CH # 05 VECTORS

SCALAR QUANTITIES (SCALARS):

"All those quantities which are completely specified by only their unit and magnitude are called scalar quantities."

Example: Length, mass, time etc.

VECTOR QUANTITIES (VECTORS):

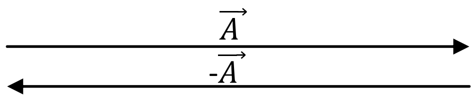
"All those quantities which are not completely specified by only their unit and magnitude as well as direction is required are called vector quantities"

Example: Momentum, Velocity, Acceleration etc.

Vector are representing by arrow on the head of the quantities. E.g: $\vec{P}$, $\vec{V}$, $\vec{a}$ etc

NEGATIVE OF A VECTOR:

"If two vectors having same magnitude but opposite in direction, then the vectors are called negative of each other."



RESULTANT VECTOR:

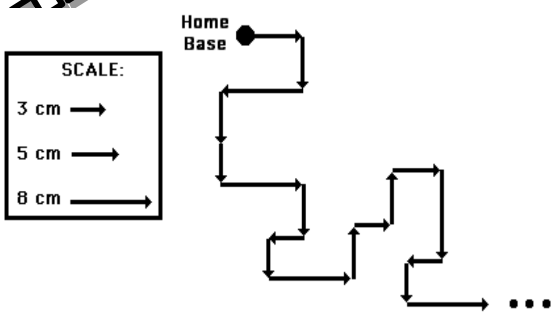
"Resultant vector is the sum of two or more vector which gives the combine effect of all vectors to be added."

ADDITION OF VECTOR:

"When two or more than two vectors are join then the process of joining is callled addition of vectors."

ADDITION OF VECTORS BY HEAD TO TAIL RULE OR GRAPHICAL METHOD OF ADDITION OF VECTORS:

- The head of the first vector is joined with the tail of the second vector
- The head of the second vector is joined with the tail of the third vector and so on.
- In this way all the vectors to be added are joined together.
- The resultant is obtained by the joining of the tail of the first vector with the head of the last vector by a straight line.
- The length of thus line represents the magnitude of the resultant vector.



RESOLUTION OF VECTOR:

"The process of splitting up a single vector into two or more vectors is called resolution of vectors."

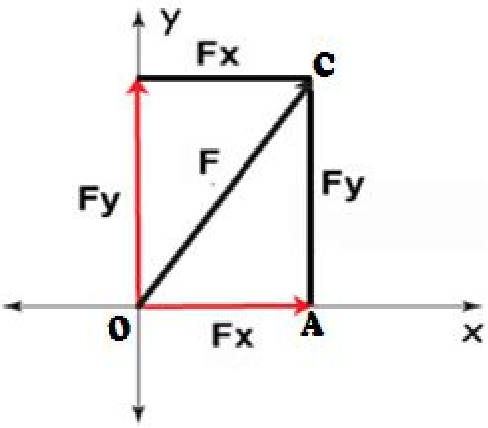
- **COMPONENTS:**

  "The vectors whose vector sum is equal to a given vector are called component of that vector."

- **HORIZONTAL COMPONENTS:**

"The component of a vector which is directed along x-axis is known as horizontal component."

If F is the vector then horizontal component of vector F will be:



$$Cos\theta = \frac{Base}{Hyp}$$

Consider ΔOAC,

$$Cos\theta = \frac{\overline{AO}}{\overline{OC}}$$

$$Cos\theta = \frac{Fx}{F}$$

$$\boxed{Fx = FCOS\theta}$$

- **VERTICAL COMPONENTS:**

"The component of a vector which is directed along y-axis is known as vertical component."

If F is the vector then vertical component of vector F will be:

$$Sin\theta = \frac{Perp}{Hyp}$$

Consider ΔOAC,

$$Sin\theta = \frac{\overline{AC}}{\overline{OC}}$$

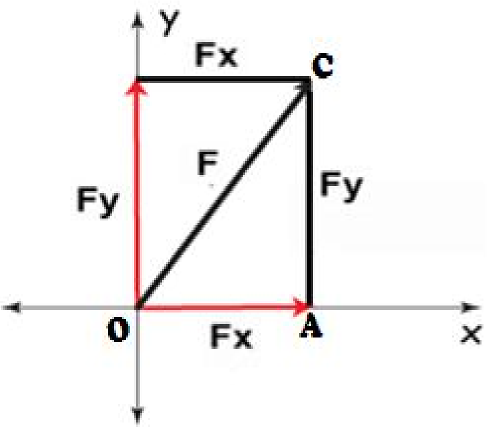
$$Sin\theta = \frac{Fy}{F}$$

$$\boxed{Fy = FSin\theta}$$

COMPOSITION OF VECTOR BY RECTANGULAR COMPONENT METHOD:

If the rectangular components of a vector are given, the magnitude and direction of the vector can be obtain thus a vector can be specified by its two rectangular components.

- **FORMULA FOR MAGNITUDE:**
  - ⇨ Consider rectangular component Fx and Fy which are represented by directed line segments OA and OB respectively, both magnitude and direction.
  - ⇨ Adding these two components by head to tail rule it can be seen that the directed line segments OC represents, in both magnitude and direction of F.
  - ⇨ To drive the expression for the magnitude and direction of F in terms of magnitude of Fx and Fy consider the right angle triangle OAC.



By using Pythagoras theorem we have

$$|Hyp|^2 = |Base|^2 + |Perp|^2$$

$$|OC|^2 = |OA|^2 + |AC|^2$$

$$|F|^2 = |F \cos\theta|^2 + |F \sin\theta|^2$$

$$|F|^2 = |Fx|^2 + |Fy|^2$$

$$F = \sqrt{Fx^2 + Fy^2}$$

The above formula gives us magnitude of the resultant vector F.

- **FORMULA FOR DIRECTION:**

  The direction of F is determined by finding the angle θ which the vector F makes with x-axis. In the right angle triangle OAC, we have.

$$\tan\theta = \frac{F \sin\theta}{F \cos\theta}$$

$$\tan\theta = \frac{AC}{OC}$$

$$\tan\theta = \frac{Fy}{Fx}$$

$$\theta = \tan^{-1}\frac{Fy}{Fx}$$

The above formula gives us direction of the resultant vector F.

*This is extra section just for knowledge.

KEY TO REMEMBER:

- Trigonometric ratio was first introduced by the Muslim mathematician Muhammad Bin Musa Khwarizmi.
- The magnitude of resultant of two or more vectors which are the same direction is equal to the sum of their magnitudes its directions remain the same.

Vectors in three-dimensional space (1978) is a book concerned with physical quantities defined in "ordinary" 3-space. It was written by J.S.R. Chisholm, an English mathematical physicist, and published by Cambridge University Press.