Medical Physics

Lecture 2

Ch3: Kinematics it Two Dimensions (vectors)

18/oct/2024

Medical Physics Ch3

Kinematics in Two Dimensions
(Vectors)

*** Vectors and Scalars :**

- A Vector is : a quantity that <u>must</u> have a $\boxed{\text{direction}}$
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  along with its $\boxed{\text{magnitude}}$
  Such as [<u>velocity</u>, <u>Force</u> ... etc]

- A Scalar is : a quantity that has <u>only</u> $\boxed{\text{magnitude}}$
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  Such as [Temperature, <u>mass</u>, <u>Energy</u>, <u>time</u>)
  So they have no direction

So → vector : magnitude + Direction
→ scalar : magnitude

Ex: $U = -3\ m/s$
↳ means going at a speed of 3 m/s to the (–) direction or west

$F_g = -5N$
↳ means the force is 5N to the (–) direction, in this case (down)

* Addition of vectors :

if we have vectors $\vec{A}$ and $\vec{B}$, Both to the same Direction, then:

ex: $\vec{A} = 7m \longrightarrow$, $\vec{B} = 3m \longrightarrow$ (x-axis)

Symbol of a vector:

vector sign $\leftarrow$ $\vec{X}$

symbol $\leftarrow$

$$\vec{A} + \vec{B} = \underbrace{\vec{R}}_{\text{means Resultant}}$$

$$\underset{\vec{A}}{\xrightarrow{7m}} + \underset{\vec{B}}{\xrightarrow{3m}} = \underset{\vec{R}}{\xrightarrow{10m}}$$

but if they aren't in the same direction:

ex: $\vec{A} = \xrightarrow{7m}$, $\vec{B} = \xleftarrow{3m}$ (x-axis)

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

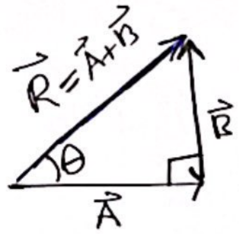
$$\vec{A} + (-\vec{B}) = \vec{R}$$

$$\underset{\vec{A}}{\xrightarrow{7}} - \underset{\vec{B}}{\xleftarrow{3}} = \underset{\vec{R}}{\xrightarrow{4m}}$$

if one is in the x-axis and the other is in the y-axis:

ex: $\vec{A} = \longrightarrow$, $\vec{B} = \uparrow$

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



* to find the Resultant we measure it to the Right scale and we get the magnitude represented by $|\vec{R}|$ then we measure the angle θ between $\vec{R}$ and the x-axis

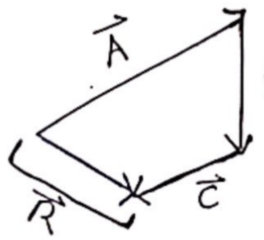
- the magnitude can also be found by using Pythgoras theorem: $\vec{R} = \sqrt{\vec{A}^2 + \vec{B}^2}$

* Representing the Resultant on a graphical scale :

1. Draw the vectors to scale
2. start by Drawing the first, then Put the next by Placing its tail at the tip of the first not changing directions
   - The rule is the same regardless of how many vectors there are
3. The arrow drawn from the <u>tail</u> of the first vector to the <u>TIP</u> of the last is the resultant we are looking for

ex: $\vec{A} = \nearrow$, $\vec{B} = \downarrow$, $\vec{C} = \swarrow$

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



Subtracting Vectors & multiplication of a vector by a scalar

- Negative vector means the same magnitude but opposite Direction of the vector

ex:

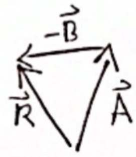
$\vec{A} = \nearrow \Rightarrow -\vec{A} = \swarrow$

