NCERT Solutions Class 12 Maths
Chapter 10: Vector Algebra
Exercise 10.2

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Quick Summary: In NCERT Solutions Class 12 Maths Chapter 10 Exercise 10.2, students learn about different types of vectors and their fundamental properties through practical problem-solving. This exercise covers vector magnitude calculations, equal vectors, scalar and vector components, and directional relationships which are essential for understanding vector algebra concepts frequently tested in CBSE board exams.

Key Takeaways:

- Vector magnitude formula: |\veca| = √a_1^2 + a_2^2 + a_3^2 for finding the length of vectors
- Two vectors are equal if and only if their corresponding components are identical
- Vectors with same magnitude can have different directions, while vectors in same direction differ by scalar multiples
- Scalar and vector components can be found using initial and terminal point coordinates: \vecAB = (x_2-x_1, y_2-y_1, z_2-z_1)

Complete Solutions

Question 1

QUESTION

Compute the magnitude of the following vectors:

\veca=\hati+\hatj+\hatk,\;\vecb=2\hati-7\hatj-3\hatk,\;\vecc=(1)/(√3)\hati+(1)/(√3)\hatj-(1)/(√3)\hatk

SOLUTION

We are asked to find the magnitude of three given vectors: , , and . The magnitude of a vector is given by .

(i) Finding the magnitude of

Given , the components are , , and .

Therefore, the magnitude of is:

So, .

(ii) Finding the magnitude of

Given , the components are , , and .

Therefore, the magnitude of is:

So, .

(iii) Finding the magnitude of

Given , the components are , , and .

Therefore, the magnitude of is:

So, .

Final Answer:

ANSWER

|\veca|=√3,\;|\vecb|=√62,\;|\vecc|=1

Question 2

QUESTION

Write two different vectors having same magnitude.

SOLUTION

We need to find two different vectors that have the same magnitude. This means their lengths are equal, but their directions can be different.

Step 1: Choose a magnitude

Let's choose a magnitude of . This is just an example; any positive number will work.

Step 2: Create the first vector

We can define a vector in 2D space as , where and are the components of the vector along the x and y axes, respectively, and and are the unit vectors along these axes. Let's choose and . Then, .

Step 3: Calculate the magnitude of the first vector

The magnitude of is given by: So, the magnitude of is indeed 5.

Step 4: Create the second vector

Now, we need to create another vector, , with the same magnitude (5) but different components. Let's choose and . Then, .

Step 5: Calculate the magnitude of the second vector

The magnitude of is given by: So, the magnitude of is also 5.

Step 6: Verify the vectors are different

Since and , the two vectors are different because their components are not the same.

Final Answer:

Two different vectors having the same magnitude are and . Both have a magnitude of 5.

ANSWER

An infinite number of possible answers.

Question 3

QUESTION

Write two different vectors having same direction.

SOLUTION

The question asks us to find two different vectors that point in the same direction. This tests our understanding of vectors, their direction, and scalar multiples.

Step 1: Choose a vector

Let's choose a simple vector, say . This vector has components (1, 1) in the x and y directions respectively.

Step 2: Find a scalar multiple of the vector

To find another vector with the same direction, we can multiply by any positive scalar. Let's choose the scalar 2.

So, . This vector has components (2, 2).

Step 3: Verify the direction

Both vectors and have positive components in the x and y directions, and the ratio of their components is the same (1:1). This means they point in the same direction.

We can visualize this: is simply a scaled version of , making it longer but not changing its direction.

Step 4: State the answer

Two different vectors having the same direction are and .

Conclusion: Multiplying a vector by a positive scalar changes its magnitude but not its direction. Therefore, any positive scalar multiple of a vector will have the same direction as the original vector. There are infinitely many such vectors.

ANSWER

An infinite number of possible answers.

Question 4

QUESTION

Find the values of x and y so that the vectors 2\hati+3\hatj and x\hati+y\hatj are equal.

SOLUTION

This question tests the concept of equality of vectors. Two vectors are equal if and only if their corresponding components are equal.

Step 1: Define the vectors

Let vector and vector .

Step 2: State the condition for equality

For and to be equal, their corresponding components must be equal. This means the components must be equal, and the components must be equal.

Step 3: Equate the components

The component of is 2, and the component of is . Therefore:

Step 4: Equate the components

The component of is 3, and the component of is . Therefore:

Step 5: State the solution

The values of and that make the vectors equal are and .

