Lesson 2: Graphical Method of Addition of Vectors in Two Dimensions (2-D)

Methods of Vector Addition

There are two commonly used methods employed to determine the vector sum of two or more vectors. The two methods that we will discuss in this unit are

I. Graphical Method

II. Algebraic Method

- **Graphical Method**
- Graphical method of vector addition gives visual understanding of vectors and it is commonly used in navigation
- Figure 2.5 represents a trip that starts at point A then to point B and ending at point C. You see that total distance traveled for the whole trip is 1.2 km + 2 km = 3.2 km, but what is the displacement from A to C? How do you get the resultant displacement given displacements from A to B and from B to C?
- In this section we will discuss Triangle law, Parallelogram law and Polygon law of addition of vectors
- When two or more vectors are added they must have the same units.

Triangle Law of Vector Addition

- **Triangle Law of Vector Addition** is a mathematical concept that is used to find the sum of two vectors.
- This law is used to add two vectors when the first vector's head is joined to the tail of the second vector and then joining the tail of the first vector to the head of the second vector to form a triangle, and hence obtain the resultant sum vector.
- That's why the triangle law of vector addition is also called **the head-to-tail method** for the addition of vectors.
- Triangle law of vector addition is used to find the sum of two vectors when the head of the first vector is joined to the tail of the second vector.

Examples

Two vectors A and B have magnitudes of 4 units and 9 units and make an angle of 30° with each other. Find the magnitude and direction of the resultant sum vector using the triangle law of vector addition formula.

Solution: The formula for the resultant vector using the triangle law are:

$|R| = \sqrt{(A^2 + B^2 + 2AB\cos\theta)}$

$\phi = \tan^{-1}[(B\sin\theta)/(A + B\cos\theta)]$

So, we have

$|R| = \sqrt{(A^2 + B^2 + 2AB \cos \theta)}$

$= \sqrt{(4^2 + 9^2 + 2 \times 4 \times 9 \cos 30°)}$

$= \sqrt{(16 + 81 + 72 \times \sqrt{3}/2)}$

$= \sqrt{(97 + 36\sqrt{3})}$

= 12.623 units

The direction of R is given by,

$\phi = \tan^{-1}[(B \sin \theta)/(A + B \cos \theta)]$

$= \tan^{-1}[(9 \sin 30°)/(4 + 9 \cos 30°)]$

$= \tan^{-1}[(9 \times 1/2)/(4 + 9 \times \sqrt{3}/2)]$

$= \tan^{-1}[(4.5)/(11.8)]$

= 20.87°

Answer: Hence, the magnitude of the resultant vector is 12.623 units and the direction is 20.87°, approximately.

Parallelogram law of vector addition

If two vectors are considered to be the adjacent sides of a parallelogram, then the resultant of the two vectors is given by the vector that is diagonal passing through the point of contact of two vectors.

Polygon law of vectors addition

The polygon law of vector addition states that **if the sides of a polygon are taken in the same order to represent a number of vectors in magnitude and direction, then the resultant vector can be represented in magnitude and direction by the closing side of the polygon taken in the opposite order.**

Subtraction of Vectors

Subtraction of vectors **involves the addition of vectors and the negative of a vector**.