



MATHS

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INTRODUCTION TO VECTORS

Illustration 1

1. The vector $\vec{a} + \vec{b}$ bisects the angle between the vectors \hat{a} and \hat{b} if
- (A) $|\vec{a}| + |\vec{b}| = 0$ (B) angle between \vec{a} and \vec{b} is zero (C) $|\vec{a}| = |\vec{b}| = 0$ (D) none of these

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Illustration 2

1. if $\vec{AO} + \vec{OB} = \vec{BO} + \vec{OC}$, then prove that B is the midpoint of AC.



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Illustration 3

1. $ABCDE$ is pentagon, prove that $\vec{AB} + \vec{BC} + \vec{CD} + \vec{DE} + \vec{EA} = \vec{0}$
 $\vec{AB} + \vec{AE} + \vec{BC} + \vec{DC} + \vec{ED} + \vec{AC} = 3\vec{AC}$



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Illustration 4

1. Prove that the resultant of two forces acting at point O and represented by \vec{OB} and \vec{OC} is given by $2\vec{OD}$, where D is the midpoint of BC.



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Illustration 5

1. Prove that the sum of all vectors drawn from the centre of a regular octagon to its vertices is the zero vector.

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Illustration 6

1. ABC is a triangle and P any point on BC. if \vec{PQ} is the sum of $\vec{AP} + \vec{PB} + \vec{PC}$, show that ABPQ is a parallelogram and Q, therefore, is a fixed point.

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Illustration 7

1. Two forces $\vec{A}B$ and $\vec{A}D$ are acting at vertex A of a quadrilateral ABCD and two forces $\vec{C}B$ and $\vec{C}D$ at C prove that their resultant is given by $4\vec{EF}$, where E and F are the midpoints of AC and BD, respectively.

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Illustration 8

1. If $O(\vec{0})$ is the circumcentre and O' the orthocentre of a triangle ABC, then prove that

i. $\vec{OA} + \vec{OB} + \vec{OC} = \vec{OO'}$

ii. $\vec{O'A} + \vec{O'B} + \vec{O'C} = 2\vec{O'O}$

iii. $\vec{AO'} + \vec{O'B} + \vec{O'C} = 2\vec{AO} = \vec{AP}$

where AP is the diameter through A of the circumcircle.

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Illustration 9

1. A unit vector of modulus 2 is equally inclined to x - and y -axes angle at an angle $\pi/3$. Find the length of projection of the vector on the z -axis.

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Illustration 10

1. If the projections of vector \vec{a} on x -, y - and z -axes are 2, 1 and 2 units ,respectively, find the angle at which vector \vec{a} is inclined to the z -axis.

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Illustration 11

1. Find a vector of magnitude 8 units in the direction of the vector $(5\hat{i} - \hat{j} + 2\hat{k})$.

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Illustration 12

1. 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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Illustration 13

1. If $\vec{a} = (-\hat{i} + \hat{j} - \hat{k})$ and $\vec{b} = (2\hat{i} - 2\hat{j} + 2\hat{k})$ then find the unit vector in the direction of $(\vec{a} + \vec{b})$.

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Illustration 14

1. Show that the points A, B and C having position vectors $(3\hat{i} - 4\hat{j} - 4\hat{k})$, $(2\hat{i} - \hat{j} + \hat{k})$ and $(\hat{i} - 3\hat{j} - 5\hat{k})$ respectively, from the vertices of a right-angled triangle.

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Illustration 15

1. If $2\vec{A}C = 3\vec{C}B$, then prove that $2\vec{O}A = 3\vec{C}B$ then prove that $2\vec{O}A + 3\vec{O}B = 5\vec{O}C$ where O is the origin.

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Illustration 16

1. Prove that points $\hat{i} + 2\hat{j} - 3\hat{k}$, $2\hat{i} - \hat{j} + \hat{k}$ and $2\hat{i} + 5\hat{j} - \hat{k}$ form a triangle in space.

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Illustration 17

1. Find the position vector of a point R which divides the line joining the point $P(\hat{i} + 2\hat{j} - \hat{k})$ and $Q(-\hat{i} + \hat{j} + \hat{k})$ in the ratio 2:1, (i) internally and (ii) externally.

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Illustration 18

1. If $\vec{a}, \vec{b}, \vec{c}, \vec{d}$ are the position vectors of points A, B, C and D , respectively referred to the same origin O such that no three of these points are collinear and $\vec{a} + \vec{c} = \vec{b} + \vec{d}$, then prove that quadrilateral $ABCD$ is a parallelogram.

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Illustration 19

1. Find the point of intersection of AB and AC and AD, where $A(6,7,0), B(16,-19,-4), C(0,3,-6)$ and $D(2,-5,10)$.

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Illustration 20

1. Find the angle of vector $\vec{a} = 6\hat{i} + 2\hat{j} - 3\hat{k}$ with x -axis.

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Illustration 21

1. i. Show that the lines joining the vertices of a tetrahedron to the centroids of opposite faces are concurrent.

ii. Show that the joins of the midpoints of the opposite edges of a tetrahedron intersect and bisect each other.

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Illustration 22

1. The midpoint of two opposite sides of a quadrilateral and the midpoint of the diagonals are the vertices of a parallelogram. Prove that using vectors.

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Illustration 23

1. Check whether the three vectors $2\hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = -3\hat{i} + 3\hat{j} + 2\hat{k}$ and $\vec{c} = 3\hat{i} + 4\hat{k}$ form a triangle or not.

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Illustration 24

1. Find the resultant of vectors $\vec{a} = \hat{i} - \hat{j} + 2\hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} - 4\hat{k}$.

Find the unit vector in the direction of the resultant vector.

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Illustration 25

1. If in parallelogram ABCD, diagonal vectors are $\vec{AC} = 2\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{BD} = -6\hat{i} + 7\hat{j} - 2\hat{k}$, then find the adjacent side vectors \vec{AB} and \vec{AD} .

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Illustration 26

1. If two sides of a triangle are $\hat{i} + 2\hat{j}$ and $\hat{i} + \hat{k}$, then find the length of the third side.



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Illustration 27

1. Three coinitial vectors of magnitudes a , $2a$ and $3a$ meet at a point and their directions are along the diagonals of three adjacent faces of a cube. Determine their resultant R . Also prove that the sum of the three vectors determined by the diagonals of three adjacent faces of a cube passing through the same corner, the vectors being directed from the corner, is twice the vector determined by the diagonal of the cube.



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Illustration 28

1. A stone is projected from level ground such that its horizontal and vertical components of initial velocity are $u_x = 10\frac{m}{s}$ and $u_y = 20\frac{m}{s}$ respectively. Then the angle between velocity vector of stone one second before and one second after it attains maximum height is:

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Illustration 29

1. If the resultant of two forces is equal in magnitude to one of the components and perpendicular to its direction, find the other components using the vector method.

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Illustration 30

1. A man travelling towards east at 8km/h finds that the wind seems to blow directly from the north. On doubling the speed, he finds that it appears to come from the north-east. Find the velocity of the wind.



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Illustration 31

1. $OABCDE$ is a regular hexagon of side 2 units in the XY -plane in the first quadrant. O being the origin and OA taken along the x -axis. A point P is taken on a line parallel to the z -axis through the centre of the hexagon at a distance of 3 unit from O in the positive Z direction. Then find vector AP .



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Illustration 32

1. If $\vec{a} = 7\hat{i} - 4\hat{j} - 4\hat{k}$ and $\vec{b} = -2\hat{i} - \hat{j} + 2\hat{k}$, determine vector \vec{c} along the internal bisector of the angle between vectors \vec{a} and \vec{b} such that $|\vec{c}| = 5\sqrt{6}$.

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Illustration 33

1. Find a unit vector \vec{c} if $-\hat{i} + \hat{j} - \hat{k}$ bisects the angle between vectors \vec{c} and $3\hat{i} + 4\hat{j}$.

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Illustration 34

1. The vectors $2\hat{i} + 3\hat{j}$, $5\hat{i} + 6\hat{j}$ and $8\hat{j} + \lambda\hat{j}$ have their initial points at $(1, 1)$. The value of λ so that the vectors terminate on one straight line, is

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Illustration 35

1. Let \vec{a} , \vec{b} and \vec{c} be three non-zero vectors which are positive non-collinear. If $\vec{a} + 3\vec{b}$ is collinear with \vec{c} and $\vec{b} + 2\vec{c}$ is collinear with \vec{a} then \vec{a} then $\vec{a} + 3\vec{b} + 6\vec{c}$ is:

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Illustration 36

1. i. Prove that the points $\vec{a} - 2\vec{b} + 3\vec{c}$, $2\vec{a} + 3\vec{b} - 4\vec{c}$ and $-7\vec{b} + 10\vec{c}$ are collinear, where \vec{a} , \vec{b} and \vec{c} are non-coplanar.
- ii. Prove that the points $A(1, 2, 3)$, $B(3, 4, 7)$ and $C(-3, -2, -5)$ are collinear. Find the ratio in which point C divides AB.

