MATHS

BOOKS - PSEB

VECTOR ALGEBRA

Example

1. Represent graphically a displacement of 40 km, 30^o west of south.

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2. Classify the following measures as scalars and vectors: $5s$

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3. Classify the following measures as scalars and vectors: $1000cm^3$

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4. Classify the following measures as scalars and vectors: $10N$

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5. Classify the following measures as scalars and vectors: $30k\frac{m}{h}$

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6. Classify the following measures as scalars and vectors: $10\frac{g}{c}m^3$

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7. Classify the following measures as scalars and vectors: $20\frac{m}{s}$

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8. Classify the following measure as scalar and vector:40watt

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9. Classify the following measure as scalar and vector: 10^(-19)coulomb

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10. Find the values of x, y and z so that the vectors $\vec{a} = x\hat{i} + 2\hat{j} + z\hat{k}$ and $\hat{b} = 2\hat{i} + y\hat{j} + \hat{k}$ are equal.

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11. Let $\vec{a} = \hat{i} + 2\hat{j}$ and $\vec{b} = 2\hat{i} + \hat{j}$. Is $|\vec{a}| = |\vec{b}|$? Are the vectors $\vec{a}$ and $\vec{b}$ equal?

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12. Find the unit vector in the direction of the vector $\vec{a} = \hat{i} + \hat{j} + \hat{k}$

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13. Find the vector in the direction of the vector $\hat{i} - 2\hat{j}$ that has magnitude 7 units.

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14. Write unit vector in the direction of the sum of vectors

$\vec{a} = 2\hat{i} + 2\hat{j} - 5\hat{k}$ and $\vec{b} = 2\hat{i} + \hat{j} + 3\hat{k}$

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15. Write the direction ratio's of the vector $\vec{a} = \hat{i} + \hat{j} - 2\hat{k}$ and hence calculate its direction cosines.

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16. Find the vector joining the points P(2, 3, 0) and Q(– 1, – 2, – 4) directed from P to Q.

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17. Consider two points P and Q with position vectors $\overrightarrow{OP} = 3\vec{a} - 2\vec{b}$ and $\overrightarrow{OQ} = \vec{a} + \vec{b}$. Find the position vector of a point R which divides the line joining P and Q in the ratio 2:1, internally.

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18. Consider two points P and Q with position vectors $\overrightarrow{OP} = 3\vec{a} - 2\vec{b}$ and $\overrightarrow{OQ} = \vec{a} + \vec{b}$. Find the position vector of a point R which divides the line joining P and Q in the ratio 2:1, externally.

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19. Show that the points : $A\left(2\hat{i} - \hat{j} + \hat{k}\right), B\left(\hat{i} - 3\hat{j} - \hat{k}\right), C\left(3\hat{i} - 4\hat{j} - 4\hat{k}\right)$ are the

vertices of a right-angled triangle.

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20. Find the angle between two vectors $\vec{a}$ and $\vec{b}$ with magnitudes 1 and 2 respectively and when $\vec{a} \cdot \vec{b} = 1$.

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21. Find angle 'Θ' between the vectors $\vec{a} = \vec{i} + \vec{j} - \vec{k}$ and $\vec{b} = \vec{i} - \vec{j} + \vec{k}$.

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22. If $\vec{a} = 5\vec{i} - \vec{j} - 3\vec{k}$ and $\vec{b} = \vec{i} + 3\vec{j} - 5\vec{k}$, then show that the vectors $\vec{a} + \vec{b}$ and $\vec{a} - \vec{b}$ are perpendicular.

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23. Find the projection of the vector $\vec{a} = 2\vec{i} + 3\vec{j} + 2\vec{k}$ on the vector $\vec{b} = \vec{i} + 2\vec{j} + \vec{k}$

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24. Find $\left|\vec{a} - \vec{b}\right|$, if two vectors $\vec{a}$ and $\vec{b}$ are such that $\left|\vec{a}\right| = 2, \left|\vec{b}\right| = 3$ and $\vec{a} \cdot \vec{b} = 4$.

