MATHS

BOOKS - KC SINHA ENGLISH

VECTOR PRODUCT OF TWO VECTORS

Solved Examples

1. If $\left|\vec{a}\right| = 2, \left|\vec{b}\right| = 7$ and $\left(\vec{a} \times \vec{b}\right) = 3\hat{i} + 2\hat{j} + 6\hat{k}$ find the angle between $\vec{a}$ and $\vec{b}$

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2. IF $\vec{a}$ and $\vec{b}$ re two vectors show that $\left|\vec{a} \times \vec{b}\right|^2 = a^2b^2 - \left(\vec{a}.\vec{b}\right)^2$

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3. If $|a| = \sqrt{26}, |b| = 7$ and $|a \times b| = 35$, find $a \cdot b$.

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4. If $\vec{a} . \vec{b} = 0$ and $\vec{a} \times \vec{b} = 0$ prove that $\vec{a} = \vec{0}$ or $\vec{b} = \vec{0}$.

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5. If $\vec{a}, \vec{b}, \vec{c}$ are three such that $\vec{a} \times \vec{b} = \vec{c}, \vec{b} \times \vec{c} = \vec{a}$ and $\vec{c} \times \vec{a} = \vec{b}$, show that $\vec{a}, \vec{b}, \vec{c}$ foem an orthogonal righat handed triad of unit vectors.

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6. If $\vec{a} = 2\hat{i} + 3\hat{j} - \hat{k}$ and $\vec{\hat{i}} + 2\hat{j} + 3\hat{k}$ find $\vec{a} \times \vec{b}$.

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7. If $\vec{a} = 3\hat{i} + \hat{j} - 4\hat{k}$ and $\vec{b} = 6\hat{i} + 5\hat{j} - 2\hat{k}$ find $\left|\vec{a} X \vec{b}\right|$

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8. If $\vec{a} = \hat{i} - 2\hat{j} + 3\hat{k}$ and $\vec{b} = 2\hat{i} + 3\hat{j} - 5\hat{k}$ then find $\vec{a} \times \vec{b}$ and verify that $\vec{a} \times \vec{b}$ is perpendicular to each one of $\vec{a}$ and $\vec{b}$.

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9. If $\vec{a} = 4\hat{i} + 3\hat{j} + 2\hat{k}$ and $\vec{b} = 3\hat{i} + 2\hat{k}$, find $\left|\vec{b} \times 2\vec{a}\right|$

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10. Find the sine of the angle between the vectors $\vec{a} = 2\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{b} = \hat{i} + 3\hat{j} + 2\hat{k}$.

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11. Find a unit vector perpendicular to the plane of two vectros. $\vec{a} = \hat{i} - \hat{j} + 2\hat{k}$ and $\vec{b} = 2\hat{i} + 3\hat{j} - \hat{k}$

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12. Show that a unilt vector perpendicular to each to the vector $3\hat{i} + \hat{j} + 2\hat{k}$ and $2\hat{i} - 2\hat{j} + 4\hat{k} is \frac{1}{\sqrt{3}}\left(\hat{i} - \hat{j} - \hat{k}\right)$ and the sine of the angle between them is $\frac{2}{\sqrt{7}}$.

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13. Find a vector of magnitude 15 which isperpendicular to both vectors $4\hat{i} - \hat{j} + 8\hat{k}$ and $-\hat{j} + \hat{k}$.

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14. If $\vec{a} = 3\hat{i} + 4\hat{j} - 5\hat{k}$ and $\vec{b} = 7\hat{i} - 3\hat{j} + 6\hat{k}$ find a unit vector along $\left(\vec{a} + \vec{b}\right) \times \left(\vec{a} - \vec{b}\right)$.

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15. Find a unit vector pependicular to the plane determined by the points (1,-1,2), (2,0,-1) and (0,2,1) .