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Illustration 37

1. Check whether the given three vectors are coplanar or non-coplanar :

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

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Illustration 38

1. Prove that the four points $6\hat{i} - 7\hat{j}$, $16\hat{i} - 19\hat{j} - 4\hat{k}$, $3\hat{j} - 6\hat{k}$ and $2\hat{i} + 5\hat{j} + 10\hat{k}$ form a tetrahedron in space.

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Illustration 39

1. If \vec{a} and \vec{b} are two non-collinear vectors, show that points $l_1\vec{a} + m_1\vec{b}$, $l_2\vec{a} + m_2\vec{b}$ and $l_3\vec{a} + m_3\vec{b}$ are collinear if $|l_1l_2l_3m_1m_2m_3| = 0$.

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Illustration 40

1. The vectors \vec{a} and \vec{b} are non collinear. Find for what value of x the vectors $\vec{c} = (x - 2)\vec{a} + \vec{b}$ and $\vec{d} = (2x + 1)\vec{a} - \vec{b}$ are collinear?

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Illustration 41

1. The median AD of the triangle ABC is bisected at E and BE meets AC at F. Find AF:FC.

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Illustration 42

1. Prove that the necessary and sufficient condition for any four points in three-dimensional space to be coplanar is that there exists a linear relation connecting their position vectors such that the algebraic sum of the coefficients (not all zero) in it is zero.

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Illustration 43

1. i. If \vec{a} , \vec{b} and \vec{c} are non-coplanar vectors, prove that vectors $3\vec{a} - 7\vec{b} - 4\vec{c}$, $3\vec{a} - 2\vec{b} + \vec{c}$ and $\vec{a} + \vec{b} + 2\vec{c}$ are coplanar.

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Illustration 44

1. If \vec{a} , \vec{b} and \vec{c} are non-coplanar vectors, prove that the four points $2\vec{a} + 3\vec{b} - \vec{c}$, $\vec{a} - 2\vec{b} + 3\vec{c}$, $3\vec{a} + 4\vec{b} - 2\vec{c}$ and $\vec{a} - 6\vec{b} + 6\vec{c}$ are coplanar.

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Illustration 45

1. Let P an interior point of a triangle ABC and AP , BP , CP meet the sides BC , CA , AB in D , E , F , respectively, Show that
$$\frac{AP}{PD} = \frac{AF}{FB} + \frac{AE}{EC}.$$

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Illustration 46

1. Points $A(\vec{a})$, $B(\vec{b})$, $C(\vec{c})$ and $D(\vec{d})$ are related as $x\vec{a} + y\vec{b} + z\vec{c} + w\vec{d} = 0$ and

$x + y + z + w = 0$, where x, y, z , and w are scalars (sum of any two of x, y, z and w is not zero). Prove that if A, B, C and D are concyclic, then

$$|xy| |\vec{a} - \vec{b}|^2 = |wz| |\vec{c} - \vec{d}|^2.$$

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Concept Application Exercise 1.1

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

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

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3. 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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4. The position vectors of P and Q are $5\hat{i} + 4\hat{j} + a\hat{k}$ and $-\hat{i} + 2\hat{j} - 2\hat{k}$, respectively. If the distance between them is 7, then find the value of a .



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5. Given three points are $A(-3, -2, 0)$, $B(3, -3, 1)$ and $C(5, 0, 2)$. Then find a vector having the same direction as that of \vec{AB} and magnitude equal to $\left| \vec{AC} \right|$.



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6. Find a vector of magnitude 5 units, and parallel to the resultant of the vectors

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



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7. Show that the points $A(1, -2, -8)$, $B(5, 0, -2)$ and $C(11, 3, 7)$ are collinear, and find the ratio in which B divides AC.



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8. If $ABCD$ is a rhombus whose diagonals cut at the origin O , then proved that $\vec{OA} + \vec{OB} + \vec{OC} + \vec{OD} + \vec{O}$.



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9. Let D, E and F be the middle points of the sides BC, CA and AB , respectively of a triangle ABC . Then prove that $\vec{AD} + \vec{BE} + \vec{CF} = \vec{0}$.

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10. Let $ABCD$ be a parallelogram whose diagonals intersect at P and let O be the origin. Then prove that $\vec{OA} + \vec{OB} + \vec{OC} + \vec{OD} = 4\vec{OP}$.

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11. If $ABCD$ is quadrilateral and E and F are the mid-points of AC and BD respectively, prove that $\vec{AB} + \vec{AD} + \vec{CB} + \vec{CD} = 4\vec{EF}$.

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12. If $\vec{AO} + \vec{OB} = \vec{BO} + \vec{OC}$, then A, B, C are (where O is the origin) a. coplanar b. collinear c. non-collinear d. none of these

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13. If the sides of an angle are given by vectors $\vec{a} = \hat{i} - 2\hat{j} + 2\hat{k}$ and $\vec{b} = 2\hat{i} + \hat{j} + 2\hat{k}$, then find the internal bisector of the angle.

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14. $ABCD$ is a parallelogram. If L and M are the mid-points of BC and DC respectively, then express \vec{AL} and \vec{AM} in terms of \vec{AB} and \vec{AD} . Also, prove that $\vec{AL} + \vec{AM} = \frac{3}{2}\vec{AC}$.

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15. $ABCD$ is a quadrilateral and E is the point of intersection of the lines joining the middle points of opposite sides. Show that the resultant of \vec{OA} , \vec{OB} , \vec{OC} and \vec{OD} is equal to $4\vec{OE}$, where O is any point.

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16. What is the unit vector parallel to $\vec{a} = 3\hat{i} + 4\hat{j} - 2\hat{k}$? What vector should be added to \vec{a} so that the resultant is the unit vector \hat{i} ?

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17. The position vectors of points A and B w.r.t. the origin are $\vec{a} = \hat{i} + 3\hat{j} - 2\hat{k}$ and $\vec{b} = 3\hat{i} + \hat{j} - 2\hat{k}$, respectively. Determine vector \vec{OP} which bisects angle AOB , where P is a point on AB .

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18. If $\vec{r}_1, \vec{r}_2, \vec{r}_3$ are the position vectors of three collinear points and scalar p and q exist such that $\vec{r}_3 = p\vec{r}_1 + q\vec{r}_2$, then show that $p + q = 1$.

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19. If \vec{a} and \vec{b} are two vectors of magnitude 1 inclined at 120° , then find the angle between \vec{b} and $\vec{b} - \vec{a}$.

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20. Find the vector of magnitude 3, bisecting the angle between the vectors $\vec{a} = 2\hat{i} + \hat{j} - \hat{k}$ and $\vec{b} = \hat{i} - 2\hat{j} + \hat{k}$.

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1. If \vec{a} , \vec{b} , \vec{c} and \vec{d} are four vectors in three-dimensional space with the same initial point and such that $3\vec{a} + 2\vec{b} + \vec{c} - 2\vec{d} = 0$, Find the point at which AC and BD meet. Find the ratio in which P divides AC and BD .

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2. Show that the vectors $2\vec{a} - \vec{b} + 3\vec{c}$, $\vec{a} + \vec{b} - 2\vec{c}$ and $\vec{a} + \vec{b} - 3\vec{c}$ are non-coplanar vectors (where \vec{a} , \vec{b} , \vec{c} are non-coplanar vectors).

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3. Examine the following vectors for linear independence :

i. $\vec{i} + \vec{j} + \vec{k}$, $2\vec{i} + \vec{j} - \vec{k}$, $-\vec{i} - 2\vec{j} + 2\vec{k}$

ii. $3\vec{i} + \vec{j} - \vec{k}$, $2\vec{i} - \vec{j} + 7\vec{k}$, $7\vec{i} - \vec{j} + 13\vec{k}$

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4. If \vec{a} and \vec{b} are non-collinear vectors and $\vec{A} = (p + 4q)\vec{a} + (2p + q + 1)\vec{b}$ and $\vec{B} = (-2p + q + 2)\vec{a} + (2p - 3q)\vec{b}$, and if $3\vec{A} = 2\vec{B}$, then determine p and q .

