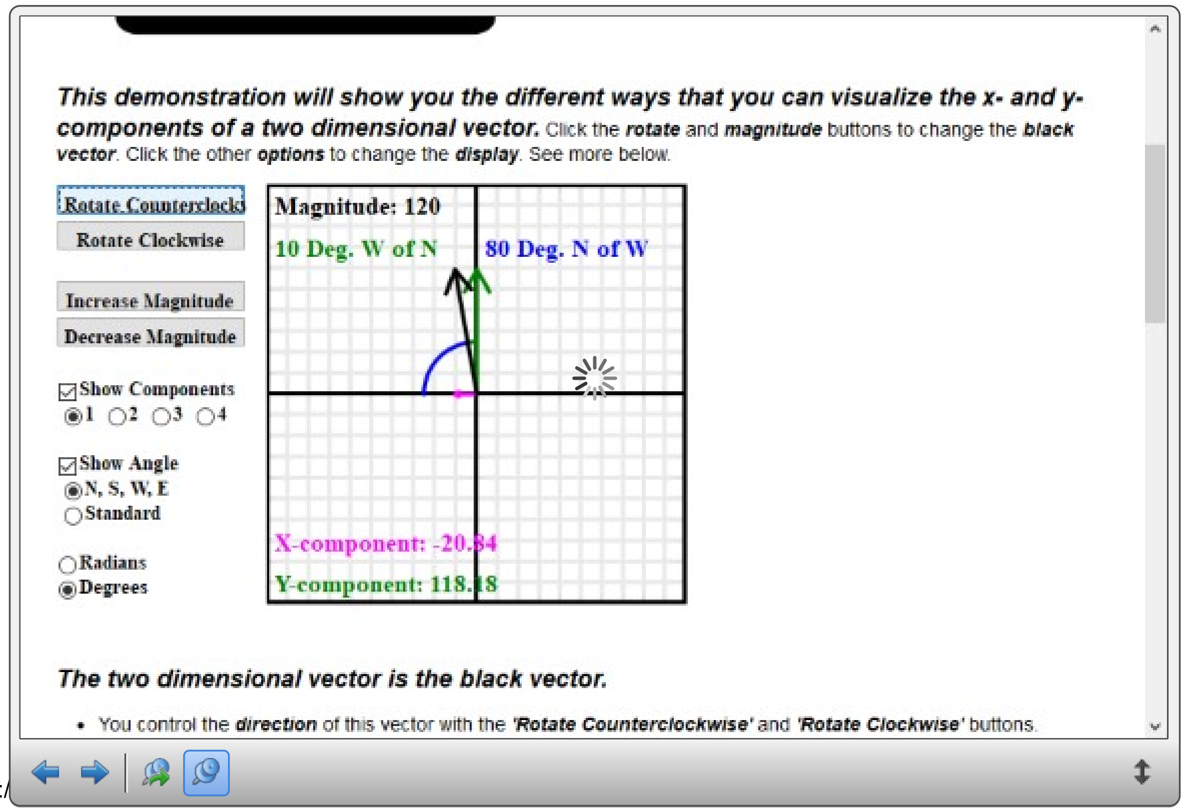


- Components are also called **projections** onto the axes (x and y)
- In 2D, the projections/ components represent both the Vertical height and Horizontal length of the original vector
- **Resolving** a vector means to find it's components

- The components are then the legs of the Right triangle formed with the original vector being the hypotenuse



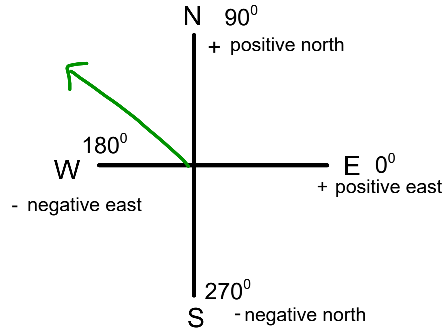
Vector Components

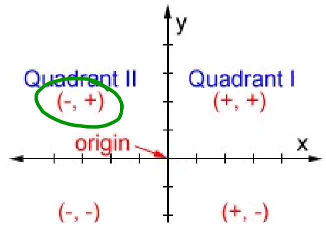


http:/

Calculating Vector Components

- Standard direction configuration
  - > N is also +y or 90^0
  - > E is also +x or 0^0
  - > Right and Up positive
    - – Left and Down negative
- Think of the vector being in a particular quadrant which tells you if a component is positive or negative



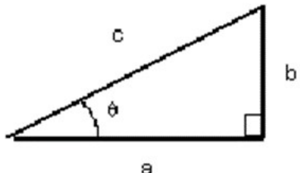


Calculating Components

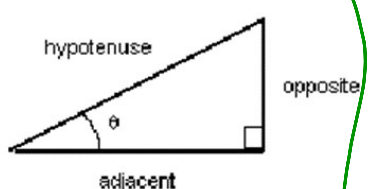
- Relate sides and the angle, θ, using SOHCAHTOA and Pythagoras

