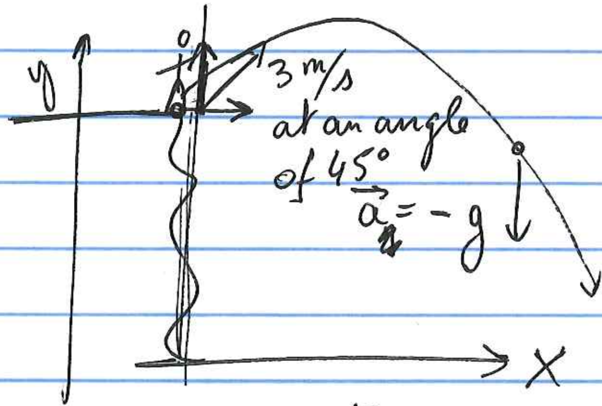
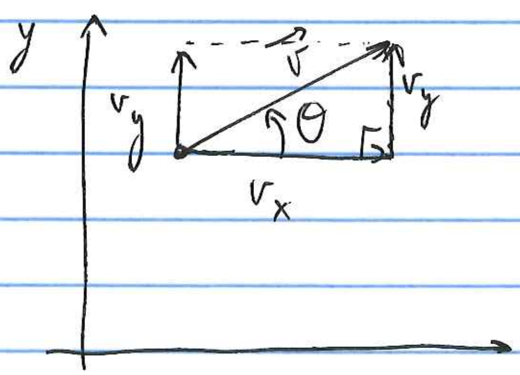
2D kinematics → vectors in 2D ~~[illegible]~~

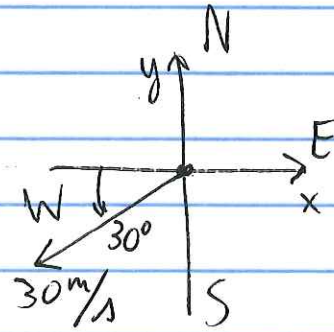


x - direction	y - direction
a_x	a_y
v_x, $v_{x,0}$ $t=0$	v_y, $v_{y,0}$
x	y

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

→ Ballistic motion





$\vec{v} = (v_x, v_y)$

magnitude $|\vec{v}| = \sqrt{v_x^2 + v_y^2}$

Pythagorean theorem

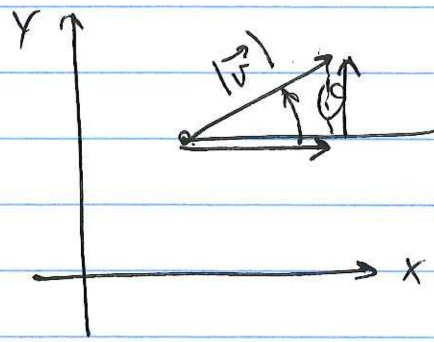
direction : $\tan\theta = \dfrac{v_y}{v_x}$

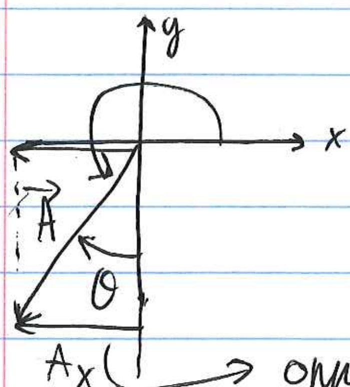
$= \dfrac{\text{opposite}}{\text{adjacent}}$

$\vec{v} = (v_x, v_y) \longrightarrow$ magnitude $|\vec{v}|$, direction θ

magnitude $|\vec{v}|$, direction θ $\rightarrow$ components

$$v_x = |\vec{v}| \cos\theta$$
$$v_y = |\vec{v}| \sin\theta$$

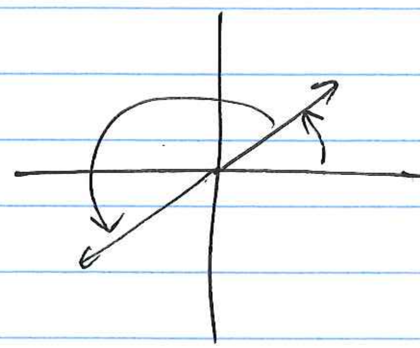


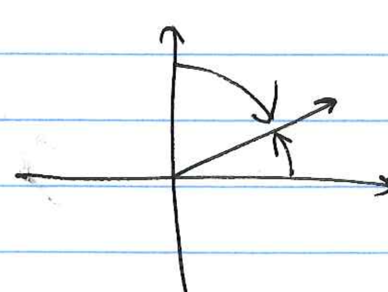


$$\begin{aligned} A_x &= |\vec{A}| \cdot \cos\left(180^\circ + (90^\circ - \theta)\right) \\ &= |\vec{A}| \cdot \cos(270^\circ - \theta) \\ &= |\vec{A}| \cdot (-\sin\theta) \\ &= -|\vec{A}| \cdot \sin\theta \end{aligned}$$