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5. If \vec{a} , \vec{b} and \vec{c} are any three non-coplanar vectors, then prove that points

$$l_1\vec{a} + m_1\vec{b} + n_1\vec{c}, l_2\vec{a} + m_2\vec{b} + n_2\vec{c}, l_3\vec{a} + m_3\vec{b} + n_3\vec{c}, l_4\vec{a} + m_4\vec{b} + n_4\vec{c}$$

are coplanar if
$$\begin{vmatrix} l_1 & l_2 & l_3 & l_4 \\ m_1 & m_2 & m_3 & m_4 \\ n_1 & n_2 & n_3 & n_4 \\ 1 & 1 & 1 & 1 \end{vmatrix} = 0$$

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6. If \vec{a} , \vec{b} and \vec{c} are three non-zero, non-coplanar vectors, then find the linear relation between the following four vectors :

$$\vec{a} - 2\vec{b} + 3\vec{c}, 2\vec{a} - 3\vec{b} + 4\vec{c}, 3\vec{a} - 4\vec{b} + 5\vec{c}, 7\vec{a} - 11\vec{b} + 15\vec{c}$$

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7. Let a, b, c be distinct non-negative numbers and the vectors $a\hat{i} + a\hat{j} + c\hat{k}, \hat{i} + \hat{k}, c\hat{i} + c\hat{j} + b\hat{k}$ lie in a plane, and then prove that the quadratic equation $ax^2 + 2cx + b = 0$ has equal roots.

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Subjective

1. The position vectors of the vertices A, B and C of triangle are $\hat{i} + \hat{j}, \hat{j} + \hat{k}$ and $\hat{i} + \hat{k}$, respectively. Find the unit vectors \hat{r} lying in the plane of ABC and perpendicular to IA , where I is the incentre of the triangle.

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2. A ship is sailing towards the north at a speed of 1.25 m/s. The current is taking it towards the east at the rate of 1 m/s and a sailor is climbing a vertical pole on the ship at the rate of 0.5 m/s. Find the velocity of the sailor in space.

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3. Given four points P_1, P_2, P_3 and P_4 on the coordinate plane with origin O which satisfy the condition $\left(\overrightarrow{OP}\right)_{n-1} + \left(\overrightarrow{OP}\right)_{n+1} = \frac{3}{2}\overrightarrow{OP}_n$. If P_1 and P_2 lie on the curve $xy=1$, then prove that P_3 does not lie on the curve

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4. $ABCD$ is a tetrahedron and O is any point. If the lines joining O to the vertices meet the opposite faces at P, Q, R and S , prove that

$$\frac{OP}{AP} + \frac{OQ}{BQ} + \frac{OR}{CR} + \frac{OS}{DS} = 1.$$

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5. A pyramid with vertex at point P has a regular hexagonal base $ABCDEF$, Position vector of points A and B are \hat{i} and $\hat{i} + 2\hat{j}$. The centre of base has the position vector $\hat{i} + \hat{j} + \sqrt{3}\hat{k}$. Altitude drawn from P on the base meets the diagonal AD at point G . Find all possible position vectors of G . It is given that the volume of the pyramid is $6\sqrt{3}$ cubic units and AP is 5 units.



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6. A straight line L cuts the lines AB , AC and AD of a parallelogram $ABCD$ at points B_1 , C_1 and D_1 , respectively. If $\left(\frac{\vec{AB}}{AB}\right)_1 = \lambda_1 \frac{\vec{AB}}{AB}$, $\left(\frac{\vec{AD}}{AD}\right)_1 = \lambda_2 \frac{\vec{AD}}{AD}$ and $\left(\frac{\vec{AC}}{AC}\right)_1 = \lambda_3 \frac{\vec{AC}}{AC}$, then prove that $\frac{1}{\lambda_3} = \frac{1}{\lambda_1} + \frac{1}{\lambda_2}$.



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7. The position vectors of the points P and Q are $5\hat{i} + 7\hat{j} - 2\hat{k}$ and $-3\hat{i} + 3\hat{j} + 6\hat{k}$, respectively. Vector $\vec{A} = 3\hat{i} - \hat{j} + \hat{k}$ passes through point P and vector $\vec{B} = -3\hat{i} + 2\hat{j} + 4\hat{k}$ passes through point Q. A third vector $2\hat{i} + 7\hat{j} - 5\hat{k}$ intersects vectors A and B. Find the position vectors of points of intersection.

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8. Show that $x_1\hat{i} + y_1\hat{j} + z_1\hat{k}$, $x_2\hat{i} + y_2\hat{j} + z_2\hat{k}$, and $x_3\hat{i} + y_3\hat{j} + z_3\hat{k}$, are non-coplanar if

$$|x_1| > |y_1| + |z_1|, |y_2| > |x_2| + |z_2| \text{ and } |z_3| > |x_3| + |y_3|.$$

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9. If \vec{A} and \vec{B} are two vectors and k any scalar quantity greater than zero,

then prove that $\left| \vec{A} + \vec{B} \right|^2 \leq (1+k) \left| \vec{A} \right|^2 + \left(1 + \frac{1}{k} \right) \left| \vec{B} \right|^2$.



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10. Consider the vectors $\hat{i} + \cos(\beta - \alpha)\hat{j} + \cos(\gamma - \alpha)\hat{k}$, $\cos(\alpha - \beta)\hat{i} + \hat{j} + \cos(\gamma - \beta)\hat{k}$ and $\cos(\alpha - \gamma)\hat{i} + \cos(\beta - \gamma)\hat{k} + a\hat{k}$ where α , β , and γ are different angles. If these vectors are coplanar, show that a is independent of α , β and γ

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11. In a triangle PQR , S and T are points on QR and PR , respectively, such that $QS = 3SR$ and $PT = 4TR$. Let M be the point of intersection of PS and QT . Determine the ratio $QM : MT$ using the vector method.

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12. A boat moves in still water with a velocity which is k times less than the river flow velocity. Find the angle to the stream direction at which the boat should be rowed to minimize drifting.

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13. If D, E and F are three points on the sides BC, CA and AB , respectively, of a triangle ABC show that the

$$\frac{BD}{CD} = \frac{CE}{AE} = \frac{AF}{BF} = -1$$

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14. In a quadrilateral $PQRS$, $\vec{PQ} = \vec{a}$, $\vec{QR} = \vec{b}$, $\vec{SP} = \vec{a} - \vec{b}$, M is the midpoint of \vec{QR} and X is a point on SM such that $SX = \frac{4}{5}SM$.

Prove that P, X and R are collinear.

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Single Correct Answer Type

1. Four non zero vectors will always be a. linearly dependent b. linearly independent c. either a or b d. none of these

- A. linearly dependent
- B. linearly independent
- C. either a or b
- D. none of these

Answer: A

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2. Let $\vec{a}, \vec{b}, \vec{c}$ be three unit vectors such that $3\vec{a} + 4\vec{b} + 5\vec{c} = \vec{0}$.

Then which of the following statements is true? (A) \vec{a} is parallel to \vec{b}
(B) \vec{a} is perpendicular to \vec{b} (C) \vec{a} is neither parallel nor perpendicular to \vec{b}
(D) $\vec{a}, \vec{b}, \vec{c}$ are coplanar

- A. \vec{a} is parallel to \vec{b}
- B. \vec{a} is perpendicular to \vec{b}
- C. \vec{a} is neither parallel nor perpendicular to \vec{b}
- D. none of these

Answer: D



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3. Let ABC be a triangle the position vectors of whose vertices are respectively $\hat{i} + 2\hat{j} + 4\hat{k}$, $-2\hat{i} + 2\hat{j} + \hat{k}$ and $2\hat{i} + 4\hat{j} - 3\hat{k}$. Then the $\triangle ABC$ is (A) isosceles (B) equilateral (C) right angled (D) none of these

A. isosceles

B. equilateral

C. right angled

D. none of these

Answer: C



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4. If $|\vec{a} + \vec{b}| < |\vec{a} - \vec{b}|$, then the angle between \vec{a} and \vec{b} can lie in the interval

A. $(-\pi/2, \pi/2)$

B. $(0, \pi)$

C. $(\pi/2, 3\pi/2)$

D. $(0, 2\pi)$

Answer: C

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5. A point O is the centre of a circle circumscribed about a triangle ABC .

Then $\vec{OA} \sin 2A + \vec{OB} \sin 2B + \vec{OC} \sin 2C$ is equal to a.

