Magnetism

Lecture 1

vectors

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This lecture is concerned with vectors. A vector has a magnitude and a direction. The speed of an object is a scalar, whereas its velocity is a vector.

A scalar quantity: is a quantity which is completely characterized by its **magnitude**. Examples of physical quantities that are scalar are **mass, time**, **temperature, volume, and work**.

A vector quantity: is a quantity which is completely characterized by its **magnitude and direction**. **Force, velocity, displacement, and acceleration are examples of vector quantities**. A vector can be represented geometrically by an **arrow** whose direction is approximately chosen and whose length is proportional to the magnitude of the vector.

Field: If at each point of a region there is a corresponding value of some **physical function**, the region is called a field. Fields may be classified as either **scalar or vector**, depending upon the type of **function** involved.

Not\\ If the value of the physical function at each point is a scalar quantity, **then the field is a scalar function**. The temperature of the atmosphere and density of a nonhomogeneous body are examples of scalar fields.

Not\\ When the value of the function at each point is a vector quantity, the field is a vector field. The wind velocity of the atmosphere, the force of gravity on a mass in space, and the force on a charged body placed in an electric field, are examples of vector fields.

Vector Algebra: For this purpose a three-dimensional Cartesian coordinate system introduced to represent the vector. The variables of this system are x,y, z.

The sum of two vectors is defined as the vector whose components are the sums of the corresponding components of the original vectors.

$\vec{C} = \vec{A} + \vec{B}$ (1)

$C_x = A_x + B_x$, $C_y = A_y + B_y$, $C_z = A_z + B_z$ (2)

When the order of the operation may be reversed with no effect on the result, the operation is said to obey the commutative law:

$\vec{A} + \vec{B} = \vec{B} + \vec{A}$ (3)

The operation of subtraction is defined as the addition of the negative. This is written as $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$ (4)

The vector addition and subtraction are associative. In vector notation this appears as

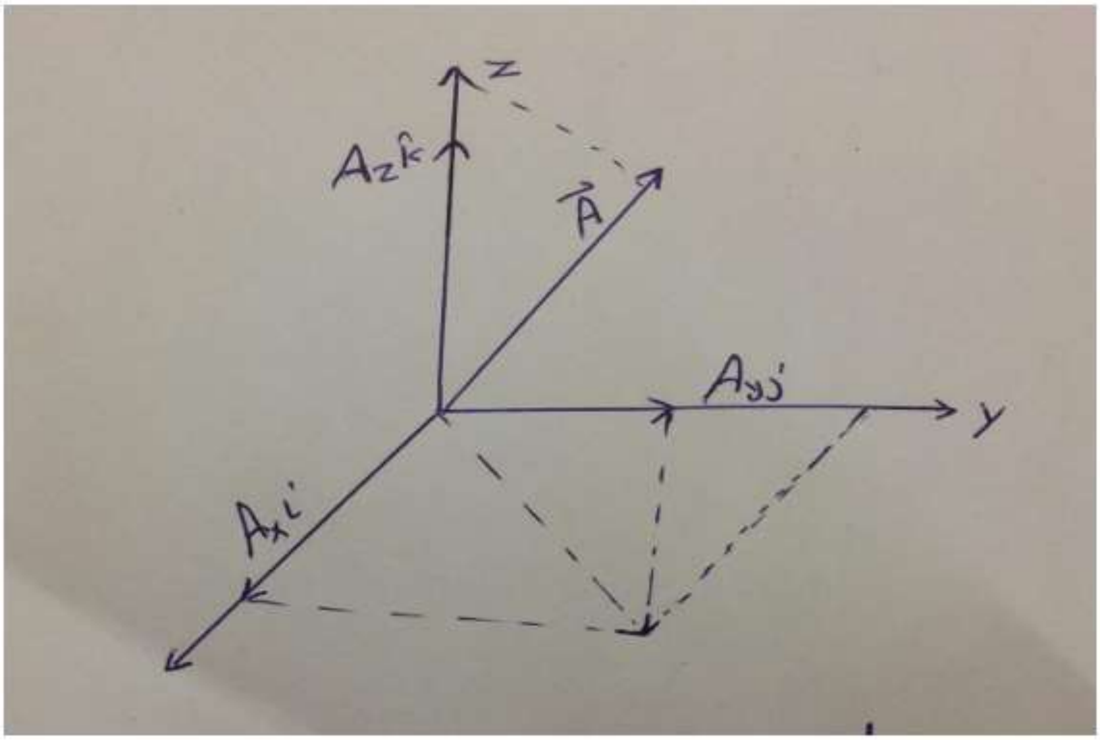

Fig.(1): A three Dimensional vector in rectangular coordinates.