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25. If $\vec{a}$ is a unit vector and $\left(\vec{x} - \vec{a}\right) \cdot \left(\vec{x} + \vec{a}\right) = 8$, then find $\left|\vec{x}\right|$

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26. For any two vectors $\vec{a}$ and $\vec{b}$, prove that $\left|\vec{a}.\vec{b}\right| \leq \left|\vec{a}\right|\left|\vec{b}\right|$

Also write the name of this inequality.

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27. For any two vectors $\vec{a}$ and $\vec{b}$, prove that : $\left|\vec{a}+\vec{b}\right| \leq \left|\vec{a}\right| + \left|\vec{b}\right|$. Also, write the name of this inequality

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28. Show that the three points with position vectors $-2\hat{i}+3\hat{j}+5\hat{k}$,$\hat{i}+2\hat{j}+3\hat{k}$ and $7\hat{i}-\hat{k}$ are collinear.

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

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

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31. Using vectors, find the area of the triangle having vertices A (1, 1, 1), B (1, 2, 3) and C (2, 3, 1).

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32. Find the area of 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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33. Write all the unit vectors in XY-plane.

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34. If $\hat{i} + \hat{j} + \hat{k}, 2\hat{i} + 5\hat{j}, 3\hat{i} + 2\hat{j} - 3\hat{k}$ and $\hat{i} - 6\hat{j} - \hat{k}$ are the position vectors of points A, B, C and D respectively, then find the angle between AB and CD. Deduce that AB and CD are collinear.

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35. Let $\vec{a}, \vec{b}, \vec{c}$ be three vectors such that $\left|\vec{a}\right| = 3, \left|\vec{b}\right| = 4, \left|\vec{c}\right| = 5$ and each one of them being perpendicular to the sum of the other two, find $\left|\vec{a} + \vec{b} + \vec{c}\right|$

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36. Three vectors $\vec{a}, \vec{b}, \vec{c}$ satisfy the condition $\vec{a} + \vec{b} + \vec{c} = \vec{0}$ Evaluate the quantity $\mu = \vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a}$ if $\left|\vec{a}\right| = 3, \left|\vec{b}\right| = 4, \left|\vec{c}\right| = 2$

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37. If with reference to the right handed system of mutually perpendicular unit vectors $\hat{i}, \hat{j}, \hat{k}$, $\vec{\alpha} = 3\hat{i} - \hat{j}, \vec{\beta} = 2\hat{i} + \hat{j} - 3\hat{k}$, then express $\vec{\beta}$ in the form $\vec{\beta} = \vec{\beta}_1 + \vec{\beta}_2$ where $\vec{\beta}_1$ is parallel to $\vec{\alpha}$ and $\vec{\beta}_2$ is perpendicular to $\vec{\alpha}$.

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Exercise

1. Represent graphically a displacement of 40 km, 30^o east of north.

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2. Classify the following measure as scalar and vector: $10Kg$

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3. Classify the following measure as scalar and vector: $2\ meters$ north-west

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4. Classify the following measure as scalar and vector: 40^o

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5. Classify the following measure as scalar and vector: $20\frac{m}{s^2}$

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6. Classify the following as scalar and vector quantities: $timeperiod$

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7. Classify the following as scalar and vector quantities: $dis\tan ce$

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8. Classify the following as scalar and vector quantities: force

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9. Classify the following as scalar and vector quantities: $velocity$

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10. Classify the following as scalar and vector quantities:work done

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11. Compute the magnitude of the following vectors: $\vec{a} = \hat{i} + \hat{j} + \hat{k}$

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12. Compute the magnitude of the following vectors: $\vec{b} = 2\vec{i} - 7\vec{j} - 3\vec{k}$ |

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13. Compute the magnitude of the following vectors: $\vec{c} = \left(\frac{1}{\sqrt{3}}\right)\vec{i} + \left(\frac{1}{\sqrt{3}}\right)\vec{j} - \left(\frac{1}{\sqrt{3}}\right)\vec{k}$

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14. Write two different vectors having same magnitude.