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16. Find the values of λ and μ for which $\left(2\hat{i} + 6\hat{j} + 27\hat{k}\right) \times \left(\hat{i} + \lambda\hat{j} + \mu\hat{k}\right) = 0$

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17. if $\vec{a} = \hat{i} - \hat{j} - 3\hat{k}$, $\vec{b} = 4\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{c} = 2\hat{i} + \hat{j} + 2\hat{k}$, verify that $\vec{a} \times \left(\vec{b} + \vec{c}\right) = \vec{a} \times \vec{b} + \vec{a} \times \vec{c}$

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18. If $\vec{a} = 3\hat{i} - \hat{j} + 2\hat{k}$, $\vec{b} = 2\hat{i} + \hat{j} - \hat{k}$, $\vec{c} = \hat{i} - 2\hat{j} + 2\hat{k}$, find $\left(\vec{a} \times \vec{b}\right) \times \vec{c}$ and $\vec{a} \times \left(\vec{b} \times \vec{c}\right)$ and hence show that $\left(\vec{a} \times \vec{b}\right) \times \vec{c} \neq \vec{a}\left(\vec{b} \times \vec{c}\right)$

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19. If $\vec{a}\, a = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{c} = \hat{i} + \hat{j} - 2\hat{k}$, verify that $\vec{a} \times \left(\vec{b} \times \vec{c}\right) = \left(\vec{a} . \vec{c}\right)\vec{b} - \left(\vec{a} . \vec{b}\right)\vec{c}$.

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20. Given $\vec{a} = \hat{i} + 2\hat{j} + \hat{k}$, $\vec{b} = -\hat{i} + 2\hat{j} + \hat{k}$ and $\vec{c} = 3\hat{i} + \hat{j}$. Find a unity vector in the directionof resultant of these vectors. Also find a vector $\vec{r}$ which is normal to both $\vec{a}$ and $\vec{b}$.

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21. The position vectors of the points A,B,C are respectively (1,1,1),(1,-1,2), (0,2,-1). Find a unit vector parallel totehplane determined by A,B,C and perpendicular to the vector (1,0,1).

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22. Find the length of perpendicular from the piont $A(1, 4, -2)$ to the line joining $P(2, 1, -2)$ and $Q(0, -5, 1)$

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23. If either $\rightarrow a = \rightarrow 0$ and $\rightarrow b = \rightarrow 0$ then $\rightarrow a \times \rightarrow b = \rightarrow 0$. Is Is the converse true? Justify your answer with an example.

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24. Prove that $\vec{a} \times \left(\vec{b} + \vec{c}\right) + \vec{b} \times \left(\vec{c} + \vec{a}\right) + \vec{c} \times \left(\vec{a} + \vec{b}\right) = 0$

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25. For three vectors $\vec{a} + \vec{b} + \vec{c} = 0$, check if $\left(\vec{a} \times \vec{b}\right) = \left(\vec{b} \times \vec{c}\right) = \left(\vec{c} \times \vec{a}\right)$

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26. Evaluate the expression $\left(\vec{a} - \vec{b}\right) \times \left(\vec{a} + \vec{b}\right) =$

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27. If $\vec{a} \times \vec{b} = \vec{c} \times \vec{d}$ and $\vec{a} \times \vec{c} = \vec{b} \times \vec{d}$ show that $\left(\vec{a} - \vec{d}\right)$ is parallel to $\left(\vec{b} - \vec{c}\right)$.

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28. If $\vec{a} \times \vec{b} = \vec{a} \times \vec{c}, \vec{a} \neq 0$ and $\vec{b} \neq \vec{c}$, prove that $\vec{b} = \vec{c} + \lambda \vec{a}$.

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29. given that $\vec{a} . \vec{b} = \vec{a} . \vec{c}, \vec{a} \times \vec{b} = \vec{a} \times \vec{c}$ and $\vec{a}$ is not a zero vector. Show that $\vec{b} = \vec{c}$.

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30. If $\vec{a} \times \vec{b} = \vec{b} \times \vec{c} \neq \vec{0}$, then prove that $\vec{a} + \vec{c} = t \vec{b}$, where t is a scalar.

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31. A solution of the vector equation $\vec{r} \times \vec{b} = \vec{a} \times \vec{b}$, where $\vec{a}$, $\vec{b}$ are two given vectors is

where λ is a parameter.

