NCERT Solutions Class 12 Maths Chapter 10: Vector Algebra Exercise 10.1

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 10 Exercise 10.1, students learn the fundamental concepts of vector algebra including vector representation, scalar vs vector quantities, and basic vector properties. This exercise covers essential definitions of coinitial, collinear, and equal vectors along with graphical representation of displacement vectors, which form the foundation for advanced vector operations crucial for CBSE Class 12 board exams.

Key Takeaways:

- Scalar quantities have only magnitude, while vector quantities have both magnitude and direction represented as \veca
- Coinitial vectors have the same initial point, collinear vectors lie on parallel lines, and equal vectors have same magnitude and direction
- Displacement vectors are represented graphically with magnitude and specific directional angles (like 30° east of north)
- Understanding basic vector properties is essential for mastering dot product \veca · \vecb and cross product \veca × \vecb in later exercises

Complete Solutions

Question 1

QUESTION

Represent graphically a displacement of 40 km, 30° east of north.

SOLUTION

This question asks us to graphically represent a displacement vector with a magnitude of 40 km and a direction of 30° east of north. This involves understanding how to represent directions on a 2D plane.

Step 1: Define the coordinate system

We'll use the standard compass directions: North, South, East, and West. North is typically considered the positive y-axis, and East is the positive x-axis.

Step 2: Determine the angle

The direction is given as "30° east of north". This means we start at the North direction (positive y-axis) and rotate 30° towards the East.

Step 3: Draw the vector

Draw a vector starting from the origin (0,0). The length of the vector should represent the magnitude of the displacement, which is 40 km. The angle between the vector and the North direction (positive y-axis) should be 30°.

Step 4: Label the vector

Label the starting point of the vector as 'O' (the origin). Label the endpoint of the vector as 'P'. The vector represents the displacement.

Step 5: Indicate the angle

Clearly indicate the 30° angle between the vector and the North direction. This can be done by drawing an arc from the North direction to the vector and labeling it as 30°.

Final Answer: The vector in the diagram represents the required displacement of 40 km, 30° east of north.

Note: The length of the vector should be proportional to 40 km based on a chosen scale (e.g., 1 cm = 10 km, so the vector would be 4 cm long). The accuracy of the angle is also crucial for a correct graphical representation.

ANSWER

In the adjoining figure, the vector \overrightarrowOP represents the required displacement.

Question 2

QUESTION

Classify the following measures as scalars and vectors.

1. 10 kg
2. 2 meters north-west
3. 40°
4. 40 watt
5. 10^-19 coulomb
6. 20\,\textm/s^2

SOLUTION

This question tests the understanding of the fundamental difference between scalar and vector quantities. A scalar quantity has only magnitude, while a vector quantity has both magnitude and direction.

(i) 10 kg

This represents mass. Mass has only magnitude (10 kg) and no direction. Therefore, it is a scalar quantity.

Answer: Scalar

(ii) 2 meters north-west

This represents a displacement. Displacement has both magnitude (2 meters) and direction (north-west). Therefore, it is a vector quantity.

Answer: Vector

(iii) 40°

This represents an angle. Angles have only magnitude (40°) and no direction associated with them in this context. Therefore, it is a scalar quantity.

Answer: Scalar

(iv) 40 watt

This represents power. Power has only magnitude (40 watt) and no direction. Therefore, it is a scalar quantity.

Answer: Scalar

(v) coulomb

This represents electric charge. Electric charge has only magnitude (coulomb) and no direction. Therefore, it is a scalar quantity.

Answer: Scalar

(vi)

This represents acceleration. Acceleration has both magnitude () and direction. Although the direction isn't explicitly stated, acceleration is inherently a vector quantity as it describes the rate of change of velocity, which is a vector.

Answer: Vector

ANSWER

1. Scalar
2. Vector
3. Scalar
4. Scalar
5. Scalar
6. Vector

Question 3

QUESTION

Classify the following as scalar and vector quantities.

