Chapter 1. Kinematics

1-1. Units, physical quantities and vectors

◆ Units and physical quantities

● Units and physical quantities

基本物理量(Physical quantity)	units	
長度(Length)	meter	m
質量(Mass)	kilogram	Kg
時間(Time)	second	s
電流 (Current)	ampere	A
溫度(Temperature)	kelvin	K
發光強度(Luminous intensity)	candela	cd
物質數量(Amount of substance)	mole	mol

● Order of magnitude

Prower of ten	Prefix(symbol)	Symbol
10^{12}	tera-	T
10^{9}	giga-	G
10^{6}	mega-	M
10^{3}	kilo-	K
10^{0}		
10^{-2}	centi-	c
10^{-3}	milli-	m
10^{-6}	micro-	μ
10^{-9}	nano-	n
10^{-12}	pico-	p
10^{-15}	feto-	f

◆ Vector Addition and Subtraction

● Scalars and Vectors

■ **Scalars** : a scalar quantity means a physical quantity is described by a single number.

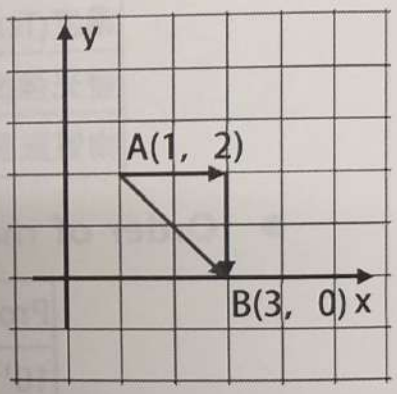
■ **Vectors** : a vector quantity has both a magnitude and a direction in space.

☞ Vectors=Ending position − starting position

⌦ 4 point are located in the x-y coordinates,

	A	B	C	D
x=	1	3	3	0
y=	2	0	3	4

Vector AB, represented as $\overrightarrow{AB}$



$\overrightarrow{AB}$ = position B - position A

= (3 , 0) - (1 , 2)

= (2 , - 2)

$= 2\sqrt{2}\ (\frac{1}{\sqrt{2}}\ ,\ -\frac{1}{\sqrt{2}})$

And negative of a vector, means vector AB in negative direction.

$\overrightarrow{BA}$ = position A - position B

= (1 , 2) - (3 , 0)

= (- 2 , 2)

$= -\overrightarrow{AB}$

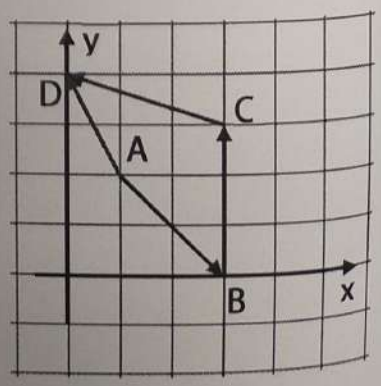
Vector AD,

$\overrightarrow{AD}$ = position D - position A

= (0 , 4) - (1 , 2)

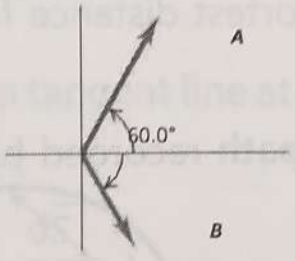
$= \overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CD}$

=(2 , - 2) + (0 , 3) + (- 3 , 1)



Example 1

Vector $\vec{\mathbf{A}}$ is 2.80 cm long and is 60.0° above the *x*-axis in the first quadrant. Vector $\vec{\mathbf{B}}$ is 1.90 cm long and is 60.0° below the *x*-axis in the fourth quadrant. Use components to find the magnitude and direction of



(a) $\vec{\mathbf{A}} + \vec{\mathbf{B}}$;

(b) $\vec{\mathbf{A}} - \vec{\mathbf{B}}$;

(c) $\vec{\mathbf{B}} - \vec{\mathbf{A}}$;

. In each case, sketch the vector addition or subtraction and show that your numerical answers are in qualitative agreement with your sketch.

Ans:

(a) $(2.35, 0.45\sqrt{3})$

(b) $(0.45, 2.35\sqrt{3})$

(c) $(-0.45, -2.35\sqrt{3})$

Exercise

Given two vectors $\vec{\mathbf{A}} = -2.00\hat{\mathbf{i}} + 3.00\hat{\mathbf{j}} + 4.00\hat{\mathbf{k}}$ and $\vec{\mathbf{B}} = 3.00\hat{\mathbf{i}} + 1.00\hat{\mathbf{j}} - 3.00\hat{\mathbf{k}}$,

(a) find the magnitude of each vector;

(b) use unit vectors to write an expression for the vector difference $\vec{\mathbf{A}} - \vec{\mathbf{B}}$;

and (c) find the magnitude of the vector difference $\vec{\mathbf{A}} - \vec{\mathbf{B}}$.

Ans:

(a) $\sqrt{29}$, $\sqrt{19}$

(b) $(-5, 2, 7)$

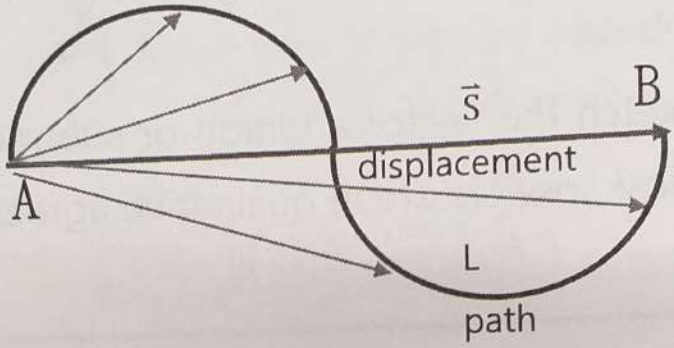
(c) $\sqrt{78}$

1-2. Displacement , Velocity , and Accerleration

◆ Displacement and length pf path :

- A **displacement** is a vector whose length is the shortest distance from the initial to the final position point.

- A **path** recorded body moving trajectory in space.



displacement	A vector along straight line betweeen AB
Length of path	Length of trajectory frome A to B

■ When time interval is large, magnitude of displacement $|\vec{S}|$ not coincide to length of path L. As the time interval shorten and adjust it to make $|\vec{S}|$ =L.

◆ Average of Velocity

- Average of Velocity: **(slope of a line connecting start and end point)**

$$\overrightarrow{V_{av}} = \frac{\overrightarrow{S}\ \text{(displacement)}}{\Delta t\ (\text{time})}$$; Δt : time interval。

- Instantaneous velocity : **(slope of a tangent line at a point)**

$$\overrightarrow{V_{ins}} = \lim_{\Delta t \to 0} \frac{\overrightarrow{S}\ \text{(displacement)}}{\Delta t\ (\text{time})} = \frac{d\overrightarrow{S}}{dt}$$)。

- Average speed : $V_{av} = \frac{L\ \text{(Length of path)}}{\Delta t\ (\text{time})}$。

- **Summary**