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32. Prove that the points A,B,C wth positon vectros $\vec{a}$, $\vec{b}$, $\vec{c}$ are collinear if and only if $\left(\vec{b} \times \vec{c}\right) + \left(\vec{c} \times \vec{a}\right) + \left(\vec{a} \times \vec{b}\right) = \vec{0}$

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33. Show that the points A, B and C with position vectors $-2\hat{i} + 3\hat{j} + 5\hat{k}$, $\hat{i} + 2\hat{j} + 3\hat{k}$ and $7\hat{i} - \hat{k}$ respectively are collinear

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34. Show that the points having position vectors $\left(\vec{a} - 2\vec{b} + 3\vec{c}\right), \left(-2\vec{a} + 3\vec{b} + 2\vec{c}\right), \left(-8\vec{a} + 13\vec{b}\right)$ re collinear whatever $\vec{a}, \vec{b}, \vec{c}$ may be

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35. Using vector method, show that the points $A(2, -1, 3), B(4, 3, 1)$ and $C(3, 1, 2)$ are collinear

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36. Find the area of the parallel whose adjacent sides are represented by the vectors $3\hat{i} + \hat{j} - 2\hat{k}$ and $\hat{i} - 3\hat{j} + 4\hat{k}$

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37. Show that the area of a parallelogram having diagonals $3\hat{i}+\hat{j}-2\hat{k}\ and\ \hat{i}-3\hat{j}+4\hat{k}$ is $5\sqrt{3}$ square units.

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38. Find the area of the triangle whose adjascent sides are determined by the vectors $\vec{a}=-2\hat{i}-5\hat{k}$ and $\vec{b}=\hat{i}-2\hat{j}-\hat{k}$.

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39. Using vector method find the area of the triangle whose vrtices are $A(1,1,1), B(1,2,3)$ and $C(2,3,1)$

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40. Prove by vector method that the area of $\triangle ABC is \frac{a^2\sin B\sin C}{2\sin A}$ where symbols have their usual meanings.

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41. Prove by vector method that the parallelogram on the same base and between the same parallels are equal in area.

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42. AD, BE and CF asre the medians of a triangle ASBC intersectiing in G. Show that $\triangle AGB = \triangle BGC = \triangle CGA = \frac{1}{3} \triangle ABC$.

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43. In a triangle ABC, prove by vector method that $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

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44. Prove by vector methods that $\sin(\alpha+\beta)=\sin\alpha\cos\beta+\cos\alpha\sin\beta$

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45. A force $F=2\hat{i}+\hat{j}-\hat{k}$ acts at point A whose position vector is $2\hat{i}-\hat{j}$. Find the moment of force F about the origin.

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46. Forces $2\hat{i}+\hat{j}, 2\hat{i}-3\hat{j}+6\hat{k}$ and $-\hat{i}+2\hat{j}-\hat{k}$ act at a point P, with position vector $4\hat{i}-3\hat{j}-\hat{k}$. Find the vector moment of the resultant of these forces about thepoint Q whose position vector is $6\hat{i}+\hat{j}=3\hat{k}$

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Exercise

1. If $\vec{a}$ and $\vec{b}$ asre two vectors such that $\left|\vec{a}\right| = 2, \left|\vec{b}\right| = 7$ and $\vec{a} \times \vec{b} = 3\hat{i} + 6\hat{k}$ find the angle between $\vec{a}$ and $\vec{b}$

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2. If $\left|\vec{a}\right| = 10, \left|\vec{b}\right| = 2$ and $\vec{a} . \vec{b} = 12$, then the value of $\left|\vec{a} \times \vec{b}\right|$ is

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3. Find $\vec{a} . \vec{b}$ if $\left|\vec{a}\right| = 2, \left|\vec{b}\right| = 5,$ and $\left|\vec{a} \times \vec{b}\right| = 8$

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4. If $\vec{a}$ and $\vec{b}$ are two such that $\left|\vec{a}\right| = 5, \left|\vec{b}\right| = 4$ and $\left|\vec{a} . \vec{b}\right| = 10,$ find the angle between $\vec{a}$ and $\vec{b}$ and hence find $\left|\vec{a} \times \vec{b}\right|$

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5. If $\vec{a} \times \vec{b} = \vec{c}$ and $\vec{b} \times \vec{c} = \vec{a}$, $showt\widehat{\vec{a}}, \vec{b}, \vec{c}$ are orthogonal in pairs. Also show that |vecc|=|veca| and |vecb|=1`

