PHYSICS

CHAPTER 2

SHORT QUESTION

Question 1

1. If the cross product of two vectors vanishes, what will you say about their orientation?

The cross product is a binary operation between two vectors which are in three-dimensional space.

The cross product of two linearly independent vectors is itself a vector that lies in a plane perpendicular to both.

If the cross product of two vectors is zero (i.e., it vanishes), it means the vectors are **parallel**.

When vectors are parallel: angle = 0°

When vectors are anti-parallel: angle = 180°

It is denoted by the symbol **×**

Cross product = $|A||B|\sin\theta$

If $\mathbf{A \times B = 0}$, then $\theta = 0°$ or $180°$

Question 2

Find the dot product of unit vectors with each other at (a) 0° and (b) 90°

Dot Product of Unit Vectors is given by:

$A \cdot B = |A||B|\cos\theta$

(a) For $\theta = 0°$:

$(1)(1)\cos(0°) = 1$

(b) For $\theta = 90°$:

$(1)(1)\cos(90°) = 0$

Question 3

Show that scalar product obeys commutative property.

Commutative Property:

Scalar product of two vectors is commutative.

Let **A** and **B** be two vectors and **θ** the angle between them.

From figure:

$$\mathbf{A} \cdot \mathbf{B} = |\mathbf{A}||\mathbf{B}|\cos\theta$$

Also,

$$\mathbf{B} \cdot \mathbf{A} = |\mathbf{B}||\mathbf{A}|\cos\theta$$

Since multiplication is commutative,

$$\mathbf{A} \cdot \mathbf{B} = \mathbf{B} \cdot \mathbf{A}$$

Hence, the scalar product obeys the commutative property.

Question 4

Solve using the properties of dot and cross product.

(a) i . (j x k)

Putting j x k = 1

i . (j x k) = i.i = 1

(b) j x (j x k)

As we know that, j x k = i

j x (j x k) = j x (i) = -k

Question 5

If both the dot product and cross product of two vectors are zero, what can you say about the individual vectors?

If two vectors are **mutually perpendicular ($\theta = 90^\circ$)**, then their scalar (dot) product is zero.

The **cross product of two parallel ($\theta = 0^\circ$)** or **anti-parallel ($\theta = 180^\circ$)** vectors is a null vector.

These both can be simultaneously true **only if one of the vectors is a null (zero) vector**.

Question 6

6. What are rectangular components of a vector? How can they be found?

Rectangular Components of a Vector:

The components of a vector that are perpendicular to each other are called rectangular components.

Representation of a Vector:

Consider a vector **A** in the Cartesian coordinate system, represented by a line **OP**, making an angle θ with the x-axis.

Draw perpendiculars from point P on x and y axes.

Let these meet axes at points Q and S respectively.

OQ = A_x = x-component of vector A

OS = A_y = y-component of vector A

So,

A = A_xi + A_yj

From right-angled triangle:

A_x = A cosθ (horizontal component)

A_y = A sinθ (vertical component)

Question 7

Give two examples for each of the scalar and vector product.

Ans. Examples of Scalar Product:

- Work is scalar product of force and displacement. [$W = F \cdot d$]
- Power is scalar product of force and velocity. [$P = F \cdot v$]
- Electric flux is scalar product of electric intensity and vector area. [$\Phi = E \cdot A$]
- Magnetic flux is scalar product of magnetic field strength and vector area. [$\Phi = B \cdot A$]

Examples of Vector Product:

- Torque is the vector product of position vector and force. [$\tau = r \times F$]
- Force on a moving charged particle in magnetic field. [$F = q(v \times B)$]
- Angular momentum is vector product of position vector and linear momentum. [$L = r \times p$]

Question 8

Show that: A · B = A_xB_x+ B_y By + AzBz

Ans. Consider two vectors A and B in space:

A = A_x î + A_y ĵ + A_z k̂

B = B_x î + B_y ĵ + B_z k̂

A · B = (A_x î + A_y ĵ + A_z k̂) · (B_x î + B_y ĵ + B_z k̂)

Using the properties of dot product:

A · B = A_xB_x(î·î) + A_y B_y (ĵ·ĵ) + A_zB_z(k̂·k̂)

A · B = A_x B_x + A_y B_y + A_zB_z

Question 9

What units are associated with the unit vectors î, ĵ and k̂?

Ans. Unit Vector:

The vector whose magnitude is one and has no unit is called a unit vector. î, ĵ, and k̂ are unit vectors used to indicate direction along the x-axis, y-axis, and z-axis respectively in a three-dimensional (Cartesian) coordinate system.

They are used to express vectors in terms of their components along these axes. For example:

A = A_x î + A_y ĵ + A_z k̂

B = B_x î + B_y ĵ + B_z k̂

THANK YOU VERY MUCH!