The subtraction of a vector means the sum of the negative

ex: $\vec{A} = \nearrow$, $\vec{B} = \longrightarrow$

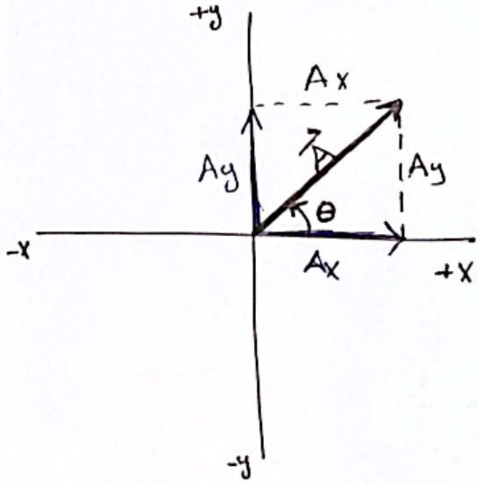
$\vec{A} - B = \vec{A} + (-\vec{B})$

$= \vec{A}\nearrow + \xleftarrow[-\vec{B}]{}$ $\approx>$



* Adding vectors by Components :

- Any vector can be resolved into <u>two</u> components along the x and y axes



ex:

we have vector $\vec{A}$

- its components are

A_x and A_y , it makes the angle $\underline{\theta}$ with the $\underline{\text{Positive}}$ x-axis

↳ θ <u>must</u> alway be measured from the <u>(+)</u> <u>x-axis</u> and <u>Caunter clockwise</u>

A here is the magnitude $|\vec{A}|$

So: $\sin\theta = \frac{A_y}{A} \approx> \boxed{A_y = A\sin\theta}$

same for $\cos\theta \approx> \boxed{A_x = A\cos\theta}$

- There are two ways to specify a vector in a given Coordinate system :

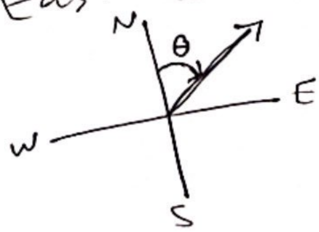
① we can give its Components A_x and A_y

② we can give its magnitude A and θ
↳ measured from (+) x-axis

In directions, The <u>last</u> thing you say . You <u>start</u> <u>with</u> from

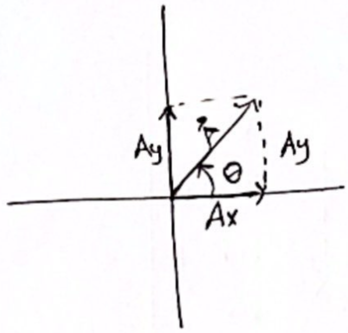
Ex:

North <u>Eeast</u> while East <u>North</u>



* if we have the components of a vector we can get the magnitude and the angle (direction) of the vectors using the relation:

* $\underbrace{A = |\vec{A}| = \sqrt{(A_x)^2 + (A_y)^2}}_{\text{magnitude}}$



* $\tan\theta = \dfrac{A_y}{A_x}$ (direction)

$\theta = \underbrace{\tan^{-1}}_{\text{tan inverse}}\left(\dfrac{A_y}{A_x}\right)$ → Always for $\tan\theta$, the angle is measured from the axis of the denomenator

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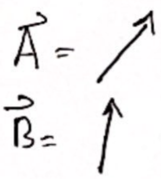
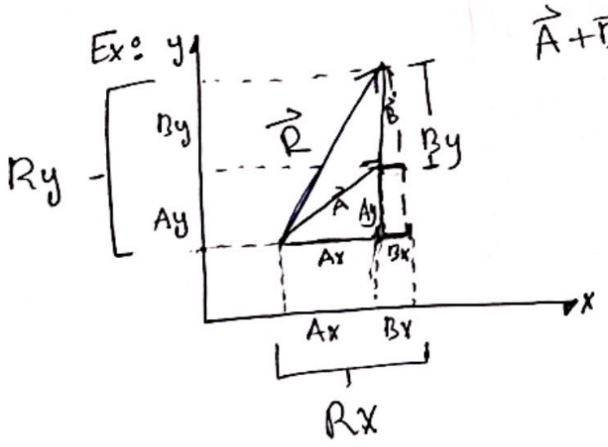
* This is applicable to added vectors:

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





* This works for however many vectors you want *

to get $\vec{R}$ we add the components that make it up, so:

$R_x = A_x + B_x \cdots$

$R_y = A_y + B_y \cdots$

$|\vec{R}| = \sqrt{(R_x)^2 + (R_y)^2}$

and for direction

$\tan\theta = \dfrac{R_y}{R_x}$

$\theta = \tan^{-1}\left(\dfrac{R_y}{R_x}\right)$