$(\vec{OA} + \vec{OB} + \vec{OC}) \sin 2A$ b. $3\vec{OG}$, where G is the centroid of triangle ABC c. $\vec{0}$ d. none of these

A. $(\vec{OA} + \vec{OB} + \vec{OC}) \sin 2A$

B. $3\vec{OG}$, where G is the centroid of triangle ABC

C. $\vec{0}$

D. none of these

Answer: C

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6. If G is the centroid of a triangle ABC , prove that

$$\vec{GA} + \vec{GB} + \vec{GC} = \vec{0}.$$

A. $\vec{0}$

B. $3\vec{GA}$

C. $3\vec{GB}$

D. $3\vec{GC}$

Answer: A

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7. If \vec{a} is a non zero vector of modulus $|\vec{a}|$ and m is a non zero scalar such that $m\vec{a}$ is a unit vector, then`

A. $m = \pm 1$

B. $a = |m|$

C. $a = 1/|m|$

D. $a = \frac{1}{m}$

Answer: C



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8. $ABCD$ parallelogram, and A_1 and B_1 are the midpoints of sides BC and CD , respectively. If $\vec{AA}_1 + \vec{AB}_1 = \lambda \vec{AC}$, then λ is equal to a.

$\frac{1}{2}$ b. 1 c. $\frac{3}{2}$ d. 2 e. $\frac{2}{3}$

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

B. 1

C. $\frac{3}{2}$

D. 2

Answer: C



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9. The position vectors of the points P and Q with respect to the origin O are $\vec{a} = \hat{i} + 3\hat{j} - 2\hat{k}$ and $\vec{b} = 3\hat{i} - \hat{j} - 2\hat{k}$, respectively. If M is a point on PQ, such that OM is the bisector of POQ, then \vec{OM} is

A. $2(\hat{i} - \hat{j} + \hat{k})$

B. $2\hat{i} + \hat{j} - 2\hat{k}$

C. $2(-\hat{i} + \hat{j} - \hat{k})$

D. $2(\hat{i} + \hat{j} + \hat{k})$

Answer: B

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10. $ABCD$ is a quadrilateral. E is the point of intersection of the line joining the midpoints of the opposite sides. If O is any point and $\vec{OA} + \vec{OB} + \vec{OC} + \vec{OD} = x\vec{OE}$, then x is equal to a. 3 b. 9 c. 7 d. 4

A. 3

B. 9

C. 7

D. 4

Answer: D

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11. The vector $\vec{AB} = 3\hat{i} + 4\hat{k}$ and $\vec{AC} = 5\hat{i} - 2\hat{j} + 4\hat{k}$ are sides of a triangle ABC . The length of the median through A is (A) $\sqrt{18}$ (B) $\sqrt{72}$ (C) $\sqrt{33}$ (D) $\sqrt{288}$

A. $\sqrt{14}$

B. $\sqrt{18}$

C. $\sqrt{29}$

D. 5

Answer: B

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12. A, B, C and D have position vectors \vec{a} , \vec{b} , \vec{c} and \vec{d} , respectively, such that $\vec{a} - \vec{b} = 2(\vec{d} - \vec{c})$. Then

A. AB and CD bisect each other

B. BD and AC bisect each other

C. AB and CD trisect each other

D. BD and AC trisect each other

Answer: D



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13. If \vec{a} and \vec{b} are two unit vectors and θ is the angle between them, then the unit vector along the angular bisector of \vec{a} and \vec{b} will be given by

A. $\frac{\vec{a} - \vec{b}}{2 \cos(\theta/2)}$

B. $\frac{\vec{a} + \vec{b}}{2 \cos(\theta/2)}$

C. $\frac{\vec{a} - \vec{b}}{\cos(\theta/2)}$

D. none of these

Answer: B



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14. let us define , the length of a vector as $|a| + |b| + |c|$. this definition coincides with the usual definition of the length of a vector $a\hat{i} + b\hat{j} + c\hat{k}$

if

A. $a = b = c = 0$

B. any two of a, b and c are zero

C. any one of a, b and c is zero

D. $a + b + c = 0$

Answer: B



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15. Given three vectors

$\vec{a} = 6\hat{i} - 3\hat{j}$, $\vec{b} = 2\hat{i} - 6\hat{j}$ and $\vec{c} = -2\hat{i} + 21\hat{j}$ such that

$\vec{\alpha} = \vec{a} + \vec{b} + \vec{c}$. Then the resolution of the vector $\vec{\alpha}$ into components

with respect to \vec{a} and \vec{b} is given by (A) $3\vec{a} - 2\vec{b}$ (B) $2\vec{a} - 3\vec{b}$ (C)

$3\vec{b} - 2\vec{a}$ (D) none of these

A. $3\vec{a} - 2\vec{b}$

B. $3\vec{b} - 2\vec{a}$

C. $2\vec{a} - 3\vec{b}$

D. $\vec{a} - 2\vec{b}$

Answer: C



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16. If $\vec{\alpha} + \vec{\beta} + \vec{\gamma} = a\vec{\delta}$ and $\vec{\beta} + \vec{\gamma} + \vec{\delta} = b\vec{\alpha}$, $\vec{\alpha}$ and $\vec{\delta}$ are non-collinear, then $\vec{\alpha} + \vec{\beta} + \vec{\gamma} + \vec{\delta}$ equals a. $a\vec{\alpha}$ b. $b\vec{\delta}$ c. 0 d. $(a + b)\vec{\gamma}$

A. $a\vec{\alpha}$

B. $b\vec{\delta}$

C. 0

D. $(a + b)\vec{\gamma}$

Answer: C



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17. In triangle ABC , $\angle A = 30^\circ$, H is the orthocenter and D is the midpoint of BC . Segment HD is produced to T such that $HD = DT$.

The length AT is equal to a. $2BC$ b. $3BC$ c. $\frac{4}{2}BC$ d. none of these

A. $2BC$

B. $3BC$

C. $\frac{4}{3}BC$

D. none of these

Answer: A



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18. Let $\vec{r}_1, \vec{r}_2, \vec{r}_3, \dots, \vec{r}_n$ be the position vectors of points

P_1, P_2, P_3, P_n relative to the origin O . If the vector equation

$a_1 \vec{r}_1 + a_2 \vec{r}_2 + \dots + a_n \vec{r}_n = 0$ hold, then a similar equation will also

hold w.r.t. to any other origin provided a. $a_1 + a_2 + \dots + a_n = n$ b.

$a_1 + a_2 + \dots + a_n = 1$ c. $a_1 + a_2 + \dots + a_n = 0$ d. $a_1 = a_2 = a_3 = \dots = a_n = 0$

A. $a_1 + a_2 + \dots + a_n = n$

B. $a_1 + a_2 + \dots + a_n = 1$

C. $a_1 + a_2 + \dots + a_n = 0$

D. $a_1 = a_2 = a_3 = \dots = a_n = 0$

Answer: C



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19. Given three non-zero, non-coplanar vectors \vec{a} , \vec{b} and \vec{c} .
 $\vec{r}_1 = p\vec{a} + q\vec{b} + \vec{c}$ and $\vec{r}_2 = \vec{a} + p\vec{b} + q\vec{c}$. If the vectors
 $\vec{r}_1 + 2\vec{r}_2$ and $2\vec{r}_1 + \vec{r}_2$ are collinear, then (p, q) is

A. $(0, 0)$

B. $(1, -1)$

C. $(-1, 1)$

D. $(1, 1)$

Answer: D



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20. If the vectors \vec{a} and \vec{b} are linearly independent and satisfying $(\sqrt{3}\tan\theta + 1)\vec{a} + (\sqrt{3}\sec\theta - 2)\vec{b} = \vec{0}$, then the most general values of θ are:

A. $n\pi - \frac{\pi}{6}, n \in Z$

B. $2n\pi \pm \frac{11\pi}{6}, n \in Z$

C. $n\pi \pm \frac{\pi}{6}, n \in Z$

D. $2n\pi + \frac{11\pi}{6}, n \in Z$

Answer: D



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21. In a trapezium ABCD the vector $\overrightarrow{BC} = \alpha \overrightarrow{AD}$. If $\overrightarrow{p} = \overrightarrow{AC} + \overrightarrow{BD}$ is collinear with \overrightarrow{AD} such that $\overrightarrow{p} = \mu \overrightarrow{AD}$, then

A. $\mu = \alpha + 2$

B. $\mu + \alpha = 1$

C. $\alpha = \mu + 1$

D. $\mu = \alpha + 1$

Answer: D



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22. Vectors $\overrightarrow{a} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\overrightarrow{b} = 2\hat{i} - \hat{j} + \hat{k}$ and $\overrightarrow{c} = 3\hat{i} + \hat{j} + 4\hat{k}$ are so placed that the end point of one vector is the starting point of the next vector. Then the vectors are

