

NDA/NA

National Defence Academy/Naval Academy Solved Paper 2013 (I)

Paper 1 (Mathematics)

1. The sum of the direction cosines of z -axis is
(a) 0 (b) $1/3$
(c) 1 (d) 3

Explanation (c) We know that, the direction cosines of z -axis are $(0, 0, 1)$.

$$\therefore \text{Sum of the direction cosines of } z\text{-axis} \\ = 0 + 0 + 1 \\ = 1$$

2. What is the area of the triangle whose vertices are $(0, 0, 0)$, $(1, 2, 3)$ and $(-3, -2, 1)$?
(a) $3\sqrt{5}$ sq units (b) $6\sqrt{5}$ sq units
(c) 6 sq units (d) 12 sq units

Explanation (a) **Cartesian Method** Let the vertices of the $\triangle ABC$ are

$$A \rightarrow (x_1, y_1, z_1) \rightarrow (0, 0, 0) \\ B \rightarrow (x_2, y_2, z_2) \rightarrow (1, 2, 3) \\ C \rightarrow (x_3, y_3, z_3) \rightarrow (-3, -2, 1)$$

$$\text{Now, } \Delta_v = \frac{1}{2} \begin{vmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{vmatrix} = \frac{1}{2} \begin{vmatrix} 0 & 0 & 1 \\ 1 & 2 & 3 \\ -3 & -2 & 1 \end{vmatrix} \\ = \frac{1}{2} (-2 + 6) = \frac{4}{2} = 2$$

$$\Delta_v = \frac{1}{2} \begin{vmatrix} x_1 & x_2 & x_3 \\ y_1 & y_2 & y_3 \\ z_1 & z_2 & z_3 \end{vmatrix} = \frac{1}{2} \begin{vmatrix} 0 & 0 & 1 \\ 3 & 1 & 1 \\ 1 & -3 & 1 \end{vmatrix} \\ = \frac{1}{2} (-9 - 1) = \frac{1}{2} \times (-10) = -5$$

$$\Delta_v = \frac{1}{2} \begin{vmatrix} y_1 & z_1 & 1 \\ y_2 & z_2 & 1 \\ y_3 & z_3 & 1 \end{vmatrix} = \frac{1}{2} \begin{vmatrix} 0 & 0 & 1 \\ 2 & 3 & 1 \\ -2 & 1 & 1 \end{vmatrix} \\ = \frac{1}{2} (2 + 6) = \frac{8}{2} = 4$$

$$\therefore \text{Required area of } \triangle ABC = \sqrt{\Delta_v^2 + \Delta_v^2 + \Delta_v^2} \\ = \sqrt{2^2 + (-5)^2 + (4)^2} \\ = \sqrt{4 + 25 + 16} \\ = \sqrt{45} = 3\sqrt{5} \text{ sq units}$$

Vector Method Let the position vector of vertices of $\triangle ABC$ are

$$OA = 0i + 0j + 0k$$

$$OB = 1i + 2j + 3k$$

$$OC = -3i - 2j + k$$

$$\text{Now, } AB = OB - OA \\ = (1i + 2j + 3k) \\ = (0i + 0j + 0k) \\ = 1i + 2j + 3k$$

$$AC = OC - OA \\ = (-3i - 2j + k) - (0i + 0j + 0k) \\ = -3i - 2j + k$$

$\therefore$ Required area of $\triangle ABC$

$$= \frac{1}{2} |AB \times AC| \\ = \frac{1}{2} \begin{vmatrix} i & j & k \\ 1 & 2 & 3 \\ -3 & -2 & 1 \end{vmatrix} \\ = \frac{1}{2} [(2 + 6)i - (1 + 9)j + (-2 + 6)k] \\ = \frac{1}{2} \sqrt{6^2 + 10^2 + 4^2} = \frac{1}{2} \sqrt{180} = 3\sqrt{5} \text{ sq units}$$



3. What is the distance between the planes $x - 2y + z - 1 = 0$ and $-3x + 6y - 3z + 2 = 0$?
(a) 3 units (b) 1 unit
(c) 0 (d) None of these

Explanation (c) The given equation of planes

$$x - 2y + z - 1 = 0 \quad \dots (i)$$

$$\text{and } -3x + 6y - 3z + 2 = 0$$

$$\Rightarrow x - 2y + z - \frac{2}{3} = 0 \quad \dots (ii)$$

Since, both planes are parallel to each other, then distance between them

$$= \frac{\left| \frac{-2}{3} - (-1) \right|}{\sqrt{1^2 + (-2)^2 + 1^2}} = \frac{\left| \frac{-2}{3} + 1 \right|}{\sqrt{1 + 4 + 1}} = \frac{1/3}{\sqrt{6}} \\ = \frac{1}{3\sqrt{6}}$$

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Table of Contents Nda Question Paper

1. Understanding the eBook Nda Question Paper
 - The Rise of Digital Reading Nda Question Paper
 - Advantages of eBooks Over Traditional Books
2. Identifying Nda Question Paper
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Nda Question Paper
 - User-Friendly Interface
4. Exploring eBook Recommendations from Nda Question Paper
 - Personalized Recommendations

- Nda Question Paper User Reviews and Ratings
- Nda Question Paper and Bestseller Lists
- 5. Accessing Nda Question Paper Free and Paid eBooks
 - Nda Question Paper Public Domain eBooks
 - Nda Question Paper eBook Subscription Services
 - Nda Question Paper Budget-Friendly Options
- 6. Navigating Nda Question Paper eBook Formats
 - ePub, PDF, MOBI, and More
 - Nda Question Paper Compatibility with Devices
 - Nda Question Paper Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Nda Question Paper
 - Highlighting and Note-Taking Nda Question Paper
 - Interactive Elements Nda Question Paper
- 8. Staying Engaged with Nda Question Paper
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Nda Question Paper
- 9. Balancing eBooks and Physical Books Nda Question Paper
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Nda Question Paper
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Nda Question Paper
 - Setting Reading Goals Nda Question Paper
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Nda Question Paper
 - Fact-Checking eBook Content of Nda Question Paper

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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