1. time period
2. distance
3. force
4. velocity
5. work done

SOLUTION

This question tests the understanding of the fundamental difference between scalar and vector quantities. Scalar quantities have only magnitude, while vector quantities have both magnitude and direction.

(i) Time period:

Time period refers to the duration of an event. It is fully described by its magnitude (e.g., 5 seconds) and does not require a direction. Therefore, it is a scalar quantity.

Answer: Scalar

(ii) Distance:

Distance is the total length of the path traveled by an object. It only considers the magnitude of the path and not the direction. For example, a car might travel 10 km. This is a scalar quantity.

Answer: Scalar

(iii) Force:

Force is a push or pull that can cause a change in motion. It is characterized by both its magnitude (e.g., 10 Newtons) and its direction (e.g., pushing to the right). Since it has both magnitude and direction, force is a vector quantity.

Answer: Vector

(iv) Velocity:

Velocity is the rate of change of displacement. It specifies both the speed of an object and the direction in which it is moving. For example, a car moving at 60 km/h towards the north. Because it has both magnitude and direction, velocity is a vector quantity.

Answer: Vector

(v) Work done:

Work done is defined as the force applied on an object multiplied by the displacement of the object in the direction of the force. Although force is a vector, work done is a scalar quantity because it represents the energy transferred and does not have a direction. Mathematically, work done , where is the force vector and is the displacement vector. The dot product results in a scalar.

Answer: Scalar

ANSWER

1. Scalar
2. Scalar
3. Vector
4. Vector
5. Scalar

Question 4

QUESTION

In Fig. 10.6 (a square), identify the following vectors.

1. Coinitial
2. Equal
3. Collinear but not equal

SOLUTION

This question tests our understanding of basic vector properties: coinitial vectors, equal vectors, and collinear vectors.

(i) Coinitial Vectors:

Coinitial vectors are vectors that start from the same initial point.

In the given figure, we need to identify vectors that originate from the same point.

By observation, vectors and both start from the same point (let's call it point A).

Therefore, vectors and are coinitial.

(ii) Equal Vectors:

Equal vectors have the same magnitude and direction, regardless of their initial points.

Looking at the figure, we need to find vectors with the same length and pointing in the same direction.

We can see that vector and vector have the same length (magnitude) and point in the same direction.

Therefore, vectors and are equal vectors.

(iii) Collinear but not Equal Vectors:

Collinear vectors are vectors that lie on the same line or parallel lines. They can have the same or opposite directions.

For vectors to be collinear but not equal, they must lie on the same line or parallel lines but have different magnitudes or opposite directions.

Observing the figure, vectors and are parallel, meaning they are collinear.

However, vector and vector have opposite directions and different magnitudes (since it's a square, is the diagonal and thus longer than).

Therefore, vectors and are collinear but not equal.

Final Answer:

1. Vectors and are coinitial.
2. Vectors and are equal.

3. Vectors and are collinear but not equal.

ANSWER

1. Vectors \veca and \vecb are coinitial.
2. Vectors \vecb and \vecd are equal.
3. Vectors \veca and \vecc are collinear but not equal.

Question 5

QUESTION

Answer the following as true or false.

1. \veca and -\veca are collinear.
2. Two collinear vectors are always equal in magnitude.
3. Two vectors having same magnitude are collinear.
4. Two collinear vectors having the same magnitude are equal.

SOLUTION

This question tests our understanding of collinear vectors, their magnitudes, and the conditions for their equality.

(i) and are collinear.

Step 1: Definition of Collinear Vectors

Two vectors are collinear if they are parallel to the same line, regardless of their magnitudes or directions. This means one vector can be expressed as a scalar multiple of the other.

Step 2: Analyzing the given vectors

We have and . We can write . Since is a scalar multiple of , they are parallel to each other.

Step 3: Conclusion

Since is a scalar multiple of , they are collinear. Therefore, the statement is true.

(ii) Two collinear vectors are always equal in magnitude.

Step 1: Understanding Collinearity and Magnitude

Collinear vectors are parallel, but their magnitudes can be different. For example, and are collinear, but , so their magnitudes are not equal.