A. not coplanar

B. coplanar but cannot form a triangle

C. coplanar and form a triangle

D. coplanar and can form a right-angled triangle

Answer: B



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23. Vectors $\vec{a} = -4\hat{i} + 3\hat{k}$; $\vec{b} = 14\hat{i} + 2\hat{j} - 5\hat{k}$ are laid off from one point. Vector \vec{d} , which is being laid off from the same point dividing the angle between vectors \vec{a} and \vec{b} in equal halves and having the magnitude $\sqrt{6}$, is a. $\hat{i} + \hat{j} + 2\hat{k}$ b. $\hat{i} - \hat{j} + 2\hat{k}$ c. $\hat{i} + \hat{j} - 2\hat{k}$ d. $2\hat{i} - \hat{j} - 2\hat{k}$

A. $\hat{i} + \hat{j} + 2\hat{k}$

B. $\hat{i} - \hat{j} + 2\hat{k}$

C. $\hat{i} + \hat{j} - 2\hat{k}$

D. $2\hat{i} - \hat{j} - 2\hat{k}$

Answer: A



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24. If $\hat{i} - 3\hat{j} + 5\hat{k}$ bisects the angle between \hat{a} and $-\hat{i} + 2\hat{j} + 2\hat{k}$, where \hat{a} is a unit vector, then

A. $\hat{a} = \frac{1}{150} (41\hat{i} + 88\hat{j} - 40\hat{k})$

B. $\hat{a} = \frac{1}{105} (41\hat{i} + 88\hat{j} + 40\hat{k})$

C. $\hat{a} = \frac{1}{105} (-41\hat{i} + 88\hat{j} - 40\hat{k})$

D. $\hat{a} = \frac{1}{105} (41\hat{i} - 88\hat{j} - 40\hat{k})$

Answer: D



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25. If $4\hat{i} + 7\hat{j} + 8\hat{k}$, $2\hat{i} + 3\hat{j} + 4\hat{k}$ and $2\hat{i} + 5\hat{j} + 7\hat{k}$ are the position vectors of the vertices A, B and C, respectively, of triangle ABC, then the

position vector of the point where the bisector of angle A meets BC is

A. $\frac{2}{3}(-6\hat{i} - 8\hat{j} - 6\hat{k})$

B. $\frac{2}{3}(6\hat{i} + 8\hat{j} + 6\hat{k})$

C. $\frac{1}{3}(6\hat{i} + 13\hat{j} + 18\hat{k})$

D. $\frac{1}{3}(5\hat{j} + 12\hat{k})$

Answer: C



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26. If \vec{b} is a vector whose initial point divides the join of $5\hat{i}$ and $5\hat{j}$ in the ratio $k:1$ and whose terminal point is the origin and $|\vec{b}| \leq \sqrt{37}$, then k lies in the interval

A. $[-6, -1/16]$

B. $(-\infty, -6] \cup [-1/6, \infty)$

C. $[0, 6]$

D. none of these

Answer: B



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27. The value of the λ so that P, Q, R, S on the sides OA, OB, OC and AB of a regular tetrahedron are coplanar. When $\frac{OP}{OA} = \frac{1}{3}$; $\frac{OQ}{OB} = \frac{1}{2}$ and $\frac{OS}{AB} = \lambda$ is (A) $\lambda = \frac{1}{2}$ (B) $\lambda = -1$ (C) $\lambda = 0$ (D) $\lambda = 2$

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

B. $\lambda = -1$

C. $\lambda = 0$

D. for no value of λ

Answer: B



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28. 'I' is the incentre of triangle ABC whose corresponding sides are a, b, c , respectively. $a\vec{IA} + b\vec{IB} + c\vec{IC}$ is always equal to a. $\vec{0}$ b. $(a + b + c)\vec{BC}$ c. $(\vec{a} + \vec{b} + \vec{c})\vec{AC}$ d. $(a + b + c)\vec{AB}$

A. $\vec{0}$

B. $(a + b + c)\vec{BC}$

C. $(\vec{a} + \vec{b} + \vec{c})\vec{AC}$

D. $(a + b + c)\vec{AB}$

Answer: A

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29. Let $x^2 + 3y^2 = 3$ be the equation of an ellipse in the $x - y$ plane.

A and B are two points whose position vectors are

$-\sqrt{3}\hat{i}$ and $-\sqrt{3}\hat{i} + 2\hat{k}$. Then the position vector of a point P on the

ellipse such that $\angle APB = \pi/4$ is a. $\pm\hat{j}$ b. $\pm(\hat{i} + \hat{j})$ c. $\pm\hat{i}$ d. none of

these

A. $\pm \hat{j}$

B. $\pm (\hat{i} + \hat{j})$

C. $\pm \hat{i}$

D. none of these

Answer: A



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30. Locus of the point P, for which \overrightarrow{OP} represents a vector with direction cosine $\cos \alpha = \frac{1}{2}$ (where O is the origin) is

A. a circle parallel to the y-z plane with centre on the x-axis

B. a conic concentric with the positive x-axis having vertex at the origin and slant height equal to the magnitude of the vector

C. a ray emanating from the origin and making an angle of 60° with the x-axis

D. a disc parallel to the y - z plane with centre on the x -axis and radius

equal to $\left| \vec{OP} \right| \sin 60^\circ$.

Answer: B



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31. If \vec{x} and \vec{y} are two non-collinear vectors and ABC is a triangle with side lengths $a, b,$ and c satisfying

$$(20a - 15b)\vec{x} + (15b - 12c)\vec{y} + (12c - 20a)(\vec{x} \times \vec{y}) = 0, \quad \text{then}$$

triangle ABC is a. an acute-angled triangle b. an obtuse-angled triangle

c. a right-angled triangle d. an isosceles triangle

A. an acute-angled triangle

B. an obtuse-angled triangle

C. a right-angled triangle

D. an isosceles triangle

Answer: C



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32. A uni-modular tangent vector on the curve

$x = t^2 + 2, y = 4t - 5, z = 2t^2 - 6t = 2$ is a. $\frac{1}{3}(2\hat{i} + 2\hat{j} + \hat{k})$ b.

$\frac{1}{3}(\hat{i} - \hat{j} - \hat{k})$ c. $\frac{1}{6}(2\hat{i} + \hat{j} + \hat{k})$ d. $\frac{2}{3}(\hat{i} + \hat{j} + \hat{k})$

A. $\frac{1}{3}(2\hat{i} + 2\hat{j} + \hat{k})$

B. $\frac{1}{3}(\hat{i} - \hat{j} - \hat{k})$

C. $\frac{1}{6}(2\hat{i} + \hat{j} + \hat{k})$

D. $\frac{2}{3}(\hat{i} + \hat{j} + \hat{k})$

Answer: A



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33. If \vec{x} and \vec{y} are two non-collinear vectors and a, b, and c represent the sides of a ABC satisfying

$(a - b)\vec{x} + (b - c)\vec{y} + (c - a)(\vec{x} \times \vec{y}) = 0$, then ABC is (where

$\vec{x} \times \vec{y}$ is perpendicular to the plane of x and y) a. an acute-angled triangle b. an obtuse-angled triangle c. a right-angled triangle d. a scalene triangle

- A. an acute-angled triangle
- B. an obtuse-angled triangle
- C. a right-angled triangle
- D. a scalene triangle

Answer: A



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34. \vec{A} is a vector with direction cosines $\cos \alpha, \cos \beta$ and $\cos \gamma$. Assuming the $y - z$ plane as a mirror, the direction cosines of the reflected image of \vec{A} in the plane are a. $\cos \alpha, \cos \beta, \cos \gamma$ b. $\cos \alpha, -\cos \beta, \cos \gamma$ c. $-\cos \alpha, \cos \beta, \cos \gamma$ d. $-\cos \alpha, -\cos \beta, -\cos \gamma$

- A. $\cos \alpha, \cos \beta, \cos \gamma$

B. $\cos \alpha, -\cos \beta, \cos \gamma$

C. $-\cos \alpha, \cos \beta, \cos \gamma$

D. $-\cos \alpha, -\cos \beta, -\cos \gamma$

Answer: C



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35. The points with position vectors $60\hat{i} + 3\hat{j}$, $40\hat{i} - 8\hat{j}$, $a\hat{i} - 52\hat{j}$ are collinear if (A) $a = -40$ (B) $a = 40$ (C) $a = 20$ (D) none of these

A. $a = -40$

B. $a = 40$

C. $a = 20$

D. none of these

Answer: A



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36. Let a, b and c be distinct non-negative numbers. If vectors $a\hat{i} + a\hat{j} + c\hat{k}$, $\hat{i} + \hat{k}$ and $c\hat{i} + c\hat{j} + b\hat{k}$ are coplanar, then c is

- A. the arithmetic mean of a and b
- B. the geometric mean of a and b
- C. the harmonic mean of a and b
- D. equal to zero

Answer: B

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37. Let

$$\vec{a} = \vec{i} - \vec{k}, \vec{b} = x\vec{i} + \vec{j} + (1-x)\vec{k} \text{ and } \vec{c} = y\vec{i} + x\vec{j} + (1+x)$$

. Then \vec{a} , \vec{b} and \vec{c} are non-coplanar for

- A. some values of x

B. some values of y

C. no values of x and y

D. for all values of x and y

Answer: D



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38. Let α, β and γ be distinct real numbers. The points whose position vector's are $\alpha\hat{i} + \beta\hat{j} + \gamma\hat{k}; \beta\hat{i} + \gamma\hat{j} + \alpha\hat{k}$ and $\gamma\hat{i} + \alpha\hat{j} + \beta\hat{k}$ a. are collinear. b. forms an equilateral triangle. c. forms a scalene triangle. d. forms a right angled triangle.

