**Bluebird secondary school**

**Kumaripati, Lalitpur**

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**“Project Work on Vectors and its Application”**

**Submitted to:**

Department of Mathematics

**Submitted by:**

Shrijan Dahal

Roll. No. SS2078120

Class: XII(C)

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**Abstract:**

Vectors are used to represent physical quantities like force, velocity, etc. Which makes vectors very useful in many fields. In this study, we explore the concept of vectors and their applications in different fields, covering topics like the properties and operations of vectors and their use in mechanics, computer graphics, navigation, and optimization problems. This study highlights the significance of vectors in modern mathematics and its practical applications in various fields.

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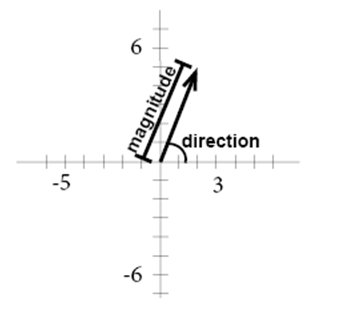
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**Chapter 1: Vectors**

Vectors are mathematical objects that have magnitude and direction and are used to represent quantities that have both these attributes. Vectors can be represented graphically as arrows or symbolically as ordered lists of numbers. Velocity, acceleration, force, weight, momentum, electric intensity etc. are examples of vector quantities.

* 1. **Definition**

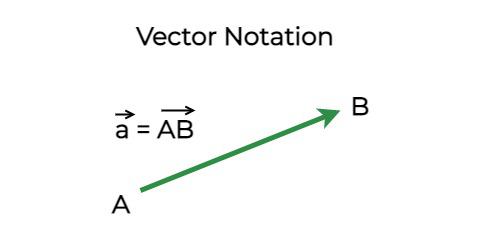
The vectors are defined as an object containing both magnitude and direction. Vector describes the movement of an object from one point to another.



The length of the segment of the directed line is called the magnitude of vector and the angle at which the vector is inclined shows the direction of the vector. The starting point of a vector is called “Tail” and the ending point (where the arrow points) is called “Head.”

**Vector Notation**

A vector AB is notated as or where the pointer points according to the direction of the vector.



* 1. **Magnitude of Vector**

Magnitude of a vector is shown by a vector enclosed in a modulus as.Mathematically, the value of a modulus is calculated by using Pythagoras Theorem i.e.

* 1. **Unit Vector**

Unit vector is a vector whose magnitude is one and is used to show the direction of a vector. Symbolically it is represented by a cap “^”, while mathematically, it is represented as a ratio between a vector and its magnitude.

* 1. **Vector Multiplication**

Vector multiplication can be performed in two ways;

1. **Scalar Multiplication**

It is the multiplication performed when vector is multiplied by a scalar.

1. **Vector Multiplication**

It is the multiplication performed between two vectors. There are two types of vector multiplication as follows,

* **Dot Product**

The dot product of two vectors always results in scalar quantity, i.e. it has only magnitude and no direction. It is represented by a dot (.) in between two vectors.

Its mathematical value is,

Where, is the angle between vectors and .

* **Cross Product**

The cross product of two vectors results in a vector quantity. It is represented by a cross sign between two vectors.

Its mathematical value is,

Where, is the angle between vectors and and is a unit vector in the direction of resultant.

* 1. **Properties of Vectors**

Some properties of vectors and laws are as follows:

1. **Commutative Property**

The order of addition does not matter. i.e.

1. **Associative Property**

The sum of three vectors has nothing to do with the order in which they are added. i.e.

1. **Distributive Property**
   1. **History of Vectors**

The mathematical concept that inspired vector analysis was the idea of complex numbers, which have two components, real and imaginary. When these numbers were visualized in a plane, they were equivalent to vectors. Many mathematicians tried to extend this system to three dimensions but were unable to do so. In 1843, William Rowan Hamilton invented a four-dimensional system that he called quaternions. The template for quaternions was:

Where w, x, y, and z representing real numbers. Hamilton called the first term (w) the scalar and the rest of the expression the vector, since it could be mapped on a space of three axes to produce a line. He developed an algebra of quaternions and lectured on them for the rest of his life.

William Kingdon Clifford, also favoured vector analysis and converted the quaternion formula into two products which he termed the scalar product and the vector product.

**Chapter 2: Application of Vectors**

Some specialized applications of vectors in real life are listed below:

* The direction in which the force is applied to move the object can be found using vectors.
* To understand how gravity uses a force of attraction on an object to work.
* The motion of a body which is confined to a plane can be obtained using vectors.
* Vectors help in defining the force applied on a body simultaneously in the three dimensions.
* Vectors are used in the field of Engineering, where the force is much stronger than the structure will sustain, else it will collapse.
* In various oscillators, vectors are used.
* Vectors also have its applications in ‘Quantum Mechanics’.
* The velocity in a pipe can be determined in terms of the vector field—for example, fluid mechanics.
* We may also observe them everywhere in the general relativity.
* Vectors are used in various wave propagations such as vibration propagation, sound propagation, AC wave propagation, and so on.
  1. **Application of Vectors in Daily life**
* **Military Usage**

Any piece of artillery that fires a projectile by employing gun power or any other type of typically explosive-based propellant is considered to be a cannon. The range, mobility, rate of fire, and angle of fire of cannons all differ from one another. Depending on the role that each type of cannon is supposed to play on the battlefield, different types of cannon mix and balance these characteristics to differing degrees. It is required to make use of this vector. Vectors decide where the projectile will head and hit on the ground.

* **Vectors in Games**

Any piece of artillery that fires a projectile by employing gun power or any other type of typically explosive-based propellant is considered to be a cannon. The range, mobility, rate of fire, and angle of fire of cannons all differ from one another. Depending on the role that each type of cannon is supposed to play on the battlefield, different types of cannon mix and balance these characteristics to differing degrees. It is required to make use of this vector. Vectors decide where the projectile will head and hit on the ground.

* **Crossing a river**

When a boat travels over a river, the speed of the boat and the speed of the river both contribute to the total speed of the boat. When the current speed of the river changes, so does the course that the boat takes. Therefore, the boatman must determine an angle for crossing the river in order to access the shore of the river in a direct manner. Vector plays an important role here.

**Conclusion**

In conclusion, vectors play a fundamental role in mathematics and have numerous applications in various fields, including physics, engineering, and computer science. Understanding the properties of vectors, such as magnitude, direction, and vector algebra, is essential for solving problems that involve multi-dimensions and complex systems.

Overall, the study of vectors and its applications is crucial to understanding the physical world and solving problems in a wide range of fields. Advances in vector analysis continue to shape our understanding of the natural world and have led to many important technological breakthroughs.

**Bibliography**

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