Pythagorean Theorem

$$\boxed{a^2+b^2=c^2 \quad or \quad c=\sqrt{a^2+b^2}}$$



SOHCAHTOA



$$H \quad \sin\theta = \frac{opposite}{hypotenuse} = \frac{O}{H} \times H$$

$$H \quad \cos\theta = \frac{adjacent}{\cancel{hypotenuse}} = A$$

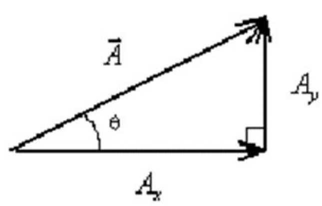
$$\tan\theta = \frac{opposite}{adjacent} = \frac{\sin\theta}{\cos\theta}$$

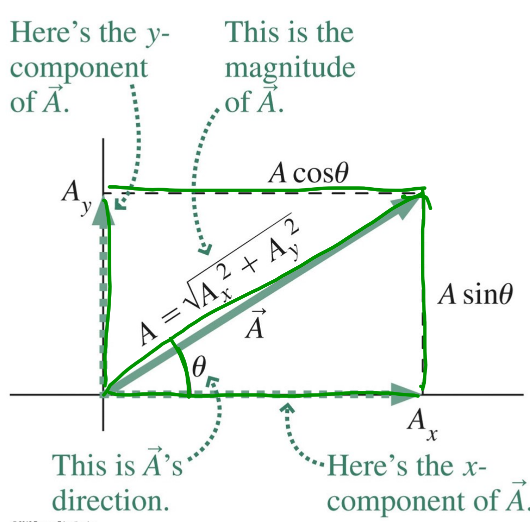
When we apply these equations to our vector, we find that if θ is the standard angle, then the following three equations are *always* true:

$$\boxed{\begin{aligned} A_x &= A\cos\theta \\ A_y &= A\sin\theta \end{aligned}}$$

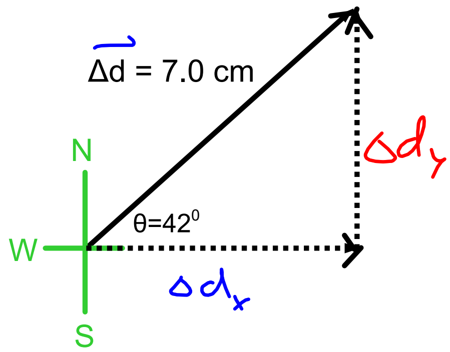
x may not always be cos

$$\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right)$$





Vector Resolution: Using Trig to Find Components



Here resultant is in quadrant I so both x and y component vectors are positive!

$\cos\theta = \frac{A}{H}$

$H\cos\theta = A$

so

$A = (7.0\,cm)\cos(42°)$

or

$\Delta dx = 5.2\,cm$

Δd_x

$\sin\theta = \frac{O}{H}$

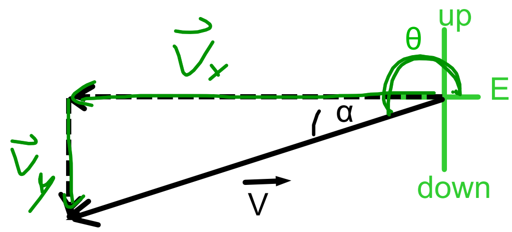
$H\sin\theta = O$

so

$O = (7.0\,cm)\sin(42°)$

or

$\Delta dy = 4.7\,cm$



Here resultant is in quadrant III so both x and y component vectors are negative!

$|\vec{v}| = 12.0\ m/s$
$\alpha = 18^0$
$\theta = 198^0$

Choice......

if you use α
you put in signs <u>as needed</u> in equation

$\vec{V}x = - |\vec{V}| \cos\alpha$

$= -(12.0\,m/s)\cos(18°)$

$= -11.4\,m/s$

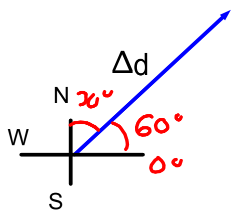
if you use <u>CCW</u> θ = 180° + α
the calculator puts signs in answer for you

$\vec{V}x = |\vec{V}| \cos\theta$

$= (12.0\,m/s)\cos(198°)$

$= -11.4\,m/s$

Ex 1. Mark's displacement at the end of his walk was 1.50 km [N 30°E]. Find his east and north displacement components.



$\Delta d_x = \Delta d \cos(\theta)$

$= (1.50\text{ km})\cos(60°)$

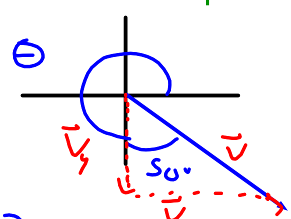
$= \boxed{0.75\text{ km}}$

$= 0.750\text{ km}$

$\Delta d_y = \Delta d \sin(\theta) = (1.50\text{ km})\sin(60°)$

$= 1.299\text{ km} = \boxed{1.30\text{ km}}$

Ex. 2 Lauren is driving 66 km/h [S 50° E]. Find her north and east vector components.