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6. Find $\vec{a} \times \vec{b}$ and $\left|\vec{a} \times \vec{b}\right|$ if $\vec{a} = 2\hat{i} + \hat{j} + 3\hat{k}$ and $\vec{b} = 3\hat{i} + 5\hat{j} - 2\hat{k}$

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7. Find $\left|\vec{a} \times \vec{b}\right|$, if $\vec{a} = \hat{i} - 7\hat{j} + 7\hat{k}$ and $\vec{b} = 3\hat{i} - 2\hat{j} + 2\hat{k}$.

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8. If $\vec{a} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = 3\hat{i} + 4\hat{j} - \hat{k}$, prove that $\vec{a} \times \vec{b}$ represents a vector which perpendicular to both $\vec{a}$ and $\vec{b}$.

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9. If $\vec{a} = 7\hat{i} + 3\hat{j} - 6\hat{k}$, $\vec{b} = 2\hat{i} + 5\hat{j} - \hat{k}$ and $\vec{c} = -\hat{i} + 2\hat{j} + 4\hat{k}$. Find $\left(\vec{a} - \vec{b}\right) \times \left(\vec{c} - \vec{b}\right)$.

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10. Two vectros $\vec{A}$ and $\vec{B}$ are obtained by joining the origin to the points whose coordinates are (1,0,-1) and (-1,1,1). Find the magnitude of the vectors $\vec{A} \times \vec{B}$ and the direction cosines of this vector.

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11. If $\vec{A} = 2\hat{i} - 3\hat{j} + \hat{k}$ and $\vec{B} = 3\hat{i} + 2\hat{j}$. Find $\vec{A} . \vec{B}$ and $\vec{A} \times \vec{B}$

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12. Find a unit vector perpendicular to the plane of two vectors $\vec{a}$ and $\vec{b}$ where $\vec{a} = 4\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{b} = -2\hat{i} + \hat{j} - \hat{k}$

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13. Find a unit vector perpendicular to the plane of two vectors $\vec{a}$ and $\vec{b}$ where $\vec{a} = \hat{i} - \hat{j}$ and $\vec{b} = \hat{j} + \hat{k}$

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14. Find unit vectors perpendicular to each of the vector in the following:

$2\hat{i} + 3\hat{j} - \hat{k}, \hat{i} + 2\hat{j} + 3\hat{k}$

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15. Find unit vectors perpendicular to each of the vector in the following:

$2\hat{i} - \hat{j} - \hat{k}, 2\hat{i} - \hat{j} + 3\hat{k}$

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16. Find unit vectors perpendicular to each of the vector in the following:

$4\hat{i} - \hat{j} + 3\hat{k}, 2\hat{i} + 2\hat{j} - \hat{k}$

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17. Find a unit vector which is perpendicular to each of the vectors in the following: $\hat{i} - \hat{j} + \hat{k}$ and $2\hat{i} + 3\hat{j} - \hat{k}$

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18. Find a unit vector which is perpendicular to each of the vectors in the following: $\hat{i} + \hat{j} - 2\hat{k}$ and $2\hat{i} - 2\hat{j} + \hat{k}$

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19. Find a unity vector perpendicular to each of the vectors $\left(\vec{a}+\vec{b}\right)$ and $\left(\vec{a}-\vec{b}\right)$, where $\vec{a}=\hat{i}+\hat{j}+\hat{k}$ and $\vec{b}=\hat{i}+2\hat{j}+3\hat{k}$

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20. Determine the angle between the vectors $\hat{i}+2\hat{j}+\hat{k}$ and $3\hat{i}+\hat{j}-\hat{k}$. Also find the unit vector perpendicular to each of the two vectors.

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21. Find a unit vectro perpendicular to the vectors $\vec{a}=3\hat{i}+2\hat{j}-\hat{k}$ and $\vec{b}=12\hat{i}+5\hat{j}-5\hat{k}$ Also determine the sine of the angle between $\vec{a}$ and $\vec{b}$.