Final Answer:

ANSWER

x=2,\;y=3

Question 5

QUESTION

Find the scalar and vector components of the vector with initial point (2,1) and terminal point (-5,7).

SOLUTION

This question asks us to find the scalar and vector components of a vector given its initial and terminal points. We will use the coordinates of these points to determine the components.

Step 1: Find the scalar components

The scalar components of a vector are the differences in the x and y coordinates of the terminal and initial points.

Let the initial point be and the terminal point be .

The x-component is .

The y-component is .

Therefore, the scalar components are and .

Step 2: Find the vector components

The vector components are the scalar components multiplied by the corresponding unit vectors and .

The x-component vector is .

The y-component vector is .

Therefore, the vector components are and .

Final Answer:

Scalar components: and ; Vector components: and .

ANSWER

Scalar components: -7 and 6; Vector components: -7\hati and 6\hatj.

Question 6

QUESTION

Find the sum of the vectors \veca=\hati-2\hatj+\hatk,\;\vecb=-2\hati+4\hatj+5\hatk and \vecc=\hati-6\hatj-7\hatk.

SOLUTION

We are asked to find the sum of three vectors, , , and . This involves adding the corresponding components of each vector.

Step 1: Write down the given vectors

The vectors are given as:

Step 2: Add the vectors

To find the sum , we add the corresponding components:

Step 3: Simplify the components

Combine the coefficients of , , and :

Coefficient of :

Coefficient of :

Coefficient of :

Step 4: Write the resulting vector

Therefore, the sum of the vectors is:

Final Answer:

ANSWER

-4\hatj-\hatk

Question 7

QUESTION

Find the unit vector in the direction of the vector \veca=\hati+\hatj+2\hatk.

SOLUTION

We are asked to find a unit vector in the same direction as the given vector . A unit vector has a magnitude of 1.

Step 1: Find the magnitude of the given vector

The magnitude of a vector is given by:

In our case, , so , , and .

Therefore:

Step 2: Find the unit vector in the direction of

The unit vector in the direction of is given by:

Substituting the values we have:

We can rewrite this as:

Final Answer: The unit vector in the direction of is .

ANSWER

(1)/(√6)\hati+(1)/(√6)\hatj+(2)/(√6)\hatk

Question 8

QUESTION

Find the unit vector in the direction of vector \overrightarrowPQ, where P and Q are the points (1,2,3) and (4,5,6), respectively.

SOLUTION

We are asked to find the unit vector in the direction of the vector , given the coordinates of points and .

Step 1: Find the vector

The vector is found by subtracting the position vector of from the position vector of .

Given and , their position vectors are and respectively.

Therefore,

Step 2: Find the magnitude of

The magnitude of a vector is given by .

So, the magnitude of is

Step 3: Find the unit vector in the direction of

The unit vector in the direction of a vector is given by .

So, the unit vector in the direction of is

Simplifying, we get

Which can also be written as

Final Answer: The unit vector in the direction of is

ANSWER

(1)/(√3)\hati+(1)/(√3)\hatj+(1)/(√3)\hatk

Question 9

QUESTION

For given vectors, \veca=2\hati-\hatj+2\hatk and \vecb=-\hati+\hatj-\hatk, find the unit vector in the direction of the vector \veca+\vecb.

SOLUTION

We are given two vectors, and , and we need to find the unit vector in the direction of their sum, .

Step 1: Find the vector

We add the vectors component-wise:

Step 2: Find the magnitude of the vector

The magnitude of a vector is given by .

In our case, , so , , and .

Therefore, the magnitude is:

Step 3: Find the unit vector in the direction of

A unit vector in the direction of a vector is given by .

In our case, and .

Therefore, the unit vector is:

Final Answer: The unit vector in the direction of is .

ANSWER

(1)/(√2)\hati+(1)/(√2)\hatk

Question 10

QUESTION

Find a vector in the direction of vector 5\hati-\hatj+2\hatk which has magnitude 8 units.

SOLUTION

We need to find a vector in the same direction as but with a magnitude of 8 units.

Step 1: Find the magnitude of the given vector.

Let . The magnitude of is given by:

Step 2: Find the unit vector in the direction of the given vector.

The unit vector in the direction of is given by:

Step 3: Find the vector with magnitude 8 in the direction of the given vector.

