PHYS 107 - Week 2 - Friday

Q Any questions

* 2D kinematics $\longrightarrow$ vectors in 2 dimensions

Motion in the two dimensions can be treated independently!

a_x, a_y = acceleration in the x direction and in the y direction

v_x, v_y = velocity in the x and y directions

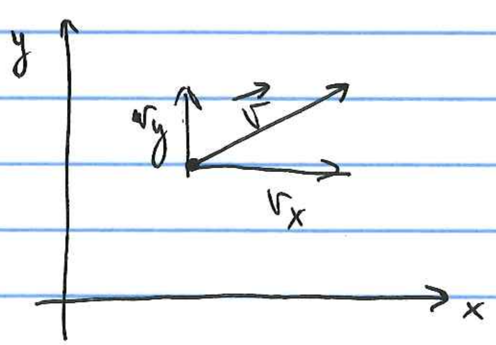
$\rightarrow$ $x = x_0 + v_{0,x} t + \frac{1}{2} a_x t^2$ $\qquad$ $y = y_0 + v_{0,y} t + \frac{1}{2} a_y t^2$

$v_x = v_{0,x} + a_x t^2$ $\qquad$ $v_y = v_{0,y} + a_y t$

$v_x^2 = v_{0,x}^2 + 2a_x (x - x_0)$ $\qquad$ $v_y^2 = v_{0,y}^2 + 2a_y (y - y_0)$

Ballistic motion $\longrightarrow$ $\boxed{a_x = 0}$ $\qquad$ same formulas $\qquad$ $\boxed{a_y = -g}$

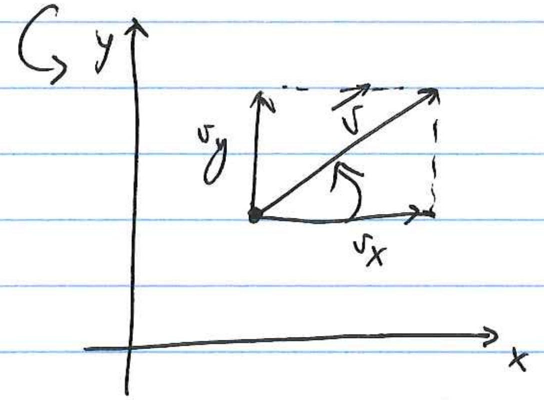
However, need to think efficiently in these 2 dimensions
$\longrightarrow$ vectors



$\vec{v} = (v_x, v_y)$
$\vec{a} = (a_x, a_y)$
$\Big\}$ magnitude direction

× Vectors : quantity with a magnitude and direction

consider vector $\vec{v} = (v_x, v_y)$ = <u>components</u>



magnitude $|\vec{v}| = \sqrt{v_x^2 + v_y^2}$
(Pythagorean theorem)

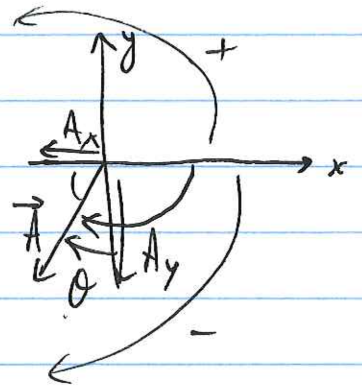
direction = angle with x axis ~~ilm~~ : $\tan\theta = \frac{v_y}{v_x}$

$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$

~~$v_x v_y$~~ $(v_x, v_y) \longrightarrow \begin{cases} |\vec{v}| = \sqrt{v_x^2 + v_y^2} \\ \tan\theta = \frac{v_y}{v_x} \end{cases}$

$|\vec{v}|, \theta \longrightarrow \begin{cases} v_x = |\vec{v}|\cos\theta \\ v_y = |\vec{v}| \sin\theta \end{cases}$

Q Vectors 4b



$\vec{A} = (A_x, A_y)$

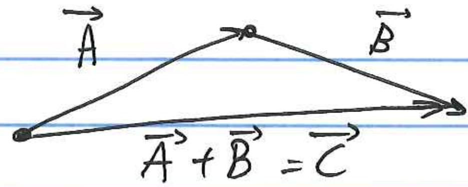
$A_x = |\vec{A}| \cos\left(-\theta - \underset{90^\circ}{\frac{\pi}{2}}\right)$

$A_y = |\vec{A}| \sin\left(-\theta - \frac{\pi}{2}\right)$

or $A_x = -|\vec{A}| \cos\left(\frac{\pi}{2} - \theta\right)$

x - component : along the x axis, sign given by direction
y - component : along the y axis, sign given by direction

* Adding vectors "head to toe"



$\vec{A}+\vec{B}=\vec{C}$

$\hookrightarrow \quad A_x + B_x = C_x$

$A_y + B_y = C_y$

Note that $|\vec{A}| + |\vec{B}| \neq |\vec{C}|$
(unless they are parallel and in the same direction)

$(\vec{A}+\vec{B}) + \vec{C} = \vec{A} + (\vec{B}+\vec{C})$
order doesn't matter

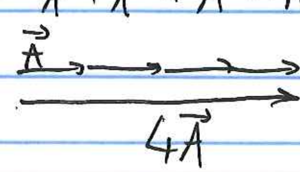
$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$ where $-\vec{B}$ has the
→ same magnitude as $\vec{B}$
→ opposite direction of $\vec{B}$

Q Vectors 2a-b

Multiplication by a scalar : $\vec{B} = r\vec{A}$ (r ↑ scalar)

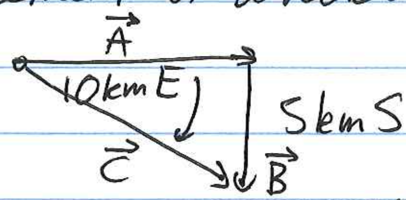
→ magnitude $|\vec{B}|$ is r times magnitude $|\vec{A}|$
→ direction is unchanged

example $4\vec{A} = \vec{A} + \vec{A} + \vec{A} + \vec{A}$



Examples: a) I walk 10 km E, then 5 km S
What is my total displacement?

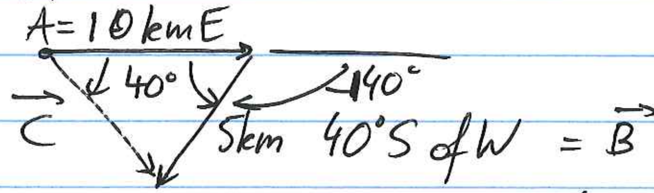
displacement is a vector → magnitude, direction



magnitude $|\vec{C}| = \sqrt{(10\,km)^2 + (5\,km)^2} = 11.2\,km$

direction θ ~~with~~ E axis: $\tan\theta = \dfrac{5\,km}{10\,km} = 26.6\,deg$
"South of East"

b)



→ use components $\vec{A} = (10\,km, 0)$
$\vec{B} = (5\,km\cos(-140°), 5\,km\sin(140))$

$\vec{C} = \vec{A} + \vec{B}$: $C_x = 10\,km + 5\,km\cos(140°)$
$C_y = 0\,km + 5\,km\sin(-140°)$

$\rightarrow |\vec{C}| = \sqrt{(C_x^2 + C_y^2)}$

$\tan\theta = \dfrac{C_y}{C_x}$