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22. What is the unit vector perpendicular to each of the vectors $2\hat{i}-\hat{j}+\hat{k}$ and $3\hat{i}+4\hat{j}-\hat{k}$? Prove that the sine of the angle between these two vectors is $\sqrt{\frac{155}{156}}$

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23. If A,B,C are points (1,0,-1), (0,1,-1) and (-1,0,1)` respectively find the sine of the angle between the lines AB and AC.

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24. Calculate the components of a vector of magnitude unity which is at right angles to the vectors $2\hat{i}+\hat{j}-4\hat{k}$ and $3\hat{i}+\hat{j}-\hat{k}$.

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25. If the position vectors of the three points A,B,C are $2\hat{i}+4\hat{j}-\hat{k}, \hat{i}+2\hat{j}-3\hat{k}$ and $3\hat{i}+\hat{j}+2\hat{k}$ respectively, find a vector perpendicular to the plane ABC.

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26. Given $\vec{a}=\frac{1}{7}\left(2\hat{i}+3\hat{j}+6\hat{k}\right), \vec{=}\frac{1}{7}\left(3\hat{i}-6\hat{j}+2\hat{k}\right)$ and $\vec{c}\frac{1}{7}\left(6\hat{i}+2\hat{j}-3\hat{k}\right)$. Show that $\vec{a}, \vec{b}, \vec{c}$ are of unit length mutually perpendicular and that $\vec{a}\times\vec{b}=\vec{c}$.

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27. If $\vec{a}=7\hat{i}+3\hat{j}-5\hat{k}, \vec{b}=2\hat{i}+5\hat{j}-\hat{k}$ and $\vec{c}-\hat{i}+2\hat{j}+4\hat{k}$, then verify that $\vec{a}\times(b+c)=\vec{a}\times\vec{b}+\vec{a}\times\vec{c}$

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28. Let $\vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$, $\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}$ and $\vec{c} = c_1\hat{i} + c_2\hat{j} + c_3\hat{k}$ then show that $\vec{a} \times \left(\vec{b} + \vec{c}\right) = \vec{a} \times b + \vec{a} \times \vec{c}$

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29. If $\vec{a} = 2\hat{i} + 5\hat{j} - 7\hat{k}$, $\vec{b} = -3\hat{i} + 4\hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - 2\hat{j} - 3\hat{k}$, show that $\left(\left(\vec{a} \times \vec{b}\right) \times \vec{c}\right), \vec{a} \times \left(\vec{b} \times \vec{c}\right)$ are not same .

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30. If $\vec{a} = 2\hat{i} + 2\hat{j} - \hat{k}$, $\vec{b} = 3\hat{i} - \hat{j} - \hat{k}$ and $\vec{c} = \hat{i} + 2\hat{j} - 3\hat{k}$ then verify that $\vec{a} \times \left(\vec{b} \times \vec{c}\right) = \left(\vec{a}.\vec{c}\right)\vec{b} - \left(\vec{a}.\vec{b}\right)\vec{c}$.

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31. Find the perpendicular distance of $P\left(-\hat{i} + 2\hat{j} + 6\hat{k}\right)$ from the line joining $A\left(2\hat{i} + 3\hat{j} - 4\hat{k}\right)$ and $B\left(8\hat{i} + 6\hat{j} - 8\hat{k}\right)$

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32. Let $\vec{a} = (3, -1, 0)$ and $\vec{b} = \left(\frac{1}{2}, \frac{3}{2}, 1\right)$ Fidnthe vector $\vec{c}$ satisfying $\vec{a} \times \vec{c} = 4\vec{b}$ and $\vec{a} . \vec{c} = 1$

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33. If $\vec{a} = \hat{i} - \hat{j} + \hat{k}$ and $\vec{b} = \hat{j} - \hat{k}$, then find a vector $\vec{a}$ such that $\vec{a} \times \vec{c} = b$ and $\vec{a} . \vec{c} = 3.$

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34. If $\vec{a} = (0, 1, -1,)$ and $\vec{c} = (1, 1, 1)$ are given vectors then find a vector $\vec{b}$ satisfying $\vec{a} \times \vec{b} = \vec{c}$ and $\vec{a} . \vec{b} = 3$

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35. Show that:

$\left(\vec{a}-\vec{d}\right)\times\left(\vec{b}-\vec{c}\right)+\left(\vec{b}-\vec{d}\right)\times\left(\vec{c}-\vec{a}\right)+\left(\vec{c}-\vec{d}\right)\times\left(\vec{a}$

is independent of $\vec{d}$.