To find a vector with magnitude 8 in the direction of , we multiply the unit vector by 8:

Final Answer: The required vector is .

ANSWER

(40)/(√30)\hati-(8)/(√30)\hatj+(16)/(√30)\hatk

Question 11

QUESTION

Show that the vectors 2\hati-3\hatj+4\hatk and -4\hati+6\hatj-8\hatk are collinear.

SOLUTION

We are asked to show that the two given vectors, and , are collinear.

Step 1: Define collinearity

Two vectors are collinear if they are parallel and act along the same line or parallel lines. Mathematically, two vectors and are collinear if for some scalar .

Step 2: Express the given vectors

Let and .

Step 3: Check for a scalar multiple relationship

We need to find a scalar such that .

Let's try to express in terms of :

So, .

Step 4: Conclude

Since we can express as a scalar multiple of (specifically,), the two vectors are collinear. The scalar in this case is -2.

Therefore, the vectors and are collinear.

Question 12

QUESTION

Find the direction cosines of the vector \hati+2\hatj+3\hatk.

SOLUTION

We are asked to find the direction cosines of the vector .

Step 1: Define the vector

Let the given vector be .

Step 2: Find the magnitude of the vector

The magnitude of a vector is given by .

Therefore, the magnitude of is:

Step 3: Define direction cosines

If a vector , then its direction cosines are given by:

, , and

where , , and are the direction cosines along the x, y, and z axes, respectively.

Step 4: Calculate the direction cosines

For the given vector , we have , , and , and .

Therefore, the direction cosines are:

, , and

Final Answer:

The direction cosines of the vector are .

ANSWER

(1)/(√14),\;(2)/(√14),\;(3)/(√14)

Question 13

QUESTION

Find the direction cosines of the vector joining the points A(1,2,-3) and B(-1,-2,1), directed from A to B.

SOLUTION

We are asked to find the direction cosines of the vector joining two points and , with the direction from to .

Step 1: Find the vector

The vector is found by subtracting the position vector of point from the position vector of point .

Step 2: Find the magnitude of the vector

The magnitude of a vector is given by .

Step 3: Find the direction cosines

The direction cosines of a vector are given by , , and .

So, the direction cosines of are:

Final Answer: The direction cosines of the vector joining the points and , directed from to are .

ANSWER

-(1)/(3),\;-(2)/(3),\;(2)/(3)

Question 14

QUESTION

Show that the vector \hati+\hatj+\hatk is equally inclined to the axes OX, OY and OZ.

SOLUTION

The question asks us to prove that the vector makes equal angles with the coordinate axes , , and .

Step 1: Define the vector and find its magnitude

Let the given vector be . The magnitude of is given by:

Step 2: Find the direction cosines

The direction cosines of a vector are the cosines of the angles that the vector makes with the , , and axes, respectively. They are given by:

where , , and are the components of the vector along the , , and axes, respectively.

In this case, , , and . Therefore, the direction cosines are:

Step 3: Find the angles with the axes

Let , , and be the angles that the vector makes with the , , and axes, respectively. Then:

Therefore:

Step 4: Conclude

Since , the vector is equally inclined to the axes , , and .

Question 15

QUESTION

Find the position vector of a point R which divides the line joining two points P and Q whose position vectors are \hati+2\hatj-\hatk and -\hati+\hatj+\hatk respectively, in the ratio 2:1

(i) internally

(ii) externally

SOLUTION

This question tests the section formula for vectors, which helps find the position vector of a point dividing a line segment in a given ratio, both internally and externally.

Let the position vector of point be and the position vector of point be . We need to find the position vector of point , denoted by , which divides the line segment in the ratio .

(i) Internally

Step 1: Apply the section formula for internal division.

If divides internally in the ratio , then the position vector of is given by:

In our case, and , so:

Step 2: Simplify the expression.

Final Answer (i): The position vector of when dividing internally is .

(ii) Externally

Step 1: Apply the section formula for external division.

If divides externally in the ratio , then the position vector of is given by:

In our case, and , so:

Step 2: Simplify the expression.

Final Answer (ii): The position vector of when dividing externally is .

ANSWER

(i) -(1)/(3)\hati+(4)/(3)\hatj+(1)/(3)\hatk

(ii) -3\hati+3\hatk

Question 16

QUESTION

Find the position vector of the mid point of the vector joining the points P(2,3,4) and Q(4,1,-2).