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15. Write two different vectors having same direction.

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16. Find the values of x and y so that the vectors $2\vec{i} + 3\vec{j}$ and $x\vec{i} + y\vec{j}$ are equal.

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

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18. Find the sum of the vectors $\vec{a} = \vec{i} - 2\vec{j} + \vec{k}, \vec{b} = -2\vec{i} + 4\vec{j} + 5\vec{k}, \vec{c} = \vec{i} - 6\vec{j} - 7\vec{k}$

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19. Find the unit vector in the direction of the vector $\vec{a} = \vec{i} + \vec{j} + 2\vec{k}$

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20. Find the unit vector in the direction of vector $\overrightarrow{PQ}$, where P and Q are the points (1, 2, 3) and (4, 5, 6), respectively.

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21. For given vectors, $\vec{a} = 2\vec{i} - \vec{j} + 2\vec{k}$, $\vec{b} = -\vec{i} + \vec{j} - \vec{k}$ find the unit vector in the direction of the vector $\vec{a} + \vec{b}$

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22. Find a vector in the direction of vector $5\vec{i} - \vec{j} + 2\vec{k}$ which has magnitude 8 units.

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23. Show that the vectors $2\vec{i} - 3\vec{j} + 4\vec{k}, -4\vec{i} + 6\vec{j} - 8\vec{k}$ are collinear.

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24. Find the direction cosines of the vector $\vec{i} + 2\vec{j} + 3\vec{k}$ I

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

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26. Show that the vector $\vec{i} + \vec{j} + \vec{k}$ is equally inclined to the axes OX, OY and OZ.

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27. Find the position vector of a point R which divides the line joining two points P and Q whose position vectors are $P\left(\vec{i} + 2\vec{j} - \vec{k}\right)$ and $Q\left(-\vec{i} + \vec{j} + \vec{k}\right)$ respectively, in the ratio 2 : 1, internally.

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28. Find the position vector of a point R which divides the line joining two points P and Q whose position vectors are $P\left(\vec{i} + 2\vec{j} - \vec{k}\right)$ and $Q\left(-\vec{i} + \vec{j} + \vec{k}\right)$ respectively, in the ratio 2 : 1, externally.

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

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30. Show that the points A, B and C with position vectors, $\vec{a} = 3\vec{i} - 4\vec{j} - 4\vec{k}, \vec{b} = 2\vec{i} - \vec{j} + \vec{k}, \vec{c} = \vec{i} - 3\vec{j} - 5\vec{k}$, respectively form the vertices of a right angled triangle.

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31. If $\vec{a}$ and $\vec{b}$ are two collinear vectors then which of the following are incorrect :

A. $\vec{b} = \lambda\vec{a}, f \text{ or } somescalar\lambda$

B. $\vec{a} = \pm \vec{b}$

C. the respective components of $\vec{a}$ and $\vec{b}$ are proportional.

D. both the vectors $\vec{a}$ and $\vec{b}$ have same direction, but different magnitudes.

Answer:

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32. Find the angle between two vectors $\vec{a}$ and $\vec{b}$ with magnitudes $\sqrt{3}$ and 2,respectively having $\vec{a} \cdot \vec{b} = \sqrt{6}$

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

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34. Find the projection of the vector $\hat{i}+\hat{j}$ on the vector $\hat{i}-\hat{j}$

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35. Find the projection of the vector $\vec{i}+3\vec{j}+7\vec{k}$ on the vector $7\vec{i}-\vec{j}+8\vec{k}$

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36. Show that the given vector is a unit vector: $\left(\frac{1}{7}\right)\left(2\hat{i}+3\hat{j}+6\hat{k}\right)$

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37. Show that the given vector is a unit vector: $\left(\frac{1}{7}\right)\left(3\hat{i}-6\hat{j}+2\hat{k}\right)$

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38. Show that the given vector is a unit vector: $\left(\frac{1}{7}\right)\left(6\vec{i}+2\vec{j}-3\vec{k}\right)$

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39. Find $\left|\vec{a}\right|$ and $\left|\vec{b}\right|$, if $\left(\vec{a}+\vec{b}\right)\cdot\left(\vec{a}-\vec{b}\right)=8$ and $\left|\vec{a}\right|=8\left|\vec{b}\right|$.