$\vec{A} + (\vec{B} + \vec{C}) = (\vec{A} + \vec{B}) + \vec{C} = (\vec{A} + \vec{C}) + \vec{B} = \vec{A} + \vec{B} + \vec{C}$ (5)

In other words, the parentheses are not needed.

The unit vector $\hat{a}$ has a magnitude of one ($|\hat{a}| = 1$) and points from A's tail or anchor to its head or tip

unit vector\\ $\hat{a}$: $A = \hat{a}|A| = \hat{a}A$. $a = A/|A|$. (6)

$A = \hat{x}A_x + \hat{y}A_y + \hat{z}A_z$, (7)

$A = |A| = +\sqrt[2]{A2\,x + A2\,y + A2\,z}$. (8)

The scalar (or dot) product of two co-anchored vectors A of two co-anchored vectors A and B, denoted A·B and pronounced "A dot B," is defined geometrically as the product of the magnitude of A and the scalar component of B along A, or vice versa. Thus, $A\cdot B = AB\cos\theta_{AB}$, (9)

Example \\ $\vec{A} = 3\hat{i} + 4\hat{j}$

1-find $\vec{A}$ **2 - unit vector** $\vec{A}$

Sol

$\left|\vec{A}\right| = \sqrt{{A_x}^2 + {A_y}^2} ...(2-1)$ 3= A_x . 4= A_y

$\left|\vec{A}\right| = \sqrt{(3)^2 + (4)^2}$

$\left|\vec{A}\right| = \sqrt{9+16}$

$\vec{A}$ units $\left|\vec{A}\right| = 5$

$\hat{u}_{\vec{A}} = \frac{1}{5}(3\hat{i} + 4\hat{j})$

= $\hat{u}_{\vec{A}} = \frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}$

Find the values of x, y, and z, which make the following vectors equal

$\vec{A} = \hat{i} + 2\hat{j} + 3z\hat{k}$ $\vec{B} = (x-3)^2\hat{i} + y\hat{j} + \hat{k}$

Sol \\ $\hat{i} + 2\hat{j} + 3z\hat{k} = (x-3)^2\hat{i} + y\hat{j} + \hat{k}$

$1 = (x-3)^2$

2 = y **3z = 1**

$\boxed{x=4}$ $\boxed{y=2}$ $\boxed{z=\frac{1}{3}}$

Vector or Cross Product

The vector (or cross) product of two vectors A and B, denoted A×Bandpronounced“A cross B,” yields a vector defined as A×B=ˆnABsinθAB,   (10)

Vector and Scalar Triple Product

$$(\vec{A} \times \vec{B}) = \begin{matrix} Ax & Ay & Az \\ Bx & By & Bz \end{matrix}$$

Given vectors A = ˆx2− ˆ y+ ˆz3 and B = ˆ y2− ˆ z3, compute (a) A×B, (b) ˆ y×B, and (c) (ˆ y×B)·A.

Solution: (a)

$$A\times B = \begin{matrix} x & y & z \\ 2 & -1 & 3 \\ 0 & 2 & -3 \end{matrix}$$

=ˆ x((−1)×(−3)−3×2)−ˆy(2×(−3)−3×0) +ˆz(2×2−(−1×0)) =−ˆ x3+ˆy6+ˆz4.

(b) ˆ y×B = ˆ y×(ˆ y2−ˆz3) =−ˆ x3

(c) (ˆ y ×B)·A = −ˆ x3·(ˆ x2− ˆy+ˆz3) = −6.

Given A = ˆ x− ˆ y+ˆz2, B = ˆy+ˆz, and C = −ˆ x2+ˆ z3, find (A×B)×Candcompareit with A×(B×C).

What does a vector field describe?

A) The magnitude of scalar quantities in a region

B) The direction of a scalar field

C) The value of vector quantities at each point in a region**.**

D) The volume of a vector   E) The scalar properties of a field

Which of the following is an example of a vector quantity?**

A) Temperature B) Time C) Work D) Force**.** E) Mass