Unit 1: Kinematics & Dynamics

Kinematics → study of motion

dynamics → " " causes of motion

uniform motion → constant velocity

accelerated motion → w/ changing velocity

scalar	vector
speed → rate of change of distance (per unit time)	velocity → rate of change of displacement
distance	displacement → change in position
	position → location in space
$v = \frac{d}{t}$	$\vec{v} = \frac{\vec{d}}{t}$

acceleration → rate of change of $\vec{v}$

$$a = \frac{v_f - v_i}{t}$$

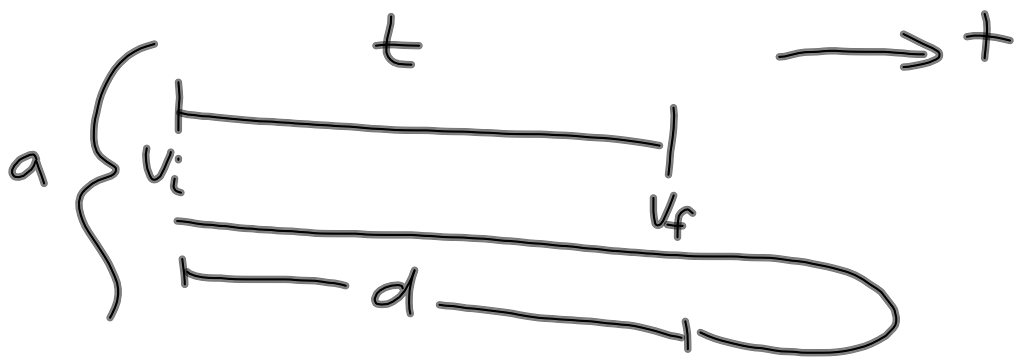
def. of average velocity (if $\vec{a}$ is constant)

$$v_{AV} = \frac{v_i + v_f}{2} = \frac{d}{t}$$

$$v_f^2 = v_i^2 + 2ad$$

$$\frac{d}{t} = \frac{v_i + v_f}{2} \qquad a = \frac{v_f - v_i}{t} \qquad v_f^2 = v_i^2 + 2ad$$

$$d = v_i t + \frac{1}{2}at^2 \qquad d = v_f t - \frac{1}{2}at^2$$



Vector Math

- multiply a vector by a scalar

  $n\vec{v}$ = n * magnitude of $\vec{v}$ in same direction as $\vec{v}$

  $(n * |\vec{v}|)$

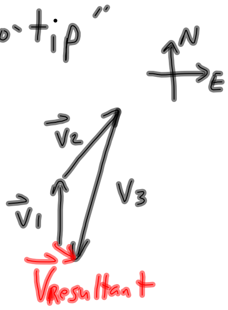
- adding 2 vectors

3 methods → all "tail-to-tip"

$\vec{V_1} = 25 \frac{m}{s}$ [N]

$\vec{V_2} = 37 \frac{m}{s}$ [N 30° E]

$\vec{V_3} = 45 \frac{m}{s}$ [S 20° W]



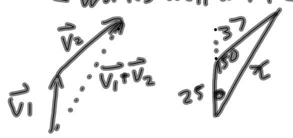
1) Scale Diagram
- easy
- imprecise
- time consuming

$\vec{V_1} = 25 \frac{m}{s}$ [N]

$\vec{V_2} = 37 \frac{m}{s}$ [N 30° E]

$\vec{V_3} = 45 \frac{m}{s}$ [S 20° W]

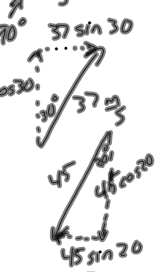
2) Trig. method
- works well with 2 vectors



cos law → x
sin law → θ
x $\frac{m}{s}$ [N θ E]

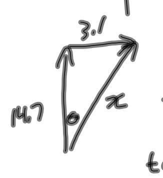
3) Components
- divide each vector into orthogonal components

	①	②	③
N⁺ S⁻	25 $\frac{m}{s}$	32 $\frac{m}{s}$	-42.3 $\frac{m}{s}$
E⁺ W⁻	0	18.5 $\frac{m}{s}$	-15.4



N-S Tot 14.7 $\frac{m}{s}$

E-W 3.1 $\frac{m}{s}$



$x^2 = 14.7^2 + 3.1^2$

$x = 15$

$\tan\theta = \frac{3.1}{14.7}$ θ=12

$\vec{V}_{Res.} = 15 \frac{m}{s}$ [N 12° E]

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t}$$

Hobbes is running 8.0 m/s [N] the turns to run 8.0 m/s [E] in 5.0 s. What is his average $\vec{a}$?

$\vec{v}_i = 8\ \frac{m}{s}$ [N]

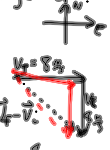
$\vec{v}_f = 8\ \frac{m}{s}$ [E]

$t = 5\ s$ E 15° S

$\vec{a} = ?$

$-\vec{v}_i = 8\ \frac{m}{s}$ [S]

$$\vec{a} = \frac{\vec{v}_f - \vec{v}_i}{t} = \frac{\vec{v}_f + (-\vec{v}_i)}{t} = \frac{11.3\ \frac{m}{s}\ [E 45° S]}{5\ s} = 2.26\ \frac{m}{s^2}\ [\text{"}]$$



$x^2 = 8^2 + 8^2$

$= 11.3$

$\theta = 45°$

$\vec{v}_f - \vec{v}_i = 11.3\ \frac{m}{s}$ [E 45° S]

$$d = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$$

$v_i = 8\ \frac{m}{s}$ [N]

$a = 2\ \frac{m}{s^2}$ [E 30° S]

$t = 10\ s$

$\vec{v}_i t = 80\ m$ [N]

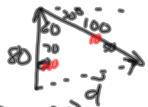
$\frac{1}{2}\vec{a}t^2 = \frac{1}{2}t^2(\vec{a})$

$= 50\vec{a}$

$= 100\ m$ [E 30° S]

$\frac{\sin\theta}{100} = \frac{\sin 60}{92}$

$\theta = 70°$



$d^2 = 80^2 + 100^2 - 2(80)100\cos 60$

$= 6400 + 10000 - 8000$

$= 8400$

$d = 92\ m$

$\vec{d} = 92\ m$ [N 70° E]