$\theta = 270° + 50° = 320°$

$V_x = V\cos(\theta)$

$= (66\text{ km/h})\cos(320°)$

$= 50.56\text{ km/h}$

$= \boxed{51\text{ km/h}}$

$V_y = V\sin(\theta) = (66\text{ km/h})\sin(320°)$

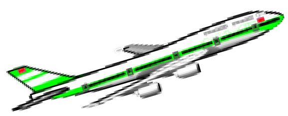
$= -42.42\text{ km/h} = \boxed{-42\text{ km/h}}$

-42 km/h [N]
[90°]

42 km/h [S]
[270°]

Application

Ex. 3 a) How much time would be required for a plane taking off at an average velocity of 245 km/h [E 33° up] to reach a cruising altitude of 1.75 km?



b) How much time did it take for the plane achieve a displacement of 0.25 km in the eastward direction immediately following take off?

Ex. 4

Throw the ball such that it leaves your hand moving at

10 m/s [E 30 ° up]. The ball is released at an unknown height above the floor.

a) How much time will it take the ball to reach its maximum height above the floor?

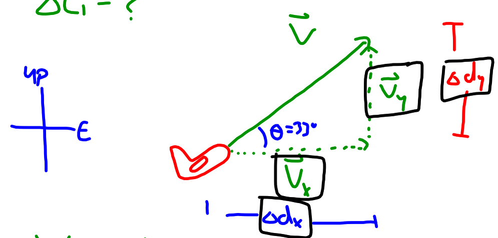
b) If the ball finishes its flight and hits the floor in 1.27s, what was the horizontal displacement of the ball (or its "range") during the flight?

Do Practice Problems 1-3 on Page 459

#3. $\vec{v} = 245\ km/h\ [E\ 33°\ up]$

$\Delta \vec{d}_y = 1.75\ km\ [up]$

$\Delta t_1 = ?$



$V_y = V \sin\theta = (245\ km/h)\sin(33°)$

$= 133.437\ km/h$

$\vec{v} = \frac{\Delta \vec{d}}{\Delta t_1} \longrightarrow V_y = \frac{\Delta d_y}{\Delta t_1}$

$\Delta t_1 = \frac{\Delta d_y}{V_y} = \frac{(1.75\ km)}{(133.437\ km/h)}$

$= 0.013115\ h \times \frac{3600\ s}{1\ h}$

$= 47.213\ s \approx \boxed{47.2\ s}$

b) $\Delta \vec{d}_x = 0.25\ km\ [E]$

$\Delta t_2 = ?$

$V_x = V\cos(\theta) = (245\ km/h)\cos(33°)$

$= 205.474\ km/h$

$V_x = \frac{\Delta d_x}{\Delta t_2} \rightarrow \Delta t_2 = \frac{\Delta d_x}{V_x}$

$= \frac{(0.25\ km)}{(205.474\ km/h)}$

$= 0.0012167\ h \times \frac{3600\ s}{1\ h} = 4.3801\ s$

$= \boxed{4.4\ s}$

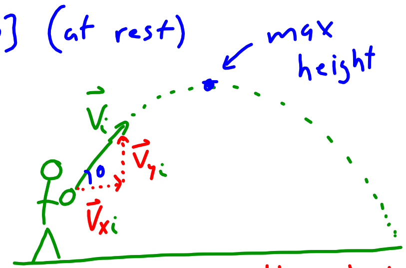
Practice Problems #1 → 3 page 459

#4) $\vec{V}_i = 10\ m/s\ [E\ 30°\ up]$

$\vec{V}_{yf} = 0\ m/s\ [up]$ (at rest)

$\vec{g} = 9.81\ m/s^2\ [down]$

$\Delta t_1 = ?$



V_y changes throughout because of $\vec{g}$

V_x stays constant

$V_{yi} = V_i \sin\theta$

$= (10\ m/s)\sin(30°)$

$= 5\ m/s$

$\Delta\vec{v} = \vec{a}\Delta t_1 = \vec{g}\Delta t_1 \longrightarrow \Delta t_1 = \frac{\Delta\vec{v}}{\vec{g}}$

[up] so "+"

$\Delta t_1 = \frac{V_{fy} - V_{iy}}{g} = \frac{(0\ m/s) - (5\ m/s)}{(-9.81\ m/s^2)}$ [down] so "–"

$= 0.50968\ s = \boxed{0.5\ s}$

b) $\Delta t_2 = 1.27\ s$

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

$V_{xi} = V_i \cos(\theta) = (10\ m/s)\cos(30°)$

$= 8.6603\ m/s$

$\Delta d_x = V_{xi}\Delta t_2 = (8.6603\ m/s)(1.27\ s)$

$= 10.9985\ m$

$= \boxed{10\ m}$