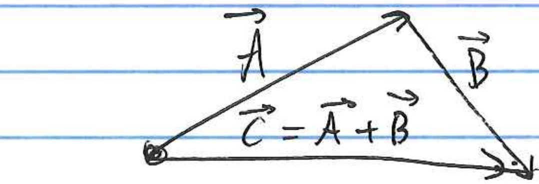
$A_x \longrightarrow$ opposite to θ $\rightarrow$ $A_x = -|\vec{A}| \sin\theta$

$$\begin{aligned} &\cos(270^\circ - \theta) \\ &= -\underbrace{\cos(90^\circ - \theta)}_{\sin\theta} \\ &= -\sin\theta \end{aligned}$$





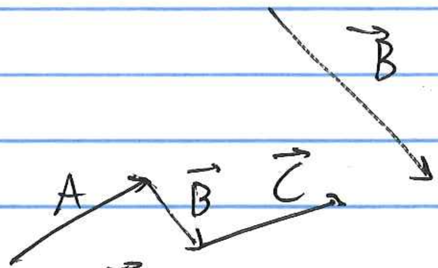
* Adding vectors



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

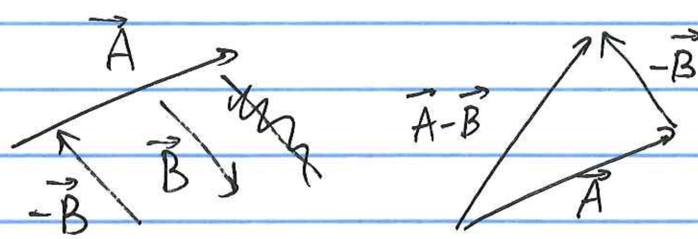
$$\begin{cases} A_x + B_x = C_x \\ A_y + B_y = C_y \end{cases}$$ component

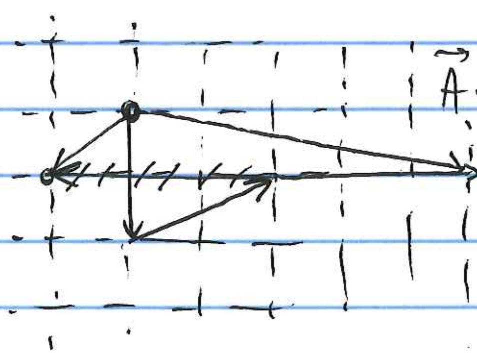
Note: $|\vec{A}| + |\vec{B}| \neq |\vec{C}|$
(unless they are parallel and in the same direction)



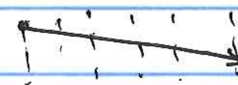
$$\vec{A} + \vec{B} + \vec{C} = \vec{A} + \vec{C} + \vec{B}$$

$$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$$



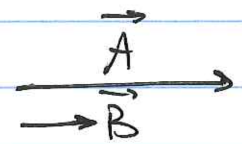


$\vec{A} + \vec{B} + \vec{C} =$ ↙

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

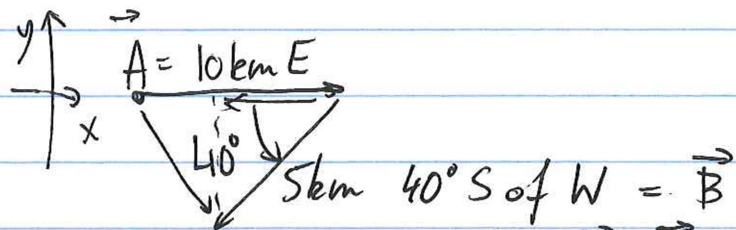
$\vec{B} = 4\vec{A} = \vec{A} + \vec{A} + \vec{A} + \vec{A}$

$\vec{B} = r\vec{A}$, same direction, but magnitude $r|\vec{A}|$



$\vec{B} = 0.3\,\vec{A}$

Example



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

what is my total displacement?
✓ magnitude?
direction?

$A_x = +10\text{km}$, $A_y = 0$

$B_x = -5\text{km}\cos 40°$, $B_y = -5\text{km}\sin 40°$

$C_x = 10\text{km} - 5\text{km}\cos 40°$ ...
$C_y = -5\text{km}\sin 40°$ ...

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

$$\tan\theta = \frac{C_y}{C_x} \rightarrow \theta$$