A. are collinear

B. form an equilateral triangle

C. form a scalene triangle

D. form a right-angled triangle

Answer: B



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39. The number of distinct values of λ , for which the vectors $-\lambda^2\hat{i} + \hat{j} + \hat{k}$, $\hat{i} - \lambda^2\hat{j} + \hat{k}$ and $\hat{i} + \hat{j} - \lambda^2\hat{k}$ are coplanar, is

A. zero

B. one

C. two

D. three

Answer: C



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40. If $\vec{a} = \hat{i} + \hat{j} + \hat{k}$, $\vec{b} = 4\hat{i} + 3\hat{j} + 4\hat{k}$ and $\vec{c} = \hat{i} + \alpha\hat{j} + \beta\hat{k}$

are linearly dependent vectors and $|\vec{c}| = \sqrt{3}$ then:

A. $\alpha = 1, \beta = -1$

B. $\alpha = 1, \beta = \pm 1$

C. $\alpha = -1, \beta = \pm 1$

D. $\alpha = \pm 1, \beta = 1$

Answer: D



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Multiple Correct Answer Type

1. The vectors $x\hat{i} + (x + 1)\hat{j} + (x + 2)\hat{k}$, $(x + 3)\hat{i} + (x + 4)\hat{j} + (x + 5)\hat{k}$ and $(x + 6)\hat{i}$ are coplanar if x is equal to

A. 1

B. -3

C. 4

D. 0

Answer: A::B::C::D

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2. The sides of a parallelogram are $2\hat{i} + 4\hat{j} - 5\hat{k}$ and $\hat{i} + 2\hat{j} + 3\hat{k}$. The unit vector parallel to one of the diagonals is

A. $\frac{1}{7}(3\hat{i} + 6\hat{j} - 2\hat{k})$

B. $\frac{1}{7}(3\hat{i} - 6\hat{j} - 2\hat{k})$

C. $\frac{1}{\sqrt{69}}(\hat{i} + 2\hat{j} + 8\hat{k})$

D. $\frac{1}{\sqrt{69}}(-\hat{i} - 2\hat{j} + 8\hat{k})$

Answer: A::D

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3. The vector \vec{a} has the components $2p$ and 1 w.r.t. a rectangular Cartesian system. This system is rotated through a certain angle about the origin in the counterclockwise sense. If, with respect to a new system, \vec{a} has components $(p + 1)$ and 1 , then p is equal to

a. -4 b. $-1/3$ c. 1 d. 2

A. -1

B. $-1/3$

C. 1

D. 2

Answer: B::C



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4. If points $\hat{i} + \hat{j}$, $\hat{i} - \hat{j}$ and $p\hat{i} + q\hat{j} + r\hat{k}$ are collinear, then

A. $p = 1$

B. $r = 0$

C. $q \in R$

D. $q \neq 1$

Answer: A::B::D



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5. If $\vec{a}, \vec{b}, \vec{c}$ are non coplanar vectors and λ is a real number, then the vectors $\vec{a} + 2\vec{b} + 3\vec{c}, \lambda\vec{b} + 4\vec{c}$ and $(2\lambda - 1)\vec{c}$ are non coplanar for

A. $\mu \in R$

B. $\lambda = \frac{1}{2}$

C. $\lambda = 0$

D. no value of λ

Answer: A::B::C



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6. If the resultant of three forces $\vec{F}_1 = p\hat{i} + 3\hat{j} - \hat{k}$, $\vec{F}_2 = 6\hat{i} - \hat{k}$ and $\vec{F}_3 = -5\hat{i} + \hat{j} + 2\hat{k}$ acting on a particle has a magnitude equal to 5 units, then the value of p is

A. -6

B. -4

C. 2

D. 4

Answer: B::C



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7. If the vectors $\hat{i} - \hat{j}$, $\hat{j} + \hat{k}$ and \vec{a} form a triangle then \vec{a} may be (A) $-\hat{i} - \hat{k}$ (B) $\hat{i} - 2\hat{j} - \hat{k}$ (C) $2\hat{i} + \hat{j} + \hat{k}$ (D) $\hat{i} + \hat{k}$

A. $-\hat{i} - \hat{k}$

B. $\hat{i} - 2\hat{j} - \hat{k}$

C. $2\hat{i} + \hat{j} + \hat{k}$

D. $\hat{i} + \hat{k}$

Answer: A::B::D



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8. The vector $\hat{i} + x\hat{j} + 3\hat{k}$ is rotated through an angle θ and doubled in magnitude, then it becomes $4\hat{i} + (4x - 2)\hat{j} + 2\hat{k}$. Then values of x are

(A) $-\frac{2}{3}$ (B) $\frac{1}{3}$ (C) $\frac{2}{3}$ (D) 2

A. 1

B. $-\frac{2}{3}$

C. 2

D. $\frac{4}{3}$

Answer: B::C

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9. \vec{a} , \vec{b} and \vec{c} are three coplanar vectors such that $\vec{a} + \vec{b} + \vec{c} = 0$.

If three vectors \vec{p} , \vec{q} and \vec{r} are parallel to \vec{a} , \vec{b} and \vec{c} , respectively,

and have integral but different magnitudes, then among the following

options, $|\vec{p} + \vec{q} + \vec{r}|$ can take a value equal to

A. 1

B. 0

C. $\sqrt{3}$

D. 2

Answer: C::D

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10. If non-zero vectors a and b are equally inclined to coplanar vector c ,

then c can be

$$\text{A. } \frac{|\vec{a}|}{|\vec{a}| + 2|\vec{b}|} \vec{a} + \frac{|\vec{b}|}{|\vec{a}| + |\vec{b}|} \vec{b}$$

$$\text{B. } \frac{|\vec{b}|}{|\vec{a}| + |\vec{b}|} \vec{a} + \frac{|\vec{a}|}{|\vec{a}| + |\vec{b}|} \vec{b}$$

$$\text{C. } \frac{|\vec{a}|}{|\vec{a}| + 2|\vec{b}|} \vec{a} + \frac{|\vec{b}|}{|\vec{a}| + 2|\vec{b}|} \vec{b}$$

$$\text{D. } \frac{|\vec{b}|}{2|\vec{a}| + |\vec{b}|} \vec{a} + \frac{|\vec{a}|}{2|\vec{a}| + |\vec{b}|} \vec{b}$$

Answer: B::D



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11. If $A(-4, 0, 3)$ and $B(14, 2, -5)$, then which one of the following points lie on the bisector of the angle between \vec{OA} and \vec{OB} (O is the origin of reference)? a. $(2, 2, 4)$ b. $(2, 11, 5)$ c. $(-3, -3, -6)$ d. $(1, 1, 2)$

A. $(2, 2, 4)$

B. (2, 11, 5)

C. (-3, -3, -6)

D. (1, 1, 2)

Answer: A::C::D



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12. In a four-dimensional space where unit vectors along the axes are

$\hat{i}, \hat{j}, \hat{k}$ and \hat{l} , and $\vec{a}_1, \vec{a}_2, \vec{a}_3, \vec{a}_4$ are four non-zero vectors such that

no vector can be expressed as a linear combination of others and

$$(\lambda - 1)(\vec{a}_1 - \vec{a}_2) + \mu(\vec{a}_2 + \vec{a}_3) + \gamma(\vec{a}_3 + \vec{a}_4 - 2\vec{a}_2) + \vec{a}_3 + \delta\vec{a}_4 = \vec{0}$$

then

A. $\lambda = 1$

B. $\mu = -2/3$

C. $\gamma = 2/3$

D. $\delta = 1/3$

Answer: A::B::D



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13. Let ABC be a triangle, the position vectors of whose vertices are respectively

$7\hat{j} + 10\hat{k}$, $-\hat{i} + 6\hat{j} + 6\hat{k}$ and $-4\hat{i} + 9\hat{j} + 6\hat{k}$. Then, ΔABC is

- A. isosceles
- B. equilateral
- C. right angled
- D. none of these

Answer: A::C



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1. A vector has components p and 1 with respect to a rectangular Cartesian system. The axes are rotated through an angle α about the origin in the anticlockwise sense.