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40. Evaluate the product $\left(3\hat{a}-5\hat{b}\right)\cdot\left(2\hat{a}+7\hat{b}\right)$

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41. Find the magnitude of two vectors $\vec{a}$ and $\vec{b}$, having the same magnitude and such that the angle between them is 60^o and their scalar product is $\frac{1}{2}$.

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42. Find $\left|\vec{x}\right|$, if for a unit vector $\vec{a}$, $\left(\vec{x}-\vec{a}\right)\cdot\left(\vec{x}+\vec{a}\right)=12$

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43. If $\vec{a}=2\vec{i}+2\vec{j}+3\vec{k}$, $\vec{b}=-\vec{i}+2\vec{j}+\vec{k}$ and $\vec{c}=3\vec{i}+\vec{j}$ are such that $\vec{a}+\lambda\vec{b}$ is perpendicular to $\vec{c}$, then find the value of λ

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44. Show that $\left|\vec{a}\right|\vec{b}+\left|\vec{b}\right|\vec{a}$ is perpendicular to $\left|\vec{a}\right|\vec{b}-\left|\vec{b}\right|\vec{a}$ for any two non zero vectors $\vec{a}$ and $\vec{b}$

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45. If $\vec{a}\cdot\vec{a}=0$ and $\vec{a}\cdot\vec{a}b=0$, then what can be concluded about the vector $\vec{b}$?

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46. If $\vec{a}$, $\vec{b}$, $\vec{c}$ are unit vectors such that $\vec{a}+\vec{b}+\vec{c}=0$, find the value of $\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}$

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47. If either vector $\vec{a} = 0$or $\vec{b} = 0$, then $\vec{a} \cdot \vec{b} = 0$.But the converse need not be true. Justify your answer with an example.

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48. If the vertices A, B, C of a triangle ABC are (1,2,3), (-1,0,0), (0,1,2) respectively, then find $\angle ABC$ [$\angle ABC$ is the angle between the vectors $\overrightarrow{BA}$ and $\overrightarrow{BC}$]

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49. Show that the points $A(1, 2, 7), B(2, 6, 3)$ ਅਤੇ $C(3, 10, -1)$ are collinear.

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50. Show that the points $A\left(2\vec{i}-\vec{j}+\vec{k}\right), B\left(\vec{i}-3\vec{j}-5\vec{k}\right), C\left(3\vec{i}-4\vec{j}-4\vec{k}\right)$ are the vertices of a right angled triangle.

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51. If $\vec{a}$ is a nonzero vector of magnitude $'a'$ and λ a nonzero scalar, then $\lambda\vec{a}$ is unit vector if:

A. $\lambda=1$

B. $\lambda=-1$

C. $a=|\lambda|$

D. $a=\frac{1}{|\lambda|}$

Answer:

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

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53. Find a unit vector perpendicular to each of the vector $\vec{a} + \vec{b}$ and $\vec{a} - \vec{b}$ where $\vec{a} = 3\vec{i} + 2\vec{j} + 2\vec{k}$ and $\vec{b} = \vec{i} + 2\vec{j} - 2\vec{k}$

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54. If a unit vector $\vec{a}$, makes angles $\frac{\pi}{3}$ with $\hat{i}$, $\frac{\pi}{4}$ wih $\hat{j}$ and an acute angle θ with $\hat{k}$, then find θ and hence, the components of $\vec{a}$.