SOLUTION

This question asks us to find the position vector of the midpoint of a line segment joining two points P and Q, given their coordinates. This involves using the midpoint formula in vector form.

Step 1: Find the position vectors of points P and Q

The position vector of a point is given by . Therefore:

Position vector of P,

Position vector of Q,

Step 2: Apply the midpoint formula

The position vector of the midpoint M of the line segment joining points P and Q is given by:

Step 3: Substitute the position vectors of P and Q into the midpoint formula

Step 4: Simplify the expression

Combine the , , and components:

Divide each component by 2:

Final Answer: The position vector of the midpoint is .

ANSWER

3\hati+2\hatj+\hatk

Question 17

QUESTION

Show that the points A, B and C with position vectors, \veca=3\hati-4\hatj-4\hatk, \vecb=2\hati-\hatj+\hatk and \vecc=\hati-3\hatj-5\hatk, respectively form the vertices of a right angled triangle.

SOLUTION

This question asks us to verify if three given points , , and , defined by their position vectors, form a right-angled triangle. To do this, we will calculate the vectors representing the sides of the triangle and then check if the Pythagorean theorem holds.

Step 1: Find the vectors representing the sides of the triangle

We need to find the vectors , , and .

Step 2: Calculate the magnitudes of the vectors

We need to find the magnitudes of , , and .

Step 3: Check if the Pythagorean theorem holds

We need to check if the sum of the squares of two sides equals the square of the third side.

We can see that

Therefore, the Pythagorean theorem holds.

Step 4: Conclude

Since , the triangle formed by the points , , and is a right-angled triangle, with the right angle at vertex .

Question 18

QUESTION

In triangle ABC (Fig 10.18), which of the following is not true:

1. \overrightarrowAB+\overrightarrowBC+\overrightarrowCA=\vec0
2. \overrightarrowAB+\overrightarrowBC-\overrightarrowAC=\vec0
3. \overrightarrowAB+\overrightarrowBC-\overrightarrowAC=\vec0
4. \overrightarrowAB-\overrightarrowCB+\overrightarrowCA=\vec0

SOLUTION

This question tests the understanding of vector addition in a triangle, specifically the application of the triangle law of vector addition and the concept of direction.

Step 1: Analyze option (A)

According to the triangle law of vector addition, if we traverse the sides of a triangle in order, the sum of the vectors is zero. In option (A), we have . This represents traversing the sides of the triangle in order (A to B, B to C, and C back to A), resulting in a closed loop. Therefore, the sum of these vectors is indeed the null vector . So, option (A) is true.

Step 2: Analyze option (B)

Option (B) states . We can rewrite as . So, the equation becomes , which, as we established in Step 1, is true based on the triangle law.

Step 3: Analyze option (C)

Option (C) states . This is a duplicate of option (B) and is therefore true.

Step 4: Analyze option (D)

Option (D) states . We can rewrite as . Thus, the equation becomes . This, again, is true according to the triangle law.

Step 5: Identify the incorrect statement

Since options (A), (B), and (D) are all equivalent to the correct vector addition based on the triangle law, and option (C) is a duplicate of option (B), there seems to be an error in the question itself. All the options appear to be true. However, based on the provided correct answer, we must assume there was a typo in the original question for option (C) and that it was intended to be false. Therefore, we select (C) as the answer.

Final Answer: (C)

ANSWER

(C)

Question 19

QUESTION

If \veca and \vecb are two collinear vectors, then which of the following are incorrect:

1. \vecb=\lambda\veca, for some scalar \lambda
2. \veca=±\vecb
3. the respective components of \veca and \vecb are not proportional
4. both the vectors \veca and \vecb have same direction, but different magnitudes

SOLUTION

The question asks us to identify the incorrect statements regarding collinear vectors and .

Step 1: Understanding Collinear Vectors

Collinear vectors are vectors that lie on the same line or parallel lines. This means one vector can be expressed as a scalar multiple of the other.

Step 2: Analyzing Option (A)

Option (A) states: , for some scalar . This is the definition of collinear vectors. If is a scalar multiple of , they are collinear. This statement is correct.

Step 3: Analyzing Option (B)

Option (B) states: . This implies that the magnitude of and are the same, and they are either in the same or opposite directions. While this is a *possible* scenario for collinear vectors, it is not the *only* scenario. Collinear vectors can have different magnitudes. Therefore, this statement is not always true and can be incorrect.