Statement 1: If the vector has component $p + 2$ and 1 with respect to the new system, then $p = -1$.

Statement 2: Magnitude of the original vector and new vector remains the same.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: A



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2. Statement 1: if three points P, Q and R have position vectors \vec{a}, \vec{b} , and \vec{c} , respectively, and $2\vec{a} + 3\vec{b} - 5\vec{c} = 0$, then the points $P, Q,$ and R must be collinear. Statement 2: If for three points $A, B,$ and $C, \vec{AB} = \lambda\vec{AC}$, then points $A, B,$ and C must be collinear.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: A



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3. Statement 1: If \vec{u} and \vec{v} are unit vectors inclined at an angle α and \vec{x} is a unit vector bisecting the angle between them, then $\vec{x} = (\vec{u} + \vec{v}) / (2 \sin(\alpha/2))$. Statement 2: If ΔABC is an isosceles triangle with $AB = AC = 1$, then the vector representing the bisector of angle A is given by $\vec{AD} = (\vec{AB} + \vec{AC}) / 2$.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: D

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4. Statement 1: If $\cos \alpha$, $\cos \beta$, and $\cos \gamma$ are the direction cosines of any line segment, then $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$. Statement 2: If $\cos \alpha$, $\cos \beta$, and $\cos \gamma$ are the direction cosines of any line segment, then $\cos^2 \alpha + \cos^2 \beta + \cos^2 \gamma = 1$.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: B



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5. Statement 1: The direction cosines of one of the angular bisectors of two intersecting lines having direction cosines as l_1, m_1, n_1 and l_2, m_2, n_2 are proportional to $l_1 + l_2, m_1 + m_2, n_1 + n_2$. Statement 2: The angle between the two intersection lines having direction cosines as l_1, m_1, n_1 and l_2, m_2, n_2 is given by $\cos \theta = l_1 l_2 + m_1 m_2 + n_1 n_2$.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: B

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6. Statement 1: In ΔABC , $\vec{AB} + \vec{BC} + \vec{CA} = 0$ Statement 2: If $\vec{OA} = \vec{a}$, $\vec{OB} = \vec{b}$, then $\vec{AB} = \vec{a} + \vec{b}$

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: C

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7. Statement 1 : $\vec{a} = 3\vec{i} + p\vec{j} + 3\vec{k}$ and $\vec{b} = 2\vec{i} + 3\vec{j} + q\vec{k}$ are parallel vectors if $p = 9/2$ and $q = 2$.

Statement _____ 2 _____ : _____ If

$\vec{a} = a_1 \vec{i} + a_2 \vec{j} + a_3 \vec{k}$ and $\vec{b} = b_1 \vec{i} + b_2 \vec{j} + b_3 \vec{k}$ are parallel,

then $\frac{a_1}{b_1} = \frac{a_2}{b_2} = \frac{a_3}{b_3}$.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: A



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8. Statement 1 : If $|\vec{a} + \vec{b}| = |\vec{a} - \vec{b}|$, then \vec{a} and \vec{b} are perpendicular to each other.

Statement 2 : If the diagonals of a parallelogram are equal in magnitude, then the parallelogram is a rectangle.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: A



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9. Statement 1 : Let $A(\vec{a})$, $B(\vec{b})$ and $C(\vec{c})$ be three points such that $\vec{a} = 2\hat{i} + \hat{k}$, $\vec{b} = 3\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{c} = -\hat{i} + 7\hat{j} - 5\hat{k}$. Then OABC is tetrahedron.

Statement 2 : Let $A(\vec{a})$, $B(\vec{b})$ and $C(\vec{c})$ be three points such that vectors \vec{a} , \vec{b} and \vec{c} are non-coplanar. Then OABC is a tetrahedron, where O is the origin.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: A

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10. Statement 1: Let \vec{a} , \vec{b} , \vec{c} and \vec{d} be the position vectors of four points A, B, C and D and $3\vec{a} - 2\vec{b} + 5\vec{c} - 6\vec{d} = \vec{0}$. Then points $A, B, C,$ and D are coplanar. Statement 2: Three non-zero, linearly dependent coinitial vector $(\vec{P}Q, \vec{P}R$ and $\vec{P}S)$ are coplanar. Then $\vec{P}Q = \lambda\vec{P}R + \mu\vec{P}S$, where λ and μ are scalars.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.
- B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.
- C. Statement 1 is true and Statement 2 is false.
- D. Statement 1 is false and Statement 2 is true.

Answer: A



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11. Statement 1 : If $|\vec{a}| = 3$, $|\vec{b}| = 4$ and $|\vec{a} + \vec{b}| = 5$, then $|\vec{a} - \vec{b}| = 5$.

Statement 2 : The length of the diagonals of a rectangle is the same.

- A. Both the statements are true, and Statement 2 is the correct explanation for Statement 1.

B. Both the statements are true, but Statement 2 is not the correct explanation for Statement 1.

C. Statement 1 is true and Statement 2 is false.

D. Statement 1 is false and Statement 2 is true.

Answer: A

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Linked Comprehension Type

1. ABCD is a parallelogram. L is a point on BC which divides BC in the ratio 1:2. AL intersects BD at P. M is a point on DC which divides DC in the ratio 1:2 and AM intersects BD in Q.

Point P divides AL in the ratio

A. 1:2

B. 1:3

C. 3:1

D. 2:1

Answer: C



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2. ABCD is a parallelogram. L is a point on BC which divides BC in the ratio 1:2. AL intersects BD at P. M is a point on DC which divides DC in the ratio 1:2 and AM intersects BD in Q.

Point Q divides DB in the ratio

A. 1:2

B. 1:3

C. 3:1

D. 2:1

Answer: B



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3. ABCD is a parallelogram. L is a point on BC which divides BC in the ratio 1:2 AL intersects BD at P. M is a point on DC which divides DC in the ratio 1:2 and AM intersects BD in Q.

Q. $PQ:DB$ is equal to

A. $2/3$

B. $1/3$

C. $1/2$

D. $3/4$

Answer: C

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4. Let OABCD be a pentagon in which the sides OA and CB are parallel and the sides OD and AB are parallel as shown in figure. Also, $OA:CB=2:1$ and

OD:AB=1:3. if the diagonals OC and AD meet at x, find OX:OC.

A. $3/4$

B. $1/3$

C. $2/5$

D. $1/2$

Answer: C



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5. Let OABCD be a pentagon in which the sides OA and CB are parallel and the sides OD and AB are parallel as shown in figure. Also, OA:CB=2:1 and OD:AB=1:3. if the diagonals OC and AD meet at x, find OX:OC.

A. $5/2$

B. 6

C. $7/3$

D. 4

Answer: B



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6. If ABCDEF is regular hexagon, then $\overrightarrow{AD} + \overrightarrow{EB} + \overrightarrow{FC}$ is

A. $2 \overrightarrow{AB}$

B. $3 \overrightarrow{AB}$

C. $4 \overrightarrow{AB}$

D. none of these

Answer: C



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7. Consider the regular hexagon ABCDEF with centre at O (origin).

Q. Five forces $\vec{AB}, \vec{AC}, \vec{AD}, \vec{AE}, \vec{AF}$ act at the vertex A of a regular hexagon ABCDEF. Then, their resultant is (a) $3AO$ (b) $2AO$ (c) $4AO$ (d) $6AO$

A. $3\vec{AO}$

B. $2\vec{AO}$

C. $4\vec{AO}$

D. $6\vec{AO}$

Answer: D



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8. Let A,B,C,D,E represent vertices of a regular pentagon ABCDE. Given the position vector of these vertices be $a, a+b, b, \lambda a$ and λb respectively.

Q. AD divides EC in the ratio

A. $1 - \cos \frac{3\pi}{5} : \cos \frac{3\pi}{5}$

B. $1 + 2 \cos \frac{2\pi}{5} : \cos \frac{\pi}{5}$

C. $1 + 2 \cos \frac{\pi}{5} : 2 \cos \frac{\pi}{5}$

D. None of these

Answer: C



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9. Let A,B,C,D,E represent vertices of a regular pentagon ABCDE. Given the position vector of these vertices be $a, a+b, b, \lambda a$ and λb respectively.

