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Vector Algebra

Subject: Mathematics | Mentor: Chetan Sir

SANKALP 2026  
Refining the Edge

“Your second chance is not a retry, it’s a redemption.”

Session: Practice Test #01 | Start Time: \_\_\_\_\_ End Time: \_\_\_\_\_ Target Score: \_\_\_\_\_ / 100

SECTION A: MULTIPLE CHOICE QUESTIONS

- Let  $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$ ,  $\vec{b} = 2\hat{i} + 3\hat{j} - 5\hat{k}$  and  $\vec{c} = 3\hat{i} - \hat{j} + \lambda\hat{k}$  be three vectors. Let  $\vec{r}$  be a unit vector along  $\vec{b} + \vec{c}$ . If  $\vec{r} \cdot \vec{a} = 3$  then  $3\lambda$  is equal to:  
 (1) 21 (2) 30 (3) 25 (4) 27
- Let a, b, c be three distinct real numbers, none equal to one. If the vectors  $a\hat{i} + \hat{j} + \hat{k}$ ,  $\hat{i} + b\hat{j} + \hat{k}$  and  $\hat{i} + \hat{j} + c\hat{k}$  are coplanar, then  $\frac{1}{1-a} + \frac{1}{1-b} + \frac{1}{1-c}$  is equal to  
 (1) 2 (2) -1 (3) -2 (4) 1
- Let ABCD be a quadrilateral. If E and F are the mid points of the diagonals AC and BD respectively and  $(\vec{AB} - \vec{BC}) + (\vec{AD} - \vec{DC}) = k\vec{FE}$ , then k is equal to  
 (1) 4 (2) -2 (3) 2 (4) -4
- If (2, 3, 9), (5, 2, 1), (1,  $\lambda$ , 8) and ( $\lambda$ , 2, 3) are coplanar, then the product of all possible values of  $\lambda$  is  
 (1)  $\frac{21}{2}$  (2)  $\frac{59}{8}$  (3)  $\frac{57}{8}$  (4)  $\frac{95}{8}$
- The sum of the distinct real values of  $\mu$  for which the vectors  $\mu\hat{i} + \hat{j} + \hat{k}$ ,  $\hat{i} + \mu\hat{j} + \hat{k}$  and  $\hat{i} + \hat{j} + \mu\hat{k}$  are co-planar, is  
 (1) 0 (2) -1 (3) 1 (4) 2
- Let  $\vec{a} = 3\hat{i} - \hat{j} + 2\hat{k}$ ,  $\vec{b} = \vec{a} \times (\hat{i} - 2\hat{k})$  and  $\vec{c} = \vec{b} \times \hat{k}$ . Then the projection of  $\vec{c} - 2\hat{j}$  on  $\vec{a}$  is:  
 (1)  $2\sqrt{14}$  (2)  $\sqrt{14}$  (3)  $3\sqrt{7}$  (4)  $2\sqrt{7}$
- Consider three vectors  $\vec{a}$ ,  $\vec{b}$ ,  $\vec{c}$ . Let  $|\vec{a}| = 2$ ,  $|\vec{b}| = 3$  and  $\vec{a} = \vec{b} \times \vec{c}$ . If  $\alpha \in [0, \frac{\pi}{3}]$  is the angle between the vectors  $\vec{b}$  and  $\vec{c}$ , then the minimum value of  $27|\vec{c} - \vec{a}|^2$  is equal to:  
 (1) 110 (2) 124 (3) 121 (4) 105
- Let A(2,3,5) and C(-3,4,-2) be opposite vertices of a parallelogram ABCD if the diagonal  $\vec{BD} = \hat{i} + 2\hat{j} + 3\hat{k}$  then the area of the parallelogram is equal to  
 (1)  $\frac{1}{2}\sqrt{410}$  (2)  $\frac{1}{2}\sqrt{474}$   
 (3)  $\frac{1}{2}\sqrt{586}$  (4)  $\frac{1}{2}\sqrt{306}$
- Consider a  $\Delta ABC$  where A(1,3,2) B(-2,8,0) and C(3,6,7). If the angle bisector of  $\angle BAC$  meets the line BC at D, then the length of the projection of the vector  $\vec{AD}$  on the vector  $\vec{AC}$  is:  
 (1)  $\frac{37}{2\sqrt{38}}$  (2)  $\frac{\sqrt{38}}{2}$  (3)  $\frac{39}{2\sqrt{38}}$  (4)  $\sqrt{19}$
- Let  $\vec{a} = 5\hat{i} - \hat{j} - 3\hat{k}$  and  $\vec{b} = \hat{i} + 3\hat{j} + 5\hat{k}$  be two vectors. Then which one of the following statements is TRUE?  
 (1) Projection of  $\vec{a}$  on  $\vec{b}$  is  $\frac{-13}{\sqrt{35}}$  and the direction of the projection vector is opposite to the direction of  $\vec{b}$   
 (2) Projection of  $\vec{a}$  on  $\vec{b}$  is  $\frac{-17}{\sqrt{35}}$  and the direction of the projection vector is opposite to the direction of  $\vec{b}$   
 (3) Projection of  $\vec{a}$  on  $\vec{b}$  is  $\frac{17}{\sqrt{35}}$  and the direction of the projection vector is opposite to the direction of  $\vec{b}$   
 (4) Projection of  $\vec{a}$  on  $\vec{b}$  is  $\frac{13}{\sqrt{35}}$  and the direction of the projection vector is opposite to the direction of  $\vec{a}$