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55. Show that $\left(\vec{a}-\vec{b}\right)\times\left(\vec{a}+\vec{b}\right)=2\left(\vec{a}\times\vec{b}\right)$

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56. λ μ ਪਤਾ ਕਰੋ, ਜੇਕਰ $\left(2\vec{i}+6\vec{j}+27\vec{k}\right)\times\left(\vec{i}+\lambda\vec{j}+\mu\vec{k}\right)=\vec{0}$

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57. Given that $\vec{a}\cdot\vec{b}=0$ and $\vec{a}\times\vec{b}=\vec{0}$. What can you conclude about the vectors $\vec{a}$ and $\vec{b}$?

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58. Let the vectors $\vec{a},\vec{b},\vec{c}$ be given as $\vec{a}_1\hat{i}+\vec{a}_2\hat{j}+\vec{a}_3\hat{k},\ \vec{b}_1\hat{i}+\vec{b}_2\hat{j}+\vec{b}_3\hat{k},\ \vec{c}_1\hat{i}+\vec{c}_2\hat{j}+\vec{c}_3\hat{k}$.

Then show that $\vec{a} \times \left(\vec{b} + \vec{c}\right) = \vec{a} \times \vec{b} + \vec{a} \times \vec{c}$

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59. If either $\vec{a} = \vec{0}$ or $\vec{b} = \vec{0}$ then $\vec{a} \times \vec{b} = \vec{0}$. Is the converse true? Justify your answer with an example.

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60. Find the area of the triangle with vertices $A(1, 12), B(2, 3, 5), C(1, 5, 5)$

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

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62. Let the vectors $\vec{a}$ and $\vec{b}$ be such that $\left|\vec{a}\right| = 3$ and $\left|\vec{b}\right| = \frac{\sqrt{2}}{3}$, then $\vec{a} \times \vec{b}$ is a unit vector, if the angle between $\vec{a}$ and $\vec{b}$ is:

A. $\frac{\pi}{6}$

B. $\frac{\pi}{4}$

C. $\frac{\pi}{3}$

D. $\frac{\pi}{2}$

Answer:

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63. Area of a rectangle having vertices A, B, C and D with position vectors : $-\hat{i} + \left(\frac{1}{2}\right)\hat{j} + 4\hat{k}, \hat{i} + \left(\frac{1}{2}\right)\hat{j} + 4\hat{k}, \hat{i} - \left(\frac{1}{2}\right)\hat{j} + 4\hat{k}$

and $-\hat{i}-\left(\frac{1}{2}\right)\hat{j}+4\hat{k}$, respectively is:

A. $\frac{1}{2}$

B. 1

C. 2

D. 4

Answer:

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64. Write down a unit vector in XY-plane, making an angle of 30^o with the positive direction of x-axis.

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65. Find the scalar components and magnitude of the vector joining the points $P(x_1, y_1, z_1)$ and $Q(x_2, y_2, z_2)$

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66. A girl walks 4 km towards west, then she walks 3 km in a direction 30^o east of north and stops. Determine the girl's displacement from her initial point of departure.

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67. If $\vec{a} = \vec{b} + \vec{c}$, then is it true that $\left|\vec{a}\right| = \left|\vec{b}\right| + \left|\vec{c}\right|$? Justify your answer.

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68. Find the value of x for which $x\left(\hat{i}+\hat{j}+\hat{k}\right)$ is a unit vector.

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69. Find a vector of magnitude 5 units, and parallel to the resultant of the vectors $\vec{a}=2\hat{i}+3\hat{j}-\hat{k}$ and $\vec{b}=\hat{i}-2\hat{j}+\hat{k}$

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70. If $\vec{a}=\hat{i}+\hat{j}+\hat{k}$, $\vec{b}=2\hat{i}-\hat{j}+3\hat{k}$ and $\vec{c}=\hat{i}-2\hat{j}+\hat{k}$, find a unit vector parallel to the vector $2\vec{a}-\vec{b}+3\vec{c}$

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71. Show that the points $A(1,-2,-8), B(5,0,-2)$ and $C(11,3,7)$ are collinear.