Step 2: Counterexample

Consider and . Both are collinear (parallel to the x-axis), but and , so their magnitudes are different.

Step 3: Conclusion

Collinear vectors do not necessarily have the same magnitude. Therefore, the statement is false.

(iii) Two vectors having the same magnitude are collinear.

Step 1: Understanding Magnitude and Direction

Two vectors can have the same magnitude but point in different directions. If they point in different directions, they are not collinear.

Step 2: Counterexample

Consider and . Both have a magnitude of 1, but they are perpendicular to each other (parallel to the x and y axes respectively) and hence not collinear.

Step 3: Conclusion

Vectors with the same magnitude are not necessarily collinear. Therefore, the statement is false.

(iv) Two collinear vectors having the same magnitude are equal.

Step 1: Conditions for Vector Equality

For two vectors to be equal, they must have the same magnitude *and* the same direction.

Step 2: Analyzing Collinear Vectors

Two collinear vectors can have the same magnitude but point in opposite directions. For example, and are collinear and can have the same magnitude if is a non-zero vector, but they are not equal because they point in opposite directions.

Step 3: Counterexample

Let and . Then and , so they have the same magnitude. They are also collinear. However, because they have opposite directions.

Step 4: Conclusion

Two collinear vectors with the same magnitude are not necessarily equal. Therefore, the statement is false.

ANSWER

1. True
2. False
3. False
4. False

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Key Formulas

Important Formulas for Exercise 10.1

Formula / Concept	Description
Vector Quantity	A quantity that has both magnitude and direction. Examples include displacement, velocity, and force.
Scalar Quantity	A quantity that has only magnitude and no direction. Examples include mass, length, and time.
Position Vector of a Point P(x, y, z)	The vector $\vec{OP}$ starting from the origin O(0, 0, 0) and ending at the point P. It is represented as $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$.
Magnitude of a Vector	The length of a vector $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$. It is a scalar quantity. The formula is: $\|\vec{r}\| = \sqrt{x^2 + y^2 + z^2}$
Vector Joining Two Points	The vector from point $A(x_1, y_1, z_1)$ to point $B(x_2, y_2, z_2)$ is given by: $\vec{AB} = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}$
Direction Ratios	If a vector is given by $\vec{r} = a\hat{i} + b\hat{j} + c\hat{k}$, then the scalar components a, b, and c are the direction ratios of the vector.
Direction Cosines (l, m, n)	The cosines of the angles α, β, γ that a vector makes with the positive x, y, and z axes, respectively. $l = \cos\alpha$, $m = \cos\beta$, $n = \cos\gamma$ They are related by the identity $l^2 + m^2 + n^2 = 1$.
Calculating Direction Cosines from Direction Ratios	If a, b, c are the direction ratios of a vector, its direction cosines are: $l = \frac{a}{\sqrt{a^2+b^2+c^2}}$, $m = \frac{b}{\sqrt{a^2+b^2+c^2}}$, $n = \frac{c}{\sqrt{a^2+b^2+c^2}}$
Zero Vector (Null Vector)	A vector with zero magnitude and no specific direction, denoted as $\vec{0}$. Its initial and terminal points coincide.
Unit Vector	A vector with a magnitude of exactly one. The unit vector in the direction of a vector $\vec{a}$ is denoted by $\hat{a}$ and is calculated as: $\hat{a} = \vec{a}\|\vec{a}\|$
Co-initial Vectors	Two or more vectors that have the same starting (initial) point.
Equal Vectors	Two vectors are equal if they have the same magnitude and the same direction, regardless of their initial points.
Collinear Vectors	Two or more vectors are collinear if they are parallel to the same line, irrespective of their magnitudes and directions. For two vectors $\vec{a}$ and $\vec{b}$, they are collinear if $\vec{a} = \lambda \vec{b}$ for some non-zero scalar λ.
Negative of a Vector	

Formula / Concept	Description
	A vector that has the same magnitude as a given vector but points in the opposite direction. The negative of vector \veca is denoted as -\veca.

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