11. Let  $\vec{a}$  be a vector which is perpendicular to the vector  $3\hat{i} + \frac{1}{2}\hat{j} + 2\hat{k}$ . If  $\vec{a} \times (2\hat{i} + \hat{k}) = 2\hat{i} - 13\hat{j} - 4\hat{k}$ , then the projection of the vector  $\vec{a}$  on the vector  $2\hat{i} + 2\hat{j} + \hat{k}$  is
- (1)  $\frac{1}{3}$  (2) 1 (3)  $\frac{5}{3}$  (4)  $\frac{7}{3}$
12. Let  $\vec{a}$  and  $\vec{b}$  be two unit vectors such that the angle between them is  $\frac{\pi}{3}$ . If  $\lambda\vec{a} + 2\vec{b}$  and  $3\vec{a} - \lambda\vec{b}$  are perpendicular to each other, then the number of values of  $\lambda$  in  $[-1, 3]$  is:
- (1) 2 (2) 1 (3) 0 (4) 3
13. Let  $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$ ,  $\vec{b} = 3\hat{i} + \hat{j} - \hat{k}$  and  $\vec{c}$  be three vectors such that  $\vec{c}$  is coplanar with  $\vec{a}$  and  $\vec{b}$ . If the vector  $\vec{c}$  is perpendicular to  $\vec{b}$  and  $\vec{a} \cdot \vec{c} = 5$ , then  $|\vec{c}|^2$  is equal to
- (1)  $\sqrt{\frac{11}{6}}$  (2)  $\frac{1}{3\sqrt{2}}$  (3) 16 (4) 18
14. Let  $\vec{a} = 4\hat{i} - \hat{j} + \hat{k}$ ,  $\vec{b} = 11\hat{i} - \hat{j} + \hat{k}$  and  $\vec{c}$  be a vector such that  $(\vec{a} + \vec{b}) \times \vec{c} = \vec{c} \times (-2\vec{a} + 3\vec{b})$ . If  $(2\vec{a} + 3\vec{b}) \cdot \vec{c} = 1670$  then  $|\vec{c}|^2$  is equal to:
- (1) 1609 (2) 1618 (3) 1600 (4) 1627
15. Let  $\vec{a} = \hat{i} + \alpha\hat{j} + \beta\hat{k}$ ,  $\alpha, \beta \in R$ . Let a vector  $\vec{b}$  be such that the angle between  $\vec{a}$  and  $\vec{b}$  is  $\frac{\pi}{4}$  and  $|\vec{b}|^2 = 6$ . If  $\vec{a} \cdot \vec{b} = 3\sqrt{2}$ , then the value of  $(\alpha^2 + \beta^2)|\vec{a} \times \vec{b}|^2$  is equal to
- (1) 90 (2) 75 (3) 95 (4) 85
16. Let  $\vec{a}$  and  $\vec{b}$  be two vectors such that  $|\vec{b}| = 1$  and  $|\vec{b} \times \vec{a}| = 2$ . Then  $|(\vec{b} \times \vec{a}) - \vec{b}|^2$  is equal to
- (1) 3 (2) 5 (3) 1 (4) 4
17. Let O be the origin and the position vector of the point P be  $-\hat{i} - 2\hat{j} + 3\hat{k}$ . If the position vectors of the points A, B and C are  $-2\hat{i} + \hat{j} - 3\hat{k}$ ,  $2\hat{i} + 4\hat{j} - 2\hat{k}$  and  $-4\hat{i} + 2\hat{j} - \hat{k}$  respectively, then the projection of the vector  $\vec{OP}$  on a vector perpendicular to the vectors  $\vec{AB}$  and  $\vec{AC}$  is
- (1) 3 (2)  $\frac{8}{3}$  (3)  $\frac{7}{3}$  (4)  $\frac{10}{3}$
18. Let  $\vec{a} = \alpha\hat{i} + \hat{j} - \hat{k}$  and  $\vec{b} = 2\hat{i} + \hat{j} - \alpha\hat{k}$ ,  $\alpha > 0$ . If the projection of  $\vec{a} \times \vec{b}$  on the vector  $-\hat{i} + 2\hat{j} - 2\hat{k}$  is 30, then  $\alpha$  is equal to
- (1)  $\frac{15}{2}$  (2) 8 (3)  $\frac{13}{2}$  (4) 7
19. In a triangle ABC, if  $|\vec{BC}| = 3$ ,  $|\vec{CA}| = 5$  and  $|\vec{AB}| = 7$ , then the projection of the vector  $\vec{BA}$  on  $\vec{BC}$  is equal to:
- (1)  $\frac{19}{2}$  (2)  $\frac{13}{2}$  (3)  $\frac{11}{2}$  (4)  $\frac{15}{2}$
20. Let the angle  $\theta$ ,  $0 < \theta < \frac{\pi}{2}$  between two unit vectors  $\hat{a}$  and  $\hat{b}$  be  $\sin^{-1}(\frac{\sqrt{65}}{9})$ . If the vector  $\vec{c} = 3\hat{a} + 6\hat{b} + 9(\hat{a} \times \hat{b})$  then the value of  $9(\vec{c} \cdot \hat{a}) - 3(\vec{c} \cdot \hat{b})$  is
- (1) 31 (2) 27 (3) 29 (4) 24