Q. AD divides EC in the ratio

A. $\cos \frac{2\pi}{5} : 1$

B. $\cos \frac{3\pi}{5} : 1$

C. $1 : 2 \cos \frac{2\pi}{5}$

D. $1 : 2$

Answer: C

10. In a parallelogram OABC vectors $\vec{a}, \vec{b}, \vec{c}$ respectively, THE POSITION VECTORS OF VERTICES A, B, C with reference to O as origin. A point E is taken on the side BC which divides it in the ratio of 2:1 also, the line segment AE intersects the line bisecting the angle $\angle AOC$ internally at point P. if CP when extended meets AB in points F, then

Q. The position vector of point P is

A.
$$\frac{|\vec{a}| |\vec{c}|}{3|\vec{c}| + 2|\vec{a}|} \left(\frac{\vec{a}}{|\vec{a}|} + \frac{\vec{c}}{|\vec{c}|} \right)$$

B.
$$\frac{3|\vec{a}| |\vec{c}|}{3|\vec{c}| + 2|\vec{a}|} \left(\frac{\vec{a}}{|\vec{a}|} + \frac{\vec{c}}{|\vec{c}|} \right)$$

C.
$$\frac{2|\vec{a}| |\vec{c}|}{3|\vec{c}| + 2|\vec{a}|} \left(\frac{\vec{a}}{|\vec{a}|} + \frac{\vec{c}}{|\vec{c}|} \right)$$

D. None of these

Answer: B

11. In a parallelogram OABC vectors $\vec{a}, \vec{b}, \vec{c}$ respectively, THE POSITION VECTORS OF VERTICES A,B,C with reference to O as origin. A point E is taken on the side BC which divides it in the ratio of 2:1 also, the line segment AE intersects the line bisecting the angle $\angle AOC$ internally at point P. if CP when extended meets AB in points F, then

Q. The position vector of point P is

A.
$$\frac{2|\vec{a}|}{\left| \left| \vec{a} \right| - 3\left| \vec{c} \right| \right|}$$

B.
$$\frac{|\vec{a}|}{\left| \left| \vec{a} \right| - 3\left| \vec{c} \right| \right|}$$

C.
$$\frac{3|\vec{a}|}{\left| \left| \vec{a} \right| - 3\left| \vec{c} \right| \right|}$$

D.
$$\frac{3|\vec{c}|}{3\left| \vec{c} \right| - \left| \vec{a} \right|}$$

Answer: D



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1. Refer to the following diagram :



Column I	Column II
a. Collinear vectors	p. \vec{a}
b. Coinitial vectors	q. \vec{b}
c. Equal vectors	r. \vec{c}
d. Unlike vectors (same initial point)	s. \vec{d}

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2. a and b form the consecutive sides of a regular hexagon ABCDEF.

Column I	Column II
a. If $\mathbf{CD} = x\mathbf{a} + y\mathbf{b}$, then	p. $x = -2$
b. If $\mathbf{CE} = x\mathbf{a} + y\mathbf{b}$, then	q. $x = -1$
c. If $\mathbf{AE} = x\mathbf{a} + y\mathbf{b}$, then	r. $y = 1$
d. If $\mathbf{AD} = -x\mathbf{b}$, then	s. $y = 2$

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3. 

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Integer Type

1. Let ABC be a triangle whose centroid is G , orthocentre is H and circumcentre is the origin ' O '. If D is any point in the plane of the triangle such that no three of O, A, C and D are collinear satisfying the relation.

$AD+BD+CH+3HB=\lambda HD$, then what is the value of the scalar Δ .

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2. If the resultant of three forces $\vec{F}_1 = p\hat{i} + 3\hat{j} - \hat{k}$, $\vec{F}_2 = -5\hat{i} + \hat{j} + 2\hat{k}$ and $\vec{F}_3 = 6\hat{i} - \hat{k}$ acting on a particle has a magnitude equal to 5 units, then what is difference in the values of p ?

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3. Let \vec{a} , \vec{b} and \vec{c} be unit vector such that $\vec{a} + \vec{b} - \vec{c} = 0$. If the area of triangle formed by vectors \vec{a} and \vec{b} is A , then what is the value of $4A^2$?

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4. Find the least positive integral value of x for which the angle between vectors $\vec{a} = x\hat{i} - 3\hat{j} - \hat{k}$ and $\vec{b} = 2x\hat{i} + x\hat{j} - \hat{k}$ is acute.

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5. Vectors along the adjacent sides of parallelogram are $\vec{a} = 2\hat{i} + 4\hat{j} - 5\hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} + 3\hat{k}$. Find the length of the longer diagonal of the parallelogram.

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6. If vectors $\vec{a} = \hat{i} + 2\hat{j} - \hat{k}$, $\vec{b} = 2\hat{i} - \hat{j} + \hat{k}$ and $\vec{c} = \lambda\hat{i} + \hat{j} + 2\hat{k}$ are coplanar, then find the value of λ .

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7. Consider the set of eight vector $V = \{a\hat{i} + b\hat{j} + c\hat{k}; a, b, c \in \{-1, 1\}\}$. Three non-coplanar vectors can be chosen from V is 2^p ways. Then p is _____.

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8. Suppose that \vec{p} , \vec{q} and \vec{r} are three non-coplanar in R^3 , Let the components of a vector \vec{s} along \vec{p} , \vec{q} and \vec{r} be 4, 3, and 5, respectively, if the components this vector \vec{s} along $(-\vec{p} + \vec{q} + \vec{r})$, $(\vec{p} - \vec{q} + \vec{r})$ and $(-\vec{p} - \vec{q} + \vec{r})$ are x , y and z , respectively, then the value of $2x + y + z$ is

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1. Find the all the values of lamda such that $(x, y, z) \neq (0, 0, 0)$ and $x(\hat{i} + \hat{j} + 3\hat{k}) + y(3\hat{i} - 3\hat{j} + \hat{k}) + z(-4\hat{i} + 5\hat{j}) = \lambda(x\hat{i} + y\hat{j} + z\hat{k})$

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2. A vector a has components a_1, a_2 and a_3 in a right handed rectangular cartesian system OXYZ. The coordinate system is rotated about Z-axis through angle $\frac{\pi}{2}$. Find components of a in the new system.

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3. The position vectors of the points A,B, C and D are $3\hat{i} - 2\hat{j} - \hat{k}$, $2\hat{i} + 3\hat{j} - 34\hat{k}$, $-\hat{i} + \hat{j} + 2\hat{k}$ and $4\hat{i} + 5\hat{j} + \lambda\hat{k}$ respectively. If the points A, B ,C and D lie on a plane, find the value of λ .

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4. Let $OACB$ be a parallelogram with O at the origin and OC a diagonal. Let D be the mid-point of OA . Using vector methods prove that BD and CO intersects in the same ratio. Determine this ratio.



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5. In a triangle ABC , D and E are points on BC and AC , respectively, such that $BD = 2DC$ and $AE = 3EC$. Let P be the point of intersection of AD and BE . Find BP/PE using the vector method.



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6. Prove, by vector method or otherwise, that the point of intersection of the diagonals of a trapezium lies on the line passing through the midpoint of the parallel sides (you may assume that the trapezium is not a parallelogram).



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7. about to only mathematics



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8.

Let

$$\vec{A}(t) = f_1(t)\hat{i} + f_2(t)\hat{j} \text{ and } \vec{B}(t) = g_1(t)\hat{i} + g_2(t)\hat{j}, t \in [0, 1], f_1, f_2, g_1, g_2$$

are continuous functions. If $\vec{A}(t)$ and $\vec{B}(t)$ are non-zero vectors for all

$$t \text{ and } \vec{A}(0) = 2\hat{i} + 3\hat{j}, \vec{A}(1) = 6\hat{i} + 2\hat{j}, \vec{B}(0) = 3\hat{i} + 2\hat{j} \text{ and } \vec{B}(1) = 2\hat{i} + 3\hat{j}$$

Then, show that $\vec{A}(t)$ and $\vec{B}(t)$ are parallel for some t .



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Fill In The Blanks

1. If $a, b,$ and c are all different and if

$$\begin{vmatrix} a & a^2 & 1 + a^3 \\ b & b^2 & 1 + b^3 \\ c & c^2 & 1 + c^3 \end{vmatrix} = 0 \text{ Prove that } abc = -1.$$

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2. If the vectors $a\hat{i} + \hat{j} + \hat{k}, \hat{i} + b\hat{j} + \hat{k}, \hat{i} + \hat{j} + c\hat{k}$ ($a \neq 1, b \neq 1, c \neq 1$) are coplanar then the value of $\frac{1}{1-a} + \frac{1}{1-b} + \frac{1}{1-c}$ is (A) 0 (B) 1 (C) -1 (D) 2

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True Or False

1. The points with position vectors $\vec{x} + \vec{y}, \vec{x} - \vec{y}$ and $\vec{x} + \lambda\vec{y}$ are collinear for all real values of λ .

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