Chapter one

The vectors

1-1 physical Quantities

Scalar quantity: the quantity that is completely specified by a number and appropriate units, such as Temperature, mass, time,………etc.

Vector quantity: is a physical quantity that is completely specified by a number and appropriate units plus a direction in which it is affect, such as displacement, velocity, acceleration, force,….etc.

Let $\vec{A}$ a vector, it's magnitude $|A|$, and $\hat{n}$ is the unit vector defined as a dimensionless vector having a magnitude of exactly (1). Then we can write the vector $\vec{A}$ as:

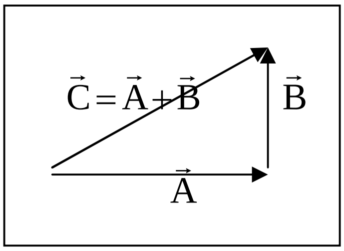
$$\vec{A} = \hat{n}|A| \qquad\qquad \vec{A} = \underrightarrow{\hat{n}|A|}$$

1-2 Multiplying a Vector by a Scalar

If $\vec{A}$ a vector multiplied by a scalar quantity (n) then (n$\vec{A}$) is the vector has the same direction of $\vec{A}$ and magnitude (n A).

1-3 Adding Vectors

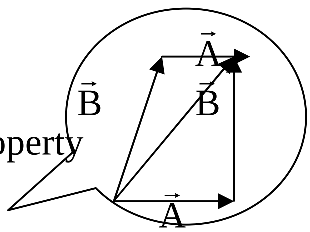
Draw vector $\vec{A}$, then draw vector $\vec{B}$ write it's tail starting from the tip of $\vec{B}$. The vector $\vec{C}$ is the resultant of adding $\vec{A}$ and $\vec{B}$. The resultant $\vec{C}$ is the vector drawn from the tail of $\vec{A}$ to the tip of $\vec{B}$.



**Properties of Adding*

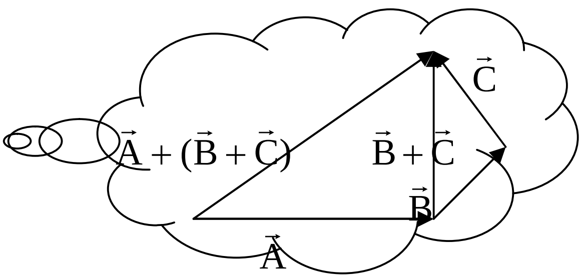
(a) The commutative property

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



(b) Associative Property

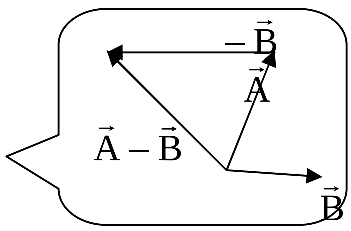
$(\vec{A}+\vec{B})+\vec{C}=\vec{A}+(\vec{B}+\vec{C})$



1-4 Subtracting Vectors

For two vector $\vec{A}$ and $\vec{B}$

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

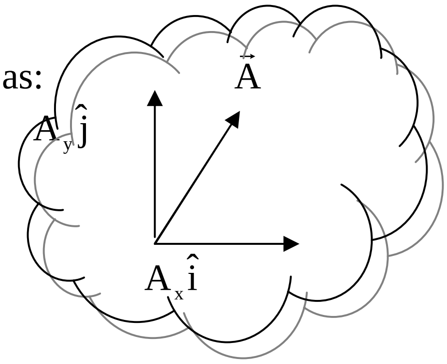


1-5 Vectors Analysis

We use the symbols i, j and k to represent unit vectors in the position x, y and z direction respectively. The magnitude of each unit vector equals unity, that is

$$|i| = |j| = |k| = 1$$

In xy-plane , we represent the vector $\vec{A}$ as:



$$\vec{A} = A_x\hat{i} + A_y\hat{j}$$

For $\vec{A}, \vec{B}$ are two vectors, where

$$\vec{A} = A_x\hat{i} + A_y\hat{j} \quad , \vec{B} = B_x\hat{i} + B_y\hat{j}$$

The resultant of $\vec{A}$ and $\vec{B}$ is R

$$R = \vec{A} + \vec{B} = (A_x\hat{i} + A_y\hat{j}) + (B_x\hat{i} + B_y\hat{j})$$

$$R = (A_x + B_x)\hat{i} + (A_y + B_y)\hat{j}$$

Then , the component of the resultant R are:

$$R_x = A_x + B_y \qquad , R_y = A_y + B_y$$

Then the magnitude of the resultant R and it's direction are written as:

$$R = \sqrt{R_x^2 + R_y^2} \quad = \sqrt{(A_x + B_x)^2 + (A_y + B_y)}^2$$

And

$$\tan\theta = \frac{R_y}{R_x} \quad \text{or } \theta = \tan^{-1}\frac{R_y}{R_x}$$

Now, for $\vec{A}$ and $\vec{B}$ are two vectors have x , y and z components, we express these vectors in the form :

$$\vec{A} = A_x\hat{i} + A_y\hat{j} + A_z\hat{k}$$

$$\vec{B} = B_x\hat{i} + B_y\hat{j} + B_z\hat{k}$$

And the resultant R of the vectors is:

$$R=\vec{A}+\vec{B}=(A_x+B_x)\hat{i}+(A_y+B_y)\hat{j}+(A_z+B_z)\hat{k}$$