Scalar quantities and vector quantities

If we mentioned that the degree of body (37 °C), it is a complete information ***(value only)***

But if we mentioned that the car is moving with speed (50km/h), we mentioned magnitude and unit of measurement, but keep the question in any direction moving car, is the East or the West or in any direction.

Then the speed of the car can be written in fully (50 km/h East), have been identified both ***magnitude and direction***, so the velocity is a vector quantity.

*****Physical quantities can be classified into***

Scalar	Vector
It is a physical quantity known by its ***magnitude only*** ***Such as;*** distance, mass, time temperature and energy	It is a physical quantity known by its ***magnitude and direction.*** ***Such as;*** displacement, velocity, acceleration and force

1- The difference between the distance and displacement

****Distance:***

Path length covered (harvested) during movement from one position to another

The distance is scalar quantity only ***need to know the value (magnitude) only***

When the amount of distance coupled with the direction of the movement ***called in this case displacement.***

****Displacement:***

It is the straight distance in a certain direction from the start point to the end point

****Example:***

A runner moves a displacement ***(50m) west***, then move in the opposite direction displacement ***(30m) east***, calculate the distance and displacement made by a runner

****Solution:***

Distance covered (S) = 50 + 30 = 80 m

Displacement covered (d) = +50 – 30 = +20 m

Where we consider that displacement of the West is positive and a negative offset to the East

The result shows that the body had happened to it in the end displacement = (20m) in the west direction.

***Example:**

A body moves from point **(A)** until it reached the point **(B)**, covered a distance ***150 m*** and then returned the same way a distance of ***50m*** until it reached the point (C), ***calculate the distance and displacement covered***.

***Solution:**

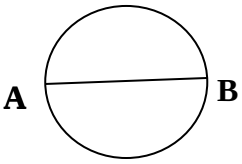
S = 150 + 50 = 200 m

d =+ 150 – 50 = + 100 m ***(the direction of motion from A to B)***

It has been considered that the displacement in the direction of ***A to B is positive*** and from ***B to C is negative***

***Example:**

A body moves from point **(A),** covered a distance **12m** until it reached the point **(B)** and then move in the direction perpendicular to the first track distance **5m** until it reached the point (C), ***calculate the distance and displacement covered***.



***Solution:**

S = 12 + 5 = 17 m

d $(\overrightarrow{AC}) = \sqrt{(AB)^2 + (BC)^2} = \sqrt{144 + 25} = \sqrt{169} = 13$ **m (the direction of motion from A to C)**

***Example:**

Body moves on the perimeter it's radius 7m, from B → A and then from A → B → A

****Vector representation:**

Vector is represented with directed line segment its length proportion with the value of the vector start from the starting point and point towards the end point

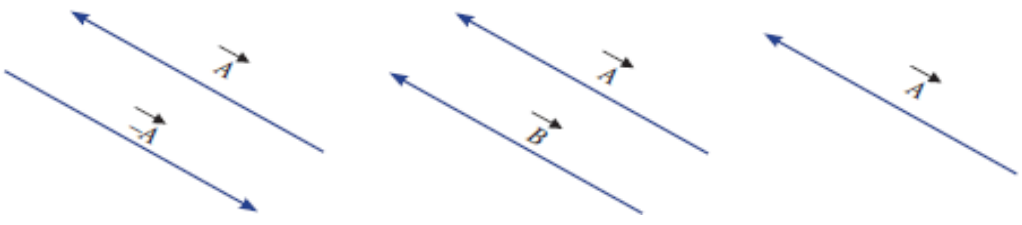
Vector is symbolized with dark **A** or normal character and above it a small arrow

****Graphic representation of vectors:**

Vector is represented by a drawing a line segment directed appropriate scale so that

a- The length of the line segment represents the amount of vector.

b- The direction of the line segment represents the direction of vector.



***Vector algebra basics:**

1- When two vectors be equal:

If the two are same in the amount and had the same direction ***(even if different starting point each)***

2- Vector $\vec{A}$ its numerical value equal to the numerical value of the vector $-\vec{A}$, but in reverse (opposite direction)

Note that:

If we multiply the vector $-\vec{A}$ by (-1) became equal to the vector $\vec{A}$ magnitude and direction

***Vectors resultant (outcome) by adding**

When two or more forces affect the body in different directions, in any direction moves the body and how much is the amount of force that move?