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72. Find the position vector of a point R which divides the line joining two points P and Q whose position vectors are $P\left(2\vec{a}+\vec{b}\right)$ and $Q\left(\vec{a}-3\vec{b}\right)$ externally in the ratio 1 : 2. Also, show that P is the mid point of the line segment RQ.

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73. The two adjacent sides of a parallelogram are given by the vectors $2\hat{i}-4\hat{j}+5\hat{k}$ and $\hat{i}-2\hat{j}-3\hat{k}$ Find a unit vector parallel to its diagonal (longer). Also find the area of parallelogram.

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74. Show that the direction cosines of a vector equally inclined to the axes OX, OY and OZ are $\left(\frac{1}{\sqrt{3}}\right), \left(\frac{1}{\sqrt{3}}\right), \left(\frac{1}{\sqrt{3}}\right)$

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75. If $\vec{a} = \hat{i} + 4\hat{j} + 2\hat{k}$, $\vec{b} = 3\hat{i} - 2\hat{j} + 7\hat{k}$ and $\vec{c} = 2\hat{i} - \hat{j} + 4\hat{k}$ then find a vector $\vec{d}$ (which is $\perp$ ar to both $\vec{a}$ and $\vec{b}$) and $\vec{c} . \vec{d}$ =15.

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76. The scalar product of the vector $\hat{i} + \hat{j} + \hat{k}$ with a unit vector along the sum of vectors $2\hat{i} + 4\hat{j} - 5\hat{k}$and $\lambda\hat{i} + 2\hat{j} + 3\hat{k}$ is equal to one. Find the value of λ.

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77. If $\vec{a}, \vec{b}, \vec{c}$ are mutually perpendicular vectors of equal magnitudes, show that the vector $\vec{a} + \vec{b} + \vec{c}$ is equally inclined to $\vec{a}, \vec{b}$ and $\vec{c}$.

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78. Prove that $\left(\vec{a} + \vec{b}\right) \cdot \left(\vec{a} + \vec{b}\right) = \left|\vec{a}\right|^2 + \left|\vec{b}\right|^2$, if and only if $\vec{a}, \vec{b}$ are perpendicular, given $\vec{a} \neq \vec{0}, \vec{b} \neq \vec{0}$.

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79. If θ is the angle between two vectors $\vec{a}$ and $\vec{b}$, then $\vec{a} \cdot \vec{b} \geq 0$ only when:

A. $0 < \theta < \frac{\pi}{2}$

B. $0 \leq \theta \leq \frac{\pi}{2}$

C. $0 < \theta < \pi$

D. $0 \leq \theta \leq \pi$

Answer:

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80. Let $\vec{a}$ and $\vec{b}$ be two unit vectors and θ is the angle between them. Then $\vec{a} + \vec{b}$ is a unit vector if:

A. $\theta = \frac{\pi}{4}$

B. $\theta = \frac{\pi}{3}$

C. $\theta = \frac{\pi}{2}$

D. $\theta = 2\frac{\pi}{3}$

Answer:

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81. The value of : $\hat{i} \cdot \left(\hat{j} \times \hat{k}\right) + \hat{j} \cdot \left(\hat{i} \times \hat{k}\right) + \hat{k} \cdot \left(\hat{i} \times \hat{j}\right)$ is :

A. 0

B. -1

C. 1

D. 3

Answer:

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82. If θ is the angle between two vectors $\vec{a}$ and $\vec{b}$, then $\left|\vec{a} \cdot \vec{b}\right| = \left|\vec{a} \times \vec{b}\right|$ when θ is equal to :

A. 0

B. $\frac{\pi}{4}$

C. $\frac{\pi}{2}$

D. π

Answer:

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