### SECTION B: NUMERICAL VALUE TYPE

21. Let  $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$  and  $\vec{b} = \hat{i} + \hat{j} - \hat{k}$ . If  $\vec{c}$  is a vector such that  $\vec{a} \cdot \vec{c} = 11$ ,  $\vec{b} \cdot \vec{c} = 27$  and  $\vec{b} \cdot (\vec{a} \times \vec{c}) = 27$  then  $|\vec{a} \times \vec{c}|^2$  is equal to .....
22. Let ABC be a triangle of area  $15\sqrt{2}$  and the vectors  $\vec{AB} = \hat{i} + 2\hat{j} - 7\hat{k}$ ,  $\vec{BC} = a\hat{i} + b\hat{j} + c\hat{k}$  and  $\vec{AC} = 6\hat{i} + d\hat{j} - 2\hat{k}$ ,  $d > 0$ . Then the square of the length of the largest side of the triangle ABC is .....
23. Let  $\vec{a} = 2\hat{i} - 3\hat{j} + 4\hat{k}$ ,  $\vec{b} = 3\hat{i} + 4\hat{j} - 5\hat{k}$  and a vector  $\vec{c}$  be such that  $\vec{a} \times (\vec{b} + \vec{c}) + \vec{b} \times \vec{c} = \hat{i} + 8\hat{j} + 13\hat{k}$ . If  $\vec{a} \cdot \vec{c} = 13$ , then  $(24 - \vec{b} \cdot \vec{c})$  is equal to .....
24. Let  $\vec{c}$  be the projection vector of  $\vec{b} = \lambda\hat{i} + 4\hat{k}$ ,  $\lambda > 0$ , on the vector  $\vec{a} = \hat{i} + 2\hat{j} + 2\hat{k}$ . If  $|\vec{a} + \vec{c}| = 7$ , then the area of the parallelogram formed by the vectors  $\vec{b}$  and  $\vec{c}$  is .....
25. Let  $\vec{a} = 3\hat{i} + 2\hat{j} + \hat{k}$ ,  $\vec{b} = 2\hat{i} - \hat{j} + 3\hat{k}$  and  $\vec{c}$  be a vector such that  $(\vec{a} + \vec{b}) \times \vec{c} = 2(\vec{a} \times \vec{b}) + 24\hat{j} - 6\hat{k}$  and  $(\vec{a} - \vec{b} + \hat{i}) \cdot \vec{c} = -3$ . Then  $|\vec{c}|^2$  is equal to .....