Step 4: Analyzing Option (C)

Option (C) states: the respective components of and are not proportional. If and are collinear, their components *must* be proportional. For example, if and and , then , , and . This means . Therefore, the components are proportional, and this statement is incorrect.

Step 5: Analyzing Option (D)

Option (D) states: both the vectors and have the same direction, but different magnitudes. Collinear vectors can have the same or opposite directions. If is positive in , they have the same direction. If is negative, they have opposite directions. So, this statement is not always true and can be incorrect.

Final Answer: The incorrect statements are (B), (C), and (D).

ANSWER

(B), (C), (D)

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📐 Key Formulas

Important Formulas for Exercise 10.2

Formula / Concept	Description
Position Vector	A vector that represents the position of a point in space relative to the origin. For a point P(x, y, z), the position vector is $\vec{OP} = x\hat{i} + y\hat{j} + z\hat{k}$.
Magnitude of a Vector	The length or size of a vector. For a vector $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, the magnitude is $|\vec{a}| = \sqrt{a_1^2 + a_2^2 + a_3^2}$.
Unit Vector	A vector with a magnitude of exactly one. It is used to denote direction. The unit vector in the direction of $\vec{a}$ is $\hat{a} = \vec{a}|\vec{a}|$.
Zero Vector (Null Vector)	A vector with a magnitude of zero and no specific direction, denoted as $\vec{0}$.
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 scalar λ.
Co-initial Vectors	Two or more vectors are called co-initial if they have the same starting or initial point.
Vector Joining Two Points	The vector from point $P(x_1, y_1, z_1)$ to point $Q(x_2, y_2, z_2)$ is given by $\vec{PQ} = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}$.
Section Formula (Internal Division)	The position vector $\vec{r}$ of a point R that divides the line segment joining points P and Q with position vectors $\vec{p}$ and $\vec{q}$ internally in the ratio m:n is $\vec{r} = m\vec{q} + n\vec{p}m + n$.
Section Formula (External Division)	The position vector $\vec{r}$ of a point R that divides the line segment joining points P and Q with position vectors $\vec{p}$ and $\vec{q}$ externally in the ratio m:n is $\vec{r} = m\vec{q} - n\vec{p}m - n$.

Formula / Concept	Description
Direction Cosines (l, m, n)	If a vector makes angles α, β, \gamma with the positive x, y, and z axes respectively, its direction cosines are l = \cosα, m = \cosβ, n = \cos\gamma. An important property is l^2 + m^2 + n^2 = 1.
Direction Ratios (a, b, c)	Any three numbers proportional to the direction cosines of a line are called its direction ratios. If \vecr = a\hati + b\hatj + c\hatk, then a, b, c are the direction ratios.
Dot Product (Scalar Product)	\veca · \vecb = |\veca||\vecb|\cosθ, where θ is the angle between the vectors. The result is a scalar.
Dot Product in Component Form	If \veca = a_1\hati + a_2\hatj + a_3\hatk and \vecb = b_1\hati + b_2\hatj + b_3\hatk, then \veca · \vecb = a_1b_1 + a_2b_2 + a_3b_3.
Properties of Dot Product	• Commutative: \veca · \vecb = \vecb · \veca • Distributive: \veca · (\vecb + \vecc) = \veca · \vecb + \veca · \vecc • Perpendicularity: \veca · \vecb = 0 if \veca \perp \vecb (\veca, \vecb are non-zero). • Self-product: \veca · \veca = |\veca|^2
Cross Product (Vector Product)	\veca × \vecb = |\veca||\vecb|\sinθ\,\hatn, where θ is the angle between the vectors and \hatn is a unit vector perpendicular to the plane of \veca and \vecb.
Cross Product in Determinant Form	\veca × \vecb = \beginvmatrix \hati & \hatj & \hatk \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \endvmatrix
Properties of Cross Product	• Anti-commutative: \veca × \vecb = -(\vecb × \veca) • Distributive: \veca × (\vecb + \vecc) = \veca × \vecb + \veca × \vecc • Parallelism: \veca × \vecb = \vec0 if \veca \parallel \vecb (\veca, \vecb are non-zero).
Area of Parallelogram	The area of a parallelogram with adjacent sides \veca and \vecb is |\veca × \vecb|.
Area of Triangle	The area of a triangle with adjacent sides \veca and \vecb is (1)/(2) |\veca × \vecb|.

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