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36. Prove that

$\left(\vec{a}+3\vec{b}\right)\times\left(\vec{a}+\vec{b}\right)+\left(3\vec{a}-5\vec{b}\right)\times\left(\vec{a}-\vec{b}\right)=0$

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37. Prove that: $\left|\left(\vec{a}+\vec{b}\right)\times\left(\vec{a}-\vec{b}\right)\right|=2ab \text{ if } \vec{a}\perp\vec{b}$

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38. given that $\vec{a}.\vec{b}=\vec{a}.\vec{c}, \vec{a}\times\vec{b}=\vec{a}\times\vec{c}$ and $\vec{a}$ is not a zero vector. Show that $\vec{b}=\vec{c}$.

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39. Find the value of $\left|\left(\hat{i}+\hat{j}\right)\times\left(\hat{i}+2\hat{j}+\hat{k}\right)\right|$

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40. Find the value of $\left|\left(3\hat{i}+\hat{j}\right)\times\left(2\hat{i}-\hat{j}\right)\right|$

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41. Find the value of $\left|\hat{i}\times\left(\hat{i}+\hat{j}+\hat{k}\right)\right|$

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42. Find the value of $\left|\hat{i}\times\hat{j}\right|+\hat{j}\times\hat{k}|$

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43. Prove that: $\left(2\hat{i}+3\hat{j}\right)\times\left(\hat{i}+2\hat{j}\right)=\hat{k}$

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44. Prove that: $\left(2\vec{a}-\vec{b}\right)\times\left(\vec{a}+2\vec{b}\right)=5\vec{a}\times\vec{b}$.

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45. Show that the three points whose position vectors are $-3\hat{i}+\hat{j}+5\hat{k}, 2\hat{i}+3\hat{k}, -13\hat{i}+3\hat{j}+9\hat{k}$ are collinear

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46. Show that the three points whose position vectors are $\vec{a}-2\vec{b}+3\vec{c}, 2\vec{a}+3\vec{b}-4\vec{c}, -7\vec{b}+10\vec{c}$ are collinear

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47. Find the area of the prallelogram whose adjacent sides are $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{b} = 3\hat{i} - 2\hat{j} + \hat{k}$.

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48. Find the area of the parallelogram whose adjacent sides are given by the vectors $\vec{a} = 3\hat{i} + \hat{j} + 4\hat{k}$ and $\vec{b} = \hat{i} - \hat{j} + \hat{k}$.

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49. Find the area of the parallelogram whose adjacent sides are given by the vectors $\vec{a} = \hat{i} - \hat{j} + 3\hat{k}$ and $\vec{b} = 2\hat{i} - 7\hat{j} + \hat{k}$`

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50. Find the area of the parallelogram having diagonals $2\hat{i} - \hat{j} + \hat{k}$ and $3\hat{i} + 3\hat{j} - \hat{k}$

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51. Find the area of a parallelogram whose diagonals are the vectors $2\vec{m} - \vec{n}$ and $4\vec{m} - 5\vec{n}$, $where \vec{m}$ and $\vec{n}$ are unit vectors forming an angle of 45^0

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52. Show that the area of the triangle whose two adjacent sides are determined by the vectors $\vec{a} = 3\hat{i} + 4\hat{j}$, $\vec{b} = -5\hat{i} + 7\hat{j}$ is $20\frac{1}{2}$ square units.

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53. Find the vector area of the triangle, the position vectors of whose vertices are $\hat{i} + \hat{j} + 2\hat{k}, 2\hat{i} + 2\hat{j} - 3\hat{k}$ and $3\hat{i} - \hat{j} - \hat{k}$

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54. Find the area of the triangle with vertices A(1, 1, 2), B(2, 3, 5) and C(1, 5, 5).

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55. Show by vector method that $\sin(\alpha - \beta) = \sin\alpha\cos\beta - \cos\alpha\sin\beta$.

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56. Show by vector method that $\sin 2A = 2\sin A\cos A$.

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