Note that:

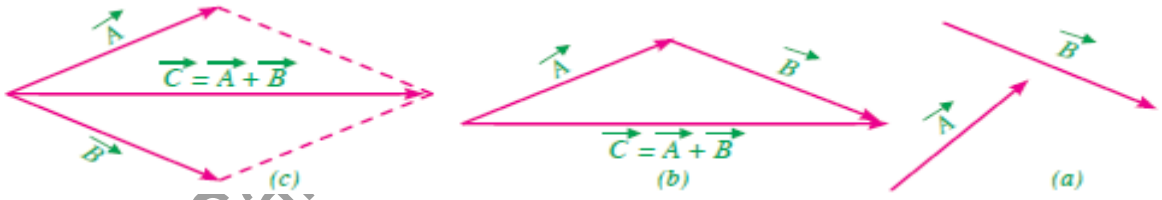
The force that affect the body as a result of the impact of several force is called outcome (resultant) force.

Determines the direction of the outcome force by the direction in which it moves the body.

***Vectors are added in two ways**

1- Draw a triangle as shown in Figure

2- Draw a parallelogram where **A** and **B** are two adjacent sides shall be representative of the diameter outcome vectors as shown in Figure



Example:

Find the resultant of two forces, one in the direction of the **X axis** is F_x = 4N, and the other in the direction of the **Y axis** is the F_y = 3N.

Solution:

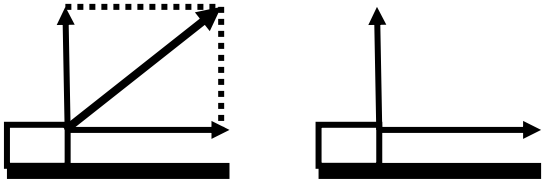
Complete the parallelogram, we get a rectangle ***(because the two forces are perpendicular to each other).***

Connect (blade) diameter, shall be is the ***resultant force***

The application of the Pythagorean theorem can find a numerical value for the outcome force (F) ***as follows***

$$\therefore F = \sqrt{F_x^2 + F_y^2} = \sqrt{16 - 9} = \sqrt{25} = 5\text{N}$$

$$\tan\theta = \frac{F_y}{F_x} = \frac{3}{4} \qquad \theta = 36^\circ.87$$

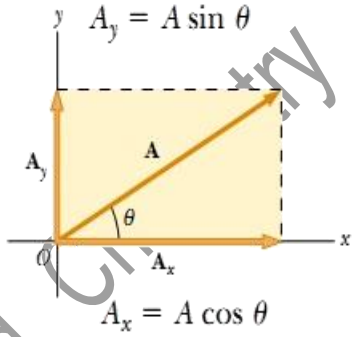


***Vector analysis:**

It is the reverse process of adding vectors

For example a girl dragging other by a rope in the direction makes angle (θ) with the horizontal, The force (F) can be analyzed into two forces perpendicular on (X, Y) axis

$F_y = F \sin\theta \quad F_x = F \cos\theta$



***Vectors product (multiply):**

There are different forms to vectors products

1- Scalar product:

The result of scalar product between two vectors $\vec{A}, \vec{B}$

$$\vec{A} . \vec{B} = AB \cos\theta$$

The result is a scalar quantity equal to the product of the numerical value of the first **(A)** in the numerical value of the second **(B)** in the cosine of the angle between the two vectors (***cos θ***), and the point between two vectors is called ***(dot)***

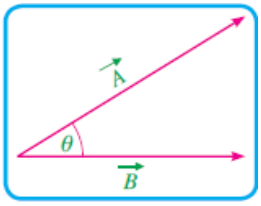
2- Vector product:

The result of vector product between two vectors $\vec{A}, \vec{B}$

$$\vec{C} = \vec{A} \wedge \vec{B} \sin\theta \ \vec{n}$$

The result is equal to the product of the numerical value of the first **(A)** in the numerical value of the second **(B)** in the sine of the angle between the two vectors (***sin θ***) in the $\vec{n}$, and the sign between two vectors is called ***(cross)***

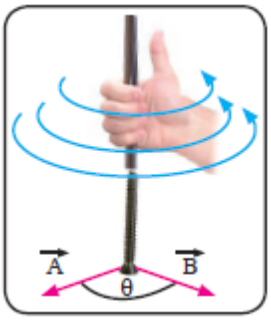
Where $(\vec{n})$ is the unit vectors in the perpendicular direction level which include two vectors $\vec{A}, \vec{B}$



And determines the direction of **$(\vec{C})$** rule called right hand rule

***Right hand rule**

By moving the fingers of the right hand of the first vector towards the second vector across the small angle between them, Shall be thumb points for the result of vector product.



Note that: In the case of vector product

(θ) located between $\vec{A}, \vec{B}$

$\vec{A} \wedge \vec{B} \neq \vec{B} \wedge \vec{A} \qquad \vec{A} \wedge \vec{B} = -\vec{B} \wedge \vec{A}$